2.3.2 N is odd.

$$\underline{v}_\psi(\psi) = \begin{bmatrix} \underline{v}_{\psi_1}(\psi) \\ 1 \\ \underline{J}\underline{v}_{\psi_1}^*(\psi) \end{bmatrix}$$

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

$$\underline{w}^H = [\underline{w}_1^H \quad \frac{1}{N} \quad \underline{w}_1^T\underline{J}] \, .$$

$$B_\psi(\psi) = \underline{w}^H \underline{v}_\psi(\psi) = [\underline{w}_1^H \quad \frac{1}{N} \quad \underline{w}_1^T\underline{J}] \begin{bmatrix} \underline{v}_{\psi_1}(\psi) \\ 1 \\ \underline{J}\underline{v}_{\psi_1}^*(\psi) \end{bmatrix}$$

$$= \underline{w}_1^H \underline{v}_{\psi_1}(\psi) + \frac{1}{N} + \underline{w}_1^T \underline{v}_{\psi_1}^*(\psi)$$

$$= 2Re\left\{\underline{w}_1^H \underline{v}_{\psi_1}(\psi)\right\} + \frac{1}{N}$$

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

$$= \frac{2}{N} Re\left\{e^{-j\psi} \sum_{m=0}^{\frac{N-3}{2}} e^{-jm\psi}\right\} + \frac{1}{N}$$

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

$$= \frac{2}{N} Re\left\{e^{-j\frac{N+1}{4}\psi} \frac{\sin(\frac{N-1}{4}\psi)}{\sin\frac{\psi}{2}}\right\} + \frac{1}{N}$$

$$= \frac{2}{N} \frac{\cos(\frac{N+1}{4}\psi)\sin(\frac{N-1}{4}\psi)}{\sin\frac{\psi}{2}} + \frac{1}{N}$$

$$= \frac{1}{N} \frac{2\cos(\frac{N+1}{4}\psi)\sin(\frac{N-1}{4}\psi) + \sin\frac{\psi}{2}}{\sin\frac{\psi}{2}}$$

$$= \frac{1}{N} \frac{\sin(\frac{N}{2}\psi) - \sin\frac{\psi}{2} + \sin\frac{\psi}{2}}{\sin\frac{\psi}{2}}$$

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