



# Metal Detector With Beat Frequency Method

**Nuryadin Fair**

Department of Electrical Engineering, Faculty of Industrial Technology, Indonesian Islamic University, Yogyakarta

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## ABSTRACT

The bomb terror that occurred in various regions is very troubling, because it causes us to feel anxious when we go anywhere. Bombs which are usually made of metal must be detected by a device called a metal detector "Tanaan" which can detect the presence of metal either embedded in metal or covered in other materials other than metal such as in suitcases or bags. On this occasion a metal detector with using the "Beat Frequency Oscillator" method. The metal detector with this method uses two oscillators, namely the search coil and the reference oscillator. Inside the search coil oscillator there is a sensor in the form of a coil of copper wire and email where the frequency of the search coil oscillator is in, will change when the sensor is on. a certain distance adjacent to the metal. While the reference oscillation, has. Is a stable frequency. When a signal with frequency. If the signal generated by the search coil oscillator is mixed (mixed) with the signal generated by the reference oscillator, a pure frequency and both frequencies will be produced which can be heard by humans. The resulting sound is like a tapping sound with a certain rhythm and is often known as a heat note.

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## Corresponding Author:

Nuryadin Adil,  
Electrical engineering major  
Faculty of Industrial Technology, Indonesian Islamic University, Yogyakarta  
JI Kaliurang Kec. Ngemplak - Kab. Sleman 55584 - Prov. In Yogyakarta  
Email: [nuryadin23adil@gmail.com](mailto:nuryadin23adil@gmail.com)

## 1. INTRODUCTION

Currently bombs which are usually made of metal must be detected with expensive equipment and only certain agencies have them. Along with the development of technology in the field of electronics, this is no longer a problem, because we can make our own "metal detector" at a fairly cheap and affordable cost. In fact, there are many methods used to make a good metal detector using a microcontroller or not, one of which is the "beat frequency" method. Metal detectors with this method are quite cheap to manufacture but quite effective and efficient in detecting the presence of metal embedded in the ground or encased in material other than metal, such as those stored in suitcases or bags. a problem can be taken as follows:

1. This detector is only for detecting metal, both visible and covered with other materials.
2. The Search Coil Oscillator in this detector works in the frequency range of approximately 100 kHz while the reference oscillator operates in the frequency range of around 890 kHz.

3. This metal detector uses three indicators in metal detection, consisting of a speaker, a vu meter, and a series of lights. What can be obtained from this research is to deepen knowledge and understanding of the principles and workings of metal detectors, especially metal detectors that use the beat frequency method.

## 2. RESEARCH METHOD

In making a metal detector, there are actually many methods used to find out the presence of metal hidden underground or in other materials, such as the fixed frequency resonance method, the magnetometer method, the beat frequency oscillator (BFO) method and many other methods. In this design we try to design a metal detector using the beat frequency oscillator method. This detector works based on the resonant frequency that has been set to change when there is a metal object close to the sensor in the form of a search coil. If the sensor in the form of a search coil is adjacent to a metal it will cause a change in the characteristics of the oscillator circuit, due to changes in these characteristics it will result in changes in the output frequency of the oscillator circuit. The metal detector with the BFO method uses two oscillators, namely the search coil oscillator and the reference oscillator. When a signal with a certain frequency generated by the search coil oscillator is mixed (mixed) with the frequency generated by the reference oscillator, it will produce a signal with a different frequency from the two frequencies and this signal can be heard by human physiological hearing. The sound produced is like a "beat" sound with a certain rhythm and is often known as a beat note. Therefore this detector is called the beat frequency method. The frequency changes depending on the size of the detected metal and the distance between the sensor and the detected metal, and when this beat rhythm has been amplified by an amplifier it can be connected to a small speaker to listen to the resulting beat rhythm. Figure 3.1 shows a block diagram of a metal detector using the beat frequency oscillator (BFO) method.

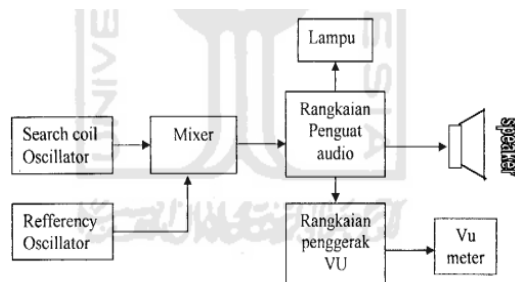


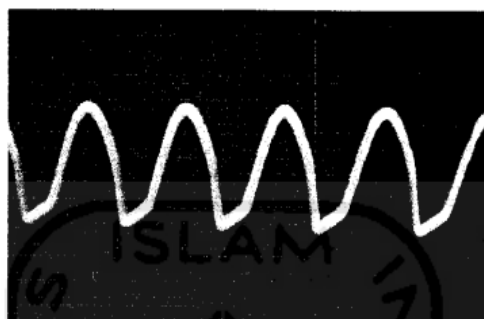
Figure 1. Metal Detector Block Diagram using the beat frequency method

## 3. RESULTS AND DISCUSSIONS

Tests are carried out with the aim of knowing the extent of the performance and sensitivity of the metal detector that has been designed. There are three types of tests carried out, which include testing parts of the system, testing the system as a whole, and testing for various types of disturbances. Tool testing includes testing the shape of the signal generated by each system as well as testing the circuit power supply. Testing the shape of the signal is done by observing the output waveform of each point on the circuit using an oscilloscope. The point that is observed for the output waveform is the output of the search coil oscillator, reference oscillator, frequency divider circuit, Schmitt trigger circuit, and the output of the mixer.

