1. Experimental Content

1) Study and acknowledge electron spin resonance phenomenon
2) Measure Lande's *g*-factor of DPPH sample
3) Learn how to use microwave devices in ESR system
4) Understand standing wave by changing resonant cavity length
5) Measure standing wave field distribution in resonant cavity
6) Determine waveguide wavelength λ_g

2. Experimental Procedure

Read and follow the manual before installation and operation of this apparatus. Refer to Figure 8 for connections and installations.

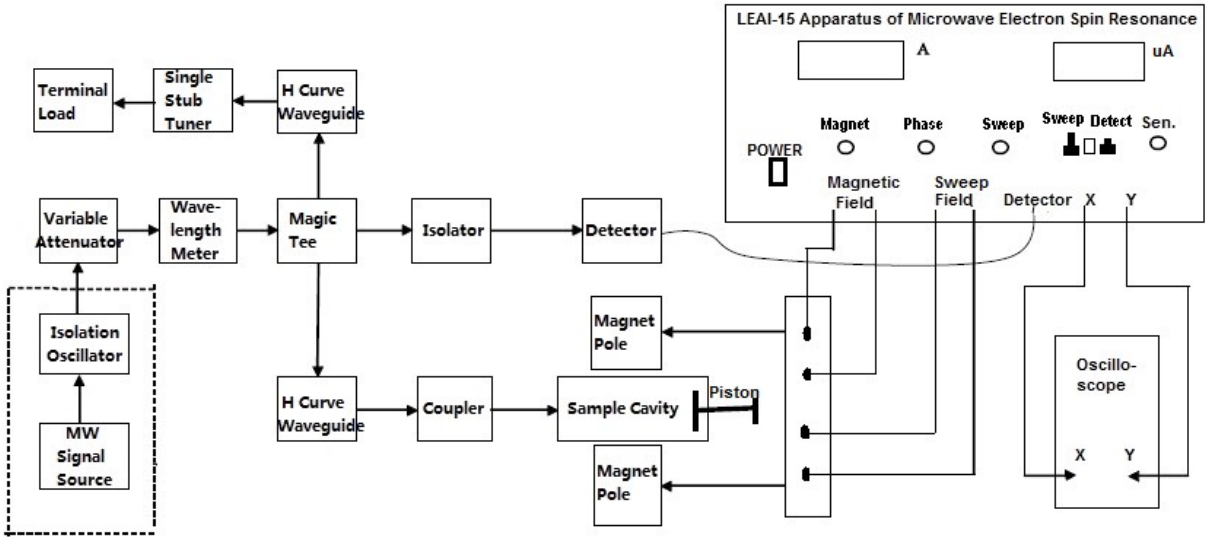


Figure 8 Block diagram of the experimental system

1) Before power-up, turn the variable attenuator in clockwise direction to maximum. Turn "Magnet" and "Sweep" of the main unit in counterclockwise direction to minimum. Turn on power to the main unit, and preheat for 20 minutes.
2) Remain "Magnet" in minimum position, turn "Sweep" in clockwise direction to maximum, press down "Sweep/Detect" button. The system is now in detection status. The detected signal is shown on the indication meter.
3) Place the sample in the center of the magnetic field (around 91 mm position on the scale).
4) Turn the single stub tuner in clockwise direction to scale "0".
5) Signal source works in equal-amplitude mode ("Equal-A"). Adjust the variable attenuator and detection sensitivity "Detect Sen." knob to make the indicator on the indication meter above 2/3 of full scale.
6) Set the output frequency of the microwave signal source at around 9370 MHz by adjusting the micrometer of the oscillator.
7) Use wavelength meter to measure the frequency of the microwave signal as follows: turn the micrometer of the wavelength meter at an expected reading value by referring to the

frequency-scale table of the wavelength meter as attached, then slowly and carefully adjust the micrometer to find the absorption point of the signal (at this point signal decreases sharply), look up "Frequency-Scale Table of 3 cm Cavity Wavelength Meter" to determine the oscillation frequency. If the oscillation frequency deviates too much from 9370 MHz, the oscillation frequency of the signal source should be adjusted to make it close to 9370 MHz. After frequency measurement, the micrometer of the wavelength meter should be detuned from the resonant point.

