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# Confirming the Signal Integrity in Transmission of Digital Signals on Microstrip Straight Circuits via the Eye Diagrams

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## Abstract

Because of the high volume of processing, transmission, and information storage, electronic systems presently requires faster clock speeds tosynchronizethe integrated circuits. Presently the “speeds” on the connections of a printed circuit board (PCB) are in the order of the GHz. At these frequencies the behavior of the interconnects are more like that of a transmission line, and hence distortion, delay, and phase shift- effects caused by phenomena like cross talk, ringing and over shot are present and may be undesirable for the performance of a circuit or system.Some of these phrases were extracted from the chapter eight of book “2-D Electromagnetic Simulation of Passive Microstrip Circuits” from the corresponding author of this paper.

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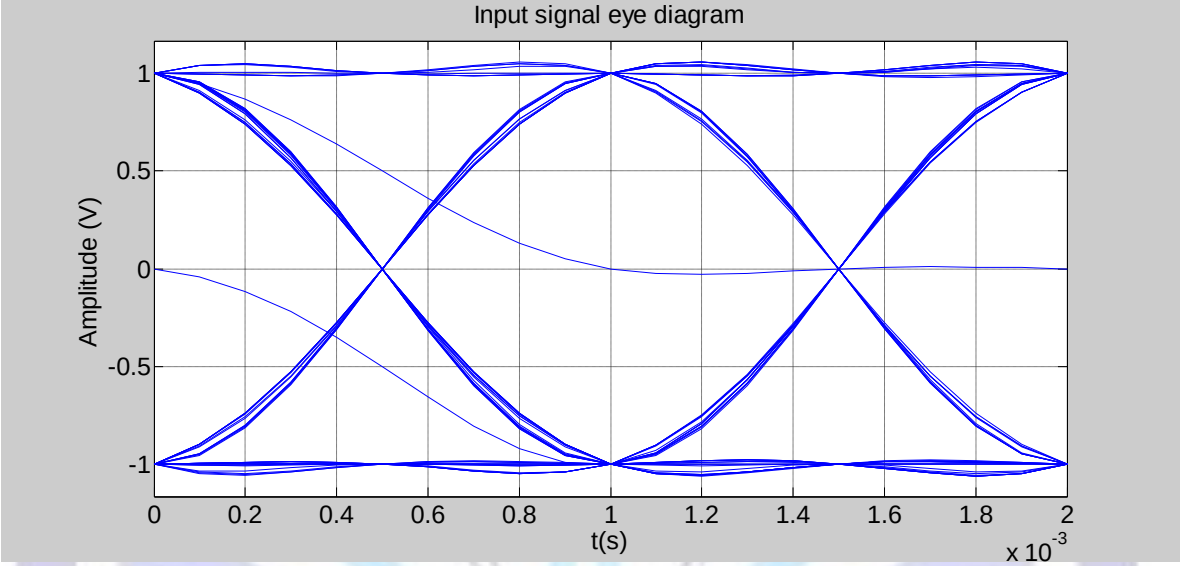


Figure 1. Input signal eye diagram. Frequency (5 GHz).

