TRANSMITTER CONTROL FOR MODULE OUTPUT IN THE AUI-C2M INTERFACES

(COMMENT #60)

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Supporters

Comment

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Signal swing and Tx equalization are important in PAM4 since the receiver has a limited linear range. A large swing at the host input may prevent linear operation and detection of PAM4. Attenuation has been used in past Rx designs, but it is becoming harder to implement with the large bandwidth requirements for 100G.

The current module output specifications have limited information about output swing and ISI (only implicitly through far-end eye height and far-end precursor ISI ratio, which are defined with a single channel), and do not mention any control of the Tx setting. With the large range of C2M host channels, it is unlikely that a fixed Tx setting will be usable for all hosts.

Actual modules even in 50G have some control of equalization and swing. There are indications that this control is required for actual operation.

If we ignore this capability in the specifications, some hosts may not be able to operate with the settings used for module output compliance; this means the module compliance specs are useless and measuring them is a waste of time.

The standard should at least mention the module's Tx control capabilities (with reference to external documents) and preferably define requirements for them, with management variables and control registers. It will be beneficial if the Tx specifications include these capabilities.

SuggestedRemedy

A presentation is planned with further details.

Proposal

- Add a subclause under **120G.3.2 Module output characteristics** with content as follows:

120G.3.2.1 Module output control (optional)

The module may optionally provide control of its output equalization and amplitude. If implemented, this functionality may be used by the host management to optimize the module output signal for the specific host channel and receiver.

An example of a management interface which provides control of module output is described in sections 6.2.4.2 and 6.2.4.3 of the Common Management Interface Specification (CMIS)[1].

Usage of the management interface for controlling module output is outside the scope of this standard.

[1] CMIS specifications are available at http://www.qsfp-dd.com/wp-content/uploads/2019/05/QSFP-DD-CMIS-rev4p0.pdf.

- Add a corresponding PICS item where appropriate.

Why?

- Module output control may be required to support PAM4 in many C2M links.
  - Output swing may be too high for low-loss channels
  - Equalization may need tuning for specific channel and host Rx
  - Without this control, supporting a wide range of C2M channels and CR links in a host Rx adds significant burden to a SERDES design (with likely impact on power).
- As shown in the following slides, module output control is defined in at least one external specification.
  - No need to redefine, we can refer to that specification instead.
  - Suggested as an optional feature in case not all modules implement this control.
- Normative module output characteristics (for compliance) are not changed
  - But most are currently TBD.

Module control as described in the CMIS document (1)

6.2.4.2 Rx Output Emphasis Control

The Rx Output Emphasis Control is a four-bit field per lane. Refer to Table 8-34 to determine if the module supports Rx Output Emphasis Control. Refer to Table 8-30 for the maximum Rx output emphasis supported by the module. Rx output emphasis is defined at the appropriate test point defined by the relevant standard. The code values and the corresponding output equalization are defined as follows:

Table 6-5 Rx Output Emphasis Codes

Code Value	Bit pattern	Post-Cursor Equalization	Pre-Cursor Equalization
0	0000b	No Equalization	No Equalization
1	0001b	1 dB	0.5 dB
2	0010b	2 dB	1.0 dB
3	0011b	3 dB	1.5 dB
4	0100b	4 dB	2.0 dB
5	0101b	5 dB	2.5 dB
6	0110b	6 dB	3.0 dB
7	0111b	7 dB	3.5 dB
8-10	1000b-1010b	Reserved	Reserved
11-15	1011b-1111b	Custom	Custom

Note: The pre-cursor equalizer settings in dB approximates to
Pre EQ (dB)=-20*log10((1-C(-1)/(C(-1)+C(0)+C(1)))
The post-cursor equalizer settings in dB approximates to
Post EQ (dB)=-20*log10(1-C(1)/(C(-1)+C(0)+C(1)))

Module control as described in the CMIS document (2)

6.2.4.3 Rx Output Amplitude Control

The Rx Output Amplitude Control is a four-bit field per lane. The output amplitude is measured with no equalization enabled. Refer to Table 8-34 to determine if the module supports Rx Output Amplitude Control and Table 8-30 to determine which codes are supported. Output amplitude is defined at the appropriate test point defined by the relevant standard. The code values and the corresponding output amplitude are defined as follows:

Table 6-6 Rx Output Amplitude Codes

Code Value	Bit pattern	Output Amplitude
0	0000b	100-400 mV (P-P)
1	0001b	300-600 mV (P-P)
2	0010b	400-800 mV (P-P)
3	0011b	600-1200 mV (P-P)
4-14	0100b-1110b	Reserved
15	1111b	Custom