ROBOTICS AND AUTOMATION
Drives and Control System for Automation
UNIT-4

Programming Logic Controller (PLC)

Programmable Logic Controller is a short abbreviation of PLC. PLC is basically known as **"Primary controller"** or **"Programmable controller"**. Programmable Logic Controller :

PLC is a solid-state control device or computerized industrial controller that performs discrete or sequential logic in the factory or automation environment.
Basically, PLC is a combination of software and hardware. It acts as the brain of the machine or system for automation control systems.

Technical Definition of PLC:
The programmable logic controller is defined by National Electrical Manufacture Associations [NEMA] as, The digital electronic device that uses programmable memory to store instructions and implement specific function such as programming logic, sequence, timing, counting and arithmetic operations to control electronic machines and technical process.

Schematic figure of the PLC (Compact/Mini PLC)

The PLC controller devices can be executed or operated by automatically and manually. For its operation, it consumes additional manpower, time, utility, and accurate operation in the system.

The most benefit of PLC: It performs precise operations within very less time. It consists of many components for controlling devices. To understand the different operations performed by PLC, I am explaining each useful PLC components with the help of block diagram in detail.

Basic Block Diagram of PLC System

The block diagram of PLC consists of different components. Each component has associated specific functions and operations in the PLC.

The list of basic components are.

- Input and Output Modules
- Power Supply
- Control Processing Unit (CPU)
- Memory System
- Communication Protocols
- Programming

You can see all these above PLC components in the below figure.

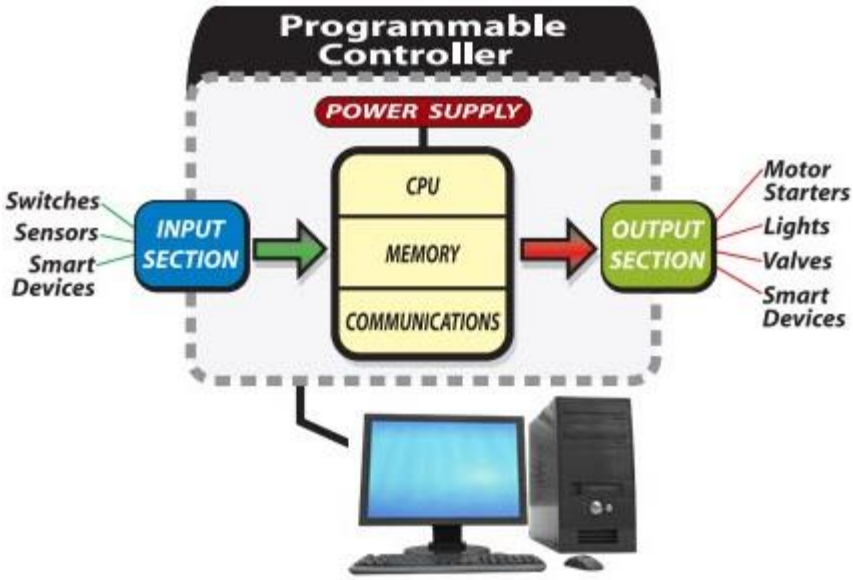


Image Source

1. Input and Output (I/O) Modules:

The input/output modules in PLC are of two types. It can be either digital or analog.Just like any other device or machine, we have to provide input to the PLC controller. It yields output.

For example, when the user presses a button, the motor starts. Here the switch button is input. The motor is an output device.

In PLC, to take the input and to return the output, there are an I/O modules.

The input modules are used for providing an interface for input devices like different types of switches (push button switch, selector switch, limited switch), sensors, etc.

The output modules are used for providing an interface for output devices like motor, fan, relay, light, lamp, electric heater, solenoid valve, buzzer, etc.

2. Power Supply:

There is no science to make the electrical device works without providing power supply.Every device operates around you need power whether if its electrical or mechanical or any other power supply.For PLC, we need an electrical power supply.

The power supply provides power to all other components to operates. It provides power to the input/output modules, memory system, and processor. The function of the power supply is to provide the DC or AC power to operate the PLC.

How much power does it require to operate PLC?
Most of the PLCs work at 220VAC or 24VDC.

3. Central Processing Unit (CPU):

Central Processing Unit is the heart of the PLC system. The function of the CPU is to store and run the PLC software programs.

It helps to perform the basic arithmetic, logic, controlling, and input/output operations specified by the instructions. It consists of the three subparts as memory, processor and power supply.

4. Memory System:

A memory system is responsible for storing and retrieving data and information.Overall memory is classified into four sections based on the types of data it stores.

- Input/Output Image Memory
- Data Memory
- User Memory
- Executive Memory

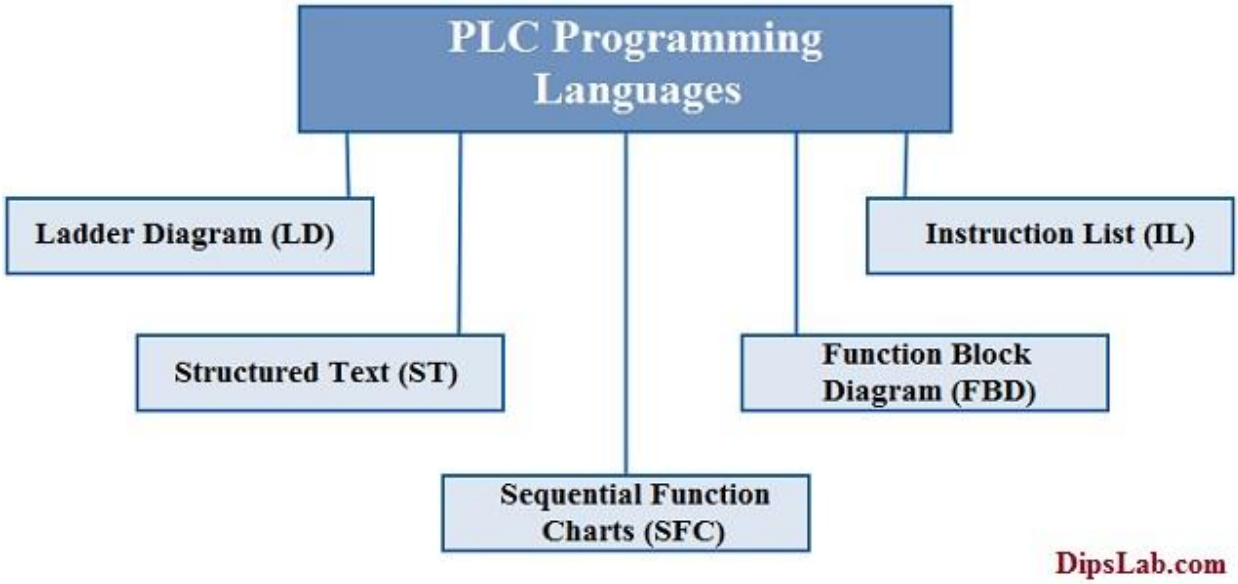
5. Communication Protocols:

The communication protocols are useful for exchanging the information or data between connected devices through a network.

