Memristor-based Tunable Oscillator for Frequency Hopping Spread Spectrum Technology

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Abstract

This study presents an implementation of a tunable frequency generator exploiting the multistate property of memristors. Traditional oscillators generate a particular frequency and, hence, require a digital phase-locked loop frequency synthesizer to produce a range of frequencies from a single reference frequency. Frequency synthesizer circuits use loop filters, programmable dividers and voltage-controlled oscillators. This complex circuitry has problems such as loss of synchronization and low frequency resolution. Our proposed oscillator can generate a range of frequencies based on memristors that can be tuned using a particular pattern.

One major application of this tunable oscillator is in Frequency hopping spread spectrum (FHSS) technology, which efficiently deals with signal jamming, interference, and interception. In FHSS, a communication channel is divided into many narrow bands, and each data packet is sent at different frequencies at different times following a pseudo-random hopping pattern. We have designed a pseudorandom number sequence generator using memristors. These pseudorandom signals are fed into a digital system that maps each signal to a particular frequency from a look-up table, generating the frequency hopping pattern in Figure 3(b). The digital system controls the conductance of the memristors used in the oscillator circuit, thus generating signals with desired frequency. The associated block diagram is shown in Figure 1.

Our PN sequence generator operates based on the multistate property of two memristors. Each memristor is assigned an initial value. The state of one memristor decides the next state of the other memristor through a feedback system. The pseudorandom pattern depends on the initial assigned state. Generally, Linear feedback shift Registers are used to produce the pseudo-random pattern where with N number of registers, the maximum number of divided channels is limited to 2^N. On the contrary, our generated pattern can generate eight states utilizing two memristors, which can be further extended by increasing the number of memristors. Figure 3(a) shows the diagram of our tunable oscillator circuit. The memristors in this circuit can be switched within 300 μs using the digital system. Figure 2(a) shows the I-V characteristics of the memristors and 2(b) shows the multistate property of memristors with different compliance currents.

Experimental results will be presented in the conference.

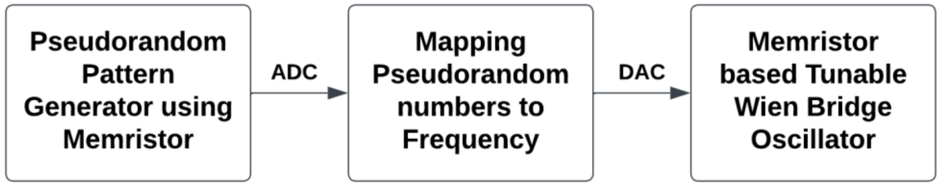

Figure 1: Block Diagram of our proposed system

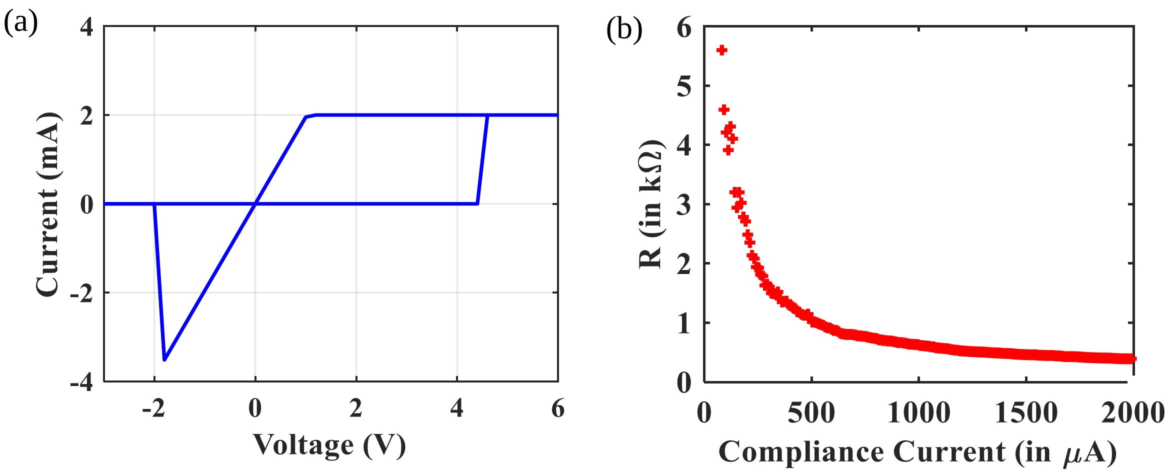

Figure 2: (a) I-V characteristics of memristor. (b) resistance vs compliance current of memristor.

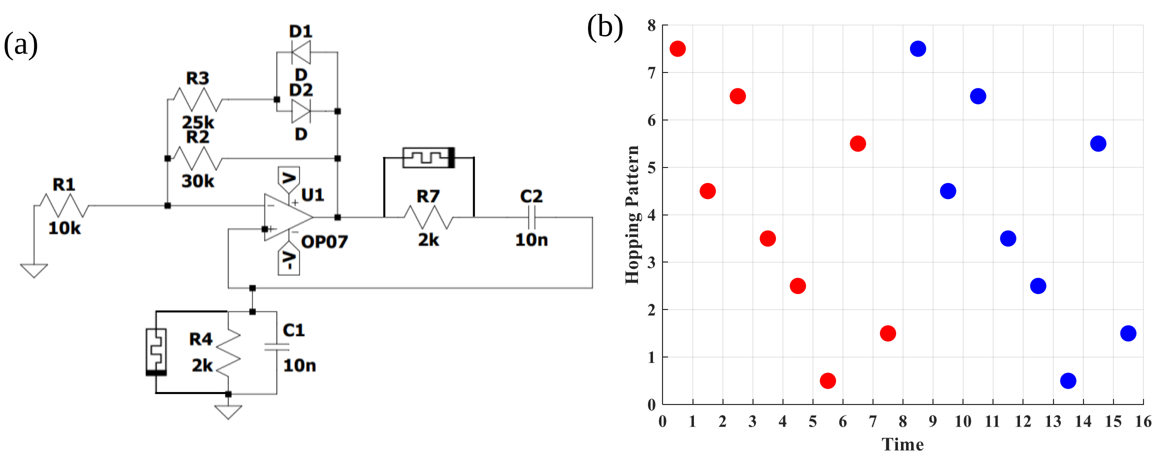

Figure 3: (a) Schematic of memristor based oscillator circuit. (b) Frequency hopping pattern with time.