In the realm of modern technology, communication amongst devices is paramount to having embedded systems that work properly. Many systems that we use every day rely on data being transmitted and received. Imagine a world where your phone couldn't easily connect to the phone of your close friends or family. Or worse yet, imagine if a military base didn't have a stable line of communication with their pilots who need their assistance with navigation. Communication in embedded technology is everywhere – in our phones, our TVs, our smart watches, and even our dishwashers. The specific aspect of communication technology that I will expound more on are very high frequency (VHF) antennas.

What Are the Commercial Applications of VHF Antennas?

The VHF antenna offers many commercial applications such as television broadcasting, FM radio broadcasting, and long-range data communication (up to several kilometers). There are a plethora of companies who produce these VHF antennas such as radio companies, marine/boat companies, and standard educational companies. The types of VHF antennas on the market are also plentiful. Some common VHF antenna designs include VHF arrays, multi-element Yagi antennas, log periodic antennas, and conical array antennas. VHF arrays are simple dipole antennas with a reflector and director element added. A Yagi antenna also contains a director and reflector, but it can have a gain of up to 20 dB, making them popular for transmitting weak signals. Log periodic antennas are high gain antennas that operate on a broad frequency band. Lastly, conical array antennas have driven elements that are bent forward to make a conical shape (Wilhite). The cost of these antennas varies from about $10 for a flimsy, cheap option all the way up to upwards of $1000 for a more bulky, well-built one. Examples of VHF antennas on the market range from cheap mobile antennas for amateur radio to very expensive antennas for bulky aircraft or boats.

How Do VHF Antennas Work?

VHF antennas allow for data to be transmitted and received within the radio frequency range of 30 MHz to 300 MHz. The performance standards for VHF antennas include the maximum range it can transmit/receive data, the accuracy of data transmitted/received, how accurate it can communicate with moving targets, the gain of the signal received, and much more. How well an antenna can perform these operations depend on a few theoretical concepts such as radiation pattern, radio interference, the communication protocol the antenna uses, and much more. In antenna theory, radiation pattern is known as "the variation of the power radiated by an antenna as a function of the direction away from the

antenna" (antenna-theory). Radio interference, also known as electromagnetic interference, is when other devices that isn't the target transmits signals on the same frequency one is trying to receive a signal from. Finally, a communication protocol is set system that allows for multiple devices to communicate with one another. All frequencies on the radio spectrum serve a purpose. The frequency range at which VHF operates is where most FM radio broadcasting is done as well as come television broadcasting. It serves well for constant communication across long distances which makes it popular amongst the military, entertainment services, and amateur radio engineers.

What Are the Building Blocks for Implementing a VHF Antennas?

The elements for implementing a VHF antenna are very simple. Some antennas only require conductive material, such as copper rods. It is still an ongoing research to come up with a material that is optimal for antenna fabrication. "Innovative dielectric materials based on geopolymers represent a cost-efficient and eco-friendly alternative to current materials used in electronics and electric engineering applications … They have demonstrated that various high-k dielectric materials, i.e. zirconia (ZrO2), barium titanate (BaTiO3) and yttria (Y2O3) and with a high percentage up to 60%, can be added to geopolymers to improve the dielectric properties" (Vlasceanu). Antenna engineers have also been trying to minimize antennas so they can be more mobile. These researchers have used complex antenna shapes, loading techniques, and artificial magnetic materials to try to achieve a smaller antenna design. Antennas work with other hardware (such as communication devices and radios) and other software (such as communication protocols and antenna simulation software) to transmit data over a certain frequency.

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