Measuring Sensitivity of Transponder Coils

Introduction

The sensitivity of a transponder coil is a measure of its ability to receive a signal from the transmitting antenna. Higher sensitivity ratings can equate to longer read distances and the ability to receive weaker signals at the design frequency.

Note: Sensitivity is only one of many factors that affect read distance. The design of the PCB, specifically composition, placement and orientation of all the components, plays a significant role in the actual read distance that can be achieved.

Different methods of measuring sensitivity produce different results. In order to make a fair comparison of similar transponder coils from different manufacturers or from different families of one manufacturer, the method of measuring sensitivity must be consistent. There are several accepted methods of measuring the sensitivity of transponder coils. The following test setup and calculations can be used to produce consistent and repeatable results.

Test materials

Function generator

Helmholtz coil. 6.5″ (16.5 cm) diameter coils, 2.75″ (7 cm) between coils.

HP/Agilent 34401A Multimemert or equivalent to measure at 125 kHz.

Two 0.2 Ohm resistors

Test Setup

Refer to Figure 1 to set up the test equipment.

1. Solder the transponder coil and two test leads to a printed circuit board.

2. Orient the transponder coil in the Helmholtz coil as shown in Figure 1.

   Note: Ensure that the test leads of the transponder coil go through the coils of the Helmholtz. Routing the leads parallel to the coils can adversely affect the accuracy of the measurements.
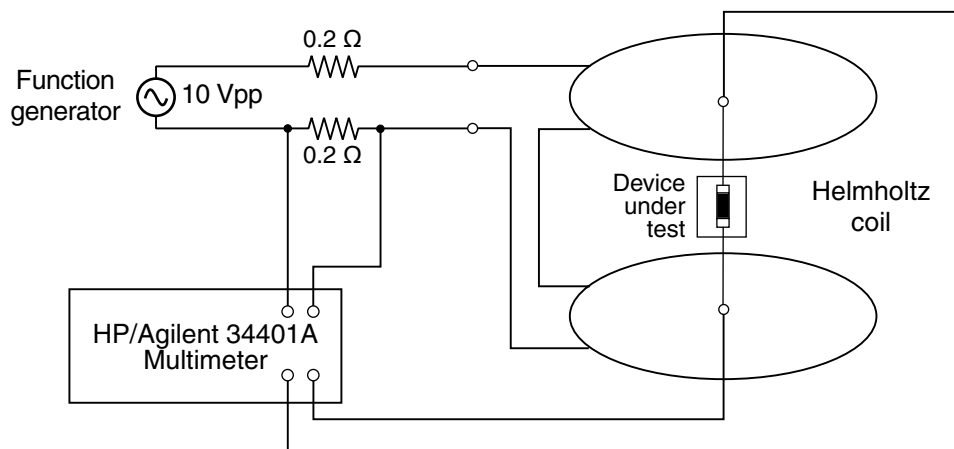
3. Connect all the test equipment.

Figure 1. Test Setup for Measuring Transponder Coil Sensitivity

4. Set the function generator to create a 125 kHz sine wave at 10 Vpp.

5. Use the multimeter to take the following measurements:
   Voltage across one of the resistors (Vres).
   Voltage across the transponder coil (Vdut)

Calculating Sensitivity

The sensitivity of a transponder coil is defined by the following equation:

$$\text{Sensitivity} = \frac{\text{Vdut}}{\text{I} \times \text{K}} \qquad (1)$$

Where:
Vdut = Voltage across the device under test
K = Helmholtz constant (0.0543 µT/mA)
I is defined by the following equation:

$$\text{I} = \frac{\text{Vres}}{\text{R}} \qquad (2)$$

Where:
Vres = Voltage across one of the resistors
R = Resistance of the resistor

Note: The Helmholtz constant is different for each coil. The constant is supplied by the manufacturer of the Helmholtz coil. If the constant is unknown, it can be calculated using a DUT with a known sensitivity.

Use the following equation to calculate the constant for a Helmholtz coil:

$$\text{K} = \frac{\text{Vdut}}{\text{I} \times \text{sensitivity}} \qquad (3)$$

Sample Calculations

The Helmholtz constant used in these calculations is 0.0543 µT/mA. The diameter of each coil is 6.5″ (16.5 cm) and the distance between the coils is 2.75″ (7 cm).

4308RV-495
R = 0.2 Ohms
Vres = 27.69 mVac
Vdut = 350.2 mVac
K = 0.0543 µT/mA
Solving for I: 27.69 / 0.2 = 138.45 mA
Invoking Equation 1:

$$\text{Sensitivity} = \frac{350.2 \text{ mVac}}{138.45 \text{ mA} \times 0.0543 \text{ µT/mA}}$$

$$= \frac{350.2 \text{ mVac}}{7.52 \text{ µT}}$$

$$= 46.57 \text{ mV/µT}$$

5315TC-495
R = 0.2 Ohms
Vres = 27.69 mVac
Vdut = 302.5 mVac
K = 0.0543 µT/mA
Solving for I: 27.69 / 0.2 = 138.45 mA
Invoking Equation 1:

$$\text{Sensitivity} = \frac{302.5 \text{ mVac}}{138.45 \text{ mA} \times 0.0543 \text{ µT/mA}}$$

$$= \frac{302.5 \text{ mVac}}{7.52 \text{ µT}}$$

$$= 40.23 \text{ mV/µT}$$

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