

# ICLAB 2023-Fall Lab03 Note

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# AXI Handshake Process

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# Handshake Process Scenario 1

□ Slave: Valid    Master: Ready

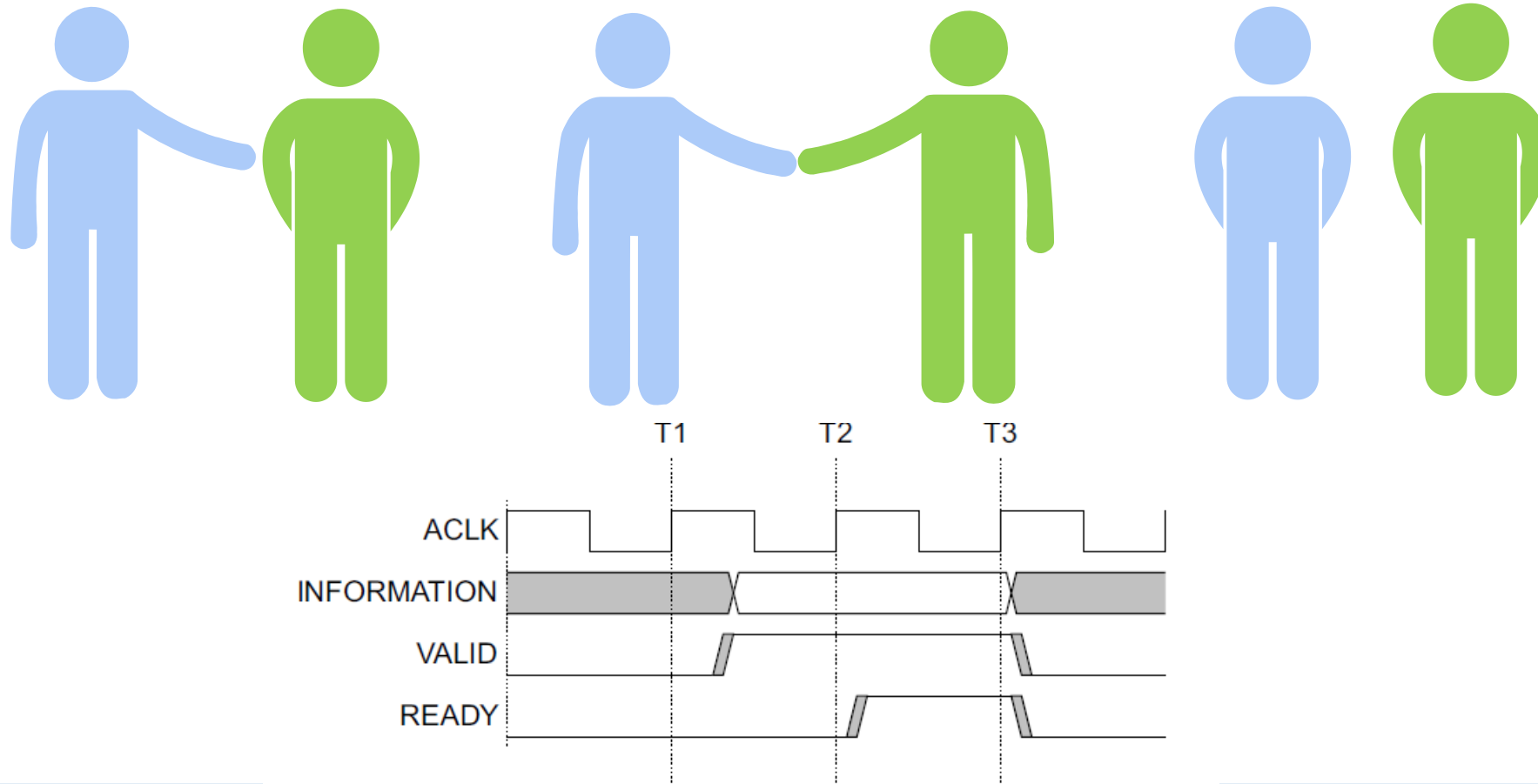


