Memo: Creditcard PC Ethernet problem

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1 Summary

It has been found out in recent tests, that the Digital Logic CCPC, the ELAN520 based SM520 microcontroller, suffers from a severe problem on the LAN connection. This problem results in a bad or failing network connection at 100Mbit/s, when cables longer than approximately 10 m are used. In this case the PC will not be able to boot. Details can be found in the following sections in particular in section 3.

2 Workarounds

Since the current suspicion is that the cause is an intrinsic problem with the design of the CCPC module itself (c.f. section 3) only workarounds can be offered:

- Verify that your design respects the trace recommendations of reference [2] as closely as possible. In particular try to design the routes for 100 MHz and care for equal short length of the pairs.
- Remove a possible capacitance on the transmit side (last page of [2]) and try to choose a lower value for the capacitance on the receive side. This has shown improvements on the TELL1 board.
- If you still can change your design, it might be better to use a discrete magnetics module instead of the Pulseeng integrated magnetics connector.
- Use high-quality Ethernet cables: Cat 5e or Cat 6.
- Do not exceed cable-lengths of 5 m. Be aware that in office and lab-installations the "wall-plugs" might only be patch-panels and be a considerable distance away from the actual switch ports. If you must go for a longer distance, make sure to use 10 Mbit and not 100 Mbit. Most switches can be forced into 10 Mbit mode. This is necessary, because the switch and the CCPC will negotiate the highest possible speed. This will result in the connection being unstable, re-negotiation will occur, the result will be 100 Mbit, etc...

3 Details of the problem

The Ethernet standard [1] defines that a compliant cabling using unshielded twisted pair cables of quality category 5 or better, between two end nodes, that is for example a PC and a switch, can consist of 5 m patch-cables on both ends, going into patch-panels which can be connected by a cable of up to 90 m length. That means that a standard compliant Ethernet MAC (media access controller) must be capable to operate reliably over 100 m, including to patch-panels. The bit error rate (BER) on such a connection must be less than 10^{-10}. In practice devices such as PCI NICs (network cards) and switches perform much better, i.e. longer or lesser quality cables still allow a reliable connection.

Recent tests of the CCPC have shown that this is not fulfilled. Even on the reference development board provided by Digitallogic, it is not possible to establish a connection to a switch or hub, using a cable of $\tilde{5}0$ m. This is in particular true for operation at 100 Mbit/s. For 10 Mbit/s the situation is better[1], but it seems to be dependent on the specific switch, router or cable used, and also on the unit-under-test.

While systematic tests will be done very soon, with cables of varying lengths it seems already now clear that even very careful design and signal termination are not sufficient to avoid this problem.

Currently we think that the problem is related to the relatively long traces between the magnetics and the MAC and, more importantly, the fact that a connector, the 240-pin MOLEX connector of the CCPC, is used in between the two chips.

A series of pulse measurements have been done and are shown in Figures 1, 2, 3, 4, 5, 6. In these measurements the signals have been measured between the magnetics and the MAC on the TELL1 *not on the CCPC* and the magnetics and the MAC on an Ethernet switch (a TNET 10/100 MBit switch).

The most interesting measurements are probably the ones in Figure 1 and Figure 2. For the long cable the signal degradation and the reflections can be seen.

The transmitting of the CCPC, as measured on the switch shown in Figures 5 and 6, looks better and is consistent with the observation that reception breaks down much before transmission[2].

4 Measures to be taken for the installation in Point 8

Ethernet switches will be installed in the racks containing CCPCs. The details will be made clear in an update to [3]. This will limit the distance between CCPC and switch port to maximal 10m and remove the two patch-panels. The switches will be one U high and replace one to two patch-panels.

[1] On the latest version of the TELL1 board, 110 m including two patch-panels could be used reliably at 10 Mbit/s.

[2] At a higher level this manifests itself in boot requests from the CCPC being received by the server, but the CCPC never booting, presumably because the answers from the server are never properly received.

