CAUI-4 Ad hoc

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Agenda

- Patent Policy: This meeting is an official IEEE ad hoc. Please review the patent policy at the following site prior to the meeting. http://www.ieee802.org/3/patent.html
- Review implementation of ran_01_062714_CAUI4 / transmitter equalization specification
- Review our comment against P802.3bm Draft 3.0 related to adaptive CTLE Rx equalization for CAUI4 C2M – Gary Nicholl / Allessandro Cavaciuti
- D3.0 comment discussion
- Next meeting: TBD

83D.1

The CAUI-4 bidirectional link is described in terms of a CAUI-4 transmitter, a CAUI-4 channel, and a CAUI-4 receiver. Figure 83D–2 depicts a typical CAUI-4 application, and Equation (83D–1) (illustrated in Figure 83D–3) summarizes the informative differential insertion loss budget associated with the chip-to-chip application. The CAUI-4 chip-to-chip interface comprises independent data paths in each direction. Each data path contains four differential lanes which are AC coupled. The nominal signaling rate for each lane is 25.78125 GBd. The CAUI-4 transmitter on each end of the link is adjusted to an appropriate setting based on channel knowledge~~.~~ . If implemented, the transmitter equalization feedback mechanism described in 83D.3.3.2 may be used to identify an ~~approximate setting with the~~ appropriate setting. The adaptive or adjustable receiver ~~performing~~ performs the remainder of the equalization~~. Operation and control of this receiver is outside the scope of this standard~~.

