ELECTROMAGNETIC WAVE PROPAGATION THROUGH CLOSED METAL SYSTEMS

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Introduction

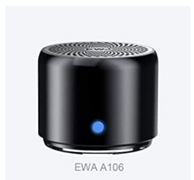
A Faraday cage is an enclosure that shields electromagnetic fields from entering or exiting the cage. While metals with high electrical conductivity are expected to effectively demonstrate the operation of a Faraday cage, preliminary observations of a sealed cast iron cylinder allowing the transmission of Bluetooth signals between a smartphone and wireless earbuds across it suggested the need for further exploration. This research utilizes Bluetooth connectivity tests through sealed metal cylinders made of cast iron, aluminum, and stainless steel to analyze the working of Faraday cages, explore related material properties, and isolate possible reasons for the conflict in expected behavior when the electromagnetic transmission is detected through such cages.

Methods and Materials

Initial Connectivity Test:
Testing Bluetooth connectivity between a smartphone and a speaker to check for transmission of signal through cylinders made of different materials

RF Signal Strength Test:
Using an RF receiver to measure the strength of an electromagnetic signal transmitted by an RF generator placed within different metal cylinders

Bluefruit Spatial Test:
Utilizing the Bluefruit LE Module in an Adafruit Feather to read the strength of the emitted Bluetooth signal when placed within a metal cylinder and connected to a smartphone outside the enclosure



Bluetooth Speaker

Handheld RF Spectrum Analyzer

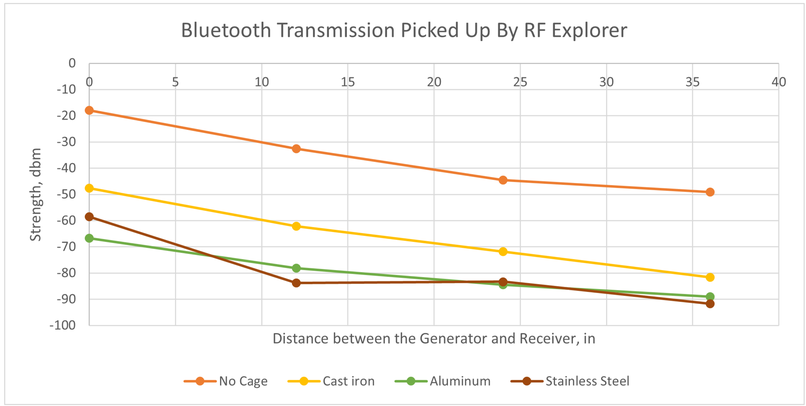
Handheld RF Signal Generator

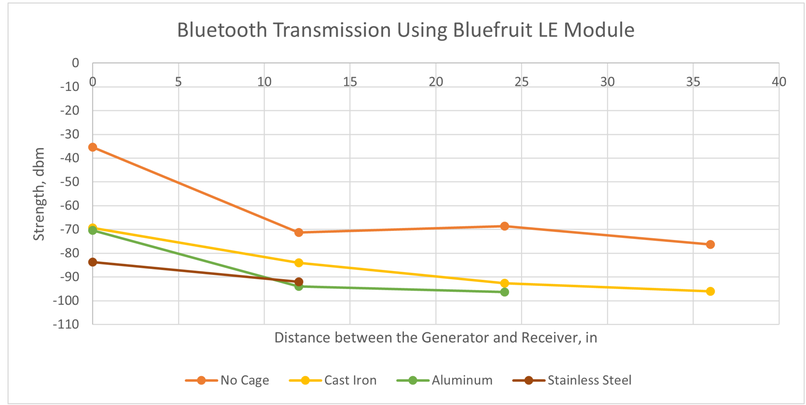
Results

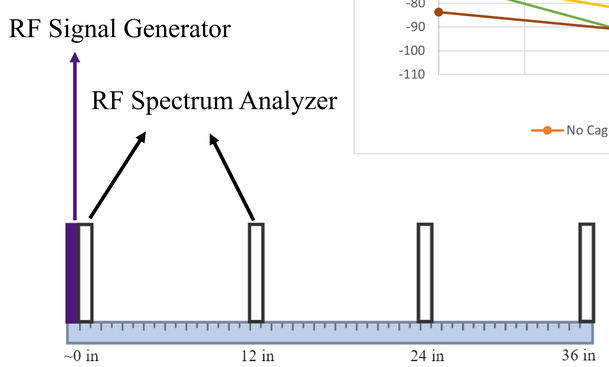

Cast Iron


Aluminum


316 Stainless Steel







Testing Set-up

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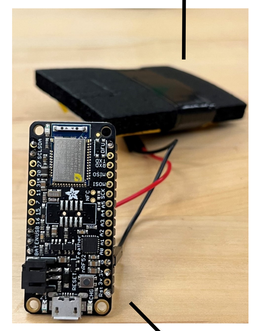
A metal enclosure is expected to act as a Faraday cage, which is a structure that blocks electromagnetic fields from transmitting across it. However, initial tests suggested the presence of Bluetooth transmission through a cast iron enclosure, resulting in this research that observes the working of Faraday cages when made of different metals. Through Bluetooth tests, we were able to capture the propagation of electromagnetic waves through all three metal cages used as well as compare the strength of the transmitted signal through the different metals.

3.7V Li-Po Battery


Adafruit Feather with Bluefruit LE Module

Bluefruit Connect App on IOS and Android

Conclusion

Our observations and experimentation have shown that certain types of metal cages that were expected to function as Faraday cages did not show expected behavior when tested with short ranged radio frequency waves. This conflict raises questions about the effectiveness of metal cylinders as Faraday cages for shielding against other types of electromagnetic waves, such as microwaves. The objective of our upcoming research is to investigate the effectiveness of metal cylinders as Faraday cages for microwave shielding. We aim to investigate the inconsistencies in the behavior of these metal enclosures while also making ground-breaking discoveries in this area of study, as the applications of our research are vast.