# Sequencing

The required activation sequence is: A+, B+, A-, B-

…a-, a+, b-, and b+ are limit switches for cylinder A and B as Shown. Assume a starting switch to start operation and that initially switch b- is active . Program a PLC to achieve the job
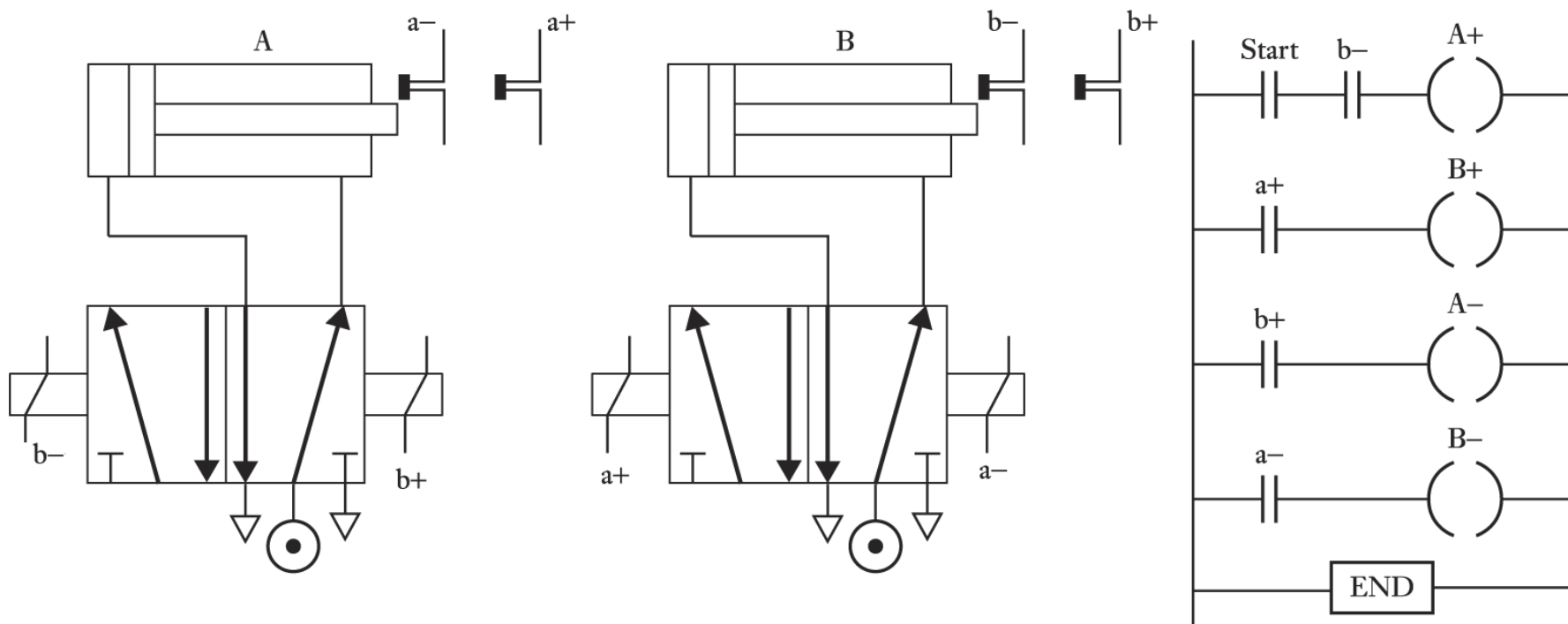


Figure 21.18  Cylinder sequencing

# Timers and Counters

- Counters and timers are supplied as a features of PLC to achieve tasks involve time delays and events counting

- Most PLC do not provides these elements as hardware, but as software that can be programmed with help of clock pulses

# Timers

**Two approaches are used to consider timers in PLC:**
**1- May be considered to behave like relays with coil. The timer is treated as an output which when energized operates its contact every where (Fig. a)**
**2- May also be considered as a delay block in a rung which delays signal in that rung reaching the output (Fig.b & C)**
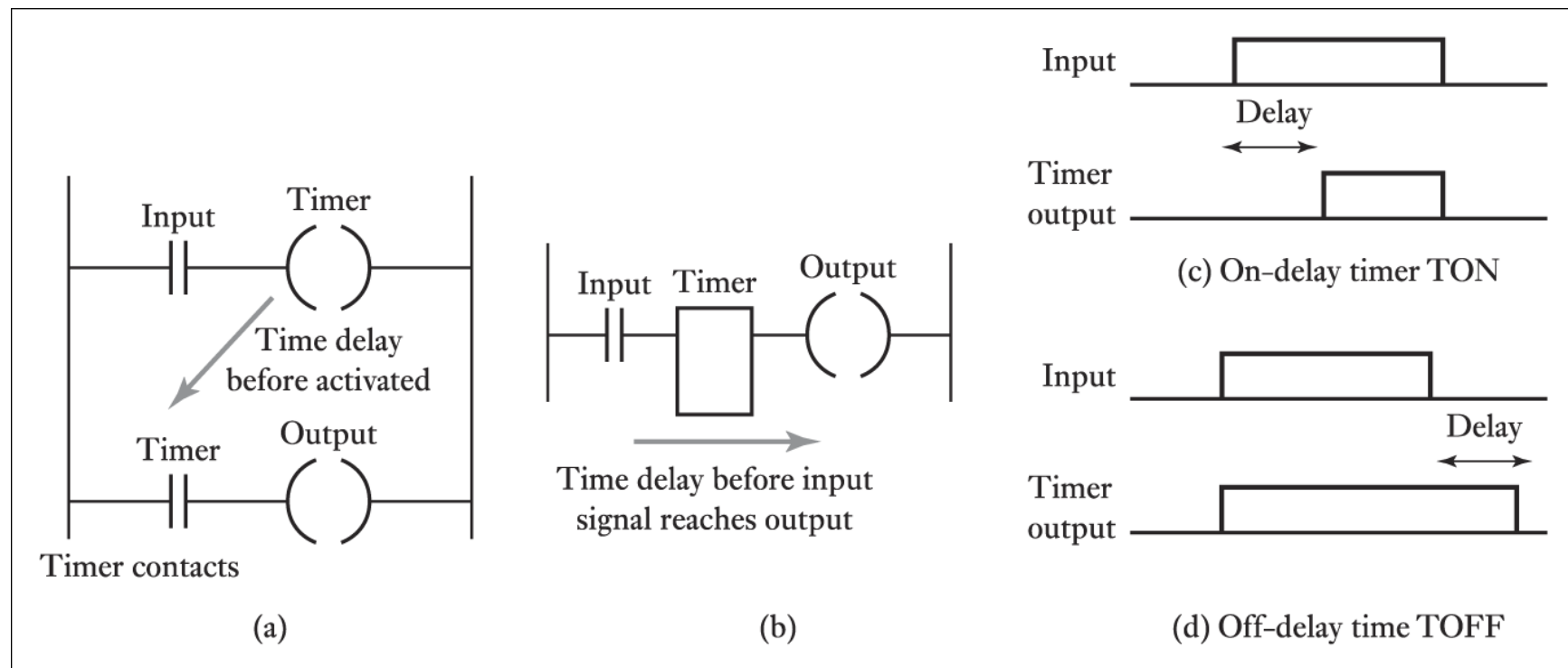


