Electricity

Electromagnetic oscillations and waves
Propagation of microwaves along lines

LD Physics Leaflets

P3.7.5.2

Qualitative demonstration of guiding of microwaves along a metal waveguide

Objects of the experiments

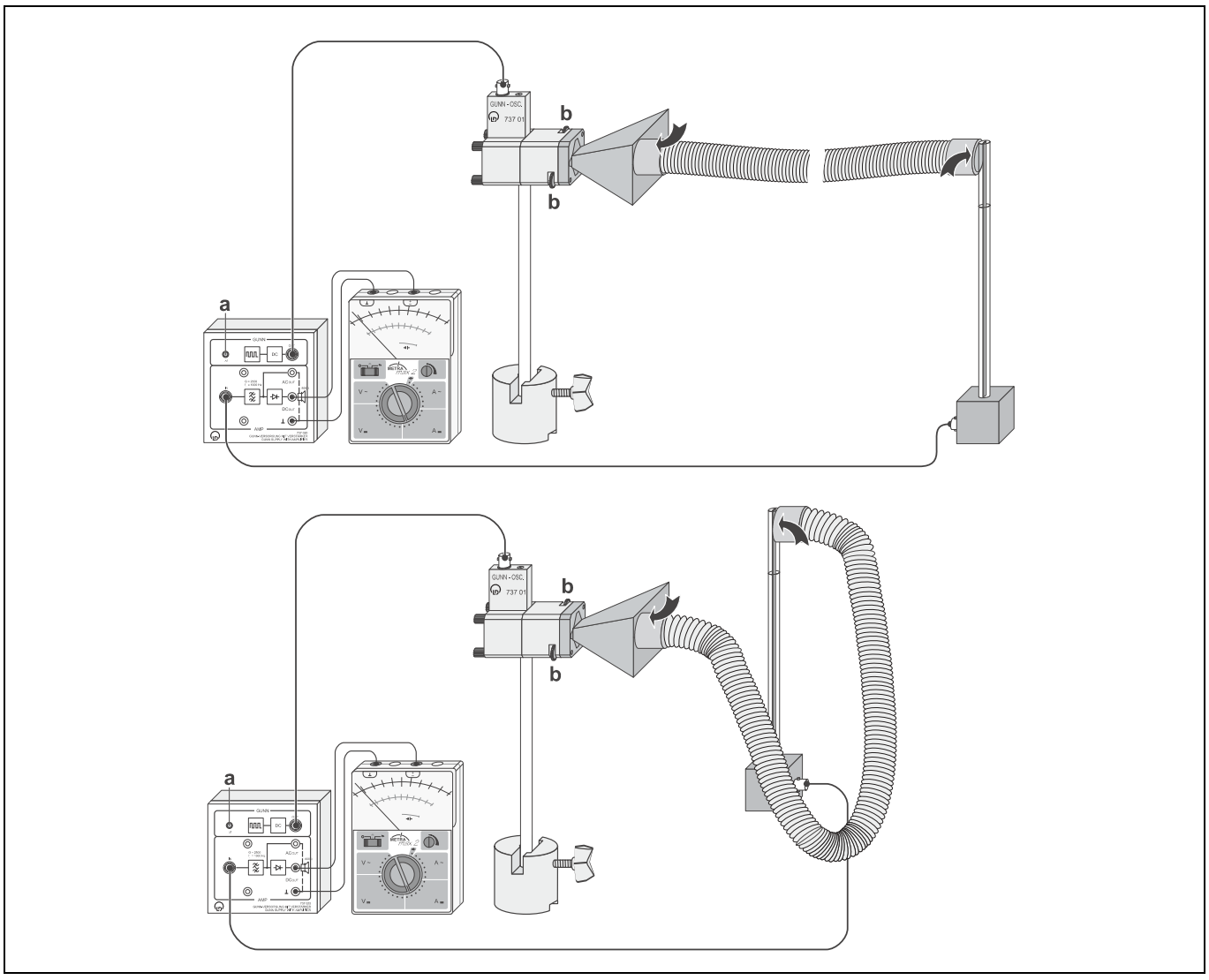
- Demonstrating the almost loss-free guiding of microwaves along a metal waveguide.
- Demonstrating the “bent” guiding of microwaves along a bent metal waveguide to an arbitrary place.

Principles

Even strong beamed microwave fields diverge in the transverse direction when propagating in free space so that the field strength decreases with increasing distance in the direction of propagation. This disadvantage can be circumvented if the microwaves are guided, e.g., by a waveguide.

The waveguide is completely divided from the surrounding space by conductive walls and may have, e.g., a circular cross

Fig. 1 Experimental setup for guiding microwaves through a flexible metal waveguide



Apparatus

1 Gunn oscillator	737 01
1 large horn antenna	737 21
1 stand rod 245 mm, with thread	309 06 578
1 Gunn power supply with amplifier	737 020
1 E-field probe	737 35
1 physics microwave accessories I	737 27
1 voltmeter, DC, $U \leq 10$ V e.g.	531 100
1 saddle base	300 11
2 BNC cables, 2 m	501 022
1 pair of cables, 100 cm, black	501 461

Safety notes

Attention, microwave power! The microwave power released from the Gunn oscillator is approx. 10–15 mW, which is not dangerous to the experimenter. However, in order that students are prepared for handling microwave systems with higher power, they should practise certain safety rules.

- Never look directly into the transmitting horn antenna.
- Before positioning anything in the experimental setup, always disconnect the Gunn oscillator.

section. Inside the waveguide, electromagnetic waves with all wavelengths below a limiting wavelength λ_k can be transferred almost without any losses. If the walls are made of a flexible material, the waves can even be guided along a “bent path” to an “arbitrary” place in the room.

Setup

The experimental setup is illustrated in Fig. 1.

– Attach the Gunn oscillator to the horn antenna with the quick connectors **(b)**.
– Align the horn antenna horizontally, screw the 245 mm long stand rod into the corresponding thread and clamp it in a saddle base.
– Connect the Gunn oscillator to the output OUT via a BNC lead. Connect the E-field probe to the amplifier input and the voltmeter to the output DC OUT of the Gunn power supply.
– Set up the E-field probe in front of the centre of the horn antenna.
– Set the modulation frequency with the frequency adjuster **(a)** so that the multimeter displays maximum received signal.

Carrying out the experiment

– Set up the E-field probe in front of the horn antenna at a distance of approx. 1 m, and measure the received signal *U*.
– Hold one end of the flexible waveguide into the horn antenna at a depth of approx. 1 cm, hold the other end immediately in front of the E-field probe, and measure the received signal *U*.
– Take the E-field probe to a place beside the horn antenna where the received signal is about $U = 0$ V.
– Hold the flexible waveguide between the horn antenna and the E-field probe, and measure *U* again.
– Deform the waveguide arbitrarily and measure U once more.

Measuring example

E-field probe at a distance of approx. 1 m in front of the antenna:

$U = 0.2$ V without waveguide, $U = 9$ V with waveguide

E-field probe beside the antenna:

$U = 0$ V without waveguide, $U = 9$ V with waveguide

E-field probe at an arbitrary position:

$U > 6$ V if the waveguide is arbitrarily deformed

Evaluation and results

Guided by a waveguide, the transferred microwave power is much less dampened than in free space.

By means of a flexible waveguide, microwave power can be guided to any location.

LD DIDACTIC GmbH · Leyboldstrasse 1 · D-50354 Hürth · Phone (02233) 604-0 · Telefax (02233) 604-222 · E-mail: info@ld-didactic.de