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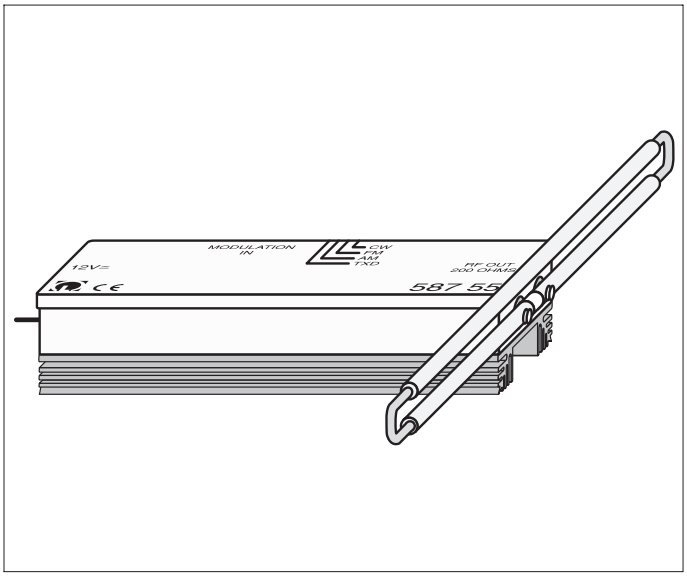


Instruction sheet 587 55

UHF Transmitter (587 55)
Lecher System with Accessories (587 56)
Set of Dipoles in Water Tank (587 54)

Electromagnetic compatibility

The UHF transmitter is classified as an educational device for studying electromagnetic phenomena. It is used to investigate the propagation of electromagnetic waves in space and on Lecher lines.

Experiment setups using the UHF transmitter may not always conform to the limit values of class A (group 2 of standard EN 55011). Such setups may cause interference in other devices in the experiment room of a school or educational institution; the proper function of devices situated outside of the experiment room is generally not affected. However, radio interference can occur up to a distance of several hundred meters.

The UHF transmitter may only be operated under the supervision of qualified personnel, e.g. a teacher, and may not be operated at all outside of the designated experiment room of a school or other institution. The UHF transmitter may not be connected to other communications systems or terminal devices.

Laws and regulations, official requirements

Before putting the UHF transmitter into operation, it is your responsibility to ensure that all applicable laws and regulations are observed.

For example, users in Germany are required to obtain approval from the federal telecommunications regulatory authority. If you have any questions regarding the requirements which apply to you when setting up and operating radio systems for instructional purposes, please contact the authorities who regulate such matters in your country.

Safety notes

It is the responsibility of the user to take all precautions to ensure that devices installed outside of the experiment room can continue to function properly.

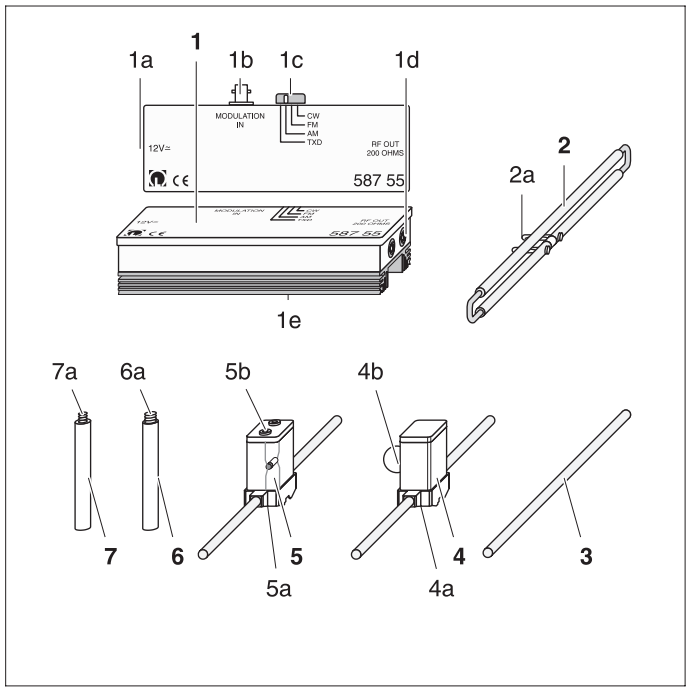
- Do not operate the transmitter longer than is necessary to conduct the experiment.
- Set up the experiment horizontally (not vertically).
- Where necessary, also operate the UHF transmitter at reduced power for continuous wave experiments (AM mode without modulation).

