Low Power Reflection Amplifier using extracted S-parameter of Tunnel Diode in RFID Application

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Radio-frequency identification (RFID) systems rely on back-scatter communication where the tag reflects some portion of the received signal from an interrogator. The amount of reflection depends on the antenna terminated load in the tag. The integrated circuit in the tag selects different load to modulate the antenna Radar Cross Section (RCS). This variation in RCS causes a modulation of the scattered signal and it can be read in the reader. The most challenging issue in passive RFID systems is their short-range communication. This occurs because only a small portion of the received signal is reflected and the received signal experiences path-loss two times: when it is received and when it is scattered again.

Many solutions have been proposed to increase the coverage area of backscatter communication systems including using a retro-directive antenna or reflection amplifiers. The retro-directive antenna needs an array of antennas, which is not desirable in low profile RFID systems. Thus, using a reflection amplifier is a prominent way to increase the range of communication in RFIDs. Reflection amplifiers show a reflection coefficient with magnitude larger than one due to their negative input impedance. It means that the reflected signal experience a gain in the amplifier port. There are several ways to generate a negative input resistance by properly terminating a transistor or using devices that have negative input such as Gunn or tunnel diodes. Tunnel diodes have low profile and ultra-low power consumption, which make them good candidates for RFID applications.

In this presentation, a reflection amplifier to increase backscatter efficiency and communication range in RFID systems is proposed. We measured the S-parameter characteristic of the tunnel diode using the TRL method. The extracted data was used to design the reflection amplifier to operate at 890 MHz for the RFID UHF band. We checked the output frequency spectrum to monitor any unwanted spurs to avoid Signal to Noise Ratio (SNR) degradation. This reflection amplifier consumes 0.2 mW DC power at bias voltage of 200 mV, making it an ideal candidate to amplify backscattered electromagnetic field in RFID transceivers. The gain of the proposed reflection amplifier is 17 dB for the incident power of -30 dBm. We fabricated a prototype circuit that shows a good agreement between simulation and measurement.