Lecture 2
Programming PLC

Apply Logic Instructions

Learning Outcome

- Implement digital logic operation
- Implement common instructions found in ladder logic such as
    - Timer
    - Counter
    - Set/reset
    - Edge detection
- Apply timing diagrams to solve logic and sequencing problems
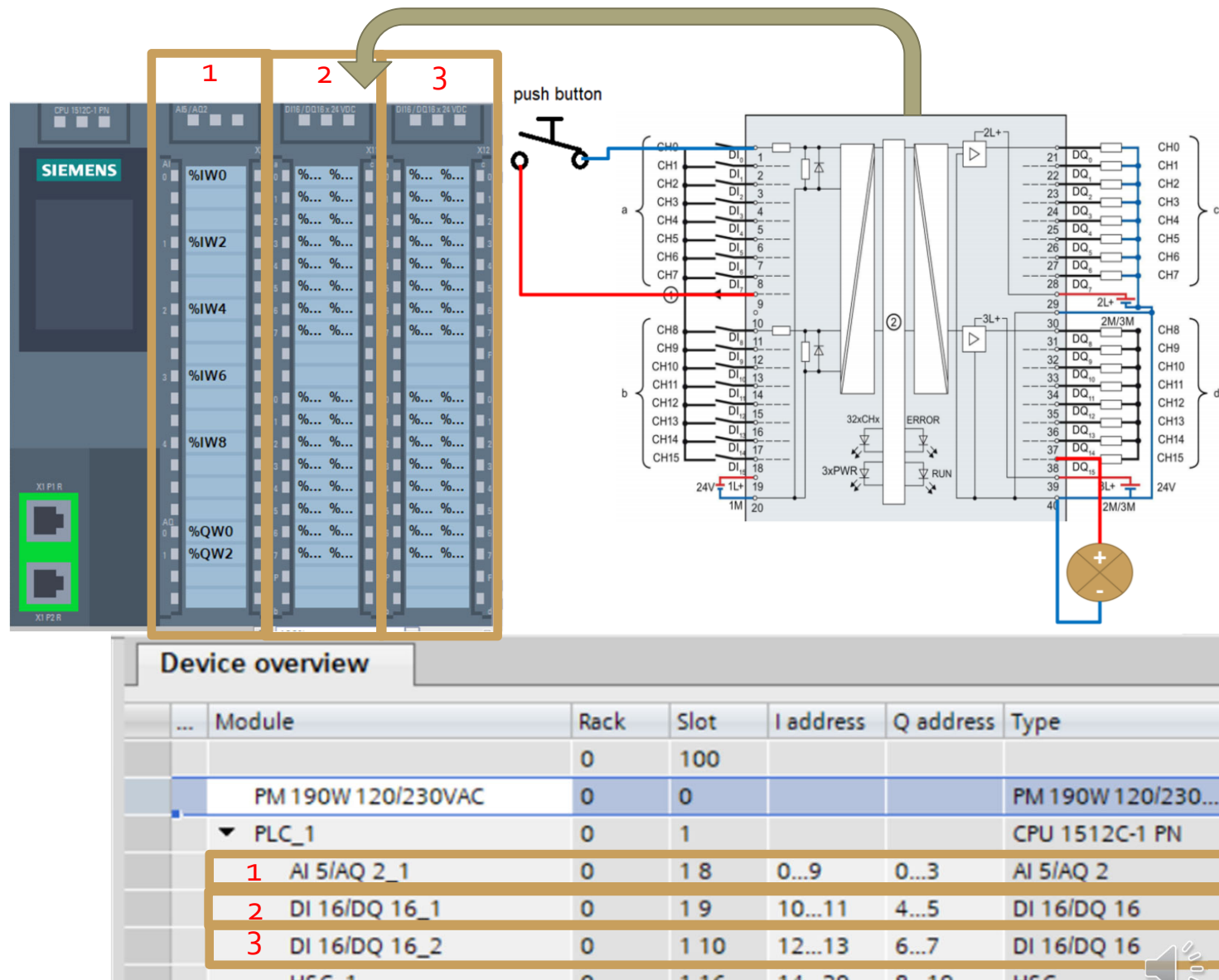- Translate task description into Sequential Function Chart (SFC)

