Associative memories allow the retrieval of previously stored messages given a part of their content. In this paper, we are interested in associative memories based on c-partite graphs that were recently introduced. These memories are almost optimal in terms of the amount of storage they require (efficiency) and allow retrieving messages with low complexity. We propose a generic implementation model for the retrieval algorithm that can be readily mapped to an integrated circuit and study the retrieval performance when hardware components are affected by faults. We show using analytical and simulation results that these associative memories can be made resilient to circuit faults with a minor modification of the retrieval algorithm. In one example, the memory retains 88% of its efficiency when 1% of the storage cells are faulty, or 98% when 0.1% of the binary outputs of the retrieval algorithm are faulty. When considering storage faults, the fault tolerance exhibited by the proposed associative memory can be comparable to using a capacity-achieving error correction code for protecting the stored information.