$$\begin{aligned}\Psi_{124} &= C_1\left(|02du\rangle + |02ud\rangle + i\,|0du2\rangle + i\,|0ud2\rangle + |20du\rangle + |20ud\rangle + i\,|2du0\rangle + i\,|2ud0\rangle + i\,|d02u\rangle + i\,|d20u\rangle - |du02\rangle - |du20\rangle + i\,|u02d\rangle + i\,|u20d\rangle - |ud02\rangle - |ud20\rangle\right)\\ &\quad + C_2\left(-|dduu\rangle + i\,|duud\rangle - i\,|uddu\rangle + |uudd\rangle\right)\end{aligned} \tag{1}$$

$$C_1 = \frac{\frac{-i}{16}\left(U + \sqrt{16\,t^2 + U^2}\right)}{t} \tag{2}$$

$$C_2 = -\left(\frac{1}{2}\right) \tag{3}$$