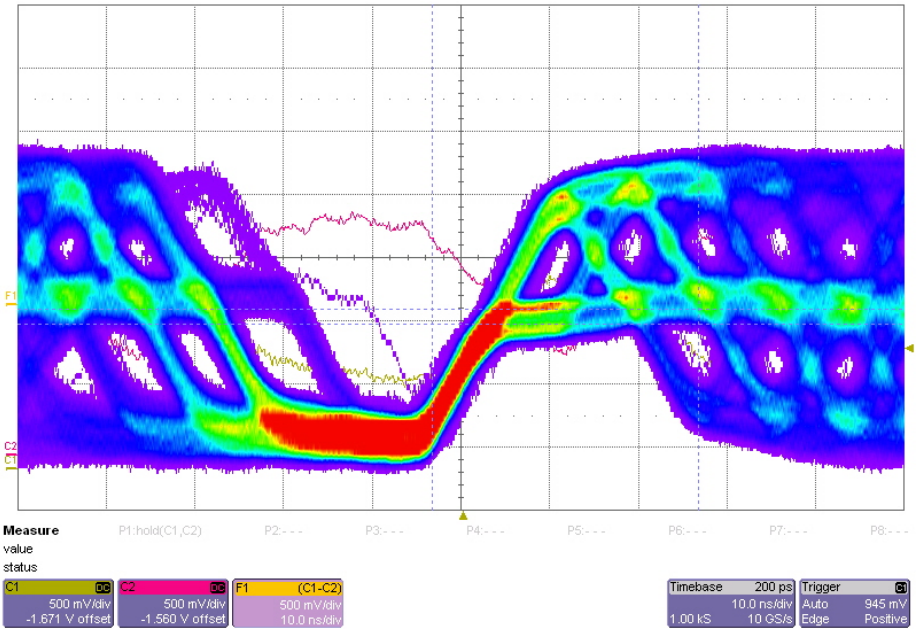

Figure 1: CCPC receiving from switch over 5 m cable

References

[1] IEEE, editor. *IEEE 802.3 LAN/MAN CSMA/CD Access Method*. IEEE, 2002.

[2] Corp. Intel. *82559 LAN on Motherboard (LOM) Design Guide*, 1999. http://developer.intel.com/design/network/products/lan/controllers/82559.htm.

[3] Niko Neufeld. DAQ and ECS Ethernet cabling in UXA85 D1, D2, D3. EDMS 497862, CERN, 2004. https://edms.cern.ch/document/497862/3.

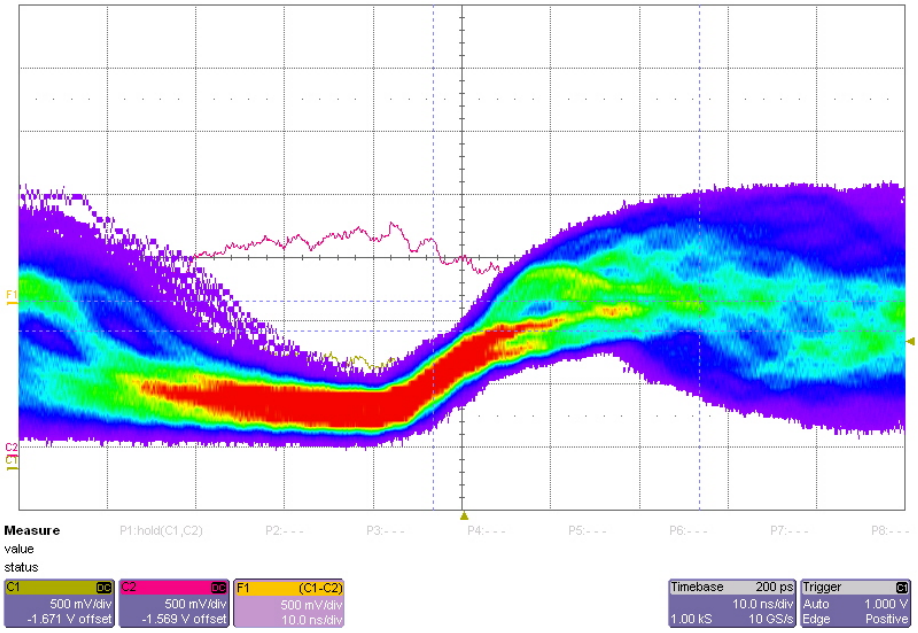

Figure 2: CCPC receiving from switch over 50 m cable and a patch-panel, showing the signal degradation and reflections.

