R3B Si TRACKER CABLE

TEST REPORT

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Date: 22/05/2012

Department: NPG, Technology

Project: R3B Si Tracker Detector

Customer: Internal

1. Scope

The aim of the test described below is to test a low-cost (<£100) very high density (34 LVDS pairs) 10 meter cable, in order to establish, whether the cable can reliably send and receive signals over a 10 meter distance.

2. Equipment used

- Lecroy wavepro 950 1GH oscilloscope
- AP033 active differential probes 500MHz
- TTi QL 355 PSU
- 2x Spartan 3an custom made boards
- 1x Honda VHDCI 2 meter cable
- 1x Honda VHDCI 10 meter cable (HH-68R010MB-019)

3. Set-up

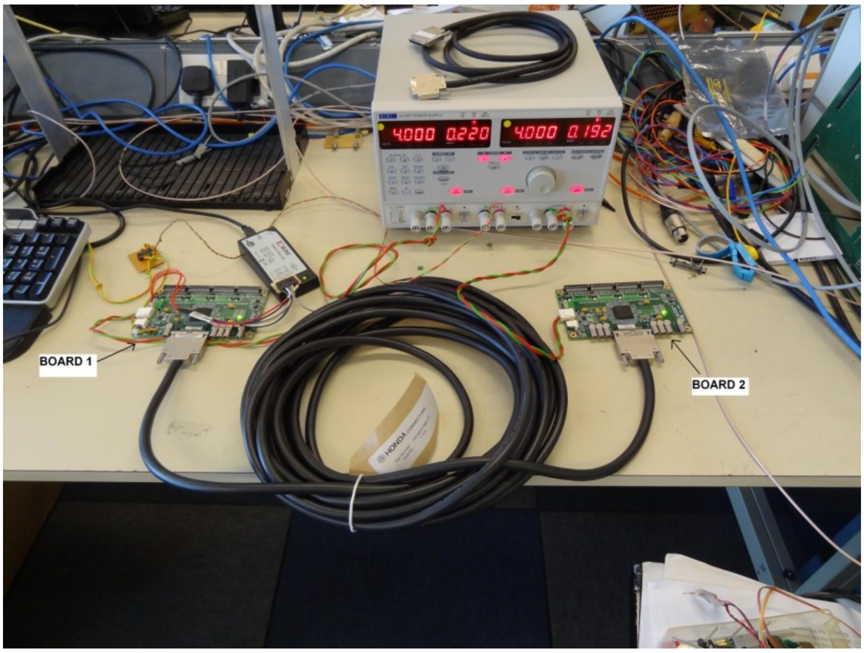

Figure 1 cable test setup

Board 1 (Figure 1) generates 10 23-bit pseudo-random binary sequences (PRBS) that are maximum length and sends them down to board 2 along with a clock (100MHz). The falling edge of the clock is aligned with the bit edge (rising aligned with the middle of the bit).

Board 2 receives the 10 PRBS signal on the rising edge of the clock and forwards them back to board 1 along with the clock, the falling edge of which is again aligned with the bit edge.

Board 1 receives the data on the rising edge and waits for a predefined pattern to arrive in order to sync with the PRBS generator. Once pattern is found, it checks every bit against locally generated PRBS sequence. If an error is found, then an error counter is incremented for that channel. Every time the sync pattern is found, a sync counter is incremented.

The error counter and the sync counter are read by the processor every couple of seconds and send to a RS232 terminal.

4. PRBS seed values

Chipscope was inserted on board 2 to make sure that the 10 PRBS signals output different data at any one time. This is to make sure that any cross talk issues between the twisted pairs can be identified.

