Example 6.16 Determine the coefficients of a linear phase FIR filter of length M=15 has a symmetric unit sample response and a frequency response that satisfies the conditions $(0)_{S}=(0$

$$H\left(\frac{2\pi k}{15}\right) = 1 \quad k = 0, 1, 2, 3$$

 $= 0 \quad k = 4, 5, 6, 7$

Example 6.17 Using frequency sampling method, design a bandpass filter with the following specifications.

sampling frequency F = 8060Mz

Solution

$$|H(k)| = 1$$
 for $0 \le k \le 3$ and $12 \le k \le 14$
= 0 for $4 \le k \le 11$

|H(k)| | 0 1 2 3 4 5 6 7 8 9 10 11 1213 14 → k

Determine the filter coefficients for N=7.

Fig. 6.60 Ideal magnitude response with samples for example 6.16

$$\theta(k) = -\left(\frac{N-1}{N}\right) \pi k$$

$$= \frac{-14}{15} \pi k \quad 0 \le k \le 7$$

and

$$\theta(k) = 14\pi - \frac{14\pi k}{15}$$
 for $8 \le k \le 14$

$$H(k) = e^{-j14\pi k/15} \quad \text{for} \quad k = 0, 1, 2, 3$$

$$= 0 \quad \text{for} \quad 4 \le k \le 11$$

$$= e^{-j14\pi(k-15)/15} \quad \text{for} \quad 12 \le k \le 14$$

$$h(n) = \frac{1}{N} \left[H(0) + 2 \sum_{k=1}^{\frac{N-1}{2}} Re\left(H(k)e^{j2\pi nk/15}\right) \right]$$

$$= \frac{1}{15} \left[1 + 2 \sum_{k=1}^{7} Re\left(e^{-j14\pi k/15}e^{j2\pi nk/15}\right) \right]$$

$$= \frac{1}{15} \left[1 + 2 \sum_{k=1}^{3} \cos\frac{2\pi k(7-n)}{15} \right]$$

$$= \frac{1}{15} \left[1 + 2 \cos\frac{2\pi (7-n)}{15} + 2 \cos\frac{4\pi (7-n)}{15} + 2 \cos\frac{6\pi (7-n)}{15} \right]$$

$$h(0) = h(14) = -0.05; \quad h(1) = h(3) = 0.041 \quad h(4) = h(10) = -0.1078$$

$$h(2) = h(12) = 0.0666; \quad h(3) = h(11) = -0.0365 \quad h(5) = h(9) = 0.034$$

$$h(6) = h(8) = 0.3188 \quad h(7) = 0.466$$