EENG-5560 Final Project Report

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Specifications

Requirement	Design Follows Requirement
Input data width: 4 bits	Yes
Homogeneous Computational Units (CUs)	Yes
Heterogeneous Interconnects	Yes
Interconnects with mirroring	Yes
Pass and No Op operation support	Yes
Support for all of the DFGs on the Super-architecture	Yes

Design

Block diagram

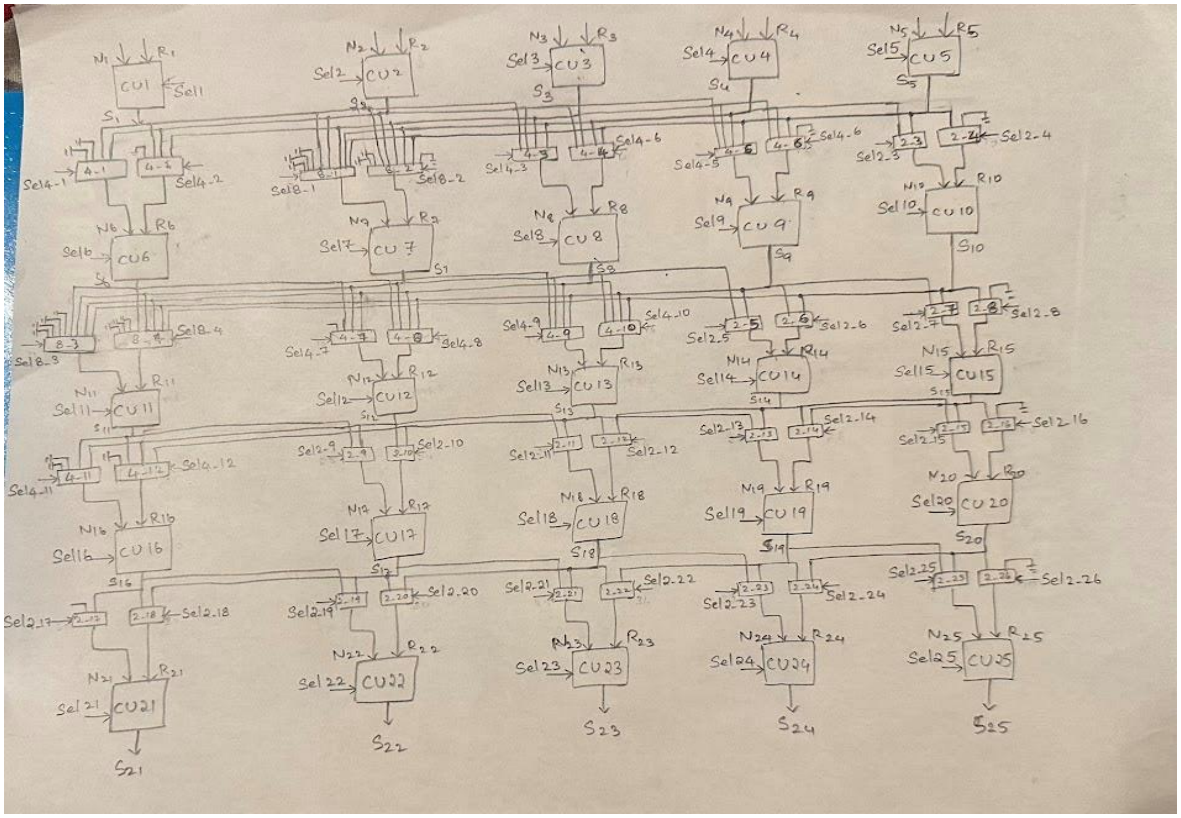


Figure 1-Block diagram of 5 X 5 Fabric

- The block diagram shows the 5 x 5 reconfigurable architecture fabric.(5 rows & 5 columns)
- The fabric consists a total of 25 CU's (Computational Unit's), 4 no's of 8:1 mux's, 12 no's of 4:1 mux's, and 24 no's of 2:1 mux's
- The data width for the CU is 4 bits wide.
- Each CU can perform 19 operations. These include Arithmetic, Shift and Comparison operations.

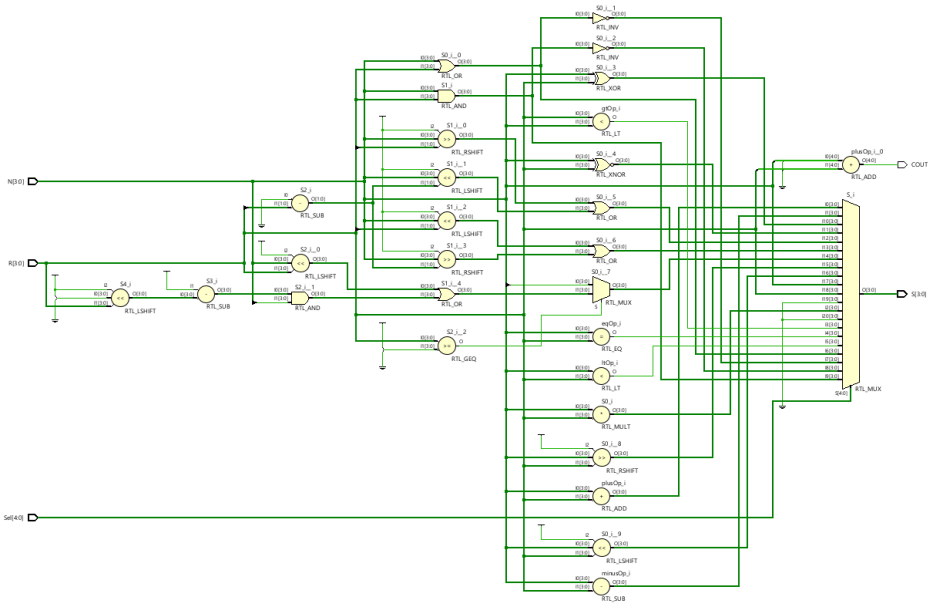
- Each of the mux's used are operated based on mirroring concept.
- The CU's in the fabric are operated based on the Data flow graphs given in the problem. And the operation of the fabric is left justified.
- There is no multi-level connectivity in the fabric.
- Pass Gates are used in the fabric to pass the output values from 1st row to 3rd /4th / 5th row CU's. Two pass gates are used for this, namely Pass gate 1 & Pass gate 2.
- CU with Pass Gate 1 operation passes the output for Input 1.
- CU with Pass Gate 2 operation passes the output for Input 2.
- Depending on data flow graph's given each CU does the operation specified to it.
- The rest of all CU's are set to No Operation (NOOP), where these CU's output is 0000 irrespective of inputs.
- We will get the final outputs from S21 and S22 depending on DFG's.

Overall Component: 5 x 5 Fabric

- Overall ports:
  - Inputs:
    - N1, R1, N2, R2, N3, R3, N4, R4, N5, R5: 4 bits
    - Sel 1 - Sel 25: 5 bits (CU Sel's)
  - Outputs:
    - S21, S22, S23, S24, S25: 4 bits

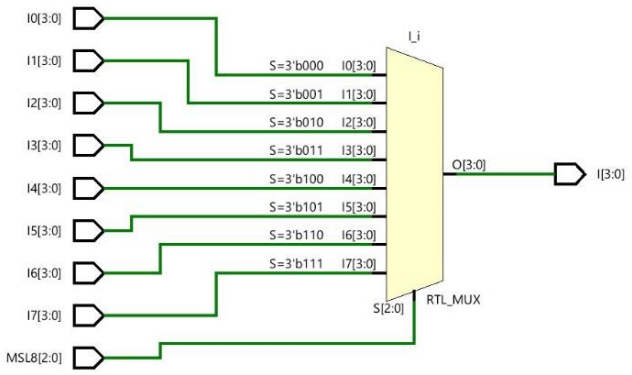
- Subcomponents:

  - **ALU**



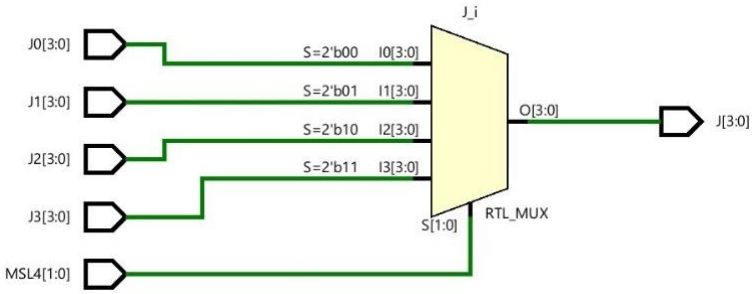
N, R: Input's (4 bits)
S: Output (4 bits)
Sel: Selector (5 bit's)

- **8:1 Mux**



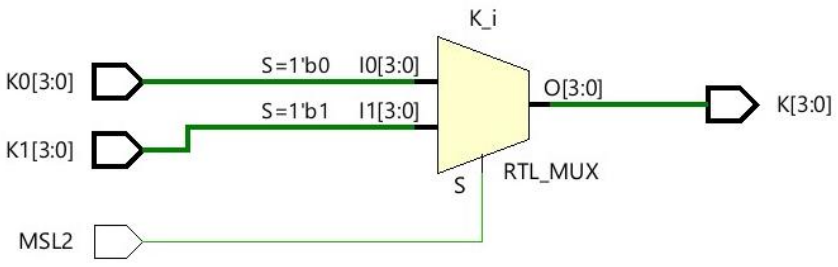
I0,I1,I2,I3,I4,I5,I6,I7 : Inputs(4 bit)
MSL8 : Selector (3 bits)
I : Output(4 bit)

- **4:1 Mux**



J0,J1,J2,J3 : Inputs(4 bit)
MSL4 : Selector(2 bit)
J : Output(4bit)

- **2:1 Mux**



K0, K1: Inputs (4 bit)
MSL2: Selector (1 bit)
K: Output (4 bit)

- Necessary intermediate signals:

    - S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12, S13, S14, S15, S16, S17, S18, S19, S20, S21, S22, S23, S24, S25: outputs of CU's given as input's to 8:1,4:1,2:1 mux's.

    - N6,R6,N7,R7,N8,R8,N9,R9,N10,R10,N11,R11,N12,R12,N13,R13,N14,R14,N15,R15, N16,R16,N17,R17,N18,R18,N19,R19,N20,R20,N21,R21,N22,R22,N23,R23,N24,R24, N25,R25 : Output's from mux's given as input's to next row CU's, 4 bits

Opcode table: (FOR CU's)

OPCODE	**OPERATION**
00000	ADDITION (+)
00001	SUBTRACTION (-)
00010	MULTIPLICATION (*)
00011	EQUAL TO (=)
00100	GREATER THAN (>)
00101	LESS THAN (<)
00110	OR
00111	NOR
01000	AND
01001	XOR
01011	XNOR
01100	ROR (rotate right)
01101	ROL (rotate left)
01110	ASL (arithmetic shift left)
01111	LSR (logical shift right)
10000	LSL (logical shift left)
10001	PASS GATE-1
10010	PASS GATE-2
10011	NO OPERATION

Design explanation:

- The design of the 5 x 5 fabric satisfies all the conditions that were given in the DFG's.
- Two Input's(4bit) are given to each and every CU presented in the fabric. Based on the DFG the operations are assigned to each CU depending on their Opcode(Sel line). And output(4 bit) is generated
- A total of 25 CU's are included in this fabric.
- For the connectivity between the 1st row CU's to the next row CU's we used different mux's(8:1/4:1/2:1) depending on the connectivity. i.e., output's of 1st row CU's are given as input's to next row CU's and so on up to 5 rows.
- For this handling we used two mux's(which are mirrored to each other) for each CU inputs. We used mirroring concept to connect the mux's. Basically the two mux's combined gets us reachability. i.e., for 2:1 pair of mux's it is -1 to +1 and for 4:1 pair of mux's -2 to +2 and for 8:1 pair of mux's it is -4 to +4
- We used 8:1 mux, because we have operated our CU's in the fabric to be left justified. So in this case, if the 1st CU of 2nd row wants to get an input from 5th CU of 1st row we can easily reach with the help of mirrored 8:1 mux.
- Similarly 4:1 and 2:1 mux's are used by considering the data flow that was specified in the DFG's given and the type of CU connections that are specified in all DFG's.

- **For DFG-1:** As given in the DFG the operations and connectivity for the CU's are given accordingly. CU1 performs addition, CU2 performs multiplication, CU3-addition, CU4-subtraction, CU-5 multiplication, for the given set of inputs for each CU.
- Now the outputs from the first row CU's i.e., S1,S2,S3,S4,S5 are given as inputs to the next row CU's by using mux's. The output's from row 1 CU's are first given as inputs to mux's present below and the output's from the mux's based on the sel line of the mux(MSL) is given as input to next row CU.
- For **CU6(SUB)** inputs N6,R6 are taken from outputs of CU1 & CU3. For this Mux's 4_1, 4_2 are used. For mux 4_1, pins J0,J1 are grounded. And J2 is connected to S1& J3 is connected to S2. And in mux 4_2 J0 pin is grounded and pins J1,J2,J3 are connected to S1,S2,S3 respectively. Mux 4_1 gives output from pin J2 by setting MSL4_1 as "10". And mux 4_2 gives output from pin J3 by setting MSL4_2 as "11".
- For **CU7(ADD)** inputs N7,R7 are taken from outputs of CU3 & CU5 . For this Mux's 8_1, 8_2 are used. For mux 8_1, pins I0,I1,I2 are grounded and pins I3,I4,I5,I6,I7 are connected to outputs S1,S2,S3,S4,S5 respectively. In mux 8_2 pins I0,I1,I7 are grounded and I2,I3,I4,I5,I6 are connected to outputs S1,S2,S3,S4,S5 respectively. Mux 8_1 gives output from pin I5 by setting MSL8_1 as "101" and for mux 8_2 from pin I6 by setting MSL8_2 as "110".
- For **CU8(SUB)** inputs N8,R8 are taken from outputs of CU2 & CU4 . For this Mux's 4_3, 4_4 are used. For mux 4_3, pins J0,J1,J2,J3 are connected to outputs S1,S2,S3,S4 respectively. In mux 4_4 pins J0,J1,J2,J3 are connected to outputs S2,S3,S4,S5 respectively. Mux 4_3 gives output from pin J1 by setting MSL4_3 as "01" and for mux 4_4 from pin J2 by setting MSL4_4 as "10".
- For **CU9(PG 2)** inputs N9,R9 are taken from outputs of CU2 & CU5 . For this Mux's 4_5, 4_6 are used. For mux 4_5, pins J0,J1,J2,J3 are connected to outputs S2,S3,S4,S5 respectively. In mux 4_6 pins J0,J1,J2 are connected to outputs S3,S4,S5 respectively, pin J3 is grounded. Mux 4_5 gives output from pin J0 by setting MSL4_5 as "00" and for mux 4_6 from pin J2 by setting MSL4_6 as "10".
- For **CU10(NOOP)** inputs N10,R10 are taken from outputs of CU5 & CU5 . For this Mux's 2_3, 2_4 are used. For mux 2_3, pins K0,K1 are connected to outputs S4,S5 respectively. In mux 2_4 pin K0 is connected to output S5, pin K1 is grounded. Mux 2_3 gives output from pin K1by setting MSL2_3 as "1" and for mux 2_4 from pin K0 by setting MSL2_4 as "0".
- Now the output's from CU6, CU7, CU8, CU9, CU10 are S6, S7, S8, S9, S10 respectively. These outputs are given as inputs to third row CU's, CU11-CU15 by using mux's.
- For **CU11(OR)** inputs N11,R11 are taken from outputs of CU6 & CU8 . For this Mux's 8_3, 8_4 are used. For mux 8_3, pins I0,I1,I2,I3 are grounded and pins I4,I5,I6,I7 are connected to outputs S6,S7,S8,S9 respectively. In mux 8_3 pins I0,I1,I2 are grounded and pins I3,I4,I5,I6,I7 are connected to outputs S6,S7,S8,S9,S10 respectively. Mux 8_3 gives output from pin I4 by setting MSL8_3 as "100" and for mux 8_4 from pin I5 by setting MSL8_4 as "101".
- For **CU12(AND)** inputs N12,R12 are taken from outputs of CU7 & CU8 . For this Mux's 4_7, 4_8 are used. For mux 4_7, pins J1,J2,J3 are connected to outputs S6,S7,S8 respectively, pin J0 is grounded. In mux 4_8 pins J0,J1,J2,J3 are connected to outputs S6,S7,S8,S9 respectively. Mux 4_7 gives output from pin J2 by setting MSL4_7 as "10" and for mux 4_8 from pin J2 by setting MSL4_8 as "10".
- For **CU13(NAND)** inputs N13,R13 are taken from outputs of CU6 & CU9 . For this Mux's 4_9, 4_10 are used. For mux 4_9, pins J0,J1,J2,J3 are connected to outputs S6,S7,S8,S9 respectively. In mux 4_10 pins J0,J1,J2,J3 are connected to outputs S7,S8,S9,S10 respectively. Mux 4_9 gives output from pin J0 by setting MSL4_9 as "00" and for mux 4_10 from pin J2 by setting MSL4_10 as "10".

