PLC Hardware

The Programmable Logic Controller abbreviated by PLC is a special microprocessor based controlled system. Also it is a special type of computer capable of withstanding vibration, higher temperature , higher humidity and optimized for control tasks in industrial environment rather than calculation and display tasks assigned to the normal computer.

From the point of view of operation, the PLC uses battery supported programmable memory to store user program's instructions and to implement logic functions, arithmetic functions, timing functions, counting functions, sequencing functions in addition to special control functions like PID controller , high speed counting, and position control. To do the application the PLC has being programmed to, the PLC reads the states of the field input devices connected to its input strip, uses these information as the independent variables of the user program function and updates the commands directed to the field output devices connected to the its output strip.

The PLC system basically consists of seven functional components. As shown in fig.1, these are the central processing unit , the memory, the input interface unit, the output interface unit, the communication interface circuit. All communications between these PLC's main units take place via four buses: These are:

The data bus: This bus is used to transfer the data between the CPU , the memory, and the input / output units.

The address bus: This one is responsible for transferring the address of the memory the data will be send to or fetched from.

The control bus : The control bus controls and synchronize all the traffic between the PLC main units.

The I/O System bus: This last bus is used for I/O communication.

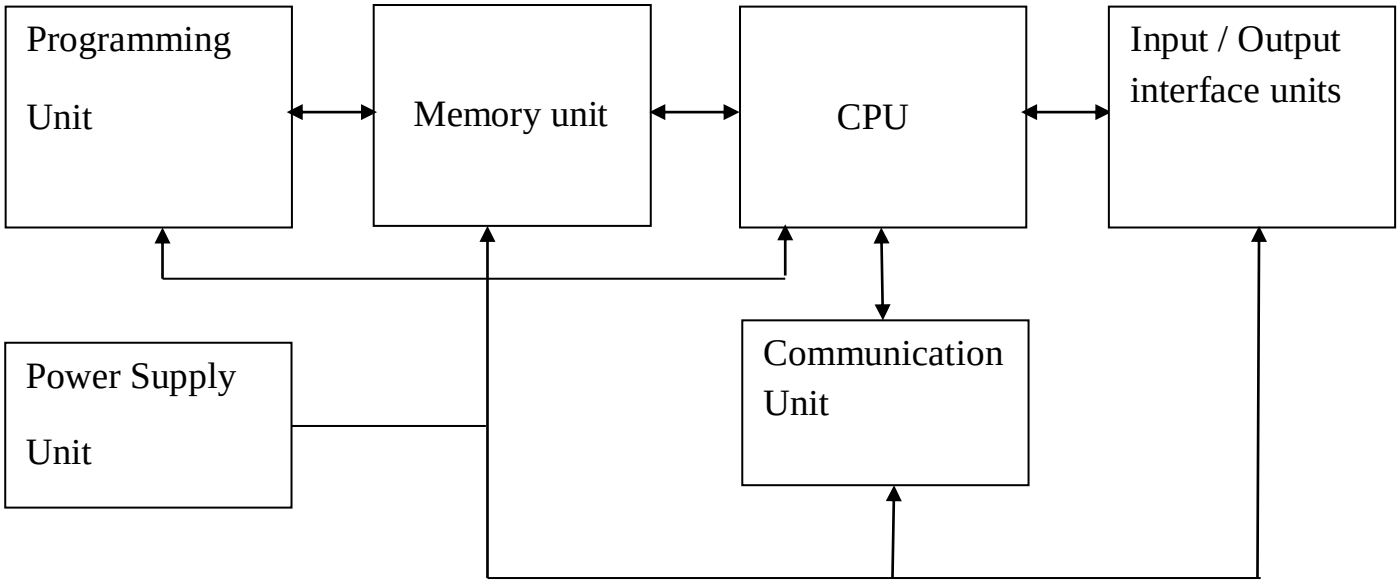

Fig.1: PLC System's Functional Components

Central Processing Unit:

The CPU is considered as the PLC's brain. It has the following items :

1- An arithmetic and control unit (ALU) responsible for carrying out arithmetic , logical operations, and data manipulation on the data held in the memory according to the instruction of the user program.

2- Memory registers to store information accompanied to the program execution.

3- Control unit to generate the timing signal required to synchronize and control all the PLC activities.

Memory Unit :

It is the place where the program containing the control instructions is stored. Also it is the place where data from inputs terminals and data for output terminals are stored. In general , the PLC may have :

- Read only memory (ROM) to permanently store the PLC operating system .

- Random access memory (RAM) to store the user created program.

- Random access memory (RAM) to store data related to the input and output devices in addition to that of timers, counters , and other internal devices.