Figure A3-2 VALID before READY handshake

# Handshake Process Scenario 2

❑ Slave: Valid    Master: Ready

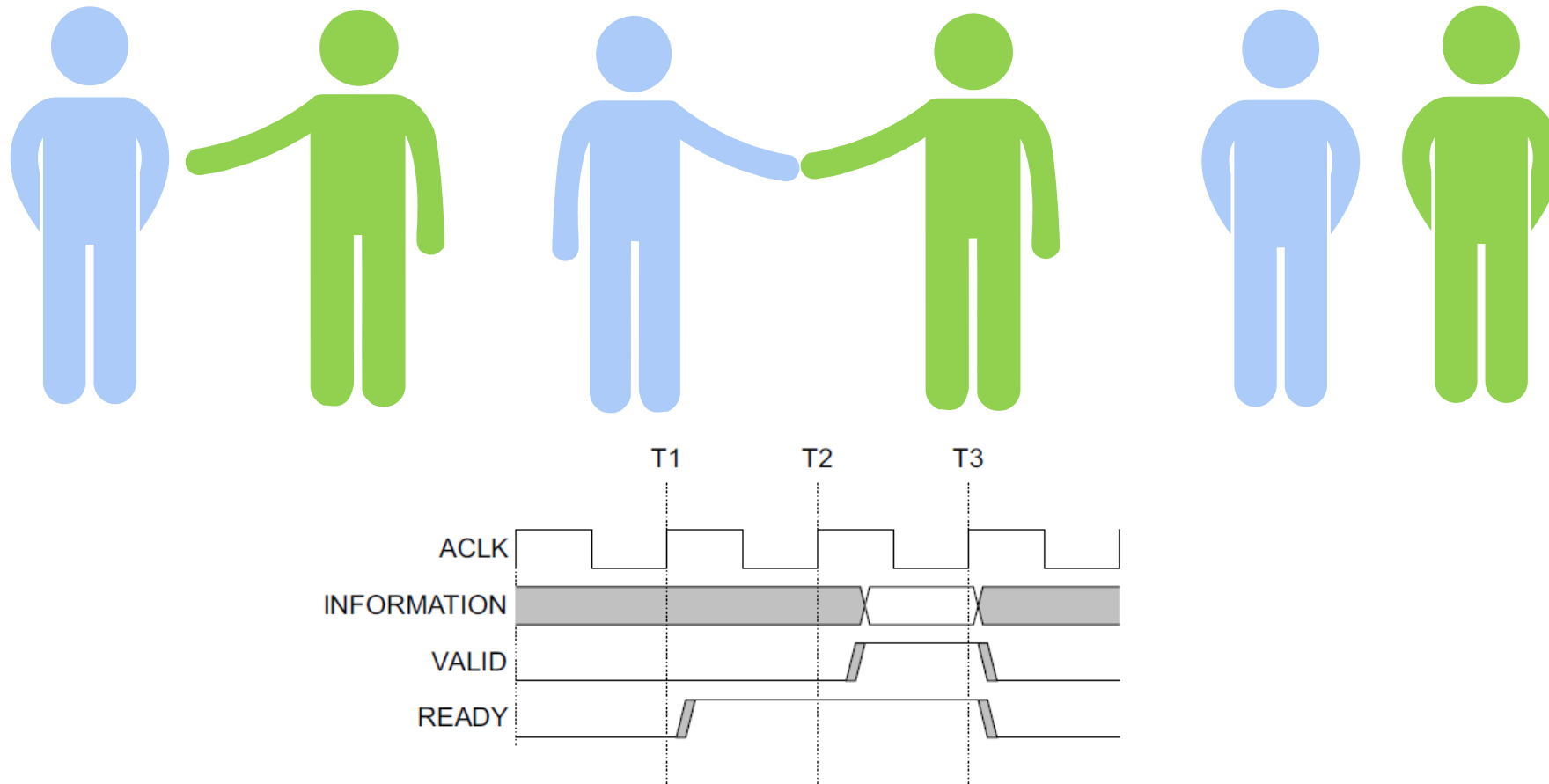


Figure A3-3 READY before VALID handshake

# Handshake Process Scenario 3

□ Slave: Valid    Master: Ready

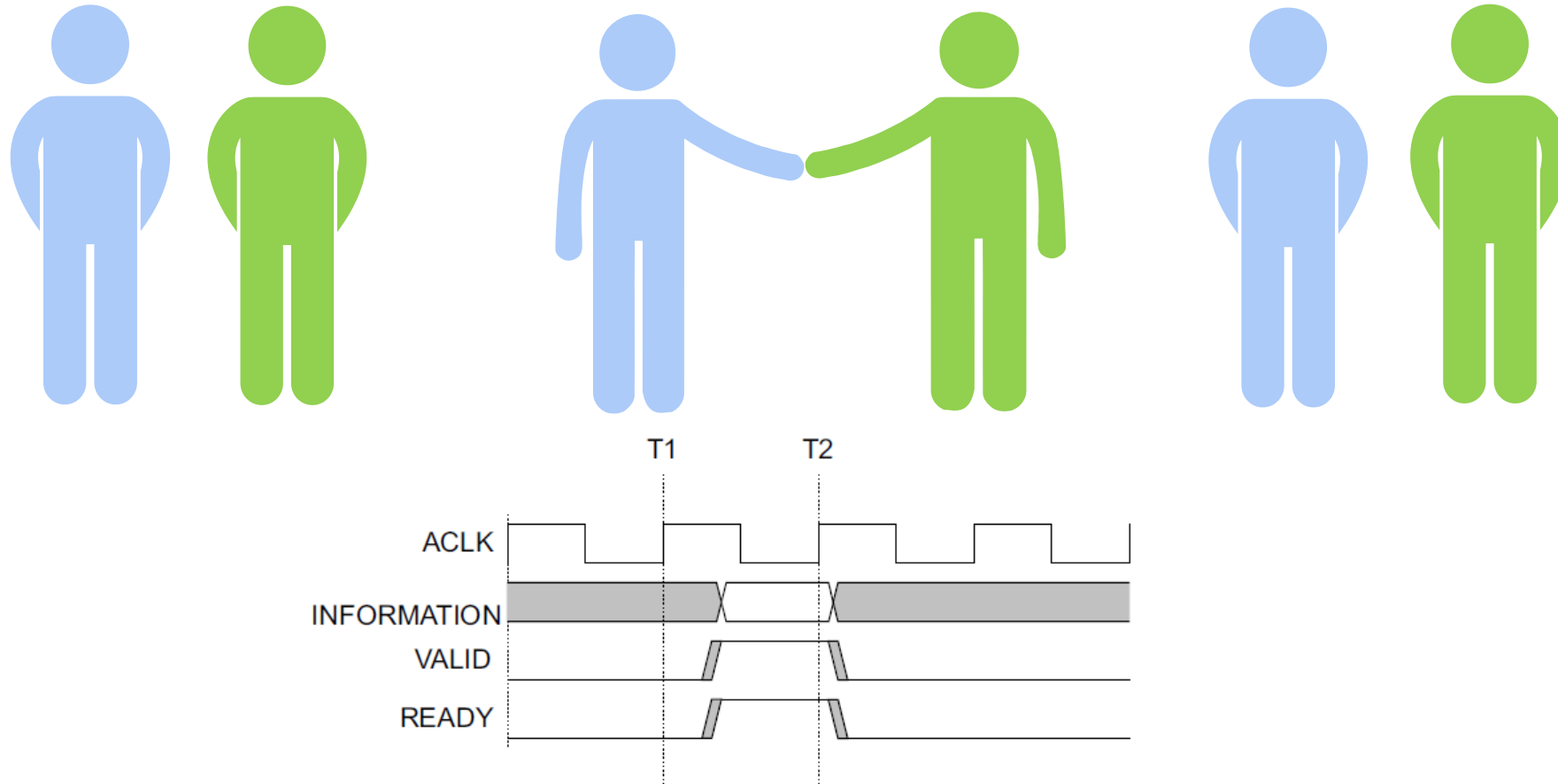


Figure A3-4 VALID with READY handshake

# Handshake Process

- ❑ the **VALID** signal of one **AXI** component must not be dependent on the **READY** signal of the other component in the transaction.
- ❑ the **READY** signal can wait for assertion of the **VALID** signal.

