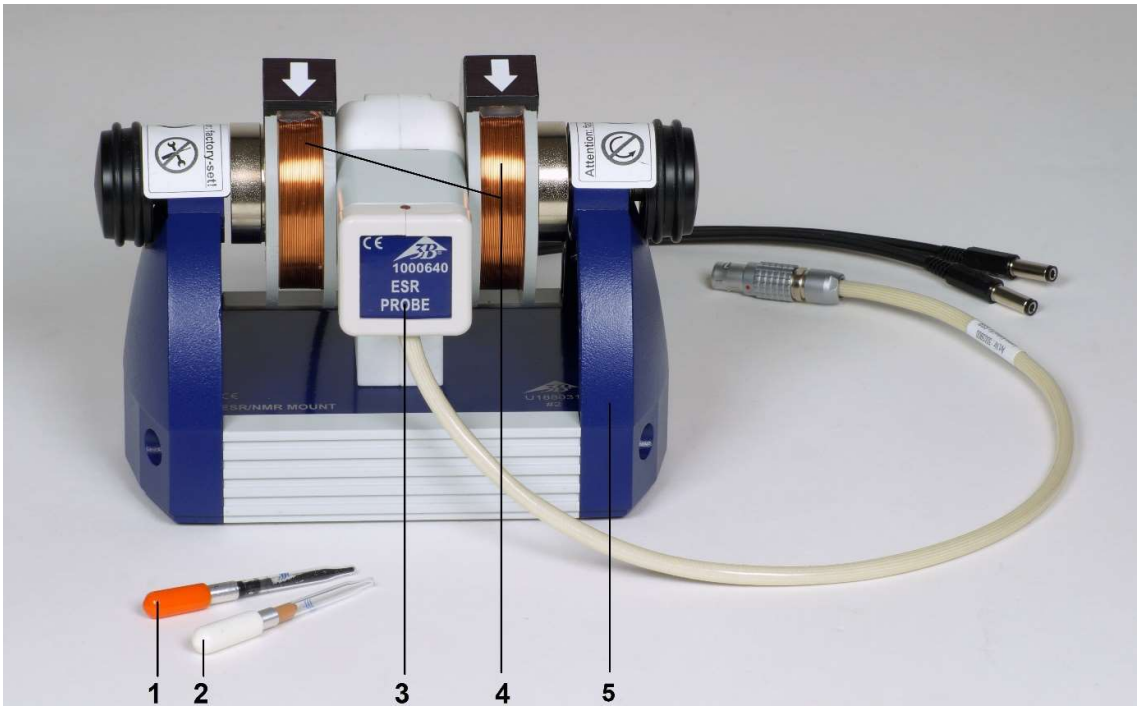
3B SCIENTIFIC® PHYSICS

ESR Module 1022705

Instruction manual

08/20 SD/ GH



1 DPPH-sample
2 Comparison sample
3 ESR-probe
4 Pair of magnetic coils
5 Base unit

1. Safety instructions

The ESR module is only for use in conjunction with the ESR/ NMR control unit (1022700/ 1022702). No external voltages may be applied!

Since the module is calibrated at the factory, no settings need to be made on the hardware. Destruction of the warranty seals will result in loss of warranty.

Always handle the DPPH sample with care! **DPPH can cause allergic skin reactions. May cause allergy, asthma-like symptoms or breathing difficulties when inhaled!**

2. Description

The ESR module is for use in conjunction with the ESR/NMR control unit (1022700 resp. 1022702) to investigate electron spin resonance in DPPH.

The set consists of the factory-set base unit with the two magnetic coils, the ESR probe with a high frequency coil, a DPPH sample and an empty comparison sample.

A measurement report is supplied with each ESR module.

3. Equipment supplied

1 Base unit with mounted pair of magnetic coils
1 ESR probe
1 Comparison sample
1 DPPH sample
1 Measurement report

4. Technical data

Frequency range:	approx. 38 - 75 MHz
Probe connection:	4-pole Lemo plug
Sample diameter:	4.5 mm
Distance sample inlet to center of measuring chamber	approx. 26 mm

Magnetic coils

Coils:	500 each
Magnetic flux density:	0 – 3.67 mT
Connectors:	coaxial connector 5.5 x 25 mm
Dimensions:	approx. 175x125x125mm^3
Weight:	approx. 2.25 kg

5. Additionally required equipment

1 ESR/NMR control unit (230 V, 50/60 Hz) 1022700
or
1 ESR/NMR control unit (115 V, 50/60 Hz) 1022702
1 Digital oscilloscope, 2x 30 MHz 1020910
or
1 PC oscilloscope 2x 25 MHz 1020857
2 HF-cables 1002746

