*Abstract*— This paper proposes a time-interleaved RF carrier modulation and demodulation technique, suitable for millimeter wave and submillimeter wave frequency mixer applications under a constraint of active device speed limitation. The presents are in essence mixer arrays where modulated outputs by a series of time-delayed carriers with a reduced frequency, compared with a carrier frequency in fundamental mixers, will be interleaved in the time domain to synthesize the final output. The mixer arrays inherit a filtering function of a transversal filter, and the time interleaving process is equivalent to the filtering process where the arrays select the fundamental tone or its harmonics of a carrier in a periodic manner. The carrier waveform and duty-cycle play important roles in the noise performance of the mixer arrays. A comprehensive noise analysis is presented in this paper for both cases of correlated-noise mixer arrays and uncorrelated-noise mixer arrays. To minimize output noise power, optimization of carrier duty-cycle and noise filtering technique have been proposed and analyzed extensively for various types of carrier pulse. Finally analytical mismatch models are provided and output SNR degradations under finite mismatches among mixer array elements have been discussed based on the mismatch models. All theoretical analyses are verified through behavioral mixer array simulations including Monte-Carlo statistical simulations.