

802.3cy D0.5 FEC Related Comments

March 8, 2022

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Introduction

- 802.3cy January Interim Motion #5 passed
- Need to update FEC related texts in D0.5
- A preliminary list of changes are shown in the following slides

Motion #5

Move to adopt the following FEC and Interleaving: RS(936,846) with L=1,2,4,8 with editorial license to implement

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S: Mike Tu

Technical ($\geq 75\%$)

Motion Passes by unanimous consent

802.3ch vs. 802.3cy FEC Related Parameters

	802.3ch	802.3cy
FEC	RS (360,326,m=10)	RS (936,846,m=10)
# data bits	3250	8450
# oam bits	10	10
# data+oam bits	3260	8460
# FEC encoded bits	3600	9360
# parity bits	340	900
# 64B/65B blocks	50	130
Interleaving depth	1, 2, 4	1, 2, 4, 8
FEC frame nsec	320	332.8
PAM4 symbols per FEC	1800	4680

Page 72 Line 37-39 165.1.3

To maintain a bit error ratio (BER) of less than or equal to 10^{-12} , the <<.3cy PHY>> PHYs add 900 bits of Reed-Solomon forward error correction (RS-FEC) parity to each group of 130 64B/65B blocks. The PAM4 mapping, scrambler, RS-FEC, interleaver, and PAM4 encoder/decoder are all contained in the PCS (see 165.3).

Page 73 Line 30-35 165.1.3.1

These 65-bit blocks are then aggregated into groups of 130 blocks. The contents of each group are contained in a vector `tx_group` 130×65 B. Next, a 10-bit OAM field is appended to form a 8460-bit block. A number, L , of these 8460-bit blocks are formed into an RS-FEC input superframe, then encoded by the RS-FEC $(936, 846, 2^{10})$ and the round-robin interleaving as described in 165.3.2.2.16. The RS-FEC output superframe consists of $L \times 9360$ bits. The duration of the superframe is $L \times 332.8$ ns.

Page 73 Line 39-43 165.1.3.1

tx_group130x65B<8449:0> is defined as:

$$\text{tx_group130x65B}\langle 65 \times i + j \rangle = \text{tx_coded}_i\langle j \rangle$$

where $i = 0$ to 129, $j = 0$ to 64, and $\text{tx_coded}_i\langle 64:0 \rangle$ is the i^{th} 64B/65B block where $\text{tx_coded}_0\langle 64:0 \rangle$ is the first block transmitted.

Page 87 Line 12-15 165.3.2.2

After mapping the 25GMII transfers to 64B/65B blocks, the subsequent functions of the PCS Transmit process take L groups of 130 65B blocks and append a 10-bit OAM field to each group. This forms the input to an L -interleaved RS-FEC which adds $L \times 900$ parity bits. The resulting $L \times 9360$ bits are then scrambled. These bits are then mapped, two at a time, into a PAM4 symbol.

Page 87 Line 18-20 165.3.2.2

In each symbol period, when communicating with the PMA, the PCS Transmit generates a PAM4 symbol that is transferred to the PMA via the PMA_UNITDATA.request primitive. The symbol period, T , is $1000 / 14.0625$ ps.

Page 87 Line 38-42 165.3.2.2

During transmission, the 130 blocks of 65B encoded bits are appended with a 10-bit OAM field to form the RS-FEC input frame. During data encoding, PCS Transmit utilizes L-interleaved (L = 1, 2, 4, or 8) Reed-Solomon encoders to generate and append 900 parity check bits to form 9360-bit (936,846) RS-FEC frames that are interleaved into an L-interleaved RS-FEC superframe.

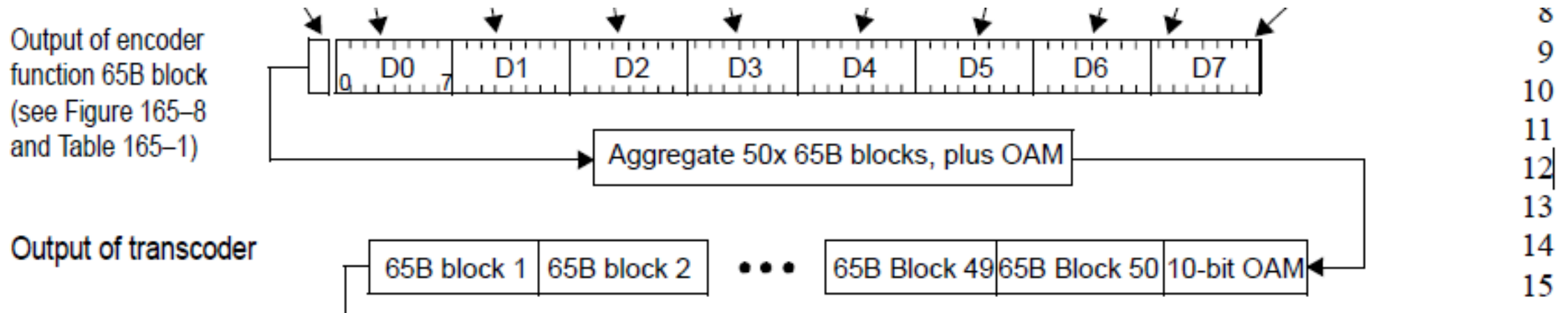
Page 87 Line 44-48 165.3.2.2

Each RS-FEC input superframe consists of $8460 \times L$ bits, or $846 \times L$ Reed-Solomon message symbols. The interleaving function is integrated with the RS-FEC encoding, applying a round-robin interleaving scheme and distributing the 10-bit Reed-Solomon message symbols into L RS-FEC encoders. After encoding, the RS-FEC frames from each encoder are recombined into one single interleaved RS-FEC superframe, which consists of $936 \times L$ symbols, or $9360 \times L$ bits.

Page 87 Line 51-53 165.3.2.2

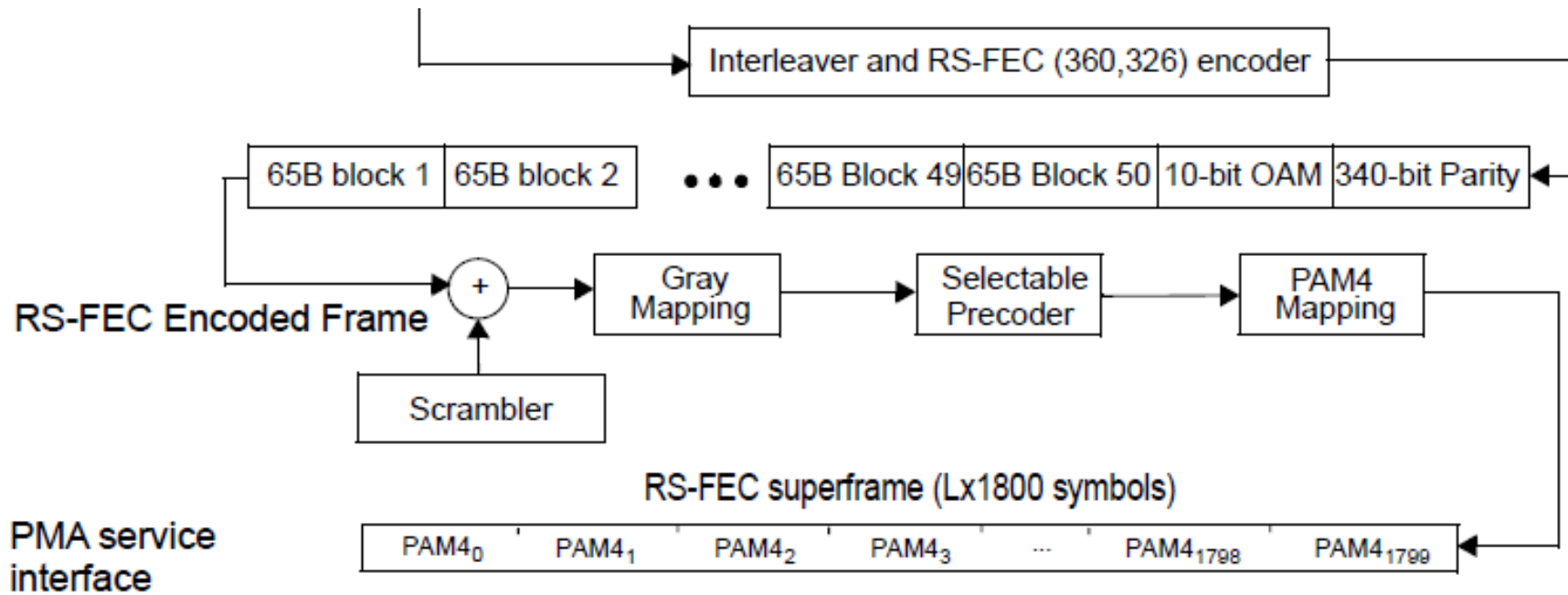
L is called the interleaving depth, and the possible choices of L are 1, 2, 4, and 8. The interleaver settings requested in each direction of transmission may be different, and the value of L used by the transmitter is determined by the link partner and signaled during the PAM2 training mode Infofield exchange.

Page 89 Line 9-15 Figure 165-6



1. Change "50x 65B" to "130x 65B"
2. Change "65B Block 49" to "65B Block 129"
3. Change "65B Block 50" to "65B Block 130"

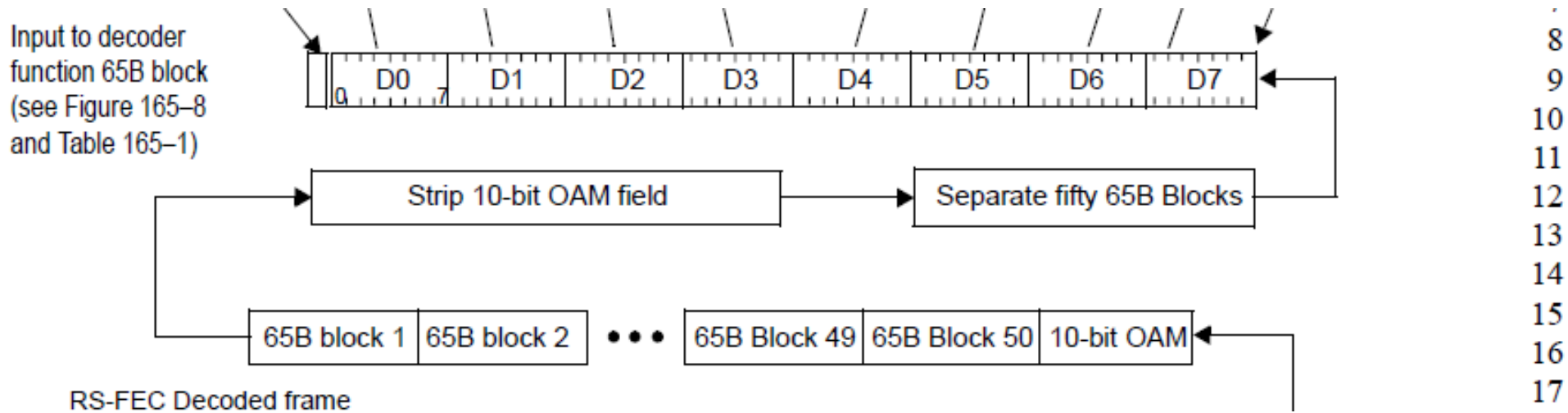
Page 89 Line 17-28 Figure 165-6



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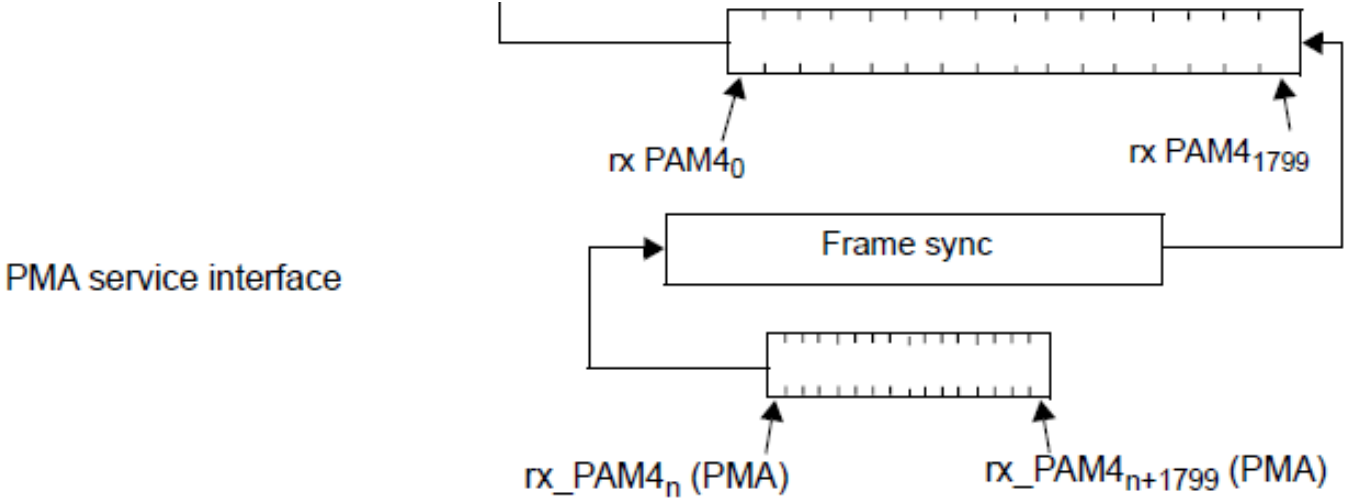
1. Change “RS-FEC (360,326)” to “RS-FEC (936,846)”
2. Change “65B Block 49” to “65B Block 129”
3. Change “65B Block 50” to “65B Block 130”
4. Change “340-bit Parity” to “900-bit Parity”
5. Change “Lx1800” to “Lx4680”
6. Change “PAM4₁₇₉₈” to “PAM4₄₆₇₈”, and “PAM4₁₇₉₉” to “PAM4₄₆₇₉”

Page 90 Line 8-17 Figure 165-7



1. Change “Separate fifty 65B Blocks” to “Separate 130x 65B Blocks”
2. Change “65B Block 49” to “65B Block 129”
3. Change “65B Block 50” to “65B Block 130”

Page 90 Line 28-38 Figure 165-7



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- 1. Change “rx PAM4₁₇₉₉” to “rx PAM4₄₆₇₉”
- 2. Change “rx_PAM4_{n+1799} (PMA)” to “rx_PAM4_{n+4679} (PMA)”

Page 94 Line 29-33 165.3.2.2.14

- The resulting RS-FEC frame of **130** 65B blocks, followed by the 10-bit OAM field and **900** parity bits is **9360** bits. See Figure 165–6 and 165.3.2.2.17 for details on PCS bit ordering and RS-FEC encoding.
- The RS-FEC encoding takes the **8460**-bit vector, consisting of tx_group**130**x65B, and the 10-bit OAM_field, and shall generate the **90** 10-bit parity symbols (**900** bits total).

Page 94 Line 46-50 165.3.2.2.15

- 25GBASE-T1 supports $L = 1, 2, 4, \text{ and } 8$.
- The PCS Transmit shall aggregate L RS-FEC input frames into an interleaved RS-FEC input superframe. There are $8460 \times L$ bits, or $846 \times L$ Reed-Solomon message symbols in total in the input superframe. The corresponding message symbols are $m_{846 \times L - 1}, m_{846 \times L - 2}, \dots, m_1, m_0$.

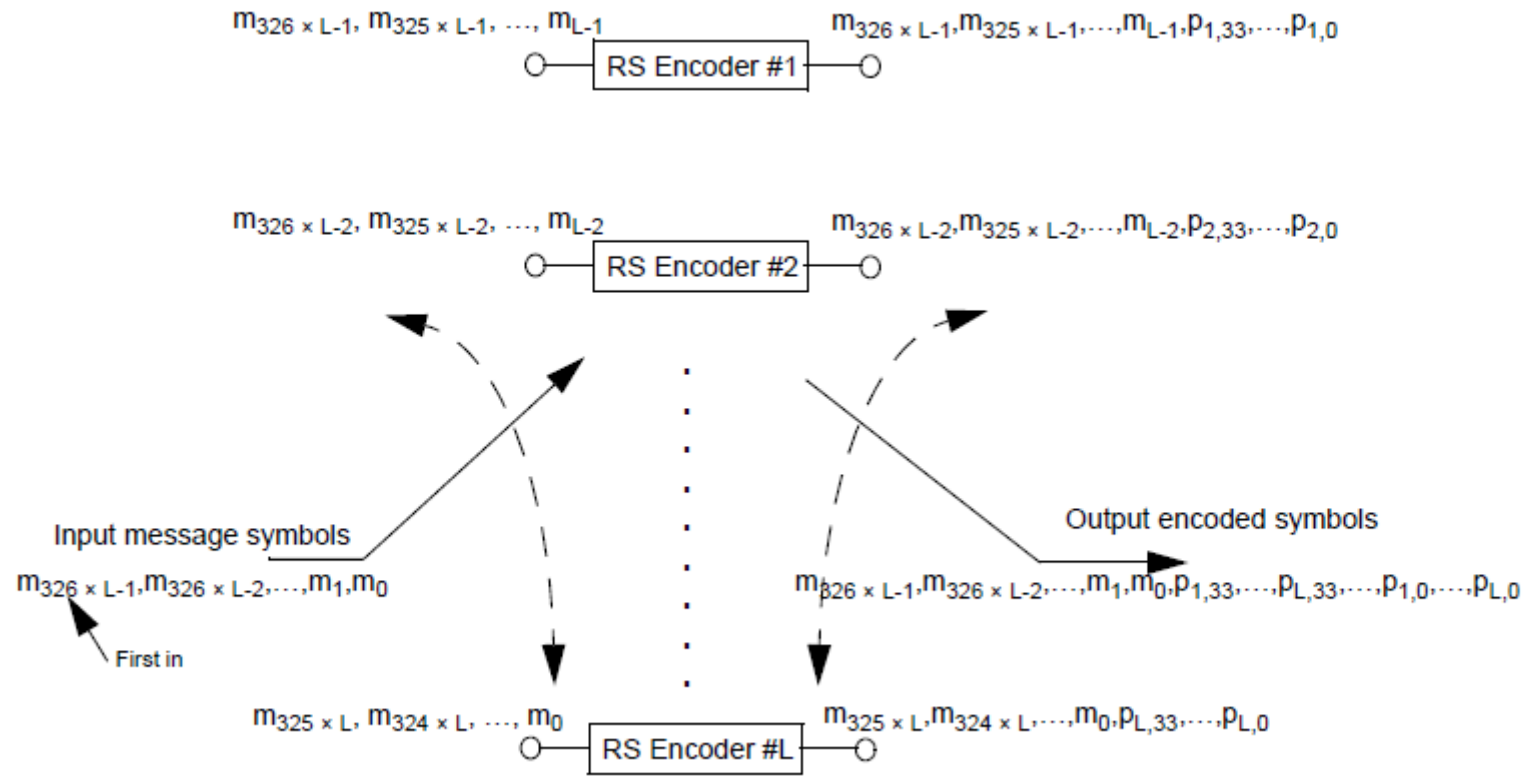
Page 95 Line 6-7 Figure 165-9

$m_{326 \times L-1}, m_{326 \times L-2}, \dots, m_1, m_0, p_{1,33}, \dots, p_{L,33}, \dots, p_{1,0}, \dots, p_{L,0}$, where $p_{i,r}$ is the r^{th} parity symbol of the i^{th} encoder.