S7-1500
Digital Input & Digital Output Terminals

How would you program to light up the connected LED whenever push button is pressed?
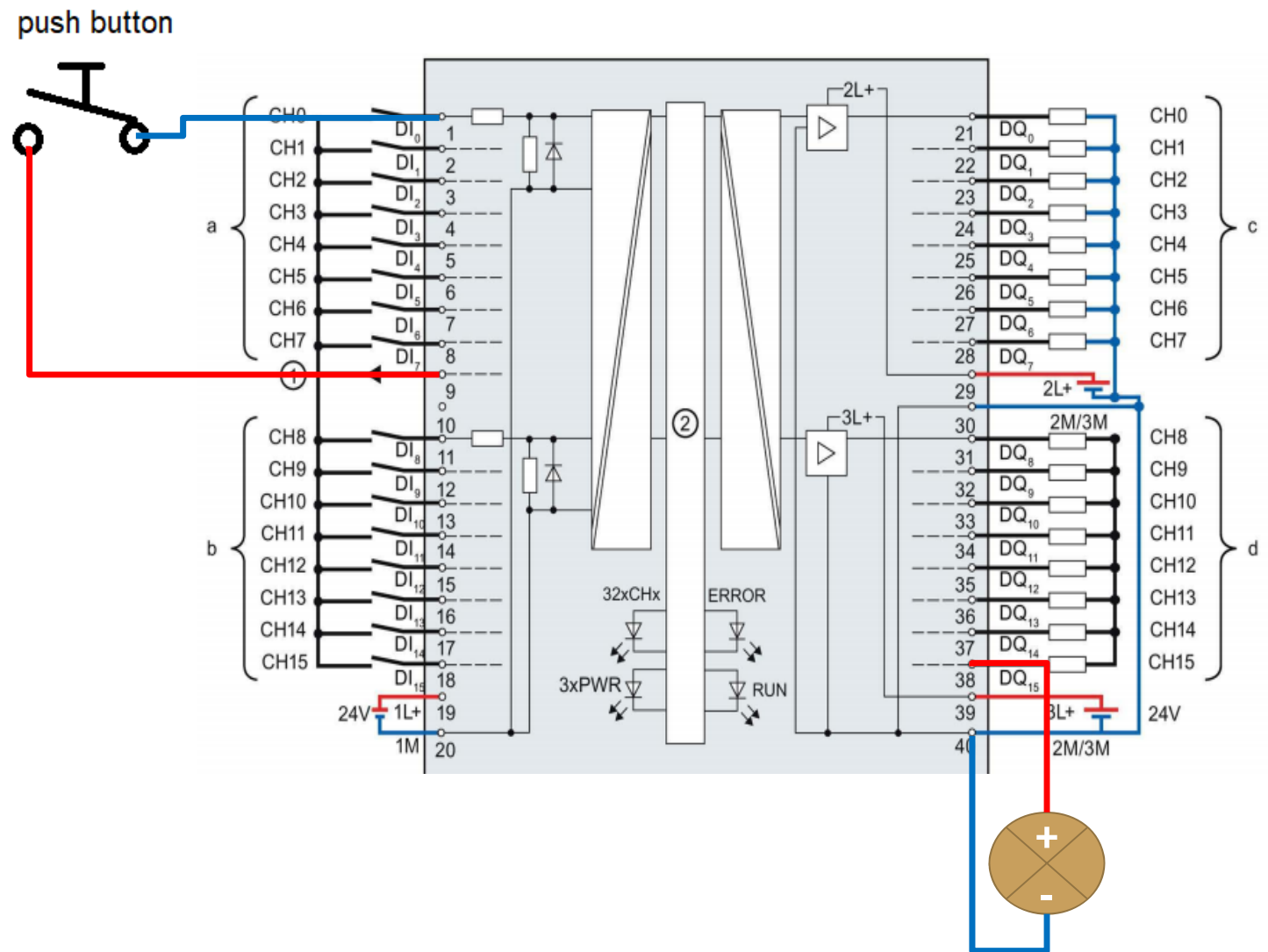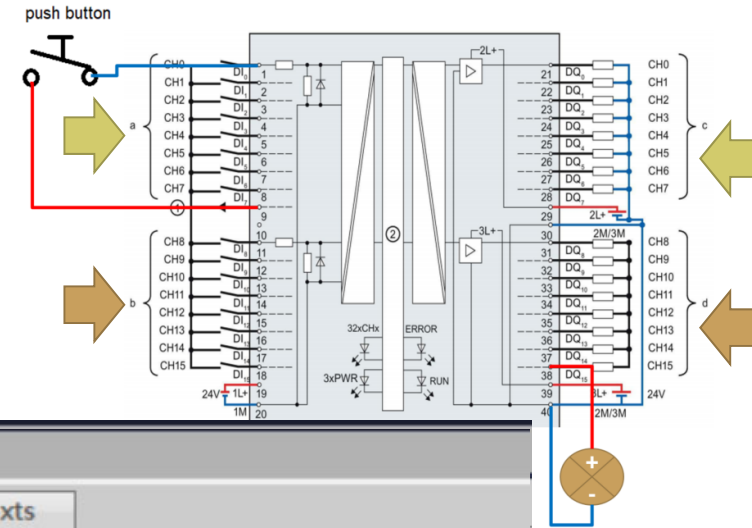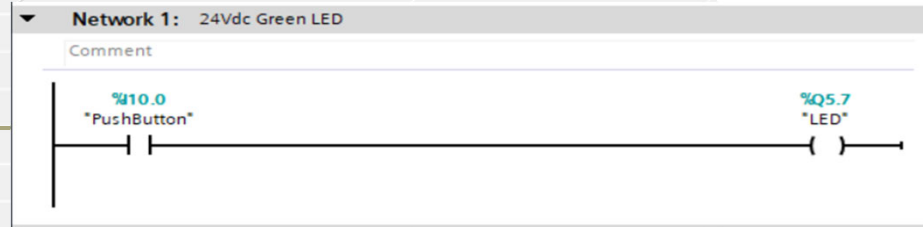
First – Identify I/O Types and I/O Address

