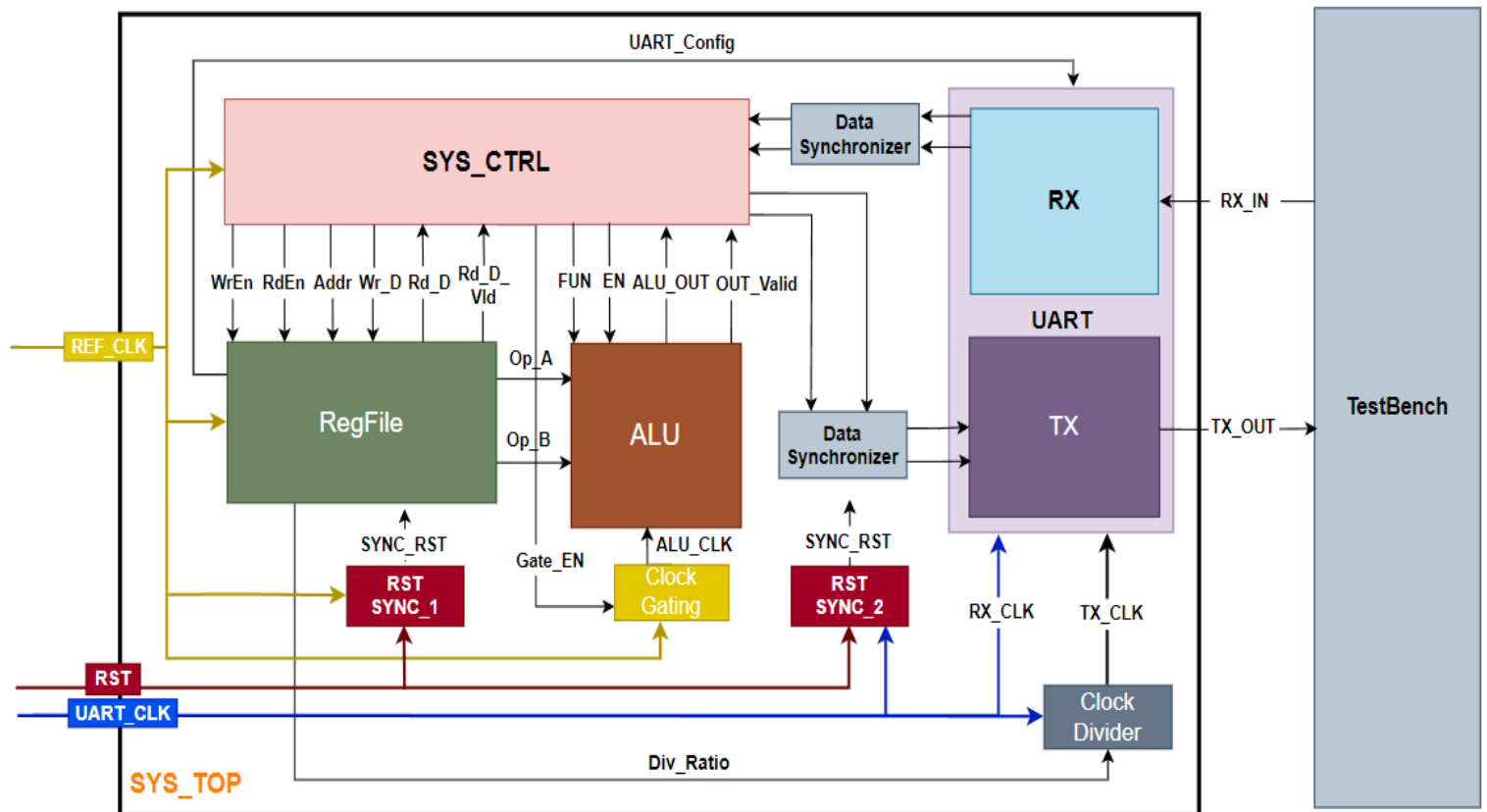


Final System



- **Description: -**

1. **This system contains 9 blocks: -**

- 1) **Clock Domain 1 (REF_CLK)**

- **RegFile**
- **ALU**
- **Clock Gating**
- **SYS_CTRL**

- **Clock Domain 2 (UART_CLK)**

- **UART_TX**
- **UART_RX**
- **Clock Divider**

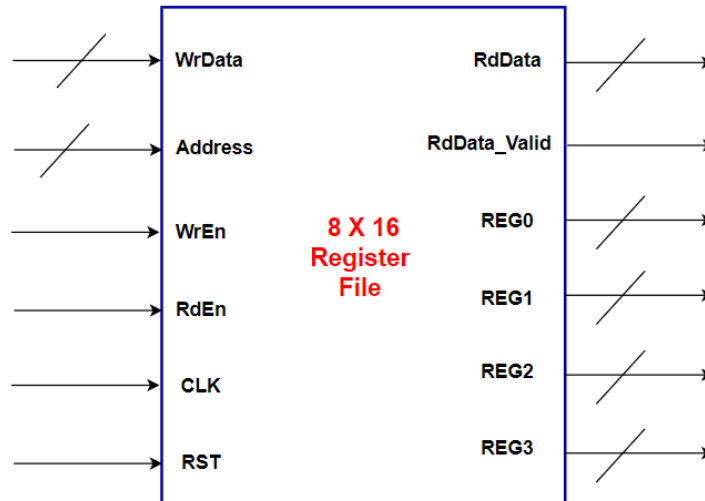
- **Synchronizers**

- **RST Synchronizer**
- **Data Synchronizer**

CLOCK Domain 1

1) RegFile: -

- Block Interface: -



- Signal Description: -

Port	Direction	Width	Description	Connected to
CLK	IN	1	Clock Signal	TOP Input Port (REF_CLK)
RST	IN	1	Active Low Reset	RST_SYNC
Address	IN	Parameterized (default : 4 bits)	Address bus	SYS_CTRL
WrEn	IN	1	Write Enable	SYS_CTRL
RdEn	IN	1	Read Enable	SYS_CTRL
WrData	IN	Parameterized (default : 8 bits)	Write Data Bus	SYS_CTRL
