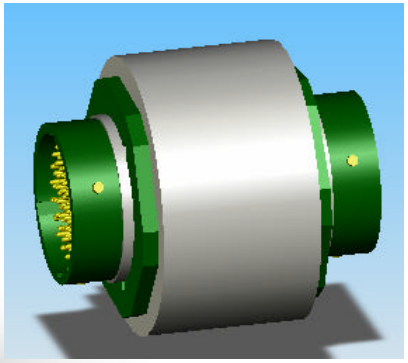
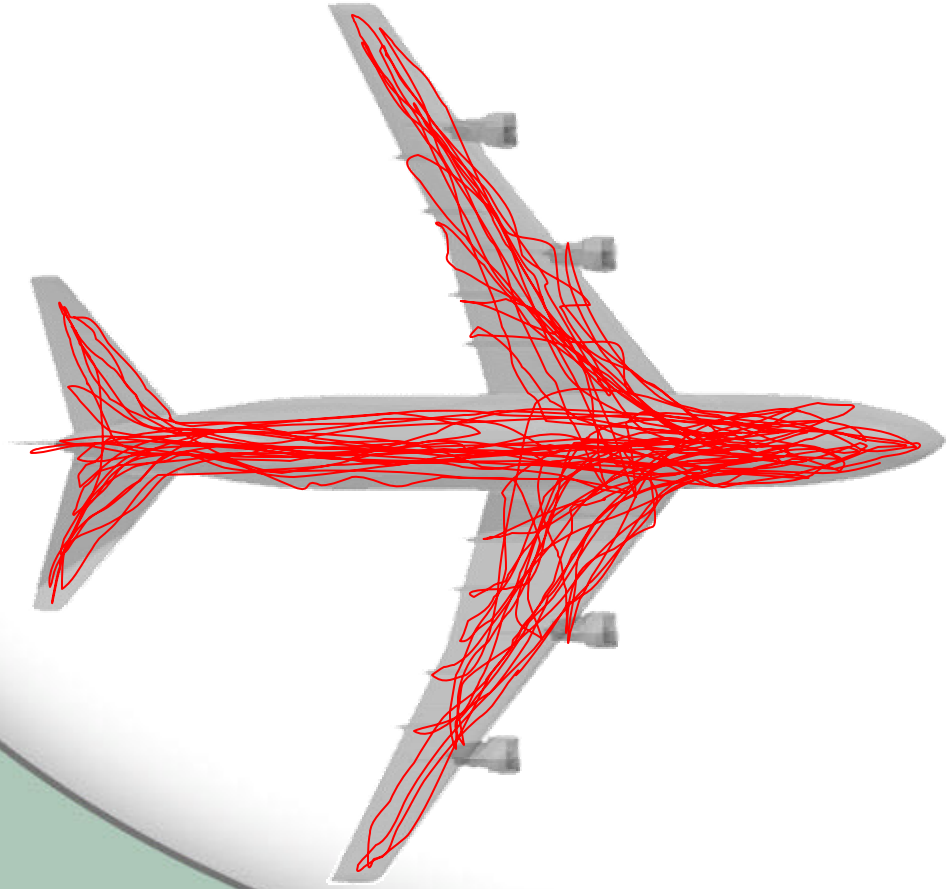
Data integration
in
Multicarrier Reflectometry Sensors

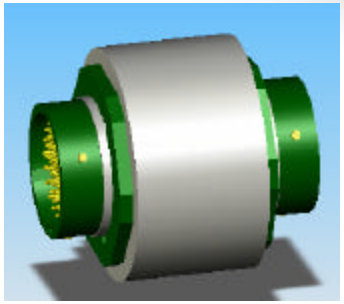


by
Afshin Edrissi

Introduction

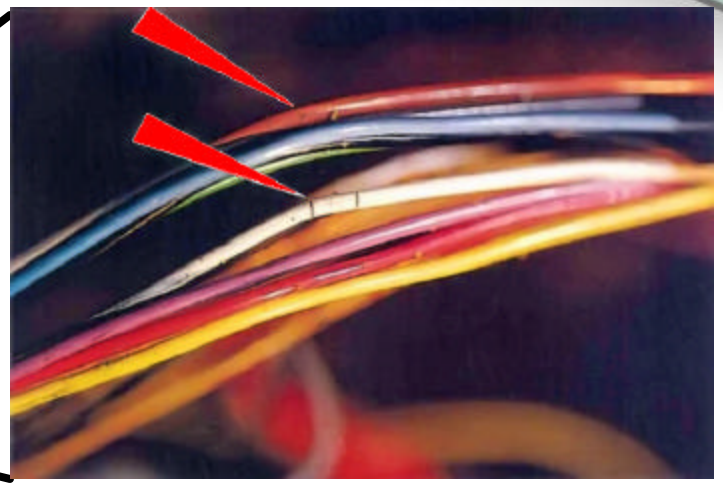
- What is a Smart Sensor?

