Towards non-invasive bio impedance sensor design based on wide bandwidth ring resonator

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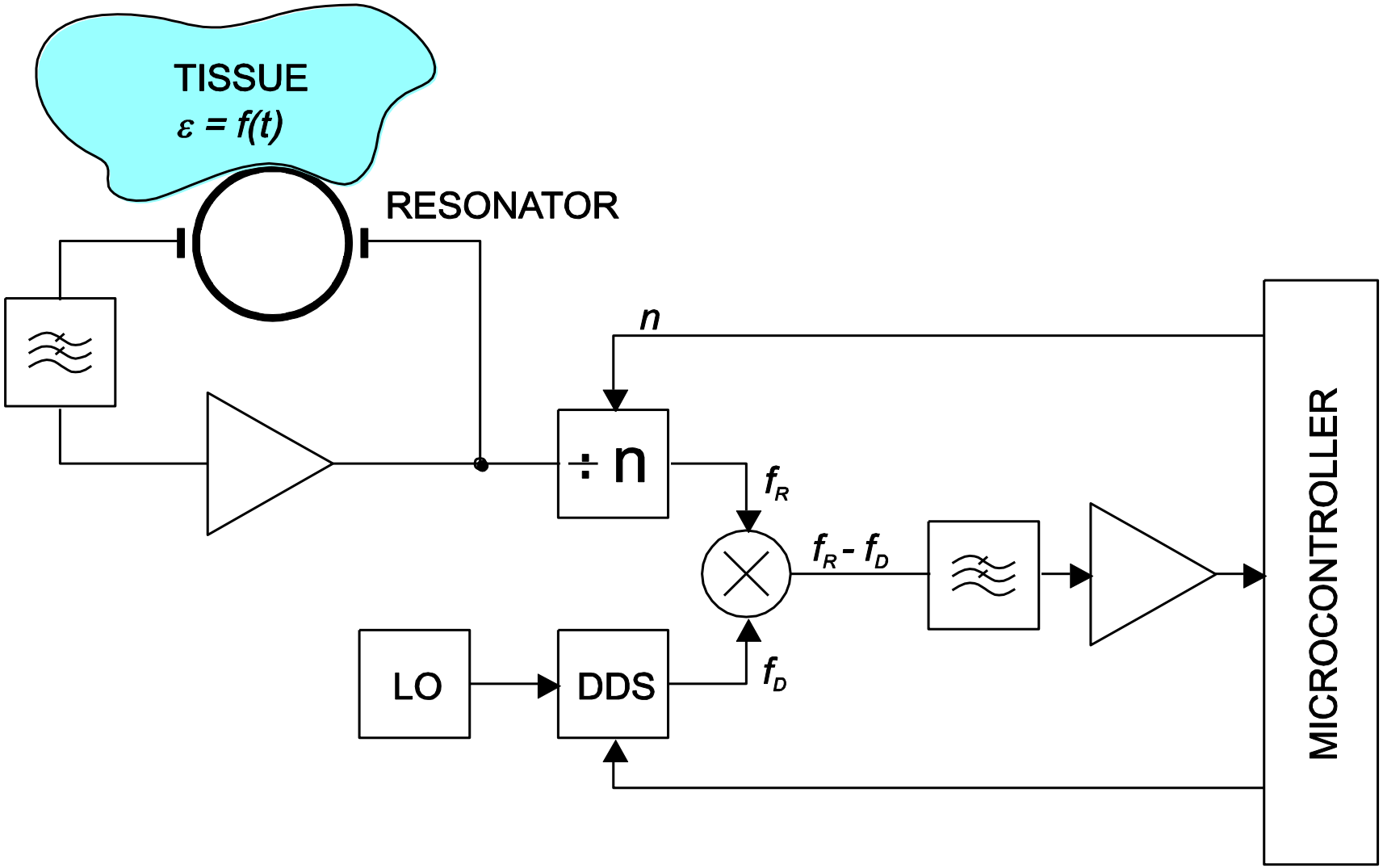
Introduction

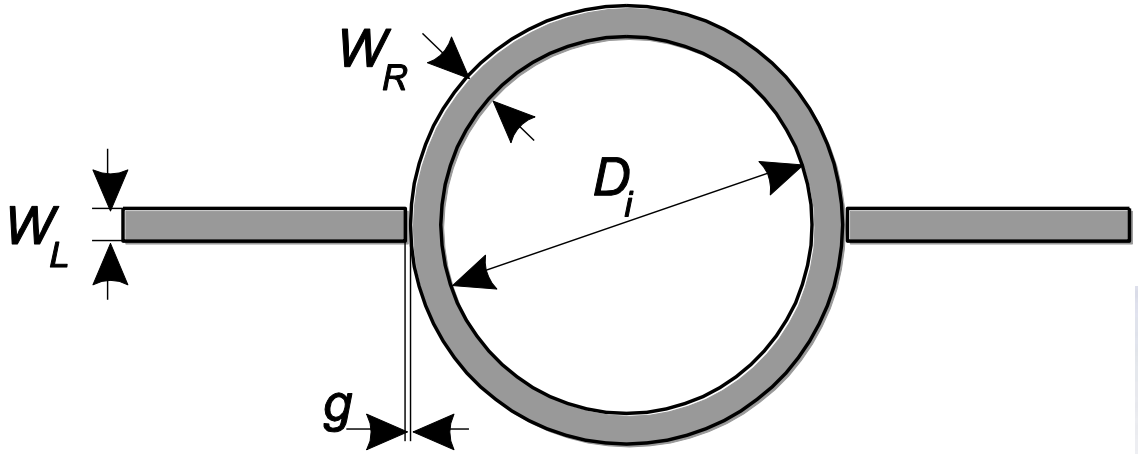
- Chest impedance: respiration activity
- Galvanic contact
  - Biopotential + bioimpedance
  - Via ECG electrodes
- Noninvasive
  - Visual (camera)
  - Doppler radar
  - Microwave distance sensor
  - Using tissue as load for ring resonator

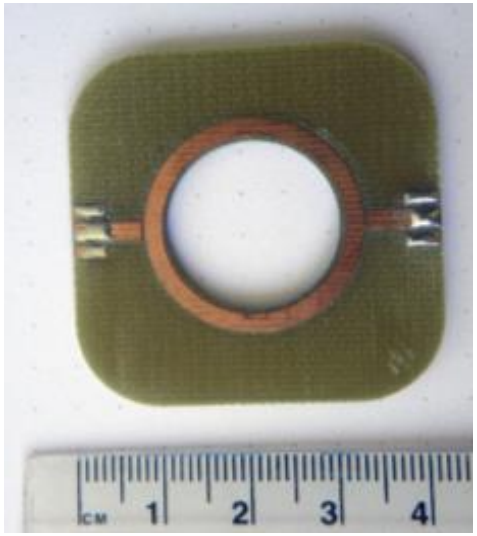
Microwave bioimpedance sensor



Resonator

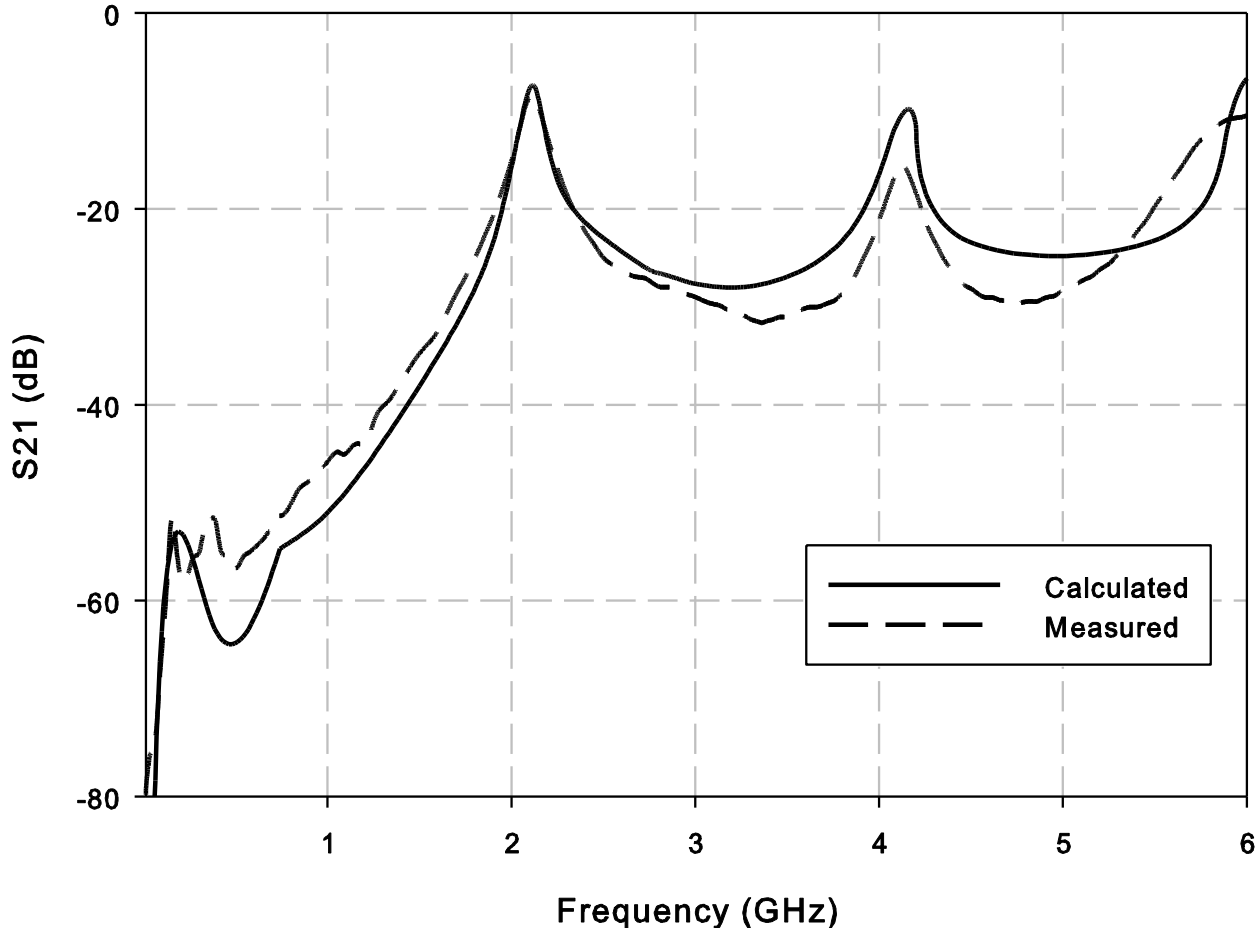
- „Common“ ring resonator





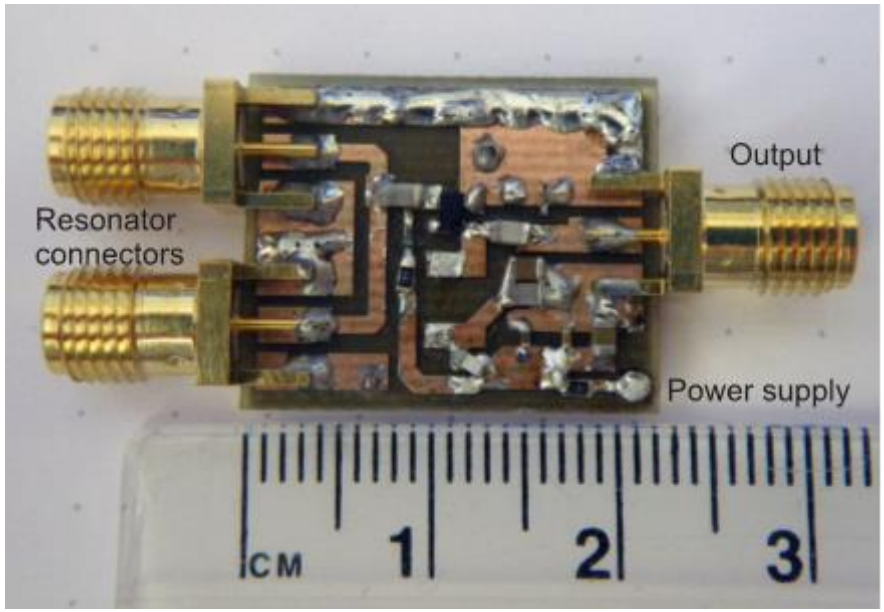
Resonator

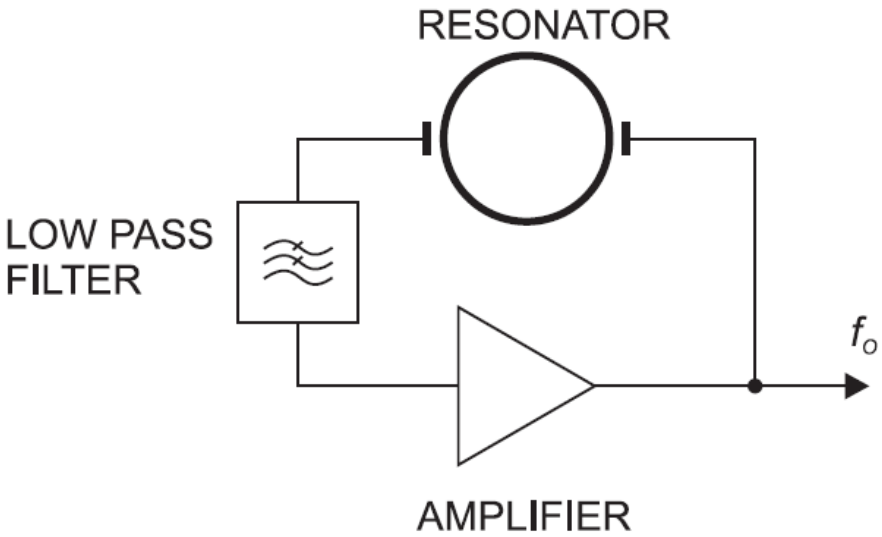
- Resonance calculation and measurement



Oscillator + LPF

- Resonator + amplifier + low pass filter
  - Conventional oscillator design with NPN

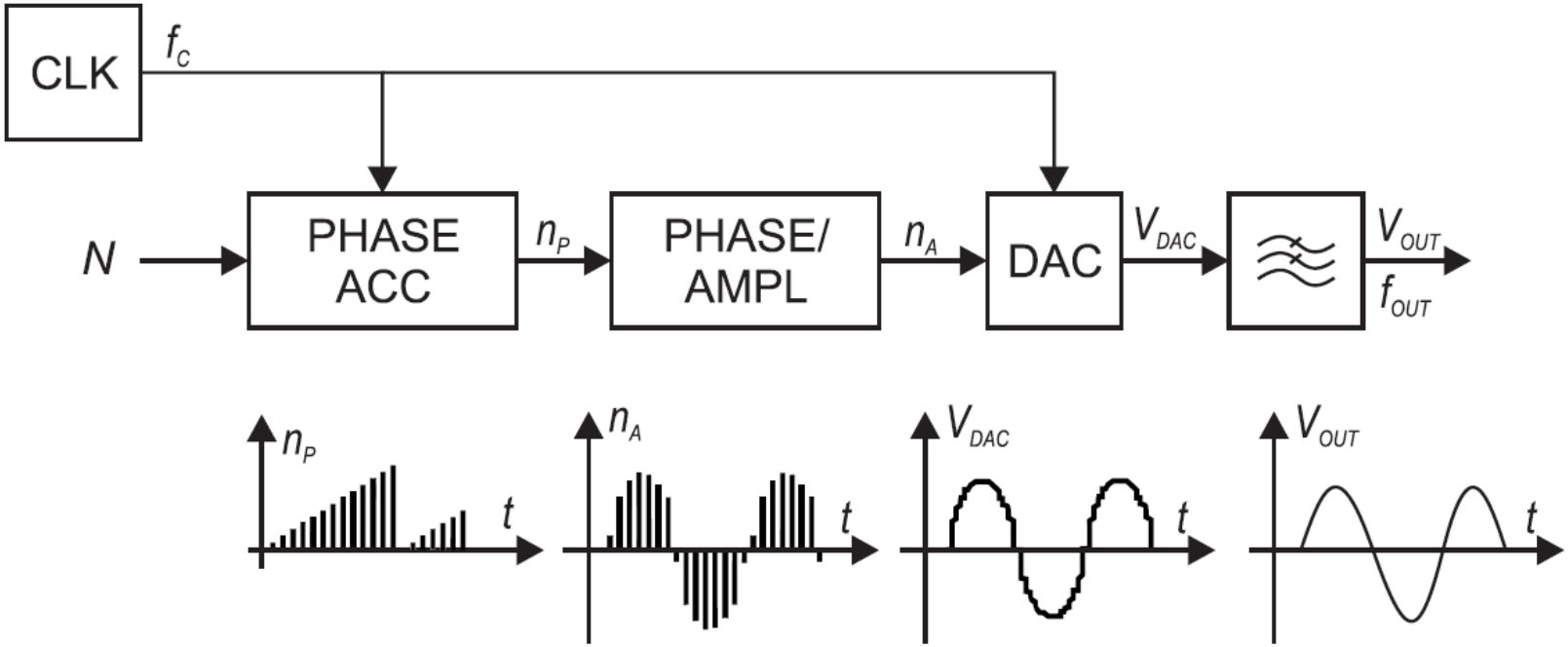




Divider

- uPB1507GV accepts 500MHz to 3GHz
- Division is pin-selectable: ÷2D, where D=8, 7, or 6
- Power consumption: relatively high
- Not for ultra-low power applications:
  - @ 5V supply: about 19mA

DDS



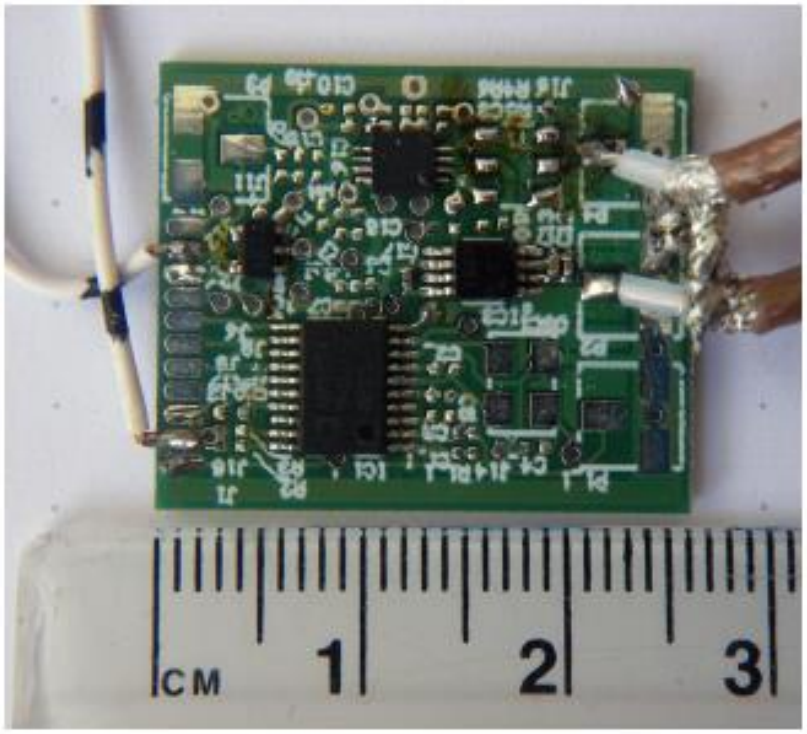
$$f_{OUT} = \frac{N f_C}{2^m}$$

$$f_{INC} = \frac{f_C}{2^m}$$

RF to Digital interface

- Divided signal and DDS signal are mixed
-

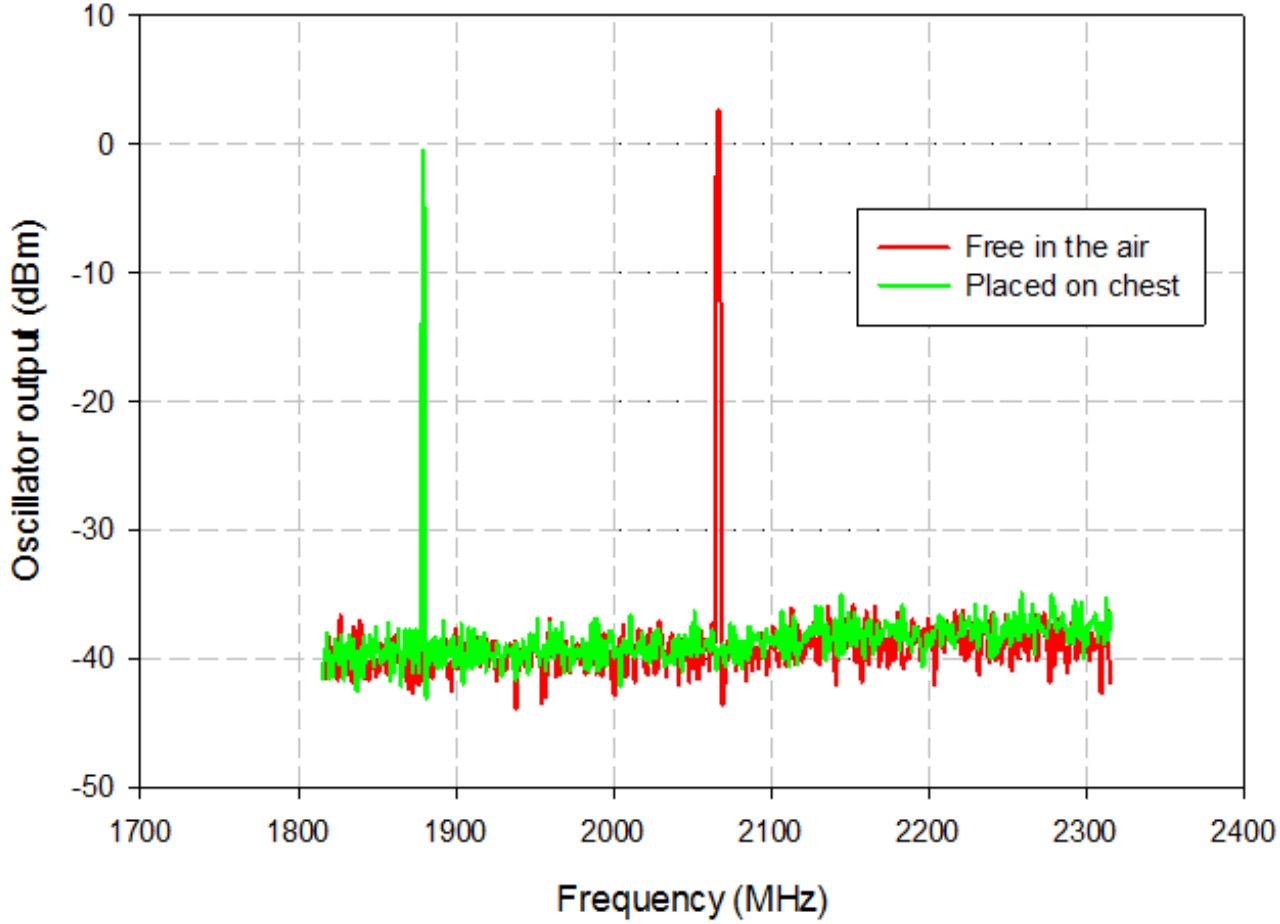
Digital interface



RF connection

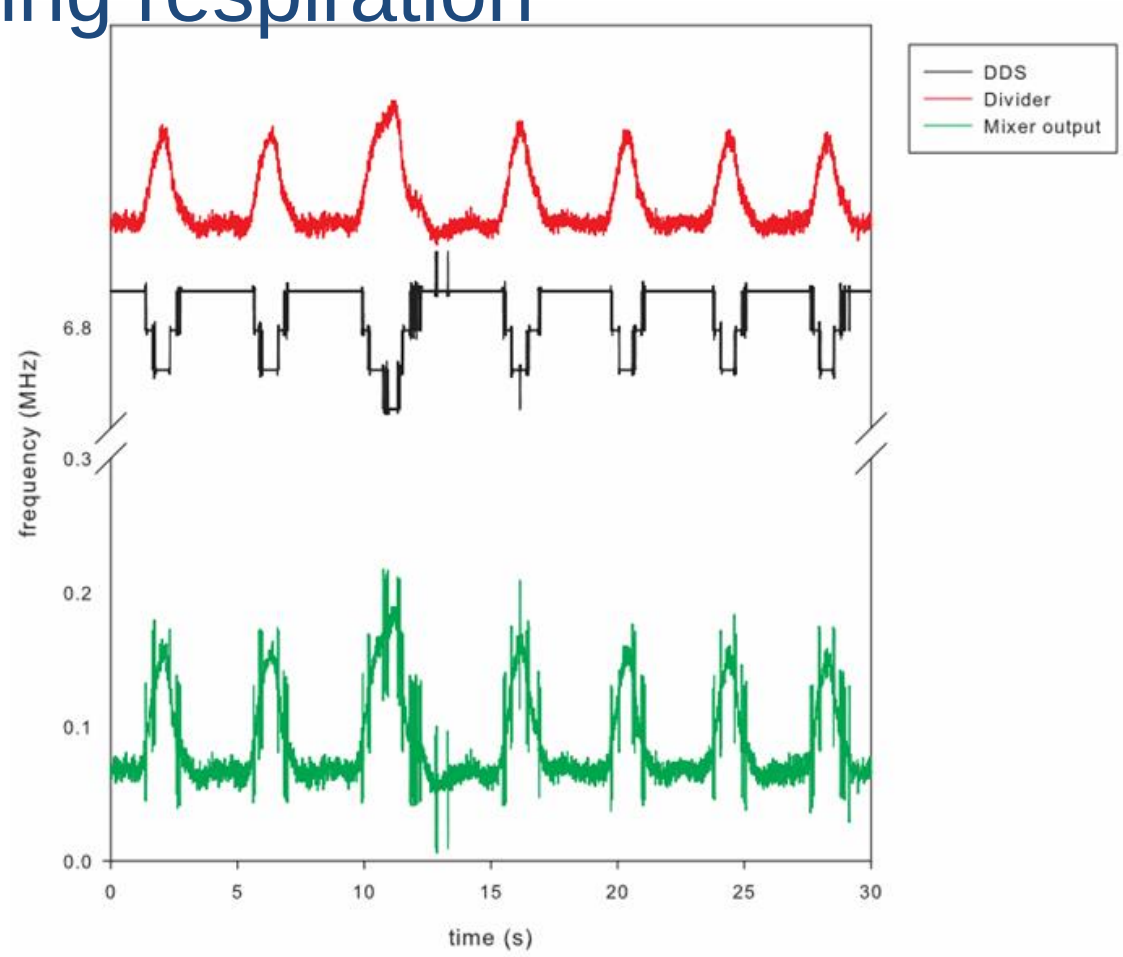
Testting ad test results

- Oscillator test



Testting ad test results

- Sensing respiration



Testting ad test results

- Some numbers:
  - oscillator output without load: 2078MHz
  - frequency shift when on chest: about 200MHz
  - Respiration detection band: 36.603MHz
    - From 1761.8MHz to 1798.4MHz
  - Power consumption when active: 15mA

Conclusion

- Proven microwave measuring principle
- Contactless, non-invasive method
- Tissue dielectric properties within the frequency range:
  - dependent only on the tissue composition and current physiological state
- Tissue composition is not changing significantly
  - Principal sensitivity of the sensor is on the tissue physiological changes
- Sensor operation successfully tested (respiration)
- Further bio-impedance measurement applications:
  - Some strong correlations between dielectric properties and different health related states