Synchronization Phenomena and Circuit Experiment of Star-Coupled van der Pol Oscillators with Additional Oscillators

Minh Hai TRAN        Yoko UWATE        Yoshifumi NISHIO
Tokushima University

1 Introduction
In our previous study, we investigated synchronization phenomena observed by adding different frequency van der Pol oscillators coupled with star combination. By computer simulations, we confirmed some of oscillators in the system were synchronized at anti-phase. In this study, we carry out circuit experiments with 4 van der Pol oscillators system. In addition, we examine in detail 4 van der Pol oscillators and 5 van der Pol oscillators.

2 Circuit Model
The circuit model used in the first pattern is shown in Fig. 1. Three van der Pol oscillators are connected as the star combination. In addition, we add a different frequency oscillator to the star-coupled van der Pol oscillators. We change the frequency of the 4th oscillator and investigate the influence of the 4th oscillator to the overall star circuit.

Fig. 1 Circuit model.

Three van der Pol oscillators are connected as the star combination. In addition, we add a different frequency oscillator to the star-coupled van der Pol oscillators. We change the frequency of the 4th oscillator and investigate the influence of the 4th oscillator to the overall star circuit.

3 Simulation Result
The amplitudes of the oscillator are shown in the Figs. 2. In Fig. 2, when the \( \omega \) increase from 1 to 1.2, the amplitudes of the 3rd and the 4th oscillator become gradually smaller. Next, when the \( \omega \) is increased to 1.4, the amplitudes of the 3rd and the 4th oscillator are perfect stop. When \( \omega \) above 1.4, the amplitudes of the 4th oscillator go on increasing. However, the amplitudes of the 3rd oscillator are almost unchanged.

Fig. 2 Amplitude of oscillator 3 and oscillator 4.

We build a real circuit as Fig. 4 to confirm the results above. The frequency \( \omega \) is changed by altering the tunnel diode of the fourth oscillator. Figure 4 shows one of my obtained circuit experimental results.

Fig. 3 Simulation result.

In Fig. 4, circuit experimental result also fit theoretical analysis results with computer calculations. The 3th oscillators stop.

4 Conclusion
We have investigated synchronization phenomena and oscillation of five oscillators with different frequencies. By carrying out computer simulations and circuit experiments, we have confirmed that oscillation of the 3th oscillators are death by increasing \( \omega \).