Coherent Chaotic Oscillator at 100MHz

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Chaotic waveforms exhibit a structure that is non-periodic, noise-like, broadband and extremely sensitive to the initial conditions of the generating system making them ideally suited for radar applications involving surveillance, interferometric synthetic aperture imaging, altimetry, vehicular collision avoidance and subsurface/ground-penetrating profiling. However, the lack of a fixed basis chaotic function and the irregular timing characteristic made receiving the radar return signal almost impossible. In 2010, a new class of chaotic oscillators, described by a continuous-time differential equation and a discrete switching condition, was recognized (N. J. Corron, J. N. Blakely, and M. T. Stahl, 'A matched filter for chaos', Chaos 20, 023123 (2010)). This class of chaotic oscillators yields itself to having a fixed basis function and consequently a stable matched filter. This paper presents our approach for implementing this coherent chaotic oscillator with a fundamental frequency of 100 MHz.

The chaotic oscillator is divided into three main blocks: the oscillator, the microstrip differentiator and the oscillator controlling unit. The oscillator is designed as a –RLC circuit using a biased BJT for the negative resistance. It oscillates around 100MHz. The output of the oscillator is fed to a differentiator and a control unit. The microstrip differentiator consists of three microstrip lines of different width and length, and a coupled microstrip line which controls the gain of the differentiator. The output of the differentiator is connected to the control unit. The control unit consists of two comparators followed by a logic block. The first comparator compares the oscillator signal to 0V, while the second comparator compares the differentiator signal to 0V. The outputs of the comparators are connected to the logic block which consists of two levels. The logic block determines whether the oscillator's DC offset sign should be flipped. The output of the control unit is used to control a 2x1 multiplexer. The inputs of the multiplexer are: a DC voltage *'A'* which is the initial condition of the oscillator, and '*–A'*. The multiplexer isolates the oscillator's signal from the control signal. The overall delay of the system extends between 1.9ns and 2.4ns.