$z_n = d_n \times d_{n-1}$, $n = 1, 2, \ldots, N$

where $d_0 = 1$.

The differential pre-coded bits are then fed to the (G)MSK encoder. The waveform of (G)MSK shown in Figure 164(b), which is the output of the (G)MSK encoder c_n, is approximately equivalent to that of filtered π/2 BPSK, if an appropriate pulse shaping filter for π/2 BPSK is employed. This is further illustrated in Figure 165(b). The filtered waveform of each modulation signal shall satisfy transmit PSD mask as in 12.1.6.

12.2.2.5.2 π/2 QPSK

The π/2 QPSK constellation diagram is shown in Figure 164(c), with four points equally spaced on a circle of radius one, representing four phases. QPSK shall encode 2 bits per symbol, with input bit d_1 being the earliest in the stream. The π/2 shift is employed to obtain a simple implementation aligning with the π/2 BPSK. The π/2 rotation is performed in the same manner as in 12.2.2.5.1. As illustrated in Figure 164(c), Gray encoding shall be employed. The normalization factor, K_{MOD} is 1.

12.2.2.5.3 π/2 8-PSK

The π/2 8-PSK constellation diagram is shown in Figure 164(d), equally spaced on a circle of radius one, representing eight phases. The π/2 8-PSK shall encode 3 bits per symbol, with input bit d_1 being the earliest in the stream. The π/2 rotation is performed in the same manner as in 12.2.2.5.1. Gray encoding shall be employed in the mapping of π/2 8-PSK. The normalization factor, K_{MOD} is 1.

12.2.2.5.4 π/2 16-QAM

The π/2 16-QAM constellation diagram is shown in Figure 164(e). The serial bit stream shall be divided into groups of four bits with input bit d_1 being the earliest in the stream. The π/2 rotation is performed in the same manner as in 12.2.2.5.1. The normalization factor for π/2 16-QAM constellation is $1/\sqrt{10}$. An approximate value of the normalization factor may be used, as long as the device conforms to the modulation accuracy requirements.

12.2.2.6 Forward Error Correction

The forward error correction (FEC) schemes are specified in this subclause. Support for RS block codes is mandatory, whereas support for LDPC block codes is optional.

12.2.2.6.1 Reed-Solomon block codes in GF(2^8)

The RS(255,239), which is the mother code, is used in payloads of CMS, MPR and MCS identifier 1 MCSs in Table 103. A shortened version of RS(255,239) is used for the base frame header and MAC subheader, as defined in 12.2.2.2.

The systematic RS code shall use the following generator polynomial [Equation (14)]:

$$g(x) = \prod_{k=1}^{16} (x + \alpha^k) \tag{14}$$

where $\alpha = 0x02$ is a root of the binary primitive polynomial $p(x)=1+x^2+x^3+x^4+x^8$. As notation, the element $M = b_7x^7 + b_6x^6 + b_5x^5 + b_4x^4 + b_3x^3 + b_2x^2 + b_1x^1 + b_0$, has the binary representation $b_7b_6b_5b_4b_3b_2b_1b_0$, where b_7 is the msb and b_0 is the lsb.

The mapping of the information octets $\boldsymbol{m} = (m_{238}, m_{237}, \ldots, m_0)$ to codeword octets $\boldsymbol{c} = (m_{238}, m_{237}, \ldots, m_0, r_{15}, r_{14}, \ldots, r_0)$ is achieved by computing the remainder polynomial *r(x)* [Equation (15)]:

$$r(x) = \sum_{k=0}^{15} r_k x^k = x^{16} m(x) \bmod g(x) \tag{15}$$

where $m(x)$ is the information polynomial [Equation (16)]:

$$m(x) = \sum_{k=0}^{238} m_k x^k \tag{16}$$

and r_k, $k = 0, \ldots, 15$, and m_k, $k = 0, \ldots, 238$, are elements of GF(2^8). The message order is as follows: m_{238} is the first octet of the message and m_0 is the last octet of the message.

For a shortened RS(L_{inf} + 16, L_{inf}), 239-L_{inf} zero elements are appended to the incoming L_{inf} octet message as follows:

$m_k = 0$, $k = L_{inf}, \ldots, 238$

These inserted zero elements are not transmitted. A shift-register implementation of the RS encoder RS(L_{inf}+16, L_{inf}) is shown in Figure 166, with additions and multiplications over GF(2^8). After m_0 has been inserted into the shift register, the switch shall be moved from the message polynomial input connection to the shift register output connection (right-to-left).

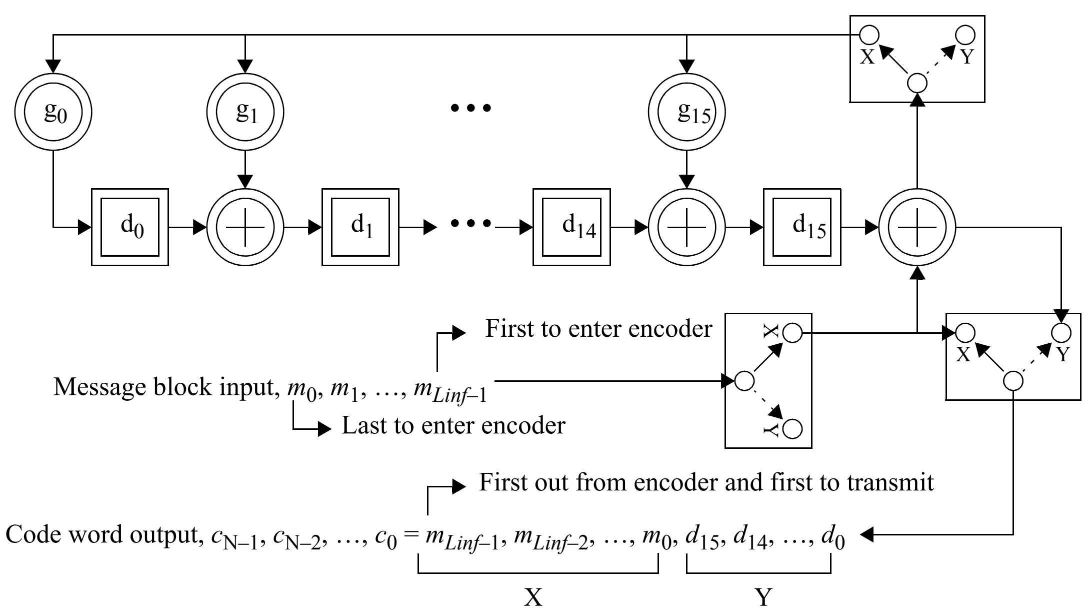

Figure 166—Reed Solomon encoder GF(2^8)

12.2.2.6.2 Irregular LDPC codes

The irregular LDPC codes are used as a high-performance error correction coding technique. The supported FEC rates, information block lengths, and codeword block lengths are described in Table 109.