6. PLC Programming:

You need programming to live the communication between different circuits of the PLC.The useful information or data are communicated by the specific communication protocols.

Most of the PLC programmer works on the ladder diagram programming language. It is pretty easy as compared to other PLC programming languages.

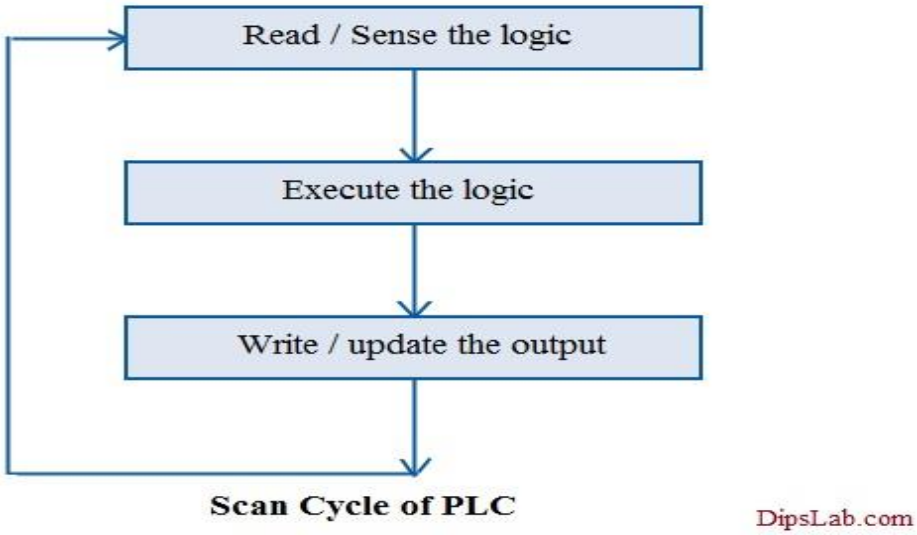


Working of the Programmable Logic Controller

The most important working principle is- the PLC is operated by continuously scanning programs. Scanning happens every time per millisecond. So, it is called as the Scan Cycle.For this scan cycle, PLC required a little amount of time in the range of milliseconds or ms.

The scan cycle consists of the following three steps.

1. Read the inputs
2. Execute the program by the CPU
3. Update the output



Step 1: Read / Sense the input:Firstly, PLC reads the on/off status of the external input signals. After scanning the input, it gets stored in the input memory.This input included switches, pushbuttons, proximity sensors, limit switches, pressure switches, etc.

Step 2: Execute the logic by the processor: This scanned input gets transferred to the CPU for processing from input memory. The processor executes the programming instructions based on the input.After the execution, the result (on/off) will be stored into the device memory.

Step 3: Update / write the output: When the program executes last instruction, it will send the on/off status to the output device memory.The outputs include solenoids, valves, motors, actuator, and pumps.All the three steps get completed under the scan time.

What is Scan Time?
The amount of time is taken by the processor to read/sense the first input and execute the last output called the Scan time.

PLC is so fast as it can easily scan and execute the program in few milliseconds i.e. 10-15 milliseconds.

Types of Programmable Logic Controller [PLC]

Two types of PLCs are used for commercial or industrial purpose.

1. Compact PLC
2. Modular PLC

What is a Compact PLC?

It is also called as **Integrated PLC** or **Fixed PLC**.
The compact PLC has a fixed number of input/output modules along with power supply and CPU.

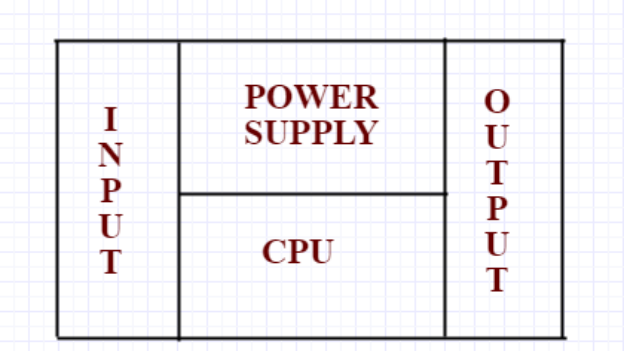


Figure1:Compact PLC

What is a Modular PLC?

It consists of a variable number of inputs and outputs. Inputs and outputs can be added to the modular PLC systems by the user.

If you look at the below PLC designing structure, it looks more like a rack. So, it is also called as **rack-mounted PLC**.

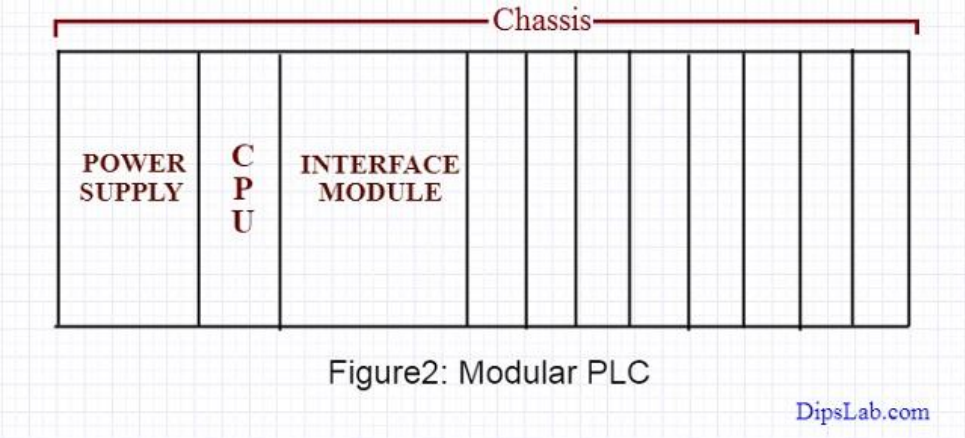


Figure2: Modular PLC

I have explained both compact and Modular PLCs in details.

Useful Programming Language for PLC

Based on the "International Electrotechnical Commission(IEC)" standard, PLC programming languages are classified into five main standards.

1. Ladder diagram (LD)
2. Instruction List (IL)
3. Structured Text (ST)
4. Function Block Diagram (FBD)
5. Sequential Function Charts (SFC)

According to the study and operations, ladder diagram (LD) is the widely PLC language for writing easily understandable programming logic.
LD has a graphical user interface. It comes with many features that give an edge over other programming languages.

Most Used PLC Brands

In the automation environment, more companies are manufacturing and working on the control system by using PLC and SCADA.

Today, there are multiple brands available for PLC system. The Asea Brown Boveri (ABB), Allen Bradley (AB), General Electric (GE), Siemens, Delta, Mitsubishi, Omron, and Schneider are some of the very popular PLC brands.
Based on the usage, Siemens PLC tops the position. Allen Bradley PLC is at the second position in Automation.

You can use any brand of PLC as per your project requirements, study, and industry need.

Applications of Programmable Logic Controller

For automation, multiple PLCs are used to monitor and control building systems in production processes.

PLCs are used in various industries like the steel industry, glass industry, cement industry, paper mill, coal mine, automobile industry, chemical industry, textile industry, robotic system, and food processing system. And the list goes on.

1. PLC in Electrical Power Station:

PLC is used in the generation, transmission, and distribution in the electrical power system.

It also controls, monitors and detects the problem in Smart Grid System. At electrical substations, automatic reclosing, circuit breaker tripping, capacitor switching, etc. can be controlled with PLCs.

- PLC is used in the smart grid system.
- It is used to detect auto assembly line system in a substation.
- Some electrical equipment can be operated with PLC.
- It is used in phase sequence detection and monitoring system.
- Fault detection and protection of an induction motor can be controlled by using the sensor and PLC.

2. PLC in Industrial Applications:

In the industrial environment, manufacturing, monitoring, and controlling machine and different types of equipment are automated by PLC.

Various industrial applications that use PLC are given below.

- Machine handling system
- Conveyor belt system
- Automatic car washing system
- Automatic packing and labeling system
- For mine, water level fuzzy control system
- Automatic bottle or liquid filling system
- Industrial timer control system for multiple machines
- Industrial temperature controller for a different purpose
- Automatic drainage water monitoring and control system
- Fault detection and protection of an induction motor by using the sensor
- Real-time power plant coal level sensing

3. PLC in Commercial Applications:

We can see the growth of PLC in commercial control applications. With the use of PLC, applications can easily operate without or with very minimal manpower or physical hard work.

Here are some basic commercial application uses PLC.

- Automatic smart traffic control signal system
- The design of smart elevator control system
- Flashing light controlling system
- Fire detection and alarm system
- The automated guided vehicle system
- Useful for the automatic parking system
- Sequence or numerical counting system
- In the roller coasters machine
- Pressure controller in multi-pump applications

4. PLC in Domestic Applications:

For the domestic purpose, PLC act as a remote operating device or automatic sensing device. We can automate some day-to-day activities with PLC.

Here are some useful domestic applications we can automate with PLC.

- Water tank level control system
- Automatic door closing and opening system
- The remote monitoring application like Air compressor
- Other remote controlling or switching purposes like light, motor, fan, etc.

5. PLC in Education Department:

Engineering students mostly prefer the automation system for doing their academic or research projects. It is a big trend.As part of the project, you can automate any commercial or domestic applications using PLC.your project should be designed to automate a specific task. It should work under real-time and with superior reliability and best performance.These are the above various applications of the PLC.

Advantage and Disadvantage of PLC

In PLC basics we are also interested in learning some advantages and disadvantages of PLC.

Advantages:

1. PLC (especially Compact PLC) has a lower cost associated with it as compared to the other automation technology.
2. It increases reliability.
3. Programming used for PLC is easy to write and understand. LD PLC programming is easiest.
4. PLC has the ability to easily communicate and connect with the computer. You can use various standard communication protocol.
5. PLC does not take much space. They are smaller in size.
6. Fast operation (No booting time) is one of the advantages.
7. Modification is possible. You can easily make the changes in an already implemented design.
8. PLC has low maintenance associated with it.
9. Modular designing makes development easy.

10. PLC has fast scan time (near about 10-15 millisecond). It requires very less operation time to perform any task.

Disadvantages:

There are only a few disadvantages as compare to the advantages.

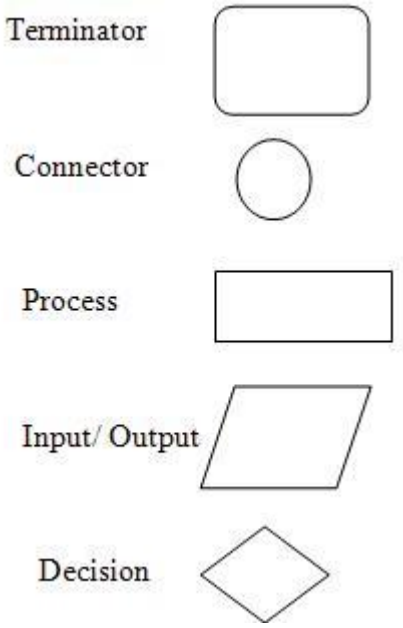
1. You can operate one program at a time.
2. PLC has some working limitations. The performance decreases in case of high temperature, vibration conditions.

Programming software tool in PLC:

The basic functioning of the PLC relies on the control logic or the programming technique used. Programming can be done using flowcharts or using ladder logic or using statement logics or mnemonics.

Interlinking all these, let us see how we can actually write a program in PLC.

- Compute the flowchart. A flowchart is the symbolic representation of the instructions. It is the most basic and simplest form of control logic which involves only logic decisions. Different symbols are as given below:



- Write the Boolean expression for the different logic. Boolean algebra usually involves logic operations like AND, OR, NOT, NAND and NOR. The different symbols are:

\+ OR operator

. AND operator

! NOT operator.

PLC Software

In a previous blog entry, we covered the basics of Programmable Logic Control, including components and operation. In this installment, we will discuss PLC software. Software is used in a PLC to create user projects and programs, which allow the PLC to operate. The software allows each user to create individual and unique programs for each type of PLC.

Software vs. Firmware

The terms software and firmware both refer to digitally stored programs and data structures that are read and written by computers. Although they may seem interchangeable, they have distinct definitions.

Firmware:

Firmware can be referred to as the actual program or operating system a PLC uses to execute logical instructions. Firmware often is stored in the internal memory or on electrically erasable programmable read-only memory (EEPROM). **Firmware** is a specific class of computer software that provides the low-level control for the device's specific hardware. Firmware can either provide a standardized operating environment for the device's more complex software (allowing more hardware-independence), or, for less complex devices, act as the device's complete operating system, performing all control, monitoring and data manipulation functions. Typical examples of devices containing firmware are embedded systems, consumer appliances, computers, computer peripherals, and others. Almost all electronic devices beyond the simplest contain some firmware.

Firmware is held in non-volatile memory devices such as ROM, EPROM, or flash memory. Changing the firmware of a device was rarely or never done during its lifetime in the past but is nowadays a common procedure; some firmware memory devices are permanently installed and cannot be changed after manufacture. Common reasons for updating firmware include fixing bugs or adding features to the device. This may require ROM integrated circuits to be physically replaced or flash memory to be reprogrammed through a special procedure.

Software:

Software is usually reserved for computer applications that allow for the logical creation, monitoring, and troubleshooting of a PLC program. Software is written to assist the installed firmware. One example of PLC software is the RSLogix™ series developed by Allen-Bradley for use with their controllers.

