

A BASELINE PROPOSAL FOR 25GBASE-KR PMD

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Background

- Most study group discussions were focused on cable PHYs and FEC options; some addressed the architecture aspects of supporting multiple FEC options.
- Backplane PHY wasn't really discussed...
 - Perhaps seen as a simple follow-up to cable PHY
 - Perhaps seen as trivial
- Path towards a baseline proposal was presented in [ran_25GE_01_1114](#)
- Goal of this proposal is to make progress in a hopefully non-controversial area.

Scope

Adopted and approved Objectives

- Support a MAC data rate of 25 Gb/s
- Support full-duplex operation only
- Preserve the Ethernet frame format utilizing the Ethernet MAC
- Preserve minimum and maximum FrameSize of current IEEE 802.3 standard
- Support a BER of better than or equal to 10^{-12} at the MAC/PLS service interface (or the frame loss ratio equivalent)
- Support optional Energy-Efficient Ethernet operation
- Define a single-lane 25 Gb/s PHY for operation over a printed circuit board backplane consistent with channels specified in IEEE Std 802.3bj-2014 Clause 93
- Define a single-lane 25 Gb/s PHY for operation over links consistent with copper twin axial cables, with lengths up to at least 3m
- Define a single-lane 25 Gb/s PHY for operation over links consistent with copper twin axial cables, with lengths up to at least 5m
- Define a single-lane 25 Gb/s PHY for operation over MMF consistent with IEEE P802.3bm Clause 95
- Provide appropriate support for OTN

Scope

New Clauses/Annexes

Clause	Changes
X	Introduction to 25 Gb/s networks
X+1	25G RS + XXVMII
X+2	25G PCS ***
X+3	25G FEC
X+4	25G PMA
X+5	25GBASE-CR PMD (copper cable) ***
X+6	25GBASE-KR PMD (backplane)
X+7	25GBASE-SR PMD (MMF optical)
Annex (X+4)A	XXVAUI chip-to-chip
Annex (X+4)B	XXVAUI chip-to-module
Annex (X+5)A	25GBASE-CR TP parameters and channel characteristics
Annex (X+5)B	25GBASE-CR cable/host use cases ***
	*** indicates Clauses/Annexes that need significant work

- Structure suggested in [brown_092414a_25GE_adhoc](#)

Introduction

- Proposal is for the PMD clause. Some assumptions are made on other clauses.
- Build upon clause 93 structure:
 - Auto-negotiation – required, but details not specified in the PMD clause (refer to clause 73)
 - PCS – PMD clause refers to the appropriate PCS (new) clause
 - RS, MII, PMA, FEC, AUI – refer to the respective single-lane (new) clauses
- FEC choice?
 - RS-FEC is required at the minimum for meeting the project objective (“channels specified in Clause 93”).
 - For the baseline, it is proposed to specify RS-FEC as the only mode.
 - We could add other modes later if there is consensus.
- The remainder of this presentation lists the proposed content of the PMD clause (X+6).

Overview subclause

(X+6).1 Overview

This clause specifies the 25GBASE-KR PMD and baseband medium. [The specifications are based on 100GBASE-KR4 \(Clause 93\) but with a single lane instead of four lanes. This clause is also associated with Annex 93A, Annex 93B and Annex 93C.](#)

When forming a complete Physical Layer, a PMD shall be connected to the appropriate PMA as shown in Table (X+6)–1, to the medium through the MDI and to the management functions that are optionally accessible through the management interface defined in Clause 45, or equivalent.

(Table (X+6)–1 shown in next slide)

A 25GBASE-KR4 PHY with the optional Energy-Efficient Ethernet (EEE) capability may optionally enter the Low Power Idle (LPI) mode to conserve energy during periods of low link utilization.

Figure (X+6)–1 shows the relationship of the 25GBASE-KR PMD sublayers and MDI to the ISO/IEC Open System Interconnection (OSI) reference model.

