

RF Wireless Interface

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Abstract

This project was focused on designing and producing a bi-directional RF data link. It shall be compatible with a RS-232 serial interface and should also implement the IEEE 802.15.4 standard for wireless communications. The goal of this design is to provide a proof of concept for future wireless applications designed by Attero Tech.

The 802.15.4 standard was chosen to satisfy the requirement of a low power application while maintaining a moderate data rate (250kbps).

Background Information

Wireless technology and research in the field of wireless technology has rapidly increased in the last decade. For instance, in a January 2005 Gartner Inc. survey, 1300 CIOs (Chief Information Officer) labeled wireless-related technologies first and third on their priority lists for that year.

The industry sponsor for this project, Attero Tech, requires the use of the IEEE standard 802.15.4. This is the 15th working group of the IEEE 802 which specializes in wireless personal area network (WPAN) standards. It includes four task groups that are indicated by the last number. In the case of this specific design, 802.15.4, the fourth task group will be used. Task group 4 is a low rate WPAN that deals with low data rate but very long battery life and very low complexity.

Among other wireless communication protocols, the 802.15.4 spectrum is located in the 2.4 GHz ISM band (Industrial, Scientific and Medical band).

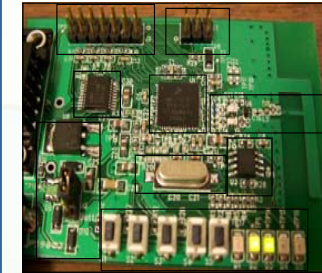
Requirements/Specifications

The following is a list of design parameters that were outlined by Attero Tech. These parameters form the basis of the design.

- ❖ Bi-directional data transfer – This design must be able to transmit as well as receive data with minimizing the raw error rate.
- ❖ Baud Rate – A maximum baud rate of 57,600 baud is desired while a minimum of 19,200 baud in each direction is required.
- ❖ Minimum Connection Distance – A minimum connection distance of 50 feet through one wall at a baud rate of 19,200 is required.
- ❖ Wireless Compatible – This design must comply with the IEEE 802.15.4 standard. This involves choosing components and hardware that are 802.15.4 compliant.
- ❖ Components – As previously stated chosen components must be 802.15.4 compliant. Components must also fit a certain size requirement that will allow them to comply with the form factor designated by Attero Tech.
- ❖ PCB – The PCB should be implemented as a two layer PCB.



Physical Components



Component Network Key

- MCI3213
- I/O Header
- Power Network
- Switches and LEDs
- Crystal Oscillator
- RF Network
- BDM Port
- EEProm
- RS-232 Transceiver

Software



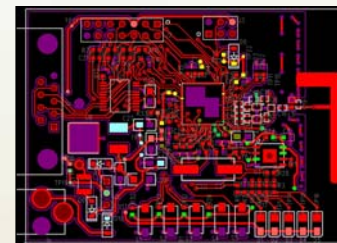
Programming – The main application used to work with the software on the board was Freescale's Codewarrior Development Studio. In addition, to help write the software, we used Freescale's BeeKit to ensure that 802.15.4 compatibility was met in our tests. The 802.15.4 standards included special standards dealing specifically with automatic Cyclic Redundancy Error Checking, as well as standards for acknowledgement (ACK) and non-acknowledgement (NACK) signals. These 802.15.4 compliant BeeKit applications implemented an energy detection scan to allow for network efficiency within a crowded band.

System Conditions

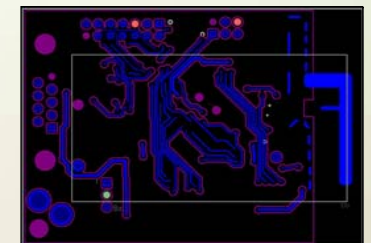
Environment – The overall goal of this design is to correctly receive and transmit data indoors through a minimum of one wall. Various different mediums will be considered and used in order to better understand the capabilities and limitations of the system. Any improvements that can be made on the operating conditions will be considered by the design team.

Range – This design should be able to correctly receive and transmit data at a minimum of 50 feet. Any improvements that can be made upon this minimum range requirement will additionally be considered by the design team.

Board Layout



Top Layer



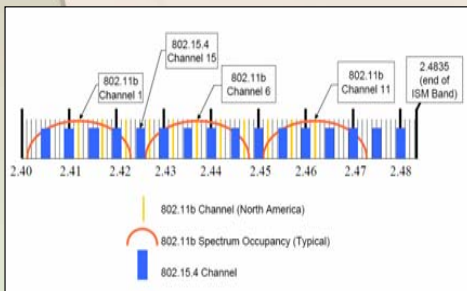
Bottom Layer

A printed circuit board design was chosen to minimize the overall size of the board and increase the turn around on mass producing the circuit. The board layout was chosen to be a two layer board. This design was created by the IPFW senior design team using Mentor Graphics – Pads (PCB Design Suite). The design was then sent to Advanced Circuits to be mass produced.

Results

- ❖ RF Performance
 - ❖ Desired Range Exceeded (65 Feet)
 - ❖ Signal Strength Penetration Exceeded (6 Walls)
- ❖ UART Performance
 - ❖ Baud Rate Exceeded (57,600 baud)
- ❖ Link Robustness
 - ❖ Raw Packet Error Rate Test Performed
 - ❖ Measured at different ranges with multiple interferences

Residential Testing	Raw Packet Error Rate
Distance and Medium	Good Packets out of 1000
10 ft / 1 wall	998
20 ft / 2 walls	999
50 ft / 3 walls	999
80 ft / 3 walls (interior to exterior test)	661
50 ft / 3 walls (CH 9 Microwave test)	235



2.4 GHz ISM Band