Figure 21.20  (a), (b) Delay-on timer, (c) timing with on-delay, (d) timing with off-delay

# Timers

**Normally timers can be set from 0.1s through 999s in step of 0.1s**

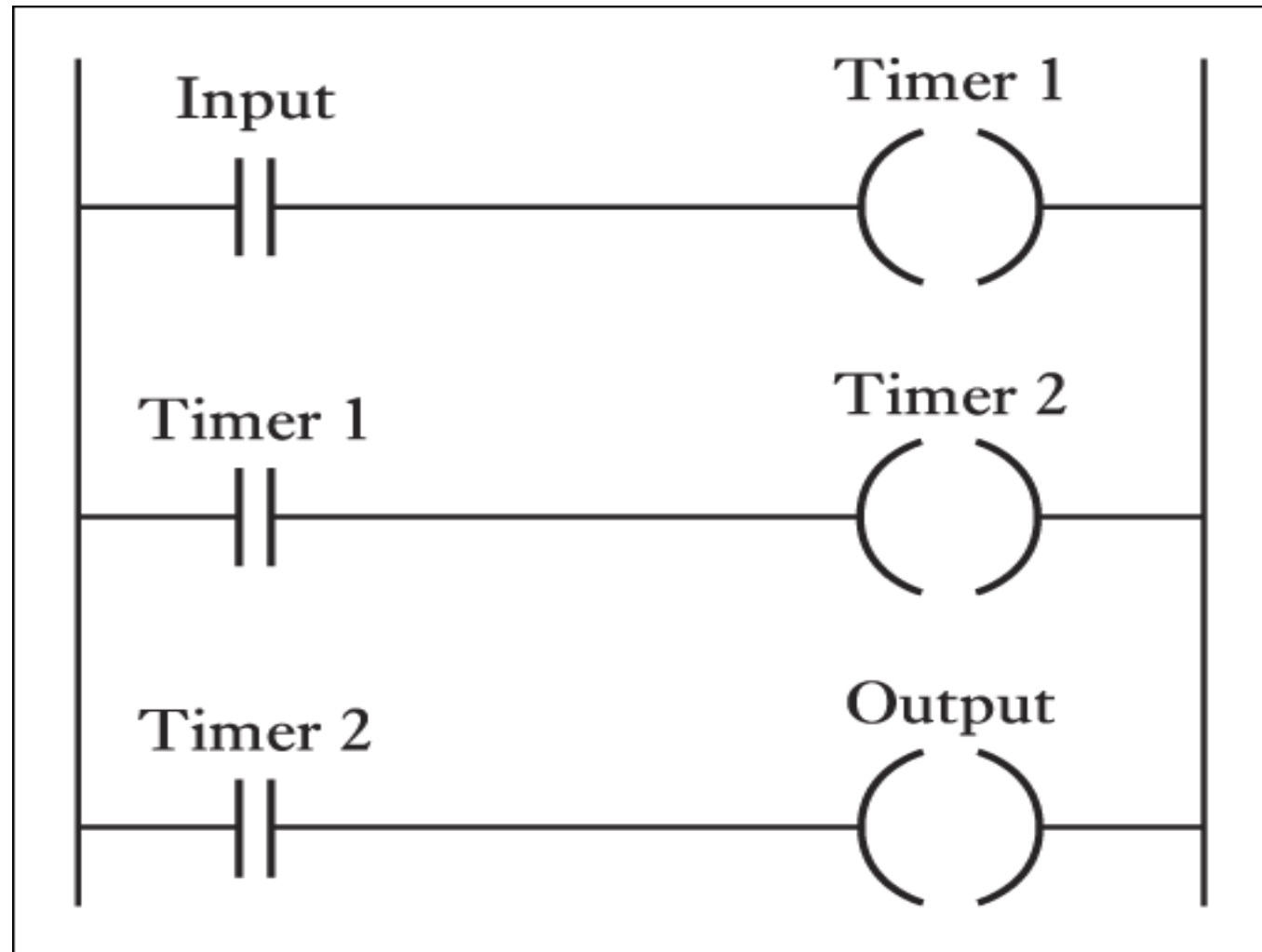**Timers can be linked together or cascaded to give larger delay times**

