Chapter Seven

Data Handelling

This chapter is about PLC operations involving blocks of data (words) representing a value.

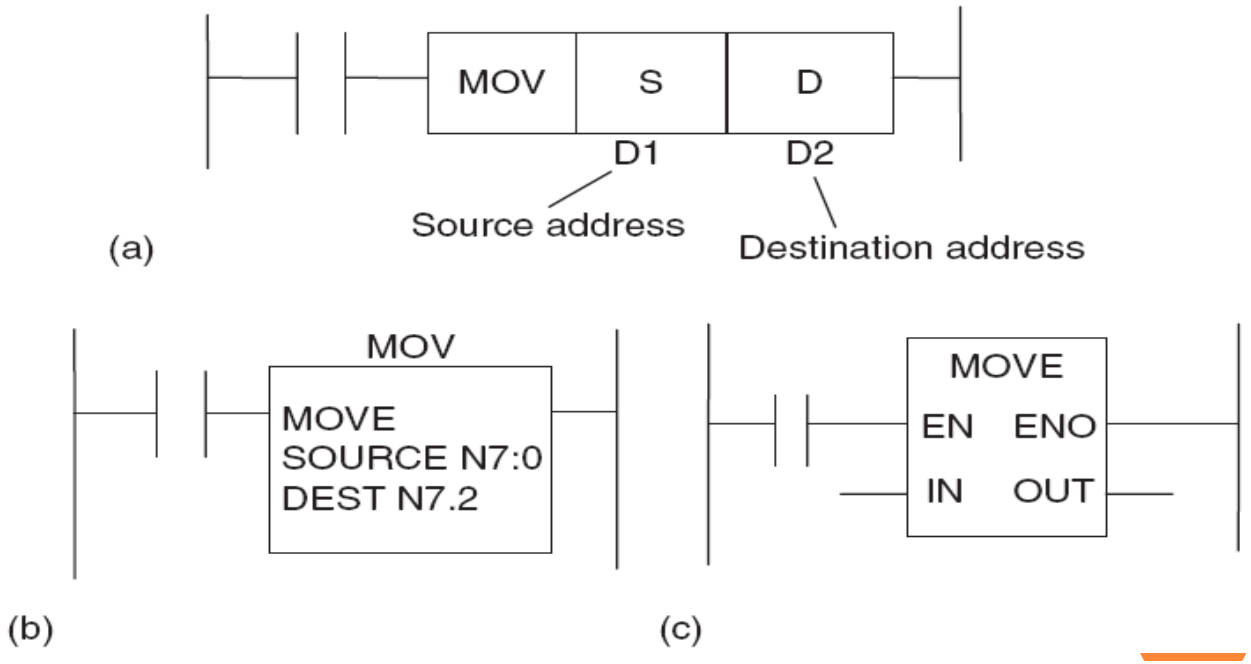
Data Handling

Data handling consists of operations involving moving or transferring numeric information stored in one memory word location to another word in a different location, comparing data values, and carrying out simple arithmetic operations.

The following are examples of data-handling instructions to be found with PLCs.

1. Data Movement

The figure shows the form used by three manufacturers to move data from one location or register to another. When there is an input to | | in the rung, the move occurs from the designated source

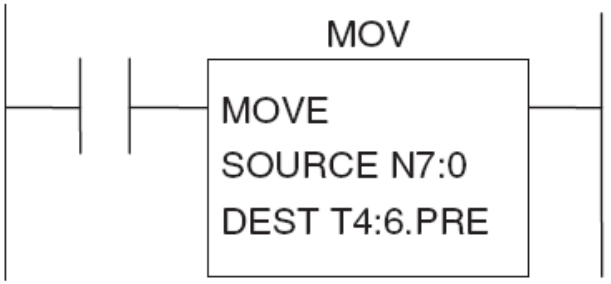


Data movement: (a) Mitsubishi, (b) Allen-Bradley, and (c) Siemens.

address to the designated destination address.