TYPES OF VARIABLE

A Variable is a container that holds information, there are many different types and again it depends on the PLC that is in use. The main Variable types (also known as Data Types) are:

- BOOL: Digital Data (True / False)
- BYTE: Numerical Data / Bitwise Data (0 - 255)

- INT: Numerical Data (-32768 - 32767)
- UINT: Numerical Data (0 - 65535)
- SINT: Numerical Data (-128 - 127)
- USINT: Numerical Data (0 - 255)
- DINT: Numerical Data (-2147483648 - 2147483647)
- WORD: Numerical Data / Bitwise Data (0 - 65535)
- DWORD: Numerical Data / Bitwise Data (0 - 4294967295)
- REAL: Numerical Data (-3.402823e+38 - 3.402823e+38)
- ARRAY: Array of Any Data type (Declared as "ARRAY [0..10] OF DataType)

Most PLCs support the above, some PLCs will support a selection of the below also:

- LWORD: Numerical Data / Bitwise Data (0 - 18446744073709551615)
- UDINT: Numerical Data (0 - 4294967295)
- LINT: Numerical Data (-9,223,372,036,854,775,808 - 9,223,372,036,854,775,807)
- ULINT: Numerical Data (0 - 18446744073709551615)
- VARIANT: Object (Anything)
- NULL: Object (Nothing)

The additional variables are generally only supported by 64bit PLCs and Runtimes. Variant & Null data types are advanced and not common in PLCs.

In addition to the above Data Types, there are also different Variable attributes (modes if you like):

- CONSTANT - Variable that is hard coded and cannot be changed at runtime
- RETAIN - Variable that remembers it's last value between loss of power supply to the PLC. Most PLCs have a limit on the maximum amount of data that can be retained. Older PLCs may retain everything by default or have special ranges of registers that are retained, so make sure you check.
- PERSISTENT - A variable that retains it's last value even after a re-initialisation of the PLC or the PLC is warm started. The only way to reload the default data is to cold start the PLC or perform a full download. **Note**: Persistent variables can be dangerous if used incorrectly, especially if indirect addressing / pointers are being used.

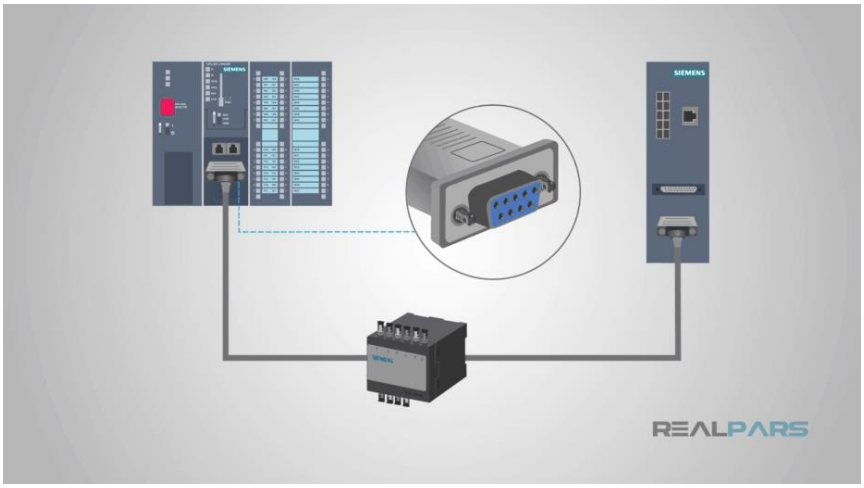
RS-232 Communications

RS-232 is an asynchronous communications method (a marching band must be “in sync” with each other so that when one steps they all step. They are asynchronous in that they follow the band leader to keep their timing).

We use a binary system to transmit our data in the ASCII format. PLCs serial port is used for transmission/reception of the data, it works by sending/receiving a voltage, With RS232, normally, a 1 bit is represented by a voltage -12 V, and a 0 by a voltage +12 V. (The voltage between +/- 3 volts is considered There are 2 types of RS-232 devices.)

DTE – Data Terminal Equipment and a common example is a computer.
DCE – Data Communications Equipment and a common example is a modem.
PLC may be either a DTE or DCE device.
When plc and external device are both DTE, (or both DCE) devices they can't talk to each other. The solution is to use a null-modem connection.

Usually, The plc is DTE and the external device is DCE.

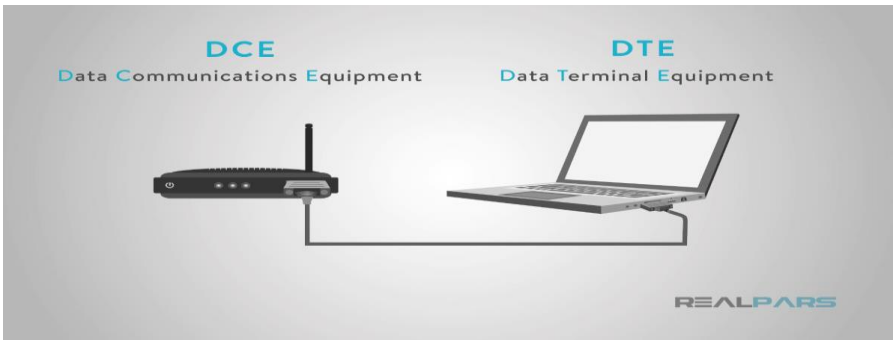


Using RS-232 with PLC

Some manufacturers include RS-232 communication capability in the main processor. Some use the "programming port" for this. Others require a special module to "talk RS-232" with an external device.

External device may be an operator interface, an external computer, a motor controller, a robot, a vision system, etc.

To communicate via RS-232 we have to setup:
1. Where, in data memory, will we store the data to be sent?
2. Where, in data memory, will we put the data we receive from the external device?

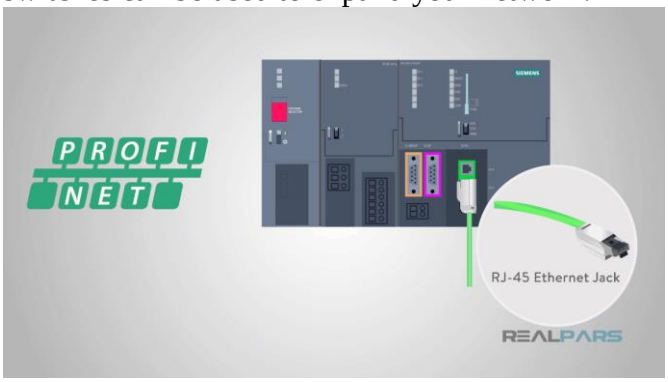


PROFINET:

Profinet is a newer, Ethernet-based industrial communications protocol. The physical interface used for Profinet is a standard RJ-45 Ethernet jack.

Profinet cables are easily recognizable by their green color. While in some cases a standard Ethernet cable *may* be used to connect two Profinet devices, official Profinet cables *should* be used as they contain robust shielding and are designed to function well in harsh industrial environments.

Profinet operates at 100 megabits per second, and cables may be up to 100 meters in length. Due to its high-speed operation and a response time of less than 1 millisecond, Profinet is ideal for high-speed applications.
Because Profinet uses the same physical connection standards as Ethernet, standard Ethernet switches can be used to expand your network.



