ME1400 EMI and EMC

Lab 4

Controlling Crosstalk: Time-Domain Perspective

v1.03

Objectives

i) To measure crosstalk in the time domain
ii) To investigate the factors affecting the crosstalk level

Equipment Required

i) Keysight Technologies DSO1022A/ DSO6032A/DSO7032A Oscilloscope
ii) ME1400 EMI Source Module

Accessories Required

i) ME1400 Transmission Line Module
ii) Termination Board
iii) 2 x 50 Ω Terminator, SMA(m)
iv) 1 x SMA(m)-to-SMA(m) jumper cable, 0.18 m

WARNING:

When probing an active PCB such as this hardware kit with an oscilloscope, excessive radiation can result due to the probe and cables, which act as antennas. Only perform this experiment in a laboratory environment without the presence of any sensitive instruments. If this hardware kit does cause harmful interference to radio or television reception, which can be determined by turning the hardware kit off and on, try correcting the interference by performing one or more of the following actions:

— Reorient or relocate the receiver unit
— Increase the separation between the hardware kit and the receiver unit
— Connect the hardware kit into an outlet on a different electrical circuit from the receiver unit

If none of the above works, turn off the hardware kit and consult the dealer or/and an experienced radio/TV technician for assistance.

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1. Introduction

In the second part of this EMI experiment, we are going to do the following:

- Measure the level of crosstalk between parallel traces or transmission lines on a printed circuit board (PCB).
  Note: The transmission can be considered as a pair of conductors, consisting of the trace on the topside and the ground plane underneath the PCB.
- Investigate the physical factors that contribute to a lower level of crosstalk between PCB traces.

In the time-domain measurement, the active trace is energized by a digital pulse of known amplitude and rise/fall time. The induced voltages on the near and far ends of the adjacent trace are then measured with an oscilloscope with appropriate bandwidth and probes. Note that in both frequency and time-domain characterization, the traces have to be properly terminated with the correct impedance. Since the traces are actually transmission lines with a 50 Ω characteristic impedance, both active and passive traces need to be terminated with a 50 Ω impedance at both ends.