The UHF transmitter is ready for operation and emits high-frequency energy as soon as it is connected to the supply voltage.

- Deactivate the UHF transmitter immediately when the experiment is finished by switching off the plug-in supply unit.

The output amplifier of the UHF transmitter is proof against sustained short-circuit and no-load operation and can withstand mismatches up to a standing wave ratio of 20:1. In spite of this, always avoid sustained extreme mismatches.

- Never operate the UHF transmitter without terminating the antenna output with the loop dipole, the Lecher line or the 200 Ω terminator resistor.



A UHF transmitter (587 55)

1 UHF transmitter
Power input (1a)
Modulation input (1b)
Mode switch (1c)
Antenna output (1d)
Internal thread M6 (1e)

2 Loop dipole
4-mm plug (2a)

3 Antenna rod

4 Receiver dipole with lamp
Screw thread M4 (4a)
Lamp 3.8 V (4b)

5 Receiver dipole with diode
Screw thread M4 (5a),
4-mm sockets (5b)

6 Mounting rod for UHF transmitter
M10 thread (6a)

7 Mounting rod for receiver dipoles
Internal thread M4 (7a)

A.1 Description

The UHF transmitter is used to investigate the propagation of electromagnetic waves in free space (e.g. in the air), in dielectric media (e.g. in water) and on Lecher lines. It can be used in continuous wave mode or with a modulating signal; the modulating signal can be an audio signal, a video signal (with some restrictions) or a TTL data signal.

The pluggable loop dipole functions as a transmitter antenna; the enclosed antenna rod acts as a director when placed in front of the receiver antenna, and as a reflector when placed behind it.

Two receiver antennas can be used. The receiver dipole with lamp indicates the field strength of the received signal as a function of the antenna distance and polarization in a qualitative manner through the change in lamp brightness. The receiver antenna with diode demodulates the high-frequency received signal and can be connected to a multimeter for quantitative display of the field strength or to an audio-frequency amplifier to generate an audio or video signal.

A.2 Scope of supply

1 UHF transmitter

1 Loop dipole

1 Antenna rod

1 Receiver dipole with diode

1 Receiver dipole with lamp

1 Mounting rod for UHF transmitter

1 Mounting rod for receiver dipole

A.3 Technical data

UHF transmitter:

Operating data:

Frequency:	433.92 MHz (± 100 ppm) ISM band (industrial, scientific, medical) of UHF range
Wavelength:	69.14 cm
Operating voltage	12 V (AC, DC and mixed voltage)
Power consumption:	15 W

Operating modes:

CW (continuous wave)

FM (frequency modulation)

AM (amplitude modulation)

TXD (transmit data):	digital data input for data transmission with the PC using on/off keying (OOK)

Modulation options:

Amplitude modulation AM:	100 Hz...10 kHz, max. 1 V_{pp}
Frequency modulation FM:	100 Hz...10 kHz, max. 1 V_{pp}
Transmit data TXD:	max. 4 kbps, TTL level

Output power (into Z = 200 Ω):

CW:	3.0 W
FM:	3.0 W
AM:	1.5 W
TXD:	3.0 W with reduction to 0.3 W

Standing-wave resistance:

for Lecher line experiments max. 20 : 1

Connections:

Power input	12 V DIN switching socket for DIN cannon plug of plug-in power supply
Modulation input	BNC socket
Antenna output	4-mm safety sockets, high-frequency power output with symmetrical supply, for loop dipole, Lecher line or 200 Ω terminator

General data:

Housing:	20.5 cm × 8.5 cm × 50 cm full metal enclosure with integrated heat sink
Weight:	400 g

Loop dipole:

Characteristic wave impedance:	200 Ω
Connection:	4-mm plug pair for connecting to antenna output or open end of the Lecher line
Dimensions:	14 cm × 7 mm dia.

Antenna rod:

Dimensions:	32 cm × 7 mm dia.

Receiver dipoles:

Lamp data:	3.8 V / 70 mA
Lamp socket:	E10
Dimensions:	14 cm × 7 mm dia.

Mounting rods:

Mounting rod for UHF transmitter	13 cm × 10 mm dia.
Mounting rod for receiver dipole	13.7 cm × 10 mm dia.

