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The Decimation-Hadamard Transform of Two-level
Autocorrelation Sequences

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Abstract A new method to study and search for 2-level autocorrelation sequences for both binary and non-binary cases is developed. This method is iteratively to apply two operations: decimation and the Hadamard transform based on general orthogonal functions, referred to as the *decimation-Hadamard transform (DHT)*. The second iterative DHT can transform one class of such sequences into another inequivalent class of such sequences, a process called *realization*. The existence and counting problems of the second iterative DHT are discussed. Using the second iterative DHT, and starting with a single binary m -sequence (when n is odd), we believe one can obtain all the known two-level autocorrelation sequences of period $2^n - 1$ which have no subfield factorization. We have verified this for odd $n \leq 17$. Interestingly, no previously unknown examples were found by this process for any odd $n \leq 17$. This is supporting evidence (albeit weak) for the conjecture that all families of cyclic hadamard difference sets of period $2^n - 1$ having no subfield factorization are no known, at least for odd n . Experimental results are provided.

Index words 2-level autocorrelation sequences, iterative decimation-Hadamard transform, trace representation, orthogonal functions, group characters.