**PROJECT IITB\_RISC**

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**HARDWARE FLOW CHARTS**

ADD:

|  |  |
| --- | --- |
| IR11-9 RF\_A1 |  |
| IR8-6 RF\_A2 | S1 |
| IR5-3 RF\_A3 |  |
| RF\_D1 T1 |  |
| RF\_D2 T2 |  |
| PC ALU\_A |  |
| +1 ALU\_B |  |
| ALU\_OUT PC |  |

|  |  |
| --- | --- |
| T1 ALU\_A |  |
| T2 ALU\_B | S2 |
| ALU\_OUT RF\_D3  PC MEM\_A  MEM\_D |  |

ADC:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| PC ALU\_A  +1 ALU\_B  ALU\_OUT PC | | | S3 | |
|  | C | | |  |
| S4 | PC MEM\_A  MEM\_D IR | |  |  | | --- | --- | | IR11-9 RF\_A1 |  | | IR8-6 RF\_A2 | S5 | | IR5-3 RF\_A3 |  | | RF\_D1 T1 |  | | RF\_D2 T2 |  | | |  |

|  |  |
| --- | --- |
| T1 ALU\_A |  |
| T2 ALU\_B | S2 |
| ALU\_OUT RF\_D3  PC MEM\_A  MEM\_D |  |

ADZ:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| PC ALU\_A  +1 ALU\_B  ALU\_OUT PC | | | S3 | |
|  | Z | | |  |
| S4 | PC MEM\_A  MEM\_D IR | |  | | --- | | IR11-9 RF\_A1 | | IR8-6 RF\_A2 | | IR5-3 RF\_A3 | | RF\_D1 T1 | | RF\_D2 T2 | | | S5 |

|  |  |
| --- | --- |
| T1 ALU\_A |  |
| T2 ALU\_B | S2 |
| ALU\_OUT RF\_D3  PC MEM\_A  MEM\_D |  |

ADL:

|  |  |
| --- | --- |
| IR11-9 RF\_A1  IR8-6 RF\_A2  IR5-3 RF\_A3  RF\_D1 T1  RF\_D2 T2  PC ALU\_A  +1 ALU\_B  ALU\_OUT PC | S28 |
|  |  |
| T1 ALU\_A  T2 S1 ALU\_B  ALU\_OUT RF\_D3  PC MEM\_A  MEM\_D | S6 |

ADI:

|  |  |
| --- | --- |
| IR11-9 RF\_A1  IR8-6 RF\_A2  RF\_D1 T1  IR5-0 SE16 T2  PC ALU\_A  +1 ALU\_B  ALU\_OUT PC | S7 |
|  |  |
| T1 ALU\_A  T2 ALU\_B  ALU\_OUT RF\_D3  PC MEM\_A  MEM\_D | S2 |

NDU:

|  |  |
| --- | --- |
| IR11-9 RF\_A1 |  |
| IR8-6 RF\_A2 |  |
| IR5-3 RF\_A3 |  |
| RF\_D1 T1 | S1 |
| RF\_D2 T2 |  |
| PC ALU\_A |  |
| +1 ALU\_B |  |
| ALU\_OUT PC |  |

|  |  |
| --- | --- |
| T1 ALU\_A |  |
| T2 ALU\_B |  |
| ALU\_OUT RF\_D3  PC MEM\_A  MEM\_D | S2 |

NDC:

|  |  |  |  |
| --- | --- | --- | --- |
| PC ALU\_A  +1 ALU\_B  ALU\_OUT PC | | | S3 |
|  | C | |  |
| S4 | PC MEM\_A  MEM\_D IR | |  | | --- | | IR11-9 RF\_A1 | | IR8-6 RF\_A2 | | IR5-3 RF\_A3 | | RF\_D1 T1 | | RF\_D2 T2 | | S5 |

|  |  |
| --- | --- |
| T1 ALU\_A |  |
| T2 ALU\_B |  |
| ALU\_OUT RF\_D3  PC MEM\_A  MEM\_D | S2 |

NDZ:

|  |  |  |  |
| --- | --- | --- | --- |
| PC ALU\_A  +1 ALU\_B  ALU\_OUT PC | | | S3 |
|  | Z | |  |
| S4 | PC MEM\_A  MEM\_D IR | |  | | --- | | IR11-9 RF\_A1 | | IR8-6 RF\_A2 | | IR5-3 RF\_A3 | | RF\_D1 T1 | | RF\_D2 T2 | | S5 |

|  |  |
| --- | --- |
| T1 ALU\_A |  |
| T2 ALU\_B |  |
| ALU\_OUT RF\_D3  PC MEM\_A  MEM\_D | S2 |

LHI:

|  |  |
| --- | --- |
| IR11-9 RF\_A3  IR8-0 S7 RF\_D3  PC ALU\_A  +1 ALU\_B  ALU\_OUT PC | S12 |
|  |  |
| PC MEM\_A  MEM\_D IR | S4 |

LW:

|  |  |
| --- | --- |
| IR11-9 RF\_A3  IR8-6 RF\_A1  IR5-0 SE16 T2  PC ALU\_A  +1 ALU\_B  ALU\_OUT PC | S16 |
|  |  |
| PC MEM\_A  MEM\_D IR  T2 ALU\_B  RF\_D1 ALU\_A  ALU\_OUT T1 | S27 |
|  |  |
| T1 MEM\_A  MEM\_D RF\_D3 | S17 |