Below are the 10 PRBS signals (Figure 2) as received by board 2:

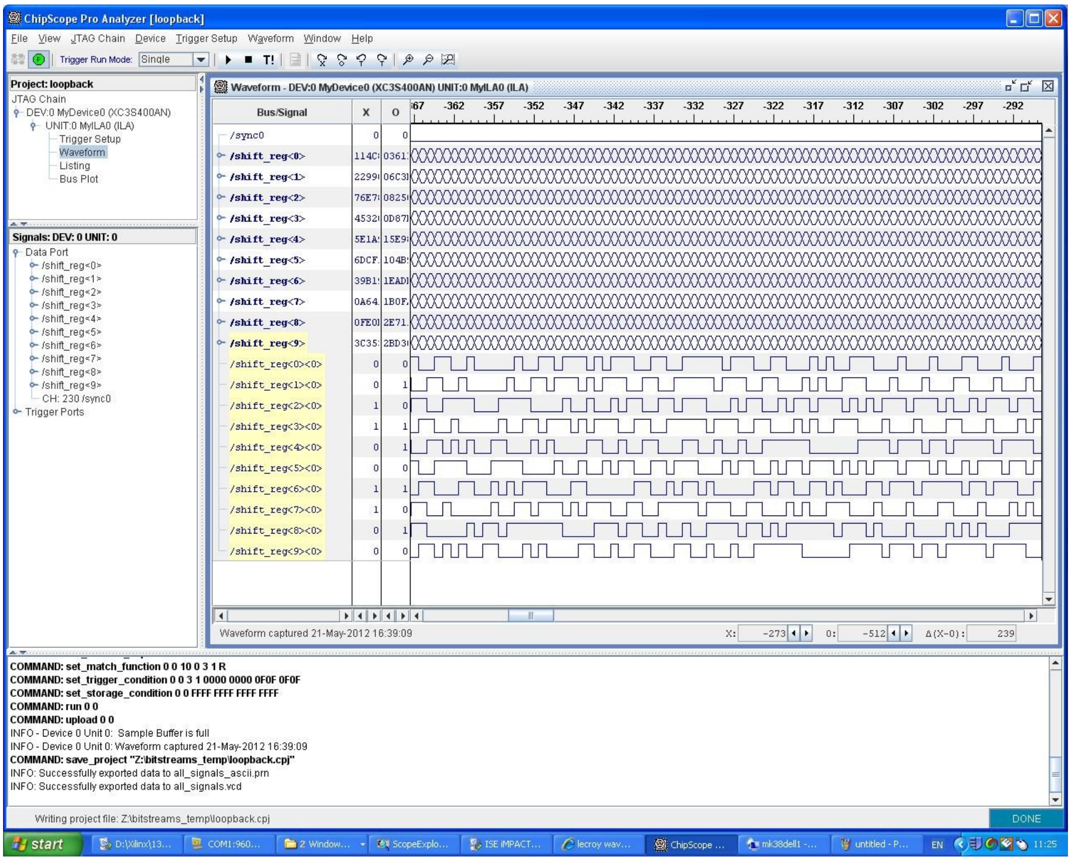

Figure 2 PRBS sequences

And the PRBS seed values (Figure 3):

