Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: [RF Devices for Millimeter-Wave Applications]
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Re : []
Abstract:[RF Devices for mm-Wave applications are introduced.]
Purpose:[Contribution for millimeter-wave interest group]

RF Devices for Millimeter-Wave Applications

RF Devices for V-band (50-75GHz) Applications

- **Gallium Arsenide (GaAs) Devices**
  - pHEMT: high F_T (>80GHz) and Fmax (>200GHz), low noise and high output power
  - HBT: low phase noise in oscillators
  - Mature process technology for 4 – 6 inch wafers
  - Foundry services available (provided by several companies in US, Europe, Japan and Taiwan)
- **Indium Phosphide (InP) Devices**
  - Higher F_T and Fmax, lower noise compared to GaAs devices
  - Lower breakdown voltage i.e. inadequate for high power applications
- **Silicon Germanium (SiGe) Devices**
  - Higher F_T and Fmax (>100GHz) for low voltage devices
  - Possible integration with other circuits (BiCMOS)

Requirements

- **Transceiver**

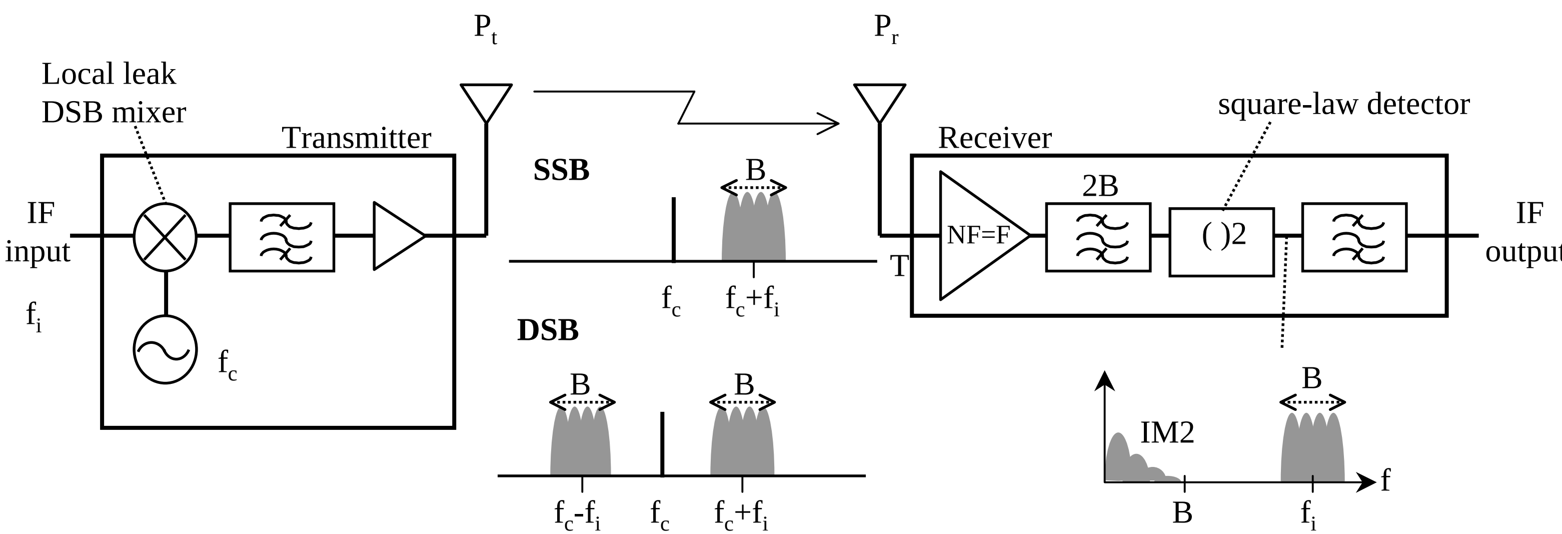
  - Design with careful consideration of mmW device properties: some components are difficult to be obtained such as low-phase noise local oscillators, high linearity amplifiers, and narrow band-pass filters.

- **Package**

  - Simple module structure to be easily fabricated at mass production
  - Low loss interconnects
  - No parasitic radiation, oscillation and resonance due to packaging structure

