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**New Designs for Signal Sets with Low
Cross-correlation, Balance Property and Large Linear
Span: $GF(p)$ Case**

Guang Gong

Abstract New designs for families of sequences over $GF(p)$ with low cross correlation, balance property and large linear span are presented. The key idea of the new designs is to use short p -ary sequences of period v with the 2-level auto correlation function to construct a set of long sequences with the designed properties. The resulting sequences are of interleaved sequences of period v^2 . There are v cyclically shift distinct sequences in each family. The maximal magnitude of cross/out-of-phase auto correlation of sequences in the family is $2v + 3$ which is optimal with respect to the Welch bound. In particular, for binary case, cross/out-of-phase auto correlation vales belong to the set $\{1, -v, v + 2, 2v + 3, -2v, -1\}$. Each sequence in the family is balanced and has large linear span. For binary case, any sequence in such a family where the short sequences are quadratic residue sequences achieves the maximal linear span. For non-binary case, the new design gives the first type of signal type of signal sets with optimal correlation, balance property and large linear span.

Keywords Interleaved sequences, low cross correlation, 2-level auto correlation, randomness property, linear span, finite field, non-binary sequences.