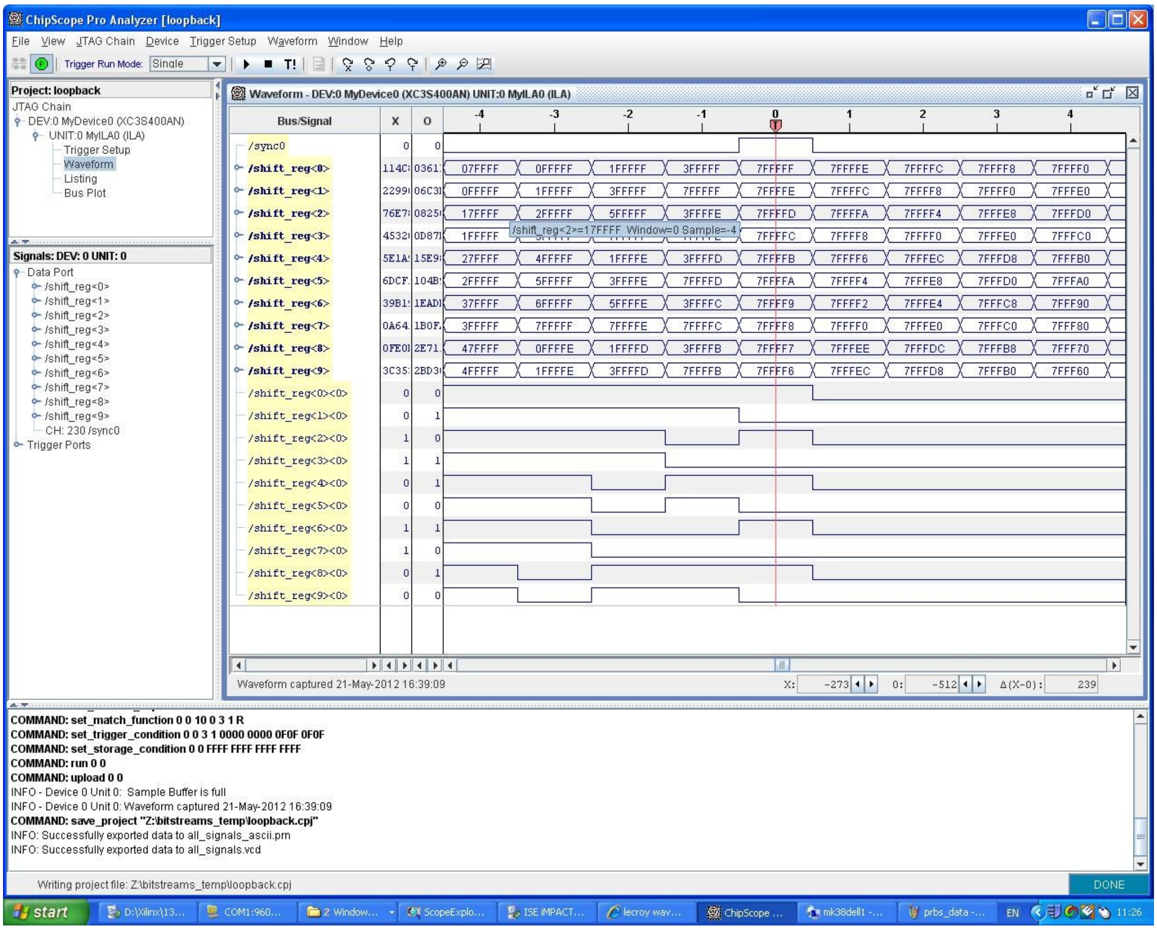

Figure 3 PRBS seed values

5. Eye diagrams

Eye diagrams are taken with the clock fed to the external input of the oscilloscope, which is used to trigger the data. The persist function is then enabled to produce the eye diagram.

3 eye diagrams are taken:

The first is with no cable (Figure 4), probing at the output data and clock pins of board 1, the second is with a Honda 2 meter cable probing at the input data and clock pins of board 2 (Figure 5) and the third is with a Honda 10 meter cable probing again at the input data and clock pins of board 2 (Figure 6).

