

# Integrated silicon optical transmitter to carry large volumes of data between CPUs

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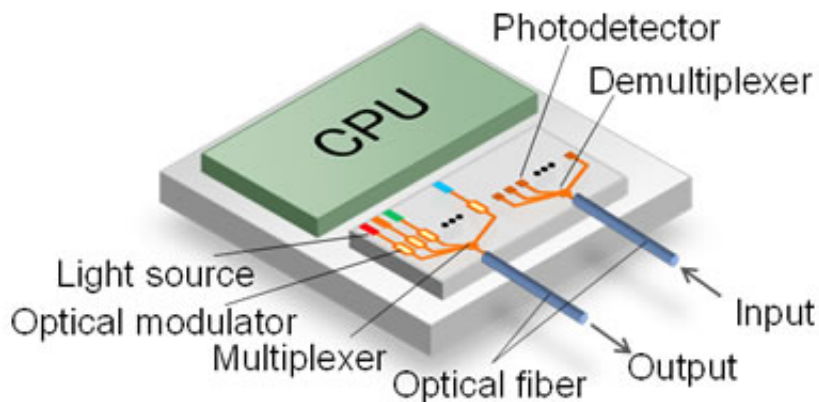


Figure 1. Integrated silicon optical transceiver for large-volume data transmission.

Fujitsu Laboratories Limited today announced the development of an integrated silicon optical transmitter for use in an optical transceiver, which is essential for enabling large volumes of data to be transmitted between CPUs.

[Thermal fluctuations](#) from the heat emitted by CPUs have a large impact on both the light source built into optical transmitters located near CPUs and the optical modulators that encode data into the light emitted from the light source. This means a thermal [control mechanism](#) has been required to ensure that the operating wavelengths of both the light source

and optical modulator consistently match. Fujitsu Laboratories previously devised a structure incorporating both the light source and optical modulator that did not require thermal control and demonstrated identical thermal properties by using separate prototypes of the light source and the optical modulator. This time, using the same structure to make a prototype optical transmitter that integrates the light source and optical modulator on the same silicon chip, Fujitsu Laboratories demonstrated that it could achieve optical modulation signals at speeds of 10 Gbps at temperatures ranging from 25°C to 60°C without a thermal control mechanism. Moreover, the overall electricity consumed by the optical transmitter was reduced by roughly half compared to previous methods.

This technology enables compact, low-power optical transceivers to be mounted directly in CPU packaging. Through its application exaflops-class supercomputers and high-end servers requiring high-[speed transmission](#) of large volumes of data, the technology paves the way for super-high-speed computers.

In recent years, [supercomputer](#) performance has been roughly doubling every 18 months. Right now, work is underway to produce exaflops-class supercomputers with a target date around 2020. The creation of these ultrafast computers will require high-volume data [transmission technology](#) that allows individual CPUs to transfer data to each other at tens of terabits per second. With existing electrical interconnects based on copper wire, however, the dramatic increases required in circuit space, number of transmission lines, and electricity consumption in accordance with the higher data volumes are thought to make it difficult to achieve the data transmission speeds needed for exaflops-class supercomputers. As a result, consideration is being given to the use of optical interconnect technology in which, as shown in figure 1, CPUs are connected using light. Recently, in particular, attention is being focused on the development of silicon photonics technology enabling optical

transceivers to be compact and densely integrated, and that enables integration of electrical and optical components.

The transmitter component of an optical transceiver comprises a light source and an optical modulator that encodes data into the light emitted by the light source. A good candidate for the optical modulator is a ring resonator, as it is compact and energy efficient. But because the optical transceiver is located near the CPU, the lasing wavelength and the operating wavelength of the ring-resonator-based optical modulator do not coincide with each other due to heat from the CPU, resulting in information not being encoded in the light. A thermal control mechanism is needed to ensure that they match exactly, which, however, is an obstacle to making the transceiver compact and energy efficient.

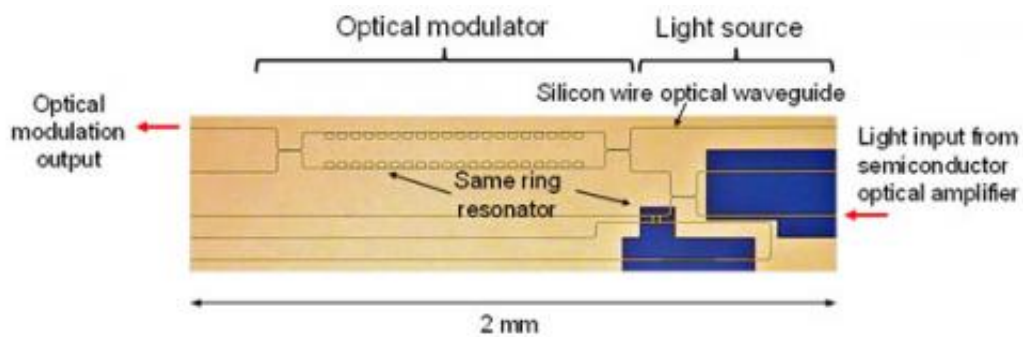


Figure 2. Prototype optical transmitter integrating light source and optical modulator.

