DISPERSION ANALYSIS IN COAXIAL CABLES

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Introduction

- Coaxial cable is a **Bandwidth-limited channel,** implying it cannot operate over entire range of frequency spectrum.
- **Dispersion** is a phenomenon of signal distortion which arises due to frequency dependence of **phase velocity** of signal components.

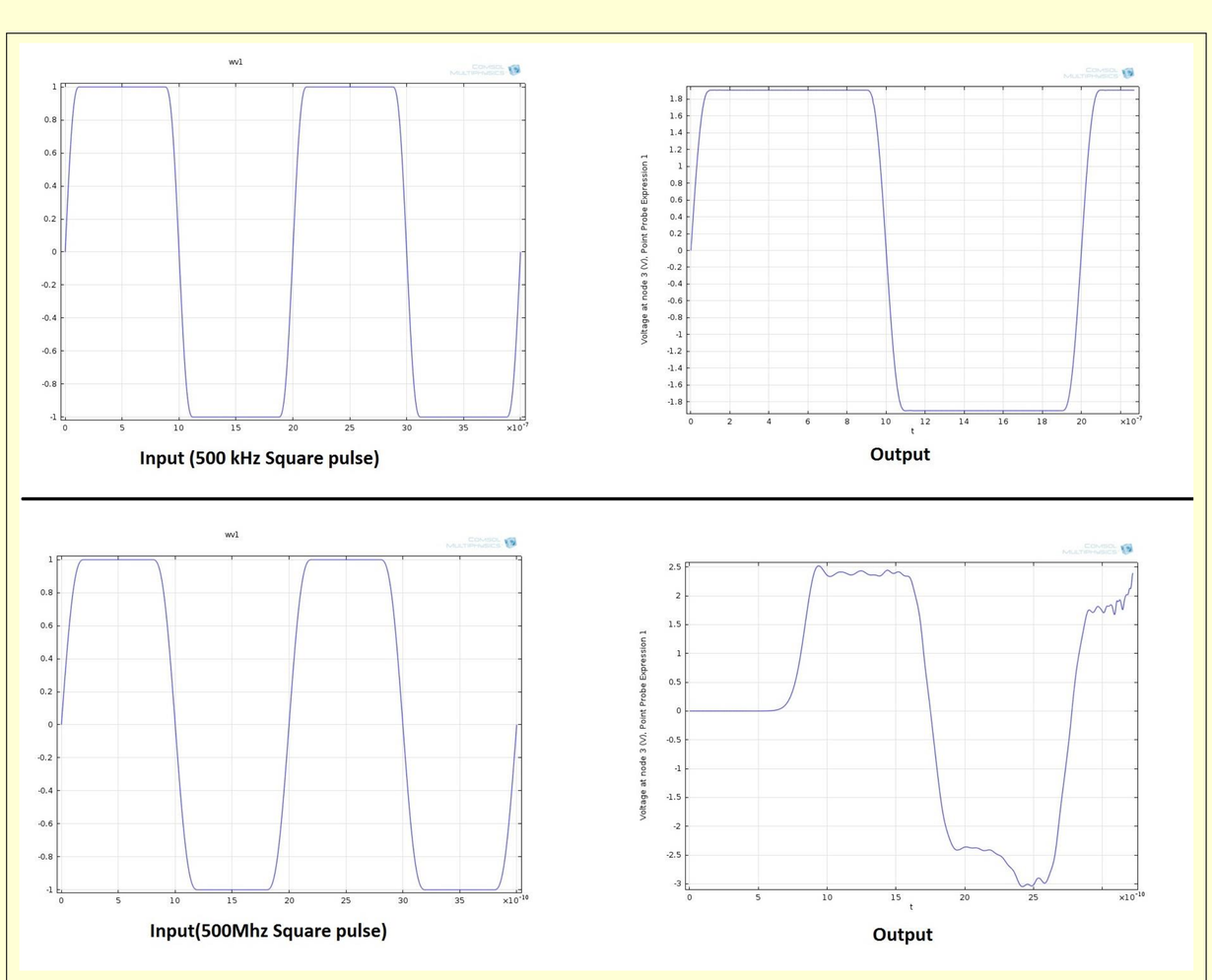


Figure 1. Square pulse distortion due to dispersion.