- For **CU14(NOOP)** inputs N14,R14 are taken from outputs of CU8 & CU9 . For this Mux's 2_5, 2_6 are used. For mux 2_5, pins K0,K1 are connected to outputs S8,S9 respectively. In mux 2_6 pin K0,K1 are connected to outputs S9,S10. Mux 2_5 gives output from pin K0 by setting MSL2_5 as "0" and for mux 2_4 from pin K0 by setting MSL2_6 as "0".
- For **CU15(NOOP)** inputs N15,R15 are taken from outputs of CU9 & CU10 . For this Mux's 2_7, 2_8 are used. For mux 2_7, pins K0,K1 are connected to outputs S9,S10 respectively. In mux 2_8 pin K0 is connected to output S10, K1 is grounded. Mux 2_7 gives output from pin K0 by setting MSL2_7 as "0" and for mux 2_8 from pin K0 by setting MSL2_8 as "0".
- Now the output's from CU11, CU12, CU13, CU14, CU15 are S11, S12, S13, S14, S15 respectively. These outputs are given as inputs to fourth row CU's, CU16-CU20 by using mux's.
- For **CU16(XOR)** inputs N16,R16 are taken from outputs of CU11 & CU12 . For this Mux's 4_11, 4_12 are used. For mux 4_11, pins J0,J1 are grounded and pins J2,J3 are connected to outputs S11,S12 respectively. In mux 4_12 pin J0 is grounded and pins J1,J2,J3 are connected to outputs S11,S12,S13 respectively. Mux 4_ 11 gives output from pin J2 by setting MSL4_11 as "10" and for mux 4_12 from pin J2 by setting MSL4_12 as "10".
- For **CU17(NOR)** inputs N17,R17 are taken from outputs of CU12 & CU13 . For this Mux's 2_9, 2_10 are used. For mux 2_9, pins K0,K1 are connected to outputs S11,S12 respectively. In mux 2_10 pin K0,K1 are connected to outputs S12,S13. Mux 2_9 gives output from pin K1 by setting MSL2_9 as "1" and for mux 2_10 from pin K1 by setting MSL2_10 as "1".
- For **CU18(NOOP)** inputs N18,R18 are taken from outputs of CU12 & CU14 . For this Mux's 2_11, 2_12 are used. For mux 2_11, pins K0,K1 are connected to outputs S12,S13 respectively. In mux 2_12 pin K0,K1 are connected to outputs S13,S14. Mux 2_11 gives output from pin K0 by setting MSL2_11 as "0" and for mux 2_12 from pin K1 by setting MSL2_12 as "1" .
- For **CU19(NOOP)** inputs N19,R19 are taken from outputs of CU13 & CU14 . For this Mux's 2_13, 2_14 are used. For mux 2_13, pins K0,K1 are connected to outputs S13,S14 respectively. In mux 2_14 pin K0,K1 are connected to outputs S14,S15. Mux 2_13 gives output from pin K0 by setting MSL2_13 as "0" and for mux 2_14 from pin K0 by setting MSL2_14 as "0".
- For **CU20(NOOP)** inputs N20,R20 are taken from outputs of CU14 & CU15 . For this Mux's 2_15, 2_16 are used. For mux 2_15, pins K0,K1 are connected to outputs S14,S15 respectively. In mux 2_16 pin K0 is connected to output S15, and pin K1 is grounded. Mux 2_15 gives output from pin K0 by setting MSL2_15 as "0" and for mux 2_16 from pin K0 by setting MSL2_16 as "0".
- The output's from CU16, CU17, CU18, CU19, CU20 are S16, S17, S18, S19, S20 respectively. These outputs are given as inputs to fifth row CU's, CU21-CU25 by using mux's.
- For **CU21(PG 1)** inputs N21,R21 are taken from outputs of CU16 & CU17 . For this Mux's 2_17, 2_18 are used. For mux 2_17, pin K0 is grounded and pin K1 is connected to output S16. In mux 2_18 pins K0,K1 are connected to S16,S17 respectively. Mux 2_17 gives output from pin K1 by setting MSL2_17 as "1" and for mux 2_18 from pin K1 by setting MSL2_18 as "1".
- For **CU22(PG 2)** inputs N22,R22 are taken from outputs of CU16 & CU17 . For this Mux's 2_19, 2_20 are used. For mux 2_19, pins K0,K1 are connected to outputs S16,S17 respectively. In mux 2_20 pin K0,K1 are connected to outputs S17,S18. Mux 2_19 gives output from pin K0 by setting MSL2_19 as "0" and for mux 2_20 from pin K0 by setting MSL2_20 as "0".
- For **CU23(NOOP)** inputs N23,R23 are taken from outputs of CU17 & CU19 . For this Mux's 2_21, 2_22 are used. For mux 2_21, pins K0,K1 are connected to outputs S17,S18 respectively. In mux 2_22 pin K,K1 are connected to outputs S18,S19. Mux 2_22 gives output from pin K0 by setting MSL2_21 as "0" and for mux 2_22 from pin K1 by setting MSL2_10 as "1".

- For **CU24(NOOP)** inputs N24,R24 are taken from outputs of CU18 & CU19 . For this Mux's 2_23, 2_24 are used. For mux 2_23, pins K0,K1 are connected to outputs S18,S19 respectively. In mux 2_24 pin K0,K1 are connected to outputs S19,S20. Mux 2_23 gives output from pin K0 by setting MSL2_23 as "0" and for mux 2_24 from pin K0 by setting MSL2_24 as "0".
- For **CU25(NOOP)** inputs N25,R25 are taken from outputs of CU19 & CU20 . For this Mux's 2_25, 2_26 are used. For mux 2_25, pins K0,K1 are connected to outputs S19,S20 respectively. In mux 2_26 pin K0 is connected to output S20and K1 is grounded. Mux 2_25 gives output from pin K0 by setting MSL2_25 as "0" and for mux 2_26 from pin K0 by setting MSL2_26 as "0".
- The output's from CU21, CU22, CU23, CU24, CU25 are S21, S22, S23, S24, S25 respectively.
- For the DFG-1 we take outputs from CU21,CU22. i.e., S21&S22.

- **For DFG-2:** As given in the DFG the operations and connectivity for the CU's are given accordingly. CU1 performs subtraction, CU2 performs multiplication, CU3-NOOP, CU4-addition, CU-5 multiplication, for the given set of inputs for each CU.
- Now the outputs from the first row CU's i.e., S1,S2,S3,S4,S5 are given as inputs to the next row CU's by using mux's. The output's from row 1 CU's are first given as inputs to mux's present below and the output's from the mux's based on the sel line of the mux(MSL) is given as input to next row CU.
- For **CU6(PG 1)** inputs N6,R6 are taken from outputs of CU1 & CU3. For this Mux's 4_1, 4_2 are used. For mux 4_1, pins J0,J1 are grounded. And J2 is connected to S1& J3 is connected to S2. And in mux 4_2 J0 pin is grounded and pins J1,J2,J3 are connected to S1,S2,S3 respectively. Mux 4_1 gives output from pin J2 by setting MSL4_1 as "10". And mux 4_2 gives output from pin J3 by setting MSL4_2 as "11".
- For **CU7(ADD)** inputs N7,R7 are taken from outputs of CU1 & CU4 . For this Mux's 8_1, 8_2 are used. For mux 8_1, pins I0,I1,I2 are grounded and pins I3,I4,I5,I6,I7 are connected to outputs S1,S2,S3,S4,S5 respectively. In mux 8_2 pins I0,I1,I7 are grounded and I2,I3,I4,I5,I6 are connected to outputs S1,S2,S3,S4,S5 respectively. Mux 8_1 gives output from pin I3 by setting MSL8_1 as "011" and for mux 8_2 from pin I5 by setting MSL8_2 as "101".
- For **CU8(SUB)** inputs N8,R8 are taken from outputs of CU1 & CU5 . For this Mux's 4_3, 4_4 are used. For mux 4_3, pins J0,J1,J2,J3 are connected to outputs S1,S2,S3,S4 respectively. In mux 4_4 pins J0,J1,J2,J3 are connected to outputs S2,S3,S4,S5 respectively. Mux 4_3 gives output from pin J0 by setting MSL4_3 as "00" and for mux 4_4 from pin J3 by setting MSL4_4 as "11".
- For **CU9(ADD)** inputs N9,R9 are taken from outputs of CU2 & CU5 . For this Mux's 4_5, 4_6 are used. For mux 4_5, pins J0,J1,J2,J3 are connected to outputs S2,S3,S4,S5 respectively. In mux 4_6 pins J0,J1,J2 are connected to outputs S3,S4,S5 respectively, pin J3 is grounded. Mux 4_5 gives output from pin J0 by setting MSL4_5 as "00" and for mux 4_6 from pin J2 by setting MSL4_6 as "10".
- For **CU10(PG 1)** inputs N10,R10 are taken from outputs of CU4 & CU5 . For this Mux's 2_3, 2_4 are used. For mux 2_3, pins K0,K1 are connected to outputs S4,S5 respectively. In mux 2_4 pin K0 is connected to output S5, pin K1 is grounded. Mux 2_3 gives output from pin K0 by setting MSL2_3 as "0" and for mux 2_4 from pin K0 by setting MSL2_4 as "0".
- Now the output's from CU6, CU7, CU8, CU9, CU10 are S6, S7, S8, S9, S10 respectively. These outputs are given as inputs to third row CU's, CU11-CU15 by using mux's.
- For **CU11(ROR)** inputs N11,R11 are taken from outputs of CU6 & CU9 . For this Mux's 8_3, 8_4 are used. For mux 8_3, pins I0,I1,I2,I3 are grounded and pins I4,I5,I6,I7 are connected to outputs S6,S7,S8,S9 respectively. In mux 8_3 pins I0,I1,I2 are grounded and pins I3,I4,I5,I6,I7 are connected to outputs S6,S7,S8,S9,S10 respectively. Mux 8_3 gives output from pin I4 by setting MSL8_3 as "100" and for mux 8_4 from pin I6 by setting MSL8_4 as "110".

- For **CU12(PG 2)** inputs N12,R12 are taken from outputs of CU7 & CU8 . For this Mux's 4_7, 4_8 are used. For mux 4_7, pins J1,J2,J3 are connected to outputs S6,S7,S8 respectively, pin J0 is grounded. In mux 4_8 pins J0,J1,J2,J3 are connected to outputs S6,S7,S8,S9 respectively. Mux 4_7 gives output from pin J2 by setting MSL4_7 as "10" and for mux 4_8 from pin J2 by setting MSL4_8 as "10".
- For **CU13(LSL)** inputs N13,R13 are taken from outputs of CU7 & CU10 . For this Mux's 4_9, 4_10 are used. For mux 4_9, pins J0,J1,J2,J3 are connected to outputs S6,S7,S8,S9 respectively. In mux 4_10 pins J0,J1,J2,J3 are connected to outputs S7,S8,S9,S10 respectively. Mux 4_9 gives output from pin J1 by setting MSL4_9 as "01" and for mux 4_10 from pin J3 by setting MSL4_10 as "11".
- For **CU14(NOOP)** inputs N14,R14 are taken from outputs of CU8 & CU9 . For this Mux's 2_5, 2_6 are used. For mux 2_5, pins K0,K1 are connected to outputs S8,S9 respectively. In mux 2_6 pin K0,K1 are connected to outputs S9,S10. Mux 2_5 gives output from pin K0 by setting MSL2_5 as "0" and for mux 2_4 from pin K0 by setting MSL2_6 as "0".
- For **CU15(NOOP)** inputs N15,R15 are taken from outputs of CU9 & CU10 . For this Mux's 2_7, 2_8 are used. For mux 2_7, pins K0,K1 are connected to outputs S9,S10 respectively. In mux 2_8 pin K0 is connected to output S10, K1 is grounded. Mux 2_7 gives output from pin K0 by setting MSL2_7 as "0" and for mux 2_8 from pin K0 by setting MSL2_8 as "0".
- Now the output's from CU11, CU12, CU13, CU14, CU15 are S11, S12, S13, S14, S15 respectively. These outputs are given as inputs to fourth row CU's, CU16-CU20 by using mux's.
- For **CU16(GREATER THAN)** inputs N16,R16 are taken from outputs of CU11 & CU13 . For this Mux's 4_11, 4_12 are used. For mux 4_11, pins J0,J1 are grounded and pins J2,J3 are connected to outputs S11,S12 respectively. In mux 4_12 pin J0 is grounded and pins J1,J2,J3 are connected to outputs S11,S12,S13 respectively. Mux 4_ 11 gives output from pin J2 by setting MSL4_11 as "10" and for mux 4_12 from pin J3 by setting MSL4_12 as "11".
- For **CU17(EQUAL TO)** inputs N17,R17 are taken from outputs of CU11 & CU12 . For this Mux's 2_9, 2_10 are used. For mux 2_9, pins K0,K1 are connected to outputs S11,S12 respectively. In mux 2_10 pin K0,K1 are connected to outputs S12,S13. Mux 2_9 gives output from pin K0 by setting MSL2_9 as "0" and for mux 2_10 from pin K0 by setting MSL2_10 as "0".
- For **CU18(NOOP)** inputs N18,R18 are taken from outputs of CU12 & CU14 . For this Mux's 2_11, 2_12 are used. For mux 2_11, pins K0,K1 are connected to outputs S12,S13 respectively. In mux 2_12 pin K0,K1 are connected to outputs S13,S14. Mux 2_11 gives output from pin K0 by setting MSL2_11 as "0" and for mux 2_12 from pin K1 by setting MSL2_12 as "1" .
- For **CU19(NOOP)** inputs N19,R19 are taken from outputs of CU13 & CU14 . For this Mux's 2_13, 2_14 are used. For mux 2_13, pins K0,K1 are connected to outputs S13,S14 respectively. In mux 2_14 pin K0,K1 are connected to outputs S14,S15. Mux 2_13 gives output from pin K0 by setting MSL2_13 as "0" and for mux 2_14 from pin K0 by setting MSL2_14 as "0".
- For **CU20(NOOP)** inputs N20,R20 are taken from outputs of CU14 & CU15 . For this Mux's 2_15, 2_16 are used. For mux 2_15, pins K0,K1 are connected to outputs S14,S15 respectively. In mux 2_16 pin K0 is connected to output S15, and pin K1 is grounded. Mux 2_15 gives output from pin K0 by setting MSL2_15 as "0" and for mux 2_16 from pin K0 by setting MSL2_16 as "0".
- The output's from CU16, CU17, CU18, CU19, CU20 are S16, S17, S18, S19, S20 respectively. These outputs are given as inputs to fifth row CU's, CU21-CU25 by using mux's.
- For **CU21(PG 1)** inputs N21,R21 are taken from outputs of CU16 & CU17 . For this Mux's 2_17, 2_18 are used. For mux 2_17, pin K0 is grounded and pin K1 is connected to output S16. In mux 2_18 pins K0,K1 are connected to S16,S17 respectively. Mux 2_17 gives output from pin K1 by setting MSL2_17 as "1" and for mux 2_18 from pin K1 by setting MSL2_18 as "1".

- For **CU22(PG 2)** inputs N22,R22 are taken from outputs of CU16 & CU17 . For this Mux's 2_19, 2_20 are used. For mux 2_19, pins K0,K1 are connected to outputs S16,S17 respectively. In mux 2_20 pin K0,K1 are connected to outputs S17,S18. Mux 2_19 gives output from pin K0 by setting MSL2_19 as "0" and for mux 2_20 from pin K0 by setting MSL2_20 as "0".
- For **CU23(NOOP)** inputs N23,R23 are taken from outputs of CU17 & CU19 . For this Mux's 2_21, 2_22 are used. For mux 2_21, pins K0,K1 are connected to outputs S17,S18 respectively. In mux 2_22 pin K,K1 are connected to outputs S18,S19. Mux 2_22 gives output from pin K0 by setting MSL2_21 as "0" and for mux 2_22 from pin K1 by setting MSL2_10 as "1".
- For **CU24(NOOP)** inputs N24,R24 are taken from outputs of CU18 & CU19 . For this Mux's 2_23, 2_24 are used. For mux 2_23, pins K0,K1 are connected to outputs S18,S19 respectively. In mux 2_24 pin K0,K1 are connected to outputs S19,S20. Mux 2_23 gives output from pin K0 by setting MSL2_23 as "0" and for mux 2_24 from pin K0 by setting MSL2_24 as "0".
- For **CU25(NOOP)** inputs N25,R25 are taken from outputs of CU19 & CU20 . For this Mux's 2_25, 2_26 are used. For mux 2_25, pins K0,K1 are connected to outputs S19,S20 respectively. In mux 2_26 pin K0 is connected to output S20and K1 is grounded. Mux 2_25 gives output from pin K0 by setting MSL2_25 as "0" and for mux 2_26 from pin K0 by setting MSL2_26 as "0".
- The output's from CU21, CU22, CU23, CU24, CU25 are S21, S22, S23, S24, S25 respectively.
- For the DFG-2 we take outputs from CU21,CU22. i.e., S21&S22.

- **For DFG-3:** As given in the DFG the operations and connectivity for the CU's are given accordingly. CU1 performs addition, CU2 performs subtraction, CU3-multiplication, CU4-multiplication, CU-5 NOOP, for the given set of inputs for each CU.
- Now the outputs from the first row CU's i.e., S1,S2,S3,S4,S5 are given as inputs to the next row CU's by using mux's. The output's from row 1 CU's are first given as inputs to mux's present below and the output's from the mux's based on the sel line of the mux(MSL) is given as input to next row CU.
- For **CU6(SUB)** inputs N6,R6 are taken from outputs of CU1 & CU2. For this Mux's 4_1, 4_2 are used. For mux 4_1, pins J0,J1 are grounded. And J2 is connected to S1& J3 is connected to S2. And in mux 4_2 J0 pin is grounded and pins J1,J2,J3 are connected to S1,S2,S3 respectively. Mux 4_1 gives output from pin J2 by setting MSL4_1 as "10". And mux 4_2 gives output from pin J2 by setting MSL4_2 as "10".
- For **CU7(PG 2)** inputs N7,R7 are taken from outputs of CU1 & CU3 . For this Mux's 8_1, 8_2 are used. For mux 8_1, pins I0,I1,I2 are grounded and pins I3,I4,I5,I6,I7 are connected to outputs S1,S2,S3,S4,S5 respectively. In mux 8_2 pins I0,I1,I7 are grounded and I2,I3,I4,I5,I6 are connected to outputs S1,S2,S3,S4,S5 respectively. Mux 8_1 gives output from pin I3 by setting MSL8_1 as "011" and for mux 8_2 from pin I4 by setting MSL8_2 as "100".
- For **CU8(ADD)** inputs N8,R8 are taken from outputs of CU2 & CU4 . For this Mux's 4_3, 4_4 are used. For mux 4_3, pins J0,J1,J2,J3 are connected to outputs S1,S2,S3,S4 respectively. In mux 4_4 pins J0,J1,J2,J3 are connected to outputs S2,S3,S4,S5 respectively. Mux 4_3 gives output from pin J1 by setting MSL4_3 as "01" and for mux 4_4 from pin J2 by setting MSL4_4 as "10".
- For **CU9(SUB)** inputs N9,R9 are taken from outputs of CU2 & CU4 . For this Mux's 4_5, 4_6 are used. For mux 4_5, pins J0,J1,J2,J3 are connected to outputs S2,S3,S4,S5 respectively. In mux 4_6 pins J0,J1,J2 are connected to outputs S3,S4,S5 respectively, pin J3 is grounded. Mux 4_5 gives output from pin J0 by setting MSL4_5 as "00" and for mux 4_6 from pin J1 by setting MSL4_6 as "01".

