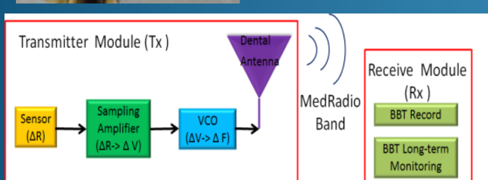
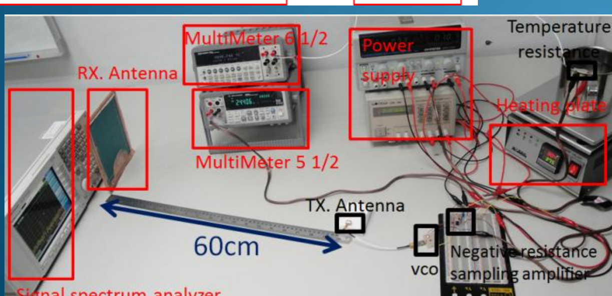
藉ESL輔助設計之無線低侵入式植入生理信號監測系統
Wireless Low-invasive Implantable Systems for Physiological Signal Monitoring by Using ESL Design





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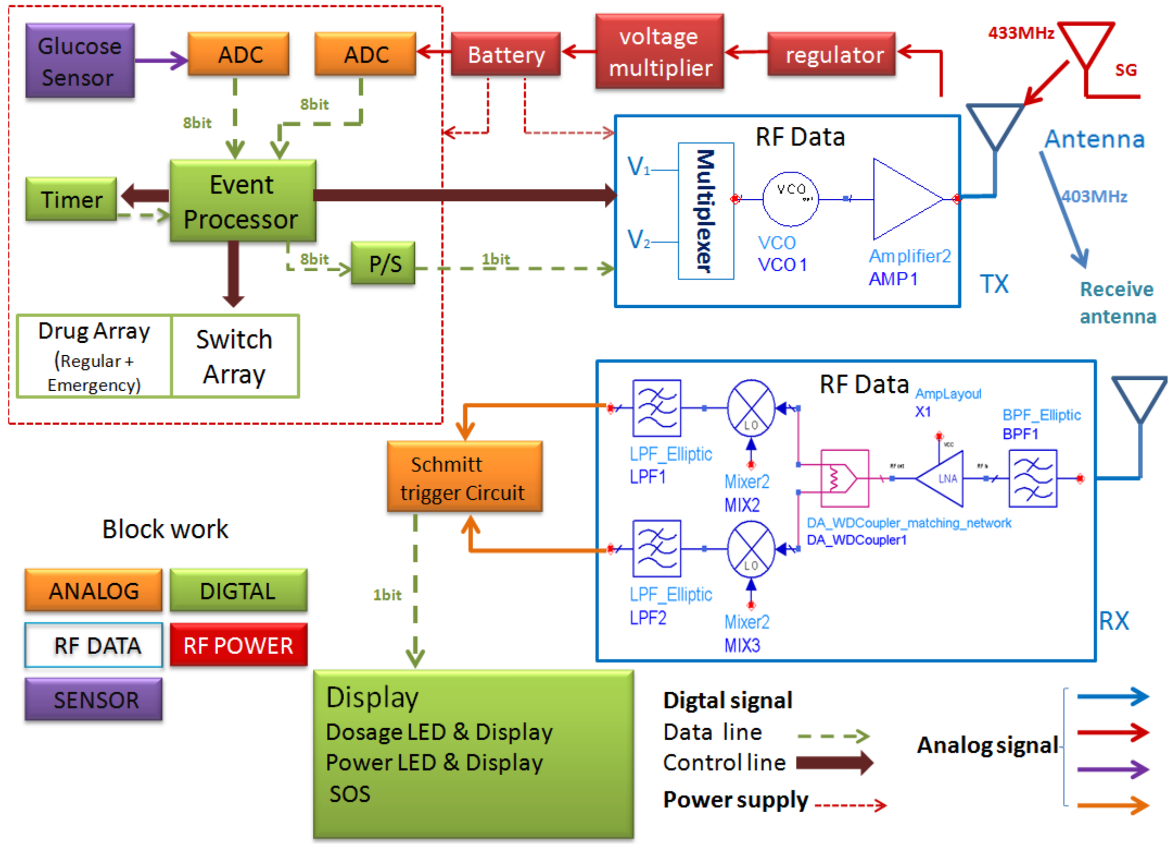
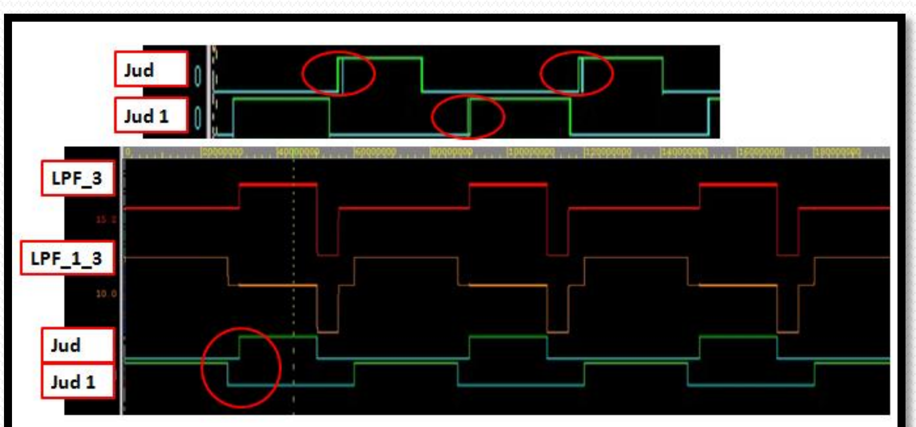
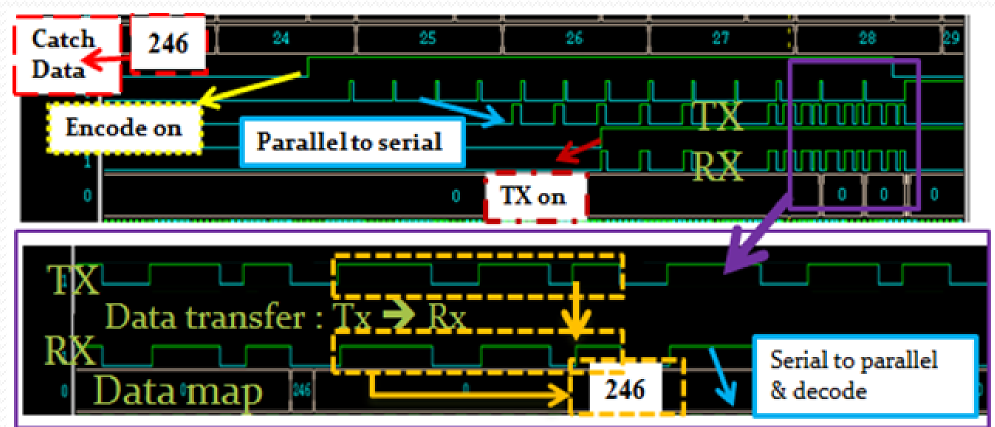
ESL Design / Heterogeneous Integration Simulation

- Challenge:
  - 整合模擬,
  - Base Band的取捨是很困難的課題［數位(1 KHz) vs RF(406 MHz)］
- Results:
  - ESL Design：
  - (S/W)以整合結果提早發現問題
  - 嘗試不同架構
  - 訂出系統規格
- The Proposed Method
  - 精簡模擬時間的設計
  - 解頻 (ExeResolution)的設定
  - 基本功能(functional-based)驗證
  - 模組可分開操作(power gating)機制

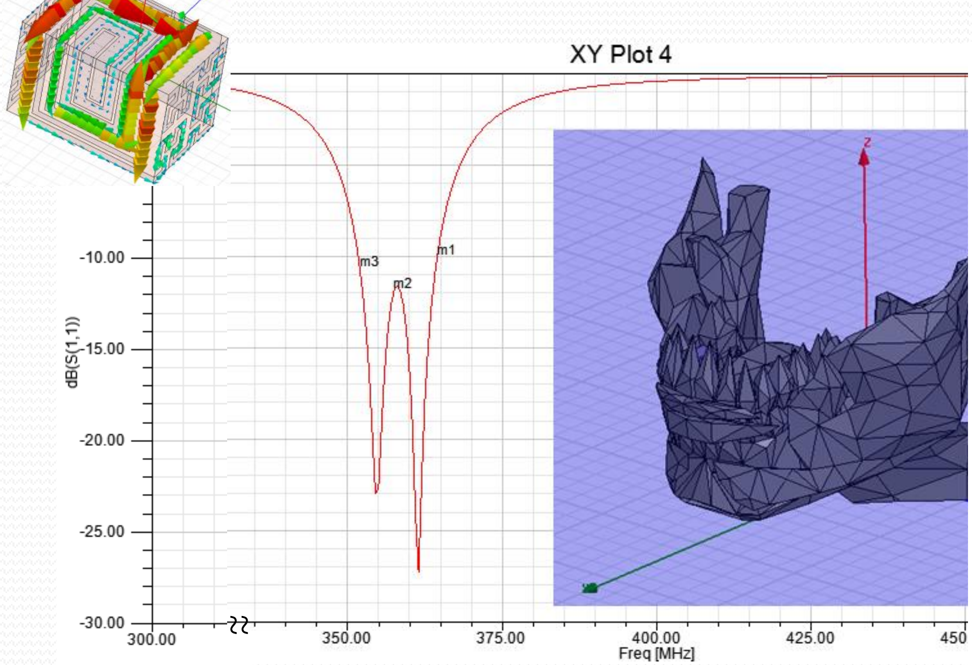




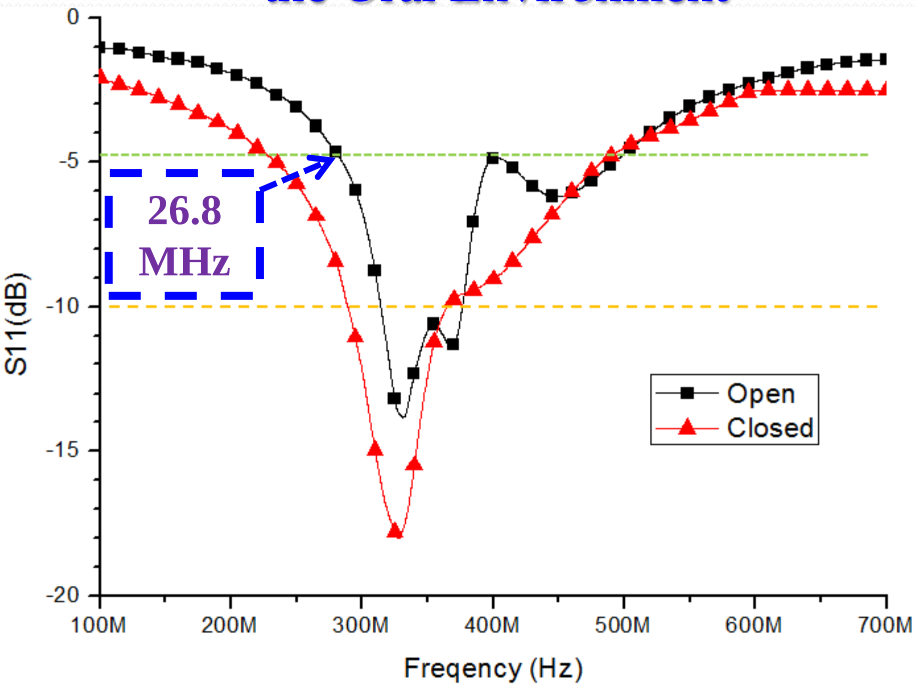


Results of Teeth Antenna

The Simulation Results



The Measurement Results in the Oral Environment



- Two resonant modes: 364.5 ~ 357.5 MHz
- Detailed realistic human oral cavity environments are simulated

Practical Oral Measurement (with IRB protocol)

- Open Mouth: 314.4~376.5 MHz (BW=62.1 MHz)
- Closed Mouth: 290 ~ 347 MHz (BW= 57 MHz)

Comparison of Antenna Performance

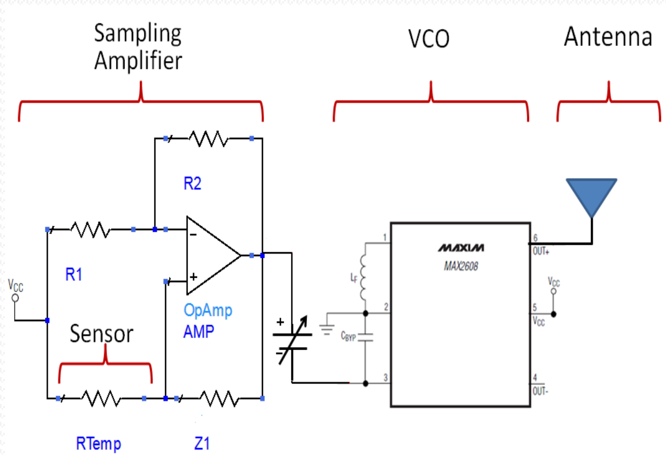
Antennas	Volume (mm^3) with insulation	Area (mm^2)	Body Model	BW (MHz) (S_{11} < -10 dB)	Max Gain (dBi)
[1]	27x27x6=2754.0	459	2/3 Muscle	23	-35
[2]	22.5x22.5x5	506.3	Skin mimic gel	5.7	-26
[3]	7.5^2xπx1.9=335.7	353.3	Skin	30	-26
[4]	11.5^2xπx24.72=1027 (including electronics and power supply)	415.3	Muscle	3.3	-29
[5]	17x17x18=5202.0	867	Muscle	225.5	-28.5
Type II	8^2x11.5=736	128	Teeth	5	-26.7
Proposed	7x7x10.5=514.5 8x8x11.5=736(Cap)	245	Oral	11.5 57~62*	-3.8

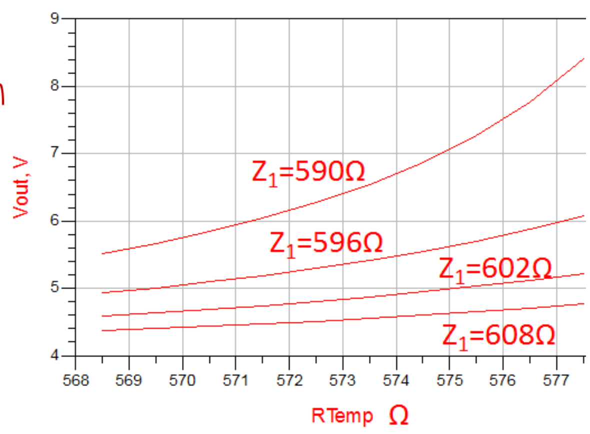
[*] measured bandwidth

- Type II: the smallest antenna in size in the literature (up to 2011)
- The proposed teeth antenna achieves wide bandwidth and high gain.

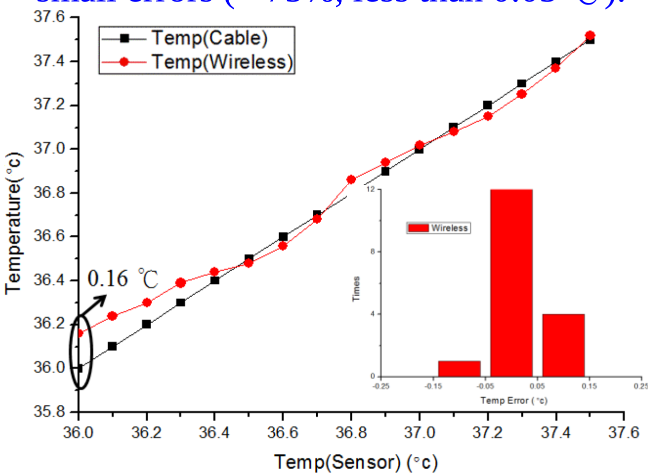
High Resolution Temperature Sampling

- Sampling & Sensitivity
  - Most implantable devices have limited resolutions
  - In case of a tiny thermal senor (ΔR): 2.68Ω (36 ℃ ~37.5 ℃), < 0.5%
  - Conventional voltage divider (ΔR => ΔV) << our proposed sampling
    - Required at least 0.05224 (=$\Delta V_m/\Delta R_{Temp}$) vs. Traditionally maximal 0.00144
    - Less sensitivity
    - Less dynamic range
- Proposed Single Stage High Sensitivity Sampling
  - Improve sensitivity and dynamic ranges (both tunable)
  - Single biasing V_s setup.
- Simplest Transmitter + Readout Integration Design with Acceptable Error Rates





small errors (> 75%, less than 0.05 ℃).



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