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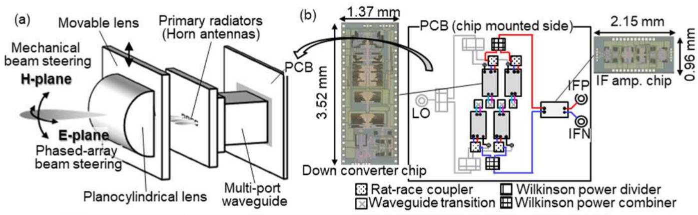
259 GHz Phased-array CMOS Receiver Module with 25.9 Gb/s Data Rate

S. Hara[(1)], M. H. Mubarak[(1)], A. Kasamatsu[(1)], Y. Sugimoto[(2)], K. Sakakibara[(2)], K. Takano[(3)], T. Yoshida[(4)], S. Amakawa[(4)], and M. Fujishima[(4)]
(1) National Institute of Information and Communications Technology, Koganei, Japan; e-mail: s-hara@nict.go.jp; moh.mubarak@nict.go.jp; kasa@nict.go.jp
(2) Nagoya Institute of Technology, Nagoya, Japan; e-mail: sugimoto.yoshiki@nitech.ac.jp; sakaki@nitech.ac.jp
(3) Tokyo University of Science, Noda, Japan; e-mail: ktakano@rs.tus.ac.jp
(4) Hiroshima University, Higashi-hiroshima, Japan; e-mail: tyoshida@dsl.hiroshima-u.ac.jp; amakawa@hiroshima-u.ac.jp; fuji@hiroshima-u.ac.jp

The sub-terahertz (THz) band above 100 GHz has been the focus of extensive research in the pursuit of high-speed wireless communications beyond 5G. Phased-array systems for beam steering have received particular attention due to their ability to efficiently enhance equivalent isotropically radiated power (EIRP) and antenna gain. These systems enable effective control over the beam pattern, contributing to improved wireless communication performance. However, the antenna pitch ($\leq \lambda/2$) of the array required to reduce the grating lobe is not easily achieved because of the short wavelength in the sub-THz band (λ is wavelength). Various sub-THz phased array systems have been developed using IC and packaging technologies, including on-chip antenna arrays, series-fed patch arrays, and vertically stacked antennas on printed circuit boards (PCBs).

In this paper, a two-dimensional beam-steerable CMOS receiver (RX) module operating at around 260 GHz will be presented. Its configuration integrates a one-dimensional phased array fabricated on a printed circuit board (PCB) with four CMOS receiver chips for E-plane steering and a mechanically steered antenna for H-plane steering. In this phased array system, the down-converter chips are mounted in a staggered arrangement relative to the waveguide transitions arranged in one dimension due to chip size and antenna pitch constraints. The phase-shifted differential output IF signals from the receiver chips are combined effectively in the passive components arranged with point symmetry on PCB. The phased-array CMOS RX module achieves a wireless data rate of 25.9 Gb/s with a steering range of 28˚.



(c)

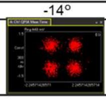
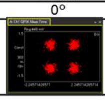
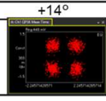
Ch / RF [GHz]	57 / 259.2		
Data rate [Gb/s]	25.92		
Beam angle	-14°	0°	+14°
Constellation			
Band power [dbm]	-16.92	-12.42	-16.42
EVM [%rms]	28.08	19.33	25.11
BER	1.85e-04	1.15e-07	3.41e-05

Figure 1. (a) 2D beam steering RX module , (b) PCB mounting, and (c) wireless link measurement results.

1. T. Yoshida, et al., “A 2D Beam-Steerable 252–285-GHz 25.8-Gbit/s CMOS Receiver Module,” *2023 IEEE Asian Solid-State Circuits Conference (A-SSCC)*, Nov. 2023, pp. 1-3.
2. M. Yamazaki, et al., “Broadband differential-line-to-waveguide transition in multi-layer dielectric substrates with an X-shaped patch element in 280 GHz band,” *IEEE Trans. Microwave Theory and Tech.*, **71**, 6, Jan. 2023, pp. 2616-2624.
3. S. Hara, et al., “25.9-Gb/s 259-GHz Phased-Array CMOS Receiver Module with 28° Steering Range” *2024 IEEE Radio & Wireless Symposium (RWS),* Jan. 2024, pp. 1-4.