### 3.1. Search Coil Oscillator

From the test results at the output of the search coil oscillator, a waveform is obtained as shown in the following figure.

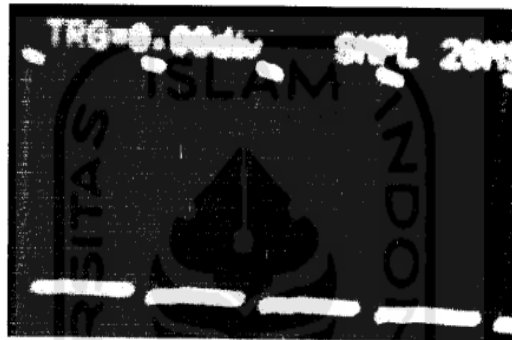


**Figure 2.**The output waveform of the search coil oscillator

Description: Position time/div: 5 us Volt/div position:  $0.2 \times 10 = 2$  volts From the figure above, the voltage value  $V_{pp}$  and period (T) can be determined.  $V_{pp} = \text{Vertical div} \times \text{Volt/div}$   $V_{pp} = 2.4 \times 2 = 4.8$  Volt  $T = \text{Horizontal div} \times \text{Time/div}$   $T = 1.6 \times 5 \times 10^{-8} \text{ s} = 0.000008 \text{ s}$  42 43.

### 3.2.Schmitt trigger

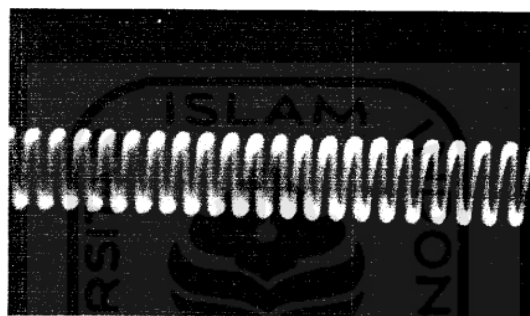
From the test results at the output of the Schmitt trigger, a waveform is obtained as shown in Figure 4.2 below.



**Figure 3.**Schmitt trigger output waveform

### 3.3.Reference oscillator

From the test results at the output of the reference oscillator, a waveform is obtained as shown in the following figure.



**Figure 4.**The output waveform on the reference oscillator

Description: Time/div position: 5us Volt/div position:  $0.5 \times 10 = 5V$  From the picture above, the voltage value  $V_{pp}$  and period (T) can be determined.  $V_{pp} = \text{Vertical div} \times \text{Volt/div}$   $V_{pp} = 1.6 \times 5 = 8$  Volt  $T = \text{Horizontal div} \times \text{Time/div}$   $T = 0.6 \times 5 \text{ us} = 0.000003 \text{ s}$ .

### 3.4.Divider circuit

From the test results at the output of the frequency divider circuit, the waveform is obtained as shown in the following figure.

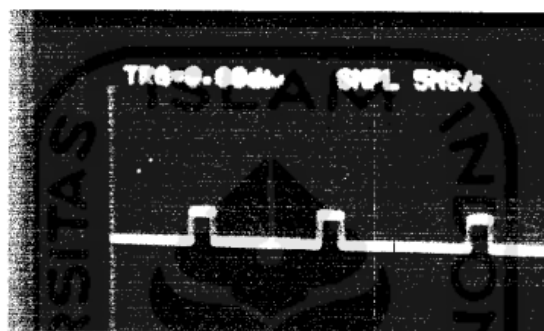


**Figure 5.**The output wave on the frequency divider circuit

Description: Position time/div; 5 us Volt/div position:  $0.1 \times 10^{-4}$  V From the picture above, the voltage value  $V_{pp}$  and penode (T) can be determined.  $V_{pp} \sim$  Vertical div x Volt/div  $V_{pp} = 0.4 \times 10^{-4}$  Volt T = Horizontal div x Time/div  $T = 1.8 \times 5 \text{ns} = 0.000014 \text{ s}$

### 3.5. Mixers

From the test results at the mixer output, a waveform is obtained as shown in the following figure.



**Figure 5.**The output wave on the mixer circuit

Description: Time/div position: 20 ms Volt/div position:  $1 \times 10 = 10$  V From the picture above, the  $V_{pp}$  voltage value and period (T) can be determined.  $V_{pp} =$  Vertical div x Volt/div  $V_{pp} = 0.8 \times 10 \text{ V} = 8 \text{ V}$  T = Horizontal div x Time/div  $T = 2.4 \times 20 \text{ ms} = 0.048 \text{ s}$

From the results of testing the output of each point in the circuit, it is obtained that the output generated by the search coil oscillator is in the form of a sine wave and then after the output is inserted into the schmitt trigger circuit, a square wave is produced. In the reference oscillator, the resulting signal is in the form of a sine wave, while the output generated by the frequency divider circuit is in the form of a square wave signal. The output of the search coil oscillator and reference oscillator is then fed to the mixer. The output from the mixer is a square wave.

## 4. CONCLUSION

From the results of tests on metal detectors with the hea, frequency method, several conclusions can be drawn, among others

1. The sensitivity of the detector is greatly influenced by the size and distance between the metal and the sensor.
2. Tests for disturbances carried out by bringing the source of the natural magnetic field closer to the metal have no effect on the sensitivity of the detector

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