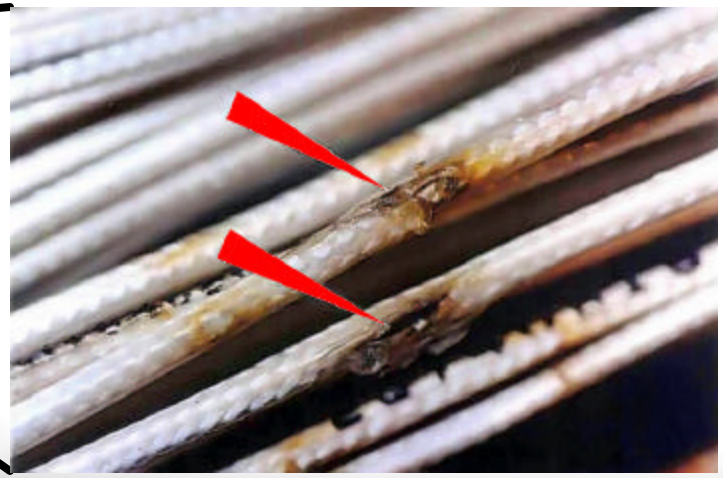




Introduction

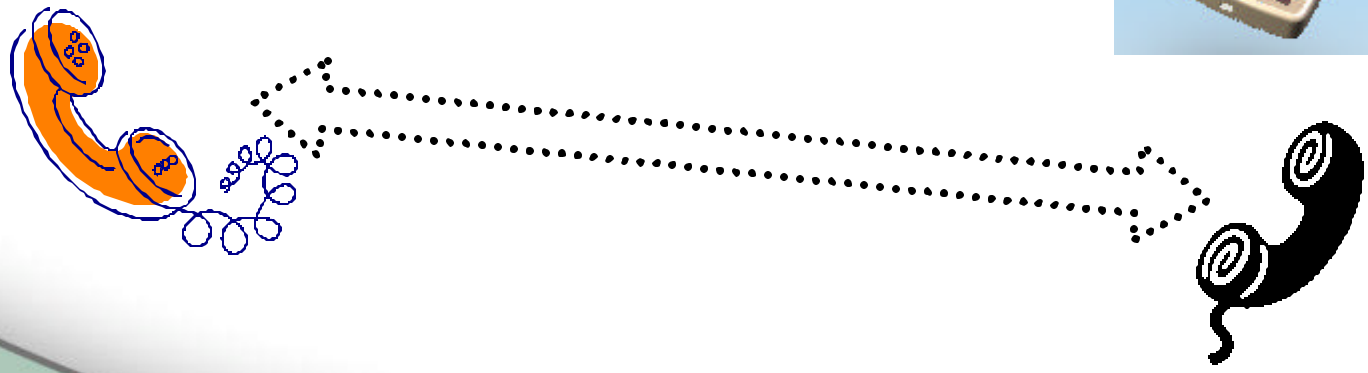
- Important to detect faults to prevent hazards





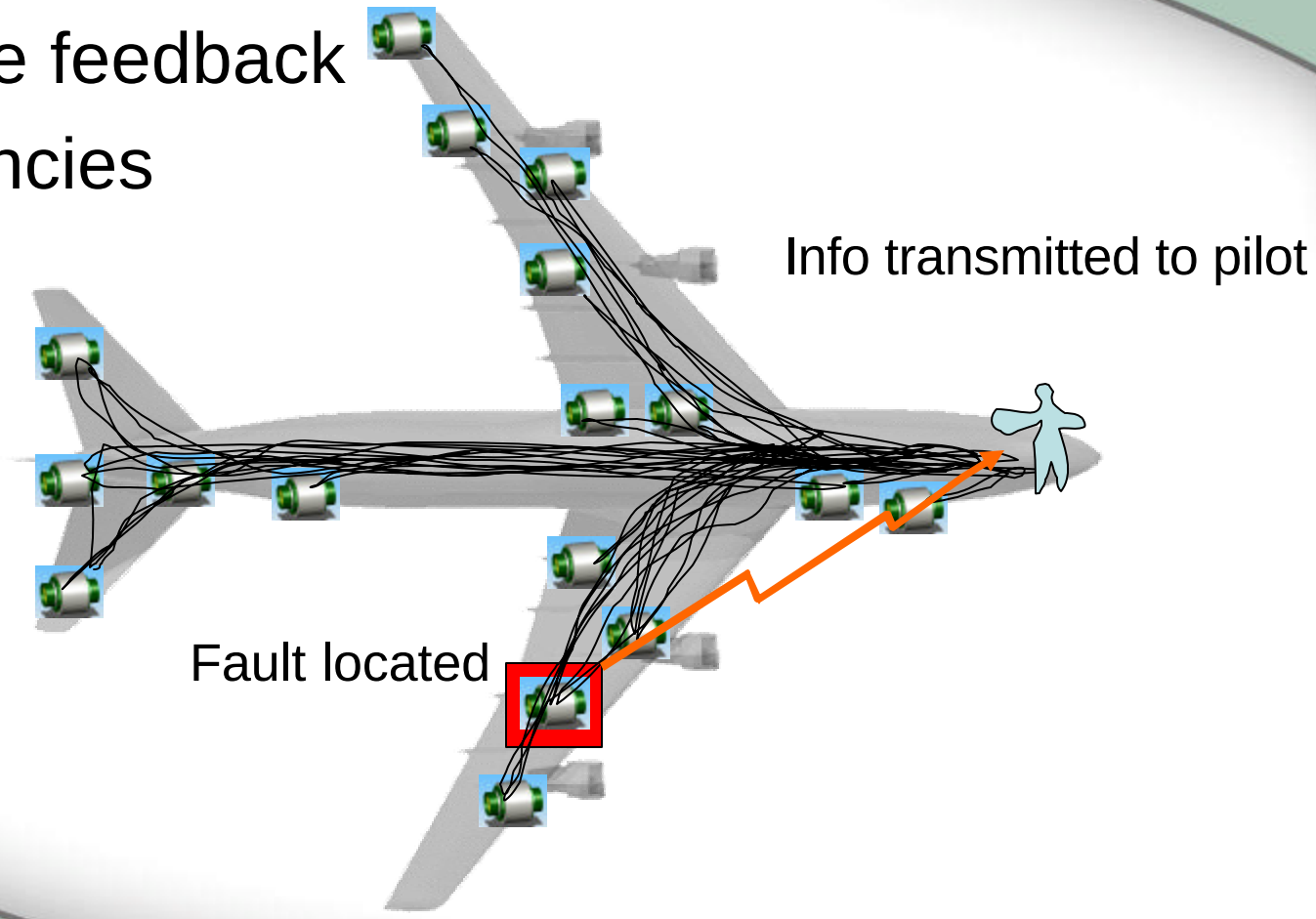
Purpose and Function

- Why Data communication?
  - Communicate to the outside world
  - Increase the capability of the sensors
  - Expanding the capabilities to new applications

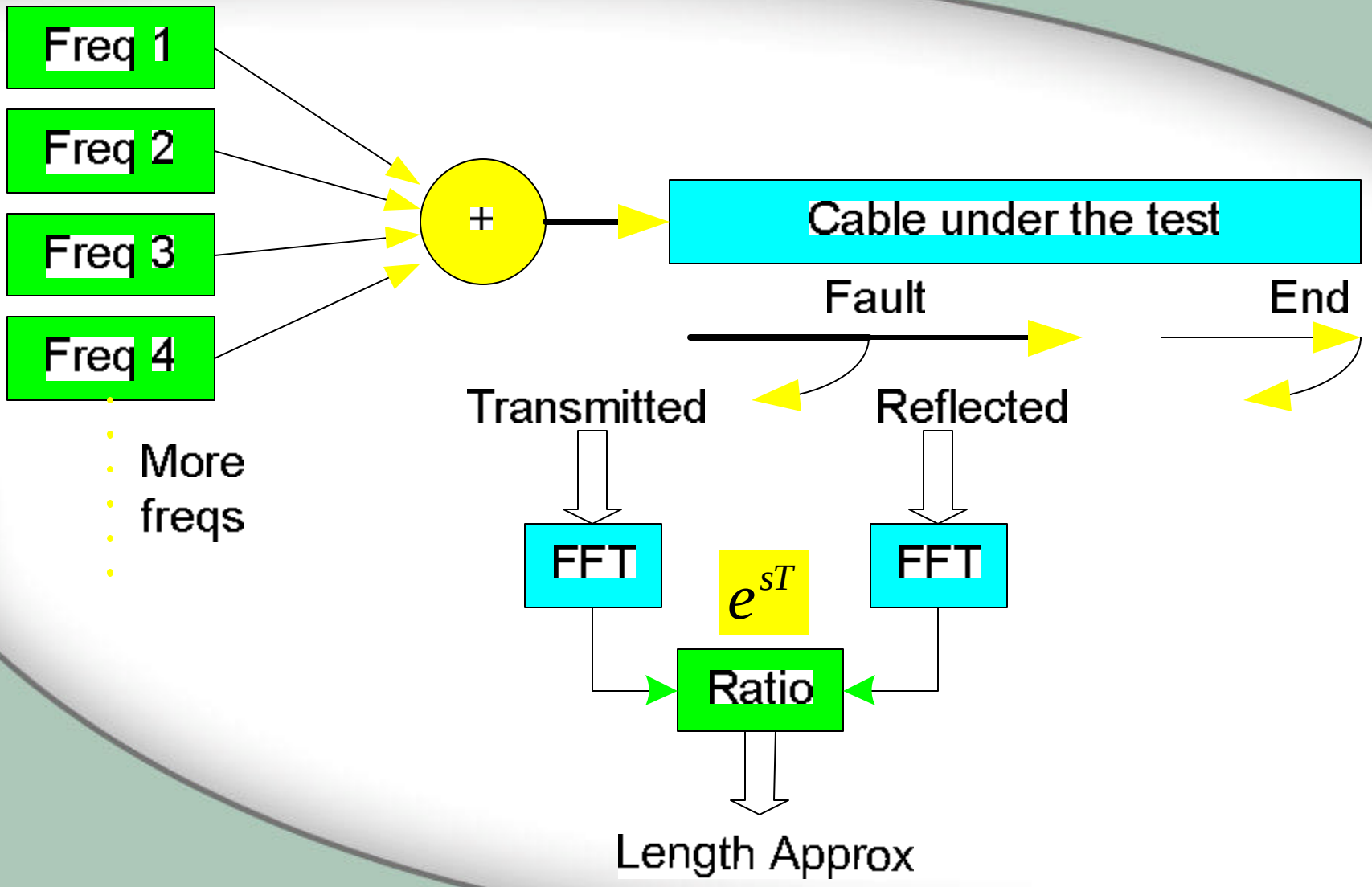


Purpose and Function

- Example
  - Real-time feedback in emergencies



Purpose and Function



Project Design

- Design Specification:
  - Designed for up to 100 ft cables
  - Can operate without interference to existing systems
  - Uses the unused portion of frequency spectrum

Project Design

- Simulation
  - Matlab and Simulink
  - Xilinx ISE and Modelsim
- Implementation
  - Xtreme DSP
    - Analog to Digital Converter
    - Digital to Analog Converter
    - Field Programmable Gate Array (FPGA)
    - LEDs and other analog components

Project Design

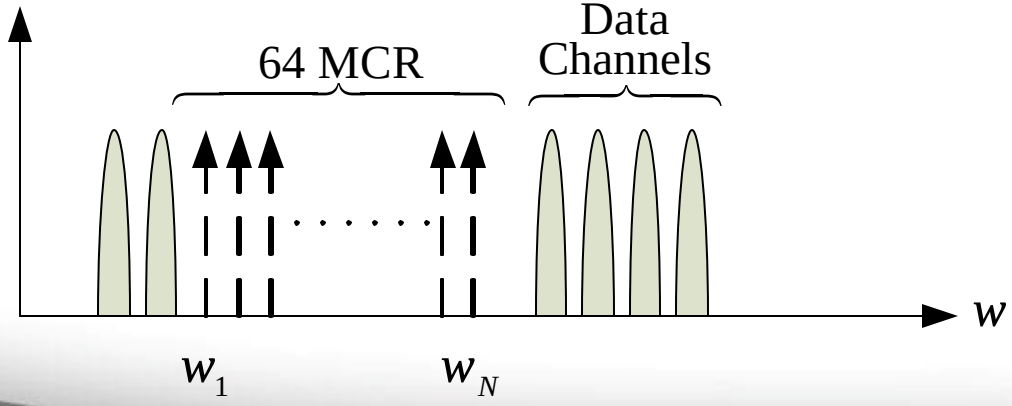
- Goals
  - Digital Signal Processing (DSP)
  - Minimum of 2kHz per data channel
  - Minimum of 24 real-time adjustable channels
  - Adjustable in frequency spectrum

Data Integration

- Possible integration methods
  - Use the MCR waves to transfer data
    - High hardware and software cost
    - Difficult to implement
    - Lower accuracy on the detected faults