SW:

|  |  |
| --- | --- |
| IR11-9 RF\_A2  IR8-6 RF\_A1  IR5-0 SE16 T2  PC ALU\_A  +1 ALU\_B  ALU\_OUT PC | S13 |
|  |  |
| PC MEM\_A  MEM\_D IR  T2 ALU\_B  RF\_D1 ALU\_A  ALU\_OUT T1 | S14 |
|  |  |
| T1 MEM\_A  RF\_D2 MEM\_D | S15 |

LM:

|  |  |
| --- | --- |
| IR11-9 RF\_A1  RF\_D1 T1  IR8-0 S16 T2  PC ALU\_A  +1 ALU\_B  ALU\_OUT PC | S8 |

|  |  |  |  |
| --- | --- | --- | --- |
| PC MEM\_A  MEM\_D IR | | | S29 |
|  |  | |  |
| S9 | T214-12 ALU\_A  +1 ALU\_B  ALU\_OUT T214-12  T2 S1 T2 | |  | | --- | | T214-12 RF\_A3  T2\_0 | | T1 MEM\_A, ALU\_A  MEM\_D RF\_D3  +1 ALU\_B  ALU\_OUT T1 | | S10 |

SM:

|  |  |
| --- | --- |
| IR11-9 RF\_A1  RF\_D1 T1  IR8-0 T2  PC ALU\_A  +1 ALU\_B  ALU\_OUT PC | S8 |

|  |  |  |  |
| --- | --- | --- | --- |
| PC MEM\_A  MEM\_D IR | | | S29 |
|  |  | |  |
| S9 | T214-12ALU\_A  +1 ALU\_B  ALU\_OUT T214-12  T2 S1 T2 | |  | | --- | | T214-12 RF\_A2 | | T1 MEM\_A, ALU\_A  RF\_D2 MEM\_D  +1 ALU\_B  ALU\_OUT T1 | | S11 |

JRI:

|  |  |
| --- | --- |
| IR11-9 RF\_A1  RF\_D1 T1  IR8-0 SE16 T2 | S18 |
|  |  |
| T1 ALU\_A  T2 ALU\_B  ALU\_OUT PC | S19 |
|  |  |
| PC MEM\_A  MEM\_D IR | S4 |

JLR:

|  |  |
| --- | --- |
| IR11-9 RF\_A3  IR8-6 RF\_A2 | S20 |
|  |  |
| PC ALU\_A  +1 ALU\_B  ALU\_OUT RF\_D3  RF\_D2 PC, MEM\_A  MEM\_D IR | S21 |

JAL:

|  |  |
| --- | --- |
| IR11-9 RF\_A3  IR8-0 SE16 T2  PC ALU\_A  +1 ALU\_B  ALU\_OUT T1 | S22 |
|  |  |
| T1 RF\_D3  PC ALU\_A  T2 ALU\_B  ALU\_OUT PC | S23 |
|  |  |
| PC MEM\_A  MEM\_D IR | S4 |

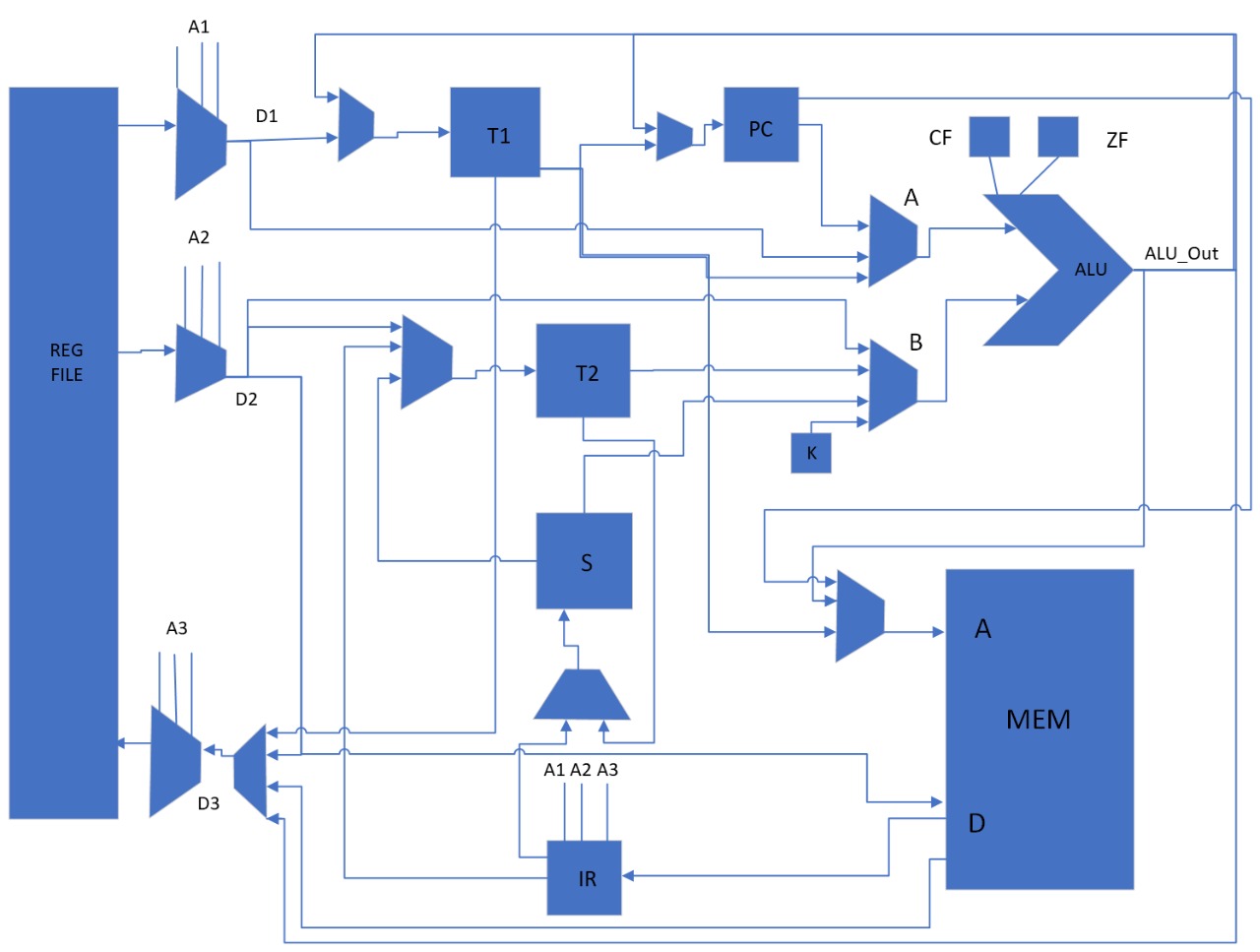
BEQ:

|  |  |
| --- | --- |
| IR11-9 RF\_A1  IR8-6 RF\_A2  PC ALU\_A  IR5-0 SE16 ALU\_B  ALU\_OUT T1 | S24 |

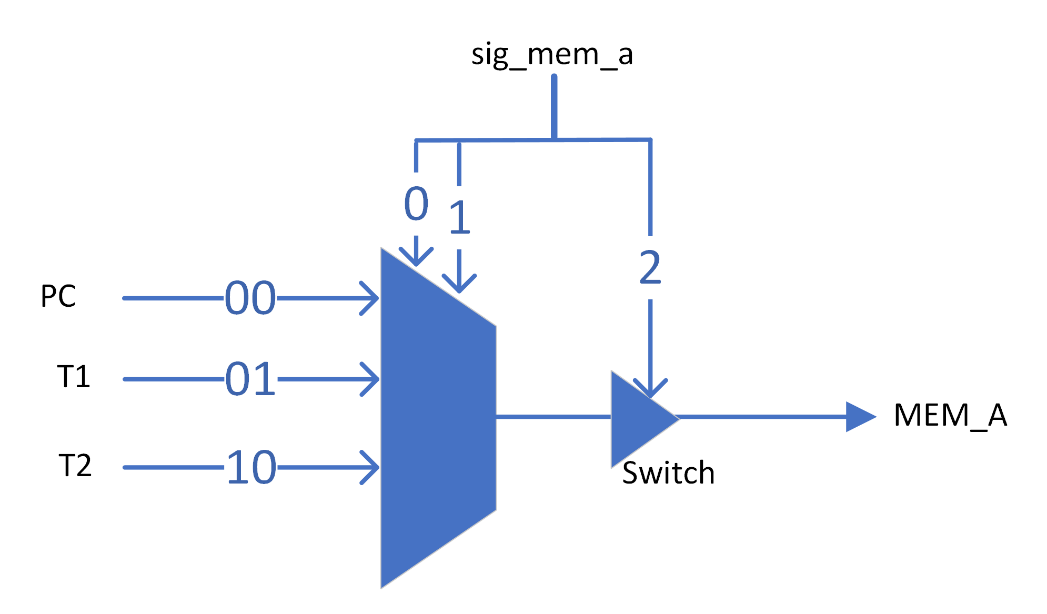
|  |  |  |  |
| --- | --- | --- | --- |
| RF\_D1 ALU\_A  RF\_D2 ALU\_B | | | S25 |
|  | Z | |  |
| S3 | PC ALU\_A  +1 ALU\_B  ALU\_OUT PC | |  | | --- | | T1 PC, MEM\_A | | MEM\_D | | S26 |