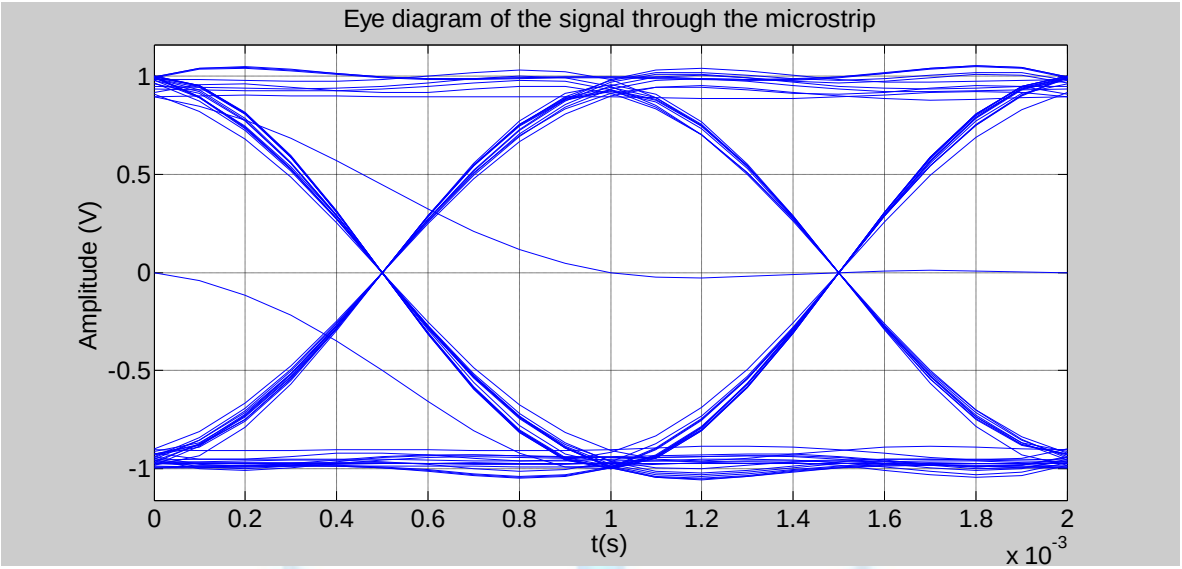


**Figure 2. Eye diagram through the microstrip. Frequency (10 GHz).**

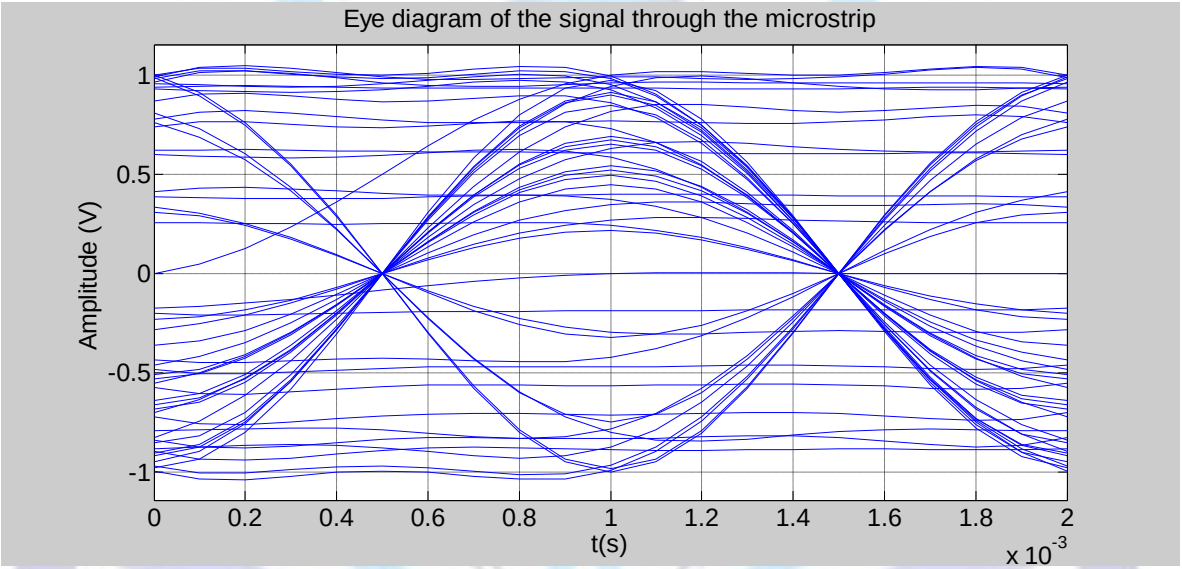


**Figure 3. Eye diagram through the microstrip. Frequency (15 GHz).**

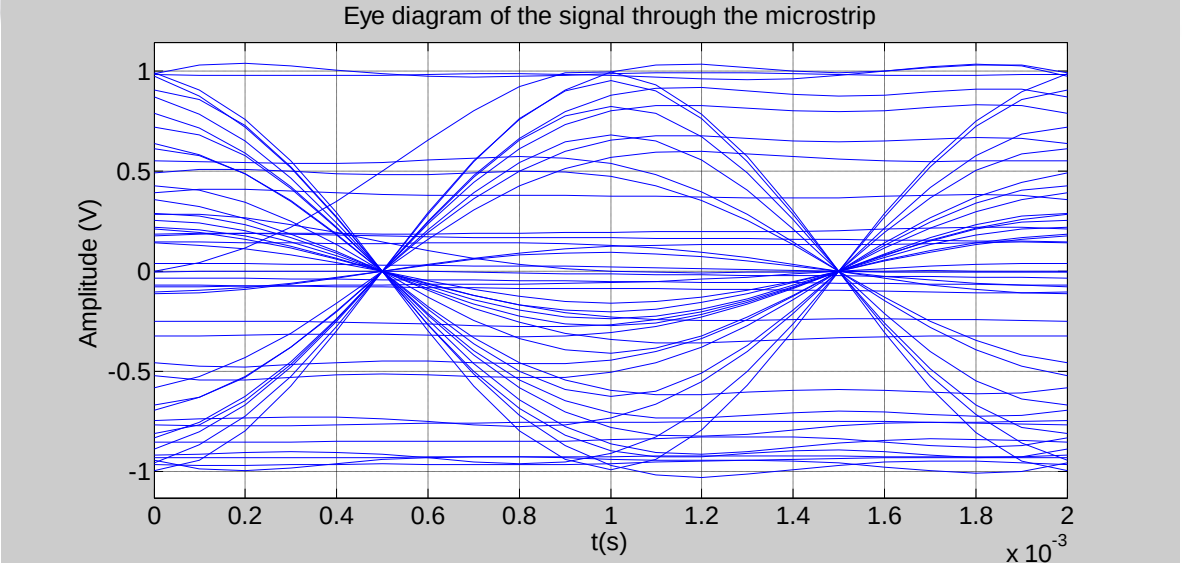

**Figure 4. Eye diagram through the microstrip. Frequency (20 GHz).**

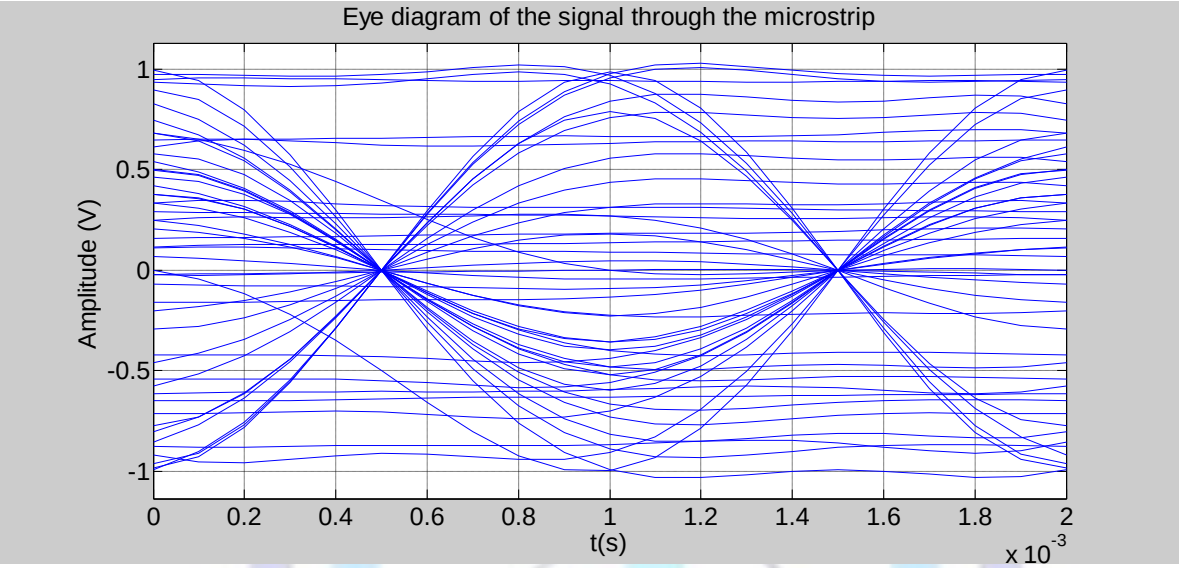


**Figure 5. Eye diagram through the microstrip. Frequency (25 GHz).**

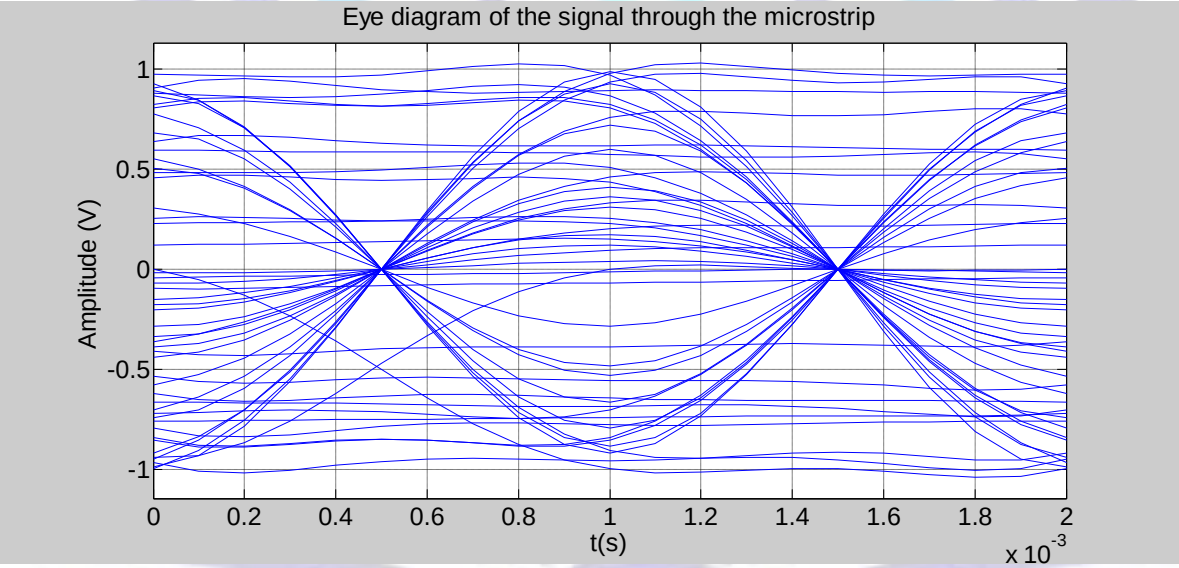


