ENABLING DC COUPLED CHANNELS (COMMENT #58)

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Supporters

COMMENT

Cl **163** *SC* **163.9.1** *P* **175** *L* **35** # 58

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Comment Type **T** *Comment Status* **X**

As was discussed in the January 2020 meeting there is interest in enabling DC-coupled channels in some applications (mainly backplane and C2C) when the two link partners support this operation. Avoiding AC coupling capacitors in the channels can help board design, improve signal integrity, and reduce costs, and it is becoming a common requirement.

Current channel specs refer back to 93.9.4 where it is stated that AC coupling capacitors may not exist between TP0 and TP5, but in that case some specifications may need modifications for interoperability (without stating the modifications explicitly). This leaves the burden of defining new Rx and Tx specifications to implementers and integrators - with no standard to assist them.

Indeed, the current transmitter specifications in 120F.3.1 and in 163.9.1 allow high common mode voltage up to 1.9 V, which is detrimental for DC coupling with modern CMOS devices. This high value is also not useful for Tx design with modern applications.

DC coupling can be supported by limiting the Tx common mode voltage to a more reasonable and useful range. If this is done, the existing specs may be useable without change for DC coupled channels (although receivers may still need special support for this).

This proposal is specific for KR and C2C specifications which require on-board AC coupling; CR and C2M have AC coupling in the cable and in the module, respectively, so they need a separate discussion.

SuggestedRemedy

In the transmitter characteristics tables of Clause 163 and Annex 120F, Change the Tx common mode voltage to be between 0.2 and 0.8 volts.

Additional content may be beneficial for the AC coupling subclauses. I intend to provide some text in a presentation, to complement the suggested Tx specs.

Proposed changes (1)

- Change common mode voltage specifications in both Table 163–5 and Table 120F–1 as shown:

DC common-mode voltage (max.)[1]	93.8.1.3	~~1.9~~ 0.8	V
DC common-mode voltage (min.)[1]	93.8.1.3	~~0~~ 0.2	V

Proposed changes (2)

- Delete the second paragraph in 163.10 (reference to 93.9.4)
- Insert new AC coupling subclause:

163.10.3 AC-coupling

AC-coupling shall be implemented within the channel (between TP0 and TP5) using DC-blocking capacitors. The low-frequency 3 dB cutoff of the channel shall be less than 100 kHz.

Systems with no AC-coupling within the channel are considered engineered links. It is the system integrator's responsibility to verify that the transmitter and the receiver are compatible with the common-mode voltage differences that may exist in this configuration.

- Add a reference to this subclause in 120F.4, and delete the AC-coupling statements in 120F.1.

Benefits of not using AC coupling capacitors

- Enable higher density routing of multi-lane boards (e.g. high radix switches)
- Eliminate discontinuity from vias to outer layer – better signal integrity

Current text describing non-AC-coupled channels

93.9.4 AC-coupling

The 100GBASE-KR4 transmitter shall be AC-coupled to the receiver. Common-mode specifications are defined as if the DC-blocking capacitor is implemented between TP0 and TP5. Should the capacitor be implemented outside TP0 and TP5, the common-mode specifications in Table 93–4 may not be appropriate.

The impact of a DC-blocking capacitor implemented between TP0 and TP5 is accounted for within the channel specifications. Should the capacitor be implemented outside TP0 and TP5, it is the responsibility of implementers to consider any necessary modifications to common-mode and channel specifications required for interoperability as well as any impact on the verification of transmitter and receiver compliance.

The low-frequency 3 dB cutoff of the AC-coupling shall be less than 50 kHz.

- Subsequent KR PMD clauses 111 and 137 refer back to this subclause.
- C2C annexes just state that the channel is AC-coupled, with no discussion of location.
- “it is the responsibility of implementers…” ➔ problem
  - No guidance or reference
  - Interoperability is not guaranteed

Reasoning for the proposed change

- Wide range of Tx common mode voltage allowed in previous Ethernet PMDs (from 0 up to 1.9 V)
  - Meaning single-ended signal may be < 0V or > 2V
  - Without AC coupling, the Rx will be directly connected to the Tx
  - Rx can be designed to support this connection (e.g. internal AC coupling) but…
- Problem: Modern devices often have only lower voltage supplies
  - Feeding single-ended voltage above supply to Rx input may open HSD diodes, create nonlinear effects and possibly damage the device
  - Feeding single-ended voltage below ground to Rx can have similar effects
- Solution: reduce the allowed Tx common mode range
  - Proposed values (from 0.2 V to 0.8 V) allow differential PtP of 600 mV without causing adverse effects.
  - These values do not practically limit Tx design in modern CMOS processes.

BACKUP