

# Electro-Optic Sampling Detection of CW-THz Signals Using MZM-Based Flat Comb Generator

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**Abstract** We proposed and demonstrated 100 GHz-band spectrum measurement based on electro-optic (EO) sampling using a Mach-Zehnder-modulator-based flat comb generator (MZ-FCG). An Optical two-tone signal was extracted from a 10 GHz-spaced optical comb by a pair of optical bandpass filters, and was modulated on an EO crystal by 100 GHz-band signal generated from the frequency multiplier. As a result, the 100 GHz-band signal was successfully detected, which had SN ratio of greater than 20 dB.

**Keywords** Terahertz Wave , Electro-Optic Sampling , Optical Comb

## 1. Introduction

In spectrum measurement of terahertz (THz) sources, Fourier transform infrared spectrometers or frequency mixers are generally used. Electro-optic (EO) sampling attracts a great deal of attention, because it is capable of broadband detection in the range from microwave to THz waves in room-temperature [1-3]. In this paper, to realize highly accurate frequency measurement, we propose a method for THz frequency measurement based on EO sampling using a Mach-Zehnder-modulator-based flat comb generator (MZ-FCG).

## 2. Experiments

Figure 1 shows the setup for spectrum measurement of THz waves using MZ-FCG. This system is based on the EO sampling method, in which the EO crystal acts a mixer down-converting the THz waves to intermediate signals via optical combs. By

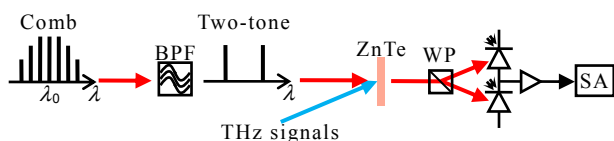


Fig. 1. Setup for spectrum measurement of THz waves using MZ-FCG. BPF: bandpass filter, WP: Wollaston prism, SA: Spectrum analyzer.

adopting an optical modulator based comb source as an optical local signal, highly accurate spectrum measurement is realized. Thus, in this system, we used the MZ-FCG as a comb source. The MZ-FCG generates 10 GHz-spaced optical combs [4]. A pair of optical bandpass filters extracts two-tone signal from the optical comb [5]. The two-tone signal is modulated by a THz signal, which creates optical sidebands. By detecting the modulated two-tone signal using a balanced photodetector and a spectrum analyzer (SA), the spectrum of the THz signal is observed.

Figure 2 shows a spectrum of 100 GHz-band signal generated from a frequency multiplier. The frequency spacing of the two-tone was set to 100 GHz, and that of the THz source was set to 100.00005GHz (the frequency difference,  $\Delta f$ , was 50 kHz). As a result, a THz spectrum was successfully observed. The signal-to-noise (SN) ratio was greater than 20 dB.

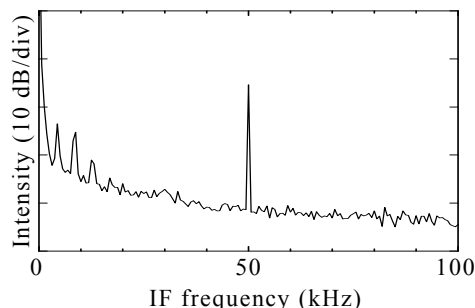


Fig. 2. A spectrum of a detected 100 GHz signal.

#### 4. Summary

We proposed and demonstrated 100 GHz-band spectrum measurement based on EO sampling using MZ-FCG. The optical two-tone signal was extracted from the optical combs by a pair of bandpass filters, and was modulated by 100 GHz-band signal generated from the frequency multiplier. As a result, the 100 GHz-band signal was successfully detected, which had SN ratio of greater than 20 dB.

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