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Operating instructions

 The unit complies with the corresponding EC guidelines.

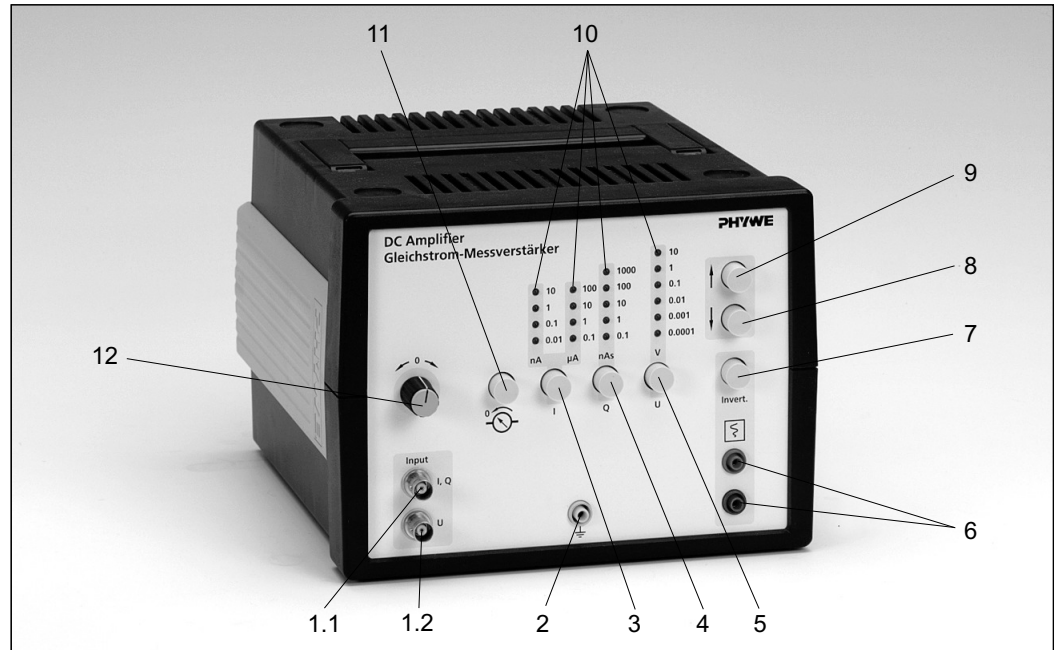


Fig. 1: Front view of the DC Measuring Amplifier 13620.93.

1 SAFETY PRECAUTIONS



Carefully read these operating instructions completely before operating this instrument. This is necessary to avoid damage to it, as well as for user-safety.

- Check that your mains supply voltage corresponds to that given on the type plate fixed to the instrument.
- Install the instrument so that the on/off switch and the mains connecting plug are easily accessible.
- Do not cover the ventilation slots.
- Take care that no liquids or objects enter in through the ventilation slots.
- Only use the instrument in dry rooms in which there is no risk of explosion.
- Do not start up this instrument should there be visible signs of damage to it or to the line cord.
- Only use the instrument for the purpose for which it was designed.

2 PURPOSE AND DESCRIPTION

The DC Measuring Amplifier is a versatile instrument for the measurement of very low DC currents, for the measurement of charges - in particular in experiments on electrostatics - and also for the quasi-static measurement of direct voltages. The selection of the 19 measurement ranges is made using buttons. A matrix of light emitting diodes indicates the active measurement range. An output voltage of 10 V corresponds to a full scale deflection. Any voltmeter, recorder or computer

measurement system (COBRA) can be used for the display.

3 OPERATION

3.1 Initial operation

The DC Measuring Amplifier is connected to the AC mains using the equipment connecting lead supplied with the instrument. Please ensure that the mains voltage agrees with the operating voltage details shown on the type plate. The rectangular fuse holder situated above the equipment connection plug can only be opened with the aid of a screwdriver or similar tool when the mains lead is withdrawn.

The mains switch is located at the back of the unit. The instrument is ready for operation immediately after being switched on.

In order that the measurement accuracy can be maintained, a warm-up time of about 5 minutes should be allowed before taking measurements.

3.2 Functional and operating elements

The unit is held in an impact-resistant plastic housing. The cover plate of the housing has a carrying handle that can be swung upwards. The base plate has a similar handle, which can be swung out to enable the instrument to stand in an inclined position. Four rubber feet ensure slip-resistance and stability. The instrument can be stacked on other instruments having the same type of housing, whereby the rubber feet stand in the pan-shaped hollows of the instrument below for increased security against displacement. When units are stacked, the sloped position is only permissible for the top-most unit.

All other functional elements and controls are located on the front panel (Fig. 1).

1.1 BNC socket INPUT I, Q

for connecting the measurement circuit in the operating modes for current and charge measurement. The outer pole is connected with the equipment ground and the protective earth.

1.2 BNC socket INPUT U

for connecting the measurement circuit in the operating mode for voltage measurement. The outer pole is connected with the equipment ground and the protective earth.

2 Earthing socket

is connected with the earth lead via the line cord.

3 Button I

for switching into the operating mode "Current measurement".

4 Button Q

for switching into the operating mode "Charge measurement".

5 Button U

or switching into the operating mode "Voltage measurement".

6 Pair of sockets OUTPUT

for the connection of an instrument with a range 10 VDC range. The internal voltage limit becomes active at an output voltage of about 10.5 V - i.e. the output voltage then does not correspond to the measurement.

7 Button INVERT

for inverting the output signal.

8 Button

for reducing the measurement range in all operating modes.

9 Button

for increasing the measurement range in all operating modes.

10 Light emitting diode matrix

for indicating the operating mode and the measurement range.

11 Button

for discharging the input in the operating mode "Q". The input remains short-circuited for approximately one second after the button is released.

12 Control knob

for the electrical adjustment of the zero point.

The adjustment should be carried out with an open input (10 nA range) in the "I" operating mode and with a short-circuited input [1.1] (button 11 pressed) in the "Q" operating mode. In the "U" operating mode the input [1.2] should be short-circuited. When changing to more sensitive ranges, the zero-point adjustment should be corrected if necessary.

3.3 General

The instrument has been designed for direct voltage signals. Alternating voltage signals, even those of a low amplitude, could destroy it. Measurements in the more sensitive ranges may be subject to interference from electrostatic charges and induction voltages. The following precautions can reduce these effects:

- The use of screened leads.
- Experiments are conducted on a conductive, earthed base.
- Avoid movement in the complete area around the experimental apparatus during the measurement.

The buttons (8) and (9) for the selection of the measurement range only respond when they are briefly held down. With continuous pressure on the button (> 0.5 s) the measurement range changes consecutively and continuously.

3.4 Current measurement

The instrument has an extremely low voltage drop of only 0.5 mV on all current measurement ranges. When connecting the measurement circuit, it should be ensured that the outer pole of the BNC socket is grounded. The instrument cannot, for example like a portable multimeter, be connected at any point in a circuit.

The resistance of the external circuit must have a certain minimum value so that the amplifier operates precisely. The minimum values depend on the selected measurement range and are given under "Technical specifications". If values below these are present, then a zero offset is produced and the stated measurement accuracy is not achieved.

In spite of the low internal resistance, the amplifier is very effectively protected against overload even in the current measurement operating mode. Provided the voltage dropped across the input does not exceed 250 VDC, then no damage will occur.

3.5 Voltage measurement

In the voltage measurement operating mode the input [1.2] has an extremely high resistance of more than $10^{11} \Omega$. For precise measurements it is assumed that the source resistance is at least a factor 1000 lower, i.e. $10^8 \Omega$ or less.

With an open-circuit input it is unavoidable that the input will charge up as a result of the minimal amount of current flowing out of the input of the operational amplifier. An instrument connected to the output will therefore show a reading. The input [1.2] should be briefly short circuited before each voltage measurement in order to check the zero point. With the input short circuited the instrument connected to the output should indicate zero. If this is not the case, the output voltage must be set to zero with the control knob (12).

(Zero-point balancing in the 10 nA current measurement range (see above) also produces a sufficiently accurate zero point for the "U" operating mode.)

Voltage measurements are also possible in the charge measurement operating mode (see section 3.6). With this type of voltage measurement, the response time is delayed, which can be useful for suppressing interference signals.

3.6 Charge measurement

This operating mode corresponds to a large extent to the voltage mode with the difference that a high quality measuring capacitor of 100 nF is connected in parallel to the input. In this way the charge measurement ranges of 1000 nAs...0.1nAs are created from the voltage ranges of 10 V...1 mV.

For the measurement of the charge on a capacitor, the capa-

ditor is connected to the previously discharged input (button 11) of the amplifier. The capacitance should now have been disconnected from the voltage source used for the charging process. The charge can be read off directly.

The measurement method assumes that the charge is completely transferred from the capacitor C, which is under investigation, to the measuring capacitor C0 in the input of the amplifier. This is the case for all electrostatic experiments involving conductors where $C \ll C_0$. If this condition is not satisfied, then the actual charge Q can be calculated from the measured charge Q' as follows:

$$Q = \left(1 + \frac{C}{C_0}\right) \cdot Q'$$



Important!