How would you program to light up the connected LED whenever push button is pressed?

Device overview

...	Module	Rack	Slot	I address	Q address	Type
		0	100			
	PM 190W 120/230VAC	0	0			PM 190W 120/230...
▼	PLC_1	0	1			CPU 1512C-1 PN
1	AI 5/AQ 2_1	0	1 8	0...9	0...3	AI 5/AQ 2
2	DI 16/DQ 16_1	0	1 9	10...11	4...5	DI 16/DQ 16
3	DI 16/DQ 16_2	0	1 10	12...13	6...7	DI 16/DQ 16
	HSC_1	0	1 16	14...20	8...19	HSC

Assign I/O & Tag Declaration

DI 16/DQ 16_1 [Module]

| General | IO tags | System constants | Texts |

	Name	Type	Address	Tag table	Comment
⬛DI	PushButton	Bool	%I10.0	Default tag table	Normally Open PB
		Bool	%I10.1		
		Bool	%I10.2		
		Bool	%I10.3		
		Bool	%I10.4		
		Bool	%I10.5		
		Bool	%I10.6		
		Bool	%I10.7		
		Bool	%I11.0		
		Bool	%I11.1		
		Bool	%I11.2		
		Bool	%I11.3		
		Bool	%I11.4		
		Bool	%I11.5		
		Bool	%I11.6		
		Bool	%I11.7		

DI 16/DQ 16_1 [Module]

| General | IO tags | System constants | Texts |

	Name	Type	Address	Tag table	Comment
		Bool	%Q4.0		
		Bool	%Q4.1		
		Bool	%Q4.2		
		Bool	%Q4.3		
		Bool	%Q4.4		
		Bool	%Q4.5		
		Bool	%Q4.6		
		Bool	%Q4.7		
		Bool	%Q5.0		
		Bool	%Q5.1		
		Bool	%Q5.2		
		Bool	%Q5.3		
		Bool	%Q5.4		
		Bool	%Q5.5		
		Bool	%Q5.6		
⬛DI	LED	Bool	%Q5.7	Default tag table	24Vdc Green LED

