Tandem single sideband modulation scheme for doubling spectral efficiency of analogue fibre links

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Using a dual-electrode Mach-Zehnder modulator, a 'tandem' single sideband modulator has been constructed that doubles the spectral efficiency of a system by enabling the transmission of different data streams in the upper and lower sidebands of the same optical carrier.

Introduction: Optical single sideband (SSB) modulation has received a great deal of attention recently as a method for reducing the dispersion penalty of analogue fibre optic systems [1, 2]. The 'tandem' approach presented in this Letter modifies this concept by allowing different information to be transmitted in each sideband of the same optical wavelength, thus doubling the information-carrying capacity. Tandem SSB carriers are spaced twice as far apart than in SSB systems, which makes them easier to reject by microwave filtering than in the conventional SSB case. In this Letter, we demonstrate, for the first time to our knowledge, the transmission of two different data streams on the two sidebands of the same optical carrier. The transmitter was built using a LiNbO$_3$ dual electrode Mach-Zehnder modulator.

Experimental setup: Fig. 1 shows the experimental setup. The light source was an external cavity tunable laser diode (ECT-LD), tunable around 1550 nm. The light from the ECT-LD was coupled into a dual electrode Mach-Zehnder modulator (DE-MZM) through a polarisation controller. An externally triggered pattern generator with 2$^7 - 1$ pseudorandom bit sequences provided the two baseband signals. The data was modulated using binary phase-shift keying (BPSK) onto a sub-carrier at a frequency $f_c = 7$ GHz. The power in each of the two arms, $A$ and $B$, was 17 dBm. The two signals were then fed to the two inputs of a 90° hybrid coupler. The outputs of the 90° hybrid were used to drive the DE-MZM through bias-Ts. The DE-MZM was biased at quadrature. An erbium-doped fibre amplifier (EDFA) was used to boost the output optical power. At the receiver, both the upper and the lower sidebands were separated by a combination of an optical circulator (OC) and a reflective fibre grating (FBG filter) with a full width half maximum of 20 GHz centred at ~193.7 THz (Fig. 2). The signal was detected by a photodetector (HP lightwave converter 13924A) with a responsivity of 3000 V/W for a 50 Ω load. The output was connected to an oscilloscope (HP 54520C) to monitor the eye diagrams.

Results and discussion: Fig. 3 shows the sideband suppression obtained from the dual-electrode Mach-Zehnder modulator. As a preliminary test,
All-electronic high-speed programmable wavelength tunable parametric optical oscillator

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A method for all-electronically controlling the wavelengths of parametric optical oscillations in optical fibers is described. The proposed device consists of a semiconductor laser, a photodetector, a photoconductive switch, and an optical fiber. The device is capable of controlling the wavelength of the optical output in 1-nm increments, making it possible to tune the output of the device over a range of 10 nm. The device has the potential to be used in a variety of applications, including optical communication systems and optical data storage systems.

References


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