Demonstration of a 245 GHz Real-Time Wireless Communication link

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***Abstract*— A wireless communications system with a carrier frequency of 245 GHz and a data rate of 30 gigabits per second (Gbps) at a 1.2 m distance is demonstrated. The system consists of low-complexity and real-time baseband modules to provide the high-speed wideband signal processing capability. Multi-channel base-band signals are combined and converted to 15.65 ± 6.25 GHz wideband intermediate frequency (IF) signals. A 50 Gbps wireless communication system is currently development, and the technical progress will be presented at the conference. The new wireless communication technology will find great potential for future high-speed communications beyond 5G technology, especially, for space applications, such as intersatellite communication where atmospheric attenuation is negligible.**

I. INTRODUCTION

THE ever-increasing demands for broadband and high-speed wireless communications has driven the wireless communications moving towards higher frequency bands, such as millimeter and terahertz (THz) waves. The ultra-wide bandwidth of THz frequencies makes it possible to achieve huge data rates from tens of gigabits per second (Gbps) to potentially terabits per -second (Tbps). THz communications have emerged as a promising candidate to support the heavy data traffic and exploding network capacity in the future 6G wireless networks and space communications. THz communication holds great potential for space applications potentially facilitating long-range high-speed communication between satellites and satellites to high-altitude aircraft.

Despite great potential, research on THz wireless communication is in its infancy and has not yet been demonstrated in practical applications due to various challenges such as high path losses, lack cost-efficient high-performance components, complicated system configuration, etc. Some research progress, however, has been made in recent years based on either electronics or optical approaches [1-4].

We present here our recent progress on developing a high-speed, real-time wideband wireless communication system operating at 245 GHz. A 16 quadrature amplitude modulation (QAM) scheme has been used in four base-band channels, which occupy the 10 GHz frequency band in total, to achieve an overall 30 Gbps data rate. Low-complexity implementation with low resource usage and a high frequency of the system clock on the field programmable gate array (FPGA) is applied in the base-band development. IF modules operating at 15.65 GHz were applied to combine the base-band signals for frequency conversion and signal transmission at 245 GHz. In addition, a 50 Gbps system at the same carrier frequency range is under development and the system performance results will be presented at the conference.

II. RESULTS

Fig. 1 shows the photograph of the 245 GHz wireless link system set-up with the transmitter and receiver separation distance of 1.2 m. The transmitter and the receiver each consist of three modules: base-band module, IF module, and THz front-end module. The base-band module on the transmitter side has 4 channels of in-phase and quadrature-phase (I/Q) outputs, with each I/Q output generating signals at a speed of 7.5 Gbps within the 2.5 GHz bandwidth. Hence, the total data rate and bandwidth of the base-band modules are 30 Gbps and 10 GHz, respectively. The IF modules are connected to the 245 GHz THz front-end modules for frequency up-conversion, transmission, detection, and demodulation. A pair of horn antennas with 25 dBi gain are connected to the THz transmitter and receiver.

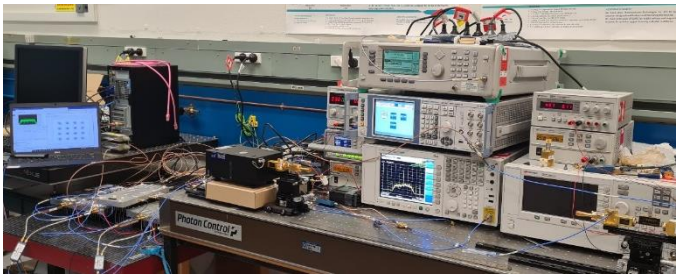

Fig. 1. Photograph of the 245 GHz wireless communication demonstration platform at 1.2m distance.

Fig. 2 shows the system test result of the overall wireless communication link at 1.2 m distance, where the constellation star diagram for each channel with 16 (QAM) modulation of the THz wireless link is given. The error vector magnitude (EVM) is below -17 dB in all four channels. The measurement result suggests a high quality of the wireless communication link results. It is shown that the present system has achieved a high speed with a relatively lower sampling rate, owing to the large bandwidth utility.

Based on above described the 30 Gbps wireless link system, a new 50 Gbps communication baseband module has been developed and applied to the above system. The new baseband module consists of two sub-channels, and each has a pair of I/Q port with 0-2.5 GHz bandwidth. The module features higher modulation order (64 QAM) and improved spectrum efficiency (50 Gbps over 10 GHz bandwidth). The new two channel module instead of four-channel system described above makes the system more compact and efficient. IF configuration is modified accordingly, with single stage frequency conversion to reduce conversion loss and noise interference.

Fig. 3 shows the latest measurement result of the constellation of the full system at the transmitter and receiver separation distance of 40 cm using the 64 QAM modulation scheme. Continuing system optimization is still underway and more detailed results will be presented at the conference.

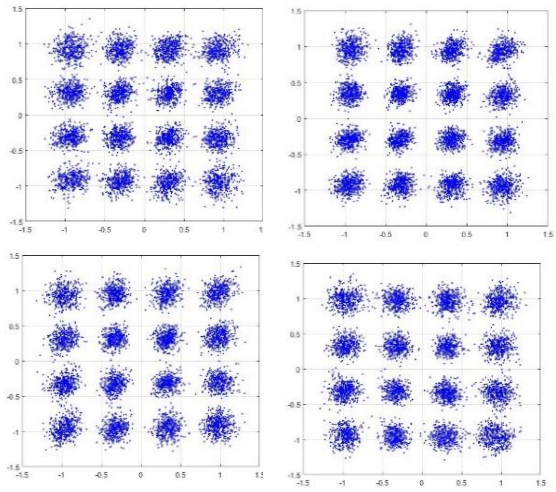

Fig. 2. Measured constellation diagrams of four channels, each with 16 QAM modulation, of the THz wireless link at 1.2m distance.

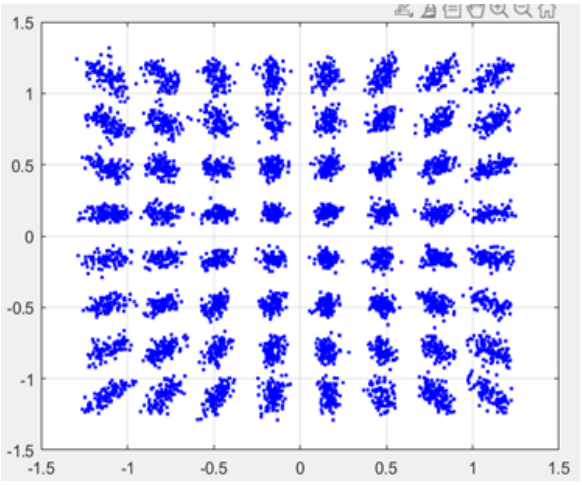

Fig. 3. Measured constellation diagrams with 64 QAM modulation scheme at a 40 cm distance.

III. Summary

A 245 GHz real-time wireless communications system with a data rate of 30 Gbps is demonstrated. Initial results of a 50 Gbps system of the same operating frequency is also presented. The successful demonstration of the ultra-high data rate wireless links promises great potential for next-generation communication systems, such as high-speed high-capacity indoor data transfer and inter-satellite communications.

IV. Acknowledgements

This research is supported by Commonwealth Scientific and Industrial Research Organization (CSIRO) Space Technology Future Science Platform Project ST-R2-03.

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