Low Power Pulse-Based Communication

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Introduction

Low power communication is desirable for various applications:
- Medical sensing inside the human body
- Small scale robotic communication

These applications require relatively low bandwidth with intermittent data transmission. The primary design constraints for these systems are:
- Power consumption
- Communication bandwidth

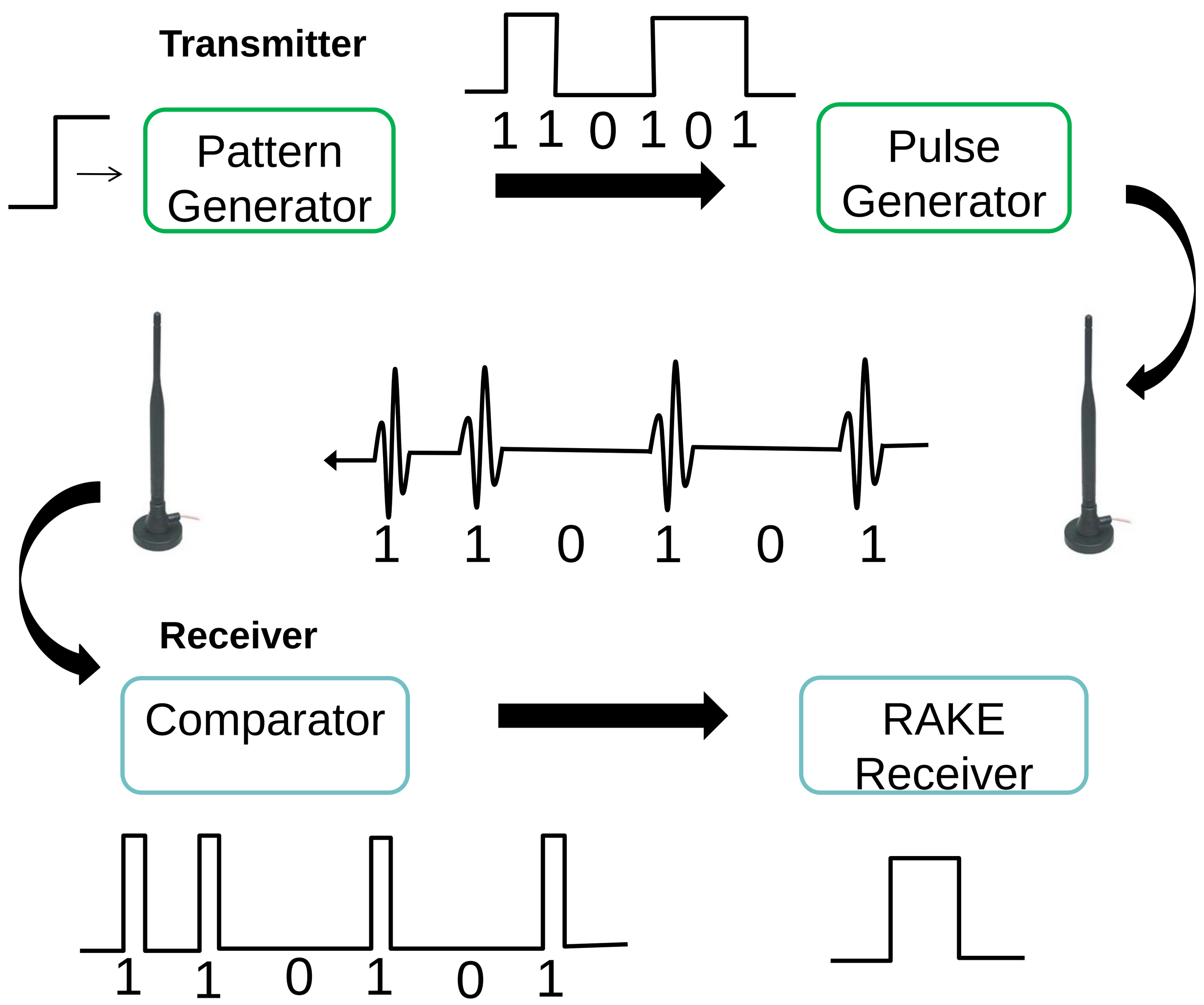
Conventional communication systems utilize:
- Radio frequency carrier on which data is modulated
  - Requires constant power consumption
  - Dissipates energy into human flesh

