PROGRAMMABLE LOGIC CONTROLLER

Prashant Ambadekar

INTRODUCTION

A programmable logic controller (PLC) is

- a user friendly micro-processor based microcomputer
- consisting of hardware and software
- designed to control the operation of Industrial equipment and processes.

Advantage: PLC can be easily programmed and reprogrammed.

PLC has tremendous impact on Industrial control and instrumentation due to

- its high reliability
- flexibility at the design and implementation stages.

Need of PLC

A computer having i/p o/p interfaces can be used to control external devices.

Computers are not industrially hardened.

Cannot handle line-voltages and currents above certain levels.

Not designed to with-stand the temperature, humidity, and vibration on shop floors.

These drawbacks of a general purpose computer have been rectified by developing a PLC.

DEFINATION

PLC can be defined as digital electronic device that uses a programmable memory to store instructions and to implement functions such as logic, sequencing, counting and timing in order to control machine, processes and instrumentation

“A digitally operating electronic system, designed for use in an industrial environment, which uses a programmable memory for the internal storage of user- oriented instructions for implementing specific functions such as logic , sequencing , timing , counting and arithmetic, to control through digital or analog inputs and outputs, various types of machines or processes.

DEFINATION

According to NEMA (National Electrical Manufacture’s Association ,USA),the definition of PLC has been given as:

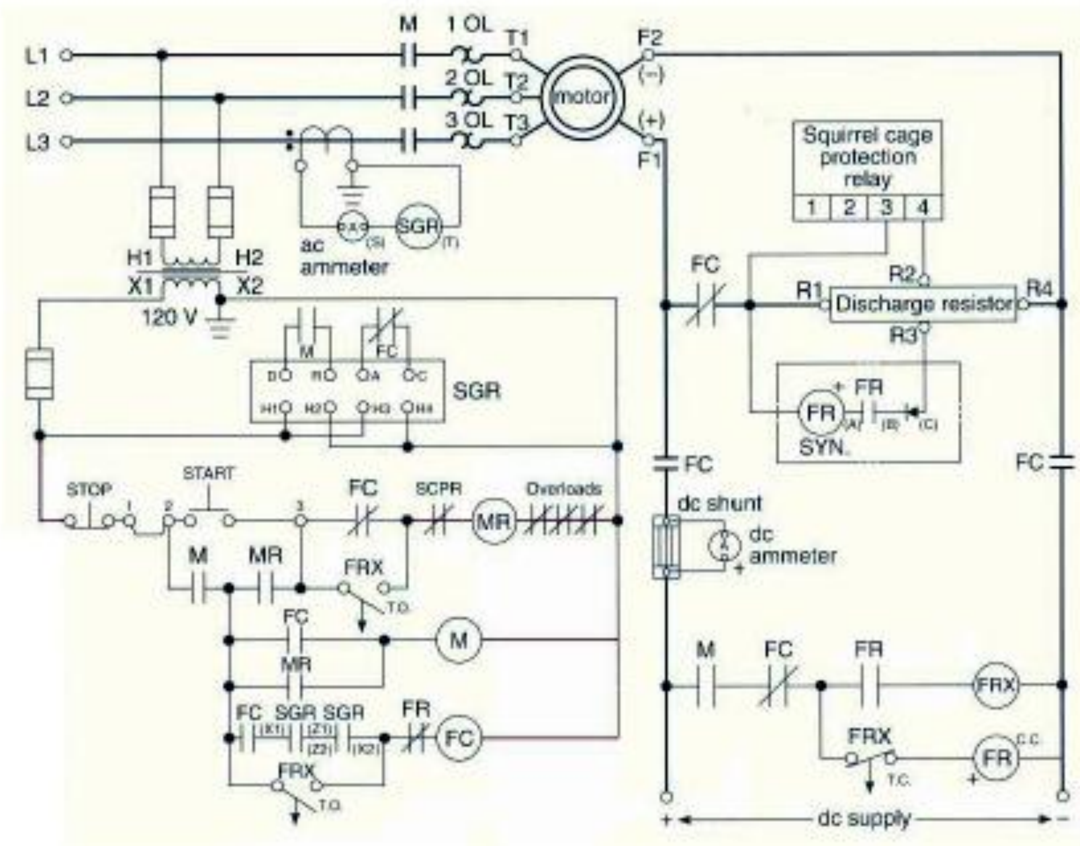
“Digital electronic devices that uses a programmable memory to store instructions and to implement specific functions such as logic , sequencing, timing, counting, and arithmetic to control machines and processes.”

Advantages of PLC Control Systems

- Flexible
- Faster response time
- Less and simpler wiring
- Solid-state - no moving parts
- Modular design - easy to repair and expand
- Handles much more complicated systems
- Sophisticated instruction sets available
- Allows for diagnostics “easy to troubleshoot”
- Less expensive

Advantages of a PLC Control System

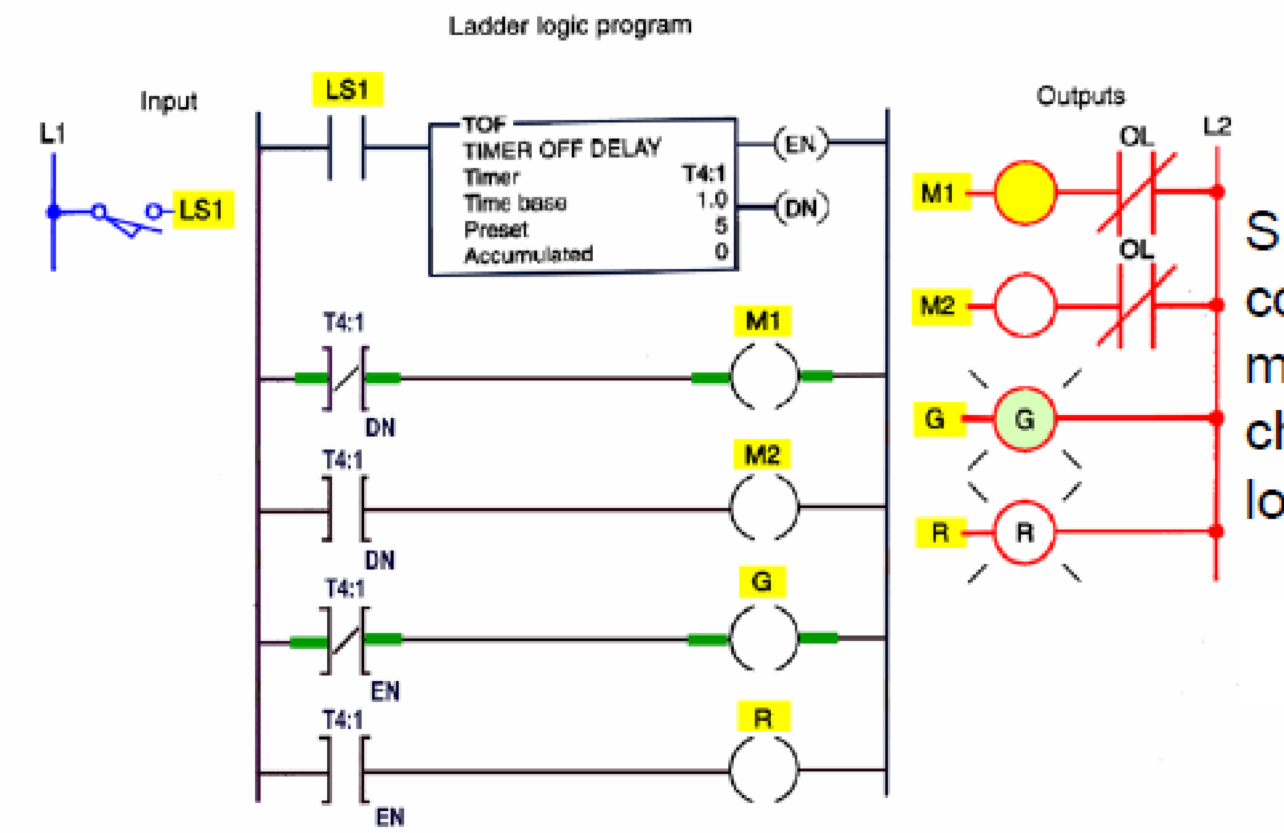
Eliminates much of the hard wiring that was associated with conventional relay control circuits.



The program takes the place of much of the external wiring that would be required for control of a process.

Advantages of a PLC Control System

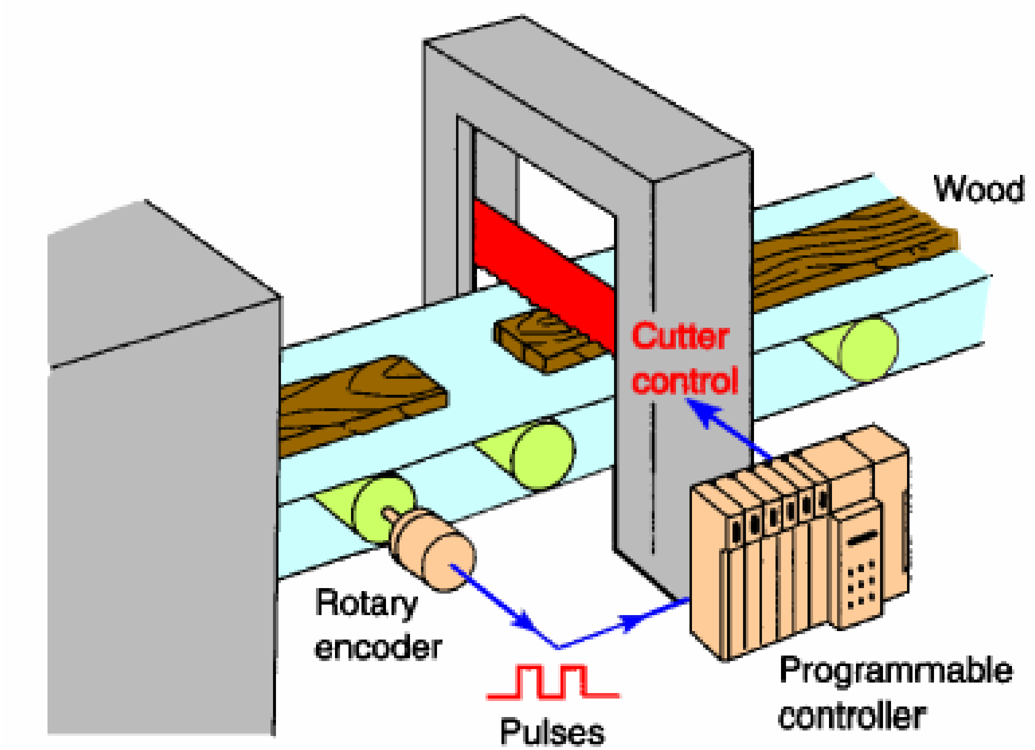
Increased Reliability:
Once a program has been written and tested it can be downloaded to other PLCs.



Since all the logic is contained in the PLC's memory, there is no chance of making a logic wiring error.

Advantages of a PLC Control System

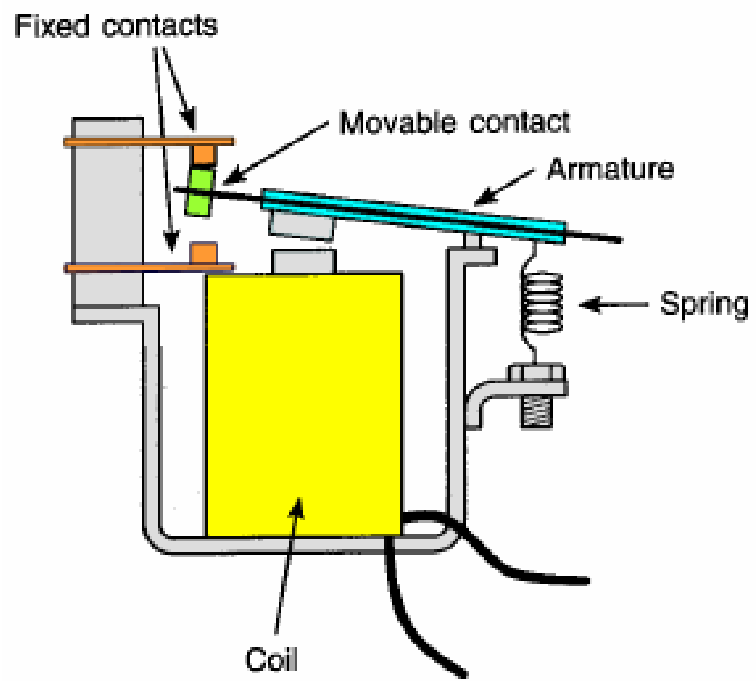
More Flexibility:
Original equipment manufacturers (OEMs) can provide system updates for a process by simply sending out a new program.



It is easier to create and change a program in a PLC than to wire and rewire a circuit. End-users can modify the program in the field.

Advantages of a PLC Control System

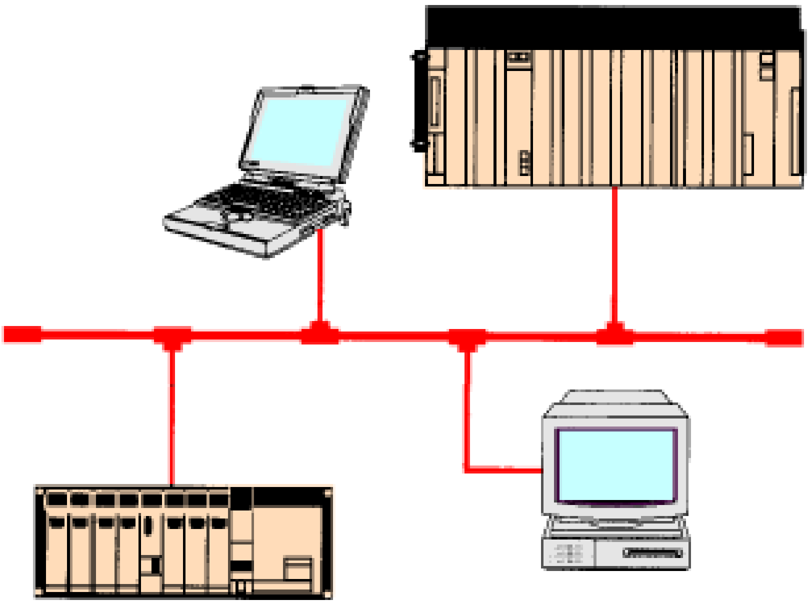
Lower Costs:
Originally PLCs were designed to replace relay control logic. The cost savings using PLCs have been so significant that relay control is becoming obsolete, except for power applications.



Generally, if an application requires more than about 6 control relays, it will usually be less expensive to install a PLC.

Advantages of a PLC Control System

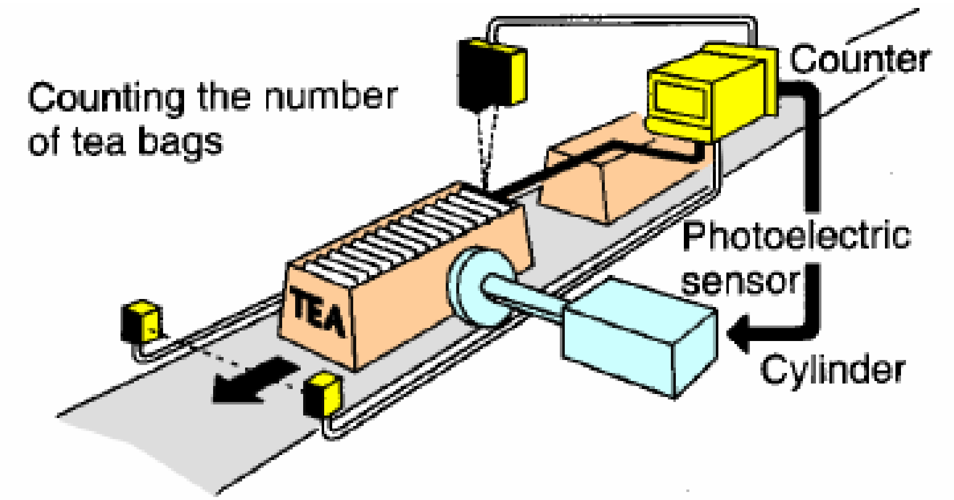
Communications Capability:
A PLC can communicate with other controllers or computer equipment.



They can be networked to perform such functions as: supervisory control, data gathering, monitoring devices and process parameters, and downloading and uploading of programs.

Advantages of a PLC Control System

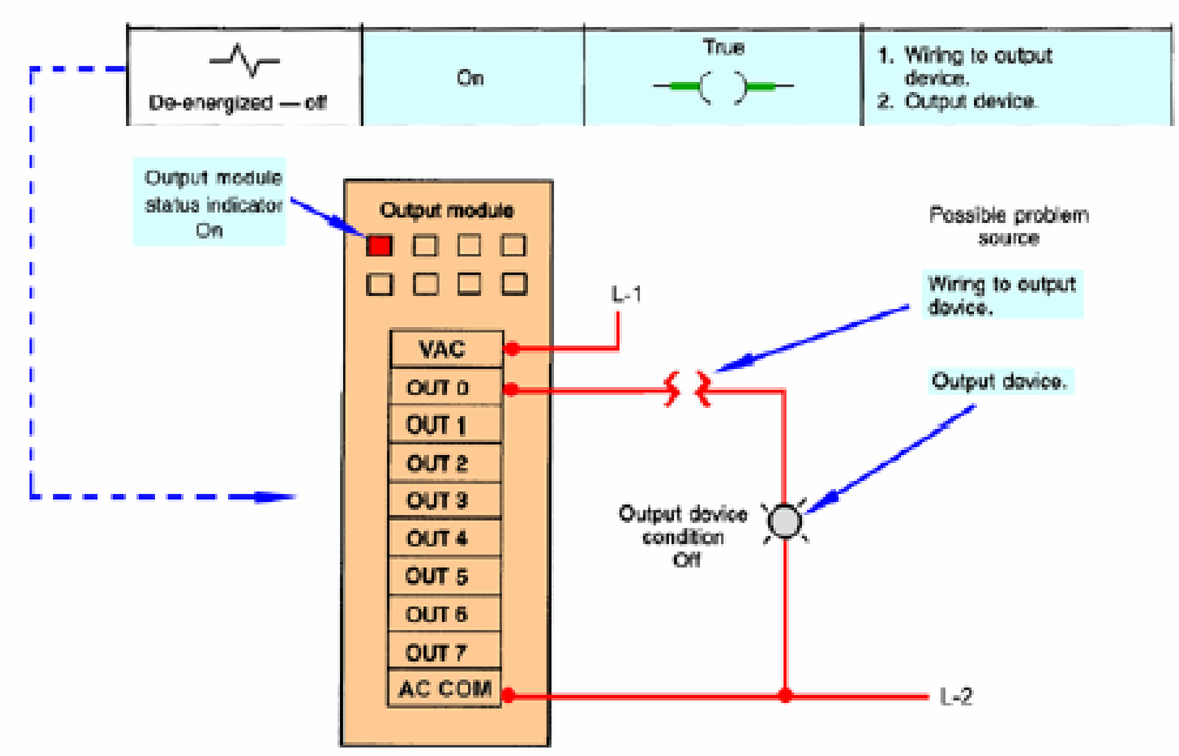
Faster Response Time:
PLCs operate in real-time which means that an event taking place in the field will result in an operation or output taking place.



Machines that process thousands of items per second and objects that spend only a fraction of a second in front of a sensor require the PLC's quick response capability.

Advantages of a PLC Control System

Easier To Troubleshoot:
PLCs have resident diagnostic and override functions allowing users to easily trace and correct software and hardware problems.



The control program can be watched in real-time as it executes to find and fix problems

Comparison between Relay and PLC

Features	**Electromechanical relay**	**PLC**
Size of the controller	Bulky	Compact
Programming	Time consuming	Easy
Flexibility	Rewiring required	Reprogramming required
Cost	Expensive	Less expensive
Maintenance	Poor	Minimum
Fault finding and troubleshooting	Difficult	Easy to identify fault and repair

Application Areas

PLCs are suitable for a variety of automation tasks.
They provide a simple and economic solution to many automation tasks such as :

- Operator control and monitoring
- Plant start-up, shut-down

Any manufacturing application that involves controlling repetitive is a potential candidate for PLC usage:

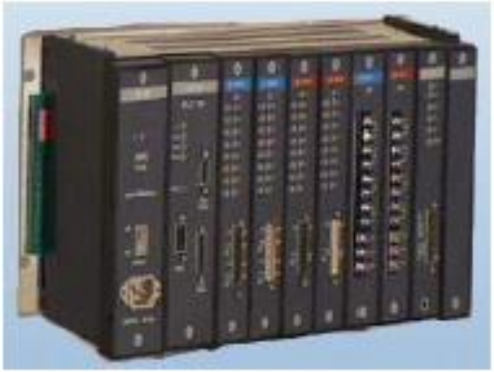
Machine tools,
Automatic assembly equipment,
Molding and extrusion machinery,
Textile machinery,
Automatic test equipment.

Application Areas

Some typical industrial areas that widely deploy PLC controls are

Chemical/ Petrochemical	**Metals**	**Manufacturing /Machining**
Batch process	Blast Furnace	Material Conveyors, Cranes
Pipeline Control	Continuous Casting	Assembly
Weighing, Mixing	Rolling Mills Milling	Grinding, Boring
Finished Product Handling	Soaking Pit Plating	Welding, Painting
Water/ Waste Treatment	Steel Melting Shop	Molding/ casting/forming

PLCs Versus Personal Computers



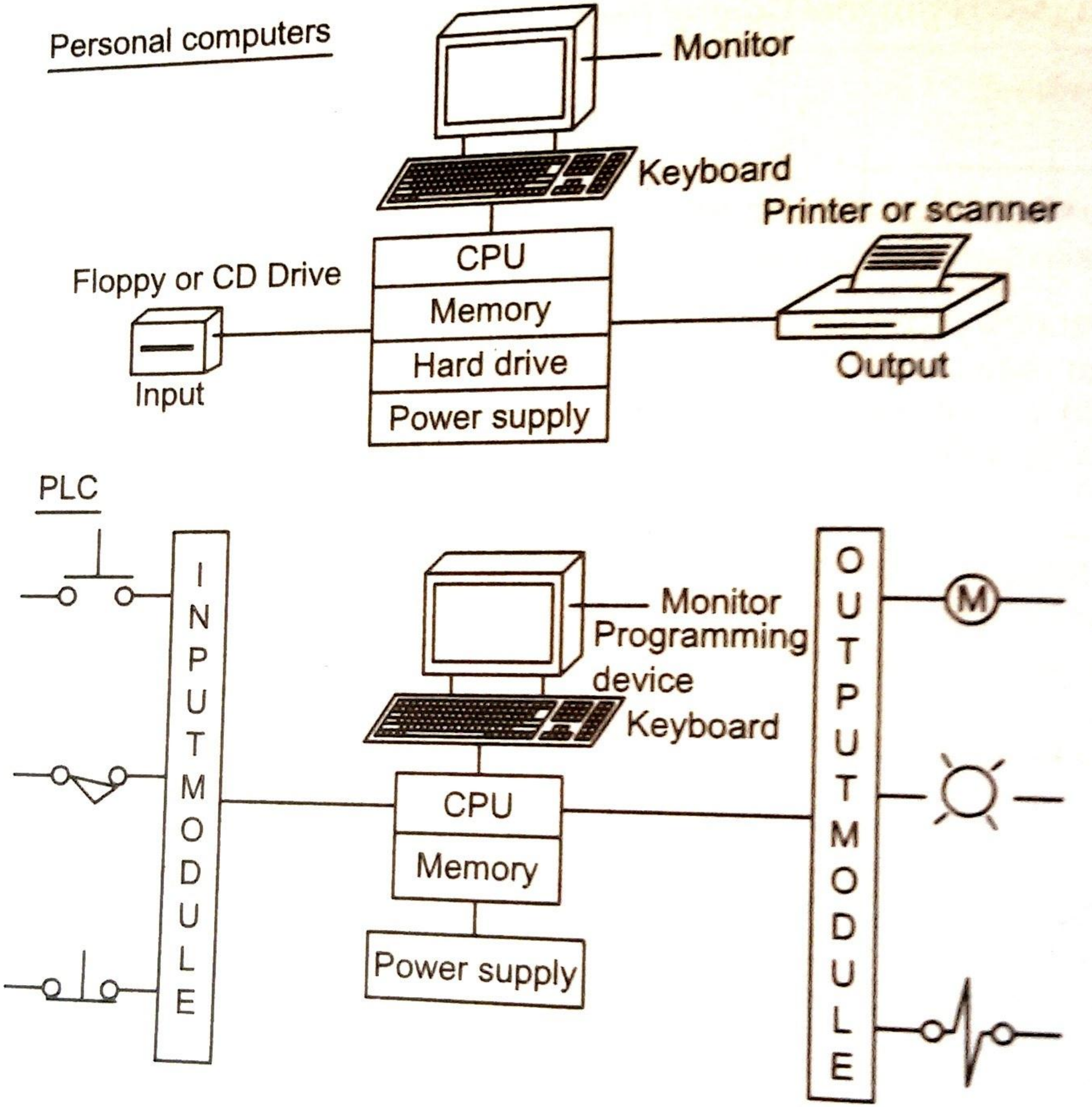
Same basic architecture

PLC

- Operates in the industrial environment
- Is programmed in relay ladder logic
- **Has i/p devices like switch ,push button and sensor.**
- **Has o/p devices like coils, solenoids, motors and conveyors.**

PC

- Capable of executing several programs simultaneously, in any order
- Some manufacturers have software and interface cards available so that a PC can do the work of a PLC

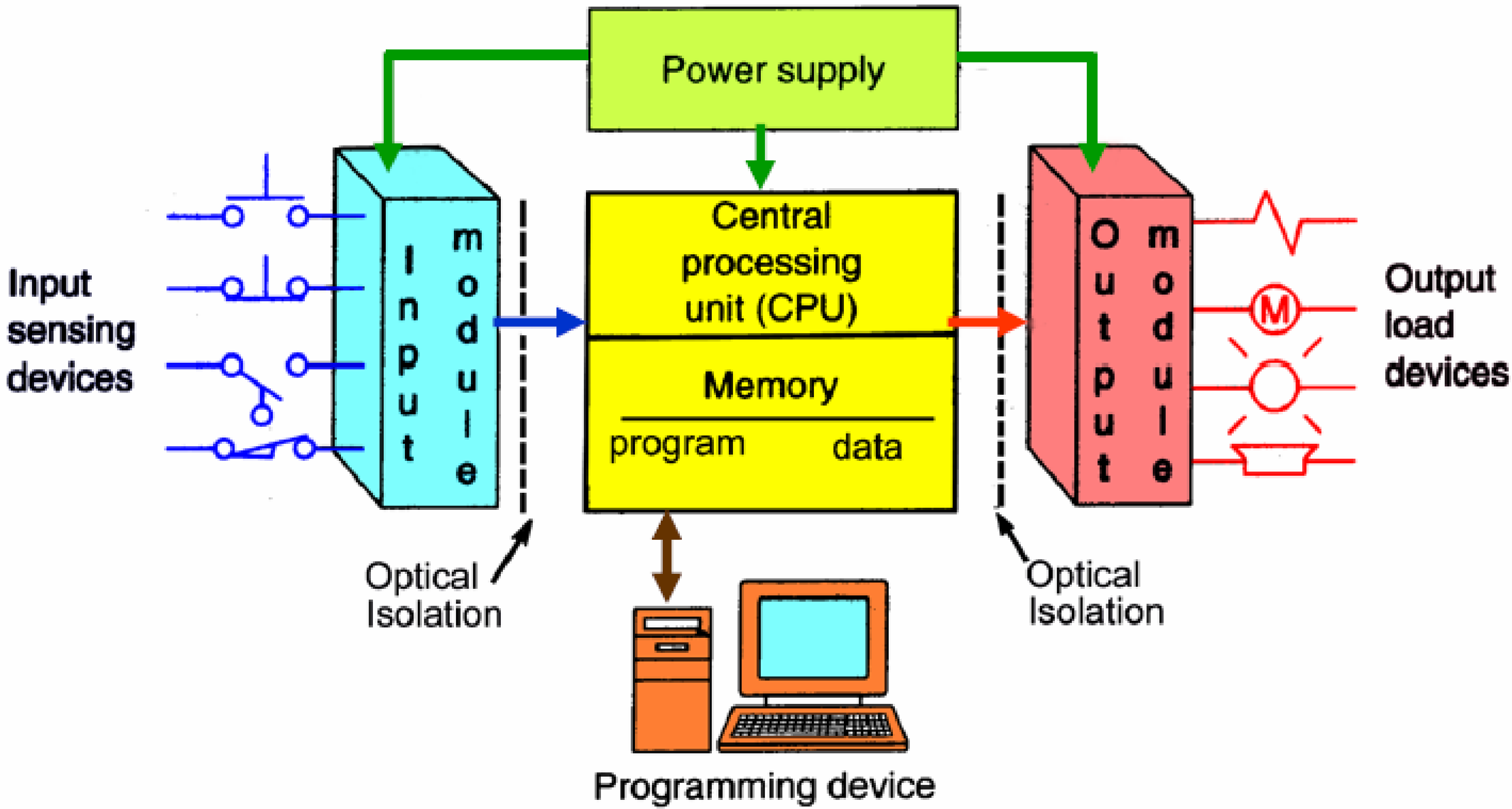


PLCs versus Computers

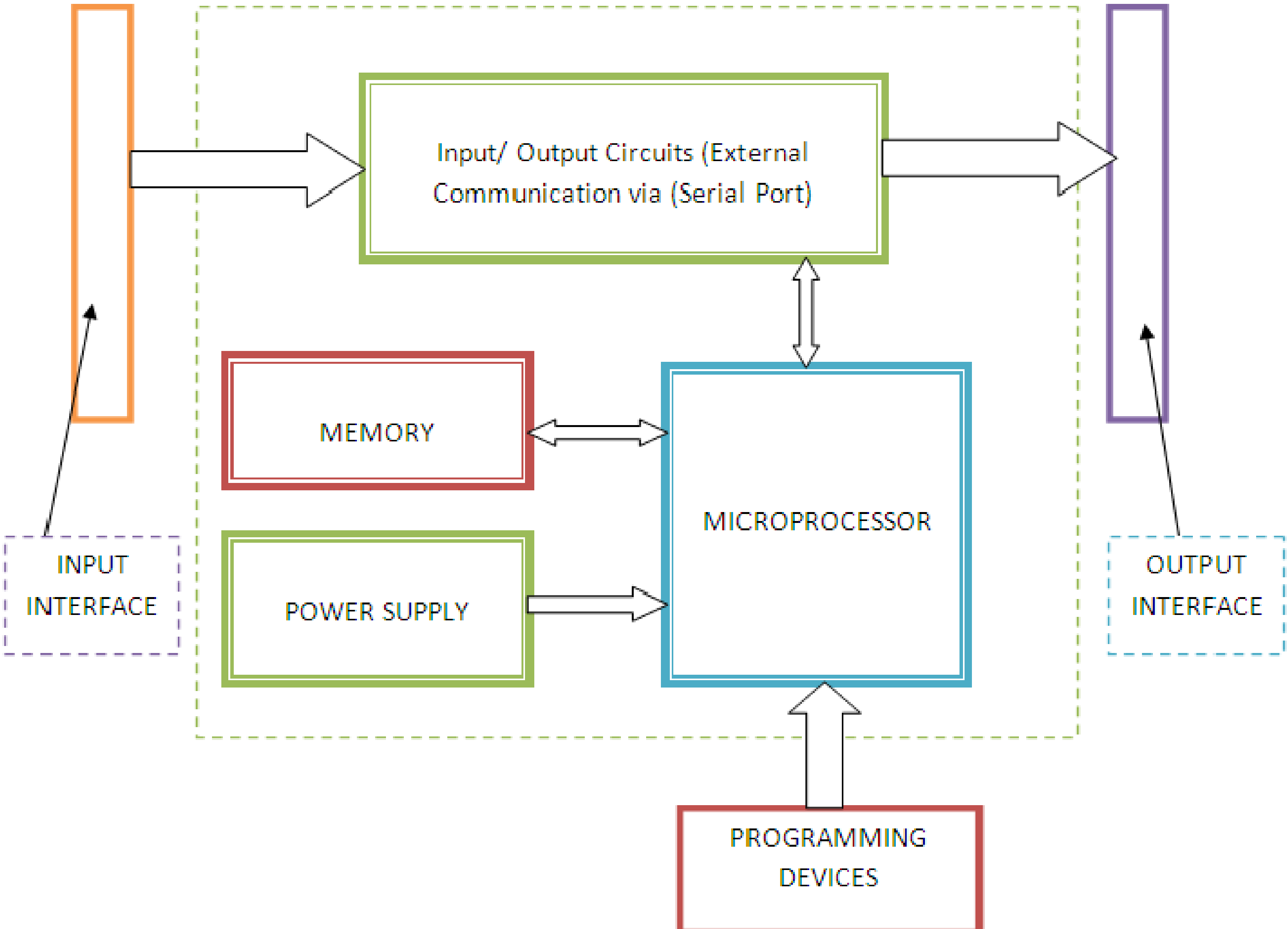
Both have similar i/p o/p interface, keyboard and monitor.

Both have CPU that controls the entire function.

PLC System



Power supply
Input sensing devices
Input
module
Central processing unit (CPU)
Memory
program
data
Output
module
Output load devices
M
Optical Isolation
Optical Isolation
Programming device



Block Diagram of PLC

The basic elements or components of a PLC are :

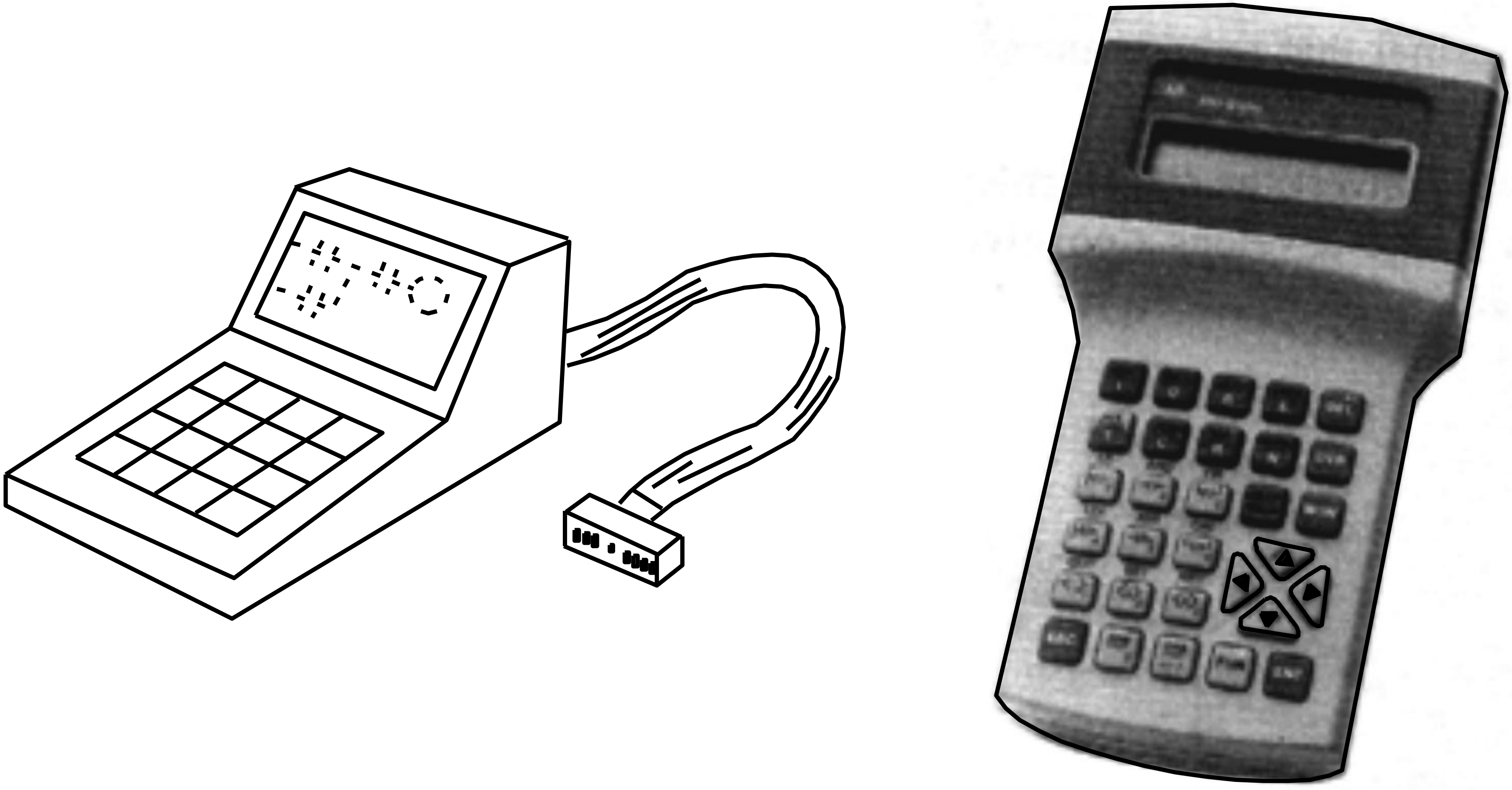
- Power supply unit
- Programming unit
- Processor
- Input output section
- Housing

Power supply unit :

- The power supply unit provides voltage that is necessary to operate the circuit throughout the controller.
- Some sections of the PLC, such as input and output unit require an AC voltage.
- Other sections like internal circuit of processing unit require a low level DC voltage.
- The power supply may also contain a back-up battery for the memory device to retain data if an AC power failure occurs.
- Some PLC's include a battery indicator, which indicates if the battery charge becomes low.

Programming unit :

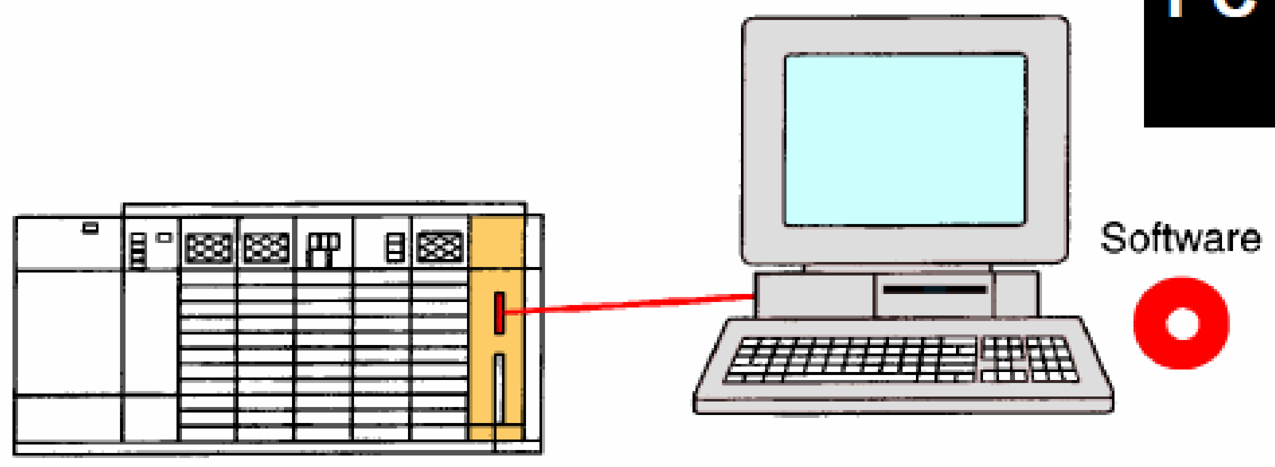
- External electronic device that is connected to the PLC when programming occurs.
- Allows the user to enter data and to edit and monitor programs stored in the processor unit.
- Programming unit communicates with the processor unit by using a data communication link.
- Two programming devices can be used to load the program in to the processor memory.
- CRT terminal
- Small key board



A handheld PLC programming unit

Programming Device

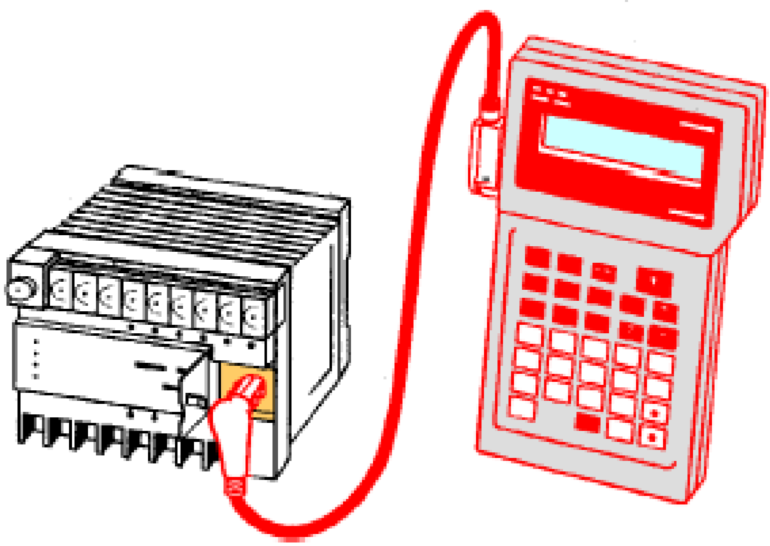
PC with appropriate software



- A personal computer (PC) is the most commonly used programming device
- The software allows users to create, edit, document, store and troubleshoot programs
- The personal computer communicates with the PLC processor via a serial or parallel data communications link

Programming Device

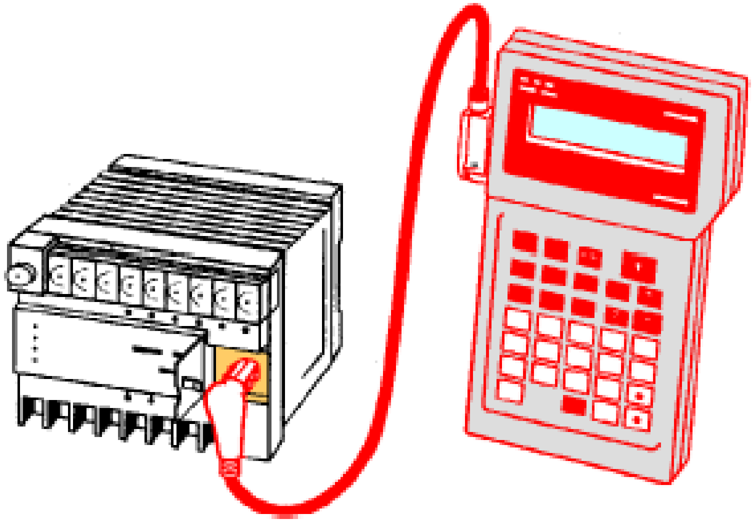
Hand-held unit with display



- Hand-held programming devices are sometimes used to program small PLCs
- They are compact, inexpensive, and easy to use, but are not able to display as much logic on screen as a computer monitor

Programming Device

Hand-held unit with display



- Hand-held units are often used on the factory floor for troubleshooting, modifying programs, and transferring programs to multiple machines.

Processor :

- The processor is a computer that executes a program to perform the specific operations.

- It controls the operation of the entire system.
    - The processor is composed of three main units.
    - Central Processing Unit (CPU).
    - Arithmetic Logic Unit (ALU).
    - Memory.

- **Input output interface :**
- PLC is designed to be connected to industrial equipment.
- This connection is accomplished by means of input/output interface (unit).
- The i/p interface receive process and machine signals and convert them into an acceptable form for the PLC.
- Inputs are defined as the signals given to the controller. These signals inform the real time status of the process variable to the controller.
- The signal can be analog or digital.
- The signals are given to the controller in the form of voltage, current or resistance.

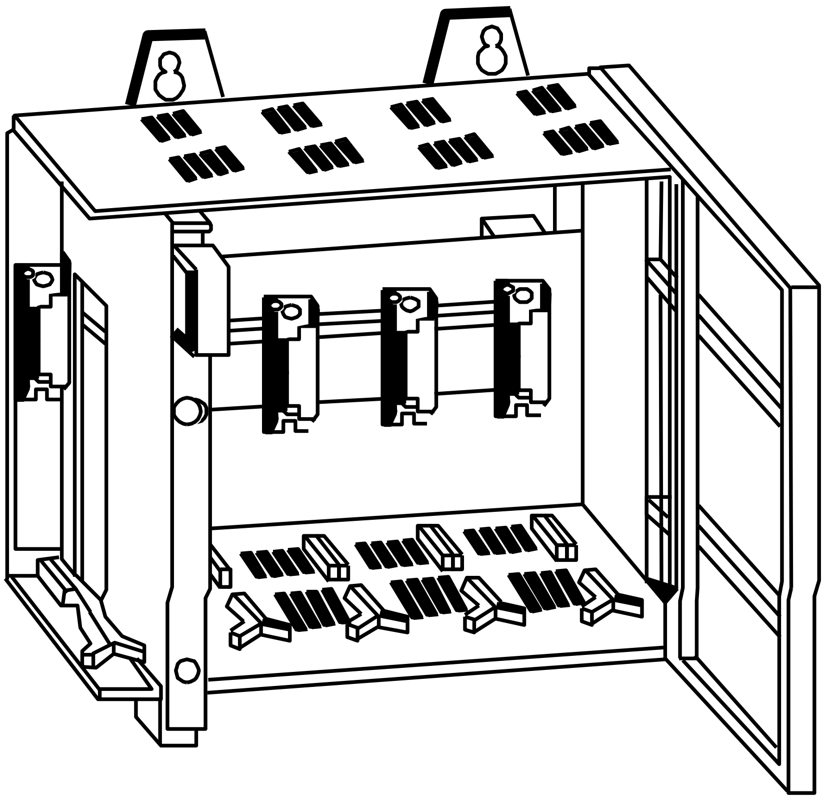
- **Input output interface :**
- The output interface converts PLC control signals into a form which can be used by the process equipment.
- Outputs are defined as signals given from the controller to the industrial equipment. The output signals can be discrete, analog or register. These output signals are given to the sensors, solenoid valves, control valves, switches, push buttons etc.

Housing :

The elements of PLC are installed in a suitable housing to withstand the shop environment.

They are easily inserted in to the channels provided in the housing.

One typical housing of PLC is shown in Fig



Operation of PLC:

During program execution, the processor reads all the inputs , and according to control application program , energizes and de-energizes the outputs.

Once all the logic has been solved, the processors will update all the outputs. The process of reading the inputs, executing the control application program, and updating the output is known as scan.

During the scan operation, the processor also performs housekeeping tasks.

The cycle consisting of reading of inputs, executing the control program, and actuating the output is known as “scan” and the time to finish this task is known as “scan time” .

Operation of PLC :-

The speed at which PLC scan depends upon the clock speed of CPU.

The time to scan depends upon following parameter:

· Scan rate
· Length of the program
· Types of functions used in the program

Faster scan time implies the inputs and outputs are updated frequently.

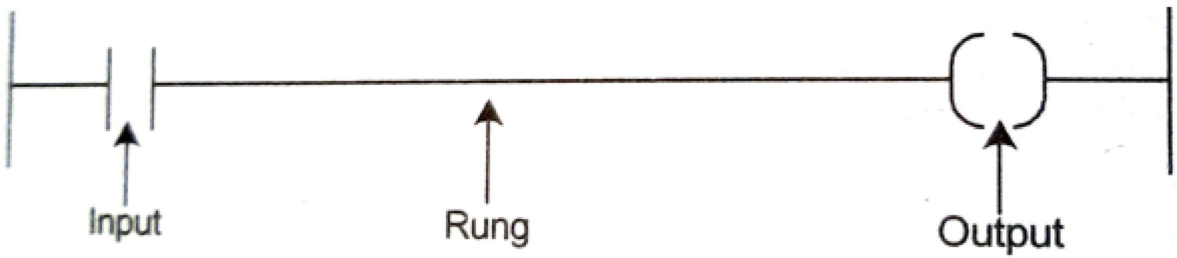
Some leading PLC manufacturers:

- ABB
- Allen Bradley
- Honeywell
- Siemens
- GE
- Fanuc
- Mitsubishi
- Modicon
- Omron

PLC PROGRAMMING BASICS

PLC Programming

A ladder logic diagram consists of the following three elements:



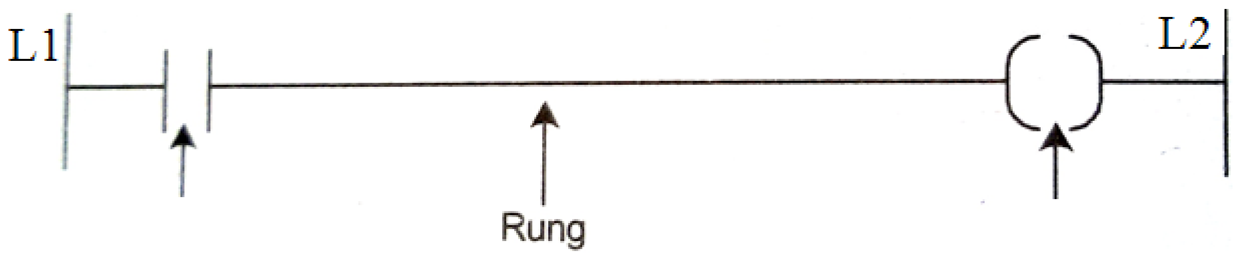
- Input
- Output
- Rung

- The horizontal line is called as rung.
- Rung contains the input and output elements.

- In ladder logic the input element is referred as contact and output element is referred as coil.

PLC Programming

- The two vertical lines at the end of rung are called as rails.
- Rails are represented as L1 and L2
- Rails represents the voltage potential of the ladder logic diagram.
- For AC circuit L1 is high terminal & L2 is low terminal.
- For DC circuit, L1 is positive terminal & L2 is negative terminal.



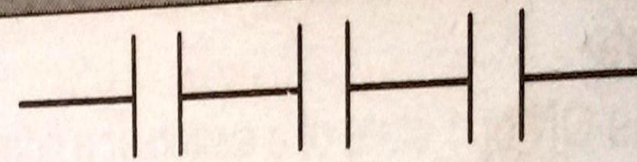
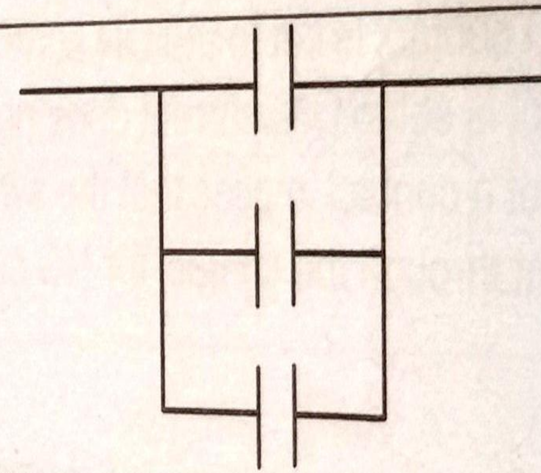
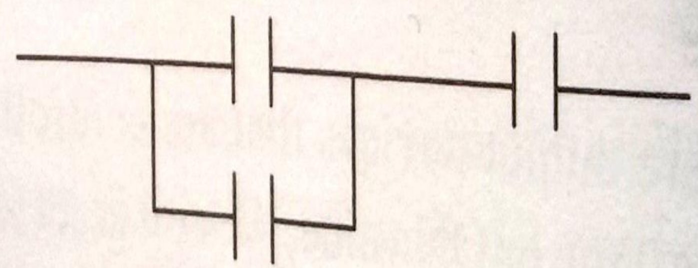
PLC Programming

In Ladder logic the following terms are interchangeably used:

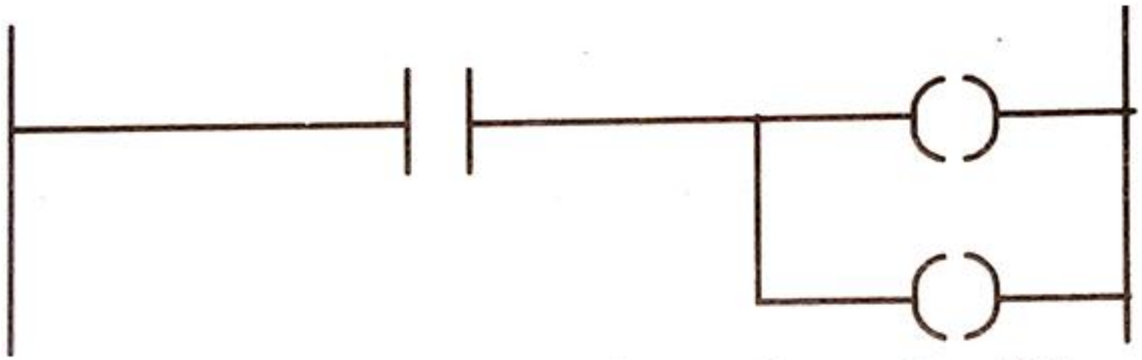
True ON 1 --- to depict the switched ON state of a device.

False OFF 2 -- to depict the switched OFF state of a device.

PLC Programming

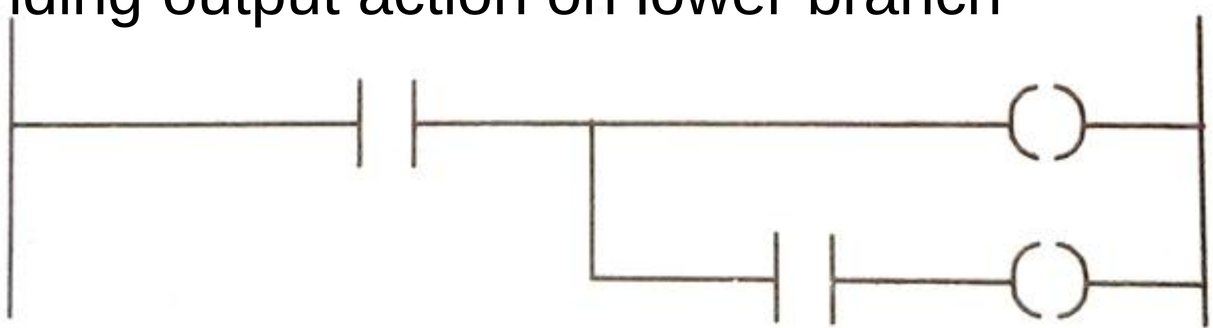
Multiple Input Conditions	Arrange Inputs In	Ladder Logic Diagram
All conditions should be met	Series	
Any one condition should be met	Parallel	
A combination of conditions	In combination	

If there are multiple output action then place these action in parallel

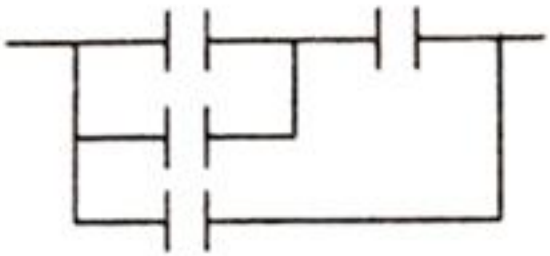


Multiple Output Actions for an Input Condition

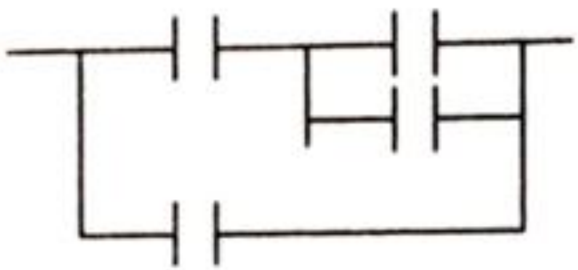
If the second output action requires an additional input condition, place the output action in parallel.
Then place the input condition that differs and the corresponding output action on lower branch



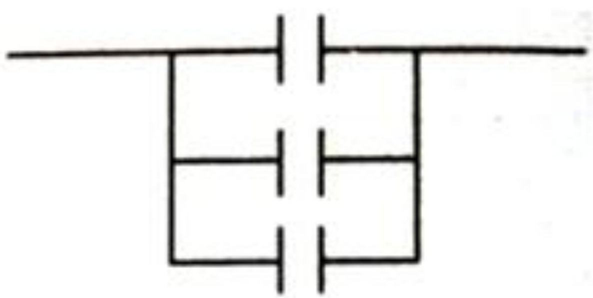
Multiple Output Actions with an Additional Input Condition



(a) Nested branches with same start



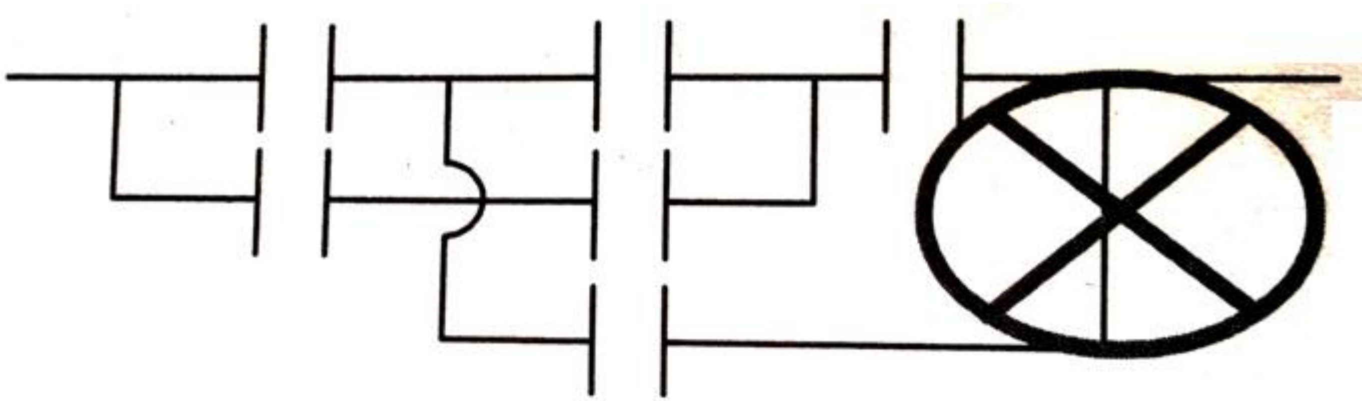
(b) Nested branches with same end



(c) Parallel branches

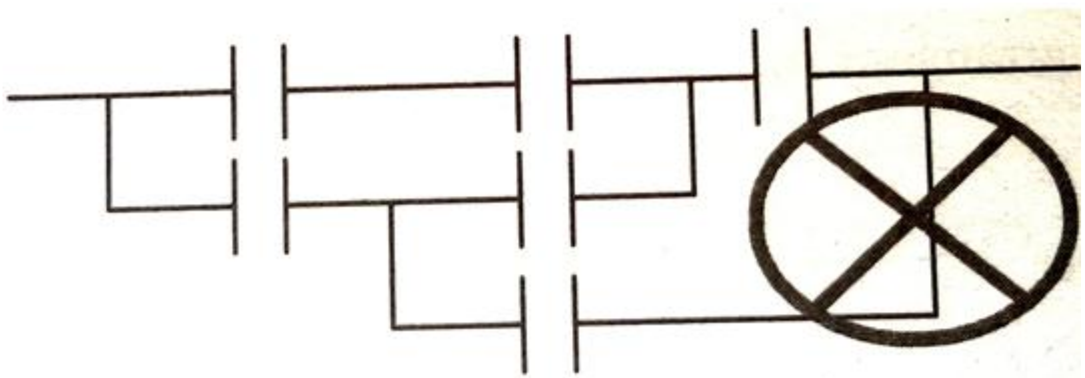
- Nested branches have either a common end point or a common start point.
- Parallel branches have same start and end points.
- There is no limitation to the number of parallel branches a rung can have depending on the capacity of PLC RAM.

Do not overlap branches. A overlapped branch means a branch starts inside the branch and ends outside the branch



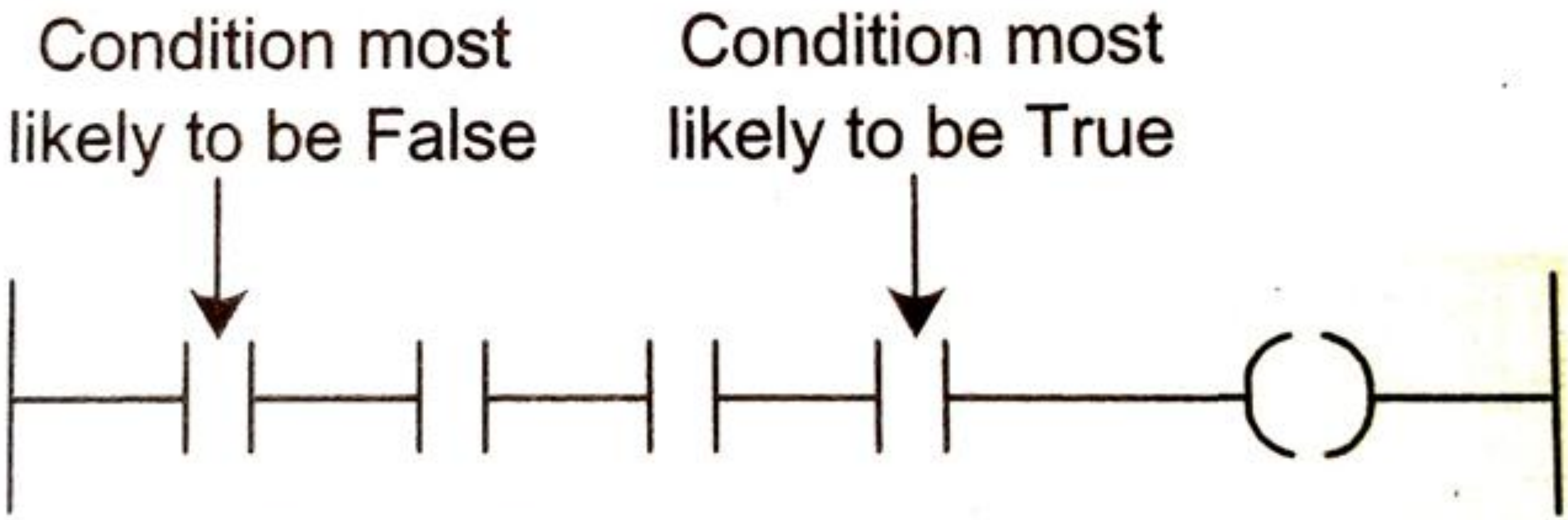
Overlapped Branch

Do not start a branch at one level and end at other level.



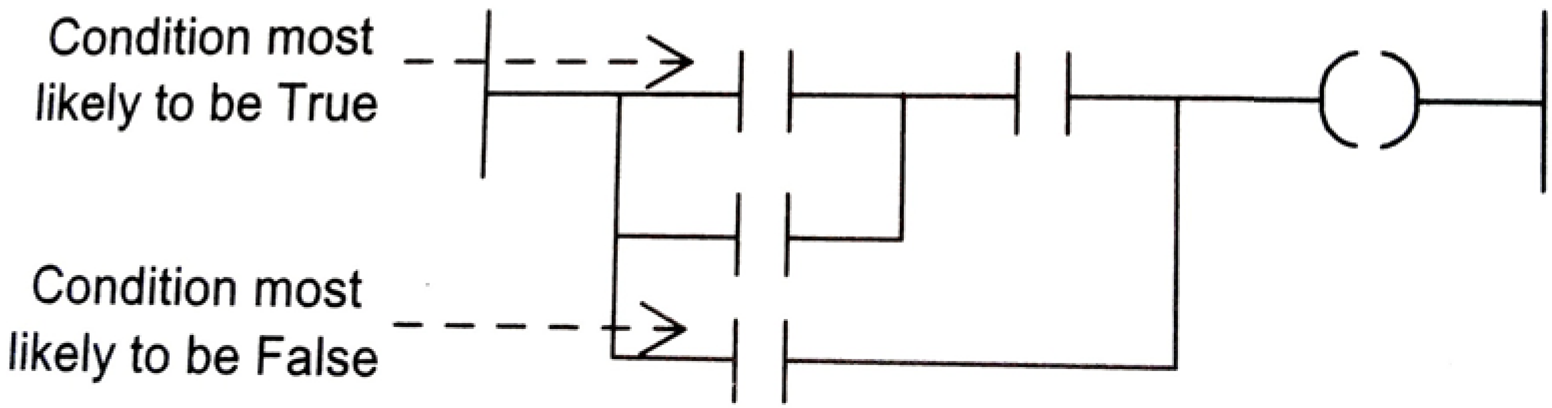
Branch Starting and Ending at Different Levels

While placing input conditions in series, in a situation where all the conditions should be met, place the condition most likely to be false to the extreme left end. Place the input conditions from left to right in order of most likely to be false and then most likely to be true.



Placing Input Conditions in a Series

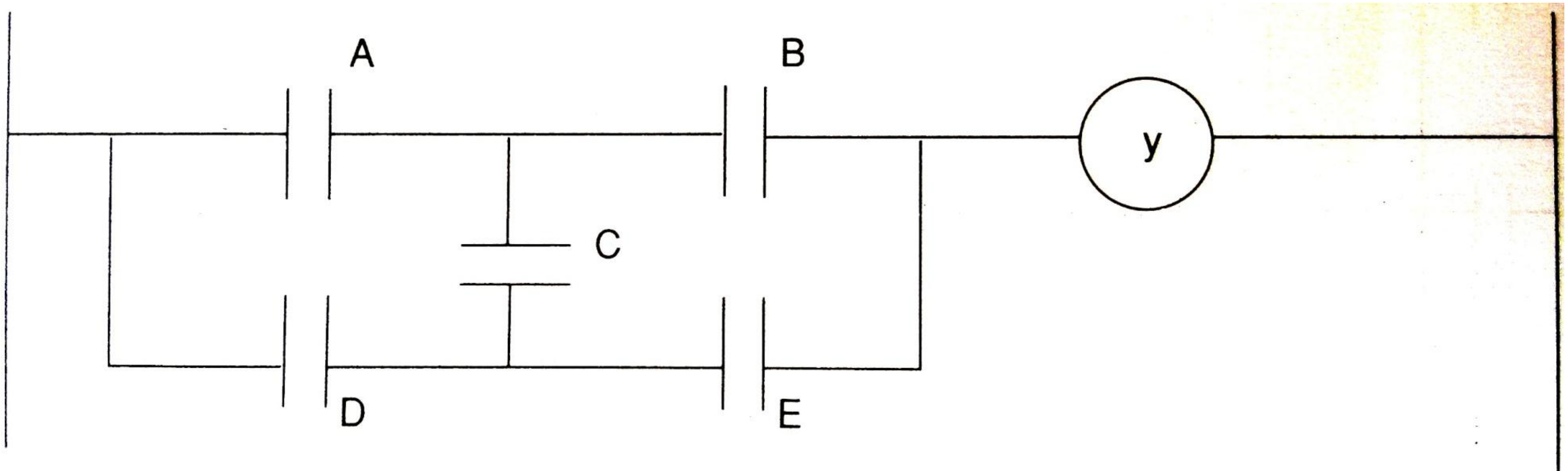
While placing input conditions in parallel, in a situation where one of the conditions should be met, place the condition most likely to be true on the top. And the input conditions most likely to be false at the bottom.



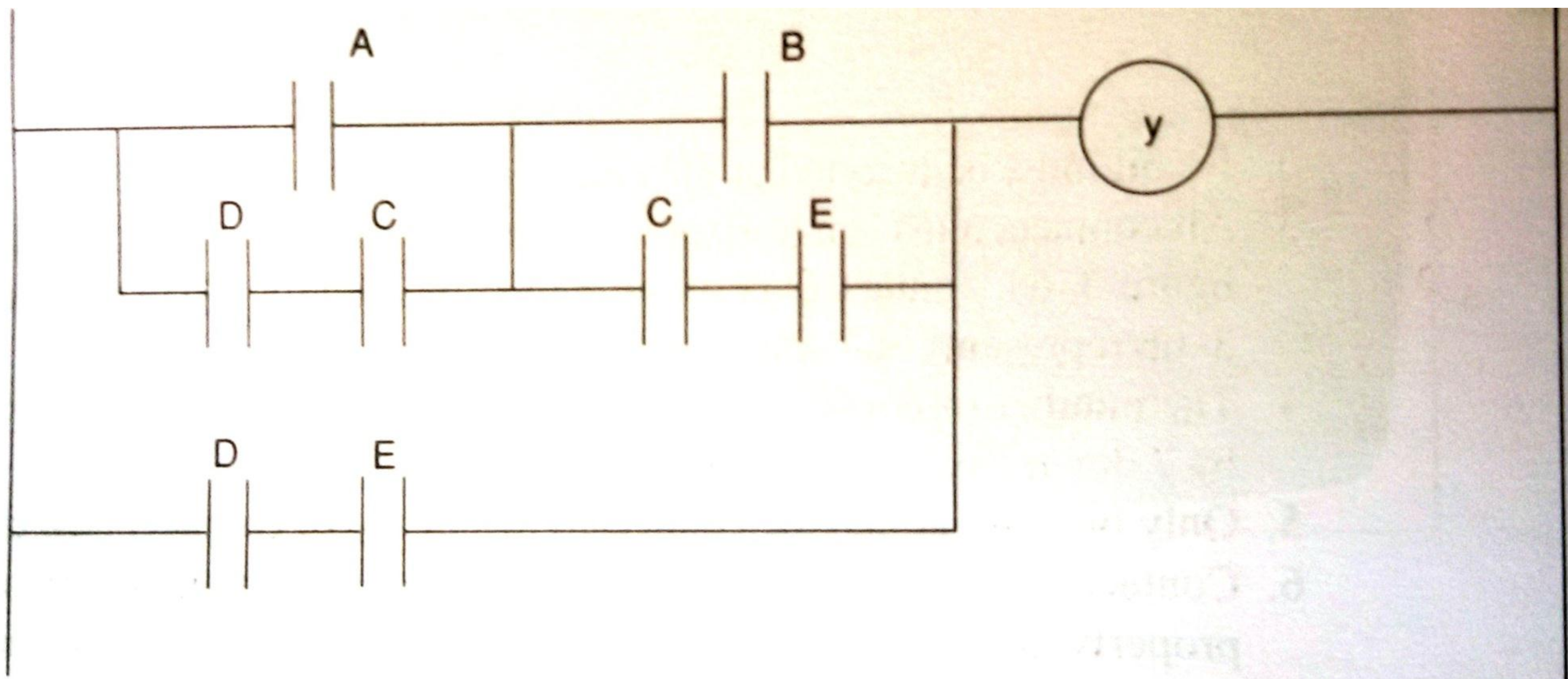
Placing Input Conditions in Parallel

A contact must always be inserted in slot 1 in upper left corner

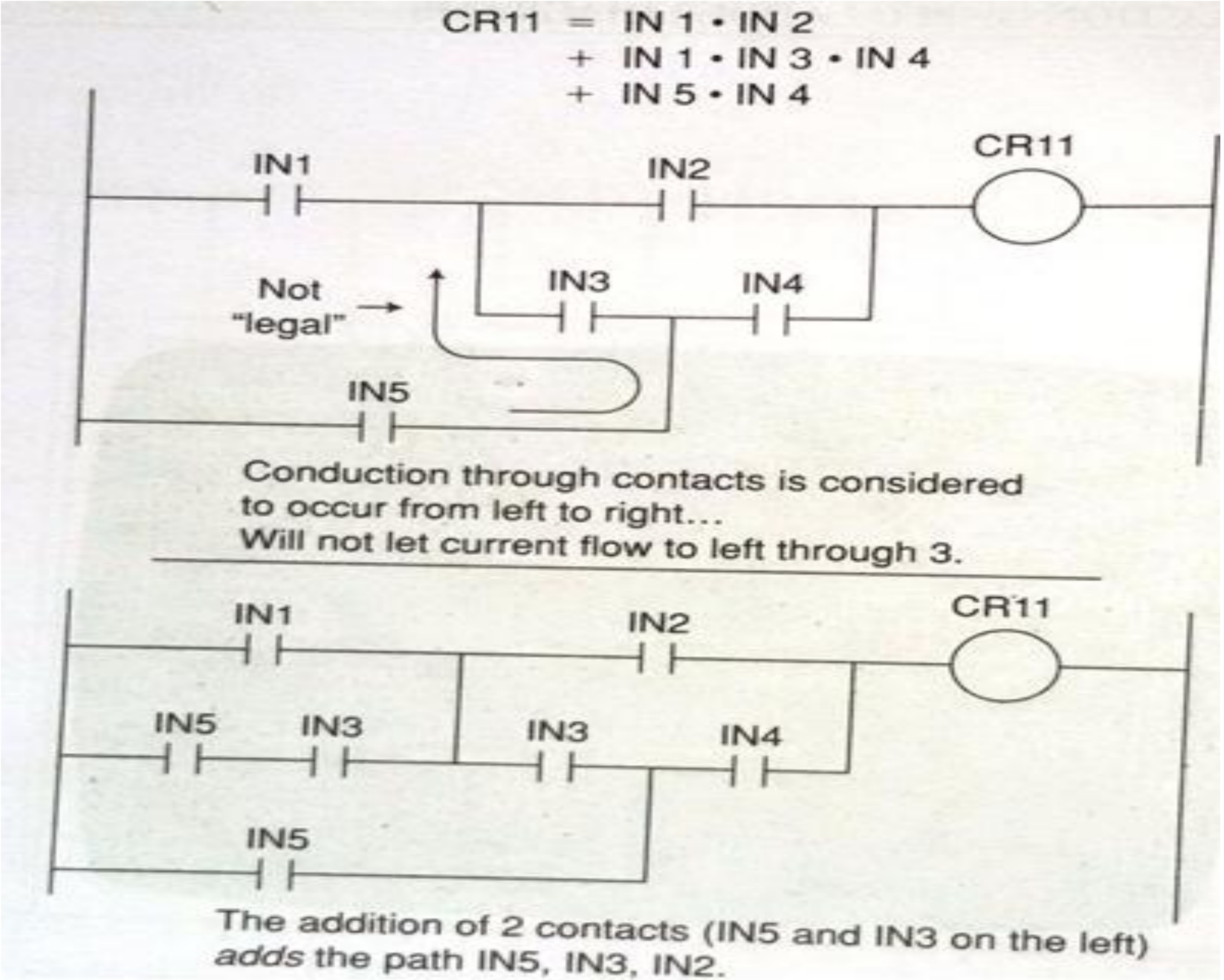
All contacts must be placed horizontally.



No vertically oriented contacts allowed

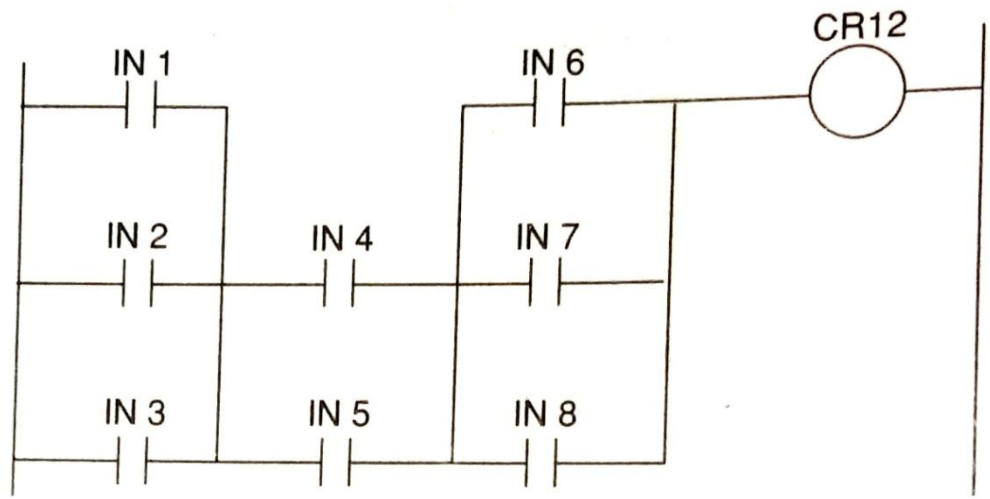


One solution to vertically
oriented contact problem



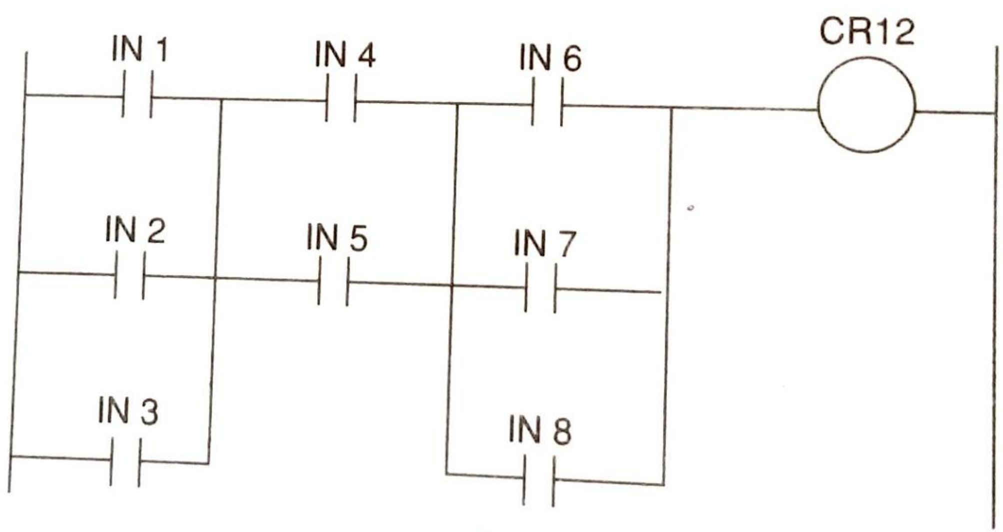
Flow must be left to right

Contact progression should be straight across

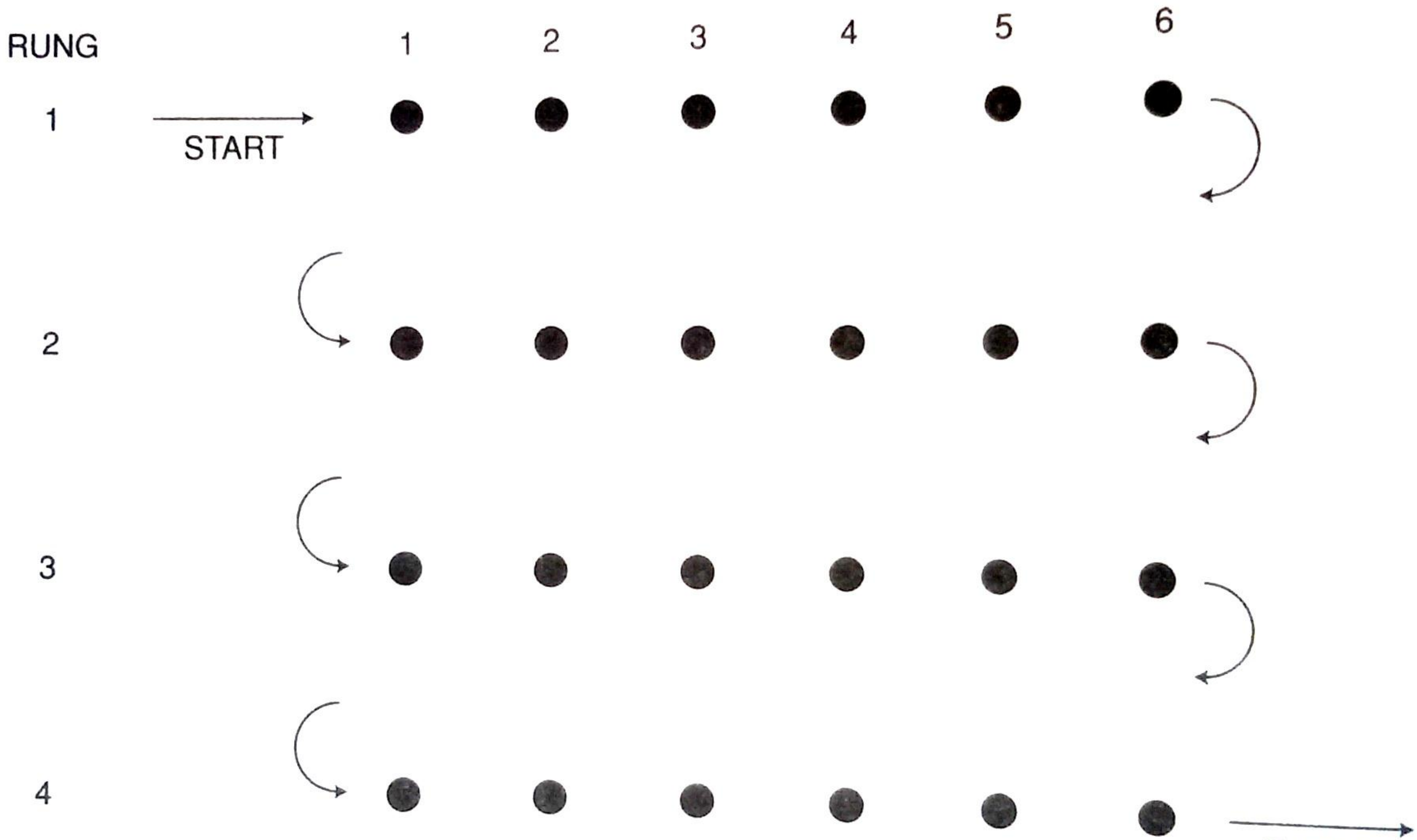


Incorrect

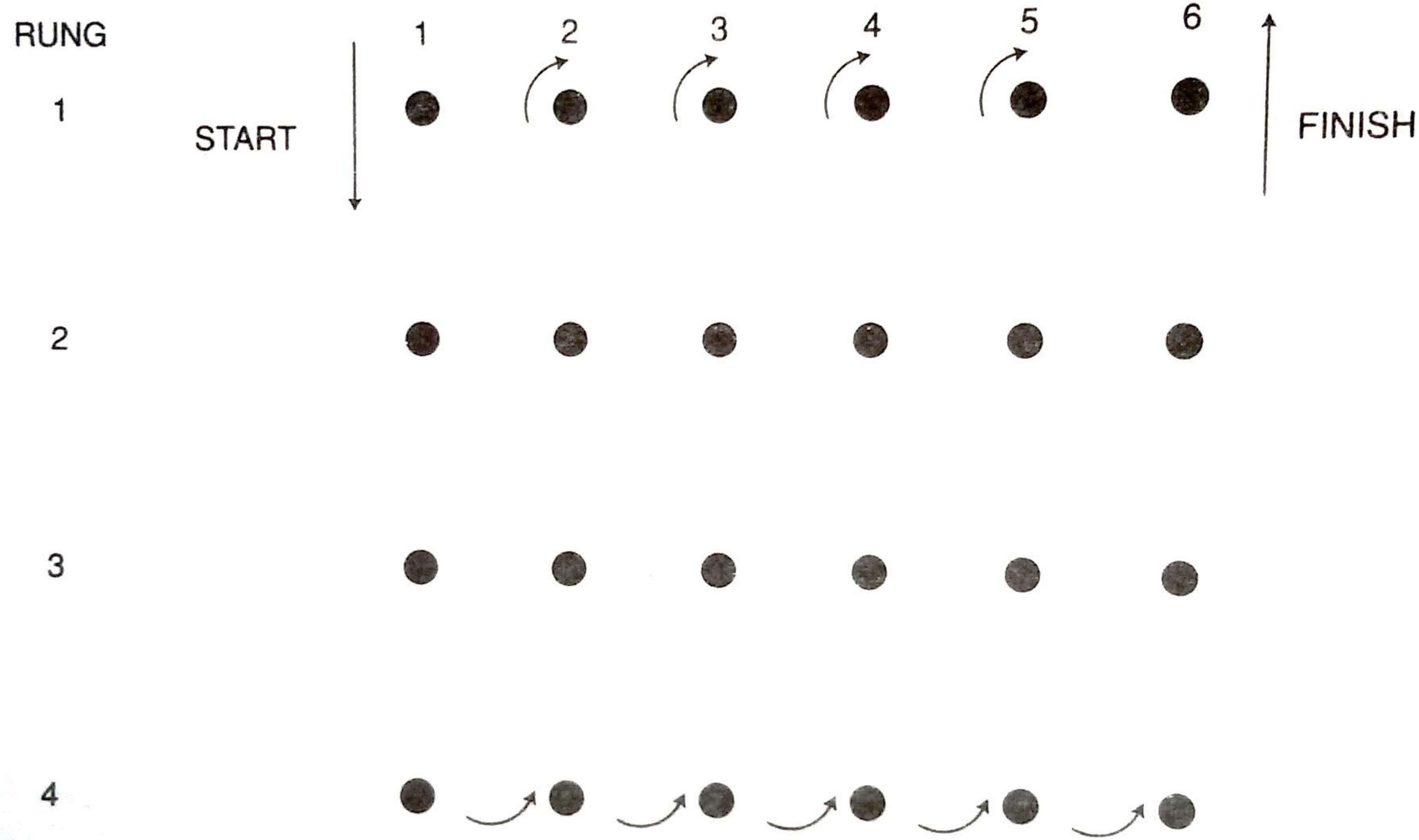
Use the topmost available junctions



Correct



RUNG SCANNING
(a)

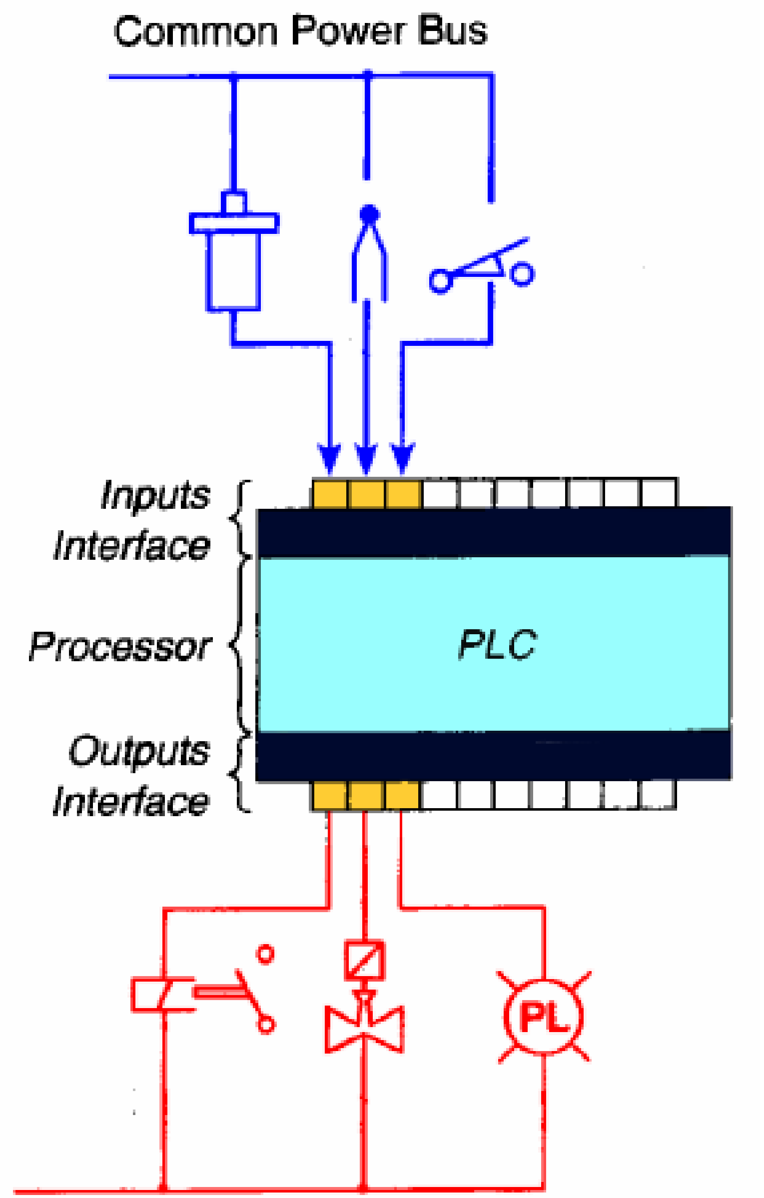


COLUMN SCANNING
(b)

I/O Configurations

Fixed I/O

- Is typical of small PLCs
- Comes in one package, with no separate removable units.
- The processor and I/O are packaged together.
- Lower in cost – but lacks flexibility.

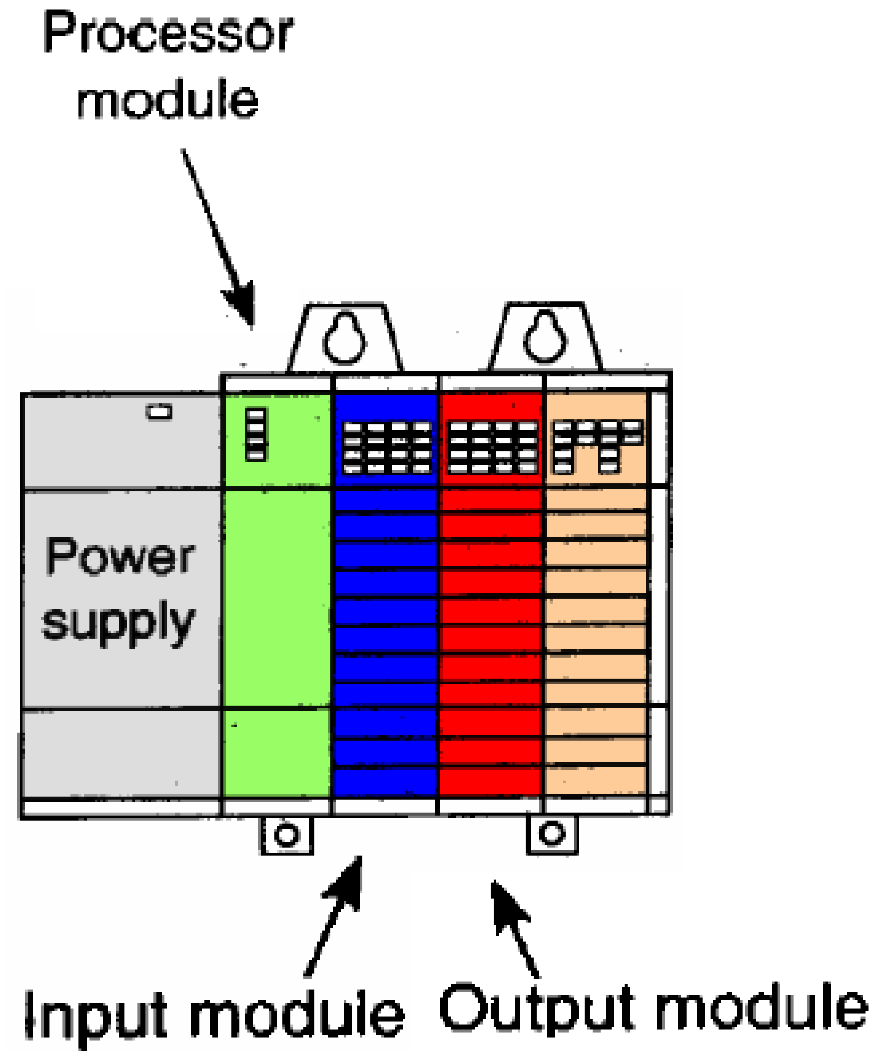


I/O Configurations

Modular I/O

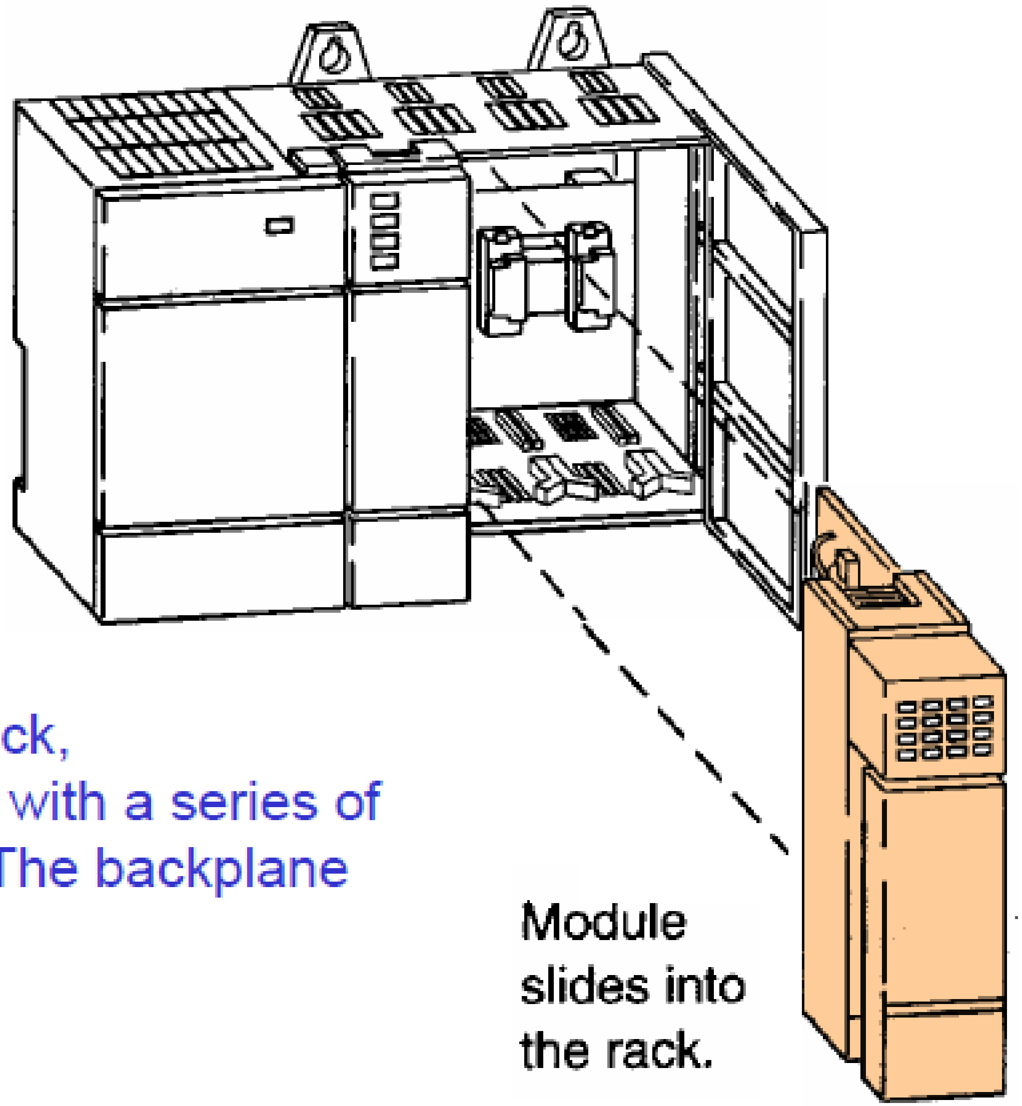
Is divided by compartments into which separate modules can be plugged.

This feature greatly increases your options and the unit's flexibility. You can choose from all the modules available and mix them in any way you desire.



I/O Configurations

Modular I/O

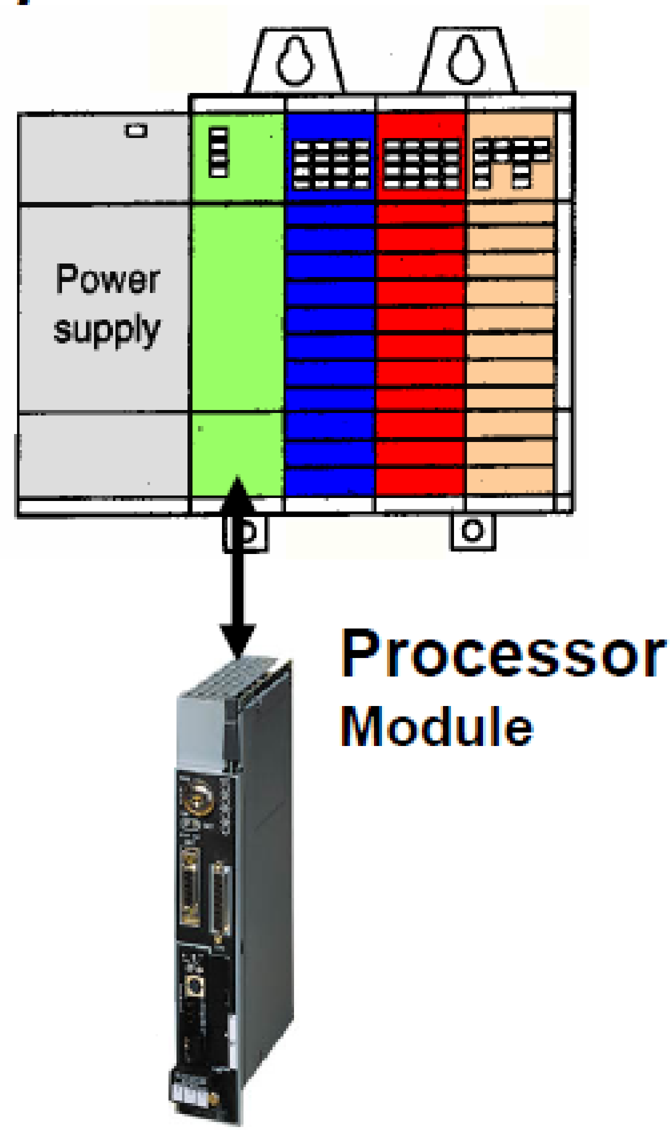


When a module slides into the rack,
it makes an electrical connection with a series of contacts - called the *backplane*. The backplane is located at the rear of the rack.

Module slides into the rack.

Processor (CPU)

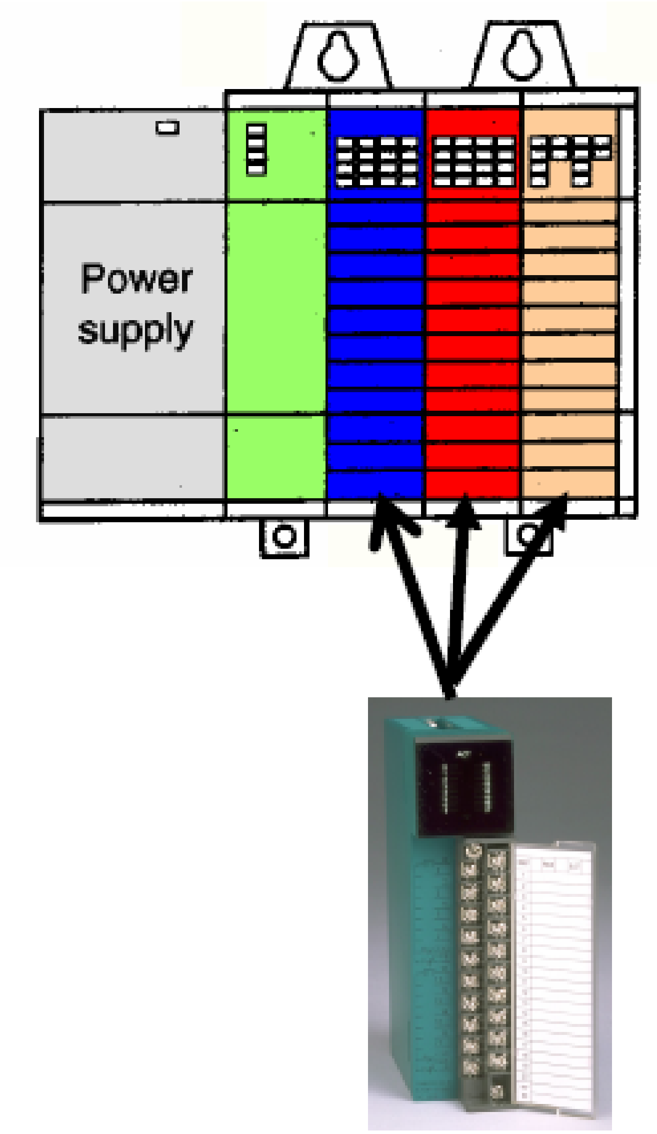
- Is the “brain” of the PLC.
- Consists of a microprocessor for implementing the logic, and controlling the communications among the modules.
- Designed so the desired circuit can be entered in relay ladder logic form.
- The processor accepts input data from various sensing devices, executes the stored user program, and sends appropriate output commands to control devices.



I/O Section

Consists of:

- Input modules
- Output modules.

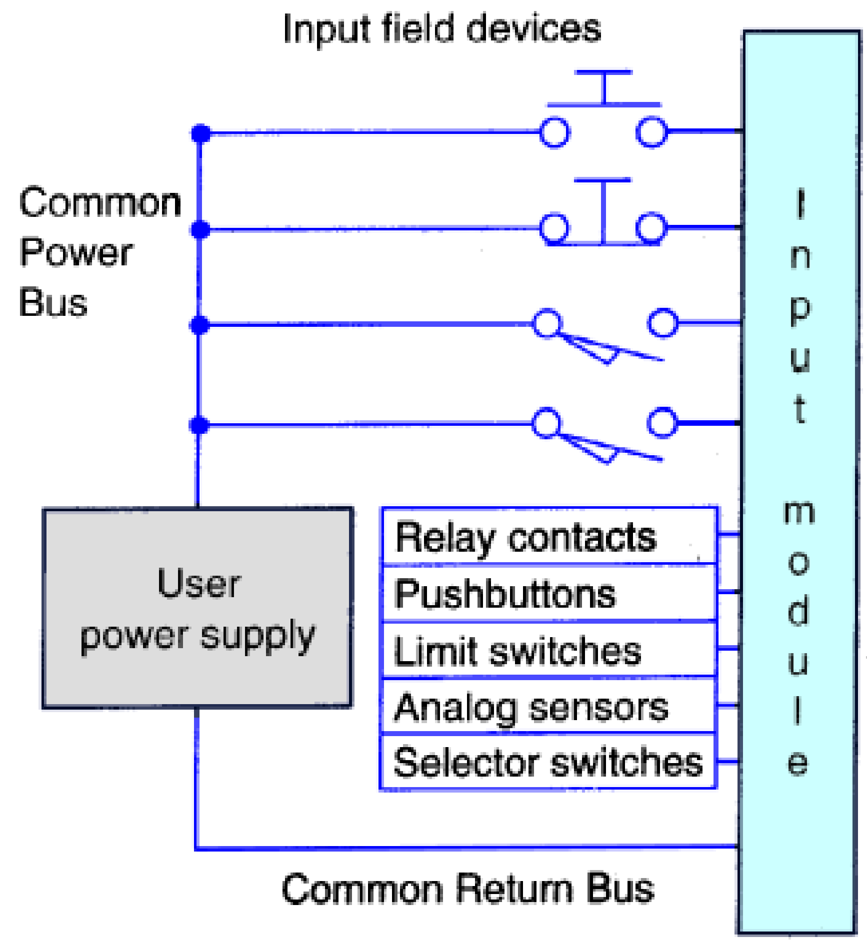


I/O Section

Input Module

- Forms the interface by which input field devices are connected to the controller.

- The terms “field” and “real world”are used to distinguish actual external devices that exist and must be physically wired into the system.

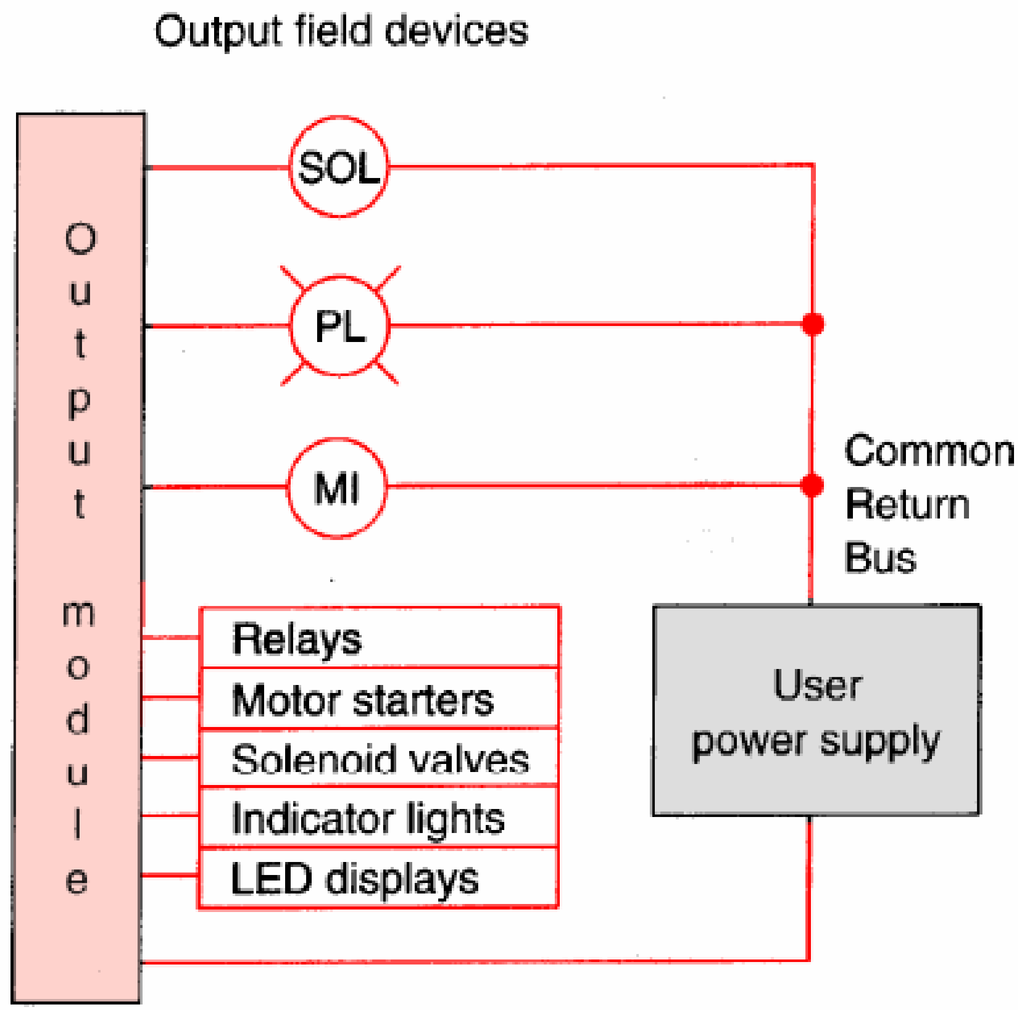


I/O Section

Output Module

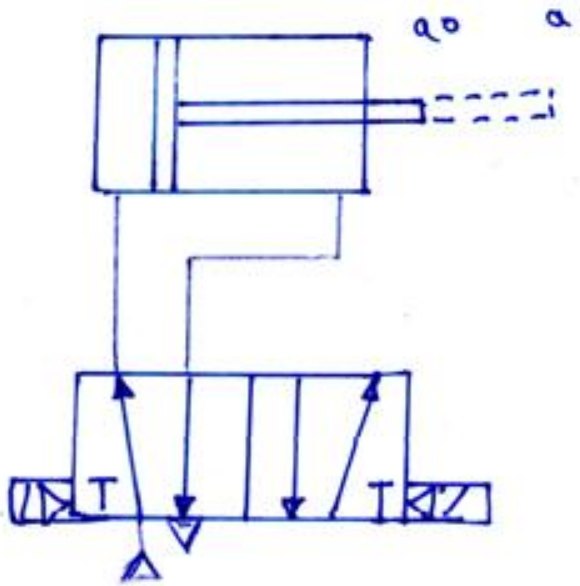
- Forms the interface by which output field devices are connected to the controller.

- PLCs employ an optical isolator which uses light to electrically isolate the internal components from the input and output terminals.

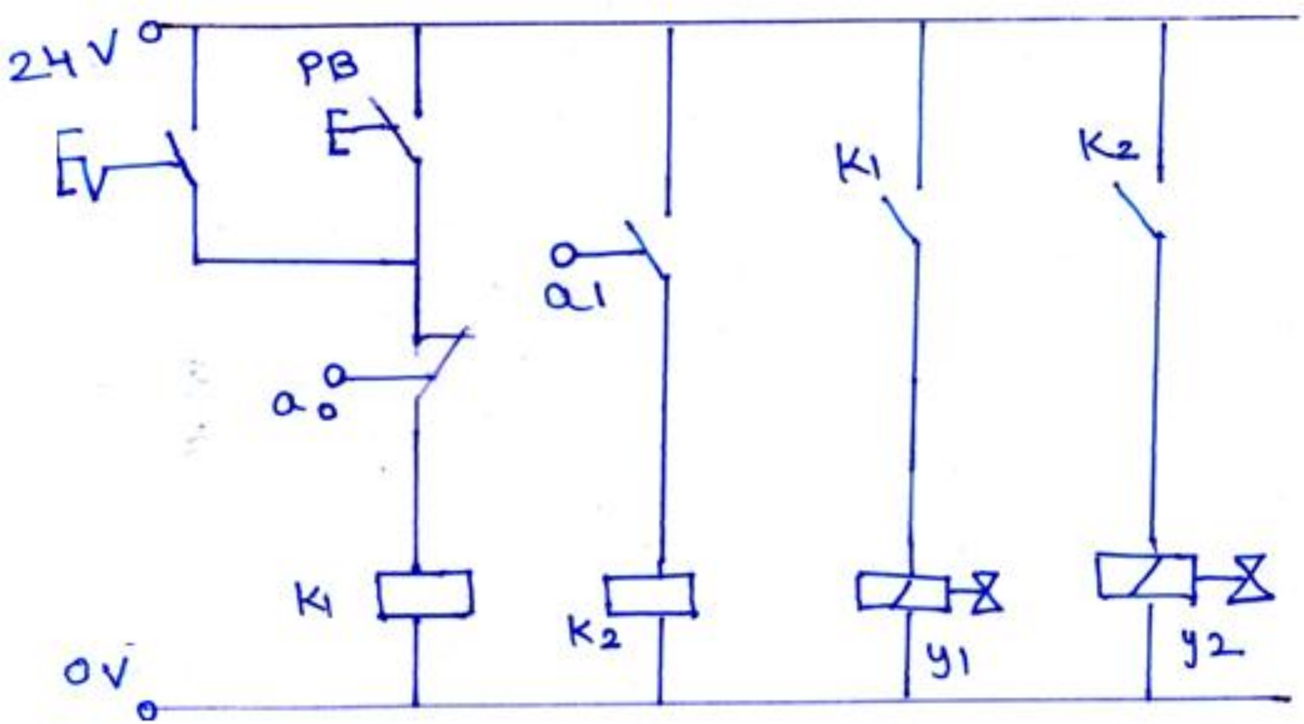


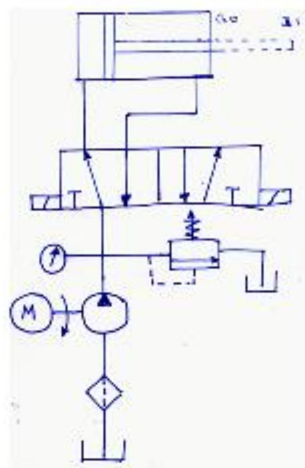
PLC CIRCUIT DIAGRAM

1

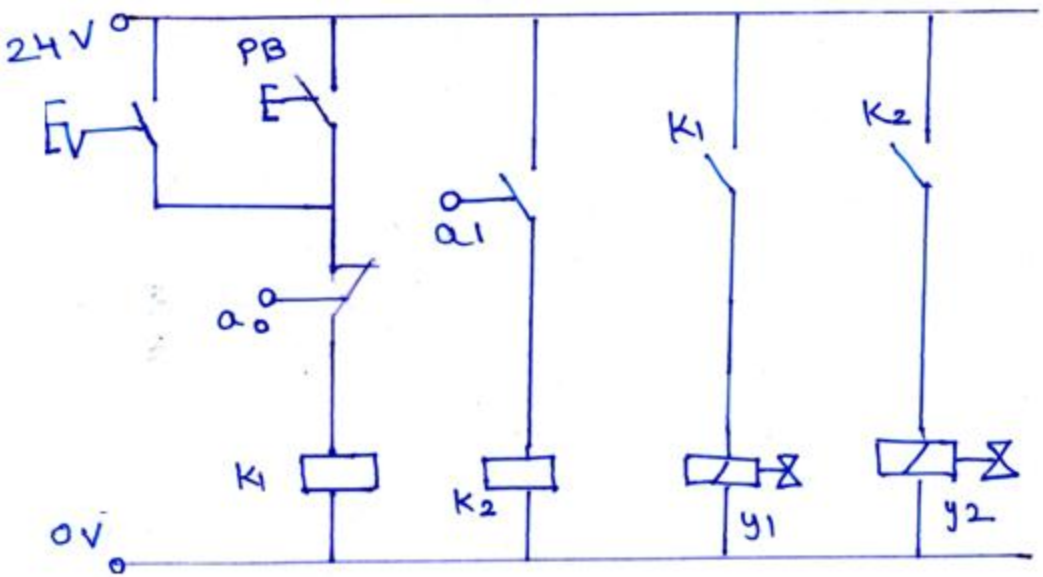


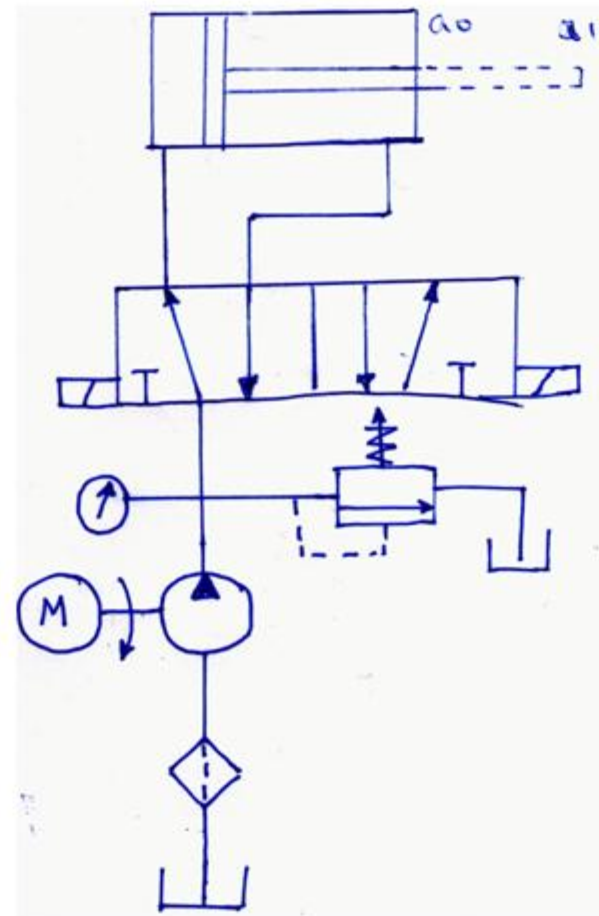
A+ / A-



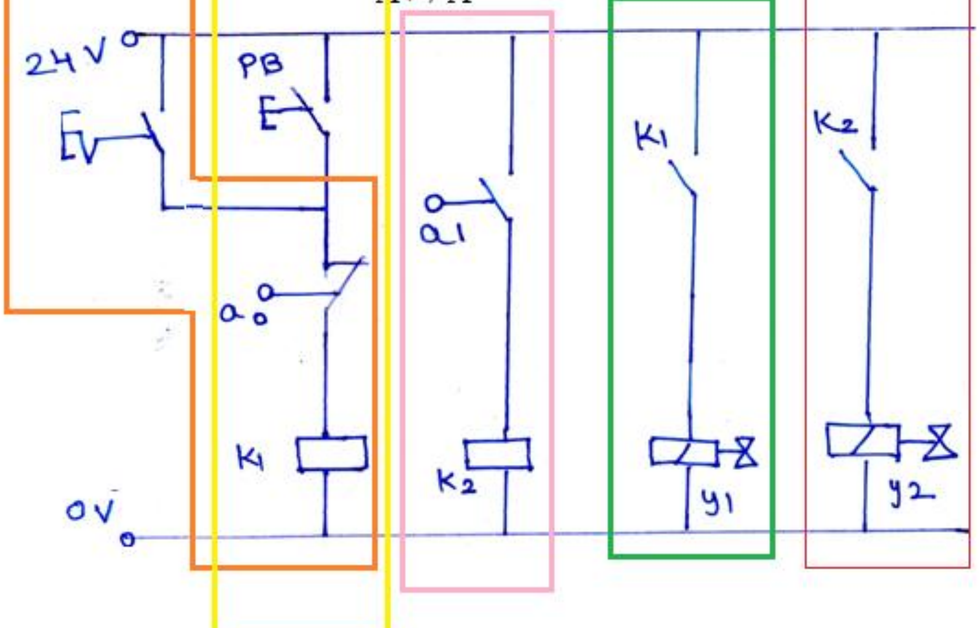


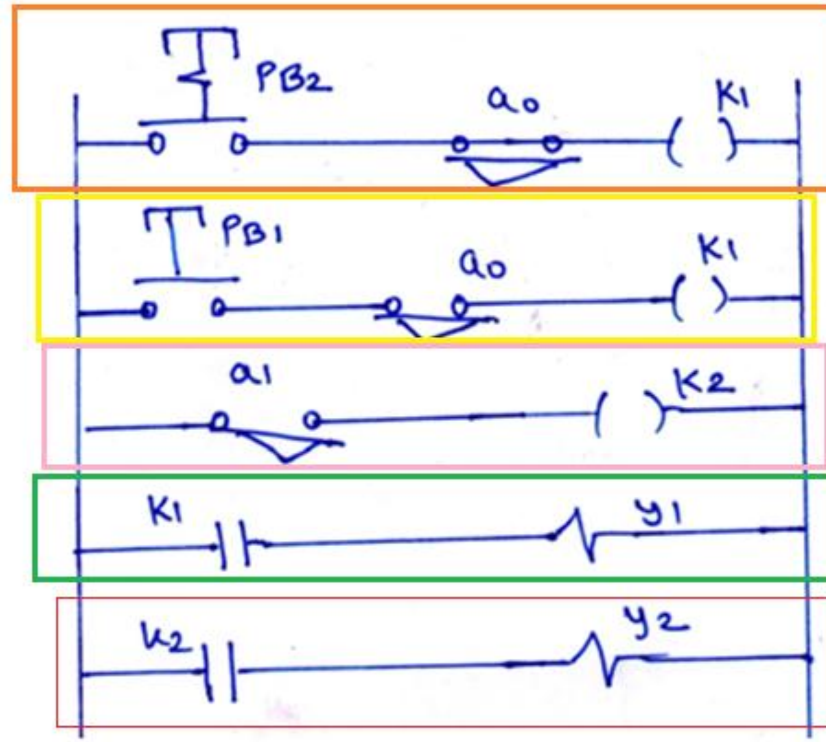
A+ / A-



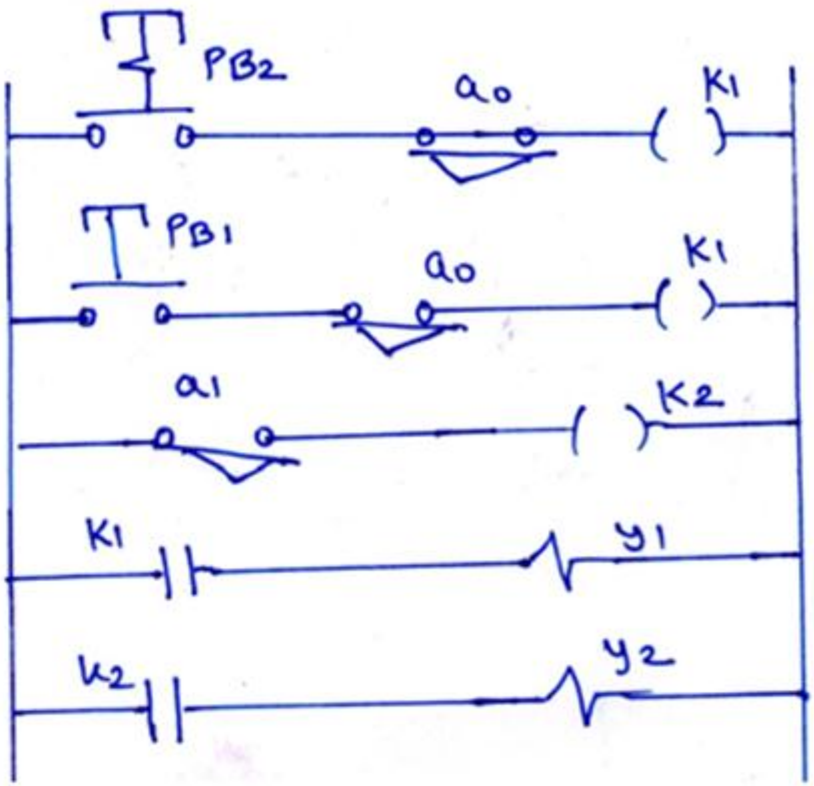


A+ / A-

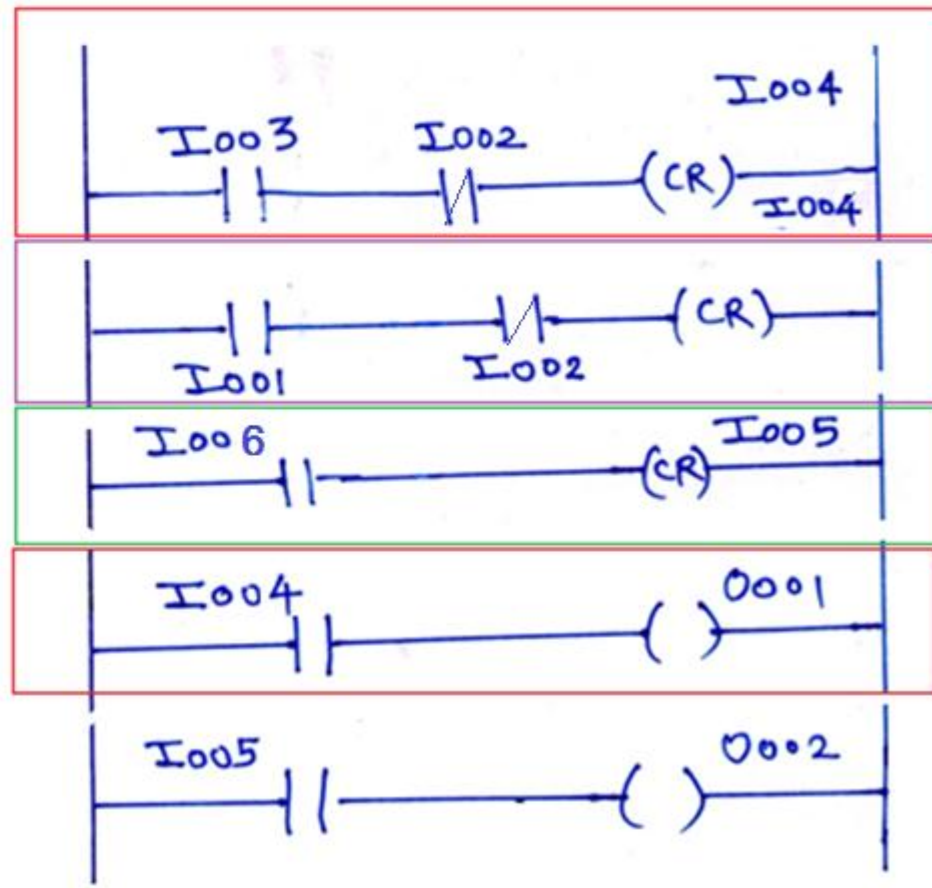




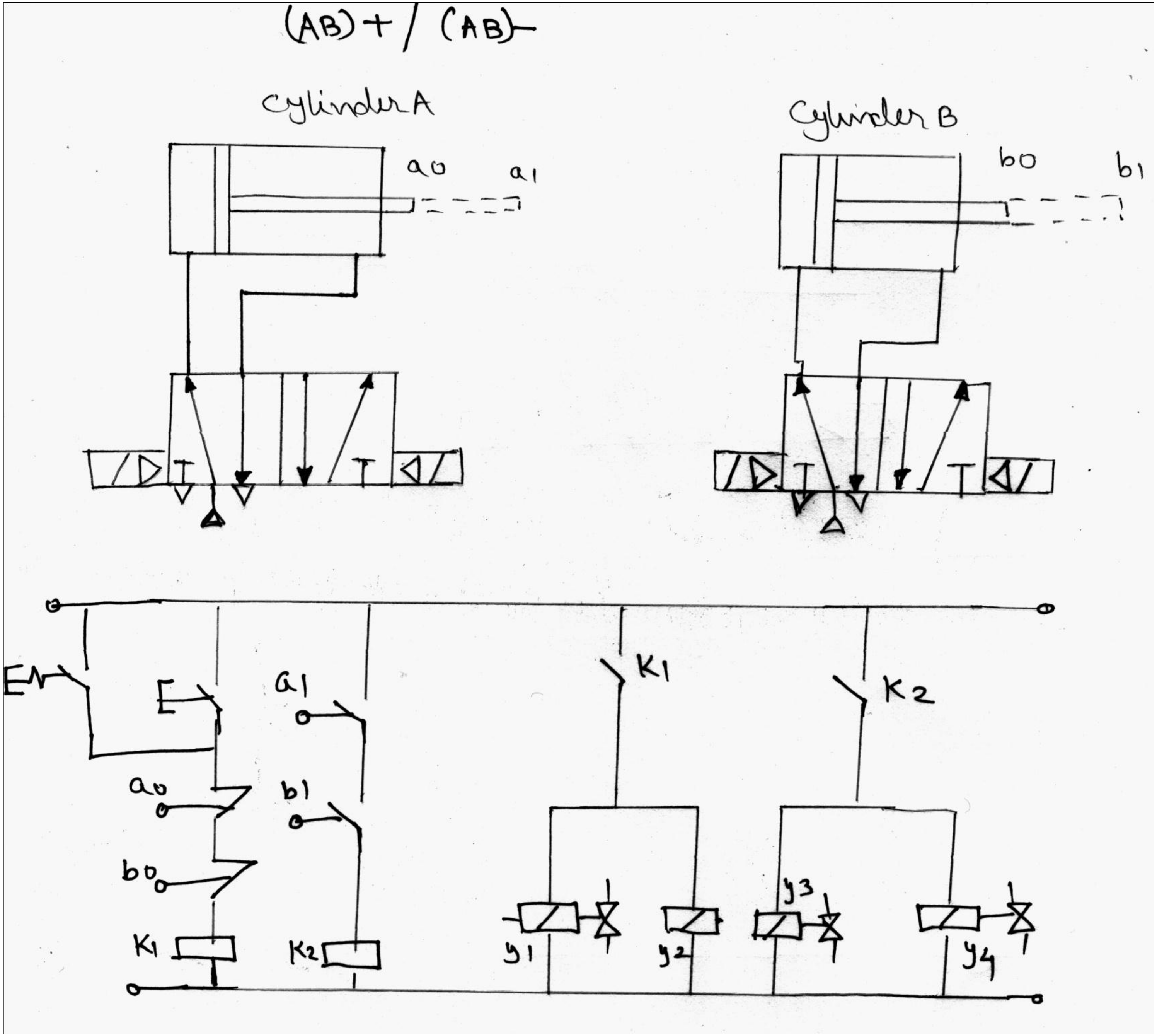
Physical Ladder Diagram

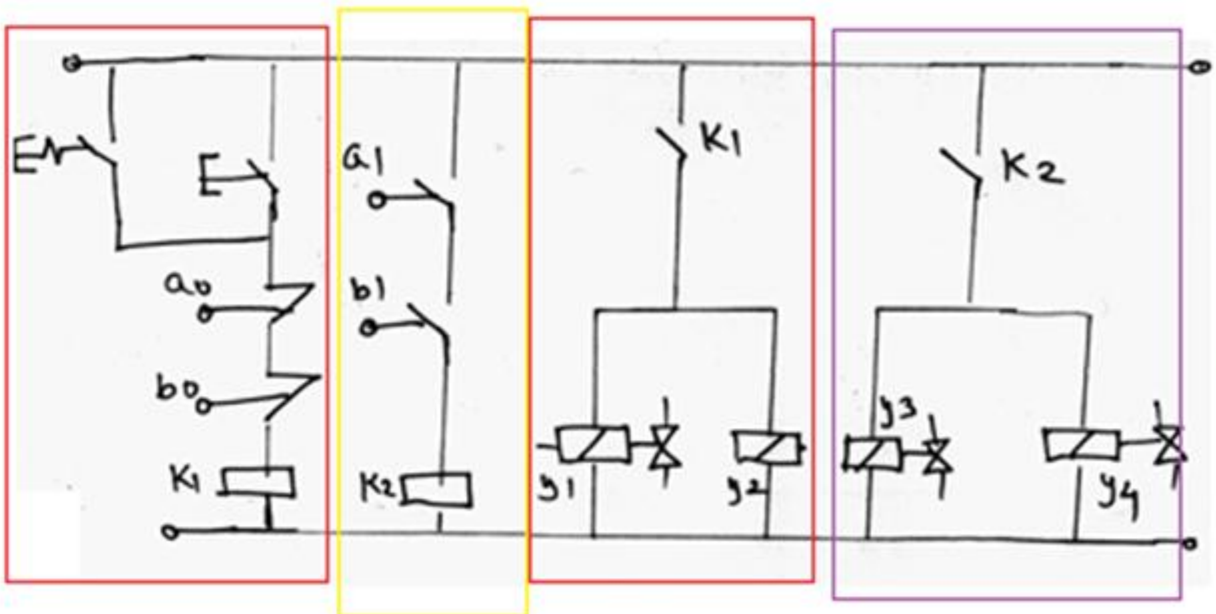


Physical Ladder Diagram

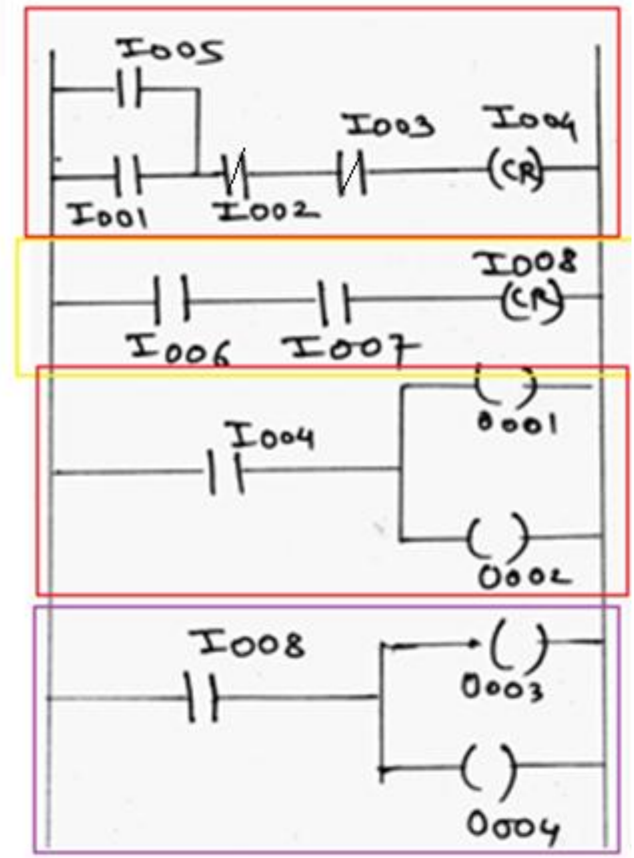


PLC Program

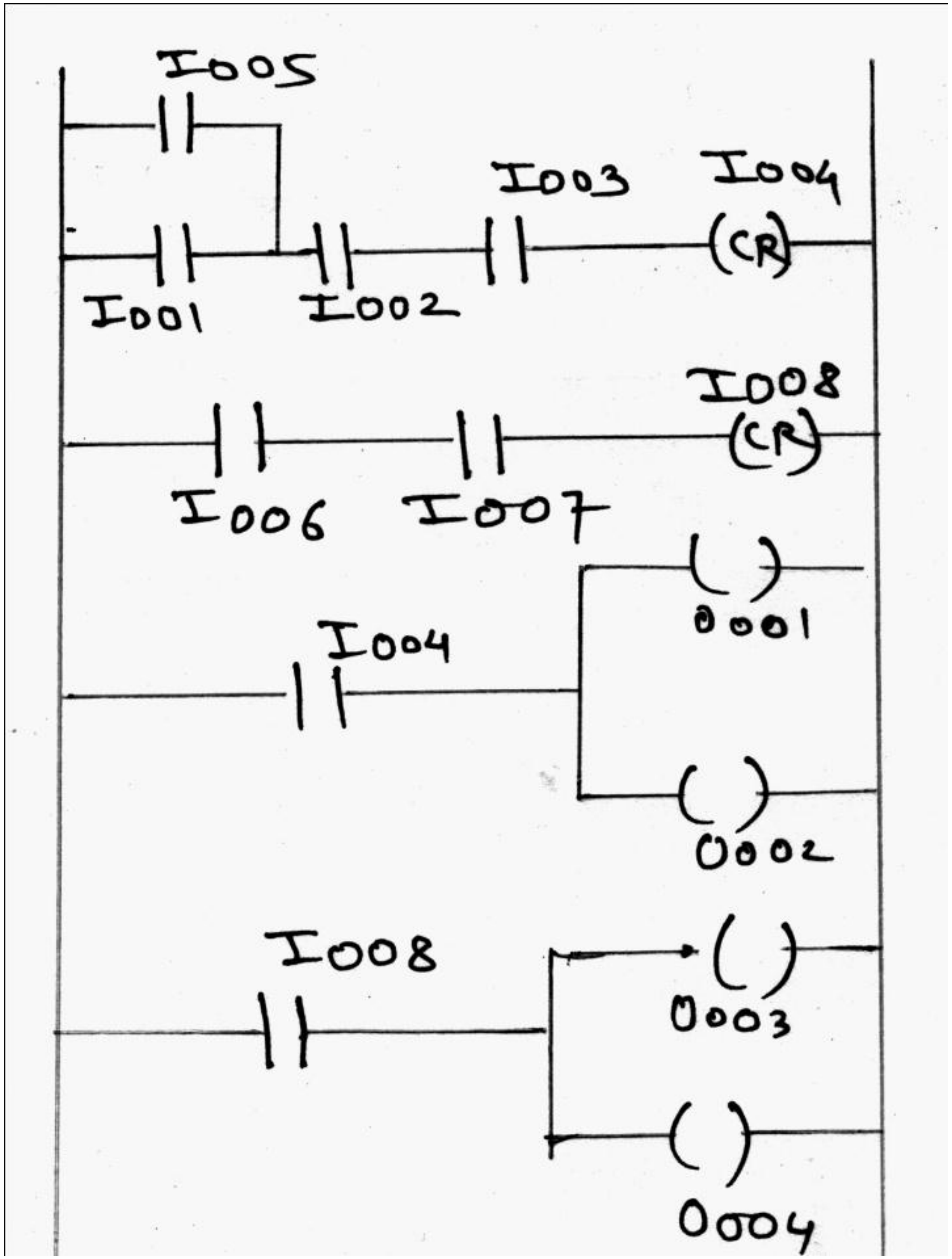

(AB)+ / (AB)-
Cylinder A
a0
a1
Cylinder B
b0
b1
E
E
a1
K1
K2
a0
b1
b0
K1
K2
y1
y2
y3
y4



Relay Circuit

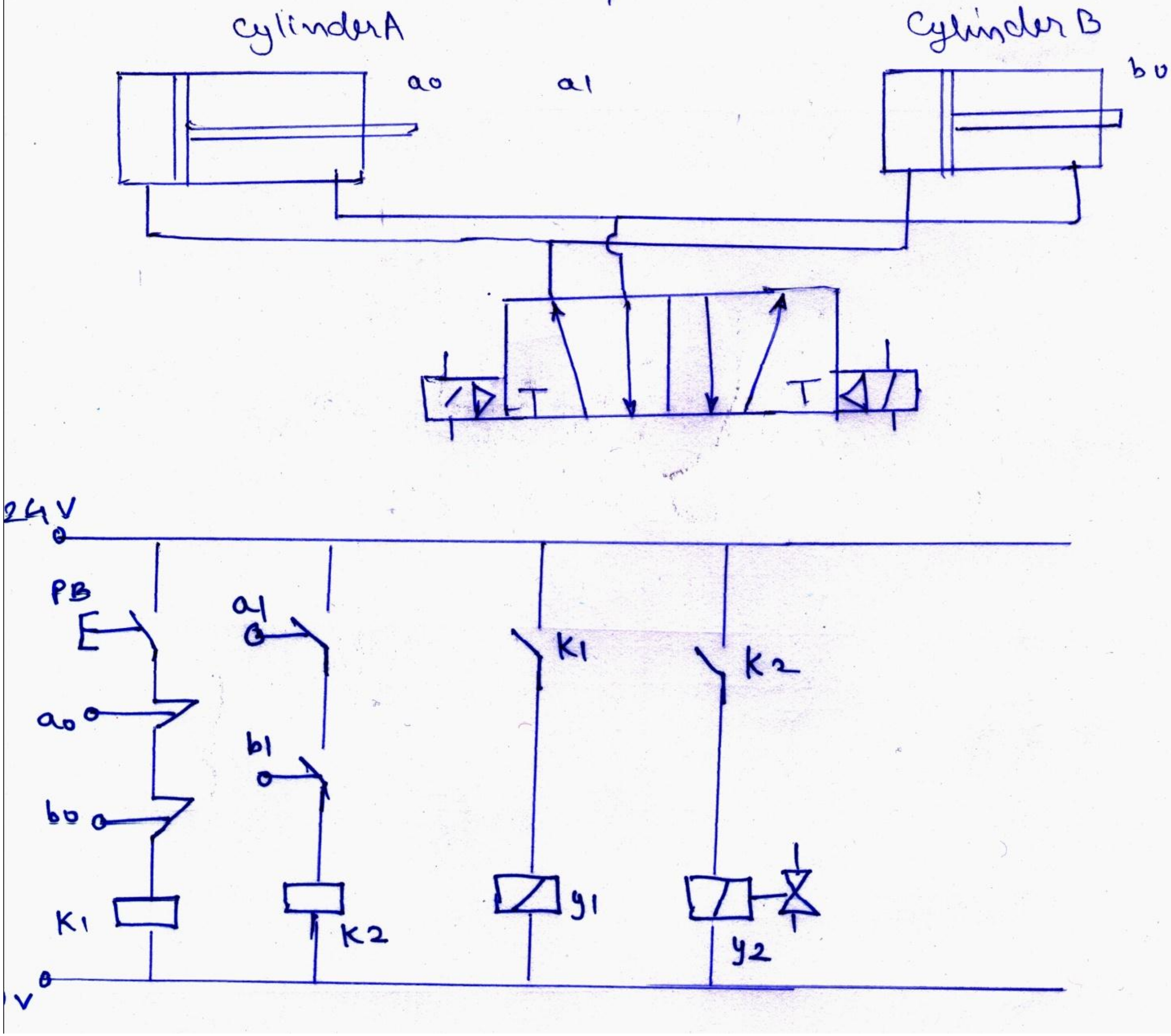


PLC Diagram

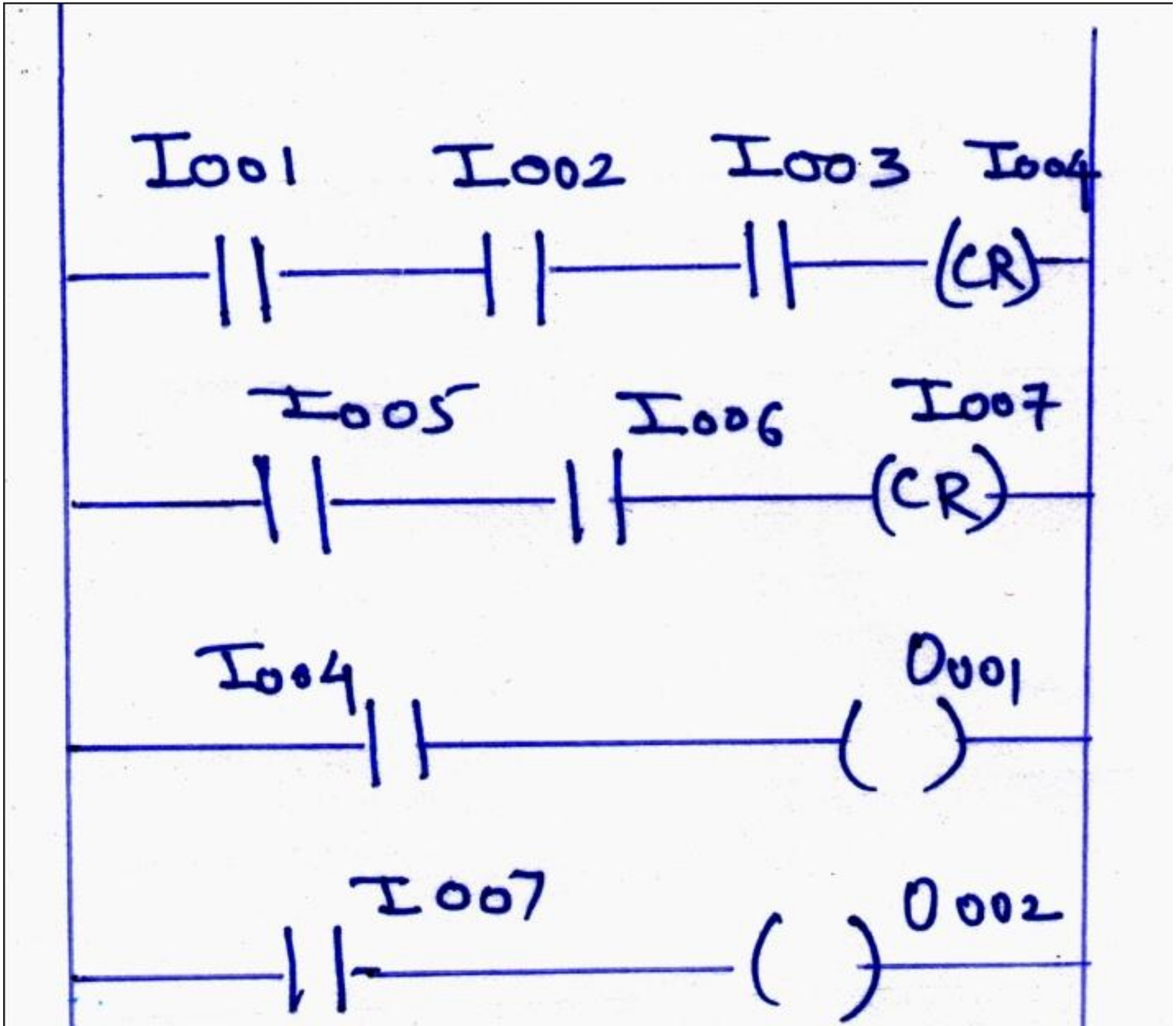


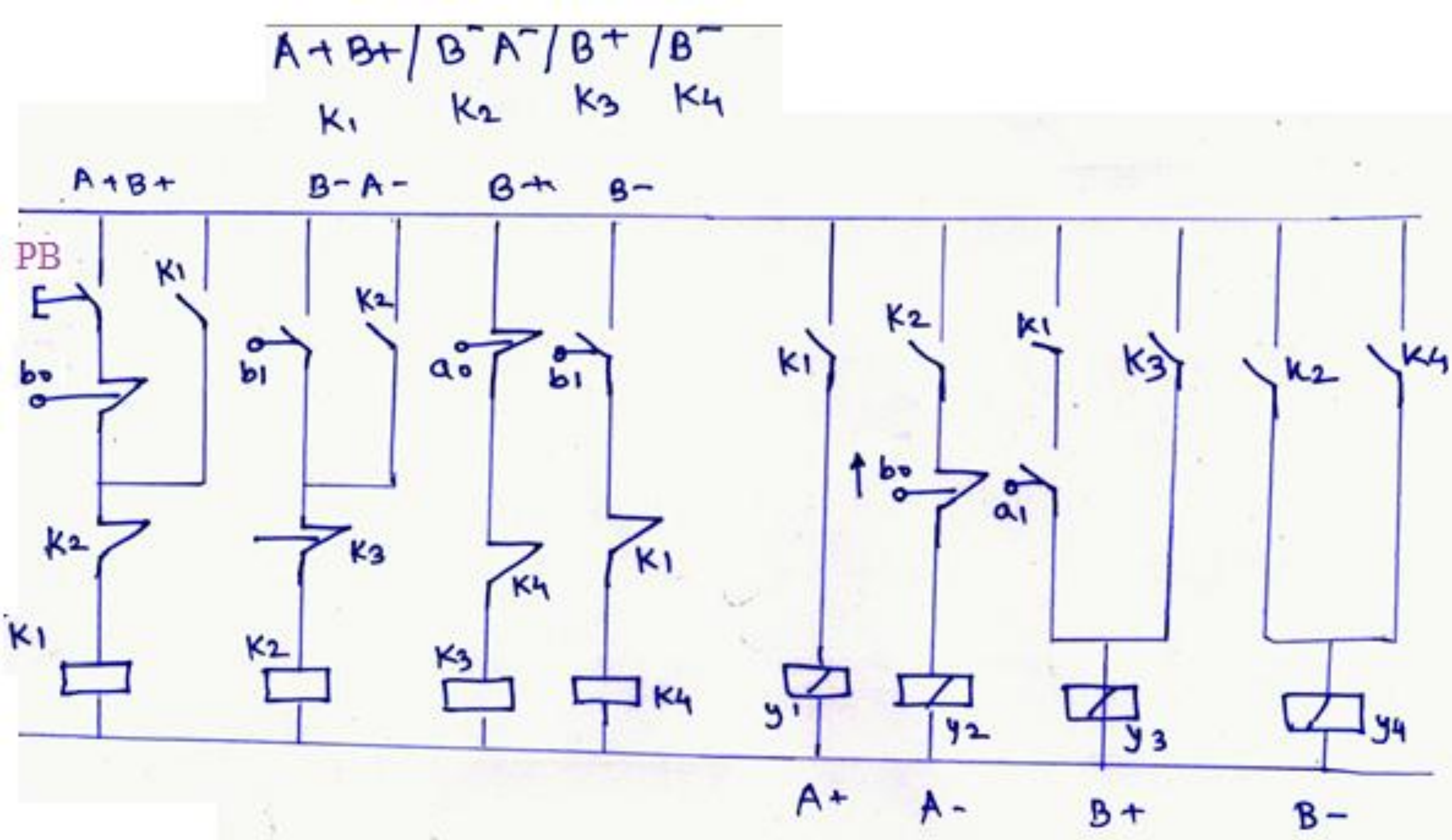
I005
I003
I004
(CR)
I001
I002
I008
(CR)
I006
I007
0001
I004
0002
I008
0003
0004

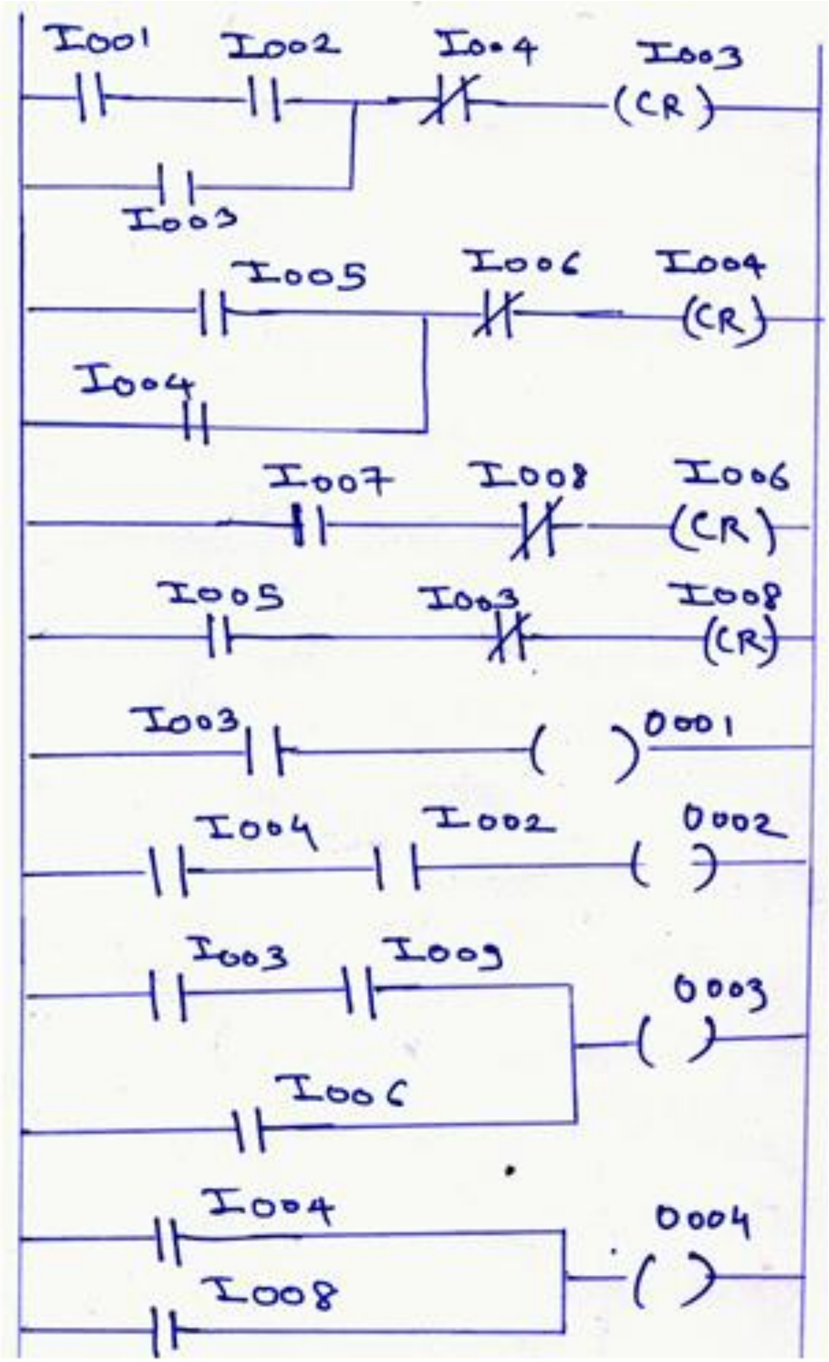
(AB)+/(AB)-



CylinderA
Cylinder B
a0
a1
b0
24V
PB
a1
K1
K2
a0
b1
b0
K1
K2
y1
y2
V


I001
I002
I003
I004
(CR)
I005
I006
I007
(CR)
I004
O001
I007
O002


A+B+ / B- A- / B+ / B-
K1 K2 K3 K4
A+B+
B- A-
B+
B-
PB
K1
K2
b0
b1
a0
b1
K2
K3
K4
K1
K1
K2
K3
K4
K1
K2
K1
K3
K2
K4
b0
a1
y1
y2
y3
y4
A+
A-
B+
B-

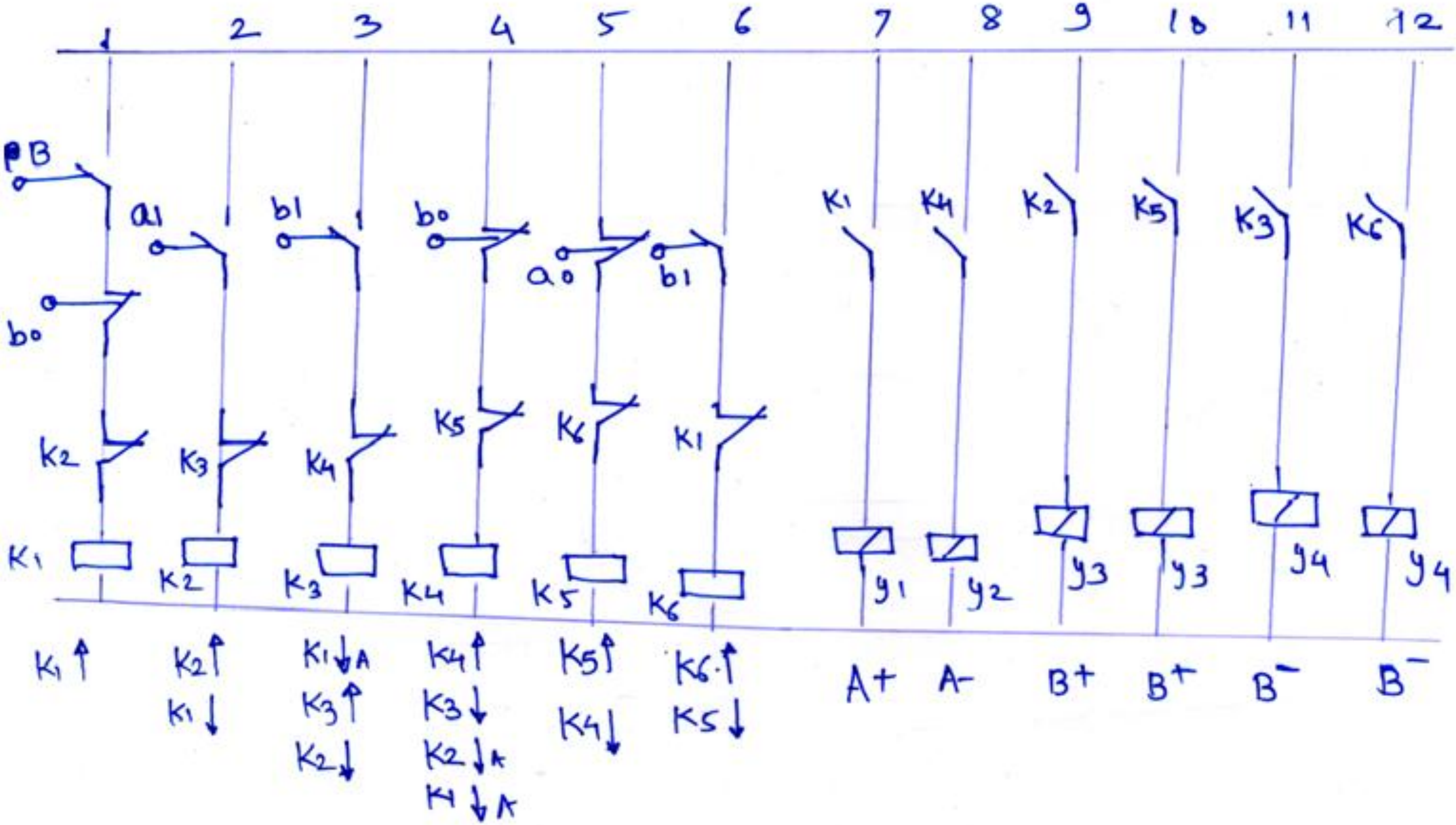


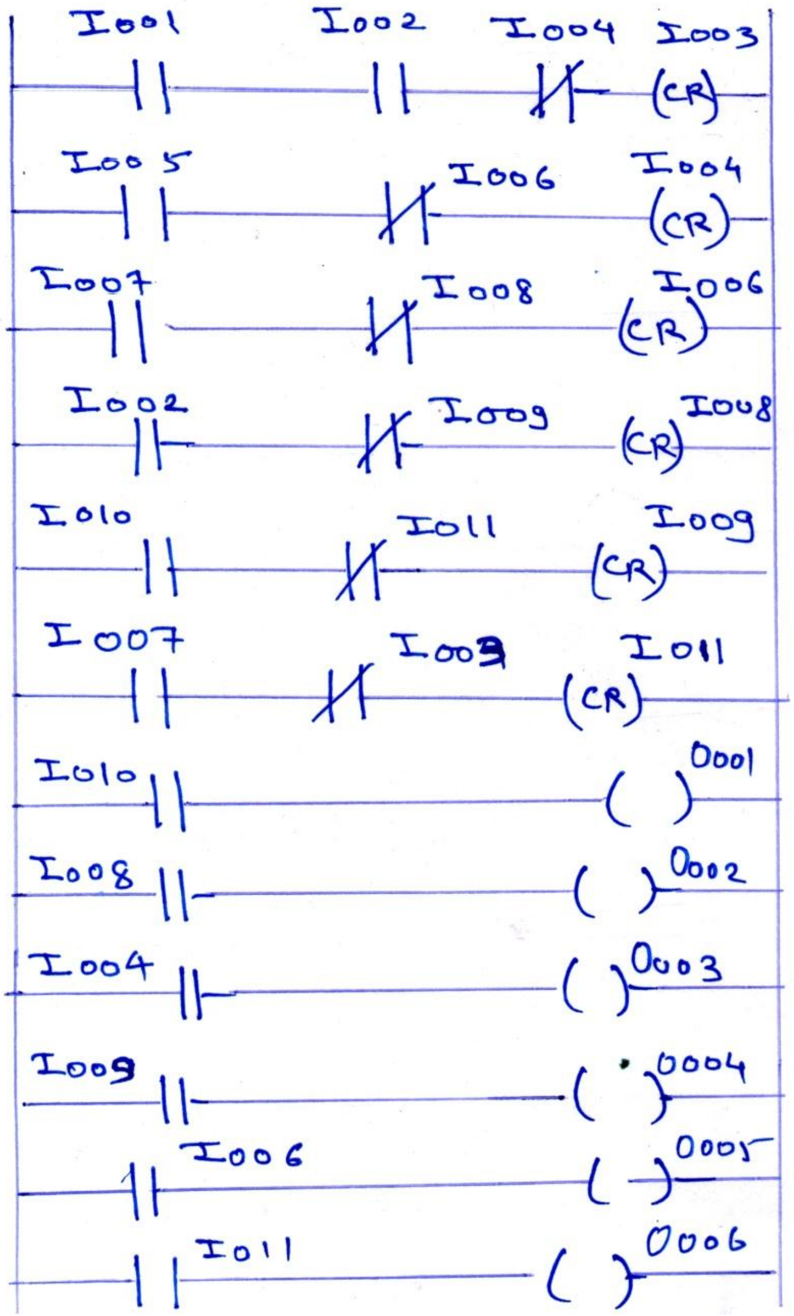
I001
I002
I004
I003
(CR)
I003
I005
I006
I004
(CR)
I004
I007
I008
I006
(CR)
I005
I003
I008
(CR)
I003
0001
I004
I002
0002
I003
I009
0003
I006
I004
0004
I008

A+ B+ / B- A- / B+ / B-

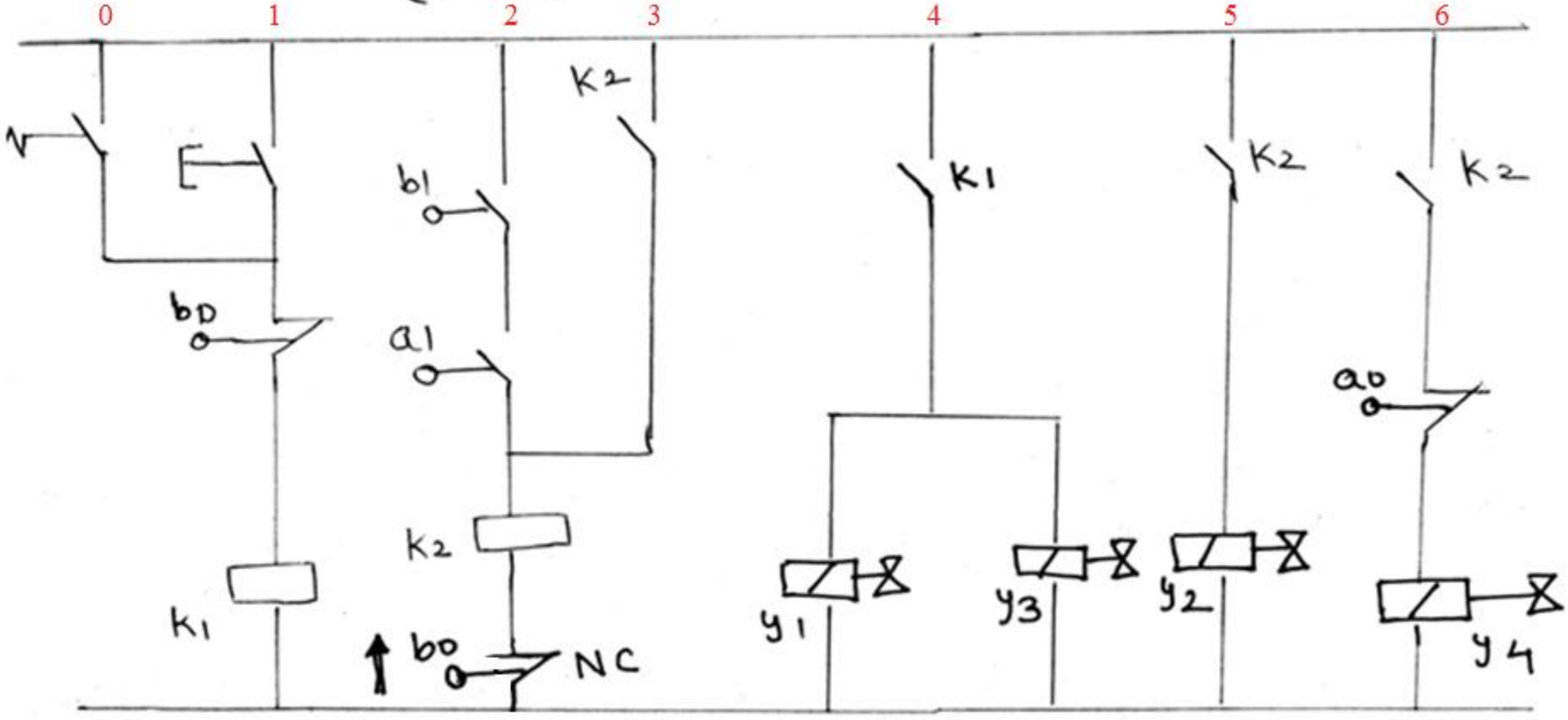
A+/B+/B−/A−/B+/B−

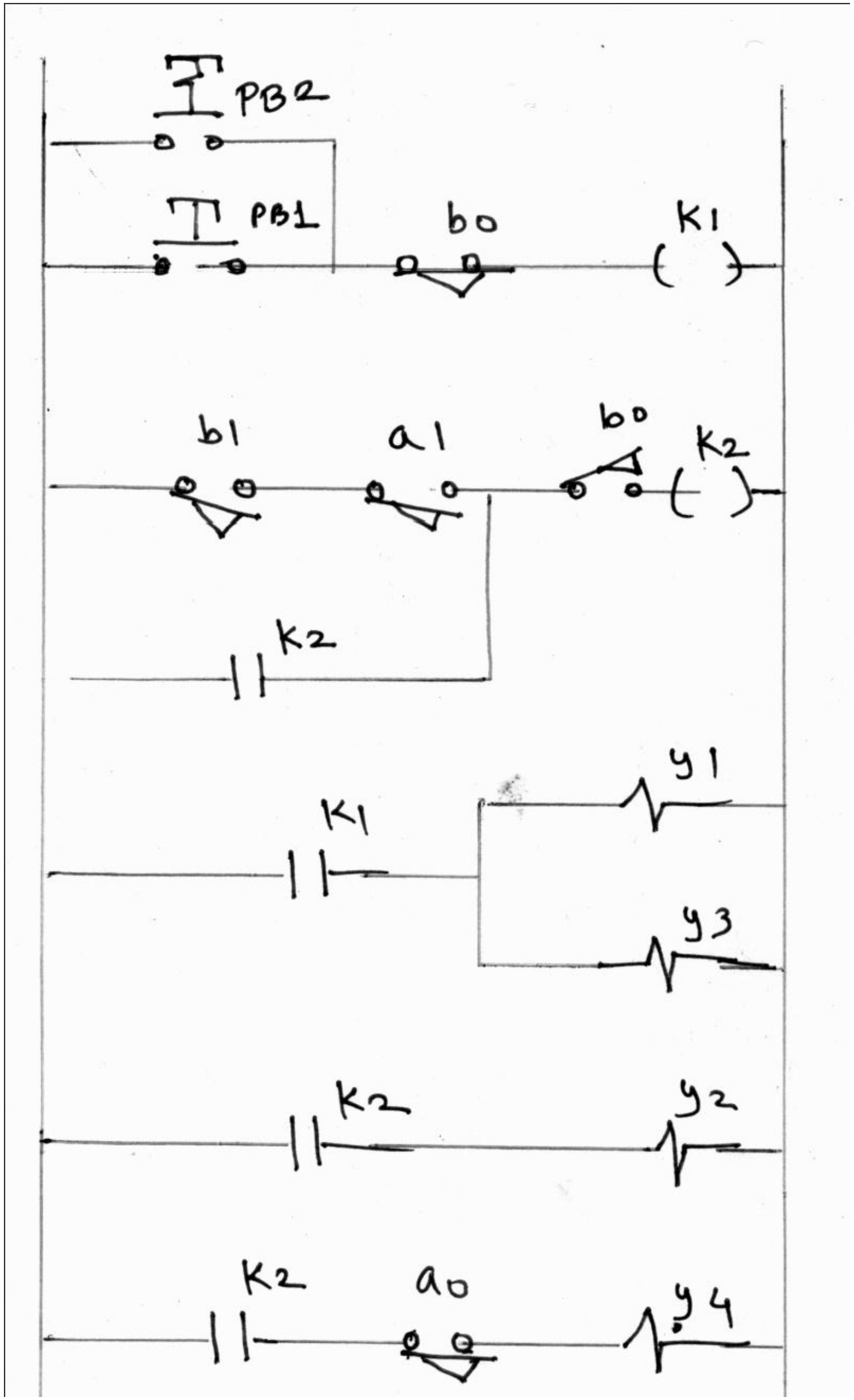
K1 K2 K3 K4 K5 K6

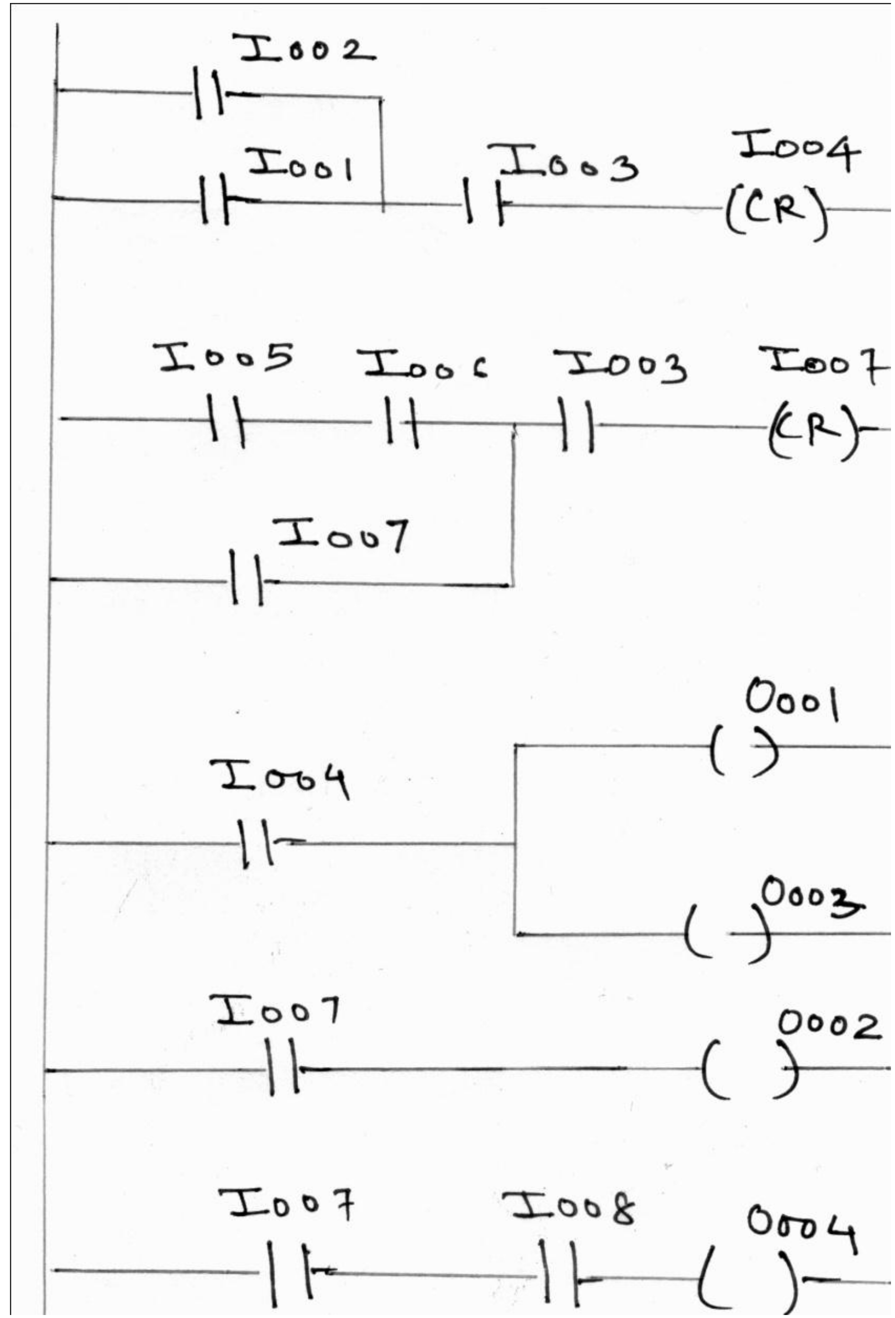


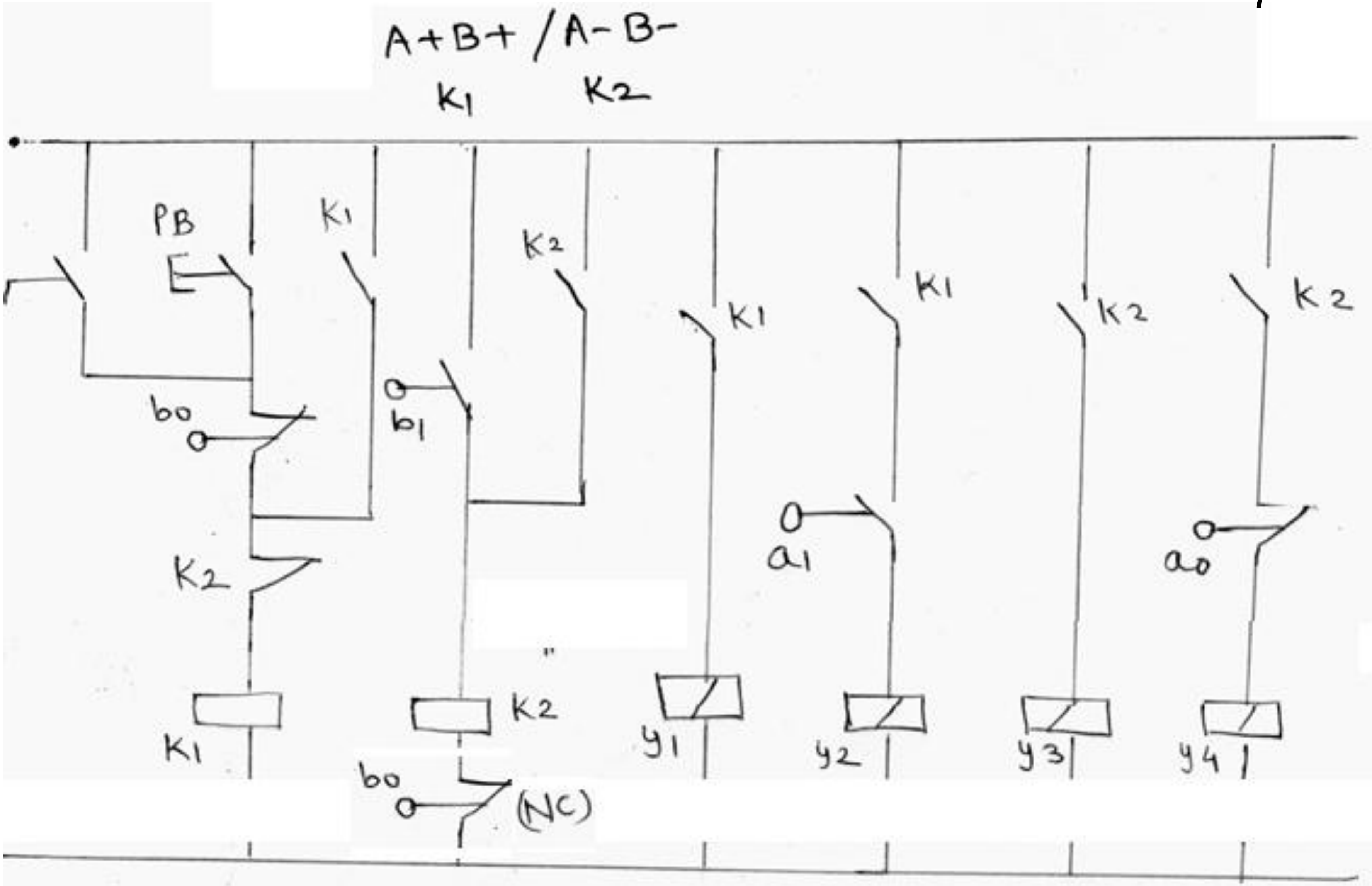

I001
I002
I004
I003
CR
I005
I006
I004
CR
I007
I008
I006
CR
I002
I009
I008
CR
I010
I011
I009
CR
I007
I009
I011
CR
I010
0001
I008
0002
I004
0003
I009
0004
I006
0005
I011
0006

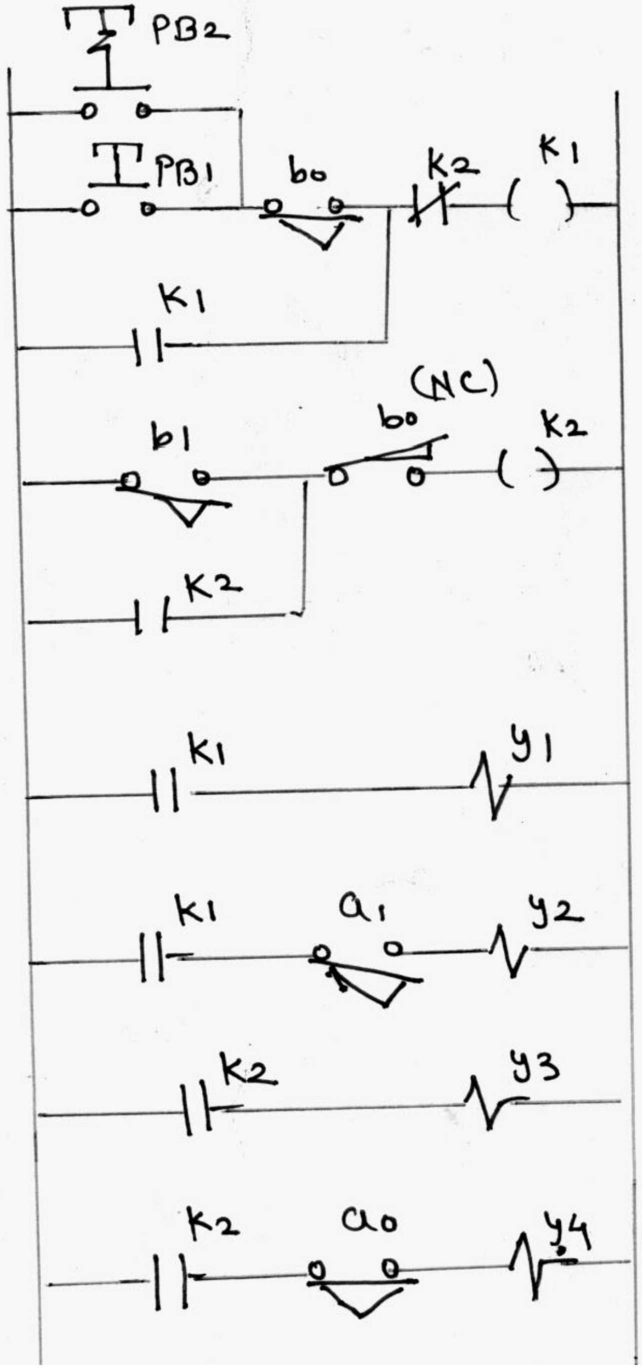
(AB)+ / A- B-

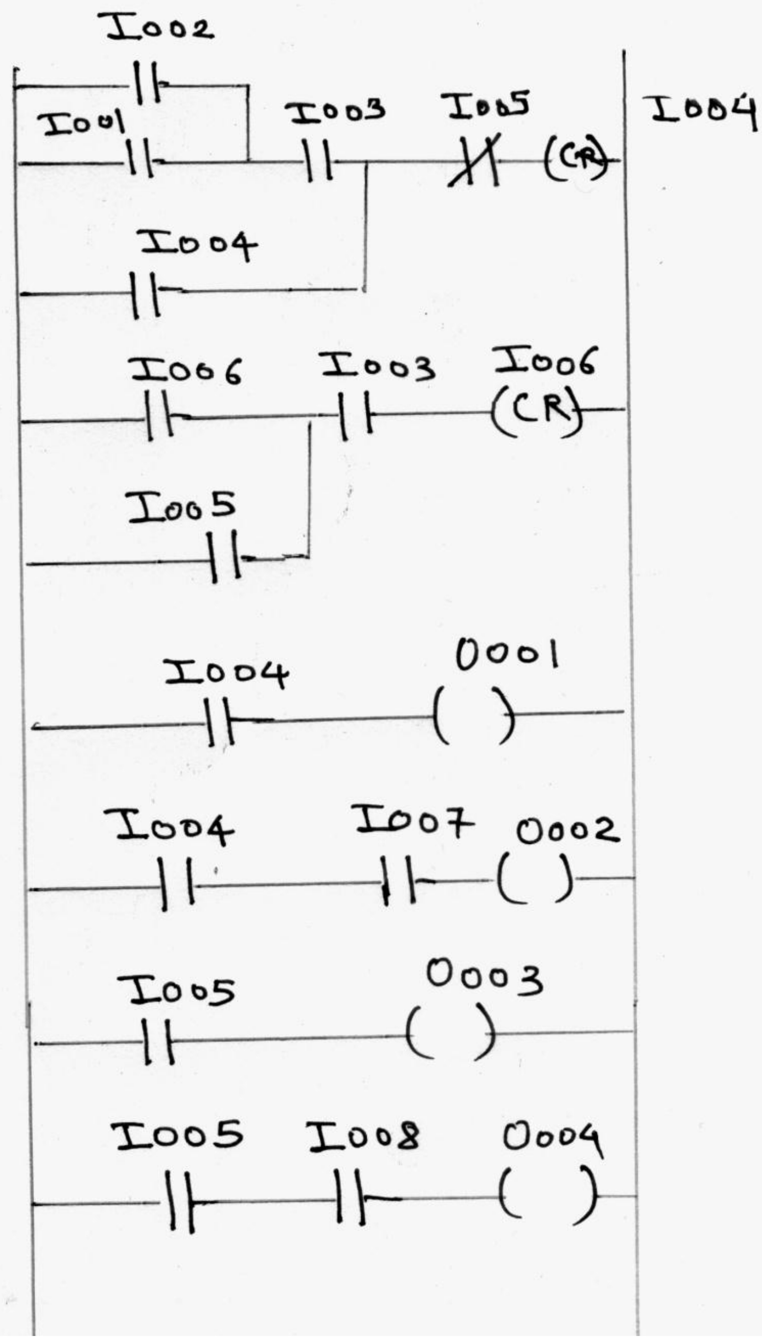



PB2
PB1
b0
K1
b1
a1
b0
K2
K2
K1
y1
y3
K2
y2
K2
a0
y4

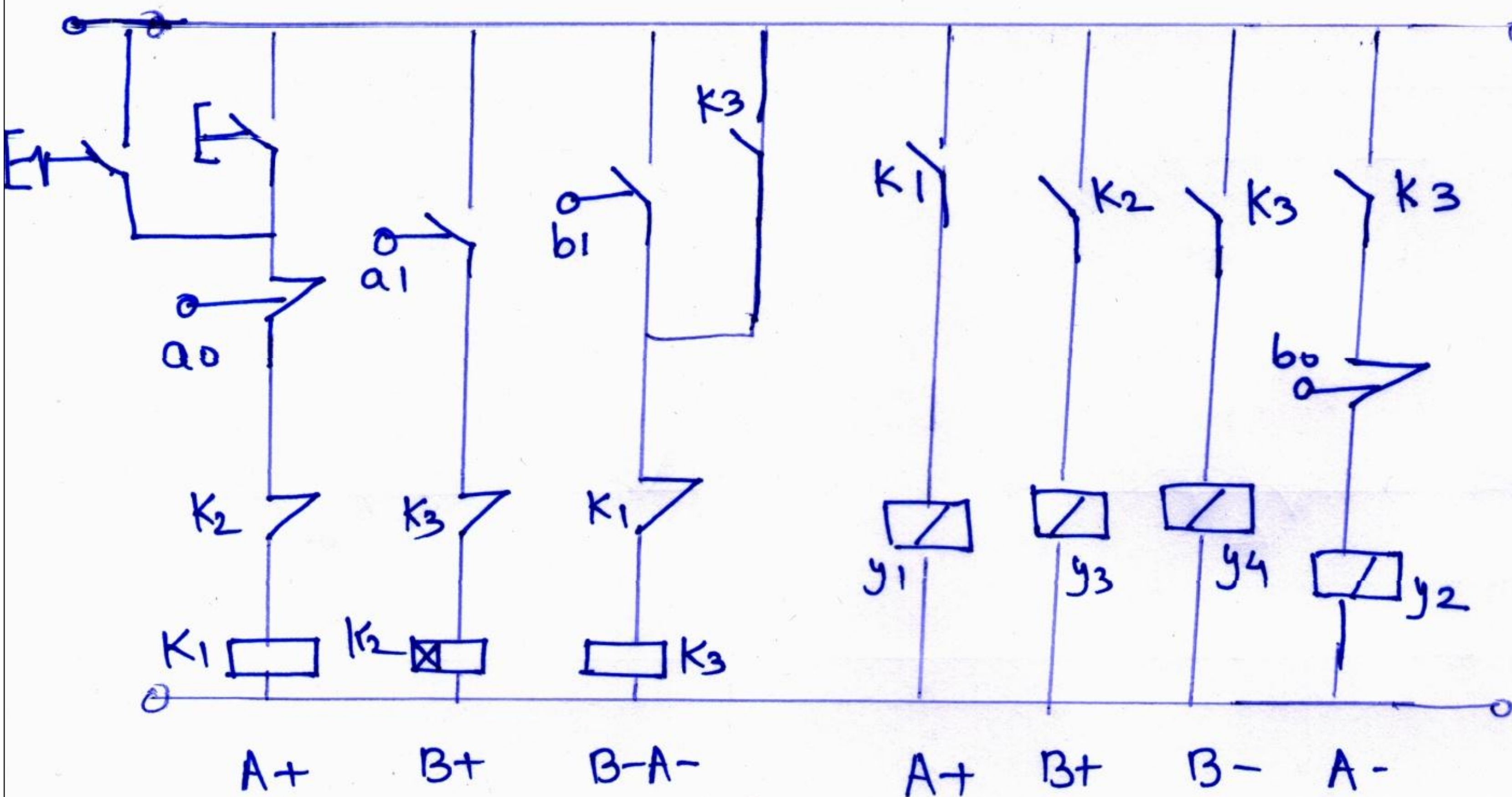

I002
I001
I003
I004
(CR)
I005
I006
I003
I007
(CR)
I007
O001
I004
O003
I007
O002
I007
I008
O004

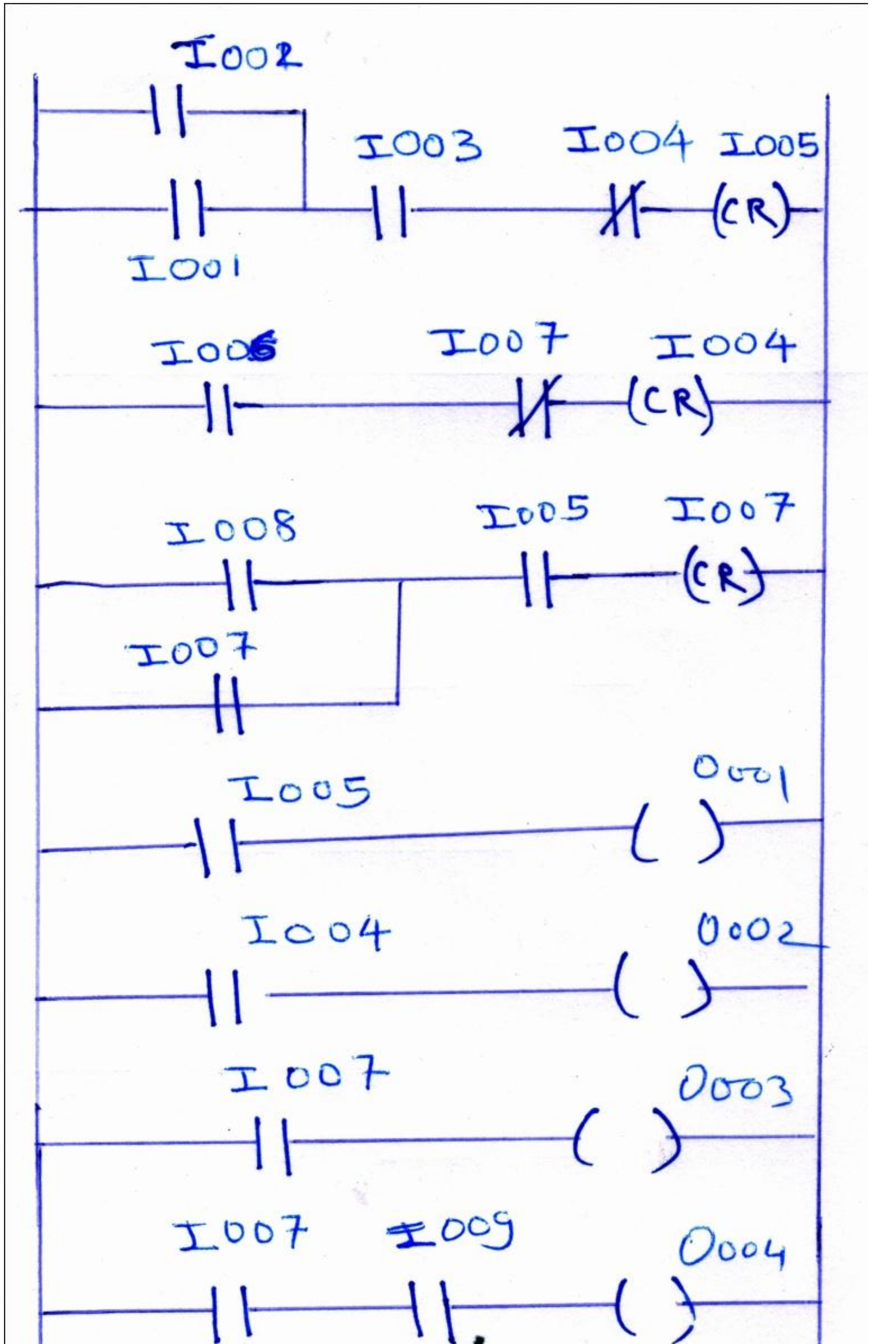

A+B+ / A- B-
K1
K2
PB
K1
K2
K1
K1
K2
K2
b0
b1
a1
a0
K2
K1
K2
y1
y2
y3
y4
b0
(NC)

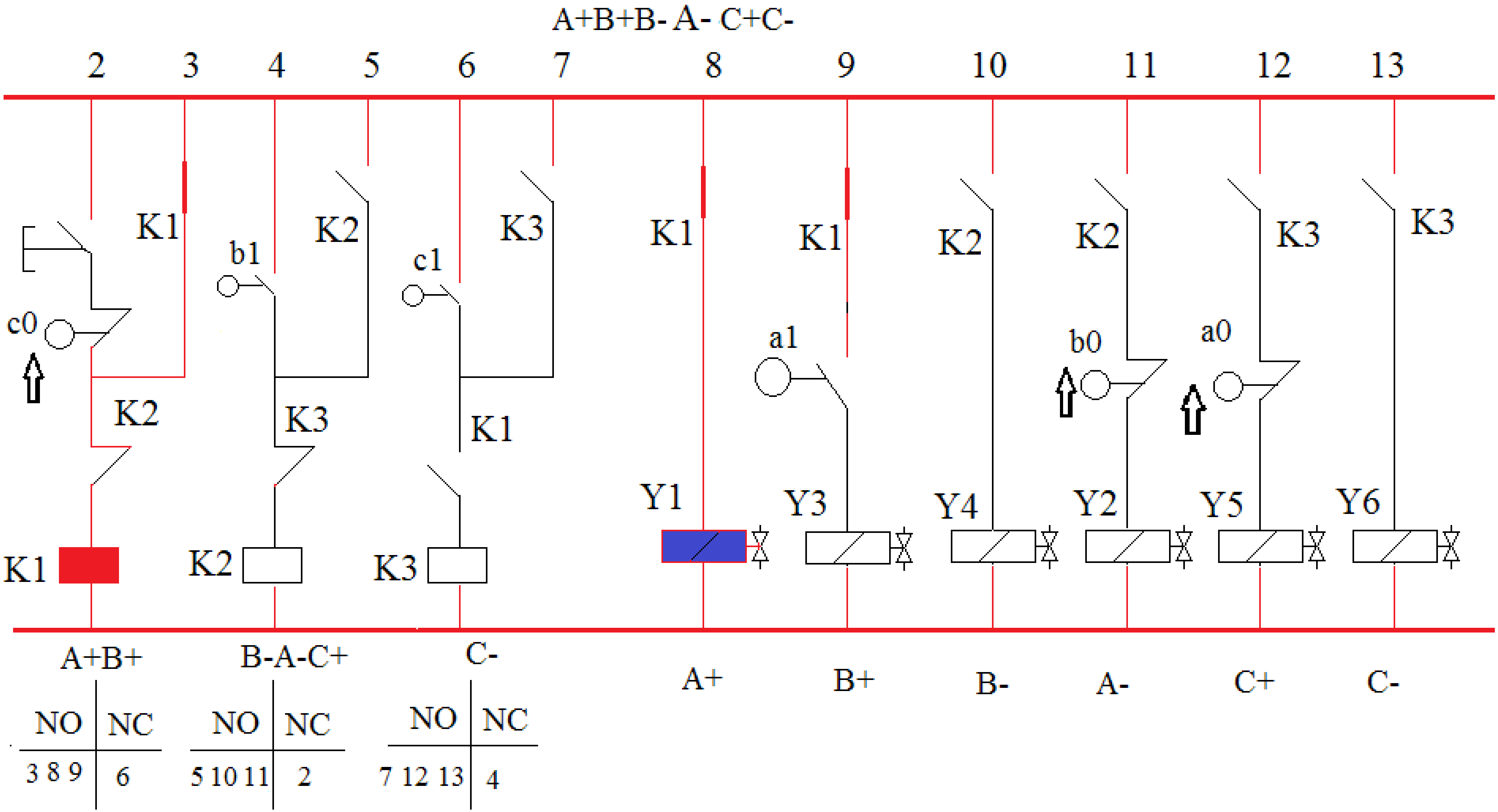

PB2
PB1
bo
K2
K1
K1
(NC)
b1
bo
K2
K2
K1
y1
K1
a1
y2
K2
y3
K2
ao
y4


I002
I001
I003
I005
(CR)
I004
I004
I006
I003
I006
(CR)
I005
I004
0001
I004
I007
0002
I005
0003
I005
I008
0004

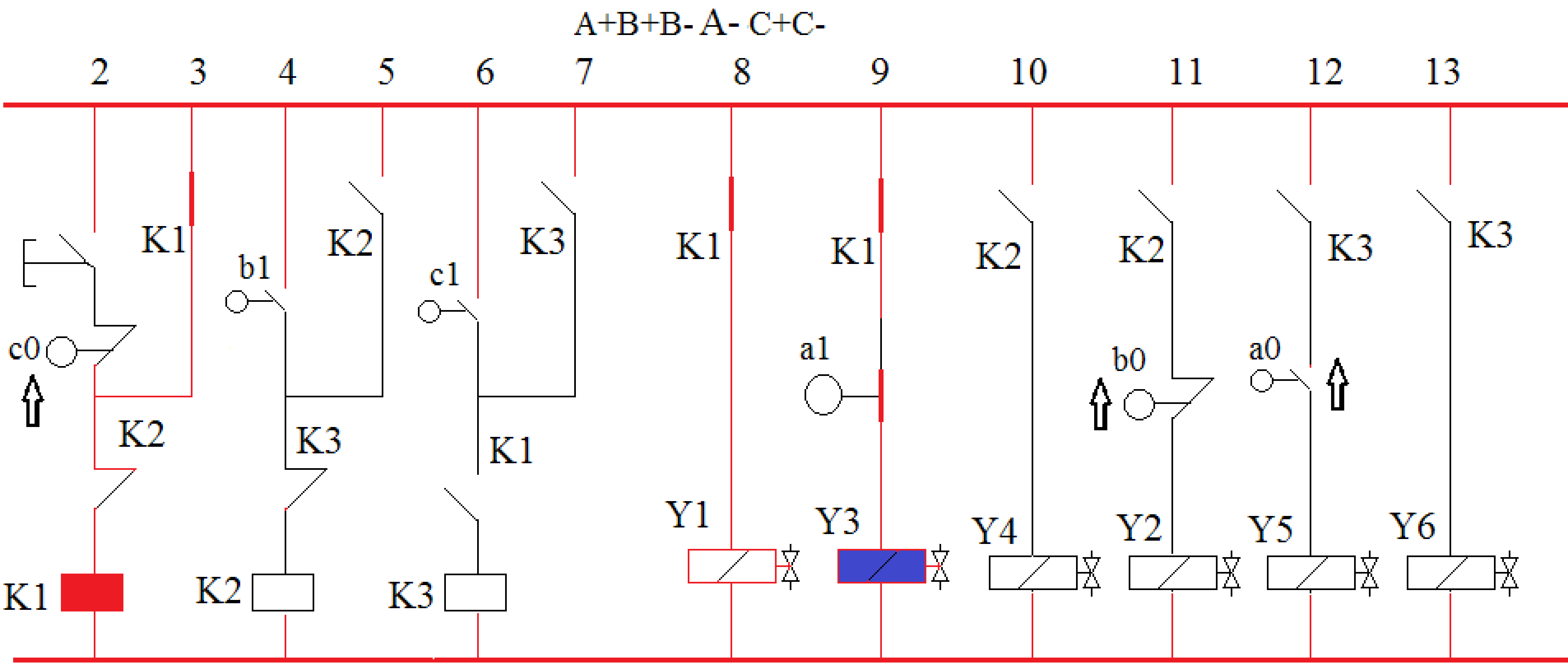
A+/Delay B+ /B- A-




I002
I003
I004
I005
(CR)
I001
I006
I007
I004
(CR)
I008
I005
I007
(CR)
I007
I005
O001
( )
I004
O002
( )
I007
O003
( )
I007
I009
O004
( )



A+B+B- A- C+C-
2
3
4
5
6
7
8
9
10
11
12
13
K1
b1
K2
c1
K3
K1
K1
K2
K2
K3
K3
c0
a1
b0
a0
K2
K3
K1
Y1
Y3
Y4
Y2
Y5
Y6
K1
K2
K3
A+B+
B-A-C+
C-
A+
B+
B-
A-
C+
C-
NO
NC
3 8 9
6
NO
NC
5 10 11
2
NO
NC
7 12 13
4



A+B+

NO	NC
3 8 9	6

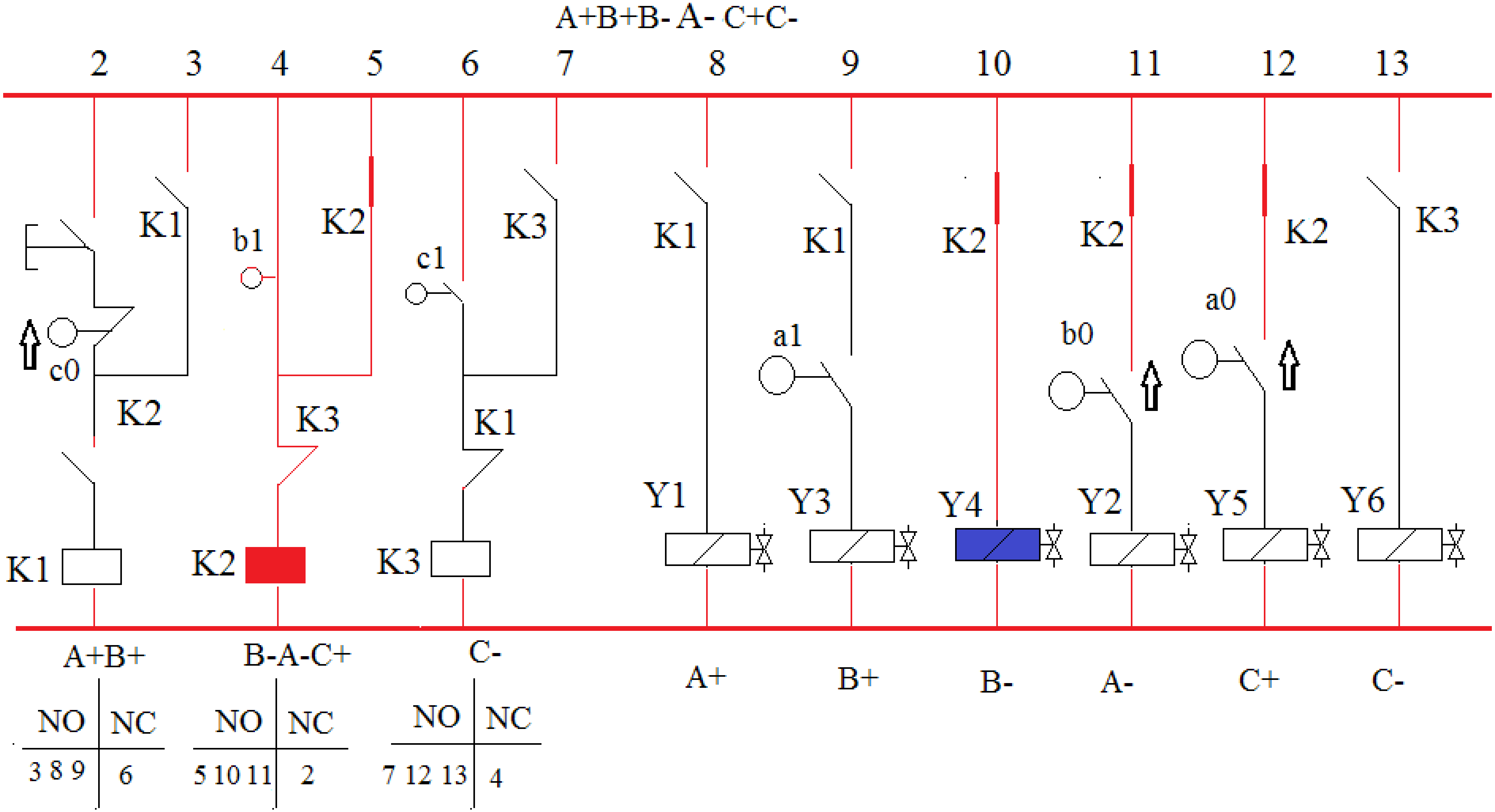
B-A-C+

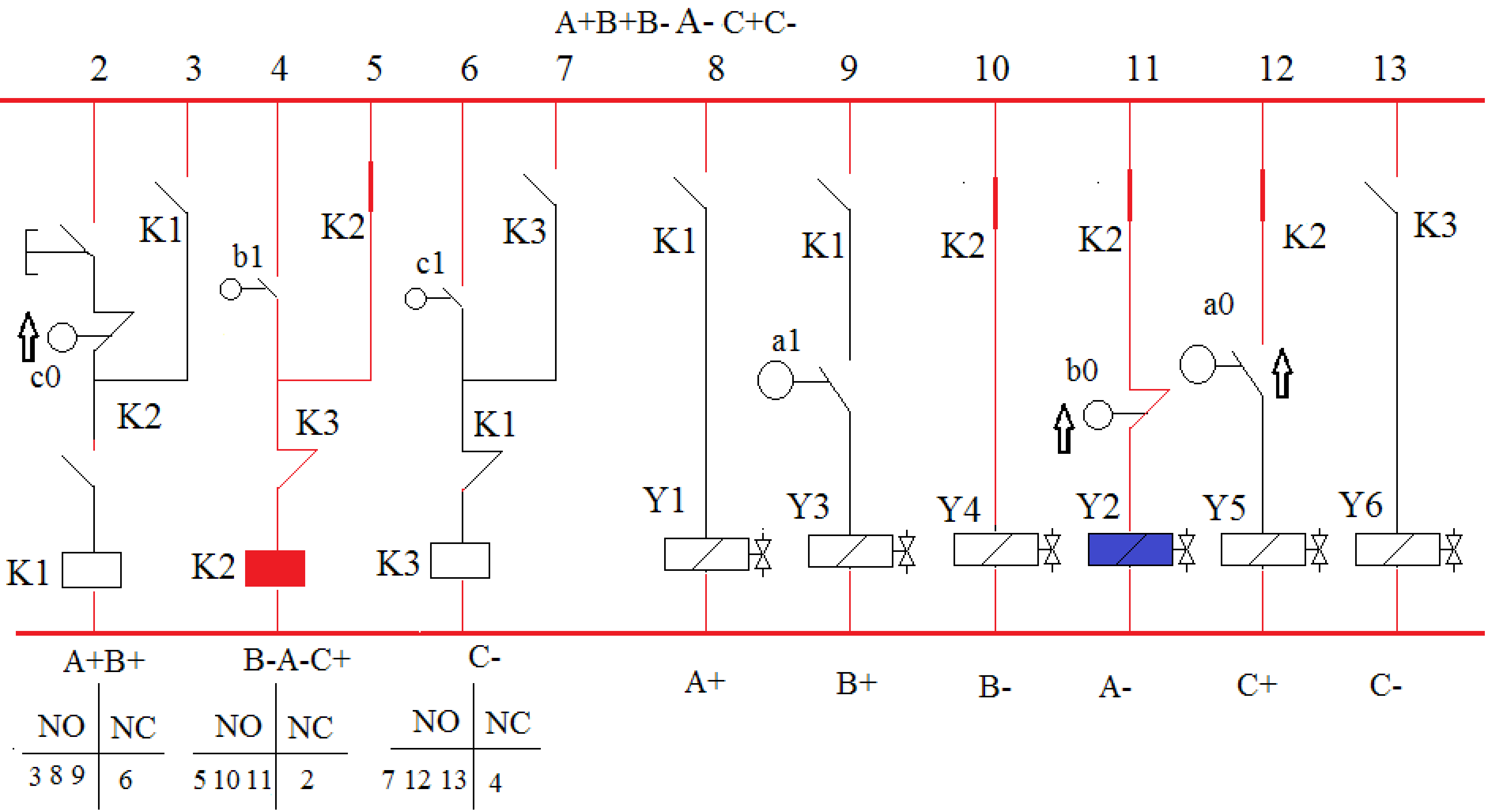
NO	NC
5 10 11	2

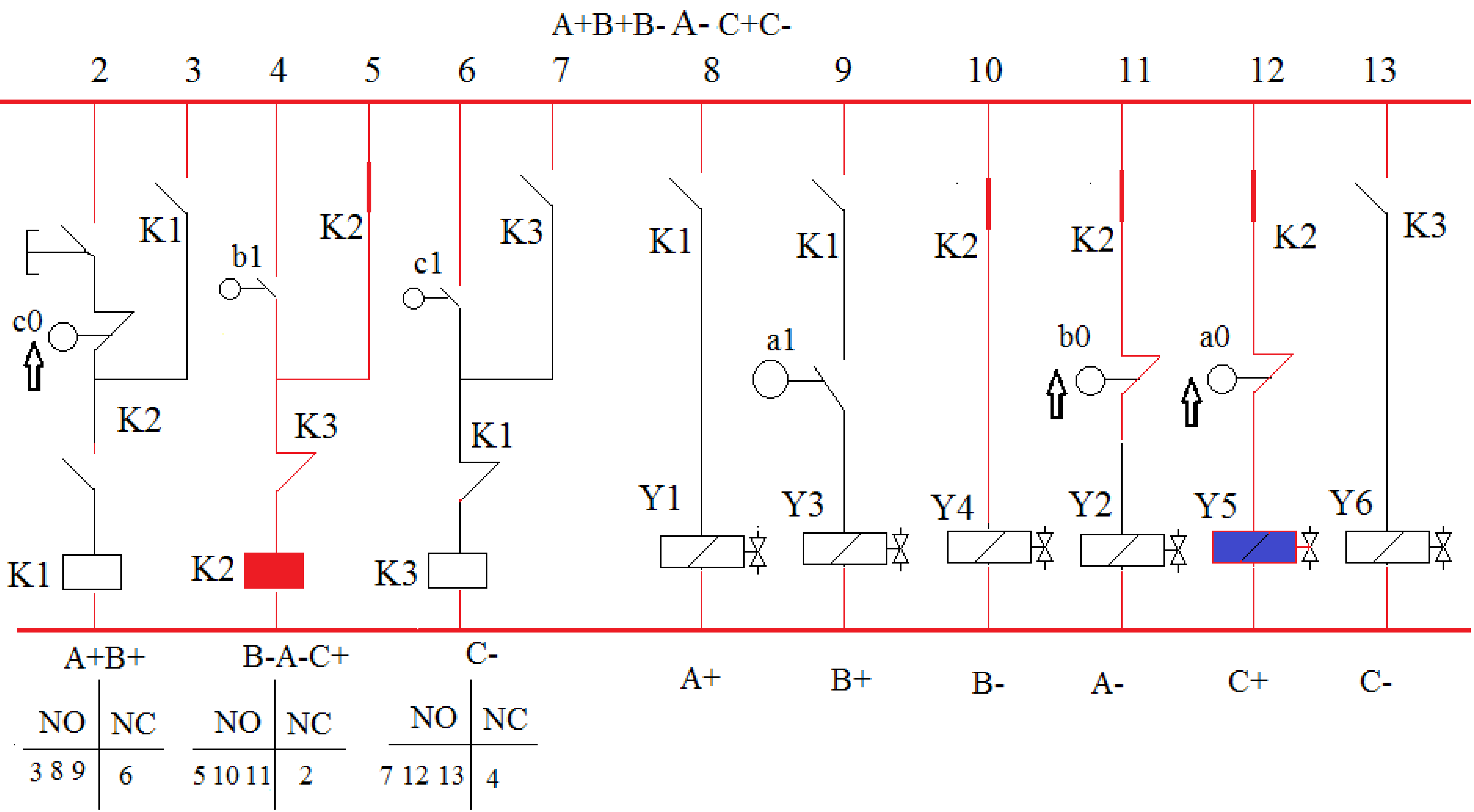
C-

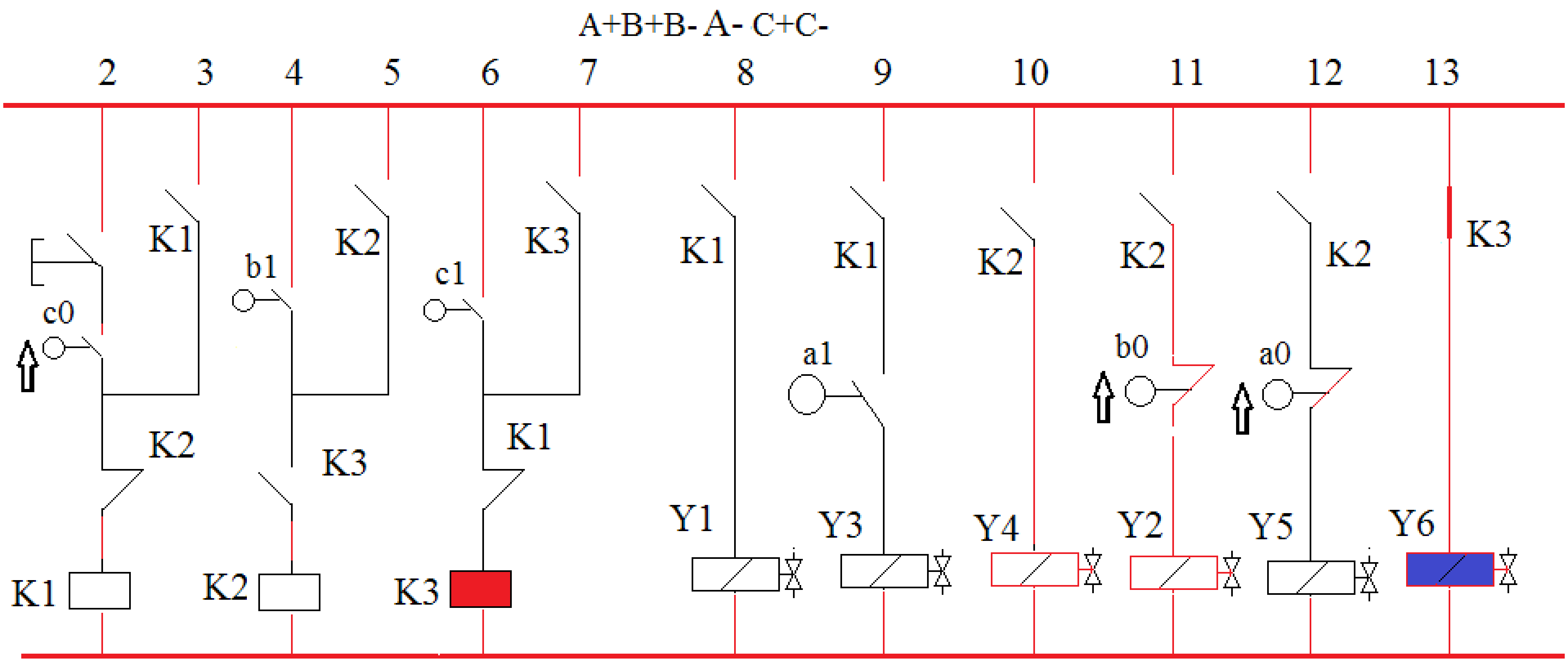
NO	NC
7 12 13	4

A+ B+ B- A- C+ C-


A+B+B- A- C+C-
2 3 4 5 6 7 8 9 10 11 12 13
K1 K2 b1 K2 c1 K3 K1 K1 K2 K2 K2 K3
c0 a1 b0 a0
K2 K3 K1
Y1 Y3 Y4 Y2 Y5 Y6
K1 K2 K3
A+B+ B-A-C+ C-
A+ B+ B- A- C+ C-
NO NC
3 8 9 6
NO NC
5 10 11 2
NO NC
7 12 13 4


A+B+B- A- C+C-
2 3 4 5 6 7 8 9 10 11 12 13
K1 K2 K3 K1 K1 K2 K2 K2 K3
b1 c1 a1 b0 a0 c0
K2 K3 K1
Y1 Y3 Y4 Y2 Y5 Y6
K1 K2 K3
A+B+ B-A-C+ C- A+ B+ B- A- C+ C-
NO NC
3 8 9 6
NO NC
5 10 11 2
NO NC
7 12 13 4


A+B+B- A- C+C-
2 3 4 5 6 7 8 9 10 11 12 13
K1 K2 K3 K1 K1 K2 K2 K2 K3
c0 b1 c1 a1 b0 a0
K2 K3 K1
Y1 Y3 Y4 Y2 Y5 Y6
K1 K2 K3
A+B+
B-A-C+
C-
A+ B+ B- A- C+ C-
NO NC
3 8 9 6
NO NC
5 10 11 2
NO NC
7 12 13 4



A+B+

NO	NC
3 8 9	6

B-A-C+

NO	NC
5 10 11	2

C-

NO	NC
7 12 13	4

Industrial Applications

PLC

Example : 1

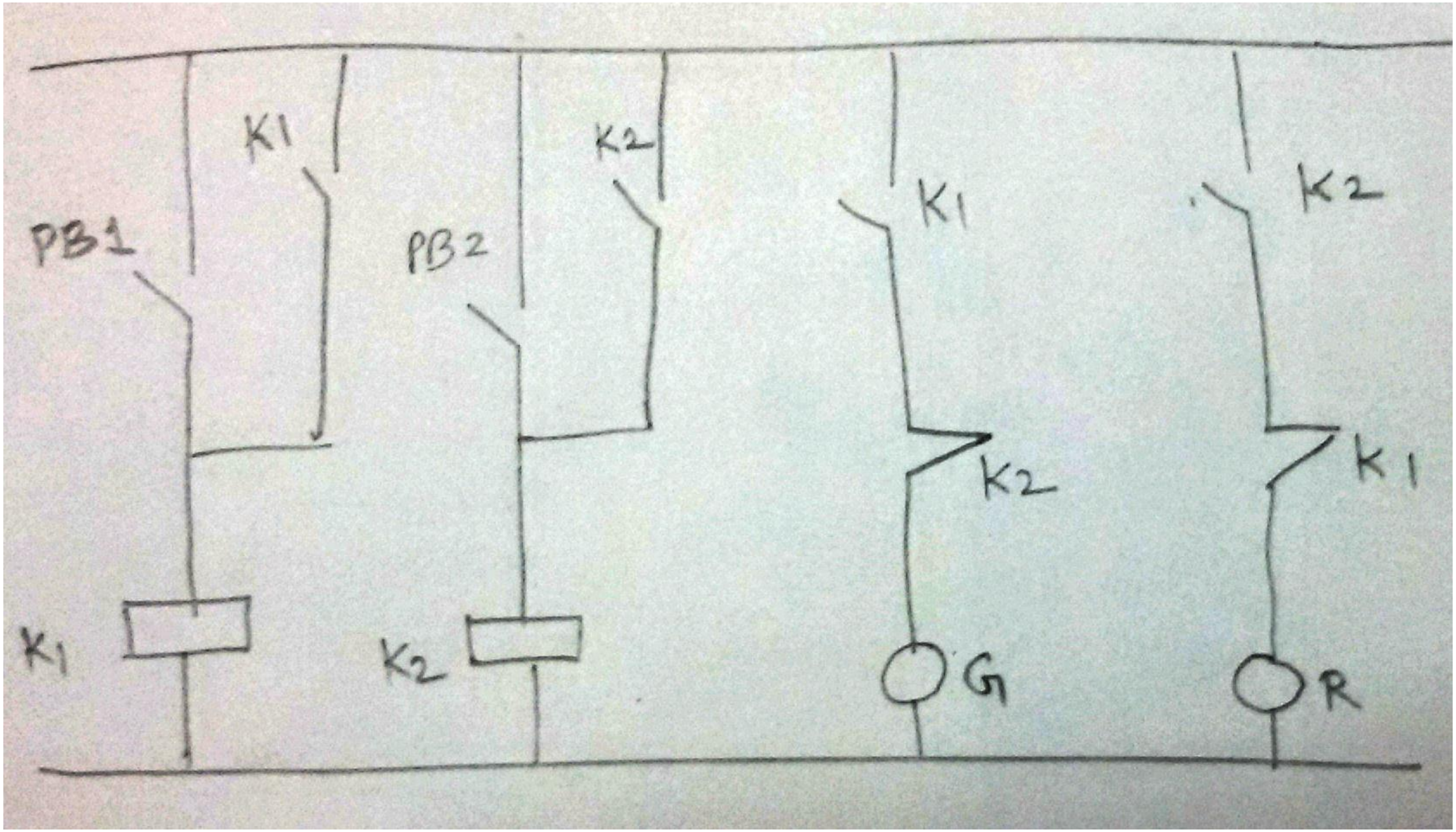
PB1 and PB2 are two push buttons.
There are two lamps green and red.

Develop a PLC diagram to meet the following requirements:

1. When PB1 is pushed, green lamp should be ON and it will continue to be ON till PB2 is pushed.

2. When PB2 is pushed, red lamp should be ON and it will continue to be ON till PB1 is pushed.

3. If PB1 and PB2 both are pushed simultaneously, both lights should go OFF.



Inputs:

PB1

PB2

Relay coil K1

Relay coil k2

Contacts:

K1- NO : 1, 2, 5

NC: 6

K2- NO : 3, 4, 6

NC : 5

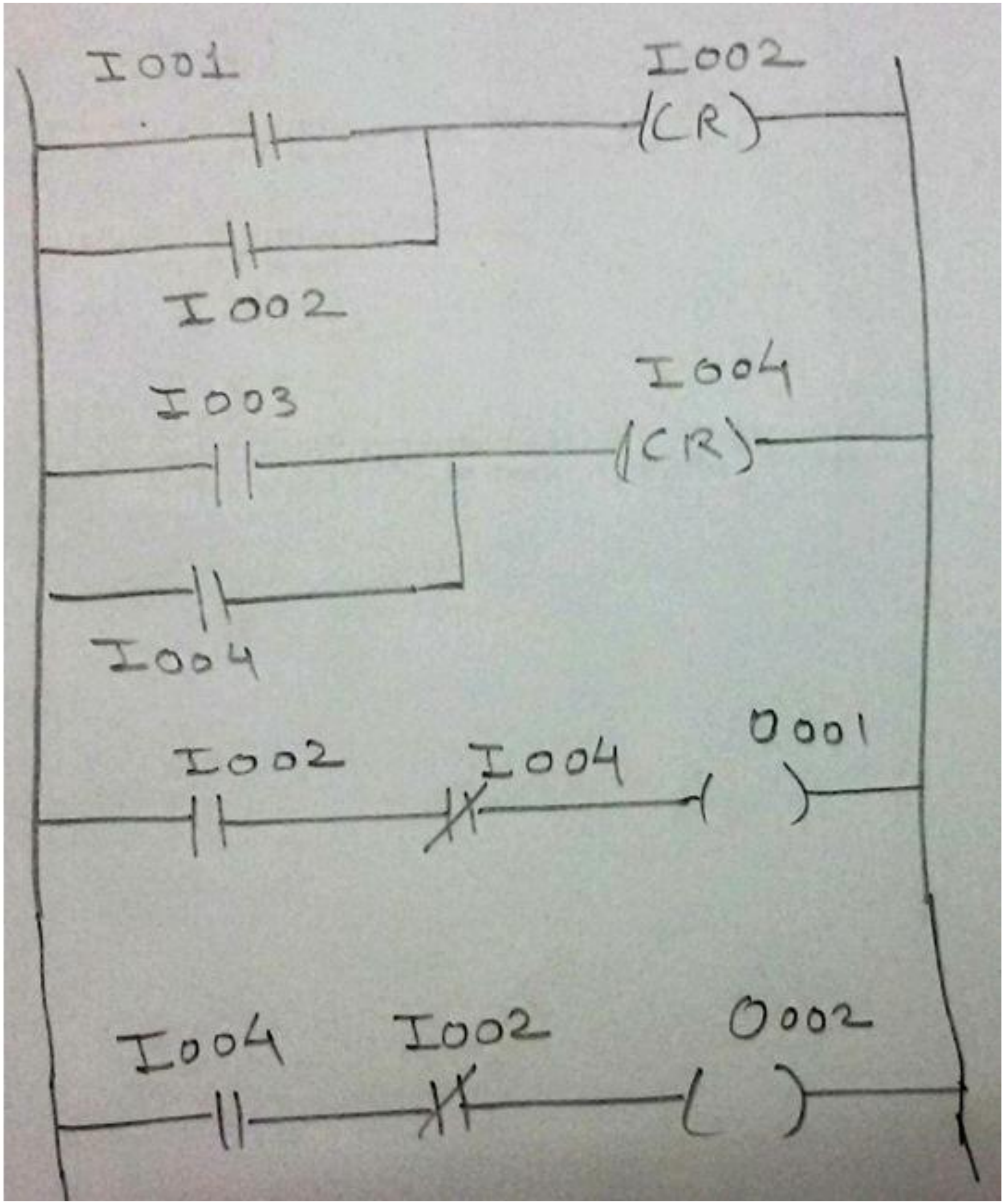
Outputs:

LED Green

LED Red

ALLOCATION TABLE

Element	Code	Address	Description
Push Button 1	PB1	I001	If status = 1, PB gets connected If status = 0, connection is lost
Push Button 2	PB2	I003	If status = 1, PB gets connected If status = 0, connection is lost
Relay Coil 1	K1	I002	If status = 1, signal given to actuator If status = 0, no signal passed
Relay Coil 1	K1	I002	If status = 1, signal given to actuator If status = 0, no signal passed
Green lamp	G	O001	If status = 1, light is ON If status = 0, light is OFF
Red lamp	R	O002	If status = 1, light is ON If status = 0, light is OFF



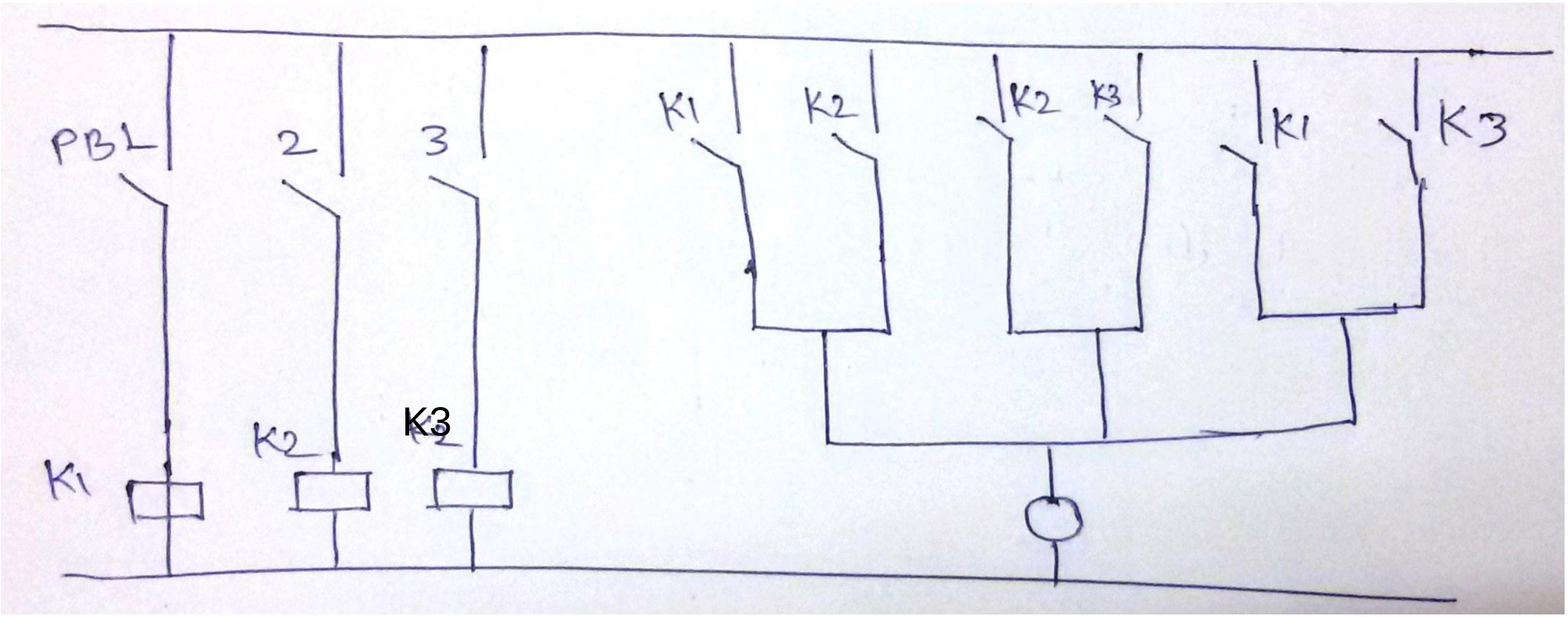
I001
I002
(CR)
I002
I003
I004
(CR)
I004
I002
I004
O001
I004
I002
O002

Example : 2

In ABC bank, to open the safe vault, three unique keys are needed. The three keys are with three officers. The safe vault can be opened only if two keys are used.

Develop a PLC diagram to meet the following requirements:

1. When any key is inserted, the corresponding relay is activated.
2. When any two keys are inserted, a green lamp should be ON.



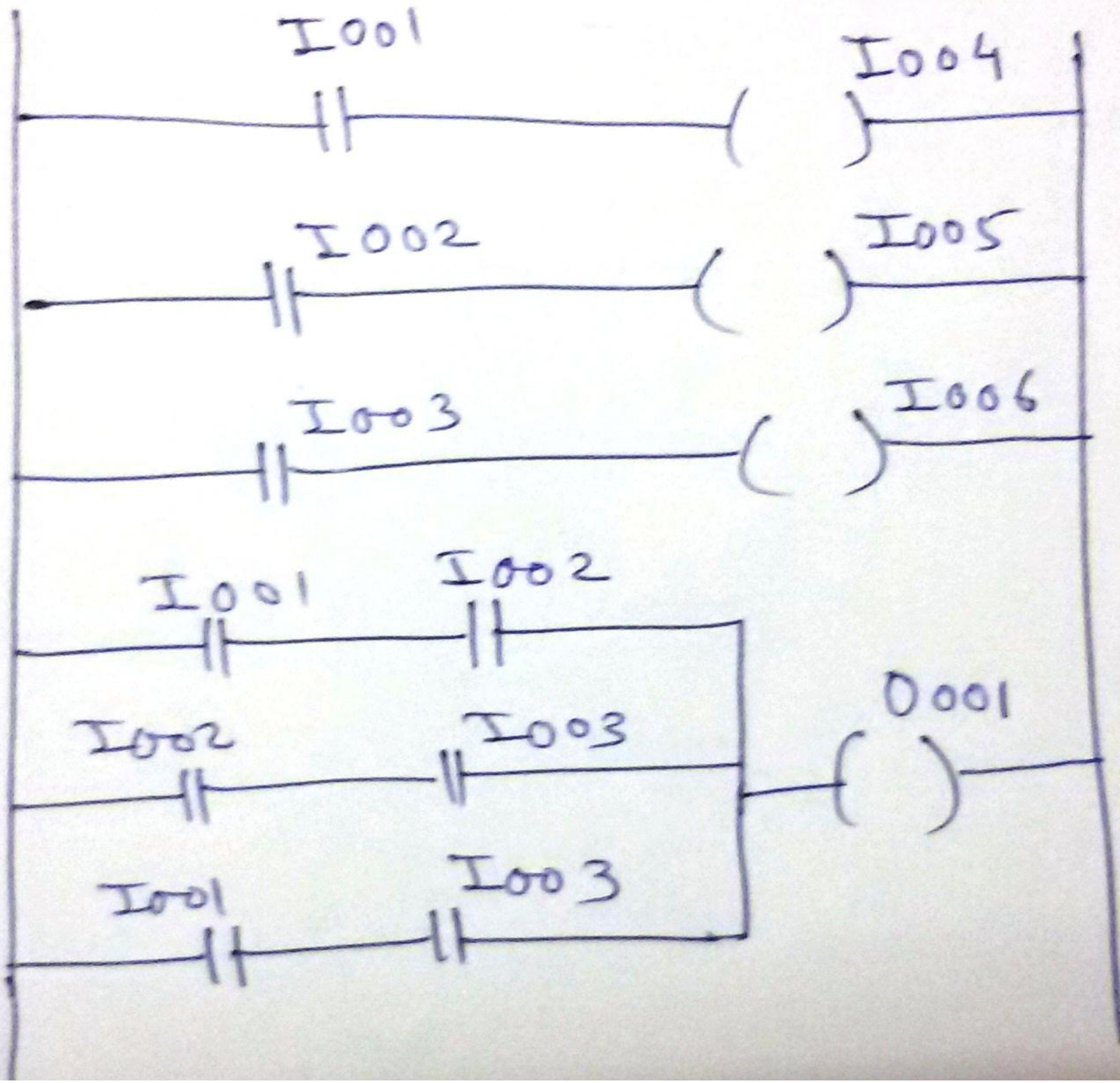
Inputs:
PB1
PB2
PB3
Relay coil K1
Relay coil k2
Relay coil k2

Contacts:
K1- NO : 1, 4, 8

K2- NO : 2, 5, 6

K3- NO : 3, 7, 9

Outputs:
LED Green


I001
I004
I002
I005
I003
I006
I001
I002
O001
I002
I003
I001
I003

TIMERS

- Timer is a device that introduces a time delay in a circuit or a system.

- Timers are classified as :
- Electromechanical timer:
  - It uses an oil dashpot or spring to introduce time delay.

- Electronic timer:
  - It uses electronic circuit.

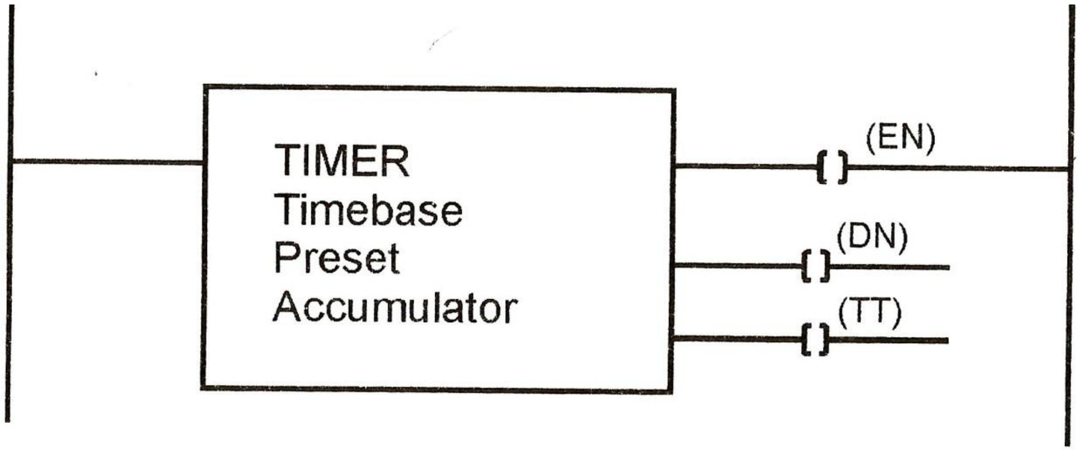
- PLC timer:
  - Time delay is introduced by programming.

PLC TIMERS

- Many control tasks require the programming of time.
- For example:
  - To stop/start motor after/before some time/operation.
  - To open/close valve after/before some time.
  - To keep lubricating pump ON after motor is OFF.
- The timers of a PLC are realised in the form of software modules and are based on the generation of digital timing.
- Memory space is allocated in system memory to store the values of the delay time.

PLC TIMERS

- The representation of the timer address varies from manufacturer to manufacturer.



Schematic Diagram of a Function Block PLC Timer

- Left of timer function block are timer enable contact.
- When closed, power passes to left terminal, timer starts.
- When open, power stops to flow, timer stops.

Delay Timer function block has three output contacts:

- DN – Done bit :

  When the timer is timed out done bit DN is set.

- EN – Enable bit :

  It follows the input enabled status.

  if enable contact is true, then EN bit is true.

- TT – Timer Timing bit:

  It is set when the timer is operating.

Functions in a Timer

Accumulator Value: ACC:

- This is the time that has been elapsed, since the timer was last reset.

Preset Value: PRF:

- This specifies the value that the timer must reach before the controller sets the done bit.

Time base

- It is the rate at which timer increments.
- The most common time bases are 0.01 sec, 0.1 sec, 1 sec intervals.

Time address:

- It is the unique identity in memory.
- For Allen Bradley PLC timer address is T4

Retentive and non-retentive Timer

Non-Retentive:

- When timer ACC are reset to zero, each time the input enable contact is open, it is said to be non-retentive timer.

- Does not retain or remember the ACC when enable contacts are opened.

Retentive:

- When timer ACC does not reset to zero, each time the input enable contact is open, it is said to be retentive timer.

- It retain or remember the ACC even when enable contacts are opened.

- To reset timer, reset instruction is used.
- E.g. motor run for a month to be recorded.

Function block

- Each timer address is made up of 3 word element 0,1 and 2

- Word 0 is control word, 1 stores PRE, 2 stores ACC value.

- EN is stored in bit 15 of word 0.
- TT in 14 and DN in 13.
- Each PRE and ACC are 16 bit words stored in 1 and 2 resp.

Explanation of Timer Words

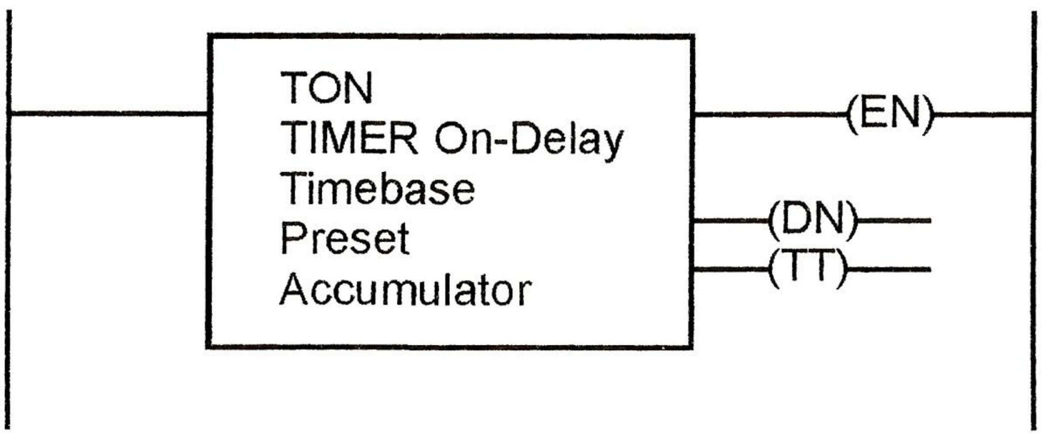
	15	14	13	12	11	10	9	8	7 ... 0
Word 0	EN	TT	DN	b̸	b̸	b̸	b̸	b̸	Internal bit
Word 1	Preset value (PRE)								
Word 2	Accumulator value (ACC)								

Two types of PLC timer

PLC ON delay timer :

The timer will be ON state when it receives a start input signal. The signal state of output changes from ON (1) to OFF (0), when preset timing is reached.

The signal state of the output changes from OFF (0) to ON (1) when preset time has been reached with reference to change of RLO (Result of logic operation) from 0 to 1(ON) at the start input



Function Block of an ON-Delay Timer

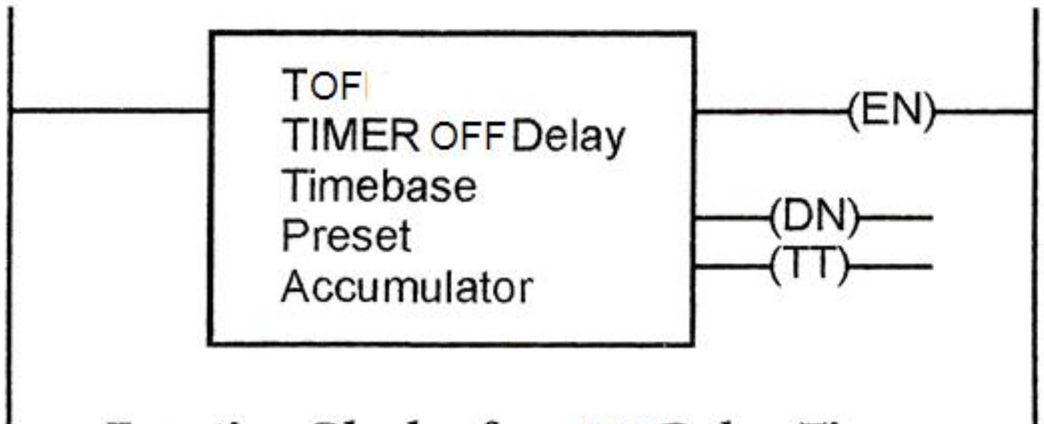
Functions of an ON-Delay Timer

Output bit	Is set when	Remains set until use of the following
Timer Done Bit	Accumulator value is normally greater than the preset value.	Rung condition becomes false.
Timer Enable Bit	Rung conditions are true.	Rung conditions become false.
Timer Timing Bit (TT)	Rung conditions are true and the all values are less than the PRESET value.	Rung conditions become false or when the done bit is set.

PLC off delay timer :

- The timer will be OFF (0) state when it receives a start input signal.
- The signal state of output changes from OFF (0) to ON (1) , when preset timing is reached.

- The signal state of the output changes from ON (1) to OFF (0) when preset time has been reached with reference to change of RLO from 1 to 0 (OFF) at the start input.

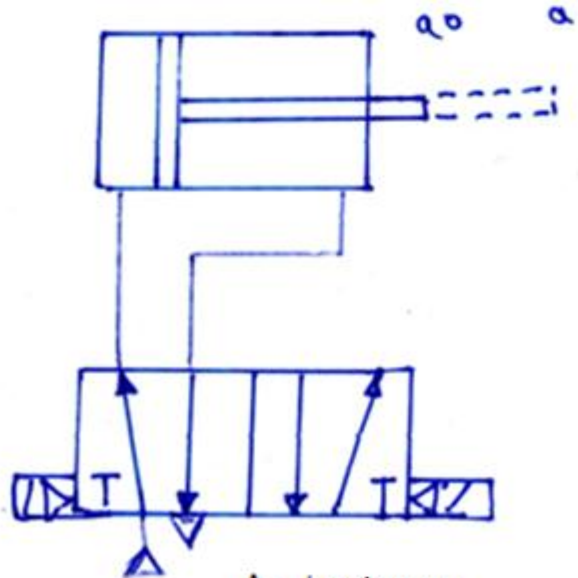


Function Block of an OFF-Delay Timer

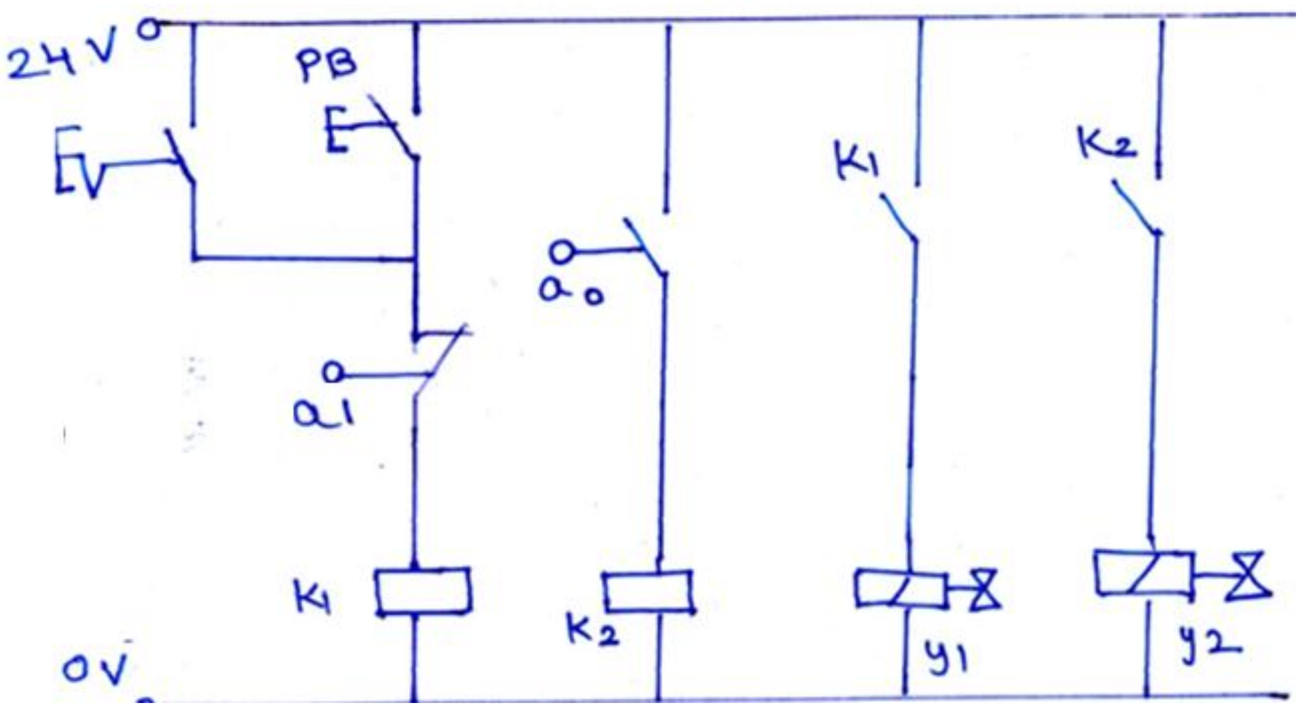
Functions of an OFF -Delay Timer

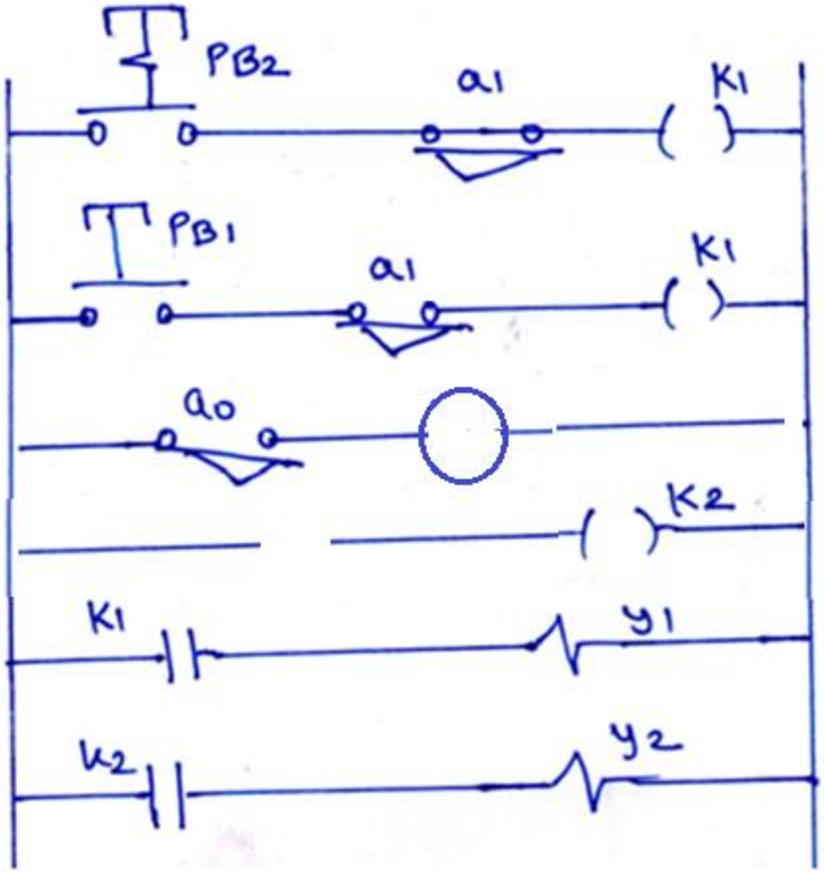
Output bit	Is set when	Remains set until use of the following
Timer Done Bit (DN)	Rung conditions are true.	Rung condition becomes false and the accumulator value is greater than or equal to the preset value.
Timer Enable Bit (EN)	Rung conditions are false and the accumulator value is less than the preset value.	Rung conditions become true or when the done bit is set.
Timer Timing Bit (TT)	Rung conditions are true.	Rung conditions become false.

Example : 1

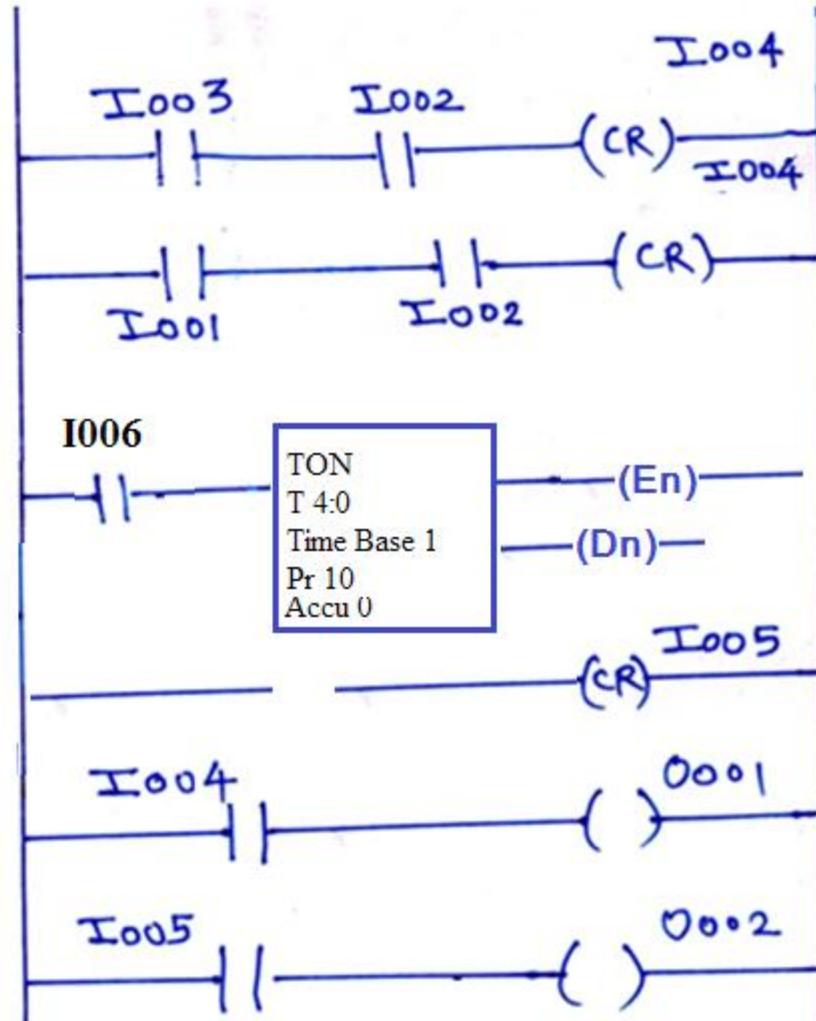


A- / Delay A+





Physical Ladder Diagram



PLC Program

EXAMPLE 2:

Draw a ladder diagram for two motor system:

- Starting push button starts motor 1.
- After 10 sec motor 2 is ON.
- Stopping switch stops motor 1 and 2
- Time base 1 s

EXAMPLE 2:

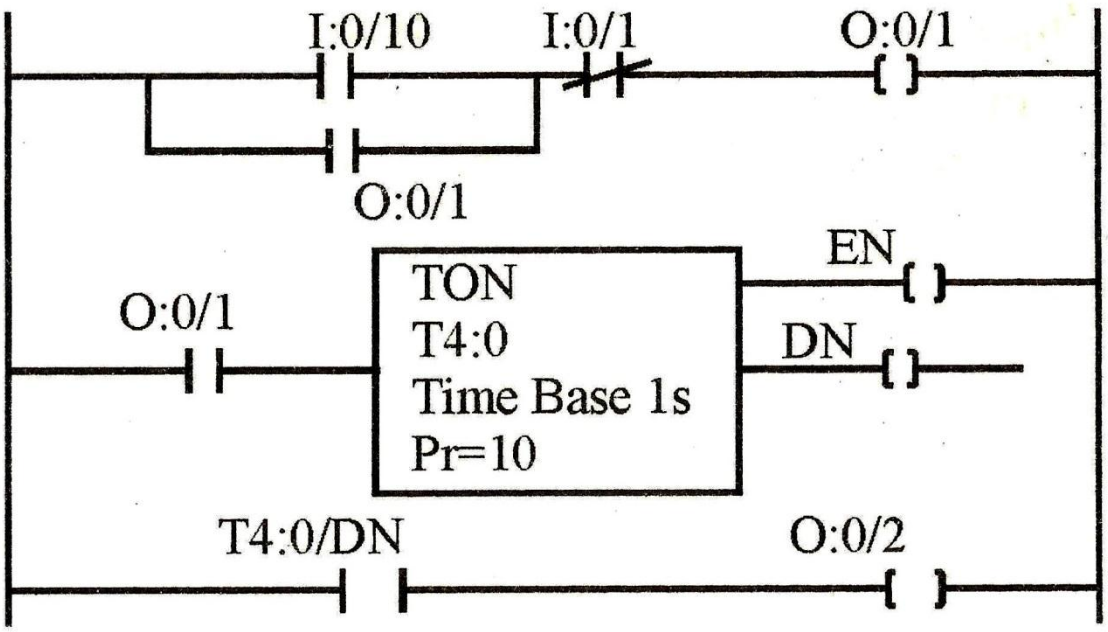
Inputs

start = I:0/1
stop = I :0/1

OUTPUTS

M1 = O:0/1
M2 = O:0/2

- Starting push button starts motor 1.
- After 10 sec motor 2 is ON.
- Stopping switch stops motor 1 and 2



Ladder Diagram

EXAMPLE 3:

Draw a ladder diagram for two motor system:

- Starting push button starts motor 1 and 2.
- Stopping switch stops motor 1 and after 15 s motor 2
- Time base 1 s

EXAMPLE 3:

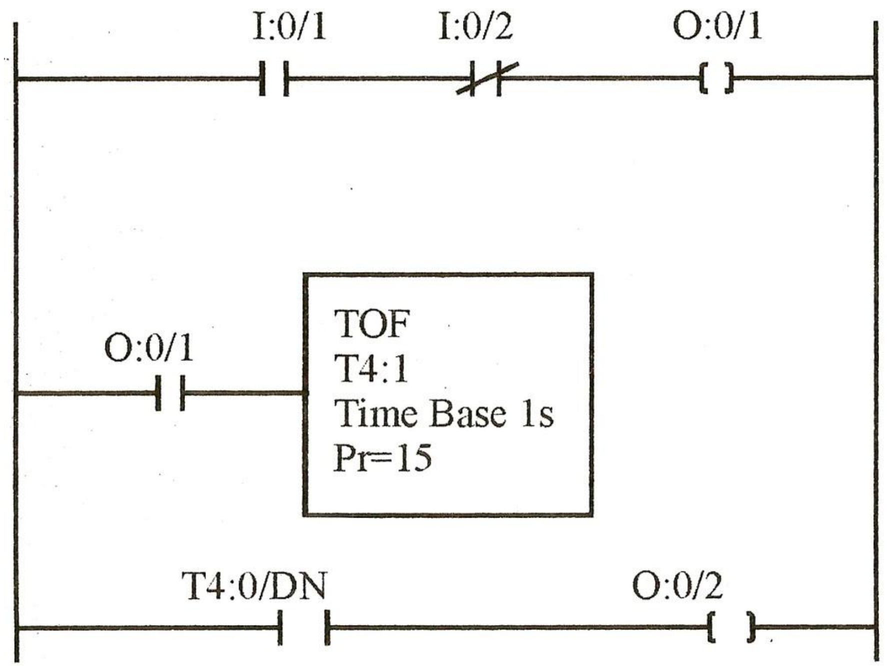
Inputs

start = I:0/1
stop = I :0/1

OUTPUTS

M1 = O:0/1
M2 = O:0/2

- Starting push button starts motor 1 and 2.
- Stopping switch stops motor 1 and after 15 s motor 2



Ladder Diagram

Example : 4

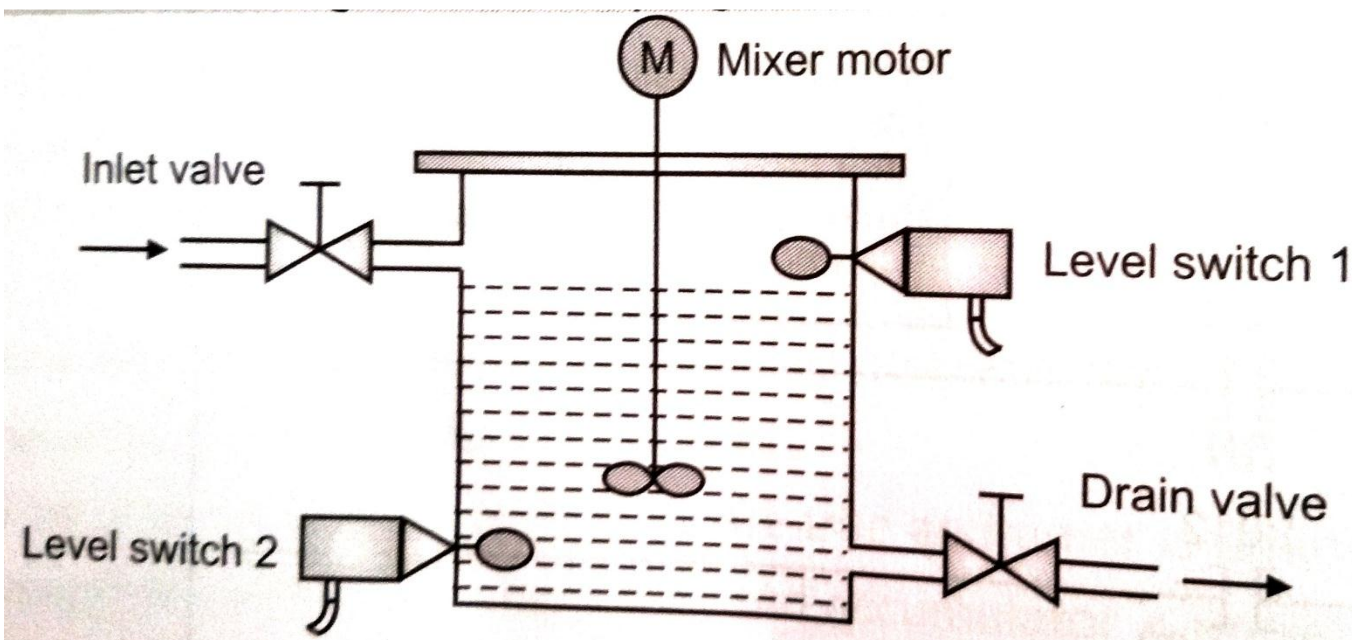
A batch process involves filling a vat with a liquid, mixing and drain with PLC

The sequence is

Inlet valve opens and liquid fills in the vat untill it is full.

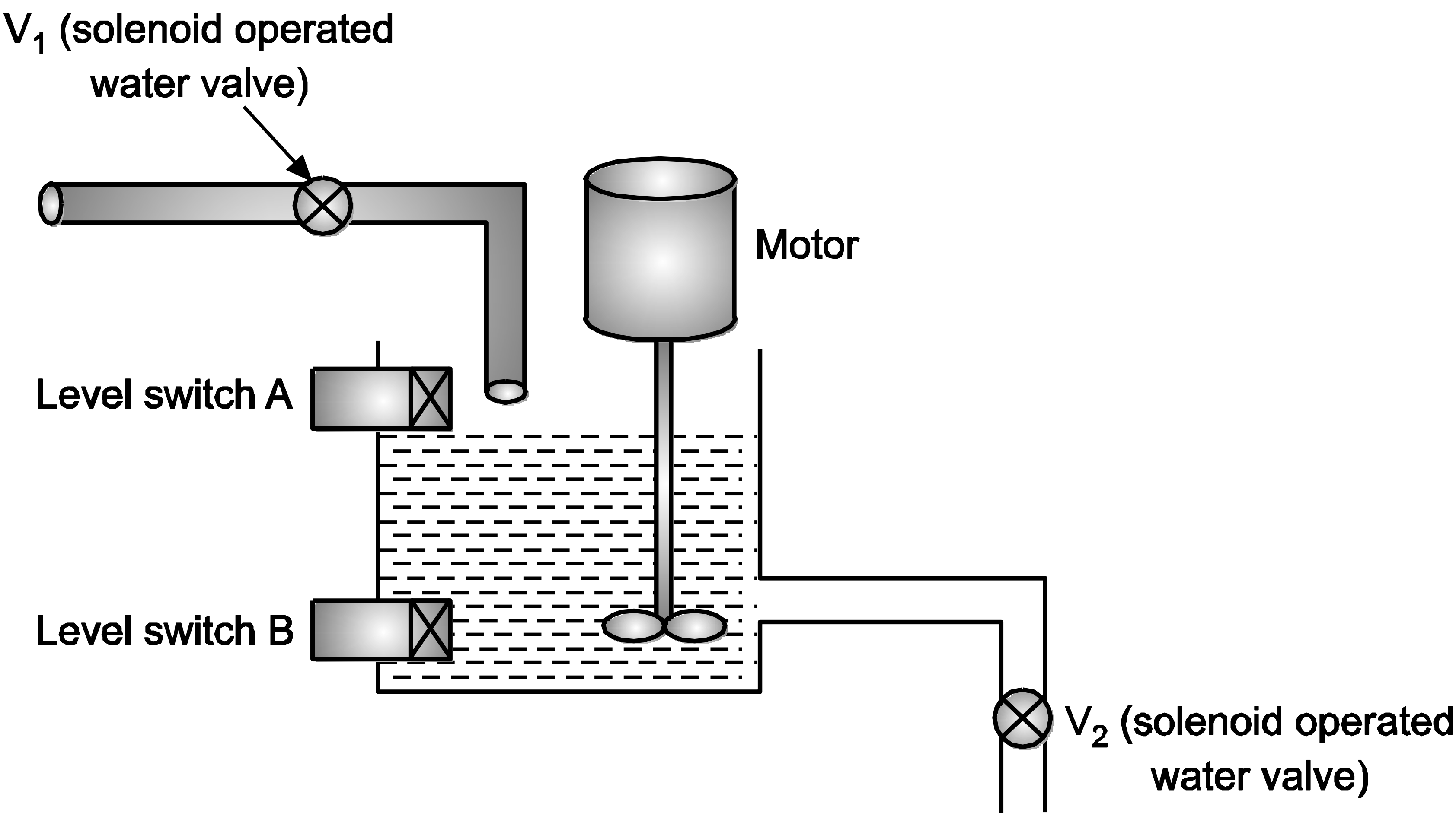
Liquid is mixed for 3 minutes

Drain valve opens and drain the tank.



A process tank shown in Fig. is sequenced to mix the liquid fertilizer according to the following sequence of operations.

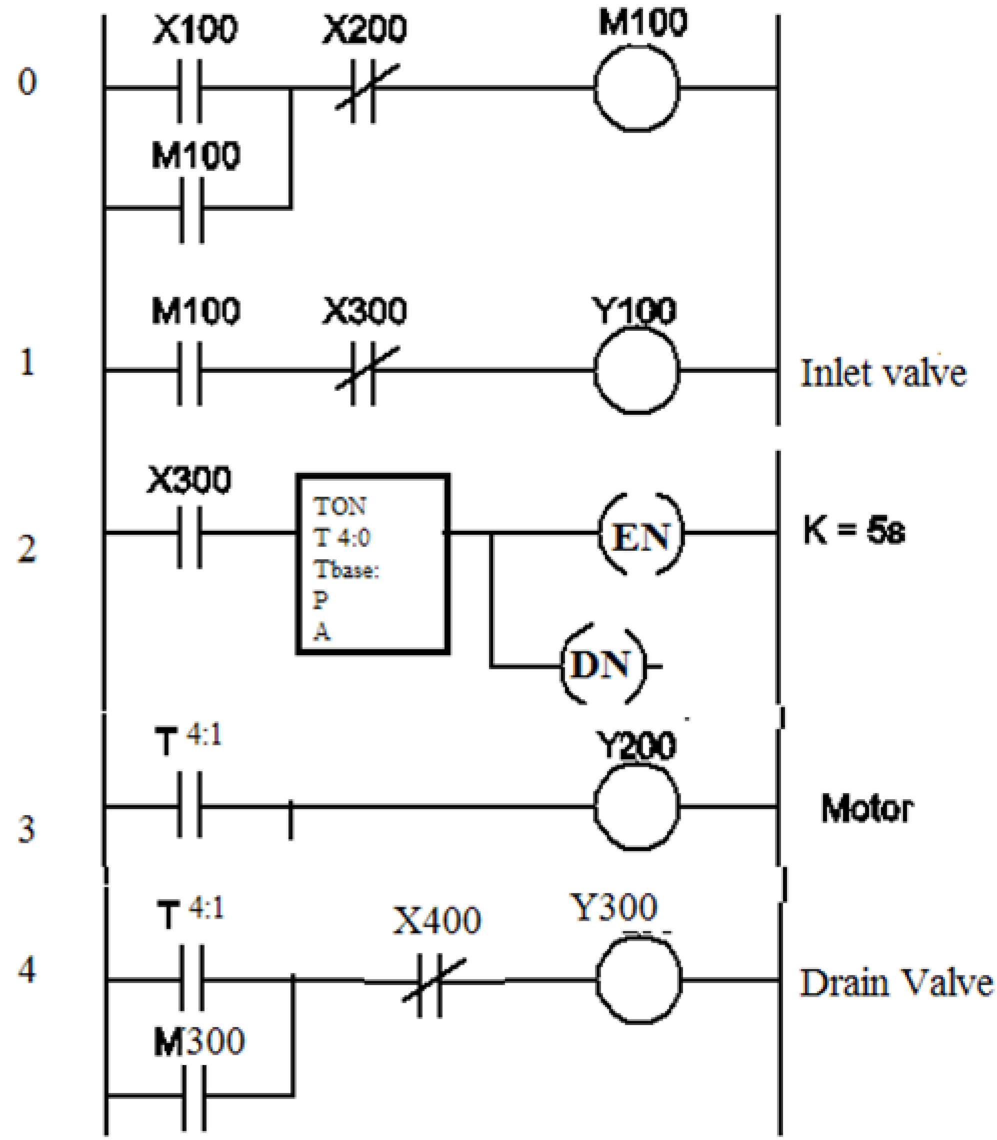
- A start pushbutton is pressed to start the operation and the water valve "V_1" is being operated to open in order to fill the tank up to a preset level sensed by a level switch "A".
- As the tank fills, a level switch "A" closes the NO contact to energize the stirrer motor to start automatically and operate it for 5 s to mix the fluid.
- When the stirrer motor stops, the solenoid operated water valve "V_2" is energized to empty the tank.
- When the tank is completely empty the level switch "B" opens and de-energizes the solenoid operated valve “V_2".
- A stop button is pressed to stop the operation.



V_1 (solenoid operated water valve)
Motor
Level switch A
Level switch B
V_2 (solenoid operated water valve)

Input devices		Output devices	
X100	Startbutton	Y100	Water valve V_1
X200	Stop switch	Y200	Motor
X300	Level switch A	Y300	Water valve V_2
X400	Level switch B		

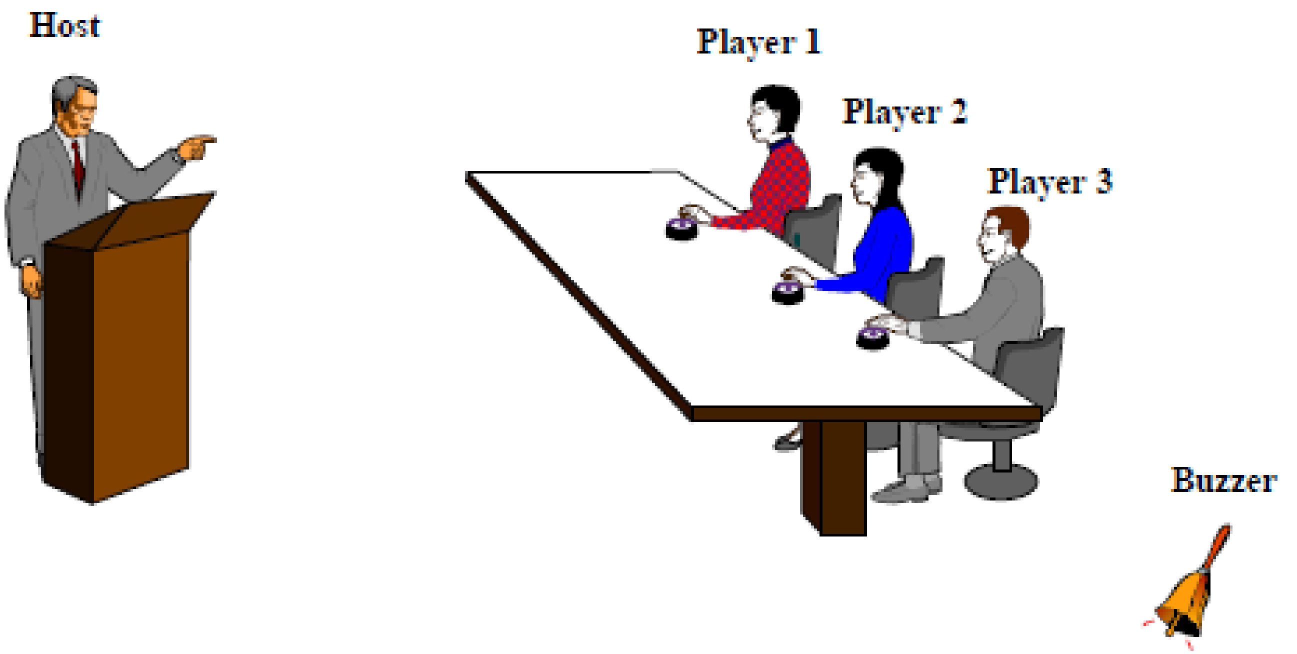
Input devices		Output devices	
X100	Start	Y100	valve V_1
X200	Stop switch	Y200	Motor
X300	Level switch A	Y300	valve V_2
X400	Level switch B		



SELECTION OF PLC

- No .of inputs that can be connected.
- No. of outputs that can be connected.
- Memory size.
- Speed of operation.
- Type and rating of input devices.
- Type and rating of output devices.

Example : 5



The game buzzer control requirement:

1. After the Host has finished with question.
2. The 3 players will press the switch in front of them to fight to be first to answer the question.
3. The buzzer will sound for 10 sec after any one of the players has touched the switch.
4. The light indicator in front of each player will light-up and only reset by the Host switch.

Example : 6

In ABC bank, to open the safe vault, three unique keys are needed. The three keys are with three officers. The safe vault can be opened only if two keys are used.

Develop a PLC diagram to meet the following requirements:

1. When any key is inserted, the corresponding relay is activated.
2. When any two keys are inserted, a green lamp should be ON.

3. Further, after inserting first key if second key is not inserted within 30 seconds, the buzzer should ring.