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WiseSkin RTD 2013

Ultra Low Power Radio for WiseSkin Communication system

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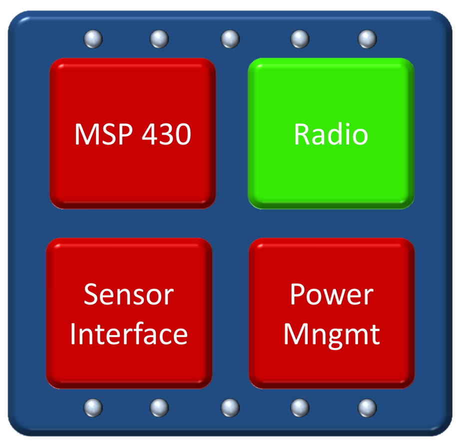


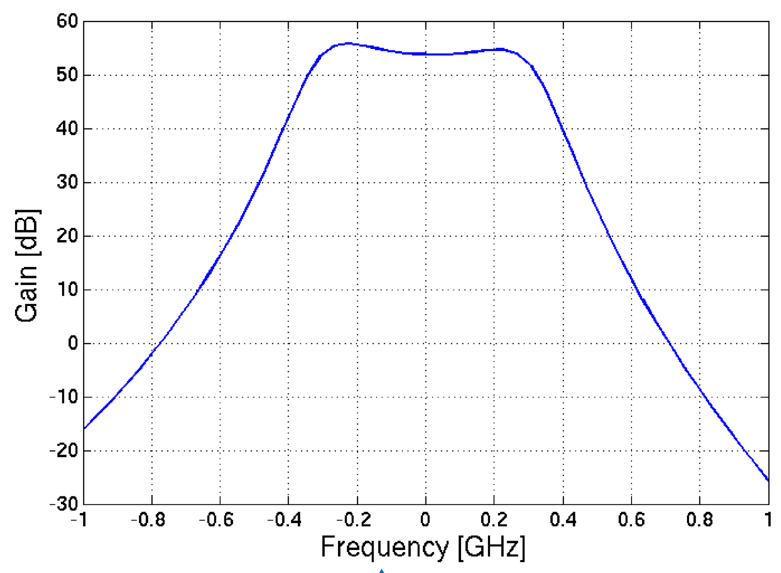
The WiseSkin concept for tactile prosthetics targets the restoration of a natural sense of touch to persons using prosthetics. In order to achieve flexibility, freedom of movement and comfort, the sensing capabilities built into the artificial skin must be unobtrusive, highly miniaturized and ultra-low power (ULP). Advances in the fields of micro and nanotechnology as well as biological systems enable ever more powerful miniaturized sensor devices, opening the door to new solutions. Our aim is to develop a high density wireless sensor network embedded in an artificial skin that offers scalability, robustness, ease of use and manufacturability. Work presented here focuses on the Ultra Wide Band FM receiver that will be a part of the miniature radio used for communication between the sensor nodes

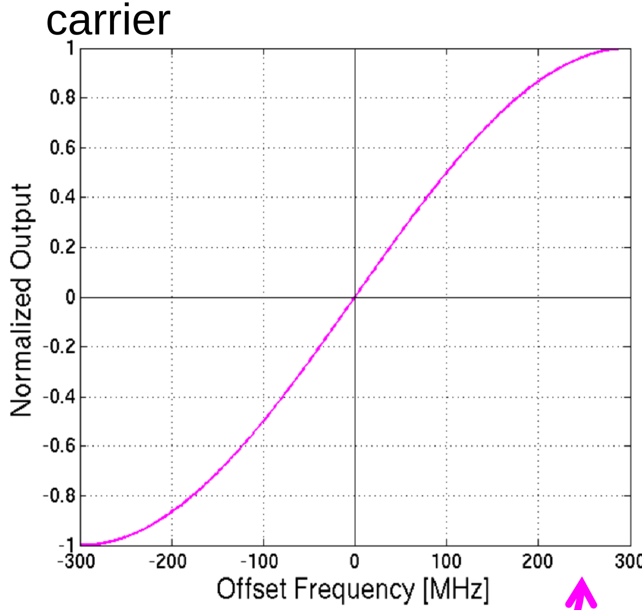
FM-UWB Receiver

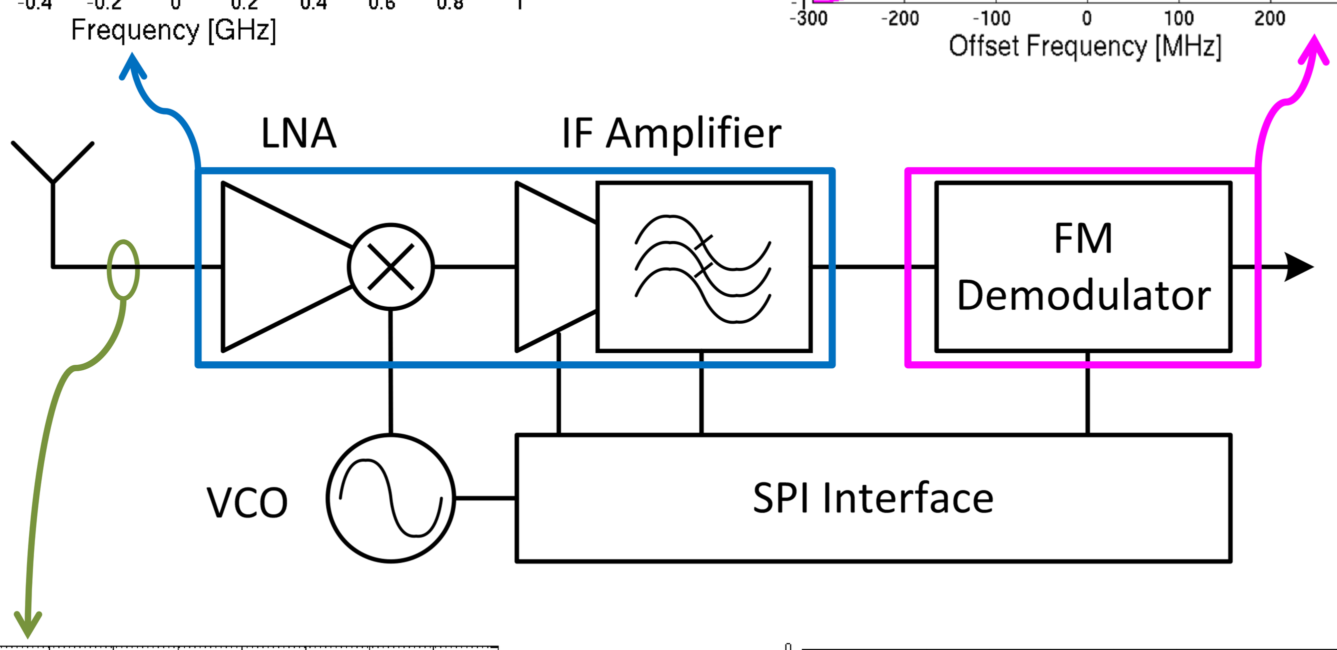
- Receiver is designed for 500 MHz wide input signal centered around 4 GHz
  - Robust against fading in frequency selective channels
  - Antenna dimensions small enough
- Lowest power FM-UWB receiver reported in literature consumes around 590 µW
- Proposed receiver should consume 400 µW while providing similar performance
- Estimated sensitivity is -80 dBm at 200 kb/s

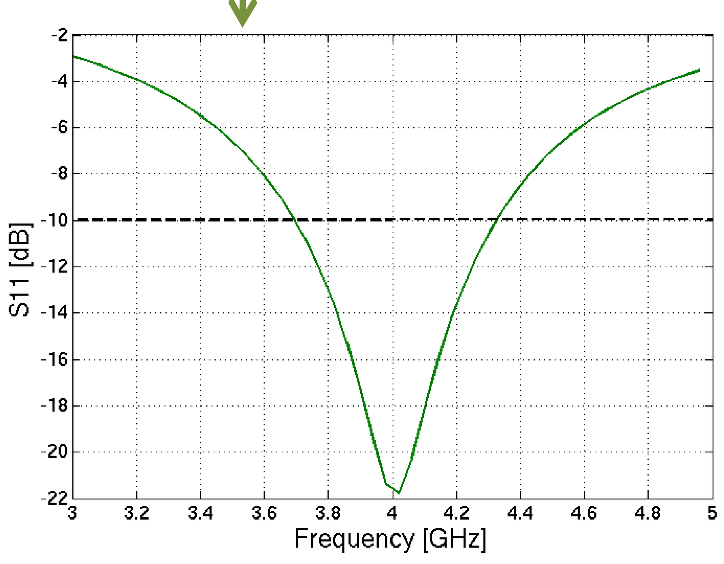
- Conversion Gain of the Receiver
  - Around 50 dB gain from LNA, mixer and IF amplifiers
  - Most of the gain comes from the IF amplifiers that operate at a lower frequency and consume less power

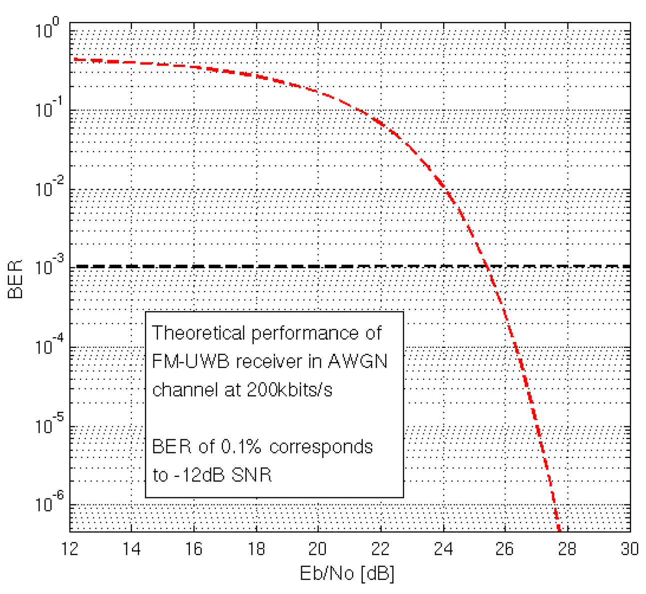
- Wideband FM demodulator
  - Delay line demodulator
  - Designed for 500 MHz wideband signal
  - Characteristic is monotonous within ±300 MHz offset from the carrier







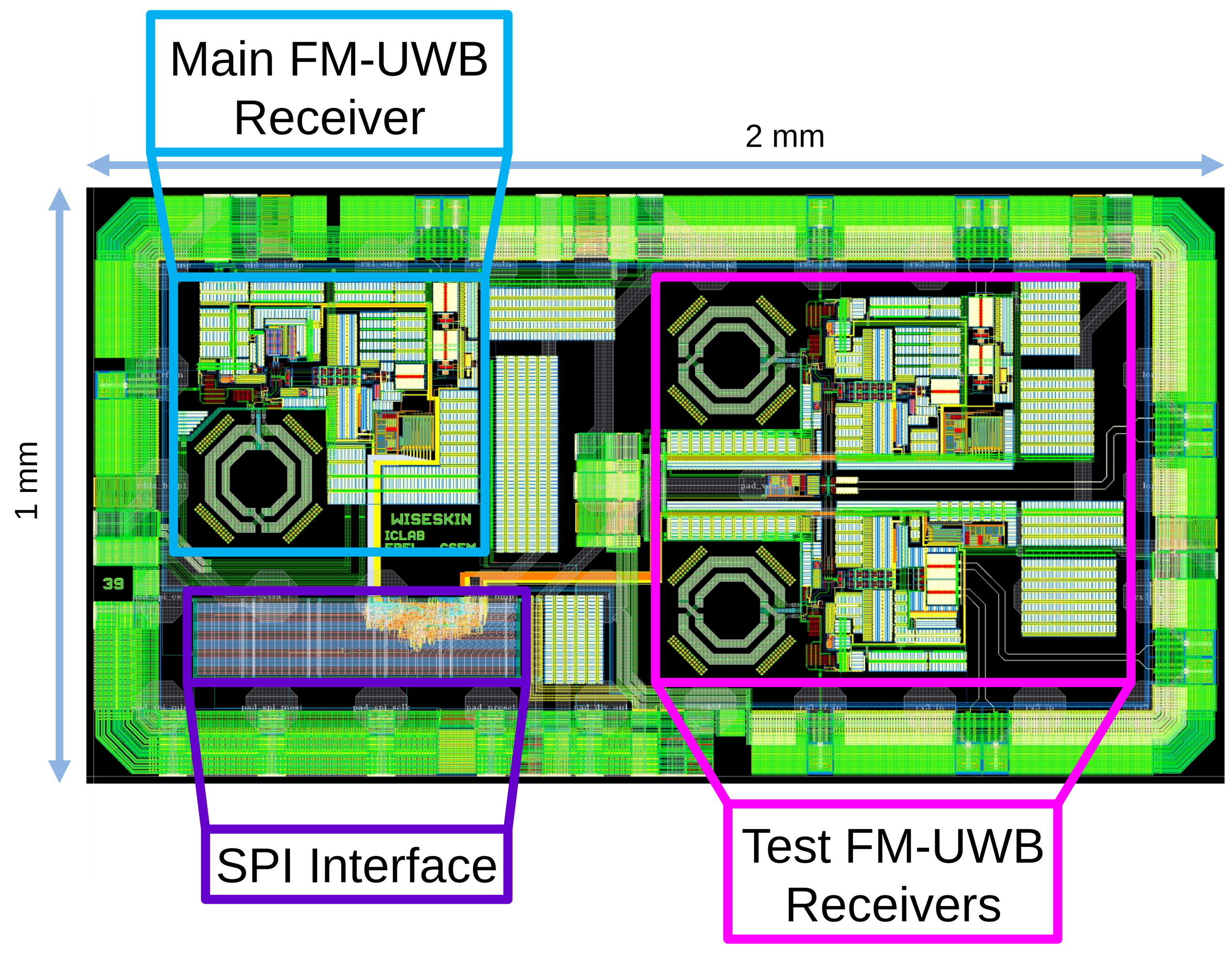




- Input matching
  - Input reflection coefficient is lower than -10 dB in range from 3.7 GHz to 4.3 GHz
  - Can be calibrated to compensate for process variation if necessary

- Calculated Bit Error Rate of the FM-UWB receiver as a function of bit energy
- BER of -10 dB corresponds to SNR of -12 dB

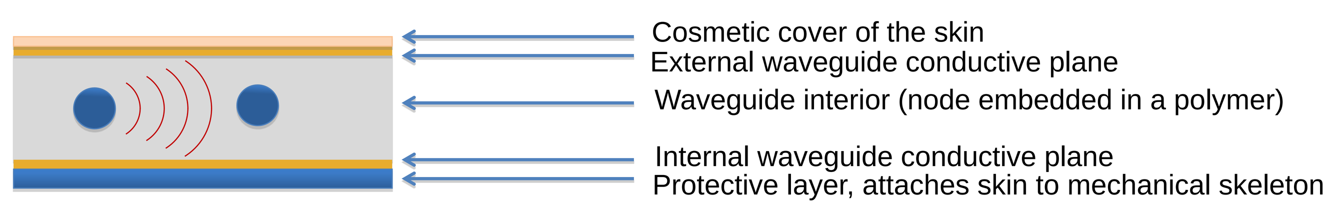
Implemented Chip



- Test chip designed in 65 nm CMOS technology
- Core of the receiver occupies 0.2 mm^2
- Together with the transmitter, final radio could be integrated on a 1 mm^2 die
- Small enough to fit on a sensor node
- Two more versions of the receiver added for testing
  - Provide access to different parts of the receiver
  - Provide more flexibility and an option to implement a different demodulator on a PCB

Next steps

- Further reduction of the receiver power
- Optimization of the receiver performance based on channel characteristics
  - Communication inside a waveguide:



  - Potentially small losses
  - Shielding from external interferers
- Design of a low power transmitter
- Integration on a miniature sensor node together with the microcontroller and sensors