Profinet devices have three different types of addresses:

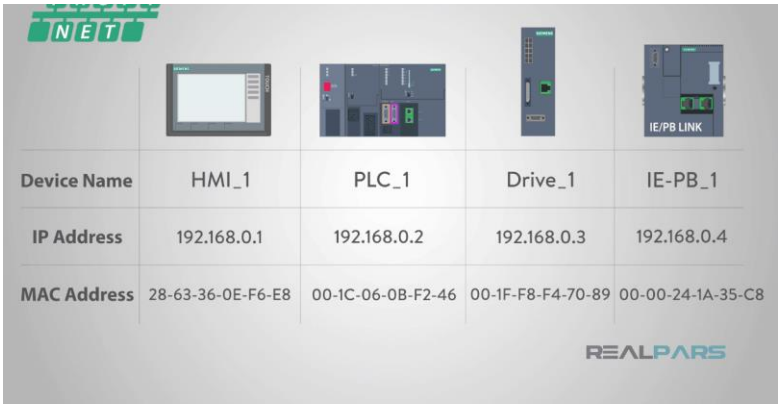
1) IP address

2) MAC address

3) Device name

All Ethernet devices use IP addresses and MAC addresses, but the device name is unique to Profinet devices.

As an automation engineer, you will be primarily concerned with Device Names and IP addresses as you configure your Profinet networks.



Due to its higher speed and greater flexibility, Profinet is becoming the preferred communications protocol for industrial application.

Both protocols are widely used today, and being familiar with both of them will be essential to your job as a controls engineer.

PROFINET IO Benefits

PROFINET IO is a unique industrial Ethernet application layer. It offers many benefits over competing application layers including:

- High Speed Operation – The real time communication channel provides high speed message exchange by bypassing the time required to process the TCP/IP stack.
- Seamless and nearly identical Siemens S7 PLC integration to Profibus
- Support for time critical motion control applications
- Short Startup
- Distributed Intelligence
- Ease of installation
- Minimum commissioning time and engineering support

PROFIBUS

PROFIBUS or Process Field Bus was introduced in 1989 and it is sometimes confused with PROFINET. It links plant automation modules with the process control. PROFIBUS uses a multi drop single cable to connect the devices. This method is cost effective especially for larger sites when compared to old methods. Its installation cost is low and it is easy to find faults as well

because it is a single cable.

Types of PROFIBUS

There are two types or versions of PROFIBUS commonly known as

1. PROFIBUS DP
2. PROFIBUS PA

Here is a brief introduction to both of these types.

PROFIBUS DP
It runs over two core screened cable that is violet sheathed and its speed varies from 9.6Kbps to 12Mbps. A particular speed can be chosen for a network to give enough time for communication with all the devices present in the network. If systems change slowly then lower communication speed is suitable and if the systems change quickly then effective communication will happen through faster speed. The RS485 balanced transmission that is used in PROFIBUS DP only allows 32 devices to be connected at once but more devices can be connected and network can be expanded with the use of hubs or repeaters.

PROFIBUS PA
It is slower than PROFIBUS DP and runs at fixed speed of 31.2Kbps via blue sheathed two core screened cable. The communication may be initiated to minimise the risk of explosion or for the systems that intrinsically need safe equipment. The message formats in PROFIBUS PA are identical to PROFIBUS DP.

A maximum of 9 segments (trunk line) are allowed on a network. The devices are the branches coming off the trunk line. Up to 32 individual devices can be connected to a single segment. That number can be expanded up to 126 if repeaters are used. Each PROFIBUS segment can be a maximum of 1200 meters in length. There are 10 defined communication speeds and each has a maximum defined cable length that's permitted.

Master /Slave

PROFIBUS uses a master/slave configuration for communication. It is usually a single master device (aPLC) that talks with multiple slave devices (sensors). The master devices poll the slaves whenthey have the token. Slave devices only answer when asked a question. They are passive and the master can be said to be active. The slave devices just collect data and pass it to the master device when asked to do so.

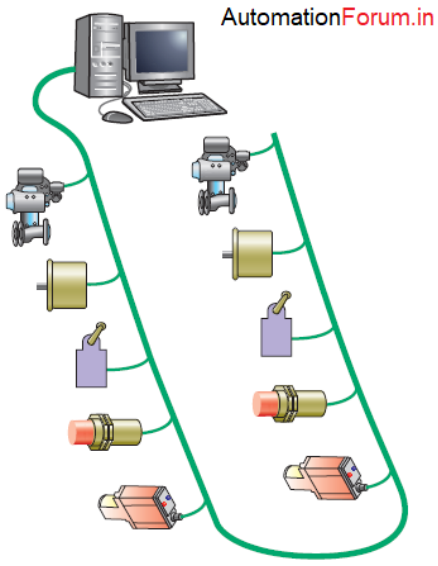
DeviceNet

DeviceNet is an example of a device-level local area network (LAN). DeviceNet is an open device-level network. It is relatively low speed but efficient at handling the short messages to and from I/O modules.

DeviceNet brings LAN technology down to the lowest level of the manufacturing enterprise on the shop floor.

Why is **DeviceNet needed?**

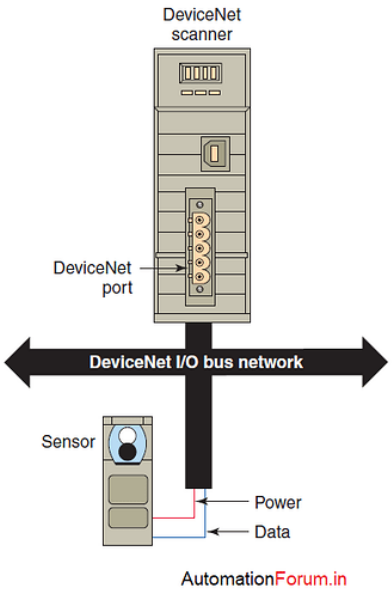
The **PLCs** are becoming more powerful by increasing the capablity of the number of the device can be connected, so the Conventional systems have racks of inputs and outputs with each I/O device wired back to the controller.



DeviceNet system

The DeviceNet protocol dramatically reduces costs by integrating all I/O devices on a 4-wire trunk network with data and power conductors in the same cable. This direct connectivity reduces costly and time-consuming wiring.

Features of DeviceNet:



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The basic function of a DeviceNet I/O bus network is to communicate information with, as well as supply power to, the field devices that are connected to the bus. The PLC drives the field devices directly with the use of a network scanner instead of I/O modules.

- Read inputs from a device.
- Write outputs to a device.
- Download configuration data.
- Monitor a device's operational status.

The scanner module communicates with the controller to exchange information which includes:

- Device I/O data
- Status information
- Configuration data
- DeviceNet also has the unique feature of having power on the network. This allows devices with limited power requirements to be powered directly from the network, further reducing connection points and physical size.
- DeviceNet uses the Common Industrial Protocol, called CIP, which is strictly object-oriented.
- Two different types of objects are defined in the CIP specification: communication objects and application-specific objects.
- A DeviceNet network can support up to 64 nodes and the network end-to-end distance is variable, based on network speed.
- Typical layout of the trunk wiring for a DeviceNet network:

- Communications data is carried over two wires with a second pair of wires carrying power.
- The field devices that are connected to the network contain intelligence in the form of microprocessors or other circuits.
- These devices can communicate not only the on/off status of field devices but also diagnostic information about their operating state.