Network 1: 24Vdc Green LED

Comment

```
  %I10.0                                                          %Q5.7
"PushButton"                                                      "LED"
     | |                                                          ( )
```

PLC Address Types & Memory Map

File Type	
I	Input
Q	Output
M	Memory
DB	Data block

File Type	
Input (I)	Physically connected to input device
Output (Q)	Physically connected to output device
Memory (M)	Internally used for bit, byte or data operation
Data block (DB)	Store data, able to be used by different program blocks. Variety of data types could be defined and associated to the DB
Timers (DB)	
Counters (DB)	

%	1st prefix	2nd prefix	Specific location	Meaning	
	I			Input	
	Q			Output	
	M			Memory	
		None or X		Boolean	: 1 bit
		B		Byte	: 8 bit
		W		Single word	: 16 bit
		D		Double word	: 32 bit
		L		Long word	: 64 bit

Call options
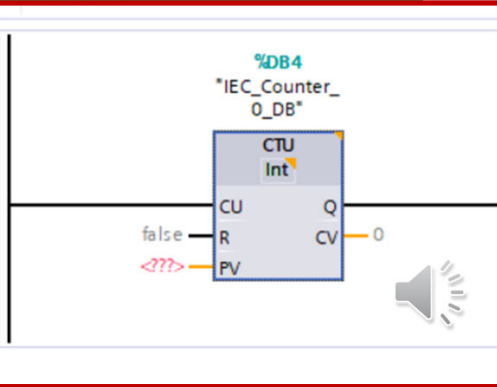
Data block
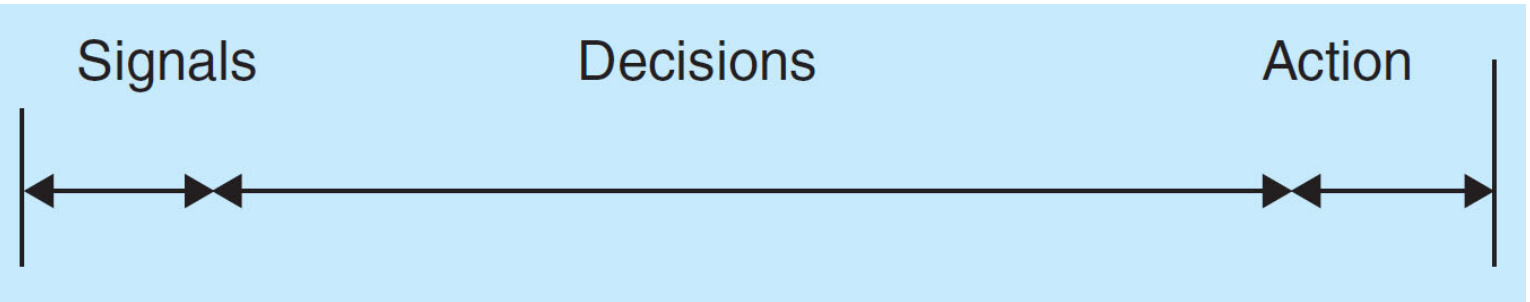
Single instance

Name: IEC_Counter_0_DB
Number: 4
○ Manual
● Automatic

If you call the function block as a single instance, the function block saves its data in its own instance data block.

Parameter instance

more...

OK   Cancel

%DB4
"IEC_Counter_0_DB"

CTU
Int

CU   Q
false — R
<???> — PV   CV — 0

Ladder Logic Diagram

| Signals	Decisions	Action

- Similar to hardwired relay control with 3 basic sections:
  - Signal
  - Decision
  - Action
- Every instruction is examined
- If TRUE, continuity/power flow of the rung is maintained
- When all input instructions are TRUE, the output would be set to 1 (ON)

