

Comment i-31:

Single PMD w/ optional RS-FEC

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January 18-19, 2016

Supporters



- Phil Sun (Credo Semiconductor)
- Tomoyuki Arai (Socionext)

- Proposal : Merge two PMDs to one PMD with optional RS-FEC
 - 25GBASE-CR-S & 25GBASE-CR → 25GBASE-CR w/ optional RS-FEC
 - 25GBASE-KR-S & 25GBASE-KR → 25GBASE-KR w/ optional RS-FEC

- I made the same proposal against Draft 2.1 (comment #12).

- In October 2015 Interim meeting in Milpitas, many people were actually positive for this proposal. However, many people were also worried about extra delay, because it was a recirculation ballot, and it is a big change anyway, although mostly editorial. So, I was asked to postpone it to the initial sponsor ballot, and we decided not to make the change at that time.

- Hence, I bring back the same proposal, and I would like to review some points for clarification and facilitate discussion.

The Problem of Two PMDs (Draft 3.0)

■ FEC-mode resolution is quite complicated.

- 2 Technology Ability fields (A9|A10) x 2 FEC capability fields (F2|F3)
→ 3 FEC modes

http://www.ieee802.org/3/by/public/adhoc/architecture/hidaka_100715_25GE_adhoc.pdf (slide 4)

dudek_3by_03a_0315.pdf(slide 4) vs D2.1

Table 73-5—Priority Resolution

7	25GBASE-KR or 25GBASE-CR	25 Gb/s 1 lane
8	25GBASE-KR-S or 25GBASE-CR-S	25 Gb/s 1 lane, short reach
A9	25GBASE-KR-S or 25GBASE-CR-S	
A10	25GBASE-KR or 25GBASE-CR	

- a) F0 is 10 Gb/s per lane FEC ability
- b) F1 is 10 Gb/s per lane FEC requested
- c) F2 is 25G RS-FEC requested
- d) F3 is 25G BASE-R FEC requested

A10 (Remote) AND A10 (Local)
 HCD resolved between Two PMDs with CR being higher priority than CR-S
 F2 (Remote) OR F2 (Local)
 F3 (Remote) OR F3 (Local)

	HCD		OR of RS-FEC REQ	OR of 25G BASE-R REQ	Usage
	CR	CR-S			
0		Y	0	0	noFEC
0		Y	X	1	BASE-R
0		Y	1	X	BASE-R
1	Y		0	0	noFEC
1	Y		0	1	BASE-R
1	Y		1	X	RSFEC

HCD is Highest Common Denominator with CR being higher priority than CR-S
 OR is the OR function of the appropriate FEC Request from the two ends.
 X is don't care.

A Solution by a Single PMD (My Proposal)

- The same truth table can be implemented with a single PMD.
 - 3 FEC capability fields (F2|F3|F4) → 3 FEC modes

http://www.ieee802.org/3/by/public/adhoc/architecture/hidaka_100715_25GE_adhoc.pdf (slide 5)

Unified Logic-Based Resolution w/ Single PMD

- Define single PMD with optional RS-FEC
 - F2 = 25G RS-FEC ability
 - F3 = 25G RS-FEC requested
 - F4 = 25G BASE-R FEC requested

F2 (Remote) AND F2 (Local)	Single PMD (No need to resolve)		F3 (Remote) OR F3 (Local)	F4 (Remote) OR F4 (Local)	Usage
	CR	HCD CR-S	OR of RS-FEC REQ	OR of 25G BASE-R REQ	
0		Y	0	0	noFEC
0		Y	X	1	BASE-R
0		Y	1	X	BASE-R
1	Y		0	0	noFEC
1	Y		0	1	BASE-R
1	Y		1	X	RSFEC

HCD is Highest Common Demoninator with CR being higher priority than CR-S
 OR is the OR function of the appropriate FEC Request from the two ends.
 X is don't care.

■ Which is good for the user?

- Joel Goergen stated a concern for the single PMD approach:

Key concern for this approach is the requirement for the user to understand what is implemented within the silicon to ensure interoperability

- *E.g. 5m cable operation, both ends designated 25GBASE-CR but only one end has implemented RS-FEC.*

http://www.ieee802.org/3/by/public/adhoc/architecture/goergen_120215_25GE_adhoc_v2.pdf (slide 10-13)

■ Have we discussed thoroughly?

- Not necessarily.

