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Single DVCCTA based High frequency incremental/decremental Memristor Emulator and its Application

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ABSTRACT: Memristor emulator based on TiO_2 model is introduced. The proposed circuit uses current mode building block DVCCTA (Differential Voltage Current Conveyor Transconductance Amplifier) using 0.25 *μm* CMOS technology. The presented circuit uses single CMOS based DVCCTA, three resistors and one capacitor. It can operate upto 1 MHz in both the incremental and decremental configuration by interchanging the connections. Theoretical analysis of the proposed circuit resulting in the equivalent memristance equation is done and non-ideal analysis is also included. PSPICE simulations are performed. Simulation results agree well with theoretical assumption. To verify the practicability of the circuit, PCB prototype has been made using AD844AN and CA3080. The experimental demonstration is carried out for 50 kHz and 100 kHz. **Moreover, the circuit has also been tested for non-volatility features. It is observed from the experimental test result and using 0.25 *μm* CMOS technology that maximum frequency is 10 kHz and 50 kHz respectively.** To check the functionality of the circuit two combinations of memristor are connected in serial and parallel and desired results are obtained. Memristor based high pass filter is also discussed so as to study the memristor behavior in comparison to the resistor.

Keywords: Current mode circuits, Memristor emulator, pinched hysteresis loop

1. INTRODUCTION

Memristor is a non-linear resistor with memory. It is the fourth fundamental element postulated by Leon Chua in 1971 [1]. Memristor is having a relationship between charge and flux. Generic properties of memristive system are derived and explained by Kang [2]. Memristive system is a zero phase shift dynamic system. Three essential characteristics for a device to behave like a memristor is discussed in [3]. In 2008, S. Williams et al. [4] developed a nanoscale solid state device in HP Laboratory, which exhibited memristive behavior. It consist of a thin film layer of TiO_2 (Titanium dioxide) sandwiched between two platinum electrodes. One of the layers is doped with oxygen vacancies which act like a semiconductor and the other layer which is undoped acts like an insulator. Its resistance changes according to the magnitude and polarity of the voltage applied across the device. Memristors are non-volatile as its resistance does not change when no voltage is applied. Its compatibility with CMOS technology [5]-[6] has drawn the attention of many researchers to further explore its application. The literature survey reveals that many applications of memristor have already been discussed. It is used in chaotic circuits which basically uses the non-linear dynamic behavior of memristor to produce chaos. Many chaotic circuits based on memristors have been proposed in [7]-[10]. It can be used in neuromorphic circuits [11], nonvolatile memories, signal processing [12], analog circuits like programmable analog circuits [13], conversion of analog signal to digital signal and back to analog signal from digital signal [14], adaptive filters, oscillators [15] and logic implementation. Many spice macromodels have been introduced to mimic the memristor behavior [16]-[19]. However, it is available only for simulation purpose. Recently, Bio Inspired Technologies released an integrated circuit called as Neuro Bit Memristors [20] which is basically a chalcogenide ion conducting memristor device and can change its resistance state by using the advantage of reversible dendrite growth. However, it can be configured only in incremental