Advantages of DeviceNet:

- Faster installation times
- Less expensive compared to traditional point-to-point wiring.
- DeviceNet devices can sometimes offer more control features compared to traditional/switched devices.
- DeviceNet technology can be used with either PLC or PC-based control systems.
- Most devices provide useful diagnostic information which can make systems easier to troubleshoot and minimize downtime.

ControlNet:

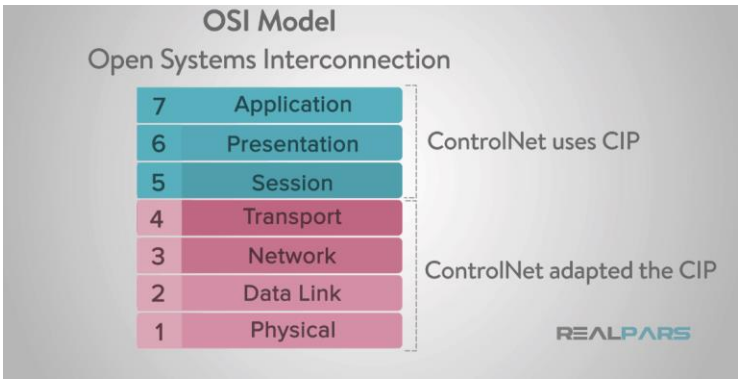
ControlNet is an open industrial network protocol and is managed by "Open DeviceNet Vendors Association" or ODVA.

ControlNet is based on a "token-passing" bus control network and we will talk more about how this part works as we move along.

1. Introduction to ControlNet

ControlNet utilizes the Common Industrial Protocol (CIP) for the upper layers of the Open Systems Interconnection or "OSI model" that has seven layers: Physical, data link, network, transport, session, presentation, and application.

The designers of ControlNet adapted the CIP layers of transport, network, data link and physical to fit the needs of the ControlNet network.

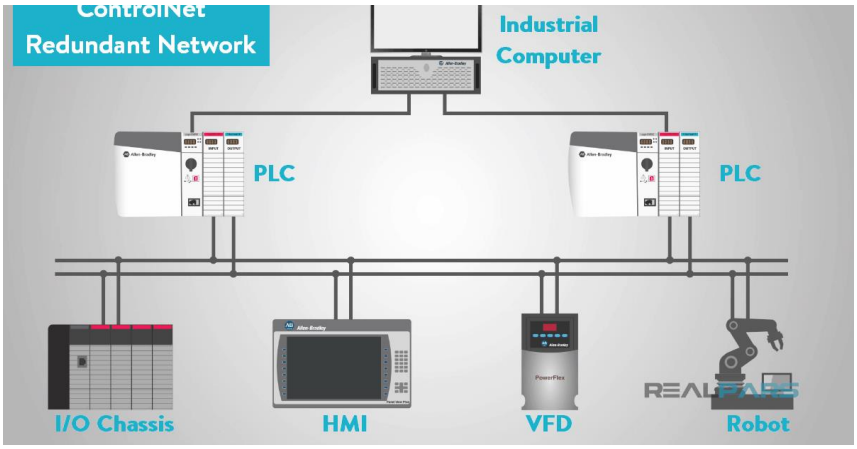


ControlNet was designed to provide reliable, high-speed control and I/O data transfer by using programming that sets the logic to specific timing over the network.

It also provides for critical messaging that does not rely on timing to be executed without interfering with the transport of control and I/O data.

The types of devices that the ControlNet network talks to are Programmable Logic Controllers, I/O chassis, HMIs, personal computers, drives, and robots.

It is typically used for redundant applications and/or applications that work best with scheduled communications.



ControlNet has a data transfer rate of 5 Mbps and is in the mid-range of the three popular networks with EtherNet/IP ranging from 10 Mbps to 1 Gbps and DeviceNet ranging from 125 to 500 Kbps.

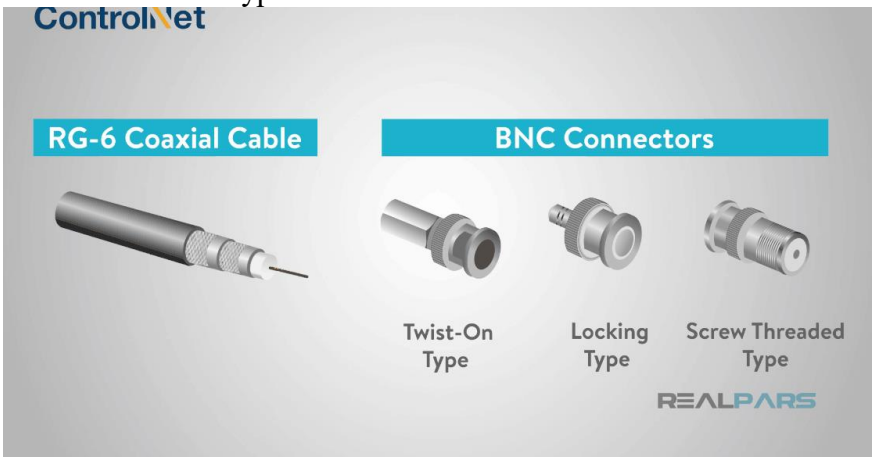
2. ControlNet Physical Layer

Now let's move on to the physical media of ControlNet.

2.1. ControlNet Connectors

ControlNet cables are RG-6 coaxial cable types with BNC connectors.

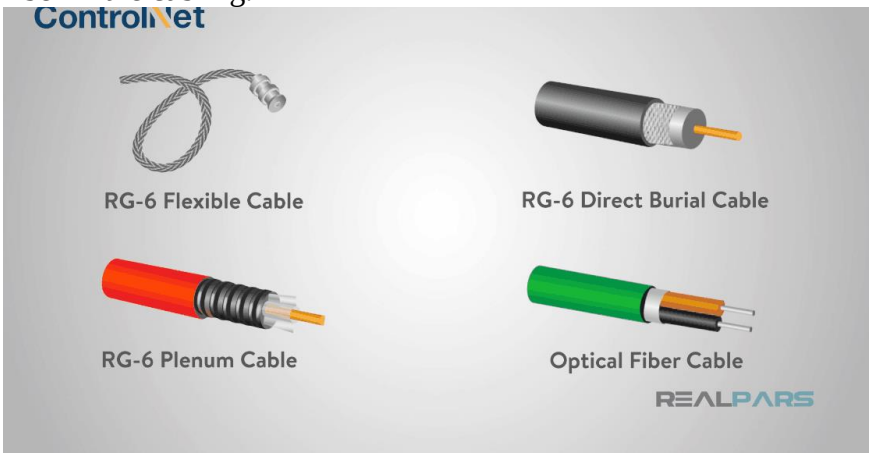
BNC connectors can either be a "twist-on" and "locking type" or a more rugged design that is a "screw threaded" type for more harsh environments.



