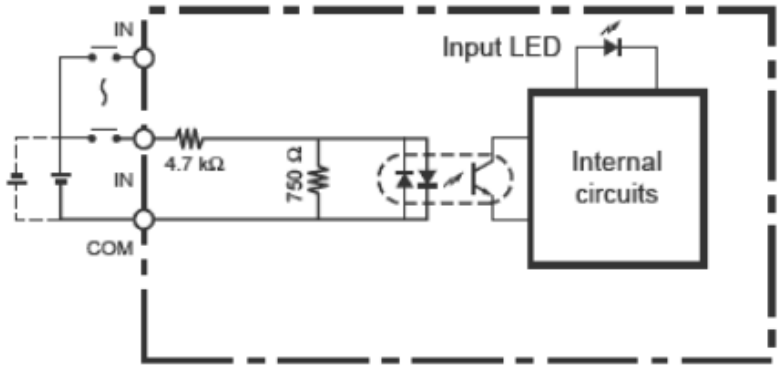
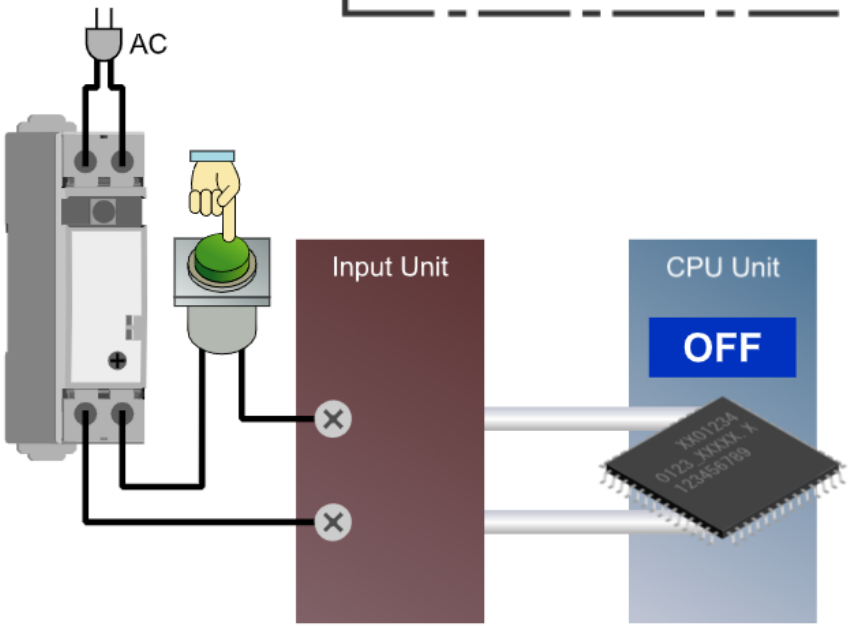
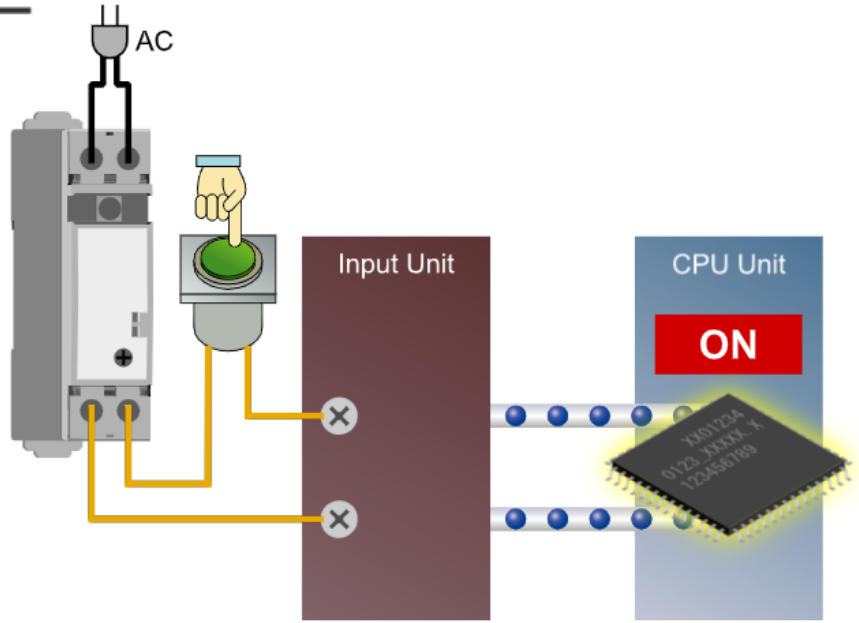
WIRING PLC

Circuit configuration - Normal input (CP1 model)

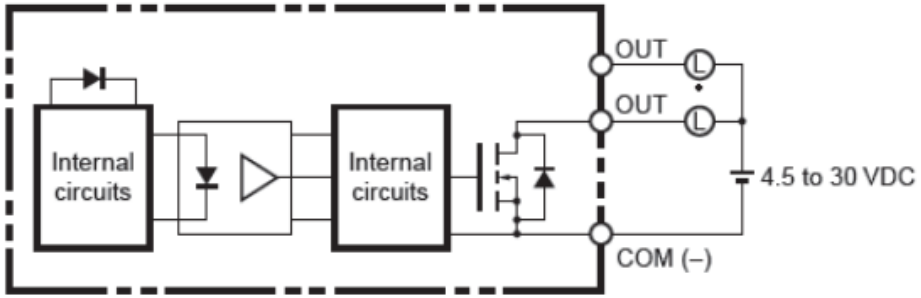


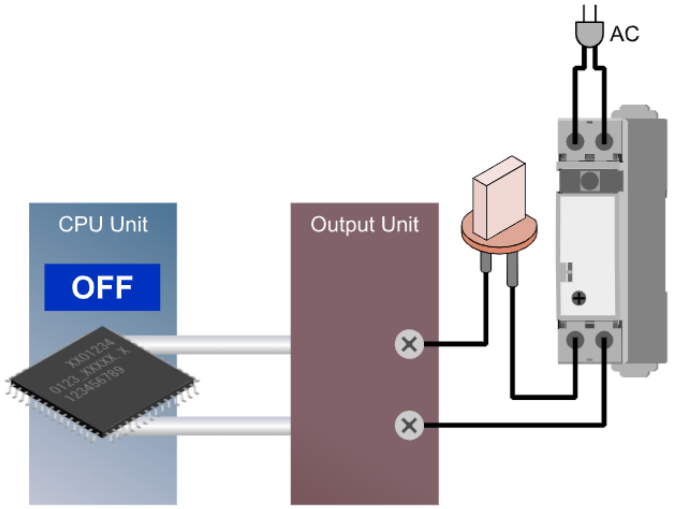




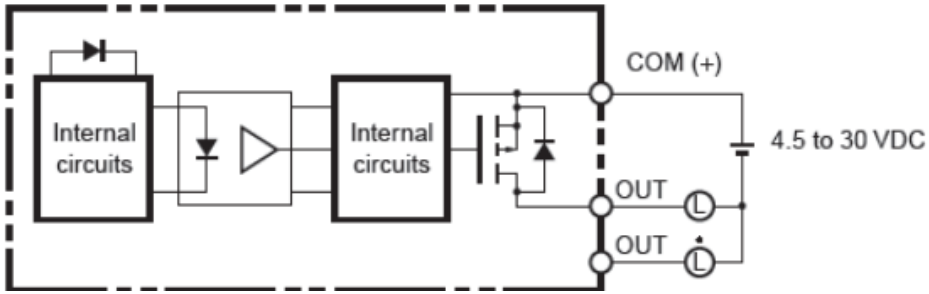
WIRING PLC

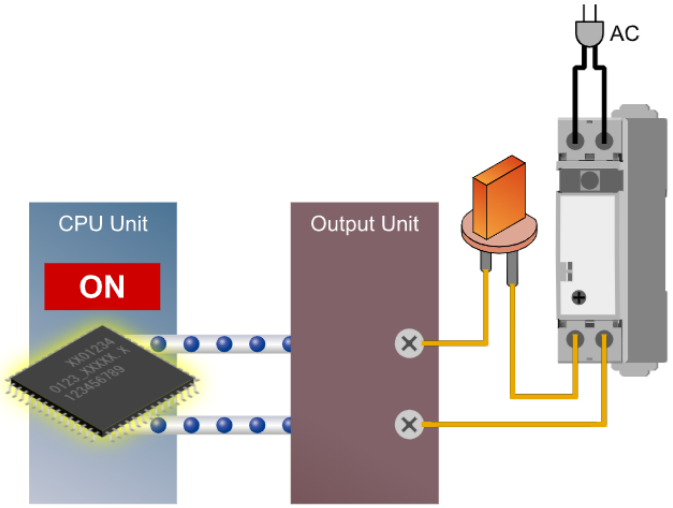
Sinking Outputs





Sourcing Outputs





I/O ADDRESS

The devices connected to the PLC are given a specific numeric identifier. We call it an I/O (**I**nput/**O**utput) address.

- The address is a unique number to identify I/O (Input/Output) devices.
- An address is composed of a word (CH=channel) address and a bit number in decimal form.
- Each digital device which is connected to Input Units or Output Units is assigned a single bit.
- The devices are allocated addresses depending on the terminal numbers in which inputs and outputs are connected.
- The addresses where are generally used for I/O devices are called the "CIO (Core IO)" area.

I/O ADDRESS

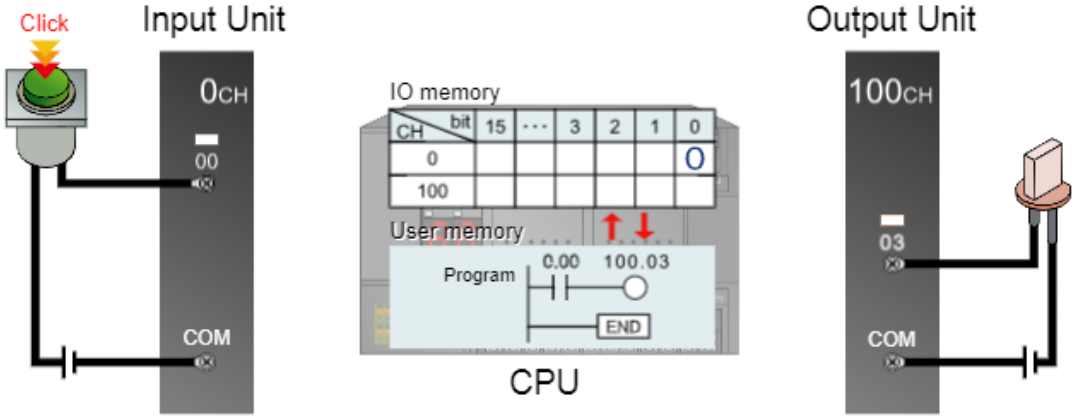
Digits are different depending on the PLC model. The CP1 and CJ2 models manage devices by six-digit addresses.

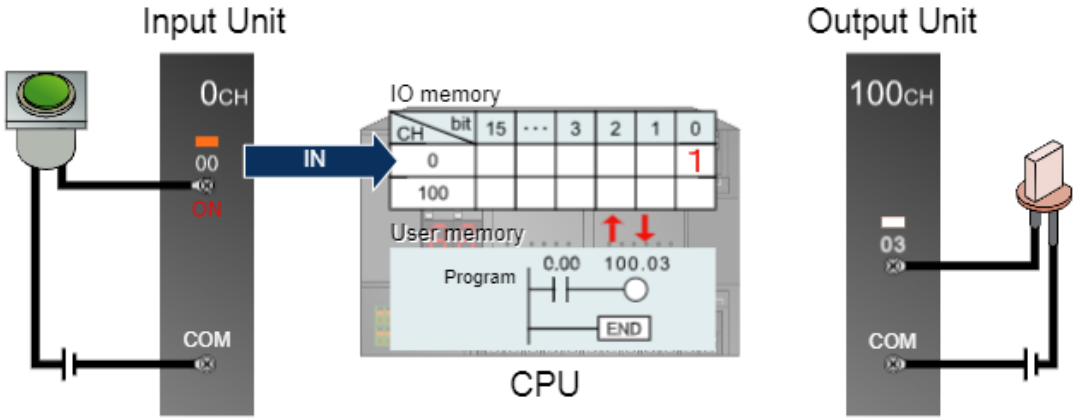
For example,
CIO **000000** means **word (CH) 0000 bit 00**.
CIO **010003** means **word (CH) 0100 bit 03**.

You can omit "0" in higher-digit of address, and put the dot between CH and bit number to identify it clearly.

For example,
CIO **0.00** indicates **word (CH) 0000 bit 00**.
CIO **100.03** indicates **word (CH) 0100 bit 03**.

CPU I/O MEMORY

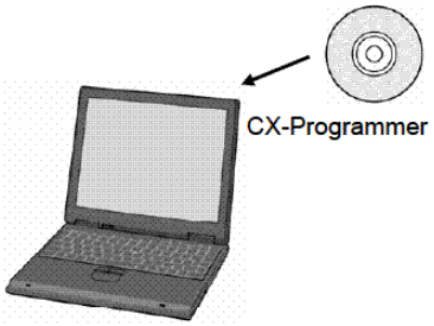




PROGRAMING DEVICE

CX-Programmer:

The CX-Programmer is widely used for programming and monitoring of PLCs.



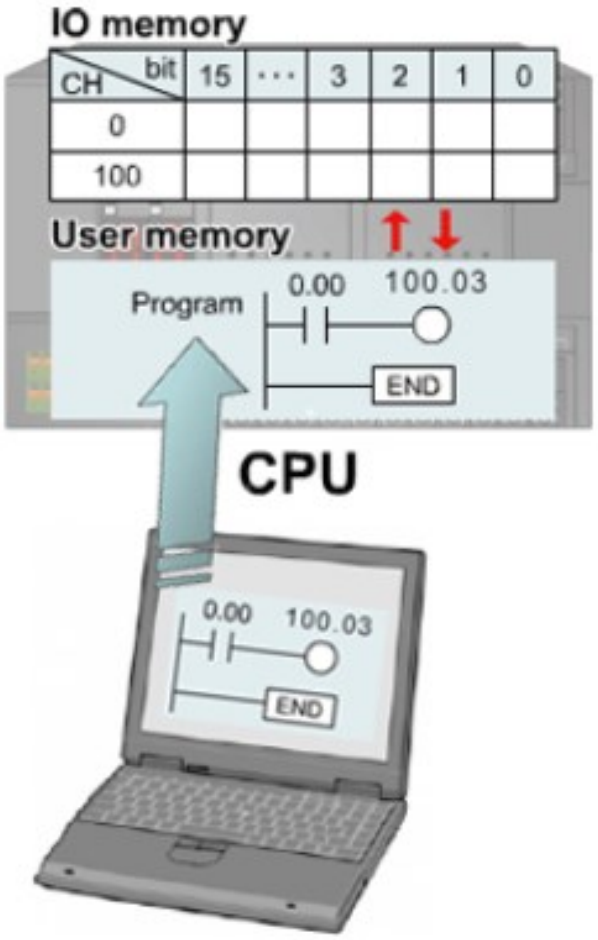
CX-One:

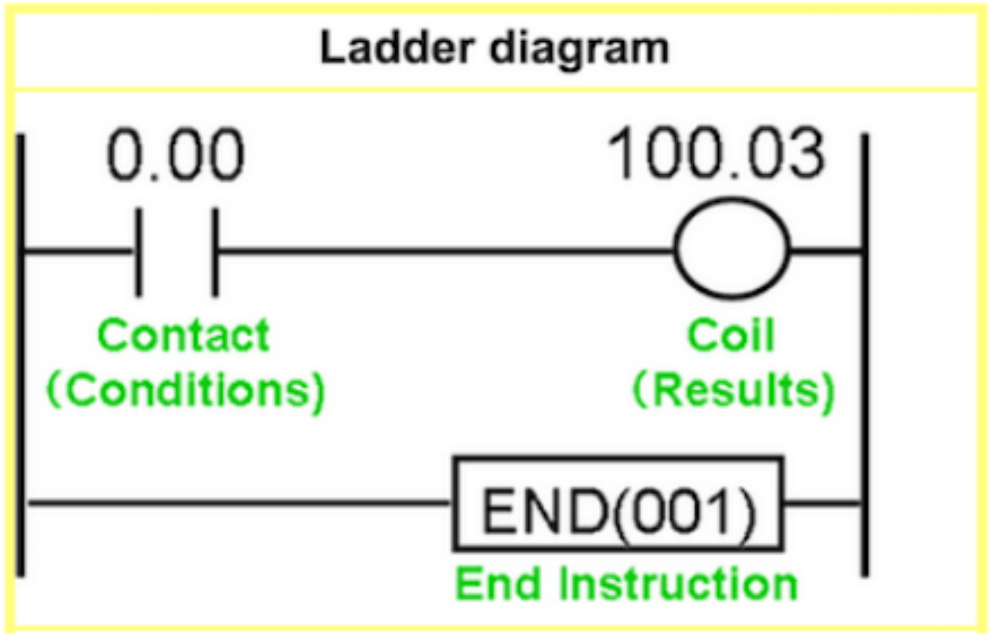
The CX-Programmer is included in the FA Integrated Tool Package, CX-One. The CX-One strives to reduce user's total cost of ownership by providing a seamless environment to operate the Support Software required for all processes, from FA system design to operation and maintenance.