The maximum voltage 250 VDC on the amplifier input should also not be exceeded in this operating mode. A particular risk is present with electrostatic experiments involving high voltage power supplies. It is essential that the conductor to be measured is isolated from the voltage source used for charging before it contacts the amplifier input. Otherwise damage to the instrument cannot be avoided!

The charge measurement operating mode can also be used for the measurement of voltages. Depending on the characteristics of the experimental circuit, the response time is delayed due to the parallel capacitor. This may be desirable for the suppression of interference. Furthermore, the internal resistance is greater by a factor of 50 in the "Q" operating mode.

The charge measurement ranges 1000 nAs...0.1 nAs correspond to the voltage measurement ranges of 10 V...1 mV. (The most sensitive voltage measurement range 100 µV is only available in the voltage measurement operating mode.)

4 NOTES ON OPERATION

This high-quality instrument fulfills all of the technical requirements that are compiled in current EC guidelines. The characteristics of this product qualify it for the CE mark.

This instrument is only to be put into operation under specialist supervision in a controlled electromagnetic environment in research, educational and training facilities (schools, universities, institutes and laboratories).

This means that in such an environment, no mobile phones etc. are to be used in the immediate vicinity. The individual connecting leads are each not to be longer than 2 m.

The instrument can be so influenced by electrostatic charges and other electromagnetic phenomena that it no longer functions within the given technical specifications. The following measures reduce or do away with disturbances:

Avoid fitted carpets; ensure potential equalization; carry out experiments on a conductive, earthed surface, use screened cables, do not operate high-frequency emitters (radios, mobile phones) in the immediate vicinity.

5. TECHNICAL SPECIFICATIONS (typical for 25°C)

Operating temperature range 5...40°C

Relative humidity < 80%

General

Inputs	BNC sockets
Overload protection	± 250 VDC in all operating modes [No alternating voltage signals are permitted]
Output	Pair of 4 mm safety sockets
Voltage	0...10 V
Output resistance	1 kΩ
Overload protection	short-circuit proof

Current measurement

Measurement ranges	100 µA, 10 µA,...10 pA (8 ranges)
Accuracy	typical ≤ 3%
Zero-point drift	typical ≤ 0.5%/K
Voltage drop	typical ≤ 0.5 mV

Minimum external resistance

Range:	
100 µA	100 Ω
10 µA	1 kΩ
1 µA	10 kΩ
100 nA	100 kΩ
10 nA	1 MΩ
1 nA	10 MΩ
100 pA	100 MΩ
10 pA	1 GΩ

Voltage measurement

Measurement ranges	10 V, 1 V,...100 µV (6 ranges)
Accuracy	typical ≤ 3% (ranges 10 V...1 mV) typical ≤ 5% (range 100 µV)
Zero-point drift	typical ≤ 1%/K (ranges 10 V...1 mV) typical ≤ 2%/K (range 100 µV)
Eingangswiderstand	> 10 ¹¹ Ω

Charge measurement

Measurement ranges	1000 nAs, 100 nAs,...0,1 nAs (5 ranges)
Accuracy	typical ≤ 3%
Measurement capacitor	100 nF ±1%
Insulation resistance	> 5 · 10 ¹² Ω
Self-charge rate	typical < ±12 pAs/min

Mains supply

The instrument corresponds to protection class I. It is only to be connected to a socket with an earth lead connection.

Connecting voltage (+6%/-10%)	see type plate
Mains frequency	50/60 Hz
Power consumption	10 VA
Mains fuse (5 mm x 20 mm)	see type plate
Housing dimensions (mm)	230 x 168 x 236 (W, H, D)
Weight	approx. 3 kg

6 NOTES ON THE GUARANTEE

We guarantee the instrument supplied by us for a period of 24 months within the EU, or for 12 months outside of the EU. Excepted from the guarantee are damages that result from disregarding the Operating Instructions, from improper handling of the instrument or from natural wear.

The manufacturer can only be held responsible for the function and technical safety characteristics of the instrument, when maintenance, repairs and alterations to the instrument are only carried out by the manufacturer or by personnel who have been explicitly authorized by him to do so.

7 WASTE DISPOSAL

The packaging consists predominately of environmentally compatible materials that can be passed on for disposal by the local recycling service.



Should you no longer require this product, do not dispose of it with the household refuse. Please return it to the address below for proper waste disposal.

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