



# Examination of Crosstalk in Transmission Lines

Undergraduate Researcher: Amanda J. Penning, South Dakota State University  
Faculty Advisors: Dr. Charles Tolle and Dr. Thomas Montoya, Department of ECE  
Dr. Alfred Boysen, Department of Humanities  
Research Experience for Undergraduates – Summer 2014



## Objectives

- Design and build a mother board that will route an interference free signal into a test board 'aggressor' trace and maintain the integrity of the signal as it is routed from the 'victim' trace to be measured.
- Design and build test boards that violate the design rules and measure the amount of signal picked up by the victim trace.
- Develop a lab for future electrical engineering students that enables them to directly observe the difference made by trace placement and shielding.

## Procedures

- Understand the properties of crosstalk and basic electronic circuits as well as printed circuit board layout.
- Utilized Altium Designer® version 2010 to devise the circuit connections and layout.
- Milled boards using LPKF ProtoMat C60™ milling machine.
- Populated board using Weller WES51 soldering iron.
- Programmed STM32 F4 Discovery™ micro-controller to generate the input signal.
- Employed an aMG USB Converter-N Adapter™ to interface between the test boards and the computer.



## Abstract

Crosstalk is any phenomenon by which a signal transmitted on one circuit or channel of a transmission system creates an undesired effect in another circuit or channel. Electrical engineers have known of the existence of crosstalk since shortly after the advent of electronic circuits but instead of publishing how to identify it, what it looks like, and how it's created, what has been published is how to avoid and/or reduce its effects. This study will intentionally create circuit boards with varying degrees and types of crosstalk in an effort to educate future electrical engineering students on its appearance on an oscilloscope and other measurement devices.

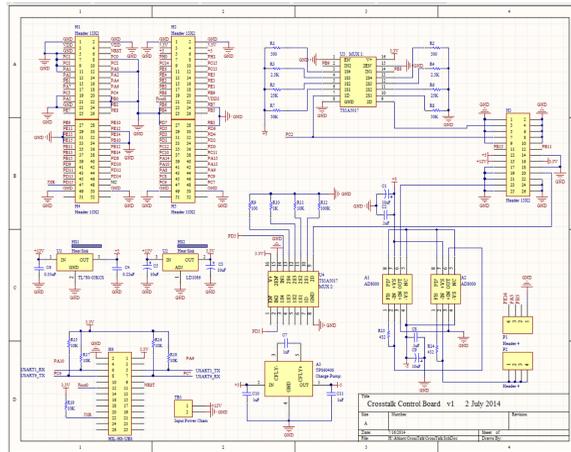


Figure 1: Schematic diagram of mother board

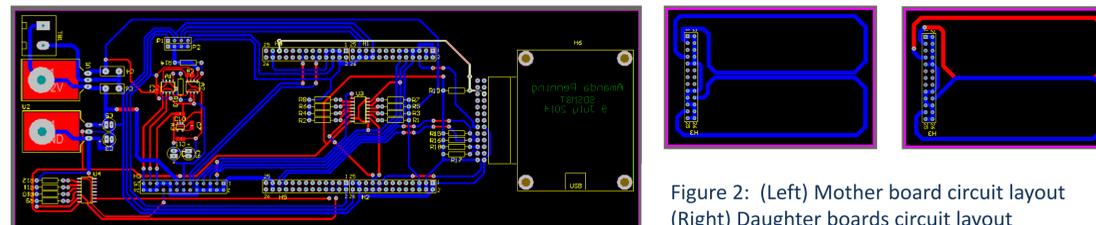


Figure 2: (Left) Mother board circuit layout (Right) Daughter boards circuit layout

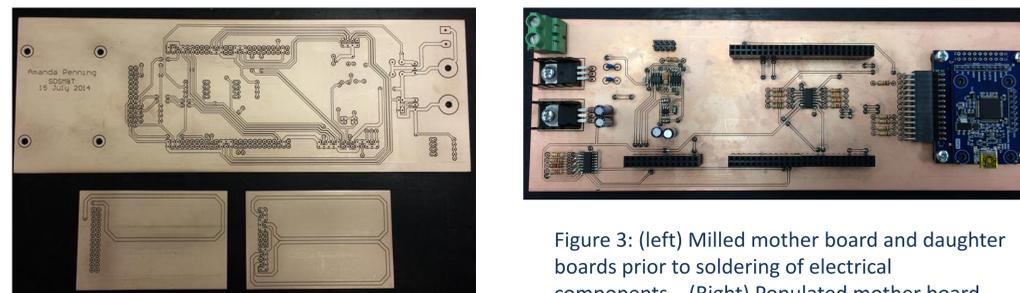


Figure 3: (left) Milled mother board and daughter boards prior to soldering of electrical components. (Right) Populated mother board.

## Results

At this time no tests have been run due to the fact that the design and layout of the mother board as well as the programming of the micro-controller took longer than expected. It was critical that the layout be precise and provide the clean, interference free input and shielded output that is imperative for this experiment to be accurate.

## Conclusion

The data should show that when spacing between the traces is increased, the amount of voltage induced on the victim trace will decrease. Similarly, when a shield trace is placed between the aggressor and victim traces the instance of crosstalk will decrease.

## Future Work

- Design and test additional daughter boards, measuring the impact of trace placement and shielding.
- Add nichrome wires to simulate heat noise.
- Add electrical components and measure their affect on the crosstalk signals.
- Alter input signal to see the effect, if any, on crosstalk.
- Develop undergraduate laboratory experiments for electrical engineering students for study and visualization of crosstalk.

Acknowledgements: This work was made possible by the National Science Foundation REU Site: Bringing Us Together, Improving Communications and Lives EEC-1359476  
I would like to thank Mr. Steven Lawler for his guidance and assistance, as well as the students in the Controls Lab, especially Conrad Farnsworth for helping with circuit design, and Adrian Del Grosso for programming the micro-controller. I would also like to thank Dr. Melody Jewell for recommending me to this program. Finally I would like to thank NSF for providing this opportunity.