2.3.1 (N even)

For uniform weighting, $\underline{w}^H = \frac{1}{N}[1 \cdots 1]_{1\times N}$

$$\underline{w}_1^H = \frac{1}{N}[1 \cdots 1]_{1\times \frac{N}{2}}$$

$$B_\psi(\psi) = \underline{w}^H \underline{v}_\psi(\psi) = 2\,\mathrm{Re}[\underline{w}_1^H \underline{v}_{\psi_1}(\psi)] \quad , \text{ where}$$

$$\underline{v}_{\psi_1}(\psi) = \begin{bmatrix} e^{-j\frac{N-1}{2}\psi} \\ \vdots \\ e^{-j\frac{1}{2}\psi} \end{bmatrix}_{\frac{N}{2}\times 1}$$

$$B_\psi(\psi) = 2\,\mathrm{Re}\left\{ \frac{1}{N}[1 \cdots 1] \begin{bmatrix} e^{-j\frac{N-1}{2}\psi} \\ \vdots \\ e^{-j\frac{1}{2}\psi} \end{bmatrix} \right\}$$

$$= \frac{2}{N}\,\mathrm{Re}\left\{ e^{-j\frac{1}{2}\psi} \sum_{m=0}^{\frac{N}{2}-1} e^{-jm\psi} \right\}$$

$$= \frac{2}{N}\,\mathrm{Re}\left\{ e^{-j\frac{1}{2}\psi} \frac{1 - e^{-j\frac{N}{2}\psi}}{1 - e^{-j\psi}} \right\}$$

$$= \frac{2}{N}\,\mathrm{Re}\left\{ e^{-j\frac{N}{4}\psi} \frac{\sin\frac{N}{4}\psi}{\sin\frac{\psi}{2}} \right\}$$

$$= \frac{2}{N} \frac{\cos\frac{N}{4}\psi \;\sin\frac{N}{4}\psi}{\sin\frac{\psi}{2}}$$

$$= \frac{1}{N} \frac{\sin\frac{N}{2}\psi}{\sin\frac{\psi}{2}} \qquad -\frac{2\pi d}{\lambda} \le \psi \le \frac{2\pi d}{\lambda}$$