

Improving 200G MMF Link Margin by enabling Presets

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Overview

- ☐ Benefits of ILT for optics
- ☐ Current E1 and O1 ILT frames
- ☐ Enabling ILT for 200G MMF
- ☐ Defining ILT Presets
- ☐ Summary.

Potential OLT Knobs One May Adjust

- ❑ **OLT baseline with 4 pages will have sufficient space that future projects may choose to control various type of optical parameters to improve optical link performance and/or reach – not part of current proposed baseline**
 - Preset in classical ILT only used for FFE adjustment
 - Adjusting transmit FFE taps autonomously (pre-emphasis) or Overshoot – important for VCSELs
 - OMA control – maybe not as important for VCSELs
 - Inner/Output Eye Adjustment - important for VCSELs
 - MZM compression – NA for VCSELs
 - EA modulators asymmetrical compression – NA for VCSELs
 - CD penalty on links > 2km on outer wavelengths L0 and L3 – NA for VCSELs
- ❑ **Some of the above controls may impact baseline TDECQ which doesn't always produce the best BER, as long as adjustment are not disruptive the receiver MMSE will select best operating Preset.**

Current Clause 178B ILT

□ Current copper E1 and optics O1 ILT capabilities

Table 178B-2—Control field structure for E1 interfaces

Bit(s)	Name	Description
15:14	Reserved	Transmit as 0, ignore on receipt
13:11	Initial condition request	13 12 11 1 1 1 = Reserved 1 0 1 = Preset 6 0 1 1 = Preset 5 0 0 1 = Preset 4 1 1 0 = Preset 3 1 0 0 = Preset 2 0 1 0 = Preset 1 0 0 0 = Individual coefficient control
10	Continue training	1 = Continue training 0 = Switch to data when training is completed
9:8	Modulation and precoding request	9 8 1 1 = PAM4 with precoding 1 0 = PAM4 without precoding 0 1 = Reserved 0 0 = PAM2
7	Reserved	Transmit as 0, ignore on receipt
6:5	Training pattern request	6 5 1 1 = free-running PRBS31 1 0 = Reserved 0 1 = free-running PRBS13 0 0 = synchronous PRBS13
4:2	Coefficient select	4 3 2 1 0 0 = Reserved 1 0 1 = $c(-3)$ 1 1 0 = $c(-2)$ 1 1 1 = $c(-1)$ 0 0 0 = $c(0)$ 0 0 1 = $c(1)$ 0 1 x = Reserved
1:0	Coefficient request	1 0 1 1 = No equalization 1 0 = Decrement 0 1 = Increment 0 0 = Hold

Table 178B-3—Control field structure for O1 interfaces

Bit(s)	Name	Description
15:11	Reserved	Transmit as 0, ignore on receipt
10	Continue training	1 = Continue training 0 = Switch to data when training is completed
9:8	Modulation and precoding request	9 8 1 1 = PAM4 with precoding 1 0 = PAM4 without precoding 0 1 = Reserved 0 0 = PAM2
7	Reserved	Transmit as 0, ignore on receipt
6:5	Training pattern request	6 5 1 1 = free-running PRBS31 1 0 = Reserved 0 1 = free-running PRBS13 0 0 = synchronous PRBS13
4:0	Reserved	Transmit as 0, ignore on receipt

Enabling Presets for Optical ILT

- ❑ **AUI and KR/CR already support Presets and enabling Presets for O1 PMDs is straight forward as shown below**
 - ILT O2 tables highlighted text should go into Annex 178B addendum.

Table 178B-x Control field O2 supporting Presets

Bit(s)	Name	Description
15:14	Reserved	Transmit as 0, ignore on receipt
13:11	Initial condition request (new item to support Preset)	13 12 11 1 1 1 = Reserved 1 0 1 = Reserved 1 1 0 = Reserved 1 0 0 = Reserved 0 1 1 = Preset 3 0 1 0 = Preset 2 0 0 1 = Preset 1 0 0 0 = Reserved
10	Continue training	1 = Continue training 0 = Switch to data when training is completed
9:8	Modulation and precoding request	9 8 1 1 = PAM4 with precoding 1 0 = PAM4 without precoding 0 1 = Reserved 0 0 = PAM2
7	Reserved	Transmit as 0, ignore on receipt
6:5	Training pattern request	6 5 1 1 = free-running PRBS31 1 0 = Reserved 0 1 = free-running PRBS13 0 0 = synchronous PRBS13
4:0	Reserved	Transmit as 0, ignore on receipt

Table 178B-y Status field O2 supporting Presets

Bit(s)	Name	Description
15	Receiver ready	1 = Training is complete and the receiver is ready for data 0 = Request for training to continue
14	ILT	Transmit as 1
13:12	Training pattern status	13 12 1 1 = free-running PRBS31 1 0 = Reserved 0 1 = free-running PRBS13 0 0 = synchronous PRBS13
11:10	Modulation and precoding status	9 8 1 1 = PAM4 with precoding 1 0 = PAM4 without precoding 0 1 = Reserved 0 0 = PAM2
9	Receiver frame lock	1 = Frame boundaries identified 0 = Frame boundaries not identified
8	Initial condition status (new item to support Preset)	1 = Updated 0 = Not updated
7	Parity	Even parity bit
6:0	Reserved	Transmit as 0, ignore on receipt

