RF parameter estimation using lightwave modulation

***Abstract*—RF signal processing via lightwave and its technique is known as "microwave- and millimeter-wave photonics (MWP)". This approach possesses some advantages such as avoidance from electromagnetic noises, and wide-bandwidth operation originating from the frequency range of lightwave higher than that of an RF signal with the degree of 4-5 orders. Now various functions have been demonstrated by adopting MWP: RF signal generation in high-frequency region, frequency upconversion and ultra-narrowband RF notch filters.**

In this invited talk, we introduce an RF signal measurement based on MWP [1]. This scheme utilizes a beat signal between two lightwaves whose phases are independently modulated by a reference RF signal and the RF signal under the test. Into the beat signal, parameters of the RF signal under the test are reflected so that these parameters such as its amplitude and phase can be estimated. Since the frequency of the beat signal becomes into kHz-order one, broadband frequency response is not required in the electronic circuit for the RF parameter estimation.

First, we investigated the case where the frequency of the reference RF signal is the same as that of the RF signal under the test, and found that the beat signal has been expressed using these parameters. Based on the expression derived from model analysis, RF parameter estimation was conducted from the experimentally-obtained beat signal. The phases of the 10-GHz RF signal has been successfully obtained from the beat signal acquired by the experiment via offline processing. For the parameter estimation a prototype has been also designed and implemented as an electronic circuit.

We also extended this scheme by adopting higher-order optical sidebands due to modulation by a reference RF signal, in order to decrease reference RF signal frequency required for RF parameter estimation [2]. This extended approach will be presented from the view of both model analysis and experimental verification.

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[1] A. Chiba, et al: Optics Letters 46(11), 2646-2649 (2021).

[2] A. Chiba, et al: Proc. CLEO Pacific Rim 2022, P-CTh6-05 (2022).

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