

Charge and Discharge Apparatus

1017781 (230 V, 50/60 Hz)

1017780 (115 V, 50/60 Hz)

Instruction manual

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|---|-----------------------------------|---|---|
| 1 | Charge/discharge function switch | 5 | Digital counter display |
| 2 | Terminals for external resistor | 6 | Switch for selecting level of reference voltage |
| 3 | Terminals for external capacitor | 7 | Selector switch for R/C pair |
| 4 | Terminal for plug-in power supply | 8 | Reset button for digital counter |

1. Safety instructions

The charge and discharge apparatus conforms to safety regulations for measuring instruments, control systems and laboratory equipment as specified in DIN EN 61010 part 1. It is designed for use in dry rooms suitable for operation of electrical equipment.

Safety of the equipment can be guaranteed as long as it is used as stipulated. Safety is not, however, assured if the equipment is not used properly or is handled carelessly.

If it may be concluded that it is no longer safe to use the equipment without risk (e.g. if there is visible damage to it), it should be withdrawn from use immediately.

- Only use the equipment in dry rooms.
- Only use with the plug-in power supply provided.

2. Description

The charge and discharge apparatus is designed for recording points along a charging and discharging curve for three built-in resistor-capacitor pairings or similar external pairings. It can also be used to determine the values of the resistors and capacitors used. The equipment consists of a voltage comparator, a digital counter for measuring the charging or discharging time and three internal resistor-capacitor pairs.

The voltage comparator compares the charging or discharging voltage across the capacitor with a reference voltage, which can be pre-set to any of 11 levels from 0.5 V to 9.5 V.

Once the function switch is set to START-CHARGE or DISCHARGE, the digital counter starts counting until the set reference voltage is reached, at which point it stops. Prior to this, the digital counter is set to zero by means of the RESET button. If it is not reset, the counter works by adding times together.

Three RC pairs can be formed from the three built-in resistors and the internal capacitor, selected via INTERN 1, INTERN 2 and INTERN 3. There is also an EXTERN setting which connects the voltage comparator to the terminals for external resistors and capacitors.

Charge and discharge apparatus 1017781 is provided with a plug-in power supply for 230 V ($\pm 10\%$), whereas model 1017780 has one for 115 V ($\pm 10\%$).

3. Technical data

Internal capacitor:	2000 μF $\pm 10\%$
Internal resistors:	2.2 k Ω , 5.1 k Ω , 10 k Ω
Voltage U_0 :	10 V
Digital counter:	4-digit, quartz-controlled, 1 place of decimal
Maximum time:	200 s
Resolution:	100 ms
Power supply:	Plug-in supply, 12 V AC, 2000 mA
Dimensions:	260 x 220 x 55 mm
Weight (incl. power supply)	1700 g

4. Accessories

For carrying out measurements on external resistors and capacitors, the following plug-in components are recommended:

Capacitor, 1000 μF	1017806
Resistor, 4.7 k Ω	1012920
Resistor, 10 k Ω	1012922
Resistor, 22 k Ω	1012924

5. General instructions

When the selector switch is set to INTERN 1, INTERN 2 or INTERN 3, the internal capacitor will be connected to the terminals used for an external capacitor.

- Do not connect an external capacitor when carrying out measurements on the internal RC pairs.

The charging and discharging times measured are affected by bounce periods, which can be made worse if the charge/discharge switch is turned tentatively.

- Always turn the switch quickly.
- To determine the time more accurately, it may be advisable to carry out each measurement at least three times and take the average.
- Only choose external RC pairings which have a time constant $R \cdot C > 4 \text{ s}$.

6. Operation

6.1 Turning on

- Connect the charge and discharge apparatus to the mains via the plug-in power supply provided.

6.2 Measurements on internal resistor-capacitor pairs

- Remove any external resistors or capacitors.
- Set the selector knob to INTERN 1, INTERN 2 or INTERN 3.

6.3 Measurements on external resistor-capacitor pairs

- Plug an external resistor and capacitor into the relevant terminals.
- Set the selector knob to EXTERN.



Fig. 1 Measurement on an external resistor-capacitor pair

6.4 Measurement of charging time

- Set the function switch to CHARGE – STOP.
- Set the reference level selector to the required voltage.
- Briefly press the the RESET button to reset the digital counter to zero.
- Set the function switch to CHARGE – START, to start charging and measurement of time.
- Make a note of the time measured as soon as the counter stops.

6.5 Measurement of discharging time

- Follow a similar procedure as for the charging curve, except that the function switch should be set to DISCHARGE – STOP and then DISCHARGE – START.

7. Experiments

7.1 Plotting of charging curve

- Set the voltage level selector to 0.5 V and determine the charging time as specified under 6.4.
- To measure the time for the next value, turn the selector switch up to the next level and repeat each step of the procedure.

