

# Digital Communications – SDR Project

## Guide to Work through the 802.11a Receiver Article

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### Week 1

- Lookup the 802.11a OFDM system design parameters
  - Bandwidth, sub-carrier spacing, number of sub-carriers, IFFT/ FFT size, number of data sub-carriers, number of pilot sub-carriers
  - Why are there unused sub-carriers and where are they located?
  - OFDM symbol duration, sampling rate, OFDM symbol length (samples), cyclic prefix length
  - Frame prefix sequence, length, repetition, duration
- Read section 2.1 and understand what it means
  - Where are the mentioned tags?
- Work yourself through Section 2.2
  - Identify the blocks that calculate the autocorrelation
  - Identify the blocks that calculate the power
  - Try to obtain a graph like Figure 2
  - Explore the effect of varying  $N_{win}$ , e.g. in the graph like Figure 2
- Week 2
  - Understand the *OFDM Sync Short* block
    - What does the block do
    - What is the meaning of the thresholds
    - Explore the effect of changing the thresholds
    - Understand the limitations of the approach taken, and try to demonstrate a case where it breaks
- Week 3
  - Understand the block *OFDM Sync Long* (Section 2.3)
  - Understand the algorithm for frequency offset correction.
    - Where it is implemented?
    - Which parameters could you vary?
    - Why is there a delayed input? Could you change that value and what would the impact be of doing that?
- Week 4
  - Understand symbol alignment (Section 2.4)
    - How is symbol alignment done (algorithm logic)?
    - Why is matched filtering used for symbol alignment but not for frame detection?
    - Have a look at the code that implements equation 6.
    - Why do you add 64 in expression 7?

- What does the stream to vector block do?
- Week 5
  - Understand Phase Offset Correction (Section 2.5)
    - Why do you need to correct the phase?
    - Find the code that estimates the phase offset
    - How are you correcting the phase, i.e. which values are being changed?
- Week 6
  - Understand the *OFDM Equalize Symbols* module
    - What does it do?
    - Why is the implementation limited to deal with BPSK and QPSK modulation?
    - Which other functions are performed in this block?
  - Work through Section 2.7
    - Look up the frame format for 802.x frames and how the data in the initial fields is transmitted. You are already looking into the MAC layer.
      - Recall what you learned in Computer Networks course about framing. How can you delimit a frame?
    - What is the Signal Field? Which information is sent there? Why is this information necessary?
    - How is that information encoded?
- Week 7
  - Work through decoding the payload (Section 2.8)
    - Which abstract receiver blocks are within the module *OFDM Decode Mac*?
    - How many constellation symbols are demodulated at once? Why? Can you change this? What is the impact of changing this?
      - What is the actual process of digital demodulation? What is the input and the output, and how is the conversion done?
      - Look at the code if necessary.
    - Understand what is de-interleaving.
      - Watch the video in Panopto explaining what is de-interleaving.
      - Find the code that does de-interleaving and understand it.
    - Understand de-scrambling
      - What is scrambling/ descrambling? Why is it used?
      - How can the receiver de-scramble without explicit knowledge of the scrambler initial state?
        - Which fields of the received frames are used and how?
- Week 8
  - Understand the decoding (Section 2.8)
    - Will add detailed questions about the decoding later
  - Try out your 802.11a receiver with a real 802.11a access point. Can you see the received frames?
    - Read Section 8 (Interoperability)