

CS-226 Course Project

2020-Spring Semester

Department of Computer Science

Indian Institute of Technology, Bombay - Powai

Date : 21st May, 2021

Team:

Akash Reddy G 190050038

D Chandrasekhar 190050031

M Satwik 190050107

K Vishwanth 190050131

FSM States

States:-

S₀:
 $PC \rightarrow mem_addr$ | $IR.wr$
 $mem_D \rightarrow IR$

S_α:
 $PC \rightarrow ALUa$ |
 $t_1 \rightarrow ALUb$ | $PC.wr$
 $ALUc \rightarrow PC$

S₁:
 $IR_{11-9} \rightarrow RF_A1$ | $t_1.wr$
 $IR_{8-6} \rightarrow RF_A2$ | $t_2.wr$
 $RF_D1 \rightarrow t_1$ | $t_3.wr$
 $RF_D2 \rightarrow t_2$
 $\vec{O}_{16} \rightarrow t_3$

S₂:
 $t_1 \rightarrow ALUa$ | $t_3.wr$
 $t_2 \rightarrow ALUb$
 $ALUc \rightarrow t_3$

S₂¹:
 $t_1 \rightarrow ALUa$ | $t_3.wr$
 $t_2 \rightarrow ALUb$ | $ALU.nand$
 $ALUc \rightarrow t_3$

S₃:
 $t_3 \rightarrow RF_D3$ | $RF.wr$
 $IR_{5-3} \rightarrow RF_A3$

S₄:
 $t_1 \rightarrow ALUa$ | $t_3.wr$
 $SE_6(IR_{5-0}) \rightarrow ALUb$
 $ALUc \rightarrow t_3$

S₅:
 $t_3 \rightarrow RF_D3$ | $RF.wr$
 $IR_{8-6} \rightarrow RF_A3$

S₆:
 $Imm9e16(IR_{8-0}) \rightarrow RF_D3$ | $RF.wr$
 $IR_{11-9} \rightarrow RF_A3$

S₇:
 $t_2 \rightarrow ALUa$ | $t_2.wr$ (asynchronous)
 $SE_6(IR_{5-0}) \rightarrow ALUb$
 $ALUc \rightarrow t_2$] synchronous

S₈:
 $t_2 \rightarrow mem_addr$ | $t_3.wr$
 $mem_D \rightarrow t_3$

S₉:
 $t_2 \rightarrow mem_addr$ | $mem.wr$
 $t_1 \rightarrow mem_in$

S₁₀:
 $IR_{11-9} \rightarrow RF_A3$ | $RF.wr$
 $t_3 \rightarrow RF_D3$

S11:

$t_1 \rightarrow \text{mem_addr} \mid t_2 \cdot \text{wr}$
 $\text{mem_D} \rightarrow t_2$

S12:

$t_2 \rightarrow \text{RF_D3} \mid \text{RF} \cdot \text{wr}$
 $t_3 \xrightarrow{2-D} \text{RF_A3} \mid t_3 \cdot \text{wr}$
 $t_3 \rightarrow \text{ALUa}$
 $t_1 \rightarrow \text{ALUb}$
 $\text{ALUC} \rightarrow t_3$

S19:

$t_1 \rightarrow \text{ALUa} \mid t_1 \cdot \text{wr}$
 $t_1 \rightarrow \text{ALUb}$
 $\text{ALUC} \rightarrow t_1$

S13:

$t_3 \rightarrow \text{ALUa} \mid t_3 \cdot \text{wr}$
 $t_1 \rightarrow \text{ALUb} \mid t_2 \cdot \text{wr}$
 $\text{ALUC} \rightarrow t_3$
 $t_3 \rightarrow \text{RF_A1}$
 $\text{RF_D1} \rightarrow t_2$

S14:

$t_1 \rightarrow \text{ALUa} \mid t_1 \cdot \text{wr}$
 $t_1 \rightarrow \text{ALUb} \mid \text{Mem} \cdot \text{wr}$
 $\text{ALUC} \rightarrow t_1$
 $t_1 \rightarrow \text{mem_addr}$
 $t_2 \rightarrow \text{mem_in}$