|  |  |
| --- | --- |
| PC MEM\_A  MEM\_D | S4 |

**DATAPATH**

****

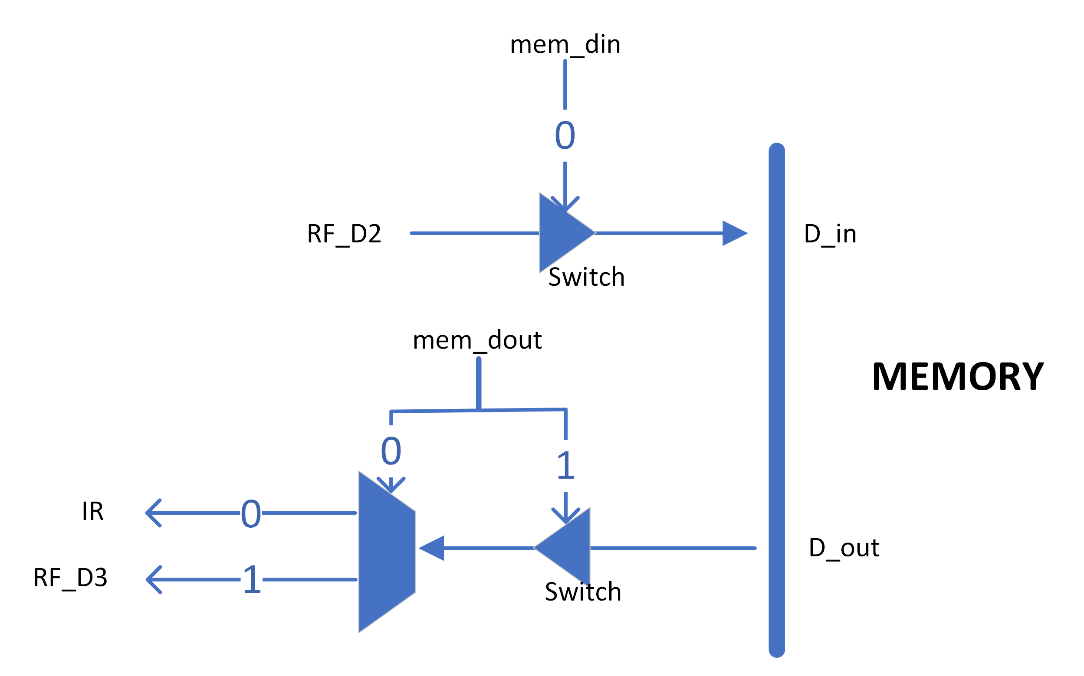
**CONTROL WORD DECODER**

MEM\_A

|  |  |  |
| --- | --- | --- |
| USAGE IN FLOWCHART | EXAMPLE STATE | CONTROL BITS (PQR) |
| PC → MEM\_A | S4 | 000 |
| RF\_D2 → PC, MEM\_A | S21 | 001 |
| T1 → MEM\_A | S26 | 010 |
| T2 → MEM\_A | S10 | 100 |
| NONE | S8 | 110 |

Decoder Logic

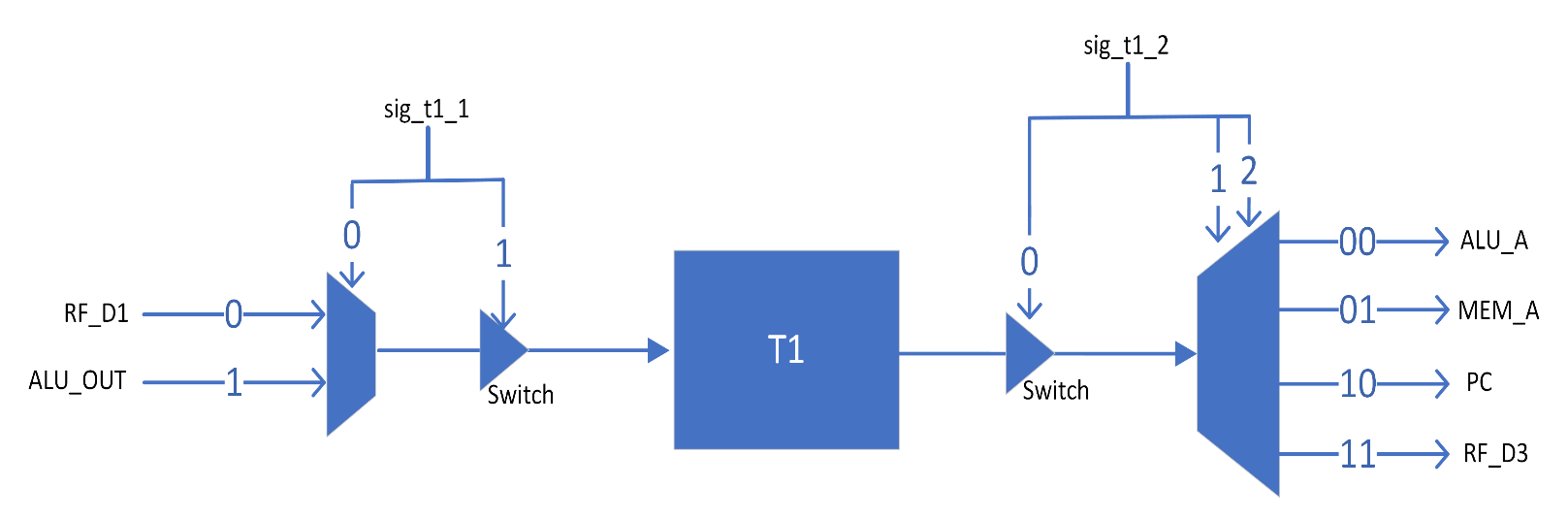
|  |  |
| --- | --- |
| SIG\_MEM\_A[1] |  |
| SIG\_MEM\_A[2] |  |
| SIG\_MEM\_A[3] |  |

MEM\_D

|  |  |  |
| --- | --- | --- |
| USAGE IN FLOWCHART | EXAMPLE STATE | CONTROL BITS (PQ) |
| MEM\_D → IR | S4 | 00 |
| MEM\_D → RF\_D3 | S17 | 01 |
| RF\_D2 → MEM\_D | S15 | 10 |
| NONE | S1 | 11 |

