

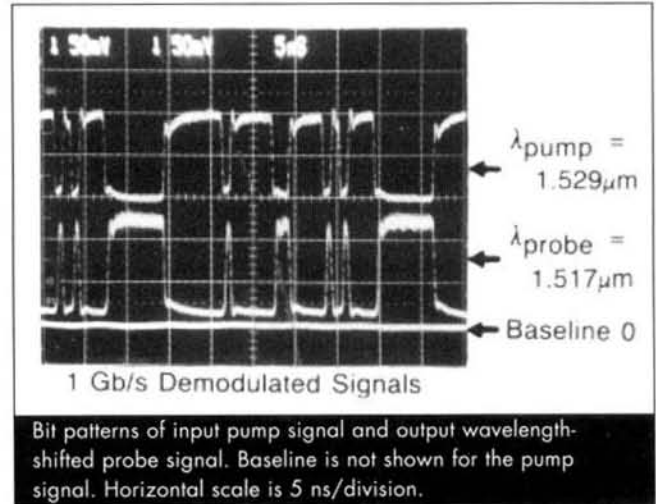
Optical Wavelength Shifter for Wavelength-Division-Multiplexed Networks

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High capacity optical communications systems can be constructed by wavelength division multiplexing (WDM), in which signals carried at different wavelengths are combined through a single optical fiber transmission network. A WDM network with many users would be based on frequency routing, in which the address of a narrow-bandpass receiver is determined by its assigned wavelength. The capacity of such a wavelength-routed WDM network is limited by the tuning range of the transmitter laser. Frequency reuse within the available optical bandwidth can substantially increase the capacity of such networks. For example, a large network can be built by interconnecting small local area networks (LANs) using wavelength shifters. In this scheme, each LAN uses the same set of wavelengths for local routing. Routing between nodes of different LANs is achieved by reassigning the wavelengths of signals flowing between LANs. The wavelength shifter needed for this application must be tunable over a large optical bandwidth and capable of operation at multi-gigabit/sec data rates, while causing negligible degradation in the signal-to-noise ratio.

A suitable wavelength shifter based on use of a semiconductor optical amplifier¹ has been demonstrated recently^{2,4}. In this device, an input intensity-modulated optical signal at bit rates up to 2.5 GBit/sec, capable of saturating the gain of the semiconductor optical amplifier by as much as 10 dB, is injected into the amplifier along with a weaker cw beam at the desired shifted wavelength. The complementary data signal is encoded on the wavelength-shifted beam because the gain of the amplifier is high when the input signal is low and low when the input signal is high. Thus, gain-saturation, usually considered a crosstalk problem for amplified transmission systems,⁵ is used here to advantage. This device does not actually transfer data from one wavelength to another, but rather copies data onto a signal at a different wavelength.

Demonstration of the device at 1 GBit/sec is shown in the figure. The input signal (pump) at 1.529 μm is clearly copied to the shifted wavelength (probe) at 1.517 μm . This result is achieved for input pump power of -2 dBm. The output modulated probe power is 0 dBm, so the device has net gain. That no signal degradation has occurred because of the wavelength shifter is demonstrated by measurements of received signal bit error curves,² which show no penalty in receiver sensitivity for data rates from 1 to 2.5 GBit/sec. Because the semiconductor optical amplifier is broadband, the wavelengths of pump and probe may be arbitrarily placed within the optical gain bandwidth of the amplifier. It is possible to reduce the input pump signal power requirements for the wavelength shifter if a semiconductor optical amplifier with residual Fabry Perot resonances is used,⁴ but



this sacrifices the arbitrary placement of input and probe wavelengths.

Two wavelength shifters have been cascaded, with only a small power penalty (2 dB) at 2 Gbit/sec.³ Also, the fanout of the device has been shown by using two probe lasers at different wavelengths, each of which is encoded with the complementary input data.³ Semiconductor optical amplifier wavelength shifters may become important building blocks in WDM systems based on interconnected LANs that require wavelength reuse and reassignment.

REFERENCES

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