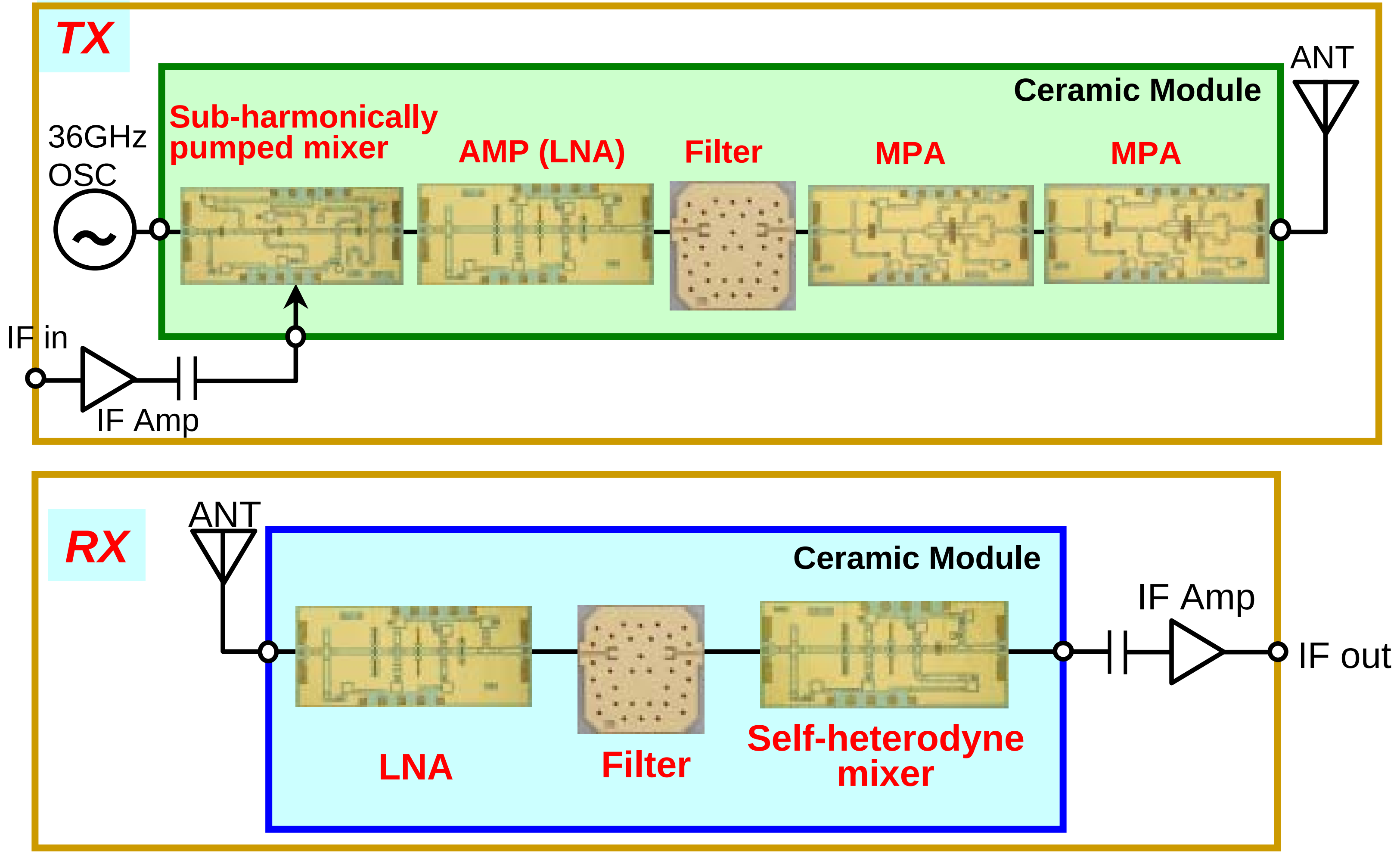
Self-heterodyne Technique

- **Transmission**
  - RF and LO transmitted simultaneously
  - Low phase noise and high stable oscillator <u>NOT</u> required
- **Reception**
  - Complete cancellation of phase-noise and frequency-offset by the self-heterodyne detection (square-law detection)



Reference: IEEE 802.15-03/119r4

Block Diagram of Self-heterodyne Transceiver



Reference: "Millimeter-Wave Ad-hoc Wireless Access System II (6)", TSMMW2003 Technical Digest, pp61-64, March 2003

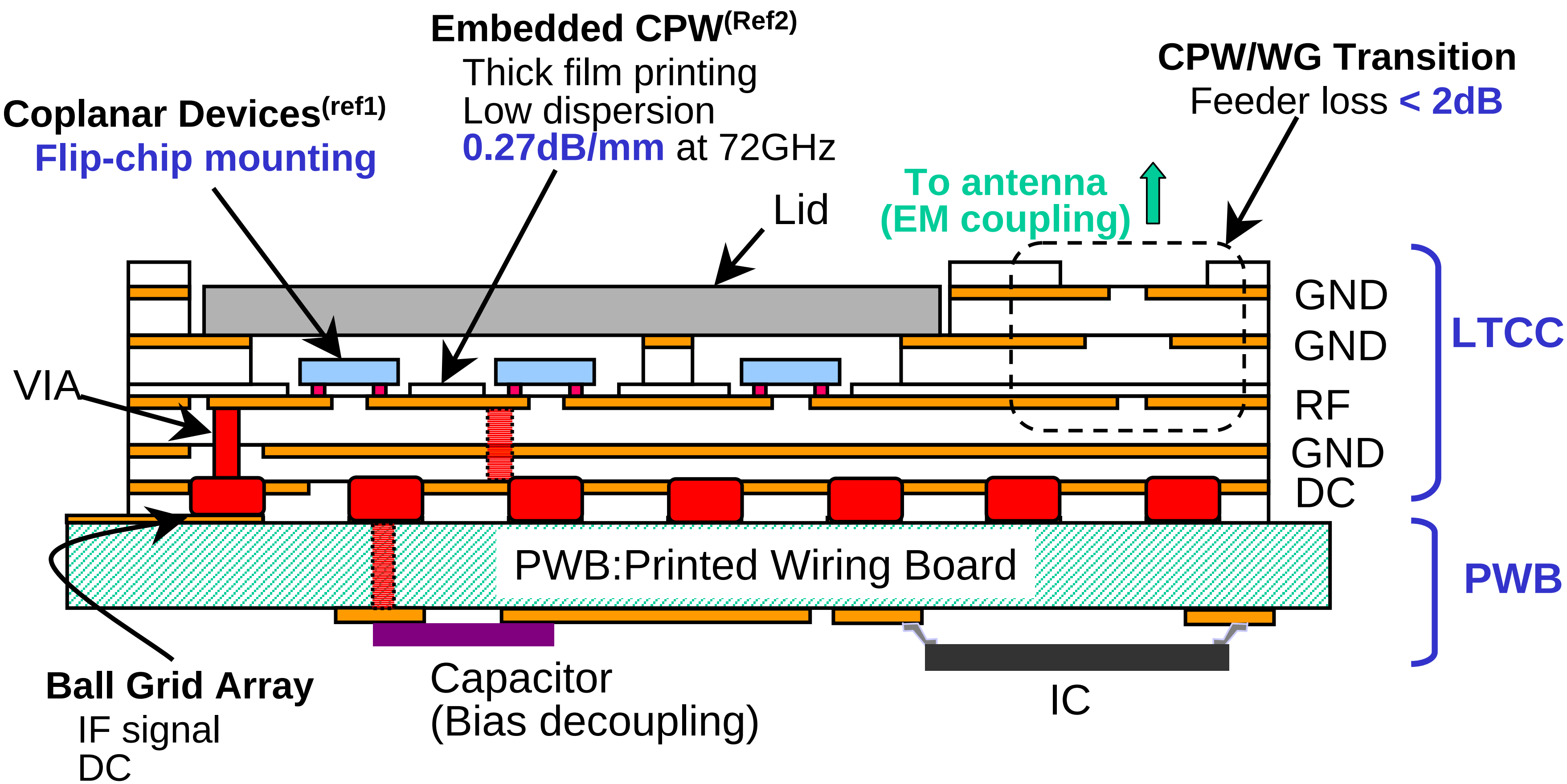
Chipset Performance

Chip	Function	Performance
Sub-harmonically pumped mixer(SHM)	Up-converting with intentional LO leakage	P_{1dB}= -22dBm @P_{LO}=-5dBm / f_{LO}=36GHz
Medium power amplifier (MPA)	Transmitting amplifier	P_{1dB}=10.2dBm, GL=11.5dB @ f=72GHz / Vd=3.3V
Low noise amplifier (LNA)	Receiving amplifier(RX) Driver amplifier(TX)	Gain ≥20dB (f:70～75GHz / Vd=3.3V)
Self-heterodyne mixer	Square-law detection	P_{IF}= -55dBm @P_1=P_2= -47dBm (f_1=72.40GHz, f_2=72.54GHz)
Filter	Filtering (TX, RX)	Insertion loss=1dB, BW=4.0GHz

ICs have been fabricated using 0.15-µm pHEMT Process

Reference: "Millimeter-Wave Ad-hoc Wireless Access System II (6)", TSMMW2003 Technical Digest, pp61-64, March 2003

Ceramic Module

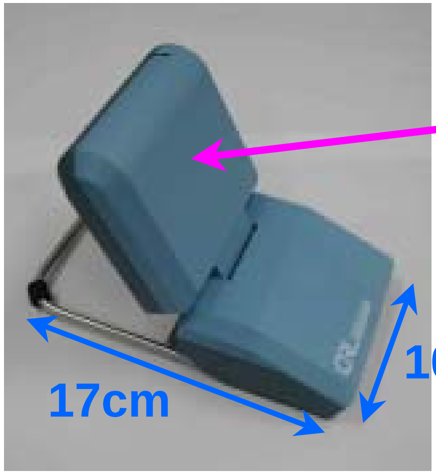


(Ref1) M. Ito et al., IEEE MTT-S IMS, p.1789, 2002

(Ref2) K. Maruhashi et al, IEEE ISSCC, p.324, 2000

Transceiver Example

Center frequency	72.4 GHz
IF frequency	140MHz or 470MHz
RF power	+10dBm (P1dB)
Duplex	TDD
Transmission	DSB self-heterodyne



Conclusion

- **RF devices operating at millimeter-wave frequencies are discussed.**
- **A trial example of the transceiver at V-band is introduced.**