Practical PCB Design and Manufacture-Lab 9 Report

Cross Talk Measurements Between Signal Returns

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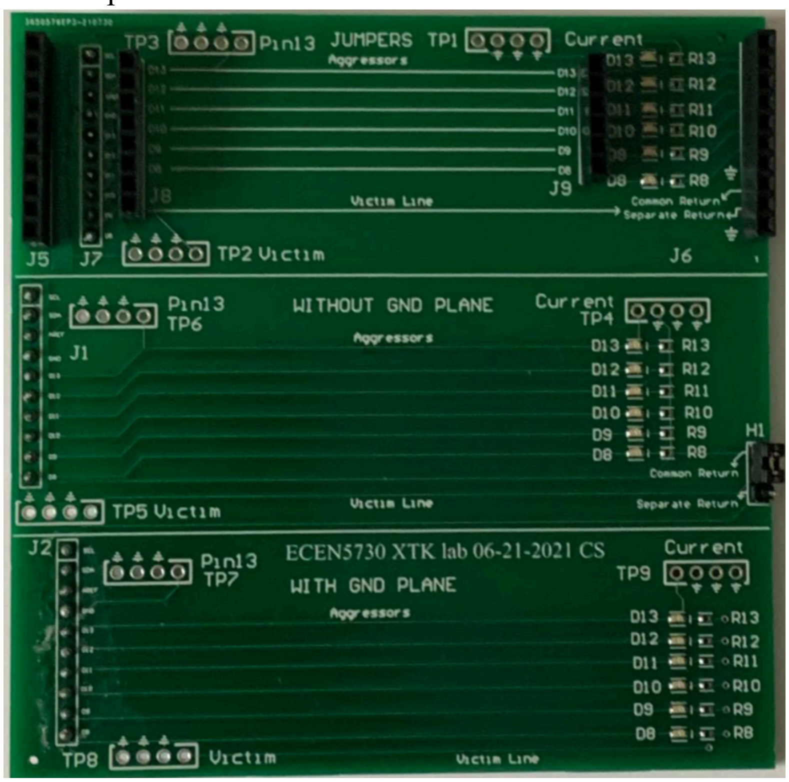
Introduction

Because the parasitic properties of interconnects in a circuit must be considered in design and assembly, much of PCB design is mitigating problems caused by non-transparent interconnects. One method of mitigating these potential problems is explored in depth in this lab. Using a special test board pictured below



we measured cross talk between an aggressor signal trace and a victim line trace with three different configurations of return paths. One of these configurations included a ground plane within the board along with a separate return path on the victim line. The other configuration did not use a ground plane and we had the ability to switch between the victim line having a separate return path and a shared return path with the aggressor signals as indicated by the H1 label on the board (these labels are referenced again later in this report).

Tools used

- Arduino UNO and respective IDE
- Keysight Digital Storage Oscilloscope

Methods and Measurements

Using the Arduino Uno, I coded digital pins 8 through 13 to switch on and off simultaneously over the course of 2 clock cycles with the code below:

```
void setup() {
  pinMode(13, OUTPUT);
  pinMode(12, OUTPUT);
  pinMode(11, OUTPUT);
  pinMode(10, OUTPUT);
  pinMode(9, OUTPUT);
  pinMode(8, OUTPUT);

}

void loop() {
  PORTB=B00111111;

  PORTB=B00000000;

}
```

After connecting the digital Arduino pins 8 through 13 to the section of the test board **that contained the ground plane** (J2), I measured the the noise on the victim line (TP8) and triggered the oscilloscope on the 47Ω resistor connected to the digital pin 13 signal (TP9):

Figure 1.) Yellow signal is the voltage measured at the 47Ω resistor (TP8) and green signal is the voltage of the victim line (TP9). Both vertical scales are 500mV/div. and the vertical time scale is 20nsec/div.

As shown in figure, the noise on the victim line has a peak to peak value of approximately 400 mV, based upon the vertical scale.

Next, I connected the Arduino pins to the section of the board **without the ground plane** (J1) and first measured the cross talk when the victim line used the **same return path** of the aggressor signals:

Figure 2.) Yellow signal is the voltage measured at the 47Ω resistor (TP4) and green signal is the voltage of the victim line (TP5). Both vertical scales are 500mV/div. and the vertical time scale is 20nsec/div.

The noise I measured on the victim line based upon the scales in the scope shot was approximately 3.3 volts peak to peak when the aggressor signal was switching between states.

Keeping the Arduino connected to the same region of the board without the ground plane, I used a switch (H1) to connect the victim line to its **own return path**, and measured the cross talk:

Figure 3.) Yellow signal is the voltage measured at the 47Ω resistor (TP4) and green signal is the voltage of the victim line (TP5). Both vertical scales are 500mV/div. and the vertical time scale is 20nsec/div

The peak to peak value of the noise in this configuration is approximately 700mV.

Takeaways

- Using a ground plane and a separate return path for signal traces will be best to reduce the cross talk between signals. As shown by the above measurements, using a ground plane along with a separate return path as opposed to no ground plane and a common return path reduced the noise on the victim line by almost 10x. The use of a ground plane is another best design practice for PCB design that has many benefits and little to no drawbacks/cost
- A separate return path is also seen to reduce crosstalk noise considerably even without the use of a ground plane. While this may be the case, the only reason to not use a ground plane in designing PCB's is a very strong and compelling reason as there are likely not many circumstances where using a ground plane would be impossible