2.2. ControlNet Cables

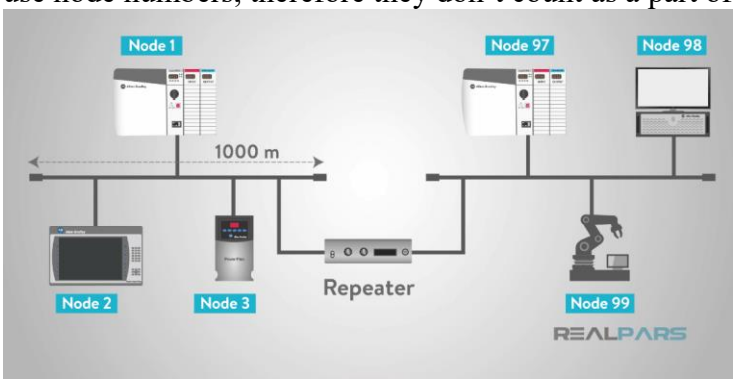
You can choose cable types such as "flexible", "direct burial", or "plenum" rated based on the application and environment that your network will be used in.

There are some applications for ControlNet that require longer distances and may use optical fiber in the cabling.



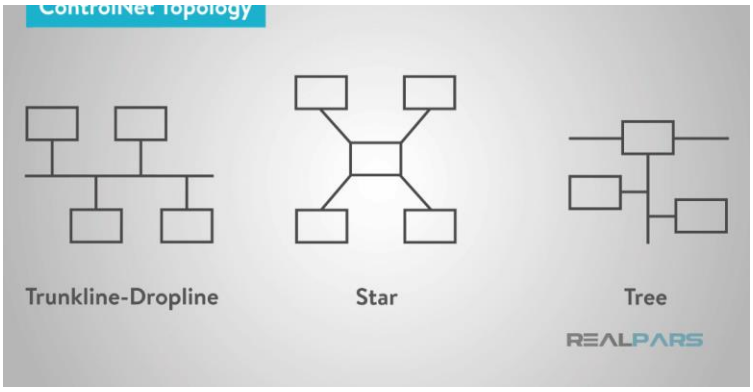
The maximum cable distance for ControlNet cables is 1000 meters unless a repeater is used. There can be a maximum of 5 repeaters (10 for redundant networks).

ControlNet can support a maximum number of 99 nodes on the network and the repeaters do not use node numbers, therefore they don't count as a part of this maximum number.

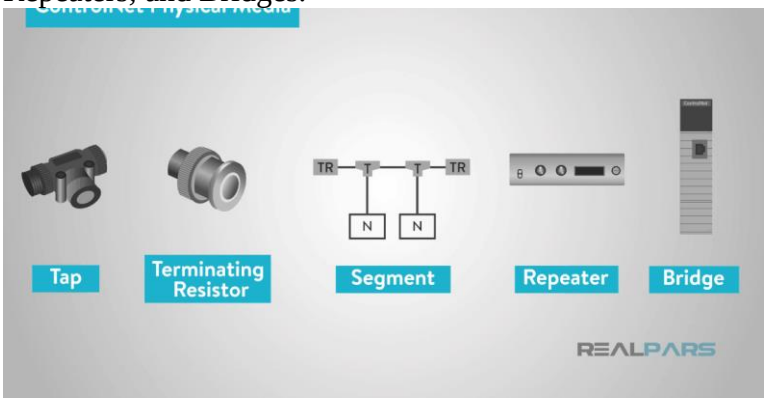


2.3. ControlNet Topology and Other Physical Media

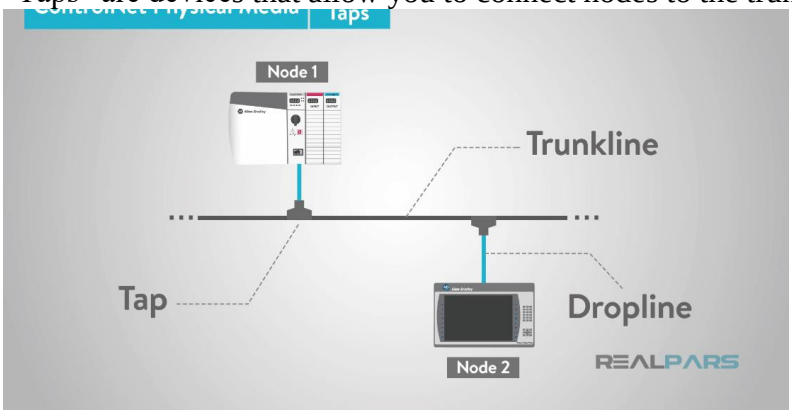
When you are designing the network, the topology options for ControlNet are trunkline-dropline, star or tree.



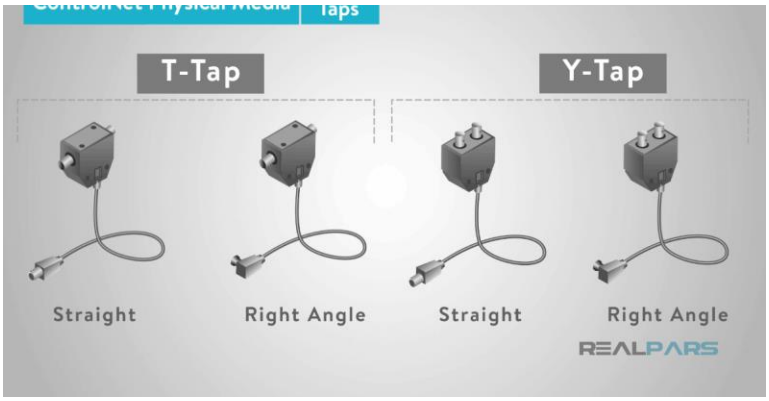
The other physical media of the ControlNet protocol are Taps, Terminating resistors, Segments, Repeaters, and Bridges.



“Taps” are devices that allow you to connect nodes to the trunk via a drop cable.



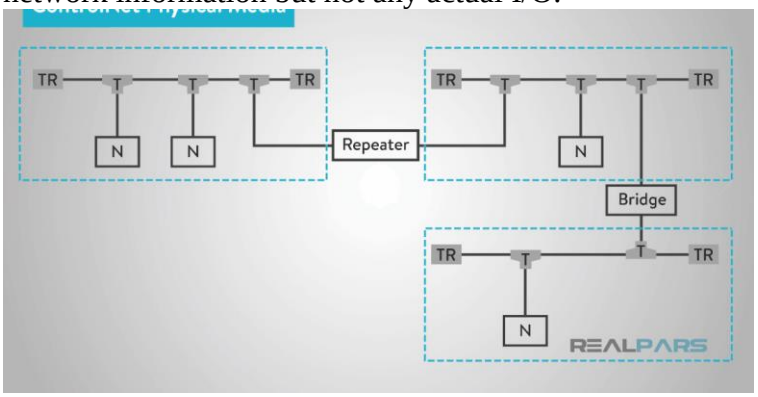
There are several types of taps, “T” or “Y”, straight and right angle that lets you have flexibility in configuring your ControlNet network.



