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Synchronization of Chaotic Colpitts Oscillators Using IGBT

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Abstract: **The certain set of circuit parameters can generate chaotic waveforms in Colpitts Oscillators. Regarding possible application to chaos-based communications the problem of mutual synchronization eventually arises in the Colpitts generators. We present the results of, experimental investigation of synchronization between two identical Colpitts generators. The method of linear difference signal has been applied.**

Keywords: **mutual synchronization, Chaotic Colpitts Oscillators Using IGBT.**

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1. INTRODUCTION

The science of chaos is evolved by a new science that is the discovery of randomness in apparently predictable physical systems have Chaotic systems are very sensitive, unstable and aperiodic, making them naturally harder to identify and to predict. Many researchers are trying to find out the ways to utilize the characteristics of chaos in communication systems and have actually achieved quite remarkable results. The field of communication in which chaotic signals are used is called Chaotic Communication. Chaos communication is a rather new field in the communications research. It evolved from the study of chaotic dynamical systems, not only in mathematics, but also in physics or electrical engineering. These Chaotic signals are irregular, aperiodic, uncorrelated, broad band, and unpredictable in nature over longer times. These properties of chaotic signals that coincide with requirements for signals applied in communication systems, in particular for different types of communication like spread-spectrum, multiuser, and secure communications. signals are spread spectrum signals. The signals which utilize large bandwidth and have low power spectrum density are spread spectrum signals in Chaotic communication. As it is known that in communication systems samples are required so, in chaotic communication systems, the samples are segments of chaotic waveforms and are nonlinear in behaviour. These chaotic waveform have nonlinear, unstable and aperiodic characteristic in chaotic communication which has lots of features that make it attractive and useful in the field of communication. In this type of chaotic communications, where the information is in the form of chaos to be transmitted is placed directly onto a wide-band chaotic signal. This idea of using chaos in communication applications has sparked when research in nonlinear dynamical systems had lead to a deeper understanding of the phenomenon and scientists and engineers were looking for practical applications. In communications, broad-band signals are used to fight channel in irregularity, in particular, narrow-band effects such as frequency-selective fading or narrowband perturbations. So, chaotic signals are used for spread-spectrum communications. Chaotic signals have a complicate structure and are very irregular. One chaos generator will produce a totally different orientation if it is slenderly disturbed in its initial conditions. This makes it difficult to guess the structure of the generator and to predict the signals over longer time intervals. In Direct Chaotic Communication (DCC), a chaotic source generates chaotic signals directly in the selected communication band. A stream of chaotic radio pulses are used to transmit the information component. At the receiver, the information can be retrieved from the chaotic radio pulses without intermediate combining Section 2 introduce colpitts oscillator Section 3 introduces the chaotic signals generation and synchronization of chaotic signals, Section 4 introduces the result how the signal is recovered and Section 5 introduces the conclusion.

2. COLPITTS OSCILLATOR

Commonly Colpitts Oscillator is used to generate sinusoidal signals, but with special seeting of circuit parameters like oscillators including BJT (Bipolar Junction Transistors) can produce noise like behavior or chaotic signals. Kennedy has reported firstly about the chaos in the colpitts oscillator, after him many authors had investigated the chaotic oscillations in this oscillator. Here we had worked with a nonlinear oscillator of Colpitts variety. This consist of a long history in the study and utilization of nonlinear oscillators for a variety of technological applications. This chaotic Colpitts oscillator is used to illustrate our suggestions on estimating parameters and unobserved states in a chaotic system. It is important to surpass the numerical study of these oscillators and reveal in an experimental setting how the ideas work, because theoretical models at best only approximately describe real experimental systems. We built the circuit shown in Fig. 1 using the following components: C1 = 22 µF, C2 = 22 µF, L = 1140 µH, REE = 200Ω , and the power supply Vcc= 10 V,

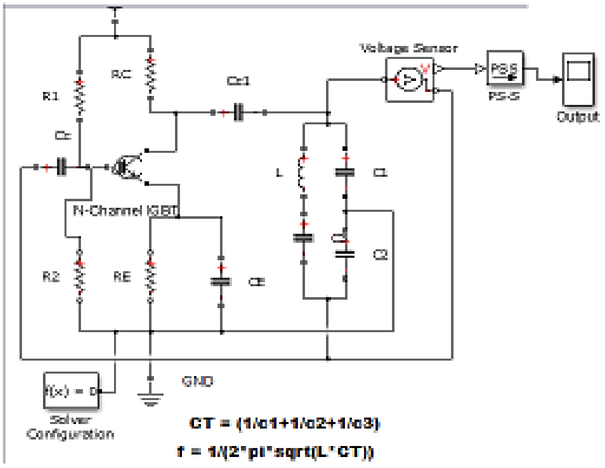

Figure 1: The Colpitts oscillator.