6. Operation

6.1 Connection to the control unit

- Insert the probe into the chamber in the base unit so that it touches the housing (Fig. 1).
- Plug the lead from the probe into the socket “Probe In” on the control unit. Take note of the slot in the connector socket.
- **Note!**

  Always be careful when connecting and disconnecting the measuring probe cable. The red dot on the connector must point in the direction of the "Sensitivity" LED. When disconnecting the plug, only pull on its housing, the plug unlocks automatically. Never pull on the cable!
- Connect the coils to the “Coil” output on the back of the console.
- Connect the control console with plug-in power supply via socket “12 VAC/1A”.
- Insert the DPPH sample (orange cap) into the sample chamber (see Fig. 2).

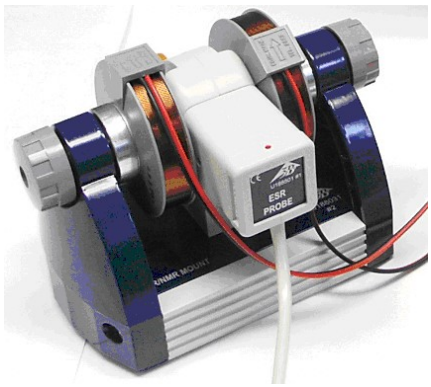


Fig. 1 Base unit with probe

Fig. 2 Base unit with DPPH sample inserted

6.2 Calibration and settings

- Connect the output “SIGNAL OUT” on the control console to channel 1 of the oscilloscope and the output “FIELD OUT” to channel 2 (see Fig. 3).
- Set the oscilloscope as follows:

  Channel 1: 1 V DC (0.5 V DC)

  Channel 2: 1 V DC (0.5 V DC)

  Time base: 5 ms

  Trigger settings:
  - Channel 2
  - Filter: low frequency
  - Trigger mode: falling edge

6.3 Experiment procedure

Note!

Mobile phones interfere with the measurement, therefore no mobile phones should be near the device during the measurement.

Use only high-quality HF cables for the measurement.

- Set a frequency of about 50 MHz on the control console (since the frequency knob is a 10-turn potentiometer, it may be necessary to turn it round several times).
- Set the sensitivity to where the maximum signal amplitude is obtained.

At the ideal setting, slight flickering of the LED may be observed. If the LED lights up brightly, the signal is overloaded.

- Note down the resonance voltage of the coil U_R and the corresponding resonant frequency ν_R.
- The resonance voltage can be read directly from the oscilloscope screen.
- Repeat the measurement for various frequencies (in 5 MHz-steps).

6.4 Evaluation

- Calculate the magnetic field according to the following equation:

$$B_R = 3{,}67\,\frac{mT}{V}\cdot U_R$$

- Plot a graph of magnetic field against frequency (see Fig. 6).

The relationship between the resonant frequency ν_R and the magnetic field at resonance B_R is as follows:

$$\nu_R = g\cdot\frac{\mu_B}{h}\cdot B_R$$

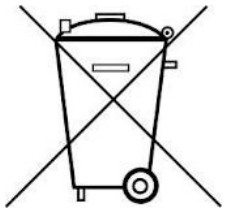
with:

$$\mu_B = 9{,}28\cdot 10^{-24}\,\frac{\mathrm{J}}{\mathrm{T}}$$

$$h = 6{,}626\cdot 10^{-34}\,\mathrm{Js}$$

7. Disposal

- The packaging should be disposed of at local recycling points.
- 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.