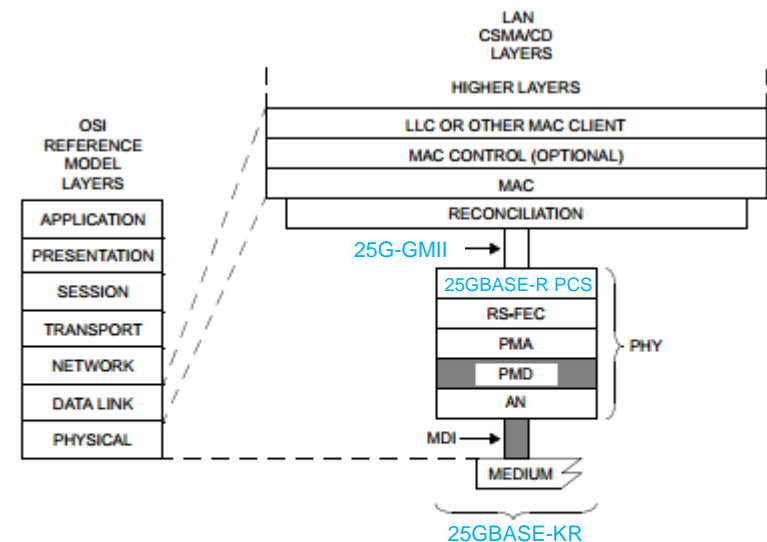
(Figure (X+6)–1 shown in next slide)

The receive path of the RS-FEC sublayer may have the option to perform error detection without correction to reduce the data delay (see (X+3)). When the receive path of the RS-FEC sublayer performs error correction, the link is required to operate with a BER of 10^{-5} or better. When the RS-FEC sublayer is configured to bypass error correction, the link is required to operate with a BER of 10^{-12} or better. In this context, a link consists of a compliant PMD transmitter, a compliant PMD receiver, and a channel meeting the requirements of (X+6).8.

For a complete Physical Layer, this specification is considered to be satisfied by a frame loss ratio (see 1.4.209a) of less than 6.2×10^{-10} for 64-octet frames with minimum inter-packet gap.

Table and Figure for overview subclause

Associated clause	25GBASE-KR
X+1—RS	Required
X+1—25G-MII	Optional
X+2—PCS	Required
X+3—RS-FEC	Required
X+4—PMA for 25GBASE-R	Required
(X+4)A—25G-AUI	Optional
73—Auto-Negotiation	Required
78—Energy-Efficient Ethernet	Optional



AN = AUTO-NEGOTIATION
 25G-MII = 25 Gb/s MEDIA INDEPENDENT INTERFACE
 LLC = LOGICAL LINK CONTROL
 MAC = MEDIA ACCESS CONTROL
 MDI = MEDIUM DEPENDENT INTERFACE

PCS = PHYSICAL CODING SUBLAYER
 PHY = PHYSICAL LAYER DEVICE
 PMA = PHYSICAL MEDIUM ATTACHMENT
 PMD = PHYSICAL MEDIUM DEPENDENT
 RS-FEC = REED-SOLOMON FORWARD ERROR CORRECTION

Subclauses 2 – 4

- **(X+6).2 PMD service interface**
 - Text based on 93.2 but with a single lane
 - Primitives (without _i):
 - PMD:IS_UNITDATA.request
 - PMD:IS_UNITDATA.indication
 - PMD:IS_SIGNAL.indication
 - PMD:IS_TX_MODE.request (for EEE deep sleep)
 - PMD:IS_RX_MODE.request (for EEE deep sleep)
- **(X+6).3 PCS requirements for Auto-Negotiation (AN) service interface**
 - Text based on 93.3
- **(X.6).4 Delay constraints**
 - Text based on 93.4, same delay in ns (< 20.48 ns); shorter in bit times, since bit time is 40 ps at 25 Gb/s. (RS-FEC excluded)

PMD MDIO function mapping

(X.6).5 PMD MDIO function mapping

- Text and tables based on 93.6 but with a single lane
- Same addresses as 10GBASE-KR, shared with 100GBASE-KR4 global or lane 0 as appropriate (compare to 72.5 and 84.6).
- Include polynomial identifier and seed control.

93.6 PMD MDIO function mapping

The optional MDIO capability described in Clause 45 defines several registers that provide control and status information for and about the PMD. If MDIO is implemented, it shall map MDIO control bits to PMD control variables as shown in Table 93–2, and MDIO status bits to PMD status variables as shown in Table 93–3.