S15:

$\text{PC} \rightarrow \text{ALUa} \mid \text{PC} \cdot \text{wr}$
 $\text{SEQ}(\text{IR}_{8-0}) \rightarrow \text{ALUb}$
 $\text{ALUC} \rightarrow \text{PC}$

S16:

$\text{IR}_{11-9} \rightarrow \text{RF_A3} \mid \text{RF} \cdot \text{wr}$
 $\text{PC} \rightarrow \text{RF_D3} \mid t_2 \cdot \text{wr}$
 $\text{IR}_{8-6} \rightarrow \text{RF_A2}$
 $\text{RF_D2} \rightarrow t_2$

S17:

$\text{PC} \rightarrow \text{ALUa}$
 $\text{SEQ}(\text{IR}_{8-0}) \rightarrow \text{ALUb} \mid \text{PC} \cdot \text{wr}$
 $\text{ALUC} \rightarrow \text{PC}$

S18:

$t_2 \rightarrow \text{PC} \mid \text{PC} \cdot \text{wr}$

Instruction- State Transition

Instructions : State transitions:-

1) ADD:-

$S_0 \rightarrow S_1 \rightarrow S_2 \rightarrow S_3 \rightarrow S_x \dots S_0$

2) ADC:-

$S_0 \xrightarrow{C=1} S_1 \rightarrow S_2 \rightarrow S_3 \rightarrow S_x \dots S_0$
 $\xleftarrow{C=0} S_0$

3) ADZ:-

$S_0 \xrightarrow{Z=1} S_1 \rightarrow S_2 \rightarrow S_3 \rightarrow S_x \dots S_0$
 $\xleftarrow{Z=0} S_0$

4) ADI:-

$S_0 \rightarrow S_1 \rightarrow S_4 \rightarrow S_5 \rightarrow S_x \dots S_0$

5) NDU:-

$S_0 \rightarrow S_1 \rightarrow S_2' \rightarrow S_3 \rightarrow S_x \dots S_0$

6) NDC:-

$S_0 \xrightarrow{C=1} S_1 \rightarrow S_2' \rightarrow S_3 \rightarrow S_x \dots S_0$
 $\xleftarrow{C=0} S_0$

7) NDZ:-

$S_0 \xrightarrow{Z=1} S_1 \rightarrow S_2' \rightarrow S_3 \rightarrow S_x \dots S_0$
 $\xleftarrow{Z=0} S_0$

8) LHI:-

$S_0 \rightarrow S_6 \rightarrow S_x \dots S_0$

9) LW:-

$S_0 \rightarrow S_1 \rightarrow S_7 \rightarrow S_8 \rightarrow S_{10} \rightarrow S_x \dots S_0$

10) SW:-

$S_0 \rightarrow S_1 \rightarrow S_7 \rightarrow S_9 \rightarrow S_x \dots S_0$

11) LA:-

$S_0 \rightarrow S_1 \rightarrow S_{11} \xrightarrow{t_3 \neq "111"} S_{19} \rightarrow S_x \dots S_0$
 $\xleftarrow{t_3 = "111"} S_{19}$
 $S_{11} \downarrow S_{12}$

12) SAi:-

$S_0 \rightarrow S_1 \rightarrow S_{13} \xrightarrow{t_3 \neq "000"} S_{14} \rightarrow S_x \dots S_0$
 $\xleftarrow{t_3 = "000"} S_{14}$

13) BEQ:-

$S_0 \rightarrow S_1 \xrightarrow{t_1 = t_2} S_{17} \dots S_0$
 $\xleftarrow{\text{else}} S_x \dots S_0$