- For **CU10(NOOP)** inputs N10,R10 are taken from outputs of CU5 & CU5 . For this Mux's 2_3, 2_4 are used. For mux 2_3, pins K0,K1 are connected to outputs S4,S5 respectively. In mux 2_4 pin K0 is connected to output S5, pin K1 is grounded. Mux 2_3 gives output from pin K1by setting MSL2_3 as "1" and for mux 2_4 from pin K0 by setting MSL2_4 as "0".
- Now the output's from CU6, CU7, CU8, CU9, CU10 are S6, S7, S8, S9, S10 respectively. These outputs are given as inputs to third row CU's, CU11-CU15 by using mux's.
- For **CU11(NOR)** inputs N11,R11 are taken from outputs of CU6 & CU7 . For this Mux's 8_3, 8_4 are used. For mux 8_3, pins I0,I1,I2,I3 are grounded and pins I4,I5,I6,I7 are connected to outputs S6,S7,S8,S9 respectively. In mux 8_3 pins I0,I1,I2 are grounded and pins I3,I4,I5,I6,I7 are connected to outputs S6,S7,S8,S9,S10 respectively. Mux 8_3 gives output from pin I4 by setting MSL8_3 as "100" and for mux 8_4 from pin I4 by setting MSL8_4 as "100".
- For **CU12(NAND)** inputs N12,R12 are taken from outputs of CU8 & CU9 . For this Mux's 4_7, 4_8 are used. For mux 4_7, pins J1,J2,J3 are connected to outputs S6,S7,S8 respectively, pin J0 is grounded. In mux 4_8 pins J0,J1,J2,J3 are connected to outputs S6,S7,S8,S9 respectively. Mux 4_7 gives output from pin J3 by setting MSL4_7 as "11" and for mux 4_8 from pin J3 by setting MSL4_8 as "11".
- For **CU13(NOOP)** inputs N13,R13 are taken from outputs of CU8 & CU9 . For this Mux's 4_9, 4_10 are used. For mux 4_9, pins J0,J1,J2,J3 are connected to outputs S6,S7,S8,S9 respectively. In mux 4_10 pins J0,J1,J2,J3 are connected to outputs S7,S8,S9,S10 respectively. Mux 4_9 gives output from pin J2 by setting MSL4_9 as "10" and for mux 4_10 from pin J2 by setting MSL4_10 as "10".
- For **CU14(NOOP)** inputs N14,R14 are taken from outputs of CU8 & CU9 . For this Mux's 2_5, 2_6 are used. For mux 2_5, pins K0,K1 are connected to outputs S8,S9 respectively. In mux 2_6 pin K0,K1 are connected to outputs S9,S10. Mux 2_5 gives output from pin K0 by setting MSL2_5 as "0" and for mux 2_4 from pin K0 by setting MSL2_6 as "0".
- For **CU15(NOOP)** inputs N15,R15 are taken from outputs of CU9 & CU10 . For this Mux's 2_7, 2_8 are used. For mux 2_7, pins K0,K1 are connected to outputs S9,S10 respectively. In mux 2_8 pin K0 is connected to output S10, K1 is grounded. Mux 2_7 gives output from pin K0 by setting MSL2_7 as "0" and for mux 2_8 from pin K0 by setting MSL2_8 as "0".
- Now the output's from CU11, CU12, CU13, CU14, CU15 are S11, S12, S13, S14, S15 respectively. These outputs are given as inputs to fourth row CU's, CU16-CU20 by using mux's.
- For **CU16(PG 1)** inputs N16,R16 are taken from outputs of CU11 & CU12 . For this Mux's 4_11, 4_12 are used. For mux 4_11, pins J0,J1 are grounded and pins J2,J3 are connected to outputs S11,S12 respectively. In mux 4_12 pin J0 is grounded and pins J1,J2,J3 are connected to outputs S11,S12,S13 respectively. Mux 4_ 11 gives output from pin J2 by setting MSL4_11 as "10" and for mux 4_12 from pin J2 by setting MSL4_12 as "10".
- For **CU17(PG 2)** inputs N17,R17 are taken from outputs of CU11 & CU12 . For this Mux's 2_9, 2_10 are used. For mux 2_9, pins K0,K1 are connected to outputs S11,S12 respectively. In mux 2_10 pin K0,K1 are connected to outputs S12,S13. Mux 2_9 gives output from pin K0 by setting MSL2_9 as "0" and for mux 2_10 from pin K0 by setting MSL2_10 as "0".
- For **CU18(NOOP)** inputs N18,R18 are taken from outputs of CU12 & CU14 . For this Mux's 2_11, 2_12 are used. For mux 2_11, pins K0,K1 are connected to outputs S12,S13 respectively. In mux 2_12 pin K0,K1 are connected to outputs S13,S14. Mux 2_11 gives output from pin K0 by setting MSL2_11 as "0" and for mux 2_12 from pin K1 by setting MSL2_12 as "1" .
- For **CU19(NOOP)** inputs N19,R19 are taken from outputs of CU13 & CU14 . For this Mux's 2_13, 2_14 are used. For mux 2_13, pins K0,K1 are connected to outputs S13,S14 respectively. In mux 2_14 pin K0,K1 are connected to outputs S14,S15. Mux 2_13 gives output from pin K0 by setting MSL2_13 as "0" and for mux 2_14 from pin K0 by setting MSL2_14 as "0".

- For **CU20(NOOP)** inputs N20,R20 are taken from outputs of CU14 & CU15 . For this Mux's 2_15, 2_16 are used. For mux 2_15, pins K0,K1 are connected to outputs S14,S15 respectively. In mux 2_16 pin K0 is connected to output S15, and pin K1 is grounded. Mux 2_15 gives output from pin K0 by setting MSL2_15 as "0" and for mux 2_16 from pin K0 by setting MSL2_16 as "0".

- The output's from CU16, CU17, CU18, CU19, CU20 are S16, S17, S18, S19, S20 respectively. These outputs are given as inputs to fifth row CU's, CU21-CU25 by using mux's.
- For **CU21(PG 1)** inputs N21,R21 are taken from outputs of CU16 & CU17 . For this Mux's 2_17, 2_18 are used. For mux 2_17, pin K0 is grounded and pin K1 is connected to output S16. In mux 2_18 pins K0,K1 are connected to S16,S17 respectively. Mux 2_17 gives output from pin K1 by setting MSL2_17 as "1" and for mux 2_18 from pin K1 by setting MSL2_18 as "1".
- For **CU22(PG 2)** inputs N22,R22 are taken from outputs of CU16 & CU17 . For this Mux's 2_19, 2_20 are used. For mux 2_19, pins K0,K1 are connected to outputs S16,S17 respectively. In mux 2_20 pin K0,K1 are connected to outputs S17,S18. Mux 2_19 gives output from pin K0 by setting MSL2_19 as "0" and for mux 2_20 from pin K0 by setting MSL2_20 as "0".
- For **CU23(NOOP)** inputs N23,R23 are taken from outputs of CU17 & CU19 . For this Mux's 2_21, 2_22 are used. For mux 2_21, pins K0,K1 are connected to outputs S17,S18 respectively. In mux 2_22 pin K,K1 are connected to outputs S18,S19. Mux 2_22 gives output from pin K0 by setting MSL2_21 as "0" and for mux 2_22 from pin K1 by setting MSL2_10 as "1".
- For **CU24(NOOP)** inputs N24,R24 are taken from outputs of CU18 & CU19 . For this Mux's 2_23, 2_24 are used. For mux 2_23, pins K0,K1 are connected to outputs S18,S19 respectively. In mux 2_24 pin K0,K1 are connected to outputs S19,S20. Mux 2_23 gives output from pin K0 by setting MSL2_23 as "0" and for mux 2_24 from pin K0 by setting MSL2_24 as "0".
- For **CU25(NOOP)** inputs N25,R25 are taken from outputs of CU19 & CU20 . For this Mux's 2_25, 2_26 are used. For mux 2_25, pins K0,K1 are connected to outputs S19,S20 respectively. In mux 2_26 pin K0 is connected to output S20and K1 is grounded. Mux 2_25 gives output from pin K0 by setting MSL2_25 as "0" and for mux 2_26 from pin K0 by setting MSL2_26 as "0".
- The output's from CU21, CU22, CU23, CU24, CU25 are S21, S22, S23, S24, S25 respectively.
- For the DFG-3 we take outputs from CU21,CU22. i.e., S21&S22.

- **For DFG-4:** As given in the DFG the operations and connectivity for the CU's are given accordingly. CU1 performs multiplication, CU2 performs addition, CU3-subtraction, CU4-multiplication, CU-5 NOOP, for the given set of inputs for each CU.
- Now the outputs from the first row CU's i.e., S1,S2,S3,S4,S5 are given as inputs to the next row CU's by using mux's. The output's from row 1 CU's are first given as inputs to mux's present below and the output's from the mux's based on the sel line of the mux is given as input to next row CU.
- For **CU6(ADD)** inputs N6,R6 are taken from outputs of CU1 & CU3. For this Mux's 4_1, 4_2 are used. For mux 4_1, pins J0,J1 are grounded. And J2 is connected to S1& J3 is connected to S2. And in mux 4_2 J0 pin is grounded and pins J1,J2,J3 are connected to S1,S2,S3 respectively. Mux 4_1 gives output from pin J2 by setting MSL4_1 as "10". And mux 4_2 gives output from pin J3 by setting MSL4_2 as "11".
- For **CU7(ADD)** inputs N7,R7 are taken from outputs of CU2 & CU4 . For this Mux's 8_1, 8_2 are used. For mux 8_1, pins I0,I1,I2 are grounded and pins I3,I4,I5,I6,I7 are connected to outputs S1,S2,S3,S4,S5 respectively. In mux 8_2 pins I0,I1,I7 are grounded and I2,I3,I4,I5,I6 are connected to outputs S1,S2,S3,S4,S5 respectively. Mux 8_1 gives output from pin I4 by setting MSL8_1 as "100" and for mux 8_2 from pin I5 by setting MSL8_2 as "101".

- For **CU8(SUB)** inputs N8,R8 are taken from outputs of CU3 & CU4 . For this Mux's 4_3, 4_4 are used. For mux 4_3, pins J0,J1,J2,J3 are connected to outputs S1,S2,S3,S4 respectively. In mux 4_4 pins J0,J1,J2,J3 are connected to outputs S2,S3,S4,S5 respectively. Mux 4_3 gives output from pin J2 by setting MSL4_3 as "10" and for mux 4_4 from pin J2 by setting MSL4_4 as "10".
- For **CU9(NOOP)** inputs N9,R9 are taken from outputs of CU2 & CU4 . For this Mux's 4_5, 4_6 are used. For mux 4_5, pins J0,J1,J2,J3 are connected to outputs S2,S3,S4,S5 respectively. In mux 4_6 pins J0,J1,J2 are connected to outputs S3,S4,S5 respectively, pin J3 is grounded. Mux 4_5 gives output from pin J0 by setting MSL4_5 as "00" and for mux 4_6 from pin J1 by setting MSL4_6 as "01".
- For **CU10(NOOP)** inputs N10,R10 are taken from outputs of CU5 & CU5 . For this Mux's 2_3, 2_4 are used. For mux 2_3, pins K0,K1 are connected to outputs S4,S5 respectively. In mux 2_4 pin K0 is connected to output S5, pin K1 is grounded. Mux 2_3 gives output from pin K1by setting MSL2_3 as "1" and for mux 2_4 from pin K0 by setting MSL2_4 as "0".
- Now the output's from CU6, CU7, CU8, CU9, CU10 are S6, S7, S8, S9, S10 respectively. These outputs are given as inputs to third row CU's, CU11-CU15 by using mux's.
- For **CU11(LSR)** inputs N11,R11 are taken from outputs of CU6 & CU7 . For this Mux's 8_3, 8_4 are used. For mux 8_3, pins I0,I1,I2,I3 are grounded and pins I4,I5,I6,I7 are connected to outputs S6,S7,S8,S9 respectively. In mux 8_3 pins I0,I1,I2 are grounded and pins I3,I4,I5,I6,I7 are connected to outputs S6,S7,S8,S9,S10 respectively. Mux 8_3 gives output from pin I4 by setting MSL8_3 as "100" and for mux 8_4 from pin I4 by setting MSL8_4 as "100".
- For **CU12(ROL)** inputs N12,R12 are taken from outputs of CU6 & CU8 . For this Mux's 4_7, 4_8 are used. For mux 4_7, pins J1,J2,J3 are connected to outputs S6,S7,S8 respectively, pin J0 is grounded. In mux 4_8 pins J0,J1,J2,J3 are connected to outputs S6,S7,S8,S9 respectively. Mux 4_7 gives output from pin J1 by setting MSL4_7 as "01" and for mux 4_8 from pin J2 by setting MSL4_8 as "10".
- For **CU13(ASL)** inputs N13,R13 are taken from outputs of CU7 & CU8 . For this Mux's 4_9, 4_10 are used. For mux 4_9, pins J0,J1,J2,J3 are connected to outputs S6,S7,S8,S9 respectively. In mux 4_10 pins J0,J1,J2,J3 are connected to outputs S7,S8,S9,S10 respectively. Mux 4_9 gives output from pin J1 by setting MSL4_9 as "01" and for mux 4_10 from pin J1 by setting MSL4_10 as "01".
- For **CU14(NOOP)** inputs N14,R14 are taken from outputs of CU8 & CU9 . For this Mux's 2_5, 2_6 are used. For mux 2_5, pins K0,K1 are connected to outputs S8,S9 respectively. In mux 2_6 pin K0,K1 are connected to outputs S9,S10. Mux 2_5 gives output from pin K0 by setting MSL2_5 as "0" and for mux 2_4 from pin K0 by setting MSL2_6 as "0".
- For **CU15(NOOP)** inputs N15,R15 are taken from outputs of CU9 & CU10 . For this Mux's 2_7, 2_8 are used. For mux 2_7, pins K0,K1 are connected to outputs S9,S10 respectively. In mux 2_8 pin K0 is connected to output S10, K1 is grounded. Mux 2_7 gives output from pin K0 by setting MSL2_7 as "0" and for mux 2_8 from pin K0 by setting MSL2_8 as "0".
- Now the output's from CU11, CU12, CU13, CU14, CU15 are S11, S12, S13, S14, S15 respectively. These outputs are given as inputs to fourth row CU's, CU16-CU20 by using mux's.
- For **CU16(XOR)** inputs N16,R16 are taken from outputs of CU11 & CU12 . For this Mux's 4_11, 4_12 are used. For mux 4_11, pins J0,J1 are grounded and pins J2,J3 are connected to outputs S11,S12 respectively. In mux 4_12 pin J0 is grounded and pins J1,J2,J3 are connected to outputs S11,S12,S13 respectively. Mux 4_ 11 gives output from pin J2 by setting MSL4_11 as "10" and for mux 4_12 from pin J2 by setting MSL4_12 as "10".
- For **CU17(XNOR)** inputs N17,R17 are taken from outputs of CU12 & CU13 . For this Mux's 2_9, 2_10 are used. For mux 2_9, pins K0,K1 are connected to outputs S11,S12 respectively. In mux 2_10 pin K0,K1 are connected to outputs S12,S13. Mux 2_9 gives output from pin K1 by setting MSL2_9 as "1" and for mux 2_10 from pin K1 by setting MSL2_10 as "1".

- For **CU18(NOOP)** inputs N18,R18 are taken from outputs of CU12 & CU14 . For this Mux's 2_11, 2_12 are used. For mux 2_11, pins K0,K1 are connected to outputs S12,S13 respectively. In mux 2_12 pin K0,K1 are connected to outputs S13,S14. Mux 2_11 gives output from pin K0 by setting MSL2_11 as "0" and for mux 2_12 from pin K1 by setting MSL2_12 as "1" .
- For **CU19(NOOP)** inputs N19,R19 are taken from outputs of CU13 & CU14 . For this Mux's 2_13, 2_14 are used. For mux 2_13, pins K0,K1 are connected to outputs S13,S14 respectively. In mux 2_14 pin K0,K1 are connected to outputs S14,S15. Mux 2_13 gives output from pin K0 by setting MSL2_13 as "0" and for mux 2_14 from pin K0 by setting MSL2_14 as "0".
- For **CU20(NOOP)** inputs N20,R20 are taken from outputs of CU14 & CU15 . For this Mux's 2_15, 2_16 are used. For mux 2_15, pins K0,K1 are connected to outputs S14,S15 respectively. In mux 2_16 pin K0 is connected to output S15, and pin K1 is grounded. Mux 2_15 gives output from pin K0 by setting MSL2_15 as "0" and for mux 2_16 from pin K0 by setting MSL2_16 as "0".
- The output's from CU16, CU17, CU18, CU19, CU20 are S16, S17, S18, S19, S20 respectively. These outputs are given as inputs to fifth row CU's, CU21-CU25 by using mux's.
- For **CU21(LESS THAN)** inputs N21,R21 are taken from outputs of CU16 & CU17 . For this Mux's 2_17, 2_18 are used. For mux 2_17, pin K0 is grounded and pin K1 is connected to output S16. In mux 2_18 pins K0,K1 are connected to S16,S17 respectively. Mux 2_17 gives output from pin K1 by setting MSL2_17 as "1" and for mux 2_18 from pin K1 by setting MSL2_18 as "1".
- For **CU22(NOOP)** inputs N22,R22 are taken from outputs of CU16 & CU17 . For this Mux's 2_19, 2_20 are used. For mux 2_19, pins K0,K1 are connected to outputs S16,S17 respectively. In mux 2_20 pin K0,K1 are connected to outputs S17,S18. Mux 2_19 gives output from pin K0 by setting MSL2_19 as "0" and for mux 2_20 from pin K0 by setting MSL2_20 as "0".
- For **CU23(NOOP)** inputs N23,R23 are taken from outputs of CU17 & CU19 . For this Mux's 2_21, 2_22 are used. For mux 2_21, pins K0,K1 are connected to outputs S17,S18 respectively. In mux 2_22 pin K,K1 are connected to outputs S18,S19. Mux 2_22 gives output from pin K0 by setting MSL2_21 as "0" and for mux 2_22 from pin K1 by setting MSL2_10 as "1".
- For **CU24(NOOP)** inputs N24,R24 are taken from outputs of CU18 & CU19 . For this Mux's 2_23, 2_24 are used. For mux 2_23, pins K0,K1 are connected to outputs S18,S19 respectively. In mux 2_24 pin K0,K1 are connected to outputs S19,S20. Mux 2_23 gives output from pin K0 by setting MSL2_23 as "0" and for mux 2_24 from pin K0 by setting MSL2_24 as "0".
- For **CU25(NOOP)** inputs N25,R25 are taken from outputs of CU19 & CU20 . For this Mux's 2_25, 2_26 are used. For mux 2_25, pins K0,K1 are connected to outputs S19,S20 respectively. In mux 2_26 pin K0 is connected to output S20and K1 is grounded. Mux 2_25 gives output from pin K0 by setting MSL2_25 as "0" and for mux 2_26 from pin K0 by setting MSL2_26 as "0".
- The output's from CU21, CU22, CU23, CU24, CU25 are S21, S22, S23, S24, S25 respectively.
- For the DFG-4 we take output from CU21 . i.e., S21.