Note on the lengths of antenna rod, receiver dipoles and loop dipole:

The ideal elementary (or "Hertz") dipole has an overall length of $\lambda/2$ and a diameter $D = 0$. For diameters $D > 0$, a contracting factor becomes apparent for the overall length and the bandwidth becomes greater. (Flatter antenna resonance curve).

A.4 Operation

A.4.1 Putting the UHF transmitter into operation:

Additionally required:

1 Plug-in unit 230 V AC / 12 V AC	562 791
1 Saddle base	300 11

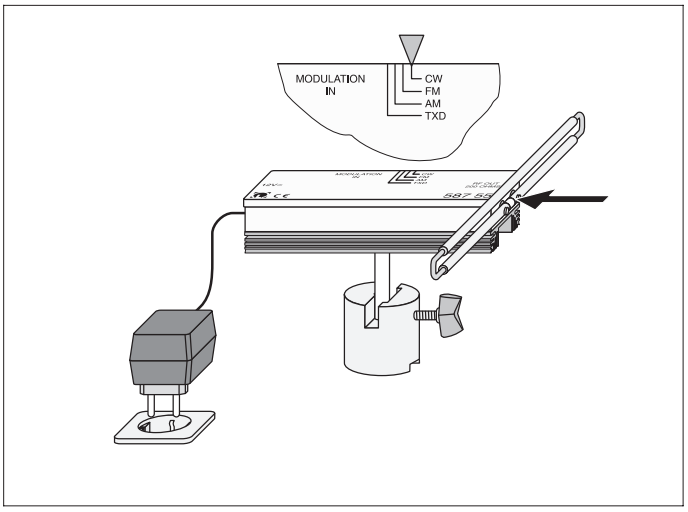
- Screw the mounting rod of the UHF transmitter into thread **(1e)** and clamp it in the saddle base.
- Connect the loop dipole **(2)** or the Lecher line (from 587 56) to antenna output **(1d)**.
- Select the desired operating mode with mode switch **(1c)**.
- Connect the plug-in supply unit to power input **(1a)**, plug the unit into a mains socket and switch it on.

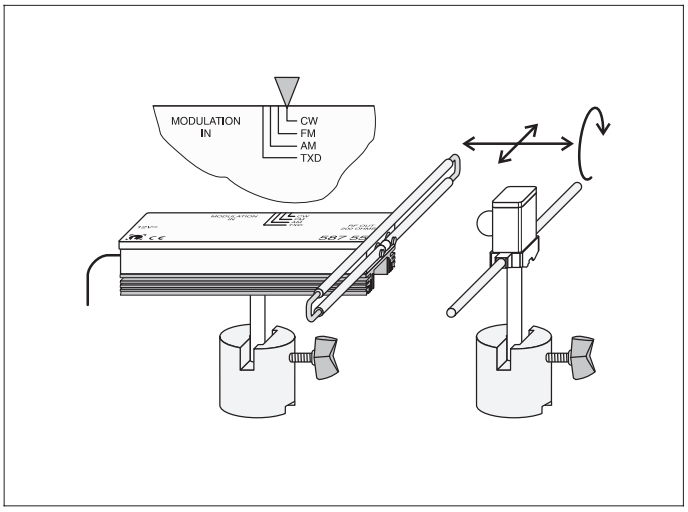
A.4.2 Using the receiver dipole with lamp:

Additionally recommended:

1 Saddle base	300 11

- Operate the UHF transmitter in CW mode using the loop dipole.
- Mount the receiver dipole with lamp using the mounting rod for receiver dipoles and align it parallel to the loop dipole so that the lamp lights up brightly.
- Vary the distance, move the receiver dipole around the loop dipole and lift it above the loop dipole, align the receiver dipole perpendicularly; observer the brightness of the lamp each time.