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- Change “ $m_{326 \times L-1}$ ” to “ $m_{846 \times L-1}$ ”
- Change “ $m_{326 \times L-2}$ ” to “ $m_{846 \times L-2}$ ”

Page 95 Line 11-29 Figure 165-9



- Change all “326” to “846”
- Change all “325” to “845”
- Change all “324” to “844”
- Change all “33” to “89”

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Page 95 Line 39-43 165.3.2.2.17

- The group of 8460 bits are encoded using a Reed-Solomon encoder operating over the Galois Field $GF(2^{10})$ where the symbol size is 10 bits. The encoder processes 846 ten-bit RS-FEC message symbols to generate 90 ten-bit RS-FEC parity symbols, which are then appended to the message to produce a codeword of 936 ten-bit RS-FEC symbols. For the purposes of this clause, the particular Reed-Solomon code is denoted as RS-FEC(936,846).

Page 95 Line 47-50 Equation 165-1

$$g(x) = \prod_{j=0}^{33} (x - \alpha^j) = g_{34}x^{34} + g_{33}x^{33} + \dots + g_4x^4 + g_3x^3 + g_2x^2 + g_1x + g_0 \quad (165-1)$$

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- Change all “34” to “90”
- Change all “33” to “89”

Page 96 Line 1-5 165.3.2.2.17

Equation (165–2) defines the message polynomial $m(x)$ whose coefficients are the message symbols m_{325} to m_0 .

$$m(x) = m_{325}x^{359} + m_{324}x^{358} + \dots + m_1x^{35} + m_0x^{34} \quad (165-2)$$

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- Change all “325” to “845”
- Change “324” to “844”
- Change “359” to “935”
- Change “358” to “934”
- Change “35” to “91”
- Change “34” to “90”

Page 96 Line 7-16 165.3.2.2.17

The message symbols are composed of the bits in $\text{tx_RSmessage}\langle 8459:0 \rangle$ where $m_{i,j} = \text{tx_RSmessage}\langle (845 - i) \times 10 + j \rangle$, for $i = 0$ to 845 , and $j = 0$ to 9 .

$\text{tx_RSmessage}\langle 8459:0 \rangle$ prior to RS-FEC (360,326) encoder is formed as follows:

$\text{tx_RSmessage}\langle 8449:0 \rangle = \text{tx_group130x65B}\langle 8449:0 \rangle$.

$\text{tx_RSmessage}\langle 8459:8450 \rangle = \text{OAM_field}\langle 9:0 \rangle$.

The first symbol input to the encoder is m_{845} .

Page 96 Line 18-21 165.3.2.2.17

Equation (165–3) defines the parity polynomial $p(x)$ whose coefficients are the parity symbols p_{33} to p_0 .

∩

$$p(x) = p_{33}x^{33} + p_{32}x^{32} + \dots + p_2x^2 + p_1x + p_0 \tag{165–3}$$

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- Change all “33” to “89”
- Change all “32” to “88”

Page 96 Line 31-33 165.3.2.2.17

The codeword polynomial $c(x)$ is then the sum of $m(x)$ and $p(x)$ where the coefficient of the highest power of x , $c_{359} = m_{325}$ is transmitted first and the coefficient of the lowest power of x , $c_0 = p_0$ is transmitted last. The first bit transmitted from each symbol is bit 0.

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- Change “359” to “935”
- Change “325” to “845”

