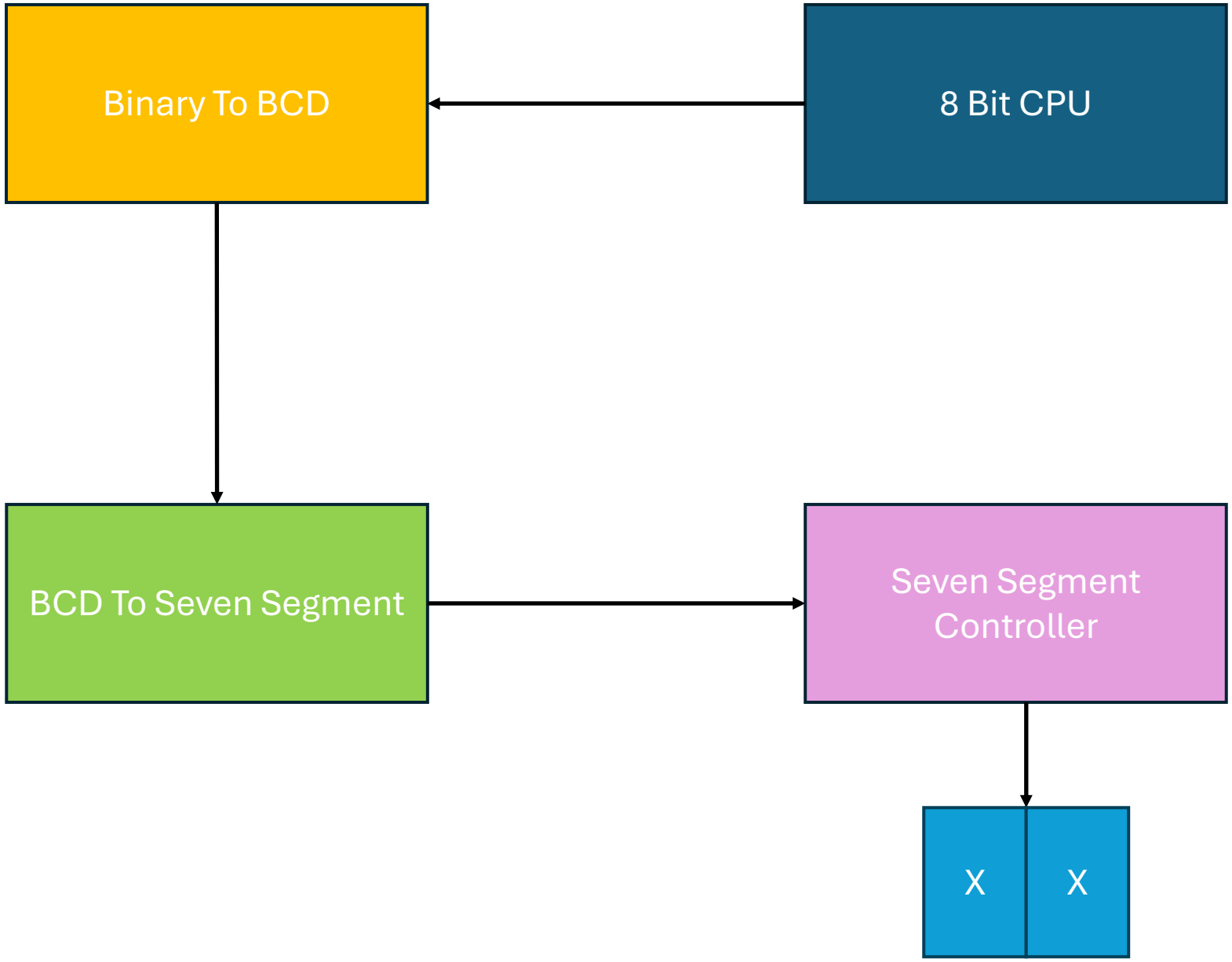