We used a N- channel IGBT the underlying model is based on a PNP bipolar transistor plus an N-channel MOSFET. The fundamental frequency of this oscillator is approximately f0 = 1/(2πpLCeq), where 1/Ceq = 1/C1 +1/C2. For the circuit elements we used, f0 ≈ 3.18 MHz. The dynamics is described by three coupled first order differential equations, obtained directly from the circuit using Kirchoff's laws:

$$C_1\frac{dU_{C1}}{dt} = I_L - I_K,$$
$$L\frac{dI_L}{dt} = V_0 - RI_L - U_{C1} - U_{C2},$$
$$C_2\frac{dU_{C2}}{dt} = I_L - I_K + I_E(U_{C2}) - I_0.$$

CASE 1. Two identical unsynchronized colpitts oscilaator generating chaotic waveforms:

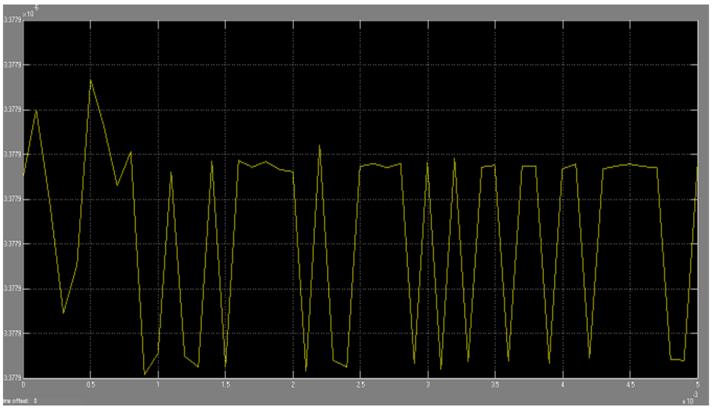

Figure 2: Typical waveform of chaotic oscillations from figure 1.

Here a N- channel IGBT has Gate-Emitter threshold voltage 6V, Collector current Ic 2mA, Collector-emitter saturation voltage, Vce(sat) 2.6 V, Rc=Re=0.001Ω, For certain sets of the circuit parameters, i.e. the coefficients the system exhibits chaotic oscillations.

3. SNCHRONIZATION OF IDENTICAL OSCILLATORS

Let us assume two identical Colpitts oscillators as generators,G1 and G2 with the transistor collectors coupled via linear resistor Rc2. Introducing the coupling coefficient k=ρ/Rk the overall system can be described by the set of six differential equations:

$$\begin{aligned}
\dot{x}_1 &= y_1 - F(z_1) + k(x_2 + z_2 - x_1 - z_1), \\
\dot{y}_1 &= c - x_1 - by_1 - z_1, \\
\varepsilon\dot{z}_1 &= y_1 - d + k(x_2 + z_2 - x_1 - z_1), \\
\dot{x}_2 &= y_2 - F(z_2) + k(x_1 + z_1 - x_2 - z_2), \\
\dot{y}_2 &= c - x_2 - by_2 - z_2, \\
\varepsilon\dot{z}_2 &= y_2 - d + k(x_1 + z_1 - x_2 - z_2).
\end{aligned}$$

Though the two Colpitts Oscillators as generators G1 and G2 are fully identical ones, the oscillations of these oscillators do not coincide with each other until the systems are not coupled.

So, now let see the waveform of the coupled generators as shown in figure 2.

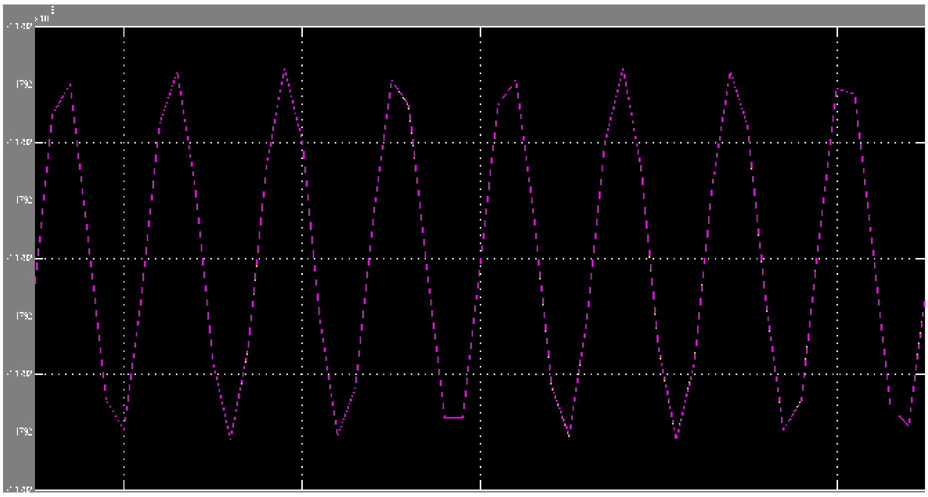

Figure 3: The Synchronized waveform of Coupled Colpitts oscillators.

In the case of unsynchronized chaotic generators the figure will be very complicated one, indicating " random" mutual phases and amplitudes of the oscillations. That the momentary amplitudes and phases of the oscillations from the two generators do coincide with each other, i.e. the oscillators are fully synchronized. We have investigated experimentally synchronization between two coupled chaotic Colpitts oscillators. The method of linear difference signal has been employed. Though this method does not allow to prove the synchronization property analytically it seems to give better results (in the sense of the SQ) than the method of decomposition of the response oscillator into passive subsystems, recently applied to the chaotic Colpitts oscillator.

4. CONCLUSION

In addition to the earlier considered technique of coupling the collectors of the transistors in the two oscillator. we have investigated an alternative technique of coupling the emitter nodes of the corresponding transistors. The threshold coupling coefficient kth appeared to be favorably smaller by a factor of about 4 in the latter case. Further investigations should focus on techniques of inserting and extracting the information signals.

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