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Avoiding long bicoloured cycles

This is an old problem of Roland Häggkvist which I believe deserves some promotion.

Over all n -edge-colourings of $K_{n,n}$, determine the minimum longest two-coloured cycle. Let's call this $f(n)$. I know that $f(n) \leq 182$ for all n and I wonder whether, for n mildly large, it is the case that

$$f(n) = \begin{cases} 4 & \text{if } n \text{ is a power of 2;} \\ 6 & \text{otherwise.} \end{cases}$$