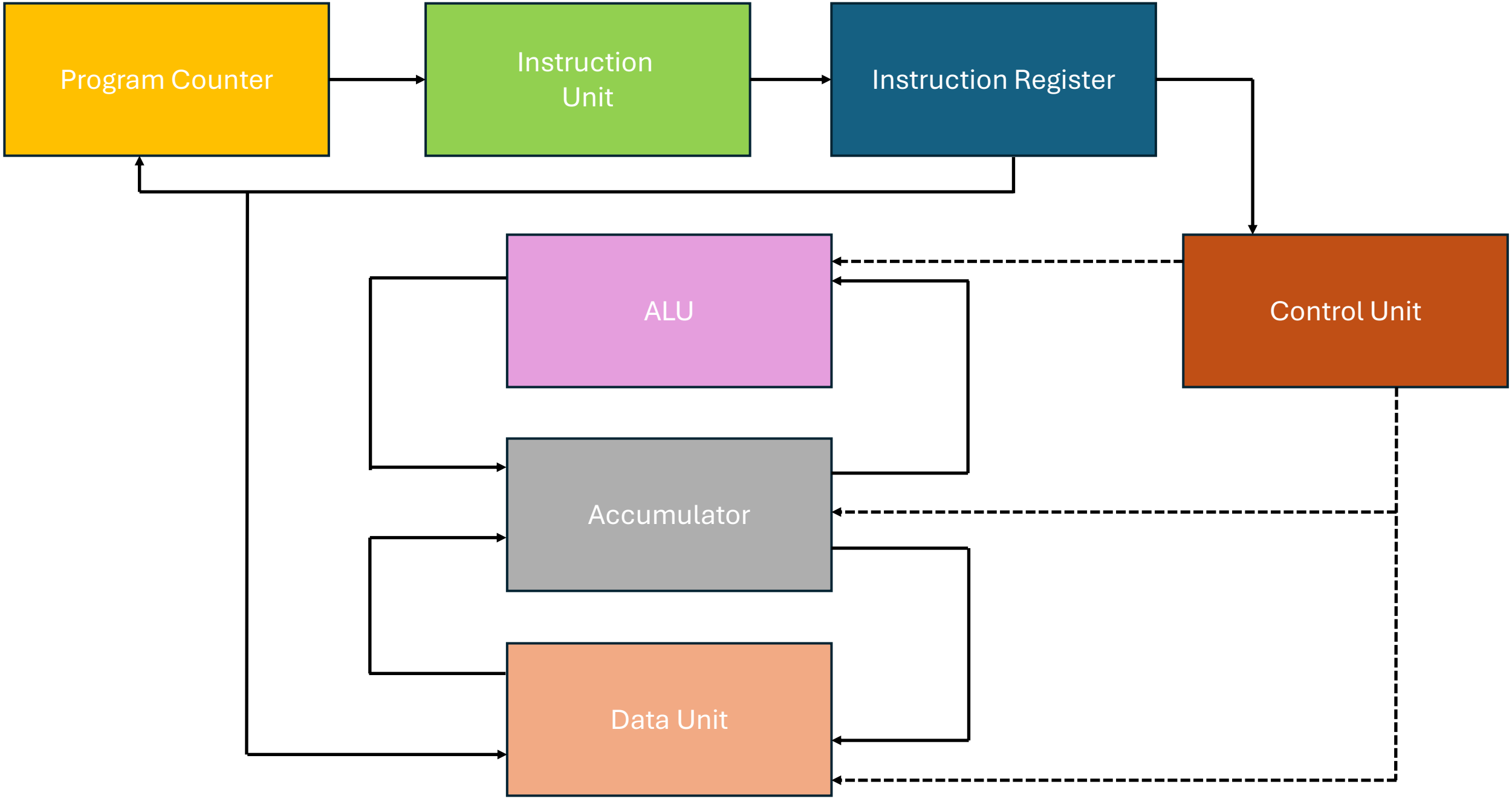