A 75-ohms “Terminating resistor” is required at each end of the trunk cable. Segments are collections of trunk cable and taps that have terminating resistors at each end. The length of each segment is dependent on how many devices are attached to the trunk.

“Repeaters” can be used to lengthen the ControlNet networks by connecting them in between the segments.

“Bridge” devices are communication connections between networks that only forward packets of network information but not any actual I/O.



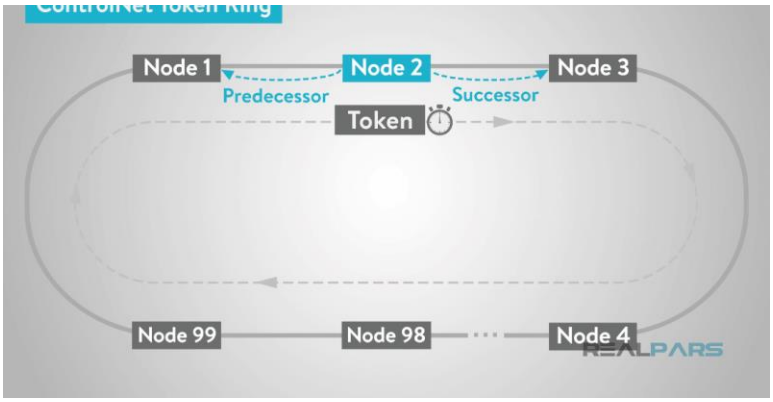
3. ControlNet Data Link Layer

3.1. ControlNet Token Ring

Now that you have seen the basics of ControlNet, let’s have a look to the other layers and get into the specifics of how it works.

As I stated earlier, it is based on a “token-passing” bus control network which implements a logical “token ring” through a coaxial cable.

In ControlNet, the nodes are assigned a MAC ID address from 1 to 99 and each node also knows the address of its predecessor and successor.



Each node has a scheduled time which is determined by a “token”.

While the node has possession of the token, it transmits data frames until it reaches the end of its transfer or the token reaches its time limit.

Introduction to Relay and PLC

What is Relay?

A relay is an electro-mechanical operator switch. In the earlier days, different types of relays are used for electric protection/controlling system.It is a hardware switching device are control the electrical circuit by using switching logic.

Major Disadvantage of Relay:

The main disadvantage is, the relay needs more wiring for performing different functions.

What is PLC?

Now a day, Programmable Logic Control (PLC) is a mini computerized industrial controller that controls the circuit.

In PLC, The basic concept of an electronic controlling system is to convert simulate the functional logic into software for automation. So, it provides a software-based solution.

Is Relay same as PLC?

For the controlling electro-mechanical system, basic functions of both Relays and PLCs are the same in the industries.

What is the advantage of PLC over Relay?

If we compare the relay with PLC, PLC systems perform better in terms of work, accuracy. PLC requires less time, less wiring.PLC is easy to maintain. There will not be much physical work.

Sr. No.	Contents	PLC	Relay
1	**Device Representations**	Programmable Logic Control (PLC) is a solid state computerized industrial controller that performs software logic by using i/o, CPU, memory.	Relay is an electro-mechanical switching hardware device (Hardware Switching Device).
2	**Playing Role**	PLC plays monitoring as well as controlling role in designing circuit.	Relay plays only controlling role in the designing circuit. Monitoring is not so easy with a relay.
3	**Working**	In the PLC, we can write the program.	In the Relay, we cannot write the program.
4	**Operation**	PLC is operated on the digital system.	Relay is operated on the analog system.
5	**Function**	PLC consists of more programming functions like timer, counter, memory, etc.	Relay gives only one fault detection function. And it does no much-advanced functionalities.
6	**Modification**	You can easily modify the designing circuit.	Modification of the electronic circuit is more difficult as com to PLC.
7	**I/O Capacity**	PLC have more capabilities of inputs and outputs.	The relay does not have more capabilities.
8	**Flexibility**	PLC provides more flexibility than the relay.	The relay provides less flexibility.
9	**Fault Detection**	You can easily find the fault by using the software.	It is very hard to find fault in the Relay circuit.
10	**Time Duration**	PLC have the time response of nearly 50 msec and above.	Relays have less than 10 msec response time.
11	**Type Of Device**	There are two types of PLC as, 1. Compact PLC 2. Modular PLC	Following the list of types of relay 1. Electromagnetic Relay 2. Thermal Relay 3. Induction Relay

12	**Picture (How does it look?)**		

PLC has more advanced functions as compared to manual work (hardware relay-base).These are the main reasons, why the industries are shifting to use PLCs over the relay.

Ethernet

Ethernet is one of the most widely implemented LAN architecture. It uses a bus, star or tree topologies. It uses the CSMA/CD access method to handle simultaneous demands. It supports data transfer rates of 10 Mbps, Fast Ethernet (100 Base-T)- 100 Mbps, and Gigabit Ethernet – 1000 Mbps.

Carrier Sense Multiple Access/Collision Detection (CSMA/CD)

This is a system where each computer listens to the cable before sending anything through the network. If the network is clear, the computer will transmit. If some other node is already

transmitting on the cable, the computer will wait and try again when the line is clear.

TCP/IP PROTOCOL

Most manufacturers who offer Ethernet compatibility to implement supervisory functions over equipment controlling plant floor functions use a transmission control protocol/internet protocol (TCP/IP) for layers 3 and 4 of the OSI model. Some PLC manufacturers offer programmable

controllers with TCP/IP over-Ethernet protocol built into the PLC processor. This allows the PLC to connect directly to a supervisory Ethernet network. Note that the PLC can also have a control network with other PLCs.

- TCP is Transmission Control Protocol and IP is Internet Protocol. These protocols are used together and are the transport protocol for the internet. When Modbus information is sent using these protocols, the data is passed to TCP where additional information is attached and given to IP. IP then places the data in a packet (or datagram) and transmits it.

TCP must establish a connection before transferring data, since it is a connection-based protocol. The Master (or Client in Modbus TCP) establishes a connection with the Slave (or Server). The Server waits for an incoming connection from the Client. Once a connection is established, the Server then responds to the queries from the Client until the client closes the connection.

CC-Link

- **CC-Link** (Control and communications link)is open industrial network that enables devices from numerous manufacturers to communicate. It was developed by Mitsubishi as a company-internal field bus network for coupling its own products with each other for the purpose of automation. It is predominantly used in machine, cell or process control applications in manufacturing and production industries
- Max.10 Mbit/s network transmission
- Based on RS485 with networks up to 1.2 km, or extended to 13.2 km with repeaters
- 64 stations per network
- Refresh time of <3.9mSecs for 65 I/O stations (distance dependent)
- Master/Slave network with Floating Masters and hot swap of stations