- Although we spent a lot of time, we still missed some discussion.
- This is also related to the operation for 5m cable with RS-FEC at only one end.

■ Does the proposal have any technical difference?

- No, for what has been discussed in public and written in Draft 3.0.

- There is minor difference for what we have not discussed (at least in public).
- This is also related to the operation for 5m cable with RS-FEC at only one end.

Which is good for the user?

- No much difference for the users who do not wish to understand what is implemented within the silicon.
 - Case of Two PMDs:
 - Buy products labeled as **25GBASE-CR, NOT 25GBASE-CR-S** for **5m** cable
 - Buy products labeled as either 25GBASE-CR or 25GBASE-CR-S for 3m cable
 - Case of Single PMD:
 - Buy products labeled as 25GBASE-CR **w/ RS-FEC, NOT w/o RS-FEC** for **5m** cable
 - Buy products labeled as any 25GBASE-CR (with or without RS-FEC) for 3m cable

- Big difference for the users who wish to understand what is implemented within the silicon.
 - Case of Two PMDs: difficult to understand
 - Obscured technical difference between 25GBASE-CR and 25GBASE-CR-S
 - Complicated FEC-mode resolution
 - Case of Single PMD: easy to understand
 - Clear technical difference between with and without RS-FEC
 - Simple FEC-mode resolution

- I think single PMD does not increase the requirements for the user to understand, but gives more chance for the user to understand.

Operation for 5m cable w/ RS-FEC at only one end



- No enforcement of RS-FEC (always applicable no matter # of PMD)
 - Option 0: Just let link goes up in BASE-R FEC mode. BER may be just high.
 - This is an easy natural option, but some user may want to enforce RS-FEC.

- Case of Two PMDs
 - Option 1: Enforce RS-FEC mode, and keep link down.
 - By requesting RS-FEC and deliberately not advertising A9 but only A10.
 - This is secret non-standard usage, because it is not described in the spec. According to Draft 3.0, 25GBASE-CR should advertise both A9 and A10, not only A10.
 - Even if we describe it in the spec, it is confusing, complicated, and difficult to understand.
 - We did not discuss this usage (at least in public), before we adopt 2 PMDs in March 2015.

- Case of Single PMD
 - Option 2: Let link goes up once in BASE-R FEC mode. Then, detect the situation and reset the link (or just alert the user).
 - By software.
 - This is much simpler than option 1, because FEC mode is resolved by only one truth table.
 - The function of hardware is different from option 1, because we now use software.

 - Option 3: Enforce RS-FEC mode, and keep link down.
 - By Auto Negotiation using another FEC-capability field which indicates “RS-FEC required”.
 - This is much simpler than option 1, because FEC mode is resolved by only one truth table.
 - The function of hardware is exactly same as option 1, because we do not use software.
 - However, we may have to modify the arbitration state diagram of Auto Negotiation.

Arbitration State Diagram of Auto Negotiation



- AN in Clause 73 never fails due to 10G FEC-mode resolution
 - 10G FEC-mode resolution always succeeds
 - F0 : 10G FEC ability
 - F1 : 10G FEC requested
 - AN fails only if there is no HCD (Highest Common Denominator) of PMDs at two ends of the link

- With option 3, AN now may fail due to FEC-mode resolution
 - AN may fail if “RS-FEC required” cannot be satisfied
 - We may have to change AN state diagram shown on right
 - I do not want to do this. Anybody?