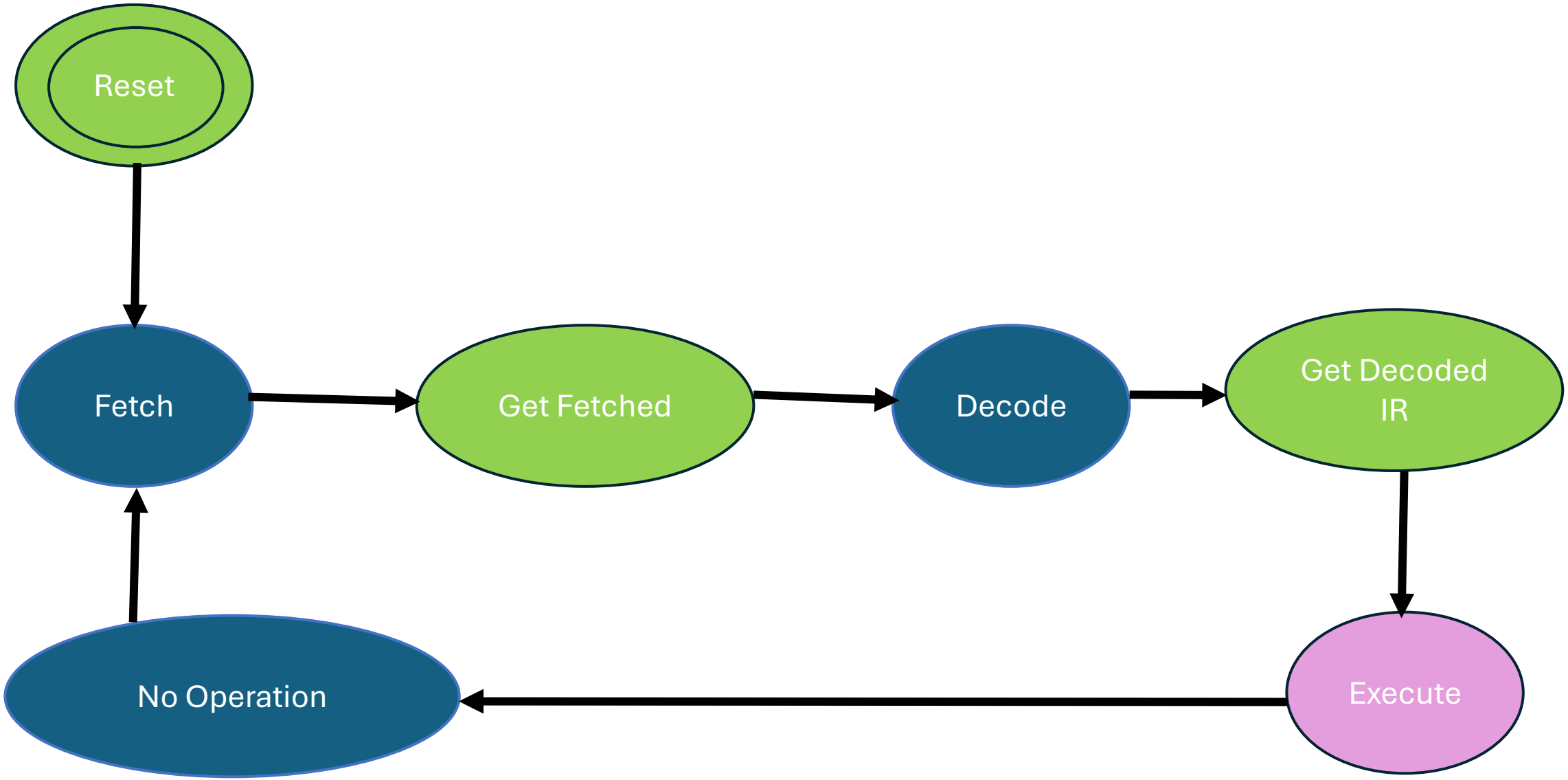
8 BIT Harvard CPU

