Synopsys Inc.

CHI VIP UVM USER GUIDE FOR 'AMBA5 CHI ISSUE C SPECIFICATION' SUPPORT

Release Version AMBA_SVT N-2018.03-1-T20180522

CONTENTS

REFERENCES

- CHI Issue C Specification - ARM-ECM-0705666 Version 3.0 - 08 Jan. 18
- ARM AMBA 5 CHI Architecture Specification - ARM IHI 0050B (ID080717) - 04 August 2017

REVISION HISTORY

Release	Supported Features
N-2018.03-1-T-20180503	AMBA CHI SVT VIP - CHI Issue C support – Initial release • Separate Read Data and Comp Response • Response after receiving first Data Packet
N-2018.03-1-T-20180512	AMBA CHI SVT VIP - CHI Issue C support • Combined CompAck with WriteData
N-2018.03-1-T-20180522	AMBA CHI SVT VIP - CHI Issue C support • CompAck without waiting for all the CompData, DataSepResp flits

1 INTRODUCTION

ARM CHI Issue C specification document is an addendum to CHI Issue B specification. This document along with CHI Issue B specification constitutes complete CHI Issue C specification requirements.

The new features to CHI in issue C are:

- Separate Read Data and Comp Response (for Data sent to the Requester from Home or Slave)
- Response after receiving first Data packet
- Combined CompAck with WriteData
- Error Handling

2 SUPPORTED FEATURES

AMBA CHI VIP supports the following CHI Issue C specification features:

- Separate Read Data and Comp Response (for Data sent to the Requester from Home or Slave).
    - CompAck generation and monitoring from RN agent before the reception of DataSepResp DAT flits.
- Response after receiving first Data packet.
    - Completion acknowledge response, CompAck, after receiving first read data packet, CompData or DataSepResp.
    - Snoop response with data, SnpRespData, must wait for receiving of all read data packets, CompData.
- Combined CompAck with WriteData.
- Error Handling

The following VIP components support the above listed features:

- CHI RN, SN agents in active and passive modes
- CHI System Monitor

Verification, Debug Features:

- Protocol Analyzer support for the above supported features.

Please refer to the section 'CHI Issue C Features' to know the specific aspects and details that are supported for each of the features listed above.

Please refer to the section 'Unsupported Features/Known Limitations' to know the specific aspects that are not supported for each of the features listed above.

Note: VIP Common N-2018.03-3 or a later release is required to use the CHI-C features.

2.1 DOCUMENTATION

This document is an addendum to CHI UVM User Guide, CHI-B UVM User Guide documents.

The CHI-C HTML class reference is located under:
$DESIGNWARE_HOME/vip/svt/amba_svt/latest/doc/chi_c_svt_uvm_class_reference/html

3 UNSUPPORTED FEATURES/KNOWN LIMITATIONS

- CHI-C features are not yet supported by CHI Interconnect VIP component.
- Functional coverage is not yet updated for CHI-C specific protocol features.

4 ENABLING CHI-C MODE

There are backward incompatible changes in CHI Issue C spec compared to earlier versions:

- Opcode field width of DAT VC is increased from 3 to 4.
- There are new opcodes on REQ, RSP VC 's introduced, which correspond to reserved values in case of earlier versions of CHI Specifications.

4.1 USER INTERFACE

To use all the CHI Issue C features including earlier CHI spec versions to Issue C, it is required to define the compile time macro `SVT_CHI_ISSUE_C_ENABLE. Once this macro is defined, all the VC signal widths will be as per CHI Issue C spec.

Once the `SVT_CHI_ISSUE_C_ENABLE compile macro is defined, to configure the CHI VIP components to work with CHI Issue C features, it is required to program the following attribute for each of the agents:

svt_chi_node_configuration::chi_spec_revision = svt_chi_node_configuration::ISSUE_C

Once `SVT_CHI_ISSUE_C_ENABLE macro is defined, still it is possible to use only features of only Issue B OR only ISSUE A by setting above configuration attribute accordingly.

Recap from CHI Issue B VIP User guide: *Note that, to use all the CHI Issue B features including earlier CHI spec versions to Issue B, users are required to define the compile time macro `SVT_CHI_ISSUE_B_ENABLE. Once this macro is defined, all the VC signal widths will be as per CHI Issue B spec. To use only CHI Issue A features, users are not required to define any of the above macros.*

4.1.1 USE MODEL DETAILS TO KEEP IN MIND

- Once `SVT_CHI_ISSUE_C_ENABLE macro is defined, all the VIP interface signal widths will be as per CHI Issue C spec. In case any of the RTL components that are connected are not yet compliant to CHI Issue C spec, it is required to tie off the required interface signals appropriately in the test bench.

4.2 LICENSING

A new CHIC BETA License is required when `SVT_CHI_ISSUE_C_ENABLE macro is defined and svt_chi_node_configuration::chi_spec_revison is set to ISSUE_C for any of the CHI VIP components.

5 CHI ISSUE C FEATURES

5.1 SEPARATE READ DATA AND COMP RESPONSE

5.1.1 OVERVIEW

For all read transactions that can have CompData response, except:

- Atomic transactions
- Exclusive Reads
- Reads with ((order_type !=NO_ORDERING_REQUIRED)&& (exp_comp_ack == 0))

This feature permits the following:

- In response to such read requests from RN: ICN generating dat_vc_flit_opcode = DATASEPRESP together with ICN generating rsp_vc_flit_opcode = RESPSEPDATA
- Corresponding to such read requests from RN, ICN generating DMT flow read request with req_vc_flit_opcode = READNOSNPSEP to SN: SN generating dat_vc_flit_opcode = DATASEPRESP to RN together with ICN generating rsp_vc_flit_opcode = RESPSEPDATA to RN

5.1.2 USER INTERFACE

5.1.2.1 CONFIGURATION ATTRIBUTES

svt_chi_system_configuration::set_hn_sep_data_rsp_enable(bit sep_data_rsp_enable[])

Indicates whether a given HN supports separate data and separate response mechanism for the applicable reads.

When set_hn_dmt_enable(bit dmt_enable[]) is also set to 1 for the same HN, it's expected that only in that case, data is expected from SN. Otherwise data is expected from HN only. In either case, RSP is expected from HN when sep_data_rsp_enable is 1 for the same HN.

5.1.2.2 TRANSACTION ATTRIBUTES

bit attribute
svt_chi_transaction::**is_respsepdata_datasepresp_flow_used** = 1'b0

- This field indicates whether Seperate Data and Separe Home Response flow is used or not

- This should not be programmed by user.
- Applicable for both RN and SN.
- This attribute along with **is_dmt_used** indicates the following:
  - is_dmt_used = 0, is_respsepdata_datasepresp_flow_used = 0: normal CompData flow without DMT
  - is_dmt_used = 1, is_respsepdata_datasepresp_flow_used = 0: normal CompData flow with DMT
  - is_dmt_used = 0, is_respsepdata_datasepresp_flow_used = 1: home sent data, home sent response

- is_dmt_used = 1, is_respsepdata_datasepresp_flow_used = 1: slave sent data, home sent response

rand bit attribute
svt_chi_transaction::**is_compack_after_respsepdata_and_all_datasepresp** = 1'b1

- Applicable only for active RN configured
with **svt_chi_node_configuration :: chi_spec_revision** >= **svt_chi_node_configuration :: ISSUE_C**.

- Applicable for all Read transactions that has exp_comp_ack=1, except read transactions with Exclusives
  - Applicable when Seperate Read Data and Seperate Home response are observed.
- In all other cases, this is not applicable.
- When set to 1 for a Read transaction with exp_comp_ack=1, CompAck is generated only after receiving RespSepData and all DataSepResp flits.
- When set to 0 for a Read transaction with exp_comp_ack=1, CompAck is generated after receiving RespSepData. In this case, CompAck is generated as per is_compack_after_all_compdata.

rand bit attribute
svt_chi_transaction::**is_compack_after_all_compdata** = 1'b1

- Applicable only for active RN configured
with **svt_chi_node_configuration :: chi_spec_revision** >= **svt_chi_node_configuration :: ISSUE_C**.

- Applicable for all Read transactions that has exp_comp_ack=1

- Default value is set to 1
- When set to 0 CompAck can be sent after
  - Rceiving first CompData for unordered Reads.
  - Receiving first DataSepResp for unordered Reads.
  - Receiving RespSepData for ordered Reads

5.2 RESPONSE AFTER RECEIVING FIRST DATA PACKET

5.2.1 OVERVIEW

CHI system monitor supports the following scenarios, where a Home Node is permitted to:

- Send read data to Requester after receiving first read data packet from a Slave
- Send read data to Requester after receiving first snoop data packet from a snooped Requester

RN agent supports the following scenarios, related to Response after receiving first Data packet:

- Completion acknowledge response, CompAck, after receiving first read data packet, CompData or DataSepResp.
- Snoop response with data, SnpRespData, must wait for receiving of all read data packets, CompData.

5.2.2 TRANSACTION ATTRIBUTES

rand bit attribute
svt_chi_transaction::**is_compack_after_respsepdata_and_all_datasepresp** = 1'b1

- Applicable only for active RN configured
with **svt_chi_node_configuration :: chi_spec_revision** >= **svt_chi_node_configuration :: ISSUE_C**.

- Applicable for all Read transactions that has exp_comp_ack=1, except read transactions with Exclusives
    - Applicable when Seperate Read Data and Seperate Home response are observed.
- In all other cases, this is not applicable.
- When set to 1 for a Read transaction with exp_comp_ack=1, CompAck is generated only after receiving RespSepData and all DataSepResp flits.
- When set to 0 for a Read transaction with exp_comp_ack=1, CompAck is generated after receiving RespSepData. In this case, CompAck is generated as per is_compack_after_all_compdata.

rand bit attribute
svt_chi_transaction::**is_compack_after_all_compdata** = 1'b1

- Applicable only for active RN configured
with **svt_chi_node_configuration :: chi_spec_revision** >= **svt_chi_node_configuration :: ISSUE_C**.

- Applicable for all Read transactions that has exp_comp_ack=1

- Default value is set to 1
- When set to 0 CompAck can be sent after
  - Rceiving first CompData for unordered Reads.
  - Receiving first DataSepResp for unordered Reads.
  - Receiving RespSepData for ordered Reads

5.2.3 PROTOCOL CHECKS

Following checks are added, refer to HTML class reference for more details:

- svt_chi_protocol_err_check::valid_snp_response_check

5.3 ERROR HANDLING

The respErr field requirements for DataSepResp, RespSepData and NCBWrDataCompAck flits are supported.

5.4 COMBINED COMPACK & WRITEDATA

CHI Issue C spec permits sending of combined WriteData and CompAck from the RN for a WriteUnique transaction, instead of sending them separately.

VIP RN supports sending NonCopyBackWrDataCompAck flits instead of NonCopyBackWriteData flits for WriteUniqueFull, and WriteUniquePtl transactions whose ExpCompAck is set to 1.

5.4.1 TRANSACTION ATTRIBUTES

Following is the transaction attribute that must be programmed to 1 if NCBWrDataCompAck flits are to be sent in place of NCBWrData:

rand bit attribute
svt_chi_transaction::**is_ncbwrdatacompack_used_for_write_xact** = 0

- This field is defined only when the compile time macro SVT_CHI_ISSUE_C_ENABLE is set. This field can be programmed to 1 only when svt_chi_node_configuration::chi_spec_revision is set to ISSUE_C.
- This field indicates that NCBWRDATACOMPACK shall be transmitted over DAT channel instead of NCBWRDATA and CompAck in response to the write type transactions when this flag is asserted.
- Applicable for WriteUnique transactions with ExpCompAck asserted.
- The Write Data and CompAck flits are transmitted only once Comp or CompDBID response is received.
- If DBIDResp is received first, this field will be overridden to zero and the NonCopyBackWriteData and CompAck flits will be transmitted separately.
- When set to 1, VIP active RN drives NCBWrDataCompAck once it receives the following responses:
  - Comp followed by DBIDResp , OR,
  - CompDBIDResp.
- When set to 0, VIP active RN always drives NCBWrData and CompAck separately.
- For all transaction types other than WriteUnique, or, for WriteUniques with ExpCompAck set to 0, this attribute is not applicable and must be set to 0.

5.4.2 PROTOCOL CHECKS

Following checks have been added in the passive RN to check the validity of the received combined WriteData and CompAck response:

*svt_chi_link_err_check::data_flit_*ncbwrdatacompack*_check:*

Checks that the data VC message fields are set to valid values for a NCBWrDataCompAck flit.

*svt_chi_protocol_err_check:: valid_*ncbwrdatacompack *_flit_for_xact_check:*

Checks that NCBWrDataCompAck is used only in case of WriteUnique transactions with ExpCompAck asserted.

svt_chi_protocol_err_check:: ncbwrdatacompack_after_comp_and_dbid_check:

Checks that NCBWrDataCompAck for a WriteUnique transaction is sent only after the reception of both Comp and DBIDResp ,or, CompDBID response. In case separate Comp and DBID responses are seen, this check additionally checks that NCBWrDataCompAck flits are sent only in case Comp was received before the DBIDResp flit.