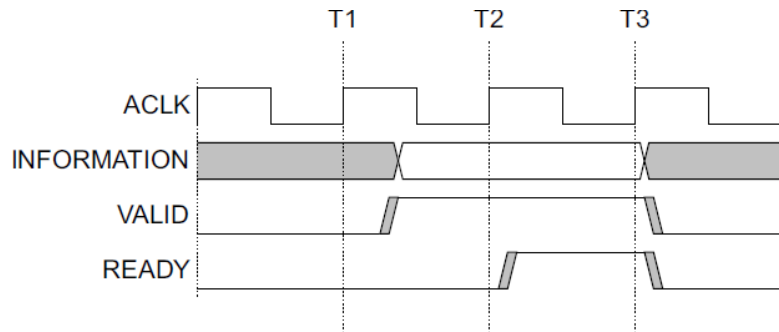


Figure A3-2 VALID before READY handshake

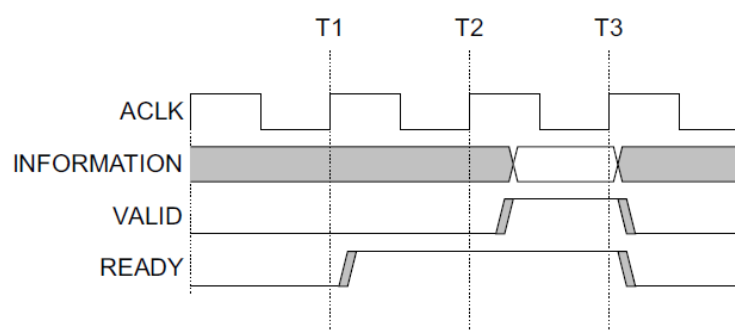


Figure A3-3 READY before VALID handshake

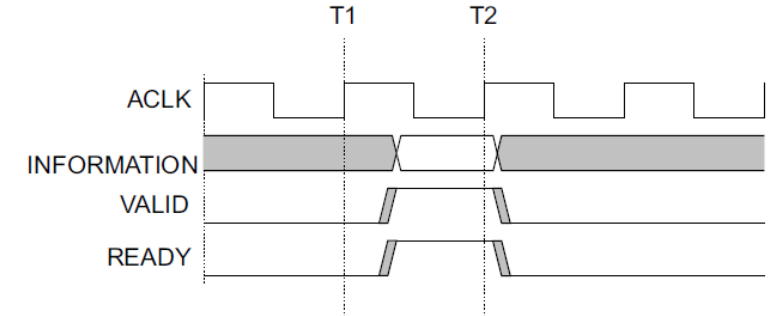


Figure A3-4 VALID with READY handshake

# AXI4-Lite Introduction

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# AXI 4 Basic Transaction

## □ Read Transaction

- Read Address Channel
- Read Data Channel

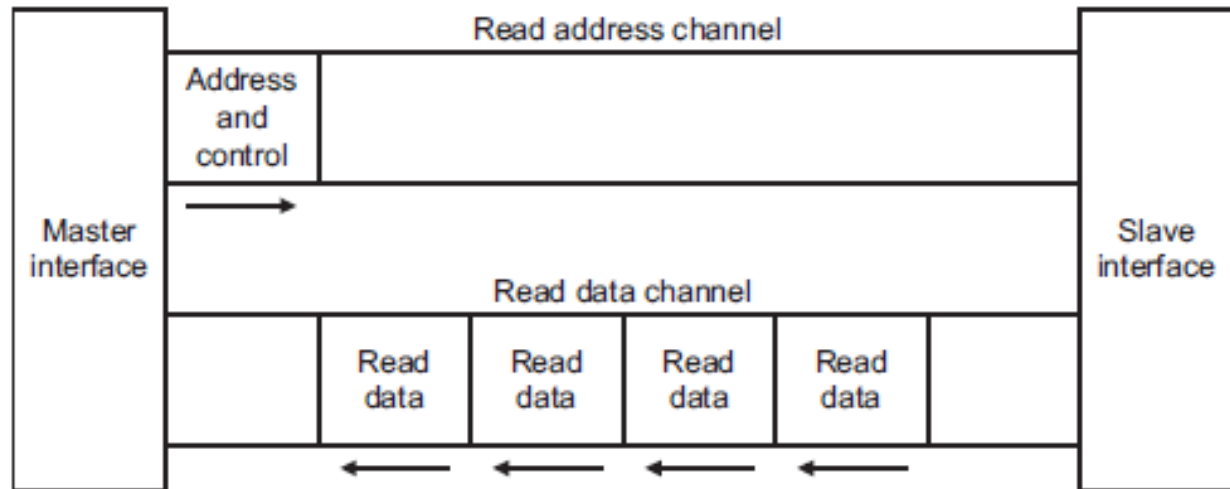


Figure 1-1 Channel architecture of reads

- Each channel have **valid-ready pair** for handshaking process

Ref [2]



# AXI 4 Basic Transaction

## □ Write Transaction

- Write Address Channel
- Write Data Channel
- Write Response Channel

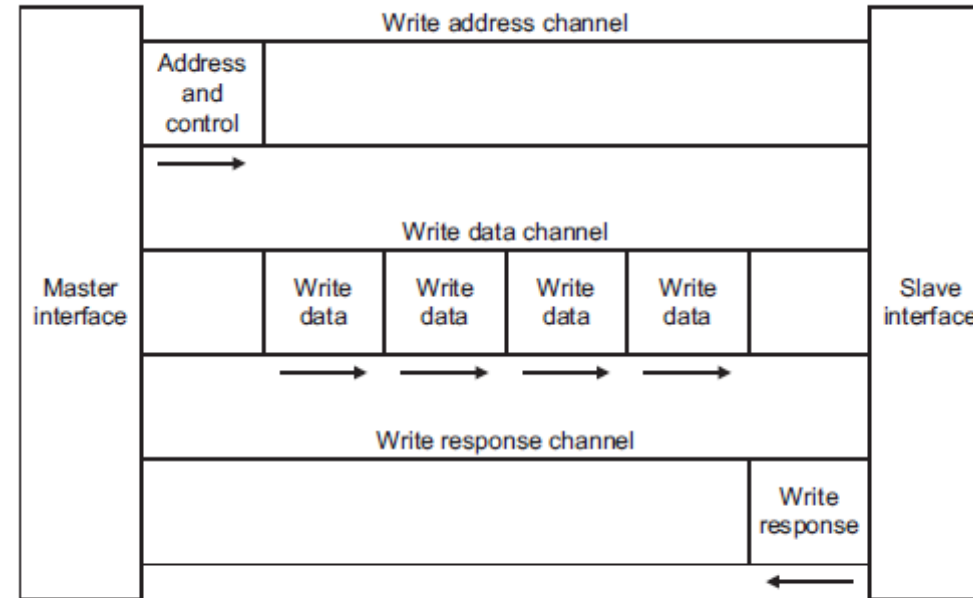


Figure 1-2 Channel architecture of writes

- Each channel have **valid-ready pair** for handshaking process

Ref [2]

# Global Signals

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Signal	Bit Width	Source	Description
<b>clk</b>	1	Clock source	Global clock signal. All signals are sampled on the <b>positive</b> edge of the global clock.
<b>rst_n</b>	1	Reset source	Global reset signal. This signal is active LOW.

# Write Address Channel

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Signal	Bit Width	Source	Description
<b>AW_ADDR</b>	32	Master	Write address.
<b>AW_VALID</b>	1	Master	Write address valid. This signal indicates that valid write address is available:  1 = address available  0 = address not available.  The address remain stable until the address acknowledge signal, <b>AW_READY</b> , goes HIGH.
<b>AW_READY</b>	1	Slave	Write address ready. This signal indicates that the slave is ready to accept an address signals:  1 = slave ready  0 = slave not ready.

# Write Data Channel

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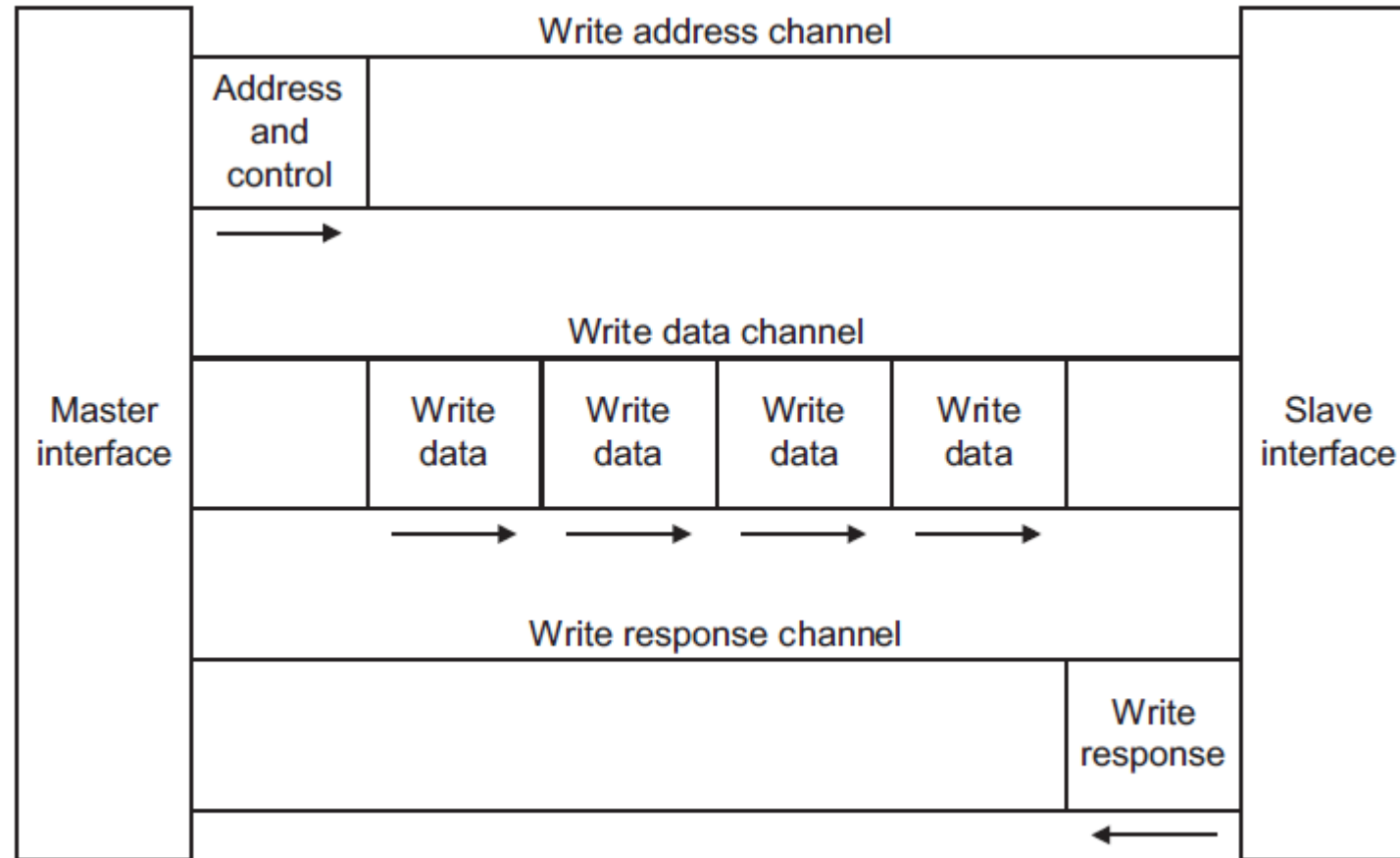
Signal	Bit Width	Source	Description
<b>W_DATA</b>	64	Master	Write data bus.
<b>W_VALID</b>	1	Master	Write valid. This signal indicates that valid write data is available: 1 = write data available 0 = write data not available.
<b>W_READY</b>	1	Slave	Write ready. This signal indicates that the slave can accept the write data: 1 = slave ready 0 = slave not ready.