- Hardware Engineering


Binary To BCD
8 Bit CPU
BCD To Seven Segment
Seven Segment Controller
X
X

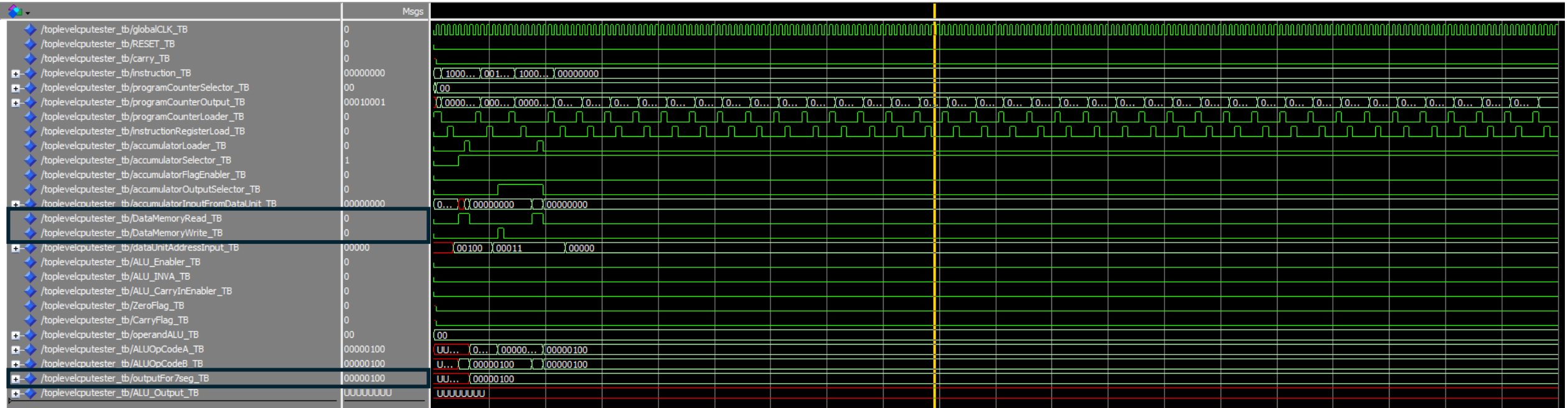

Program Counter
Instruction Unit
Instruction Register
ALU
Control Unit
Accumulator
Data Unit


Reset
Fetch
Get Fetched
Decode
Get Decoded IR
No Operation
Execute

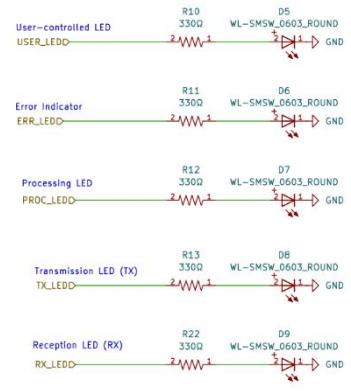
Instruction	OpCode
LOAD	100
STORE	001
SUM	010
SUB	011
AND	111
OR	101
JUMP If No Carry Flag	110
No Operation	000

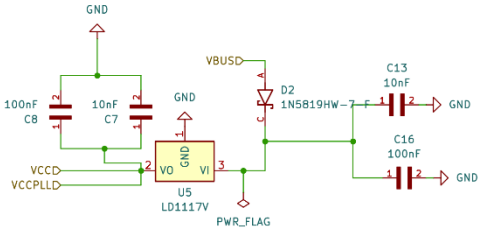
Example with Testbench

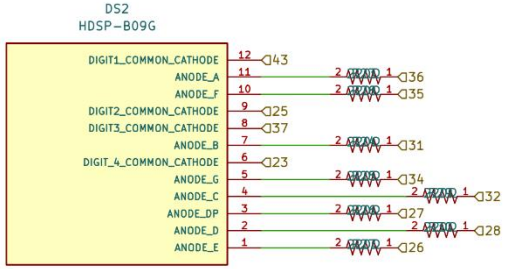
```
CASE(pcAddress) IS
                    WHEN "00000000" => instruction<="00000000";
                    WHEN "00000001" => instruction<="10000100";          --Load
                    WHEN "00000010" => instruction<="00100011";          --Store
                    WHEN "00000011" => instruction<="10000011";          --Load
                    WHEN OTHERS =>     instruction <= "00000000"; -- No Operation
END CASE;
```

