A 60GHz Direct-Conversion Transmitter in 65nm CMOS Technology

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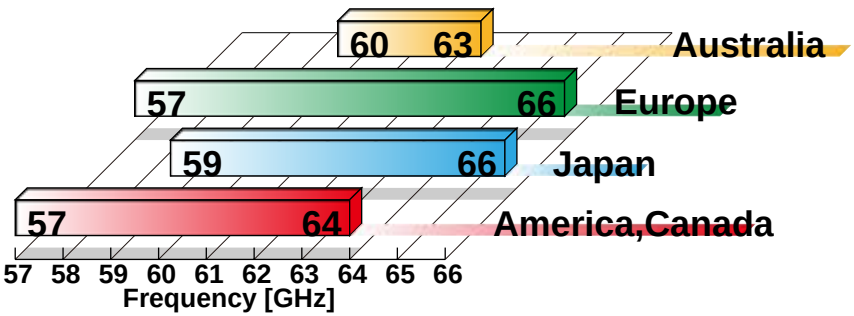
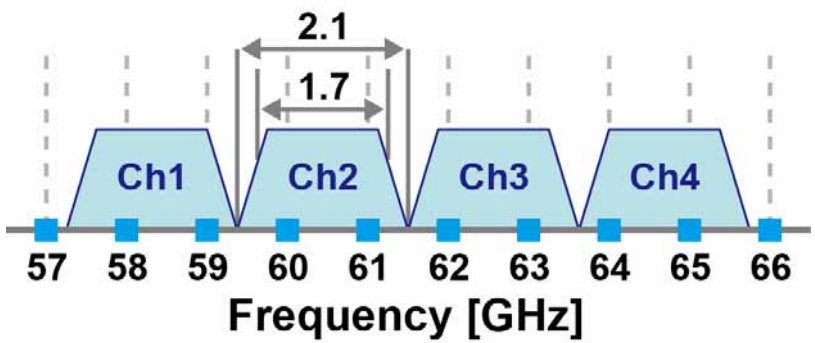
Background

- **CMOS 60GHz RF Circuits**
  - **Available wide frequency range without licenses**
  - **High data rate wireless communication**
  - **IEEE 802.15.3c**
    - **1.7 GHz x 4 ch**
    - **QPSK : 14 Gbps, 16QAM : 28 Gbps**



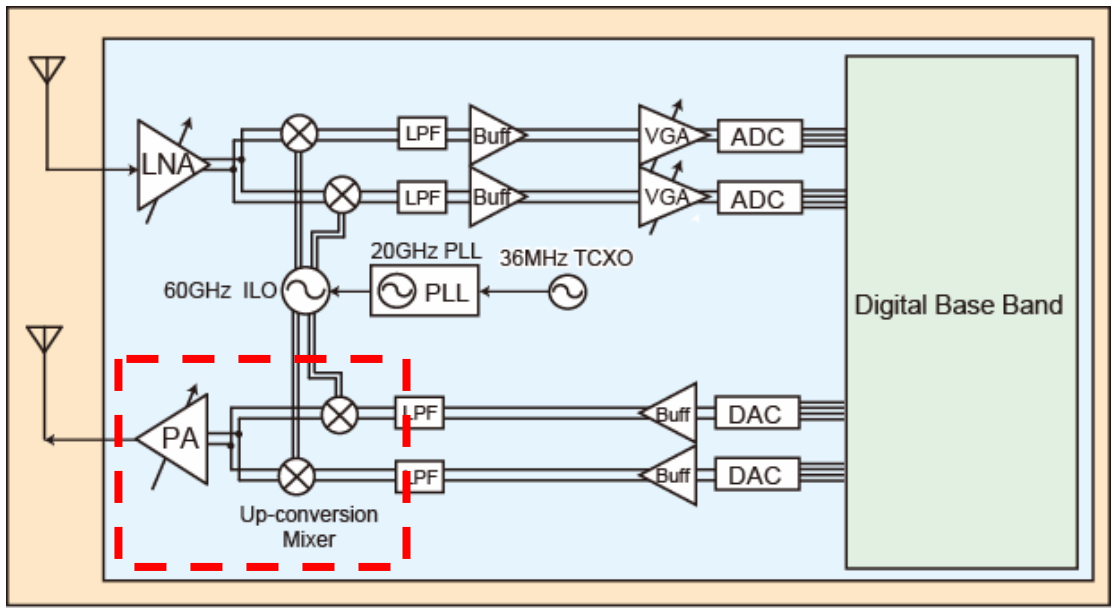
Available frequency range



IEEE 802.15.3c

RF Front-end

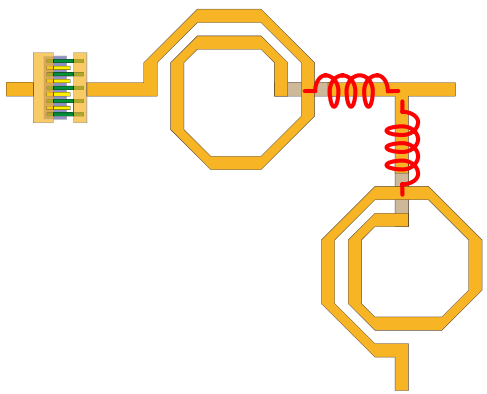
- **Direct conversion system**
  - **Power Amplifier**
  - **Up-conversion Mixer**



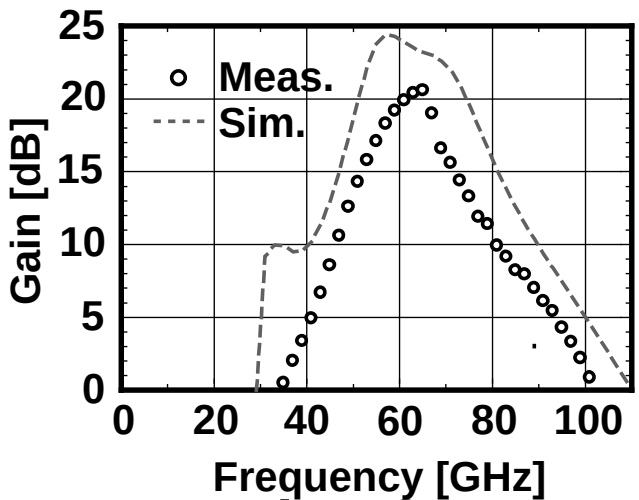
RF Front-end

Challenge

- **Parasitic elements**
  - **The present device models are not accurate at more than 20GHz.**
    - **Large error between sim. and meas.**
  - **Modeling of components is needed.**
    - **Transistors, Capacitors, TLs, Decoupling Cap.**
  - **A new de-embedding method is applied.**



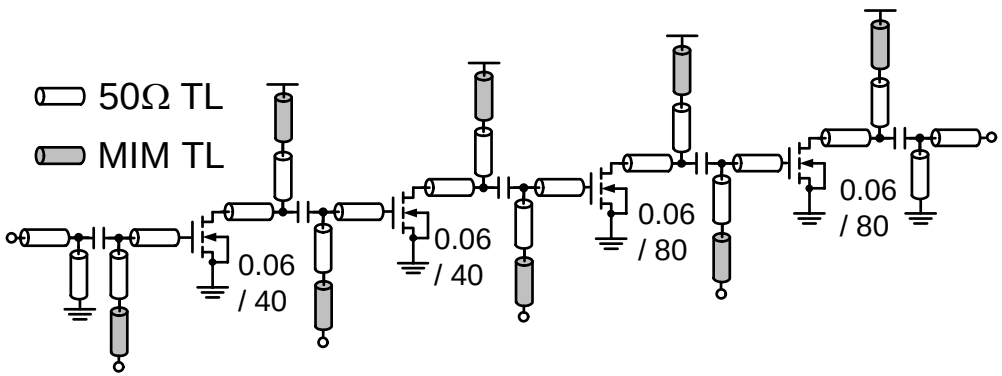
Parasitic elements



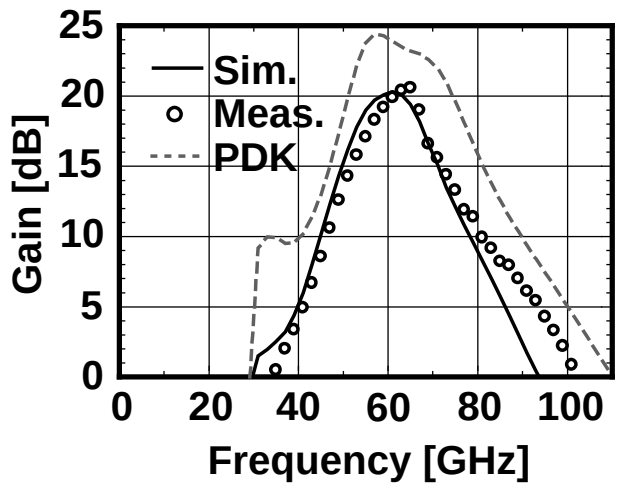
Gain of PA

Circuit design

- **Power Amplifier**
  - **CMOS 65nm process**
  - **4-stage PA**
  - **We used the device models we built.**
- **Measurement results**
  - **Simulation error reduced. 5 [dB] ⇨ 0.5 [dB]**



PA Schematic



Gain of PA

60GHz Transmitter

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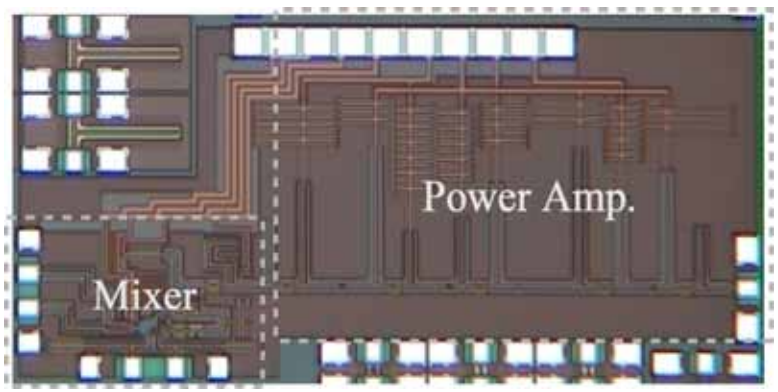
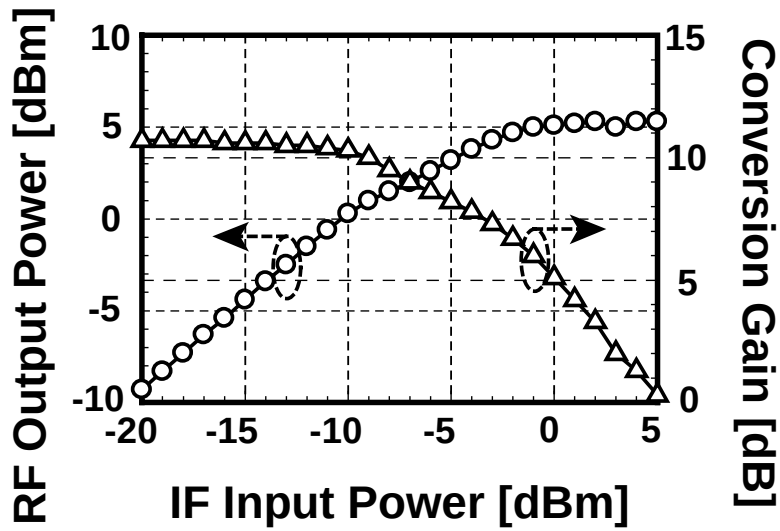
- **Power Amplifier + Up-conversion Mixer**
  - **Passive mixer**
  - **Diff. IF input, Diff. LO input, Single RF output**
- **Measurement results**
  - **Conversion Gain : 10.6 [dB]**
  - **Output Power @ 1dB : 1.6 [dBm]**



Chip photo



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Conclusion

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- **I designed a 60GHz Direct-Conversion Transmitter in 65nm CMOS Technology.**
- **The present device models are not accurate at more than 20GHz, so we built the device models, for example, transistors, capacitors, TLs and de-coupling capacitors by using a new de-embedding method.**
- **The performance of transmitter(60GHz)**
  - **Conversion Gain : 10.6 [dB]**
  - **Output Power @ 1dB : 1.6 [dBm]**