Table 93–2—100GBASE-KR4 MDIO/PMD control variable mapping

MDIO control variable	PMA/PMD register name	Register/bit number	PMD control variable
Reset	PMA/PMD control 1	1.0.15	PMD_reset
Global PMD transmit disable	PMD transmit disable	1.9.0	Global_PMD_transmit_disable
PMD transmit disable 3 to PMD transmit disable 0	PMD transmit disable	1.9.1 to 1.9.4	PMD_transmit_disable_3 to PMD_transmit_disable_0
Restart training	BASE-R PMD control	1.150.0	mr_restart_training
Training enable	BASE-R PMD control	1.150.1	mr_training_enable
Polynomial identifier 3	PMD training pattern 3	1.1453.12:11	identifier_3
Seed 3	PMD training pattern 3	1.1453.10:0	seed_3
Polynomial identifier 2	PMD training pattern 2	1.1452.12:11	identifier_2
Seed 2	PMD training pattern 2	1.1452.10:0	seed_2
Polynomial identifier 1	PMD training pattern 1	1.1451.12:11	identifier_1
Seed 1	PMD training pattern 1	1.1451.10:0	seed_1
Polynomial identifier 0	PMD training pattern 0	1.1450.12:11	identifier_0
Seed 0	PMD training pattern 0	1.1450.10:0	seed_0

Table 93–3—100GBASE-KR4 MDIO/PMD status variable mapping

MDIO status variable	PMA/PMD register name	Register/bit number	PMD status variable
Fault	PMA/PMD status 1	1.1.7	PMD_fault
Transmit fault	PMA/PMD status 2	1.8.11	PMD_transmit_fault
Receive fault	PMA/PMD status 2	1.8.10	PMD_receive_fault
Global PMD receive signal detect	PMD receive signal detect	1.10.0	Global_PMD_signal_detect
PMD receive signal detect 3 to PMD receive signal detect 0	PMD receive signal detect	1.10.1 to 1.10.4	PMD_signal_detect_3 to PMD_signal_detect_0
100GBASE-KR4 deep sleep	EEE capability	1.16.10	—
Receiver status 3	BASE-R PMD status	1.151.12	rx_trained_3
Frame lock 3	BASE-R PMD status	1.151.13	frame_lock_3
...			
Receiver status 0	BASE-R PMD status	1.151.0	rx_trained_0
Frame lock 0	BASE-R PMD status	1.151.1	frame_lock_0
Start-up protocol status 0	BASE-R PMD status	1.151.2	training_0
Training failure 0	BASE-R PMD status	1.151.3	training_failure_0

PMD functional specifications

- **(X+6).6 PMD functional specifications**
 - Text based on 93.7 but with a single lane
 - Proposed to be detailed text rather than reference to clause 93 (as content isn't too long).
 - Loopback and test patterns:
 - The single-lane PMA matching clause 49 is defined in clause 51; this PMA does not include loopback capability and test patterns (in 10GBASE-KR these are parts of the PMD).
 - Clause 83 PMA includes loopback and test patterns, including PRBS9 which is required for TX measurements in 100GBASE-KR4.
 - PMA proposal ([brown_3by_03a_0115](#)) includes loopback and test patterns generation.
 - Baseline proposal: no loopback and test patterns control in the PMD.

PMD electrical characteristics

- Since the matching subclause 93.8 is defined per-lane, electrical characteristics are proposed to be provided by back reference to matching subclauses of 93.8.

(X+6).7 PMD electrical characteristics

(X.6).7.1 Transmitter characteristics

Transmitter electrical characteristics at TP0a for 25GBASE-KR shall be the same as a single lane of 100GBASE-KR4, as summarized in Table 93-4 and detailed in 93.8.1.1 through 93.8.1.7.

(X.6).7.2 Receiver characteristics

Receiver electrical characteristics at TP5a for 25GBASE-KR shall be the same as a single lane of 100GBASE-KR4, as summarized in Table 93-5 and detailed in 93.8.2.1 through 93.8.2.4.

Channel characteristics

- Since the matching subclause 93.9 is defined per-lane, channel characteristics are proposed to be provided by back reference to 93.9.

(X.6).8 Channel characteristics

Channel characteristics for 25GBASE-KR shall be the same as a single lane of 100GBASE-KR4, as summarized in Table 93-4 and detailed in 93.8.1.1 through 93.8.1.7.

Environmental and PICS

(X+6).9 Environmental specifications

- Text based on 93.10

(X+6).10 Protocol implementation conformance statement (PICS) proforma for Clause 93, Physical Medium Dependent (PMD) sublayer and baseband medium, type 25GBASE-KR

- Text based on 93.11 and normative statements in the clause

THAT'S ALL....