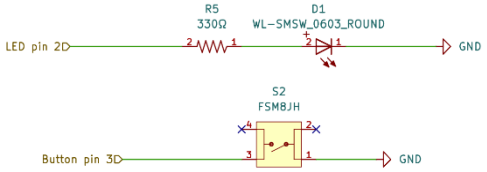


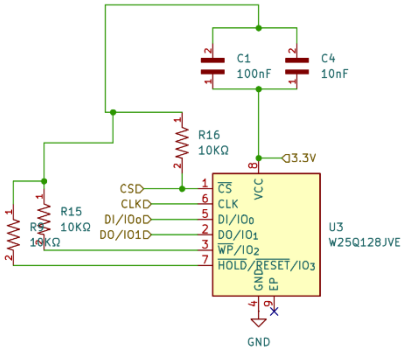
Schematic

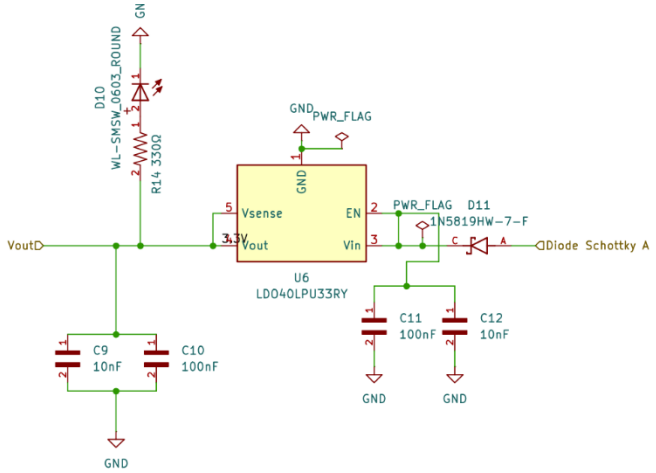

User-controlled LED
USER_LED
R10
330Ω
D5
WL-SMSW_0603_ROUND
GND
Error Indicator
ERR_LED
R11
330Ω
D6
WL-SMSW_0603_ROUND
GND
Processing LED
PROC_LED
R12
330Ω
D7
WL-SMSW_0603_ROUND
GND
Transmission LED (TX)
TX_LED
R13
330Ω
D8
WL-SMSW_0603_ROUND
GND
Reception LED (RX)
RX_LED
R22
330Ω
D9
WL-SMSW_0603_ROUND
GND