Page 96 Line 37-53 Figure 165-10

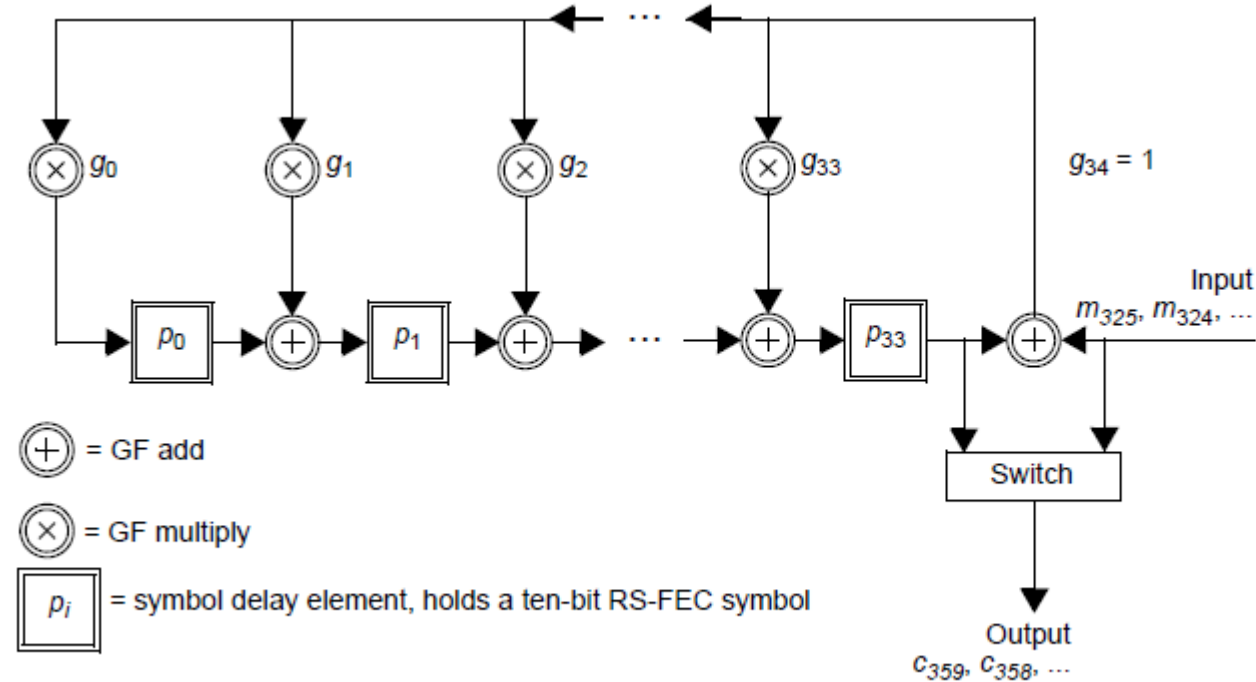


Figure 165-10—Reed-Solomon encoder functional model

- Change all “33” to “89”
- Change “ $g_{34}=1$ ” to “ $g_{90}=1$ ”
- Change “ m_{325}, m_{324}, \dots ” to “ m_{845}, m_{844}, \dots ”
- Change “ c_{359}, c_{358}, \dots ” to “ c_{935}, c_{934}, \dots ”

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Page 97 Table 165-2

RS-FEC(936,846)						
i=0 to 12	i=13 to 25	i=26 to 38	i=39 to 51	i=52 to 64	i=65 to 77	i=78 to 90
572	751	336	866	251	979	233
291	545	62	500	698	662	471
466	86	679	61	798	332	750
539	114	515	966	249	500	796
360	922	268	848	529	929	558
644	974	399	740	354	29	407
508	471	545	216	239	69	1003
534	880	575	790	679	185	997
873	423	976	172	835	182	149
519	1000	300	331	600	905	183
722	1013	654	479	301	989	814
698	1022	458	154	1011	484	944
785	822	246	334	886	797	1

Page 100 Line 24-25 165.3.2.3

- The RS-FEC decoded frame is then separated into a 10-bit OAM field and 130 64B/65B blocks.

Page 101 Line 21-24 165.3.2.3.1

- When operating in the data mode, the receiving PCS shall form a PAM4 stream from the PMA_UNITDATA.indication primitive by concatenating requests in order from rx_PAM4_0 to rx_PAM4_4679 (see Figure 165–7). It obtains block lock to the PHY frames during PAM2 training using synchronization bits provided in the training frames.

Page 132 Line 52-53 165.3.9.4.5

- Otherwise, this function returns the 14 data symbols unmodified and sets rs_check to GOOD if none of the 16 RS(936, 846) frames are uncorrectable.