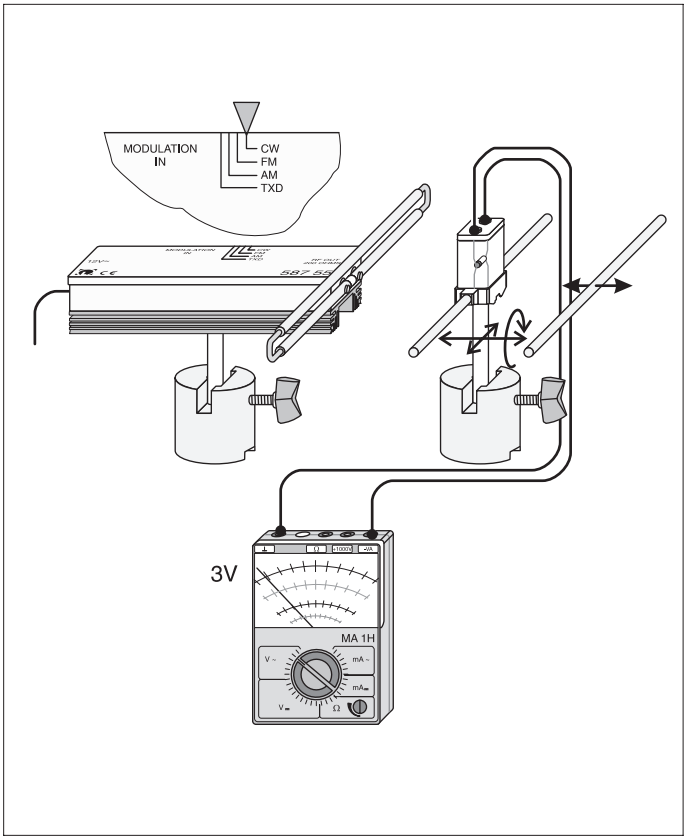




A.4.3 Using the receiver dipole with diode:

a) Additionally recommended:

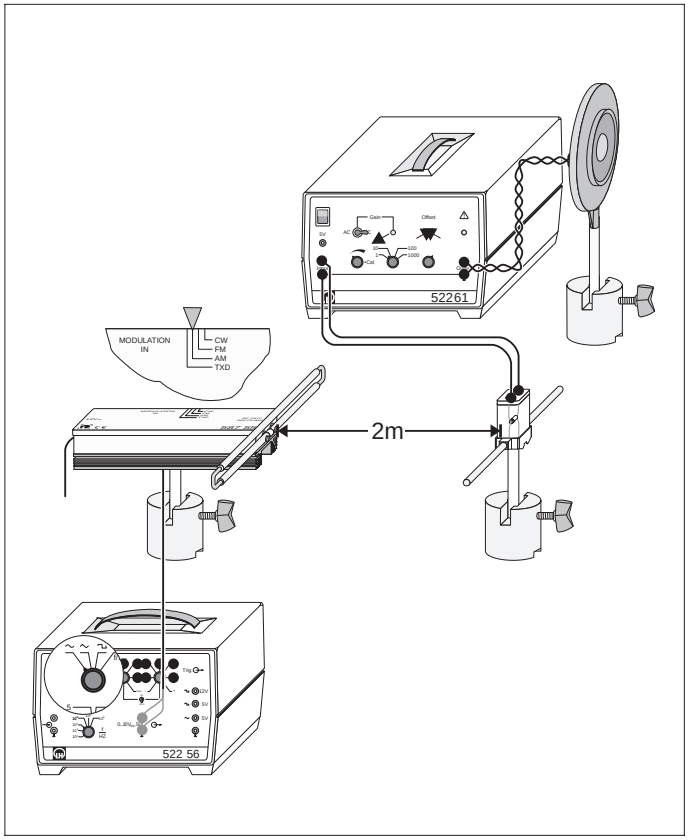
1 Multimeter MA1H	531 51
1 Saddle base	300 11



