Terahertz Wireless Communication using Silicon CMOS Integrated Circuits

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Biography

1976 Born in Kanagawa Prefecture
1996 Graduated from Faculty of Science and Technology, Tokyo University of Science
2006 Completed Doctorial Course at Tokyo University of Science
2007 Researcher at Toyota Technological Institute
2008 Research Associate at Tokyo University of Science
2013 Joined NICT
2019 Current Position

Awards, etc.

2019 Institute of Electronics, Information, and Communication Engineers 2018 Best Paper Award
2017 International Symposium on Radio-Frequency Integration Technology RFIT Award

Q&As

Q What do you like the most about being a researcher?

A Being able to deepen my understanding of cutting-edge tech across disciplines. One of the advantages of being a researcher, I think, is that you have many opportunities to have in-depth conversations with other researchers.

Q What are you currently interested in outside of your research?

A Right now I'm trying to learn how to ride my child's two-wheeled skateboard. I also enjoy observing my pet praying mantis.

Q What advice would you like to pass on to people aspiringto be researchers?

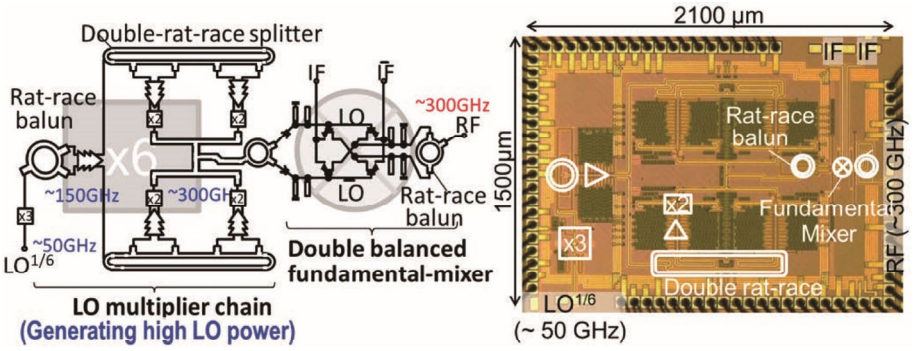
A Don't be afraid of failure. Listen to the advice of your seniors and teachers, and devote yourself to your research. Let's all work together to create new technologies.

Electromagnetic waves including radio waves and light are used in a wide range of industrial fields. Among them, the frequencies of the radio waves are allocated based on their application according to the pertinent regulations, and wireless communication techniques used in wireless LAN, smartphones, and more are in widespread use based on those standards. However, new forms of ICT are being developed in areas like IoT, big data, and AI, and there is increased demand for high-speed wireless communication capable of sending and receiving large amounts of data. To make this a reality, techniques which use wide frequency bands all at once are being proposed as possible solutions.

Terahertz (THz) waves are electromagnetic waves located between radio waves and light, and are known as an "unexplored frequency resource." If frequency ranges with low atmospheric absorption can be utilized over a wide band, THz waves hold promise as a means for realizing high-speed wireless communication. A frequency spectrum from 275 to 450 GHz, for a total band of 137 GHz, was identified at the World Radiocommunication Conference (WRC) held in 2019 (see pp. 1-3).

We have been engaged in research aimed at making THz wireless communication a reality. Through joint research with Hiroshima University and Panasonic Corporation, we successfully developed a 300-GHz-band transmitter/receiver using a silicon CMOS technology. Silicon CMOS, which is widely used in information processing devices, is easily mass-produced and is therefore suited to handling the spread of THz wireless communications. However, typical silicon CMOS technologies have a problem in that it is difficult to design an amplifier in the 300 GHz band due to the limit of the FET performance. In our work, a 300-GHz CMOS receiver combining a down conversion mixer with a high-output local oscillation driver was developed with a high-output power transmitter, and we successfully verified high-speed wireless communication in the 300 GHz band.

Moving forward, we aim to further improve the properties of the THz transmitter/receiver and put ultra-high-speed wireless communication technology in the THz band into practical applications as soon as possible.



Circuit diagram and chip photograph of 300 GHz silicon CMOS receiver circuit