8) To get a resonant cavity, adjust the piston of the sample cavity until the indication meter reads minimum. Now, a standing wave distribution is achieved in the sample cavity as shown in Figure 9.

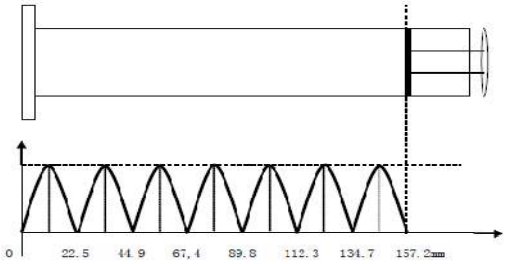
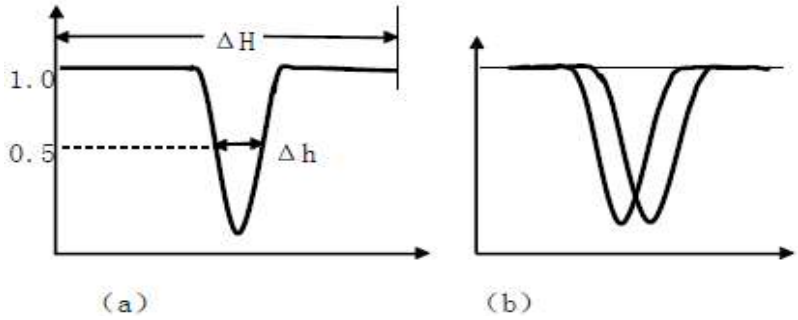


Figure 9 Standing wave distribution in the sample cavity

9) In order to increase the sensitivity of the system, one may need to reduce the attenuation of the variable attenuator to make the indication meter at full scale. Next, finely adjust the piston of the sample cavity and the single stub tuner, respectively, in the two arms of the magic tee, to minimize the readout of the indication meter. If the readout is too small, adjust the sensitivity knob "Detect Sen." to increase sensitivity.

10) Release the "Sweep/Detect" button (at pop-up position), now the indication meter displays the relative value of the sweeping field current. One can adjust "Sweep" knob to change the sweeping field current. Now, the detected signal is amplified at "Y" port connected to the "Y" channel of the oscilloscope.

11) Increase magnetic field current by turning "Magnet" knob in clockwise direction around 2.0 A (between 1.8 and 2.2 A), where electron resonance signal appears on the oscilloscope as shown in Figures 10 (a) and (b) (schematic) and 10(c) (actual experimental result). **Note**: Adjust the magnetic field current slowly while observing the signal waveform carefully on the oscilloscope to recognize the resonance absorption peak as shown in Figure 10.



(c)

Figure 10 Waveforms of electron resonance signal on oscilloscope

12) If the peak of resonant waveform is too low or the waveform quality is poor, then: (a) reduce attenuation of the variable attenuator in counterclockwise direction to increase the microwave power, or (b) increase sweeping field current by adjusting "Sweep" knob, or (c) increase sensitivity of the oscilloscope, or/and (4) adjust the adjustment screw on the flange of the microwave signal source oscillation cavity to increase the microwave output power.

13) If the resonance waveform is asymmetric on left and right sides, adjust the depth and left-right of the single stub tuner, or change the sample location in the magnetic field, and finely tune the sample cavity to achieve a satisfied resonance waveform.

14) Adjust "Phase" knob to bring the two resonance peaks to a proper location.

15) If necessary, use a Teslameter (optional) to recalibrate the magnetic field *B* and use equation (11) to calculate g-factor (the nominated g-factor is between 1.95 to 2.05):

16) Move the position of the sample, the distance between two adjacent absorption maxima points is a half of the microwave wavelength, i.e. $\lambda_g/2$.