Figure 21.22

Cascaded timers

# Timers: example circuit 1

Timers can be used for event sequencing: When the input In 1 is closed, contact Out1 will operate to start the timer, after the preset time of the timer its contact will be closed and output is switched ON
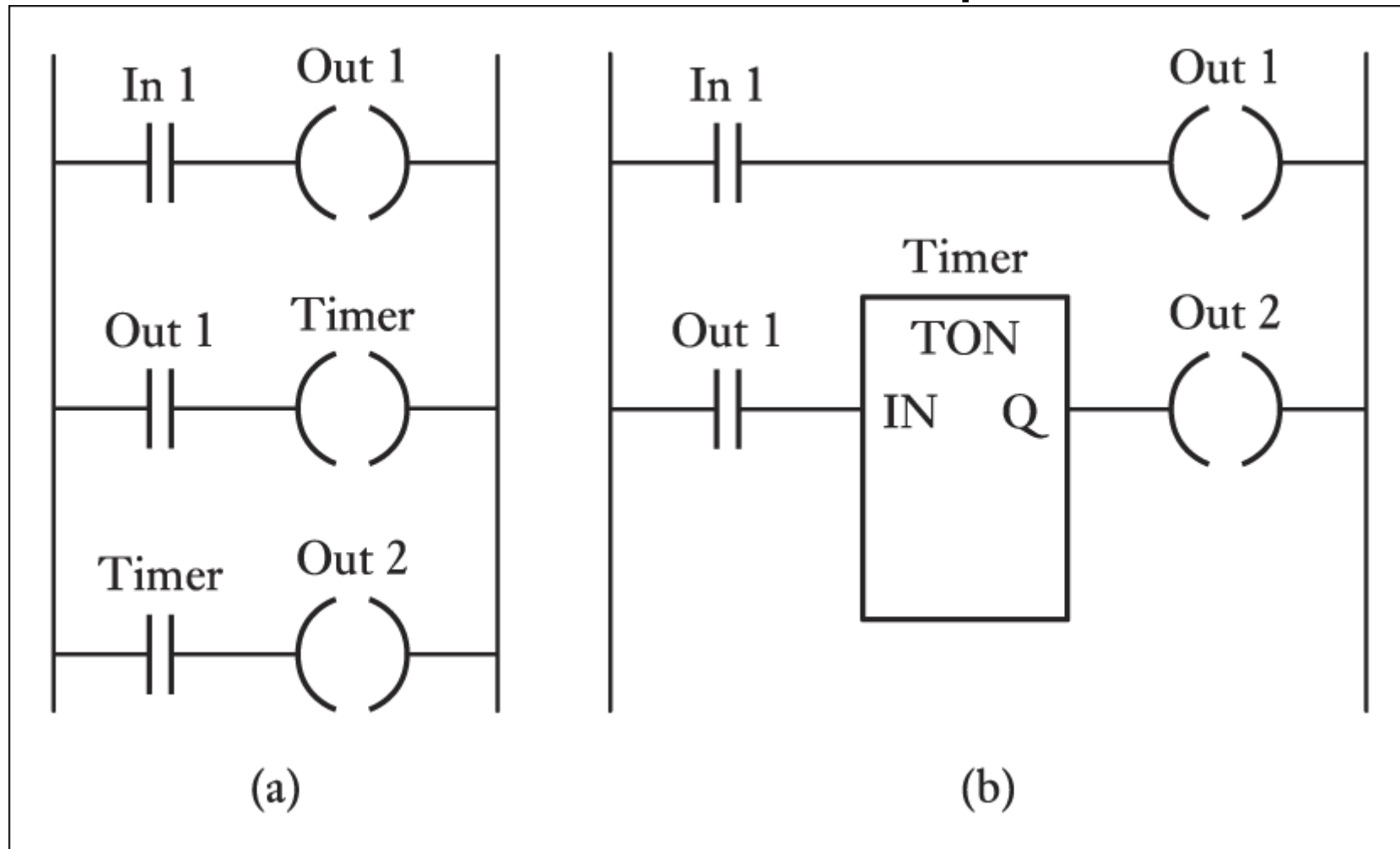


Figure 21.21  Timed sequence

# Timers: example circuit 2

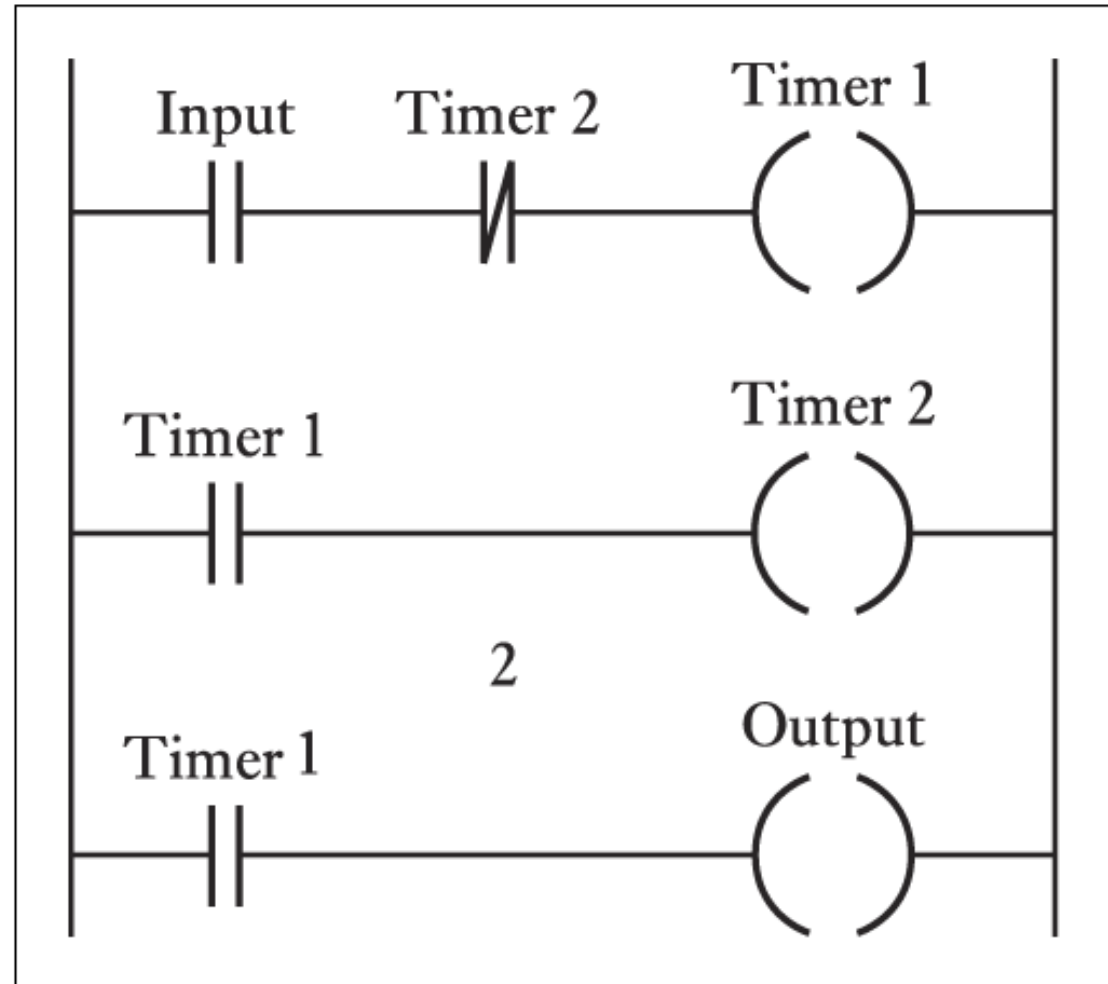Figure shows a program that can be used to cause an output to go ON for 0.5 second and then OFF for 0.5 second



Figure 21.23  On/off cyclic timer

# Timers: Delay-off timer

**Figure shows how a delay –OFF timer can be devised.**

**when the input start, the output energized and the timer start. The output contacts latch the input and keep the output ON. After the preset time, the timers come ON and breaks the latch circuit, so switching the output OFF**
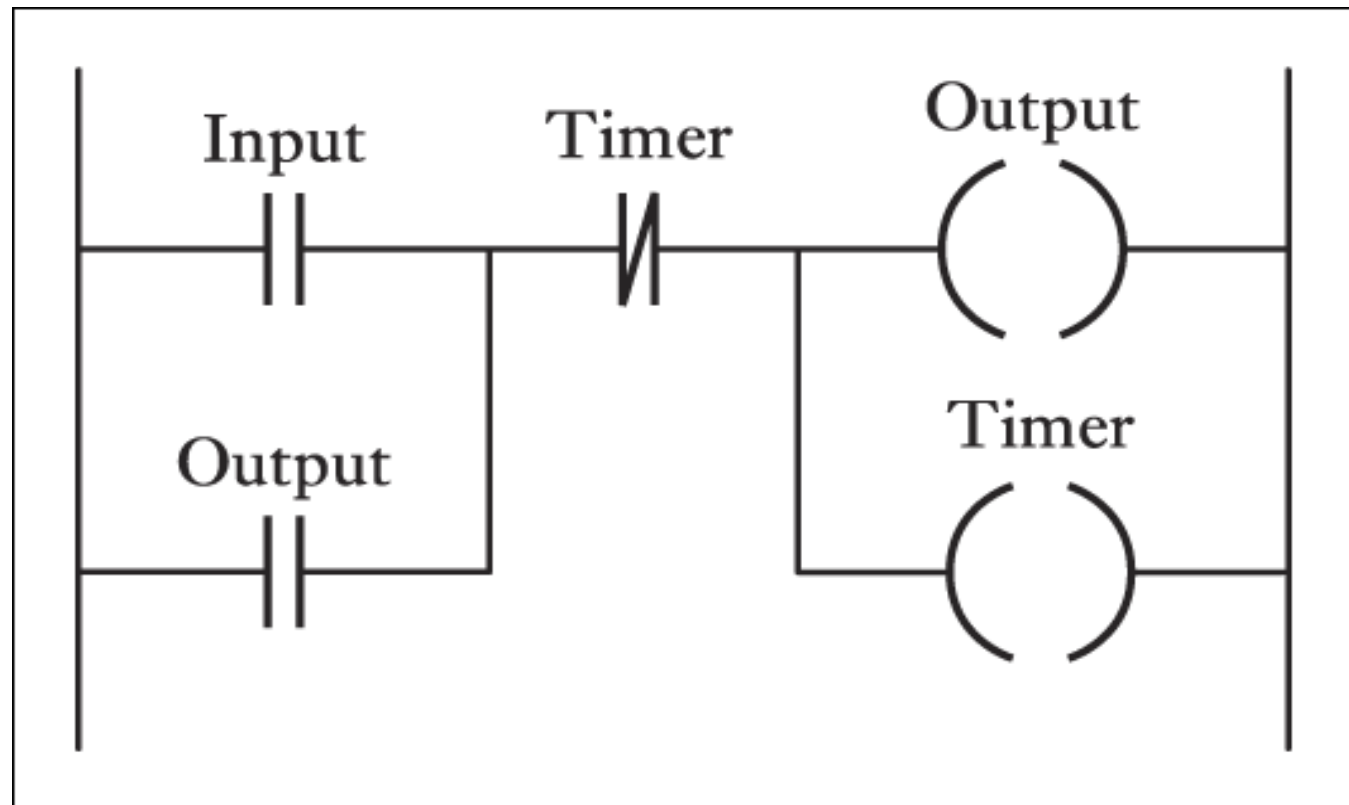
Figure 21.24
Delay-off timer

# Counters

These do not physically exist. They are simulated counters and they can be programmed to count pulses. Typically these counters can count up, down or both up and down.

- Since they are simulated they are limited in their counting speed. Some manufacturers also include high-speed counters that are hardware based.

- Up counters: count up starting form zero and when a preset value is reached, the output of the counter is ON

- Down counters: count down to zero from a preset value and then the output of the counter is ON