As an illustrative example, Tables 1 and 2 show the random access memories embedded in the high performance XGB basic unit .

To prevent the loss of the program and certain type of data when the power supply is switched off , a battery is used in the PLC to maintain the user program RAM area and also the data RAM marked as retain .

Table 1 : The user program memory embedded in the high performance XGB PLC

Item	Size (KB)	Details
Parameter Setting Area	120	- Basic Parameters - I/O parameter Area -Special Communication Module Parameter Area -User Event, Trace Parameter Area
Program Saving Area	1024	-Scan Program Area 1,2 - Variable / Comment Area
System Area	156	- User Event Trace Data Area - System Log Area - Device Backup Area
Program Backup Area	1362	- Scan Program Area - Task Program Area - Upload Area -Parameter Initialization Area - Retain Parameter Assignment Area

Table 2 : Data memory embedded in the high performance XGB PLC

System Area: - I/O information Table - Forced I/O Table - Reserved Area	20KB	
Flag Area: - System Flag (F) - Analog Image Flag (U) - Internal Special Flag (K) - High Speed Link (L)	4KB 768B 16KB 8KB	
Input Image Area (%I)	2KB	
Output Image Area (%Q)	2KB	
R Area (%R)	32KB *2block	
Direct Variable Area (%M)	32KB	
Symbolic Variable Area	64KB	

Input / Output Interface Units :

These units take mid position between the PLC internal digital circuitry and the outside environment. They allow field input devices (on/off switches, limit switches, proximity switches, shift encoders, temperature transmitters, level transmitters, pressure transmitters, etc) to control the PLC digital inputs . They allow the PLC digital outputs to control the field output devices (solenoid valves, magnetic relays, solid state relays, AC drives, stepper drive, servo drives, etc). In addition to the above, these interface circuits provide signal conditioning and isolation functions to protect the PLC and allow the input and output signals to be directly connected without the need for any extra electronic circuitry. From the point of view of PLC memory, each PLC input or output device has its unique address . These addresses are what dealt with in the user program instructions.

PLC Digital Input Interface Circuit:

The signals applied to the PLC input strip points may be AC voltage signals (24VAC, 220VAC) may be DC voltage signals (12VDC , 24VDC) depending upon the PLC brand selected. But the PLC internal voltage logic is 5VDC irrespective of the PLC brand so there is a need for an electronic circuits to map the voltage signal applied to the PLC input strip into the PLC internal 5VDC logic level. This is the function of the PLC digital input interface circuits. Figs 2 to 5 display illustrative samples of PLC input interface unit channels. Fig.2 represents an AC input channel which is fed from an AC type field input device. Fig3 stands for sink type DC input channel which is supplied from source type DC field input device. It is called so because the current flow from the field input device toward the channel .Fig.4 is also DC input channel but this one is considered as source DC input channel because of the current flow from the channel toward the field input device. Fig5 shows a DC channel which can works with both types of DC field devices.