Decoder Logic

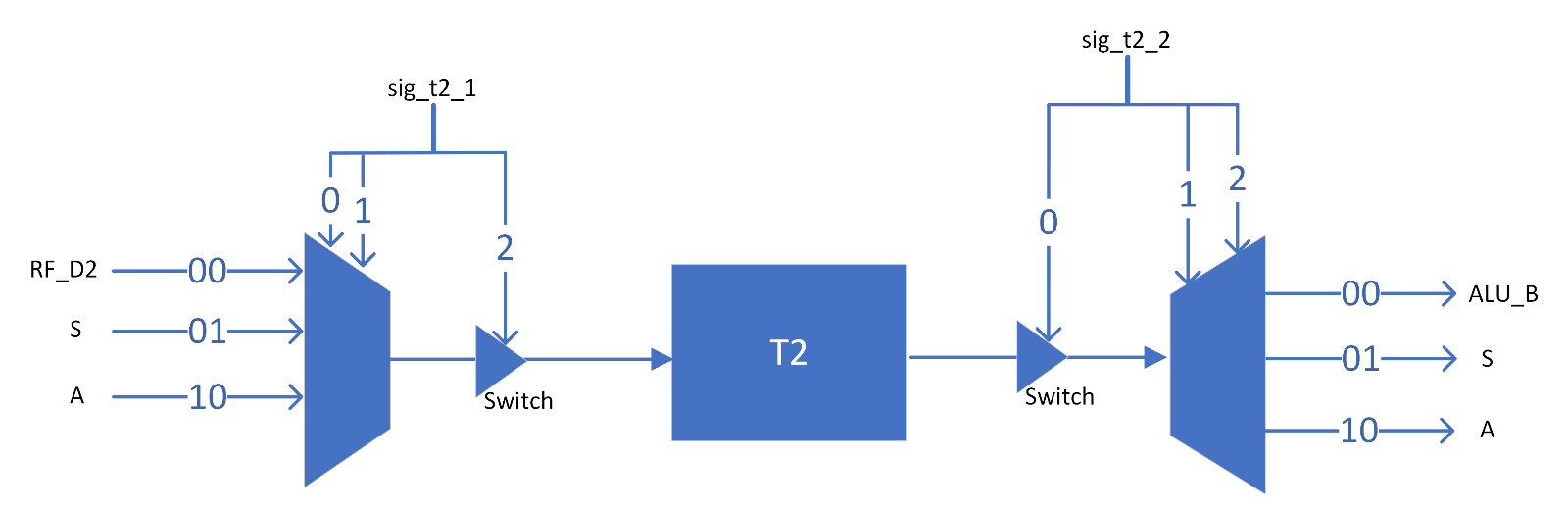
|  |  |
| --- | --- |
| SIG\_MEM\_DIN[1] |  |
| SIG\_MEM\_DOUT[2] |  |
| SIG\_MEM\_DOUT[3] |  |

T1

|  |  |  |
| --- | --- | --- |
| USAGE IN FLOWCHART | EXAMPLE STATE | CONTROL BITS (PQR) |
| RF\_D1 → T1 | S5 | 011 |
| T1 → ALU\_A | S2 | 001 |
| ALU\_OUT → T1 | S27 | 100 |
| T1 → MEM\_A | S17 | 010 |
| T1 → RF\_D3 | S23 | 101 |
| T1 → PC, MEM\_A | S26 | 110 |
| NONE | S25 | 000 |

Decoder Logic

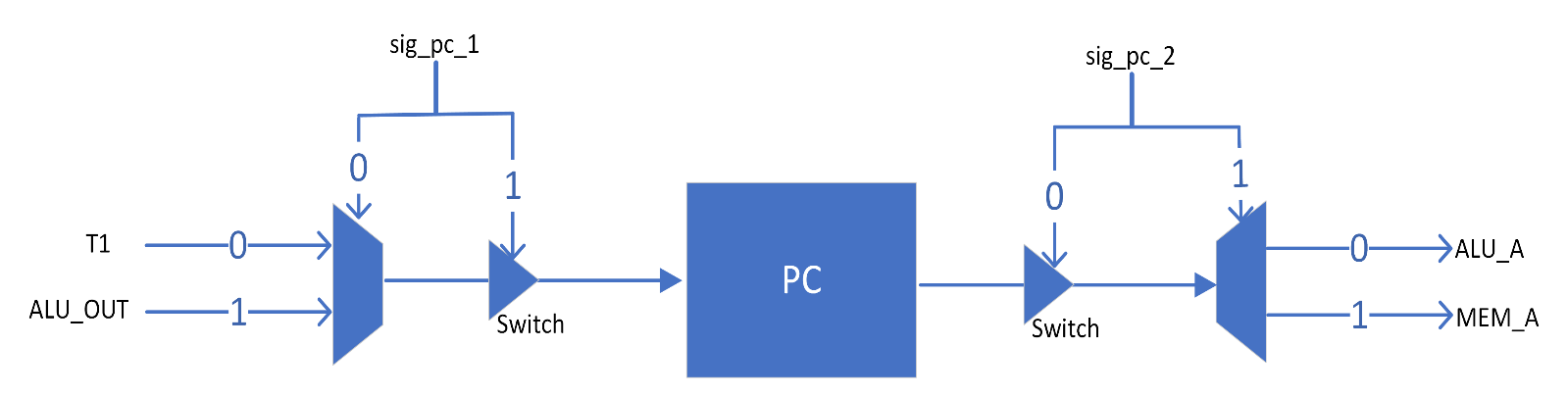
|  |  |
| --- | --- |
| SIG\_T1\_1[1] |  |
| SIG\_T1\_1[2] |  |
| SIG\_T1\_2[3] |  |
| SIG\_T1\_2[4] |  |
| SIG\_T1\_2[5] |  |

T2

|  |  |  |
| --- | --- | --- |
| USAGE IN FLOWCHART | EXAMPLE STATE | CONTROL BITS (PQR) |
| RF\_D2 → T2 | S5 | 001 |
| T2 → ALU\_B | S2 | 010 |
| T2 → S | S6 | 011 |
| SE16 → T2 | S7 | 100 |
| IR8-0 → T2 | S8 | 110 |
| T2 → S1 → T2 | S9 | 101 |
| T2 → MEM\_A, ALU\_A  ALU\_OUT → T2 | S10 | 111 |
| NONE | S3 | 000 |

