

# EE 224 Course Project : CPU

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## State Descriptions

$S_0$  (Fetching instruction from memory)

Data Transfer	Commands
PC $\rightarrow$ M.add	MDR
M.data $\rightarrow$ T1	T1.E

$S_1$  (Updating PC)

Data Transfer	Commands
PC $\rightarrow$ ALU_A	PC.E
+2 $\rightarrow$ ALU_B	ADD
ALU_S $\rightarrow$ PC	

$S_2$  (Reading operands)

Data Transfer	Commands
$T1_{11-9} \rightarrow$ RF_A1	T2.E
$T1_{8-6} \rightarrow$ RF_A2	T3.E
RF_D1 $\rightarrow$ T2	
RF_D2 $\rightarrow$ T3	

$S_3$  (Executing ADD)

Data Transfer	Commands
T2 $\rightarrow$ ALU_A	T2.E
T3 $\rightarrow$ ALU_B	ADD
ALU_S $\rightarrow$ T2	FC.E
ALU_C $\rightarrow$ FC	FZ.E
ALU_Z $\rightarrow$ FZ	

**$S_4$  (Storing the output)**

Data Transfer	Commands
$T2 \rightarrow RF\_D3$	RF_WE
$T1_{5-3} \rightarrow RF\_A3$	

**$S_5$  (Reading operands (for ADI))**

Data Transfer	Commands
$T1_{11-9} \rightarrow RF\_A1$	T2_E
$RF\_D1 \rightarrow T2$	T3_E
$T1_{5-0} \rightarrow SE\_6 \rightarrow T3$	

**$S_6$  (Checking whether the two operands are equal, and storing zero flag into T2 (without changing FZ))**

Data Transfer	Commands
$T2 \rightarrow ALU\_A$	SUB
$T3 \rightarrow ALU\_B$	T2_E
$ALU\_C \rightarrow SE\_2 \rightarrow T2$	

**$S_7$  (Updating PC if BEQ)**

Data Transfer	Commands
$PC \rightarrow ALU\_A$	ADD
$T1 \rightarrow SE\_10 \rightarrow ALU\_B$	PC_E
if( $T2_0 == 0$ ) then $ALU\_C \rightarrow PC$	
else $PC \rightarrow PC$	

**$S_8$  (Storing PC into REG\_A)**

Data Transfer	Commands
$T1_{11-9} \rightarrow RF\_A3$	RF_WE
$PC \rightarrow RF\_D3$	

**$S_9$  (Branching PC to the address  $PC + \text{immediate}$ )**

Data Transfer	Commands
$PC \rightarrow ALU\_A$	ADD
$T1_{8-0} \rightarrow SE\_9 \rightarrow ALU\_B$	
$ALU\_S \rightarrow PC$	

$S_{10}$  (Branching PC to the address in REG\_B)

Data Transfer	Commands
$T_{18-6} \rightarrow \text{RF\_A1}$ $\text{RF\_D1} \rightarrow \text{PC}$	PC_E

$S_{11}$  (Executing Load Higher Immediate)

Data Transfer	Commands
$T_{11-9} \rightarrow \text{RF\_A3}$ $T_{11-9} \rightarrow \text{PZ\_7} \rightarrow \text{RF\_D3}$	RF_WE

$S_{12}$  (Executing Load Higher Immediate)

Data Transfer	Commands
$T_{11-9} \rightarrow \text{RF\_A3}$ $T_{11-9} \rightarrow \text{PZ\_7} \rightarrow \text{RF\_D3}$	RF_WE

$S_{13}$  (Executing NAND)

Data Transfer	Commands
$\text{T2} \rightarrow \text{ALU\_A}$ $\text{T3} \rightarrow \text{ALU\_B}$ $\text{ALU\_S} \rightarrow \text{T2}$ $\text{ALU\_Z} \rightarrow \text{FZ}$	T2_E NAND FC_E

$S_{14}$  (Computing address of the memory destination)

Data Transfer	Commands
$\text{T3} \rightarrow \text{ALU\_A}$ $T_{15-0} \rightarrow \text{SE\_16} \rightarrow \text{ALU\_B}$ $\text{ALU\_C} \rightarrow \text{T3}$	ADD T3_E

$S_{15}$  (Writing to the memory)

Data Transfer	Commands
$\text{T3} \rightarrow \text{M\_add}$ $\text{T2} \rightarrow \text{M\_data}$	MWR

$S_{16}$  (Computing address of the memory destination)

Data Transfer	Commands
$\text{T3} \rightarrow \text{ALU\_A}$ $T_{15-0} \rightarrow \text{SE\_16} \rightarrow \text{ALU\_B}$ $\text{ALU\_C} \rightarrow \text{T3}$	ADD T3_E ALU_CND

$S_{17}$  (Reading from memory)

Data Transfer	Commands
T3 $\rightarrow$ M_add	MDR
T2 $\rightarrow$ M_data	T2_E

$S_{18}$  (Writing to the register)

Data Transfer	Commands
$T1_{11-9} \rightarrow$ RF_A3 T2 $\rightarrow$ RF_D3	RF_WE

$S_{19}$  (Initial step of SM)

Data Transfer	Commands
(0000000000000000) $\rightarrow$ T2 $T1_{11-9} \rightarrow$ RF_A2 RF_D2 $\rightarrow$ T3	T2_WE T3_E

$S_{20}$  (Looping step 1 of SM)

Data Transfer	Commands
counter := int( $T2_{2-0}$ ) if( $T1_{counter}=1$ ) then T3 $\rightarrow$ RF_D1 $\rightarrow$ M_data $T2_{2-0} \rightarrow$ RF_A1	MWR

$S_{21}$  (Looping step 2 of SM)

Data Transfer	Commands
T3 $\rightarrow$ ALU_A 1 $\rightarrow$ ALU_B if( $T1_{counter}=1$ ) then ALU_C $\rightarrow$ T3	T3_E ADD

$S_{22}$  (Looping step 3 of SM)

Data Transfer	Commands
T2 $\rightarrow$ ALU_A 1 $\rightarrow$ ALU_B ALU_C $\rightarrow$ T2	ADD T2_E

$S_{23}$  (Initial step of LM)

Data Transfer	Commands
(0000000000000000) $\rightarrow$ T2 $T1_{11-9} \rightarrow$ RF_A2 RF_D3 $\rightarrow$ T3	T2_WE T3_E

$S_{24}$  (Looping step 1 of LM)

Data Transfer	Commands
counter := int( $T2_{2-0}$ )	MDR
$T1_{counter} \rightarrow \text{RF\_WR}$	MDR
$T3 \rightarrow \text{M\_add}$	
$\text{M\_data} \rightarrow \text{RF\_D3}$	
$T2_{2-0} \rightarrow \text{RF\_A3}$	

$S_{25}$  (Looping step 2 of LM)

Data Transfer	Commands
$T3 \rightarrow \text{ALU\_A}$	T3_E
$1 \rightarrow \text{ALU\_B}$	ADD
if( $T1_{counter} == 1$ ) then $\text{ALU\_C} \rightarrow T3$	

$S_{26}$  (Looping step 3 of LM)

Data Transfer	Commands
$T2 \rightarrow \text{ALU\_A}$	ADD
$1 \rightarrow \text{ALU\_B}$	T2_E
$\text{ALU\_C} \rightarrow T2$	