# Write Response Channel

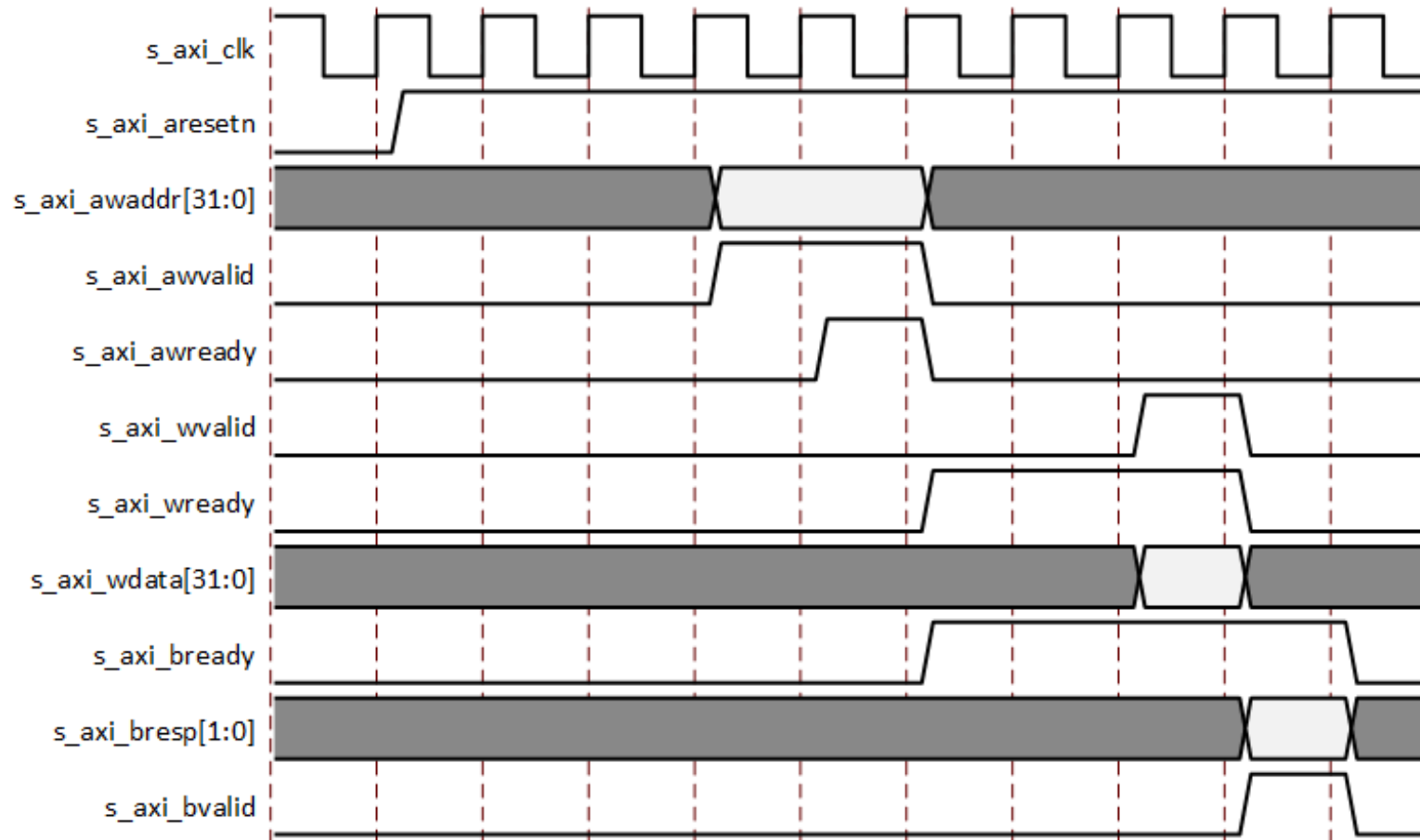
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Signal	Bit Width	Source	Description
<b>B_RESP</b>	2	Slave	Write response. This signal indicates the status of the write transaction. The allowable responses are OKAY, EXOKAY, SLVERR, and DECERR. (In this lab we only issue OKAY(2'b00))
<b>B_VALID</b>	1	Slave	Write response valid. This signal indicates that a valid write response is available: 1 = write response available. 0 = write response not available.
<b>B_READY</b>	1	Master	Response ready. This signal indicates that the master can accept the response information. 1 = master ready. 0 = master not ready.