How to Configure the Presets

- ❑ **Need to enable the DME bits to enable Presets and decide if support of Presets is optional or mandatory – if optional then it defeats the purpose**
 - AUI and CR/KR have enabled 6 Presets with 2 reserves
 - In DS proposing to enable 3 presets – additional presets can be enabled for OMA adjustment if needed
- ❑ **Propose to specify transmitters with 3 Presets, where TDECQ is met for each preset**
 - 3 presets are configured for short, medium, and long reach
 - Preset 1 – Optimized for B2B to 40% reach with maximum 20% overshoot/undershoot (default)
 - Preset 2 – Optimized for 40%-70% reach with maximum 20% overshoot/undershoot
 - Preset 3 – Optimized for 70%-100% reach with maximum 20% overshoot/undershoot
 - Preset 4 – Reserved
 - Preset 5 – Reserved
 - Preset 6 – Reserved
 - Preset 7 – Reserved
 - Preset 8 – Reserved
- ❑ **Presets are mandatory to implement for transmitters but optional to use by the receivers.**

Current Fiber Emulation Bandwidths

❑ Fiber emulation bandwidth f_A for 850 nm and 1060 nm PMDs

Table 193–12—The 3 dB bandwidth f_A of the fiber emulation filter for TDECQ measurement

PMD type	Center wavelength (range) (nm)	3 dB bandwidth f_A (GHz)
200GBASE-SR1-30 400GBASE-SR2-30 800GBASE-SR4-30 1.6TBASE-SR8-30	844 – 868	60.7
200GBASE-SR1-50 400GBASE-SR2-50 800GBASE-SR4-50 1.6TBASE-SR8-50	852 – 868	48.2

Table 194–12—The 3 dB bandwidth f_A of the fiber emulation filter for TDECQ measurement
[Editors' note: Further work on the value of the fiber emulation filter bandwidth is encouraged based on EMB guidance over 1052 – 1068 nm.]

PMD type	Center wavelength (range) (nm)	3 dB bandwidth f_A (GHz)
200GBASE-MR1 400GBASE-MR2 800GBASE-MR4 1.6TBASE-MR8	1052 – 1068	52.6

Proposed Fiber Emulation Bandwidths for Each Preset

□ Fiber emulation bandwidth f_A for 850 nm and 1060 nm PMDs

PMD type	Center wavelength (range) (nm)	Presets	Reach Optimized (m)	3 dB bandwidth f_A (GHz) TECQ/ TDECQ for Min Reach	3 dB bandwidth f_A (GHz) TDECQ for Max Reach
200GBASE-SR1-30 400GBASE-SR2-30 800GBASE-SR4-30 1.6TBASE-SR8-30	844 – 868	Preset 1	0.5-12	NA	151.8
		Preset 2	12-21	216.75	86.7
		Preset 3	21-30	86.7	60.7
200GBASE-SR1-50 400GBASE-SR2-50 800GBASE-SR4-50 1.6TBASE-SR8-50	852-868	Preset 1	0.5-20	NA	120.5
		Preset 2	20-35	120.5	68.9
		Preset 3	35-50	68.9	48.2

PMD type	Center wavelength (range) (nm)	Presets	Reach Optimized (m)	3 dB bandwidth f_A (GHz) TECQ/ TDECQ for Min Reach	3 dB bandwidth f_A (GHz) TDECQ for Max Reach
200GBASE-MR1 400GBASE-MR2 800GBASE-MR4 1.6TBASE-MR8	1052 – 1068	Preset 1	0.5-20	NA	151.8
		Preset 2	20-35	151.8	86.7
		Preset 3	35-50	86.7	60.7

Proposed Fiber Emulation Bandwidths for Each Preset

□ Fiber emulation bandwidth f_A for 850 nm and 1060 nm PMDs

Transmitter overshoot and undershoot, each lane (max)	193.9.9	27	%
Transmitter overshoot and undershoot, each lane (max)	194.9.9	27	%

Description – clause 193	Reference	Presets	3 dB bandwidth f_A (GHz) for Overshoot/Undershoot	Overshoot/Undershoot %
Transmitter overshoot and undershoot, each lane (max) for 30 m reach PMDs	193.9.9	Preset 1	NA	20
		Preset 2	151.8	
		Preset 3	86.7	
Transmitter overshoot and undershoot, each lane (max) for 50 m reach PMDs	193.9.9	Preset 1	NA	20
		Preset 2	120.5	
		Preset 3	68.9	
Description – clause 194	Reference	Presets	3 dB bandwidth f_A (GHz)	Overshoot/Undershoot %
Transmitter overshoot and undershoot, each lane (max) for MR PMDs	194.9.9	Preset 1	NA	20
		Preset 2	151.8	
		Preset 3	86.7	

Summary

☐ Enabling ILT O2 PMDs Presets is straight forward

- Proposal enables 3 Presets
 - Preset 1 (Default) optimized for 0-40% reach
 - Preset 2 optimized for 40-70% reach
 - Preset 3 optimized for 70-100% reach
- Worst case overshoot/undershoot for any Preset is 20%
- Presets are mandatory to implement by transmitters but optional to use by receivers

☐ Presets can also be enabled for OMA or inner-outer eye adjustment if they provide sufficient benefits!

Thank You