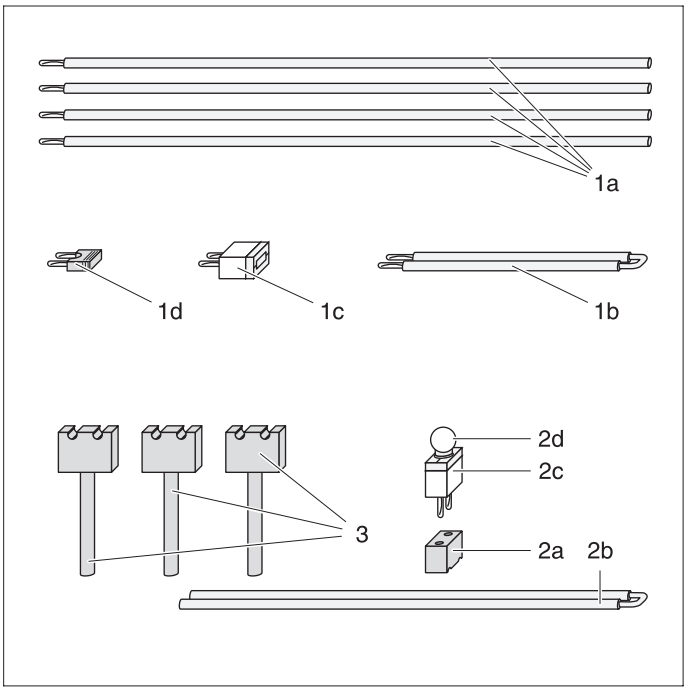
- Operate the UHF transmitter in CW mode using the loop dipole.
- Mount the receiver dipole with diode using the mounting rod for receiver dipoles.
- Connect the multimeter (measuring range 3 V DC).
- Align the receiver dipole parallel to the loop dipole so that the deflection of the multimeter is approx. 2 V.
- Vary the distance, move the receiver dipole around the loop dipole and lift it above the loop dipole, align the receiver dipole perpendicularly; observe the deflection of the multimeter each time.
- Test the effect of the horizontally arranged antenna rod **(3)** on the received signal when placed in front of and behind the receiver dipole.

b) Additionally recommended:

1 Function generator P	522 56
1 Screened cable BNC / 4 mm	575 24
1 AC/DC amplifier 30 W	522 61
1 Broad-band speaker	587 08
2 Saddle bases	300 11



- Operate the UHF transmitter in AM mode using the loop dipole.
- Mount the receiver dipole with diode using the mounting rod for receiver dipoles, connect the AC/DC amplifier and switch on AC mode.
- Connect the output of the AC/DC amplifier to the speaker, making sure to twist the connecting leads together.
- Connect the output of the function generator P to the modulation input of the UHF transmitter.
- Set up the receiver dipole approx. 2 m away from the UHF transmitter and align it parallel to the loop dipole.
- Switch the function generator to sine mode and supply a variable-frequency signal with a signal level of approx. 1 V_{pp} to the UHF transmitter. Listen to the received signal.



B Lecher system with accessories (587 56)

1 Lecher system
comprising
Open Lecher line 5λ/4 (1a),
Shorting plug λ/4 (1b),
Terminator 200 Ω (1c),
Bridging plug (1d)

2 Accessories for probe and induction loop
comprising
Plastic adapter (2a),
Coupling loop λ/2 (2b),
Lamp socket E10 (2c),
Lamp 3.8 V (2d)

3 Holders with rod

B.1 Description

The Lecher system makes possible the demonstration and investigation of electromagnetic waves on a Lecher line in four variants (open ended, terminated with characteristic wave impedance, shorted end, shorted end extended by λ/4).

A probe with lamp is used to detect the voltage antinodes along the line; this probe can be converted to an induction loop for detecting the current antinodes using a λ/2 coupling loop.

B.2 Scope of supply

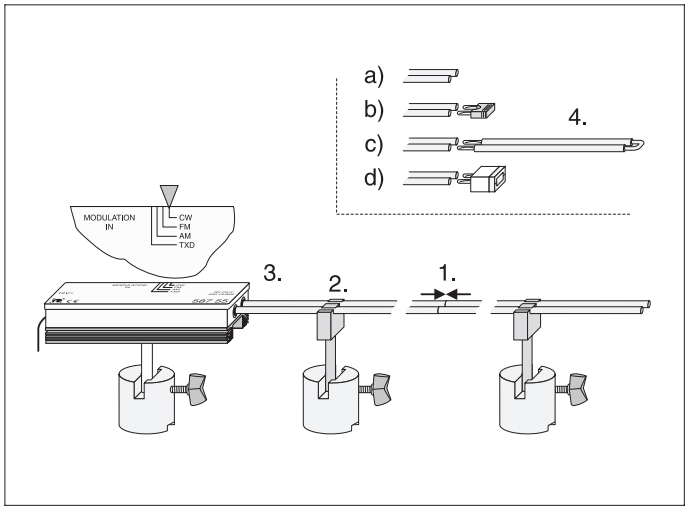
4	Sections, 44 cm, for open Lecher line 5λ/4
1	Shorting plug λ/4
1	STE resistor 200 Ω (577 35)
1	Set of 10 bridging plugs (501 511)
1	Coupling loop λ/2
1	Plastic adapter
1	Lamp socket E10 (579 06)
1	Set of 10 lamps 3.8 V (505 10)
3	Holders with rod