Data transfers might be to move a preset value to a timer or counter, or a time or counter value to some register for storage, or data from an input to a register or a register to output.

The figure shows the rung, in the **Allen-Bradley** format, that might be used to transfer a number held at address N7:0 to the preset of timer T4:6 when the input conditions for that rung are met.



A data transfer from the accumulated value in a counter to a register would have a source address of the form C5:18.ACC and a destination address of the form N7:0.

A data transfer from an input to a register might have a source address of the form I:012 and a destination address of the form N7:0.

A data transfer from a register to an output might have a source address of the form N7:0 and a destination address of the form O:030.

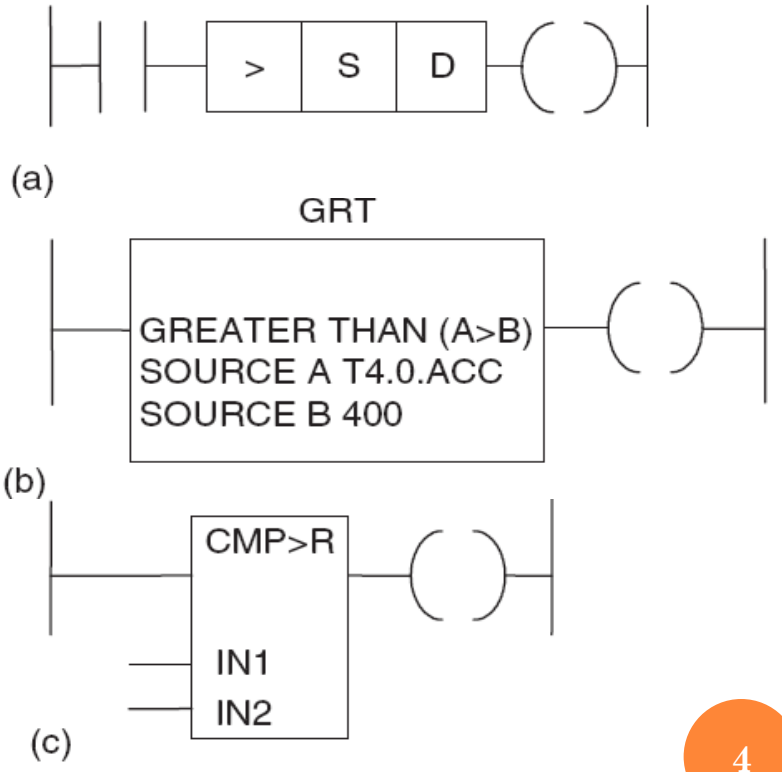
2. Data Comparison

The data comparison instruction gets the PLC to compare two data values. Thus it might be to compare a digital value read from some input device with a second value contained in a register. For example, we might want some action to be initiated when the input from a temperature sensor gives a digital value that is less than a set value stored in a data register in the PLC.

The figure shows the type of formats used by three manufacturers using the greater-than form of comparison.

In figure (a) the format is that used by **Mitsubishi**, S indicating the source of the data value for the comparison and D the destination or value against which the comparison is to be made. Thus if the source value is greater than the destination value, the output is 1.

In figure (b) the **Allen-Bradley** format has been used. Here the source of the data being compared is given as the accumulated value in timer 4.0 and the data against



(a) Mitsubishi, (b) Allen-Bradley, and (c) Siemens.

which it is being compared is the number 400.

Figure (c) shows the **Siemens** format. The values to be compared are at inputs IN1 and IN2 and the result of the comparison is at the output: 1 if the comparison is successful, otherwise 0.