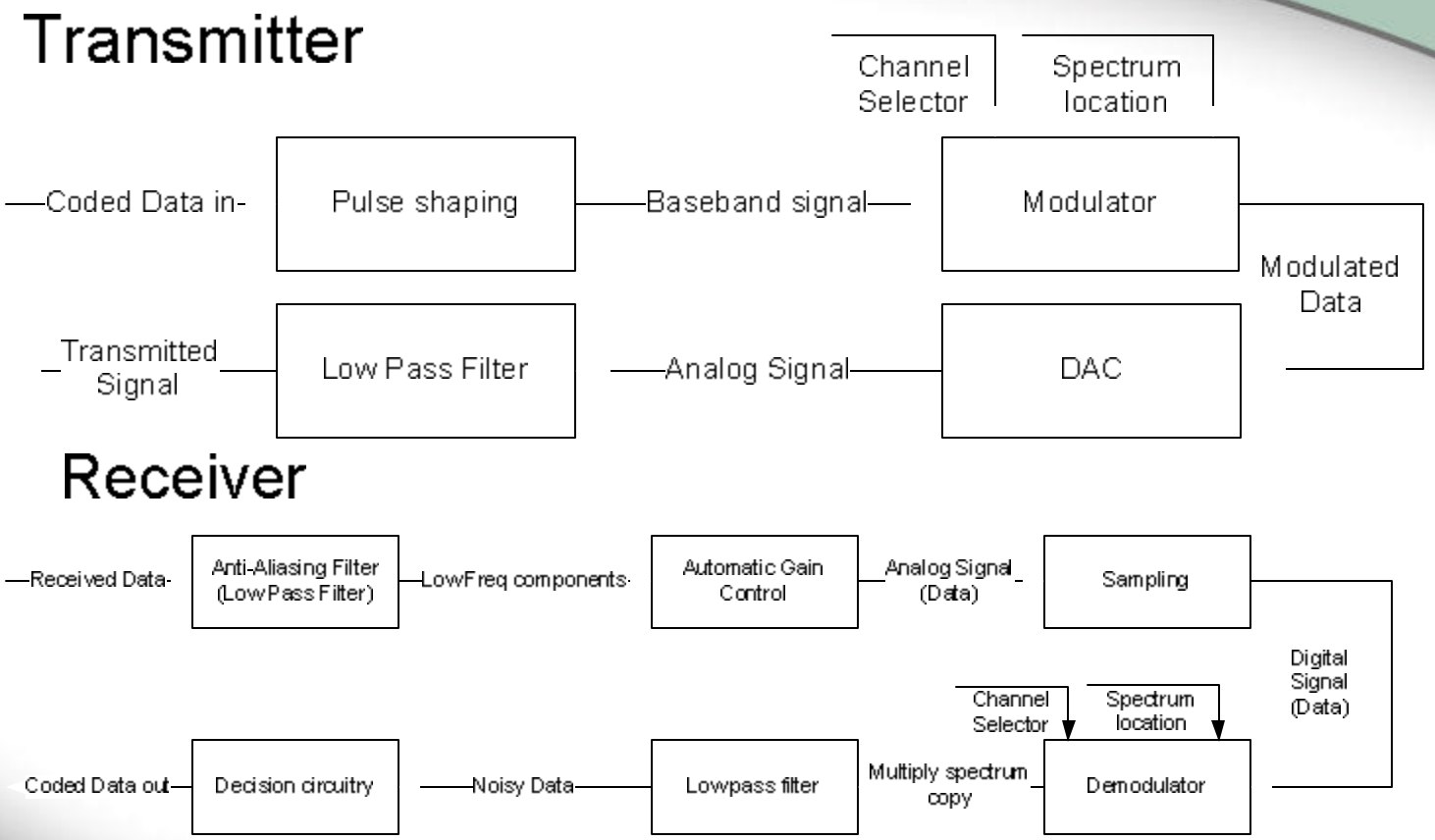
Data Integration

- Possible integration methods
  - Use the unused frequency spectrum
    - More beneficial and cost effective
    - Many algorithms to modulate
      - ASK
      - FSK
      - BPSK
      - Many more to achieve high data rate

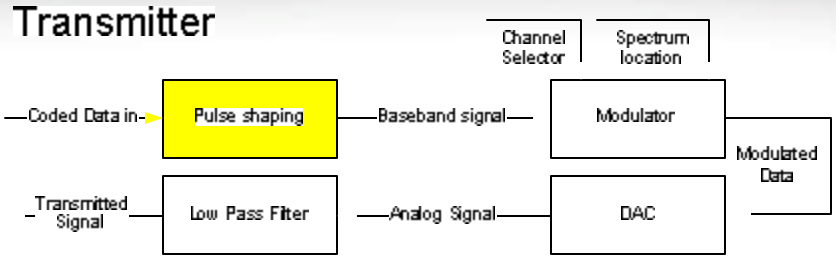


Data Integration

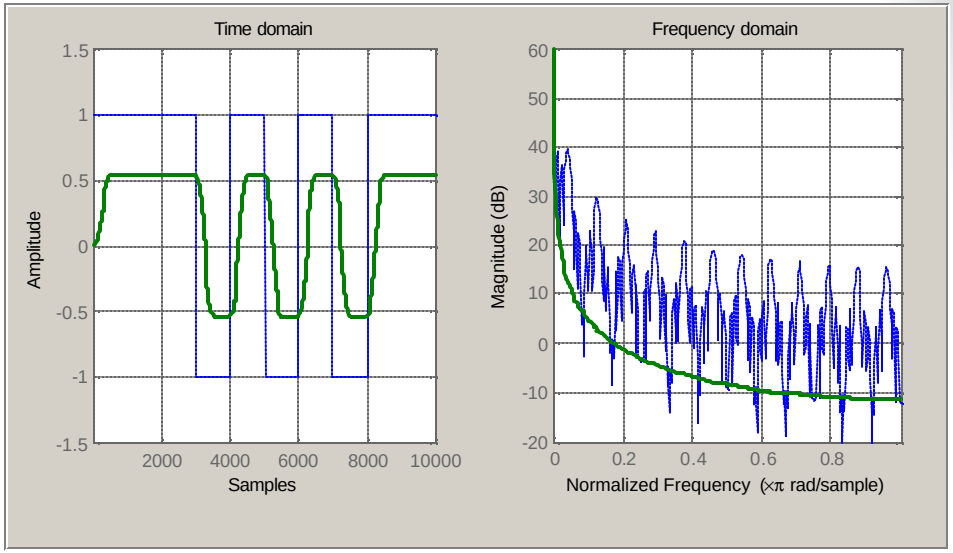
- Overall system



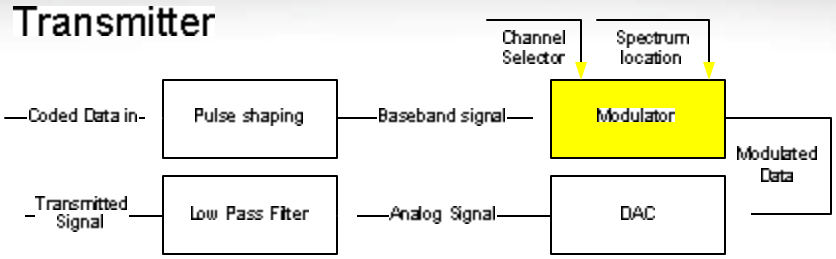
Data Integration



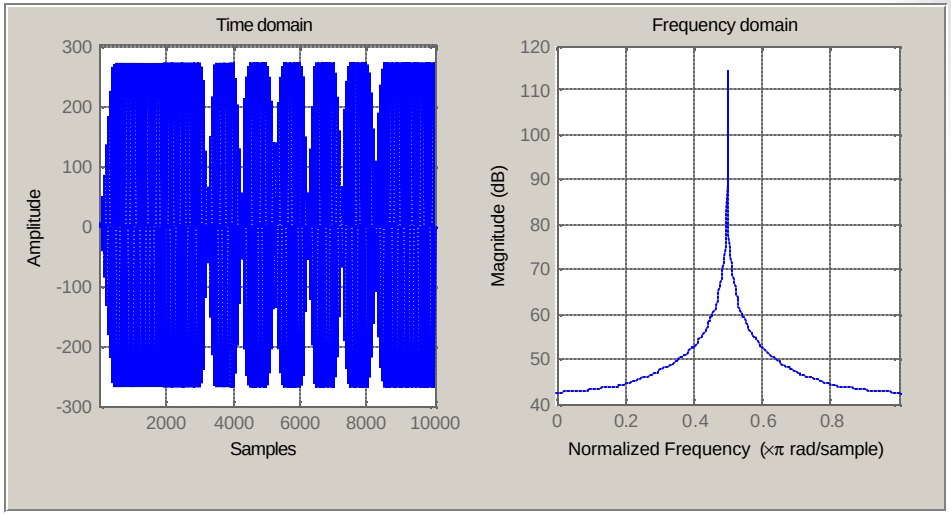
- Pulse shaping (hamming)
  - Filter to limit the frequency spectrum
  - Removes high freq components of coded data



