SECURE COMMUNICATIONS: CHAOTIC SYNCHRONIZATION ON RÖSSLER CIRCUIT

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ABSTRACT

In this paper is presented the analysis of Rössler's chaotic oscillator third order, analyzed with the Kirchhoff theory, moreover had been demonstrated that two chaotic systems that are seemingly random, it can matched on one trajectory, using two nonlinear dynamics electronics circuits, in this case rössler circuit's (on transmitter and receiver), that gives rise to send information using chaotic signals. i.e. the signal is masked, providing information encryption at hardware level; the simulation, graphics, and other results are showing using the multisim software.

Keywords: Chaotic Behaviour, Secure Communications, Attractor,

INTRODUCTION

Over the past three decades the interest in chaotic systems has intensified in several areas involving the behaviour of human behaviour and social, economic phenomena and the evolution of technology. The principles of chaos theory have been used successfully to describe and explain various natural and artificial phenomena, such as seizures (Zhi-Yuan S., Tzuyin W., Po-Hua Y., Yeng-Tseng W. 2008), the behaviour of financial markets (N. Basalto, R. Bellotti, F. De Carlo, P. Facchi, S. Pascazio. 2005), creating weather reports (Lisa G.,2009), fractal, in this modern era of science and technology can be extremely useful to study this area by academics.

On the other hand within the field of communications and electronics, chaotic synchronization is of great practical interest, since through it is possible to make important data encryption applications in telecommunications, since years ago (1990) was Pecora & Caroll realized that the chaos could be controlled and use in secure communication systems. The motivation of using chaotic systems, encryption of information is due to be unpredictable feature of such systems, which provides a high level of security.

There are two main forms of coupling, which is unidirectional master-slave systems (Master-Slave), where the teacher is the guide or reference system and the slave is driven system which is dependent on the teacher. In the case of bidirectional two systems interact and are coupled with each other creating a mutual synchronization.

Chaotic Synchronization on Rössler Circuit

Chaotic Synchronization

The meaning of chaos synchronization refers to the process which involves two (or more) chaotic systems (equivalent or nonequivalent) adjust their properties to tend to a common behavior (periodical or noisy) (Boccaletti S., 2002). This phenomenon makes initial synchronization systems evolve on different attractors so they can finally equalize, fit and match on the same path (Pecora LM and Carroll TL.,1990), (Zhi-Yuan S., Tzuyin W., Po-Hua Y., Yeng-Tseng W., 2008). It is surprising that the synchronization between two chaotic systems appears when considering the dependence of chaotic dynamics in the initial conditions of the system.

Unidirectional Coupling

The overall system consists of two subsystems coupled by a configuration master-slave type. This implies that the slave system behaviour depends on the behavior of the teacher, while the latter is not influenced by the behavior of the slave system. As a result, the slave system is forced to follow the dynamics (or a specific function of the dynamics) of the teacher. In other words, when evolution of one of the two systems is not altered by coupling the resulting configuration is a unidirectional coupling.

DEVELOPMENT

Use a chaotic generator, created from the Rössler system, which was proposed by Otto Rössler in 1976, and is a simplified circuit model proposed by Lorenz. Rössler circuit (Fig. 1) consists of an array of passive RLC elements and controlled voltage source (e).

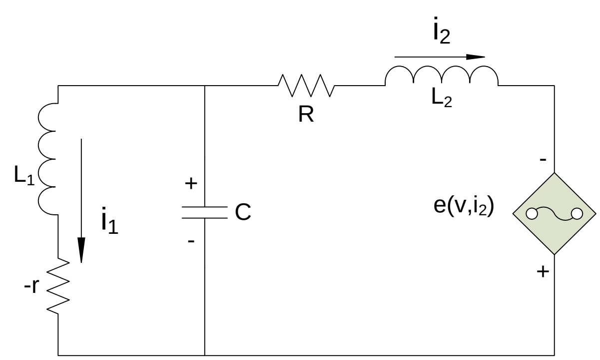


Figure 1. Rössler Circuit

If we make an analysis of meshes using Kirchhoff laws, we have:

Analyzing the first mesh.

