AUI-C2C transmitter equalization control interface proposal

(Addressing comments 11059, 11082)

Adee Ran, Intel

Comments addressed

Cl **120F** *SC* **120F.1** *P* **204** *L* **22** # 11059

Ran, Adee — Intel

Comment Type **T** *Comment Status* **D**

[Comment resubmitted from Draft 1.1. 120F.1, P202, L31]

"If implemented, the transmitter equalization feedback mechanism described in 120D.3.2.3 may be used to identify an appropriate setting"

As presented in ran_3ck_adhoc_02_021920, that mechanism supports the equalizer that was specified in the original CAUI-4 C2M (Annex 83D), which has only 3 taps with 5% coefficient resolution. The PAM4 AUIs defined in 802.3.bs (120D.3.1.5) and re-used in 802.3cd have kept this structure. However, we now have a 5-tap equalizer with a finer resolution. Even if pre-cursor tap c(-3) is removed as suggested in 120F.3.1.4 it would not be identical to the FFE in Annex 83D.

Therefore, re-using this method for 100GAUI-1 is impossible and new method should be defined. Possible solutions include a training protocol as in the PMD control function, new management variables and registers, or combinations of the two approaches.

SuggestedRemedy

A presentation with possible solutions is planned.

Proposed Response *Response Status* **W**

PROPOSED ACCEPT IN PRINCIPLE

Pending review of the following presentation and task force discussion:
http://www.ieee802.org/3/ck/public/20_03/ran_3ck_02_0320.pdf

Comment #11082 proposes updating register definitions to support the TX EQ feedback.

Cl **45** *SC* **45.2.1.129** *P* **52** *L* **50** # 11082

Healey, Adam — Broadcom Inc.

Comment Type **T** *Comment Status* **D**

[Comment resubmitted from Draft 1.1. 45.2.1.129, P50, L50]

Chip-to-chip transmitter equalization register definitions have been are written as being general for 100/200/400GAUI-n but 100GAUI-1, 200GAUI-2, and 400GAUI-4 appear to be on a trajectory to have different tap counts and coefficient step sizes.

SuggestedRemedy

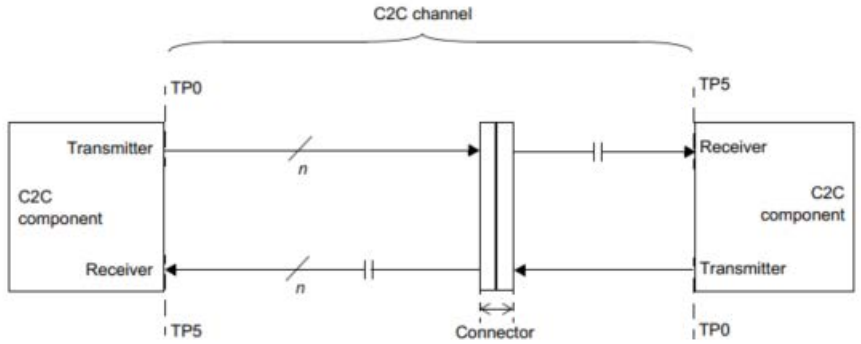
The correct amendment to 45.2.1.129 through 45.2.1.132 seems to be to indicate these registers are specific to 100GAUI-n (n > 1), 200GAUI-n (n > 2) and 400GAUI-n (n > 4) until the Annex 120F taps counts, coefficient step sizes, and control scheme are finalized. At this point it seems likely a different set of registers would be needed for Annex 120F controls.

Proposed Response *Response Status* **W**

PROPOSED ACCEPT IN PRINCIPLE

Resolve in conjunction with comment 11059.

Problem explained



Note—The number of lanes *n* is equal to 1 for 100GAUI-1, 2 for 200GAUI-2, and 4 for 400GAUI-4.