Data Integration



- Modulator
  - Shifts the signal in frequency spectrum



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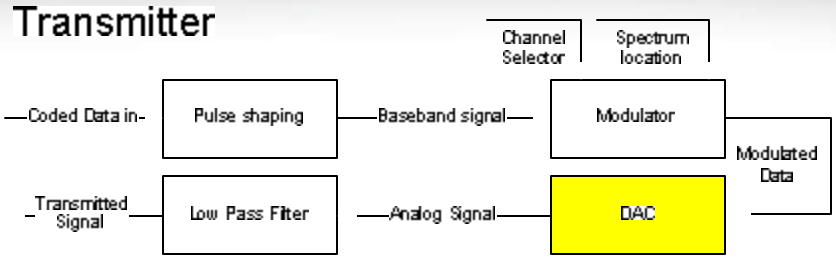
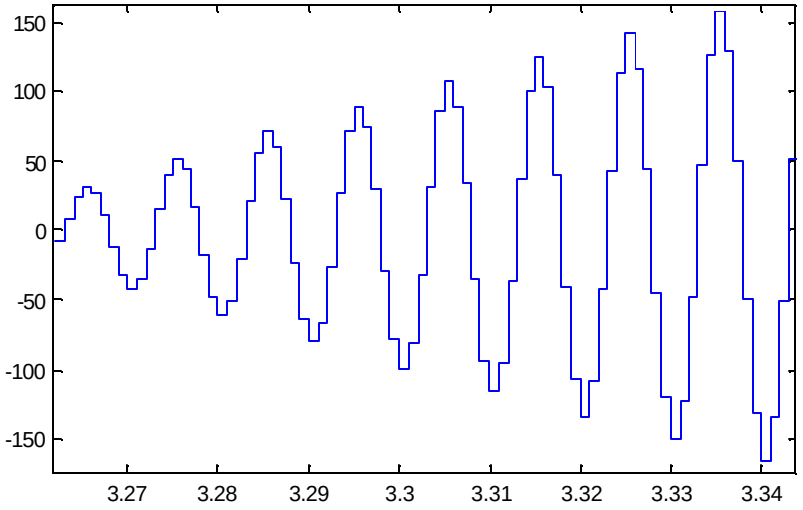
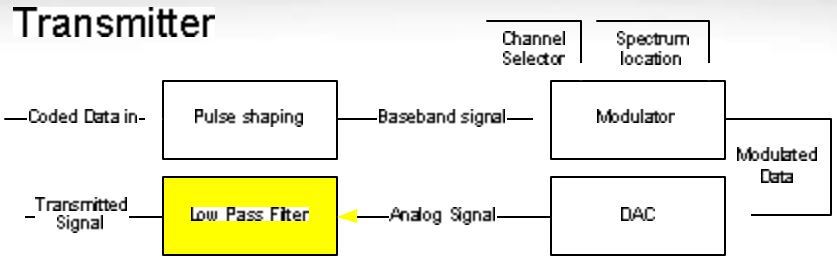


- Digital to Analog Converter
  - Converts to analog in order to transmit

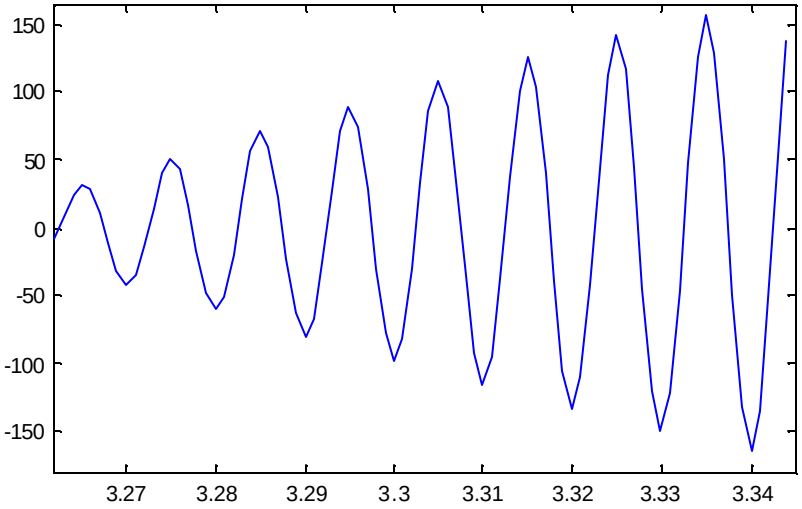


-8.0180, 8.6319, 24.2043, 31.9007, 27.4103, 11.0809, …

Data Integration



- Low pass filter
  - Removes high freq
  - smooth signal
  - Uses lower spectrum