$$0 = -V_C + V_{L_1} - V_r \tag{1}$$

Analyzing the second mesh

$$0 = -V_C + Ri_2 + V_{L_2} - e(v, i_2) \qquad (2)$$

Where obtain the equations that describe the system.

$$C\frac{dv}{dt} = -i_1 - i_2$$
$$L_2\frac{di_2}{dt} = v - Ri_2 + e(v, i_2) \qquad (3)$$
$$L_1\frac{di_1}{dt} = v + ri_1$$

Another way to write equations that describe the Rössler model is:

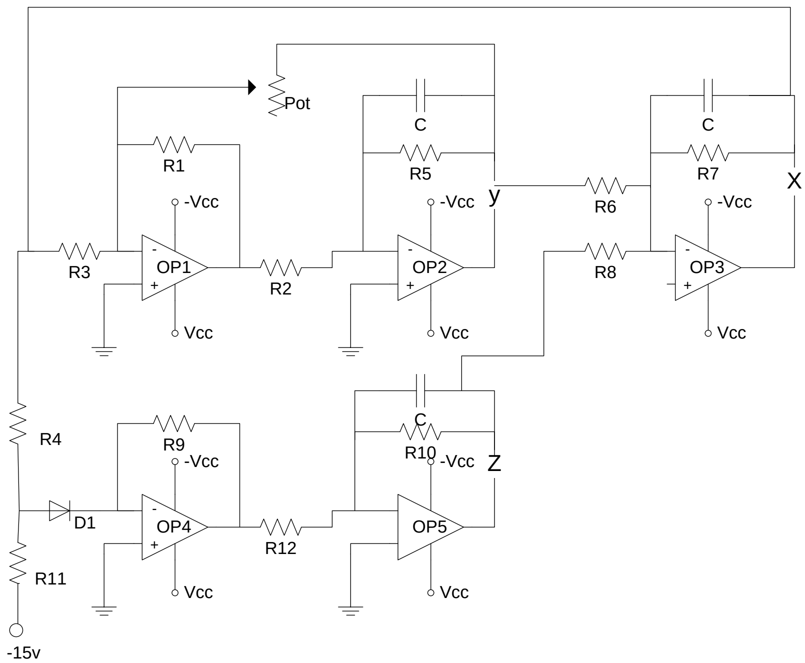
$$\dot{x} = -\alpha(\Gamma x + \beta y + \lambda z)$$
$$\dot{y} = -\alpha(-x - \gamma y + 0.002z)$$
$$\dot{z} = -\alpha(-g(x) + z) \qquad (4)$$
$$g(x) = \begin{cases} 0, & x \le 3 \\ \mu(x-3), & x > 3 \end{cases}$$

Whereα=104, Γ=0.05, β= 0.5, λ=1, γ=0.133.

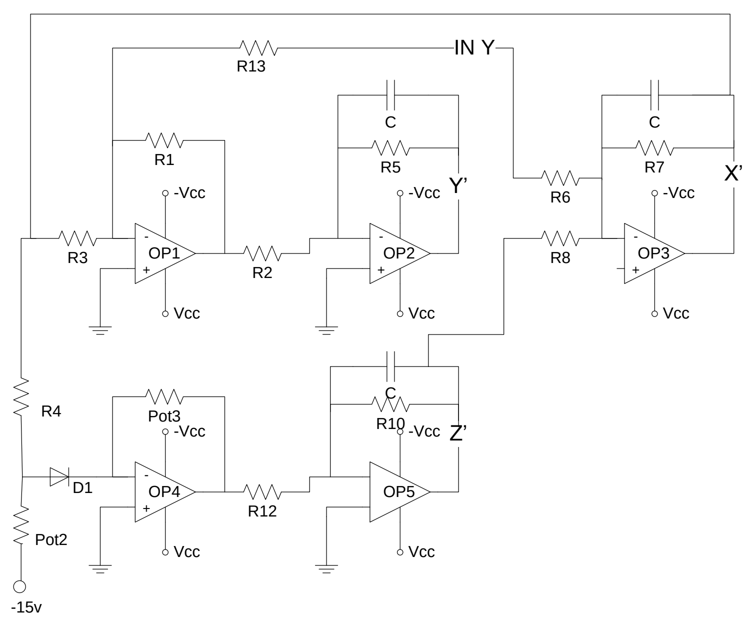
Chaotic synchronization Circuit.

