High-speed Terahertz Links based on Dielectric-lined Metallic Waveguides

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Driven by our data hungry society, chip-to-chip and device-to-device data bit rates will need to reach terabits per second in a not distant future. Such data rate will only be met if there is a shift from microwaves to millimeter-waves (ca. 30 – 300 GHz) or even Terahertz frequencies (ca. 0.3 – 1 THz) (G. Carpintero *et al.*, Semiconductor TeraHertz Technology: Devices and Systems at Room Temperature Operation, Wiley-IEEE Press, 2015). Current on-chip interconnect technology relies on printed circuit board (PCB), which is not suitable for high frequencies due to loss and dispersion limitations. Tackling these problems with complex equalization techniques will not be possible because of their high power consumption and needed area.

To address the need for high-speed links, we propose the use of dielectric-lined metallic waveguides (O. Mitrofanov, R. James, F. Aníbal Fernández, T. K. Mavrogordatos, J.A. Harrington, IEEE Trans. THz Sci. Tech. 1, 124, 2011). Despite the oversized and therefore multimode nature of this waveguide, the phenomenon known as self-filtering ensures quasi-single mode propagation of the HE_{11} mode (M. Navarro-Cía, J. E. Melzer, J. A. Harrington, and O. Mitrofanov, Silver-Coated Teflon Tubes for Waveguiding at 1–2 THz, J Infrared Milli Terahz Waves 36, 542, 2015). This fundamental HE_{11} mode is confined mostly in the low absorption air core of the waveguide, resulting in an attenuation coefficient below 10 dB/m. Notice that proposed THz PCB based transmission lines and dielectric waveguides display attenuation no lower than 100 dB/m. In addition, the dielectric-lined metallic waveguide shows very low dispersion and inhibit cross-talk given its shielding nature.

The contribution will describe the loss and dispersion limitation of dielectric-lined metallic waveguide based data links. General design criteria will be given and the capacity (bps) and energy efficiency (pJ/bit) of an optimized waveguide operating at the ALMA band 10 (787 – 950 GHz) will be discussed, see Fig. 1. Comparison with other THz waveguides will be given.

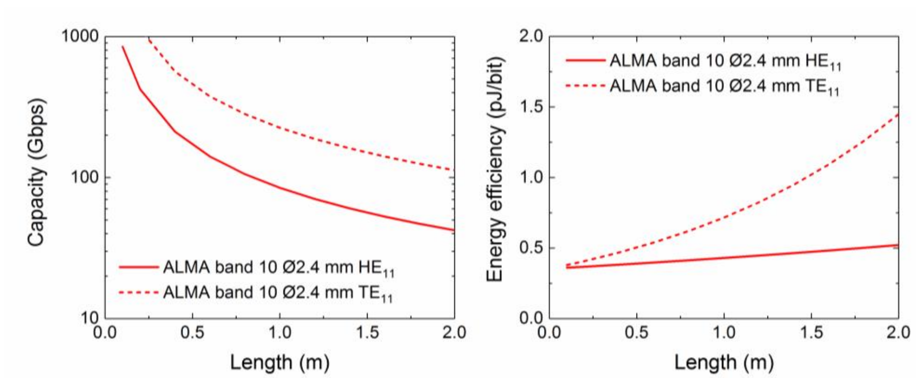

Figure 1. Capacity and energy efficiency (pJ/bit) for a data link operating at the ALMA band 10.