Soliton Oscillators

Raytheon: Raytheon Company is a technology and innovation leader specializing in defense, security and civil markets throughout the world

Goal: Research, design, and fabricate several iterations of radio frequency soliton oscillators

Evaluate the benefits and drawbacks

Key Characteristics of Solitons:

Velocity of a soliton is dependent on the amplitude of the pulse. This also controls the pulse of the wave.

Solitons maintain their shapes after collisions but there is a phase shifts

Any non-soliton waveform in a media that prefers solitons will decompose into a series of solitons pulses.

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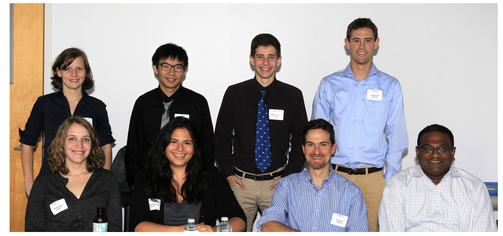
Olin College of Engineering SCOPE



Advisor: Louis Yi

Siddhartan Govindasamy

Jeffrey Holzgrafe

Mary Ruthven

Jazmin Gonzalez-Rivero

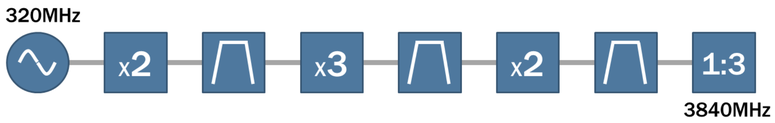
Liaison:

Rob Leoni

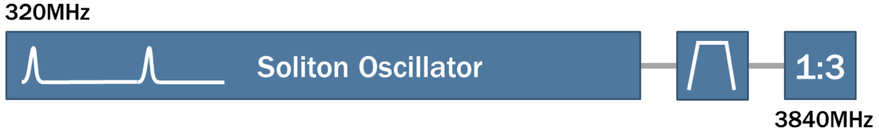
Tery Kirn

Alyssa Bawgus

Jay Patterson



Currently the generation of low phase noise oscillators in the microwave frequencies is done by using multipliers to convert an extremely stable but low frequency oscillator up to the desire frequencies. Though this method does produce low phase noise microwave frequency oscillators, there are drawbacks. Each multiplier and necessary band-pass filter both attenuates and adds more noise to system. This means there high frequency systems are usually extremely large and inefficient.

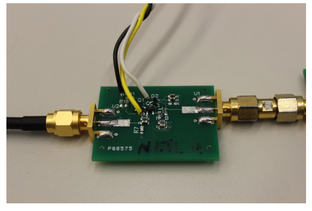


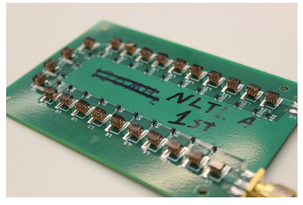
The soliton oscillator system would get rid of many of the multiplier and band-pass filters. Since solitons have many harmonics, all that is needed to get microwave frequencies is a band-pass filter at the desired frequency.

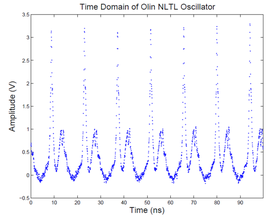
What we did:

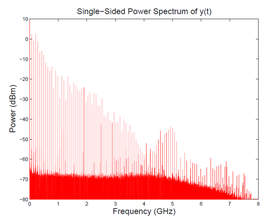
During the first semester, we focused most of our efforts on researching and designing a feasible soliton oscillator system. This included creating simulations to validate our design decisions and reading through many research papers and article journals.

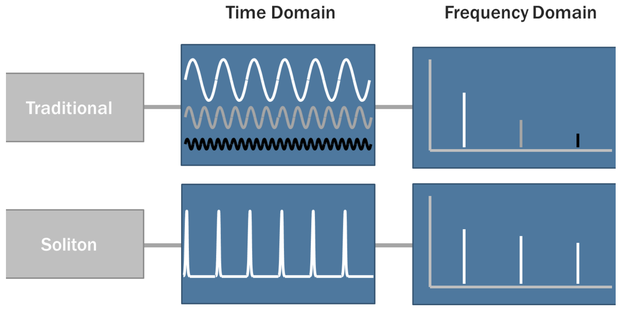
The second semester we worked on gathered experimental data from actual boards we fabricated in order to compare with our simulation results. We looked at the benefits and drawback of certain systems and different methods to improve those systems.











The diagram to the left shows the differences between the traditional method to create high frequency oscillations and the new soliton oscillation method.

In the traditional method each wave is multiplied as seen by the different color waves. This creates higher frequency harmonics with half the amplitude as seen in the frequency domain.

In the soliton oscillator method, there are more harmonics which also have higher amplitude. This means that higher frequency content does not need to be amplified as much as the traditional method.