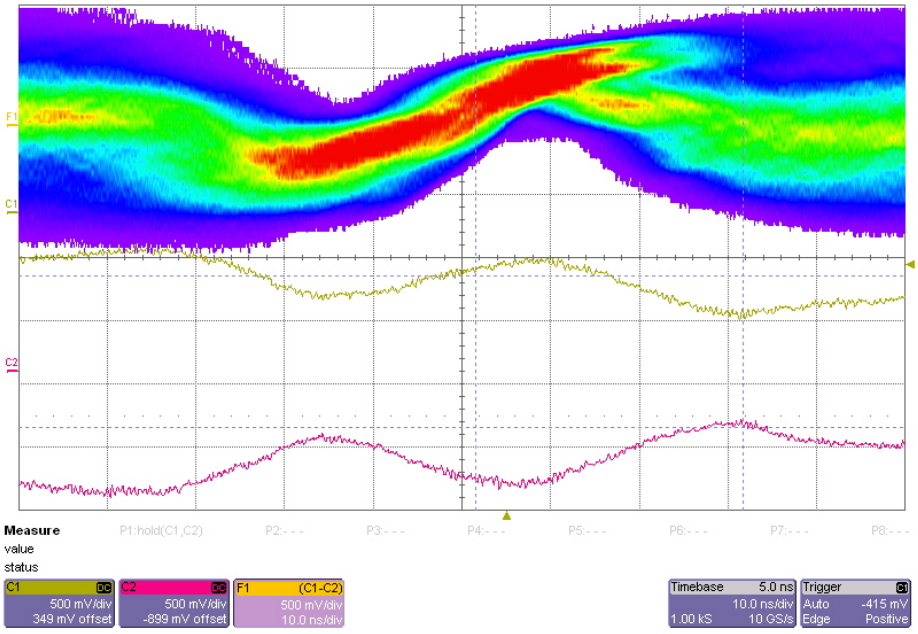

Figure 3: Signal at receive end on the TNET switch with the 3COM NIC sending on a 5 m cable.

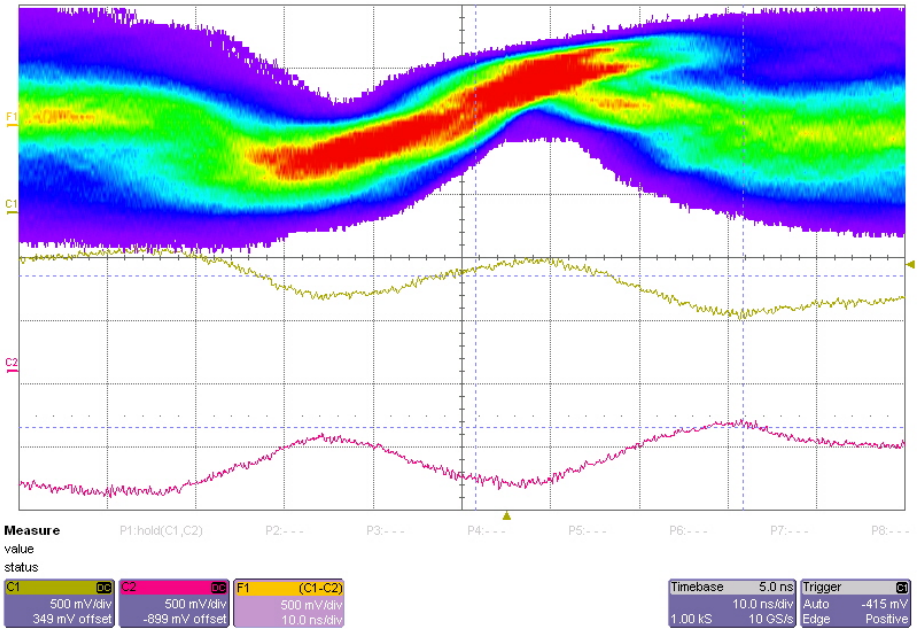

Figure 4: Signal at receive end on the TNET switch with the 3COM NIC sending on a 50 m cable with patch-panel.