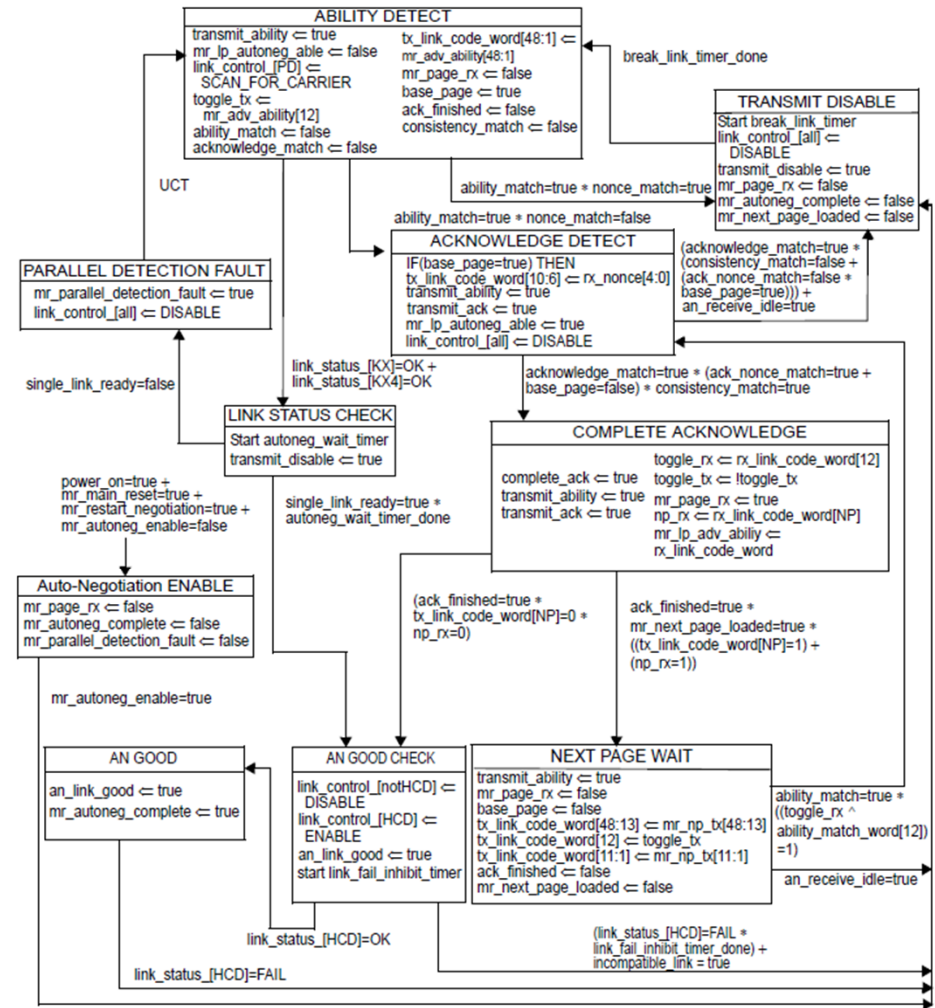


Figure 73-11—Arbitration state diagram

Summary of 5m cable w/ RS-FEC at only one end



Option	# of PMDs	Enforcement of RS-FEC mode	Link Status	FEC-mode resolution	Change of AN State diagram
0	One or Two (Always possible)	No support	Link goes up in BASE-R FEC mode (BER may be just high)		
1	Two PMDs (Draft 3.0 with secret usage)	Possible by <i>hardware</i>	Link never goes up	Has to involve HCD resolution	No
2	Single PMD (My proposal)	Possible by <i>software</i>	Link goes up once in BASE-R FEC mode and goes down (or just the user is alerted)	Done in one truth table	No
3	Single PMD (For comparison)	Supported explicitly by <i>hardware</i>	Link never goes up	Done in one truth table	<i>May be needed</i>

- I am not concerned about the requirements for the user to understand what is implemented within the silicon.
 - Rather than that, I am more concerned about the chance for the user to understand what is implemented within the silicon.

- Use of two PMDs is a compromise to enforce RS-FEC for 5m cable by *hardware* without change of AN state diagram.
 - If we pay the effort to change AN state diagram, we can enforce RS-FEC for 5m cable by *hardware*, and we can use a single PMD.
 - If we use *software*, not hardware, to enforce RS-FEC for 5m cable, we don't need to change AN state diagram, and we can use a single PMD.
 - I don't think we have thoroughly discussed these options, in particular the *software* option to enforce RS-FEC for 5m cable.

- My recommendation is a single PMD with optional FEC and to use software to enforce RS-FEC for 5m cable if it is desired

Appendix

Detail Changes

Clause 73

- P53, L46: delete “25GBASE-KR-S,” and “25GBASE-CR-S,”
- P54, L6: change “D[43:21]” with “D[42:21]”
- P54, L6: change “D[47:44]” with “D[47:43]”
- P54, L19: change assignment in Figure 73-6 as follows:
 - D42 = A21, D43 = F2, D44 = F3, D45 = F4
- P54, L44: change Table 73-4 as follows:
 - Delete row of A9 for “25GBASE-KR-S or 25GBASE-CR-S”
 - Assign A9 to “25GBASE-KR or 25GBASE-CR”
 - Assign A10 through A21 to “Reserved for future technology”
- P55, L4: delete the whole paragraph starting “25GBASE-KR-S ability are”
- P55, L9: change “A[22:11]” with “A[21:10]”
- P55, L16: change the paragraphs of cl 73.6.5 as follows:

FEC (F2:F3:F4:F0:F1) is encoded in bits D43:D47 of the base link codeword. The five FEC bits are used as follows:

 - a) F0 is 10 Gb/s per lane FEC ability
 - b) F1 is 10 Gb/s per lane FEC requested
 - c) F2 is 25G RS-FEC ability
 - d) F3 is 25G RS-FEC requested
 - e) F4 is 25G BASE-R FEC requested

Bits F2 through F4 are used for resolving FEC operation for 25G PHYs while bits F0 and F1 are used for 10 Gb/s per lane operation. Bits F0 and F1 are not used for 25G PHYs.

- P55, L30: Change the entire clause 73.6.5.1 as follows:

73.6.5.1 FEC resolution for 25G PHYs

If neither 25G PHY requests FEC operation in bits F3 or F4 then FEC is not enabled.

If either 25G PHY requests RS-FEC and both 25G PHYs have RS-FEC ability then RS-FEC operation is enabled.

Otherwise, BASE-R FEC operation is enabled.

- P55, L40: Insert the following table:

F2 (Local) and F2 (Remote)	F3 (Local) or F3 (Remote)	F4 (Local) or F4 (Remote)	FEC mode
0	0	0	no FEC
0	0	1	BASE-R FEC
0	1	X	BASE-R FEC
1	0	0	no FEC
1	0	1	BASE-R FEC
1	1	X	RS-FEC

- P56, L27: delete “25GBASE-KR-S,” and “25GBASE-CR-S,”
- P56, L34: delete “and 25GBASE-KR-S or 25GBASE-CR-S”
- P57, L5-10: delete row of 8 for “25GBASE-KR-S or 25GBASE-CR-S” and renumber rows of 9-11 with 8-10
- P57, L39-40: change the line as follows:

25GR; represents the 25GBASE-KR or 25GBASE-CR PMD.

Clauses other than 73

- P2, L2: delete “and 25GBASE-CR-S”
- P2, L3: delete “and 25GBASE-KR-S”
- P2, L7: delete “25GBASE-CR-S,”
- P2, L8: delete “25GBASE-KR-S,”
- P23, L1-14: delete clauses “1.4.64c 25GBASE-CR-S” and “1.4.64e 25GBASE-KR-S” and renumber clauses 1.4.64d/f/g as 1.4.64c/d/e
- P26, L8-9: delete lines for “25GBASE-CR-S”
- P26, L12-13: delete lines for “25GBASE-KR-S”
- P27, L26: change “25GBASE-CR, 25GBASE-CR-S, 25GBASE-KR and 25GBASE-KR-S PHYs” with “25GBASE-CR and 25GBASE-KR PHYs”
- P28, L26: change “25GR-S and 25GR” with “25GR”
- P28, L26: insert ‘RS-FEC25G Capable,’ before ‘RS-FEC25G Req’
- P28, L31: delete the definition of “25GR-S”
- P28, L35: insert the following definition before the definition of “RS-FEC25G Req”

RS-FEC25G Capable	25G RS-FEC ability as specified in Clause 73 (see 73.6.5) and Clause 108
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- P31, L38: delete “or 25GBASE-KR-S”
- P31, L39: delete “or 25GBASE-CR-S”
- P32, L13: delete “, 25GBASE-KR-S”
- P32, L14: delete “, 25GBASE-CR-S”
- P32, L29: delete “, 25GBASE-KR-S”
- P32, L31: delete “, 25GBASE-CR-S”
- P32, L45: delete “and 25GBASE-KR-S”
- P32, L47: delete “and 25GBASE-CR-S”
- P34, L13-25: change Table 45-17b as follows:
 - Delete row of “1.19.2 25GBASE-CR-S ability”
 - Delete row of “1.19.0 25GBASE-KR-S ability”
 - Reassign 1.19.2/1/0 to “25GBASE-SR/CR/KR ability”
 - Reassign 1.19.15:3 to “Reserved”
- P34, L30: change “(1.19.4)” with “(1.19.2)”
- P34, L36: change “(1.19.3)” with “(1.19.1)”
- P34, L41-46: delete clause “45.2.1.14b.3 25GBASE-CR-S ability (1.19.2)”
- P34, L47: change “(1.19.1)” with “(1.19.0)” and clause number with “45.2.1.14b.3”
- P35, L1-5: delete clause “45.2.1.14b.5 25GBASE-KR-S ability (1.19.0)”
- P47, L11-12: delete “, 25GBASE-KR-S or 25GBASE-CR-S,”
- P47, L20-29: change Table 45-209 as follows:
 - Delete row of “7.48.12 25GBASE-KR-S or 25GBASE-CR-S”
 - Reassign “7.48.12” to “25GBASE-KR or 25GBASE-CR”
 - Reassign “7.48.15:13” to “Reserved”
- P47, L49: delete “, 7.48.13” from title of clause 45.2.7.12.2
- P49, L16: delete “and 25GBASE-KR-S”
- P51, L7: change “25GBASE-KR, and 25GBASE-KR-S” with “and 25GBASE-KR”