The diode D1 represents the nonlinearity that is the circuit which involves the noninverting input of operational amplifier 4, which functions as a switch when it exceeds 3V, which determines the function g(x).

The timing presented is unidirectional or also called master-slave and consists of two identical circuits as shown in Figure 2, it is worth mentioning that the synchronization between two chaotic systems appears when considering the dependence of chaotic dynamics on initial conditions the system, one-way synchronization occurs when the teacher is the guide or reference system and the slave is driven system which is dependent on the teacher.



a)



b)

Figure 2. Schematic diagram of the one-way synchronization: a) Circuit Schematic Master, b) Circuit Schematic Slave

In the schematics we can see that the signal from the master "Y" is going to lead the slave by means of "IN" Y "and then we can see that the changes occurring in the first affected during the second year after time t come to mate.

SIMULATION SETUP

Using Multisim software we put together the master circuit shown below.

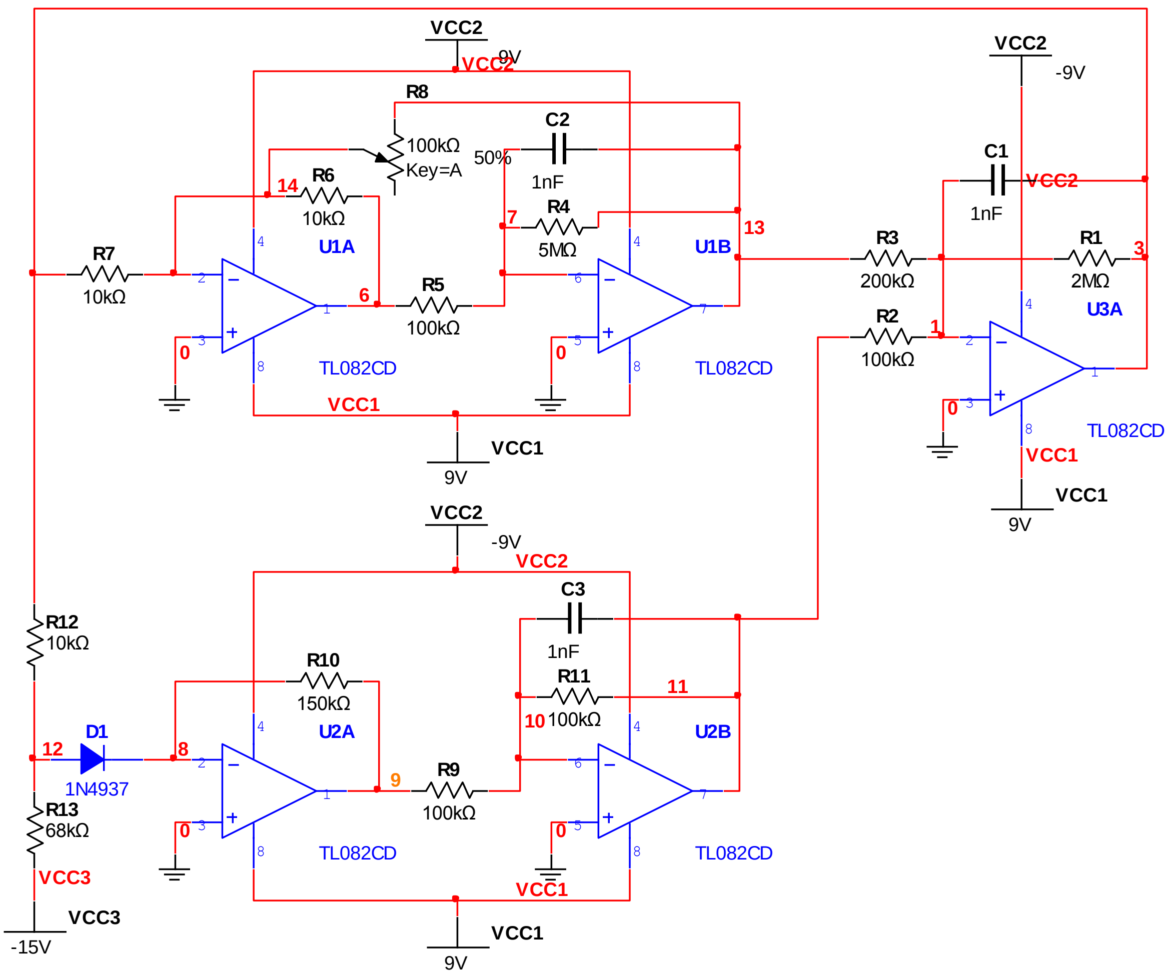
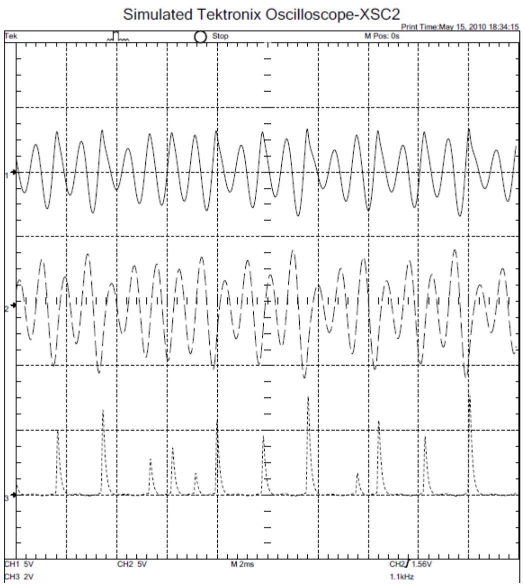
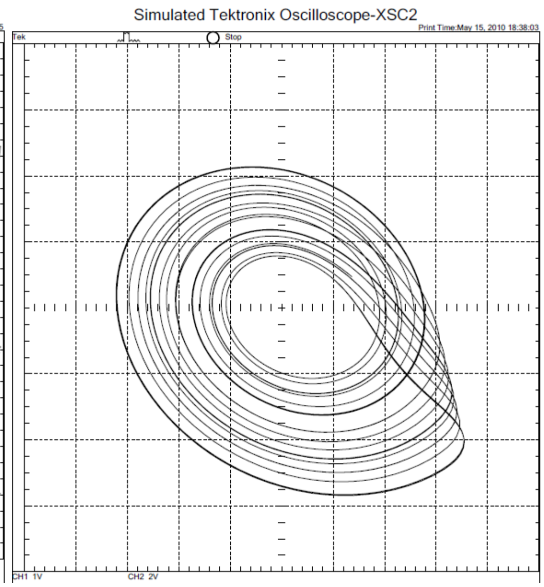
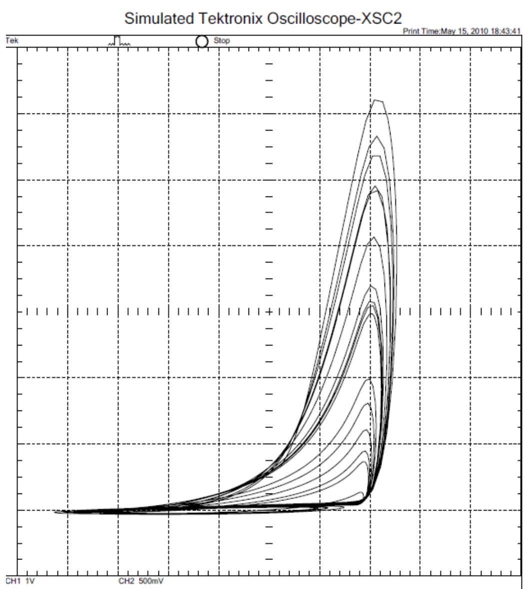


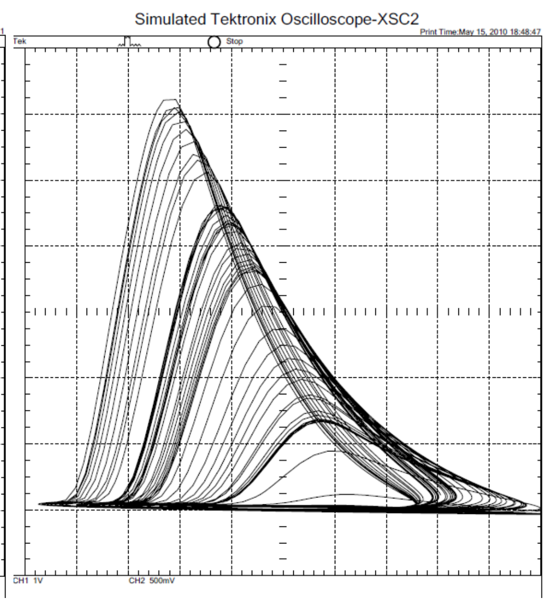
Figure 3. Circuit Master. (Rössler Circuit)





