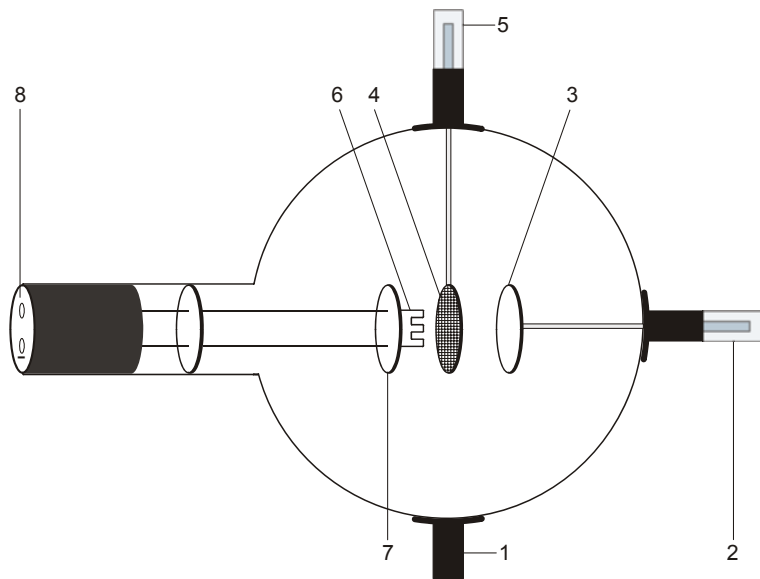


## Triode D 1000647

### Instruction sheet

05/12 ALF



- 1 Boss
- 2 4-mm plug for connecting anode
- 3 Anode
- 4 Grid
- 5 Boss with 4-mm plug for connecting grid
- 6 Heater filament
- 7 Cathode plate
- 8 4-mm sockets for connecting filament and cathode

### 1. Safety instructions

Hot cathode tubes are thin-walled, highly evacuated glass tubes. Treat them carefully as there is a risk of implosion.

- Do not subject the tube to mechanical stresses.
- Do not subject the connection leads to any tension.
- The tube may only be used with tube holder D (1008507).

If voltage or current is too high or the cathode is at the wrong temperature, it can lead to the tube becoming destroyed.

- Do not exceed the stated operating parameters.
- When the tube is in operation, the terminals of the tube may be at high voltages with which it is dangerous to come into contact.
- Only change circuits with power supply equipment switched off.
  - Only exchange tubes with power supply equipment switched off.

When the tube is in operation, the stock of the tube may get hot.

- Allow the tube to cool before dismantling.

The compliance with the EC directive on electromagnetic compatibility is only guaranteed when using the recommended power supplies.

### 2. Description

The triode allows basic experiments to be performed using the Edison effect (thermionic effect), determining the negative charge of electrons, recording triode characteristics and generating cathode rays (model of an electron gun). It also allows investigating the technical application of a triode as an amplifier and generating undamped oscillations in LC circuits.

The triode is a highly evacuated tube with a pure tungsten heater filament (cathode) and a round metal plate (anode) with a wire grid between them, all inside a clear glass bulb. The cathode, anode and grid are all aligned parallel to one another. This planar configuration corresponds to the conventional symbol for a triode. A circular metal plate attached as a backing to the filament ensures that the electric field between the anode and cathode is uniform.

### 3. Technical data

Filament voltage:	7.5 V max.
Filament current:	3 A approx.
Anode voltage:	500 V max.
Anode current:	$U_A$ 400 V and $U_F$ 6.3 V $U_G$ 0 V, $I_A$ 0.4 mA approx. $U_G$ +8 V, $I_A$ 0.8 mA approx. $U_G$ -8 V, $I_A$ 0.04 mA approx.
Grid voltage:	$\pm 10$ V max.
Glass bulb:	130 mm diam. approx.
Total length:	300 mm approx.

### 4. Operation

To perform experiments using the triode, the following equipment is also required:

1 Tube holder D	1008507
1 DC power supply 500 V (115 V, 50/60 Hz)	1003307
or	
1 DC power supply 500 V (230 V, 50/60 Hz)	1003308
1 Analogue multimeter AM51	1003074
Additionally recommended: Protective Adapter, 2-Pole	1009961

#### 4.1 Setting up the tube in the tube holder

- The tube should not be mounted or removed unless all power supplies are disconnected.
- Push the jaw clamp sliders on the stanchion of the tube holder right back so that the jaws open.
- Push the bosses of the tube into the jaws.
- Push the jaw clamps forward on the stanchions to secure the tube within the jaws.
- If necessary plug the protective adapter onto the connector sockets for the tube.

#### 4.2 Removing the tube from the tube holder

- To remove the tube, push the jaw clamps right back again and take the tube out of the jaws.

### 5. Example experiments

#### 5.1 Generation of charge carriers by a hot cathode (thermionic effect) and determining the polarity of the charge carriers so emitted

- Set up the circuit as in Fig. 1. Connect the minus pole of the anode voltage to the 4-mm socket marked with a minus.
- Set the anode voltage  $U_A$  to 400 V.

When the grid voltage  $U_G$  is 0 V the anode current is about 0.4 mA.

- Set the grid voltage to +10 V resp. -10 V.
- If the voltage of the grid is positive with respect to the anode, the anode current  $I_A$  is considera-

bly increased. If the grid is negative with respect to the cathode the anode current decreases.

A heater filament generates charge carriers. Current flows between the cathode and the anode. The charge carriers must be of negative polarity because when the grid is negative with respect to the cathode the flow of current decreases and when it is positive, the flow of current increases.

#### 5.2 Recording triode characteristics

- Set up the circuit as in Fig. 1. Connect the minus pole of the anode voltage to the 4-mm socket marked with a minus.
- $I_A - U_A$  characteristics: for constant grid voltages, determine the anode current as a function of the anode voltage and plot the values in a graph (refer to Fig. 2).
- $I_A - U_G$  characteristics: for constant anode voltages, determine the anode current as a function of the grid voltage and plot the values in a graph (refer to Fig. 2).

#### 5.3 Generating cathode rays

- Set up the circuit as in Fig. 3 so the grid and cathode form a diode. Connect the minus pole of the anode voltage  $U_A$  to the 4-mm socket marked with a minus.
- Raise the anode voltage  $U_A$  from 10 V to 80 V and measure the current flowing at the anode.

The current decreases at higher voltages since the positive potential of the grid causes it to capture electrons causing an increase in the current passing through the grid itself. Voltages greater than 100 V can lead to the destruction of the grid.

Electrons accelerated by higher potentials between the grid and the cathode can be detected beyond the grid (cathode rays). Increasing the voltage leads to higher currents which indicates a greater number of electrons being accelerated.

#### 5.4 Triode amplifier

Also required:

1 AC/DC power supply 12 V (115 V, 50/60 Hz)	1001006
or	
1 AC/DC power supply 12 V (230 V, 50/60 Hz)	1001007

1 Resistor 1 M $\Omega$

1 Oscilloscope

- Set up the circuit as in Fig. 4. Connect the minus pole of the anode voltage to the 4-mm socket marked with a minus.
  - Apply an anode voltage  $U_A$  of about 300 V.
- The oscilloscope is used to demonstrate the amplification in the signal across the resistor.
- Repeat the experiment using a variety of resistors.

Lower AC voltages at the grid lead to greater changes in voltage across a resistor connected in circuit with the anode. The amplification gain increases with the size of the resistor.

## 5.5 Generation of undamped LC oscillations

Also required:

- |                               |         |
|-------------------------------|---------|
| 1 Helmholtz pair of coils D   | 1000644 |
| 2 Barrel foot                 | 1002834 |
| 1 Capacitor 250 pF or 1000 pF |         |
| 1 Oscilloscope                |         |

**Warning! When the anode voltage is switched on, the metal parts of the coils are live. Do not touch!**

- Only change circuits with power supply equipment switched off.
- Set up the circuit as in fig. 5.
- Place the coils side by side as near one another as possible.

- Apply an anode voltage  $U_A$  of about 300 V.
- Observe the undamped oscillations on the screen of the oscilloscope.
- Rotate one of the coils to demonstrate that the occurrence and amplitude of the oscillations depends on the relative position of the two coils. Touch the coils only at the insulated parts!
- Vary the anode voltage  $U_A$  between 100 and 500 V and observe that the amplitude of the oscillations does not increase in direct proportion to  $U_A$ .
- Carry out an experiment of the same kind without capacitors so that the capacitance of the oscillating circuit is formed only by the self capacitance of the conductor.

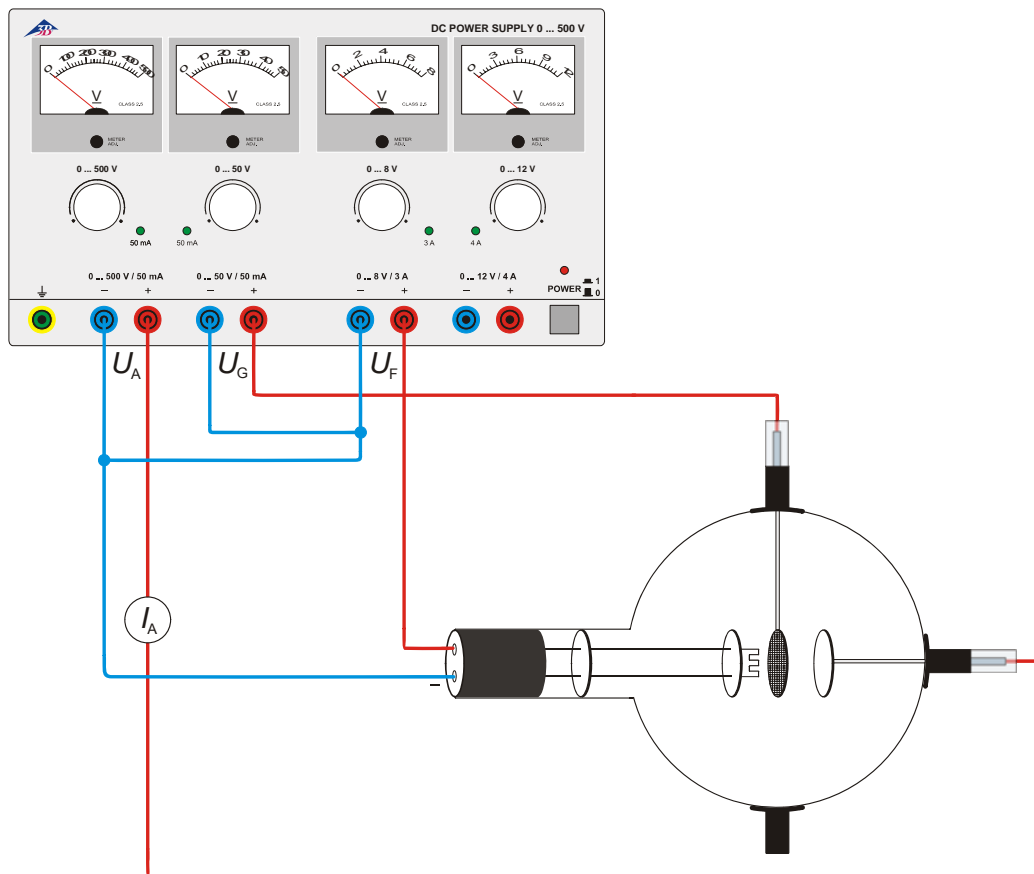


Fig. 1 Demonstration of anode current and determination of the polarity of the charge carriers