Figure 120F–2—Typical 100GAUI-1, 200GAUI-2, and 400GAUI-4 C2C application

The 100GAUI-1, 200GAUI-2, and 400GAUI-4 C2C 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 120D.3.2.3 may be used to identify an appropriate setting. The adaptive or adjustable receiver performs the remainder of the equalization.

120F.3.1 Transmitter electrical characteristics

A 100GAUI-1 C2C, 200GAUI-2 C2C, and 400GAUI-4 C2C transmitter shall meet the specifications given in Table 120F–1. The transmit output waveform may optionally be manipulated via the feedback mechanism described in 120D.3.2.3.

Annex 120F text refers to a control interface of 120D - 3-tap TxEq using absolute tap values

Table references are to C136 which has 4-tap TxEq with different step size and limits

Output waveform[b]			
Level separation mismatch ratio R_{LM}(min)	120D.3.1.2	0.95	—
Steady state voltage v_f(max)	162.9.3.1.2	0.6	V
Steady state voltage v_f(min)	162.9.3.1.2	TBD	V
Linear fit pulse peak (min)	120D.3.1.4	TBD × v_f	V
abs. step size for all taps (min.)	136.9.3.1.4	0.005	—
abs. step size for all taps (max.)	136.9.3.1.4	0.025	—
value at min. state for c(–3) (max.)	136.9.3.1.5	–0.06	—
value at max. state for c(–2) (min.)	136.9.3.1.5	0.12	—
value at min. state for c(–1) (max.)	136.9.3.1.5	–0.34	—
value at min. state for c(1) (max.)	136.9.3.1.5	–0.1	—

120F.3.1.3 Transmitter equalization settings

Each 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 five-tap transversal filter shown in Figure 120F–4. Transmitter output waveform specifications are provided in Table 120F–1. The state of the transmitter output equalization is configured via management.

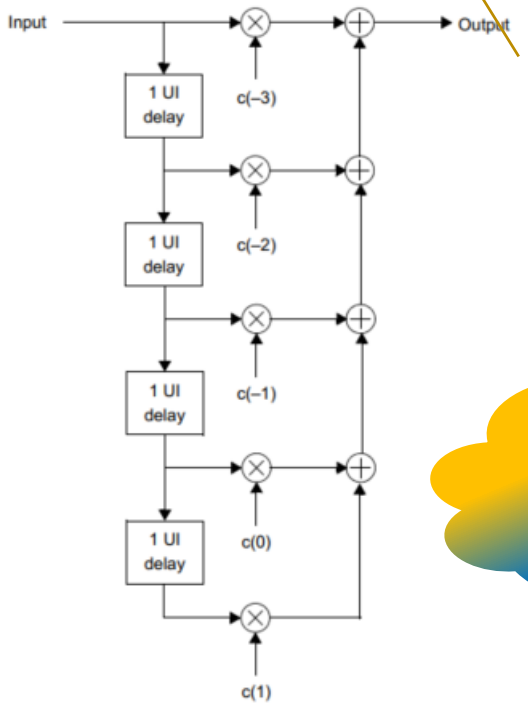


Figure 120F–4—Transmitter equalizer functional model

The TxEq is specified with 5 taps

Mess…
A new control interface is required

Control interface for CR/KR TxEq is defined in Clause 162

- This set of variables can be specified for functionality of an AUI-C2C interface as well
- Can be used without Training with only the highlighted variables
- Reusing (part of) this interface would minimize effort at this point!