Arithmetic handling:

- Arithmetic operations Addition, Subtraction & Multiplication were given in the CU for a specific opcode as mentioned in the above table.
- Overflow of bits(extra bits) is truncated by only considering second half bits.

Shift Operations:

- Shift operations ASL, LSL, LSR, ROR, ROL were used in the CU's. These operations are performed based on the opcode given as specified in the above table.
- For shift operations the first input gets shifted by the second input number of bits.

Comparison operations:

- Comparison operations used are Greater than, less than, Equal to.
- For the given inputs, if they satisfy the operation given then it is considered as TRUE condition then the generated output for that particular CU will be “1111”.
- For the given inputs, if they don’t satisfy the operation given then it is considered as FALSE condition then the generated output for that particular CU will be “0000”.

Results

Generated RTL Schematic

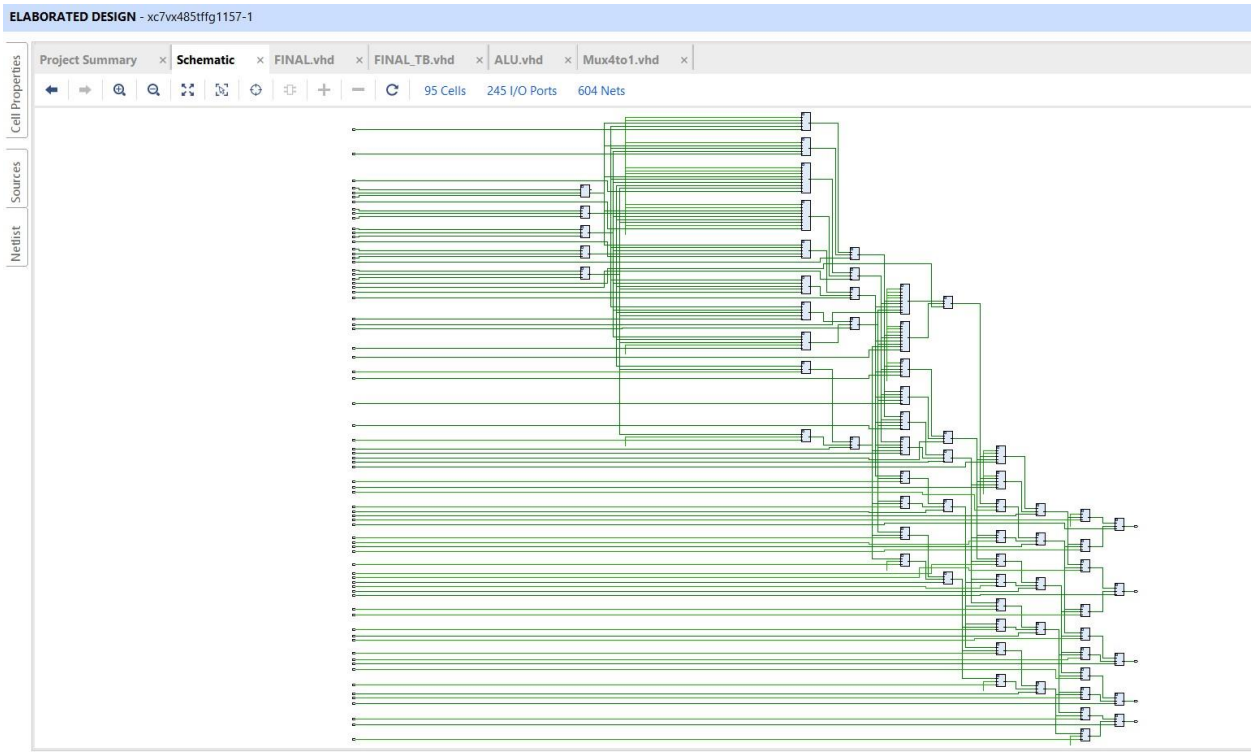
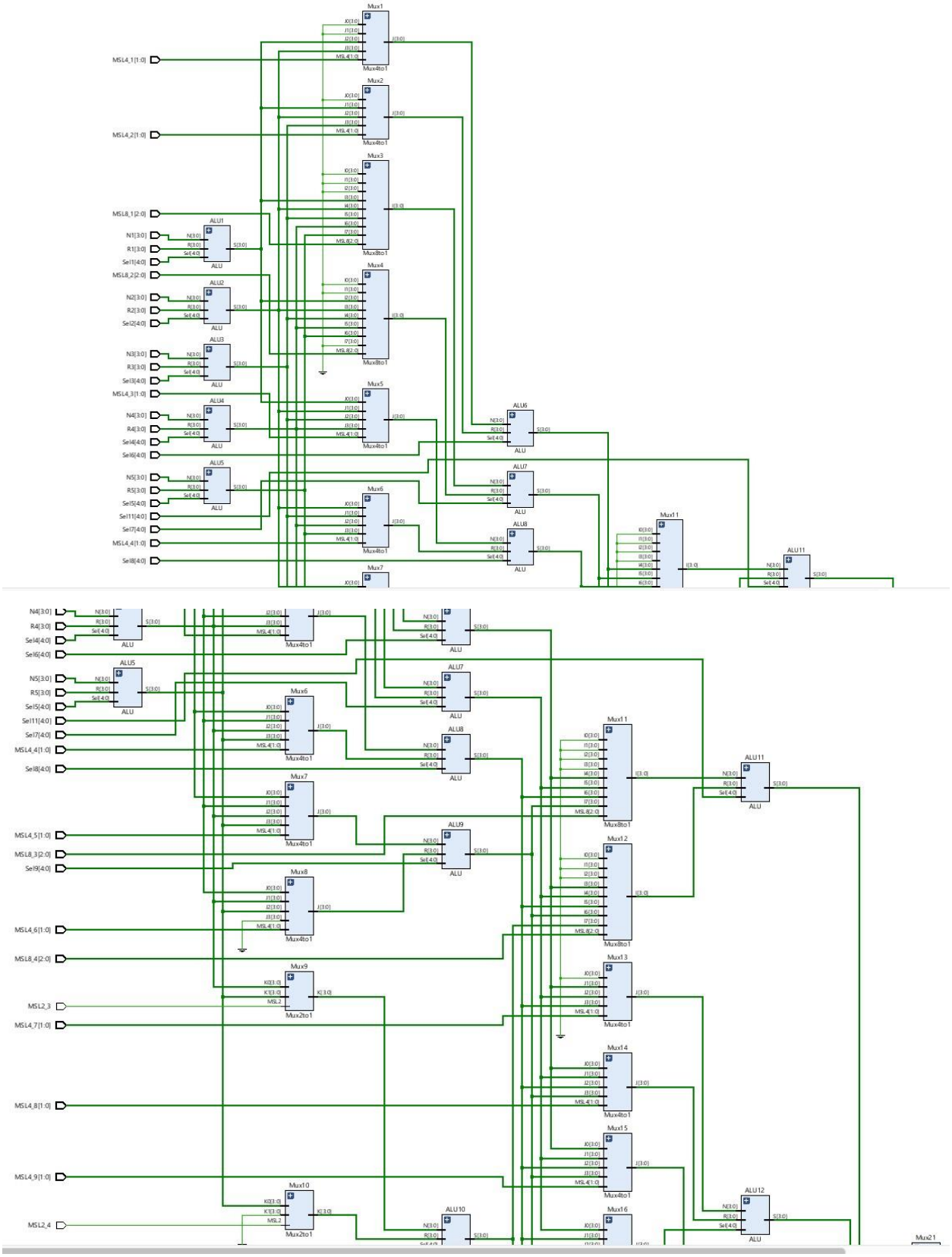
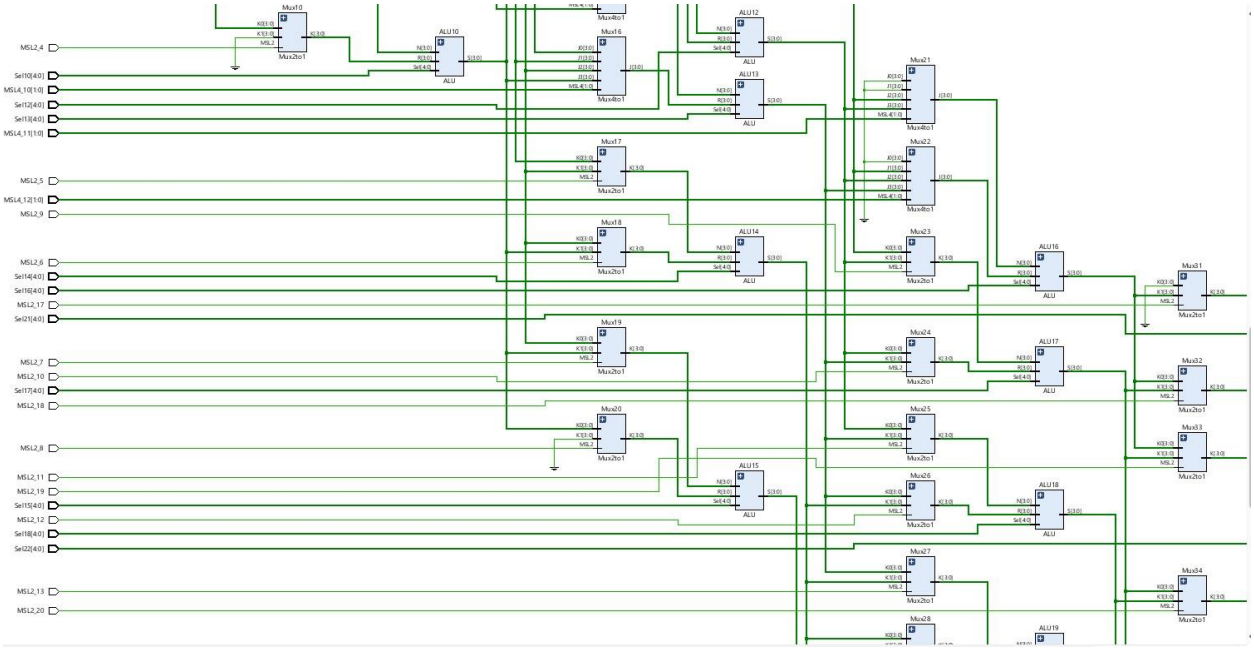
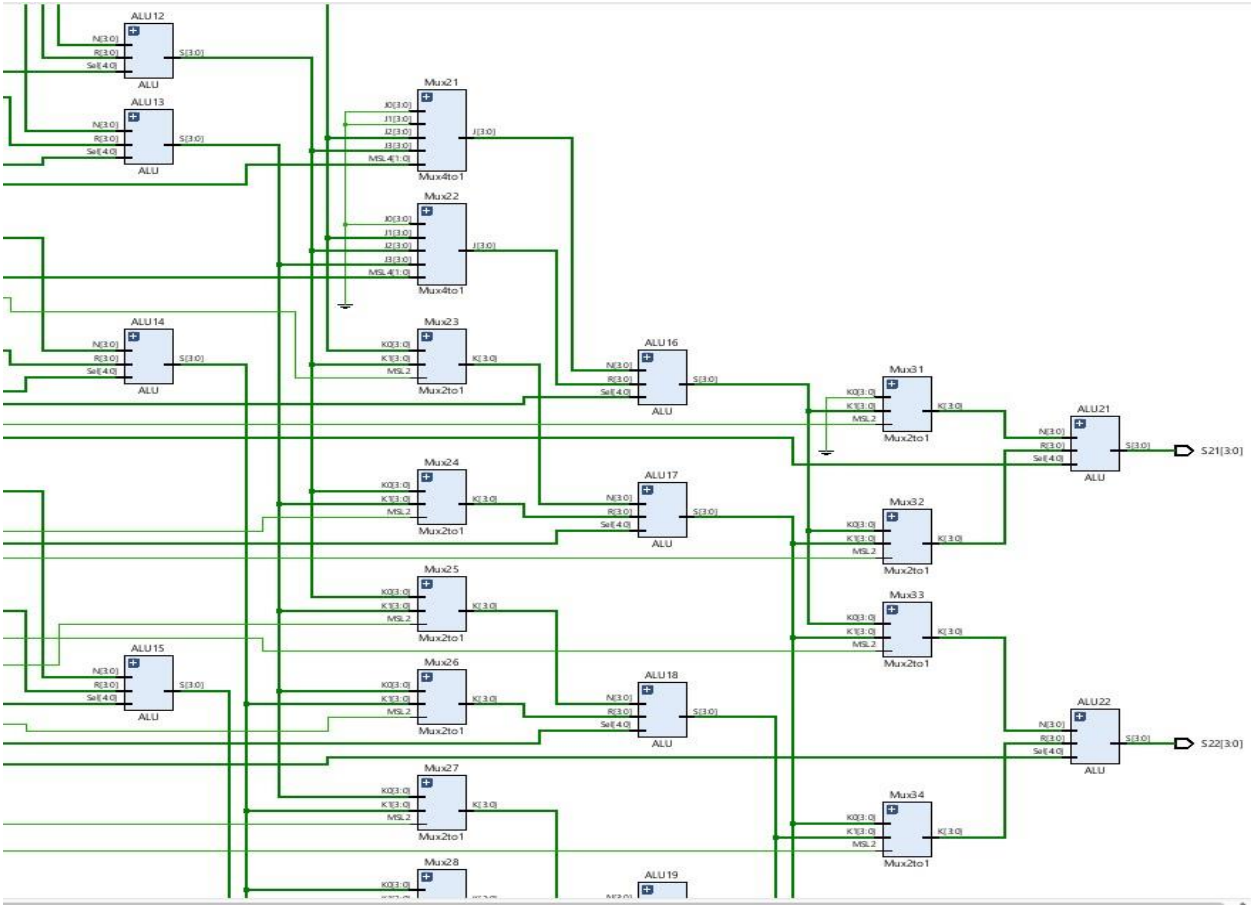


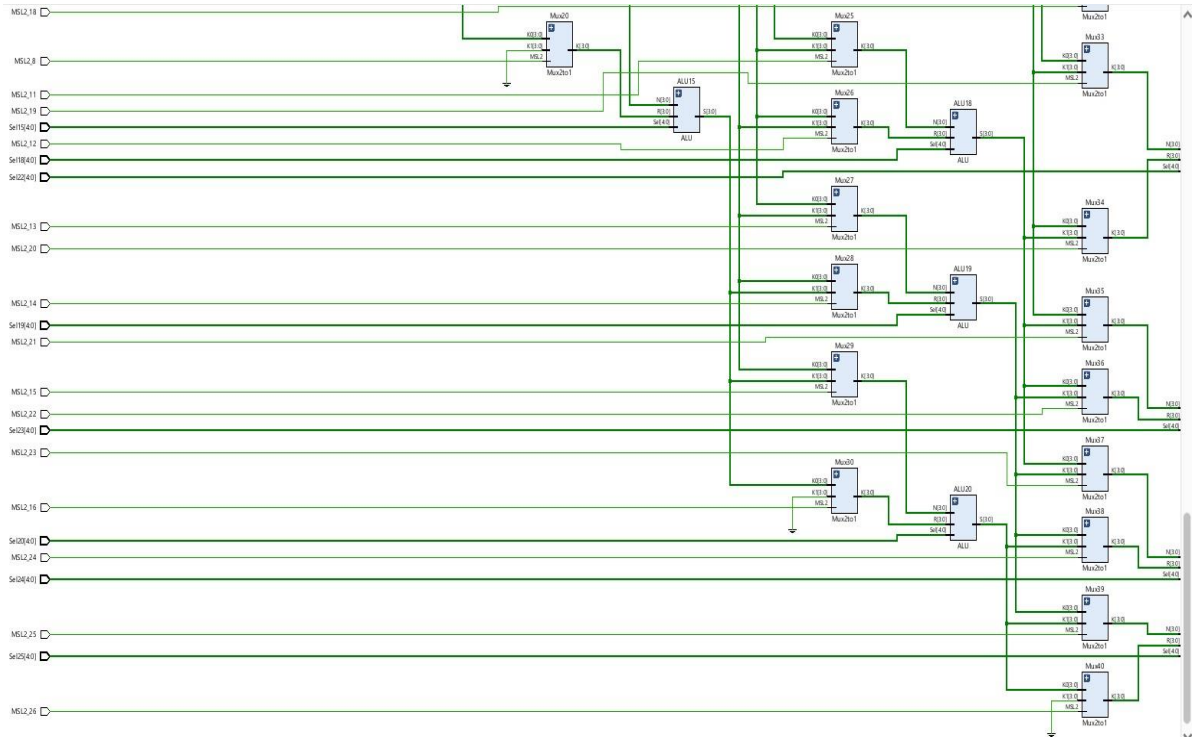
Figure 2 – Generated RTL Schematic of the 5 X 5 Fabric

