A phase-coded continuous-wave multiple-input multiple-output (MIMO) radar based on code division multiplexing is presented. Zero-correlation-zone (ZCZ) and low-correlation-zone (LCZ) sequence sets are used to separate signals from multiple transmitters at the receivers. In particular, we investigate three different sequence set types: an equidistantly shifted almost-perfect autocorrelation sequence set, sequence sets based on mutually orthogonal Golay complementary sets, and a binary LCZ sequence set. The required sequence lengths are discussed according to the physical propagation behavior in a radar sensor scenario. Furthermore, we summarize the theoretical limitations of LCZ/ZCZ sequence sets and provide examples with regard to the chosen scenario. We present measurements carried out with a software-defined radar platform, which is equipped with 16 MIMO channels operating at a frequency of 77 GHz. We investigated the behavior of the sequence sets on real hardware in the range, cross-range, and range-Doppler domains.