Table 162–7—MDIO/PMD control function mapping *(continued)*

MDIO variable	PMA/PMD register name	Register/bit number	PMD variable
Polynomial identifier	PMD training pattern, lanes 0 to 3	1.1450.12:11[b]	identifier_i
Seed	PMD training pattern, lanes 0 to 3	1.1450.15:14 1.1450.10:0[b]	seed_i
Initial condition request	BASE-R PAM4 PMD training LP control, lanes 0 to 3	1.1120.13:12[b]	ic_req
Coefficient select	BASE-R PAM4 PMD training LP control, lanes 0 to 3	1.1120.4:2[b]	coef_sel
Coefficient request	BASE-R PAM4 PMD training LP control, lanes 0 to 3	1.1120.1:0[b]	coef_req
Receiver ready	BASE-R PAM4 PMD training LP status, lanes 0 to 3	1.1220.15[b]	remote_rx_ready
Modulation and precoding status	BASE-R PAM4 PMD training LP status, lanes 0 to 3	1.1220.11:10[b]	remote_tp_mode
Receiver frame lock	BASE-R PAM4 PMD training LP status, lanes 0 to 3	1.1220.9[b]	remote_tf_lock
Modulation and precoding request	BASE-R PAM4 PMD training LD control, lanes 0 to 3	1.1320.11:10[b]	local_tp_mode
Local receiver ready	BASE-R PAM4 PMD training LD status, lanes 0 to 3	1.1420.15[b]	local_rx_ready
Initial condition status	BASE-R PAM4 PMD training LD status, lanes 0 to 3	1.1420.8[b]	ic_sts
Coefficient select echo	BASE-R PAM4 PMD training LD status, lanes 0 to 3	1.1420.5:3[b]	k
Coefficient status	BASE-R PAM4 PMD training LD status, lanes 0 to 3	1.1420.2:0[b]	coef_sts

[a]Bit reference is provide for lane 0. Status for lanes 1-3 are located in the same register.
[b]Address reference is provided for lane 0. Register for lanes 1 to 3 are located at an offset from the lane 0 register.

Proposed solution outline

- Define a register-based control interface as in 120D (and 83D)
  - But based on variables in the PMD control function of 162 instead – “local” set
- Define an optional equalization feedback interface (as in the annexes above)
  - But based on variables in the PMD control function of 162 instead – “remote” set
- Make the minimal required changes to enable these interfaces in D1.3
  - As shown in the next slides
- Additional features to be discussed in future comment cycles:
  - Refinement of interface variables and registers
  - Explicit coefficient values (in addition to relative steps)
  - Using per-lane signal detect and transmitter disable in conjunction
  - Optional use of training protocol

Proposed changes (1)

Add new subclause 120F.3.1.4:

120F.3.1.4 Transmitter control

The transmitter output equalization is characterized using the linear fit method described in 162.9.3.1.1.

Transmitter equalization shall be configurable by management using a set of control and status variables listed in Table 120F-#1, or an equivalent interface. The variables that control transmitter equalization are specific for each lane.

Definitions of the variables in Table 120F-2a are the same as the corresponding ones without the "local_" prefix in 136.8.11.7.1, with the exceptions listed in 162.8.11, and the additional exception that all variables are accessed and controlled by management instead of being mapped to training frame fields.

If a Clause 45 MDIO is implemented, the variable mapping for the transmitter control is identical to the "LD" variable mapping in Table 162-7.

Insert new Table 120F-#1 (renumber as necessary):

Variable name	Description	Management access
local_ic_req	Initial condition requested from the local transmitter.	RW
local_coef_sel	Coefficient selection in the local transmitter.	RW
local_coef_req	Update to the selected coefficient in the local transmitter.	RW
local_ic_sts	Status of initial condition request.	RO
local_k	Coefficient select echo.	RO
local_coef_sts	Coefficient update acknowledge.	RO

Proposed changes (2)

Add new subclause 120F.3.3:

120F.3.1.4 Transmitter equalization feedback (optional)

Transmitter equalization feedback is an optional capability for a receiver. If implemented, it shall operate as described in this subclause.

A receiver may generate a request to change the transmit equalization coefficients of the remote transmitter using the variables in Table 120F-#1, or an equivalent interface.

Definitions of the variables in Table 120F-2a are the same as the corresponding ones without the "remote_" prefix in 136.8.11.7.1, with the exceptions listed in 162.8.11, and the additional exception that all variables are accessed and controlled by management instead of being mapped to training frame fields.