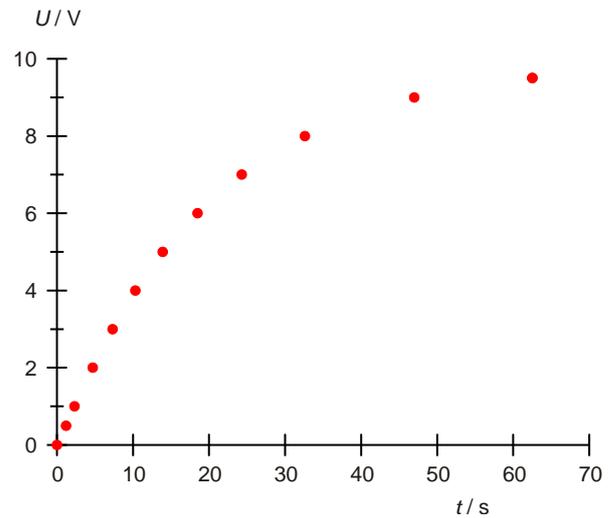


Fig. 2 Charging curve for built-in RC pair no. 3

7.2 Plotting of discharging curve

- Set the voltage level selector to 9.5 V and determine the discharging time as specified under 6.5.
- To measure the time for the next value, turn the selector switch down to the next level and repeat each step of the procedure.

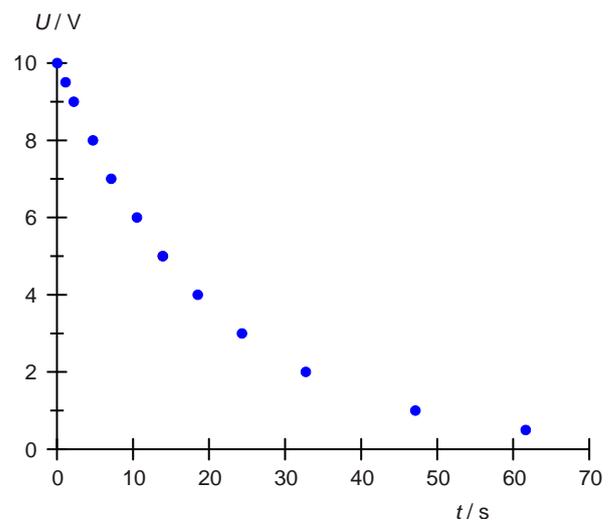


Fig. 3 Discharging curve for built-in RC pair no. 3

7.3 Determining the values of the capacitors and resistor being used

Theoretically the discharging time τ_{DC} for 0.5 V and the charging time τ_C for 9.5 V are identical. In both cases, the following applies:

$$\tau_C = \tau_{DC} = t_{5\%} = -C \cdot R \cdot \ln(20) \approx 3 \cdot C \cdot R.$$

If either R or C is known, then the other value can be calculated from τ . It is possible to obtain greater accuracy for τ by the following means:

- Measure the discharge time τ_{DC} for 0.5 V three times and take the average of the results.
- Measure the charging time τ_C for 9.5 V three times and take the average of the results.
- Take the average $t_{5\%} = \frac{1}{2}(\tau_C + \tau_{DC})$ of the average values for charging and discharging.

7.4 Determining the capacitance C of an external capacitor

- Plug in a known resistor R_e of no less than 10 k Ω along with the capacitor for which the capacitance C_e is to be determined
- Set the selector switch to EXTERN.
- Measure the time $t_{5\%}$ as specified under 7.3.
- Calculate the capacitance of the external capacitor: $C_e = \frac{t_{5\%}}{3 \cdot R_e}$

7.5 Determining the capacitance C_i of the internal capacitor

- Set the selector switch to INTERN 3.
- Measure the time τ_1 as specified under 7.3.
- Plug in an external capacitor C_e .
- Measure the time τ_2 as specified under 7.3.

The following is now true:

$$\tau_1 = 3 \cdot C_i \cdot R_3, \quad \tau_2 = 3 \cdot (C_i + C_e) \cdot R_3$$

$$\text{Therefore: } \frac{\tau_2}{\tau_1} = \frac{C_i + C_e}{C_i} = 1 + \frac{C_e}{C_i}$$

$$\text{or } \frac{C_i}{C_e} = \frac{\tau_1}{\tau_2 - \tau_1}$$

7.6 Determining the values of the internal resistors

- Set the selector switch to INTERN 1, INTERN 2 or INTERN 3.
- Measure the time $t_{5\%}$ as specified under 7.3.
- Calculate the resistance of the respective internal resistor: $R_i = \frac{t_{5\%}}{3 \cdot C_i}$.

8. Storage, cleaning and disposal

- Keep the equipment in a clean, dry and dust-free place.
- Always disconnect the equipment from the mains before cleaning.
- Do not use aggressive cleaning agents or solvents to clean the equipment.
- Use a soft damp cloth for cleaning.
- Packaging should be disposed of at a local recycling facility.
- Should you need to dispose of the equipment itself, never throw it away in normal domestic waste. Local regulations for the disposal of electrical equipment will apply.