By using the same ring resonator for both the wavelength control unit of the light source and the optical modulator, Fujitsu Laboratories previously devised a structure that made the wavelengths of the light source and optical modulator identical without the need for a thermal control mechanism. It used this structure to build separate prototypes of

the light source and optical modulator, and it previously demonstrated that their thermal properties were identical.

This time Fujitsu Laboratories made a prototype optical transmitter that integrates on the same [silicon chip](#) a light source and optical modulator employing the previously devised structure. Using this transmitter, it demonstrated that it could make the wavelengths of the light source and optical modulator identical without the need for a thermal control mechanism and could achieve optical modulation signals at speeds of 10 Gbps at temperatures ranging from 25°C to 60°C.

Figure 2 depicts the prototype silicon optical transmitter that integrates the light source and optical modulator. To enable shifts in the wavelengths caused by temperature changes to match, the same ring resonator is used for both the wavelength control unit of the light source and the optical modulator. Moreover, to safeguard operation even if there are slight differences in the wavelengths of the [light source](#) and optical modulator, the [optical modulator](#) is structured with an alignment of multiple ring resonators, increasing the operating wavelength range. Using this structure, there is no need for a thermal control mechanism, and the overall electricity consumed by the optical transmitter was reduced by roughly half compared to previous methods. It is compact, measuring roughly only 2 mm long without the semiconductor optical amplifier. Through optimization using the silicon wire optical waveguide structure, it is expected that in the future the size can be reduced to under 1 mm.

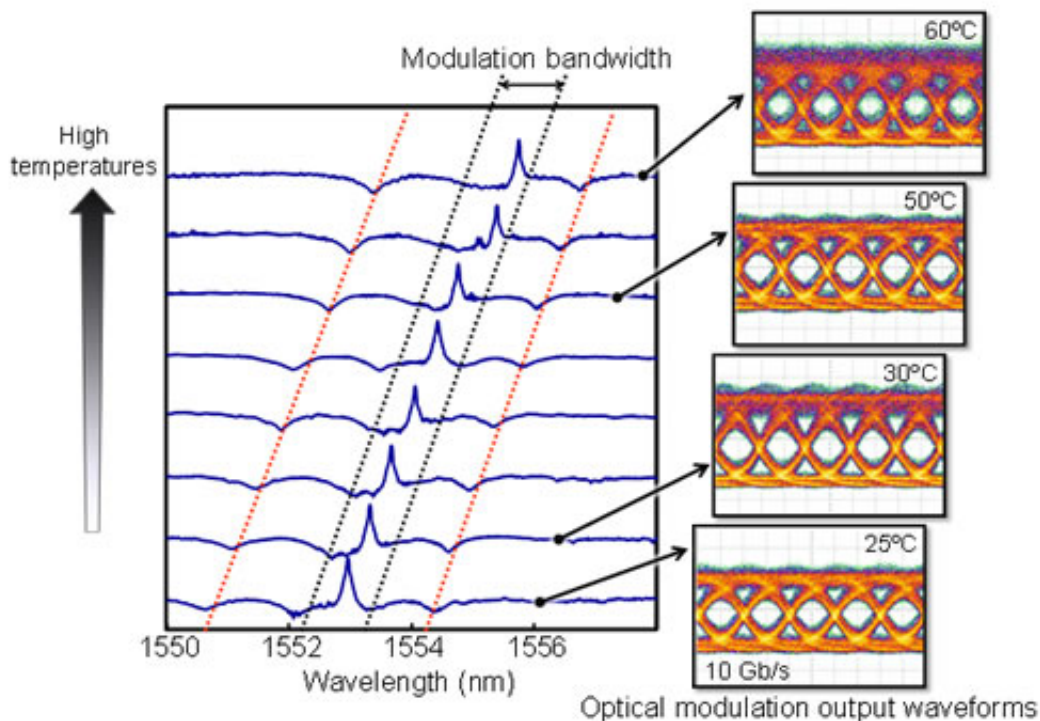


Figure 3. 10 Gbps high-speed modulation operation of the optical modulator at 25°C - 60°C.

By further increasing the speed of this optical transmitter and integrating multiple transmitters on one chip using wavelength multiplexing technology, it will be possible to create optical transmitters small enough to be embedded into CPU modules capable of transmitting large volumes of data at rates of several terabits per second.

The use of this technology enables the development of exaflops-class supercomputers and high-end servers requiring energy efficient transmission of large volumes of data between CPUs, thereby paving the way for super-high-speed computers.

Fujitsu Laboratories plans to continue development of the optical

receiver using the same silicon photonics technology, and will integrate it and this new transmitter to create a compact optical transceiver.

Moreover, by applying [wavelength](#) multiplexing technology and pursuing dense integration, it will work on developing large-capacity integrated optical interconnects capable of enabling data transmission speeds of tens of terabits per second.

**More information:** Details of this technology will be presented at the 9th Group IV Photonics international conference (GFP 2012), running August 29-31 in San Diego.

Source: Fujitsu

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