Radio Frequency Carrier Signal Generation using a Single Mach-Zehnder Modulator Based Optical Comb Generator

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Creating a radio frequency (RF) signal from the optical domain is a widely used technique for THz signal generation. The RF signal is obtained applying two optical carrier signals by photomixing in a photodiode. Because of the quadratic characteristic of the photodiode the frequency difference of the two lasers will appear in the electrical spectrum. There are two kinds of optical sources for photomixing. We can use two independent lasers at different wavelengths or an optical comb source.

In the former case the quality of the mixed RF signal is highly dependent on the lasers linewidth, temperature, power supply, etc. The RF signal accuracy is significantly influenced by the quality of the power supply. The applied lasers worked in a DWDM system before they were dismounted from the DWDM cards. The supply of the DWDM system is not stable enough for RF signal generation by photomixing. The same effect can be observed if a laboratory power supply is used as current source. The frequency instability can be solved by using laser diode (LD) driver. The linewidth of the two lasers influences the RF signal accuracy. Increasing the laser power the linewidth will decrease. However the measurement shows this reduction is much smaller than the increased uncertainty in the laser power, because of the higher current. However, the benefit of mixing two independent laser signals is an easy frequency tuning ability. Changing the temperature of one laser diode, the emission frequency can be tuned.

Another method to generate RF signals applies an optical comb generator. It can be based on a Mach-Zehnder Modulator (MZM). In this case the laser power supply stability is not as critical as in the previous method. The generated RF signal has the same spectral width if the laser current is 20 mA or 100 mA, while in the two lasers mixing way the RF signal frequency has a higher uncertainty at higher laser currents. The effect of the laser linewidth to the RF signal was investigated and we found its effect is negligible. Many publications use dual drive MZM to generate a flat comb. Our aim is to create a flat optical comb with a simple MZM, which can be found on the shelves. In the optical simulation environment (VPI TransmisisonMaker) a single drive and a dual-parallel MZM were simulated. It shows that a narrow flat optical comb can be created with a single push-pull MZM. Optical comb can be wider if a dual-parallel MZM (DP-MZM) is used. This type of MZM provides more freedom in the comb generation. It was driven two different ways: both RF ports got the same signal and only one RF port got the driving signal. The maximal flat optical comb was reached if both RF ports were fed with the RF signal. The result of the simulations was proved by measurements. They showed a similar behavior as the simulations. DP-MZM generates wider optical comb, than the single MZM. The bias values of the DP-MZM are more critical in that case. 1 V difference in the bias control results in 3 dB or higher peak changes in the optical comb detection.

The measurements showed that the optical comb can be wider if a DP-MZM is used. In this case usually 3 more peaks appeared in the detected spectrum compared to the case when a single MZM was used for comb generation. DP-MZM provides much more facilities for the comb optimization, therefore it could be a better choice as an optical comb source.