91.5.3.3 Reed-Solomon decoder

The Reed-Solomon decoder extracts the message symbols from the codeword, corrects them as necessary, and discards the parity symbols. The message symbols correspond to 20 transcoded blocks rx_scrambled.

When used to form a 100GBASE-CR4 or 100GBASE-KR4 PHY, the RS-FEC sublayer shall be capable of correcting any combination of up to t=7 symbol errors in a codeword. When used to form a 100GBASE-KP4 PHY, the RS-FEC sublayer shall be capable of correcting any combination of up to t=15 symbol errors in a codeword. The RS-FEC sublayer shall also be capable of indicating when an errored codeword was not corrected. The probability that the decoder fails to indicate a codeword with t+1 errors as uncorrected is not expected to exceed 10^{-6}. This limit is also expected to apply for t+2 errors, t+3 errors, and so on.

The Reed-Solomon decoder may provide the option to perform error detection without error correction to reduce the delay contributed by the RS-FEC sublayer. The presence of this option is indicated by the assertion of the FEC_bypass_correction_ability variable (see 91.6.3). When the option is provided, it is enabled by the assertion of the FEC_bypass_correction_enable variable (see 91.6.1).

The Reed-Solomon decoder indicates errors to the PCS sublayer by intentionally corrupting 66-bit block synchronization headers. When the decoder determines that a codeword contains errors (when the bypass correction feature is enabled) or contains errors but was not corrected (when the bypass correction feature is not supported or not enabled), it shall ensure that, for every other 257-bit block within the codeword starting with the first (1st, 3rd, 5th, etc.), the synchronization header for the first 66-bit block at the output of the 256B/257B to 64B/66B transcoder, rx_coded_0<1:0>, is set to 11. In addition, it shall ensure rx_coded_3<1:0> corresponding to the last (20th) 257-bit block in the codeword is set to 11. This will cause the PCS to discard all frames 64 bytes and larger that are fully or partially within the codeword.

The Reed-Solomon decoder may optionally provide the ability to bypass the error indication feature to reduce the delay contributed by the RS-FEC sublayer. The presence of this option is indicated by the assertion of the FEC_bypass_indication_ability variable (see 91.6.4). When the option is provided it is enabled by the assertion of the FEC_bypass_indication_enable variable (see 91.6.2).

When FEC_bypass_correction_enable is asserted, the decoder shall not bypass error indication and the value of FEC_bypass_indication_enable has no effect.

When FEC_bypass_indication_enable is asserted, additional error monitoring is performed by the RS-FEC sublayer to reduce the likelihood that errors in a packet will not be detected. The Reed-Solomon decoder counts the number of symbol errors detected on all four FEC lanes in consecutive non-overlapping ~~1 ms intervals~~blocks of 8192 codewords. If the number of symbol errors in a ~~1 ms interval~~ block of 8192 codewords exceeds ~~870~~K, then the Reed-Solomon decoder shall cause synchronization header rx_coded<1:0~~:1~~> of each subsequent 66-bit block that is delivered to the PCS to be assigned a value of 00 or 11 for a period of 60 ms to 75 ms. As a result, the PCS will set hi_ber=true which will inhibit the processing of received packets. When Auto-Negotiation is supported and enabled, assertion of hi_ber will cause Auto-Negotation to restart.

When the RS-FEC sublayer is used to form a 100GBASE-CR4 or 100GBASE-KR4 PHY, the symbol error threshold shall be K=417. When the RS-FEC sublayer is used to form a 100GBASE-KP4 PHY, the symbol error threshold shall be K=6380.

91.5.3.4 Alignment marker removal

The first 1285 message bits in every 4096th codeword is the vector am_rxmapped<1284:0> where bit 0 is the first bit received. The specific codewords that include this vector are indicated by the alignment lock and deskew function (refer to 91.5.3.1).

91.7.4.2 Receive function

Item	Feature	Subclause	Value/Comment	Status	Support
RF1	Skew tolerance	91.5.3.1	Maximum Skew of 180 ns between FEC lanes and a maximum Skew Variation of 4 ns	M	Yes [ ]
RF2	Lane reorder	91.5.3.2	Order the FEC lanes according to the FEC lane number	M	Yes [ ]
RF3	Reed-Solomon decoder for 100GBASE-CR4 or 100GBASE-KR4	91.5.3.3	Corrects any combination of up to *t*=7 symbol errors in a codeword unless error correction bypassed	KR4:M	Yes [ ] N/A [ ]
RF4	Reed-Solomon decoder for 100GBASE-KP4	91.5.3.3	Corrects any combination of up to *t*=15 symbol errors in a codeword unless error correction bypassed	KP4:M	Yes [ ] N/A [ ]
RF5	Reed-Solomon decoder	91.5.3.3	Capable of indicating when a codeword was not corrected.	M	Yes [ ]
RF6	Error indication function	91.5.3.3	Corrupts 66-bit block synchronization headers for uncorrected errored codewords (or errored codewords when correction is bypassed)	M	Yes [ ]
RF7	Error indication when error correction is bypassed	91.5.3.3	Error indication is not bypassed	BEI:M	Yes [ ] N/A [ ]
RF8	Error monitoring while error indication is bypassed	91.5.3.3	When the number of symbols errors in a 1 ms interval exceeds 870, corrupt 66-bit block synchronization headers	BEI:M	Yes [ ] N/A [ ]
RF9	Alignment marker removal	91.5.3.4	am_rxmapped removed prior to transcoding	M	Yes [ ]
RF10	256B/257B to 64B/66B transcoder	91.5.3.5	rx_coded_*j*<65:0>, *j*=0 to 3 constructed per 91.5.3.5	M	Yes [ ]
RF11	Block distribution	91.5.3.6	One 66-bit block at a time in a round robin fashion from the lowest to the highest numbered PCS lane	M	Yes [ ]
RF12	Alignment marker mapping	91.5.3.7	Map to am_rx_*x*, *x*=0 to 19 per 91.5.3.7	M	Yes [ ]

