PBG2 may perform the first read operation including a first sensing operation and a second sensing operation simultaneously or contemporaneously during each of develop periods starting from different time points and may perform the second read operation based on a valley searched according to a result of the first read operation (S200). The control circuit 500 controls the voltage generator 700 and the page buffer circuit 410 such that an on-chip valley search read operation is performed.

[125] The control circuit 500 determines whether the read operation is completed (S150). When the read operation is completed (YES in S150), the nonvolatile memory device 200 transmits (e.g., sends) the sensed data to the memory controller 100 (S160). When the read operation is not completed (NO in S150), the process returns to the operation (S120). In a conventional OCVS read operation, a sensing operation is performed three times during a first read operation, sensed results are stored in different latches and a valley is determined by comparing the results stored in the latches. Accordingly, by performing the first read operation using only two sensing operations the example embodiments enable performance of an OCVS read operation that is faster and consumes fewer resources (e.g., processor, memory and power) than the conventional OCVS read operation.

[126] Referring to FIGS. 14 through 16, for performing the on-chip valley search (OCVS) read operation (S200), the control circuit 500 controls the voltage generator 700 and the address decoder 405 such that the address decoder 405 applies a first offset read voltage (a first read voltage) VRDD to a selected word-line coupled to selected memory cells. The control circuit 500 applies the first bit-line set-up signal BLSTP1 to the first group of page buffers PBG1 to develop the first group of bit-lines from a first time point and to sense a data state of first memory cells in a region RG3 by sequentially performing the first sensing operation and the second sensing operation at least during a first develop period (S220).