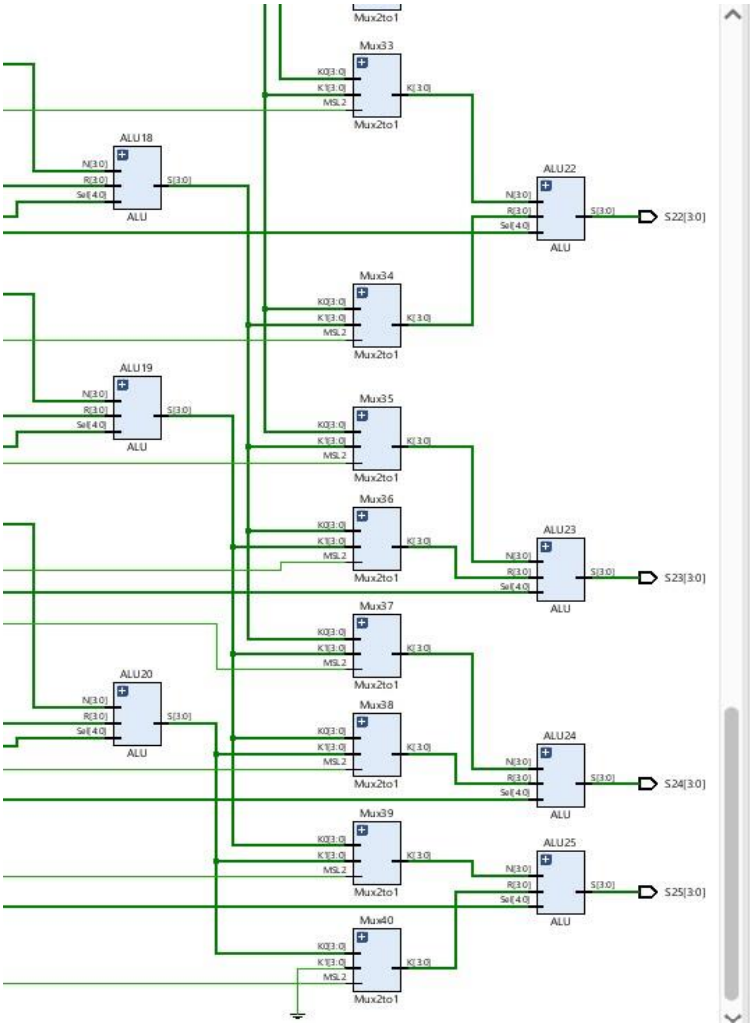
- The generated RTL schematic(fig.2) elaborated design is same as to the block diagram(fig.1) that we have designed.
- The RTL schematic generated has 25 CU’s in a 5 x 5 architecture.
- The CU’s are connected with the help of 8:1,4:1,2:1 mux’s.
- Also the mux’s are connected by using mirroring concept as shown in our block diagram and RTL schematic.
- Input’s are given for CU1(N1,R1),CU2(N2,R2),CU3(N3,R3),CU4(N4,R4),CU5(N5,R5) and outputs are taken from CU21(S21),CU22(S22),CU23(S23),CU24(S24),CU25(S25). This is the same that was shown in the block diagram and elaborated design.
- It is clearly evident that both the Block diagram and generated RTL schematic are same.


Mux1
Mux2
Mux3
Mux4
Mux5
Mux6
Mux7
Mux8
Mux9
Mux10
Mux11
Mux12
Mux13
Mux14
Mux15
Mux16
Mux21
ALU1
ALU2
ALU3
ALU4
ALU5
ALU6
ALU7
ALU8
ALU9
ALU10
ALU11
ALU12
MSL4_1[1:0]
MSL4_2[1:0]
MSL8_1[2:0]
MSL8_2[2:0]
MSL4_3[1:0]
MSL4_4[1:0]
MSL4_5[1:0]
MSL8_3[2:0]
MSL4_6[1:0]
MSL8_4[2:0]
MSL2_3
MSL4_7[1:0]
MSL4_8[1:0]
MSL4_9[1:0]
MSL2_4
N1[3:0]
R1[3:0]
Sel1[4:0]
N2[3:0]
R2[3:0]
Sel2[4:0]
N3[3:0]
R3[3:0]
Sel3[4:0]
N4[3:0]
R4[3:0]
Sel4[4:0]
Sel6[4:0]
N5[3:0]
R5[3:0]
Sel5[4:0]
Sel11[4:0]
Sel7[4:0]
Sel8[4:0]
Sel9[4:0]



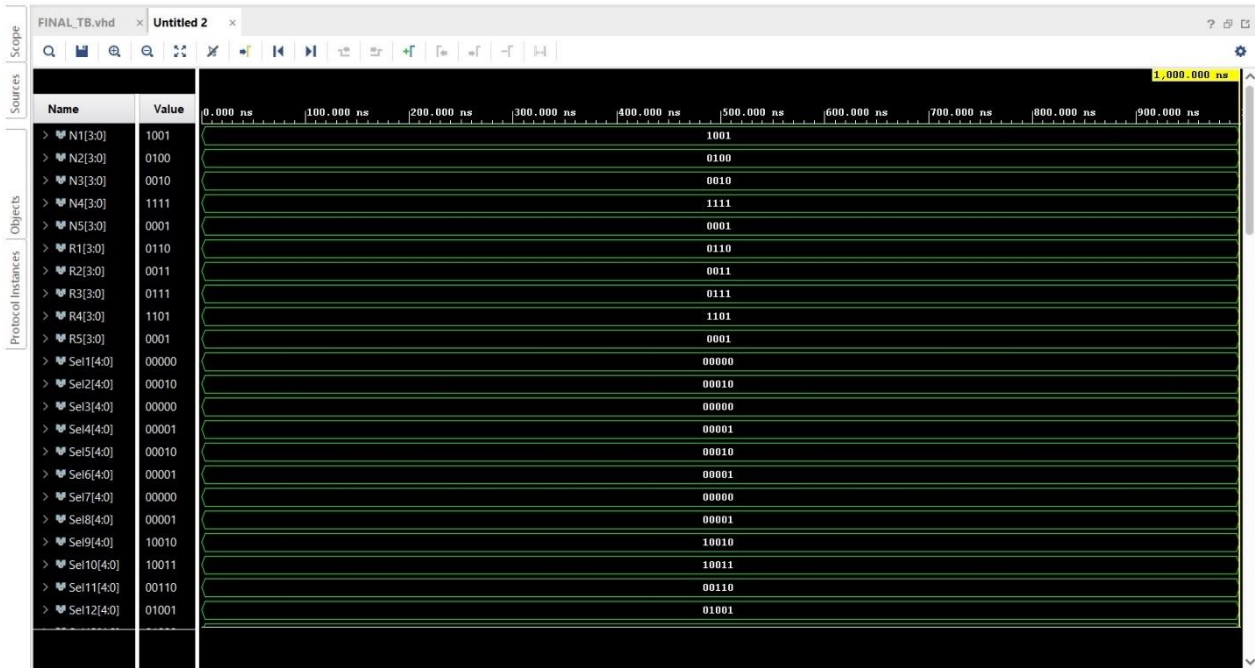

ALU12
ALU13
ALU14
ALU15
ALU16
ALU17
ALU18
ALU19
ALU21
ALU22
Mux21
Mux22
Mux23
Mux24
Mux25
Mux26
Mux27
Mux28
Mux31
Mux32
Mux33
Mux34
Mux4to1
Mux2to1
S21[3:0]
S22[3:0]

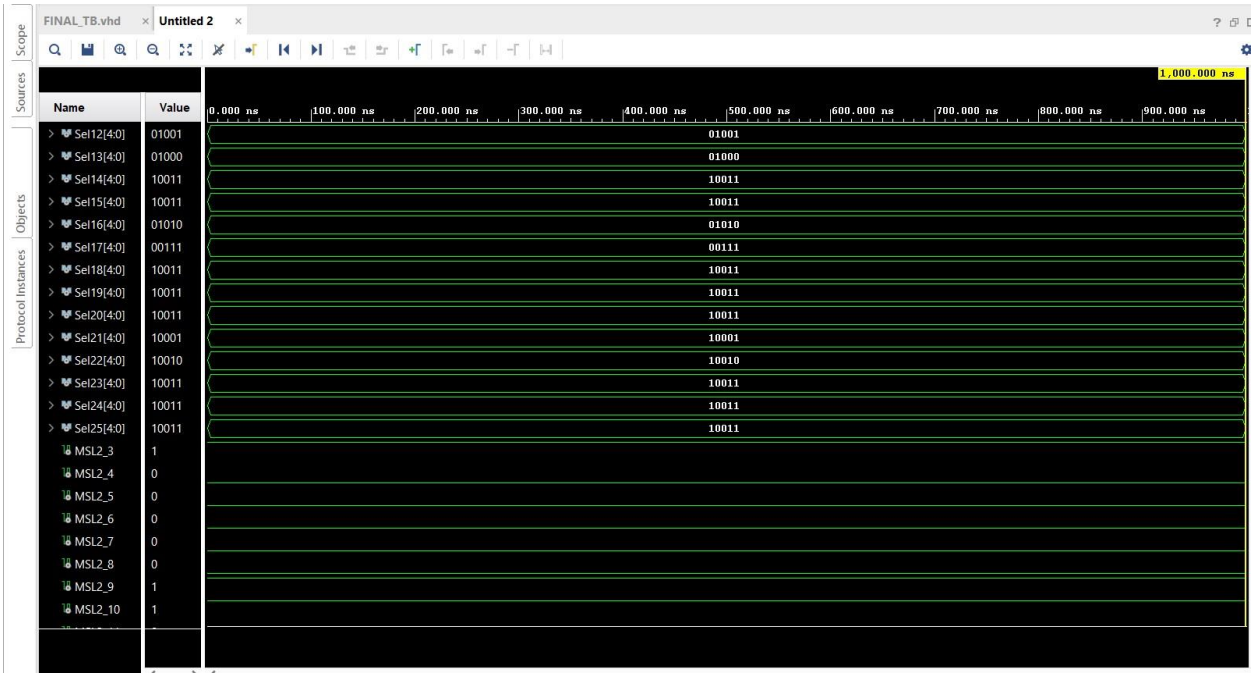


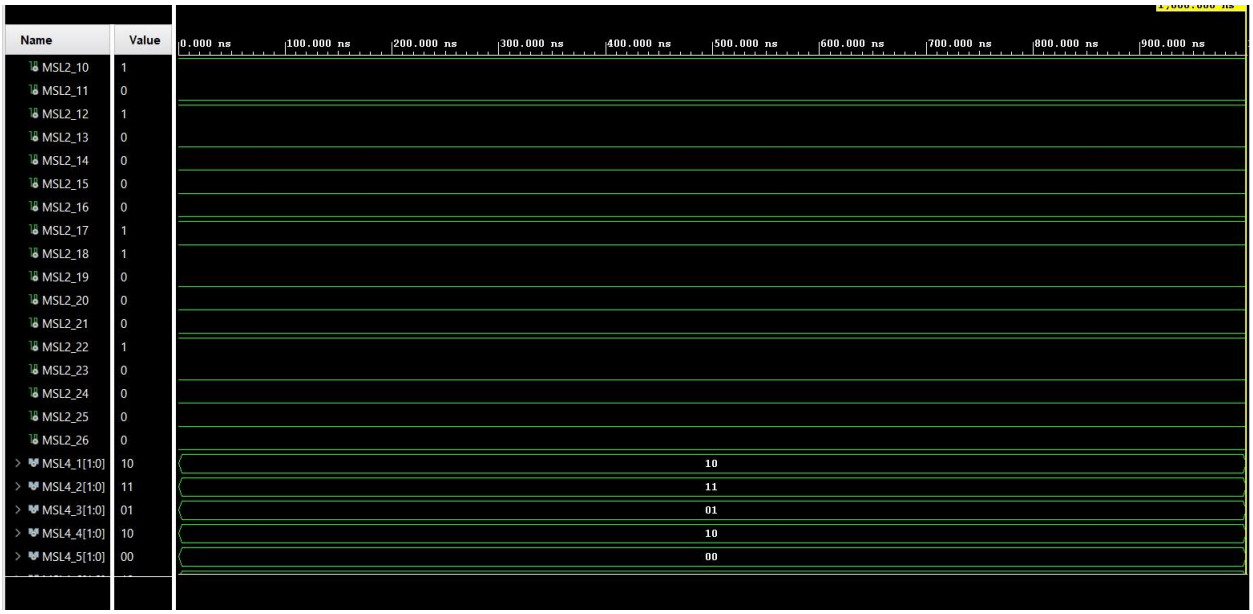

Mux33
Mux34
Mux35
Mux36
Mux37
Mux38
Mux39
Mux40
ALU18
ALU19
ALU20
ALU22
ALU23
ALU24
ALU25
S22[3:0]
S23[3:0]
S24[3:0]
S25[3:0]
Mux2to1
ALU

Waveforms

For DFG-1



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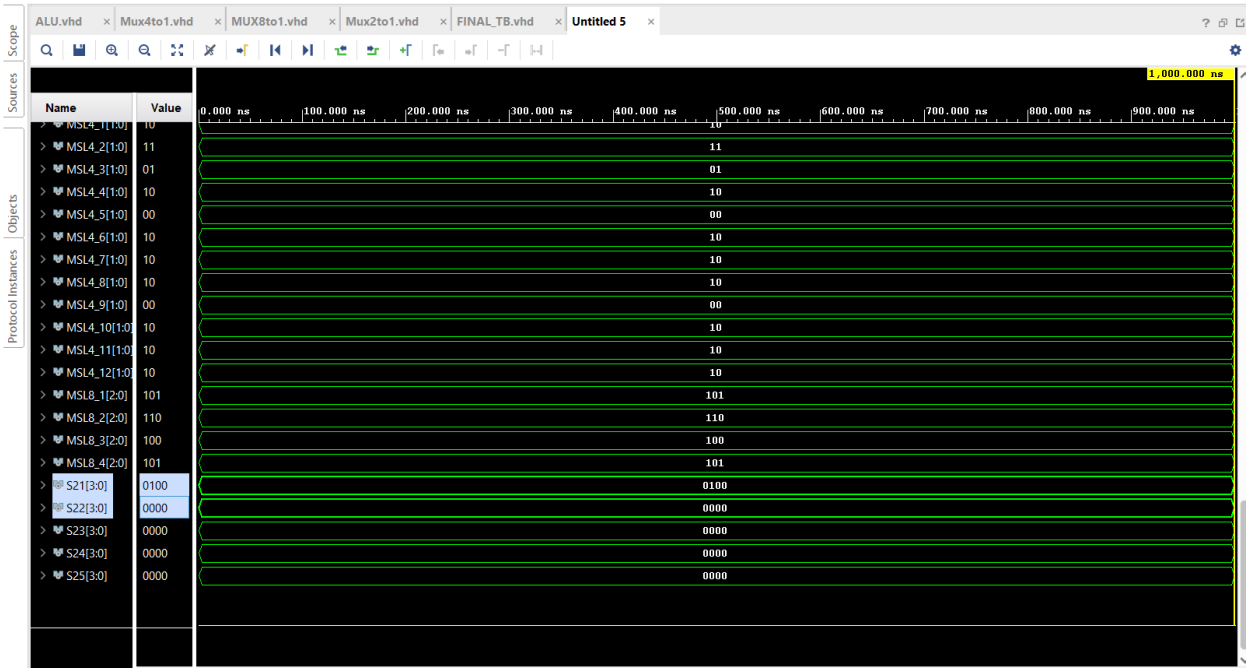
100.000 ns
200.000 ns
300.000 ns
400.000 ns
500.000 ns
600.000 ns
700.000 ns
800.000 ns
900.000 ns
MSL2_10 1
MSL2_11 0
MSL2_12 1
MSL2_13 0
MSL2_14 0
MSL2_15 0
MSL2_16 0
MSL2_17 1
MSL2_18 1
MSL2_19 0
MSL2_20 0
MSL2_21 0
MSL2_22 1
MSL2_23 0
MSL2_24 0
MSL2_25 0
MSL2_26 0
MSL4_1[1:0] 10
MSL4_2[1:0] 11
MSL4_3[1:0] 01
MSL4_4[1:0] 10
MSL4_5[1:0] 00
10
11
01
10
00


