Broadband Comb-Based Spectrum Sensing

Tech ID: 29981 / UC Case 2019-266-0

SUMMARY

Researchers at the UCLA Department of Electrical & Computer Engineering have developed a millimeter-wave spectrum analyzer that uses a non-linear fast switch to generate a broadband frequency comb local oscillator (LO) with a tunable repetition rate.

BACKGROUND

Broadband integrated circuits in millimeter-wave and terahertz (THz) frequencies provide low-cost and compact solutions for high-resolution hyper-spectral imaging and molecular spectroscopy. Non-linearity of the direct CMOS THz detectors based on the plasma-wave effect in MOS transistors recovers the power of the millimeter-wave/THz signal for building imaging arrays. However, in order to develop hyper-spectral imaging systems or trace-gas spectrometers, coherent receivers are required to extract the frequency content. Sub-harmonic mixers have been used in to coherently receive the sub-THz signals. High-power LO signals are needed in these mixers to down-convert the received signal to low frequencies and multiple VCOs need to be implemented to cover a wide LO frequency range.

INNOVATION

Researchers at UCLA have developed a millimeter-wave spectrum analyzer that uses a non-linear fast switch to generate a broadband frequency comb LO with a tunable repetition rate. A broadband frequency comb with a frequency spacing of frep is used to detect the spectrum of any received signal within the same bandwidth. An NFET is used as a broadband heterodyne plasma-wave detector to down-convert the received tones to distinguishable low frequency tones. The receiver is operated from 30 to 160 GHz, where the maximum frequency is limited by measurement equipment.

APPLICATIONS

- High-resolution hyper-spectral imaging
- Molecular spectroscopy

ADVANTAGES

- The receiver operates at a wide frequency range, thus no longer require to down-convert the received signal

STATE OF DEVELOPMENT

The described millimeter-wave spectrum analyzer was tested experimentally.

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	12,034,491	07/09/2024	2019-266

RELATED MATERIALS

- Aggrawal, H., Chen, P., Assefzadeh, M.M., Jamali, B. and Babakhani, A., 2016. Gone in a picosecond: Techniques for the generation and detection of picosecond pulses and their applications. IEEE Microwave Magazine, 17(12), pp.24-38.
- Jamali, B. and Babakhani, A., 2018. A Self-Mixing Picosecond Impulse Receiver With an On-Chip Antenna for High-Speed Wireless Clock Synchronization. IEEE Transactions on Microwave Theory and Techniques, 66(5), pp.2313-2324.

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- Babakhani, Aydin

OTHER INFORMATION

KEYWORDS

broadband, millimeter-wave, wireless communication, spectrum analyzer, spectrum sensing, CMOS, hyper-spectral imaging

CATEGORIZED AS

- **Computer**
  - Hardware
- **Engineering**
- **Sensors & Instrumentation**
  - Scientific/Research

RELATED CASES

2019-266-0

▶ Jamali, B. and Babakhani, A., 2016, May. Sub-picosecond wireless synchronization based on a millimeter-wave impulse receiver with an on-chip antenna in 0.13 µm SiGe BiCMOS. In Microwave Symposium (IMS), 2016 IEEE MTT-S International (pp. 1-4). IEEE.

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- ▶ Vibration Sensing and Long-Distance Sounding with THz Waves
- ▶ THz Impulse and Frequency Comb Generation Using Reverse Recovery of PIN Diode

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