

Contactless Cardiac Vital-Sign Sensing Using SDR-Based Continuous-Wave Radar

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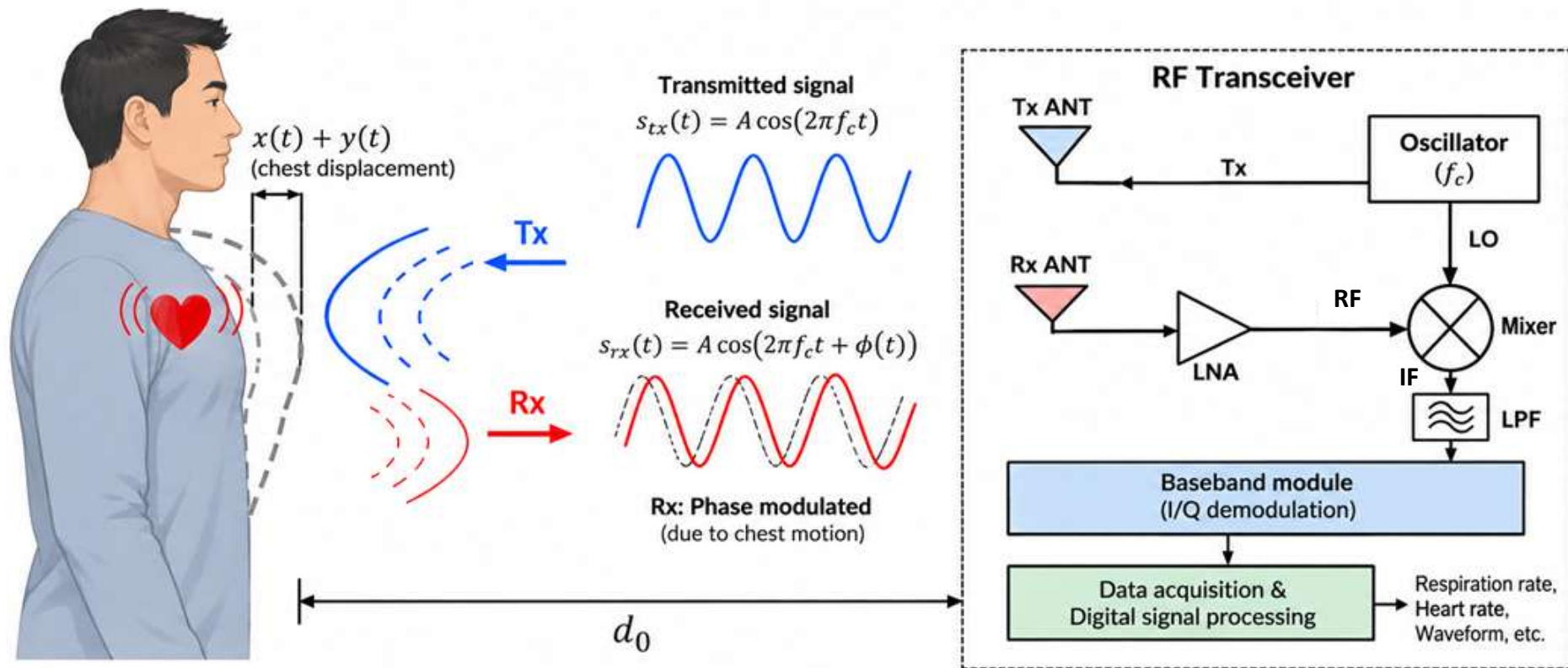
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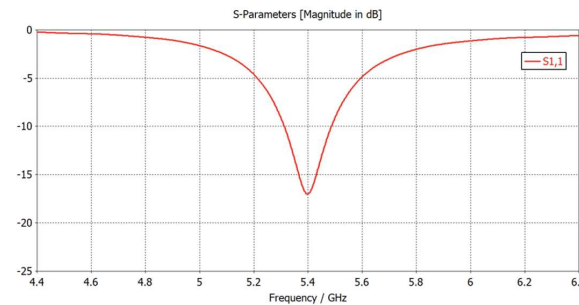
Operating principle