Boolean Instructions

PLC Normally Open Contact

- Contact is closed (ON) when the assigned bit = 1
- Start
- Stop

Start

Stop
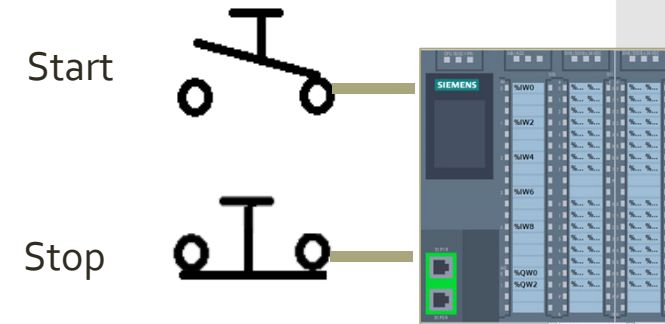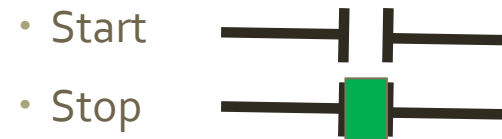
PLC Normally Closed Contact

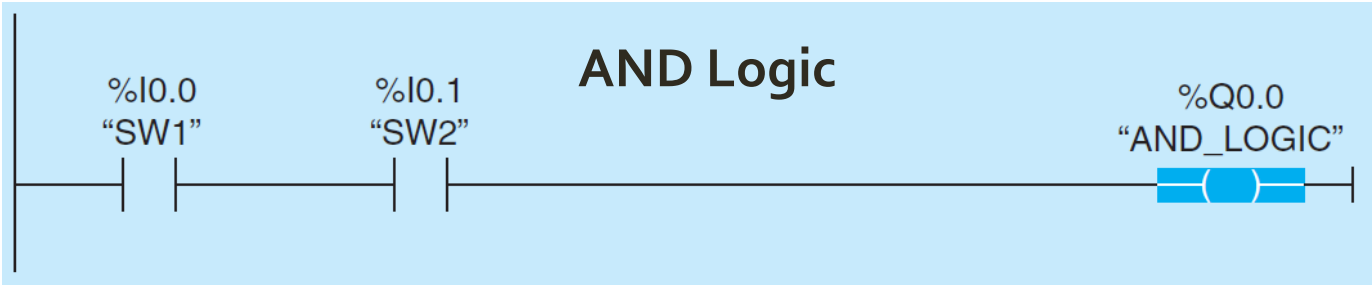- Contact is closed (ON) when the assigned bit = 0
- Start
- Stop

Output Coil

- PLC instruction writes value of an output bit depending on the power flow and is updated every scan cycle
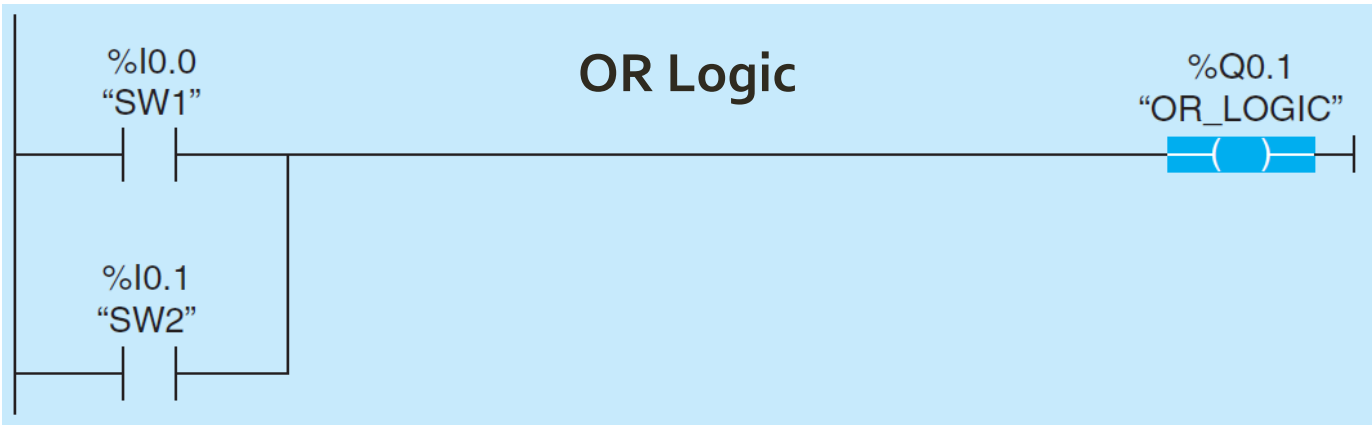- Coils shall be assigned to unique address – (no duplicate address)

