The orthogonal design of a cyclic block filtered multititone modulation (CB-FMT) system is addressed. CB-FMT is a filter bank modulation scheme that uses frequency confined prototype pulses, similarly to FMT. Differently from FMT, where the linear convolution is used, the cyclic convolution is exploited in CB-FMT. This allows to efficiently implement the system via a concatenation of discrete Fourier transforms. The necessary and sufficient orthogonality conditions are derived in time domain and frequency domain. Then, these conditions are expressed in matrix form, and the prototype pulse coefficients are parameterized with hyper-spherical coordinates. The effect of a linear time-variant transmission medium is discussed. In such a scenario, the optimal filter bank orthogonal design is considered with the objective of maximizing either the in-band-to-out-band sub-channel energy ratio or the achievable rate. Numerical results and comparisons show the performance improvements attainable with several designed optimal pulses also with respect to the use of the baseline root-raised-cosine pulse.