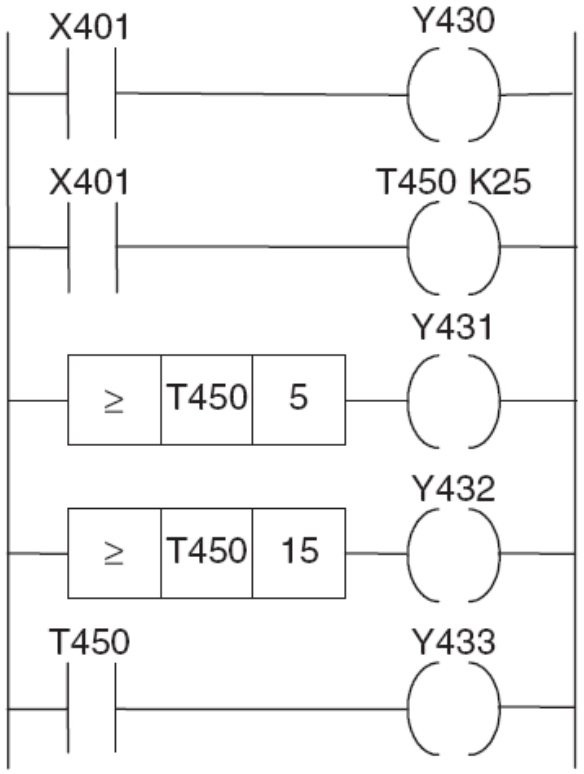
PLCs generally can make comparisons for:

- **less than** (< or LT or LES),
- **equal to** (= or = = or EQ or EQU),
- **less than or equal to** (≤ or <= or LE or LEQ),
- **greater than** (> or GT or GRT),
- **greater than or equal to** (≥ or >= or GE or GEQ),
- **and not equal to** (≠ or <> or NE or NEQ).

Example:

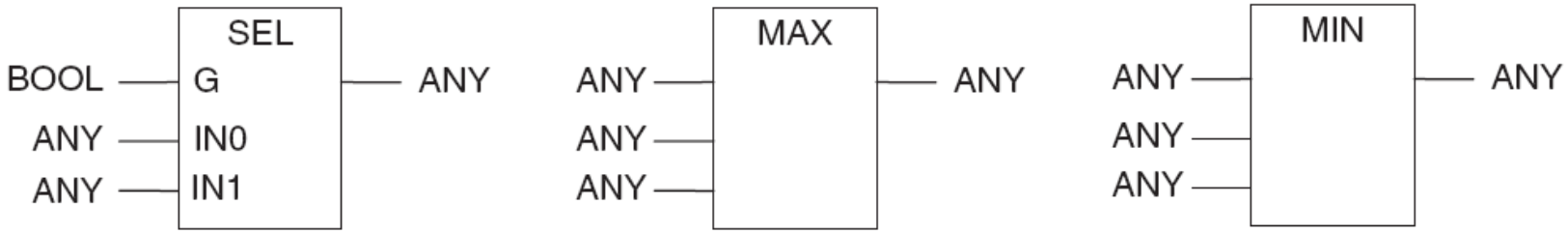
Four outputs need to be started in sequence, that is, output 1 starts when the initial switch is closed, followed sometime later by output 2, sometime later by output 3, and sometime later by output 4. Though this could be done using three timers, another possibility is to use one timer with greater-than or equal elements. The figure shows a possible ladder diagram by Mitsubishi.

When the X401 contacts close, the output Y430 starts. The timer is also started. When the timer-accumulated value reaches 5 s, the greater-than or equal-to element switches on Y431. When the timer accumulated value reaches 15 s, the greater-than or equal-to element switches on Y432. When the timer reaches 25 s, its contacts switch on Y433.



3. Data Selection

There are a number of selection function blocks available with PLCs. The figure shows the standard IEC symbols.



(a) If G = 1 then output is IN1
Else is IN0

(b) Output is the maximum value of the inputs

(c) Output is the minimum value of the inputs

IEC symbols: (a) selection, (b) maximum, and (c) minimum.

