Curriculum Topic :
Time-Domain Transmission Lines

TDT10 : Coupling on Transmission Lines

Module Outline:	
Prerequisite Skills	Competencies
Supplemental Reading and Resources	Assessments
Laboratory Activities	Power Point Slides and Notes

Prerequisite Skills

Prerequisites / Requirements:
TDT8 Reactive Loads on Transmission Lines

Competencies

Competency TDT.10: Analyze transmission lines that are coupled.

Competency Builders:
TDT.10.1 Explain the physical origin of coupling and crosstalk.
TDT.10.2 Recognize the difference between forward and backward crosstalk.
TDT.10.3 Calculate the magnitude of crosstalk using crosstalk coefficients.

Supplemental Reading and Resources

Supplemental Reading Materials:

A.F. Peterson and G.D. Durgin. *Transient Signals on Transmission Lines: An Introduction to the Non-Ideal Effects and Signal Integrity Issues in Electrical Systems*. Morgan & Claypool Publishers, 2009. Chapter 10.

Assessments

The following questions and exercises may serve as either pre-assessment or post-assessment tests to evaluate student knowledge.

Question: TDT10.1 *Competency:* TDT.10.1

Circle +, –, or = to denote whether crosstalk effects are likely to increase, decrease, or stay the same given the following change to two nearby microstrip transmission lines on a printed circuit board:

+ – = The lines move closer together
+ – = The line topology is switched to co-planar waveguide for the traces
+ – = The conductive traces are switched from aluminum to copper
+ – = The lines are routed perpendicular instead of parallel to one another
+ – = The lines are lengthened
+ – = A line of metalized vias is placed between the two line traces on the PCB

Answer:

\+ The lines move closer together
– The line topology is switched to co-planar waveguide for the traces
= The conductive traces are switched from aluminum to copper
– The lines are routed perpendicular instead of parallel to one another
\+ The lines are lengthened
– A line of metalized vias is placed between the two line traces on the PCB

Question: TDT10.2 *Competency:* TDT.10.2

You have a very high-bandwidth oscilloscope probe connected to an unexcited circuit board trace experiencing crosstalk, having clearly coupled to the clock trace carrying a high-frequency square wave. How can you tell whether this is forward or reverse crosstalk?

Answer:

If the crosstalk signal consists of alternating impulses (i.e. the time derivative of a square wave clock signal), then it is forward crosstalk. If the crosstalk signal consists of a weak copy of the clock signal, then it is reverse crosstalk.

Question: TDT10.3 *Competency:* TDT.10.3

At one point on an unexcited line, a forward crosstalk waveform measures 250 mV in amplitude. At a point 2.0 cm further down the line, the same forward crosstalk waveform measures 300 mV. What is the forward crosstalk coefficient if the nearby excited line has a function sin(100t) volts?

Answer:

The signal is increasing at a rate of 0.050V for every 0.02m of distance traveled, such that $\kappa_F = 0.025$ s m^{-1}.