Pulse-based communication systems:
- Signals are only generated during data transmission
- No power is consumed when idle
- Efficiently spreads power over communication bandwidth

Design objectives:
- Carrier-less (baseband) communication
  - o Low power consumption
- Data transmission through E.M. pulses
- Generation of short pulses
  - o Large bandwidth
  - o Fast data transmission rate
- Accurate reception of transmitted data

Design Overview

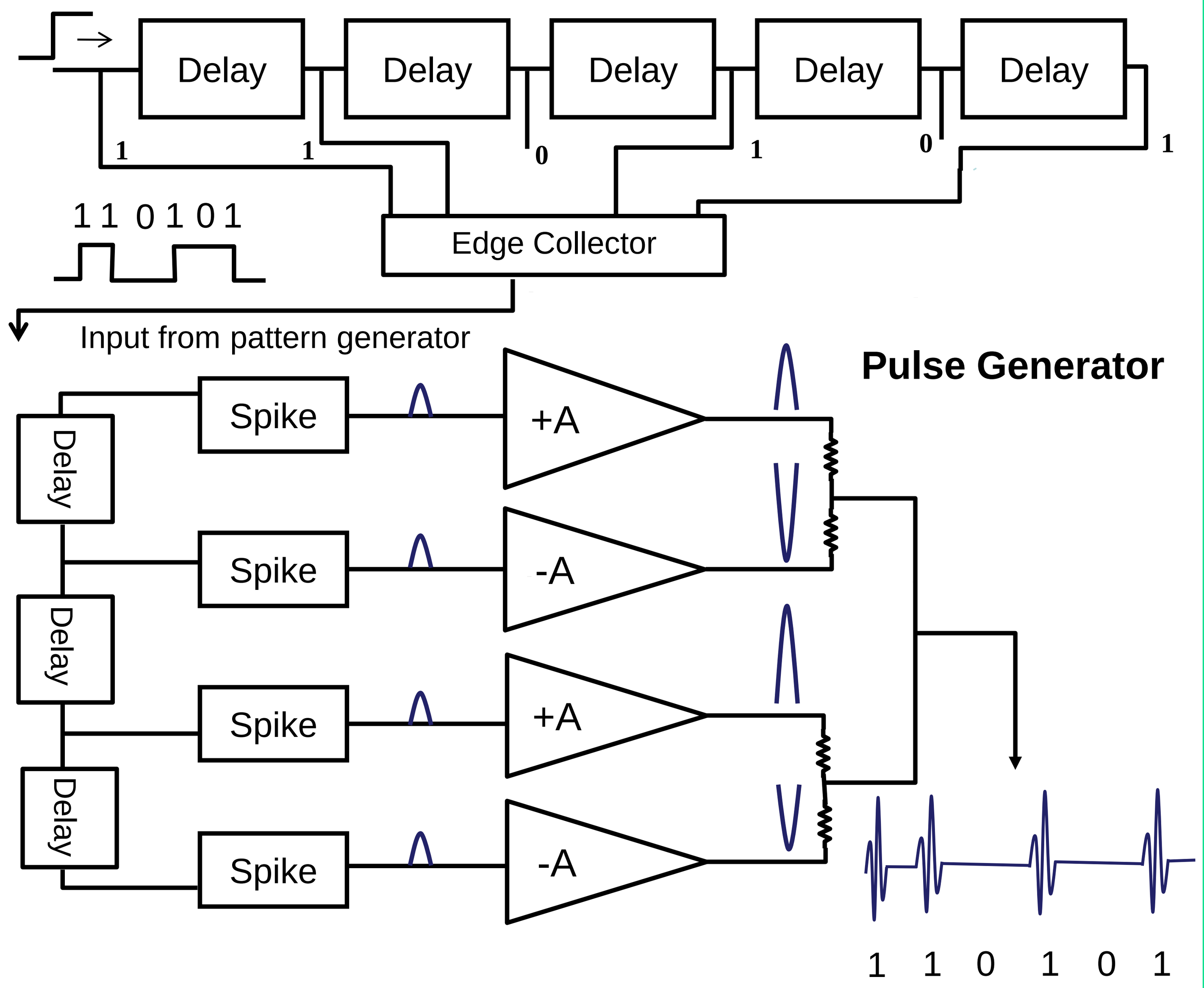
In order to transmit data, each bit is expanded into a pattern of 1's and 0's. This pattern is converted into a sequence of pulses that can be transmitted through an antenna. The receiver decodes the sequence of pulses back to the original bits of data.



Transmitter

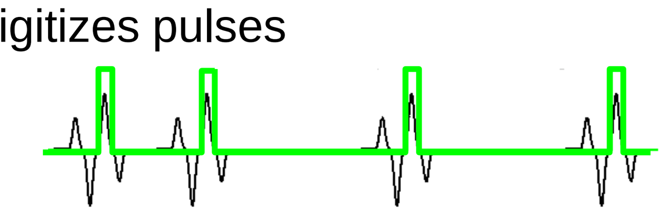
The transmitter consists of a pattern and pulse generator. The pattern generator will generate a sequence of 1's and 0's representing a bit of data. Each edge of the pattern generator's signal represents a 1. The pulse generator will generate a pulse corresponding to each 1.

Pattern Generator

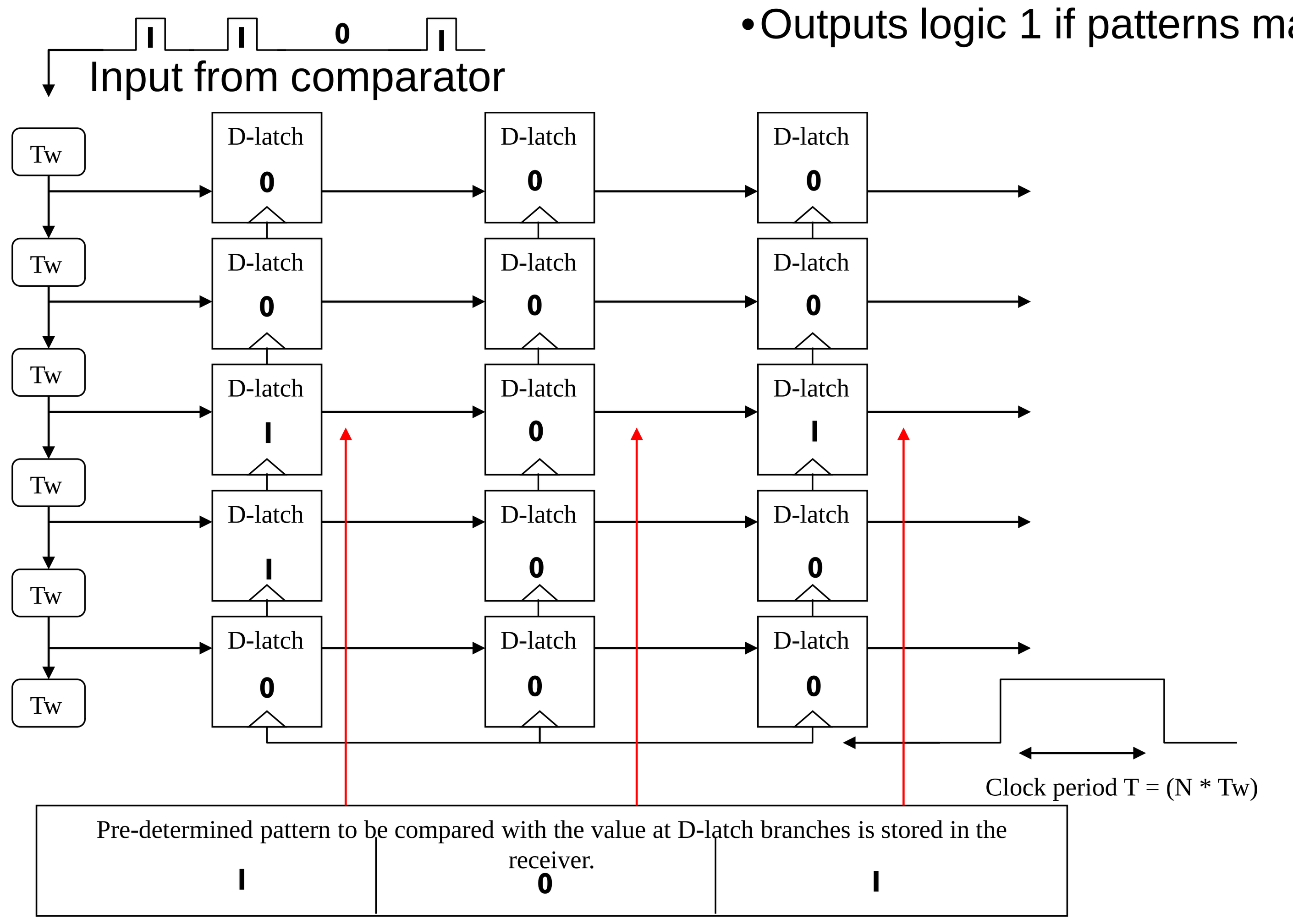


Receiver

Comparator:
- Sets a threshold to distinguish pulse from noise
- Digitizes pulses



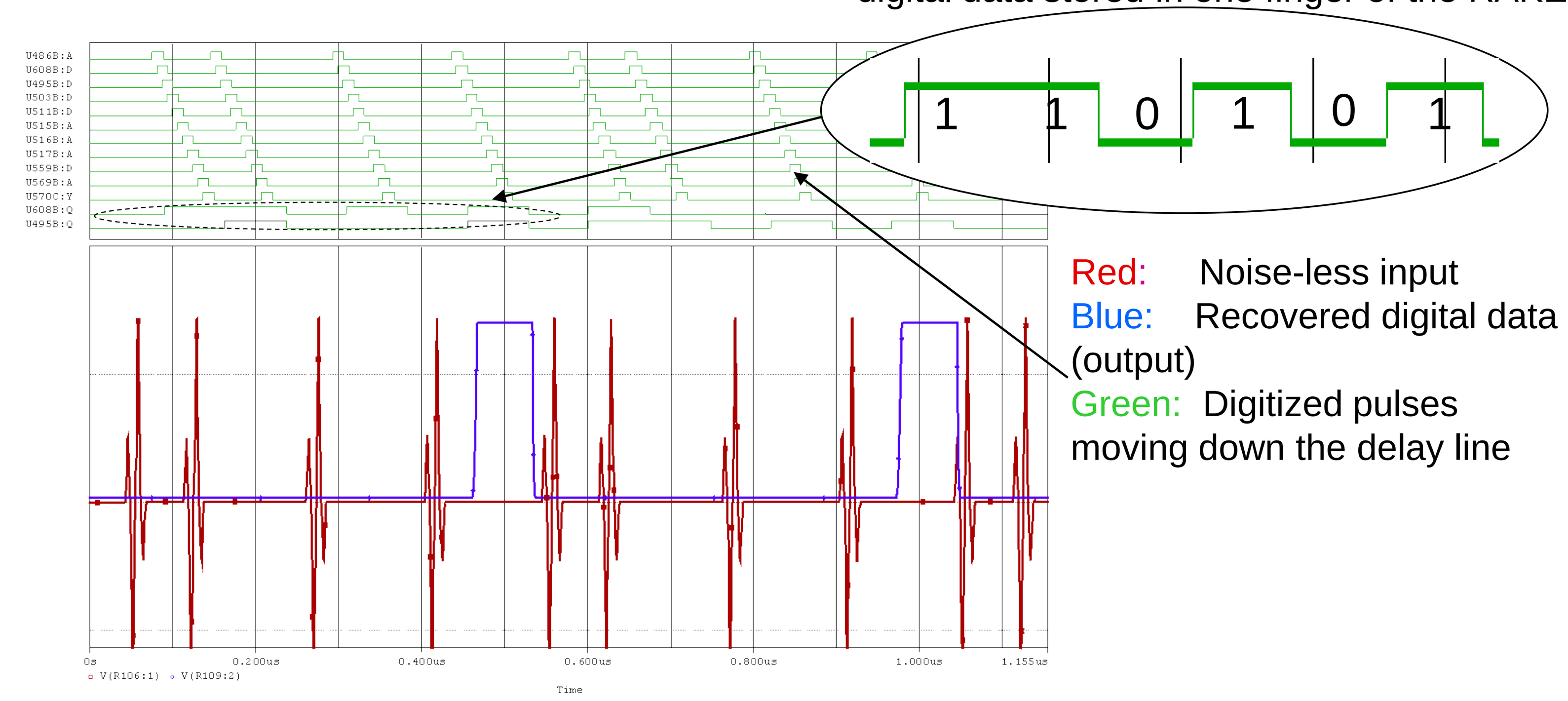
RAKE :
- Stores digital samples of received data
- Compares received data to stored pattern
- Discards false positives if patterns don't match
- Outputs logic 1 if patterns match



Simulation and Experimental Results

The transmitter and receiver were built using discrete devices wire-wrapped to a circuit board. The circuits were tested under low noise and noisy conditions.

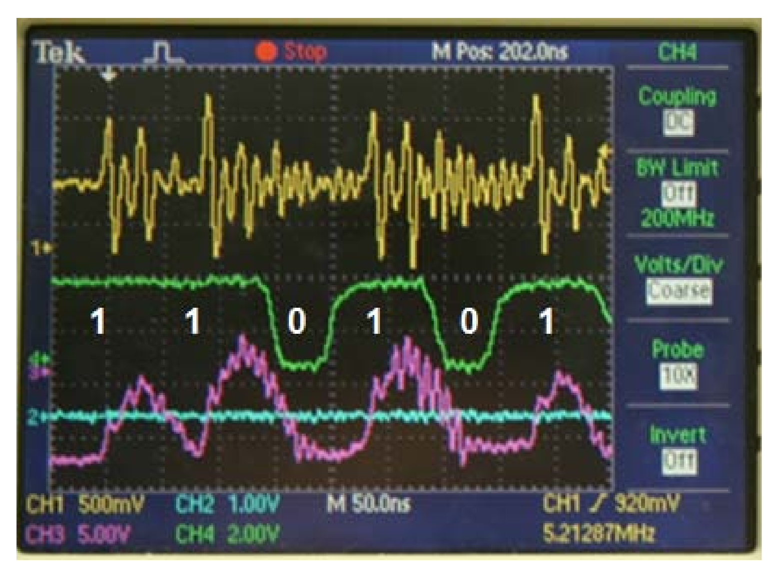
Simulation:



Experimental results: Low noise

Blue: Clock
Yellow: Filtered incoming pulses
Purple: Digital output
Green: Digital pulses in the delay line

- The RAKE is tuned for a 110110 pattern
- Pulses are much larger than noise
- Pulses are digitized without difficulties
- The RAKE recognizes the pattern
- Data is recovered at the output of the circuit



Experimental results: Noisy signal

Yellow: Incoming noisy pulses
Green: Recovered digital data (110101)
Purple: Output of the comparator circuit
Blue: Threshold

- The RAKE is tuned for a 110101 pattern
- It is hard to visually discriminate noise and pulses
- The threshold voltage is swept until a recognizable pattern appears
- The RAKE eliminates "false" pulses due to noise since they don't fit the pattern
- The correct pattern is detected and digital data is recovered.

Conclusion

- Computer simulations have shown data transmission under low noise conditions
- Testing of the transmitter and receiver have shown promising results
- Timing issues are the most persistent problems
- Despite these problems data was recovered successfully

Acknowledgment

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