Decoder Logic

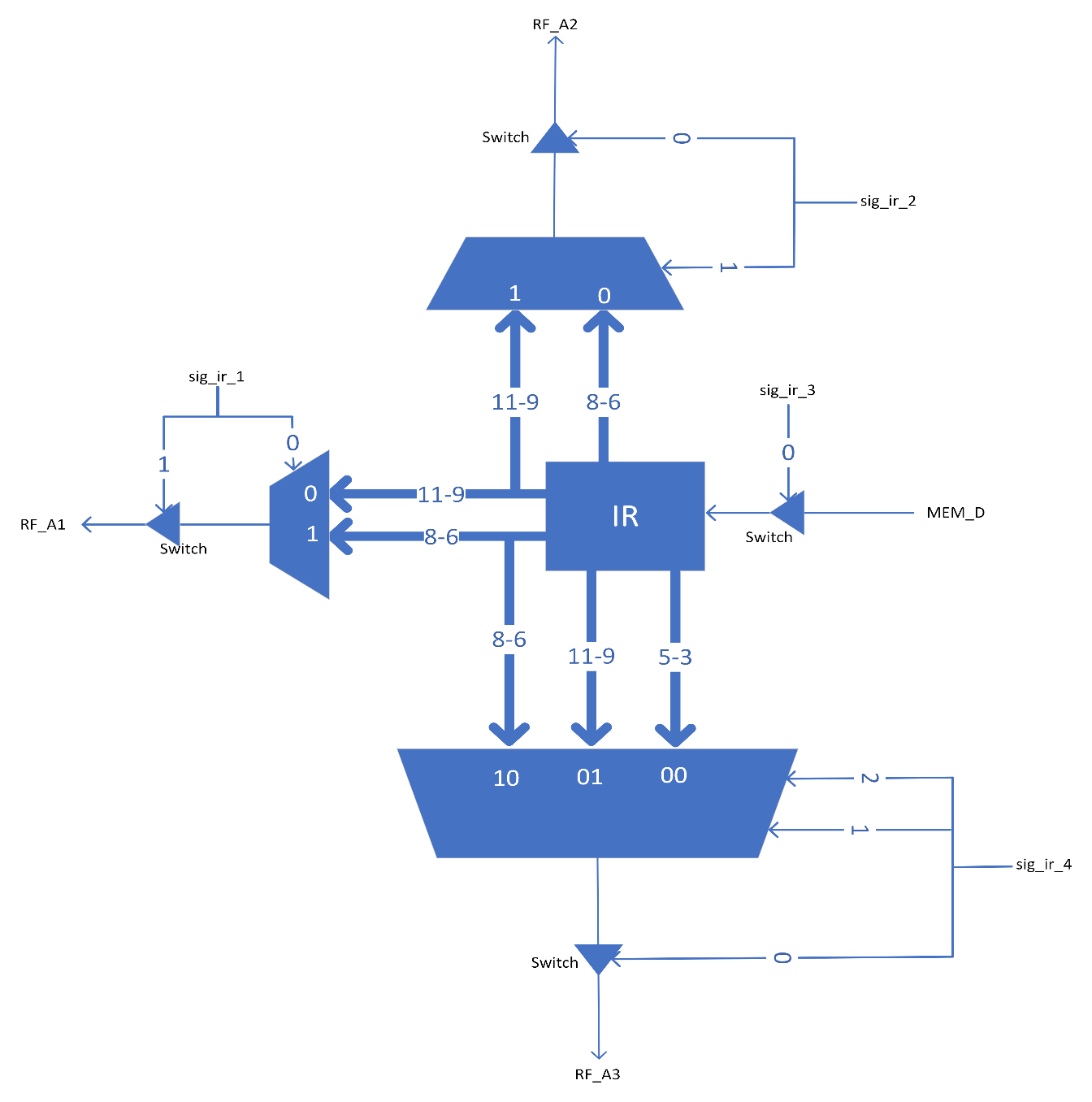
|  |  |
| --- | --- |
| SIG\_T2\_1[1] |  |
| SIG\_T2\_1[2] |  |
| SIG\_T2\_2[3] |  |
| SIG\_T2\_2[4] |  |
| SIG\_T2\_1[5] |  |

PC

|  |  |  |
| --- | --- | --- |
| USAGE IN FLOWCHART | EXAMPLE STATE | CONTROL BITS (PQR) |
| PC → ALU\_A  ALU\_OUT → PC | S1 | 110 |
| PC → MEM\_A | S2 | 010 |
| PC → ALU\_A | S22 | 011 |
| ALU\_OUT → PC | S19 | 001 |
| T1 → PC | S26 | 100 |
| RF\_D2 → PC | S21 | 101 |
| NONE | S5 | 000 |

