Given the definition of Discrete Fourier Transform:

$$\alpha[k] = \Sigma_{m=0}^{7} x(m) W_8^{mk}$$

Rewrite the x(m) into the addition of real and imaginative part.

$$\alpha[k] = \Sigma_{m=0}^{7}[x_{RE}(m) + jx_{IM}(m)] \times e^{-j\frac{2\pi}{8}mk}$$

$$= \Sigma_{m=0}^{7}[x_{RE}(m) + jx_{IM}(m)] \times [\cos\left(\frac{mk\pi}{4}\right) - jsin\left(\frac{mk\pi}{4}\right)]$$

$$= \Sigma_{m=0}^{7}\{x_{RE}(m)\cos\left(\frac{mk\pi}{4}\right) + x_{IM}(m)sin\left(\frac{mk\pi}{4}\right)$$

$$+ jx_{IM}(m)\cos\left(\frac{mk\pi}{4}\right) - jx_{RE}(m)sin\left(\frac{mk\pi}{4}\right)\}$$

$$= \Sigma_{m=0}^{7}\{[x_{RE}(m)\cos\left(\frac{mk\pi}{4}\right) + x_{IM}(m)sin\left(\frac{mk\pi}{4}\right)]$$

$$- j[x_{RE}(m)sin\left(\frac{mk\pi}{4}\right) - x_{IM}(m)\cos\left(\frac{mk\pi}{4}\right)]\}$$

Now calculate its real and imaginative part respectively. Take the real part as an example:

$$\alpha(k)_{RE} = \Sigma_{m=0}^{7}\left[x_{RE}(m)\cos\left(\frac{mk\pi}{4}\right) + x_{IM}(m)sin\left(\frac{mk\pi}{4}\right)\right]$$

$$= \Sigma_{m=0}^{3}\left[x_{RE}(m)\cos\left(\frac{mk\pi}{4}\right) + x_{IM}(m)sin\left(\frac{mk\pi}{4}\right)\right]$$

$$+ \Sigma_{m=4}^{7}\left[x_{RE}(m)\cos\left(\frac{mk\pi}{4}\right) + x_{IM}(m)sin\left(\frac{mk\pi}{4}\right)\right]$$

As an FFT algorithm, do decimation-in-time (DIT) folding,

$$= \Sigma_{m=0}^{3}\left[x_{RE}(m)\cos\left(\frac{mk\pi}{4}\right) + x_{IM}(m)sin\left(\frac{mk\pi}{4}\right)\right]$$

$$+\Sigma_{m=0}^{3}\left[x_{RE}(m+4)\cos\left(\frac{mk\pi}{4} + \frac{4k\pi}{4}\right) + x_{IM}(m+4)sin\left(\frac{mk\pi}{4} + \frac{4k\pi}{4}\right)\right]$$

Denote the second term as S,

$$S = \Sigma_{m=0}^{3}\left[x_{RE}(m+4)\cos\left(\frac{mk\pi}{4} + \frac{4k\pi}{4}\right) + x_{IM}(m+4)sin\left(\frac{mk\pi}{4} + \frac{4k\pi}{4}\right)\right]$$

$$= \Sigma_{m=0}^{3}\{\, x_{RE}(m+4)\left[\cos\left(\frac{mk\pi}{4}\right)\cos(k\pi) - \sin\left(\frac{mk\pi}{4}\right)\sin(k\pi)\right]\}$$

$$+ \Sigma_{m=0}^{3}\{\, x_{IM}(m+4)\left[sin\left(\frac{mk\pi}{4}\right)\cos(k\pi) + \cos\left(\frac{mk\pi}{4}\right)\sin(k\pi)\right]\}$$

$$= \Sigma_{m=0}^{3}\left[\, x_{RE}(m+4)\,(-1)^k\cos\left(\frac{mk\pi}{4}\right) + x_{IM}(m+4)(-1)^k\sin\left(\frac{mk\pi}{4}\right)\right]$$

Thus,

$$\alpha(k)_{RE} = \Sigma_{m=0}^{3}\left[x_{RE}(m)\cos\left(\frac{mk\pi}{4}\right) + x_{IM}(m)sin\left(\frac{mk\pi}{4}\right)\right]$$

$$+\Sigma_{m=0}^{3}\left[\, x_{RE}(m+4)\,(-1)^k\cos\left(\frac{mk\pi}{4}\right) + x_{IM}(m+4)(-1)^k\sin\left(\frac{mk\pi}{4}\right)\right]$$

$$= \Sigma_{m=0}^{3} \left\{ [\, x_{RE}(m) + (-1)^k x_{RE}(m+4)] \cos\left(\frac{mk\pi}{4}\right) \right.$$

$$\left. + [\, x_{IM}(m) + (-1)^k \, x_{IM}(m+4)] \sin\left(\frac{mk\pi}{4}\right) \right\}$$

By similar derivation, we have $\alpha(k)_{IM}$,

$$\alpha(k)_{IM} = (-j) * \Sigma_{m=0}^{3} \left\{ [\, x_{RE}(m) + (-1)^k x_{RE}(m+4)] \sin\left(\frac{mk\pi}{4}\right) \right.$$

$$\left. - [\, x_{IM}(m) + (-1)^k \, x_{IM}(m+4)] \cos\left(\frac{mk\pi}{4}\right) \right\}$$

And finally,

$$\alpha(k) = \alpha(k)_{RE} + \alpha(k)_{IM}$$

As the equation shows, $\alpha(k)_{RE}$ is sum of two 4-point inner dot. Otherwise, by rearranging the coefficient vectors, it could be derived by an 8-point inner dot. These two algorithms requires different look-up-tables(LUT).