RdData	OUT	Parameterized (default : 8 bits)	Read Data Bus	SYS_CTRL
RdData_Valid	OUT	1	Read Data Valid	SYS_CTRL
REG0	OUT	Parameterized (default : 8 bits)	Register at Address 0x0	ALU
REG1	OUT	Parameterized (default : 8 bits)	Register at Address 0x1	ALU
REG2	OUT	Parameterized (default : 8 bits)	Register at Address 0x2	UART
REG3	OUT	Parameterized (default : 8 bits)	Register at Address 0x3	Clock Divider

- **Reserved Registers Description: -**

1) REG0 (Address: 0x0)

ALU Operand A

2) REG1 (Address: 0x1)

ALU Operand B

3) REG2 (Address: 0x2)

UART Config

REG2[0]: Parity Enable

REG2[1]: Parity Type

REG2[6:2]: Prescale

4) REG3 (Address: 0x3)

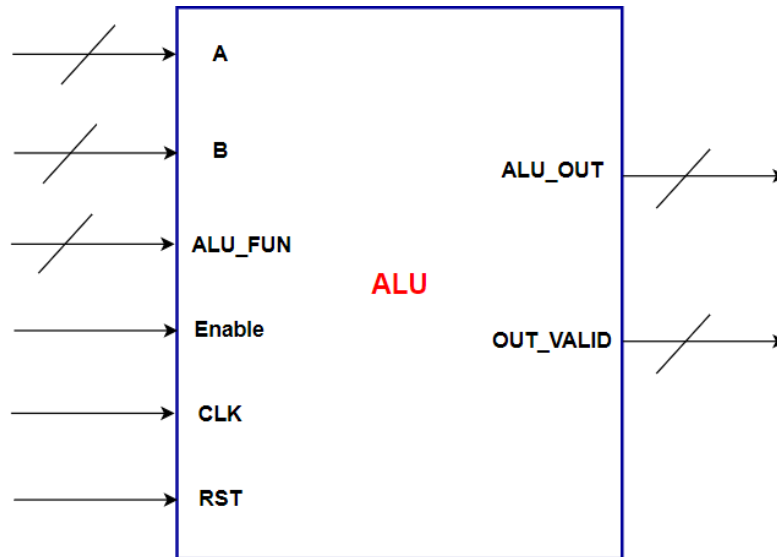
Div Ratio

REG3[0:3]: Division ratio

REG3[4:7]: Not Used

2) ALU:

- **Block Interface: -**

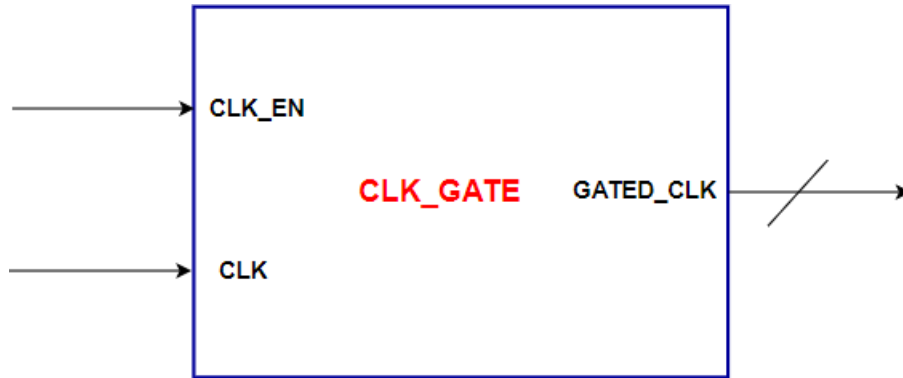


- **Signal Description: -**

Port	Direction	Width	Description	Connected to
CLK	IN	1	Clock Signal	CLK_GATE
RST	IN	1	Active Low Reset	RST_SYNC
A	IN	Parameterized (default : 8 bits)	Operand A	RegFile (REG0)
B	IN	Parameterized (default : 8 bits)	Operand B	RegFile (REG1)
ALU_FUN	IN	Parameterized (default : 4 bits)	ALU Function	SYS_CTRL
Enable	IN	1	ALU Enable	SYS_CTRL
ALU_OUT	OUT	Parameterized (default : 8 bits)	ALU Result	SYS_CTRL
OUT_VALID	OUT	1	Result Valid	SYS_CTRL

3) Clock Gating: -

- **Block Interface: -**

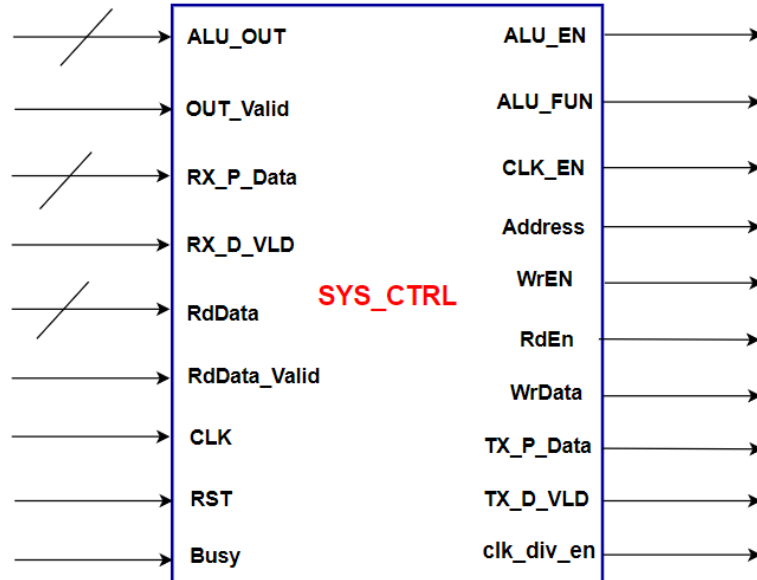


- **Signal Description: -**

Port	Direction	Width	Description	Connected to
CLK	IN	1	Clock Signal	TOP Input Port (REF_CLK)
CLK_EN	IN	1	Clock Enable	SYS_CTRL
GATED_CLK	out	1	Gated Clock signal	ALU

4) SYS_CTRL:

- Block Interface: -



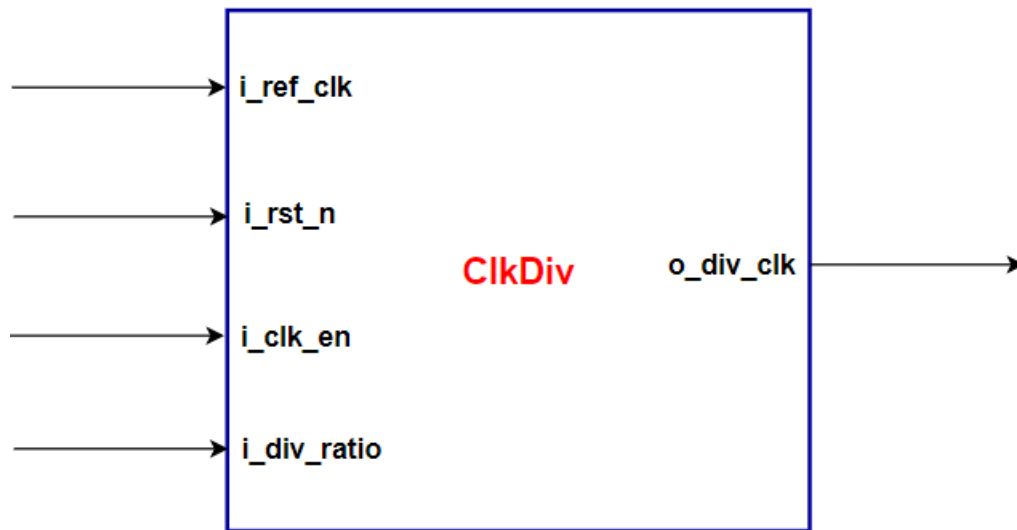
- Signal Description: -

Port	Direction	Width	Description	Connected to
CLK	IN	1	Clock Signal	TOP Input Port (REF_CLK)
RST	IN	1	Active Low Reset	RST_SYNC
ALU_OUT	IN	8	ALU Result	ALU
OUT_Valid	IN	1	ALU Result Valid	ALU
EN	OUT	1	ALU Enable signal	ALU
ALU_FUN	OUT	4	ALU Function signal	ALU
CLK_EN	OUT	1	Clock gate enable	CLK_GATE
Address	OUT	4	Address bus	RegFile
WrEn	OUT	1	Write Enable	RegFile
RdEn	OUT	1	Read Enable	RegFile
WrData	OUT	8	Write Data Bus	RegFile
RdData	IN	8	Read Data Bus	RegFile
RdData_Valid	IN	1	Read Data Valid	RegFile
RX_P_DATA	IN	8	UART_RX Data	UART_RX
RX_D_VLD	IN	1	RX Data Valid	UART_RX
TX_P_DATA	OUT	8	UART_TX Data	UART_TX
TX_D_VLD	OUT	1	TX Data Valid	UART_TX
Busy	IN	1	Uart_TX status	UART_TX
clk_div_en	OUT	1	Clock divider enable	CLKDiv