# Counters
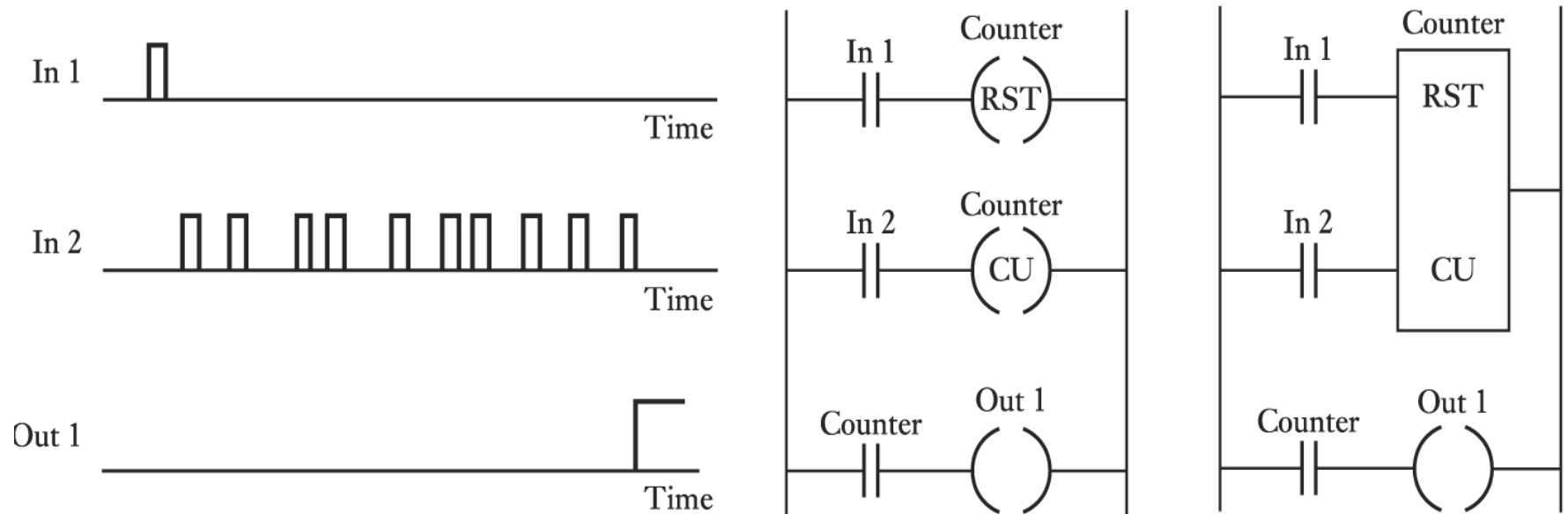


When there is an input to In2, the counter start counting, if the counter set to 10 pulses then when 10 pulses inputs have been received at In2, the counter contact will close and there will be an output from out1. If at any time during the counting there is an input to In1, the counter will be rest
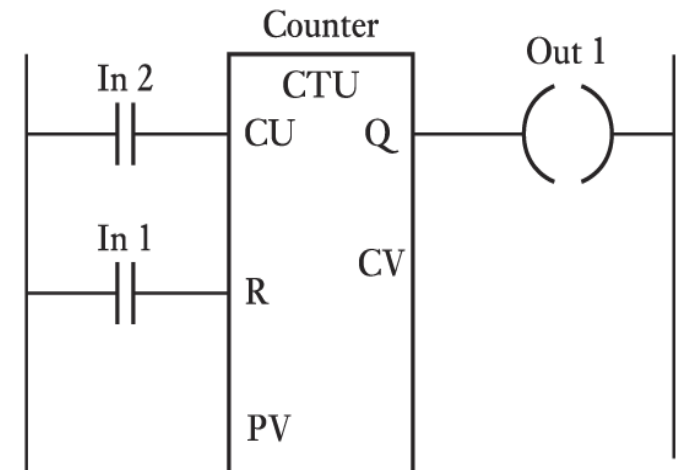
# Counters: control example

For the control circuit to direct 6 items along one path for packaging in a box and then 12 items along another path for packaging in another box.

It composed of two counters, one preset to count 6 and the other preset to count 12.

Input 1 closes its contacts to start the counting cycle, resetting both counters. Counters 1 start to count pulses in input2, it counts 6 items and then closes its contact. This activates the output, closes one path and start another. when counter 2 has counted 12 items it reset both counters and opens counter 1 contacts
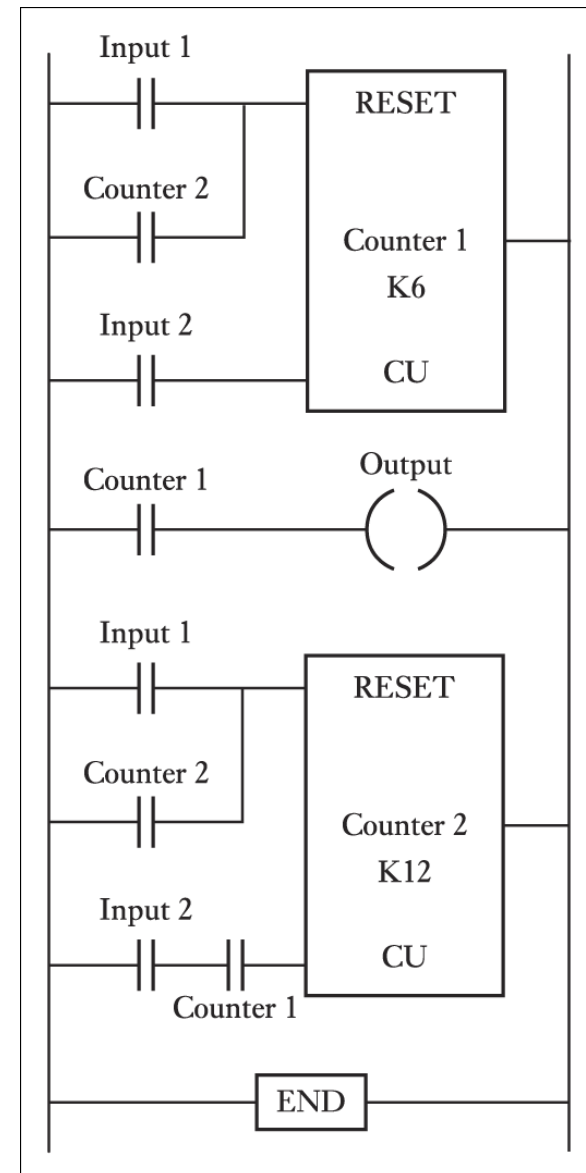


Figure 21.26  Counter

# Shift Register

- Shift registers have 3 inputs:

  one to load data into the first element of the register (OUT),

  one as the shift command (SFT)

  one as resetting (RST)

- It composed of a series of internal relays e.g. for 8 bit register we my have (M140…M147). The input to OUT (logic 0 or 1) is loaded into the first bit of the shift register. With SFT, a pulse moves the content of the register along one bit at a time , the final bit over-flowing and lost. With RST, a pulse of the closure of a contact resets the register contents to all zero
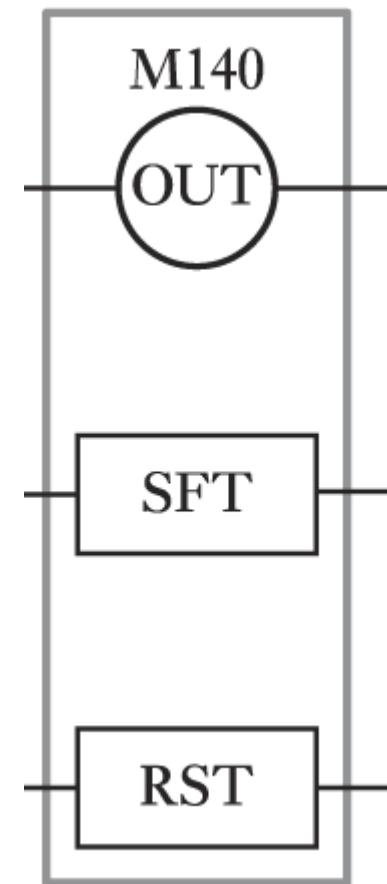
# Shift Register

**The figure shows ladder diagram involving Mitsubishi shift register,** when X400 is switched ON a logic 1 is loaded into the first element of the register i.e.(M140). The register now hold 1000 0000, M140 closes contact M140 and Y430 is ON, when contact X401 is ON the bits in the register are shifted by one place so we have 1100 000. Contact M141 thus closes and Y431 is switched ON.

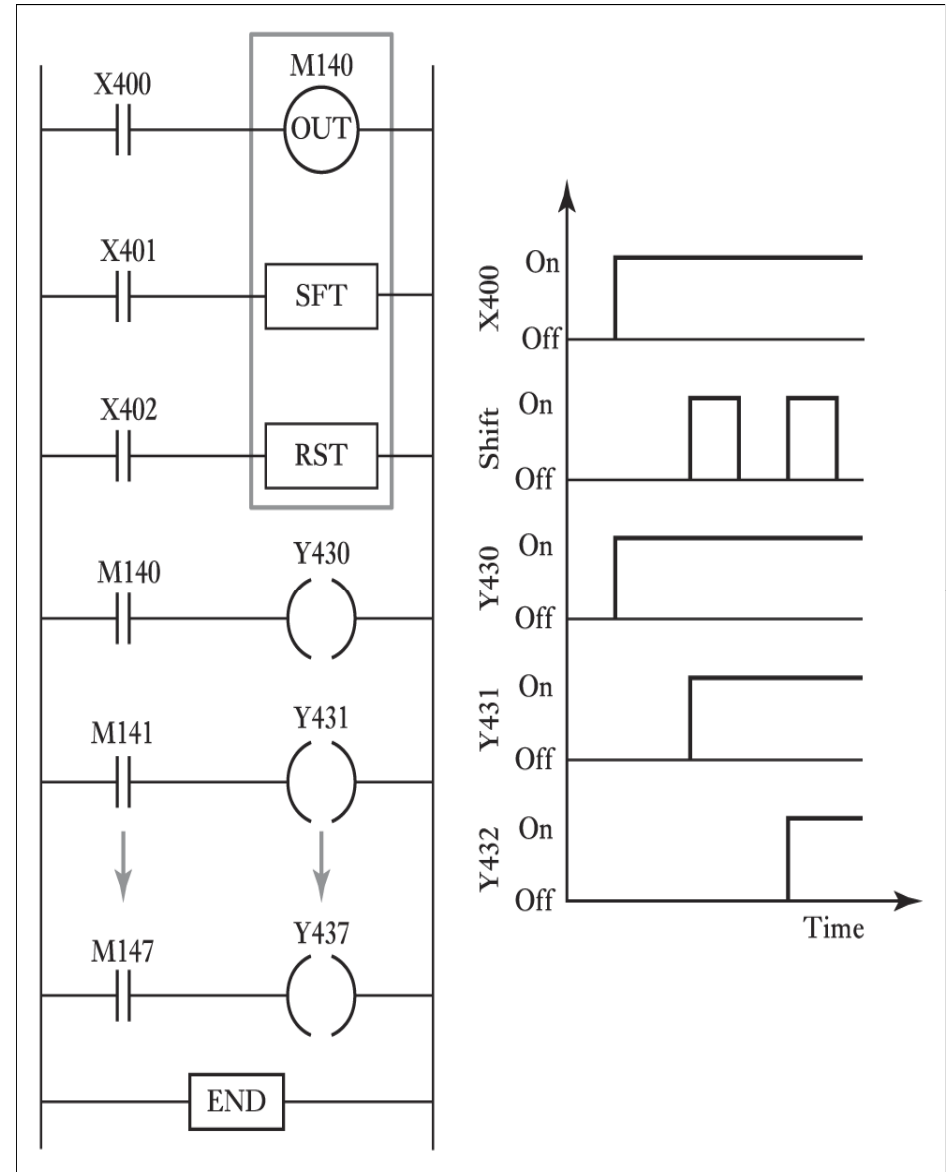Shift Register can be used in sequencing and process control



Figure 21.27   Shift register

# Master and Jump Control

Master Relays are used to control a block of output **(switched ON or OFF)**

**When In1 is closed, master relay MC1 is activated and the block of the program rungs controlled by the MC1 relay follows.**

**The end of the master relay controlled section is indicated by the reset MCR.**

**If IN1 then branch to MC1 contact section, else follow the execution**
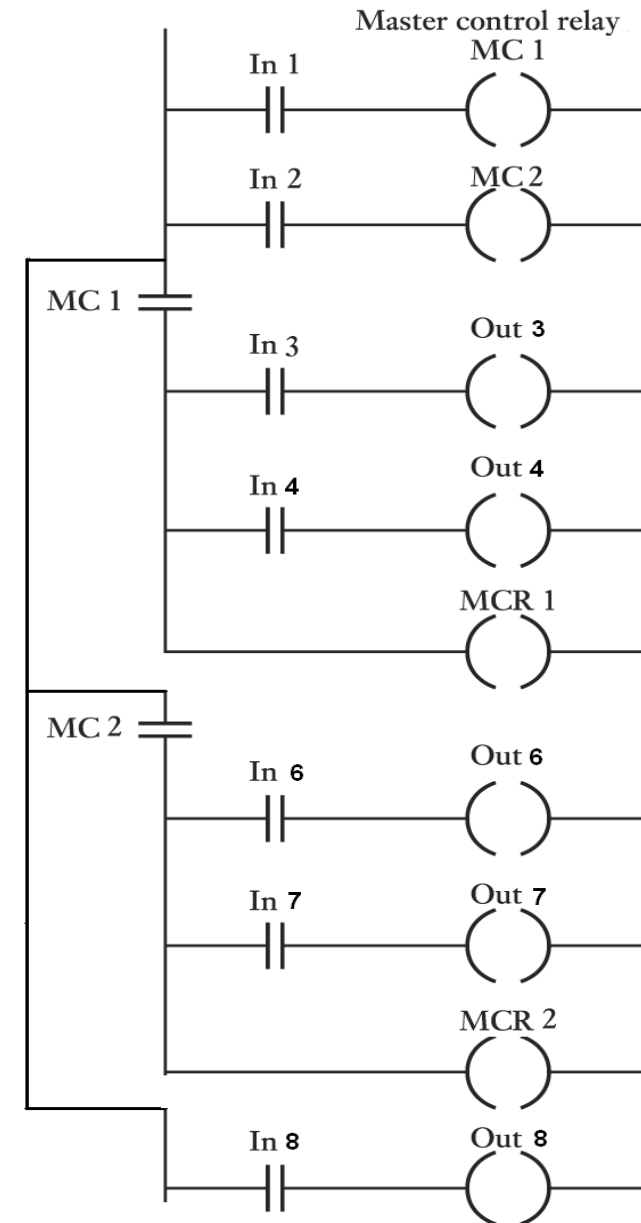


With Mitsubishi PLC an internal relay can be designed as a Master control relay as:

**MC   M100**   (* program an internal relay as Master relay*)

**MCR M100** (* indicate the end of the section controlled by MC*)

# Jump Control

Conditional jump function enables programs to be designed so that if a certain condition exists then a section of the program is jumped
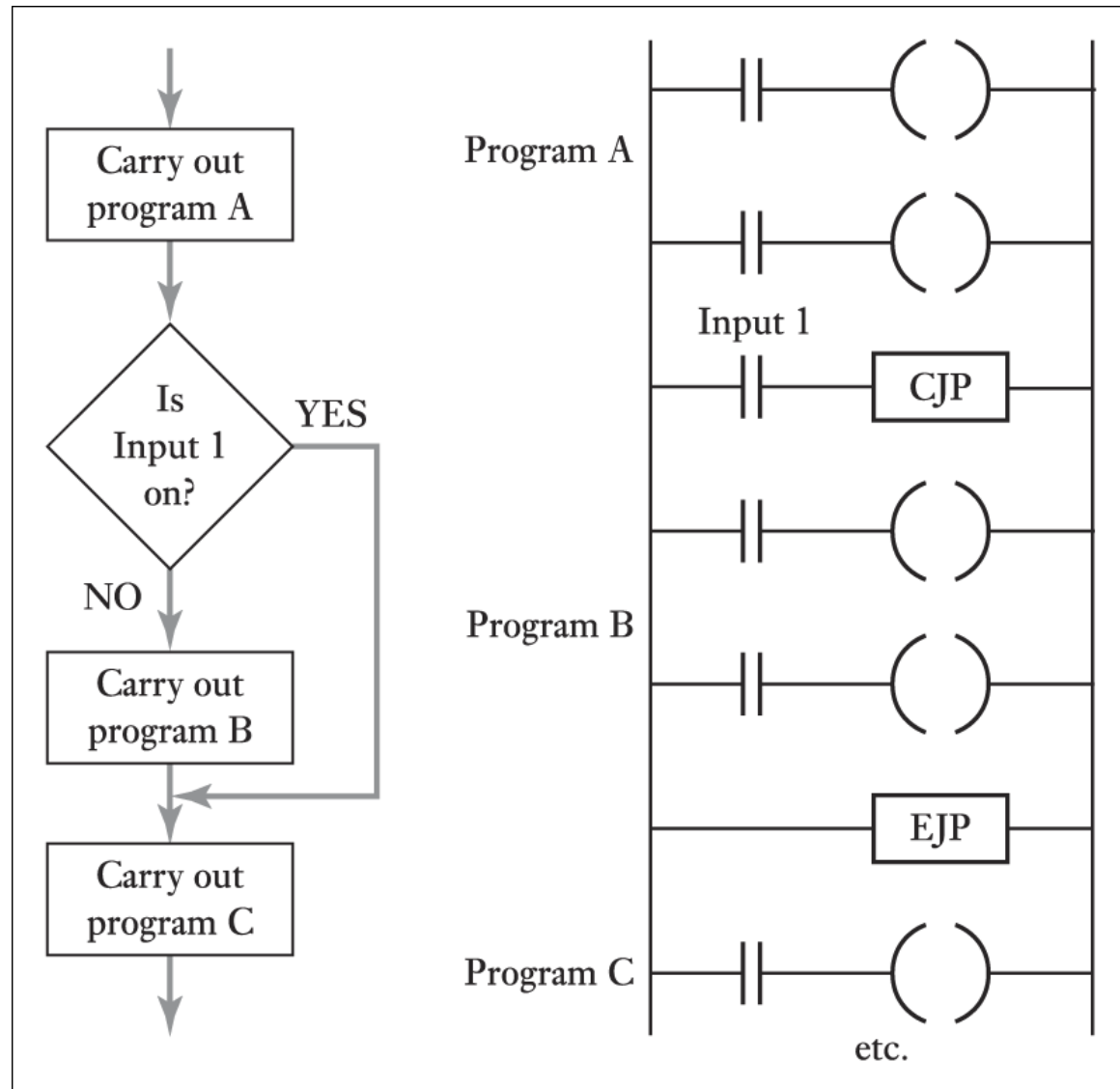
Figure 21.29   Jump

# Analogue input/output

**Many sensors and actuators working on Analog signals so, ADC are required at the PLC input while DAC are required in the Output interface of PLC**

**Figure show how DAC can be used in motor speed control to increase the motor sped gradually**
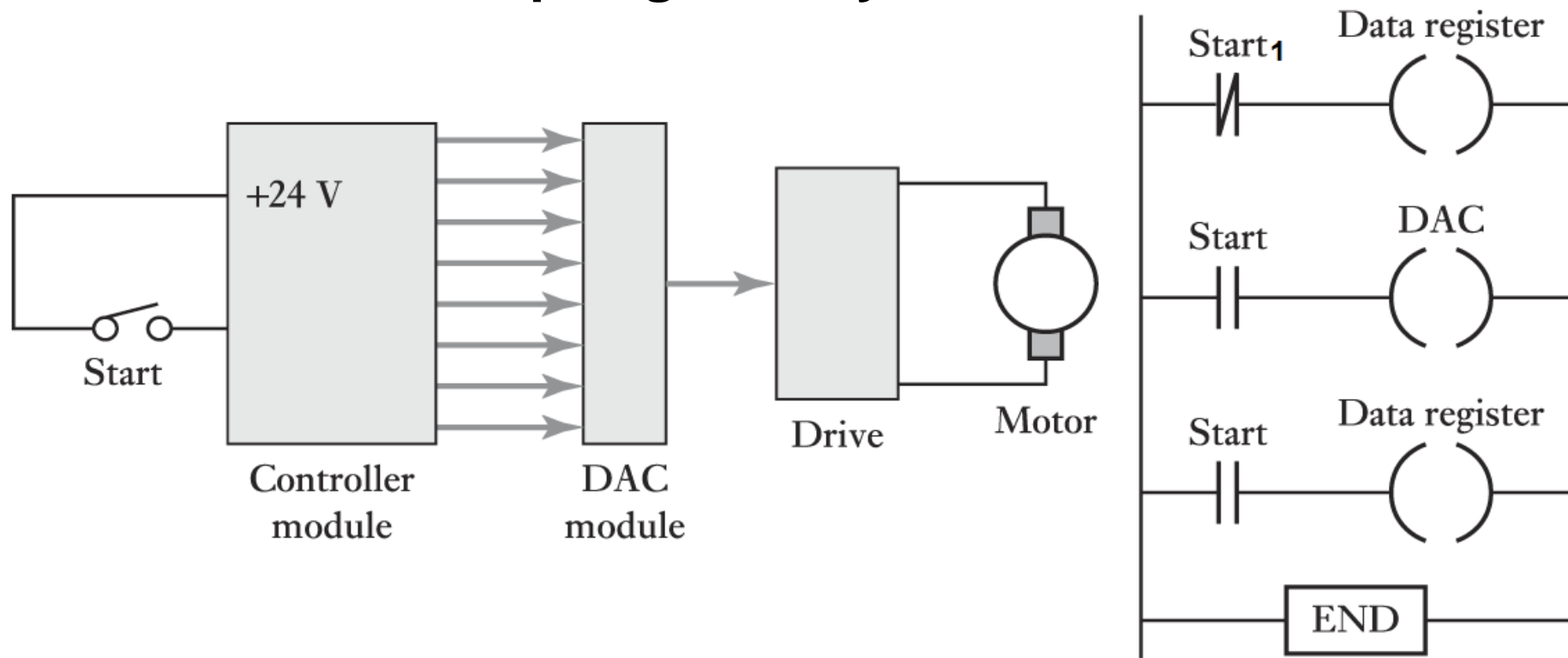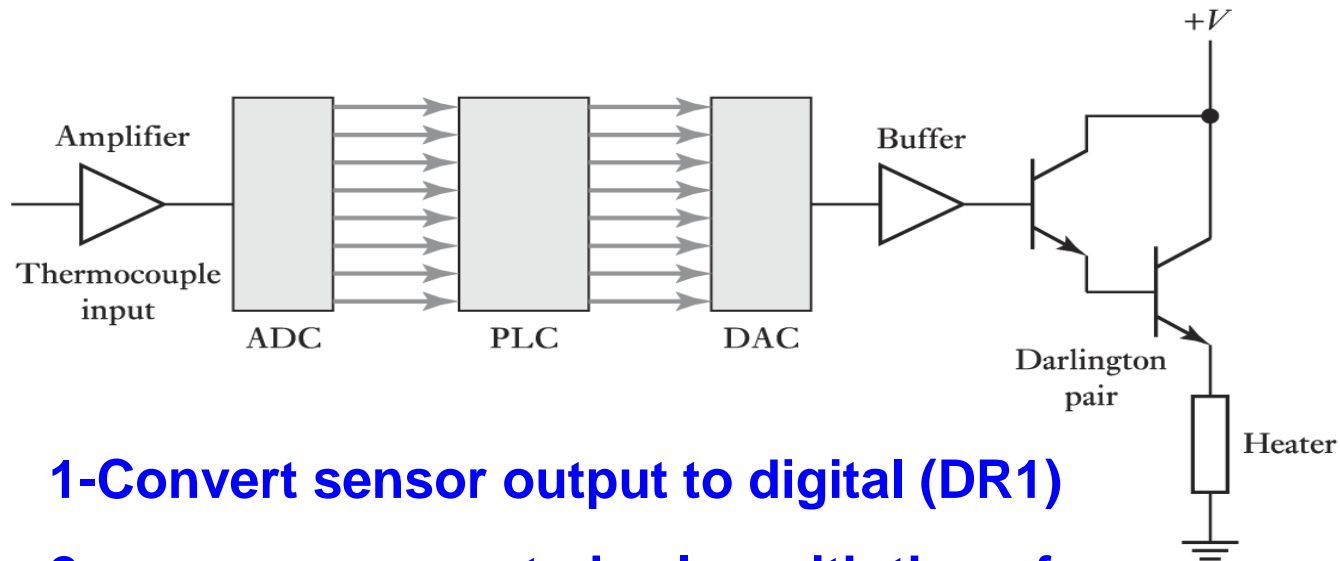


Figure 21.35  Ramping the speed of a motor

# Analogue input/output

**Example of using DAC in temperature control (proportional control)**



**1-Convert sensor output to digital (DR1)**

**2- compare converted value with the reference value in (DR2)**

**3-obtain the error result in DR3**

**4- Multiply error by Kp (x4) and store in DR3**
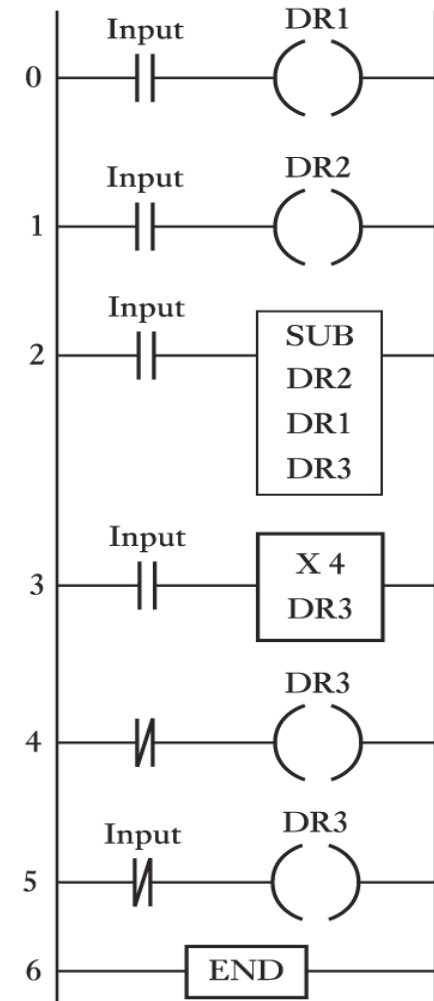
**5-convert result to analog and applied to actuator**

Figure 21.36  Proportional control of temperature