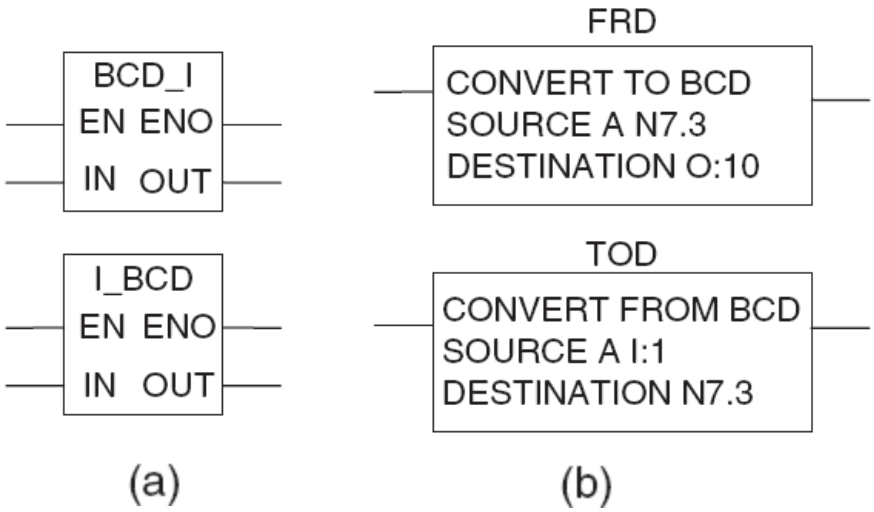
4. Data Conversion

Most PLCs provide BCD-to-binary or integer and integer or binary-to-BCD conversions.

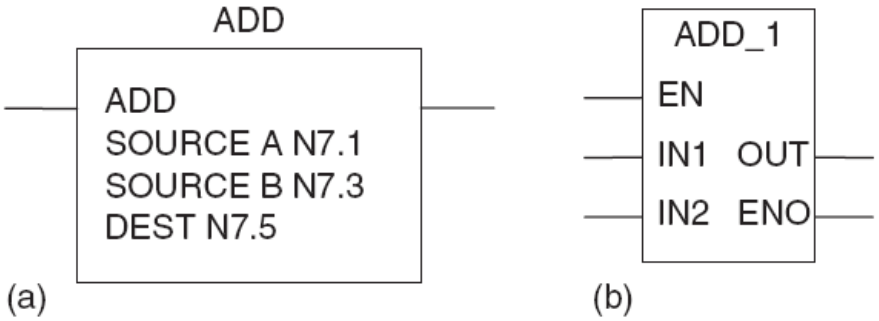
5. Arithmetic Operations

Some PLCs are equipped to carry out just the arithmetic operations of addition and subtraction, others the four basic arithmetic operations of addition, subtraction, multiplication, and division.

Figure (a) shows the **Allen-Bradley format** for ADD; the other arithmetic functions have a similar format. The data in source A, which is at N7.1, is added to that in source B, which is at N7.3, and the result is put at the destination N7.5.