Clauses other than 73

- P51, L25-30: change the paragraph inserted after the third paragraph in 69.2.3 as follows:
Backplane Ethernet also specifies 25GBASE-KR ~~and 25GBASE-KR-S~~. The 25GBASE-KR embodiment employs the PCS defined in clause 107, the BASE-R FEC defined in Clause 74, ~~the RS-FEC defined in Clause 108~~, the PMA defined in Clause 109, and the PMD defined in Clause 111, and specifies 25 Gb/s operation over one differential path in each direction. **The 25GBASE-KR PHY may optionally include the RS-FEC, as defined in Clause 108.**
- P52, L10-21: change Table 69-1a as follows:
 - Delete row of “25GBASE-KR-S”
 - Delete column of “Clause 111 25GBASE-KR-S PMD”
 - Change “Clause 108 25GBASE-R RS-FEC” for “25GBASE-KR” as “O” (Optional)
- P52, L28: delete “and 25GBASE-KR-S”
- P59, L21: change “25GBASE-CR, 25GBASE-CR-S, 25GBASE-KR, and 25GBASE-KR-S PHYs” with “25GBASE-CR and 25GBASE-KR PHYs”
- P73, L13: delete row of “25GBASE-KR-S” from Table 78-1
- P73, L16: delete row of “25GBASE-CR-S” from Table 78-1
- P73, L39: delete row of “25GBASE-KR-S 25GBASE-CR-S” from Table 78-2
- P73, L49: change “25GBASE-CR, 25GBASE-CR-S, 25GBASE-KR, and 25GBASE-KR-S PHYs” with “25GBASE-CR and 25GBASE-KR PHYs”
- P74, L16: delete “25GBASE-CR-S” and “25GBASE-KR-S”
- P76, L12-13: delete “25GBASE-CR-S,” and “25GBASE-KR-S,”
- P76, L34-35: delete “and 25GBASE-CR-S” and “and 25GBASE-KR-S”
- P76, L45: delete “25GBASE-CR-S,” and “25GBASE-KR-S,”
- P77, L42: delete row of “25GBASE-CR-S” from Table 105-1
- P77, L47: delete row of “25GBASE-KR-S” from Table 105-1
- P78, L16-31: change Table 105-2 as follows:
 - Delete row of “25GBASE-CR-S”
 - Delete row of “25GBASE-KR-S”
 - Delete column of “Clause 110 25GBASE-CR-S PMD”
 - Delete column of “Clause 111 25GBASE-KR-S PMD”
 - Change “Clause 108 25GBASE-R RS-FEC” as “O” (Optional) for “25GBASE-CR” and “25GBASE-KR”
- P79, L44: change “25GBASE-CR, 25GBASE-CR-S, 25GBASE-KR, and 25GBASE-KR-S PHYs” with “25GBASE-CR and 25GBASE-KR PHYs”
- P87, L16: delete row of “25GBASE-CR-S PMD” from Table 105-3
- P87, L19: delete row of “25GBASE-KR-S PMD” from Table 105-3
- P98, L35: change “25GBASE-KR PMD, 25GBASE-KR-S PMD, 25GBASE-CR PMD or 25GBASE-CR-S PMD” with “25GBASE-KR PMD or 25GBASE-CR PMD”
- P129, L17: change “25GBASE-CR, 25GBASE-CR-S, 25GBASE-KR, and 25GBASE-KR-S” with “25GBASE-CR and 25GBASE-KR”
- P136, L22: change “25GBASE-KR, 25GBASE-KR-S, 25GBASE-CR, or 25GBASE-CR-S” with “25GBASE-KR or 25GBASE-CR”

