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Noise Test with the HDI Link Card at UCSB, July 97

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The aim of the noise tests at Santa Barbara will be to track possible sources for the increased noise sensitivity of the prototype PC board versions of the SVT Data Transmission compared to the wire-wrap boards that are running at UCSB since last year. In order to check several alleged culprits in the design, we modified two HDI Link Cards. Modifications are mainly done in the power routing and bypassing as well as grounding and shielding.

1 Configuration of the boards

For a detailed description, please refer to Max's writup (also available from the Web). Here I will only very briefly summarize the main modifications.

1.1 HDI Link Card # 3

Card # 3 will have only minimal modifications compared to the system used at the first UCSB tests and at the CERN test beam.

Changes include two prime suspects of noise generation:

- The D5x_Local and D0x_Local traces that run diagonal and above and below the analog power traces, will be cut and jumpered.
- The bypassing between D5x_Local and D0x_Local will be improved by a 47 μF capacitor.

Everything else will be left as shown in the schematic.

1.2 HDI Link Card # 4

Card # 4 will incorporate the changes above and in addition:

- The shield connection on all connectors is isolated from the shield layer. The shield pins are drilled out. There is the possibility to connect the cable shields to the shield layer again as well as jumper the cable shield from the power to the exit cable via metal braids.
- The System_GND and shield planes are cut in between power channels 1 and 2 in order to isolate the analog power on channel 1 completely from the digital circuitry.
  Caveat: The shield of the signal and power cables can be connected via the Matching card. To avoid this, it should be sufficient to unconnect the shield braids.
- Changes in the digital circuit are that for channel 2 the output swing of the AD9696 comparator will be restricted to a diode drop. We will build in the possibility to connect either digital channel to each power channel. Also smaller coupling caps for clock and command signal translation will be tested.
- We might add the possibility to strap D0 and D0_Local together via a 10 Ω resistor.

1.3 Midplane

The Midplane should leave open the possibility to either strap together the respective grounds and +5V for HDI Link Card and DAQ Link Card as well as keeping those separated and just reference them back at the power supplies.

1.4 Matching Card

First go will be to use the standard Matching Card configuration, but take the coupling cap between D5n and D5p off (they shouldn't have been loaded in the first place).

If we have the time, we will try loading one card with the new samples of ceramic 1 μF caps.

2 Test plan – preliminary

I believe we should aim to make the big changes, i.e. the ones we think will have the biggest impact on noise performance, right at the beginning, as 'minor' changes that slightly improve the performance might have no or even slightly adverse effects after bigger changes.

1. I would suggest to first bring the system up and running with the set they already have at UCSB (the HDI Link Card used at CERN) just to make sure everything works fine, since we know what to expect in this case.

   Make sure that none of the data receivers is oscillating ! This applies to all further measurements.

   * Maybe disconnect the shield from the ground layer and make one noise measurement, since this is the standard configuration on the other 2 cards.
   * Maybe take another run without the toroids in order to check our sensitivity. The final system has to survive without them !

   These two points could also be postponed to measurements on card # 3.

2. Switch to card # 3: If our suspicions are right, the performance of card # 3 compared to the unmodified system should be significantly better. Two measurements will be on both channels, where on one channel the power bypassing is essentially mirroring the bypassing on the Matching card and on the second only bypassing between the power rail and the respective ground return will be employed.

   The measurements taken in this configuration should be regarded as the reference point for all further measurements.

3. Switch to card # 4: Now comes the playing part, different grounding and shielding configurations should be tested. Also whether there is any impact on the noise due to the output swing restriction of the data receivers.

   Different permutations of the alternatives below will be investigated:

   - Connect either power channel 1 that is isolated from the digital part of the board OR channel 2 that is as on the other HDI Link Cards.
   - Connect either the 'normal' digital channel OR the one with the modified comparator output.

- Grounding and shielding: We can leave the shield of both the power and signal cables completely floating, or jumper it across the board, or connect it to the shield plane of the board (which is isolated from the rest of the board for channel 1 and not for channel 2).
- Change the value of the bypassing between System_5V to D5x_Local and System_GND to D0x_Local.
- Does strapping the System_GND plane to the shield improve noise performance ?
- Change Matching Cards

4. Since the biggest improvement at the first test in SB was due to the presence of toroids and twisting power and signal cables together, the sensitivity of the shielding of the cables should be tested by injecting a signal on the cable shields (thanks to Natalie for this suggestion.)

5. There might be the possibility that the TTL circuitry that resides on the DAQ Link Card and drives 50 Ω cables could inject noise all the way into the HDI Link Card. In order to check this we will run the PC version of the HDI Link Card with the wire-wrap version of the DAQ Link Card and both being separated by a 0.5 m twisted pair cable.

6. Running at lower speed (ca. 10 MHz). Does this affect the noise characteristics ?

7. A complete isolation of the power cable from the HDI Link Card can be performed by using the old wire-wrap cable and just jumpering the Local_5 and Digital_5 to the HDI Link Card.

For all measurements it is extremely important to keep track of all the grounding and shielding that is actually realized, including the box where the detector sits in (floating or grounded/shielded), is the Matching card isolated from the mechanical support etc.