Table 3.1 : Summary of frequency response characteristics of linear phase FIR filters

Impulse Response h(n)	**Number of samples of h(n) N**	**The magnitude function of H(ω)**
Symmetric	Odd	Symmetric
Symmetric	Even	Antisymmetric
Antisymmetric	Odd	Antisymmetric
Antisymmetric	Even	Symmetric

Table 3.2 : Summary of $|H(\omega)|$ for linear phae FIR filters

Nature of impulse response	Magnitude function
Case I : Impulse response is symmetric and N is odd	$\lvert H(\omega)\rvert = h\left(\frac{N-1}{2}\right) + \sum_{n=1}^{\frac{N-1}{2}} 2h\left(\frac{N-1}{2}-n\right)\cos\omega n$
Case II : Impulse response is symmetric and N is even	$\lvert H(\omega)\rvert = \sum_{n=1}^{\frac{N}{2}} 2h\left(\frac{N}{2}-n\right)\cos\left(\omega\left(n-\frac{1}{2}\right)\right)$
Case III : Impulse response is antisymmetric and N is odd	$\lvert H(\omega)\rvert = \sum_{n=1}^{\frac{N-1}{2}} 2h\left(\frac{N-1}{2}-n\right)\sin\omega n$
Case IV : Impulse response is antisymmetric and N is even	$\lvert H(\omega)\rvert = \sum_{n=1}^{\frac{N}{2}} 2h\left(\frac{N}{2}-n\right)\sin\left(\omega\left(n-\frac{1}{2}\right)\right)$

① When Impulse response
Sym. & odd

Mag fn. $|H(\omega)| = h\left(\frac{N-1}{2}\right) + \sum_{n=1}^{\frac{N-1}{2}} 2h\left(\frac{N-1}{2}-n\right) \times \cos\omega n$

Phase $\angle H(\omega) = -\omega\left(\frac{N-1}{2}\right) = -\omega\alpha$

$\alpha = \frac{N-1}{2}$

② When Impulse response
Sym. & even

Mag $|H(\omega)| = \left[\sum_{n=1}^{\frac{N}{2}} 2h\left(\frac{N}{2}-n\right)\cos\left[\omega\left(n-\frac{1}{2}\right)\right]\right]$

phase $\angle H(\omega) = -\omega\left(\frac{N-1}{2}\right) = -\omega\alpha$;

$\alpha = \frac{N-1}{2}$

③ Antisym. & odd:

$|H(\omega)| = \sum_{n=1}^{\frac{N-1}{2}} 2h\left(\frac{N-1}{2}-n\right)\sin\omega n$

$\angle H(\omega) = \frac{\pi}{2} - \omega\frac{N-1}{2} = \beta - \alpha\omega$

$\beta = \frac{\pi}{2}$ & $\alpha = \frac{N-1}{2}$

④ Antisym. & even

$H(\omega)| = \sum_{n=1}^{N/2} 2h\left(\frac{N}{2}-n\right)\sin\left[\omega\left(n-\frac{1}{2}\right)\right]$

$\angle H(\omega) = \frac{\pi}{2} - \omega\frac{N-1}{2} = \beta - \alpha\omega$

$\beta = \pi/2$ & $\alpha = \frac{N-1}{2}$