

Multiband RFID communication using MTM-EBG matching networks

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RFID, Radio Frequency Identification, is a batteryless form of electronic identification. It is commonly used in supply chains, contactless cards and commercial stores to wirelessly identify tagged items. In the last few decades, a push to integrate sensing technology into RFID systems has been conducted with the aim of creating large sensing networks at extremely low cost. One of the key issues with current RFID sensing networks is the limited bandwidth of the RFID channel. In North America, this is 27 MHz with a range between 902 - 928 MHz and in Europe, 3 MHz, 865 - 868 MHz.

One of the most recent solutions, compliant with regulations, is to use both a high power and low power signal. The high power signal contains the protocol information turning the RFID chip on and the low power signal is used to sense at another frequency. During communication, the RFID chip modulates both frequencies. The modulated signals can then be read on an SDR reader where the RSSI and phase are captured. This technique is referred to in literature as virtual bandwidth (Y. Liu, R. Chen, Y. Zhou, M. Liu, Y. Hui and N. Cheng, "RFID-Based Vehicle Localization Using Virtual Wideband Multi-Frequency Continuous Wave," in *IEEE Journal of Radio Frequency Identification*, vol. 7, pp. 222-232, 2023, doi: 10.1109/JRFID.2023.3287327.). This multi-band technique can improve asset tracking accuracy, sensor reliability and read ranges as tags can harvest energy at other frequencies.

Currently, literature has utilized a virtual bandwidth between 700 MHz - 1 GHz but has not exceeded this range. Interestingly, most commercial tags operate at much higher frequencies, such as tags by IMPINJ. These IMPINJ ICs have been tested at 2.4 GHz with modified commercial readers as demonstrated in (N. Barbot, "Hands-on 2.4 GHz RFID," 2023 IEEE 13th International Conference on RFID Technology and Applications (RFID-TA), Aveiro, Portugal, 2023, pp. 245-247, doi: 10.1109/RFID-TA58140.2023.10290216.). We have also verified tag operation of the Higgs 4 RFID chip by Alien technology up to 3 GHz and the NXP G2IM chip at 2.4 GHz.

In this work, we demonstrate multi-band RFID communication of the Higgs 4 chip by utilizing a MTM-EBG matching network. The MTM-EBG is a planar, passive circuit capable of providing multiband matching to an arbitrary impedance in a compact form factor. Tag operation at both frequencies is shown and discussed in both a virtual bandwidth and direct communication sense. Furthermore, we will discuss the broadband impedance of the RFID chip between 10 MHz - 10 GHz in its power harvesting state across various power levels. Our results show that the impedance is highly non-linear between 10 MHz - 4 GHz. This is important as designers must consider what power level to design for to maximize both backscattered power and read range.