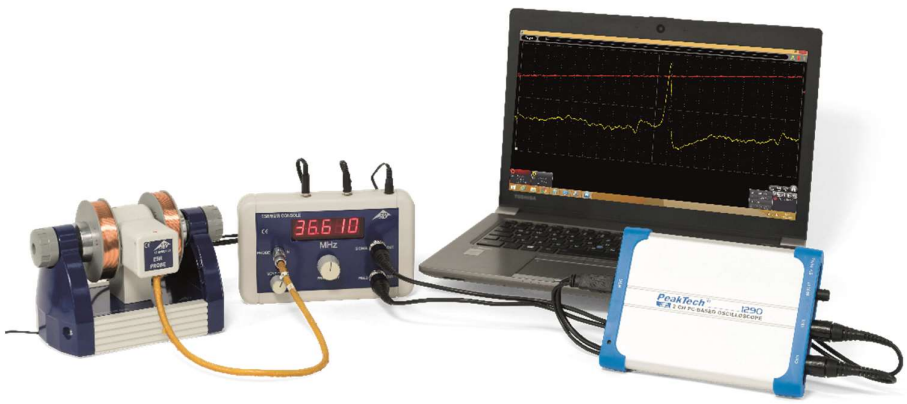


Fig. 3 ESR Experiment set-up with a PC oscilloscope

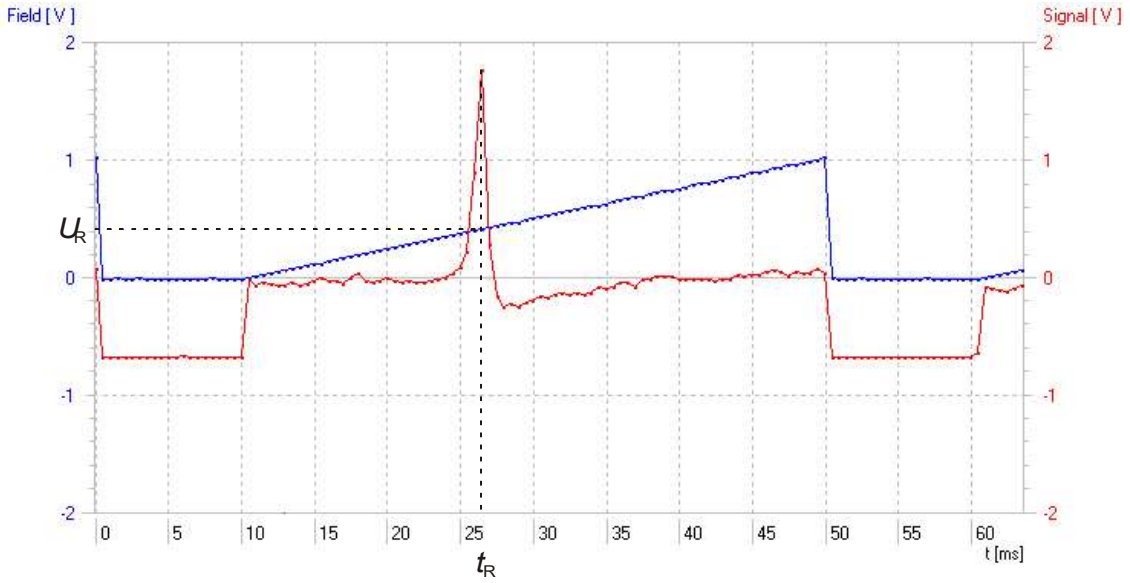


Fig. 4 Signal trace at 40 MHz (red: absorption signal as a function of time, blue: coil voltage as a function of time)

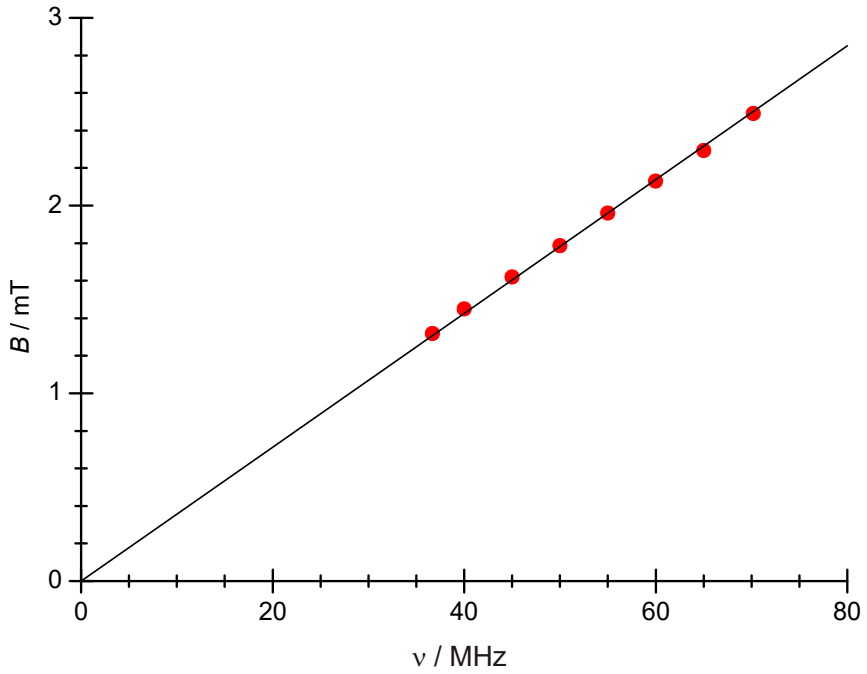


Fig. 5 Graph of magnetic field against frequency