Boolean Instructions

AND Logic

%I0.0 "SW1" — %I0.1 "SW2" — %Q0.0 "AND_LOGIC"

SW1	SW2	AND_LOGIC
0	0	0
0	1	0
1	0	0
1	1	1

SW1	SW2	OR_LOGIC
0	0	0
0	1	1
1	0	1
1	1	1

OR Logic

%I0.0 "SW1"
%I0.1 "SW2"
%Q0.1 "OR_LOGIC"

Tag Name	Address
SW1	%I0.0
SW2	%I0.1
AND_LOGIC	%Q0.0
OR_LOGIC	%Q0.1
EXOR_LOGIC	%Q0.2
EXNOR_LOGIC	%Q0.3

Boolean Instructions

Exclusive OR Logic

	%I0.0 "SW1"	%I0.1 "SW2"	%Q0.2 "EXOR_LOGIC"

(Ladder diagram: EXOR logic)

SW1	SW2	EXOR_LOGIC
0	0	0
0	1	1
1	0	1
1	1	0

SW1	SW2	EXNOR_LOGIC
0	0	1
0	1	0
1	0	0
1	1	1

Exclusive NOR Logic

%I0.0 "SW1" %I0.1 "SW2" %Q0.3 "EXNOR_LOGIC"

(Ladder diagram: EXNOR logic)

Tag Name	Address
SW1	%I0.0
SW2	%I0.1
AND_LOGIC	%Q0.0
OR_LOGIC	%Q0.1
EXOR_LOGIC	%Q0.2
EXNOR_LOGIC	%Q0.3
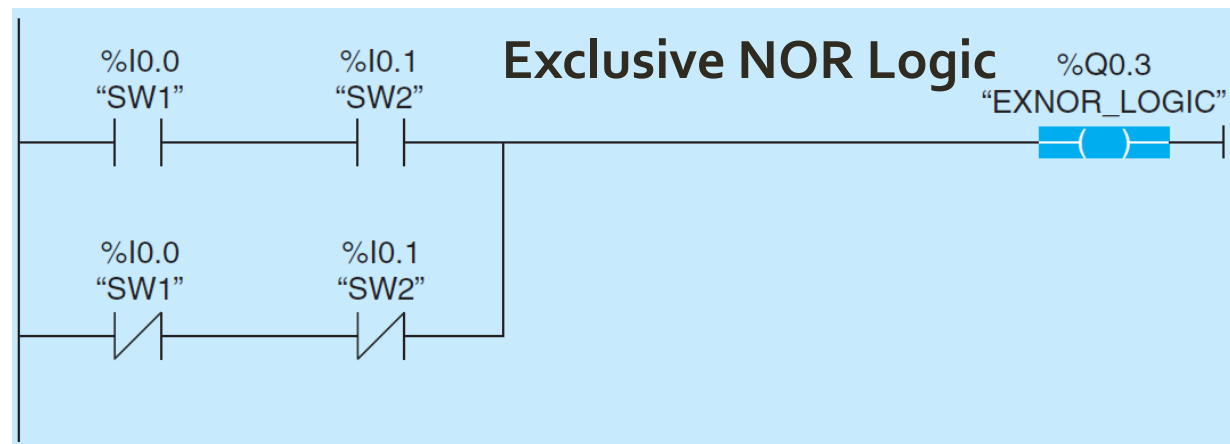
☑️ Quiz

Click the **Quiz** button to edit this object

When would we use %M to assign PLC I/O address?
Select the correct answer option:

- ◯ When we declare instance for Timer/Counter
- ◯ When we are doing logic operation without connecting to physical input or output
- ◯ When we are connecting to physical output
- ◯ When we are connecting to physical input