Support Software contained in CX-One

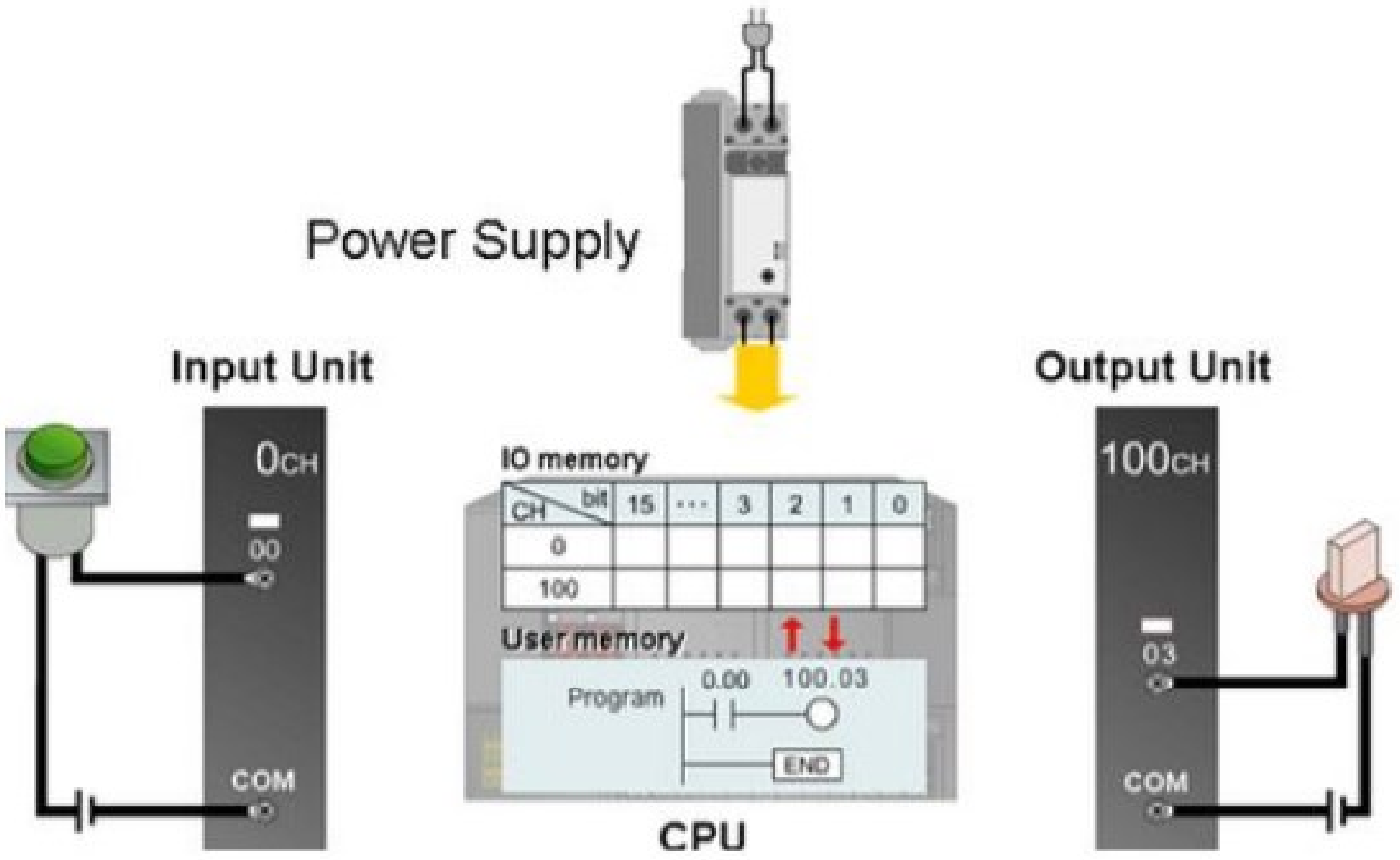
Network	CX-Integrator CX-FLnet CX-Protocol
PLC	CX-Programmer CX-Simulator Switch Box Utility
HMI	CX-Designer
Motion	CX-Drive CX-Motion-NCF CX-Motion-MCH CX-Position CX-Motion
Process	CX-Process Tool Faceplate Auto-Builder for NS CX-Thermo

CPU – User Memory

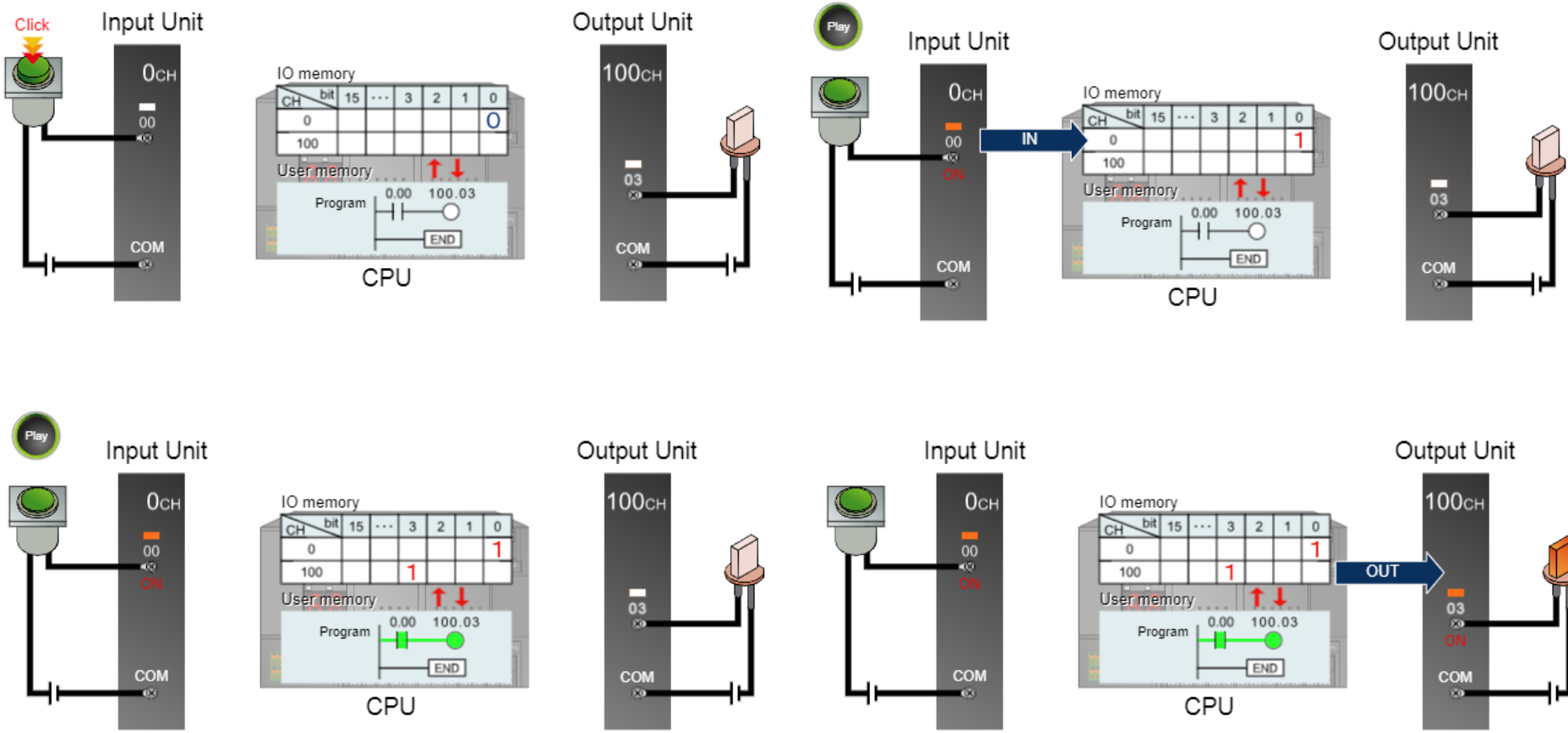




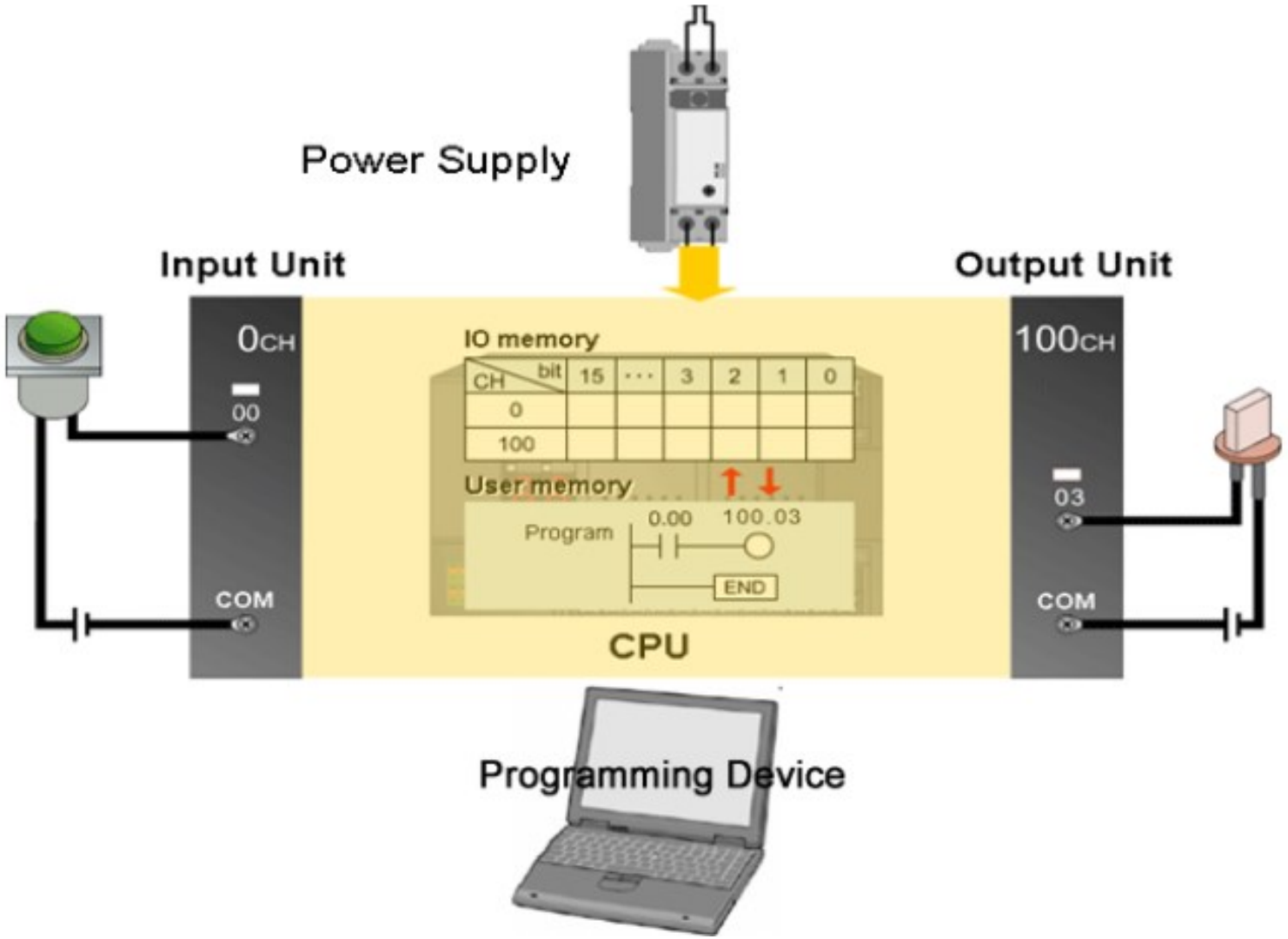
Power Supply



Running Program



SUMMARY


Power Supply
Input Unit
Output Unit
0CH
00
COM
IO memory
CH
bit
15
3
2
1
0
0
100
User memory
Program
0.00
100.03
END
CPU
100CH
03
COM
Programming Device

CYCLIC OPERATION

Startup Initialization

Initialize the hardware, check user memory.

Common Processing

Check the battery, and check the I/O bus and user program memory.

Program Execution

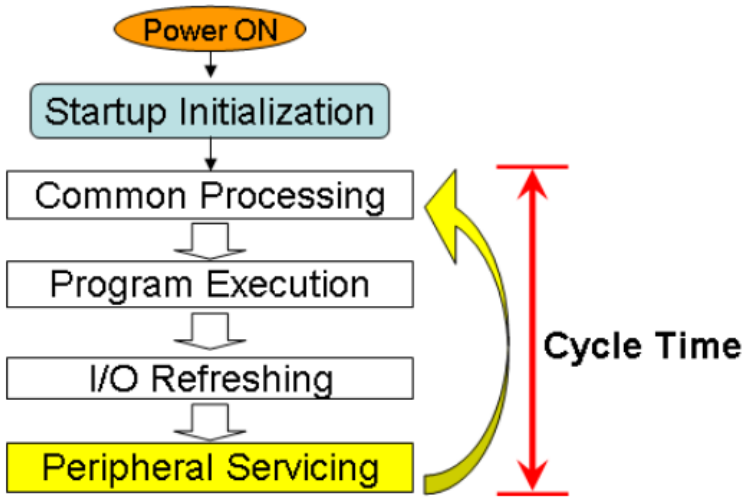
Execution of the user program.

I/O Refreshing

Exchange data between the Input/Output Units and the I/O memory of CPU Unit.

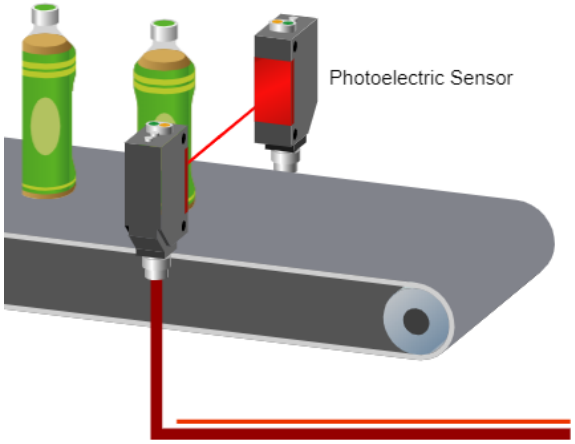
Peripheral Servicing

Execute any requests from the equipment attached to the peripheral and serial ports as well as other services.

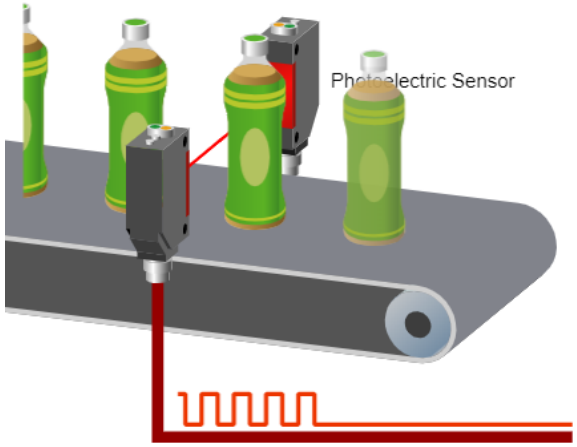


CYCLE TIME

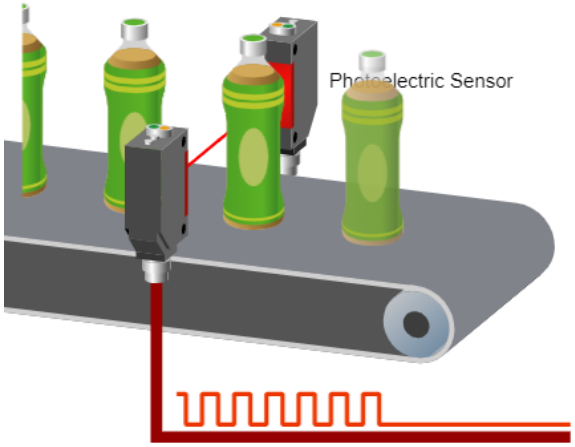
Pulse signal Input



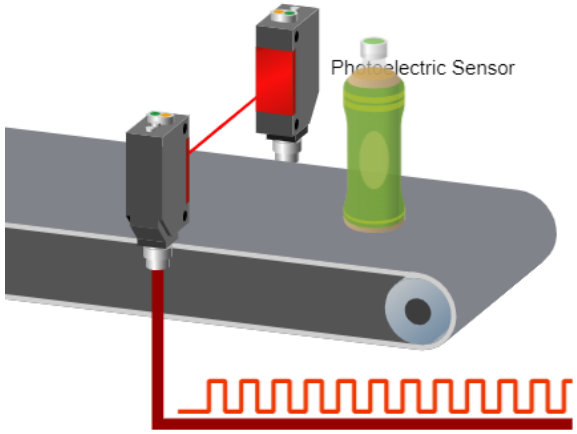
Pulse signal Input



Pulse signal Input



Pulse signal Input

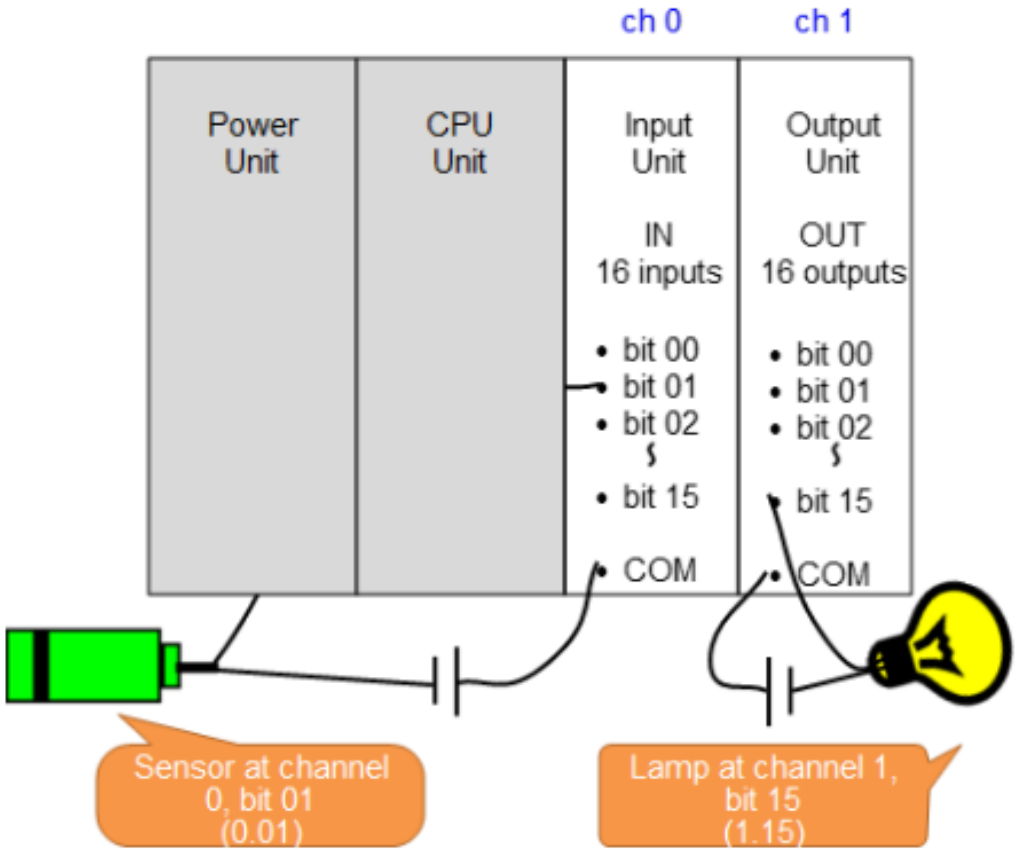


PLC BASIC PROGRAMING

Let's first become familiar with some basic information on creating programs.

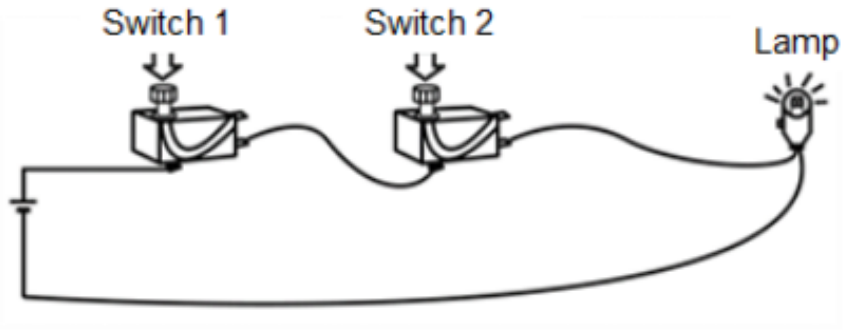
PLC BASIC PROGRAMING

C011 Microcontroller Fundamentals (Setup), or C039 Programmable Controller Fundamentals (Setup)

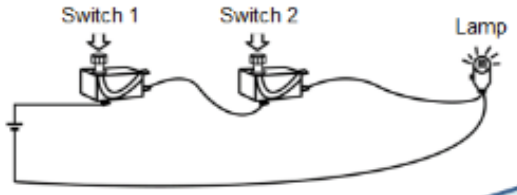


Wiring Vs Sequence Diagram

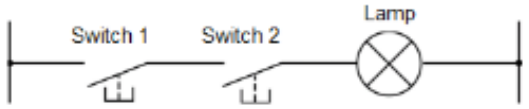
<Wiring Diagram>



<Wiring Diagram>



<Sequence Circuit Diagram>

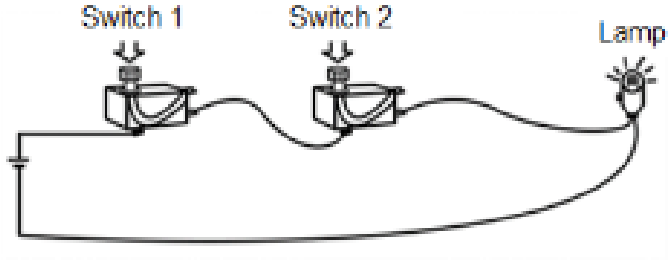


Representing this wiring diagram using symbols looks like this:

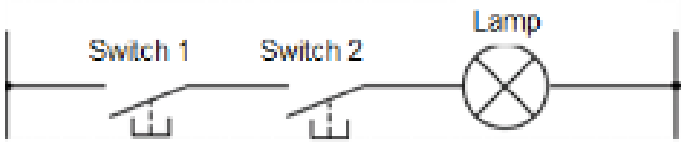
	NO contacts	NC contacts
Push-button switch		
Lamp		

Wiring Vs Sequence Diagram

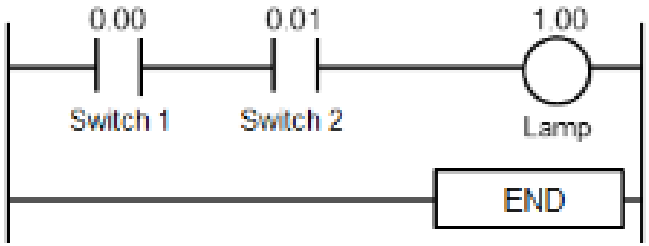
<Wiring Diagram>



<Sequence Circuit Diagram>



<Ladder Diagram>

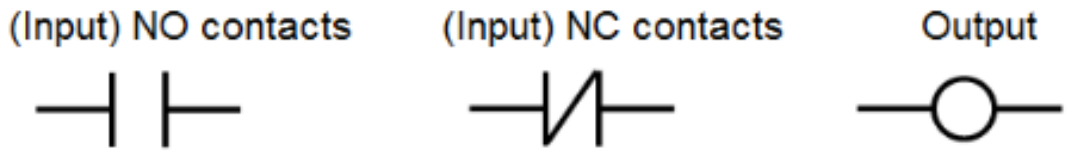


The ladder diagram representing this sequence circuit looks like this:

Ladder Diagram Symbol

Ladder diagram symbols and addresses are used to create ladder programs.

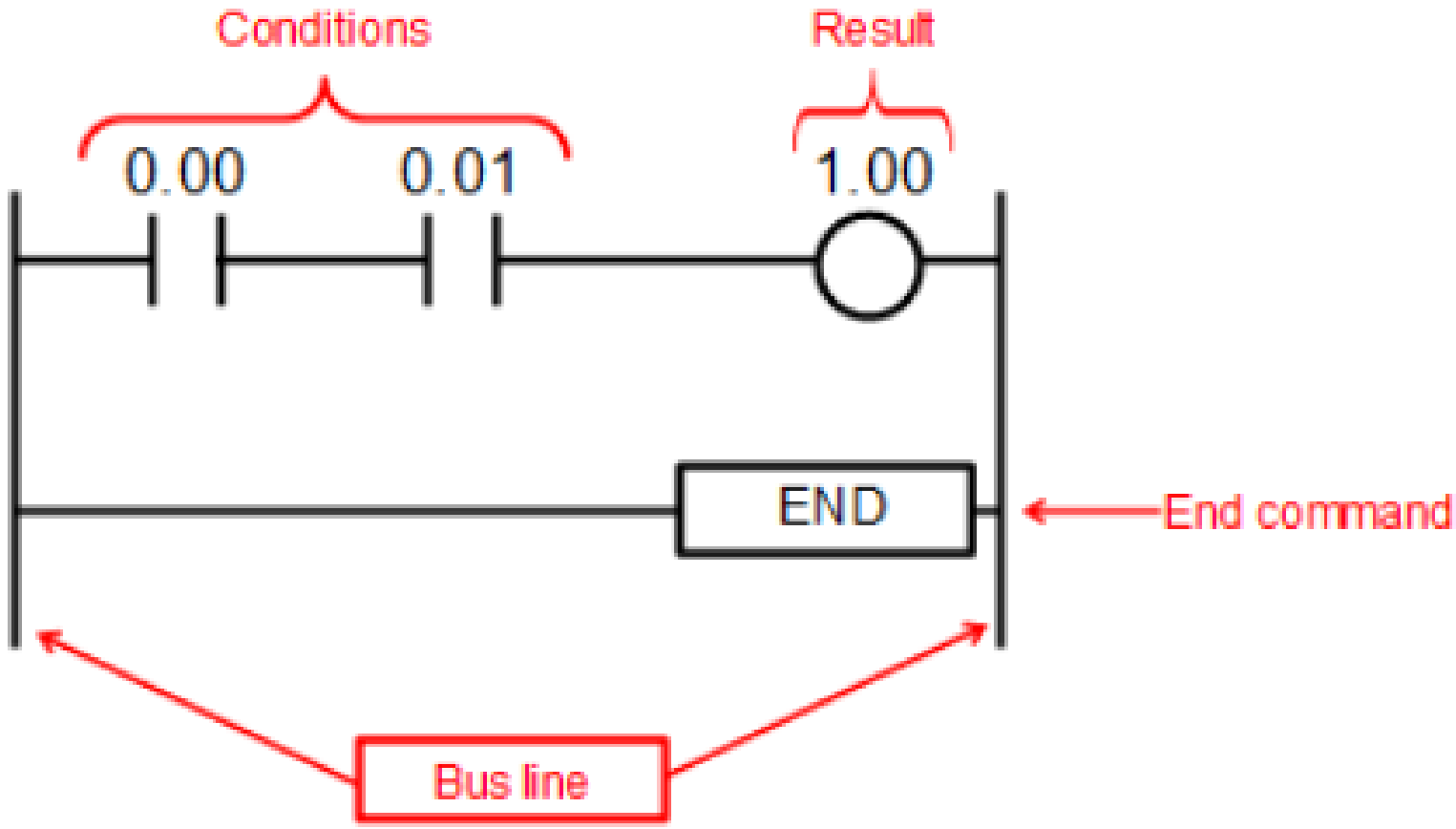
Some basic ladder diagram symbols include Input (NO contacts), Input (NC contacts), and Output.



Different symbols are used to represent different devices in sequence circuit diagrams, but in ladder diagrams, addresses are used to represent different devices.

The example diagram here represents the input device connected at channel 0, bit 00 and the output device at channel 1, bit 05.

Rules on Ladder Diagram Programs



Contact & Coil Instructions

Normally Open (NO) Contact Instruction

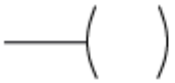
%I2.4
"Start_Motor2"

Normally Closed (NC) Contact Instruction

%I3.5
"Limit_Switch5"

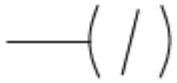
Output Coil Instruction

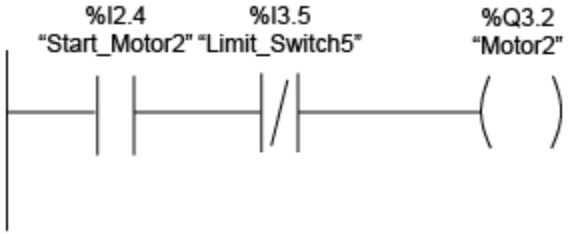
%Q3.2
"Motor2"



Inverted Output Coil Instruction
(Not available for S7-200, S7-300, and S7-400 PLCs)

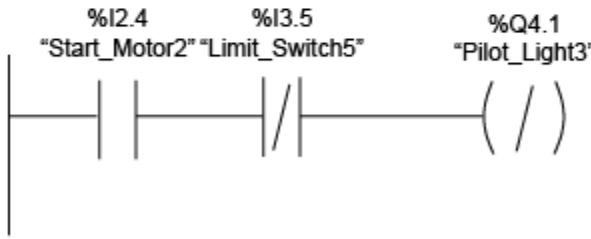
%Q4.1
"Pilot_Light3"





Truth Table

I2.4	I3.5	Q3.2
0	0	0
0	1	0
1	0	1
1	1	0

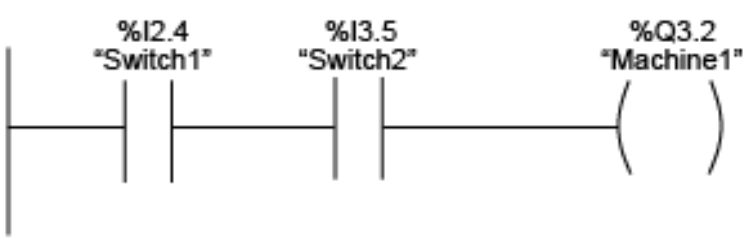


Truth Table

I2.4	I3.5	Q4.1
0	0	1
0	1	1
1	0	0
1	1	1

AND, OR & XOR Instructions

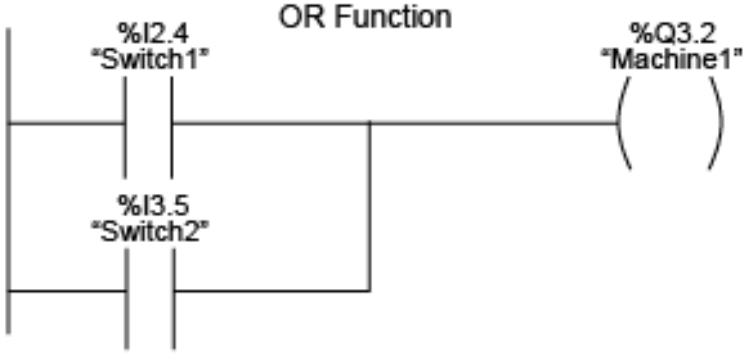
AND Function



Truth Table

I2.4	I3.5	Q3.2
0	0	0
0	1	0
1	0	0
1	1	1

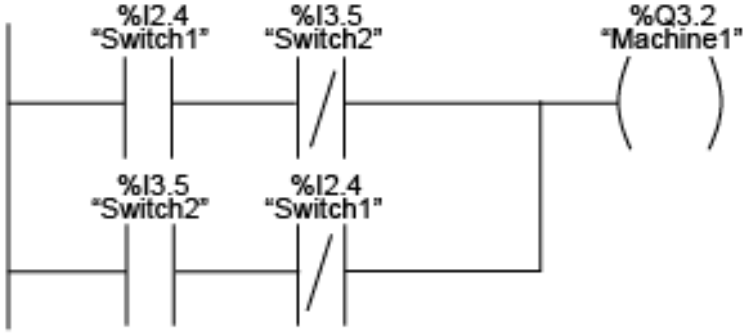
OR Function



Truth Table

I2.4	I3.5	Q3.2
0	0	0
0	1	1
1	0	1
1	1	1

Exclusive OR (XOR) Function



Truth Table

I2.4	I3.5	Q3.2
0	0	0
0	1	1
1	0	1
1	1	0

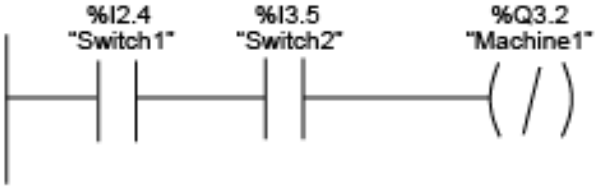
Inversion Instructions

AND Function

Truth Table

I2.4	I3.5	Q3.2
0	0	0
0	1	0
1	0	0
1	1	1

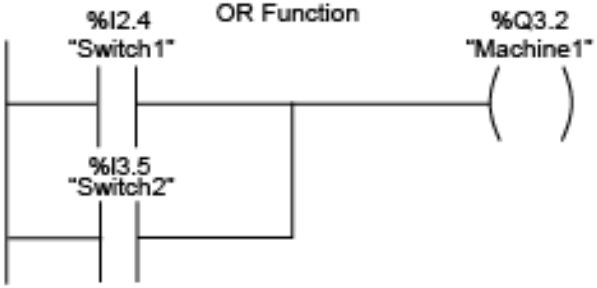
NAND Function



Truth Table

I2.4	I3.5	Q3.2
0	0	1
0	1	1
1	0	1
1	1	0

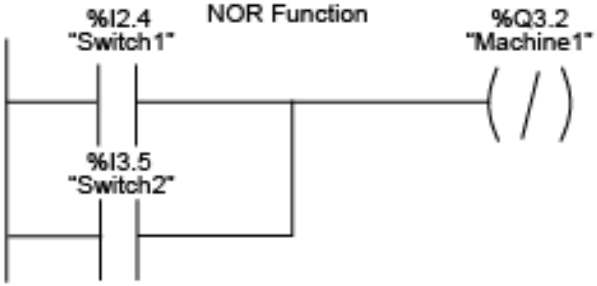
OR Function



Truth Table

I2.4	I3.5	Q3.2
0	0	0
0	1	1
1	0	1
1	1	1

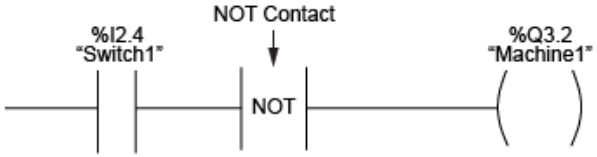
NOR Function



Truth Table

I2.4	I3.5	Q3.2
0	0	1
0	1	0
1	0	0
1	1	0

NOT Contact



Truth Table

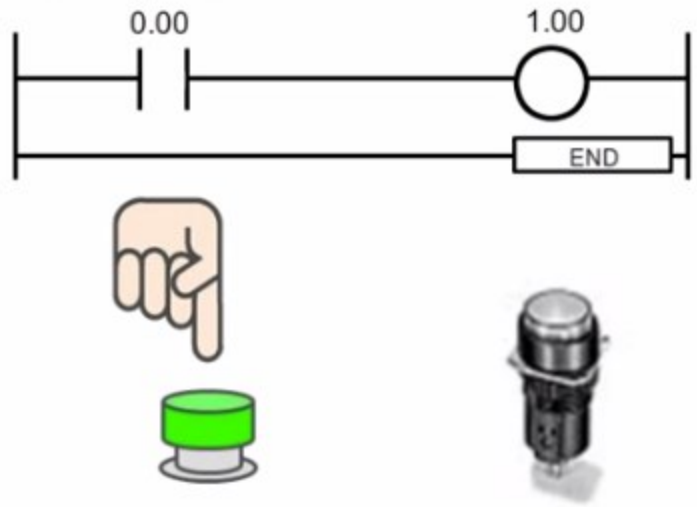
I2.4	Q3.2
0	1
1	0

Truth Table

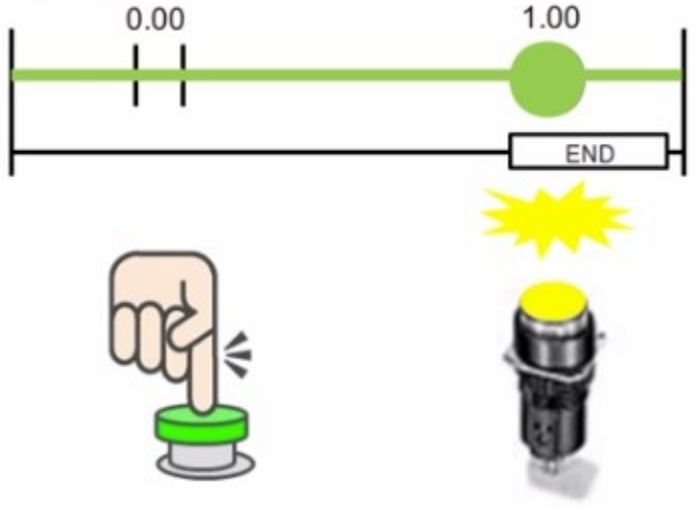
I2.4	Q3.2
0	0
1	1

NO CONTACT

<Ladder Diagram>



<Ladder Diagram>



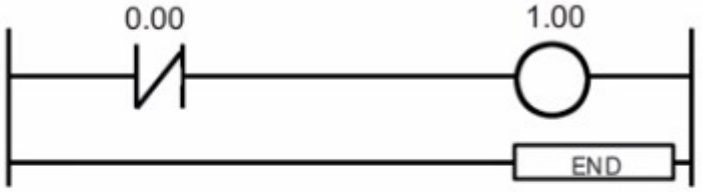
<Time Chart>

Clicking the link in blue characters opens a separate page with a definition of the term.

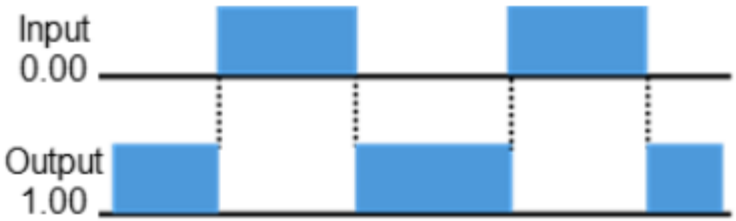
NC CONTACT

<Ladder Diagram>

<Ladder Diagram>

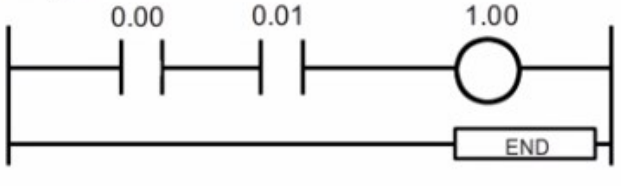


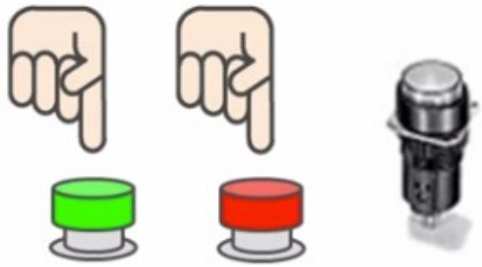
<Time Chart>



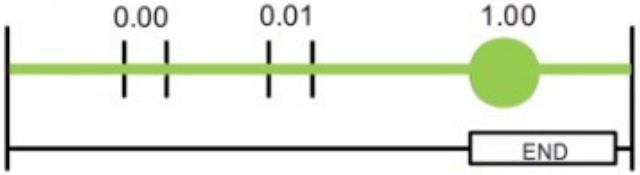
AND GATE

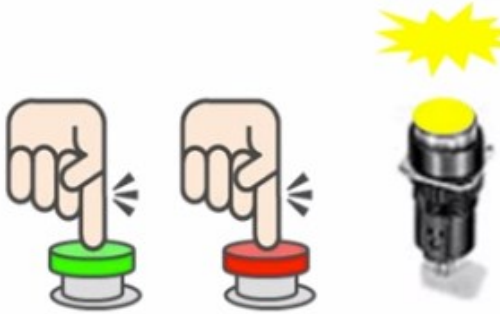
<Ladder Diagram>



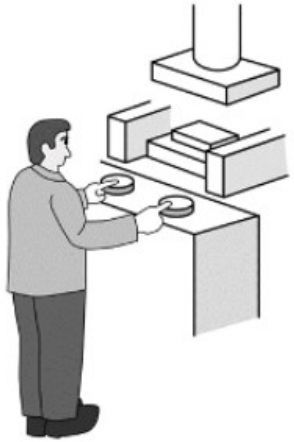


<Ladder Diagram>

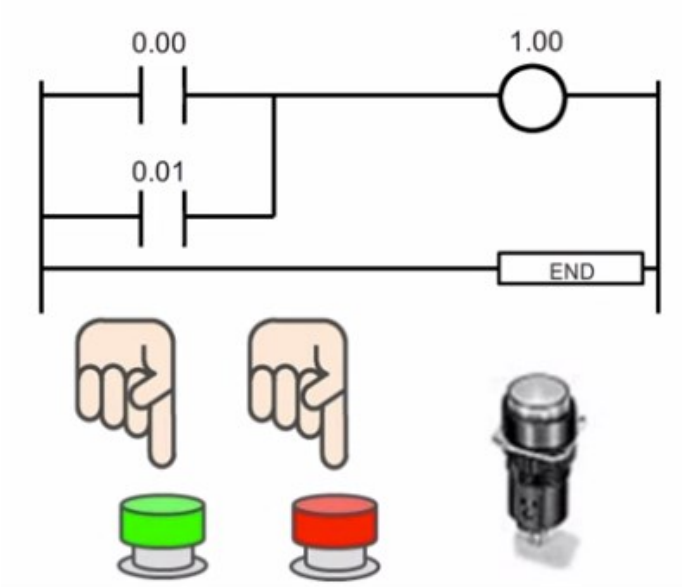


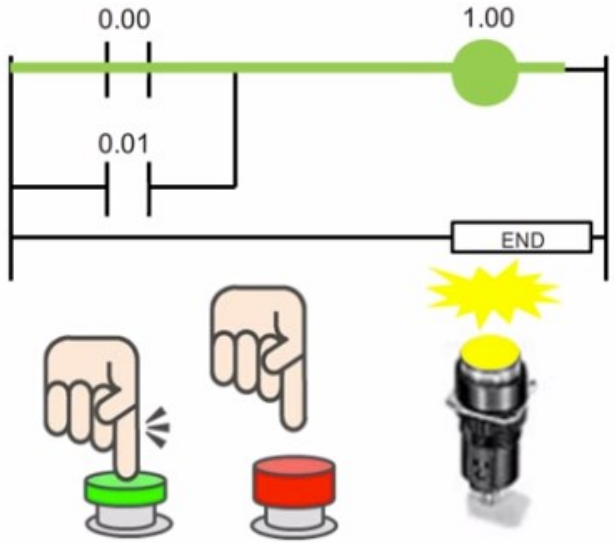


<Time Chart>



OR GATE





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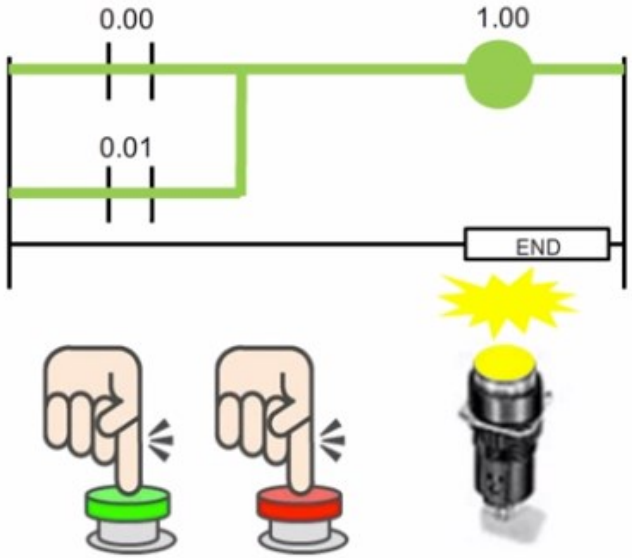

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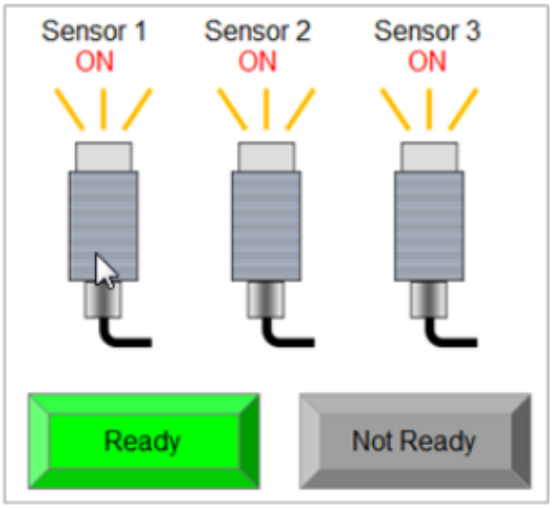
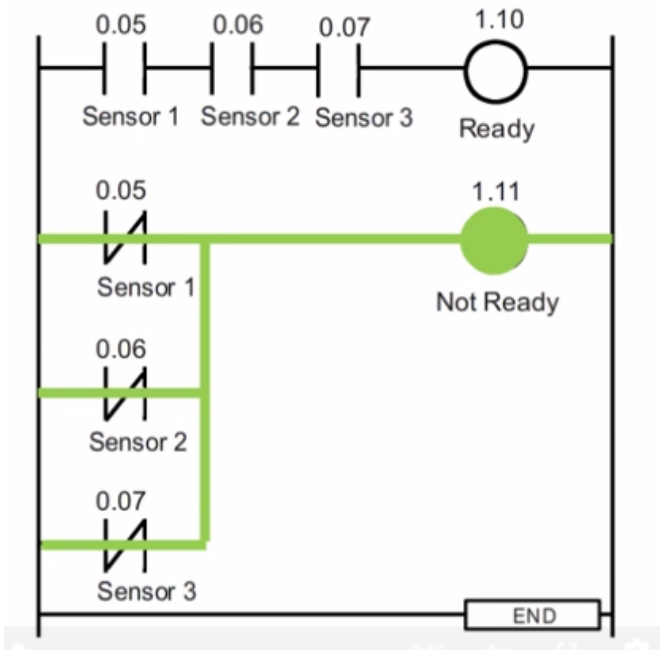
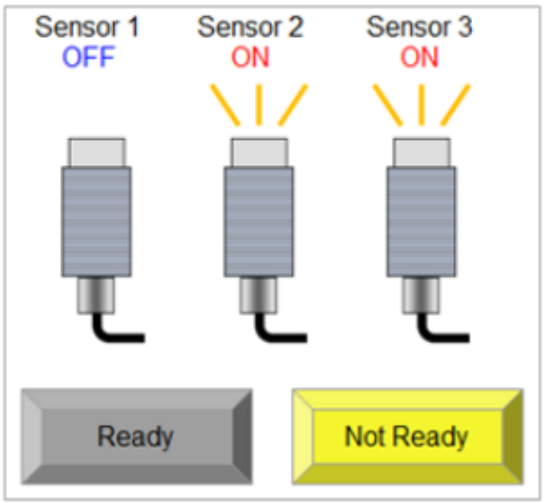

Sensor 1
ON
Sensor 2
ON
Sensor 3
ON
Ready
Not Ready


0.05
0.06
0.07
1.10
Sensor 1
Sensor 2
Sensor 3
Ready
0.05
1.11
Sensor 1
Not Ready
0.06
Sensor 2
0.07
Sensor 3
END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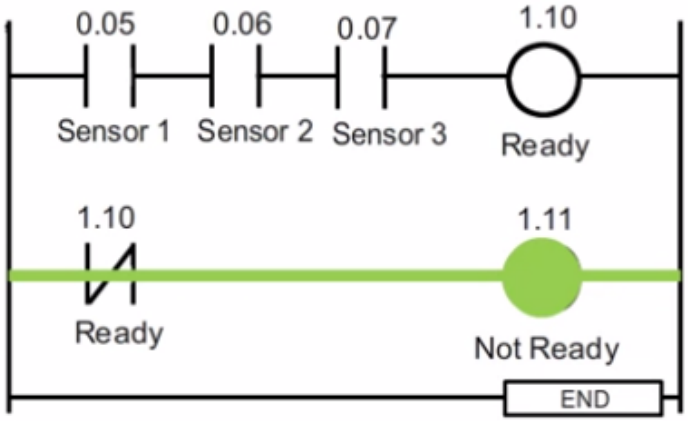
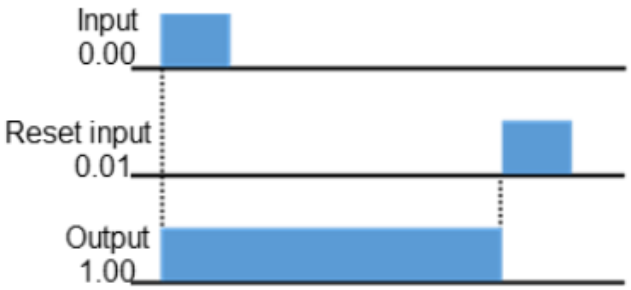
OFF
Sensor 2
ON
Sensor 3
ON
Ready
Not Ready


0.05
0.06
0.07
1.10
Sensor 1
Sensor 2
Sensor 3
Ready
1.10
1.11
Ready
Not Ready
END

Self Holding

<Time Chart>



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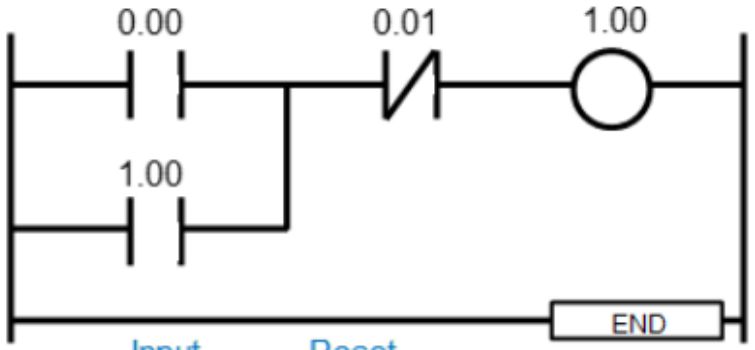
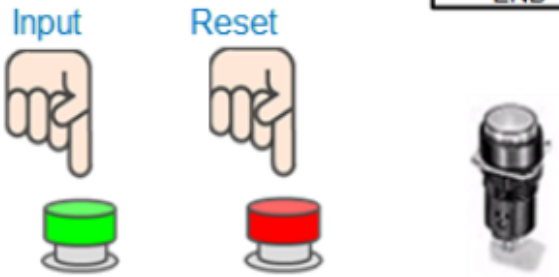
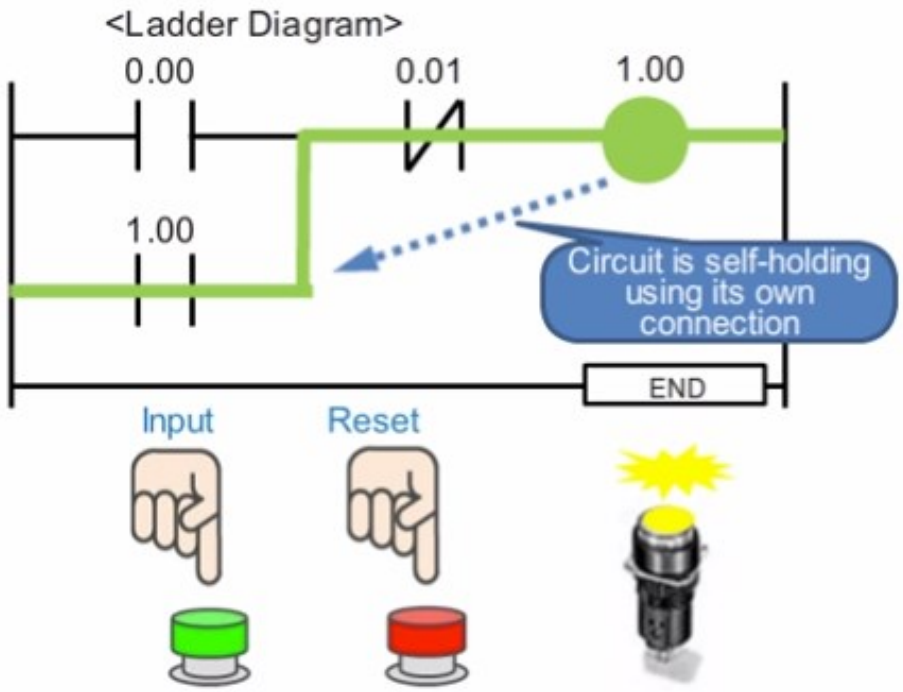




Self Holding



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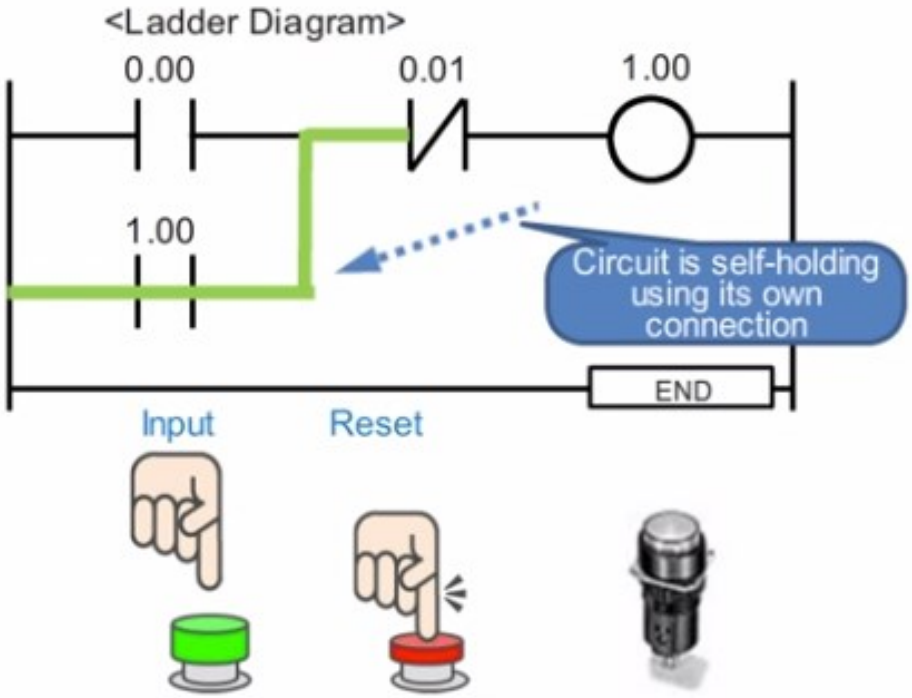
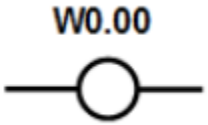


Reset

Work Area



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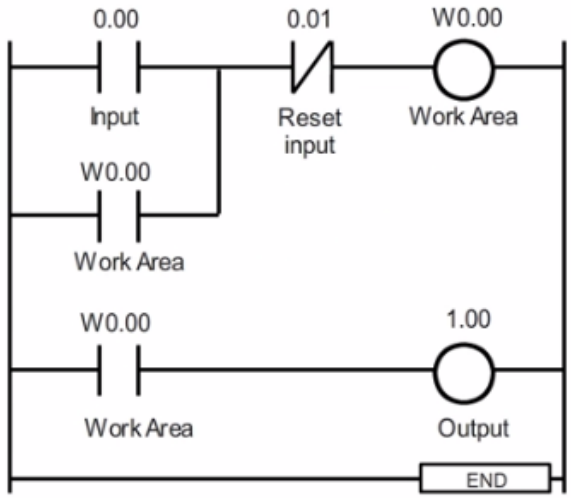

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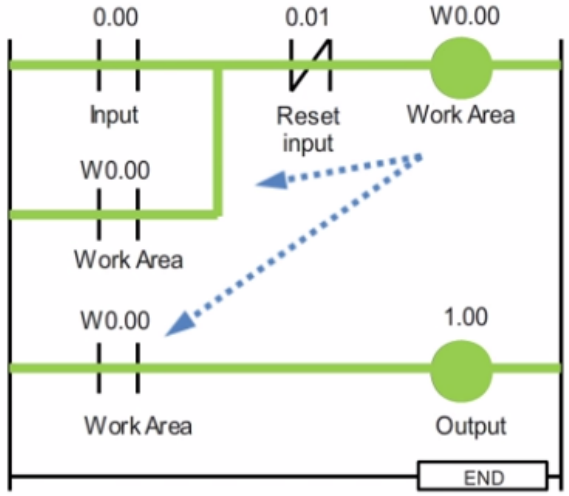

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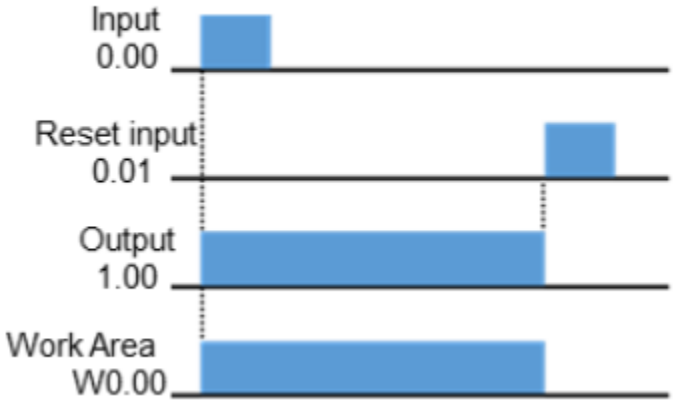
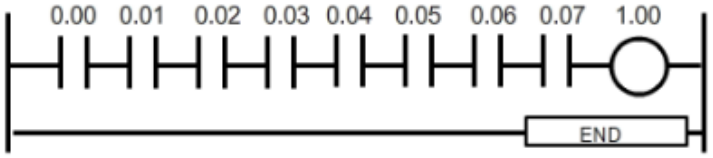
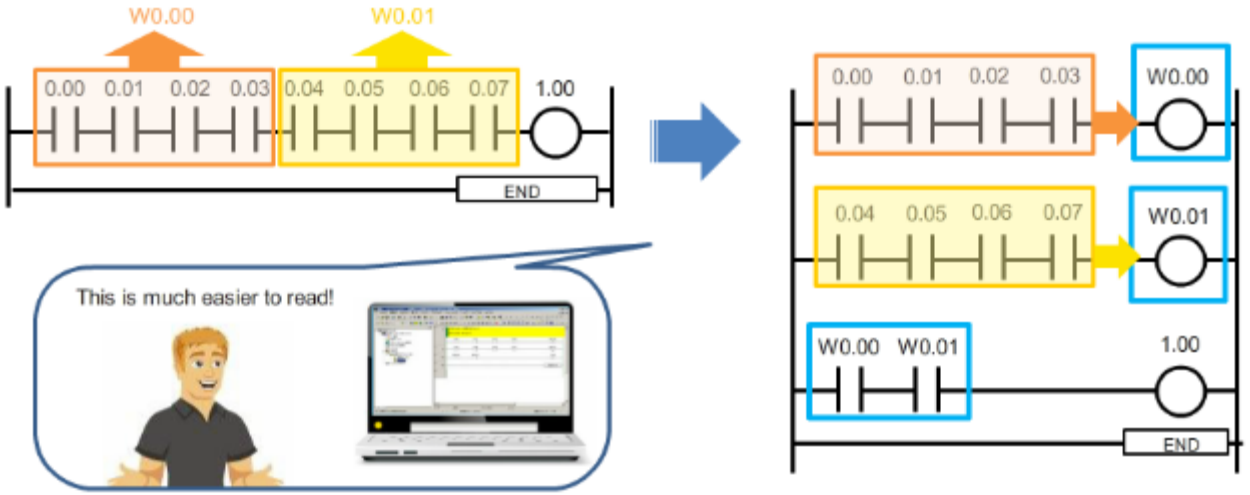
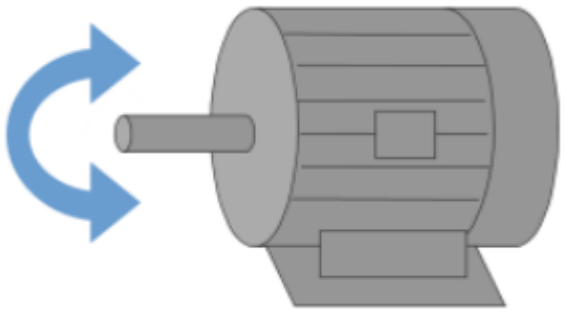


Simplified Using Work Area

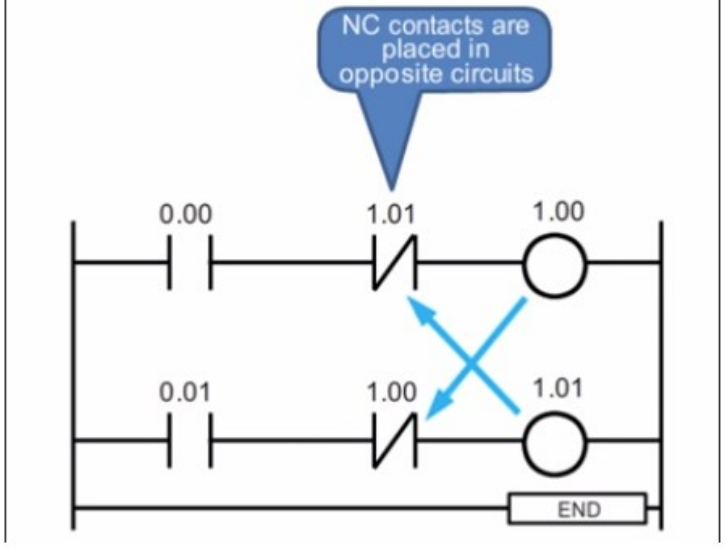


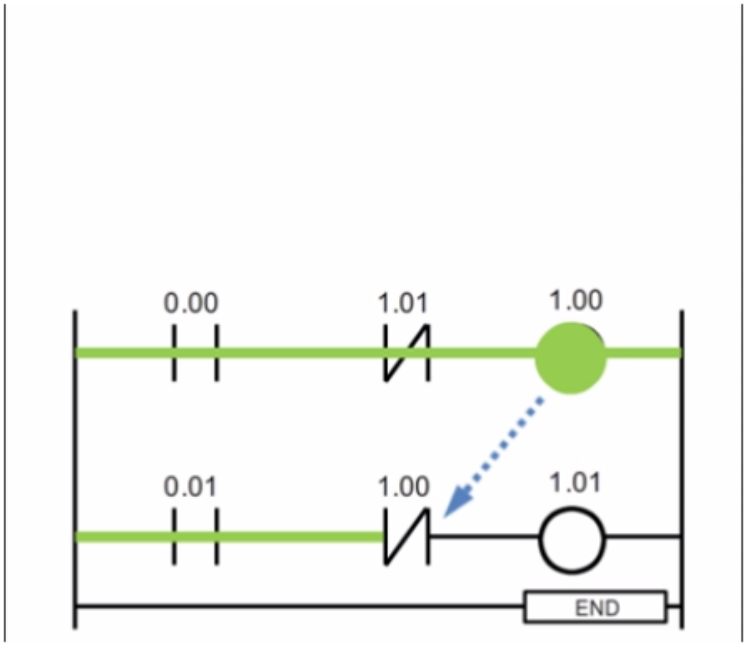


Interlock

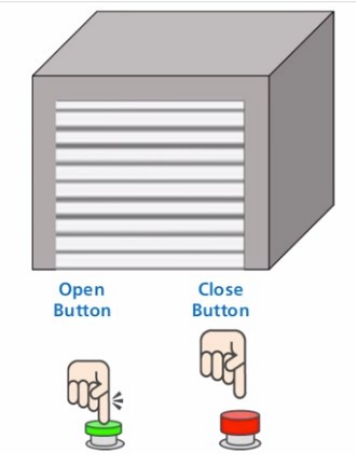


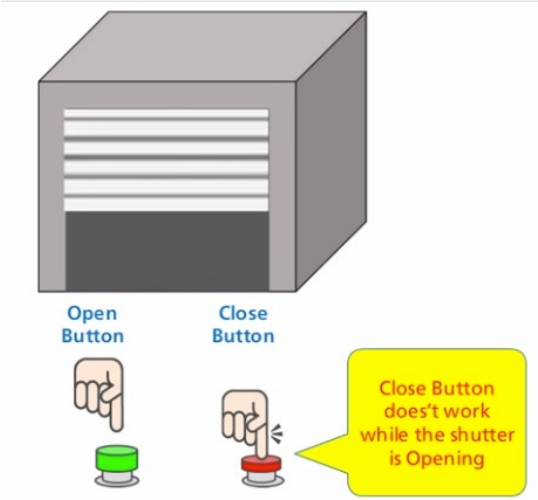
Sirkuit Pengaman (Interlock)
Motor tidak berputar bersamaan pada 2 arah yang berlawanan

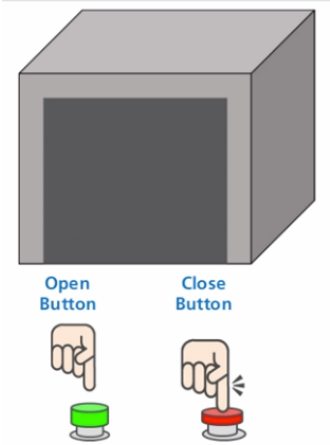


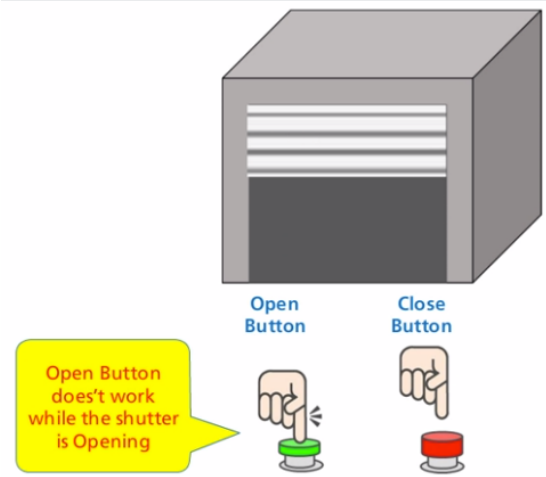


Interlock Application





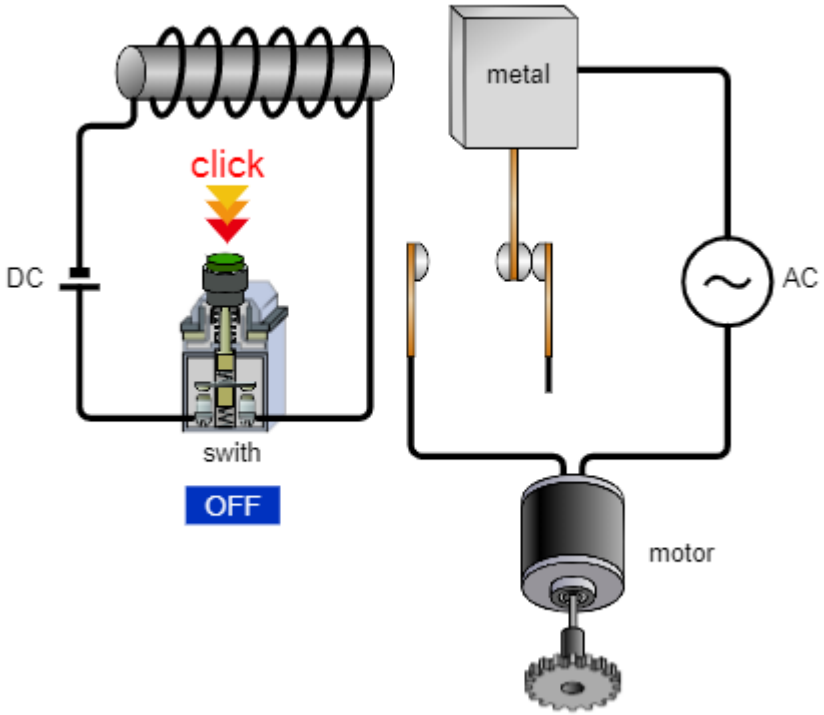


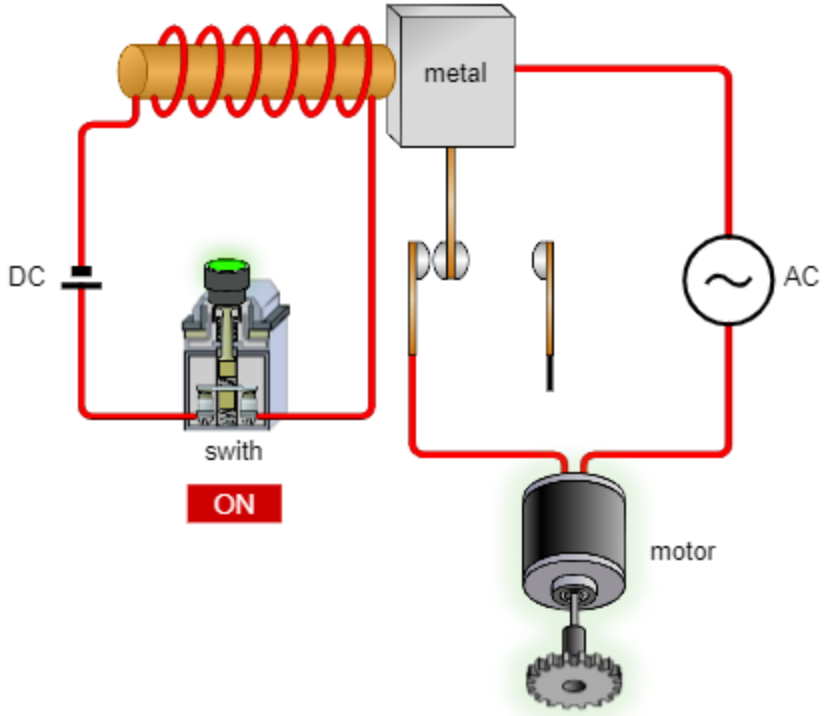


RELAY

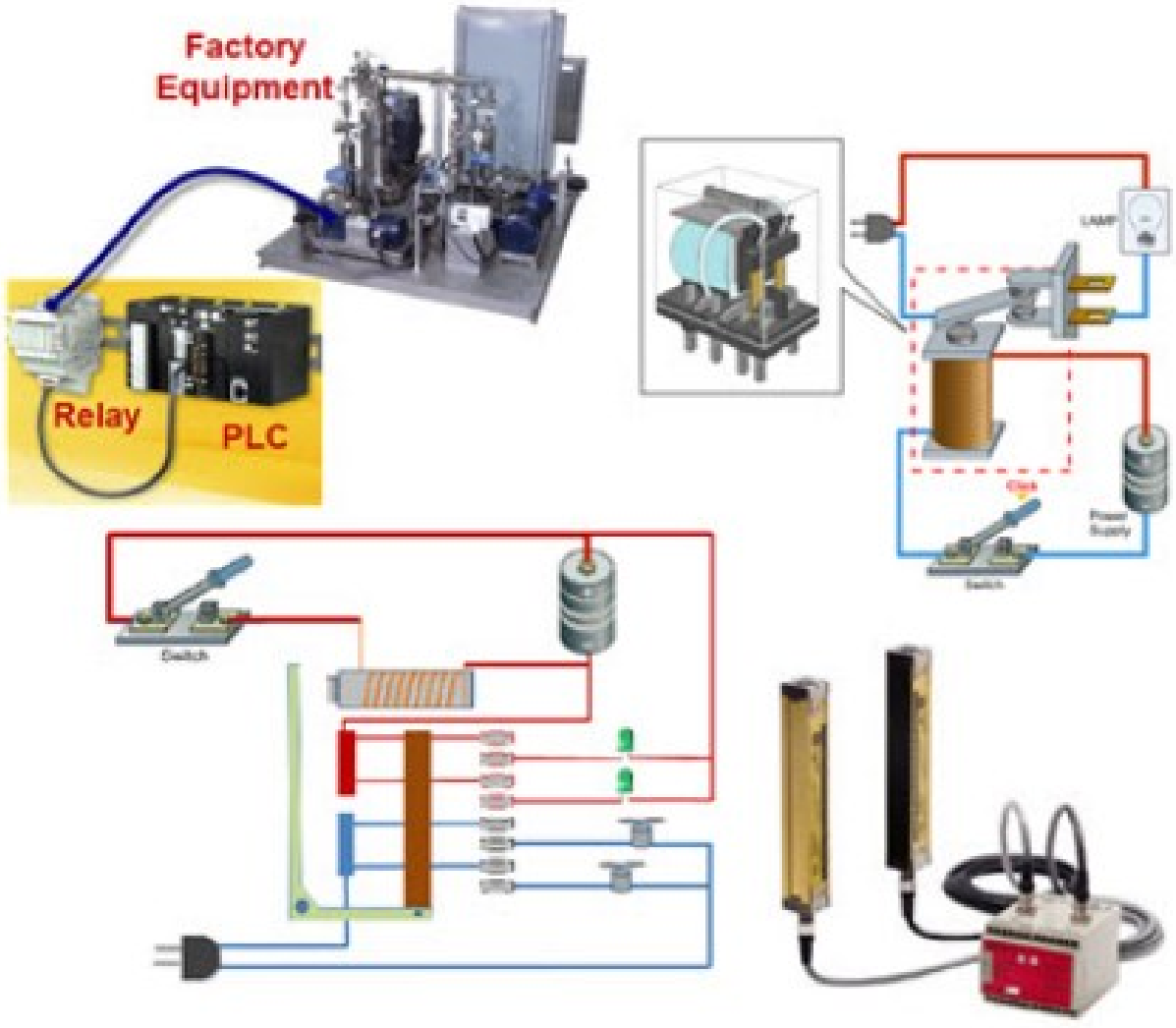
Relay is an **electrically operated switch.**

Electric → **Magnetic** → **Mechanical**





RELAY

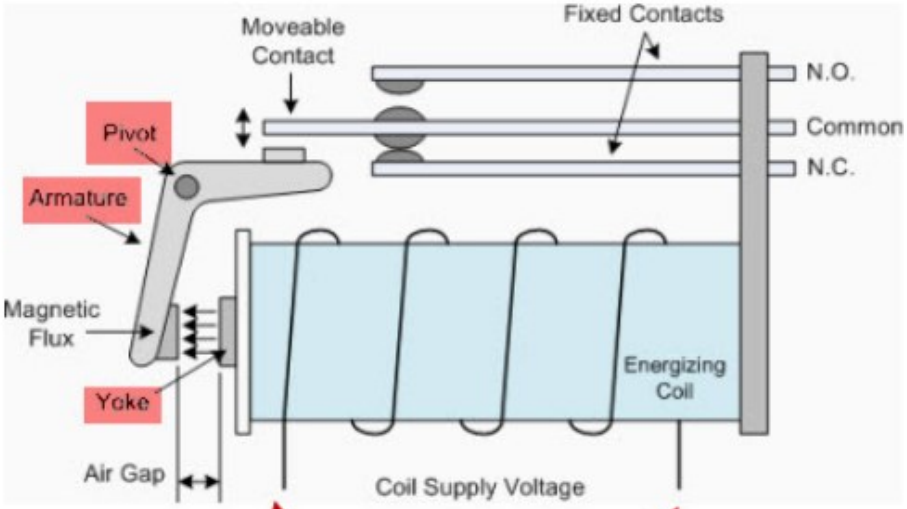


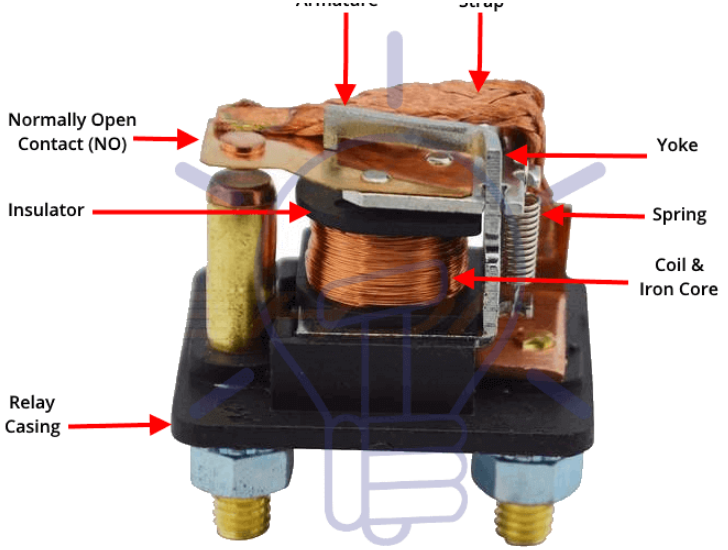
RELAY

Electromechanical relays perform many functions. Some include:

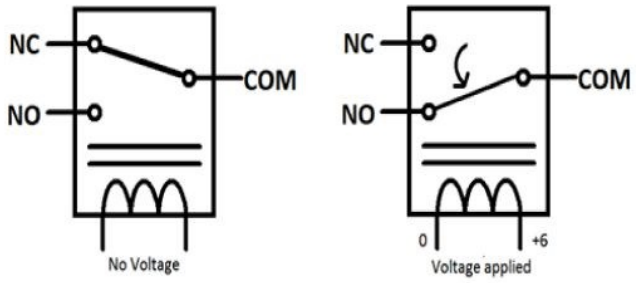
- Isolation of control circuits from load circuits, or AC powered circuits from DC powered circuits.
- Switching multiple currents or voltages to different loads using one control signal.
- Monitoring industrial safety systems and disconnecting power to machinery if safety is compromised.
- Using several to provide simple logic functions such as 'AND,' 'NOT,' or 'OR' for sequential control or safety interlocks.

RELAY CONSTRUCTION





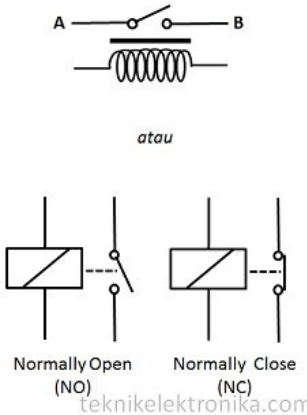
Construction of a Relay



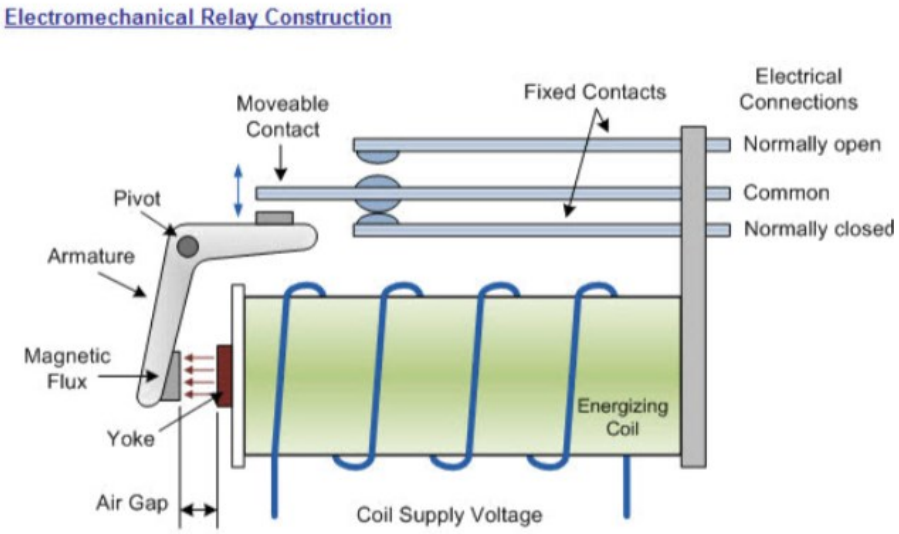
SPDT Relay Working

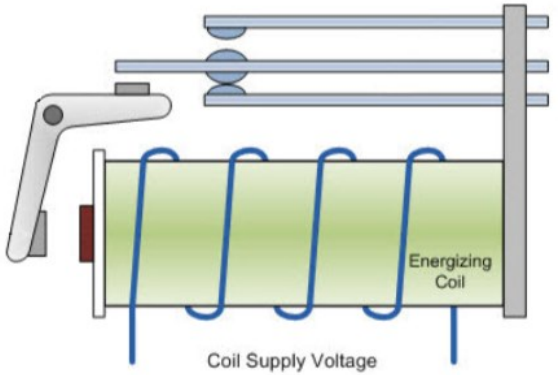
Gambar bentuk Relay

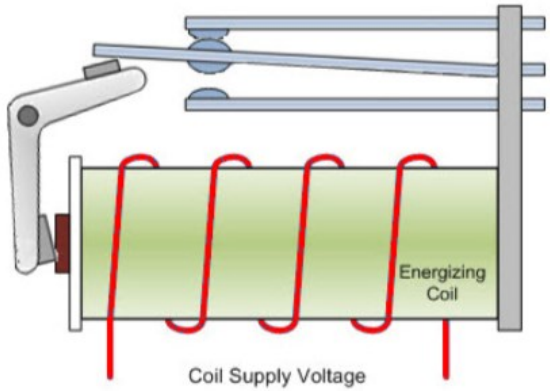
Simbol Relay



BASIC OPERATION

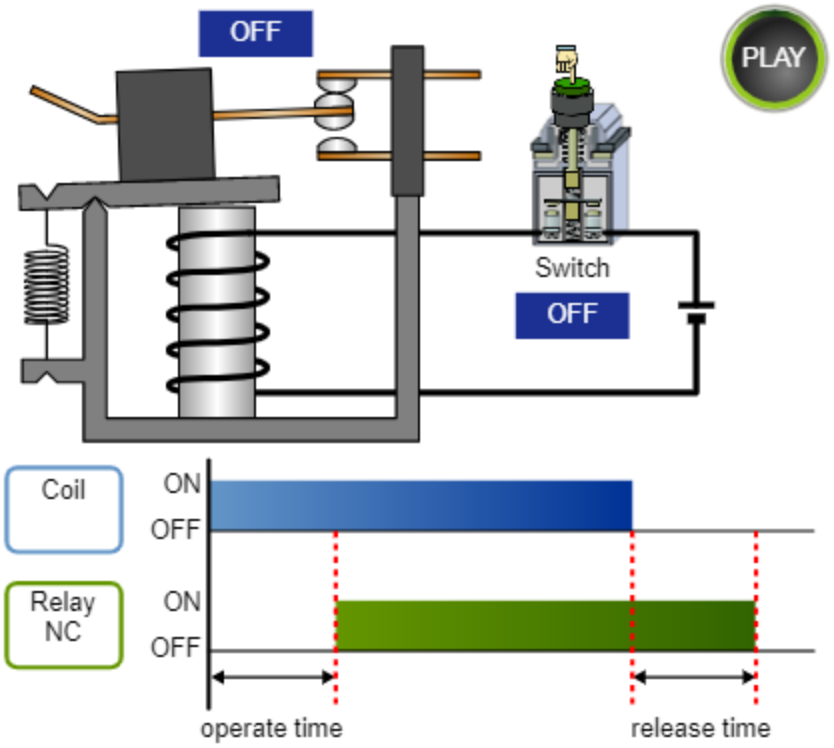






1. Power is applied to the coil inducing a magnetic field.
2. The magnetic field is converted into a mechanical force by attracting the armature.
3. The moving armature closes/opens one or more electrical contacts
4. The contacts allow switching of power to the load such as a motor, lamp, etc
5. Once coil voltage is removed, the magnetic field collapses, the contacts separate, and return to their "normal" position.

RELAY CONTACT OPERATION



The **Operate time** is the time between energizing the coil and first contact closure, not including contact bounce.

The **Release time** is time it takes the contacts to open after power has been removed from the relay coil.

RATING SPESIFICATION

Contact Ratings

Item	2-pole	
	Resistive load (cosΦ = 1)	Inductive loa (cosΦ = 0.4 L/R = 7 ms)
Rated load	5A, 250 VAC 5A, 30 VDC	2A, 250 VAC 2 A, 30 VDC
Carry current	10 A (see note)	
Max. switching voltage	250 VAC 125 VDC	
Max. switching current	10 A	
Max. switching power	2,500 VA 300 W	1,250 VA 300 W
Failure rate	5 VDC, 1 mA	

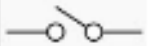
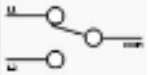
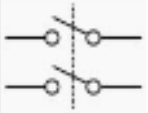
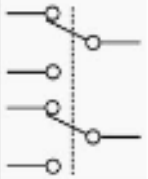
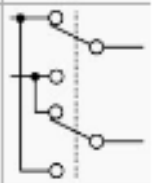
Coil Ratings

Rated voltage		
		5
AC	6 V*	214.1
	12 V	106.5
	24 V	53.8 m
	48/50 V*	24.7/ 25.7
	110/120 V	9.9/10
	220/240 V	4.8/5.3
DC	6 V*	151 mA
	12 V	75 mA
	24 V	37.7

CONTACT TIP MATERIAL

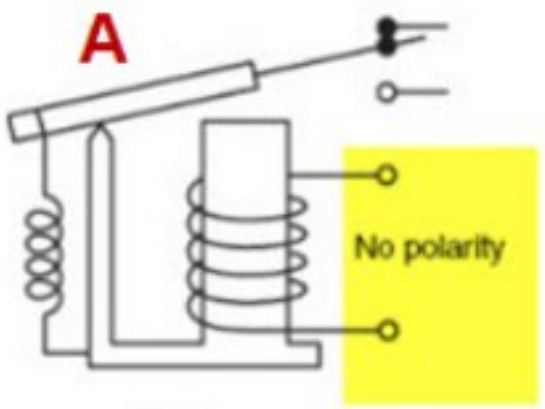
Contact Tip Material	Characteristics
Ag (fine silver)	Electrical and thermal conductivity are the highest of all metals, exhibits low contact resistance, is inexpensive and widely used. Contacts tarnish through sulphur influence.
AgCu (silver copper)	"Hard silver", better wear resistance and less tendency to weld, but slightly higher contact resistance.
AgSnIn (silver tin indium)	Better resistance to welding than cadmium which is not RoHS compliant. Good for high inrush currents and offers long life.
AgW (silver tungsten)	Hardness and melting point are high, arc resistance is excellent. Not a precious metal. High contact pressure is required. Contact resistance is relatively high, and resistance to corrosion is poor.
AgNi (silver nickel)	Equals the electrical conductivity of silver, excellent arc resistance.
AgPd (silver palladium)	Low contact wear, greater hardness. Expensive.
platinum, gold and silver alloys	Excellent corrosion resistance, used mainly for low-current circuits.

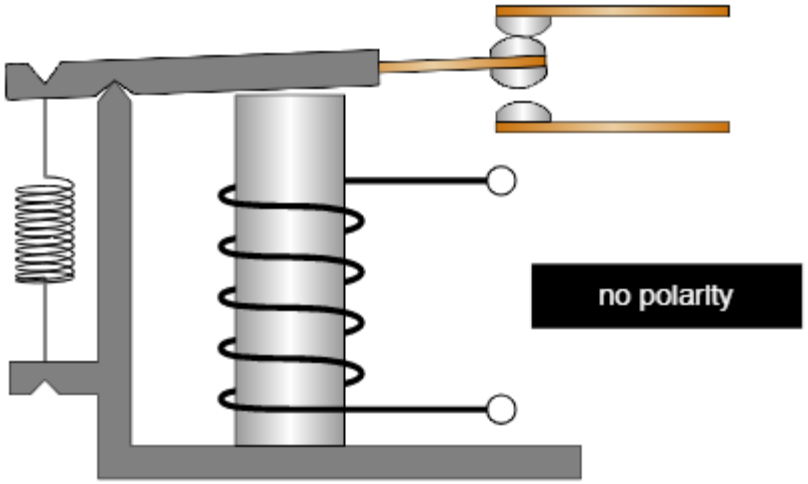
CONTACTs CONFIGURATIONs

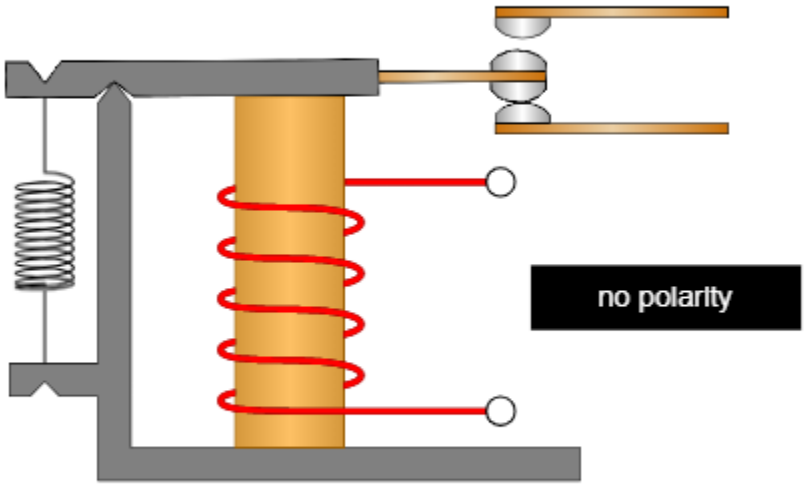
Electronics specification and abbreviation	Expansion of abbreviation	British mains wiring name	American electrical wiring name	Description	Symbol
SPST	Single pole, single throw	One-way	Two-way	A simple on-off switch. The two terminals are either connected together or disconnected from each other. An example is a light switch.	
SPDT	Single pole, double throw	Two way	Three way	A simple changeover switch: C (COM, Common) is connected to L1 or to L2.	
SPCO SPTT, c.o.	Single pole changeover *or* Single pole, centre off *or* Single Pole, Triple Throw			Similar to *SPDT*. Some suppliers use *SPCO/SPTT* for switches with a stable off position in the centre and *SPDT* for those without. [citation needed]	
DPST	Double pole, single throw	Double pole	Double pole	Equivalent to two SPST switches controlled by a single mechanism	
DPDT	Double pole, double throw			Equivalent to two *SPDT* switches controlled by a single mechanism: A is connected to B and D to E, or A is connected to C and D to F.	
DPCO	Double pole changeover *or* Double pole, centre off			Equivalent to *DPDT*. Some suppliers use *DPCO* for switches with a stable off position in the centre and *DPDT* for those without.	
		Intermediate switch	Four way switch	*DPDT* switch internally wired for polarity-reversal applications: only four rather than six wires are brought outside the switch housing; with the above, B is connected to F and C to E; hence A is connected to B and D to C, or A is connected to C and D to B.	

RELAY

Relay A will work with DC or AC and proper polarity of the wiring is not required for relay operation.



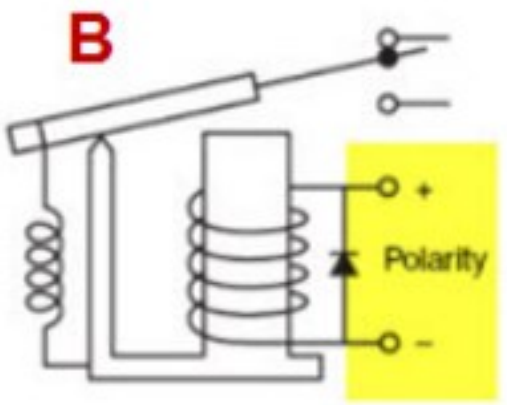


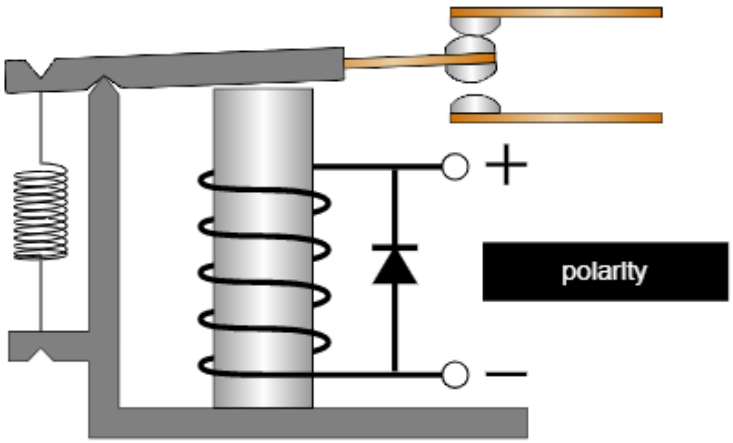


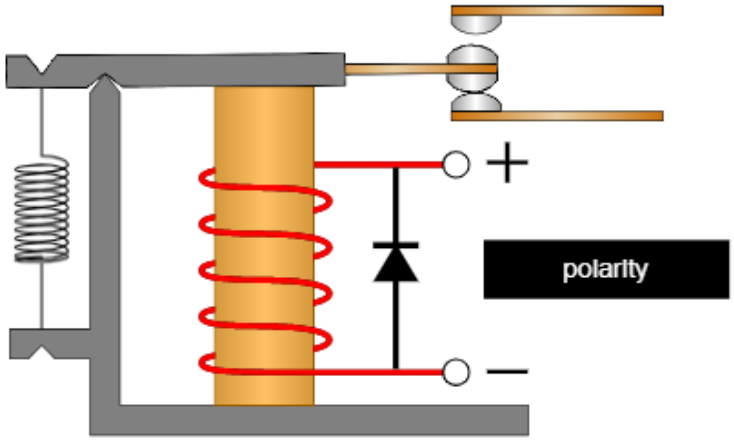
PLAY

RELAY

Relay B includes a surge absorbing diode across the relay coil to absorb the back electromotive force when the coil is de-energized. Care must be taken when connecting this type of relay to maintain proper polarity.



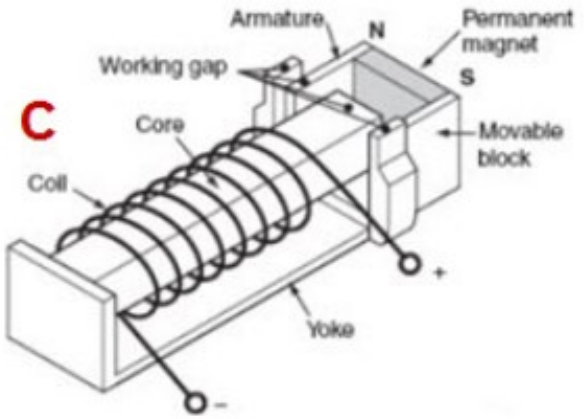


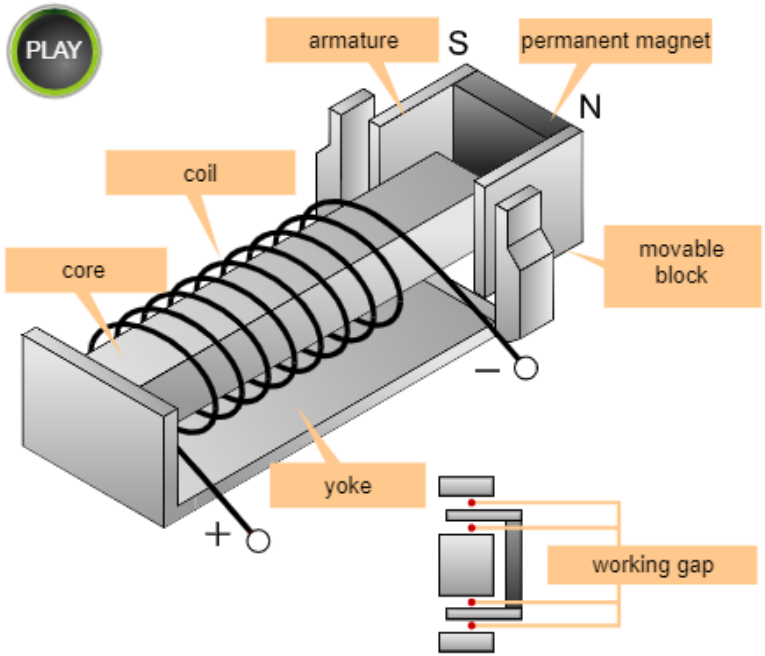


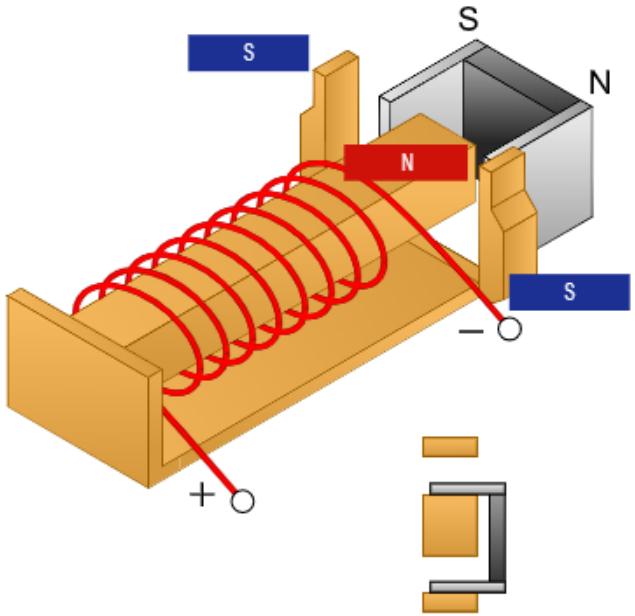
PLAY

RELAY

Relay C uses a permanent magnet to assist the electromagnetic force. The pole of the coil at the working gap is either North or South depending on the polarity of the coil.

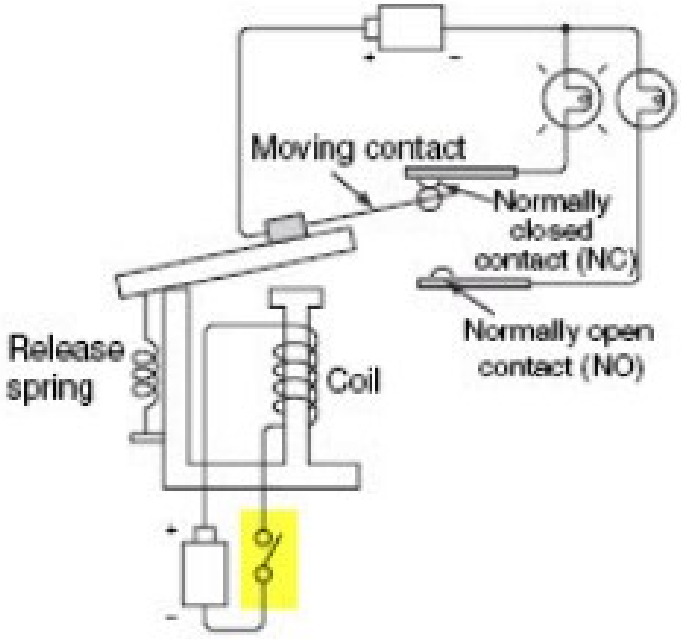




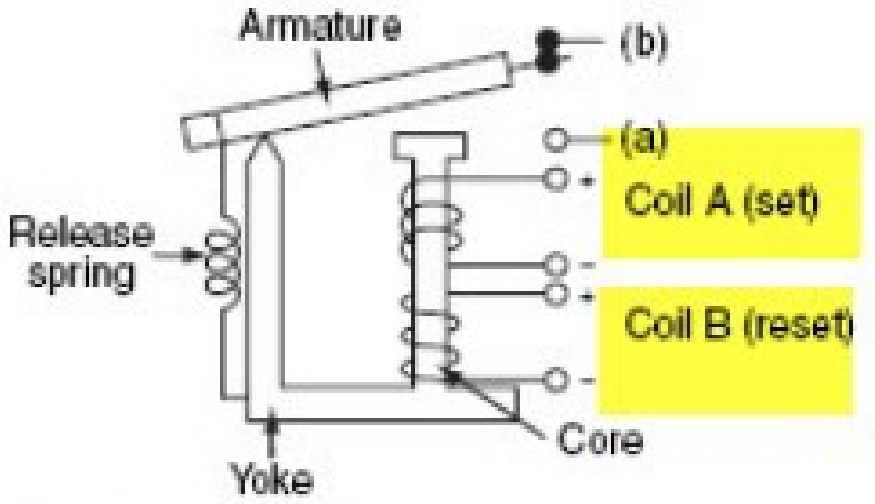


Latching vs. Non-Latching

Relays can be **Latching (Bistable) or Non-Latching (Monostable).**



Non-Latching Relay

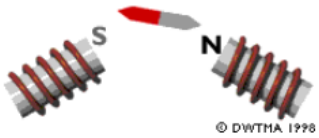


Latching Relay

AC DRIVE

An **AC Drive** is a device used to control the **rotational speed** of an AC (alternating current) motor by controlling the **frequency** of the electrical power supplied to the motor.

Motor Induksi
(Alternating Current/AC)

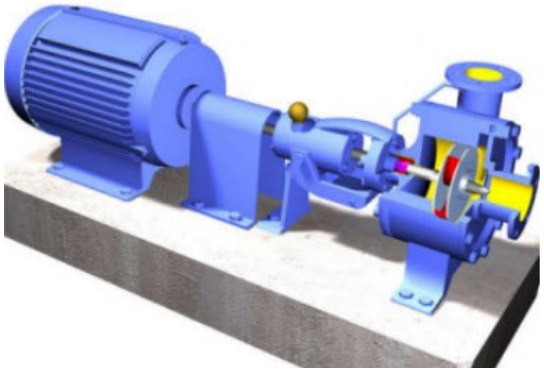


RPM

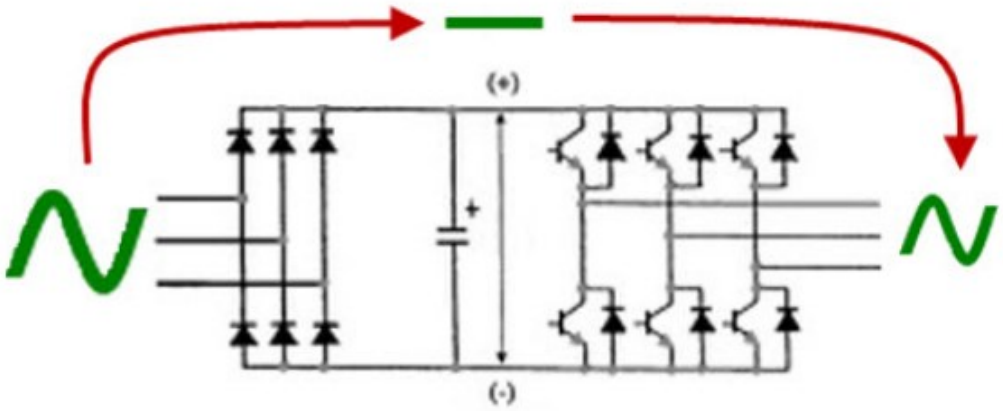
MPH

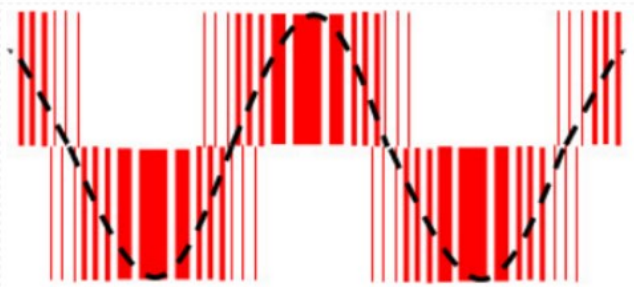
Type of AC DRIVEs

- Volts/Hz Drives (Open Loop)
- Sensorless Vector Drives (Open Loop)
- Vector Drives with feedback (Closed Loop)

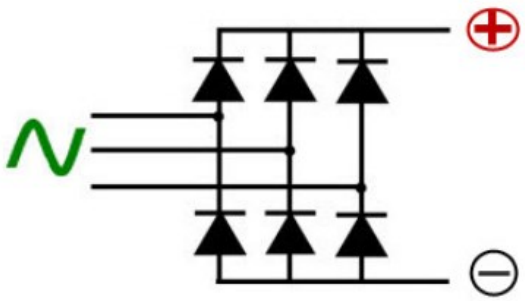


AC DRIVE COMPONENTS



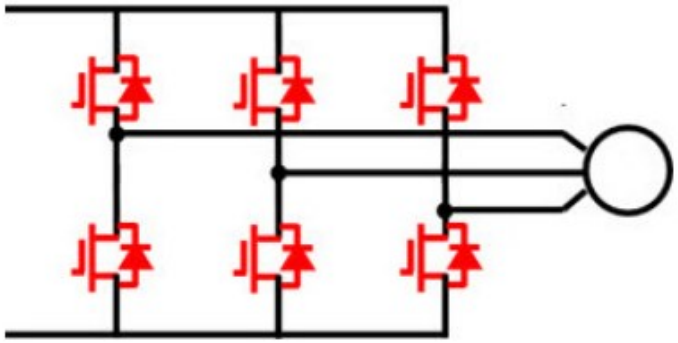


PWM
(DC to AC)



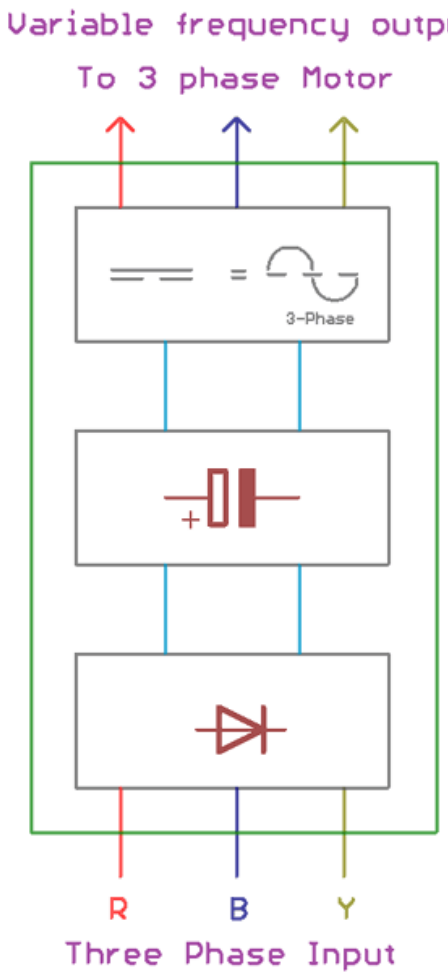
Rectifier/Penyearah
(AC to DC)

Capacitor
(Power Store)

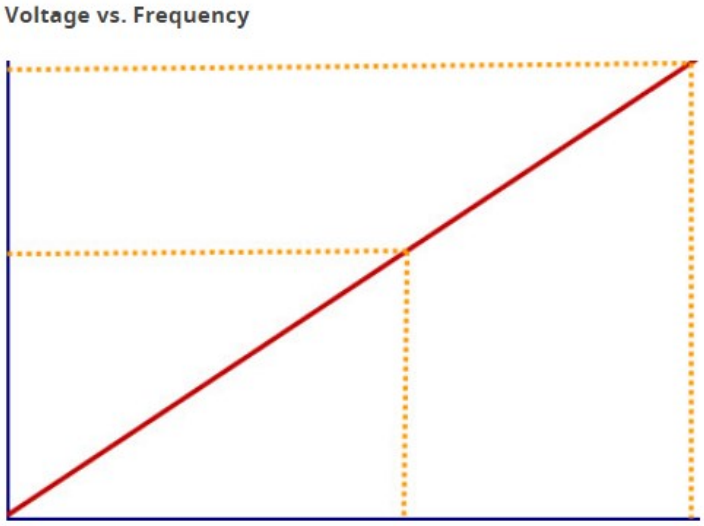


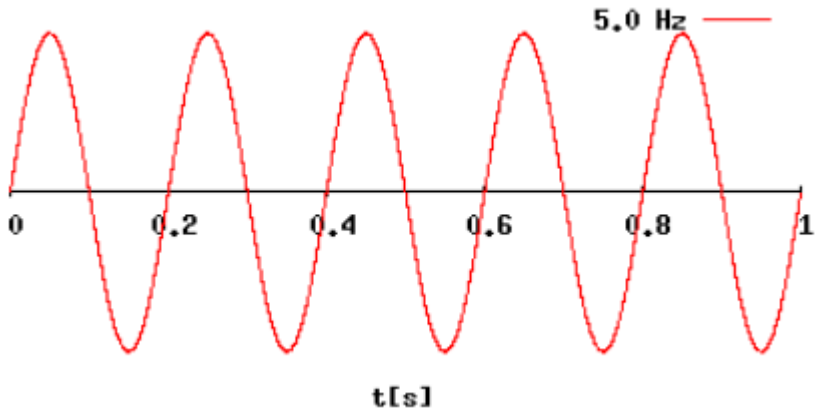
IGBT
(Transistor)

Volts per Hertz Drives

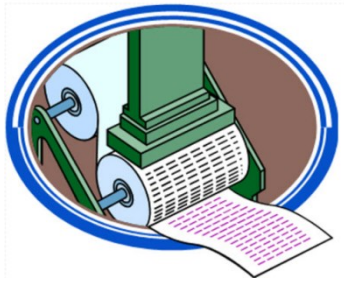


VSI drive topologies



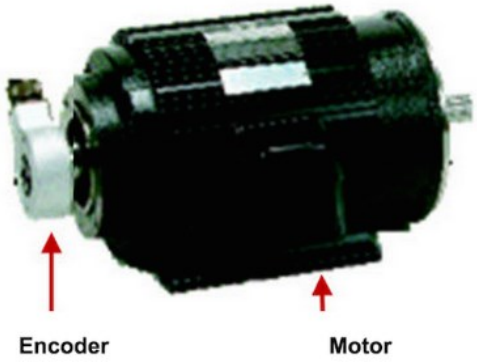


Sensorless Vector Drives



- PWM Mode (Pulse Width Modulation)
- High starting torque at low speeds (200% at 0.5Hz)
- Speed regulation is improved to <1% error
- Speed and torque reference inputs
- Self-tuning & Torque control without feedback
- Can be used with permanent magnet motors, and high speed motors up to 1000 Hz
- Low dynamic performance on sudden changing loads
- Lack the ability to hold a motor at zero speed

Vector Drives with Feedback Device



- This drive is currently the only type of AC Drive available with similar or equivalent performance to DC Drives.
- These drives monitor the voltage and current outputs, as well as encoder feedback from the motor for closed loop Vector control.
- This feedback is used to adjust the output waveform to achieve the tightest speed control.