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Investigations on Microwave Signal Generation using optical Heterodyne Techniques

ABSTRACT - Masterthesis

A number of techniques for the generation of microwave modulated optical carriers for downstream data transmission in radio-on-fiber systems have been reported and demonstrated. These include the use of optical heterodyne, self-heterodyne, resonantly enhanced semiconductor lasers and pulsed lasers. Currently, an effective technique is the optical heterodyne; in which two lasers whose frequencies differ with the required microwave frequency are used and mixed at a photodetector to produce an electrical beat signal. Since long time the improved detection sensitivity of heterodyne and homodyne detection compared to direct detection and the enhanced optical channel selectivity after down conversion to the microwave domain has been employed. The use of heterodyne detection in optical transmission system has recently gained in importance also to recover optical phase information for sophisticated electronic signal processing in optical receivers.

In this thesis, the optical heterodyne detection set-up has been done by use of two laser sources. One is a signal laser (distributed feedback laser); the other one is a reference laser and referred to as local oscillator (tunable laser). Optical spectrum analyzer and electrical spectrum analyzer are used to characterize the individual optical sources and beat signal respectively. Experiments are carried out to extract relevant parameters of optical sources, beat signal and frequency response of photodetectors. Particularly tunability of the DFB laser with source current has been measured with the help of optical spectrum analyzer. The linewidth of DFB laser and stability of the beat signal has been characterized by use of electrical spectrum analyzer.

Today, ultra-fast telecommunication systems use very high frequencies for data rates. Associated to these high frequencies, there is a need for high speed photodetectors, and by consequence the characterization of such devices are primordial. We also focus here on the optical heterodyne technique, which is suitable for bandwidth measurement of photodetector. In this thesis the heterodyne technique has been used to characterize the frequency response of different types of photodetectors using different electrical spectrum analyzers. Heterodyne technique is shown here to be an excellent mean to measure the narrow linewidth of optical sources and ultra-fast frequency response of photodetectors.