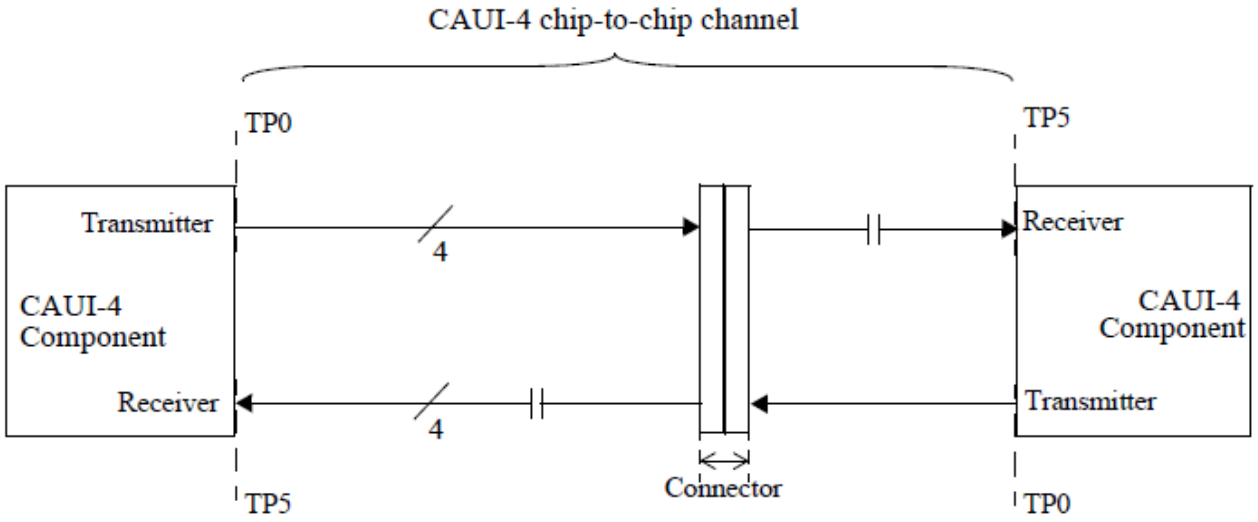

Figure 83D–2—Typical CAUI-4 chip-to-chip application

83D.3.3.1

83D.3.1.1 Transmitter equalization settings

The CAUI-4 chip-to-chip transmitter includes programmable equalization to compensate for the frequency-dependent loss of the channel and to facilitate data recovery at the receiver. The functional model for the transmit equalizer is the three tap transversal filter shown in Figure 83D–6. The transmitter output equalization is characterized using the linear fit method described in 93.8.1.5.1 where the state of the CAUI-4 transmit output is manipulated via management. ~~The pre-cursor tap value c(–1) and the post-cursor tap value c(1) are controlled independently of each other. The pre-cursor equalization ratio R_{pre} for each pre-cursor tap setting is shown in Table 83D–2 where R_{pre} is defined to be (c(0)–(c(–1))/(c(0)+c(–1)) and the post-cursor tap setting c(1) is 0. The post-cursor equalization ratio R_{pst} for each post-cursor tap setting is shown in Table 83D–3 where R_{pst} is defined to be (c(0)–c(1))/(c(0)+c(1)) and the pre-cursor tap setting c(–1) is 0.~~

The variable *Local_eq_cm1* controls the weight of the pre-cursor tap c(–1). The valid values of *Local_eq_cm1* and their effect are specified in Table 83D–2. The variable *Local_eq_c1* controls the weight of the post-cursor tap c(1). The valid values of *Local_eq_c1* and their effect are specified in Table 83D–3. *Local_eq_cm1* and *Local_eq_c1* are independent of each other and independent on each lane.

If a Clause 45 MDIO is implemented, ~~the c(–1)~~*Local_eq_cm1* and *Local_eq_c1* for each lane (0 through 3) and ~~c(1) coefficients~~ direction (transmit and receive) are accessible through registers 1.180 through 1.187 (see 45.2.1.92b through 45.2.1.92e).

Table 83D-2/3

Table 83D–2—Pre-cursor equalization

Local_eq_cm1 value	$\frac{c(-1)}{\lvert c(-1)\rvert + \lvert c(0)\rvert + \lvert c(1)\rvert}$
0	0 ±0.025
1	–0.05 ±0.025
2	–0.1 ±0.025
3	–0.15 ±0.025

Table 83D–3—Post-cursor equalization

Local_eq_c1 value	$\frac{c(1)}{\lvert c(-1)\rvert + \lvert c(0)\rvert + \lvert c(1)\rvert}$
0	0 ±0.025
1	–0.05 ±0.025
2	–0.1 ±0.025
3	–0.15 ±0.025
4	–0.2 ±0.025
5	–0.25 ±0.025

83D.3.3.2

83D.3.3.2 Transmitter equalization feedback (optional)

Transmitter equalization feedback is an optional capability for a CAUI-4 chip-to-chip receiver. If implemented, it shall be as described in this subclause.

Transmitter equalization feedback is generated for each lane (0 through 3) and direction (transmit and receive) independently. The variables that control transmitter equalization feedback are specific for each lane and direction.

A CAUI-4 chip-to-chip receiver may generate a request to change the transmit equalization coefficients of the remote transmitter to new values by setting the *Request_flag* variable to 1. The variables *Request_eq_cm1* and *Request_eq_c1* indicate the request values of *Local_eq_cm1* and *Local_eq_c1*, respectively, in the remote transmitter (see Table 83D–2 and Table 83D–3). The requested setting may be generated from the remote CAUI-4 chip-to-chip transmitter's equalization setting, which is stored in variables *Remote_eq_cm1* and *Remote_eq_c1*, and from information internal to the receiver, in an implementation specific manner.

When a CAUI-4 chip-to-chip receiver does not request a change of the remote transmitter's transmit equalization setting, it sets the *Request_flag* variable to 0. A CAUI-4 chip-to-chip receiver that does not implement transmitter equalization feedback always sets *Requests_flag* to 0.

If a Clause 45 MDIO is implemented, the variables *Request_flag*, *Requested_eq_cm1*, *Requested_eq_c1*, *Remote_eq_cm1* and *Remote_eq_c1* for each lane and direction are accessible through registers 1.180 through 1.187 (see 45.2.1.92b through 45.2.1.92e).

