

## ESR Supplementary Set 1000640

### Instruction manual

10/13 ALF



- 1 Comparison sample
- 2 DPPH sample
- 3 ESR probe
- 4 Assembly rings
- 5 Assembly cylinder

### 1. Description

The ESR supplementary set is for use in conjunction with the ESR/NMR basic set (1000637 resp. 1000638) to investigate electron spin resonance in DPPH.

The set consists of an ESR probe with a high-frequency coil, a sample of DPPH (2,2-diphenyl-1-picrylhydrazyl), an empty comparison sample, two rings and two cylinders for assembling the apparatus.

### 2. Additionally required equipment

- 1 ESR/NMR basic set (230 V, 50/60 Hz) 1000638
- or
- 1 ESR/NMR basic set (115 V, 50/60 Hz) 1000637
- 1 Analogue oscilloscope, 2x30 MHz 1002727
- 2 High-frequency cables 1002746
- alternatively
- 1 3B NET/og™ unit (230 V, 50/60 Hz) 1000540
- or
- 1 3B NET/og™ unit (115, 50/60 Hz) 1000539
- 1 3B NET/ab™ 1000544
- 2 High-frequency cables, BNC/4-mm plug 1002748
- 1 PC

### 3. Operation

#### 3.1 Assembly of basic set

The assembly rings and cylinders as well as the probe chamber on the basic unit must be free of grease and dust.

- It may be necessary to clean them with isopropanol.
- Insert the assembly rings at the right and left of the test probe chamber (see Fig. 1).

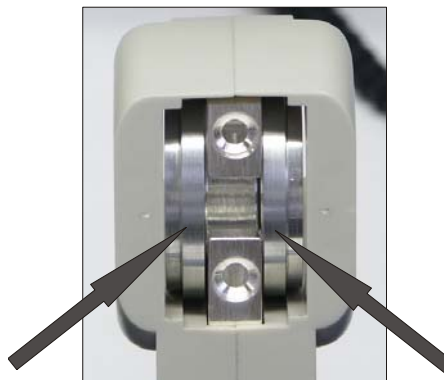


Fig. 1 Probe chamber with assembly rings inserted

- Slide the coils onto the assembly cylinder and insert them into the basic unit as shown in Fig. 2.
- Take care when doing this to ensure the direction of the windings of both coils is the same. The arrows embossed on the coils must point in the same direction.
- Tighten the knurled screws an equal amount by hand. Make sure that the assembly cylinder is located accurately on the assembly rings.



Fig. 2 Basic unit complete with coils

### 3.2 Connection to the control console

- Insert the probe into the chamber in the basic unit so that it touches the housing (see Fig. 3).
- Plug the lead from the probe into the socket "Probe In" on the control console. Take note of the slot in the connector socket.
- 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. 4).

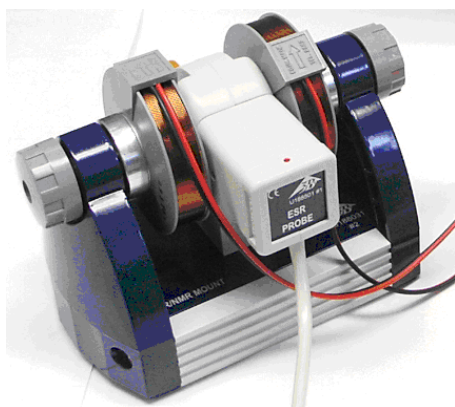


Fig. 3 Basic unit with probe



Fig. 4 Basic unit with DPPH sample inserted

### 3.3 Calibration and settings

#### 3.3.1 Use of an oscilloscope

- 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. 5).
- Set the oscilloscope as follows:  
Channel 1: 2 V DC  
Channel 2: 1 V DC  
Time base: 5 ms  
Trigger from channel 2, filter set to Low Frequency

#### 3.3.2 Use 3B NET/log™

- Connect the output "SIGNAL OUT" on the control console to input  $U_B^{IN}$  on the 3B NET-log™ unit and out "FIELD OUT" to input  $U_A^{IN}$ .
- Connect the 3B NET-log™ unit to a computer and run the 3BNET/lab™ software on the computer.
- Set up a new data record from the "Measurement lab" menu option and define the following parameters:  
Input A: Field, input mode VDC, Input range 2 V  
Input B: Signal, input mode VDC, Input range 2 V  
Measuring interval: 500  $\mu$ s (2 kHz)
- Click the "Oscilloscope" button and start the measurement.

An oscilloscope window will open.

- Set to trigger from input A, select a falling edge and a positive trigger threshold at about 10 to 20%.

### 3.4 Experiment procedure

- 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  $\nu_R$  (see Fig. 6).
- If an oscilloscope is used the resonance voltage can be read directly from the scope screen.
- If 3B NET/og™ is being used, exit oscilloscope mode and save the results. The table of measurements displayed can be displayed graphically by clicking the appropriate button and the peak can then be marked by means of the cursor. The resonance voltage for the coil  $U_R$  is then displayed.
- Repeat the measurement for various frequencies (in 5 MHz-steps).

### 3.5 Evaluation

- Calculate the magnetic field according to the following equation:

$$B_R = 3.47 \frac{\text{mT}}{\text{V}} \cdot U_R$$

- Plot a graph of magnetic field against frequency. (see Fig. 8)

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

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

where

$$\mu_B = 9.28 \cdot 10^{-24} \frac{\text{J}}{\text{T}}$$

$$h = 6.626 \cdot 10^{-34} \text{ Js}$$

### 4. Disposal

- The packaging should be disposed of at local recycling points.
- If the equipment itself needs to be scrapped, it is safe to dispose of all components other than the probe in domestic waste. The probe should be disposed of in containers dedicated to the disposal of electrical refuse.