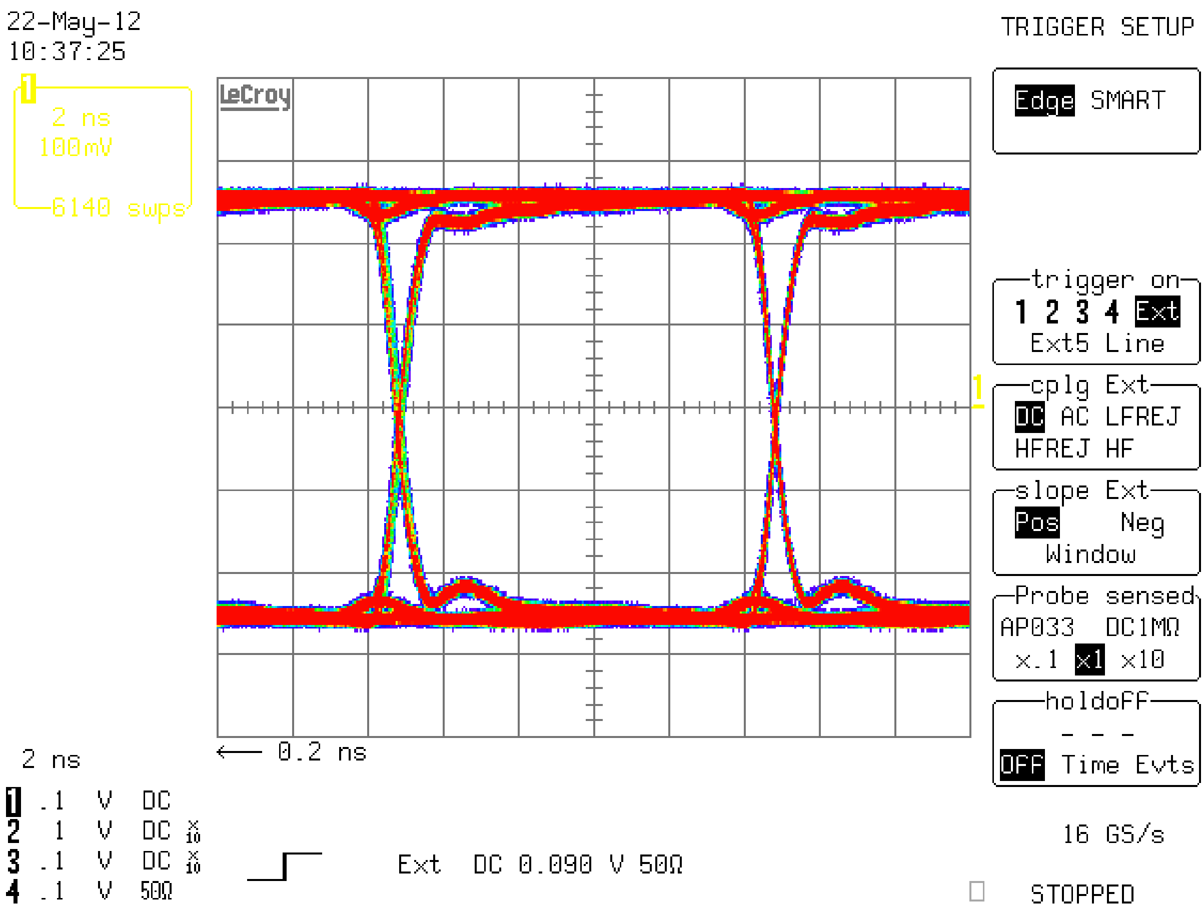

Figure 4 no cable

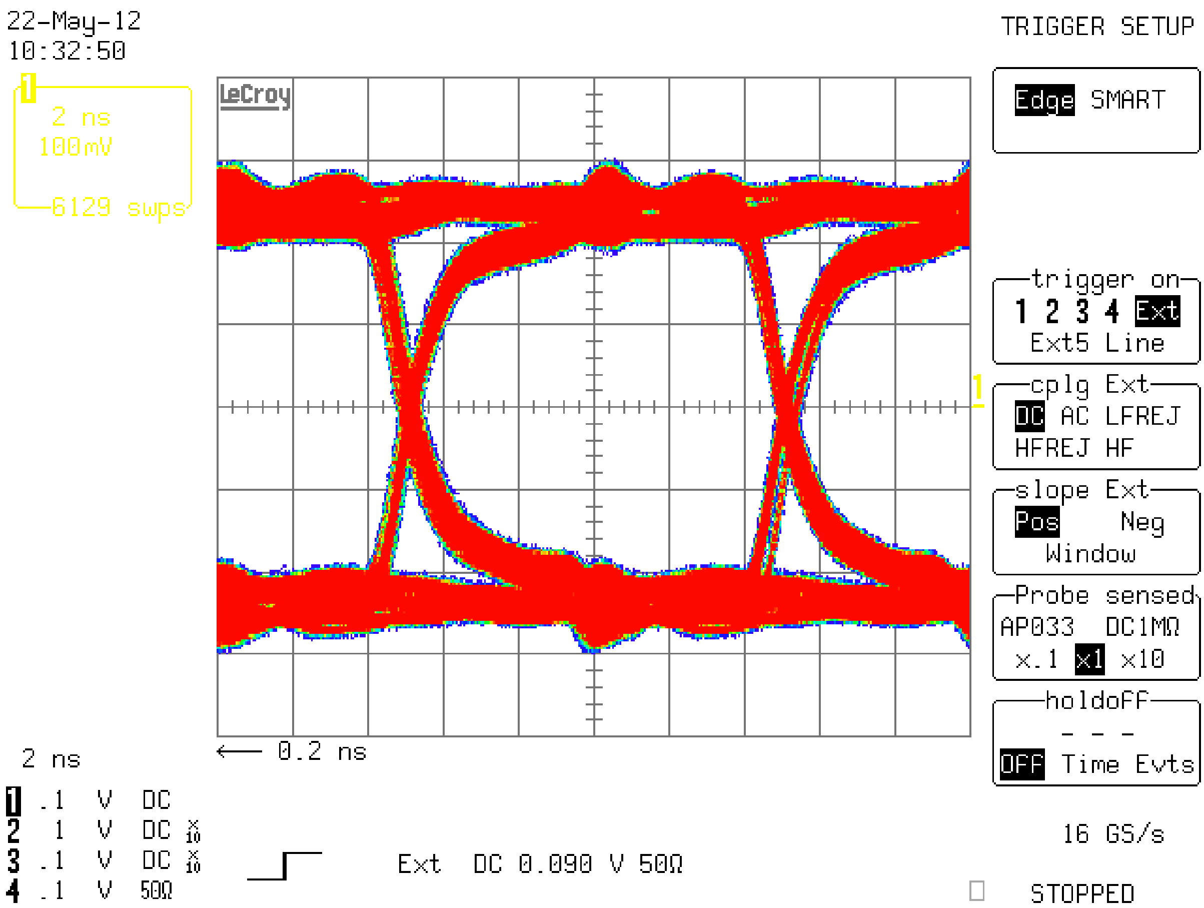

Figure 5 2m cable

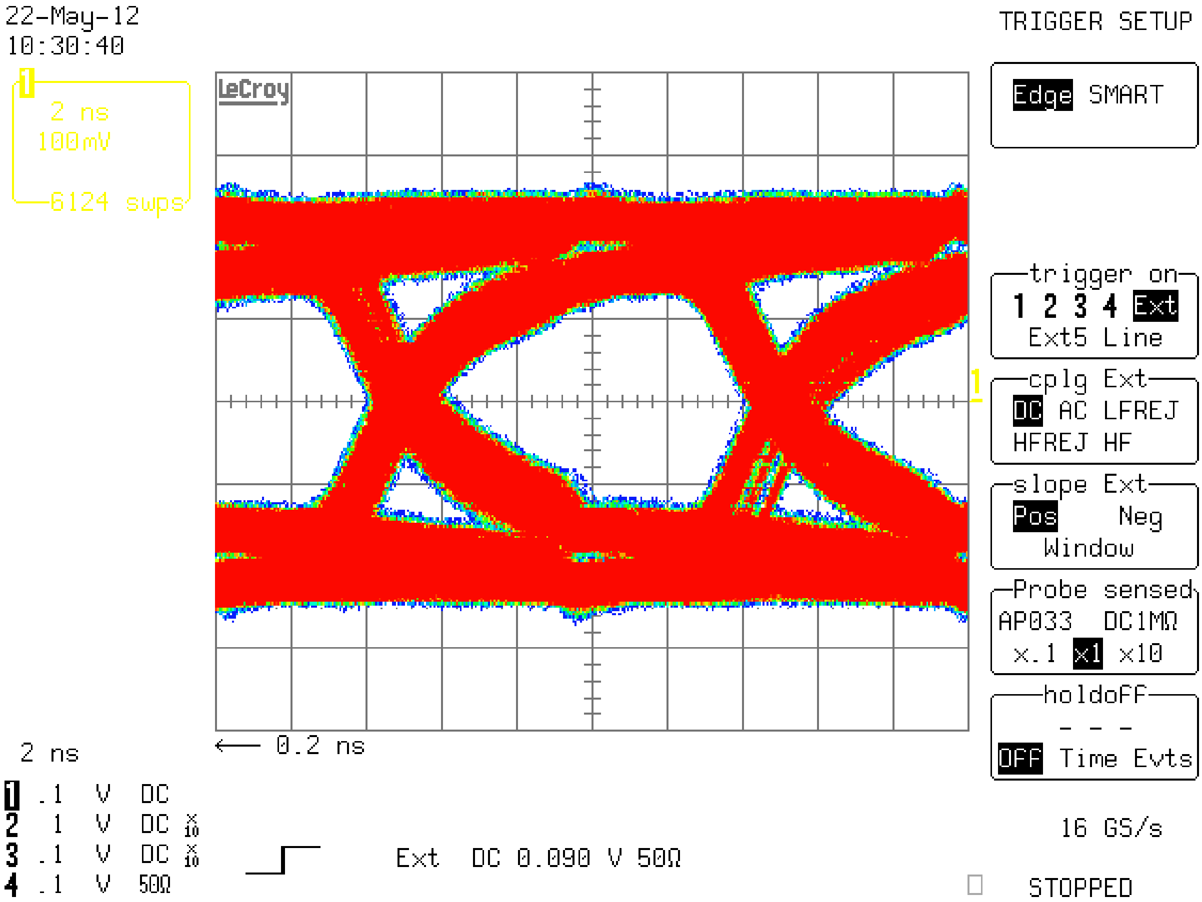

Figure 6 10m cable

The LVDS receiver threshold is 100mV. So even in the worst case of the 10-m cable, if the sampling takes places in the middle of the bit time, where the differential amplitude is 200mV (Figure 6), then this should result in a reliable reception.

6. Bit Error test

The set up was left to run for more than 3.5 days (32×10^{12} bits), in the normal lab environment of T9 (no external noise