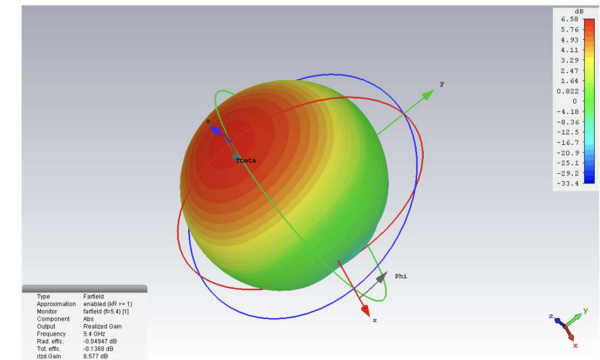
When the transmitted electromagnetic wave is reflected from the moving chest, the propagation distance changes slightly with time. Consequently, the reflected signal experiences a time-varying **phase shift**. The received signal can therefore be represented as shown above

Antenna design

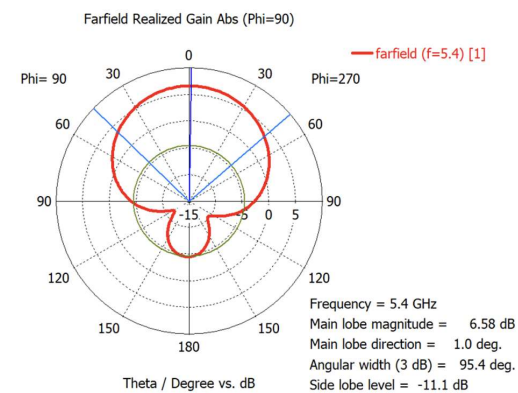
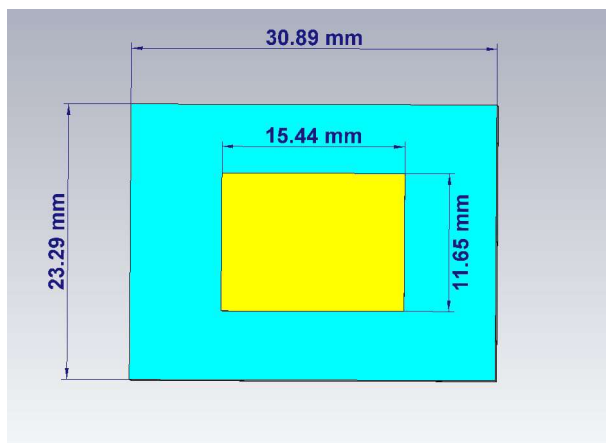
- Antenna type: **Coaxial fed patch antenna**
- Substrate: **FR-4 ($\epsilon_r=4.4$, $T=1.2\text{mm}$)**
- Center frequency: **5.4GHz**
- Band width: approximately **200MHz**
- Simulated maximum realized gain: **6.58 dBi**
- 3-dB beamwidths $\approx$ **95.4° (E-plane)** and **82.1° (H-plane)**
- Patch size: **15.44 x 11.64mm**



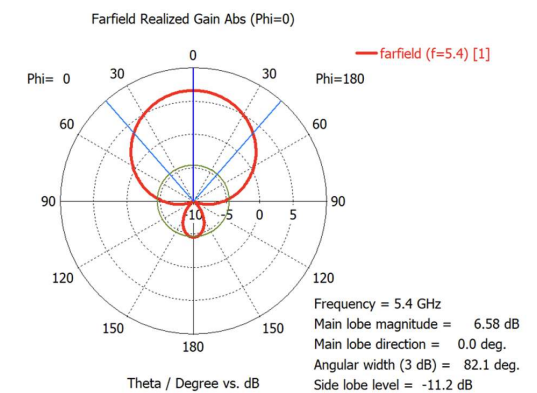
(a) Simulated reflection coefficient



(b) 3-D realized gain



(c) E-plane pattern (phi = 90 deg)



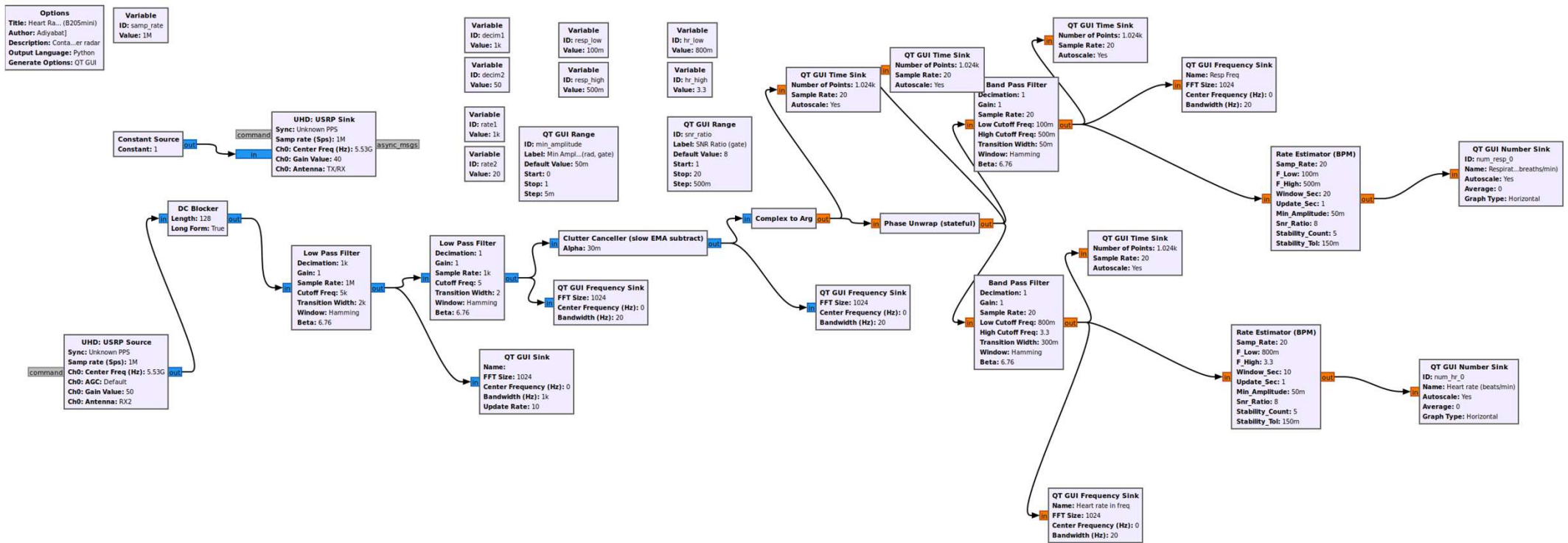
(d) H-plane pattern (phi = 0 deg)

Hardware Setup

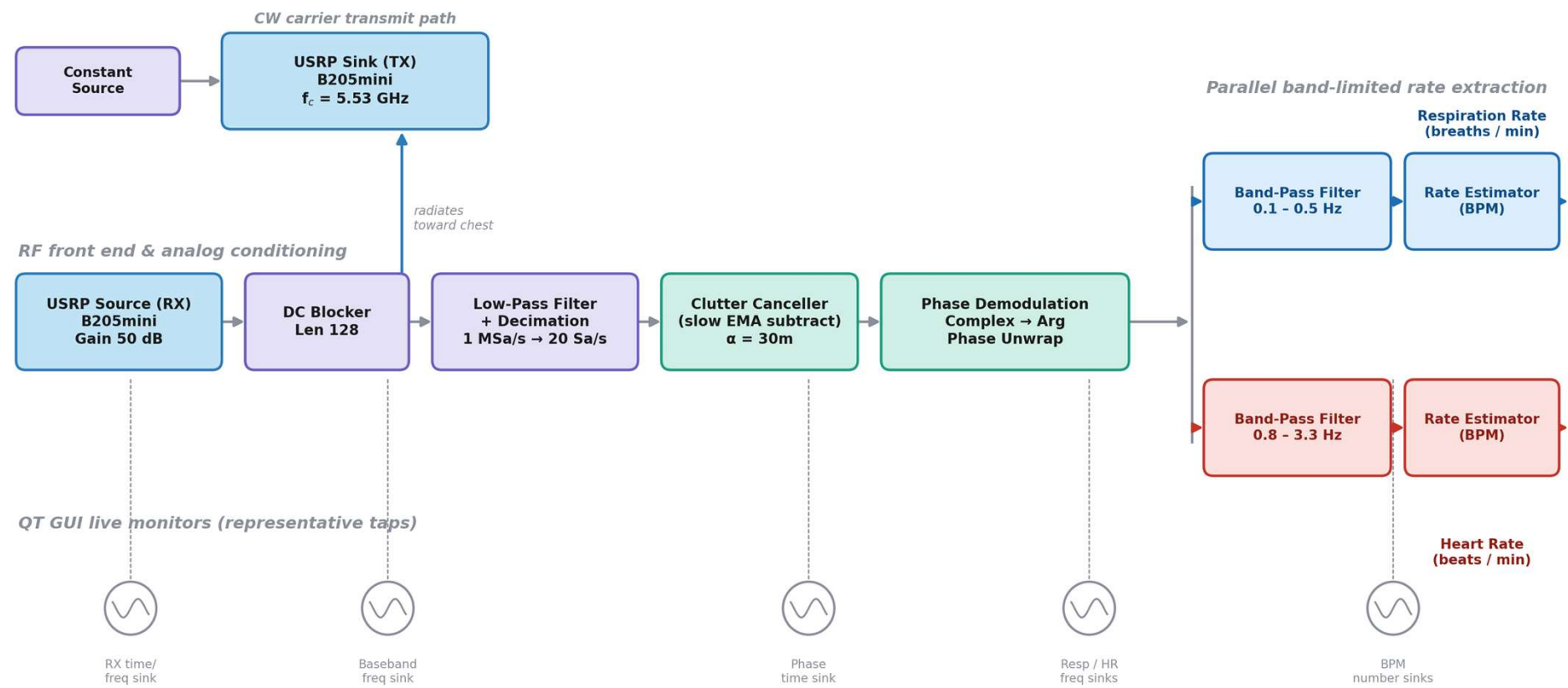
- **NI Ettus USRP B205mini**
 - Analog Devices AD9364 RFIC
 - 1 TX, 1, RX - Full Duplex
 - 70MHz-6GHz
 - Up to 56Mhz
 - 61.44MS/s (12bit resolution)
 - Xilinx Spartan-6 XC6SLX150
 - USB 3.0
- **TX and RX Patch Antennas**
 - 5.53 GHz
 - ± 3 -dB angular widths $\approx 95.4^\circ$ (E-plane) and 82.1° (H-plane); sidelobe levels near -11 dB
- **GNURadio and python for baseband signal processing**



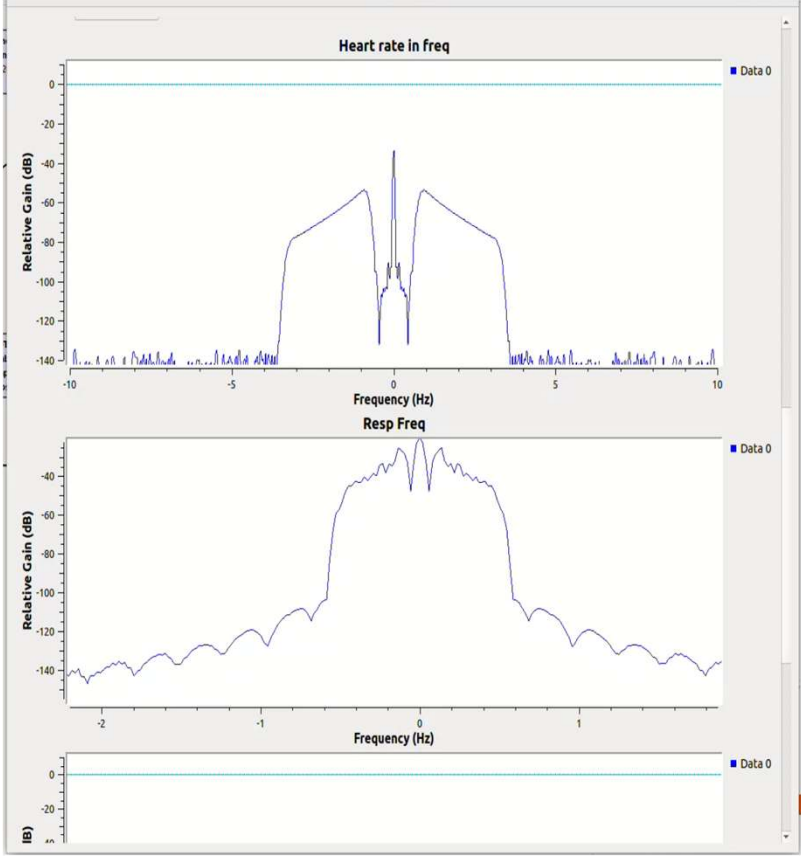
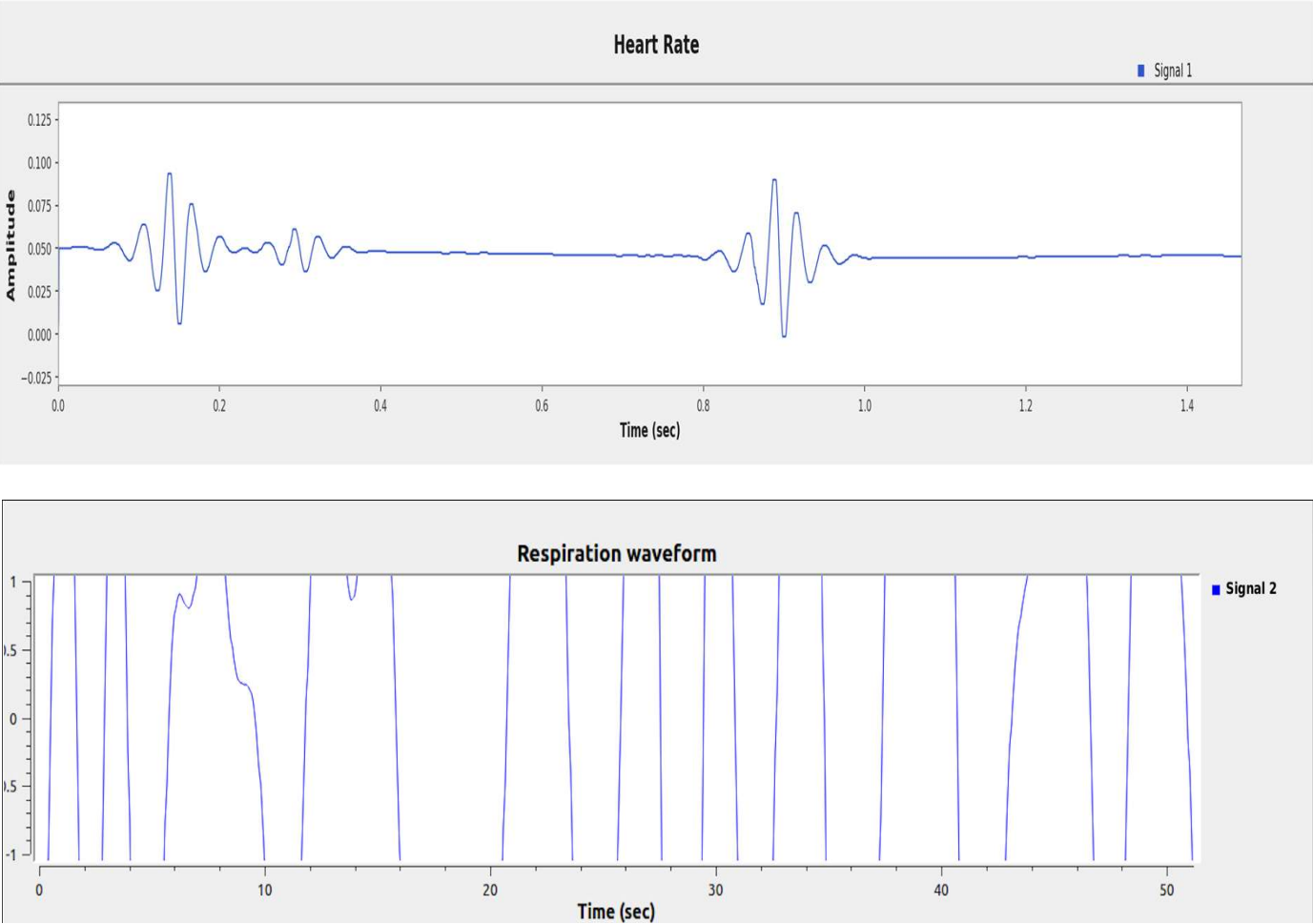
GNU radio implementation



Signal Processing Pipeline in GNU Radio



Results: Heart rate and Respiration waveform



Conclusion and Future Work

Conclusion

This work demonstrates the feasibility of **contactless vital-sign monitoring using a low-cost SDR-based continuous-wave radar and GNU Radio**.

- A custom patch antenna was designed and fabricated using CNC machining.
- A compact USRP B205mini-based CW radar system was successfully implemented for non-contact vital-sign sensing.
- The proposed GNU Radio signal-processing pipeline successfully extracted stable respiration and cardiac signals, with measured rates of approximately 12 breaths/min and 80 beats/min, respectively.

Future work

- Perform a side-by-side comparison of the radar-derived cardiac signal with a conventional electrical ECG sensor.
- Improve cardiac-signal extraction through enhanced TX–RX isolation, motion-artifact suppression, and advanced spectral estimation. Extend the validation to multiple subjects and repeated measurement sessions.

Thank You for Your Attention

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