Clauses other than 73

- P138, L2: delete “and 25GBASE-CR-S” from clause 110 title
- P138, L7: delete “, the 25GBASE-CR-S PMD”
- P138, L11: delete “and 25GBASE-CR-S”
- P138, L18-36: change Table 110-1 as follows:
 - Change “25GBASE-CR and 25GBASE-CR-S PMDs” with “25GBASE-CR PMD” in title
 - Delete column of “25GBASE-CR-S”
 - Change “108 RS-FEC” for “25GBASE-CR” as “Optional”
- P138, L41-45: delete the second statement and change the paragraph as follows:

A 25GBASE-CR PHY supports operation over cable assemblies of types CA-25G-N and CA-25G-S and optionally type CA-25G-L (see 110.10).
- P138, L47: delete “or 25GBASE-CR-S”
- P139, L10: change “25GBASE-CR and 25GBASE-CR-S PHYs” with “25GBASE-CR PHY”
- P139, L14: change “25GBASE-CR and 25GBASE-CR-S PMD sublayers” with “25GBASE-CR PMD sublayer”
- P139, L40: delete “or 25GBASE-CR-S” and align “25GBASE-CR” under curly brace in Figure 110-1
- P139, L50: delete “and 25GBASE-CR-S” from Figure 110-1 title
- P140, L3: change “25GBASE-CR and 25GBASE-CR-S PMDs” with “25GBASE-CR PMD”
- P140, L4: change “these PMDs” with “this PMD”
- P140, L35: change “25GBASE-CR and 25GBASE-CR-S PHYs” with “25GBASE-CR PHY”
- P141, L46: insert “may optionally implement” before “the 25GBASE-R RS-FEC sublayer”
- P141, L47: delete the second statement of “A 25GBASE-CR-S PHY implements the BASE-R FEC sublayer (Clause 74).”
- P142, L5-6: change the paragraph as follows:
 - A 25GBASE-CR PHY **with 25GBASE-R RS-FEC sublayer** can operate in RS-FEC, BASE-R FEC, or no-FEC mode. A **25GBASE-CR PHY without 25GBASE-R RS-FEC sublayer** can operate in either BASE-R FEC or no-FEC mode.
- P142, L21: delete “or 25GBASE-CR-S”
- P142, L46: delete “or 25GBASE-CR-S” from Figure 110-2 title
- P145, L42: change “25GBASE-CR and 25GBASE-CR-S PMDs” with “25GBASE-CR PMD”
- P146, L17: change “25GBASE-CR and 25GBASE-CR-S PHYs” with “25GBASE-CR PHY”
- P146, L23: change “25GBASE-CR and 25GBASE-CR-S PHYs” with “25GBASE-CR PHY”
- P146, L31: delete “or 25GBASE-CR-S”
- P146, L48-50: change the second paragraph of 110.8.4.2 as follows:

A 25GBASE-CR PHY shall comply with the receiver interference tolerance test requirements for the BASE-R FEC and no-FEC modes. A 25GBASE-CR PHY with 25GBASE-R RS-FEC sublayer shall comply with the receiver interference tolerance test requirements for the RS-FEC mode.
- P147, L38: delete “and 25GBASE_CR-S” from Table 110-6 title

