Estimating the power spectrum of a wide-sense stationary random process is an important component of several signal processing tasks. Distributed spectrum sensing problems naturally emerge in cases where measurements of different realizations of a random process are collected at multiple spatial locations. This paper proposes a distributed power spectrum sensing framework for autoregressive (AR) and autoregressive moving-average (ARMA) processes. The sensing model comprises a network of scattered sensors which transmit randomly filtered, sample averaged, one bit quantized power measurements to a fusion center. First, assuming that sample averaging at each sensor is sufficient to converge to the ensemble average, it is shown that AR and ARMA power spectrum estimation from the received bits can be cast as (non-convex) optimization problems with special structure. Next, the sample averaging requirement is relaxed and maximum likelihood formulations are proposed, which take into account errors caused by quantization of inaccurate soft power measurements. Leveraging the block separable structure present in these formulations, we propose Block Coordinate Descent algorithms for obtaining approximate solutions, with favorable convergence properties. Simulation results demonstrate the efficacy of the proposed approaches for reconstructing power spectra from relatively few bits, when the model parametrization is valid.