$$= \sum_{n_1,n_2,n_3,n_4} \frac{1}{2\pi R} \delta_{n_1-n_2+n_3-n_4,0} \, \hat{\Phi}^{(n_1)\dagger} \hat{\Phi}^{(n_2)} \hat{\Phi}^{(n_3)\dagger} \hat{\Phi}^{(n_4)}$$