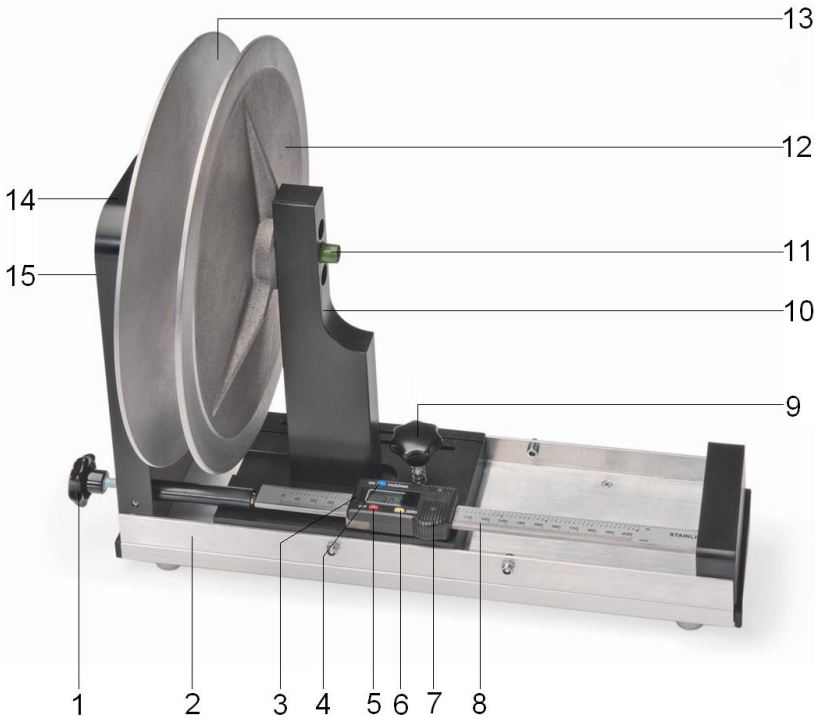
Plate Capacitor D 1006798

Instruction sheet

10/15 SP/TL/ALF



1 Fine adjustment screw
2 Guide rail
3 Measuring unit
4 Switch for changing measuring unit from mm to inches
5 On-off switch for measuring unit display
6 Zero configuration button for measuring unit
7 Battery compartment for measuring unit (button/watch battery)
8 Scale for measuring unit
9 Fastening screw
10 Guide block
11 Connector socket
12 Movable capacitor plate
13 Fixed capacitor plate
14 Stator
15 Connector socket

1. Safety instructions

Caution: the capacitor plates are not electrically isolated. Voltages may be present which are dangerous to the touch.

- When working with voltages which may be dangerous if you come into contact with them, you should make sure to take the appropriate safety measures.
- Do not touch the device during the experiment.
- For voltages which are referenced to ground, apply the reference potential to the movable capacitor plate.
- Avoid voltage arcs between the plates.

In schools and educational institutions, operation of the device must be monitored by a trained supervisor.

2. Description

The plate capacitor is designed for investigating the relationship between charge and voltage, for quantitative measurement of capacitance as a function of the plate separation, measurement of dielectric ε and for accurately determining the permittivity of free space (electric field constant) ε_0.

The apparatus features one fixed and one movable plate. The latter can be along with its guide block (10) by any distance between 0 and 160 mm and can be further adjusted by between 0 and 20 mm by means of a fine adjustment screw (1). The display of an electronic measuring unit shows the distance between the two capacitor plates. The displayed value can be configured to zero at any point along the path of travel and will then display the distance of the moveable plate from this new zero point. The separation between the plates can be read off to an accura-

cy of 1/10 mm. A switch (5) can turn the display of the measuring unit on or off, while the actual measurement acquisition continues. Another switch (4) switches the units for the display between mm and inches.

3. Technical data

Plate surface area:	500 cm^2
Plate thickness:	3 mm
Plate spacing:	0 – 160 mm
Accuracy:	1/10 mm
Measuring unit:	Electronic 0….160 mm
Battery for measuring unit:	LR44
Dimensions:	400 x 260 x 340 mm^3
Weight:	4 kg approx.