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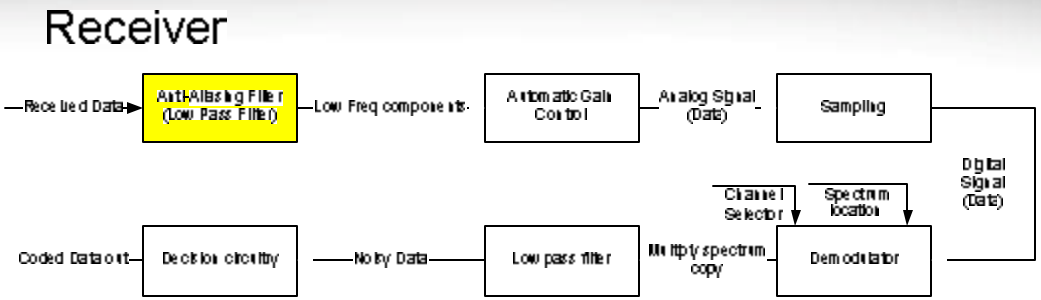
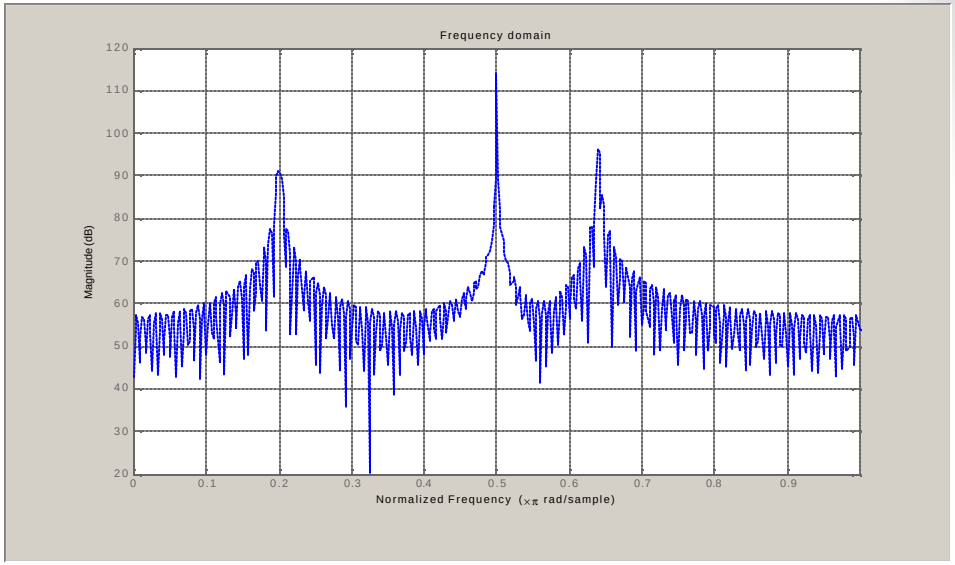


- Anti-Aliasing Filter
  - Limits the freq spectrum to Nyquist Freq of sampling



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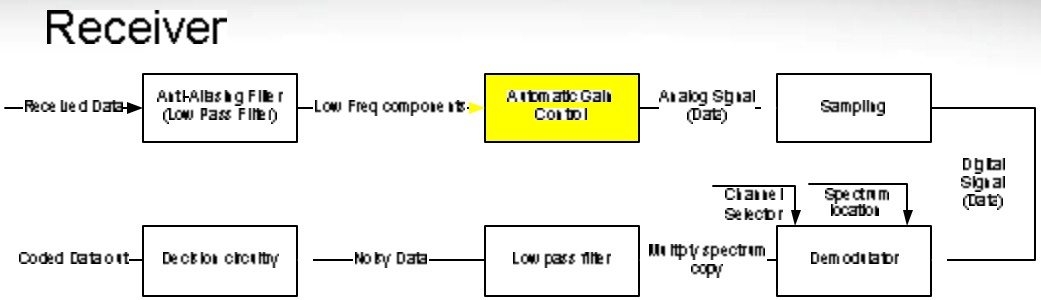
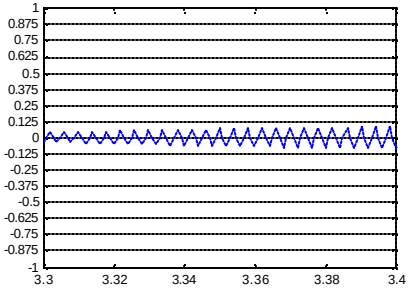
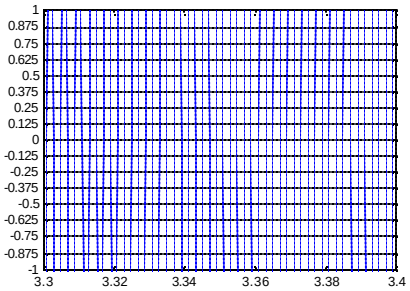
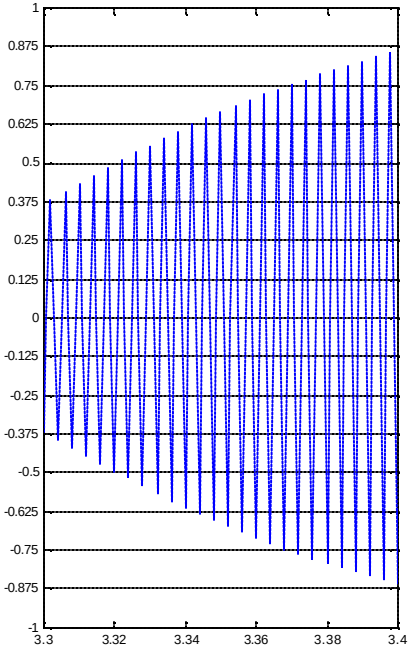


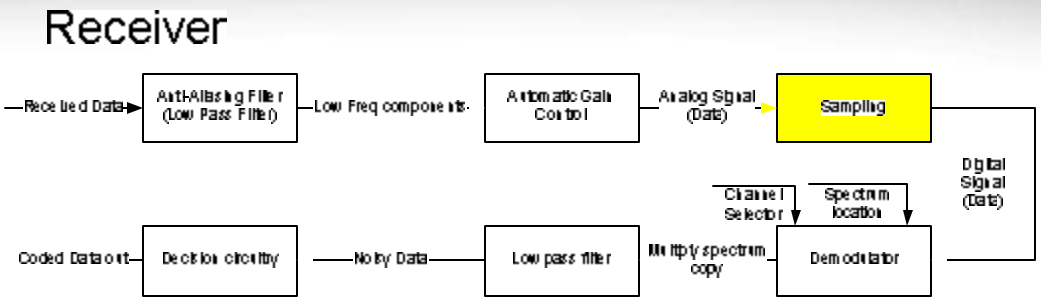
- Automatic Gain Control
  - Signal is not too small for the sampler
  - Signal is not saturated for the sampler







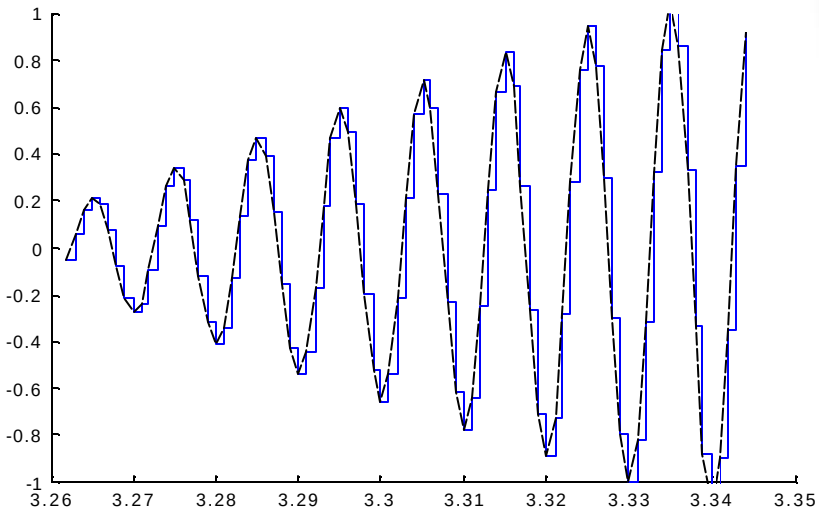
Data Integration



- Sampling

(Analog to Digital Converter)

