PTB innovationen
Technologieangebot

Cascadable optical end-to-end path stabilisation

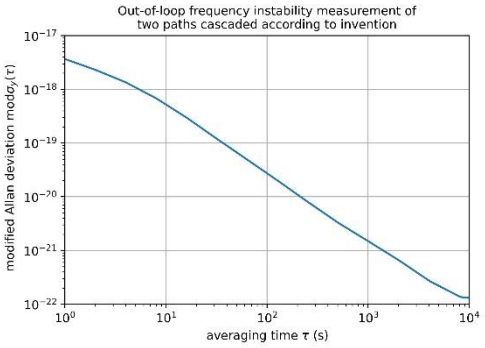

Fig. Measurement of the residual relative frequency instability of two path stabilisations, cascade-connected according to invention. Here, the limiting factors are polarisation fluctuations on the fibre links and noise in the detection electronics (both unrelated to the invention).

Advantages

- **end-to-end path stabilisation**
- **scalability and cascadability as desired**
- **frequency distribution over long path distances: overseas / inter-continental transmission of highly accurate frequencies**

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When transmitting optical signals with high frequency stability or low uncertainty, significant instabilities or losses occur along the transmission path. To maintain the quality of the signal during transmission, these instabilities or losses must be compensated. A new PTB concept provides a solution for scalable optical end-to-end path stabilisation with potentially non-reciprocal sub-paths. It can be realised with little technical effort.

Optimised path stabilisation is of particular importance for the precise transmission of optical carrier or frequency differences over a transmission path between two or more locations. The established conventional approach has considerable limitations. For example, it is not possible to use unidirectional amplifiers and there are always uncompensated sub-paths limiting the transmission quality.

The new PTB method uses reciprocity-based path stabilisation, polarisation techniques to suppress crosstalk and a two-beam interferometer to integrate non-reciprocal elements as, for example, unidirectional optical amplifiers. Another option – as an alternative to the two-beam interferometer – is the use of a phase-locked laser for signal regeneration. These approaches enable end-to-end stabilisation without any uncompensated sub-paths. Fluctuations on sub-paths are detected as beat signals. After corresponding signal processing, they are used as control signals for actuators for the frequency or phase of the light field in order to compensate for the fluctuations. The modules of the path stabilisation can be designed as self-sufficient and locally operated units which operate as unidirectional isolating amplifiers. Thus, it is possible to create distribution networks that can be scaled as desired.

Economic impact

The method can be used in the field of optical frequency measurement and the measurement of derived quantities. It is interesting for manufacturers of optical frequency combs and of time and frequency transmission systems. The basic idea of the invention enables a variety of configurations. Taking advantage of the path stabilisation, the transmission, distribution, and measurement of optical radiation provide numerous application and utilisation scenarios. By means of a suitable encapsulation that needs to be developed, the resulting product can be installed as a built-in element in a wide range of application scenarios in existing transmission paths. This applies both to long-distance fibre links and to complex networks, e.g., for in-campus distribution.

Development status

An application for a German patent has been submitted for the invention. The concept has already been implemented in various set-ups at PTB. Licences for use can be requested.

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