4. Operation

4.1 General notes

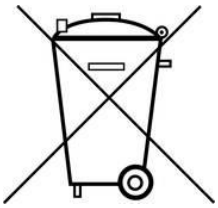
Never hold the plate capacitor apparatus other than by the guide rail (2) and the stator (14).

Conducting deposits on insulating plastic parts of the capacitor plates could lead to errors in measurements.

- Before use, clean the apparatus with a dry, microfibre cloth.
- Protect the guide rail (2) from dirt and dust. If necessary, you should clean it using a thin brush or cloth.
- After use, close the plates together and secure them with the fastening screw (9) for storage.
- Store the apparatus in a dry, dust –free location.

If the plate capacitor apparatus has not been used for a long period, it is possible to remove the watch battery from the measuring unit.

- Do not dispose of the battery in the regular household garbage. Follow the local regulations (In Germany: BattG; EU: 2006/66/EG).



4.2 Preparation

- Perform the experiment on a level surface where the apparatus cannot tip over.
- Make sure the wires to the plates are as short as possible.
- Before using the measuring unit, configure the display to zero with the two plates closed together. Push the movable plate gently against the fixed stator plate and then press the zero configuration button (6).

The fine adjustment screw is to aid with precise adjustment of the distance when the separation between the plates is small. The guide block (10) should also be gently pressed against the adjustment screw.

5. Sample experiment

Measurement of electric field constant ε_0

The following equipment is also required to complete the experiment:

1 Function generator, FG 100 @230 V	1009957
or	
1 Function generator, FG 100 @115 V	1009956
1 Precision resistor, 10 kΩ	1000685
1 Analogue oscilloscope 2x 30 MHz	1002777
1 HF patch cord, BNC/4 mm plug	1002748
Leads for experiments	

- Set up the experiment as shown in Fig. 2.
- Charge up the plate capacitor via the resistor at regular intervals using the function generator (square wave voltage). The frequency should be between 10 and 50 kHz.

Due to the capacitance C of the plate capacitor, the current (measured via the voltage across the resistor U_R) during charging and discharging exhibits a periodic exponential curve over time and is characterised by the time constant τ.

$$\tau = R \cdot C \qquad (1)$$

$$U_R(t) = U_0 \cdot e^{-t/\tau} \qquad (2)$$

- From the voltage traces on the oscilloscope, determine the time t_0 taken for the voltage to drop to half of the applied voltage.

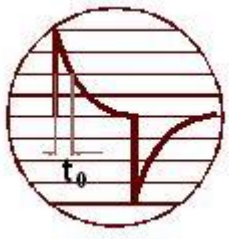


Fig. 1 Voltage curve as traced using an oscilloscope

$$C = \frac{t_0}{R \cdot \ln 2} \qquad (3)$$

- Calculate the capacitance *C* of the capacitor using equation 3.
- Calculate the field constant ε_0 from the capacitance *C*, the surface area of the plates *A* and the distance between the plates *d*.

$$C = \frac{\varepsilon_0 \cdot A}{d} \qquad (4)$$

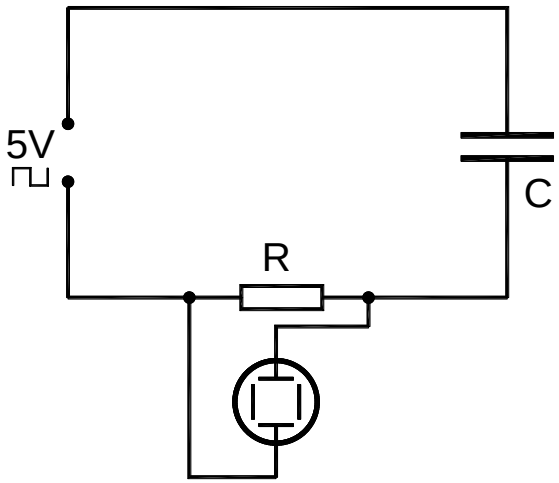


Fig. 2 Determining the permittivity of free space (or electric field constant) ε_0 from the charge/discharge function