CLOCK Domain 2

1) Clock Divider: -

- **Block Interface: -**

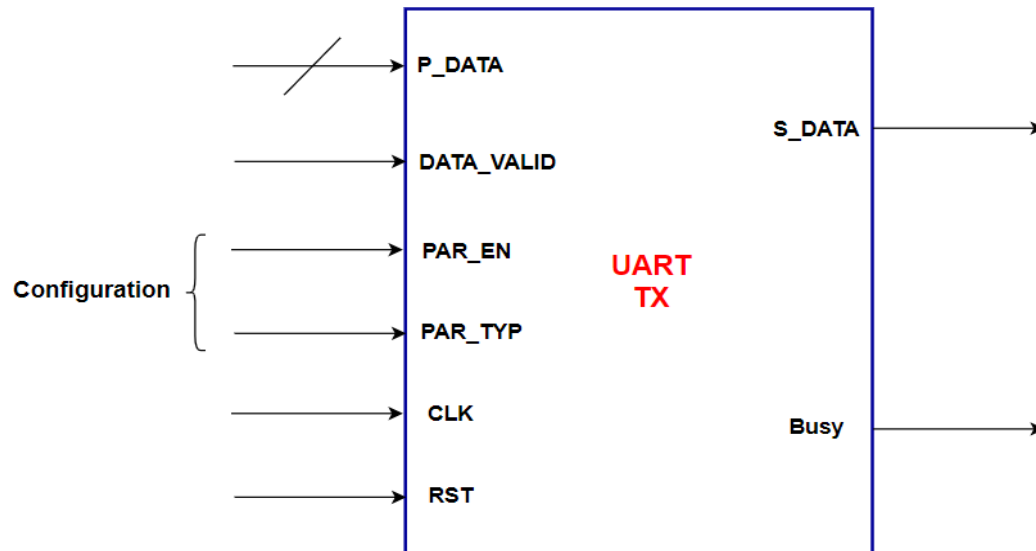


- **Signal Description: -**

Port	Direction	Width	Description	Connected to
I_ref_clk	IN	1	Clock Signal	TOP Input Port (UART_CLK)
I_rst_n	IN	1	Active Low Async Reset	RST_SYNC_2
I_clk_en	IN	1	Clock divider enable	SYS_CTRL
I_div_ratio	IN	Parameterized (default : 4 bits)	Division ratio	RegFile
O_div_clk	out	1	Divided clock	UART_TX

2) UART_TX: -

- **Block Interface: -**

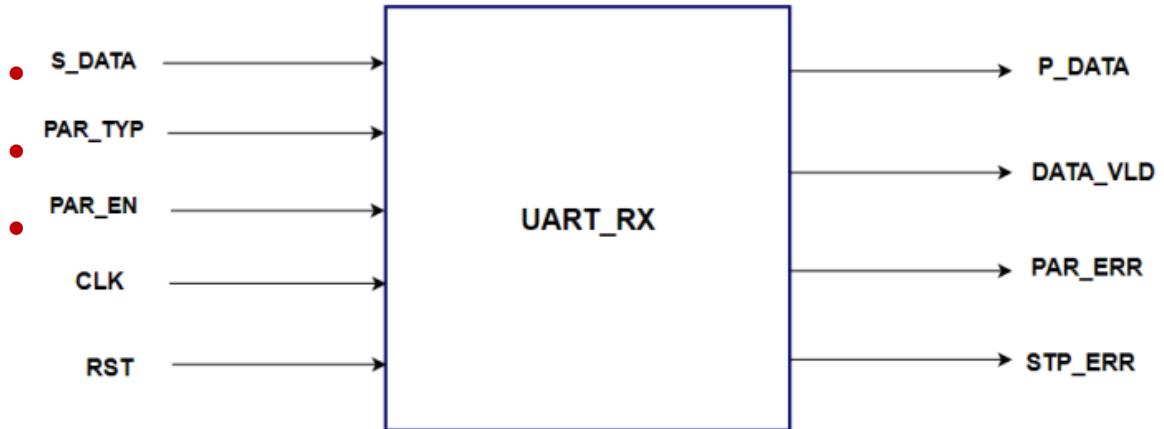


- **Signal Description: -**

Port	Direction	Width	Description	Connected to
CLK	IN	1	Clock Signal	CLKDiv
RST	IN	1	Active Low Reset	RST_SYNC_2
PAR_EN	IN	1	Parity Enable	RegFile
PAR_TYP	IN	1	Parity Type	RegFile
P_DATA	IN	Parameterized (default : 8 bits)	Parallel IN Data	SYS_CTRL
DATA_VALID	IN	1	IN Data Valid	SYS_CTRL
S_DATA	OUT	1	frame serial bits	TOP Output Port (TX_OUT)
Busy	OUT	1	Uart status signal	SYS_CTRL

3) UART_RX: -

- **Block Interface: -**



- **Signal Description: -**

Port	Direction	Width	Description	Connected to
CLK	IN	1	Clock Signal	TOP Input Port (UART_CLK)
RST	IN	1	Active Low Reset	RST_SYNC_2
PAR_EN	IN	1	Parity Enable	RegFile
PAR_TYP	IN	1	Parity Type	RegFile
S_DATA	IN	1	frame serial bits	TOP Input Port (RX_IN)
P_DATA	OUT	Parameterized (default : 8 bits)	Parallel Out Data	SYS_CTRL
DATA_VLD	OUT	1	Out Data Valid	SYS_CTRL
PAR_ERR	OUT	1	Frame parity error	TOP Output Port
STP_ERR	OUT	1	Frame stop error	TOP Output Port

