Light – undistorted and fast

Optical waveguides are entering printed circuit boards

Optical signal transmission with waveguides enables significantly higher data transmission rates than copper-bound electrical signal transmission does - an advantage that is exploited in particular in data communication. In addition, light is insensitive to electro-magnetic interference (EMI) and has other interesting characteristics. In development co-operation with well-known companies, vario-optics (Switzerland) has succeeded in combining these advantages on an electro-optical printed circuit board (EOCB). At the SMT 2005 in Nuernberg, the results were presented for the first time with a demonstrator board.

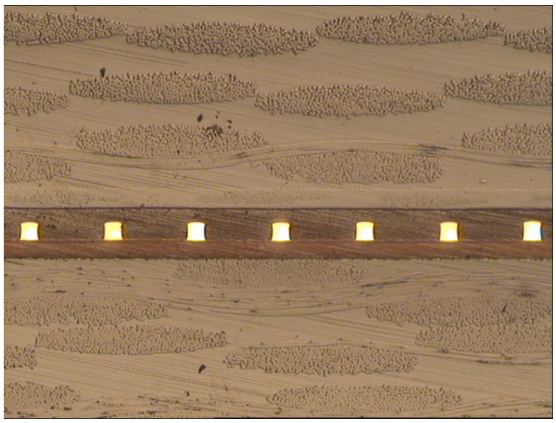


Fig. 1: Optical inner layer with seven planar waveguides

vario-optics ag, founded in July 2009 as a spin-off of the well-known company Varioprint, has included the development of printed circuit boards with optical outer and inner layers (Fig 1). The optical layers consist of polymer-based planar waveguides and a patented light-coupling concept for the optical interface.

Interesting characteristics

Light as signal transmission medium exhibits some interesting characteristics. The high frequency of light allows the transmission of substantially more data in the same period of time than conventional copper based technology does. Light waves of different wavelengths (color) do not affect each other. Therefore, the data transmission rate can be significantly increased by sending several signals at different wavelengths through the same optical waveguide (wavelength division multiplexing, WDM). Alternatively, signals can be transferred consecutively (time division multiplexing, TDM). Furthermore optical signals can be split or combined directly in the waveguide, or they can cross each other at a suitable angle so that the signal integrity is not compromised (Fig. 2).

A further advantage over electrical signal transmission is that optical signal transmission is insensitive to electro-magnetic interference, hence no EMI issues occur.

Interface to the external world

The connection of two waveguides is very sensitive to mechanical misalignments. Therefore the requirements for optical connectors are significantly higher than for electrical connectors. Thanks to the patented light-coupling concept of vario-optics, connecting losses can be kept small. In addition, the concept chosen provides a defined optical user interface between the waveguide and the source (LED, laser) or the detector.

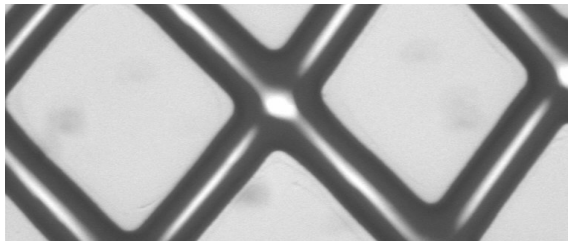


Fig. 2: Crossing waveguides

Up to one meter

Some of the light is being absorbed in the waveguide. The amount of absorption depends on the wavelength and on the type and the quality of the waveguide material. Glass exhibits very low absorption values, thus it is used for long-distance data transmission. Organic and inorganic waveguide polymers are less expensive, but have a higher absorption. Therefore such waveguides are used for short-distance signal transmission, either as fiber optic cables or planar optical waveguides in printed circuit boards.

The optical waveguides from Varioprint (Fig 3) have absorption values of < 0.05 dB/cm at a wavelength of 850 nm. They can be used for distances of up to one meter.

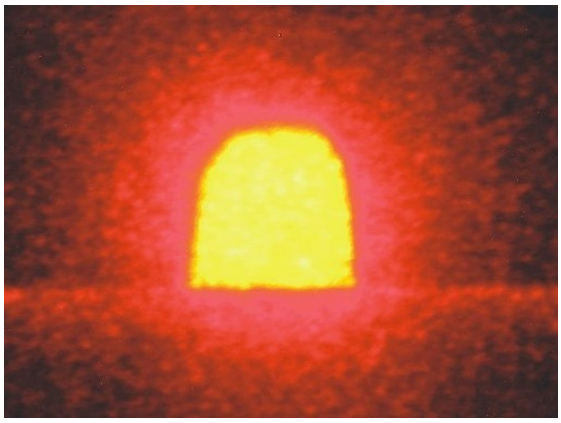


Fig. 3: Cross section of a planar waveguide

Applications

Electro-optical circuit boards are suitable for a wide range of applications. Listed below are some examples:

Broadband data communication

Optical signal transmission with planar optical waveguides on a printed circuit board is used in short-distance data links. There they replace electrical signal transmission, because in broadband applications copper will eventually reach its physical limitations in terms of bandwidth density. Vario-optics is anticipating this development by fabricating optical mother- and daughter boards (Fig 4) that use the patented light-coupling concept mentioned above.

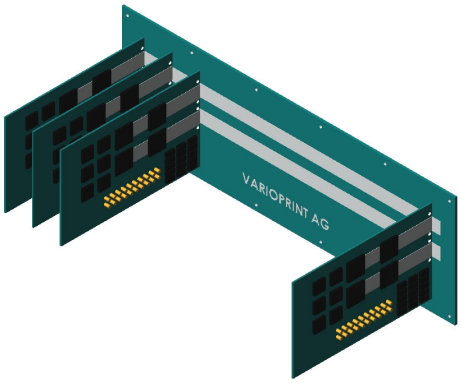


Fig. 4: Interconnected optical mother and daughter boards

Electro-magnetic Interference (EMI)

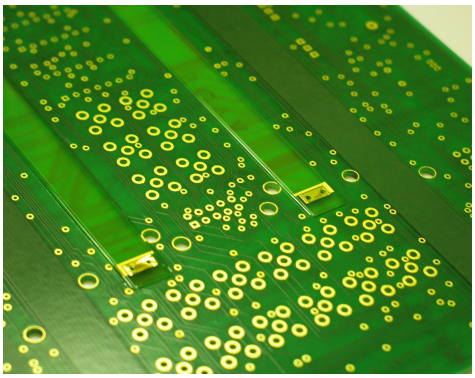
Interference in copper wire increasingly represents a technical and economic challenge owing to the increasing penetration of our everyday life with electronics and the associated signal flood at extremely close ranges. Electro-optical circuit boards also offer interesting alternatives here.

Simplified Packaging

Compared with the use of discrete optical waveguides, the new technology with integrated planar optical waveguides allows simpler packaging solutions and additional functionality. The waveguide fabrication processes are compatible with standard printed circuit boards processes. This enables cost-effective miniaturization of existing products, e.g. in sensor technology, or new products with more functionality in the same area.

Summary

Electro-optical circuit boards open up new fields of applications. vario-optics has proved the technical feasibility of this new technology.



vario-optics ag

Mittelbissaustrasse 7
CH-9410 Heiden
Switzerland

Tel.: ***+41 (0)71 898 80 60***
Fax: ***+41 (0)71 898 80 61***

e-mail: ***info@vario-optics.ch***
web: ***www.vario-optics.ch***