2. Measurement in the Time Domain: Coupled Transmission Line With High-Speed Input

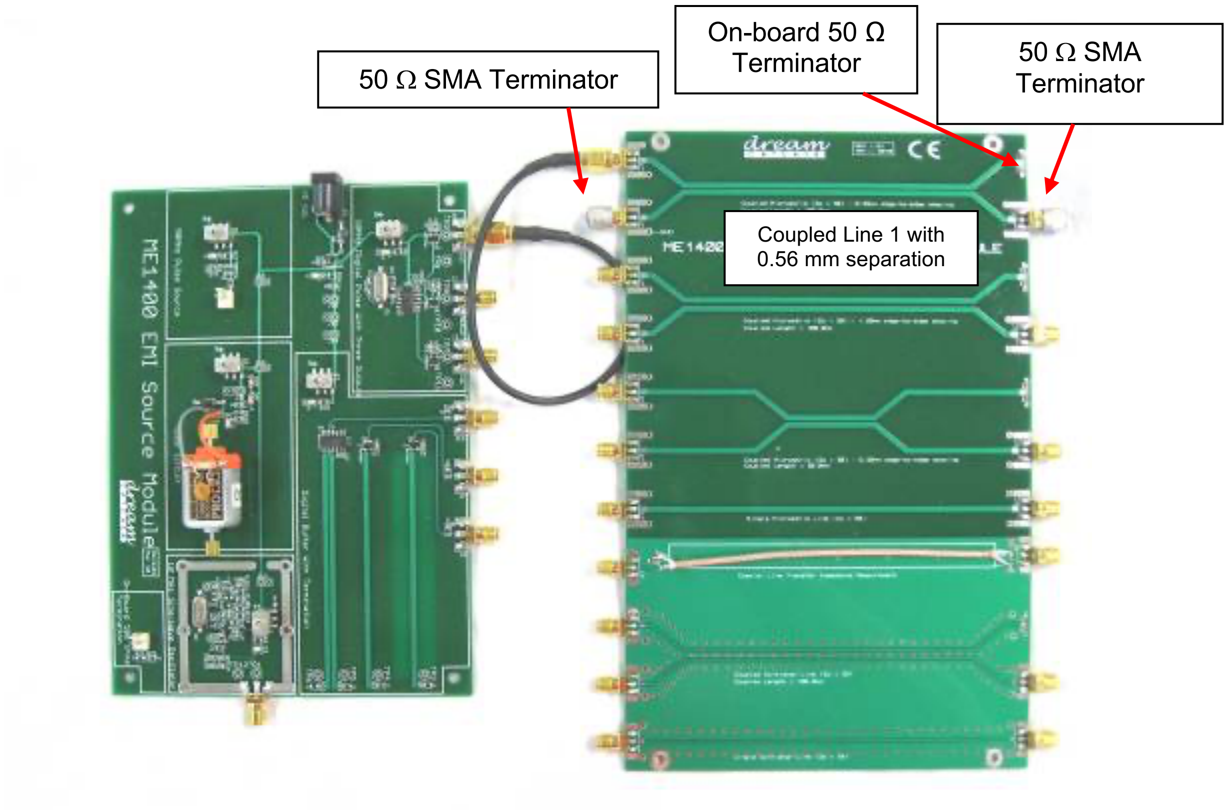


Figure 1 – Equipment Setup

1. Set up the equipment as shown in Figure 1. Connect the High-speed output of the 10 MHz Digital Pulse Source to a coupled microstrip line with a 0.56 mm edge-to-edge separation, 100 mm coupled length (Coupled Line 1).
2. Terminate the two other ports with 50 Ω SMA terminators.
3. Power on the 10 MHz Digital Pulse Source.

4. Power on the digital storage oscilloscope (DSO). Use two 10:1 probes; use Probe 1 to probe the input on the active transmission line (the line where you connect the pulse source is the active line) and Probe 2 to probe the near end of the passive transmission line (NEXT measurement) as shown in
5. Figure 2.

   Caution: Use the GND spring contact to ground the probe to ensure optimum bandwidth. See
6. Figure 3.

Figure 2 – Probing the Coupled Microstrip Line (NEXT)

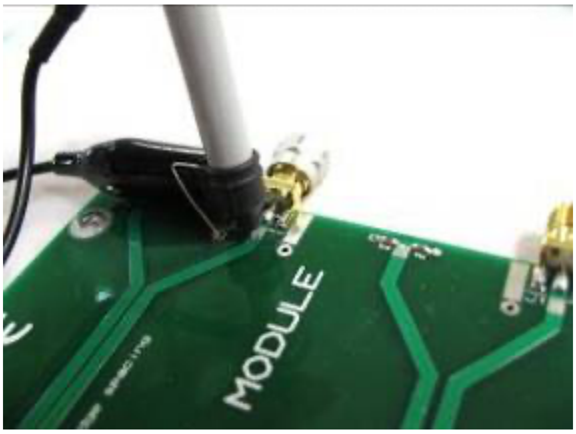


Figure 3 – Probing the Voltage and the Coupled Trace

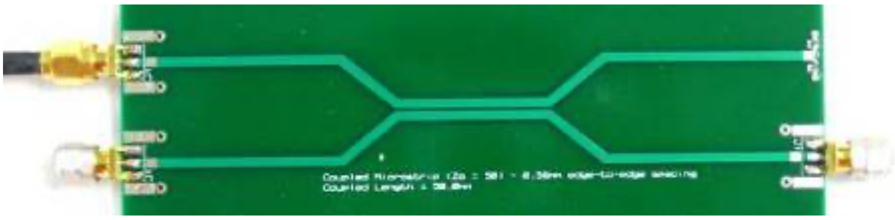
7. Set the trigger source to CH1 (e.g., Probe 1); use AC coupling.
8. Adjust the time-base, vertical-scale, offset, and trigger level to get a stable and clear waveform on the oscilloscope display.
9. Observe and sketch the result on a graph paper. You can also store the waveform into a USB flash memory stick and transfer it to a computer for analysis.
10. Repeat with Probe 2 probing the far end of the passive transmission line (FEXT measurement) as shown in
11. Figure 4 .

Figure 4 – Probing the Microstrip Line (FEXT)

3. Other Transmission Lines

1. Repeat step 1 to step 8 in Section 2 for the following coupled line:
   — Coupled microstrip line with 1.2 mm edge-to-edge separation, 100 mm coupled length (Coupled Line 2).

   — Coupled microstrip line with 0.56 mm edge-to-edge separation, 50 mm coupled length (Coupled Line 3).



   — Coupled co-planar line with 100 mm couple length (Coupled Line 4).

4. Measurement in the Time Domain: Coupled Transmission Line With Medium and Low-Speed Inputs

1. Repeat Section 2 and Section 3 with Medium-speed and Low-speed of the 10 MHz Digital Pulse Source.

5. Discussions

1. Explain the cause of the shape of the crosstalk waveforms observed. Show how the duration of the crosstalk voltage waveform is related to the input pulse.

2. Which coupled line has the lowest crosstalk for both NEXT and FEXT?

3. Which speed (high, medium, or low) of the digital pulse contribute to the highest level of crosstalk?

4. Summarize the physical characteristics of parallel traces that will minimize crosstalk level.

5. Explain the effect of crosstalk to the operation of an electronic system.

6. Revision History

Revisions	Descriptions
1.00	Initial document
1.03	Added **Revision History** and **Contact Us** section. Appended **Solutions** into the lab title. Added **Table of Contents**.

7. Contact Us

Contact Us

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