# Write Transaction



# Waveform of Write Transaction



# Read Address Channel

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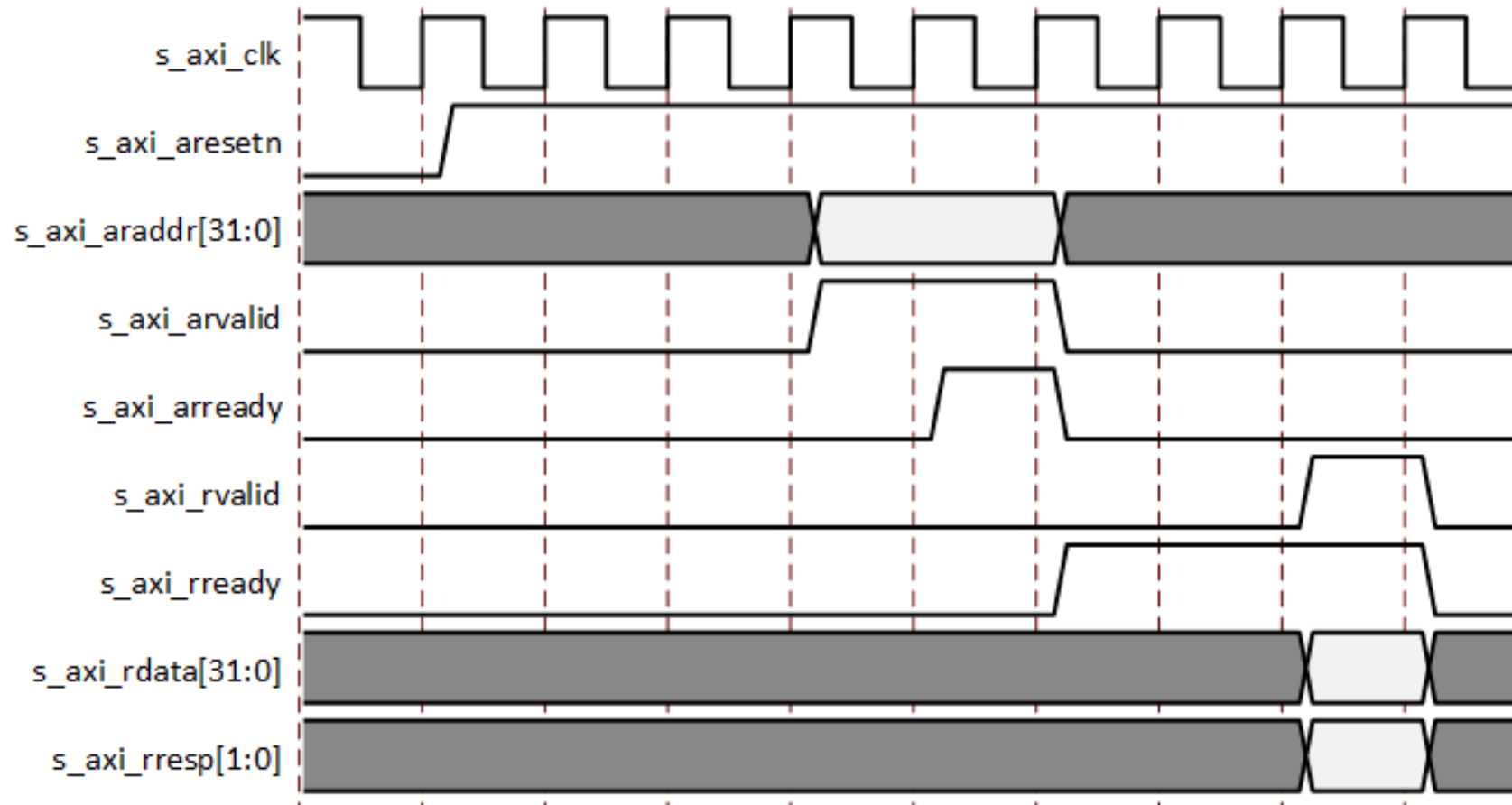
Signal	Bit Width	Source	Description
<b>AR_ADDR</b>	32	Master	Read address.
<b>AR_VALID</b>	1	Master	Read address valid. This signal indicates, when HIGH, that the read address is valid and will remain stable until the address acknowledge signal, <b>AR_READY</b> , is high. 1 = address and control information valid 0 = address and control information not valid.
<b>AR_READY</b>	1	Slave	Read address ready. This signal indicates that the slave is ready to accept an address signals: 1 = slave ready 0 = slave not ready.



# Read Data Channel

Signal	Bit Width	Source	Description
<b>R_DATA</b>	64	Slave	Read data.
<b>R_RESP</b>	2	Slave	Read response. This signal indicates the status of the read transfer. The allowable responses are OKAY, EXOKAY, SLVERR, and DECERR. (In this project we only issue OKAY)
<b>R_VALID</b>	1	Slave	Read valid. This signal indicates that the required read data is available, and the read transfer can complete:  1 = read data available  0 = read data not available.
<b>R_READY</b>	1	Master	Read ready. This signal indicates that the master can accept the read data and response information:  1 = master ready  0 = master not ready.