Item	Feature	Subclause	Value/Comment	Status	Support
RF1	Skew tolerance	91.5.3.1	Maximum Skew of 180 ns between FEC lanes and a maximum Skew Variation of 4 ns	M	Yes [ ]
RF2	Lane reorder	91.5.3.2	Order the FEC lanes according to the FEC lane number	M	Yes [ ]
RF3	Reed-Solomon decoder for 100GBASE-CR4 or 100GBASE-KR4	91.5.3.3	Corrects any combination of up to *t*=7 symbol errors in a codeword unless error correction bypassed	KR4:M	Yes [ ] N/A [ ]
RF4	Reed-Solomon decoder for 100GBASE-KP4	91.5.3.3	Corrects any combination of up to *t*=15 symbol errors in a codeword unless error correction bypassed	KP4:M	Yes [ ] N/A [ ]
RF5	Reed-Solomon decoder	91.5.3.3	Capable of indicating when a codeword was not corrected.	M	Yes [ ]
RF6	Error indication function	91.5.3.3	Corrupts 66-bit block synchronization headers for uncorrected errored codewords (or errored codewords when correction is bypassed)	M	Yes [ ]
RF7	Error indication when error correction is bypassed	91.5.3.3	Error indication is not bypassed	BEI:M	Yes [ ] N/A [ ]
RF8	Error monitoring while error indication is bypassed	91.5.3.3	When the number of symbols errors in a block of 8192 codewords exceeds *K*, corrupt 66-bit block synchronization headers	BEI:M	Yes [ ] N/A [ ]
RF9	Symbol error threshold for 100GBASE-CR4 and 100GBASE-KR4	91.5.3.3	*K*=417	BEI* KR4:M	Yes [ ] N/A [ ]
RF10	Symbol error threshold for 100GBASE-KP4	91.5.3.3	*K*=6380	BEI* KP4:M	Yes [ ] N/A [ ]
RF11	Alignment marker removal	91.5.3.4	am_rxmapped removed prior to transcoding	M	Yes [ ]
RF12	256B/257B to 64B/66B transcoder	91.5.3.5	rx_coded_*j*<65:0>, *j*=0 to 3 constructed per 91.5.3.5	M	Yes [ ]
RF13	Block distribution	91.5.3.6	One 66-bit block at a time in a round robin fashion from the lowest to the highest numbered PCS lane	M	Yes [ ]
RF14	Alignment marker mapping	91.5.3.7	Map to am_rx_*x*, *x*=0 to 19 per 91.5.3.7	M	Yes [ ]

The scattering parameters for a shunt capacitance with value C are defined by Equation (93A–8) where $j = \sqrt{-1}$ and $\omega = 2\pi f$.

$$S(C) = \frac{1}{2 + j\omega CR_0}\begin{bmatrix} -j\omega CR_0 & 2 \\ 2 & -j\omega CR_0 \end{bmatrix} \qquad (93A\text{–}8)$$

The scattering parameters for the device-side capacitance C_d are denoted as $S^{(d)} = S(C_d)$ and the scattering parameters for the package-side capacitance C_p are denoted as $S^{(p)} = S(C_p)$.

93A.1.2.3 Two-port network for the package transmission line

The scattering parameters for a 1 mm section of the package transmission line model are defined by Equation (93A–9), Equation (93A–10), and the parameters values in Table 93A–2.

$$s_{11} = s_{22} = \exp(\rho_0 + \rho_1\sqrt{f} + \rho_2 f + \rho_4 f^2) \qquad (93A\text{–}9)$$

$$s_{12} = s_{21} = \exp(\gamma_0 + \gamma_1\sqrt{f} + \gamma_2 f + \gamma_4 f^2) \qquad (93A\text{–}10)$$

Table 93A–2—Transmission line model parameters

Parameter	Real	Imaginary	Units
ρ_0	–6.47	–1.51	—
ρ_1	2.034	0.0106	1/GHz$^{1/2}$
ρ_2	–0.2712	–0.04903	1/GHz
ρ_4	2.167×10^{-3}	2.765×10^{-4}	1/GHz^2
γ_0	-4.453×10^{-4}	4.467×10^{-5}	—
γ_1	-3.317×10^{-4}	-1.444×10^{-3}	1/GHz$^{1/2}$
γ_2	-6.409×10^{-4}	–0.~~3914~~03914	1/GHz
γ_4	-1.669×10^{-5}	3.134×10^{-5}	1/GHz^2

The scattering parameters for a package transmission line whose length z_p is an integer multiple of 1 mm are derived from the scattering parameters of the 1 mm section using Equation (93A–11) and Equation (93A–12).

$$s_{11}^{(l)} = s_{22}^{(l)} = s_{11}\sum_{i=1}^{z_p} s_{21}^{2i-2} \qquad (93A\text{–}11)$$

$$s_{12}^{(l)} = s_{21}^{(l)} = s_{21}^{z_p} \qquad (93A\text{–}12)$$

The transmission line scattering parameter matrix is then denoted as $S^{(l)}$.