

Lab #6 – Design Project

In the final lab for this course, you will be engaged in the specification and design of a radio receiver conforming to an IEEE standard.

Introduction

For wireless devices to interoperate with one another, they must follow the same standard. For example, you can take your laptop and connect to WiFi networks anywhere in the world. This is possible because all WiFi or Wireless LAN devices adhere to the same standard, IEEE 802.11.

Many wireless standards fall under the auspices of the IEEE, with a notable exception being the cellular phone standards. The IEEE 802 standards are the governing documents for many familiar wired and wireless networks:

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|---------------|-----------------------------------|
| 802.3 | CSMA/CD Access Method (Ethernet) |
| 802.11 | Wireless LANs (WiFi) |
| 802.15 | Wireless PANs (Bluetooth, Zigbee) |
| 802.16 | Broadband Wireless MANs (WiMAX) |

For this lab we will be focusing on 802.15, which houses various standards for wireless Personal Area Networks (PAN). PANs are targeted for applications with a range of about 10 m, and Bluetooth is a familiar example of a wireless device that falls into the 802.15 group.

Project Objective

IEEE 802.15.4, also known as Zigbee, is a standard for wireless personal area networks. The standard specifies two different physical layers: one for 868 / 915 MHz operation, and the other for 2450 MHz operation. Within North America, both 902-928 MHz and 2.4-2.5 GHz correspond to the unlicensed bands known as the ISM bands (Industrial, Scientific, and Medical). Emission limits in the unlicensed bands are governed by the FCC in the United States, and Industry Canada in this country.

The IEEE 802.15.4-2006 standard is a lengthy document, and contains the specifications for both the physical layer and media access control (MAC). A copy of this standard is available on the course web site. You may be glad to know that the bulk of this document is devoted to the MAC, and your focus for this project is solely on the physical layer. Prior to the lab, you are expected to review the document, look for the relevant sections, and make notes such that you are ready for discussion with your instructor and

classmates during the first lab session. You will be assigned one of the two possible physical layers (900 MHz or 2.4 GHz) prior to the lab.

The first objective in this project is to create a specification for a radio receiver, including the overall Noise Figure and IIP3 requirements. This will require looking for the relevant specifications in the standard (eg. minimum receive sensitivity), and converting this information into requirements for the radio receiver.

The second objective in this project is to take the receiver specification that you had created, and translate it into a block diagram consisting of a LNA, mixer, and other blocks as needed. Each block must be sourced from a commercially available part, and companies such as Mini-Circuits, RF Micro Devices, and Maxim can provide a good starting point. The cascaded block diagram must meet the NF, IIP3, and any other specifications you had set out previously.

Project Deliverables

As a minimum, the report for this project must contain the following:

- A radio receiver specification that will satisfy the IEEE 802.15.4-2006 standard. Provide clear documentation on how you arrived at the specification, such as calculations and simulation results. It is expected that you will need to do some research to complete some calculations. However, cutting and pasting results from some website is not acceptable.
- A radio receiver block diagram containing LNA, mixer, and other components such as an antenna switch, channel filter, and variable gain amplifier (AGC). Each block must have a realistic spec attached to it, and should be sourced from commercially available parts. You must provide supporting calculations and show that the block diagram meets the receiver specification that you had created.

Report Due Date: Beginning of class on Wednesday, May 7.