ALU.vhd
Mux4to1.vhd
MUX8to1.vhd
Mux2to1.vhd
FINAL_TB.vhd
Untitled 5
Scope
Sources
Objects
Protocol Instances
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Name
Value
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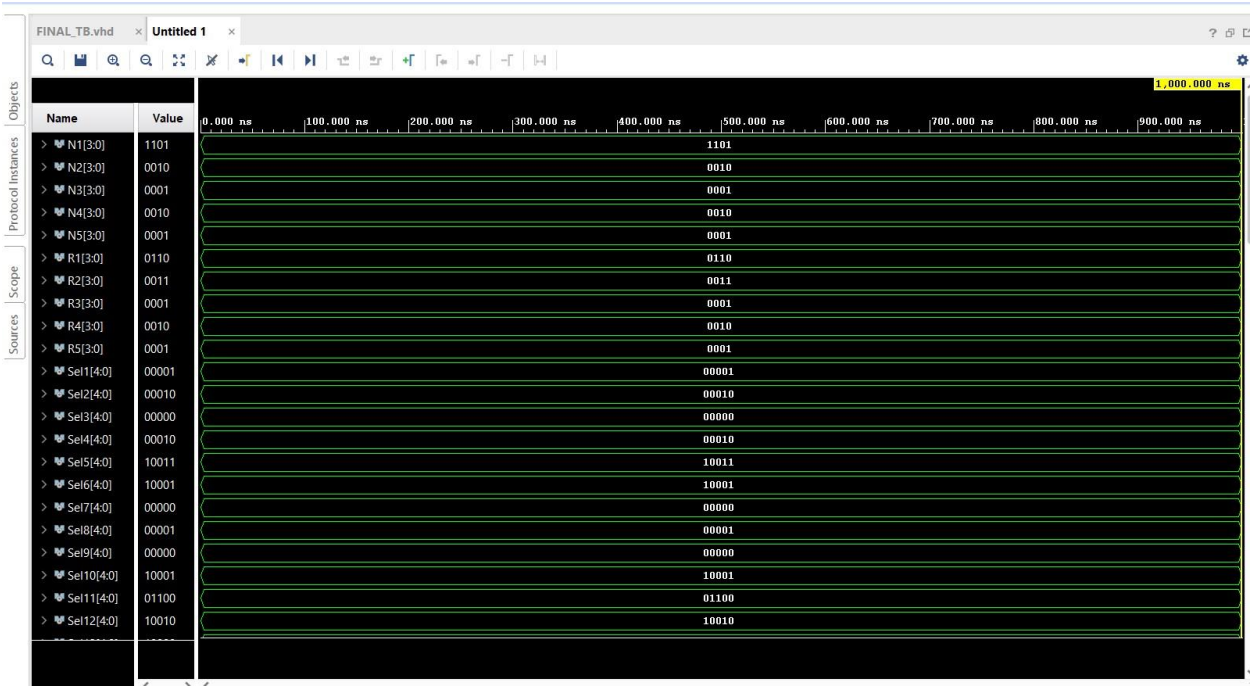
100.000 ns
200.000 ns
300.000 ns
400.000 ns
500.000 ns
600.000 ns
700.000 ns
800.000 ns
900.000 ns
MSL4_2[1:0] 11
MSL4_3[1:0] 01
MSL4_4[1:0] 10
MSL4_5[1:0] 00
MSL4_6[1:0] 10
MSL4_7[1:0] 10
MSL4_8[1:0] 10
MSL4_9[1:0] 00
MSL4_10[1:0] 10
MSL4_11[1:0] 10
MSL4_12[1:0] 10
MSL8_1[2:0] 101
MSL8_2[2:0] 110
MSL8_3[2:0] 100
MSL8_4[2:0] 101
S21[3:0] 0100
S22[3:0] 0000
S23[3:0] 0000
S24[3:0] 0000
S25[3:0] 0000
11
01
10
00
10
10
10
00
10
10
10
101
110
100
101
0100
0000
0000
0000
0000

For DFG-2


FINAL_TB.vhd
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Objects
Protocol Instances
Scope
Sources
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Name
Value
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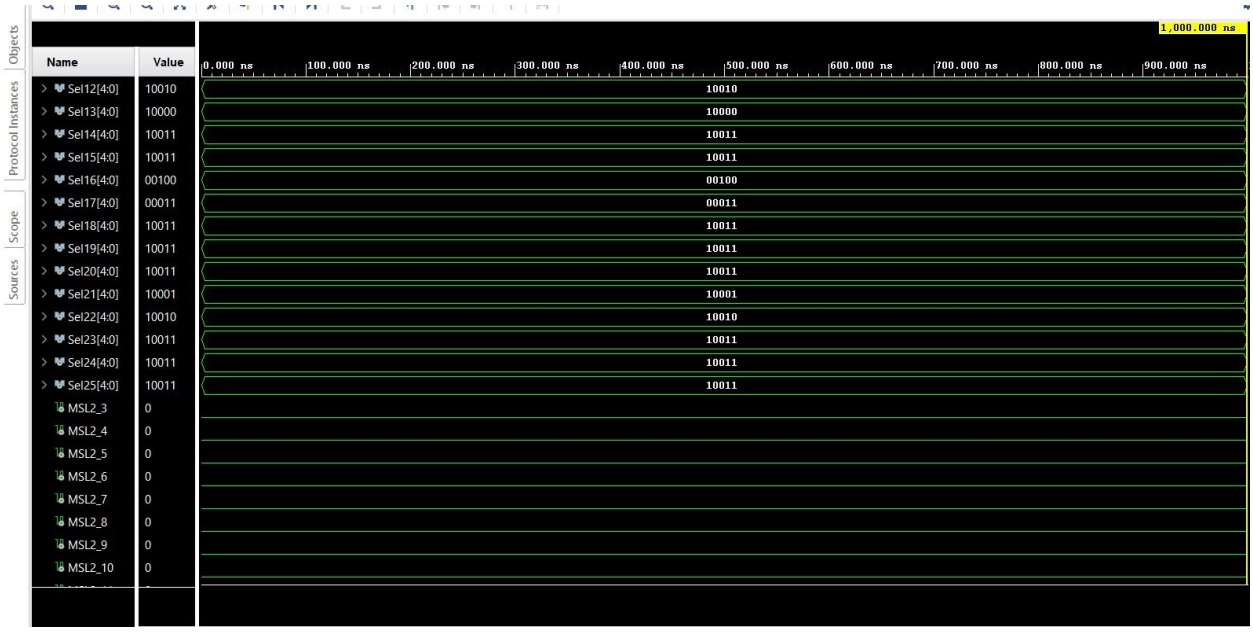
100.000 ns
200.000 ns
300.000 ns
400.000 ns
500.000 ns
600.000 ns
700.000 ns
800.000 ns
900.000 ns
N1[3:0] 1101
N2[3:0] 0010
N3[3:0] 0001
N4[3:0] 0010
N5[3:0] 0001
R1[3:0] 0110
R2[3:0] 0011
R3[3:0] 0001
R4[3:0] 0010
R5[3:0] 0001
Sel1[4:0] 00001
Sel2[4:0] 00010
Sel3[4:0] 00000
Sel4[4:0] 00010
Sel5[4:0] 10011
Sel6[4:0] 10001
Sel7[4:0] 00000
Sel8[4:0] 00001
Sel9[4:0] 00000
Sel10[4:0] 10001
Sel11[4:0] 01100
Sel12[4:0] 10010


Objects
Protocol Instances
Scope
Sources
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Value
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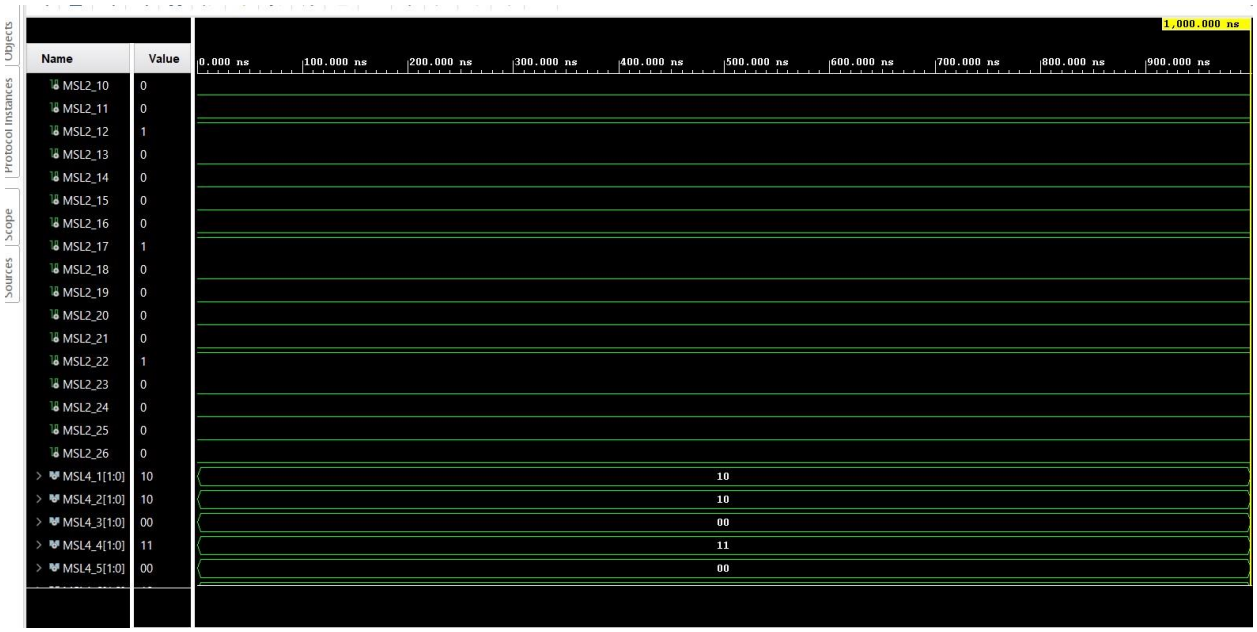
100.000 ns
200.000 ns
300.000 ns
400.000 ns
500.000 ns
600.000 ns
700.000 ns
800.000 ns
900.000 ns
Sel12[4:0] 10010
Sel13[4:0] 10000
Sel14[4:0] 10011
Sel15[4:0] 10011
Sel16[4:0] 00100
Sel17[4:0] 00011
Sel18[4:0] 10011
Sel19[4:0] 10011
Sel20[4:0] 10011
Sel21[4:0] 10001
Sel22[4:0] 10010
Sel23[4:0] 10011
Sel24[4:0] 10011
Sel25[4:0] 10011
MSL2_3 0
MSL2_4 0
MSL2_5 0
MSL2_6 0
MSL2_7 0
MSL2_8 0
MSL2_9 0
MSL2_10 0


Objects
Protocol Instances
Scope
Sources
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200.000 ns
300.000 ns
400.000 ns
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600.000 ns
700.000 ns
800.000 ns
900.000 ns
MSL2_10 0
MSL2_11 0
MSL2_12 1
MSL2_13 0
MSL2_14 0
MSL2_15 0
MSL2_16 0
MSL2_17 1
MSL2_18 0
MSL2_19 0
MSL2_20 0
MSL2_21 0
MSL2_22 1
MSL2_23 0
MSL2_24 0
MSL2_25 0
MSL2_26 0
MSL4_1[1:0] 10
MSL4_2[1:0] 10
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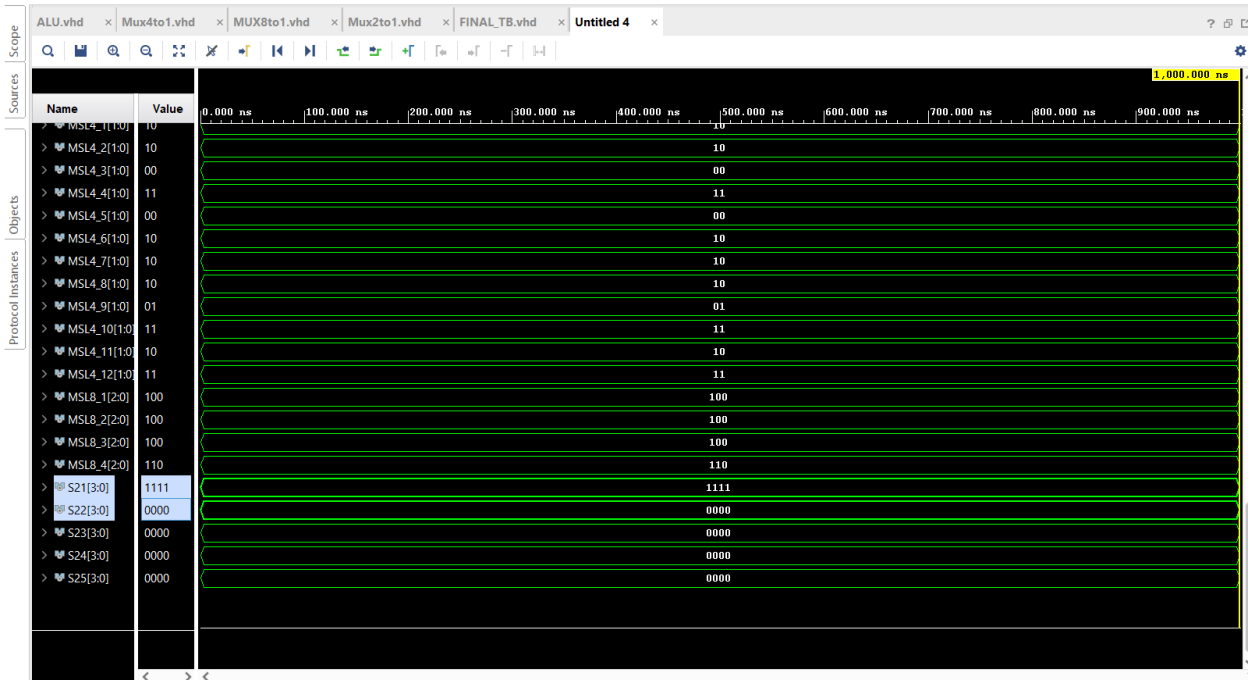
MSL4_5[1:0] 00
10
10
00
11
00


ALU.vhd
Mux4to1.vhd
MUX8to1.vhd
Mux2to1.vhd
FINAL_TB.vhd
Untitled 4
Scope
Sources
Objects
Protocol Instances
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Value
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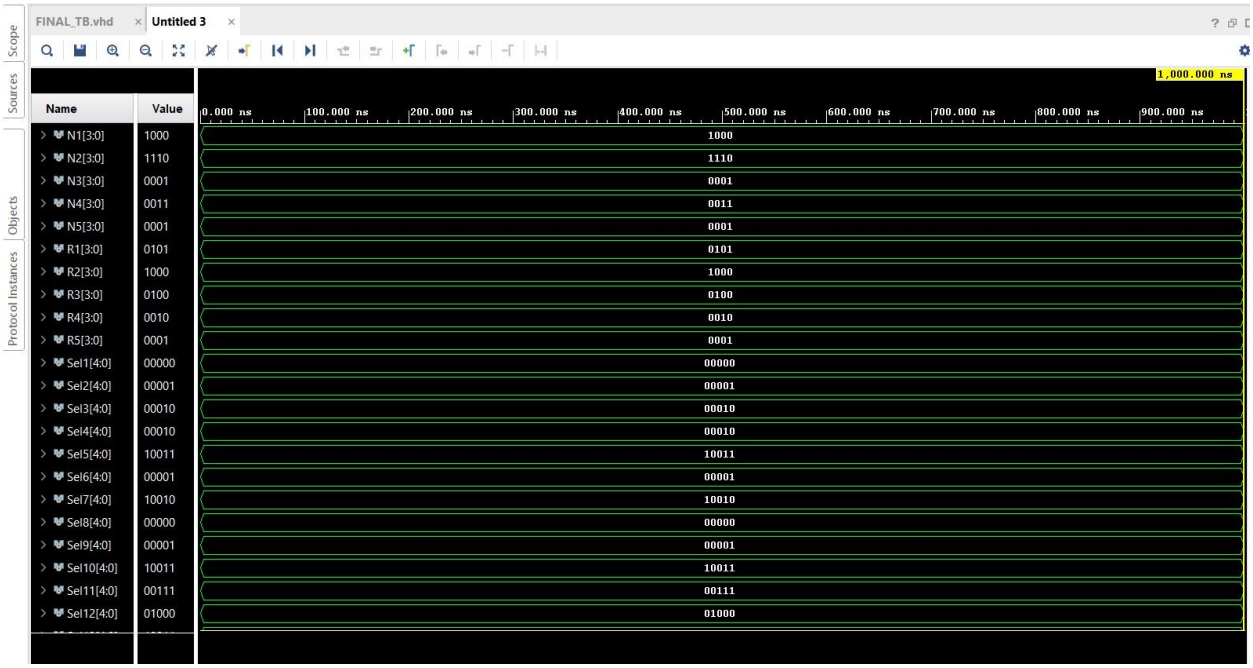
100.000 ns
200.000 ns
300.000 ns
400.000 ns
500.000 ns
600.000 ns
700.000 ns
800.000 ns
900.000 ns
MSL4_2[1:0] 10
MSL4_3[1:0] 00
MSL4_4[1:0] 11
MSL4_5[1:0] 00
MSL4_6[1:0] 10
MSL4_7[1:0] 10
MSL4_8[1:0] 10
MSL4_9[1:0] 01
MSL4_10[1:0] 11
MSL4_11[1:0] 10
MSL4_12[1:0] 11
MSL8_1[2:0] 100
MSL8_2[2:0] 100
MSL8_3[2:0] 100
MSL8_4[2:0] 110
S21[3:0] 1111
S22[3:0] 0000
S23[3:0] 0000
S24[3:0] 0000
S25[3:0] 0000
10
10
00
11
00
10
10
10
01
11
10
11
100
100
100
110
1111
0000
0000
0000
0000

For DFG-3


FINAL_TB.vhd
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Scope
Sources
Objects
Protocol Instances
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Value
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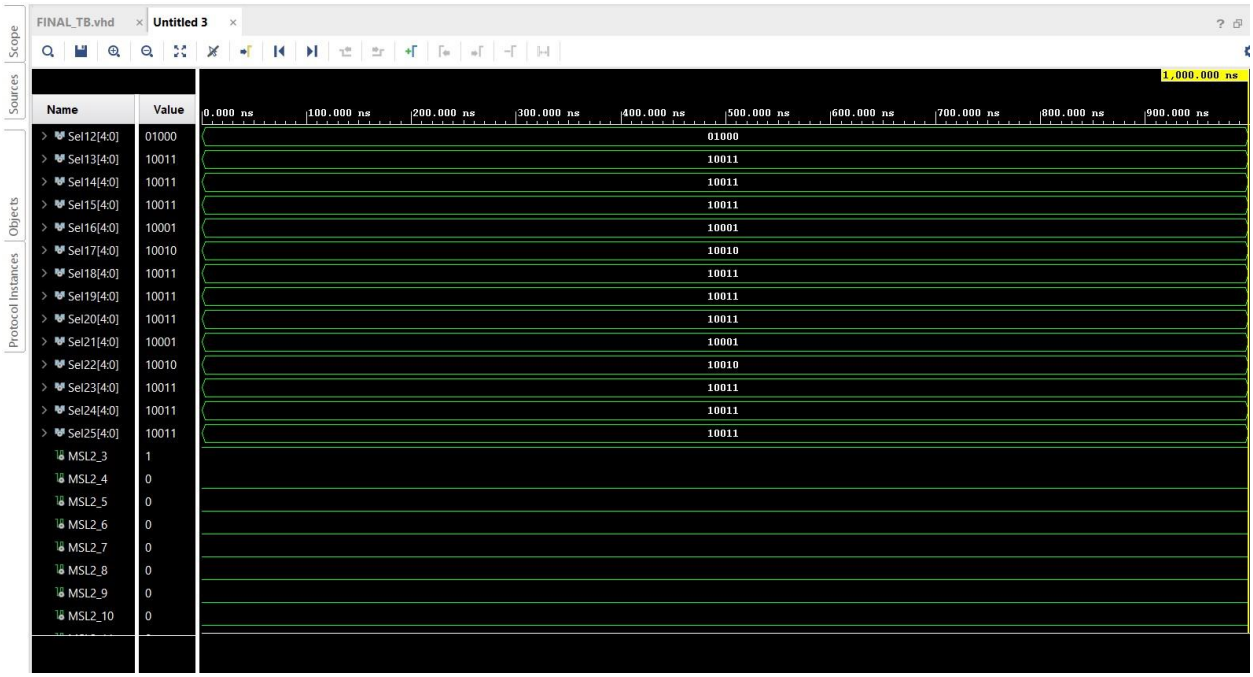
100.000 ns
200.000 ns
300.000 ns
400.000 ns
500.000 ns
600.000 ns
700.000 ns
800.000 ns
900.000 ns
N1[3:0] 1000
N2[3:0] 1110
N3[3:0] 0001
N4[3:0] 0011
N5[3:0] 0001
R1[3:0] 0101
R2[3:0] 1000
R3[3:0] 0100
R4[3:0] 0010
R5[3:0] 0001
Sel1[4:0] 00000
Sel2[4:0] 00001
Sel3[4:0] 00010
Sel4[4:0] 00010
Sel5[4:0] 10011
Sel6[4:0] 00001
Sel7[4:0] 10010
Sel8[4:0] 00000
Sel9[4:0] 00001
Sel10[4:0] 10011
Sel11[4:0] 00111
Sel12[4:0] 01000


FINAL_TB.vhd
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Scope
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Objects
Protocol Instances
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Value
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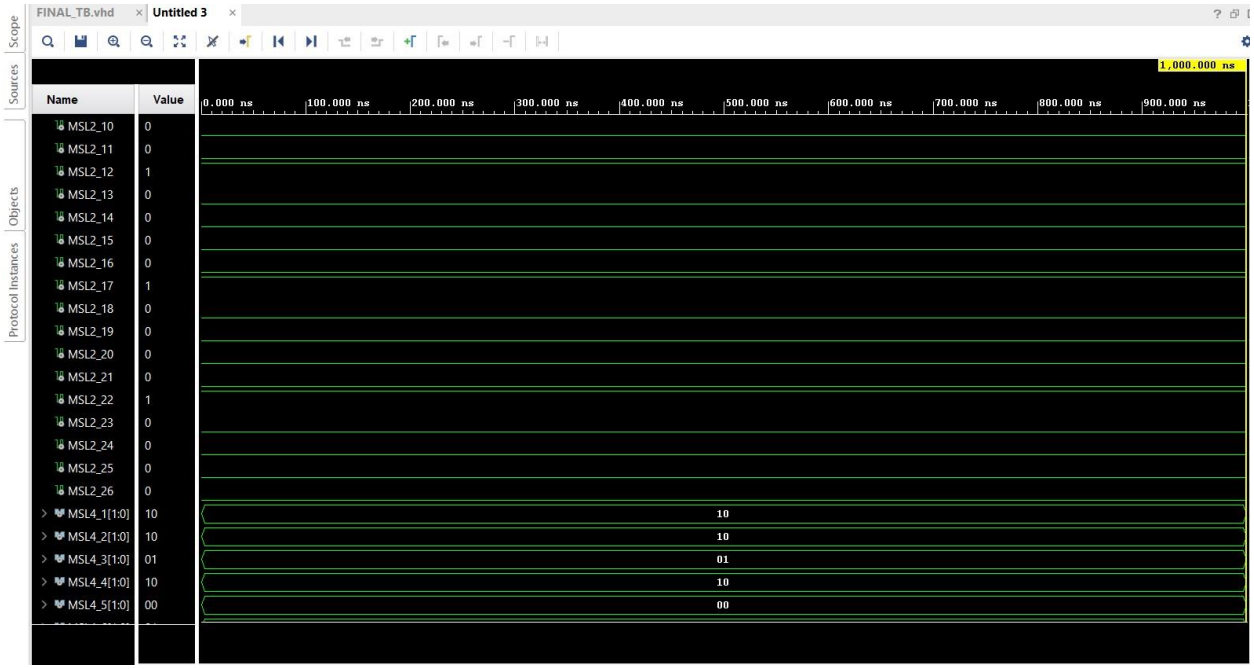
100.000 ns
200.000 ns
300.000 ns
400.000 ns
500.000 ns
600.000 ns
700.000 ns
800.000 ns
900.000 ns
Sel12[4:0] 01000
Sel13[4:0] 10011
Sel14[4:0] 10011
Sel15[4:0] 10011
Sel16[4:0] 10001
Sel17[4:0] 10010
Sel18[4:0] 10011
Sel19[4:0] 10011
Sel20[4:0] 10011
Sel21[4:0] 10001
Sel22[4:0] 10010
Sel23[4:0] 10011
Sel24[4:0] 10011
Sel25[4:0] 10011
MSL2_3 1
MSL2_4 0
MSL2_5 0
MSL2_6 0
MSL2_7 0
MSL2_8 0
MSL2_9 0
MSL2_10 0


FINAL_TB.vhd
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Scope
Sources
Objects
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Name
Value
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100.000 ns
200.000 ns
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500.000 ns
600.000 ns
700.000 ns
800.000 ns
900.000 ns
MSL2_10 0
MSL2_11 0
MSL2_12 1
MSL2_13 0
MSL2_14 0
MSL2_15 0
MSL2_16 0
MSL2_17 1
MSL2_18 0
MSL2_19 0
MSL2_20 0
MSL2_21 0
MSL2_22 1
MSL2_23 0
MSL2_24 0
MSL2_25 0
MSL2_26 0
MSL4_1[1:0] 10
MSL4_2[1:0] 10
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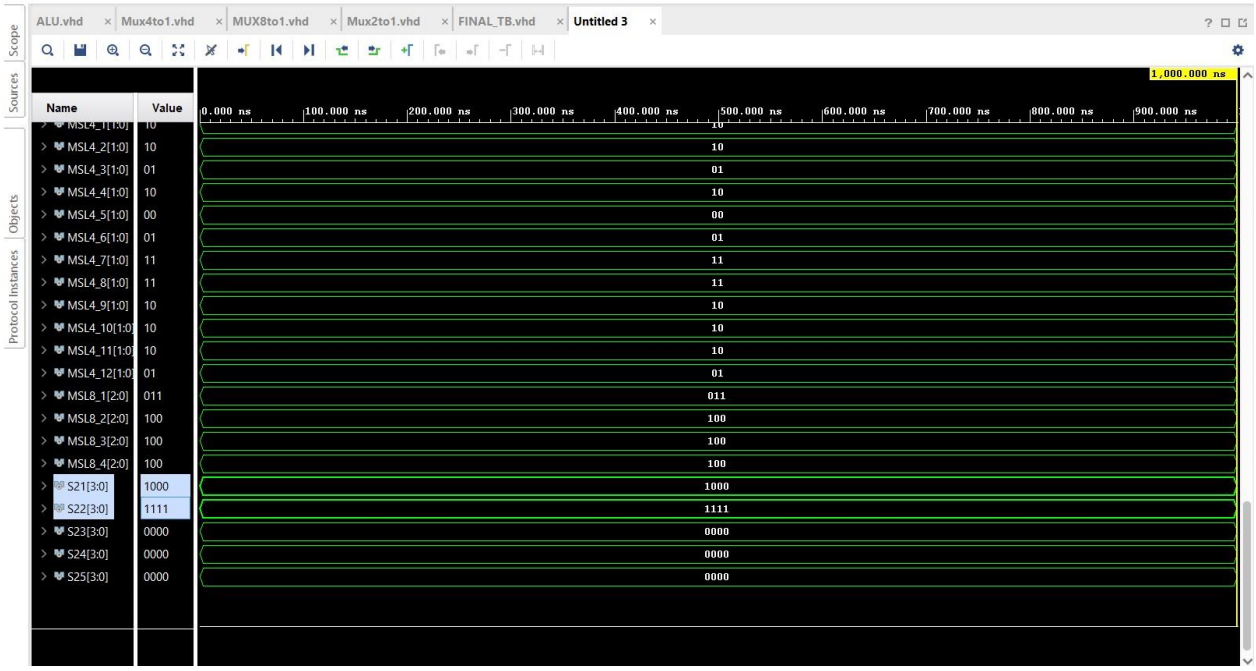
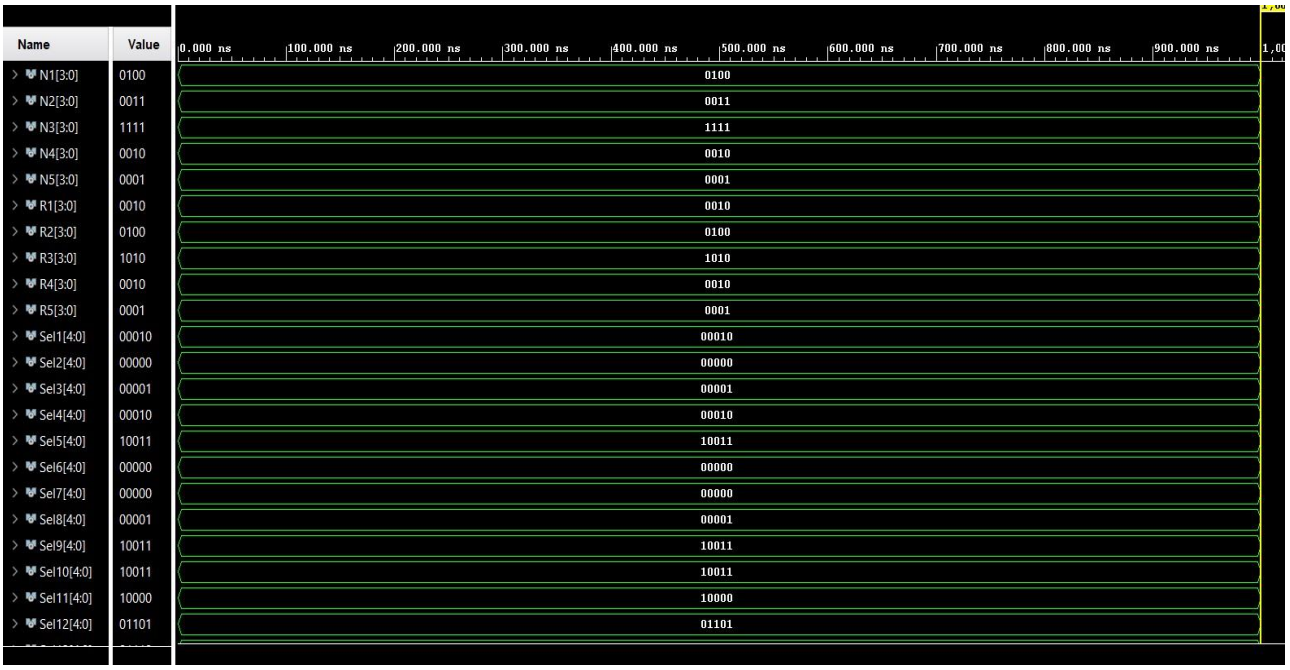
MSL4_4[1:0] 10
MSL4_5[1:0] 00
10
10
01
10
00


ALU.vhd
Mux4to1.vhd
MUX8to1.vhd
Mux2to1.vhd
FINAL_TB.vhd
Untitled 3
Scope
Sources
Objects
Protocol Instances
1,000.000 ns
Name
Value
0.000 ns
100.000 ns
200.000 ns
300.000 ns
400.000 ns
500.000 ns
600.000 ns
700.000 ns
800.000 ns
900.000 ns
MSL4_2[1:0] 10
MSL4_3[1:0] 01
MSL4_4[1:0] 10
MSL4_5[1:0] 00
MSL4_6[1:0] 01
MSL4_7[1:0] 11
MSL4_8[1:0] 11
MSL4_9[1:0] 10
MSL4_10[1:0] 10
MSL4_11[1:0] 10
MSL4_12[1:0] 01
MSL8_1[2:0] 011
MSL8_2[2:0] 100
MSL8_3[2:0] 100
MSL8_4[2:0] 100
S21[3:0] 1000
S22[3:0] 1111
S23[3:0] 0000
S24[3:0] 0000
S25[3:0] 0000
10
10
01
10
00
01
11
11
10
10
10
01
011
100
100
100
1000
1111
0000
0000
0000

For DFG-4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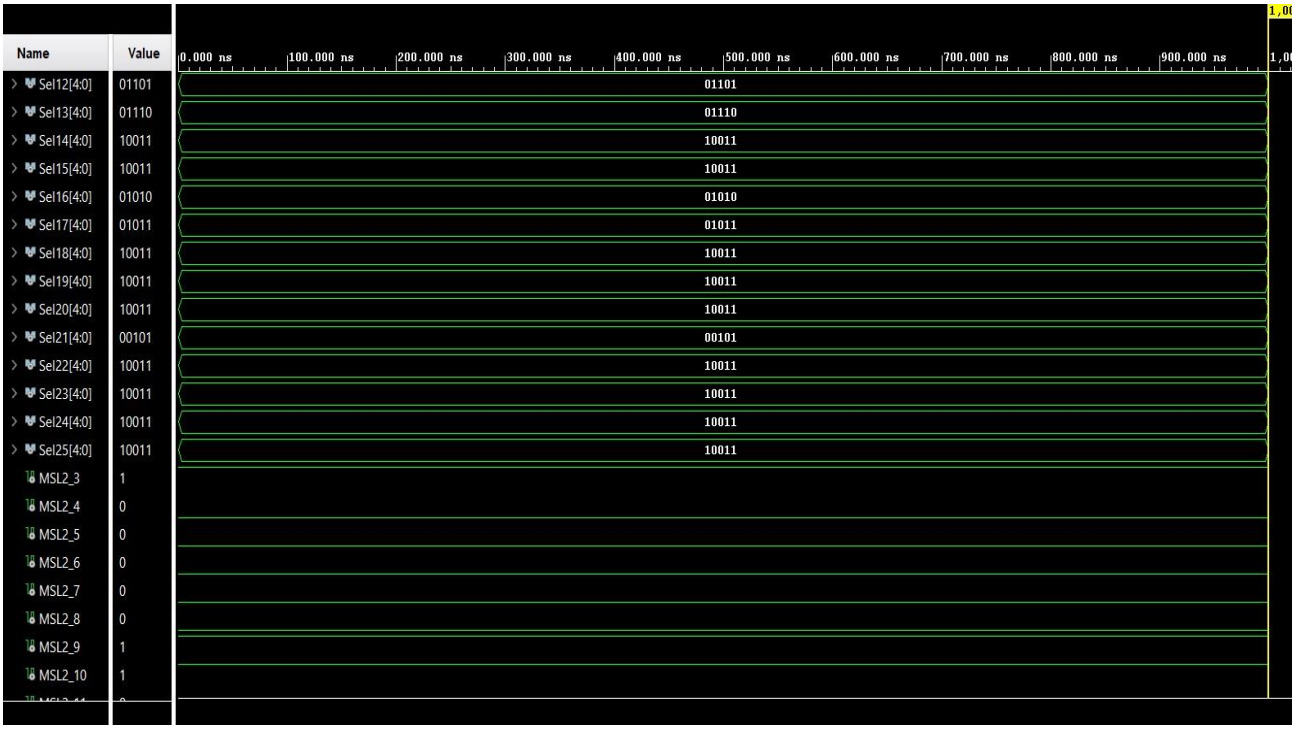
200.000 ns
300.000 ns
400.000 ns
500.000 ns
600.000 ns
700.000 ns
800.000 ns
900.000 ns
N1[3:0] 0100
N2[3:0] 0011
N3[3:0] 1111
N4[3:0] 0010
N5[3:0] 0001
R1[3:0] 0010
R2[3:0] 0100
R3[3:0] 1010
R4[3:0] 0010
R5[3:0] 0001
Sel1[4:0] 00010
Sel2[4:0] 00000
Sel3[4:0] 00001
Sel4[4:0] 00010
Sel5[4:0] 10011
Sel6[4:0] 00000
Sel7[4:0] 00000
Sel8[4:0] 00001
Sel9[4:0] 10011
Sel10[4:0] 10011
Sel11[4:0] 10000
Sel12[4:0] 01101


