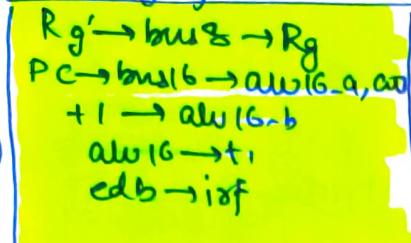


LEVEL 2 FLOW CHART:

There are total 24 different states for 19 given instructions.

- 1) MOV Rg,Rg' $\textcircled{3} \rightarrow \textcircled{2}$ $Rg = Rg'$
- 2) MOV Rg,M $\textcircled{4} \rightarrow \textcircled{5} \rightarrow \textcircled{2}$ $Rg = M[HL]$
- 3) MOV M,Rg $\textcircled{6} \rightarrow \textcircled{1} \rightarrow \textcircled{2}$ $M[HL] = Rg$
- 4) MVI Rg,D08 $\textcircled{7} \rightarrow \textcircled{8} \rightarrow \textcircled{1} \rightarrow \textcircled{2}$ $Rg = D08$
- 5) LXI R_b/SP, D16 $\textcircled{7} \rightarrow \textcircled{9} \rightarrow \textcircled{8} \rightarrow \textcircled{1} \rightarrow \textcircled{2}$ Load 16 bit into register pair
- 6) LDA D16 $\textcircled{7} \rightarrow \textcircled{10} \rightarrow \textcircled{11} \rightarrow \textcircled{8} \rightarrow \textcircled{1} \rightarrow \textcircled{3}$ copy data byte into A from M[D16]
- 7) STA D16 $\textcircled{7} \rightarrow \textcircled{10} \rightarrow \textcircled{12} \rightarrow \textcircled{2} \rightarrow \textcircled{1} \rightarrow \textcircled{2}$ Copy data byte from A into M[D16]
- 8) ADC Rg $\textcircled{13} \rightarrow \textcircled{2}$ $A = A + Rg + C$
- 9) ALI D08 $\textcircled{7} \rightarrow \textcircled{14} \rightarrow \textcircled{1} \rightarrow \textcircled{2}$ $A = A + D08 + C$
- 10) SBB Rg $\textcircled{13} \rightarrow \textcircled{2}$ $A = A - Rg - C$
- 11) ANA Rg $\textcircled{13} \rightarrow \textcircled{2}$ $A = A \text{ and } Rg$
- 12) CMP Rg $\textcircled{13} \rightarrow \textcircled{2}$ Compare A and Rg ($A < R : C=1 Z=0 ; A=R C=0 Z=1 ; A > R C=Z=0$)
- 13) JMP D16 $\textcircled{7} \rightarrow \textcircled{10} \rightarrow \textcircled{15} \rightarrow \textcircled{1} \rightarrow \textcircled{2}$ PC = D16
- 14) JC D16 $\textcircled{16} \xrightarrow{C=1} \textcircled{7} \rightarrow \textcircled{10} \rightarrow \textcircled{15} \rightarrow \textcircled{1} \rightarrow \textcircled{2}$ PC = D16 if carry set.
 $\xrightarrow{C=0} \textcircled{1} \rightarrow \textcircled{2}$
- 15) CALL D16 $\textcircled{17} \rightarrow \textcircled{18} \rightarrow \textcircled{19} \rightarrow \textcircled{7} \rightarrow \textcircled{10} \rightarrow \textcircled{15} \rightarrow \textcircled{1} \rightarrow \textcircled{2}$ Change the program sequence to location of subroutine.
- 16) CZ D16 $\textcircled{20} \xrightarrow{Z=1} \textcircled{17} \rightarrow \textcircled{18} \rightarrow \textcircled{19} \rightarrow \textcircled{7} \rightarrow \textcircled{10} \rightarrow \textcircled{15} \rightarrow \textcircled{1} \rightarrow \textcircled{2}$
 $\xrightarrow{Z=0} \textcircled{1} \rightarrow \textcircled{2}$ Call subroutine if Z flag = 1
- 17) RET $\textcircled{21} \rightarrow \textcircled{22} \rightarrow \textcircled{23} \rightarrow \textcircled{1} \rightarrow \textcircled{2}$
- 18) RZ $\textcircled{20} \xrightarrow{Z=1} \textcircled{21} \rightarrow \textcircled{22} \rightarrow \textcircled{23} \rightarrow \textcircled{1} \rightarrow \textcircled{2}$ Return if Z = 1
 $\xrightarrow{Z=0} \textcircled{1} \rightarrow \textcircled{2}$
- 19) RST n $\textcircled{17} \rightarrow \textcircled{18} \rightarrow \textcircled{19} \rightarrow \textcircled{24}$ Restart n ≡ call n*8.

1) Mov Rg, Rg'



Instruction Read
ALU16: Add
Flag: No modify
ID = 00011
Next State = 00010
Sequence Branch

(S2)

$T1 \rightarrow bus16 \rightarrow PC$
 $if \rightarrow if$

Instruction Branch

No operation
ALU16 - No op
Flag - No modify
ID = 00010
Next State = -

2) Mov Rg, M[HL]

$[HL] \rightarrow bus16 \rightarrow d0$
 $cdb \rightarrow din_{7-0}$

Sequence Branch -

Data Read
ALU16: No operation
Flag: No modify
ID: 00100
Next State: 00101

(S4)

$din_{7-0} \rightarrow bus8 \rightarrow Rg$
 $PC \rightarrow bus16 \rightarrow ALU16_a, 00$
 $+1 \rightarrow ALU16_b$
 $ALU16 \rightarrow t_1$
 $cdb \rightarrow if$

Sequence Branch

Instruction Read
ALU16: Add
Flag: No modify
ID: 00101
Next State: 00010

(S5)

ID: 00010
Next State = -

Instruction branch

3) MOV M[HL], Rg

$HL \rightarrow bus16 \rightarrow d0$
 $Rg \rightarrow bus8 \rightarrow d0$

Sequence branch

Data Write
ALU16: No operation
Flag: No modify
ID: 00110
Next State: 00001

(S6)

$PC \rightarrow bus16 \rightarrow ALU16_a, 00$
 $+1 \rightarrow ALU16_b$
 $ALU16 \rightarrow t_1$
 $cdb \rightarrow if$

Sequence branch

Instruction Read
ALU16: Add
Flag: No modify
ID: 00001
Next State: 00010

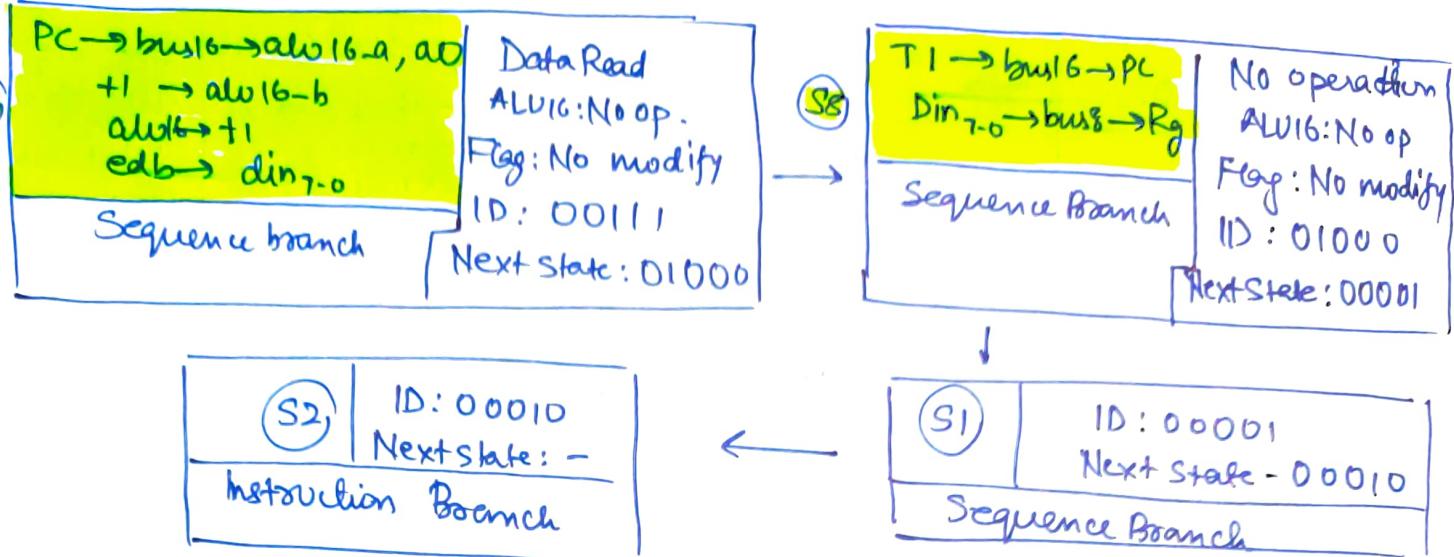
(S1)

Instruction Branch

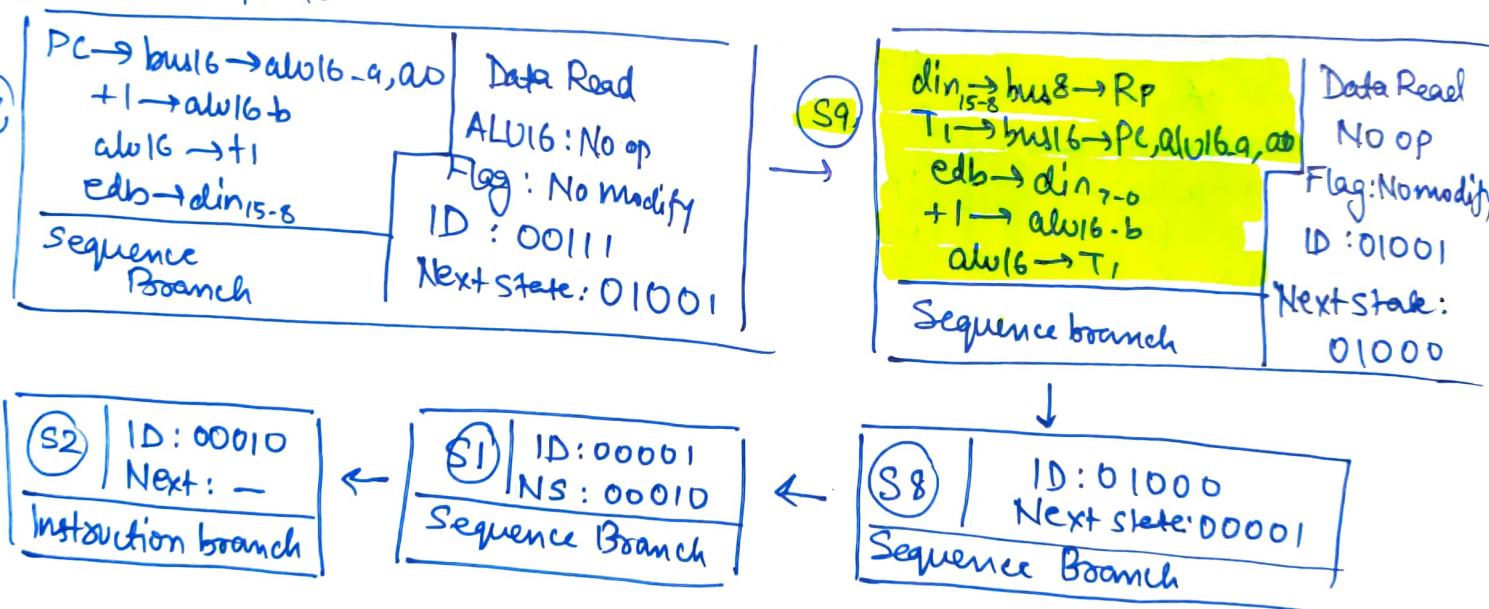
(S2)

ID: 00010
Next State = -

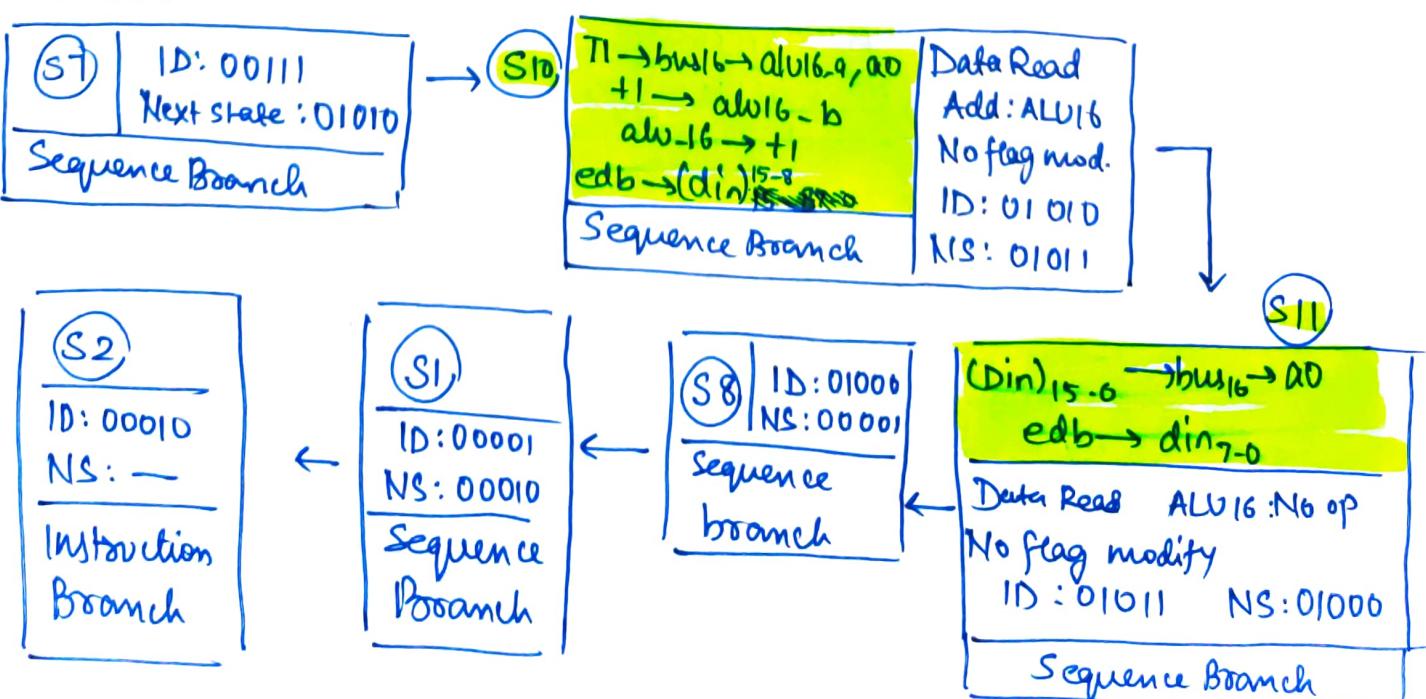
4) MVI Ry D08



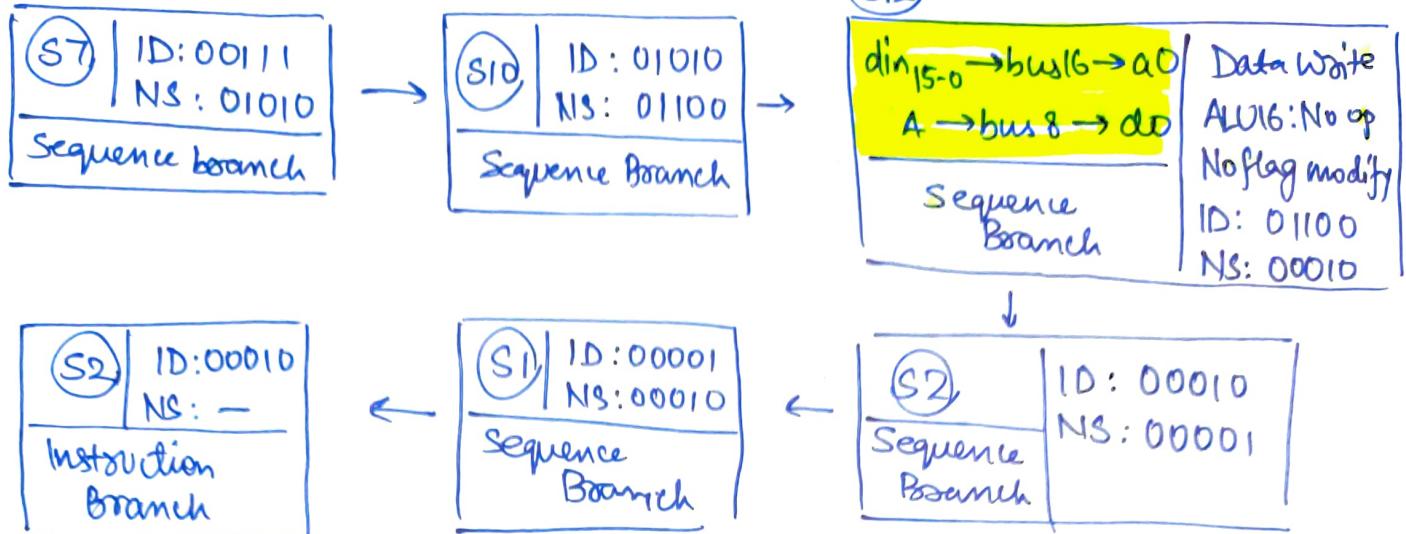
5) LXI Rp, Sp, D16



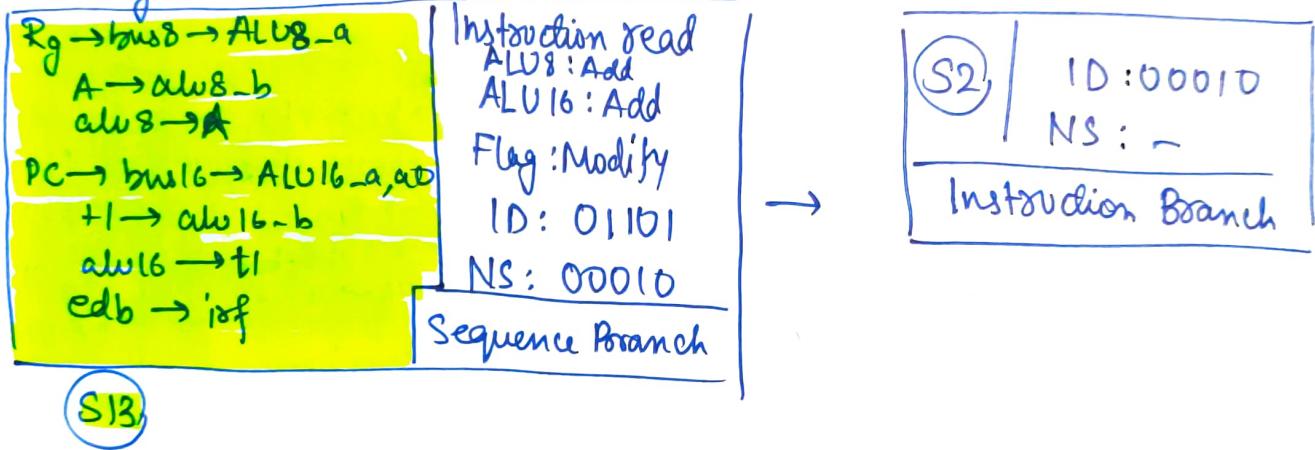
6) LDA D16



7) STA D16

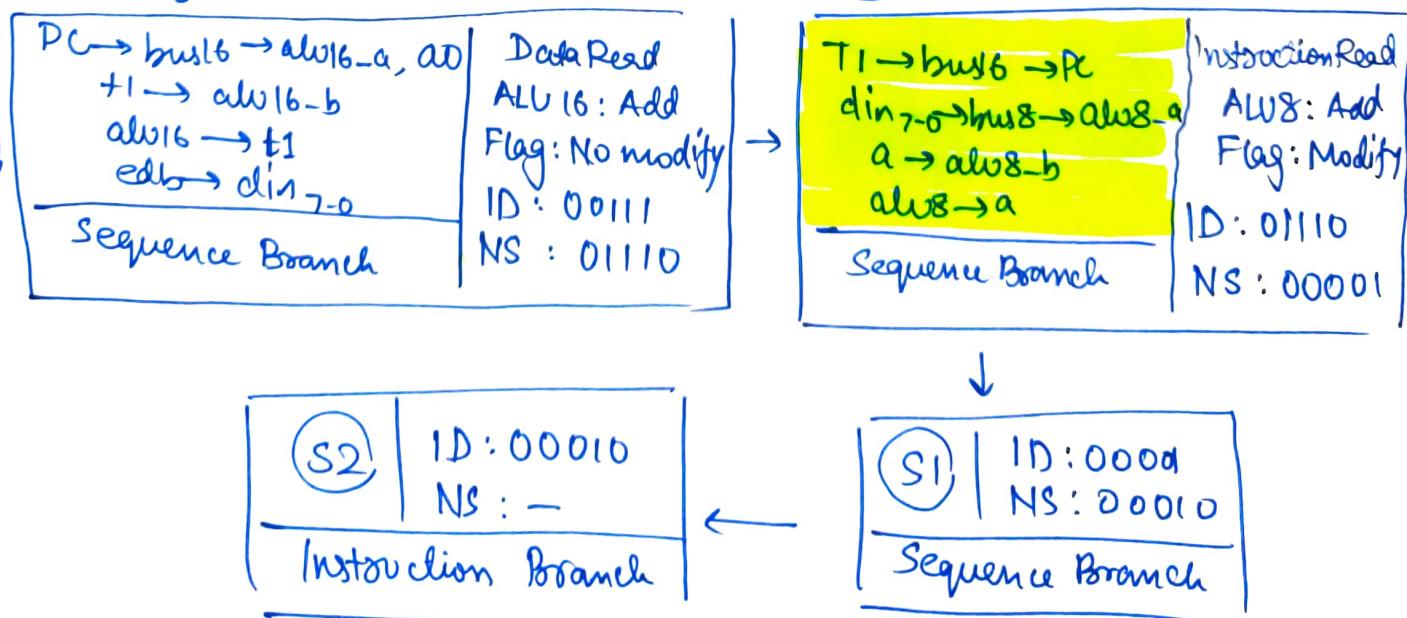


8) ADC Rg

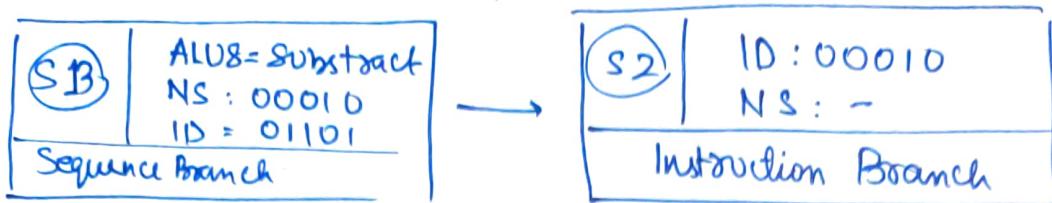


9) ACI D08

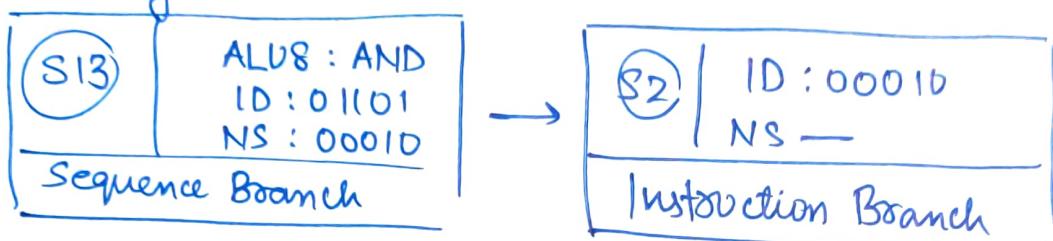
S7,



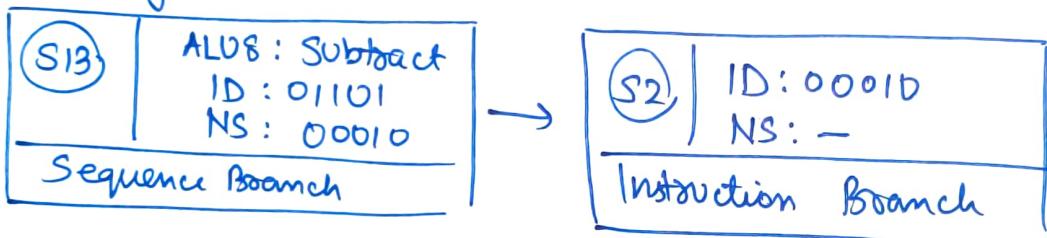
10) SBB Rg This instruction is same as ADC Rg with only change at ALU8 operation



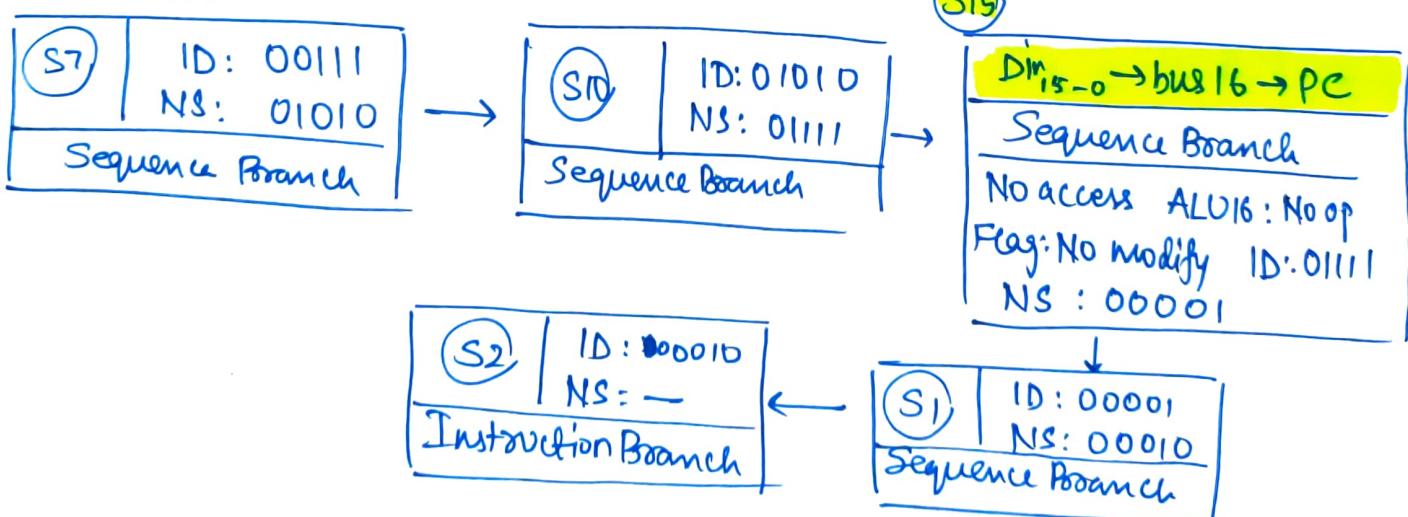
11) ANA Rg



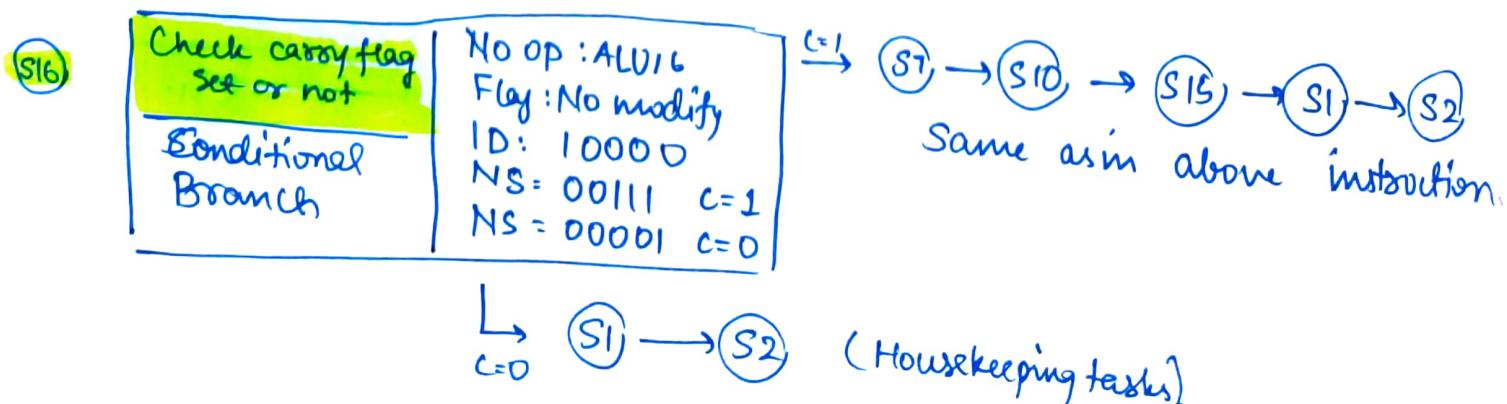
12) CMP Rg



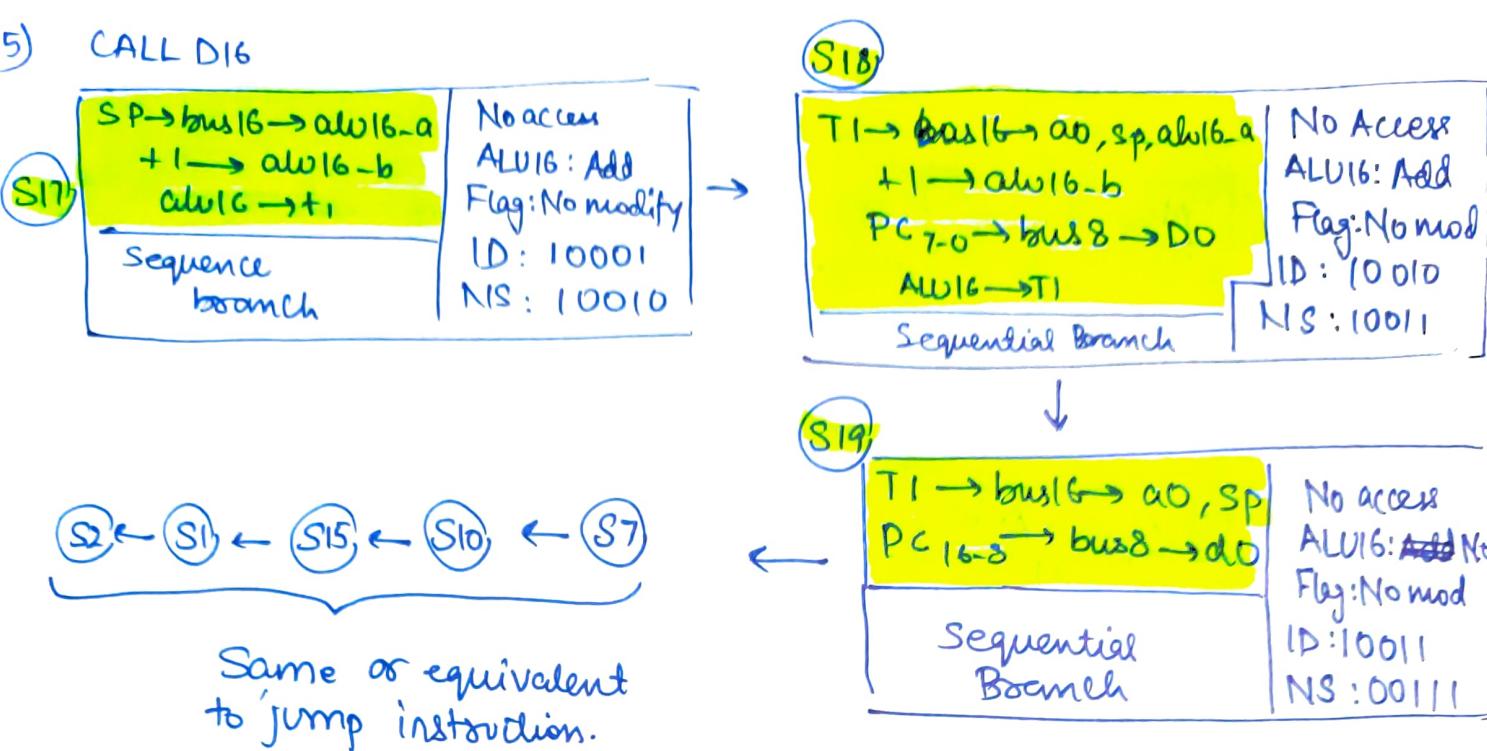
13) JMP D16



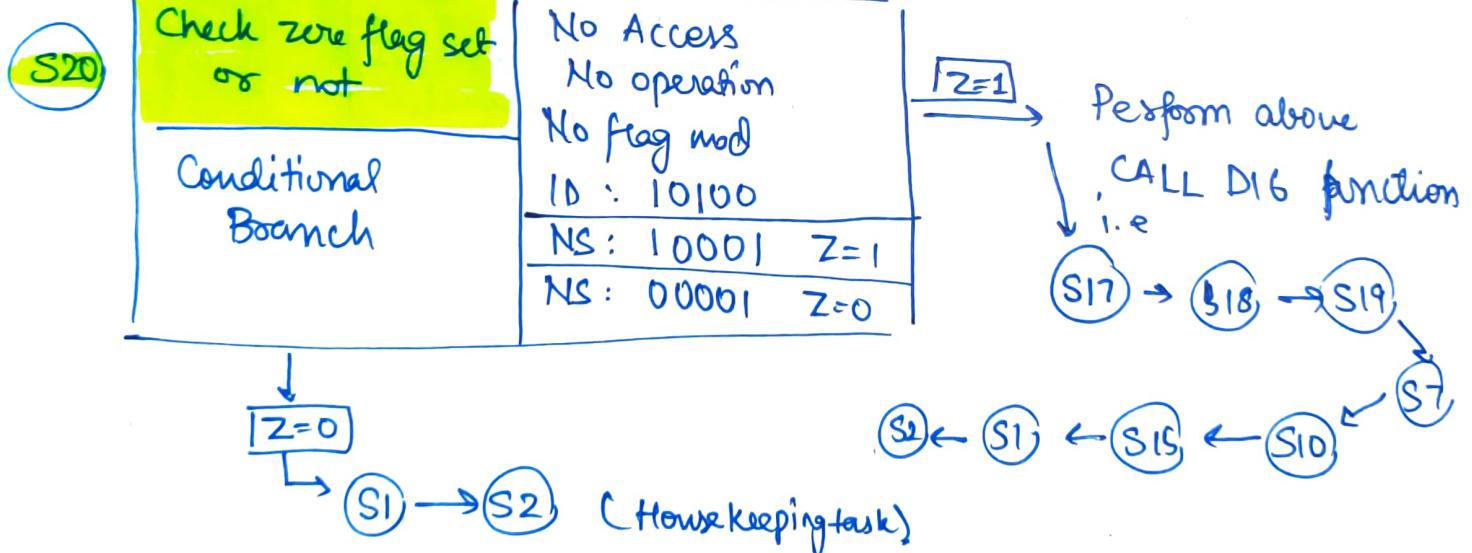
14) JC D16



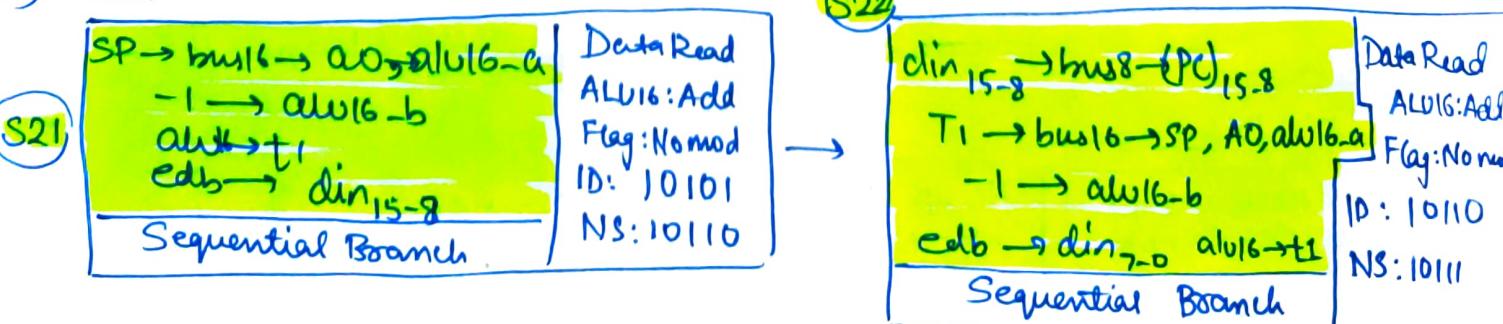
15) CALL D16

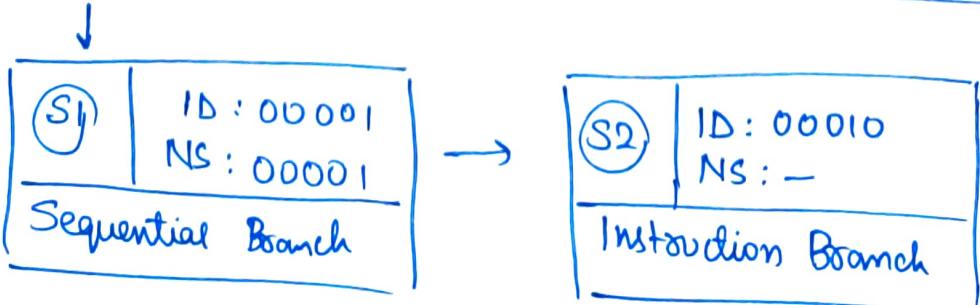
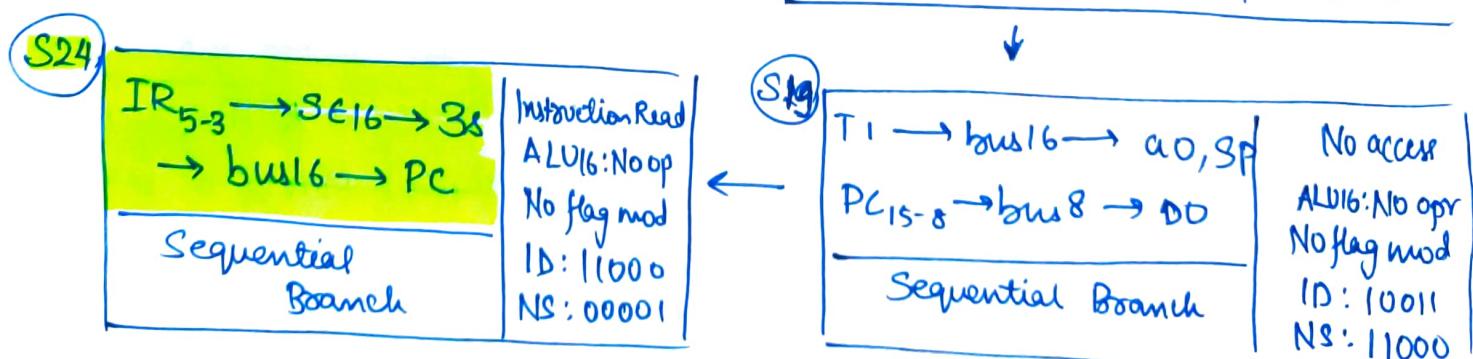
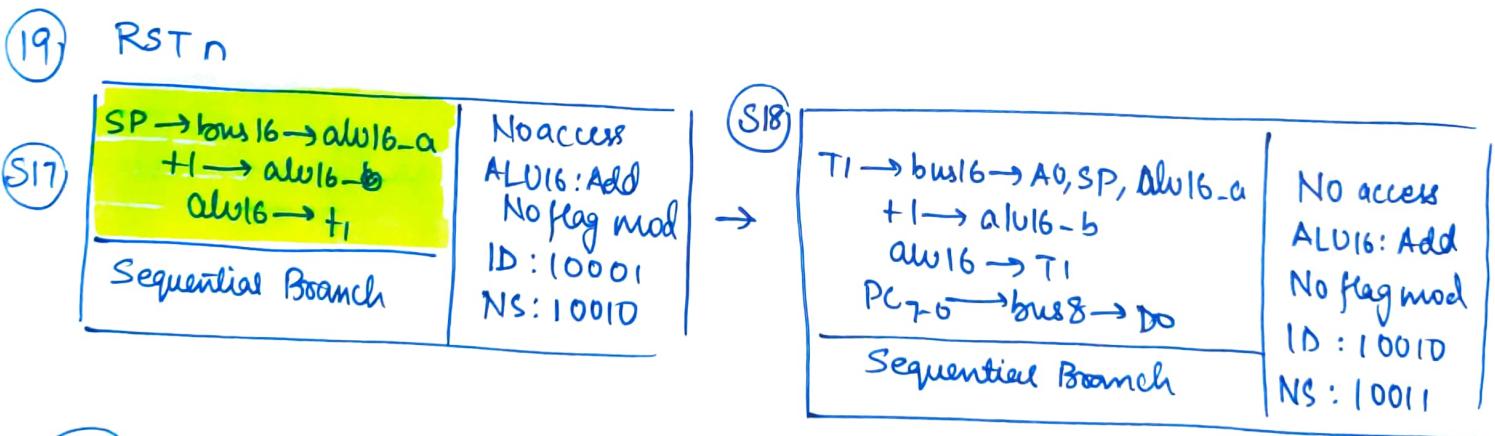
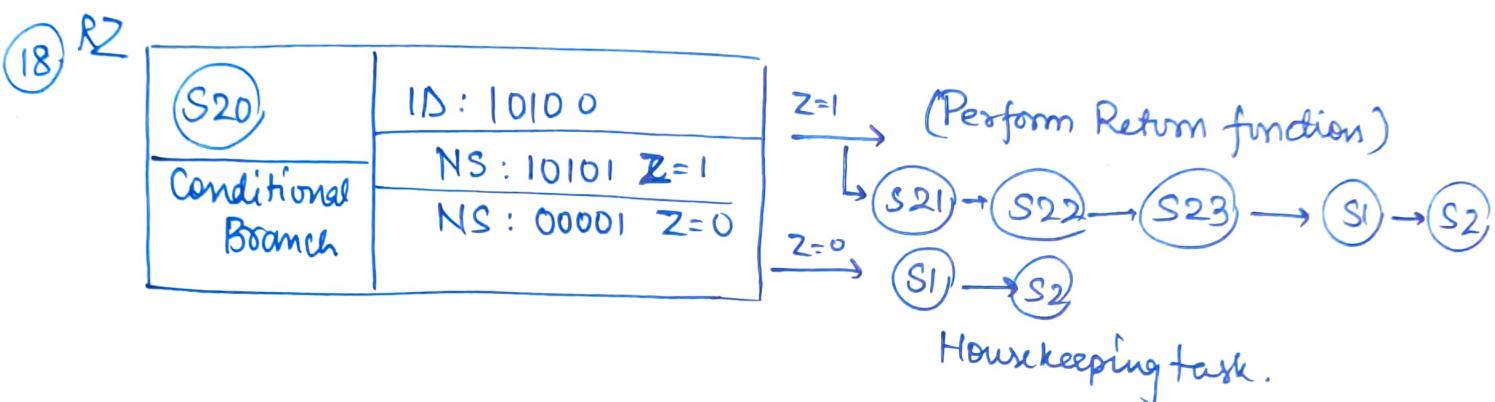
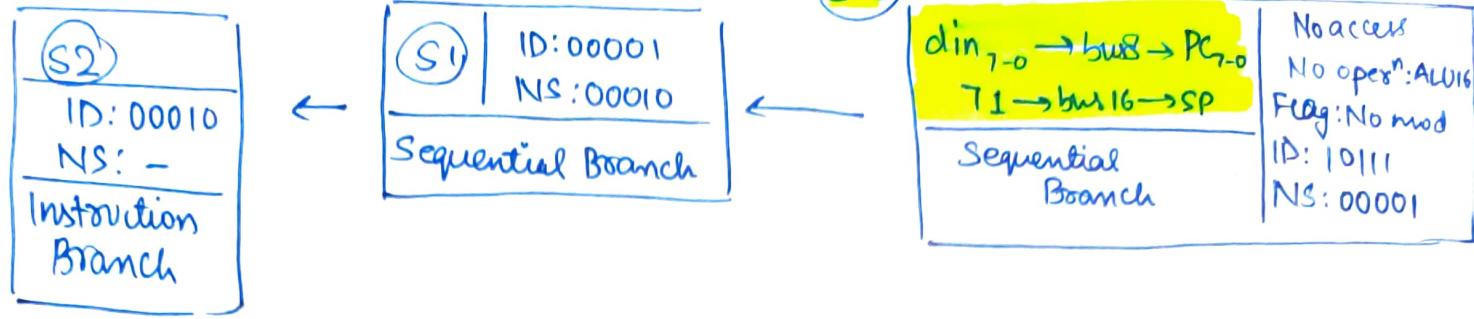


16) CZ D16



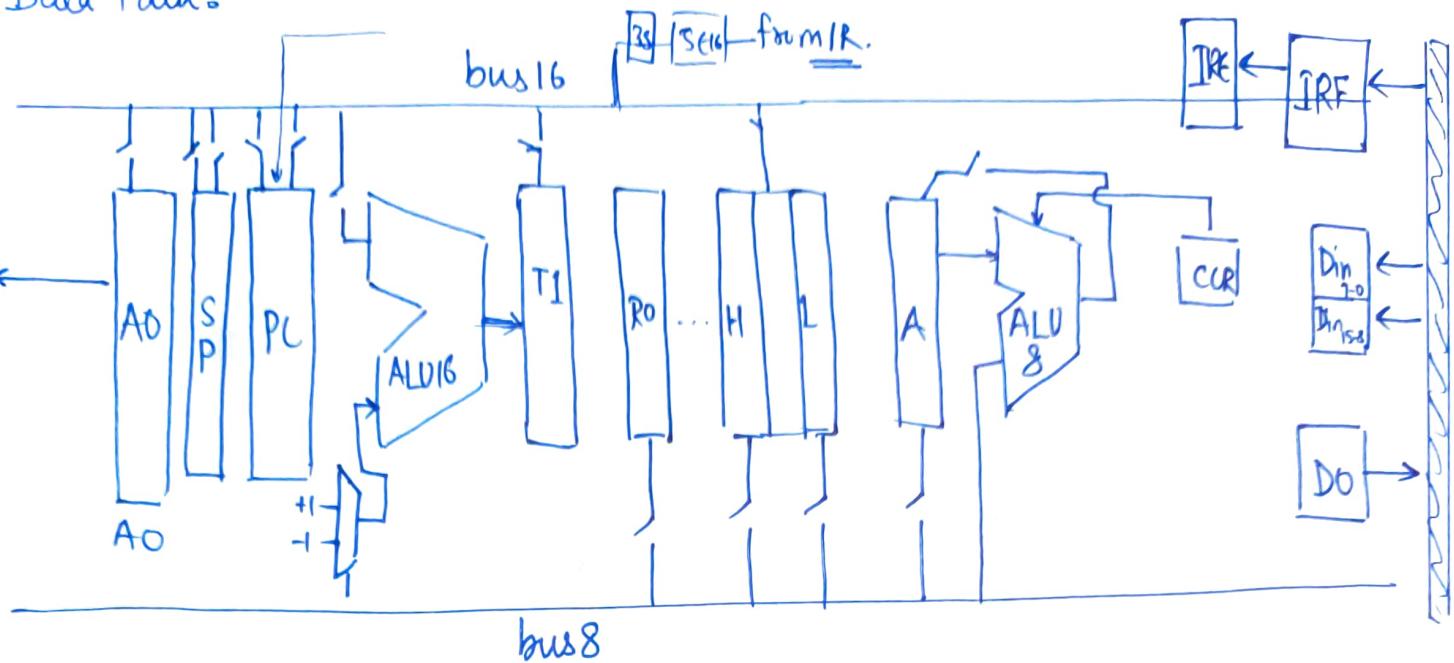
17) RET





Note: Unique states have been highlighted and in various instanciations in which same states are there, they could be used as reference

Data Paths:



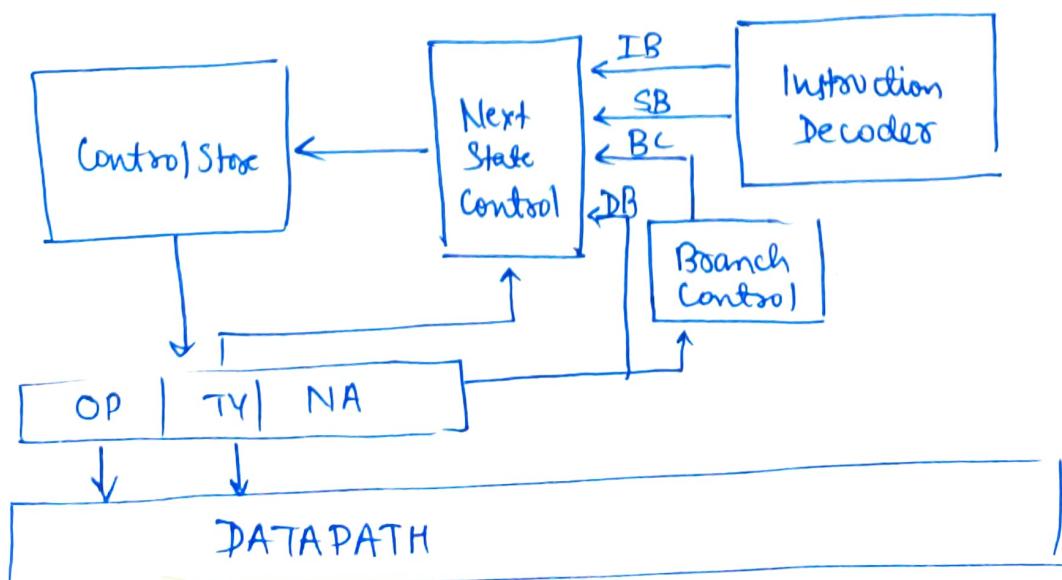
There are 2 bus 1 8-bit data bus and one 16 bit data bus.

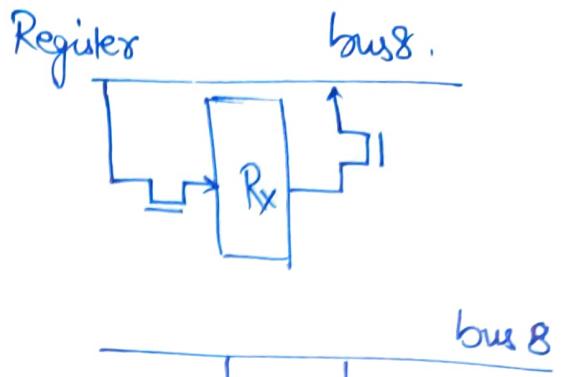
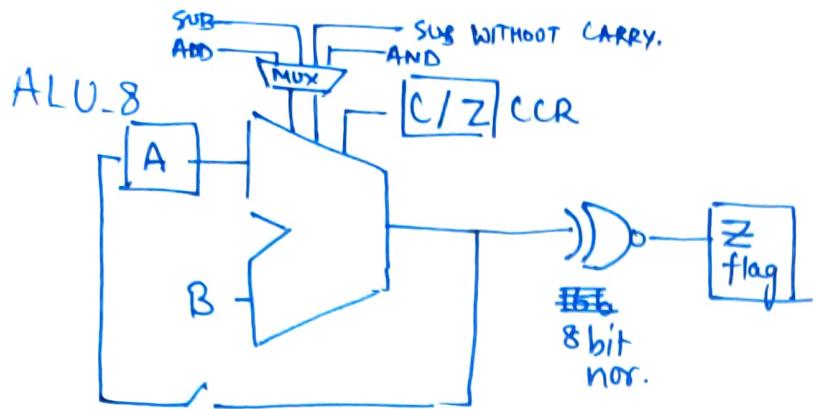
SP and PC have RD/WR pin as well as enable pin for both lower and upper byte. Same goes for Din.

For usual purpose we use Din_{7-0} but when needed we use full Din using 16-bit bus.

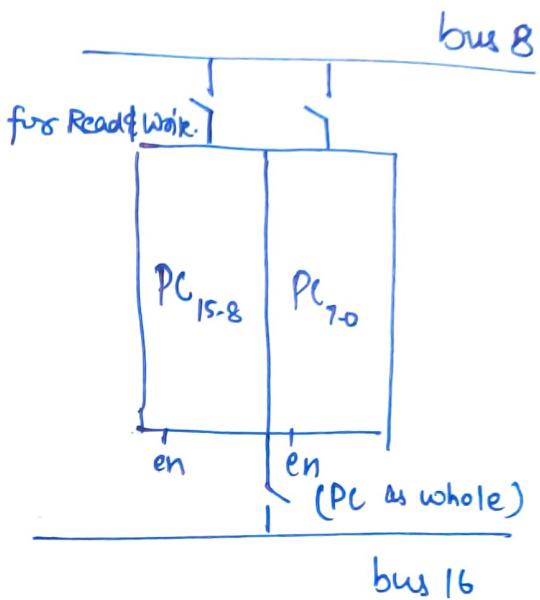
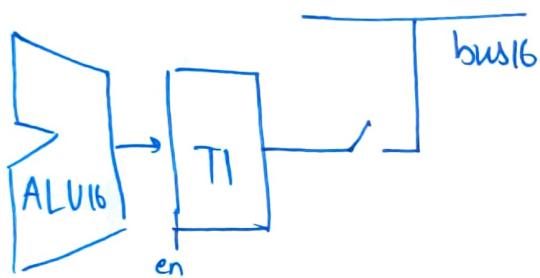
Control Pins:

AO enable, $(SP)_{15-8}, (SP_{7-0})$, $(PC_{15-8}), (PC_{7-0})$ enable and \overline{RD}/WR pin
 T1 enable, T1 \overline{RD}/WR (for bus), 1 mux control for ALU16-B,
 Register \overline{RD}/WR pin (for bus), ALU8 to A write pin, IRE and
 IRF enable pin, IRF \overline{RD}/WR pin, $(Din_{7-0}), (Din_{15-8})$ \overline{RD}/WR and
 Enable pin, DO enable pin, Din control pin.

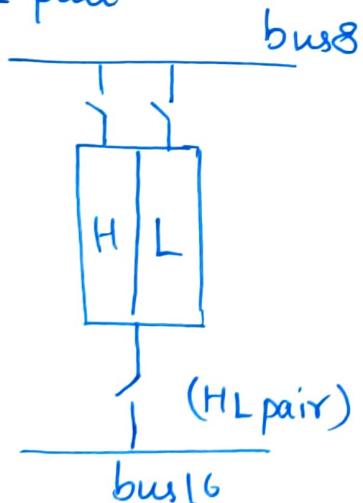




T1



HL pair



* State encoding:

There are 23 states

therefore 5 bits to represent them.

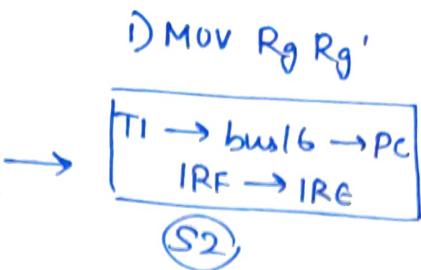
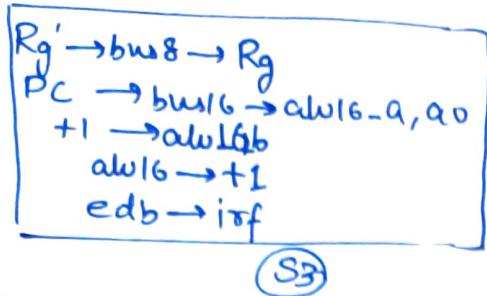
State 1 represented by 00001

State 2 → 00010

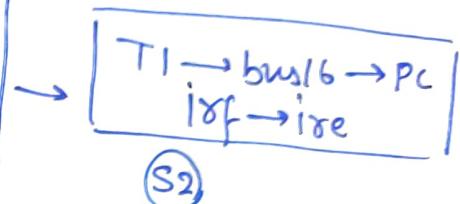
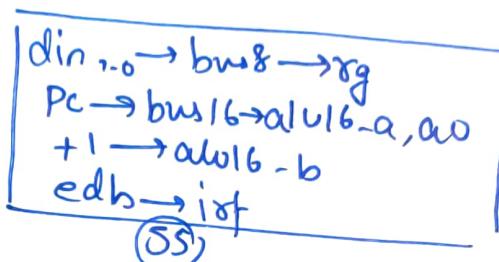
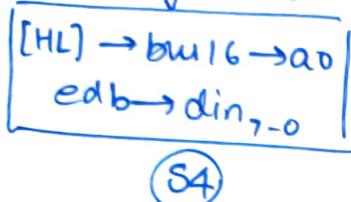
State 3 → 00011 and so on.

Till State 24 → 11000.

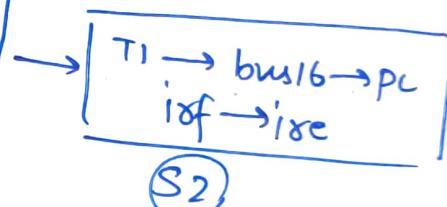
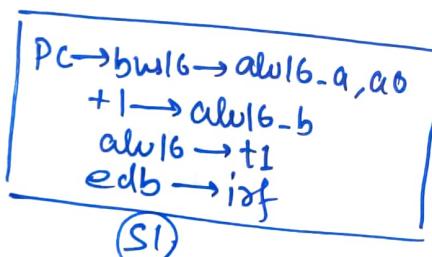
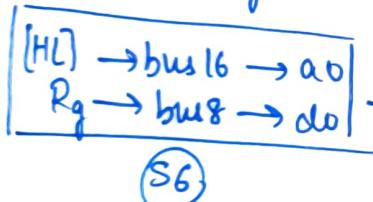
LEVEL 1 FLOWCHART



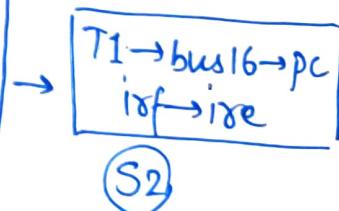
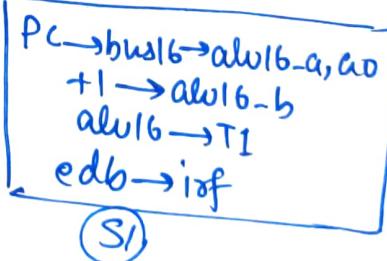
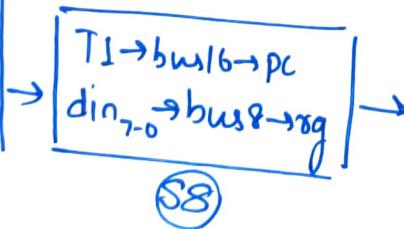
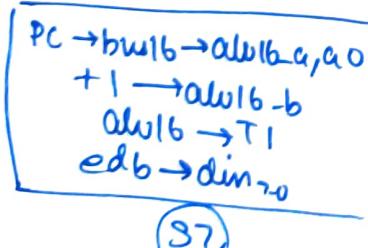
2) MOV Rg M[HL]



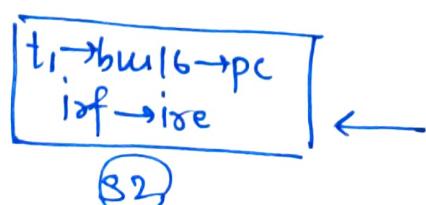
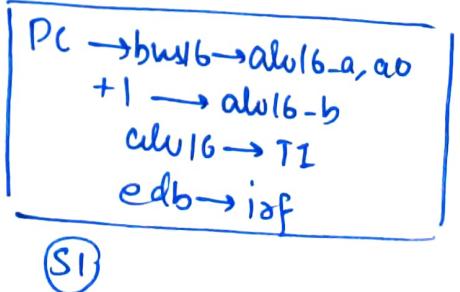
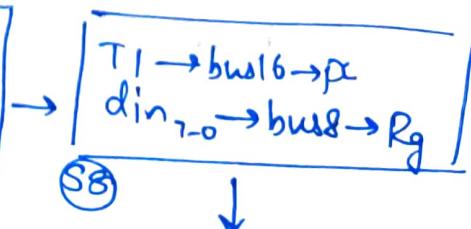
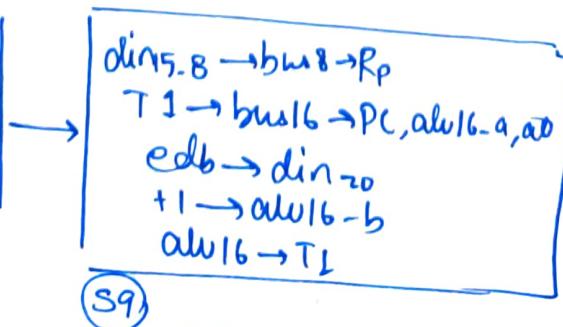
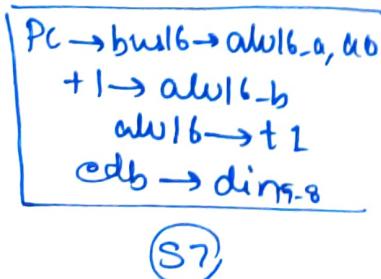
3) MOV M[HL] Rg



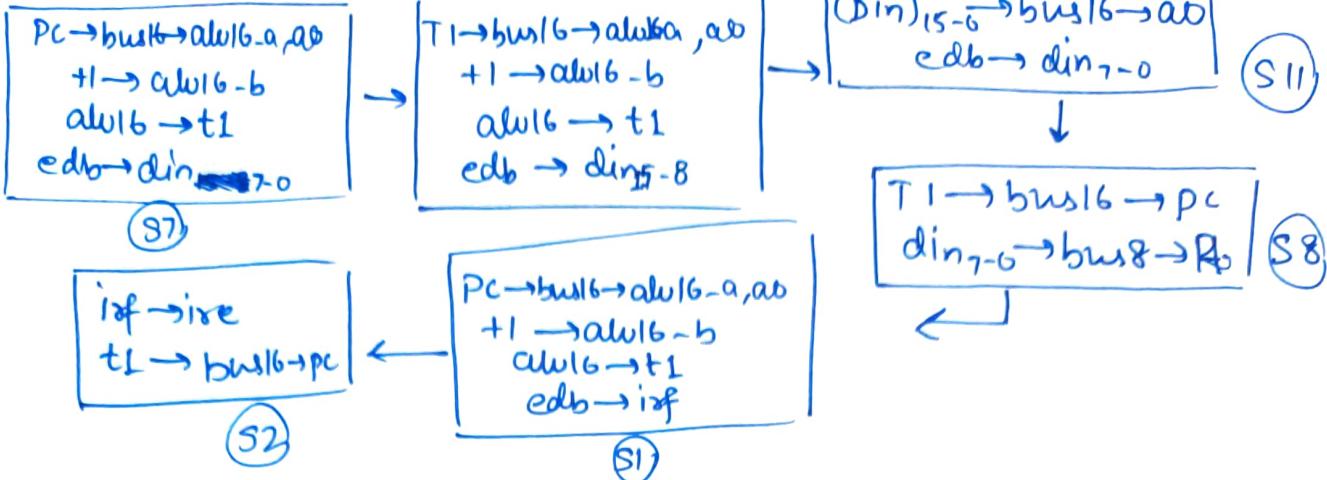
4) MVI Rg D08



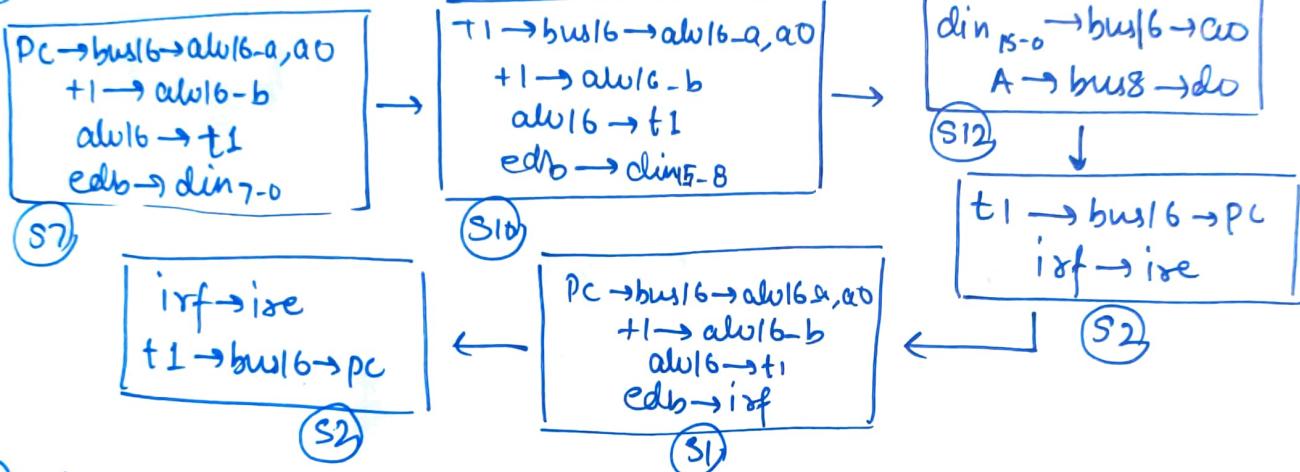
5) LXI RP/SP D16



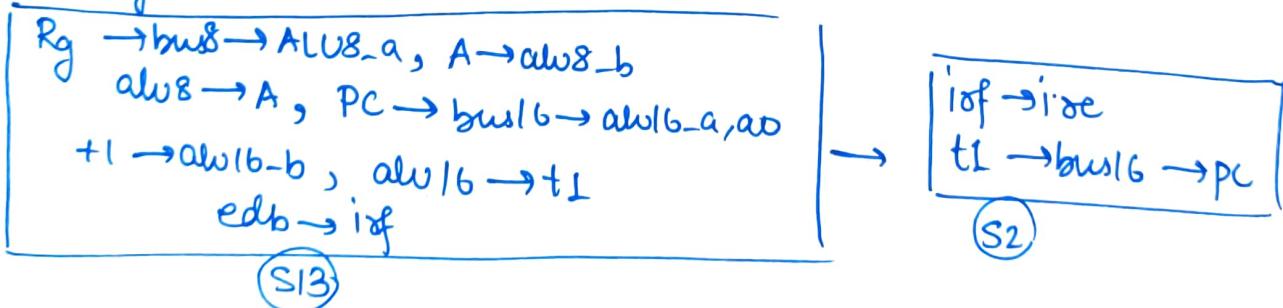
6) LDA 16



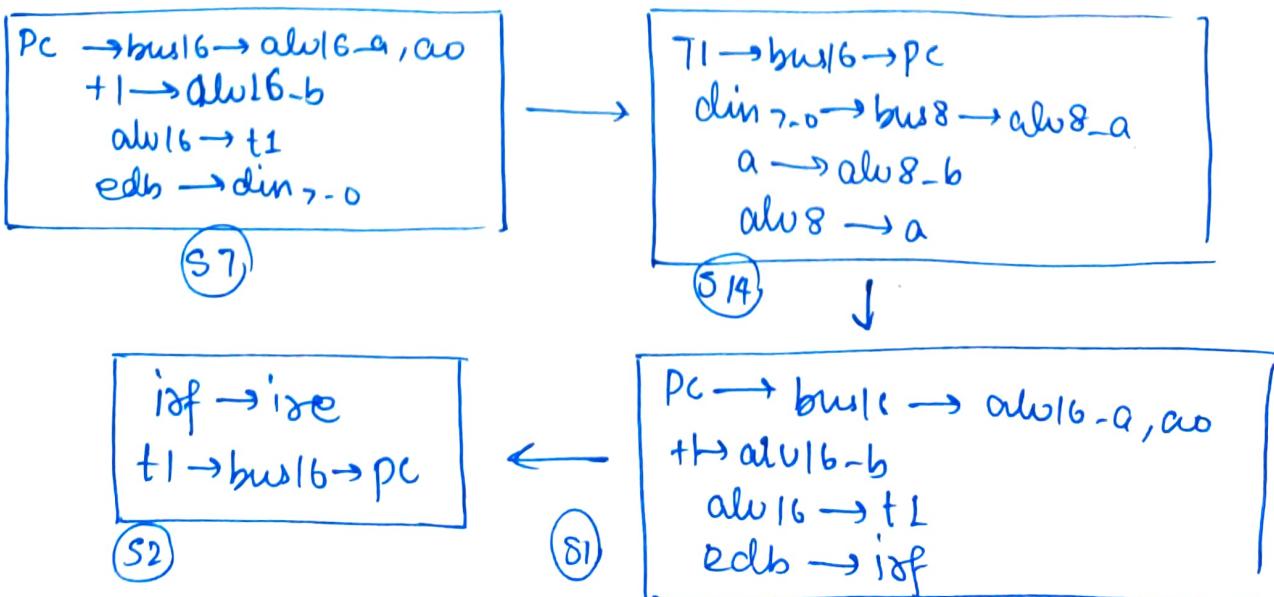
7) STA 16



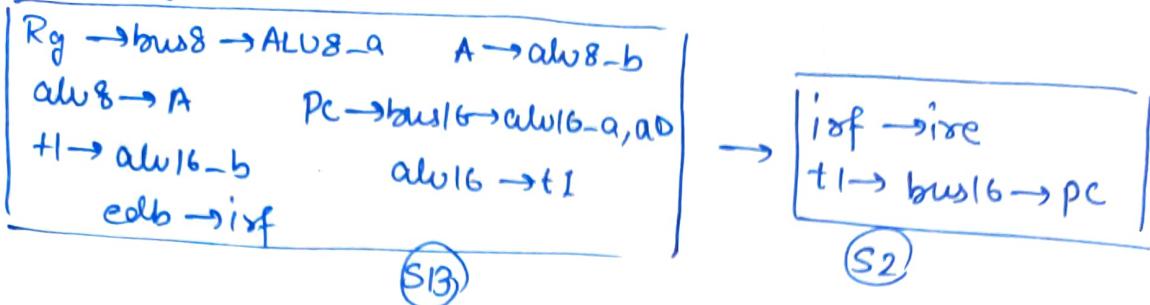
8) ADC Pg



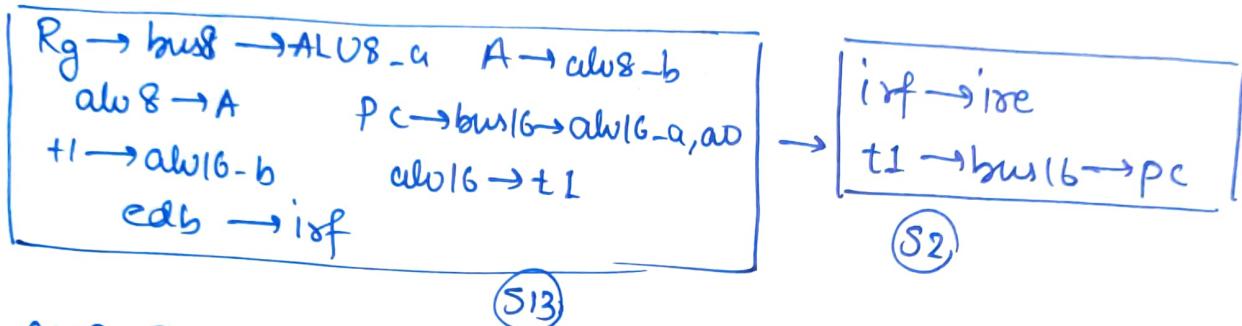
9) ACI DO8



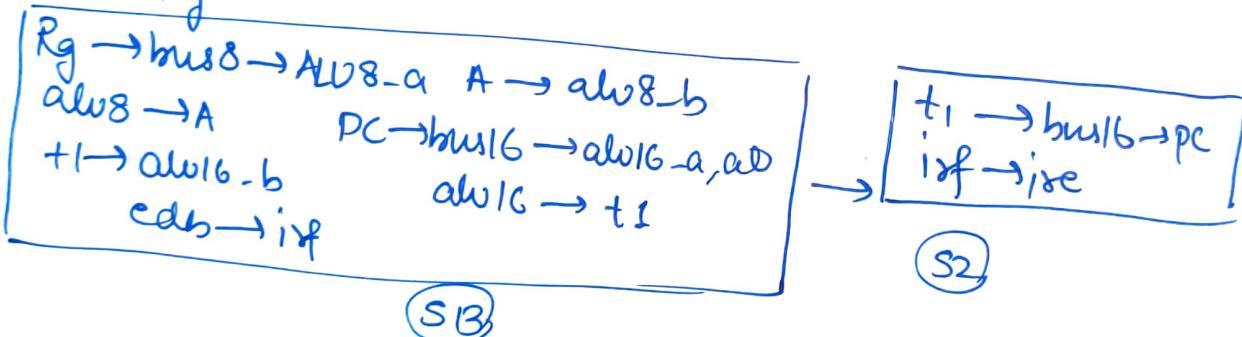
10) SBB Rg



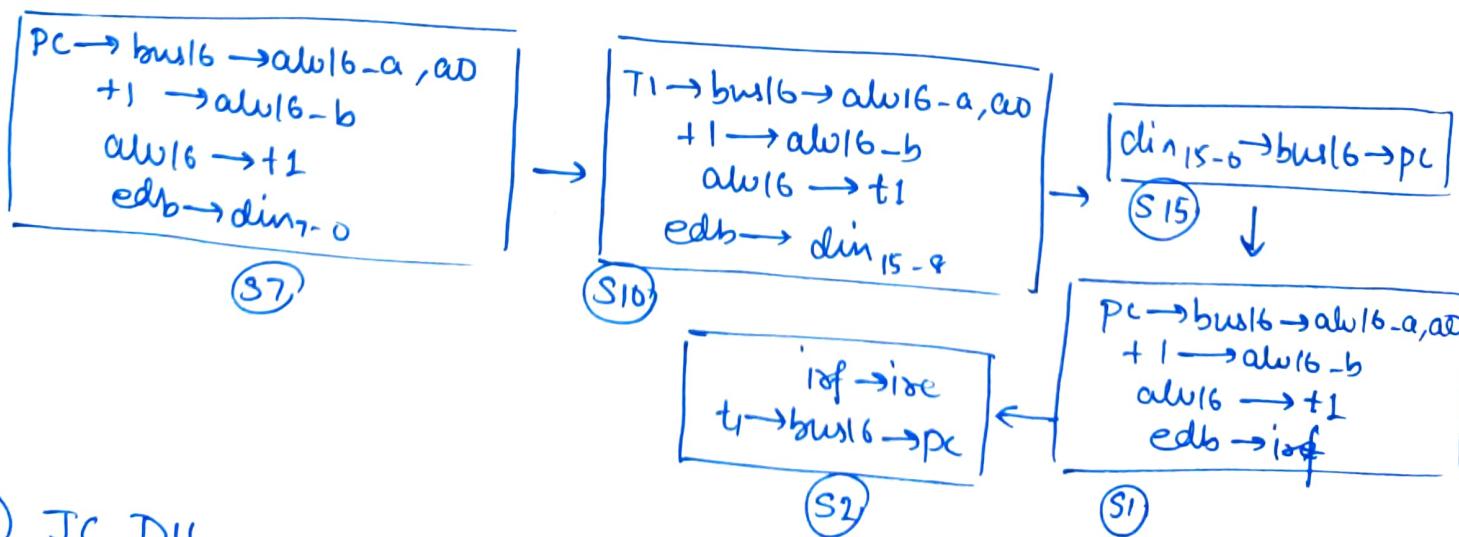
11) ANA Rg



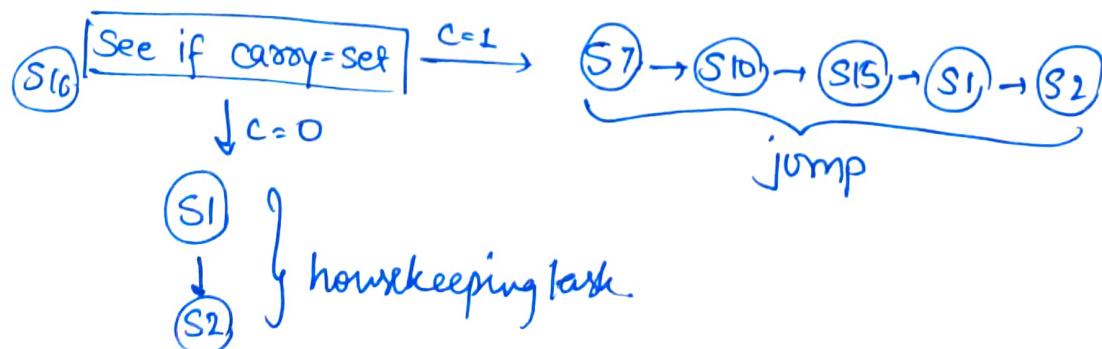
12) CMP Rg



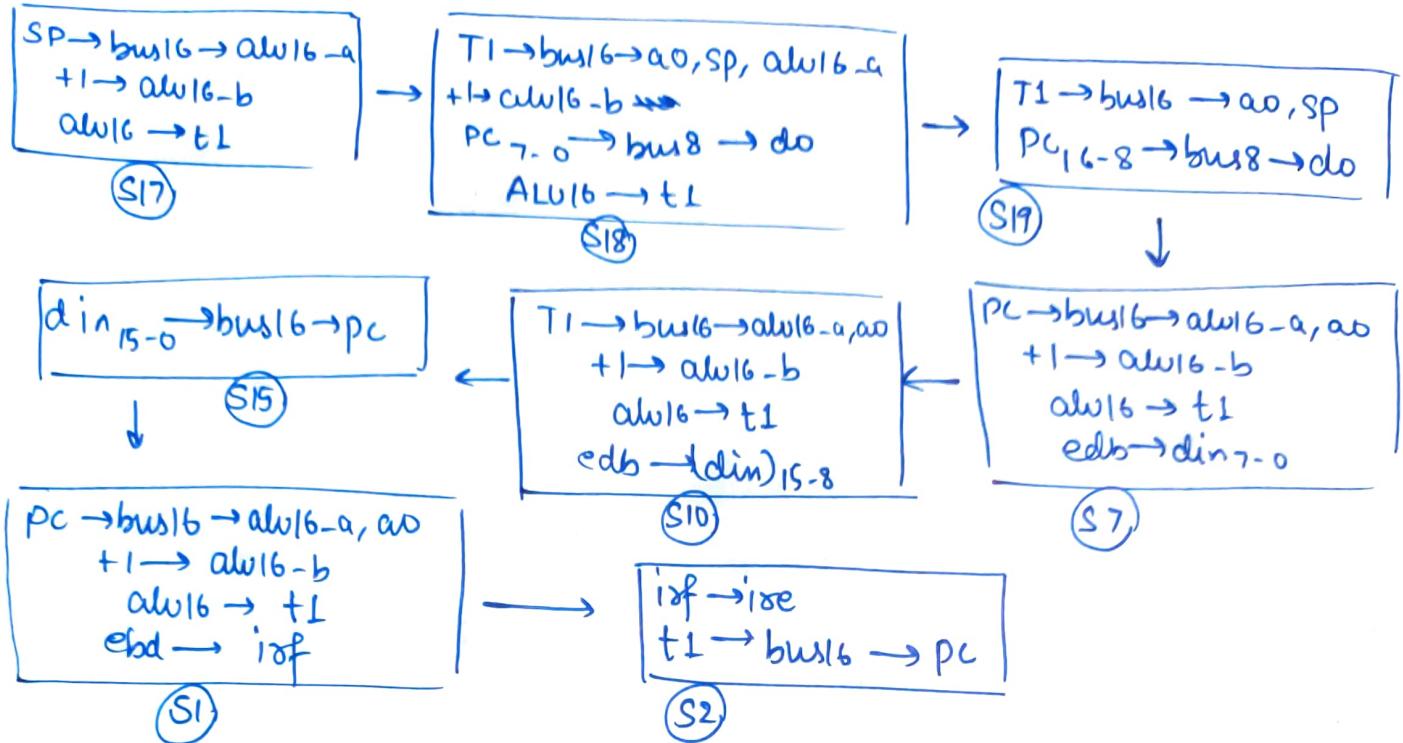
13) JMP D16



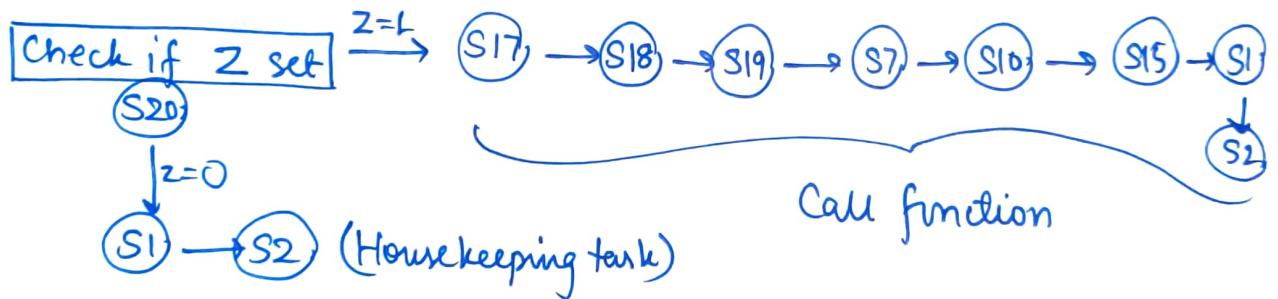
14) JC D16



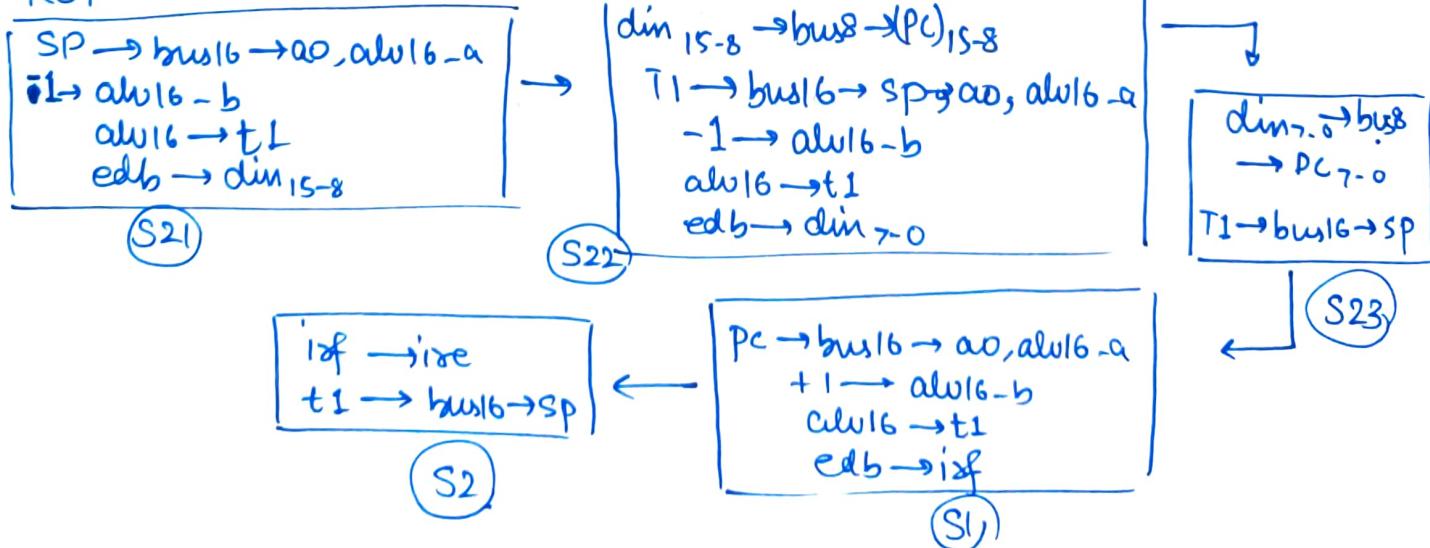
15) CALL D16



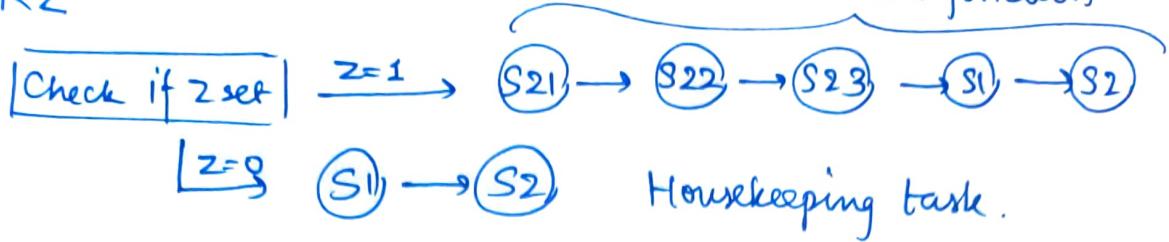
16) CZ D16



17) RET



18) RZ



19)

RSTn