  - Brings the Signal for digital processing



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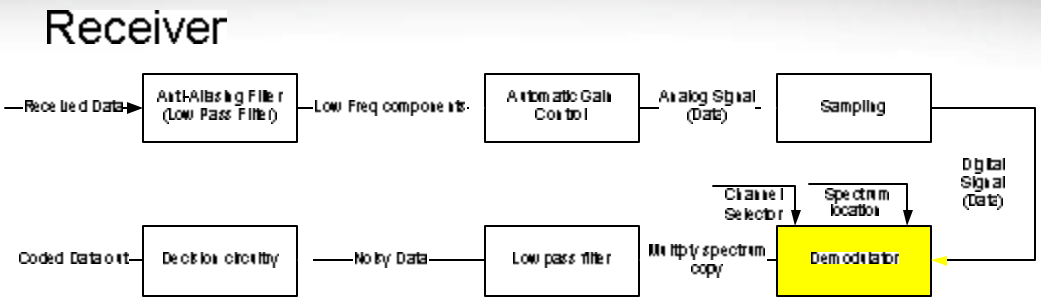
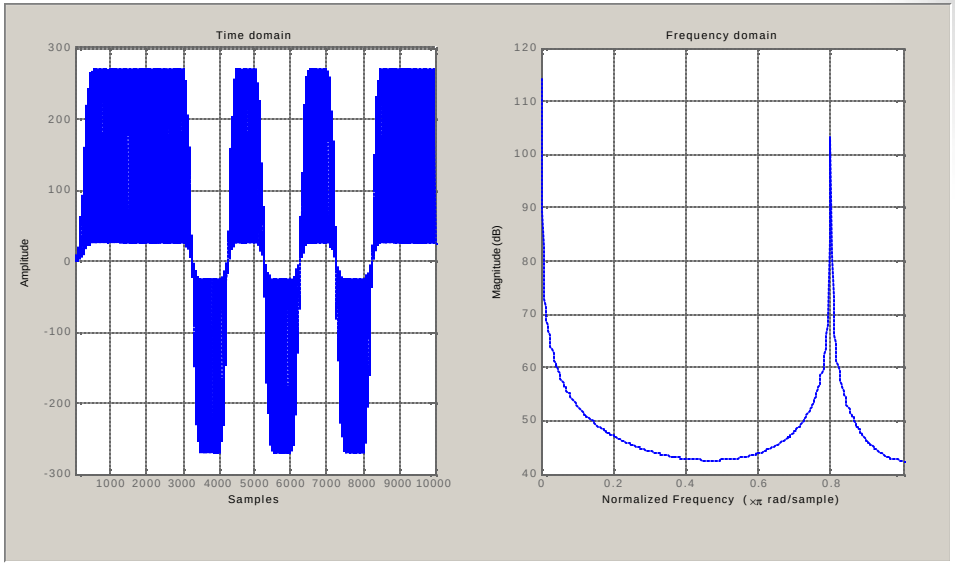


- Demodulator
  - Shifts the freq
  - DC and 2xCarrier



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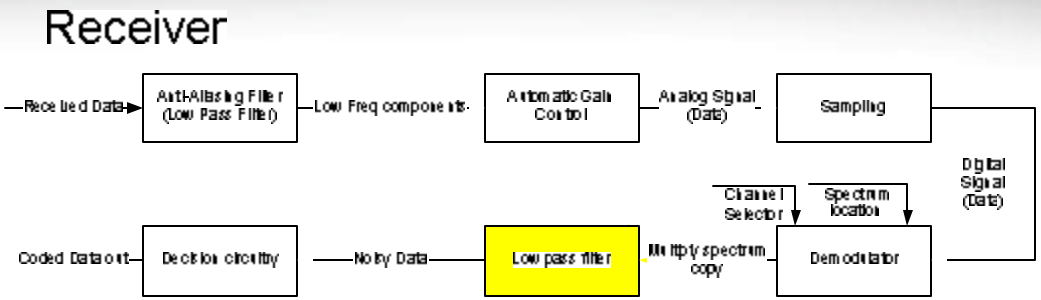
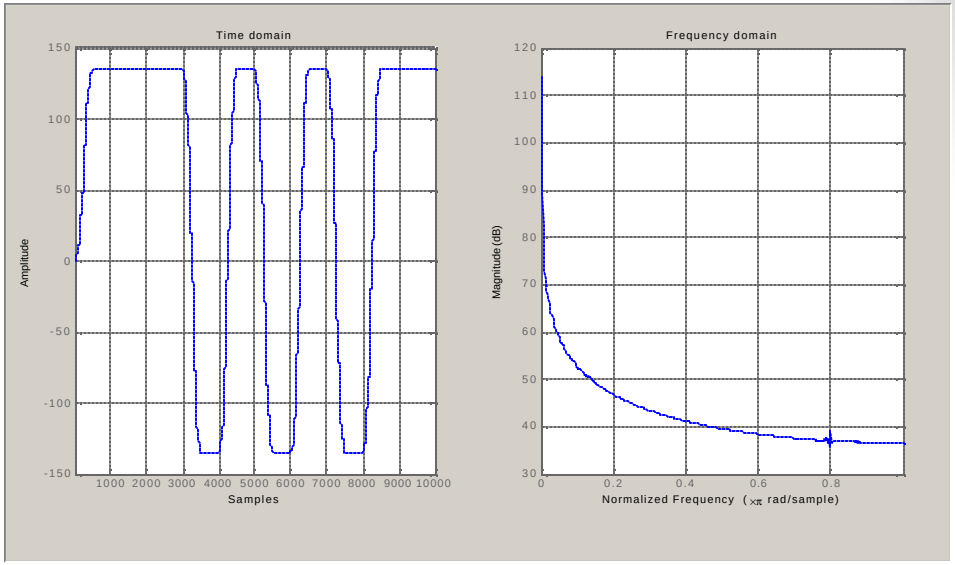