Synchronizers

1) RST_Sync: -

- **Block Interface: -**

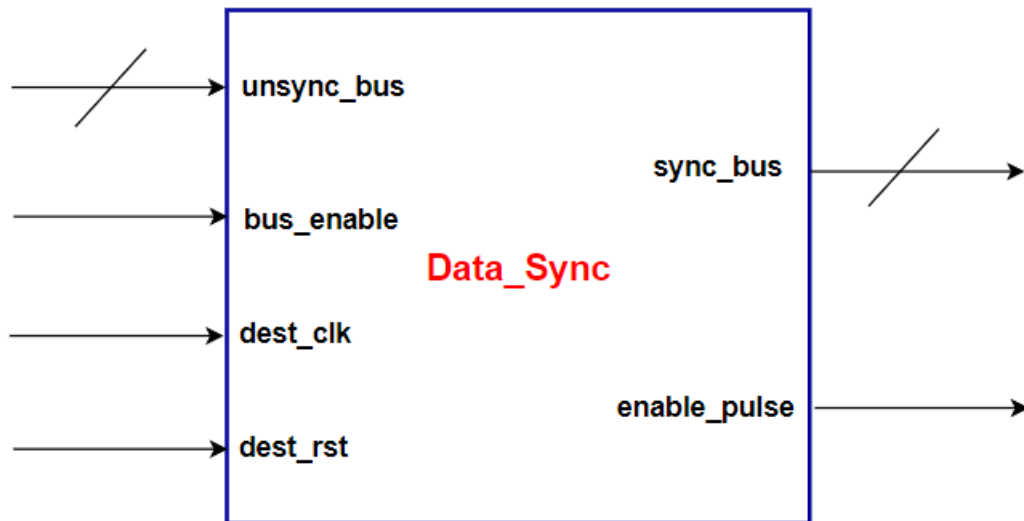


- **Signal Description: -**

Port	Direction	Width	Description
RST	IN	1	Clock Signal
CLK	IN	1	Active Low Async Reset
SYNC_RST	OUT	1	Active Low synchronized Reset

2) Data_Sync: -

- **Block Interface: -**

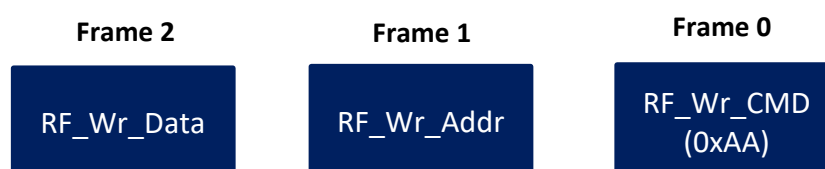


- **Signal Description: -**

Port	Direction	Width	Description
unsync_bus	IN	8	Unsynchronized bus
bus_enable	IN	1	Bus enable signal
dest_clk	IN	1	Destination Clock Signal
dest_rst	IN	1	Destination Active Low Reset
sync_bus	OUT	8	synchronized bus
enable_pulse_d	OUT	1	enable pulse signal

Introduction

- The system is responsible to do some operation based on the received **commands** from the master through **UART_RX** interface, once the operation is done, the system is responsible to send the result to the master through **UART_TX** interface.
- Supported Operations: -
 1. **ALU Operations:** -
 - Addition
 - Subtraction
 - Multiplication
 - Division
 - AND
 - OR
 - NAND
 - NOR
 - XOR
 - XNOR
 - CMP: A = B
 - CMP: A > B
 - SHIFT: A >> 1
 - SHIFT: A << 1
 2. **Register File Operations**
 - Register File Write
 - Register File read
- Supported Commands: -
 1. **Register File Write command (3 frames)**



2. Register File Read command (2 frames)



3. ALU Operation command with operand (4 frames)



4. ALU Operation command with No operand (2 frames)



System Specifications: -

- Reference clock (REF_CLK) is 50 MHz
- UART clock (UART_CLK) is 9.6 KHz
- Div_ratio is 8
- Clock Divider is always on (clock divider enable = 1)

Sequence of Operation (Must include in the testbench): -

- Initially configuration operations are performed through Register file write operations in addresses (0x2, 0x3).
- The Master (Testbench) start to send different commands (RegFile Operations, ALU operations)
- Our system will receive the command frames through UART_RX, it sent to the SYS_CTRL block to be processed
- Once the operation of the command is performed using ALU/RegFile, SYS_CTRL sends the result to the master through UART_TX
- Register File Address Range for normal write/read operations (From 0x4 to 0x15)
- Register File Addresses reserved for configurations and ALU operands (From 0x0 to 0x3)