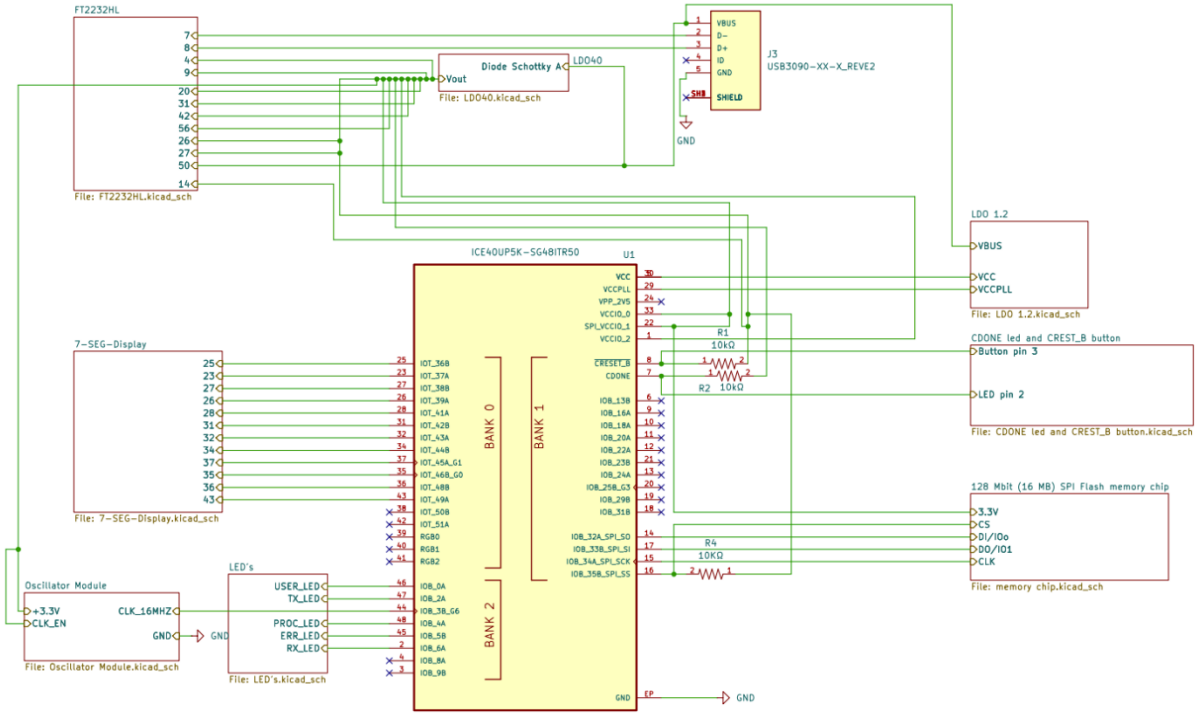

GND
100nF
C8
10nF
C7
GND
VBUS
D2
1N5819HW-7-F
C13
10nF
GND
C16
100nF
GND
VCCD
VCCPLLD
U5
LD1117V
VO
GND
VI
PWR_FLAG

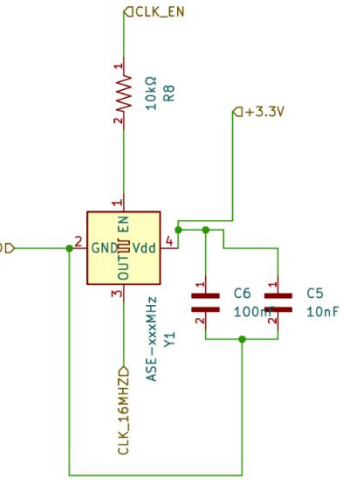

DS2
HDSP-B09G
DIGIT1_COMMON_CATHODE
ANODE_A
ANODE_F
DIGIT2_COMMON_CATHODE
DIGIT3_COMMON_CATHODE
ANODE_B
DIGIT_4_COMMON_CATHODE
ANODE_G
ANODE_C
ANODE_DP
ANODE_D
ANODE_E

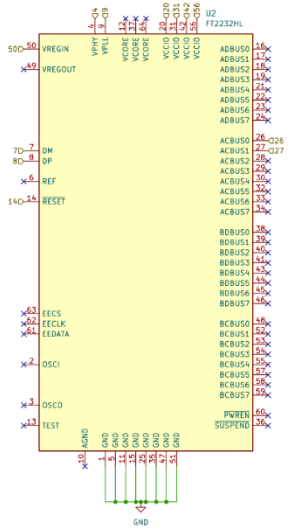

R5
330Ω
D1
WL-SMSW_0603_ROUND
LED pin 2
GND
S2
FSM8JH
Button pin 3
GND


C1
100nF
C4
10nF
R16
10KΩ
3.3V
R15
10KΩ
R17
10KΩ
CSD
CLKD
DI/IO0
DO/IO1
U3
W25Q128JVE
CS
CLK
DI/IO0
DO/IO1
WP/IO2
HOLD/RESET/IO3
VCC
GND
EP
GND