- Low pass filter
  - Removes the high freq components
  - Cleans up the signal



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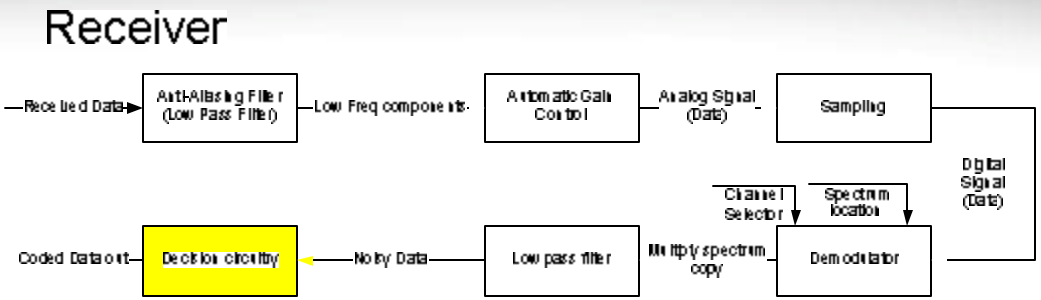
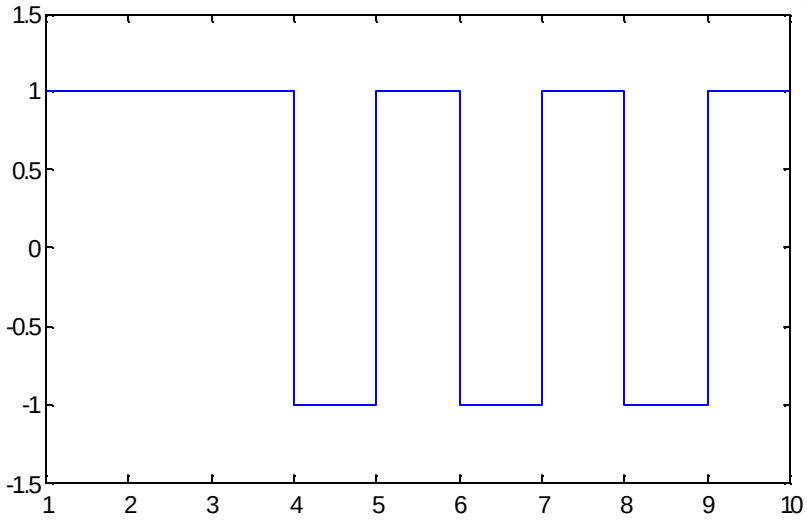
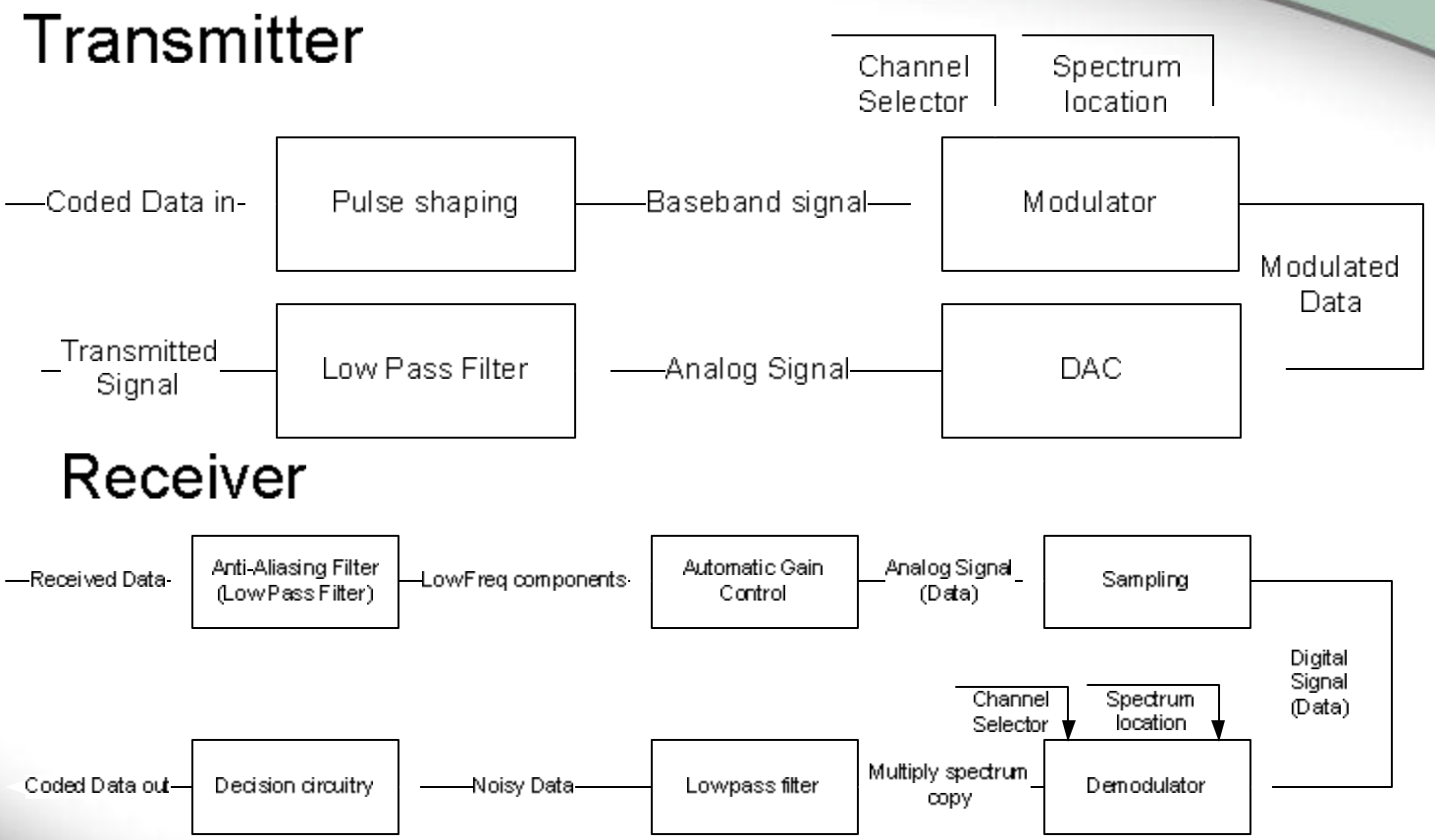


- Decision Circuitry
  - Removes the noise
  - Compares to zero and produces clean digital output



Data Integration

- Overall system



Conclusion

- Achievements
  - 28 Real-time adjustable channels
  - 6.1kHZ frequency separation
  - Adjustable in frequency spectrum location with starting from 10MHz
  - Works up to 100 ft wires

Conclusion

- Open-ended design
  - New algorithms with minimal hardware cost
  - M-Array modulation
  - Spread Spectrum
  - Frequency Hopping
  - Serial to parallel transmission using many channels
  - Many more…

Conclusion

- Some applications
  - Cars
  - Power lines
  - Computer cables
  - Networks
  - Any device that uses wires!