Name
Value
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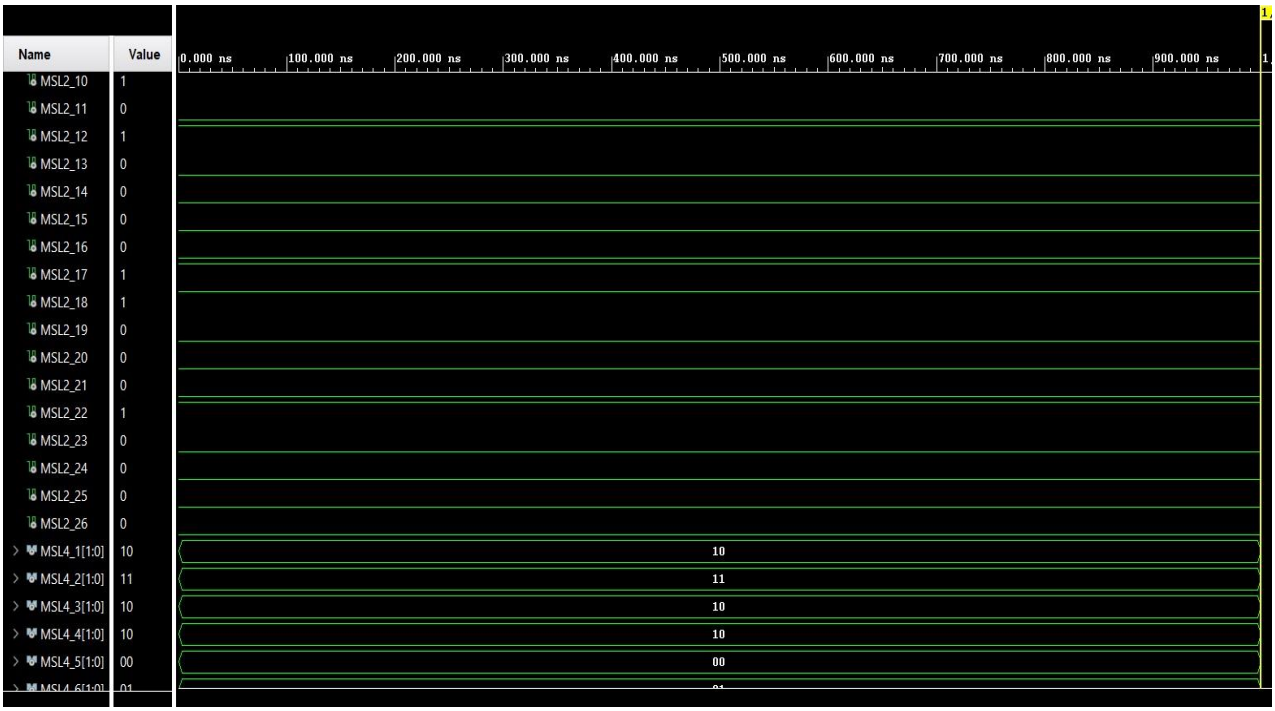
100.000 ns
200.000 ns
300.000 ns
400.000 ns
500.000 ns
600.000 ns
700.000 ns
800.000 ns
900.000 ns
Sel12[4:0] 01101
Sel13[4:0] 01110
Sel14[4:0] 10011
Sel15[4:0] 10011
Sel16[4:0] 01010
Sel17[4:0] 01011
Sel18[4:0] 10011
Sel19[4:0] 10011
Sel20[4:0] 10011
Sel21[4:0] 00101
Sel22[4:0] 10011
Sel23[4:0] 10011
Sel24[4:0] 10011
Sel25[4:0] 10011
MSL2_3 1
MSL2_4 0
MSL2_5 0
MSL2_6 0
MSL2_7 0
MSL2_8 0
MSL2_9 1
MSL2_10 1


Name
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200.000 ns
300.000 ns
400.000 ns
500.000 ns
600.000 ns
700.000 ns
800.000 ns
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MSL2_11 0
MSL2_12 1
MSL2_13 0
MSL2_14 0
MSL2_15 0
MSL2_16 0
MSL2_17 1
MSL2_18 1
MSL2_19 0
MSL2_20 0
MSL2_21 0
MSL2_22 1
MSL2_23 0
MSL2_24 0
MSL2_25 0
MSL2_26 0
MSL4_1[1:0] 10
MSL4_2[1:0] 11
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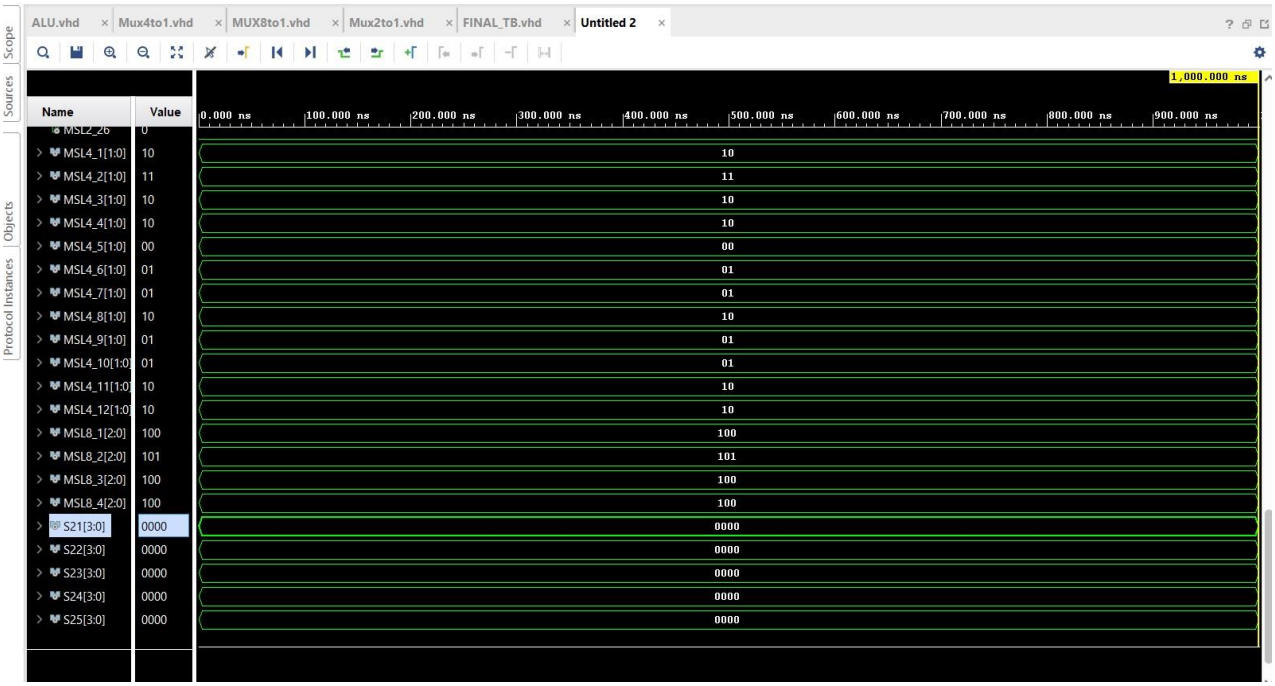
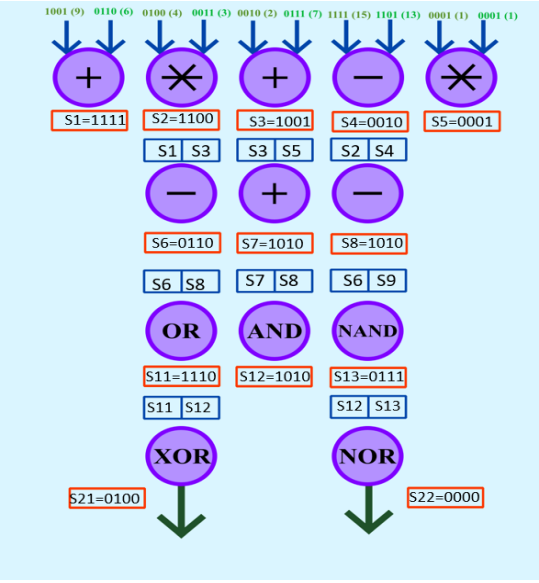
MSL4_4[1:0] 10
MSL4_5[1:0] 00
10
11
10
10
00


ALU.vhd
Mux4to1.vhd
MUX8to1.vhd
Mux2to1.vhd
FINAL_TB.vhd
Untitled 2
Scope
Sources
Objects
Protocol Instances
Name
Value
1,000.000 ns
0.000 ns
100.000 ns
200.000 ns
300.000 ns
400.000 ns
500.000 ns
600.000 ns
700.000 ns
800.000 ns
900.000 ns
MSL4_1[1:0] 10
MSL4_2[1:0] 11
MSL4_3[1:0] 10
MSL4_4[1:0] 10
MSL4_5[1:0] 00
MSL4_6[1:0] 01
MSL4_7[1:0] 01
MSL4_8[1:0] 10
MSL4_9[1:0] 01
MSL4_10[1:0] 01
MSL4_11[1:0] 10
MSL4_12[1:0] 10
MSL8_1[2:0] 100
MSL8_2[2:0] 101
MSL8_3[2:0] 100
MSL8_4[2:0] 100
S21[3:0] 0000
S22[3:0] 0000
S23[3:0] 0000
S24[3:0] 0000
S25[3:0] 0000
10
11
10
10
00
01
01
10
01
01
10
10
100
101
100
100
0000
0000
0000
0000
0000

Table/Calculations

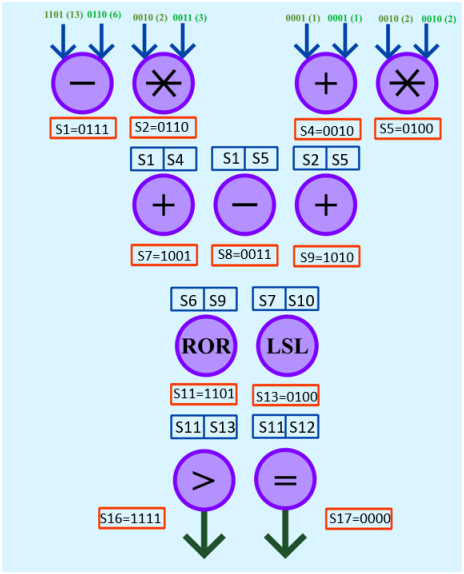
Dataflow1

CU#	Input 1	Input 2	1	2	Operation	Calculated O/p	Simulated O/p	Match
CU 1	N1	R1	1001	0110	ADD	1111	1111	Yes
CU 2	N2	R2	0100	0011	MULTIPLY	1100	1100	Yes
CU 3	N3	R3	0010	0111	ADD	1001	1001	Yes
CU 4	N4	R4	1111	1101	SUB	0010	0010	Yes
CU 5	N5	R5	0001	0001	MULTIPLY	0001	0001	Yes
CU 6	N6	R6	1111	1001	SUB	0010	0010	Yes
CU 7	N7	R7	1001	0001	ADD	1010	1010	Yes
CU 8	N8	R8	1100	0010	SUB	1010	1010	Yes
CU 9	N9	R9	1100	0001	PASS GATE 2	0001	0001	Yes
CU 10	N10	R10	0001	0001	NOOP	0000	0000	Yes
CU 11	N11	R11	0010	1010	OR	1110	1110	Yes
CU 12	N12	R12	1010	1010	AND	1010	1010	Yes
CU 13	N13	R13	0110	0001	NAND	0111	0111	Yes
CU 14	N14	R14	1010	0001	NOOP	0000	0000	Yes
CU 15	N15	R15	0001	0000	NOOP	0000	0000	Yes
CU 16	N16	R16	1110	1010	XOR	0100	0100	Yes
CU 17	N17	R17	1010	0111	NOR	0000	0000	Yes
CU 18	N18	R18	1010	0000	NOOP	0000	0000	Yes
CU 19	N19	R19	0111	0000	NOOP	0000	0000	Yes
CU 20	N20	R20	0000	0000	NOOP	0000	0000	Yes
CU 21	N21	R21	0100	0000	PASS GATE 1	0100	0100	Yes
CU 22	N22	R22	0100	0000	PASS GATE 2	0000	0000	Yes
CU 23	N23	R23	0000	0000	NOOP	0000	0000	Yes
CU 24	N24	R24	0000	0000	NOOP	0000	0000	Yes
CU 25	N25	R25	0000	0000	NOOP	0000	0000	Yes



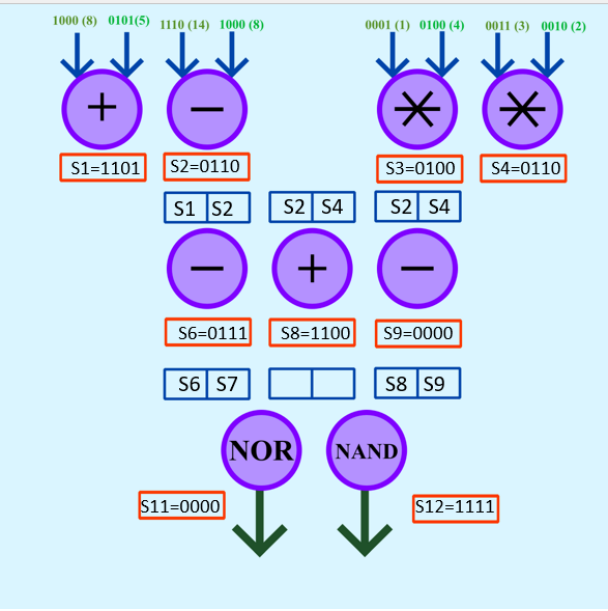
Dataflow 2

CU#	Input 1	Input 2	1	2	Operation	Calculated O/p	Simulated O/p	Match
CU 1	N1	R1	1101	0110	SUB	0111	0111	Yes
CU 2	N2	R2	0010	0011	MULTIPLY	0110	0110	Yes
CU 3	N3	R3	0001	0001	NOOP	0000	0000	Yes
CU 4	N4	R4	0001	0001	ADD	0010	0010	Yes
CU 5	N5	R5	0010	0010	MULTIPLY	0100	0100	Yes
CU 6	N6	R6	0111	0110	PASS GATE 1	0111	0111	Yes
CU 7	N7	R7	0111	0010	ADD	1001	1001	Yes
CU 8	N8	R8	0111	0100	SUB	0011	0011	Yes
CU 9	N9	R9	0110	0100	ADD	1010	1010	Yes
CU 10	N10	R10	0010	0000	PASS GATE 1	0010	0010	Yes
CU 11	N11	R11	0111	1010	ROR	1101	1101	Yes
CU 12	N12	R12	1001	0011	PASS GATE 2	0011	0011	Yes
CU 13	N13	R13	1001	0010	LSL	0100	0100	Yes
CU 14	N14	R14	0011	1010	NOOP	0000	0000	Yes
CU 15	N15	R15	1010	0010	NOOP	0000	0000	Yes
CU 16	N16	R16	1101	0100	GREATER THAN	1111	1111	Yes
CU 17	N17	R17	1101	0011	EQUAL TO	0000	0000	Yes
CU 18	N18	R18	0011	0000	NOOP	0000	0000	Yes
CU 19	N19	R19	0100	0000	NOOP	0000	0000	Yes
CU 20	N20	R20	0000	0000	NOOP	0000	0000	Yes
CU 21	N21	R21	1111	1111	PASS GATE 1	1111	1111	Yes
CU 22	N22	R22	1111	0000	PASS GATE 2	0000	0000	Yes
CU 23	N23	R23	0000	0000	NOOP	0000	0000	Yes
CU 24	N24	R24	0000	0000	NOOP	0000	0000	Yes
CU 25	N25	R25	0000	0000	NOOP	0000	0000	Yes



Dataflow 3

CU#	Input 1	Input 2	1	2	Operation	Calculated O/p	Simulated O/p	Match
CU 1	N1	R1	1000	0101	MULT	1101	1101	Yes
CU 2	N2	R2	1110	1000	SUB	0110	0110	Yes
CU 3	N3	R3	0001	0100	MULT	0100	0100	Yes
CU 4	N4	R4	0011	0010	MULT	0110	0110	Yes
CU 5	N5	R5	0001	0001	NOOP	0000	0000	Yes
CU 6	N6	R6	1101	0110	SUB	0111	0111	Yes
CU 7	N7	R7	0110	0100	PASS GATE 2	0100	0100	Yes
CU 8	N8	R8	0110	0110	ADD	1100	1100	Yes
CU 9	N9	R9	0110	0110	SUB	0000	0000	Yes
CU 10	N10	R10	0000	0000	NOOP	0000	0000	Yes
CU 11	N11	R11	0111	0100	NOR	1000	1000	Yes
CU 12	N12	R12	1100	0000	NAND	1111	1111	Yes
CU 13	N13	R13	1100	0000	NOOP	0000	0000	Yes
CU 14	N14	R14	1100	0000	NOOP	0000	0000	Yes
CU 15	N15	R15	0000	0000	NOOP	0000	0000	Yes
CU 16	N16	R16	1000	1000	PASS GATE 1	1000	1000	Yes
CU 17	N17	R17	1000	1111	PASS GATE 2	1111	1111	Yes
CU 18	N18	R18	1111	0000	NOOP	0000	0000	Yes
CU 19	N19	R19	0000	0000	NOOP	0000	0000	Yes
CU 20	N20	R20	0000	0000	NOOP	0000	0000	Yes
CU 21	N21	R21	1000	1000	PASS GATE 1	1000	1000	Yes
CU 22	N22	R22	1000	1111	PASS GATE 2	1111	1111	Yes
CU 23	N23	R23	1111	0000	NOOP	0000	0000	Yes
CU 24	N24	R24	0000	0000	NOOP	0000	0000	Yes
CU 25	N25	R25	0000	0000	NOOP	0000	0000	Yes



Dataflow 4

CU#	Input 1	Input 2	1	2	Operation	Calculated O/p	Simulated O/p	Match
CU 1	N1	R1	0100	0010	MULT	1000	1000	Yes
CU 2	N2	R2	0011	0100	ADD	0111	0111	Yes
CU 3	N3	R3	1111	1010	SUB	0101	0101	Yes
CU 4	N4	R4	0010	0010	MULT	0100	0100	Yes
CU 5	N5	R5	0001	0001	NOOP	0000	0000	Yes
CU 6	N6	R6	1000	0101	ADD	1101	1101	Yes
CU 7	N7	R7	0111	0100	ADD	1011	1011	Yes
CU 8	N8	R8	0101	0100	SUB	0001	0001	Yes
CU 9	N9	R9	0111	0100	NOOP	0000	0000	Yes
CU 10	N10	R10	0000	0000	NOOP	0000	0000	Yes
CU 11	N11	R11	1101	1011	LSR	0000	0000	Yes
CU 12	N12	R12	1101	0001	R0L	1011	1011	Yes
CU 13	N13	R13	1011	0001	ASL	0110	0110	Yes
CU 14	N14	R14	0001	0000	NOOP	0000	0000	Yes
CU 15	N15	R15	0000	0000	NOOP	0000	0000	Yes
CU 16	N16	R16	0000	1011	XOR	1011	1011	Yes
CU 17	N17	R17	1011	0110	XNOR	0010	0010	Yes
CU 18	N18	R18	1011	0000	NOOP	0000	0000	Yes
CU 19	N19	R19	0110	0000	NOOP	0000	0000	Yes
CU 20	N20	R20	0000	0000	NOOP	0000	0000	Yes
CU 21	N21	R21	1011	0010	LESS THAN	0000	0000	Yes
CU 22	N22	R22	1011	0010	NOOP	0000	0000	Yes
CU 23	N23	R23	0010	0000	NOOP	0000	0000	Yes
CU 24	N24	R24	0000	0000	NOOP	0000	0000	Yes
CU 25	N25	R25	0000	0000	NOOP	0000	0000	Yes