

RFID Liquid Measurement

Application Note

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Abstract

The design of a RFID (Radio Frequency Identification) transmitting system that will have to penetrate a medium to measure a liquid, presents a very unique challenge. In order to achieve a successful RFID system different frequencies must be examined. Due to the steel medium in which to penetrate, the skin depth must be evaluated properly. This document will explain how to implement RFID liquid measurement system for an enclosed steel tank.

Keywords

Skin Depth

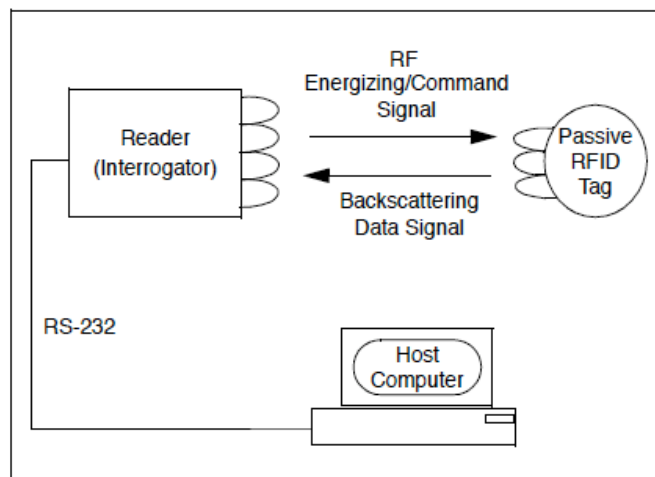
Frequency

Wavelength

Introduction

Radio Frequency Identification systems have many applications and are becoming increasingly more prevalent. They can be used in a variety of different ways such as location, asset tracking, security, and logistics, to name a few. There are two types of RFID systems, passive and active. Passive RFID systems are composed of a reader, passive tag, and a host computer. The tag consists of an antenna and silicon chip that is capable of basic modulation. This chip has non-volatile memory, which allows the chip to retain information when not powered. The tag is powered by a time-varying electromagnetic radio frequency wave. Active RFID systems have their own internal power source, unlike passive RFID. It is also important to consider that different wavelengths and frequencies penetrate different mediums.

Figure 1: Basic representation of how RFID works.



Objective

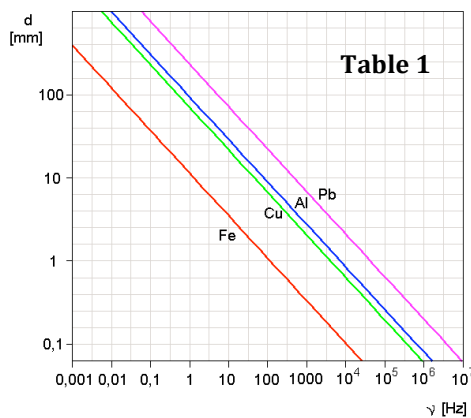
For this application a 5V DC power supply to the RFID and will be actively outputting a signal until it receives feedback from a tag placed in a floater. A microcontroller will be monitoring and controlling this sensor in order to shut off the pump when the tag is in contact with the transmitter. By selecting different frequencies and wavelengths it will allow for the correct penetration through the medium of interest.

RFID Liquid Sensing System

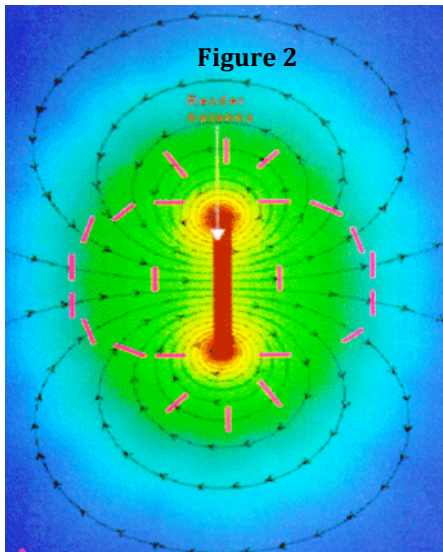
This RFID system will need to send a signal through steel. Steel primarily consists of iron and is also a highly reflective material. When working with any system in which to pass a signal through a medium the skin depth must be taken into account. In order to determine the skin depth of a material the resistivity (ρ), frequency (ω), and permeability (μ) are needed in order to determine the correct skin depth value (δ). The following equation is

generally used to determine this: $\delta = \sqrt{\frac{2\rho}{\omega\mu}}$. The resistivity of steel is of is $1.0 \times 10^{-7} (\Omega\cdot\text{m})$

and the permeability is $875 \times 10^{-6} \text{ N/A}^2$. Table 1 below allows you to determine the frequency for thickness of the material for four different materials. This will result in the skin depth and further enhance the reliability of the sensor for the medium. For this application a longer wavelength low frequency of around 125 kHz will be needed.



The RFID transmitter works directionally. Figure 2 illustrates how the transmitters' antenna pattern radiates. This pattern will ensure that the signal will only receive feedback



when the floater receiver tag is lined up with the transmitter giving an accurate result. Utilizing a low frequency longer wavelength of 125 kHz will be essential for a couple of reasons. First it will enhance the read range communication given the low power of the RFID systems. Also it is essential for reflective materials such as steel mentioned earlier. Finally given the small size of the receiver antenna tags, the longer wavelength, low frequency signal is crucial for antenna excitement.

In order to monitor these results a microcontroller will determine whether or not the transmitter is receiving feedback from the receiver tag and perform the requested action. Programming with the following code will allow for an on/off application. The “X” is the port that is to be utilized by the microcontroller.

```
TRISD = 0x10;  
int main(void)  
{  
    if(PORTDbits.X1)  
    {  
        PORTDbits.X2 = 1;  
    }  
    else  
    {  
        PORTDbits.X2 = 0;  
    }  
    return 0;  
}
```

Conclusion:

The main concern in this application is to position the antenna and prevent refraction of the signals. By using the skin depth and material, the proper calculations can be used to prevent this from happening. This implementation can then be used to determine the level of the liquid in a container.

References:

http://en.wikipedia.org/wiki/Skin_effect

<http://ww1.microchip.com/downloads/en/de1>

www.innovez-one.com/blogs/media/magnetic_flux.gif