was introduced to the set up) and no errors were reported. A copy of the terminal report is shown below:

```
channel 0 :sync_cnt_reg = 3915940 , error_cnt_reg = 0
channel 1 :sync_cnt_reg = 3915941 , error_cnt_reg = 0
channel 2 :sync_cnt_reg = 3915942 , error_cnt_reg = 0
channel 3 :sync_cnt_reg = 3915942 , error_cnt_reg = 0
channel 4 :sync_cnt_reg = 3915943 , error_cnt_reg = 0
channel 5 :sync_cnt_reg = 3915944 , error_cnt_reg = 0
channel 6 :sync_cnt_reg = 3915944 , error_cnt_reg = 0
channel 7 :sync_cnt_reg = 3915945 , error_cnt_reg = 0
channel 8 :sync_cnt_reg = 3915946 , error_cnt_reg = 0
channel 9 :sync_cnt_reg = 3915946 , error_cnt_reg = 0
```

7. Future work

Use a different pattern with long strings of 0s and 1 clk cycle of 1 (and vice versa) to check the 10 meter cables response. This test could be useful as signals as reset, valid and or trigger could be idle for a long time.

Manchester encode the PRBS data and then decoded it at board 2 and send back the decoded PRBS signal to boards 1 for checking. Take also eye diagram of the Manchester encoded data as it arrives at board 2.

Repeat bit error tests for other 3 cables.

