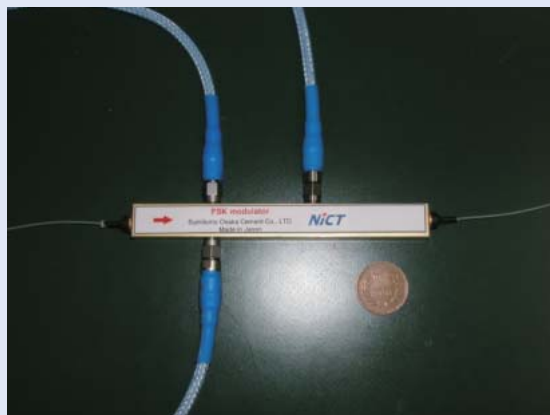


Optical Frequency Shift Keying Modulator

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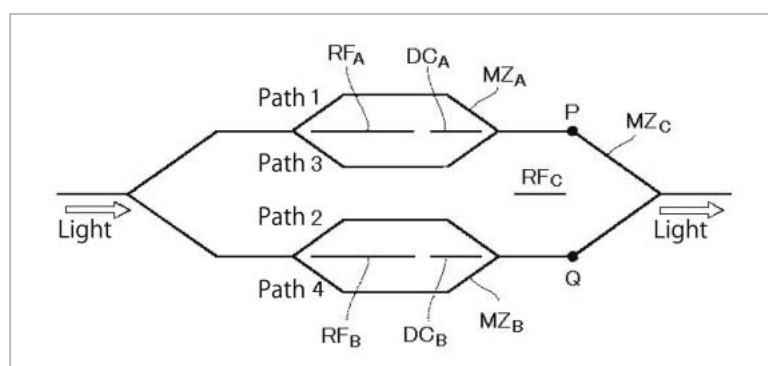


Optical frequency shift keying modulator (Prototype)

Overview of the technology

Traditional optical modulators directly modulate the laser itself. However, the upper-limit frequency of the traditional method is approximately 10 GHz, and no modulator exceeding this limit has previously been available. This invention generates sidebands using two or more phase modulators and implements optical frequency shift keying (FSK) modulation by mixing these signals appropriately and by extracting the target light (USB or LSB).

The mechanism is described as follows. First, the original optical signal is distributed to paths 1 to 4 according to the appropriate routing. The phase modulator then generates sidebands, which are added to each path of the source light. Next, the first sub Mach-Zehnder interferometer (MZ_A) mixes the source light and sideband generated in Path 1 and those generated in Path 3. Here, the source light beams in Paths 1 and 3 are in opposite phase, so that the source light is cancelled out (corresponding to suppression of the carrier component) in the output light (Point P) and only the sidebands remain. The light beams in Paths 2 and 4 are treated in the same manner to produce light with only the sideband components (Point Q). Then, to each of the pair of light beams output with only the sidebands, the main Mach-Zehnder interferometer (MZ_C) adds a signal with one of the sidebands reversed in phase, based on the change in voltage (RF_C). This process leaves only the sideband not reversed. By quickly changing the voltage to change phase, FSK modulation is implemented. This method offers increased speed of up to 18 GHz, as well as dramatic improvement in the quality of the modulated signals.



Basic configuration of optical FSK modulator

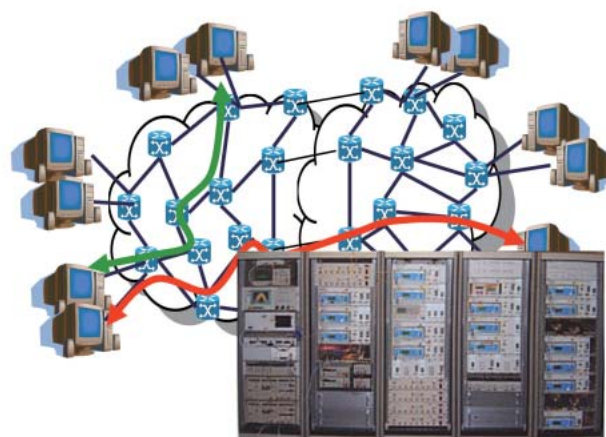
Background and features

This optical FSK modulator is an extremely effective device in implementing high-capacity, high-speed communication based on optical fibers and other media. Several modulation methods were available in early optical communication based on optical fibers: amplitude modulation, phase modulation, and frequency modulation. Research has since been conducted to increase speed while maintaining the signal-to-noise ratio (S/N). At that point, the transmission rate was several Gbps. Later, following practical application of optical amplifiers, the rate increased to several Tbps, in combination with wavelength multiplex technology. This optical FSK modulator implements high-speed transmission (at a transmission distance of 95 km) at 10 Gbps and enables the world's fastest optical frequency control today. This optical FSK modulator is based on a previously developed optical SSB modulator and is provided with frequency switching electrodes for the traveling wave, specifically designed for high-speed FSK modulation.

Optical FSK modulation is a modulation scheme that changes the frequency of light to transmit information. Thus, the amplitude of light does not change, and it is therefore possible to combine FSK modulation with intensity modulation to transmit more information. Assumed applications include the transmission of label information, which is destination information for optical packet systems. This method can add to or replace optical-FSK-modulated label information in the original intensity-modulated data. As such, the portion of networks traditionally processed electrically—causing a bottleneck reducing communication speeds—is replaced by light, which increases the speed of the network as a whole.

Commercialization

Sumitomo Osaka Cement Co., Ltd. will produce and sell this optical FSK modulator under the license of this patent. The assumed buyers of this optical FSK modulator will be restricted at first to major research institutions within and outside of Japan for test purposes. Nevertheless, when photonic networks spread to general use, this modulator could well be subject to explosive demand for use in long-haul, high-capacity optical transmission, or in photonic labeling based on the new optical signal format. We are hoping to see the wide dissemination of this optical FSK modulator as a basic device for the anticipated increasing volume of telecommunications.



Optical packet switch experiment apparatus developed by NICT and next-generation network (conceptual diagram)

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