7.1 *The frequency response,* $H(\omega)$, *if a type 2, linear phase Fir filter may be expressed as (see Table 7.1)*

$$H(\omega) = e^{-j\omega(N-1)/2}\sum_{n=1}^{N/2} b(n)\cos[\omega(n-\frac{1}{2})]$$

where b(n) is related to the filter coefficients. Explain why filters with the response above are unsuitable as high pass filters. Use a simple case (such as N=4) to illustrate your answer.

Solution

The impulse responses for Type 2 filters have positive symmetry and even length. The corresponding frequency responses are always zero at half the sampling frequency (Fs/2) which is at the high frequency end. Thus, Type 2 filters are unsuitable as high pass filters. This point can be illustrated using the above expression for N=4 (where we have introduced T to highlight the link to the sampling frequency):

$$H(\omega T) = e^{-j3\omega(N-1)/2}\sum_{n=1}^{2} b(n)\cos[\omega(n-\frac{1}{2})T]$$

$$= e^{-j3\omega T/2}\left[b(1)\cos(\omega T/2) + b(2)\cos(3\omega T/2)\right]$$

At half the sampling frequency, $f = 1/2T$ and

$$H(\omega T)\Big|_{f=\frac{1}{2T}} = e^{-j\pi/2}\left[b(1)\cos(\pi/2) + b(2)\cos(3\pi/2)\right] = 0.$$