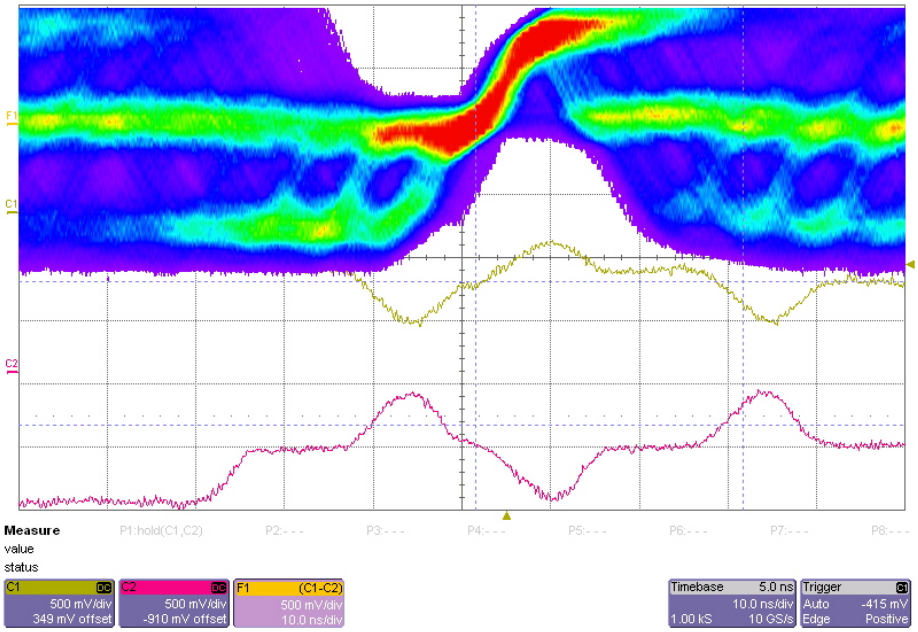

Figure 5: Signal at receive end on the TNET switch with CCPC sending on a 5 m cable.

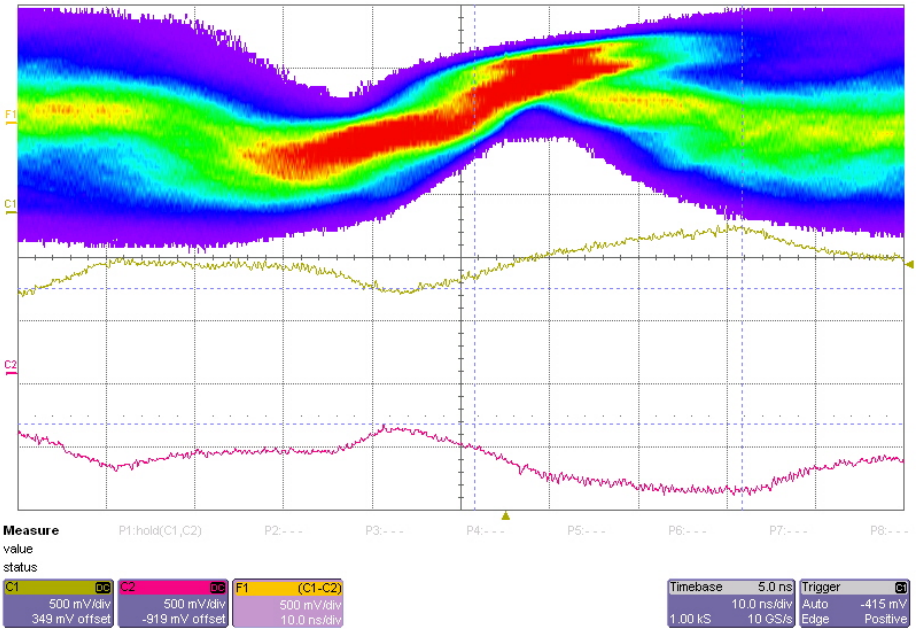

Figure 6: Signal at receive end on the TNET switch with the CCPC sending on a 50 m cable with patch-panel.