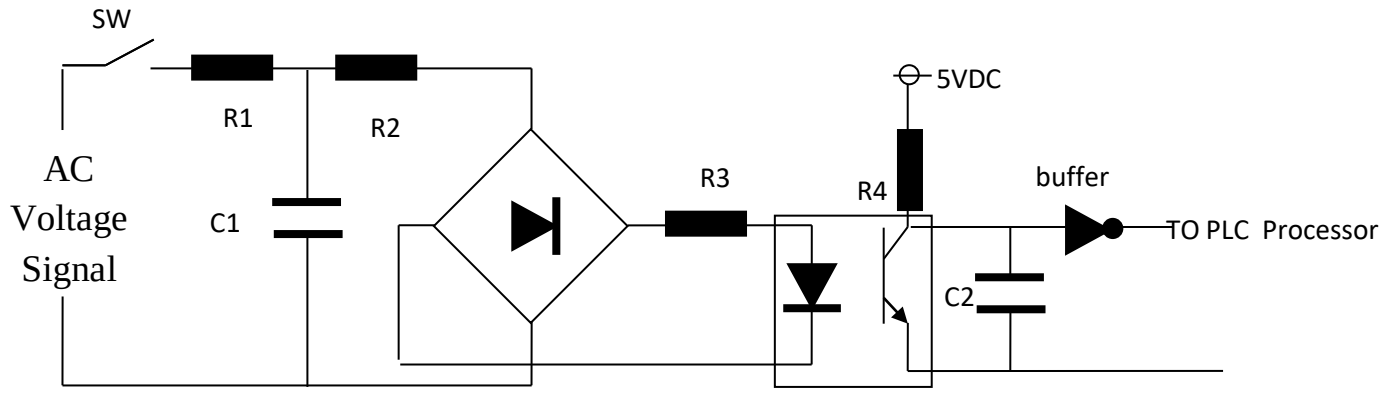

Fig. 2: AC Input Chanel

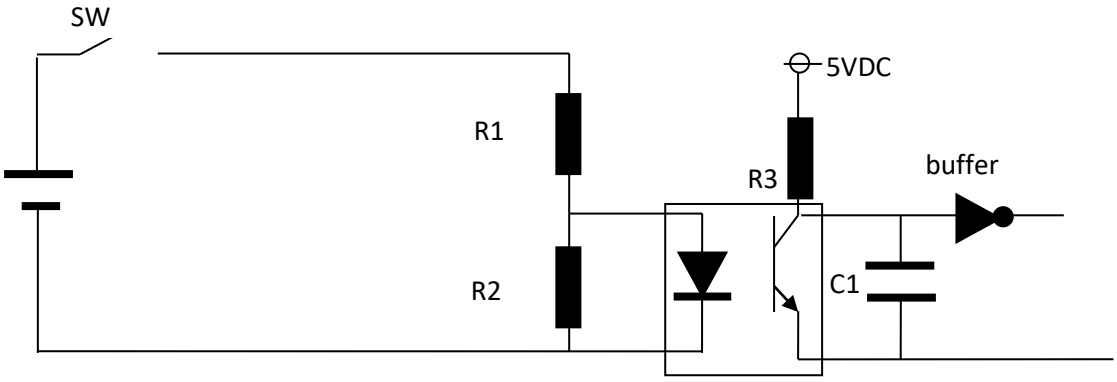

Fig. 3: DC Sink type Input Chanel

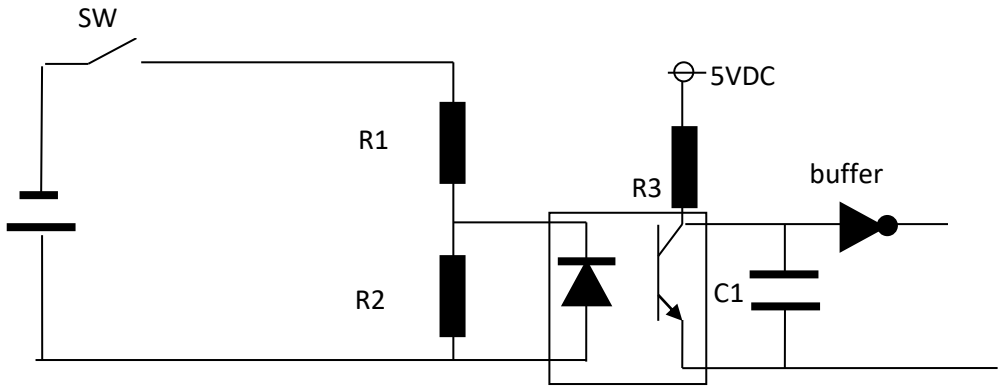

Fig. 4: DC Source type Input Chanel

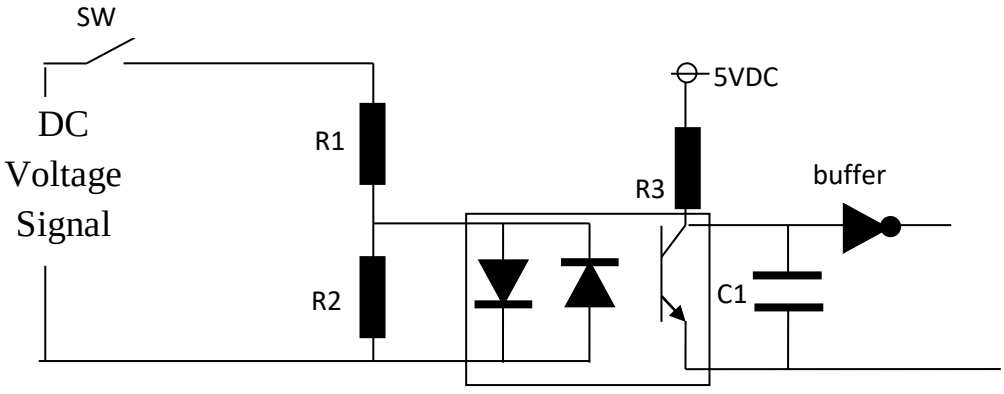

Fig. 5: DC Source / Sink type Input Chanel

PLC Digital Output Interface Circuit:

The PLC internal output logic is restricted to the 5VDC logic which means the output terminals of the PLC processor (output image register) may be 0 or 5VDC irrespective of the brand of the PLC used. The field output devices differ in their voltage need, some of them must be powered using 12VDC source, some must be powered via 24VDC source, some must be powered from 24VAC source, some from 220VAC source, some require slow ON/OFF switching and some need fast ON/OFF switching, some has no surge current, some has large surge current. The PLC processor digital output circuits have no problem with the switching speed because of their dependence on transistor switches, the only problems they have are the voltage type and current rating. As mentioned above ,they can only supply low level discrete DC voltage output signal (0 or 5VDC). so there is a need for an electronic circuits to map the processor digital output voltages in to that required by the field output devices. To achieve such mapping and to provide some form of isolation barrier, the PLC manufacturers supported their PLCs with digital output interface circuits. In this context, there are three main types as shown in Fig6 to Fig9. Fig6 displays the relay type output circuit. This type of output circuits are characterized by:

- Isolate the PLC processor output circuit from the external load circuit.
- Can be used with AC and DC external load circuits.
- It s switching frequency is low because of the mechanical nature of the relay.
- Can withstand high surge current and voltage transient because the element in contact with the load circuit is metallic contact.

Fig7 and Fig8 show Source and sink type output circuits. both uses transistor to control current flow in the field output devices. These output interface circuits are characterized by:

- Isolate the PLC processor output circuit from the external load circuit.
- Can only be used with DC circuits, because the transistor based switch allows one current flow direction.
- Load over current and high reverse voltages may destroy such type of output interface circuits.

Fig9 belong to the triac output interface circuit. It is characterized by:

- - Isolate the PLC processor output circuit from the external load circuit.
- Can only be used with AC circuits because of the triac type switching element.
- Load over current may easily destroy this type of output interface circuits.