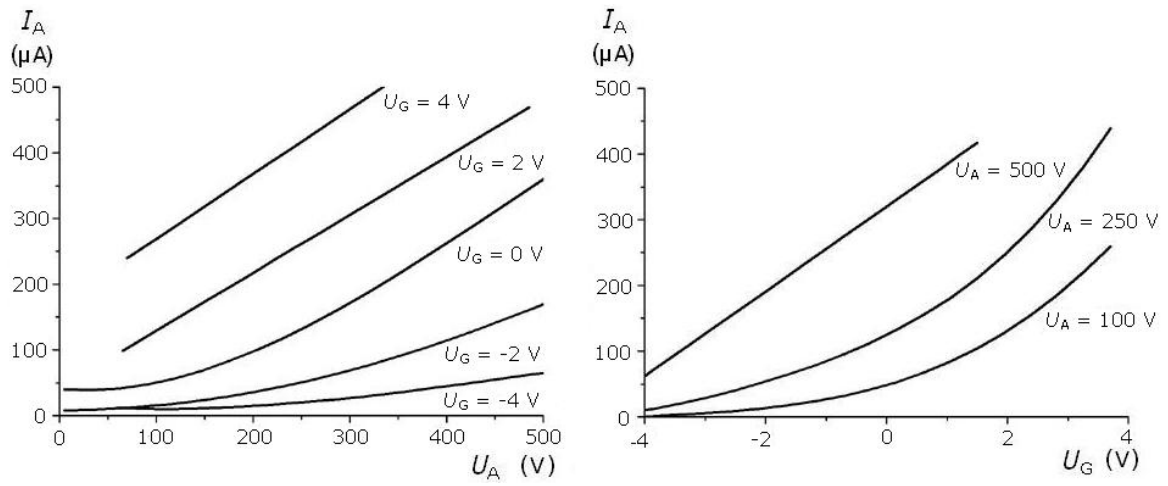


Fig. 2 Triode characteristics

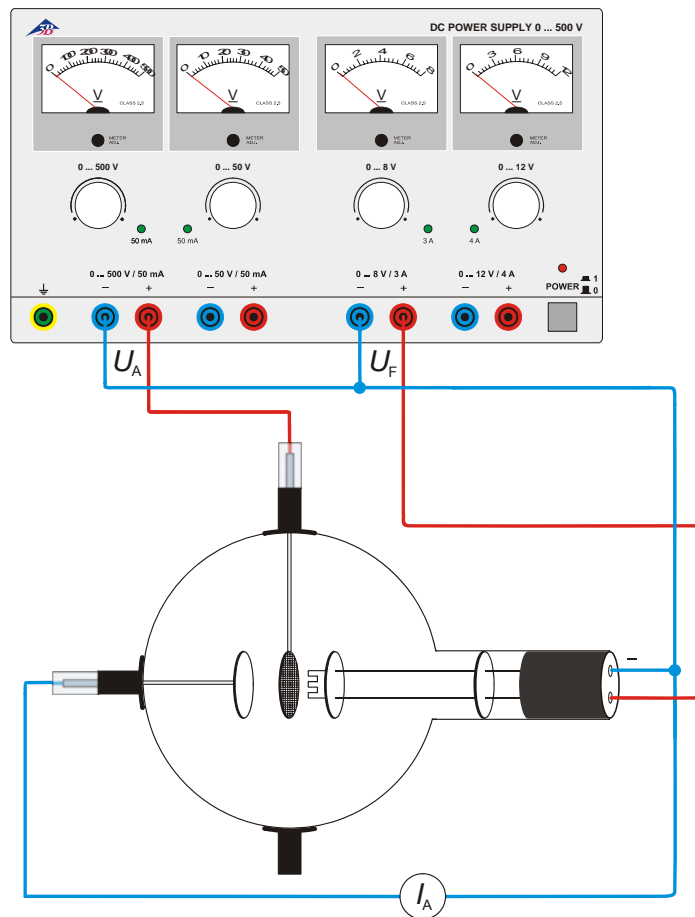


Fig. 3 Generating cathode rays