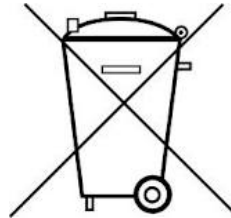


Fig. 5 ESR experiment set-up using an oscilloscope

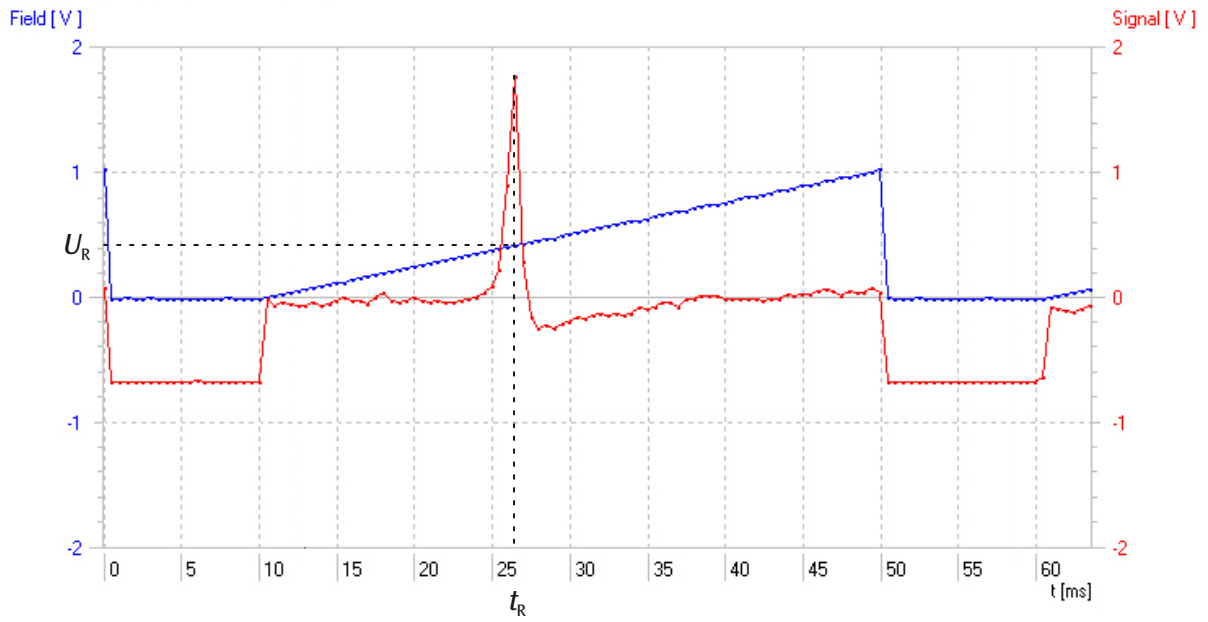


Fig. 6 Signal trace at 40 MHz (red: absorption signal as a function of time, blue: coil voltage as a function of time)

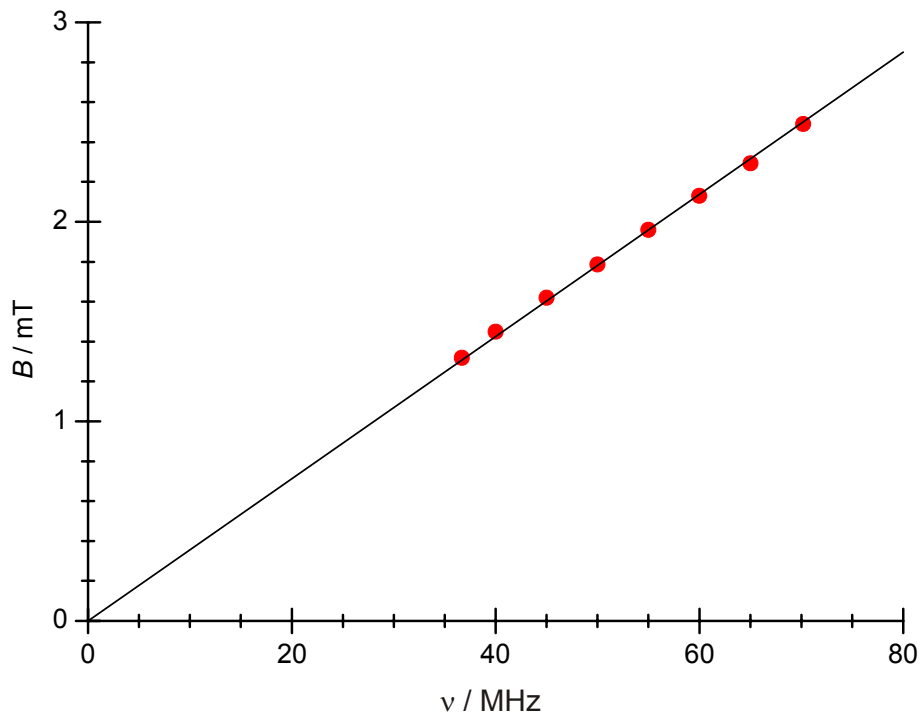


Fig. 7 Graph of magnetic field against frequency