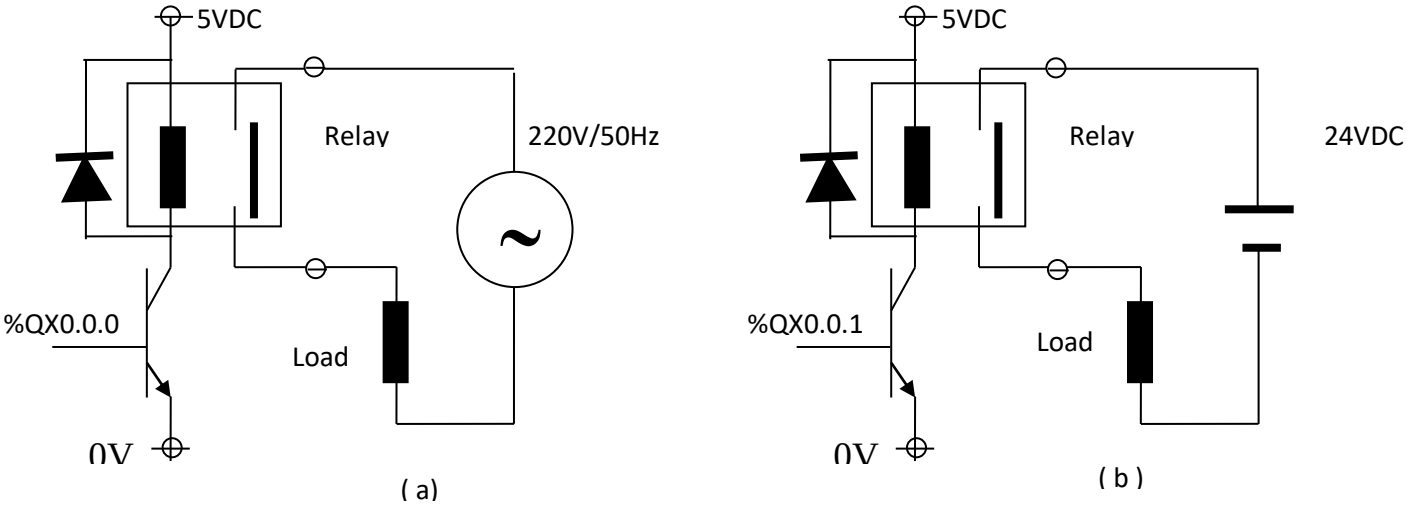

Fig. 6: Relay type Input Chanel . a): AC Load. B): DC load

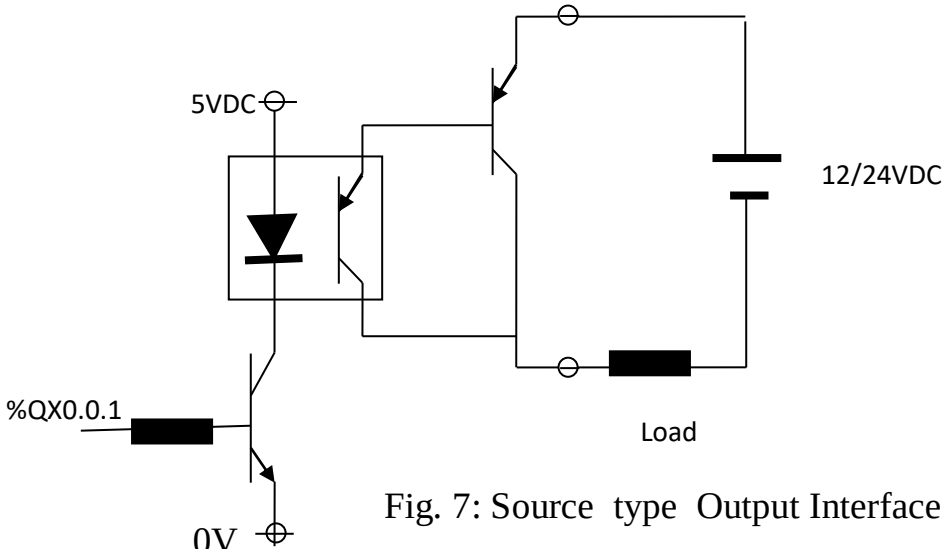

Fig. 7: Source type Output Interface

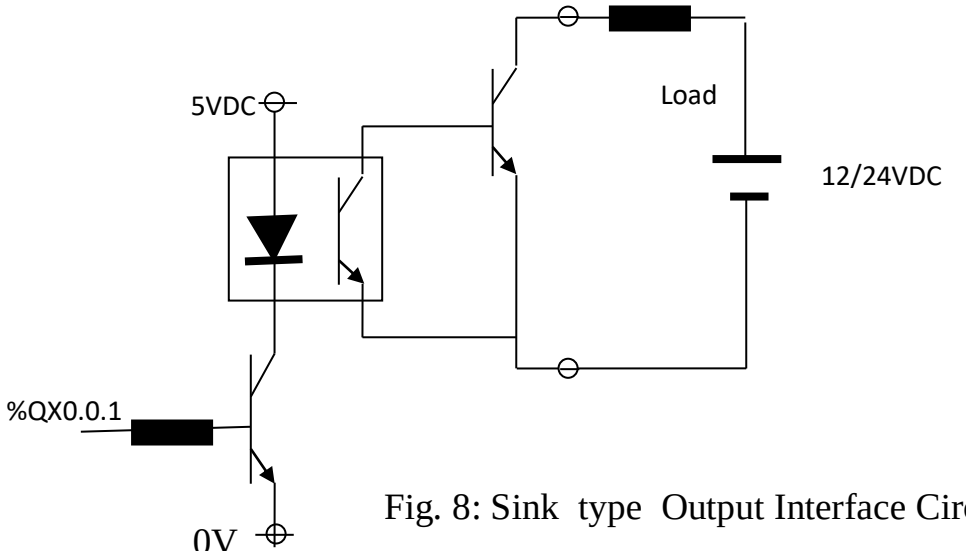

Fig. 8: Sink type Output Interface Circuit

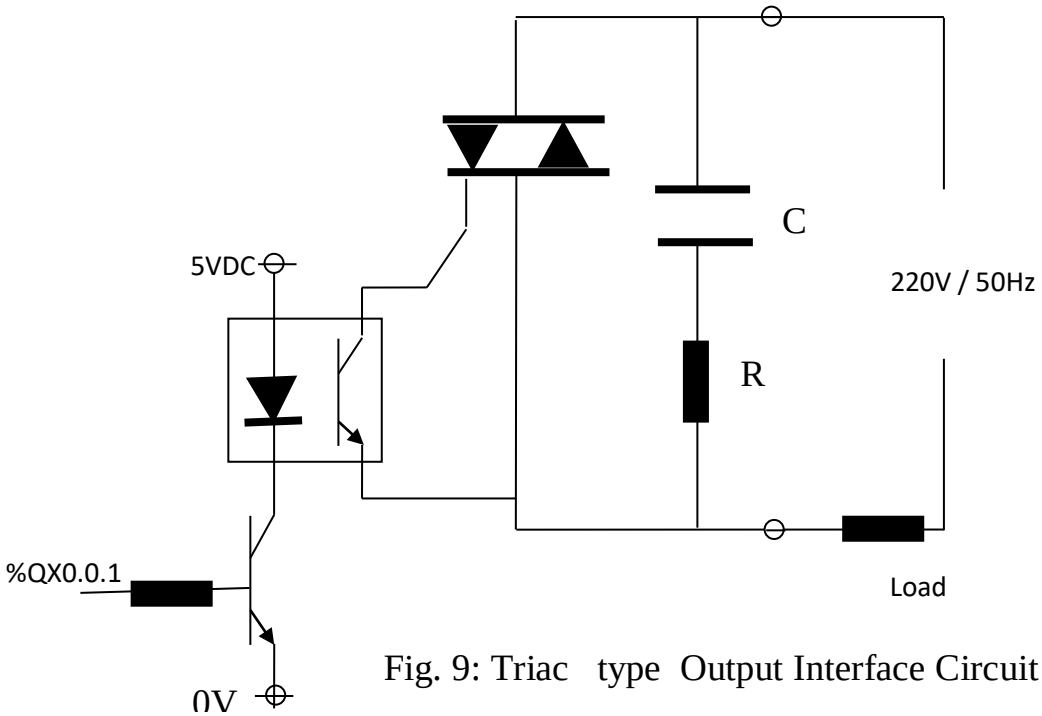

Fig. 9: Triac type Output Interface Circuit

PLC Analog To Digital Input Interface Circuit:

The PLC analog input interfacing circuits convert current or voltage input signals coming from field analog input devices (like voltage, current, temperature , speed, pressure, flow, level, vibration, weight, and position transmitters) into digital data usually word data types and assign these data to the PLC memory allocated for the analog input channels (in case of XGB-XECU PLC type, this is defined by the prefix %UW).

The typical nominal range for the accepted analog signals in XGB-XECU PLC are :

1: 0 – 20mA

2: 4 – 20mA

3: 0 – 5V

4: 1 – 5V

5: 0 – 10V

6: -10 – +10V

The digital data range representing the analog signals over their entire span can be selected from more than one options. For example, in case of XGB-XECU PLC these are:

1: 0 – 16000

2: -8000 – 8000

3: 4000 – 20000

4: 0 – 10000%

Fig. 10 and Fig11 show how the 2 wire and four wire field transmitters are connected to the PLC analog input channels .