B.3 Technical data

Characteristic wave impedance:	200 Ω
Conductor spacing:	19 mm
Diameter of conductors:	7 mm
Plug connectors:	4-mm sockets
Length:	
of Lecher line 5λ/4	88 cm
of shorting plug λ/4	17 cm
of coupling loop λ/2	31.5 cm
Lamp data:	3.8 V / 70 mA
Lamp socket:	E10

B.4 Operation

a) Assembling the Lecher line:



Additionally required:

2 Saddle bases 300 11

a) Open end

- Plug the sections of the open Lecher line together, slide on two holders with rods from one end and mount these in bases.
- Plug the 4-mm plugs into the antenna output of the UHF transmitter.

b) Shorted end:

- Plug bridging plug **(1d)** into the open end.

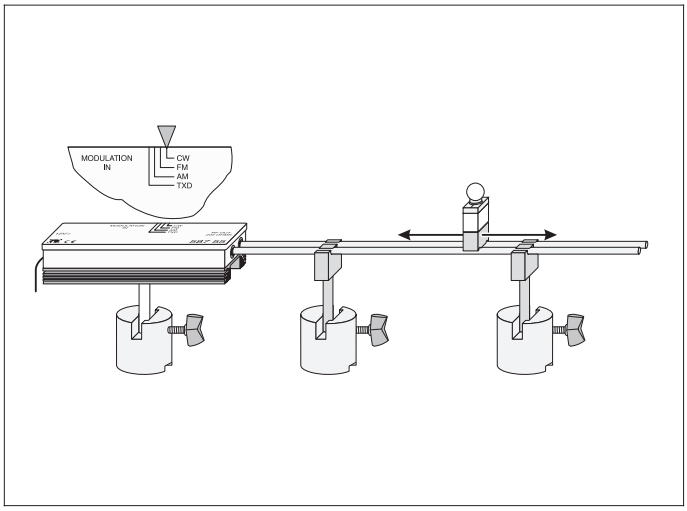
c) shorted end extended by λ/4:

- Plug the shorting plug λ/4 **(1b)** onto the open end.

d) Termination with characteristic wave impedance:

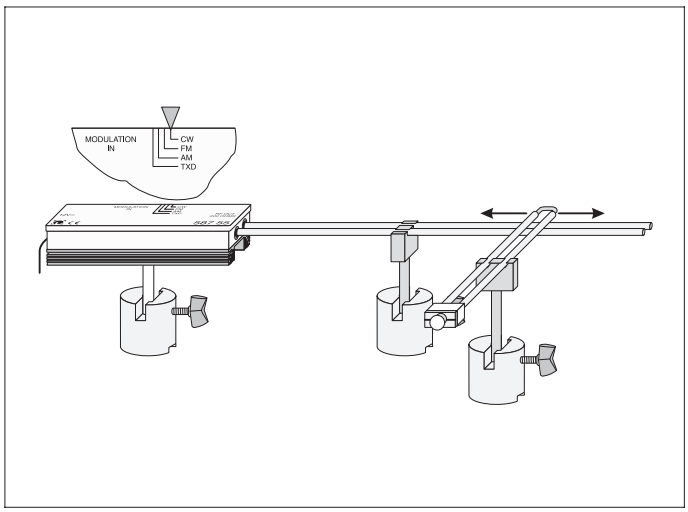
- Place the 200 Ω terminator **(1c)** onto the open end; do not leave it attached for more than 5 minutes, as the sustained load capacity is only 2 W.

b) Detecting the voltage antinodes using a probe:



- Assemble the plastic adapter and the lamp socket E 10 with lamp and place it on the Lecher line as the probe.
- Slide the probe along the Lecher line to detect the voltage antinodes and nodes as the maximum and minimum lamp brightness, respectively.

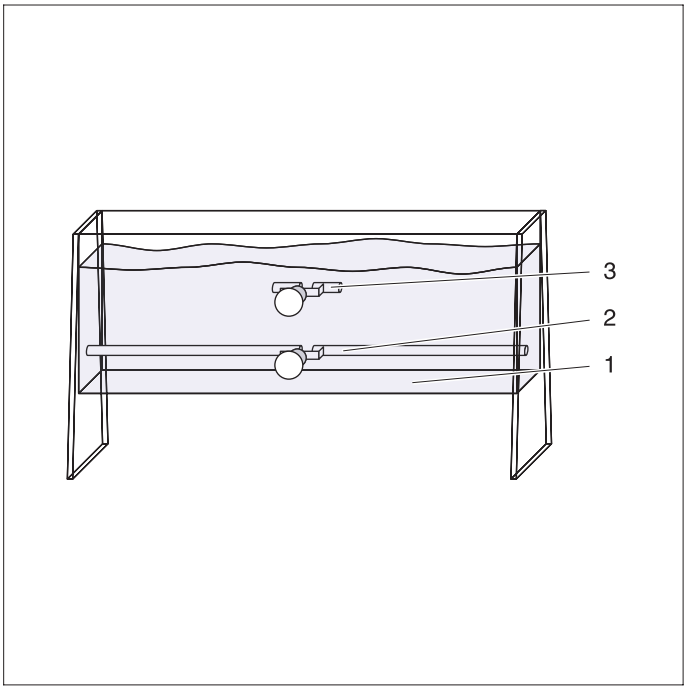
c) Detecting current antinodes using an induction loop:



Additionally recommended:

1 Saddle base 300 11

- If necessary, slide a holder with rod onto the coupling loop λ/2 and clamp it in a base.
- Plug the coupling loop λ/2 into the lamp socket E10 with lamp and set it up as close as possible above the Lecher line as an induction loop.
- Position the front end of the induction loop over the “back conductor” of the Lecher line and slide the induction loop along the Lecher line to detect the current antinodes and nodes as the maximum and minimum lamp brightness, respectively.



C Set of dipoles in water tank (587 54)

1 Water tank
2 Long λ/2 dipole, with lamp
3 Short λ/2 dipole, with lamp

C.1 Description

The set of dipoles in water tank enables the comparison of the wavelengths of UHF waves in air and in water. It contains two extended λ/2 dipoles of different lengths. The illumination of the lamp attached to a λ/2 dipole indicates the resonant absorption in air and in water in turn when the wavelength has been matched. The ratio of the dipole lengths can be used to determine the refractive index *n* or the dielectric constant ε of water for decimeter waves (n = 433.92 MHz).

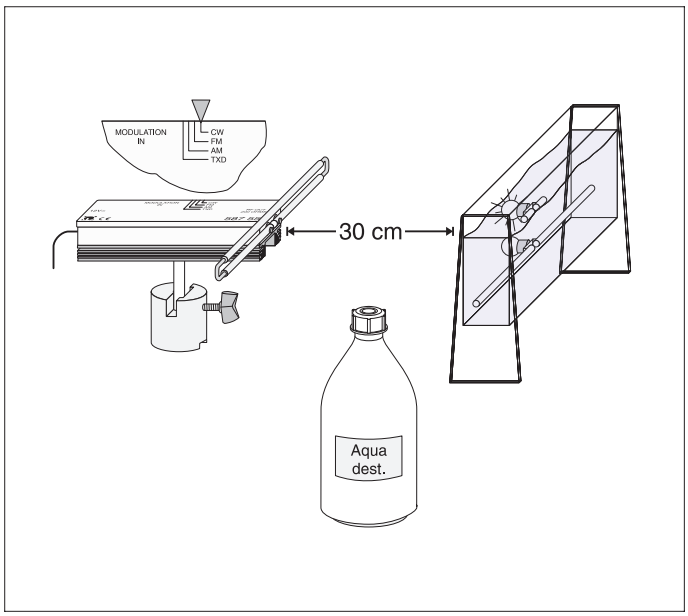
Note:

This experiment can only produce satisfactory results when distilled or demineralized water is used. When tap water is used the lamp lights up only faintly for the short λ/2 dipole.

C.2 Technical data

Dimensions of water tank:	
	33 cm × 12 cm × 5 cm
Length:	
of long λ/2 dipole:	31.5 cm
of short λ/2 dipole:	6 cm
Lamp data:	3.8 V / 70 mA
Lamp socket:	E10

C.3 Operation



– Set up the water tank approx. 30 cm from the UHF transmitter.
– Operate the UHF transmitter in CW mode using the loop dipole, align the loop dipole parallel to the λ/2 dipoles and put the UHF transmitter into operation by plugging in the supply unit. (The long λ/2 lights up in the empty water tank.)
– Slowly fill the water tank with distilled or demineralized water and observe when the lamp of the long λ/2 goes out and the short λ/2 dipole comes on.