8. Conclusions

We can conclude from the eye-diagrams and the bit error tests that the 10-m cable is suitable to be used for the R3B Si tracker readout. This is also backed up by the fact that the data in the system will be Manchester encoded (wider eye diagram, whereas the test were performed with Non-Return-Zero (NRZ) data (Appendix A). In addition to this, we still have the option to enable the pre-emphasis function of the LVDS transmitters, which was disabled during the tests.

Appendix A

The eye diagrams below are to be repeated as only one PRBS signal is generated and eye diagram is triggered on the data itself. They are included here just to show the difference Manchester encoded data (Figure 8) has on the eye diagram vs NRZ (Figure 7).

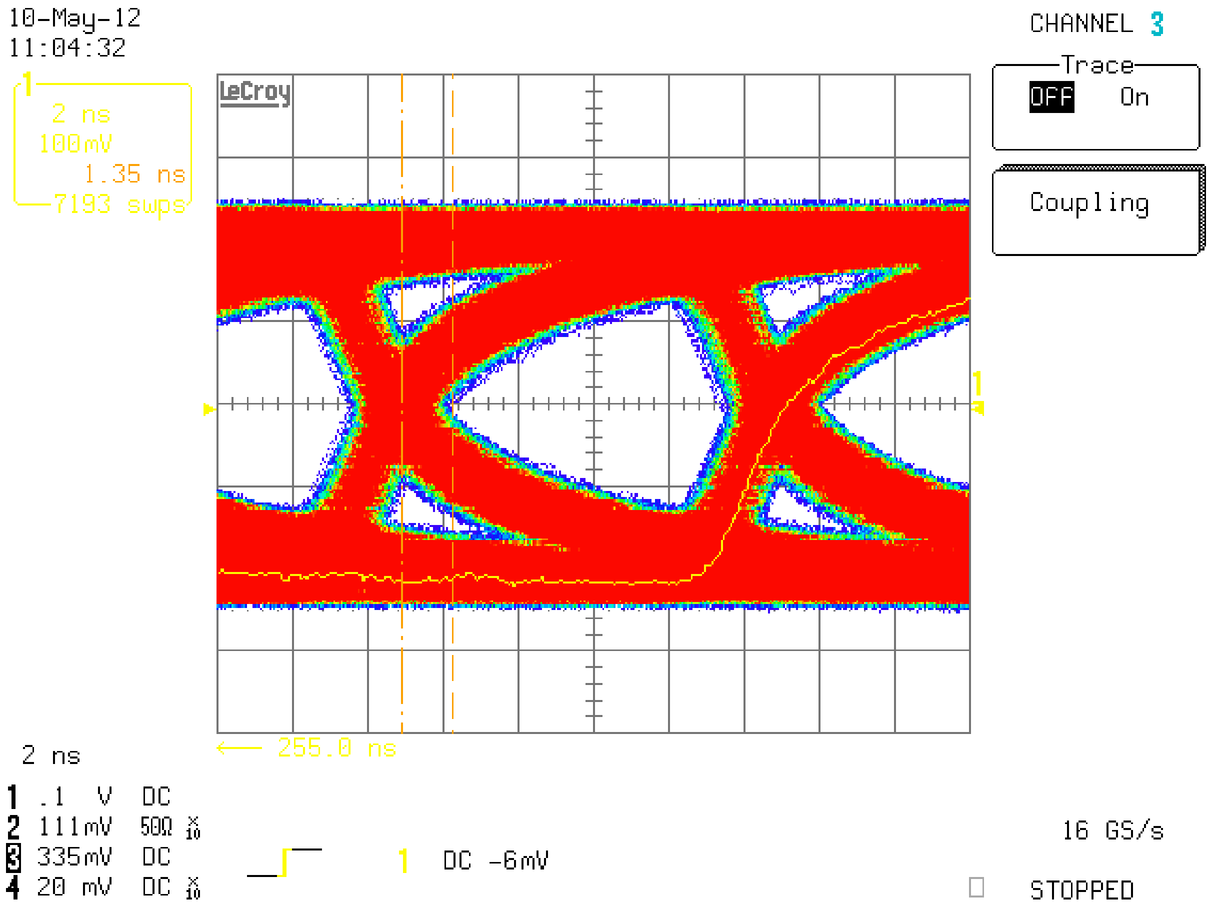

Figure 7 10m cable NRZ

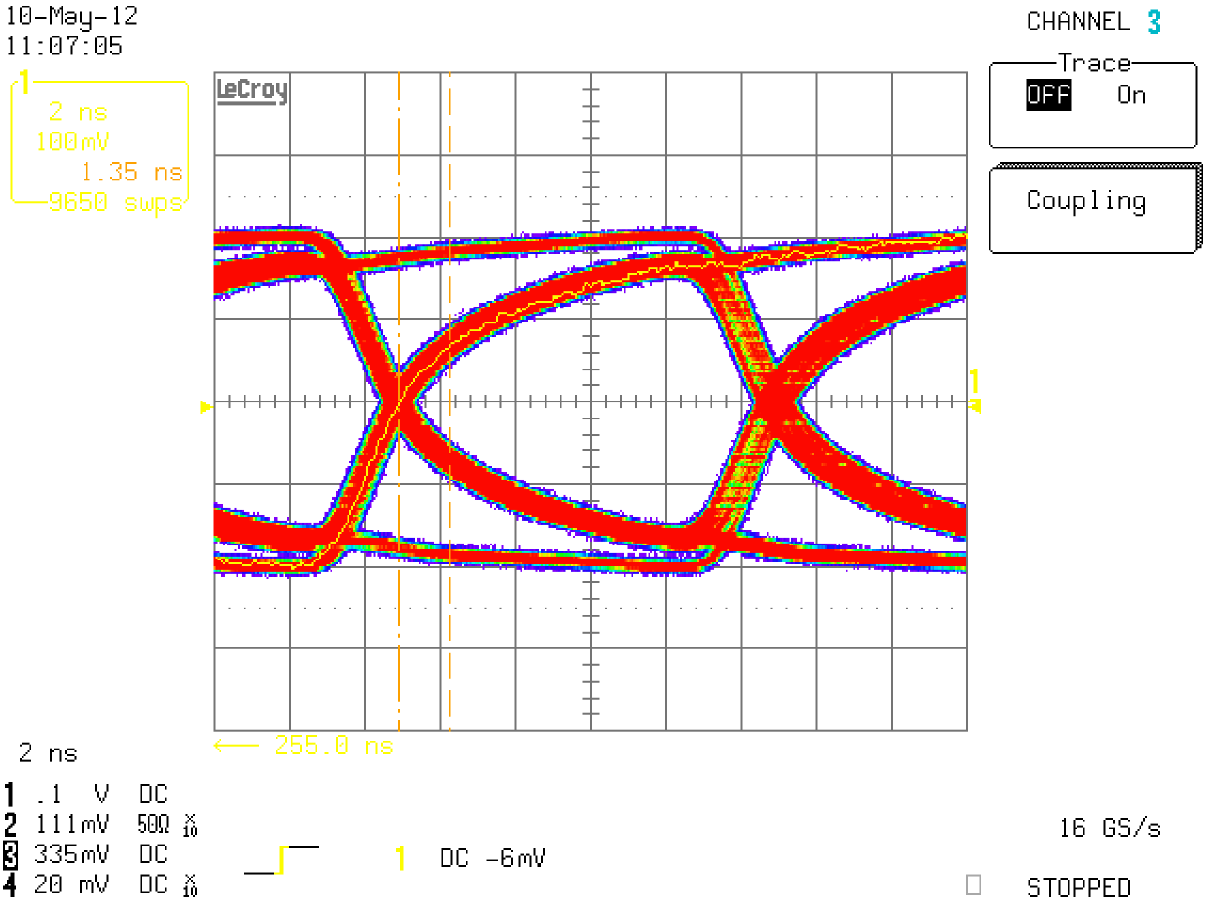

Figure 8 10m cable Manchester encoded