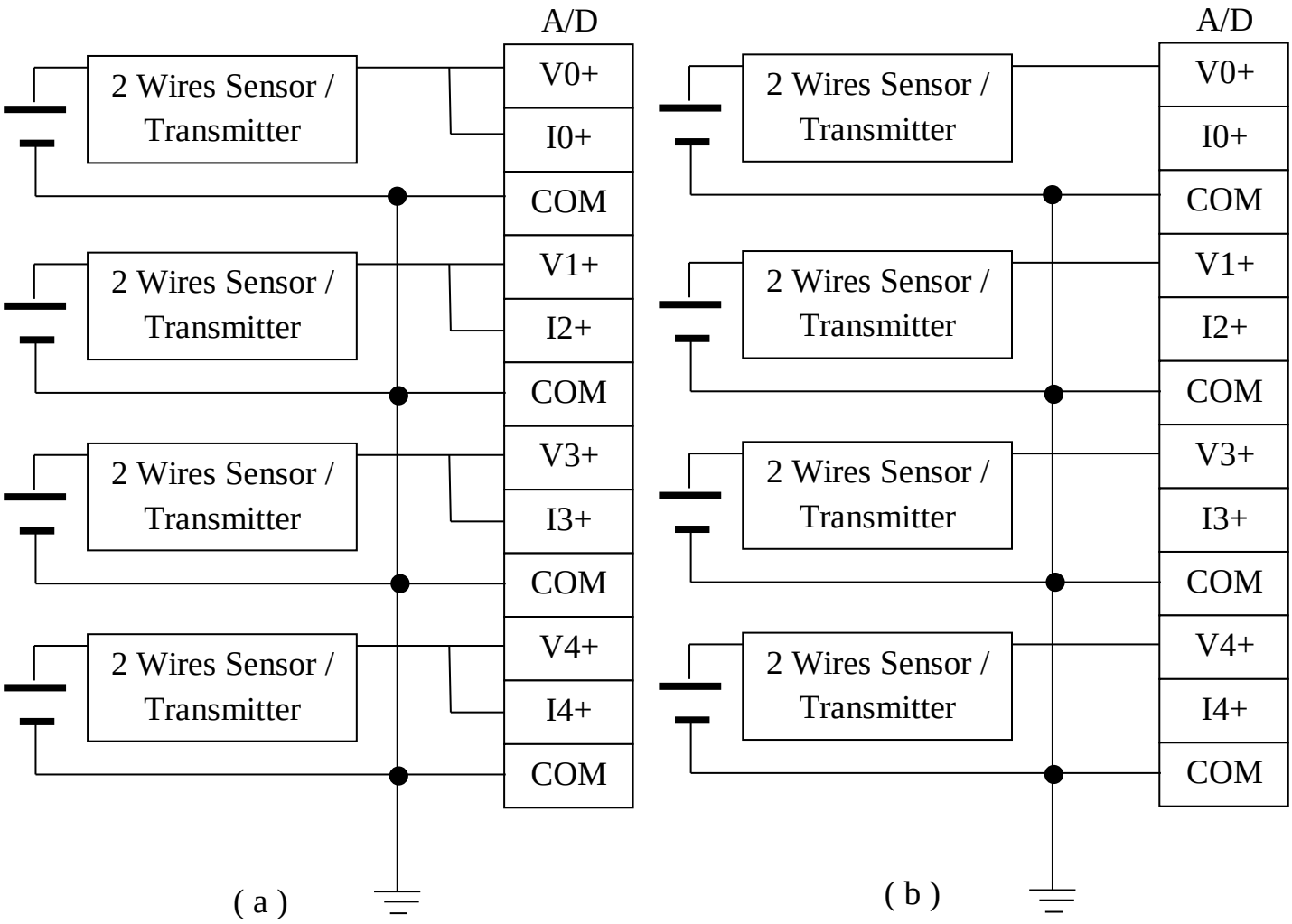

Fig.10: 2-Wire sensor/transmitter wiring. A: Current type. B: Voltage type

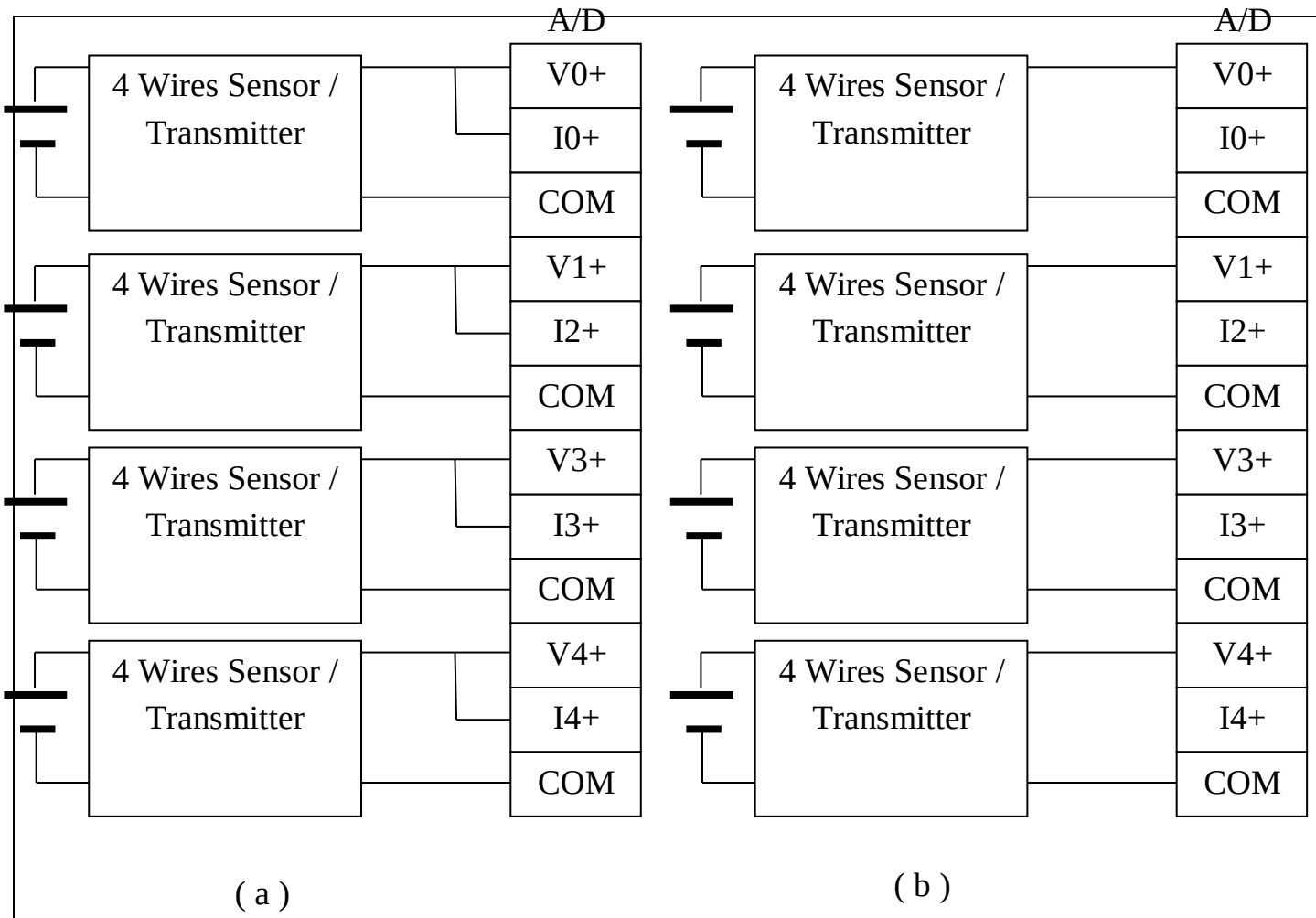

Fig.11: 4-Wire sensor/transmitter wiring. A: Current type. B: Voltage type

PLC Digital To Analog Output Interface Circuit:

The PLC digital to analog output interfacing circuits convert the digital data stored in the PLC memory allocated for the analog out channels (in case of XGB-XECU PLC type, this is defined by the prefix %UW) into analog output voltage or current signals.