**Figure 6. Eye diagram through the microstrip. Frequency (30 GHz).**

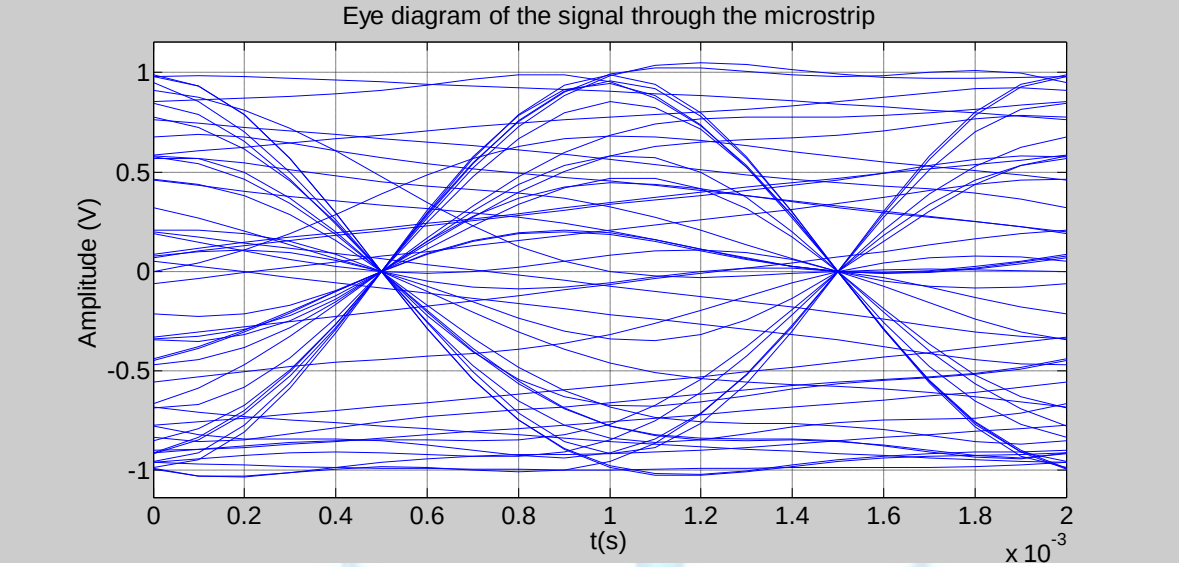


**Figure 7. Eye diagram through the microstrip. Frequency (300 GHz).**

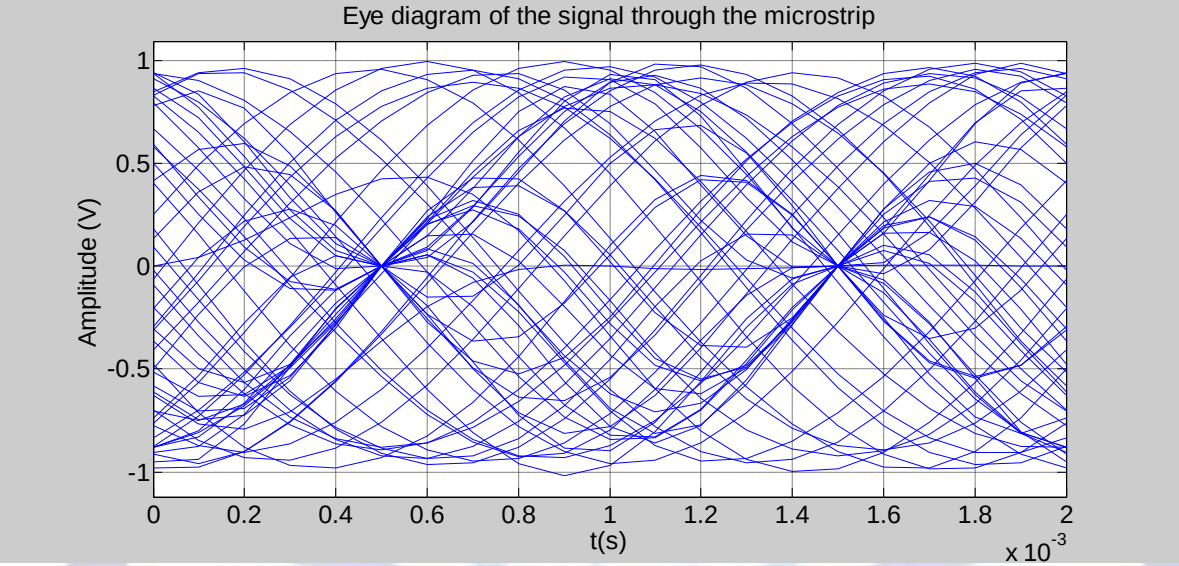


**Figure 8. Eye diagram through the microstrip. Frequency (3000 GHz).**

A very ingenious procedure to interpret the eye diagrams was presented in [21].The procedure is based on the comparison of a pre-established mask, measured directly from the eye diagram.The pre-established masks define specific regions on an eye diagram inside which the digital pulses should not be introduced.

The figures 1 to 8 showthe input signal eye diagram at 5 GHz and theeye diagram through the microstrip at different frequencies.

As can be seen from these figures, several masks have been generated for studying the signal integrity on microstrip straight circuits via the eye diagrams.

On the other hand, a distributed parameter equivalent circuit of a microstrip, can be conceived by using a transmission line model.

This distributed parameter equivalent circuit can be implemented by using electromagnetic simulation. Two powerful and confident methods to realize a good electromagnetic simulation are the method of moments (MoM)and the Finite-Difference Time-Domain Method (FDTD) (2-D Electromagnetic Simulation of Passive Microstrip Circuits).By employingthese methods the eye diagrams and hence the masks can be obtained.