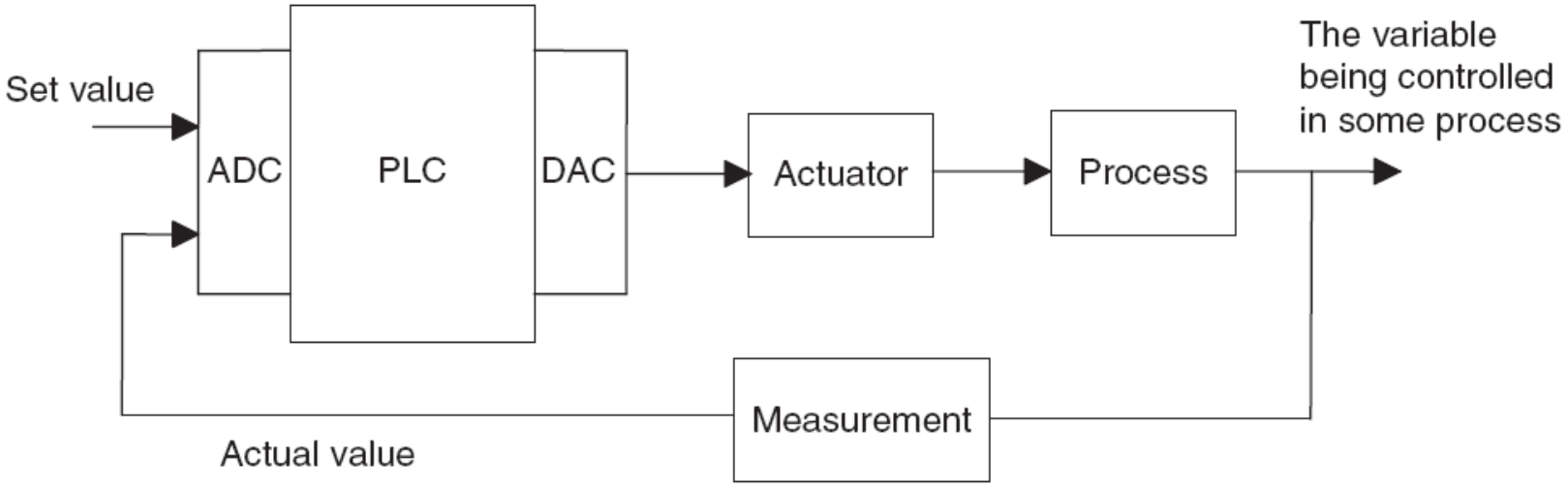


Conversion BCD-to-integer and integer-to-BCD: (a) Siemens, (b) Allen-Bradley format.



ADD: (a) Allen-Bradley format, and (b) Siemens format.

Closed Loop Control

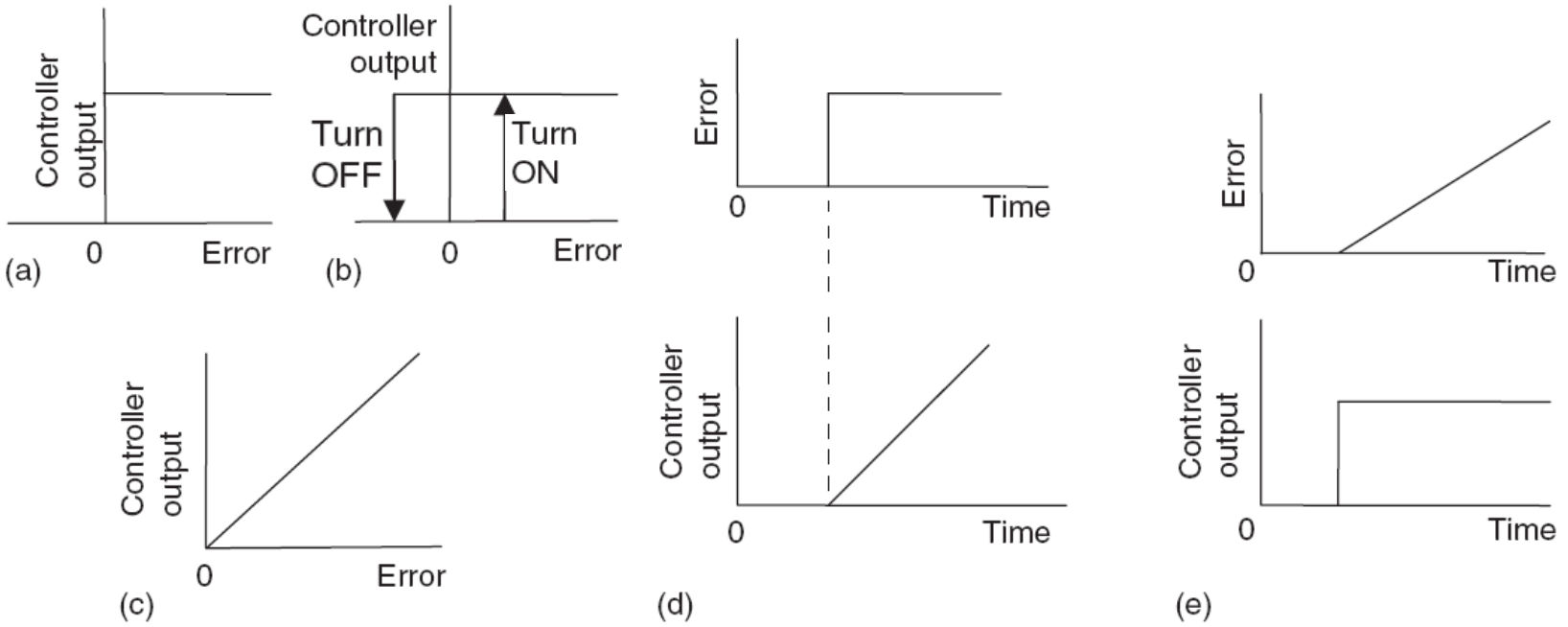


Closed loop control of some variable, such as the control of the temperature in a room, is achieved by **comparing the actual value for the variable with the desired set value and a signal is obtained representing the difference or error. A controller then takes this difference signal and gives an output signal to an actuator to reduce the difference**.

Since the actuator and the measured values are analog and thus require conversion to digital; analog-to-digital and digital-to-analog units have thus been used.

Modes of Control

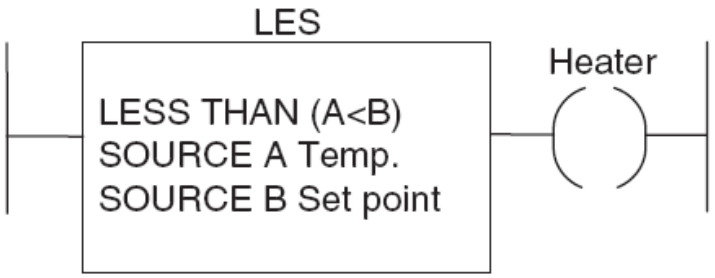
There are a number of methods by which the controller can react to an error signal:



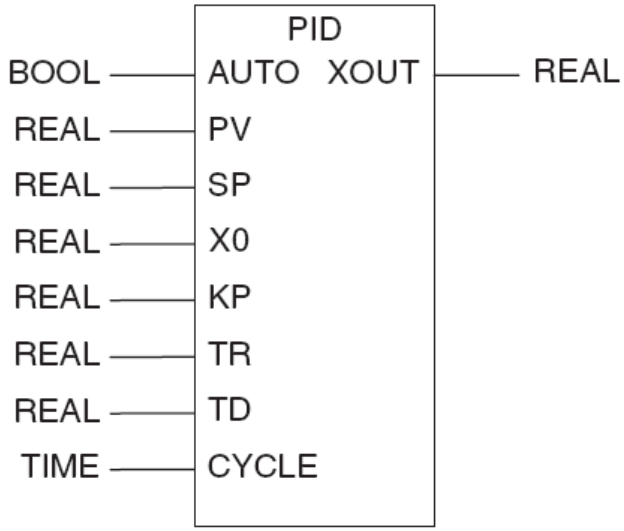
Control: (a) on-off, (b) on-off with hysteresis, (c) proportional, (d) integral, and (e) derivative.

Control with a PLC

The figure shows a PLC ladder rung that can be used to exercise **on-off control**. The output is turned on when source A, the actual temperature, is less than source B, the required temperature, that is, the set value.



Many PLCs provide the **PID** calculation to determine the controller output as a standard function block. It is then necessary to pass the desired parameters, K_P, TR, TD, and input/output locations to the routine via the PLC program. The figure shows the **IEC 1131-3** standard symbol for the PID control function.



SP is for setting the set point value. PV is the process variable being controlled. KP is input for the proportional control constant, TR for the integral time constant, TD for the derivative time constant.

REAL are real numbers, i.e. analog values.
BOOL are Boolean and so just on-off signals.

IEC 1131-3 standard symbol.