Decoder Logic

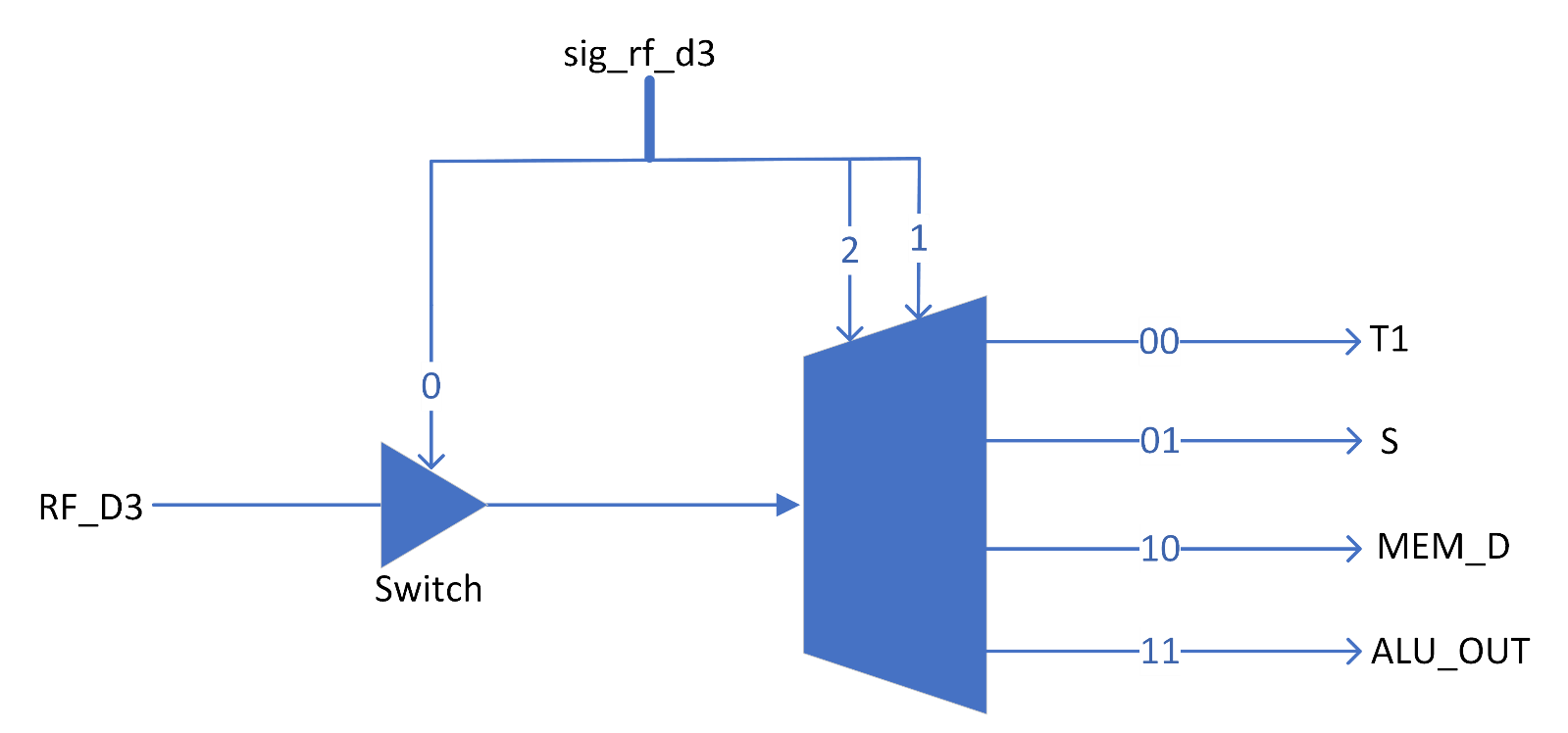
|  |  |
| --- | --- |
| SIG\_PC\_1[1] |  |
| SIG\_PC\_1[2] |  |
| SIG\_PC\_2[3] |  |
| SIG\_PC\_2[4] |  |

IR

|  |  |  |
| --- | --- | --- |
| USAGE IN FLOWCHART | EXAMPLE STATE | CONTROL BITS (PQRS) |
| IR11-9 → RF\_A1  IR8-6 → RF\_A2  IR5-3 → RF\_A3 | S5 | 0001 |
| MEM\_D → IR | S4 | 0010 |
| IR11-9 → RF\_A1  IR8-6 → RF\_A2  IR5-0 → SE16 → T2 | S7 | 0011 |
| IR11-9 → RF\_A3  IR8-0 → S7 → RF\_D3 | S12 | 0100 |
| IR11-9 → RF\_A1  IR8-0 → T2 | S8 | 0110 |
| IR11-9 → RF\_A1  IR8-0 → SE16 → T2 | S18 | 0111 |
| IR11-9 → RF\_A3  IR8-6 → RF\_A2 | S20 | 1000 |
| IR11-9 → RF\_A3  IR8-0 → SE16 → T2 | S22 | 1001 |
| IR11-9 → RF\_A2  IR8-6 → RF\_A1  IR5-0 → SE16 → T2 | S13 | 1011 |
| NONE | S17 | 0000 |

