Wrapper Boundary Register (WBR)

STRUCTURE and DEFINITIONS:

Core Input (CI): an input terminal of the unwrapped core.

Core Output (CO): an output terminal of the unwrapped core.

Wrapper Functional Input (WFI): for every core input there is a corresponding WBR functional input.

Wrapper Functional Output (WFO): for every core output there is a corresponding WBR functional output.

Input Cells: WBR cells provided for core inputs.

Output Cells: WBR cells provided for core outputs.

Cell Functional Input (CFI): for input cells, the cell's input connected to WFI; for output cells, the cell's input connected to CO.

Cell Functional Output (CFO): for input cells, the cell's output connected to CI; for outputs cells, the cell's output connected to WFO.

Cell Test Input (CTI): WBR cell's test data input.

Cell Test Output (CTO): WBR cell's test data output.

Mode: A mode is a condition or configuration of the WBR that exists in response to the state of the WIR.

Event: An event is an uninterrupted, predefined sequence of one or more steps. An event may have a characteristic instant.

Clock: A signal that controls transfer of data through sequential elements.

Shift Path: A shift path in a WBR cell are those one or more storage elements serially connected between CTI and CTO. Likewise, for the SIL modes of the P1500 wrapper, it is those same storage elements of all the cells in the WBR concatenated into a single serial path.

MODES:

A mode is a static condition or configuration of the WBR that exists in response to the state of the WIR.

Normal Mode: Mode in which the WBR is transparent to system operation.

Inward Facing (IF) Mode: Test mode where core inputs are controlled by the WBR and core outputs are observed by the WBR.

Outward Facing (OF) Mode: Test mode where wrapper functional outputs are controlled by the WBR and wrapper functional inputs are observed by the WBR.

Safe Mode: Test mode where core inputs are controlled to safe values by the WBR and wrapper functional outputs are controlled to safe values by the WBR.

EVENTS:

An event is an uninterrupted, predefined sequence of one or more steps. An event may have a characteristic instant.

Shift: Shift is an event whereby the data stored in a WBR cell's shift path is moved one storage element closer to the WBR cell's CTO. The data present at the WBR cell's CTI is loaded into the storage element of the WBR cell's shift path storage element closest to CTI.

Update: Update is an optional event whereby data stored in a WBR cell's shift path storage element closest to CTO is loaded into an off-shift path storage element.

Transfer: Transfer is an optional event dependent on the existence of the update event whereby the data present in the off-shift path storage element described in the update event is loaded into the storage element of the WBR cell's shift path storage element closest to CTI.

Capture: Capture is an event whereby the value present on the CFI at the characteristic instant is stored in a sequential element within a WBR cell. The data shall be stored in the shift path storage element closest to CTI or, optionally, in the off-path storage element described by the transfer event if and only if the transfer event is supported.

Apply: Apply is an event whereby test data becomes active and effective. While the wrapper is in inward facing mode, the apply event causes test data to be applied from input cells onto core inputs. While the wrapper is in outward facing mode, the apply event causes test data to be applied from output cells onto WBR functional outputs. The test data is the data stored in the shift path storage element closest to CTO unless the update event is supported in which case the test data shall be the data stored in the off-path storage element described in the update event. The characteristic instant of Apply is meaningful as applied to the WBR as a whole and not on a cell by cell basis.

RULES, RECOMMENDATIONS and PERMISSIONS:

WBR Structure:

Rules:

1) All non-clock and non-test digital core terminals shall be provisioned with a WBR cell.
2) The wrapper boundary register shall have at least one configuration~~s~~ in response to the state of the WIR in which all WBR cells are concatenated, in a serial configuration, CTO to CTI, except for the first and last cells which shall connect CTI to WBR's TI and CTO to WBR's TO respectively.

Permissions:

3) Core c~~C~~lock terminals may be provisioned with a WBR cell.
4) Core t~~T~~est terminals may be provisioned with a WBR cell.

WBR Cell Structure:

Rules:

1) Every WBR cell shall have at least one storage element connected between its CTI and CTO terminals.
2) Every WBR cell shall have a storage element provisioned for the purpose of servicing the Capture event and this element shall be either the shift path storage element closest to CTI or the optional update storage element, if it exists, exclusively. This choice is for cell structure, not a variable state of operation of the WBR cell.
3) Provided that the update storage element is provisioned for servicing the capture event, then the WBR cell shall support the transfer event.

Permissions:

4) Any WBR cell may have more than one storage element connected between its CTI and CTO terminals.
5) Any WBR cell may have a storage element provisioned for the purpose of servicing the Update event.

Description

For the SIL, the WBR should have a single, uniform shift path between its ~~C~~TI and ~~C~~TO. WBR Structure rules 1 and 2 and WBR Cell Structure rule 1 support this.

IEEE 1149.1 cells should be useable as P1500 WBR cells. WBR Cell Structure permission 5~~6~~ supports this.

WBR Cell Structure Rules 1 and 2 provide for a minimal implementation consisting of only a means to select test data or functional data as input to a shared storage element.

WBR Cell Structure permission 4~~5~~ is included in order to support test methodologies requiring the application of sequential patterns (i.e. path-delay, transition delay, piece-wise functional, etc.)

Captured data should enter the shift path of a cell at the location closest to CTI. WBR Cell Structure rules 3 and 4 support this. The purpose of this is to prevent captured data from stepping on apply data during sequential tests.

Capture in the cell as defined in WBR Cell Structure permission 5~~6~~ (i.e. in the update element) is intended to support test methodologies which require that functional timing and test mode timing are identical. For example, this update register may be shared with normal operation and thereby satisfies this requirement.

Normal mode:

Rules:

1) While in Normal mode, t~~he state or operation of the WBR shall affect neither the operation of the core, nor the system in which it is embedded.~~he WBR shall have no effect on the operation of the core or on the flow of signals between the system logic and the core.

Permissions:

2) While in Normal mode, the WBR may respond to the Shift event.

Inward Facing Mode:

Rules

1) While in IF mode, cells provided for core inputs shall respond to Shift, Apply and, if provisioned for it under WBR Cell Structure permission 5~~6~~ above, Update events.
2) While in IF mode, cells provided for core outputs shall respond to Shift, Capture and, if provisioned for it under WBR Cell Structure rule 3~~4~~, Transfer events.

Recommendations

3) While in IF mode, cells provided for core outputs should present “safe” data at their CFO terminals.

Outward Facing Mode:

Rules

1) While in OF mode, cells provided for core inputs shall respond to Shift, Capture and, if provisioned for it under WBR Cell Structure rule 3~~4~~, Transfer events.
2) While in OF mode, cells provided for core outputs shall respond to Shift, Apply and, if provisioned for it under WBR Cell Structure permission 5~~6~~ above, Update events.

Recommendations

3) While in OF mode, cells provided for core inputs should present “safe” data at their CFO terminals.

Safe Mode:

Recommendations

1) While in Safe mode, all cells should present “safe” data at their CFO terminals.

Permissions

2) While in Safe mode, the WBR may respond to the Shift event.

General:

Permissions

1) Events may be discrete or simultaneous or overlapping~~, provided that all other rules are abided~~.
2) Inward facing mode and outward facing mode may be operative at the same time~~, provided that all other rules are abided~~.
3) Whereas the four modes defined herein (normal, IF, OF and safe) are applied homogeneously across the entire WBR, ~~users may define~~ other modes may be defined in which the cells respond on an individual basis (normal, IF, OF or safe.)