Clauses other than 73

- P148, L1: delete “and 25GBASE-CR-S” from Table 110-6 title
- P148, L20: delete “and 25GBASE-CR-S” from Table 110-7 title
- P150, L35: change “25GBASE-CR and 25GBASE-CR-S PHYs” with “25GBASE-CR PHY”
- P150, L36: change “25GBASE-CR PHY” with “25GBASE-CR PHY with 25GBASE-R RS-FEC sublayer”
- P150, L51: change “25GBASE-CR-S” with “25GBASE-CR”
- P150, L52: change “a 25GBASE-CR PHY” with “a 25GBASE-CR PHY with 25GBASE-R RS-FEC sublayer”
- P151, L16: change “25GBASE-CR and 25GBASE-CR-S PHYs” with “25GBASE-CR PHY”
- P151, L28: change “two PHYs that can each be either 25GBASE-CR or 25GBASE-CR-S” with “two 25GBASE-CR PHYs”
- P151, L35: change “between 25GBASE-CR or 25GBASE-CR-S PHYs” with “between 25GBASE-CR PHYs”
- P151, L36: change “Since 25GBASE-CR and 25GBASE-CR-S PHYs have” with “Since 25GBASE-CR PHY has”
- P156, L47: change “both 25GBASE-CR and 25GBASE-CR-S Physical Layers” with “25GBASE-CR Physical Layer”
- P157, L2: delete “or 25GBASE-CR-S”
- P159, L3: delete “and 25GBASE-CR-S” in clause 110.13 title
- P159, L8: delete “and 25GBASE-CR-S”
- P159, L38: delete “and 25GBASE-CR-S”
- P160, L6: change row of “*CR” as follows:
 - Change “*CR” with “CR” (delete “*”)
 - Change “O” with “M”
 - Delete “No []”
- P160, L8: delete row of “CR-S”
- P160, L16: change row of “RS-FEC” as follows:
 - Change “RS-FEC” with “*RS-FEC” (insert “*”)
 - Change “CR:M” with “O”
 - Change “N/A []” with “No []”
- P161, L20: delete “and 25GBASE-CR-S” in clause 110.13.4 title
- P164, L35: in row of “RC5”, change “CR:M” with “RS-FEC:M”
- P164, L45: in row of “RC9”, change “CR:M” with “RS-FEC:M”
- P167, L2: delete “and 25GBASE-KR-S” from clause 111 title
- P167, L7: delete “, the 25GBASE-KR-S PMD”
- P167, L16-33: change Table 111-1 as follows:
 - Change “25GBASE-KR and 25GBASE-KR-S PMDs” with “25GBASE-KR PMD”
 - Delete column of “25GBASE-KR-S”
 - Change “108 – RS-FEC” for “25GBASE-KR” as “Optional”
- P167, L40: Change “111.9.1 or 111.9.2” with “111.9.2 and optionally 111.9.1”
- P167, L40-42: Delete the second and third sentences of “A 25GBASE-KR-S PHY operates over a channel meeting the requirements of 111.9.2. A 25GBASE-KR PHY interoperates with a 25GBASE-KR-S PHY.”

Clauses other than 73

- P167, L44: delete “or 25GBASE-KR-S”
- P168, L7: change “25GBASE-KR and 25GBASE-KR-S PHYs” with “25GBASE-KR PHY”
- P168, L35: delete “or 25GBASE-KR-S” and align “25GBASE-KR” under curly brace in Figure 111-1
- P168, L45: delete “and 25GBASE-KR-S”
- P168, L51: change “25GBASE-KR and 25GBASE-KR-S PMDs” with “25GBASE-KR PMD”
- P168, L52: change “these PMDs” with “this PMD”
- P169, L27: change “25GBASE-KR and 25GBASE-KR-S PHYs” with “25GBASE-KR PHY”
- P170, L38: insert “may optionally implement” before “the 25GBASE-R RS-FEC sublayer”
- P170, L39: delete the second sentence of “A 25GBASE-KR-S PHY implements the BASE-R FEC sublayer (Clause 74).”
- P170, L50: insert “with 25GBASE-R RS-FEC sublayer” after “A 25GBASE-KR PHY”
- P170, L50: change “A 25GBASE-KR-S PHY” with “A 25GBASE-KR PHY without 25GBASE-R RS-FEC sublayer”
- P171, L13: delete “or 25GBASE-KR-S”
- P171, L32: delete “or 25GBASE-KR-S” in Figure 111-2 title
- P173, L33: change “25GBASE-KR and 25GBASE-KR-S PMDs” with “25GBASE-KR PMD”
- P173, L43: change “25GBASE-KR and 25GBASE-KR-S PHYs” with “25GBASE-KR PHY”
- P174, L3: delete “and 25GBASE-KR-S”
- P174, L20-22: change the second paragraph of 111.8.3.1 as follows:

A 25GBASE-KR PHY shall comply with the receiver interference tolerance test requirements for the BASE-R FEC mode and no-FEC mode. A 25GBASE-KR PHY with 25GBASE-R RS-FEC sublayer shall comply with the receiver interference tolerance test requirements for the RS-FEC mode.
- P175, L1: delete “and 25GBASE-KR-S” from Table 111-5 title
- P175, L29: delete “and 25GBASE-KR-S” from Table 111-6 title
- P176, L10: change “25GBASE-KR and 25GBASE-KR-S PHYs” with “25GBASE-KR PHY”
- P176, L12: insert “with 25GBASE-R RS-FEC sublayer” after “25GBASE-KR PHY”
- P176, L28: change “two PHYs of type 25GBASE-KR” with “two 25GBASE-KR PHYs both with 25GBASE-R RS-FEC sublayer”
- P176, L29: change “two PHYs where one or both are type 25GBASE-KR-S” with “two 25GBASE-KR PHYs either without 25GBASE-R RS-FEC sublayer”
- P176, L39: change “25GBASE-KR channel” with “Channel for 25GBASE-KR with RS-FEC” in clause 111.9.1 title
- P176, L40: change the first sentence as follows:

A channel for 25GBASE-KR with RS-FEC is used as a link connecting two 25GBASE-KR PHYs both with 25GBASE-R RS-FEC sublayer.

Clauses other than 73

- P176, L47: change “25GBASE-KR-S channel” with “Channel for 25GBASE-KR without RS-FEC” in clause 111.9.2 title
- P176, L48-49: change the first sentence in the first paragraph of clause 111.9.2 as follows:
A channel for 25GBASE-KR without RS-FEC is used as a link between two 25GBASE-KR PHYs either or both without 25GBASE-R RS-FEC sublayer.
- P177, L6: change “25GBASE-KR” with “25GBASE-KR with RS-FEC” and “25GBASE-KR-S” with “25GBASE-KR without RS-FEC” in the title row of Table 111-8
- P178, L3: change “25GBASE-KR” with “25GBASE-KR with RS-FEC” and “25GBASE-KR-S” with “25GBASE-KR without RS-FEC” in the title row of Table 111-8
- P178, L13: change “25GBASE-KR channel” with “channel for 25GBASE-KR with RS-FEC”
- P179, L3: delete “and 25GBASE-KR-S” in clause 111.11 title
- P179, L8: delete “and 25GBASE-KR-S”
- P179, L38: delete “and 25GBASE-KR-S”
- P180, L6: change row of “*KR” as follows:
 - Change “*KR” with “KR” (delete “*”)
 - Change “O” with “M”
 - Delete “No []”
- P180, L8: delete row of “KR-S”
- P180, L16: change row of “RS-FEC” as follows:
 - Change “RS-FEC” with “*RS-FEC” (insert “*”)
 - Change “KR:M” with “O”
 - Change “N/A []” with “No []”
- P181, L2: delete “and 25GBASE-KR-S” in clause 111.11.4 title
- P184, L22: in row of “RC8”, change “KR:M” with “RS-FEC:M”
- P184, L28: in row of “RC10”, change “KR:M” with “RS-FEC:M”
- P184, L47: in row of “CC3”, change “CHNL*KR:M” with “CHNL*RS-FEC:M”
- P184, L49: in row of “CC4”, change “CHNL!*KR:M” with “CHNL!*RS-FEC:M”
- P205, L20: delete row of “25GBASE-CR-S (Clause 110)” from Table 93A-2
- P205, L23: delete row of “25GBASE-KR-S (Clause 111)” from Table 93A-2
- P225, L7: delete “and 25GBASE-CR-S” in clause 110A title
- P225, L14: delete “and 25GBASE-CR-S”
- P227, L37: delete “and 25GBASE-CR-S”
- P228, L6: delete “, 25GBASE-CR-S” in clause 110B title
- P228, L11: change “25GBASE-CR and 25GBASE-CR-S PHYs” with “25GBASE-CR PHY”
- P228, L14: change “25GBASE-CR and 25GBASE-CR-S PHYs” with “25GBASE-CR PHY”
- P231, L2: delete “, 25GBASE-CR-S” in clause 110B.2 title
- P231, L9: delete “, 25GBASE-CR-S”
- P231, L38: delete “, 25GBASE-CR-S,”
- P232, L12-13: delete “, 25GBASE-CR-S,” in clause 110.B.2.4 title

Clauses other than 73

- P233, L6: change “25GBASE-CR and 25GBASE-CR-S PHYs” with “25GBASE-CR PHY”
- P233, L13: change “either 25GBASE-CR or 25GBASE-CR-S Physical Layers” with “25GBASE-CR Physical Layer”
- P233, L25: change “25GBASE-CR or 25GBASE-CR-S PHYs” with “25GBASE-CR PHY”
- P233, L27: change “25GBASE-CR or 25GBASE-CR-S PHYs” with “25GBASE-CR PHY”
- P234, L37: delete “or 25GBASE-CR-S”
- P234, L47: delete “or 25GBASE-CR-S”

Thank you