Decoder Logic

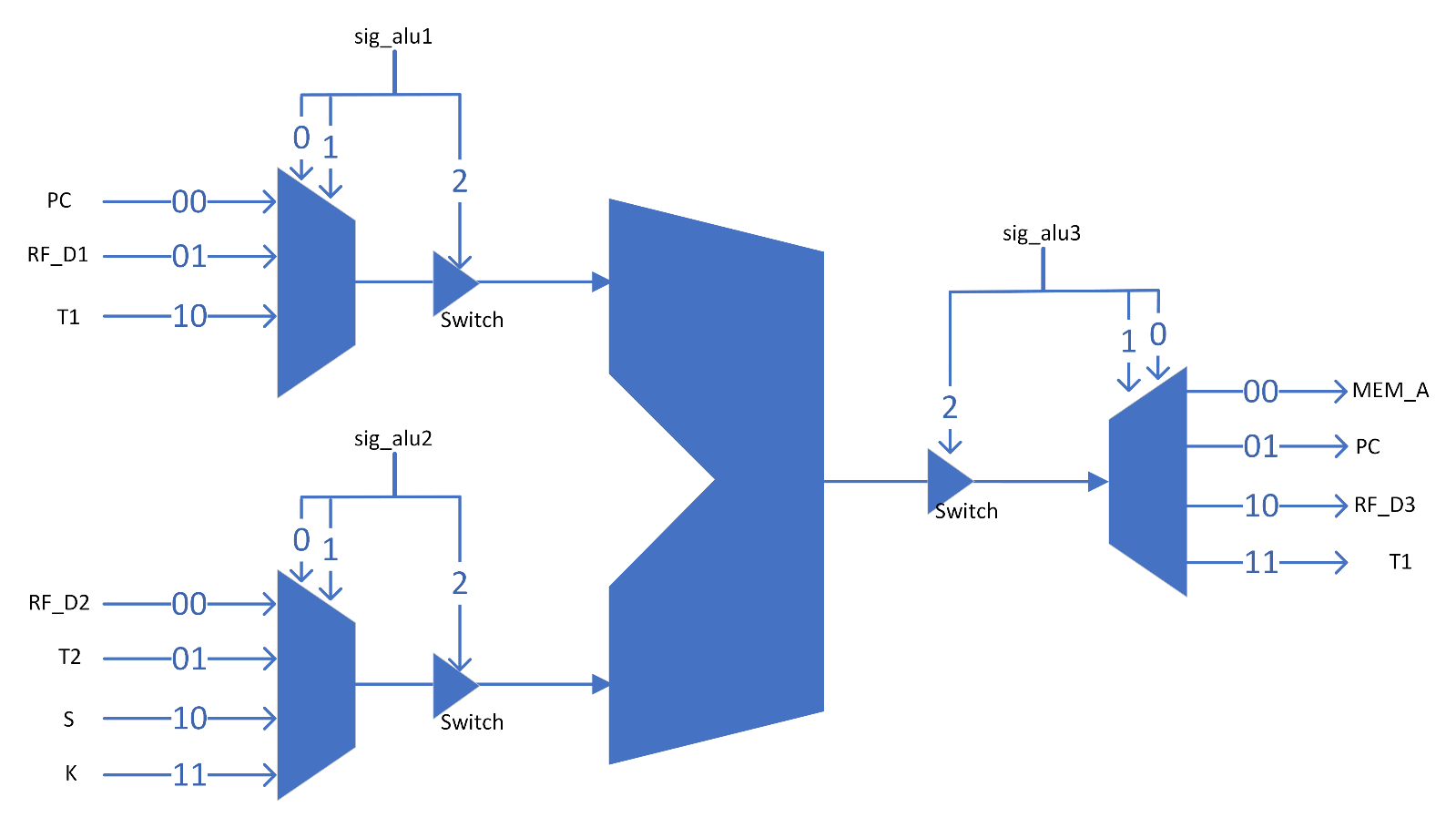
|  |  |
| --- | --- |
| SIG\_IR\_1[1] |  |
| SIG\_IR\_1[2] |  |
| SIG\_IR\_2[3] |  |
| SIG\_IR\_4[4] |  |
| SIG\_IR\_4[5] |  |
| SIG\_IR\_3[6] |  |

RF\_D3

|  |  |  |
| --- | --- | --- |
| USAGE IN FLOWCHART | EXAMPLE STATE | CONTROL BITS (PQ) |
| MEM\_D → RF\_D3 | S10 | 11 |
| ALU\_OUT → RF\_D3 | S21 | 01 |
| T1 → RF\_D3 | S23 | 00 |
| NONE | S4 | 10 |

Decoder Logic

|  |  |
| --- | --- |
| SIG\_RF\_D3[1] |  |
| SIG\_RF\_D3[2] |  |
| SIG\_RF\_D3[3] |  |

ALU

|  |  |  |
| --- | --- | --- |
| USAGE IN FLOWCHART | EXAMPLE STATE | CONTROL BITS (PQRS) |
| PC → ALU\_A  +1 → ALU\_B  ALU\_OUT → PC | S1 | 0000 |
| T1 → ALU\_A  T2 → ALU\_B  ALU\_OUT → RF\_D3 | S2 | 0001 |
| T2 → ALU\_B  RF\_D1 → ALU\_A  ALU\_OUT → T1 | S27 | 0011 |
| T1 → MEM\_A, ALU\_A  +1 → ALU\_B  ALU\_OUT → T1 | S10 | 1011 |
| T1 → ALU\_A  T2 → ALU\_B  ALU\_OUT → PC | S19 | 0100 |
| PC → ALU\_A  +1 → ALU\_B  ALU\_OUT → RF\_D3 | S21 | 0101 |
| PC → ALU\_A  +1 → ALU\_B  ALU\_OUT → T1 | S22 | 0110 |
| PC → ALU\_A  T2 → ALU\_B  ALU\_OUT → PC | S23 | 0111 |
| PC → ALU\_A  IR5-0 → SE16 → ALU\_B  ALU\_OUT → T1 | S24 | 1000 |
| RF\_D1 → ALU\_A  RF\_D2 → ALU\_B | S25 | 1001 |
| NONE | S4 | 1010 |

Decoder Logic

|  |  |
| --- | --- |
| SIG\_ALU1[1] |  |
| SIG\_ALU1[2] |  |
| SIG\_ALU1[3] |  |
| SIG\_ALU2[4] |  |
| SIG\_ALU2[5] |  |
| SIG\_ALU2[6] |  |
| SIG\_ALU3[7] |  |
| SIG\_ALU3[8] |  |
| SIG\_ALU3[9] |  |