References

[1] M. E. Hines and H. E. Stinhelfer, Time domain Oscillographic Microwave Network Analysis Using Frequency-Domain Data, 276-281, IEEE Transactions on Microwave Theory and Techniques, vol. MTT-22, No. 3, March, 1974.

[2] W. W. M. Dai, Guest Ed., “Special issue on simulation, modeling,and electricaldesign of high-speed and high-density interconnects,”*IEEE Trans. Circuits Syst.,* vol. 39, pp. 857–982, Nov. 1992.

[3] H. W. Johnson and M. Graham, *High-speed Digital Design: A Handbookof BlackMagic.* Englewood Cliffs, NJ: Prentice-Hall, 1993.

[4] E. Chiprout and M. Nakhla, *Asymptotic Waveform Evaluation andMoment Matching for Interconnect Analysis*. Boston, MA: Kluwer, 1993.

[5] R. K. Poon, *Computer Circuits Electrical Design.* Englewood Cliffs,NJ: Prentice-Hall, 1995.

[6] S. H. Hall, G. W. Hall, and J. A. McCall, *High-speed Digital SystemDesign: AHandbook of Interconnect Theory and Design Practices*. New York, NY: Wiley, 2000.

[7] M. S. Nakhla and A. Ushida, Guest Eds, “Special issue on modeling and simulation of highspeed interconnects,” *IEEE Trans. CircuitsSyst.,* vol. 39, pp. 857–982, May 2000.

[8] Stephen H. Hall and all, *“High- Speed Digital Systems Design, a Handbook of Interconnect Theory and Design Practices”*, John Willey & Sons New York, 2000.

[9] Agilent Technologies, Eric Bogatin, GigaTest Labs, *“Understanding Signal Integrity”*, April 18, 2002.

[10] Dallas Semiconductor, Maxim-ic, *“Introduction to Common Printed Circuit Transmission Lines”*, Application Note 2093, June 02, 2003.

[11] Howard Johnson and Martin Graham, *“High-Speed Signal, Advanced Black Magic”*, Prentice Hall, NJ, 2003.

[12] ALTERA, Application Note 224, High-Speed Board Layout Guidellines, September 2003, ver. 1.1, 34 pp.

[13] D. Brooks, Adjusting Signal Timing (Part 1), Technical Publication, October 2003, Mentor Graphics, 9 pp.

[14] D. Brooks, Controlling Impedances When Nets Branch Out, Technical Publication, March, 2005, Mentor Graphics, 6 pp.

[15] David M. Pozar, “Microwave Engineering”, Third Edition, John Willey & Sons, New York, 2005.

[16] Y. Deng and W. P. Maly, 2.5- Dimensional VLSI System Integration, IEEE Transactions on Very Large Scale Integration (VLSI) Systems, vol. 13, No. 6, June, 2005.

[17]A. Dueñas Jiménez, “Funciones de Prueba para la SimulaciónElectrostática de Líneas de Transmisión Abiertas de dos Conductores usando el Método de Momentos” IEEE LATIN AMERICA TRANSACTIONS.VOL. 4, NO. 6, DECEMBER 2006. (in Spanish).

[17] Intel® EP80579 Integrated Processor Product Line, Platform Design Guide, November, 2008, 349. pp.

[18] A. Dueñas Jiménez, *2-D Electromagnetic Simulation of Passive Microstrip Circuits,*Boca Raton, FL: CRC Press a Taylor and Francis Company, 2009, 274 pp.

[19] Anritsu, Field Applications Engineers, “Signal Integrity Basics”, Signal Integrity Basics White Paper_Paper2009-04134.

[20] G. Breed, High Frequency Electronics, Copyright © 2010 Summit Technical Media, LLC, 58-60.

[21] Diané Cárdenas Guillén, “Control de resonancias que se presentan en una tarjeta de circuito impreso tipo microcinta”, Master Science Thesis.(in Spanish), INSTITUTO POLITÉCNICO NACIONAL, MÉXICO, D. F., June 2012.