

Hiraishi (EX1005)

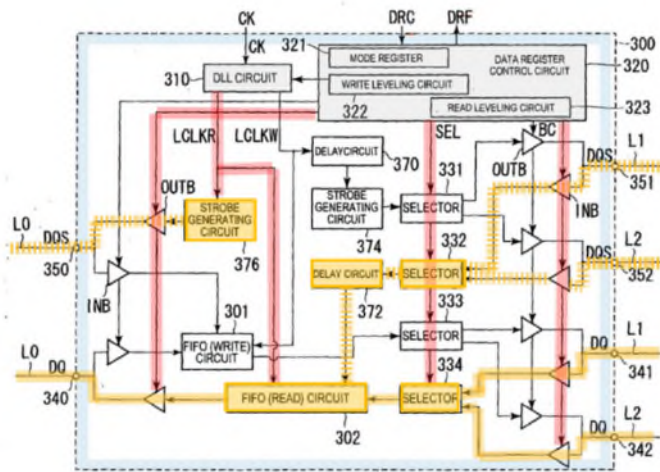


FIG. 5

[0147] FIG. 15 is a timing chart for explaining the read leveling operation between the data register buffer 300 and the memory chip 200. This operation is performed by the read leveling circuit 323 shown in FIG. 5.

[0150] The memory chip 200 receives the read command Read and performs an actual read operation. In the example shown in FIG. 15, the CAS latency is set to five clock cycles ($CL=5$), so that an output of read data DQ begins at the time T5. The read data DQ at the time of the read leveling is, for example, a signal in which a High level and a Low level are repeated in an alternate manner.

[0151] The read data DQ output from the memory chip 200 reaches the data register buffer 300, by which the data register buffer 300 can find a time A from an input timing of the read command Read that is input as a part of the control signal DRC until the read data DQ is input. The time is measured for each of the memory chips 200, stored in the data register control circuit 320 in the data register buffer 300, and used in an adjustment of an activation timing of the input buffer circuit INB and the like. In FIG. 15, two cases are shown including a first case that the time A from the input of the read command Read until the input of the read data DQ is short (between the memory chip 200-0 and the data register buffer 300-0) and a second case that the time A is long (between the memory chip 200-19 and the data register buffer 300-4).

← S4 read leveling

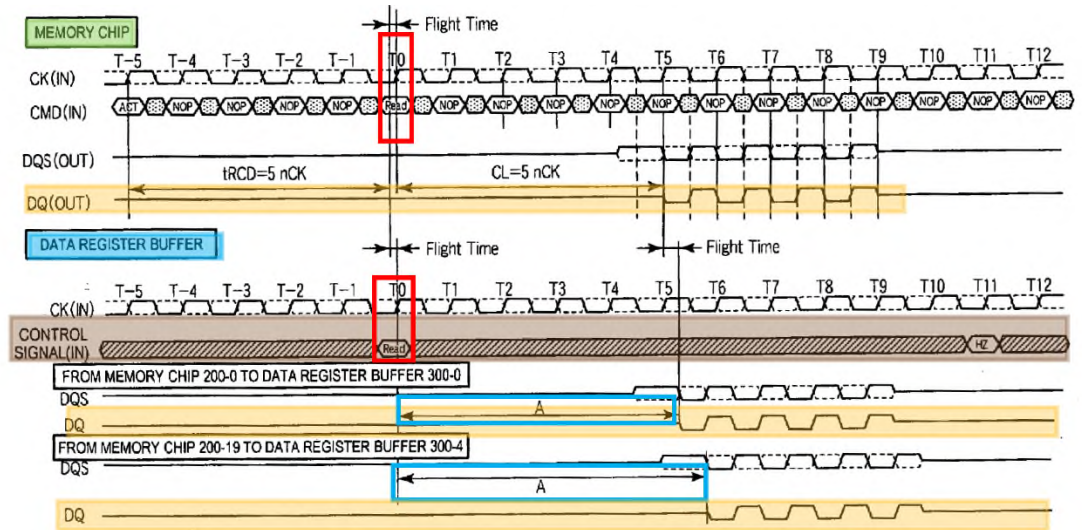


FIG. 15

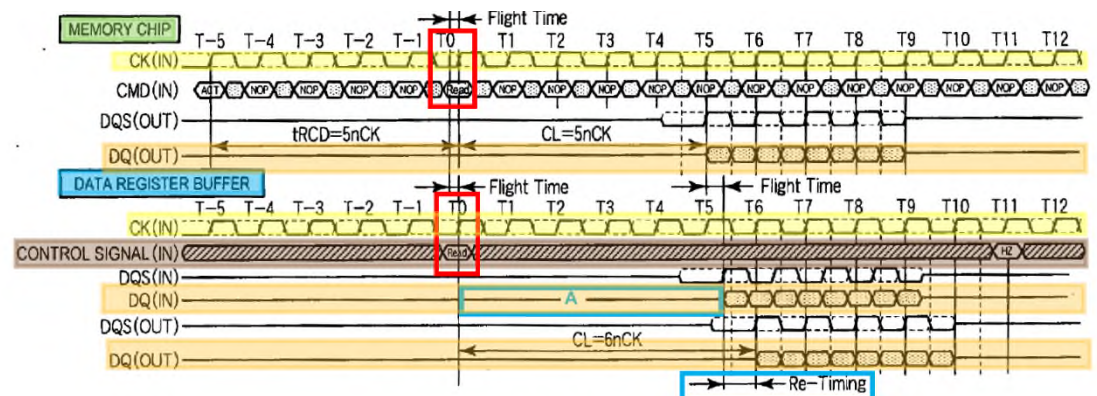


FIG. 11

[0123] FIG. 11 is a timing chart for explaining a read operation of the memory module 100 according to the present embodiment.

[0130] Thereafter, the data register buffer 300 performs a re-timing in synchronization with the internal clock LCLKR using the FIFO (Read) circuit 302 to convert CL into CL=6, and outputs the read data DQ and the data strobe signal DQS. With this configuration, it becomes possible for the memory controller to receive the read data DQ in a correct manner.

Samsung Ex. 1070, p. 1