83D.5

83D.5 Example usage of the optional transmitter equalization feedback

83D.5.1 Overview

If implemented, transmitter equalization feedback from a CAUI-4 chip-to-chip receiver may be used to tune the equalization settings of the transmitter at the other end of the CAUI-4 chip-to-chip link to the values requested by the receiver. An example of a possible transmitter equalization tuning process using transmitter equalization feedback is provided in this subclause.

In this example, two components, A and B, are connected by a CAUI-4 chip-to-chip link, such that A is closest to the PCS and B is closest to the PMD. Clause 45 MDIO is implemented by both components, with component A at device address 11 and component B at device address 10. Transmitter equalization feedback is implemented by either component A, component B, or both. One Station Management (STA) controls both components.

Figure 83D–5 depicts the components of the CAUI-4 chip-to-chip link and the registers used during the tuning procedure.

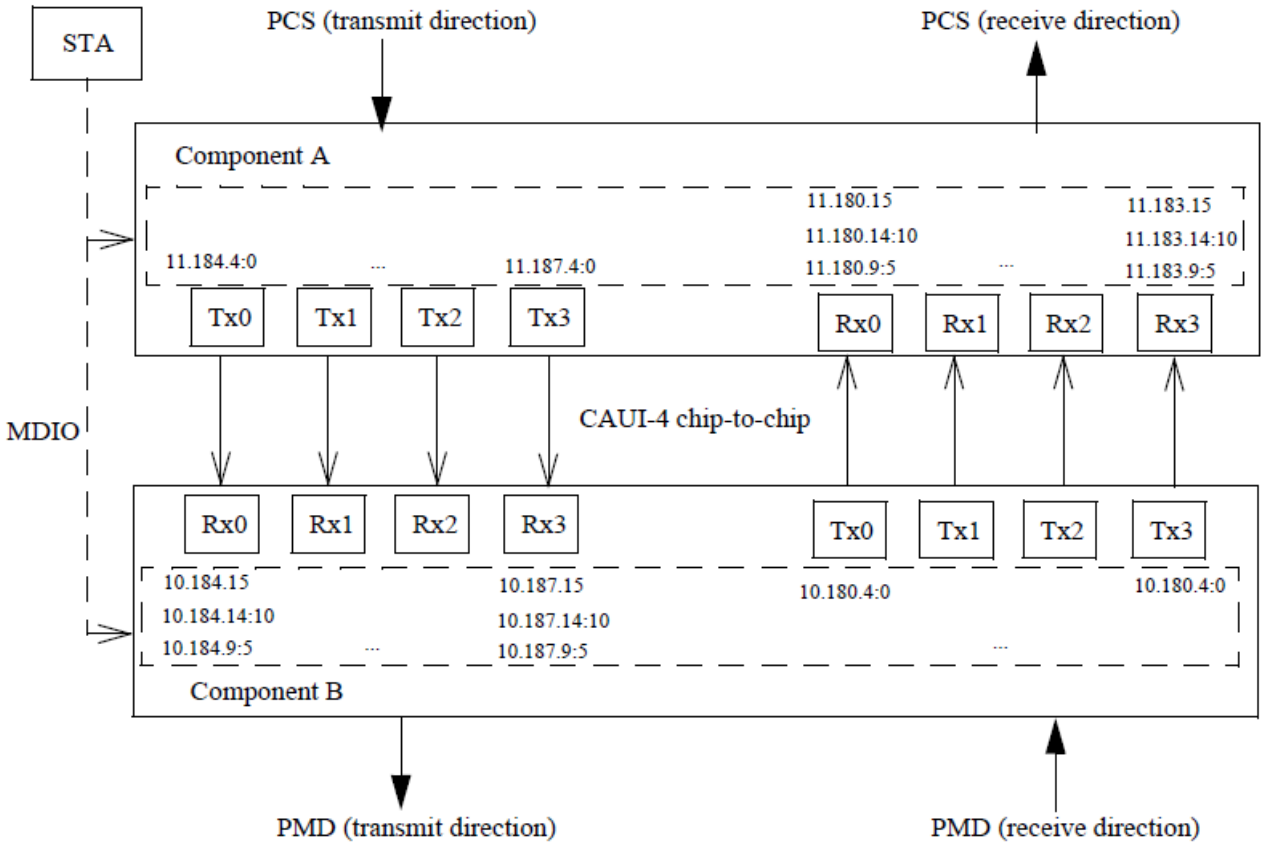

Figure 83D–5—Example transmitter equalization feedback components and registers

The STA performs the procedures described in 83D.5.2 and 83D.5.3 to tune lane 0 equalization settings in both sides of the CAUI-4 chip-to-chip link. When these procedures are completed, the STA uses similar procedures to tune equalization settings in lanes 1 through 3. When all lanes are tuned, the STA may repeat the process with another pair of components connected by CAUI-4 chip-to-chip.

Note—Using non-optimal transmitter equalization settings (or changing them) during the tuning procedure may interrupt data communication. The CAUI-4 bit error ratio is assumed to meet the requirements of 83D.3.3.1 upon completion of the tuning process.

83D.5.2 Tuning equalization settings on lane 0 in the transmit direction

1) Read *Local_eq_cm1* (11.184.1:0) and *Local_eq_c1* (11.184.4:2) from component A.
2) Write *Local_eq_cm1* and *Local_eq_c1* read from component A to *Remote_eq_cm1* (10.184.6:5) and *Remote_eq_c1* (10.184.9:7), respectively, in component B.
3) Read *Request_flag* (10.184.15), *Requested_eq_cm1* (10.184.11:10) and *Requested_eq_c1* (10.184.14:12) from component B.
4) If *Request_flag* is 0, go to tuning equalization settings on lane 0 in the Receive direction (83D.5.3)
5) If *Request_flag* is 1, write *Requested_eq_cm1* and *Requested_eq_c1* read from component B to *Local_eq_cm1* (11.184.1:0) and *Local_eq_c1* (11.184.4:2), respectively, in component A.
6) Go to step 1.

83D.5.3 Tuning equalization settings on lane 0 in the receive direction

1) Read *Local_eq_cm1* (10.180.1:0) and *Local_eq_c1* (10.180.4:2) from component B.
2) Write *Local_eq_cm1* and *Local_eq_c1* read from component B to *Remote_eq_cm1* (11.180.6:5) and *Remote_eq_c1* (11.180.9:7), respectively, in component A.
3) Read *Request_flag* (11.180.15), *Requested_eq_cm1* (11.180.11:10) and *Requested_eq_c1* (11.180.14:12) from component A.
4) If *Request_flag* is 0, proceed to tuning lane 1.
5) If *Request_flag* is 1, write *Requested_eq_cm1* and *Requested_eq_c1* read from component A to *Local_eq_cm1* (10.180.1:0) and *Local_eq_c1* (10.180.4:2), respectively, in component B.
6) Go to step 1.

Minutes

- Patent Policy:
- Review implementation of ran_01_062714_CAUI4 / transmitter equalization specification
- Discussed +/-2dB request from alessandro_01_07032014_caui
  - Request to CAUI-4 ad hoc to simulate variations in channel with current specification (+/-1dB) and proposal (+/-2dB)
- D3.0 comment discussion
  - Discussed proposed responses to TRs
- Next meeting: TBD (after San Diego)
- Attendees:
  - Pete Anslow, Ciena
  - Piers Dawe, Mellanox
  - Rich Mellitz, Intel
  - Kenji Suzuki Cortina Systems
  - Benjamin Smith Cortina Systems
  - David Brown, Semtech
  - Ryan Latchman, Macom