A solution for short-reach multimode fibre connections with non-ideal offset connectors using a tolerant launching scheme

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Forschungsgebiete: Physik, Optoelektronik, Optische Nachrichtentechnik, Kommunikationsnetze

2.1 A solution for short-reach multimode fibre connections with non-ideal offset connectors using a tolerant launching scheme

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Abstract

Der Beitrag wurde in Straßbourg bei der Photonics Europe am 11. April 2008 von Dr. Bunge dem Fachpublikum in einer Präsentation vorgestellt. Das dazu entstandene Paper [1] beruht auf den bisherigen Ergebnissen der Autoren im Bereich der Untersuchungen der Modenausbreitung in Lichtwellenleitern [2]–[4], korreliert mit unseren neuesten Ergebnissen und den Erkentnissen aus diesem Bereich.

In short-reach connections, large-diameter multimode fibres allow for robust and easy connections. Unfortunately, their propagation properties depend on the excitation conditions. We propose a launching technique using a fibre stub that can tolerate fabrication tolerances in terms of tilts and off-sets to a large extent. A study of the influence of displaced connectors along the transmission link shows that the power distributions approach a steady-state power distribution very similar to the initial distribution established by the proposed launching scheme.

For interconnection links up to several hundred meters multimode fibres are a good choice due to their robustness and ease of handling. Their relatively large diameter compared to single-mode fibres allows for robust and easy connections. Unfortunately, the propagation properties of multimode fibres depend on the coupling of light into the fibre: The impulse response changes with different excitation conditions – a fact that is measured e.g. by differential mode delay (DMD) measurements. At non-ideal connectors between different fibres, attenuation and a redistribution of power occurs, which lead to once again changing propagation properties and losses.

We investigate the influence of off-sets and tilts of connectors at the transmitter and along the on the propagation properties for different launching set-ups at the transmitter and elaborate a launching scheme that can tolerate large variations in terms of angular tilt and lateral offsets at the transmitter and at the connector along the link. For different launching schemes, the variations of coupling loss and modal noise will be investigated experimentally and maximum values assessed numerically. The influence of power re-distribution on the transmission characteristics will be shown. Finally, a standard-compliant robust launching scheme will be presen-

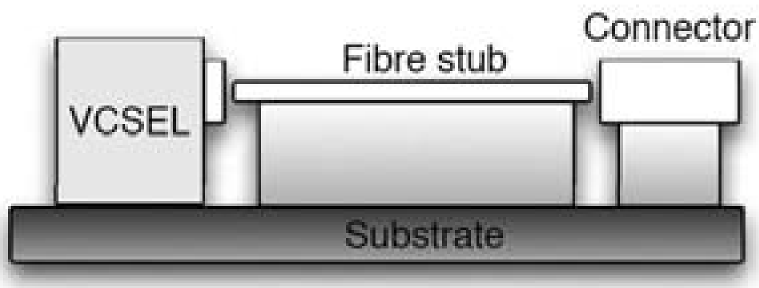

Fig. 2.1-1: *Proposed set-up for tolerant launching scheme with ibre stub between VCSEL transmitter and multimode Transmission fibre*

ted that induces a modal power distribution tolerant against launching variations and connector tolerances. The approach relies on a controlled excitation of medium-order modes of neighboring mode groups, which exhibit similar modal delay and spatial field distribution. It aims to restrict the power distribution to a small number of mode groups while simultaneously exciting as many modes within the principal mode group.

The measurements of the base-band frequency response have been conducted in the time domain and a schematic presentation of the measurement system was presented in [2] – [3].

The investigated fibres show a core diameter of 62.5 µm and a numerical aperture of approximately 0,27. The results were discussed in detail in [2].

The maximum of approximately 10% of the total power is launched into $LP_{1,3}$, $LP_{2,3}$ and $LP_{2,2}$. These modes show a smaller difference of propagation delays as in the case of x_r = 8µm. Therefore no pulse splitting occurs. The pulse only broadens. The measured and the calculated pulses show delay differences between the excited.

The launching condition of a multimode fibre link should be designed in a way that most of the power will be launched into medium-order modes and that the condition regarding the spatial power distribution will be met (Encircled Flux – total integrated intensity in an area up to a specified radius – has to be controlled at 4.5µm and 19µm). In real-world applications the manufacturers have to allow fabrication tolerances in terms of radial offsets, tilts and axial offsets while still meeting the encircled-flux conditions. This can be quite tough particularly if one wants to allow relatively wide tolerances for efficient fabrication. Therefore we propose a fibre-stub solution to alleviate changes of the input launching conditions. The set-up is depicted in Figure 2.1-1. The light will be coupled into a 24-µm-diameter fibre stub with a step-index profile, which will lead to an almost homogeneous intensity distribution after a certain fibre length independently of the input power distribution. We will investigate how long the fibre stub has to be in order to efficiently re-distribute the intensity over the total end face.In order to investigate the modal power distribution, which will be induced by the fibre stub, the propagation of all guided modes within the fibre stub was studied in detail.

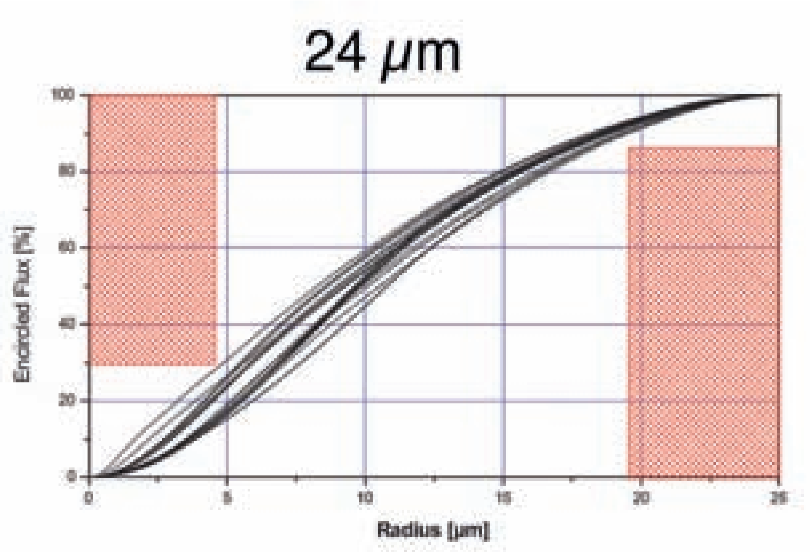

Figure 2.1-2: *Cumulated intensity distributions*

Figure 2.1-2 show the cumulated intensity distributions for the investigated launching conditions after a long fibre stub with the radius 24µm where the best results was obtained.

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