

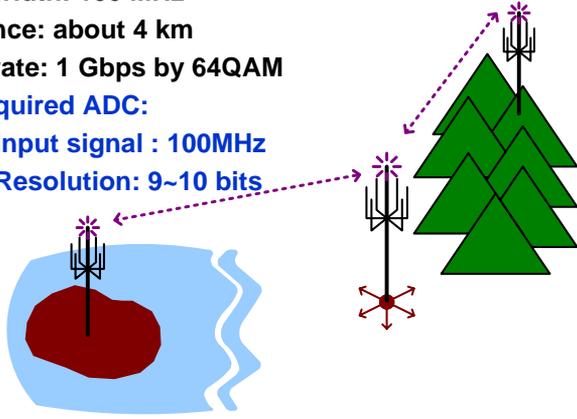
# An Injection-locked Ring Oscillator for an ADC and DAC embedded in a 38GHz-band FWA System

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## 38 GHz-Band Fixed Wireless Access (FWA) PLL for an ADC and DAC

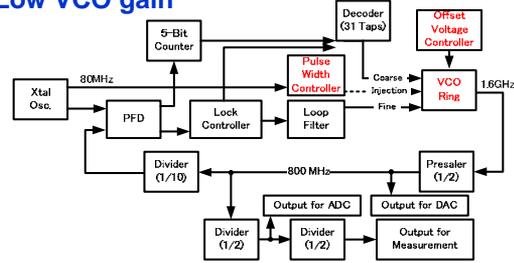
- ◆ Transmitting a huge amount of data by wireless in rural areas where the cost of wire construction is expensive

- ✓ Bandwidth: 100 MHz
- ✓ Distance: about 4 km
- ✓ Data rate: 1 Gbps by 64QAM
- ✓ Required ADC:
  - ✓ Input signal : 100MHz
  - ✓ Resolution: 9~10 bits



- ◆ Phase-locked loop (PLL) of a clock generator for the ADC and the DAC.

- Low rms jitter Characteristics for ADC [1]
  - ✓ Below 2.54 ps for 9 bits ADC
  - ✓ Below 1.27 ps for 10 bits ADC
- Low area for SoC
  - ✓ Low VCO gain

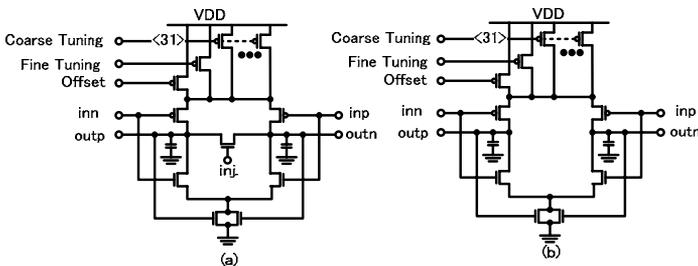


Phase-locked loop for the ADC and the DAC

## 4-Stage Injection-Locked Ring Oscillator

- ◆ 4-Stage Differential Ring Oscillator
- ◆ 3 kinds of Current Source for Low VCO gain
  - Current Source for Offset Frequency
    - ✓ Set up the center frequency of the oscillator
    - ✓ Controlled by 2bit digital code for PVT variations
  - Current Source for Coarse Tuning
    - ✓ 5bit digital code (32 steps)
    - ✓ The mean interval: 12.8MHz/step
  - Current Source for Fine tuning
    - ✓ mean VCO gain: 117MHz/V

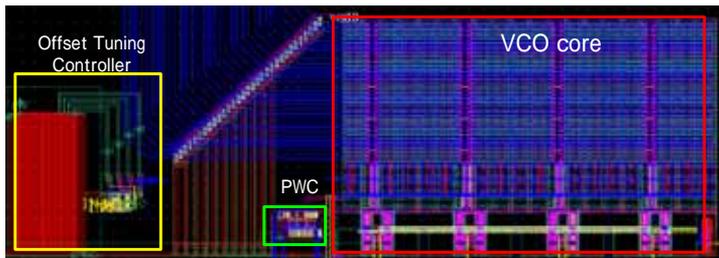
- ◆ Pulse Width Controller for Injection Lock



Delay Cells; (a) odd stage (b) even stage

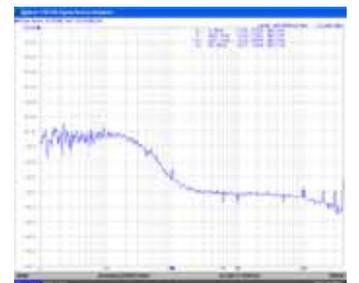
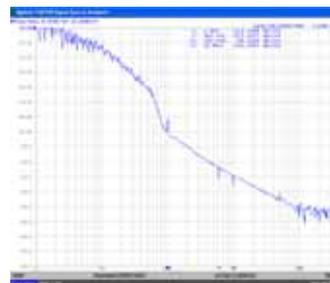
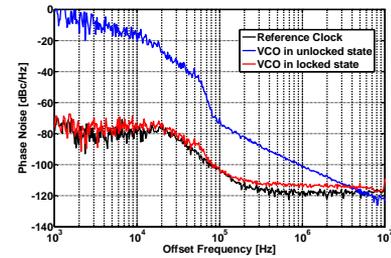
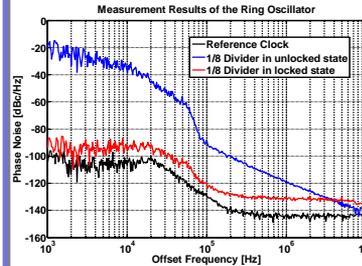
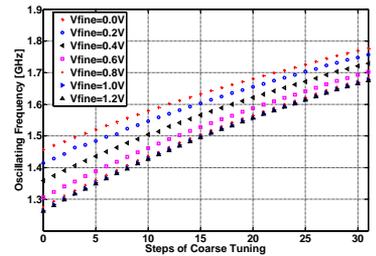
## Layout

- ◆ The Whole Area: 271 × 94 μm<sup>2</sup>
- ◆ The VCO Core Area: 114 × 94 μm<sup>2</sup>



## Measurement Results

- ◆ Coverage: 1.263 ~ 1.757 GHz
- ◆ Mean Interval between Coarse Tuning Steps
  - 12.8MHz/Step
- ◆ Mean VCO Gain of Fine Tuning
  - 117MHz/V
- ◆ 1/8 Divider Output
  - Free Running
    - Frequency: 200 MHz
    - Phase Noise @1MHz: -118.5dBc/Hz
  - Locked State
    - Phase Noise @1MHz: -131.3dBc/Hz



In Free Running

In Locked State

### References:

- [1] Brad Brannon et al., in AN-501, Analog Devices, Inc., January 1998.
- [2] T.Nakamura et al., in Proceedings of the 32nd European Conference, pp. 448-451, 2006
- [3] Chao Xu et al., in the 8th IEEE International Conference, vol. 1, pp. 55-58, 2001.