14) JAL:-

$S_0 \rightarrow S_{16} \rightarrow S_{15} \dots S_0$

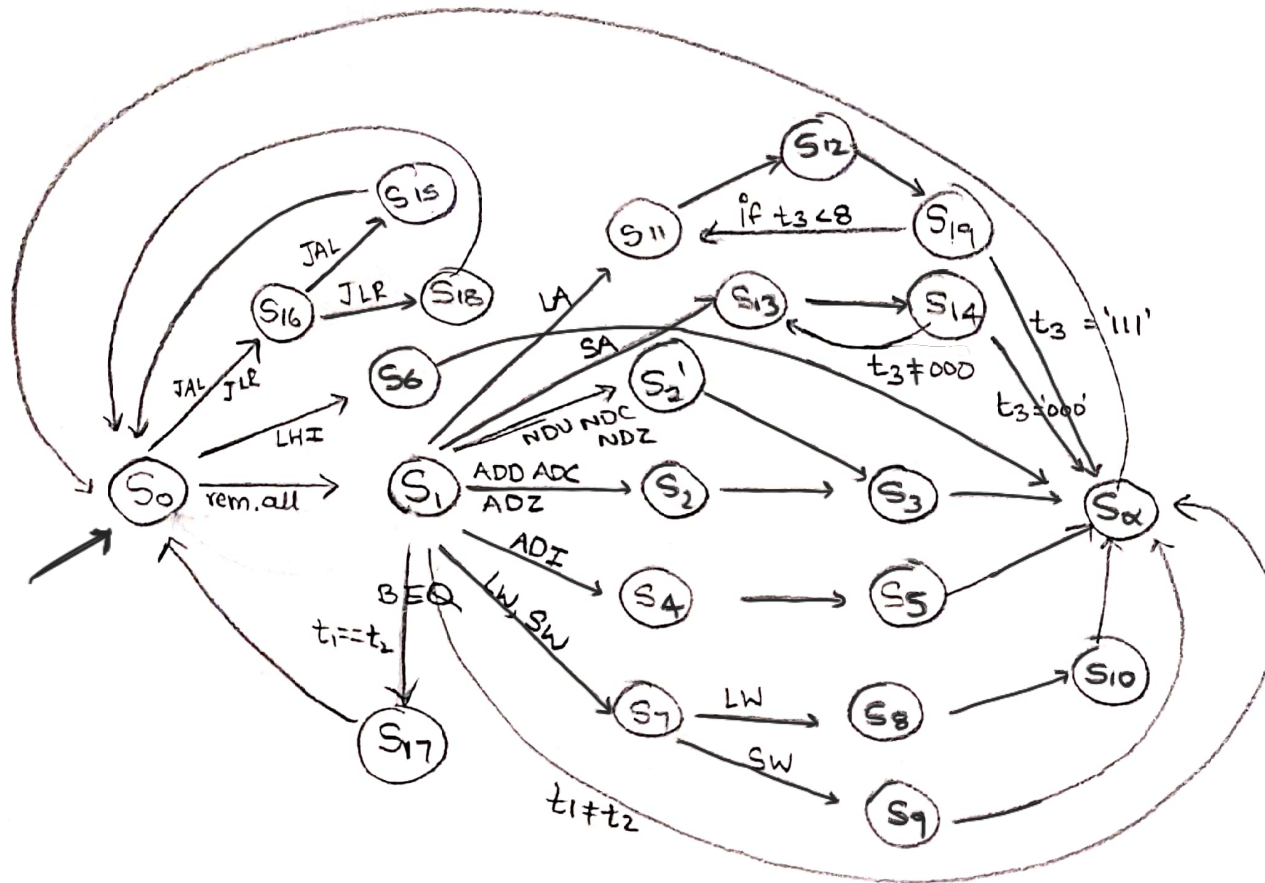
15) JLR:-

$S_0 \rightarrow S_{16} \rightarrow S_{18} \dots S_0$

FSM Diagram

State diagram:-

These states have been implemented via one-hot encoding.

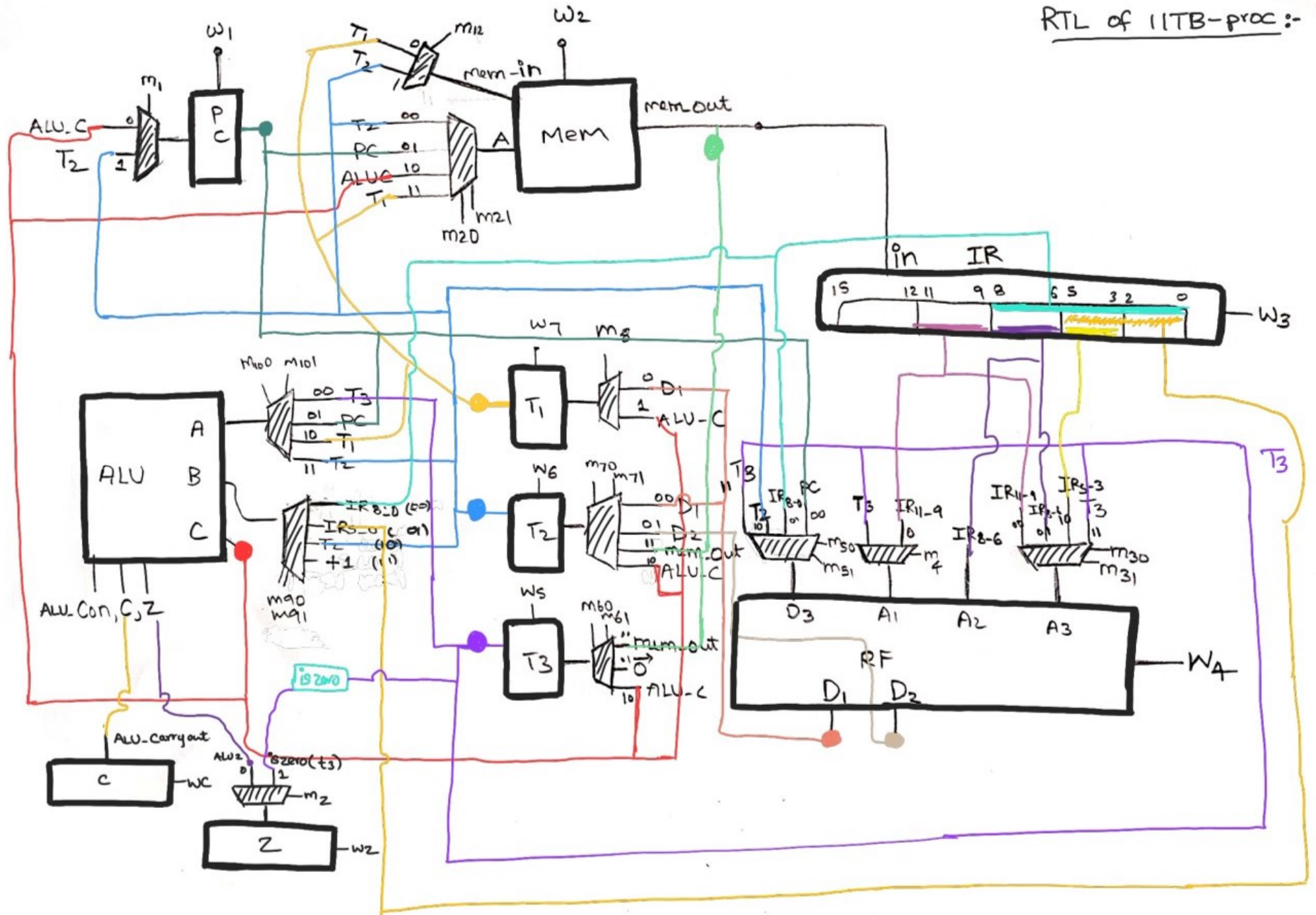


Total 21 states.

$S\alpha, S_1 - S_{19}, S_2'$

RTL circuit

RTL of IITB-proc :-



RTL:

