Safe Early Output: An Improved QDI Logic System

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DIMS has for some time been a widely accepted method of generating QDI circuits. Unfortunately due to their large size, poor performance and high power consumption, attempts have been made to generate QDI circuits with better attributes.

One method involves the use of “early output” dual-rail gates. These gates have the property of generating results as soon as they have sufficient number of inputs present. These outputs of these gates unfortunately do not reflect the state of all inputs. It becomes difficult to ensure the input latches are ready to be acknowledged or ensure the logical part of the system has fully discharged and is ready to accept another set of inputs. Guarding of such a system can be achieved in numerous methods.

A non QDI method ensures the state of all inputs but has makes timing assumptions on the discharge time of functional part of the design. Another method proposed the collection of the states of each wire pair in the functional side of the circuit and only allowing the generation of the acknowledge once the circuit was fully excited. This method has two problems. Firstly it creates “long tokens” which stretch across many stages and while the originating stage is waiting for the late and unnecessary inputs the token’s dropping edge is not released. This can pause long parts of the system across which the token extends. Secondly the approach refuses to acknowledge any inputs until all inputs have been presented. Remembering that individual inputs can be used in functions generating many outputs. Due to a late token of one of the outputs all inputs in its set are halted from being acknowledged. This spreads the effect of a single weak link to the rest of the system.

A new guarding style is proposed which aims to tackle the problems outlined above. Instead of collecting the states of the data wire pairs and then acknowledging the full set of inputs, the acknowledge can be generated before the circuit is fully excited, and its progress can be controlled by the presence of data in the functional part.

The acknowledge can be generated as soon as the result has been accepted. The propagation of the acknowledge can be then halted in places where a gate has not received a full set of valid inputs. This allows the propagation of the acknowledge to the inputs which have created the result while inputs which have not presented any data to the stage are protected from receiving an acknowledge. Only once a gate receives a full set of inputs will it propagate the acknowledge. Because the inputs which have generated the result have been acknowledged the result of the stage will have returned to NULL and a new sweep of operations can be attempted while the acknowledge is kept active localized to the area of the late inputs. Effectively the acknowledge being propagated backwards and releasing parts of the stage which have completed and makes an anti-token like system. A stage depending on its size and arrangement can hold a number of anti-tokens and allow de-synchronisation of the fast input stages from the slow inputs.