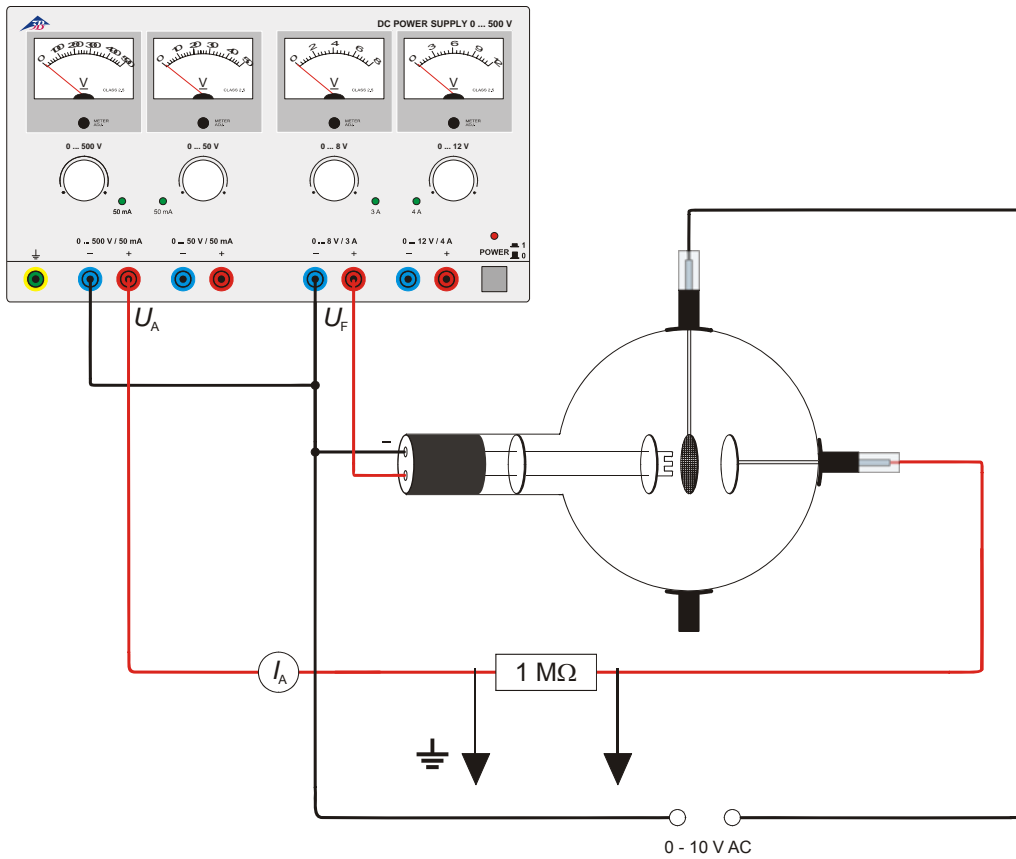


Fig. 4 Triode amplifier

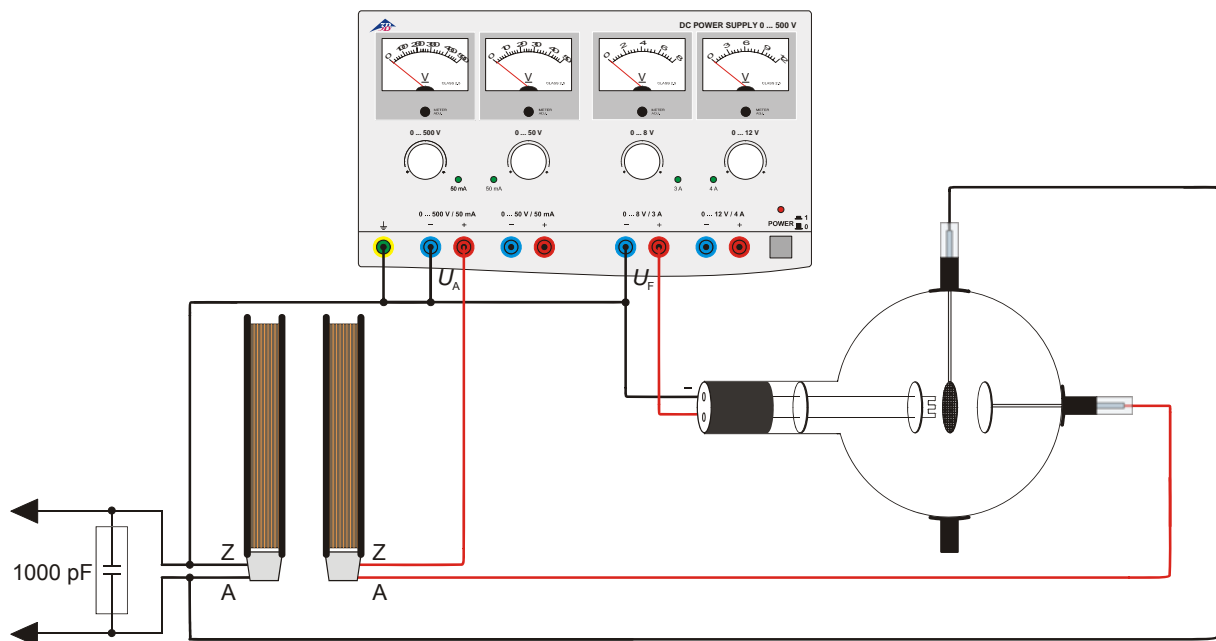


Fig. 5 Generation of undamped LC oscillations