The digital data range to be converted can be selected from more than one options. For example, in case of XGB-XECU PLC these are:

1: 0 – 16000

2: -8000 – 8000

3: 1000 – 5000

4: 0 – 10000%

The typical nominal range for the generated analog signals in XGB-XECU PLC are :

1: 0 – 5V

2: 1 – 5V

3: 0 – 10V

4: -10 – +10V

Fig. 12 Show the analog voltage and current wiring.

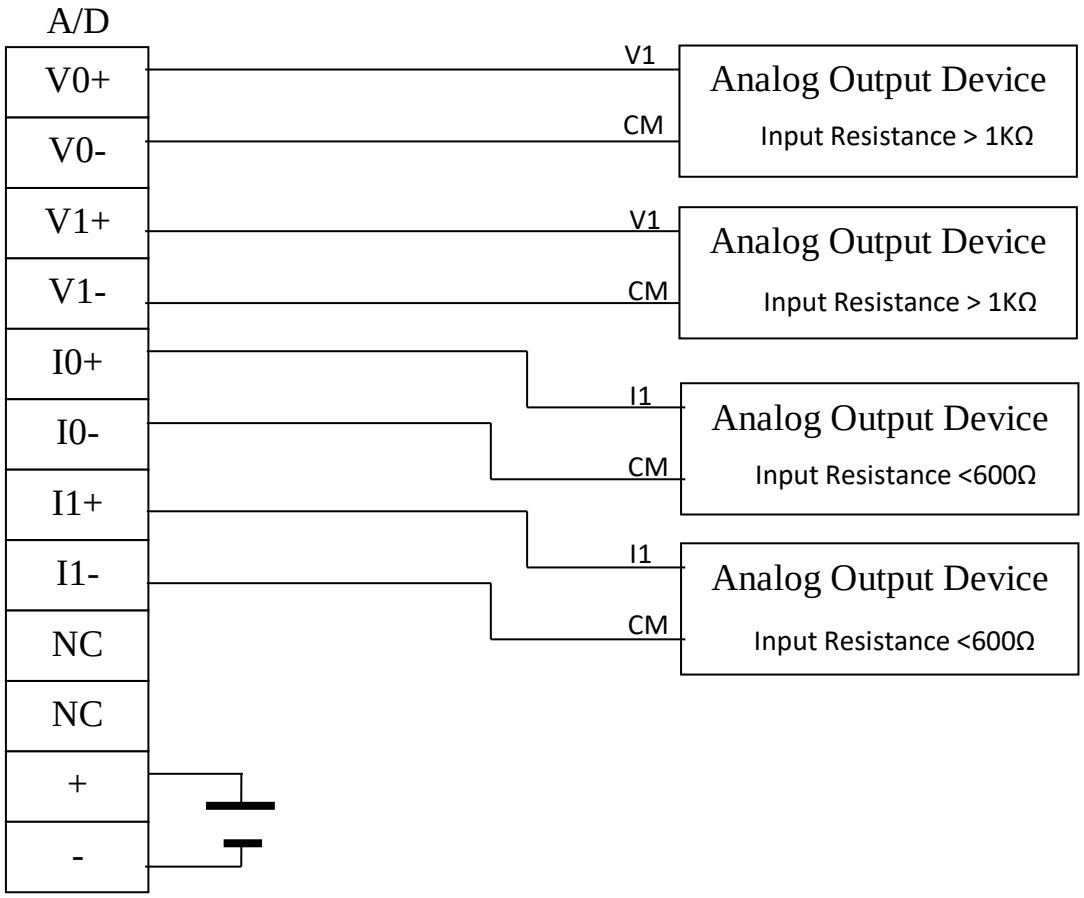

Fig.12: