Paper:

Xiongchuan Huang, Simonetta Rampu, et al.
A 2.4GHz/915MHz 51µW Wake-Up Receiver with Offset and Noise Suppression.

Presented by:

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Outline

• Introduction
• Double sampling
• Receiver
• Results
• Conclusions
Introduction

• For wireless sensor networks
• Always-on receiver monitors link
• Requires very low power consumption

• Envelope detector popular choice
  – Attenuates low level signals
  – Adds excessive noise

• Gain before detector improves SNR
  – LNA consumes additional power
  – Masking 1/f noise requires a lot of gain
Double sampling

• Double sampling
  – Sample detector output twice
  – Once with signal, once without signal
  – Subtract one from the other

• Cancels offset and LF noise
Receiver

- Step one: Sample output with signal
- Step two: Subtract noise of receiver (no signal)
Receiver

- Sampling at frequency $f_{CLK}$
- Output from envelope detector at $f_{CLK}$
  - *Avoids 1/f noise in detector & gain stages*
- Sampled back to DC
  - 1/f noise & offset converted to multiples of $f_{CLK}$
Receiver

- 90nm CMOS
- RF amplifier optimized for gain (over NF)
- High Q off-chip inductors to maintain high voltage gain
- No DC reference required for detector (output at $f_{CLK}$)
- Most gain in baseband amplifiers
- 0.5V $V_{dd}$ (analog part)
Receiver

- Received RF signal
- CLK 10MHz 50% Duty-cycle
- Envelope detector input
- PGA output
- CLKC 10MHz 25% Duty-cycle
- CLKCD 10MHz 25% Duty-cycle
- Receiver final output

Bandwidth limited
Down-sampling
"0"  "1"
Results

SNR (dB) vs. Pin (dBm) for different frequency bands:
- 915MHz, 10kbps
- 2.4GHz, 10kbps
- 915MHz, 100kbps
- 2.4GHz, 100kbps

SNR = 12dB
Results

- Mounted in QFN56 package
Conclusions

• Double sampling considerably lowers low frequency NF & offset
• Cheap and simple implementation

• 50μW OOK receiver demonstrated
Discussion

• How is input impedance affected by sampling?