Computational Methods

- The coaxial cable was excited by a sinusoidal source at one end, and voltage across the load, connected at the other end of cable was measured.
- Until signal gets propagated through coaxial cable, output voltage remains 0, and hence propagation time can be measured from output graph.
- The frequency of source was varied, and corresponding propagation time for signal was tabulated .

$$f(x) = a_0 + \sum_{n=1}^{\infty} \left(a_n \cos \frac{n\pi x}{L} + b_n \sin \frac{n\pi x}{L} \right)$$

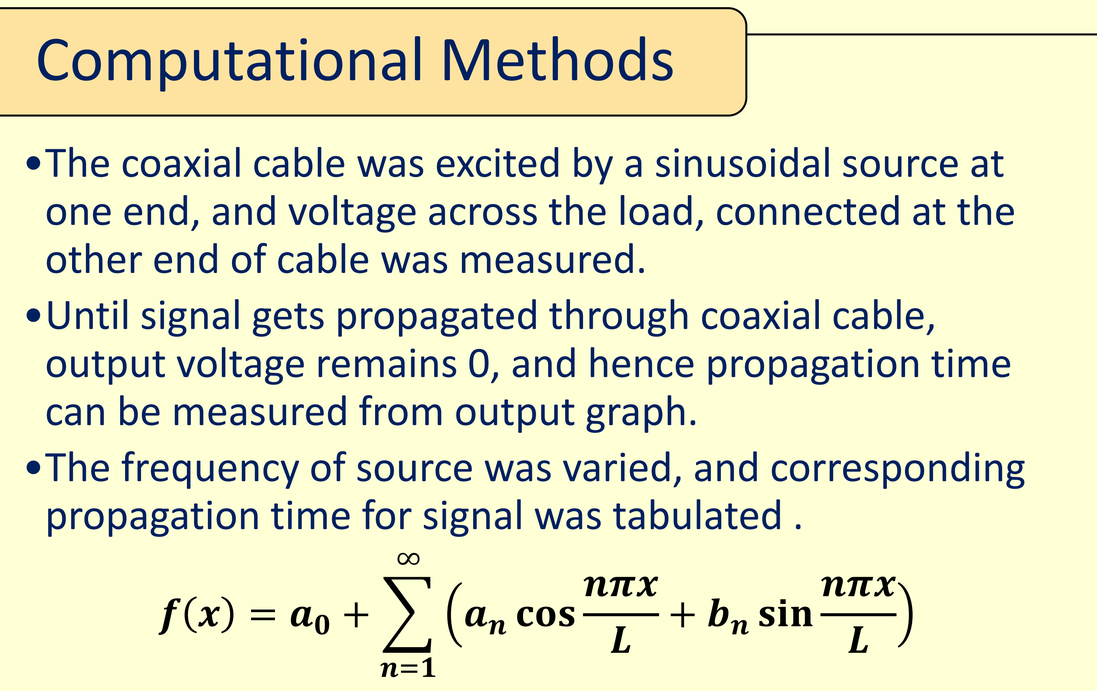


Figure 2. Modeling and Simulation Setup

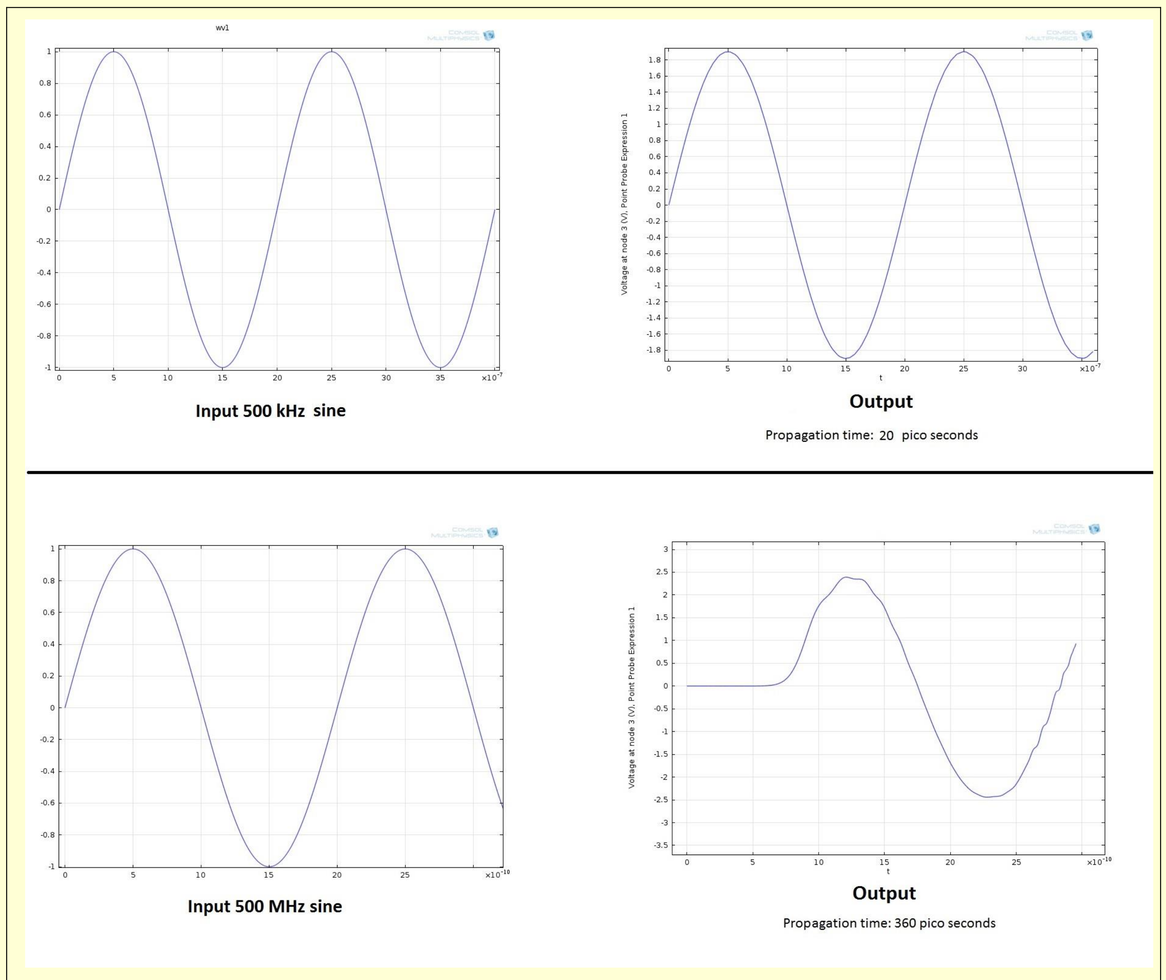
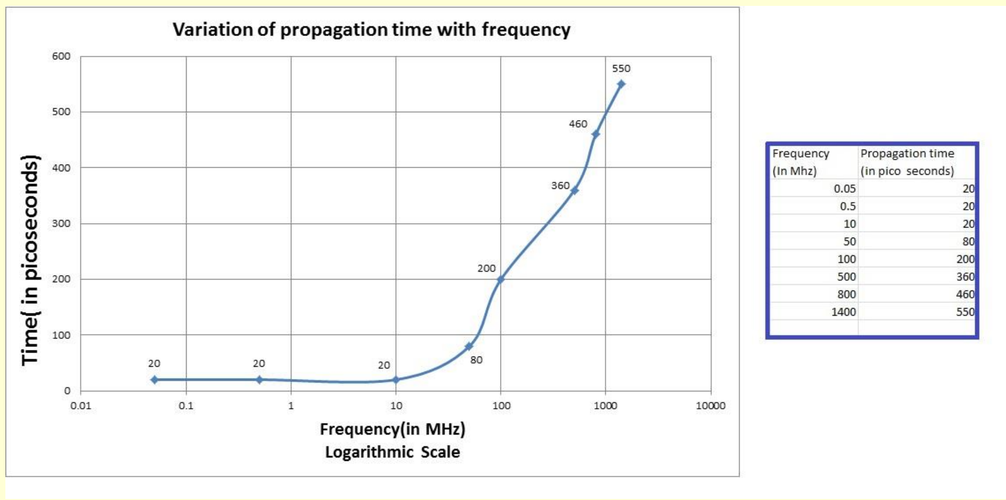


Figure 3. Measuring propagation time for sinusoidal input

Results

- **Slope** of graph in Fig 4, indicates that, **propagation time changes slightly at lower frequencies** implying low frequency signals arrive more or less at same time, while there is a higher difference in arrival time of high frequency signals.
- It's evident from fig 1, that higher frequency square pulse underwent severe distortion compared to lower frequency pulse.



Frequency (In Mhz)	Propagation time (in pico seconds)
0.05	20
0.5	20
10	20
50	80
100	200
500	360
800	460
1400	550

Figure 4. Variation of propagation time with frequency

Conclusion

- This study thus concludes that **dispersion effects become significant at higher frequency** ranges in electromagnetic spectrum (~100 MHz -2GHz) , and **places a limit on bandwidth of signal for undistorted transmission.**
- The study has implications in field of **RF and microwave transmission**, as well as **computer and instrumentation**(eg: oscilloscope) data connections, dealing with high frequency signals.

References:

1. D.M. Pozar, Microwave Engineering, Addison-Wesley
2. William Hayt Jr and John A Buck, Engineering Electromagnetics, 6e/d
3. Jon Barth and John Richner,"Distortion of Fast Pulses by Non-TEM Effects in Coaxial Cables",Barth Electronics,pp 305-312(1995)