a) **b)**





c) **d)**

Figure 4 Chaotic signals displayed on the oscilloscope. a) Signals. X, Y, Z., b) Attractor XY, c) Attractor XZ, d) Attractor YZ

We present the simulation of Master-salve synchronization using Multisim software.

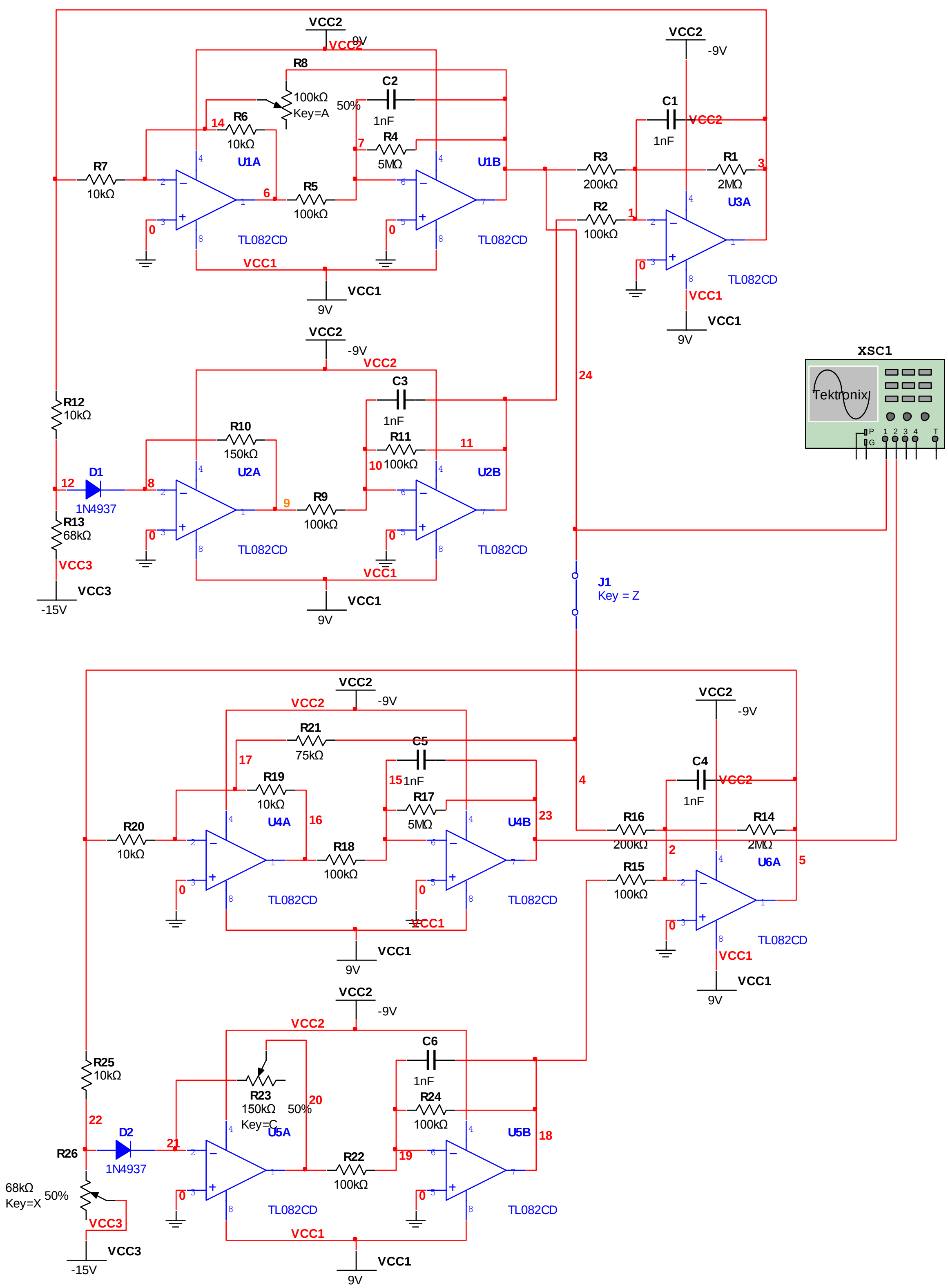


Figure 8 Circuit used for master-slave synchronization

The graphs obtained are:

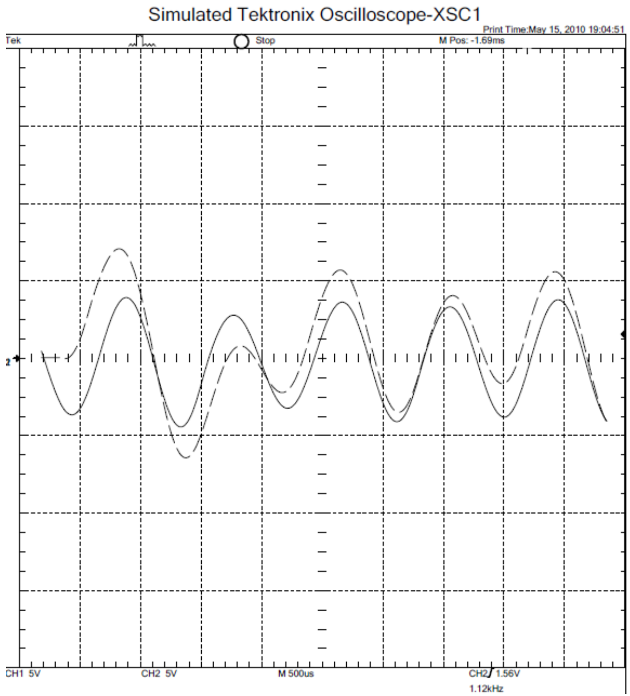


Figure 9. Synchronized Signal.

The continuous dial tone signal is part of the master system, while the discontinuous signal belongs to the slave circuit.

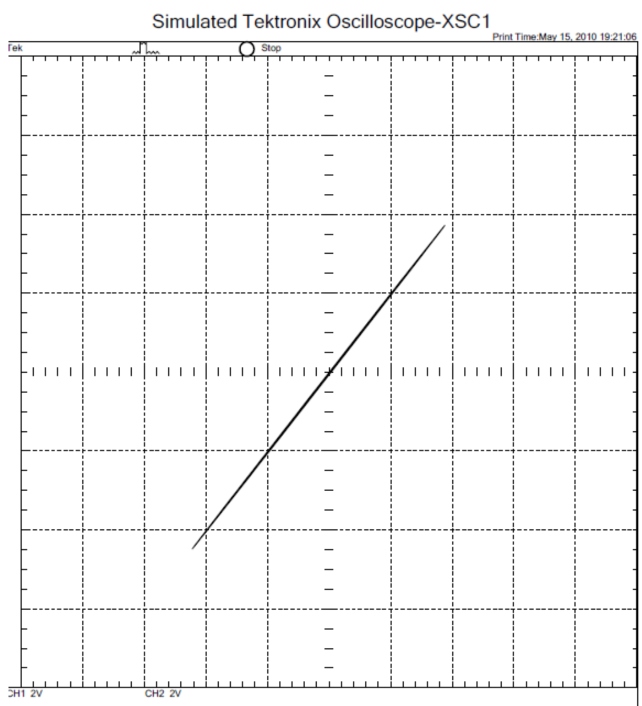


Figure 10. Oscilloscope in XY mode, Y to Y '

CONCLUSIONS

When implementing a synchronization of two nonlinear dynamical systems we are faced with different problems, one of them is the extreme sensitivity to initial conditions at the time of synchronizing the two models, which is solved by creating an adaptive synchronization, in this case potentiometer on the chaotic master generator, is varied by changing the parameters of both the master and the slave and when the potentiometer has a value of 22kΩ, the signals Y and Y 'obey the same path and the systems are synchronized in this way specific synchronization.

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