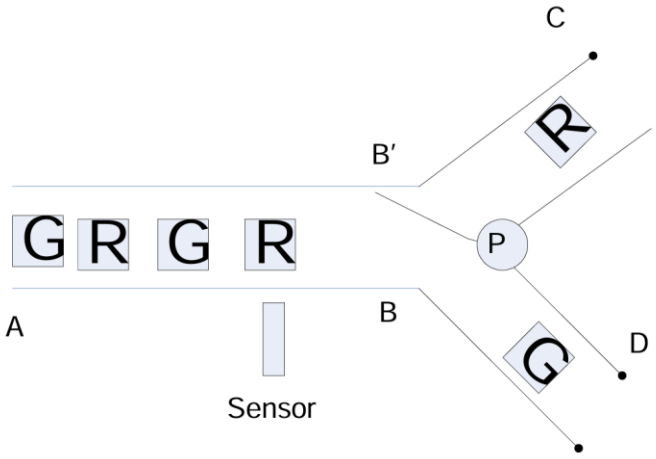
Exercise 1 - Package Separation System

Design a ladder logic diagram for a package separation system in a production line with the following requirements:

System Description:

- AB is the main conveyor belt that moves RED and GREEN color packages towards B direction.
- Start and Stop push buttons are used to turn the system ON and OFF.
- A color sensor detects package colors:
    - Red package → Sensor output = 1
    - Green/Other colors → Sensor output = 0
- P is a rotary pneumatic actuator, which controls a flap to direct packages:
    - Default Position (B' position): Packages go towards D direction (BD conveyor).
    - Activated Position (B direction): When a red package is detected, the flap moves and redirects it to C direction (B'C conveyor).
- B'C Conveyor Activation:
    - Only activates when a red package is detected (Color_Sensor = 1).
    - When B'C conveyor is active, BD conveyor must stop to prevent package collision.
- The system should be continuously operational until manually stopped
- Emergency Stop:
    - If the Stop button is pressed, all conveyors and pneumatic actuators must stop immediately.



- **Identify Inputs & Outputs**

Device	Type	Address

Control Logic Overview

Exercise 2

Modify the Ladder Logic Program from Exercise 1 to include the following additional features:

- Package Counter:
    - Add a counter to track the number of red and non-red packages passing through the system.
- Buzzer Alert:
    - Implement a buzzer that sounds whenever a package is redirected to the B'C conveyor (when a red package is detected).

Exercise 3 - Automated Grinding System

Design a ladder logic diagram for an automated grinding system with the following working conditions:

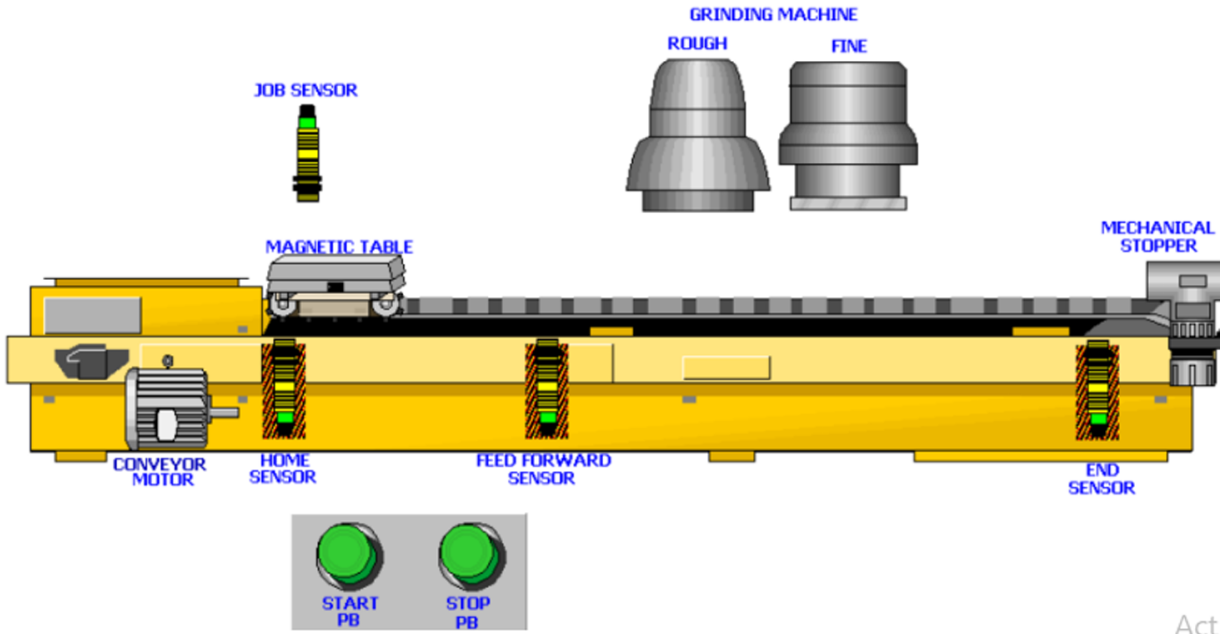
Initial Conditions:

- Home Sensor (Home_Sensor) = ON
- Job Sensor (Job_Sensor) = ON
- End Sensor (End_Sensor) = OFF

Main Operation:

- **System Start:**
  - When Start_Pb is pressed:
  - Magnetic Table (Mag_Table) turns ON immediately.
  - After a 12-second delay, both Rough Head (Rough_Head) and Fine Head (Fine_Head) turn ON.
- **Forward Motion:**
  - 7 seconds after the Start button is pressed, the motor moves forward at high speed (Fwd_High).
  - When the Feed Forward Sensor (Feed_Fwd_Sensor) is triggered, the motor should slow down (Fwd_Low).
  - The motor continues at low speed until the End Sensor (End_Sensor) is triggered.
- **Stopping the Grinding Heads:**
  - Once End_Sensor is triggered, both grinding heads (Rough_Head & Fine_Head) turn OFF.
  - The system waits for 7 seconds before reversing.
- **Reverse Motion:**
  - After the 7-second delay, the motor moves in reverse at high speed (Rev_High).
  - When the Feed Forward Sensor (Feed_Fwd_Sensor) is detected again, the motor slows down (Rev_Low).
  - Finally, the motor stops when it reaches the Home Sensor (Home_Sensor).

Note : **Use four outputs to the motor Fwd_High, Fwd_Low, Rev_High, Rev_Low**



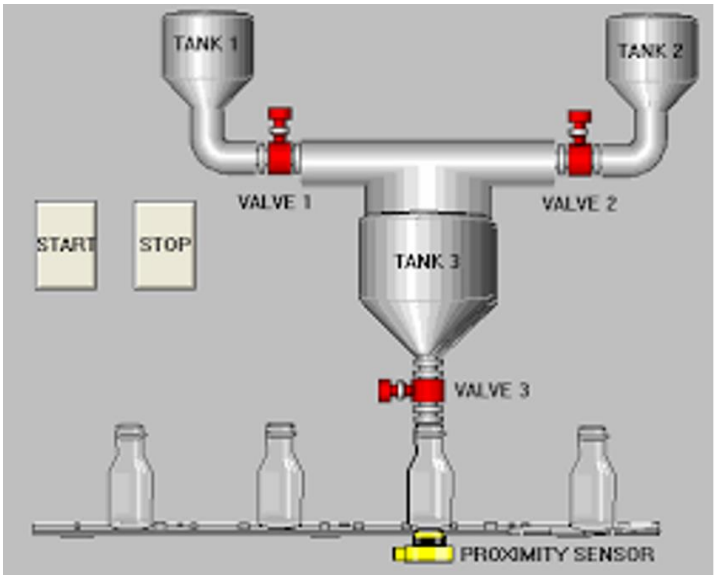
- **Identify Inputs & Outputs**

Device	Type	Address

Control Logic Overview

Exercise 4 - Automated Bottle Filling Plant

Design a ladder logic program for an automated bottle filling plant with the following conditions:



- **System Start & Stop:**
  - The plant operates using Start (Start_Pb) and Stop (Stop_Pb) push buttons.
- **Bottle Detection & Filling:**
  - A Proximity Sensor (Bottle_Sensor) detects a bottle under the filling nozzle.
  - When a bottle is detected, the conveyor stops, and Valve 3 (Valve_3) opens for 30 seconds to fill the bottle.
  - After filling, Valve 3 closes, and the conveyor starts moving again to bring the next bottle to the filling position.
- **Tank Refilling Process (After 5 Bottles):**
  - A counter (Bottle_Counter) keeps track of bottles filled.
  - When Valve 3 has opened 5 times, Valves 1 and 2 (Valve_1, Valve_2) open for 80 seconds to refill the tank.
  - While Valve_1 and Valve_2 are open:
    - Valve 3 must remain closed (no bottle filling allowed).
    - The conveyor must stop.

- Once Valve_1 and Valve_2 close, the conveyor restarts, allowing normal bottle filling to continue

- Implement a **warning buzzer (Buzzer)** that sounds when Bottle_Counter = 5 before the tank refills.

- **<u>Identify Inputs & Outputs</u>**

Device	Type	Address

<u>Control Logic Overview</u>

- Draw the hardware connection diagram, showing how the sensors, motor, relay, indicators, and buttons are connected to the Fatek FBs-24MAT2-AC PLC (with Transistor SINK (NPN) output) PLC.