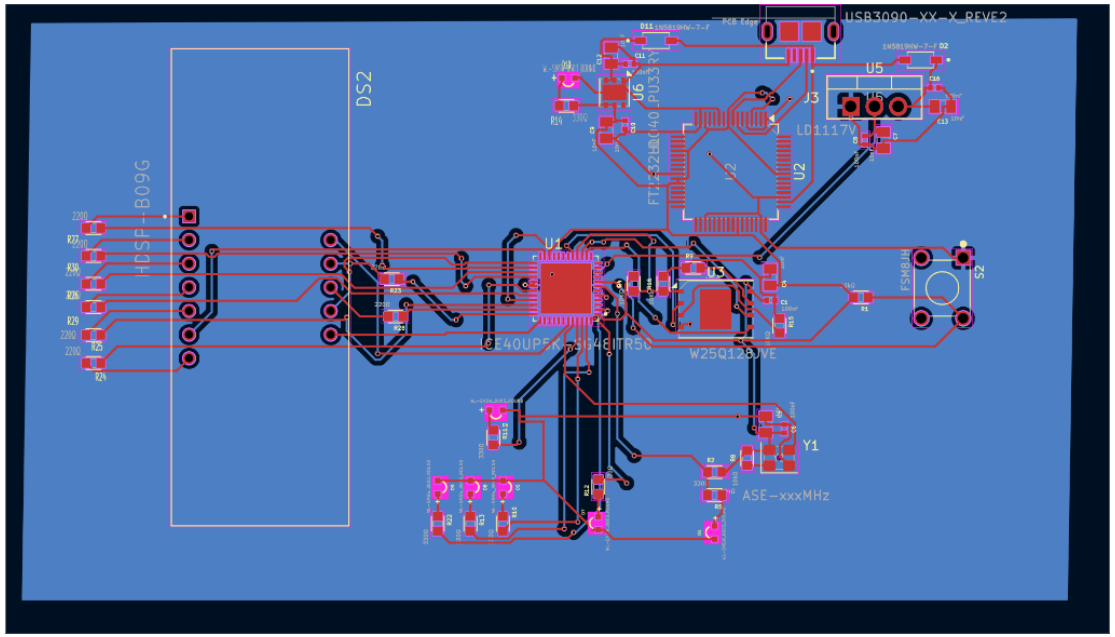

D10
WL-SMSW_0603_ROUND
R14 330Ω
GND
PWR_FLAG
GND
Vsense
Vout
EN
Vin
PWR_FLAG
D11
1N5819HW-7-F
3.3V
VoutD
Diode Schottky A
U6
LDO40LPU33RY
C9
10nF
C10
100nF
C11
100nF
C12
10nF
GND
GND
GND


FT2232HL
File: FT2232HL.kicad_sch
Diode Schottky A
LDO40
Vout
File: LDO40.kicad_sch
VBUS
D-
D+
ID
GND
SHIELD
J3
USB3090-XX-X_REVE2
GND
ICE40UP5K-SG48ITR50
U1
VCC
VCCPLL
VPP_2V5
VCCIO_0
SPI_VCCIO_1
VCCIO_2
CRESET_B
CDONE
BANK 0
BANK 1
BANK 2
R1
10kΩ
R2
10kΩ
R4
10KΩ
7-SEG-Display
File: 7-SEG-Display.kicad_sch
Oscillator Module
+3.3V
CLK_EN
CLK_16MHZ
GND
File: Oscillator Module.kicad_sch
LED's
USER_LED
TX_LED
PROC_LED
ERR_LED
RX_LED
File: LED's.kicad_sch
LDO 1.2
VBUS
VCC
VCCPLL
File: LDO 1.2.kicad_sch
CDONE led and CREST_B button
Button pin 3
LED pin 2
File: CDONE led and CREST_B button.kicad_sch
128 Mbit (16 MB) SPI Flash memory chip
3.3V
CS
DI/IO0
DO/IO1
CLK
File: memory chip.kicad_sch
GND
EP
GND