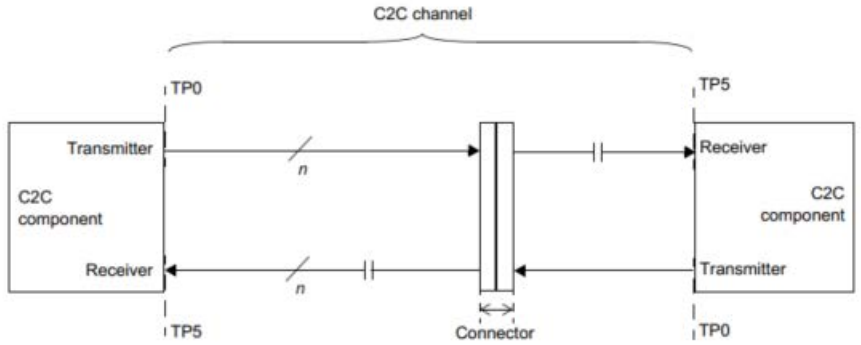
The requested setting is generated from information internal to the receiver, in an implementation specific manner.

If a Clause 45 MDIO is implemented, the variable mapping for the transmitter equalization feedback is identical to the "LP" variable mapping in Table 162-7.

Insert new Table 120F-#2 (renumber as necessary):

Variable name	Description	Management access	Reference
remote_ic_req	Initial condition requested from the remote transmitter.	RO	136.8.11.7.1
remote_coef_sel	Coefficient selection in the remote transmitter.	RO	136.8.11.7.1
remote_coef_req	Requested update to the selected coefficient in the remote transmitter.	RO	136.8.11.7.1
remote_ic_sts	Status of initial condition request from the remote transmitter.	RW	136.8.11.7.1
remote_k	Coefficient select echo.	RW	136.8.11.7.1
remote_coef_sts	Coefficient update acknowledge.	RW	136.8.11.7.1

Proposed changes (3-6) – editorial



Note—The number of lanes *n* is equal to 1 for 100GAUI-1, 2 for 200GAUI-2, and 4 for 400GAUI-4.

Figure 120F–2—Typical 100GAUI-1, 200GAUI-2, and 400GAUI-4 C2C application

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Change as shown

The 100GAUI-1, 200GAUI-2, and 400GAUI-4 C2C transmitter on each end of the link is adjusted to an appropriate equalization setting based on channel knowledge. If implemented, the transmitter equalization feedback mechanism described in 120D.3.2.3 may be used to identify an appropriate setting. The adaptive or adjustable receiver performs the remainder of the equalization.

The 100GAUI-1, 200GAUI-2, and 400GAUI-4 C2C transmitter on each end of the link is adjusted to an appropriate equalization setting, which may be based on channel knowledge. If implemented, The transmitter equalization feedback mechanism described in 120F.3.1.5 may be used to identify an appropriate setting of the link partner. The adaptive receiver performs the remainder of the equalization.

120F.3.1 Transmitter electrical characteristics

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Change as shown

A 100GAUI-1 C2C, 200GAUI-2 C2C, and 400GAUI-4 C2C transmitter shall meet the specifications given in Table 120F–1. The transmit output waveform may optionally be manipulated via the feedback mechanism described in 120D.3.2.3.

The 100GAUI-1, 200GAUI-2, and 400GAUI-4 C2C transmitter shall meet the specifications given in Table 120F–1. The transmit output waveform may be manipulated via the transmitter control interface described in 120F.3.1.4.

Output waveform[b]			
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abs. step size for all taps (min.)	136.9.3.1.4	0.005	—
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Change to

162.9.3.1.4
162.9.3.1.4
162.9.3.1.5
162.9.3.1.5
162.9.3.1.5
162.9.3.1.5

120F.3.1.3 Transmitter equalization settings

6

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Proposed changes (7) – editorial

- Delete all changes in 45.2.1.129 through 45.2.1.132 (remove these clauses from the draft)
  - These subclauses are specific to the 25G and 50G per lane AUIs and will not be used by the new AUIs.