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A filterless, polarisation-controlled 40 GHz optical millimeter-wave generation using two Mach-Zehnder modulators in parallel

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Abstract

This work demonstrates polarisation-controlled millimeter-wave generation without using an optical filter. The configuration involves two lithium-niobate Mach-Zehnder modulators operating in parallel at the maximum transmission bias point (MATP). In the proposed scheme, a 5 GHz local RF signal is subjected to frequency 8-ctupling, resulting in the generation of a 40 GHz millimeter-wave signal. The system achieves sideband suppression ratios (SSRs) of 50 dB and 44 dB in the optical and RF domains, respectively, for a modulation index of 2.868. Carrier suppression is achieved using a polarisation-based control method. An analytical assessment is carried out to evaluate the variation in SSR with changes in the extinction ratio, the azimuth angle of the polarisation controller, and the amplitude of the RF drive signal.

1. Introduction

The rapid growth in mobile data traffic is prompting telecommunications equipment operators and service providers to explore innovative, efficient cellular technologies that meet the evolving needs of communication frameworks. This increasing demand highlights the need for efficient and high-performance frequency conversion techniques in order to optimise the use of available RF spectrum to support 6G and next-generation networks [1]. Global mobile data traffic is expected to surge substantially over the next decade. Figure 1 illustrates the expected increase in worldwide mobile data traffic, based on projections from the International Telecommunication Union (ITU). It shows the forecasted monthly data volume, measured in exabytes (EB), over 10 years from 2020 to 2030. According to this projection, global mobile data traffic is expected to grow at an average annual rate of 55% from 2020 to 2030, reaching approximately 607 EB and 5016 EB per month by 2025 and 2030, respectively [2].

To address the rising demand for data services, network operators are required to transition from traditional wireless systems to more efficient, high-bandwidth systems. One promising solution to address the limitations of overcrowded spectrum is the use of higher frequency bands, particularly in the millimeter-wave (mm-wave) range. The mm-wave band generally spans frequencies from 30 GHz to 300 GHz [3]. Nevertheless, generating mm-waves above 100 GHz remains challenging due to the performance limitations of available electronic components. As an alternative, optical methods for generating and transmitting

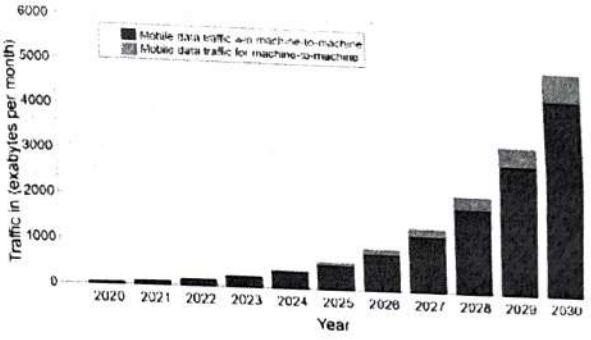

Fig. 1. Global mobile data traffic forecast for the period from 2020 to 2030 (Source: ITU).

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