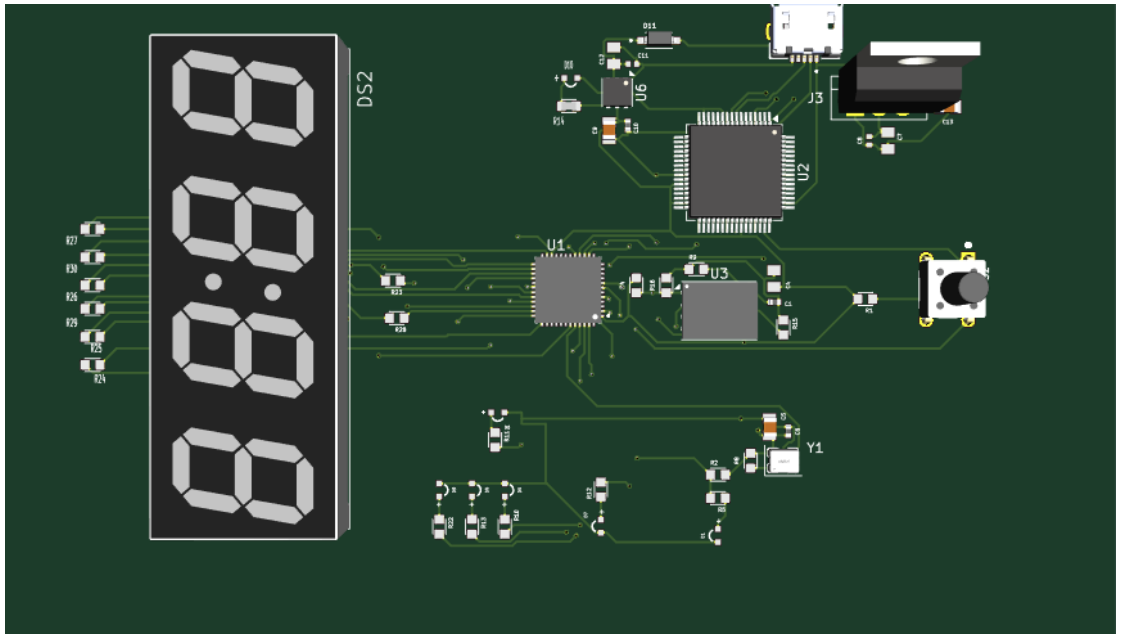

CLK_EN
R8
10kΩ
+3.3V
GND
GND
EN
OUT
Vdd
C6
100nF
C5
10nF
CLK_16MHZD
ASE-xxxMHz
Y1


U2
FT2232HL
VREGIN
VREGOUT
DM
DP
REF
RESET
EECS
EECLK
EEDATA
OSCI
OSCO
TEST
PWREN
SUSPEND
ADBUS0
ADBUS1
ADBUS2
ADBUS3
ADBUS4
ADBUS5
ADBUS6
ADBUS7
BDBUS0
BDBUS1
BDBUS2
BDBUS3
BDBUS4
BDBUS5
BDBUS6
BDBUS7
BCBUS0
BCBUS1
BCBUS2
BCBUS3
BCBUS4
BCBUS5
BCBUS6
BCBUS7
GND

LAYOUT



3D view



Physical Stackup

Copper layers: 2 | Impedance controlled | Add Dielectric Layer... | Remove Dielectric Layer...

Layer	Id	Type	Material	Thickness	Color	Epsilon R	Loss Tan
F.Silkscreen	Top Silk Screen		Not specified		Not specified		
F.Paste	Top Solder Paste						
F.Mask	Top Solder Mask		Not specified	0.01 mm	Not specified	3.3	0
F.Cu	Copper			0.035 mm			
Dielectric 1	Core		FR4	1.51 mm	Not specified	4.5	0.02
B.Cu	Copper			0.035 mm			
B.Mask	Bottom Solder Mask		Not specified	0.01 mm	Not specified	3.3	0
B.Paste	Bottom Solder Paste						
B.Silkscreen	Bottom Silk Screen		Not specified		Not specified		

Net Classes

Netclasses

Name	Clearance	Track Width	Via Size	Via Hole	µVia Size	uVia Hole	DP Width	DP Gap
SEG*	0.17 mm	0.25 mm	0.6 mm	0.3 mm	0.3 mm	0.1 mm	0.2 mm	0.25 mm
DIGIT*	0.17 mm	0.25 mm	0.6 mm	0.3 mm	0.3 mm	0.1 mm	0.2 mm	0.25 mm
1.2	0.17 mm	0.5 mm	0.6 mm	0.3 mm	0.3 mm	0.1 mm	0.2 mm	0.25 mm
GPIO_*	0.17 mm	0.25 mm	0.6 mm	0.3 mm	0.3 mm	0.1 mm	0.2 mm	0.25 mm
v*	0.17 mm	0.5 mm	0.6 mm	0.3 mm	0.3 mm	0.1 mm	0.2 mm	0.25 mm
3.3V	0.17 mm	0.5 mm	0.6 mm	0.3 mm	0.3 mm	0.1 mm	0.2 mm	0.25 mm
Default	0.17 mm	0.25 mm	0.6 mm	0.3 mm	0.3 mm	0.1 mm	0.2 mm	0.25 mm

Constraints

Copper

Minimum clearance:	0.15	mm
Minimum track width:	0.2	mm
Minimum connection width:	0.15	mm
Minimum annular width:	0.1	mm
Minimum via diameter:	0.5	mm
Copper to hole clearance:	0.25	mm
Copper to edge clearance:	0.5	mm

Holes

Minimum through hole:	0.3	mm
Hole to hole clearance:	0.25	mm

uVias

Minimum uVia diameter:	0.2	mm
Minimum uVia hole:	0.1	mm

Silkscreen

Minimum item clearance:	0	mm

Arc/Circle Approximated by Segments

Maximum allowed deviation: 0.005 mm

Note: zone filling can be slow when < 0.005 mm.

Zone Fill Strategy

Allow fillets/chamfers outside zone outline

Minimum thermal relief spoke count: 2

Length Tuning

Include stackup height in track length calculations

ther Board... | OK | Cancel

Tools:

- Xilinx Vivado
- Modelsim
- KiCAD