

## Fabrication of right-handed nonlinear transmission lines and observation of electromagnetic pulse propagation characteristics

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**Abstract:** We fabricated a right-handed nonlinear transmission line and investigated the propagation of solitary voltage waves. We found the solitary waves traveled stably along the NLTL and their velocities strongly depended on their amplitudes.

### 1. Research Background

For more than 30 years, the Propagation phenomena of electromagnetic pulses in nonlinear transmission lines (NLTLs) have attracted much attention because they have found many applications as tabletop laboratories for nonlinear dynamics of electrical waves and applications of novel nonlinear communication schemes in electronic devices.

Such an NLTL is constructed from the linear LC ladder circuit by replacing capacitors with varactor diodes (VDs). The VDs, whose capacitance strongly depends on the applied voltages, introduce nonlinearity to the NLTL.

In this study, we fabricated a right-handed nonlinear transmission line<sup>[1]</sup> composed of 40 unit cells of an L-VD ladder and observed the propagation of voltage solitons along the NLTL.

### 2. Experimental Methods

A unit cell of the NLTL fabricated in the study is consisted of a parallel varactor diode (SKYWOKS: SMV1234-079LF) and a series inductor (Murata: LQG15WH2N5B02D). A circuit board has 10 unit cells, and 4 boards are connected in series. That is, the NLTL has 40 unit cells. The input signal was a square pulse wave with an amplitude of 1 V and a width of 20 nsec.

### 3. Results and Discussions

Figure 1 shows a voltage waveform observed at the 40th unit cell of the NLTL. As can be seen, the wave consists of multiple solitary waves, while the input signal is only one single shot of a pulsed wave. The solitary waves travel stably along the NLTL, and the velocity of the waves strongly depends on their amplitudes: the larger the

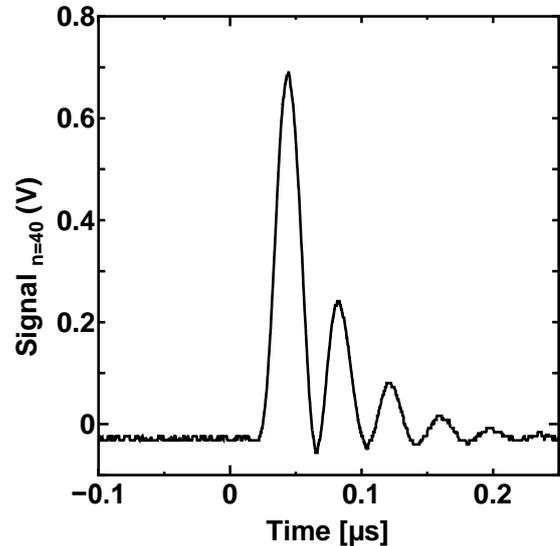


FIG. 1. A series of nonlinear voltage pulses observed at  $n = 40$ th unit cell of right-handed transmission line.

amplitude they have, the faster they propagate. These results imply that the solitary voltage waves observed in the NLTL are multiple solitons maintained by dispersion and nonlinearity of the NLTL.

### 4. Conclusion

We fabricated a right-handed nonlinear transmission line and observed the propagation of voltage solitons. DC bias dependence of the soliton propagation will be discussed at the conference.

### References

- [1] D. S. Ricketts and D. Ham, “*Electrical Solitons: Theory, Design, and Applications*”, CRC Press (2011).

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