# Numerical Simulation on the Loop-loss Dependence of the Performance of an Optically Amplified Feedback Circuit

**Shimane Univ., °Md Syful Islam, Hiroji Masuda, Biswajit Biswas, and Kokoro Kitamura**

**E-mail: n18m326@matsu.shimane-u.ac.jp**

## 1. Introduction

The optical sensing applications are important technologies in photonics applications system such as optical measurement and optical communication [1-3]. We have proposed an optical amplifier feedback circuit (OAFC) method as a new method that can significantly improve the optical power resolution [1-7]. In this paper, numerical simulations have been performed in order to clarify the loop loss dependence of the performance of the OAFC.

## 2. System Configuration

Figure 1 shows the system configuration of the OAFC in this study. The pump light of erbium-doped fiber (EDF) from the pump light source (PLS) was used as the input light (Input) of this method. The wavelength of the pump light was 1470nm. The PLS was driven with a constant current, and a variable optical attenuator (VOA) was installed after the PLS to change the input optical power of the EDF input. The OAFC has an EDF as a gain medium, optical isolators (ISO) installed on both sides of the EDF, a multiplexer (CP) for introducing the pump light, a pump light remover (PR), and other optical components in the ring. The OAFC also has an optical attenuator (ATT) for adjusting the loss, the optical bandpass filter (OBPF) for adjusting the wavelength of the output light and a splitter (BR) for extracting the output light (Output) out of the ring. The transmission bandwidth of the OBPF was 0.87 nm, and the center wavelength was 1558 nm. The value of the loop loss was changed in the range from 5.00 to 20.00 dB to clarify the loop loss dependence.

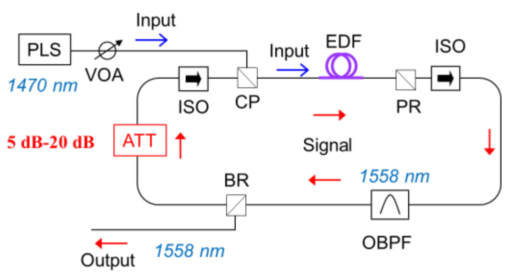


Fig. 1 System configuration

## 3. Simulation Results

The input optical power at the input port of the CP is $P_{in}$, and the output optical power is $P_{out}$. Let the slope ($S$) be $S = \Delta P_{out} / \Delta P_{in}$ [1-2]. Figure 2 shows the dependence of $S$ on $P_{in}$. Figure 3 shows the maximum slope ($S_{max}$) as a function of the loop loss. Also it shows the comparison between the experimental result and the simulated result. As shown in the figure, $S_{max}$ increases when the loop loss decreases. $S_{max}$ are 182, 160, 140, 123, 109, 95, 84, 73, 63, 55, 47, 40 and 34 at the loop loss of 5.00 dB, 6.25 dB, 7.50 dB, 8.75 dB, 10.00 dB, 11.25 dB, 12.50 dB, 13.75 dB, 15.00 dB, 16.25 dB, 17.50 dB, 18.75 dB and 20.00 dB, respectively in the numerical simulations. The $S$ values obtained by the experiment are much higher than those obtained by the numerical simulation. The reason of the difference between experimental and numerical simulation results is a future issue.

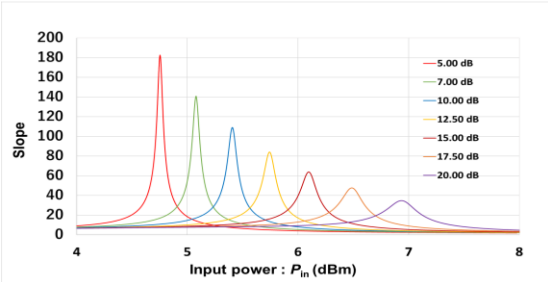


Fig. 2 Slope vs. input power

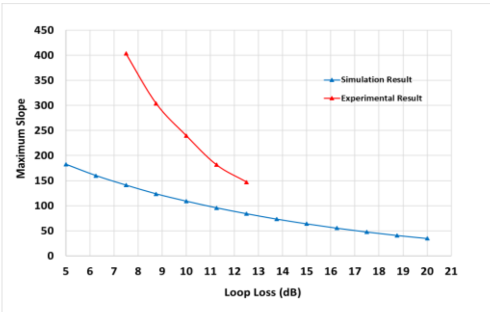


Fig. 3 Slope characteristics

## 4. Conclusion

We investigated the loop loss dependence of the performance of the OAFC by numerical simulation. We confirmed that the slope $S$ increased when the loop loss decreased. We achieved a maximum slope value $S_{max}$ of ~182 at the loop loss of 5.00 dB.

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