# Read Transaction



# SPI Introduction

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# SD Card Signal

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Signal	Bit Width	Source	Description
<b>clk</b>	1	Clock source	Global clock signal. All signals are sampled on the <b>positive</b> edge of the global clock.
<b>CS_n</b>	1	Master	Chip Select, active LOW
<b>MISO</b>	1	Slave	Master Input Slave Output. When the data is not transfer, keep HIGH. Serial In Serial Out (SISO) transmission.
<b>MOSI</b>	1	Master	Master Output Slave Input. When the data is not transfer, keep HIGH. Serial In Serial Out (SISO) transmission.

# SD Card Read Operation

## Command (from host)

Start bit + transmission bit = 2'b01

Command: CMD17 = 6'd17

Argument: address

CRC: CRC-7({Start bit, Transmission bit, Command, Argument})

End bit: 1'b1

(wait 0~8 units, units = 8 cycles)

## Response (from SD card)

Response: 0x00 (8 bits)

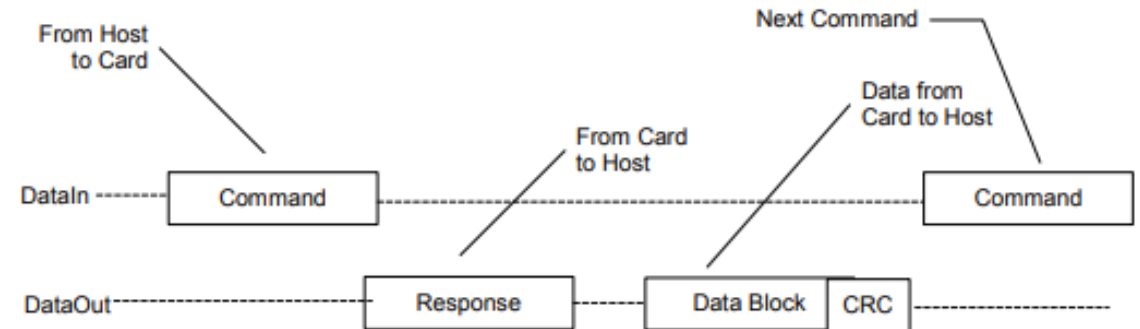
(wait 1~32 units, units = 8 cycles)

## Data (from SD card)

Start token: 0xFE (8 bits)

Data block: 64 bits (differ from the original protocol)

CRC: CRC-16-CCITT (Data block)



## Command Format

Byte 1				Bytes 2—5				Byte 6	
7	6	5	0	31			0	7	0
0	1	Command		Command Argument				CRC	

# SD Card Write Operation

## Command (from host)

Start bit + transmission bit = 2'b01

Command: CMD24 = 6'd24

Argument: address

CRC: CRC-7({Start bit, Transmission bit, Command, Argument})

End bit: 1'b1

(wait 0~8 units, units = 8 cycles)

## Response (from SD card)

Response: 0x00 (8 bits)

(wait 1~32 units, units = 8 cycles)

## Data (from host)

Start token: 0xFE

Data block: 64 bits (differ from the original protocol)

CRC: CRC-16-CCITT (Data block)

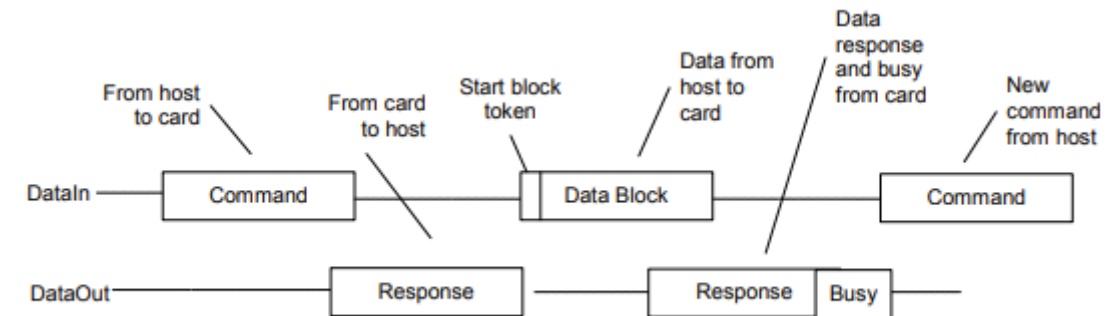
(wait 0 units, units = 8 cycles)

## Data response (from SD card)

Data\_response: 8'b00000101

Busy: keep low until finish write.

(wait 0~32 units, units = 8 cycles)



## Command Format

Byte 1			Bytes 2—5			Byte 6	
7	6	5	0			7	0
0	1	Command			Command Argument		
						CRC	
						1	