

ABSTRACT OF THE DISCLOSURE

An apparatus includes data transmitter having first through N-th data drivers configured to provide first through N-th data signals, respectively, and a strobe driver configured to provide a strobe signal, and a data receiver having a strobe buffer configured to generate a control signal based on the strobe signal, and first through N-th sense amplifiers configured to sense N-bit data based on the control signal, a reference signal and the first through N-th data signals. The bus includes a strobe TSV configured to connect the strobe driver with the strobe buffer, and first through N-th data TSVs configured to connect the first through N-th data drivers with the first through N-th sense amplifiers, respectively. A reference signal supplier controls the reference signal such that a discharge speed of the reference signal is slower than a discharge speed of each of the first through N-th data signals during data transmission.

FIG. 1