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Synchronization Phenomena in a Ring of Coupled Wien-Bridge Oscillators

Koichi Matsumoto †, Yoko Uwate †, Yoshifumi Nishio † and Seiichiro Moro ‡

† Department of Electrical and Electronic Engineering, Tokushima University
2-1 Minami-Josanjima, Tokushima 770-8506, Japan
Email: {koichi, uwate, nishio}@ee.tokushima-u.ac.jp

‡ Department of Electrical and Electronics Engineering, University of Fukui
3-9-1 Bunkyo, Fukui 910-8507, Japan
Email: moro@ppc8100.fuee.fukui-u.ac.jp

Abstract

Coupled oscillatory systems have attracted a great deal of attentions in various fields. In particular, in such systems, synchronization is very important phenomenon and many researches have been reported. In our past studies [1][2], we have reported that a certain class of coupled systems of the Wien-Bridge oscillators synchronize with 0 or ± 120 degrees in spite of the number of the oscillators.

In this study, we investigate synchronization phenomena observed in a ring of coupled Wien-Bridge oscillators by both circuit experiments and computer simulations. In the ring, each oscillator is coupled to the adjacent oscillator by a resistor. At first, we confirm that some synchronization modes where the phase shifts between two adjacent oscillators are 0 or ± 120 degrees coexist for the cases that the number of the oscillator is changed from $N=3$ to $N=10$. As increases the number of the oscillators, the number of coexisting synchronization modes increases. Next, we investigate other synchronization modes where the phase shifts between two adjacent oscillators are neither 0 nor ± 120 degrees. We found that such synchronization can be observed only for the cases of $N=5$ and $N=7$. Further, we investigate the stability of the synchronization modes and the relationship between the stability and the nonlinearity.

[1] S. Moro, Y. Nishio and S. Mori, "Synchronization Phenomena in RC Oscillators Coupled by One Resistor," IEICE Transactions on Fundamentals, vol. E78-A, no. 10, pp. 1435-1439, Oct. 1995
[2] S. Moro and T. Matsumoto, "Various Kinds of Coupled Networks with Wien-bridge Oscillators," Proc. of NOLTA'00, pp. 547-550, Sep. 2000.