INDIAN INSTITUTE OF TECHNOLOGY
KHARAGPUR

NPTEL
ONLINE CERTIFICATION COURSE

On Industrial Automation and Control

By Prof. S. Mukhopadhyay
Department of Electrical Engineering
IIT Kharagpur

Topic Lecture – 31
PLC Hardware Environment
(Cond.)

(Refer Slide Time: 00:22)

You so we have then we look at input modules input modules basically convert process level signals to processor levels so forgiving by process level signals process level signals or signals which actually exists on the field for example there could be there could be 24 volt DC signals or 230 volt AC signals or even sometimes contacts sometimes some sub RTD platinum RTD or could be a 4 to20 mille ampere current loop the signals which actually come out of sensors right.

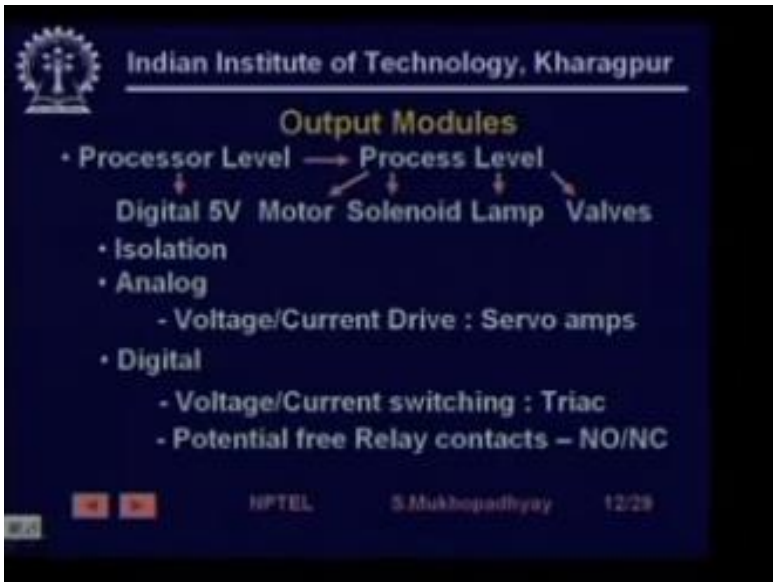
The sensors an actuator the devices so these appeals is an electronic device it is actually a digital electronic devices you as such cannot take in that kind of electrical signal so it must convert them to processor level signals which are which are digital typically five volt or maybe 2.5 volt whatever. So that job is actually done by the input modules so their job is to basically translate process level signals to processor level signals also convert them from analog to digital sometimes.

If they are not always digital so the jobs are mainly another important thing is to provide isolation because the electronics if you expose detail electronics both 215 volt or 230volt AC directly chances are that it will get damaged so you have to provide electrical or galvanic isolation using opt couplers so input modules where you often provide that they provide fault indication suppose some wire has broken often they provide fault indication this is apart from converting process level signal processor level signals.

They are generally of two types they are either analog inputs or digital inputs we understand the difference between them right so for example a contact would be digital input and a platinum RTD would be an analog input so obviously we need for the analog input modules we need to have analog to digital conversion typically 12 bits accuracy multi-channel sometimes one input module will generally supports several physical and one input module supports several input channels so there since each digital channel actually takes one bit while one each analog channel could take as much as eight or twelve bits so therefore typically an input module will support you know 32 64 128 kind of digital input channels.

Well it will support 8 16 or 32 analog channel these are just some typical values similarly sometimes it takes special inputs like you can connect directly connect thermocouples you can directly connect RTDS so inputs can be in the form of voltage current resistance etcetera sometimes it can be in the form of pulses for example a shaft angle encoder can be sometimes connected so this is the nature of input modules then we have output modules.

(Refer Slide Time: 03:50)



They do the reverse they translate processor level signals to process level signals they're there the output devices and this process level signals then go to things like motors solenoid lamps valves they have actually do work right so they have to be converted in form generally they have to made sometimes mostly they have to make be made analog or sometimes even on/off kind of signals but they have to be increased in power because they are supposed to do work right so they also provide isolation and for analogs it has to provide the voltage or current voltage and current drive so typically a unit that will provide that will be let us say a servo amplifier.

So such amplifiers will be put on output modules for digital output modules you know sometimes they will require high power you will just give a pulse and you will require that during the duration of the pulse there will be a volt there will be high current will be switched so that such a thing will be done by the output module it is typically let us say using TRIAC or maybe an IGBT today one would like to probably use an IGBT and they could also be potential free relay contacts you know that is sometimes we do that we can do suppose you want to switch a voltage or current because it is digital so it has to be on off kind of thing.

So you could actually do it in two ways one-way is to use a device electronic device which will interrupt another is to do a mechanical interrupter now since these currents can be sometimes very large. So therefore you do not directly from the output module you do not interrupt a large load current you actually use a relay which activates a contactor so the contactor is actually heavy device heavy contacts you might have seen them and they provide contacts and if you drive those, if you drive a signal into it then some relay will make the contactor work so using a low-power signal you can interrupt a high current using a contactor and really, so such outputs can be driven from digital output modules

(Refer Slide Time: 06:19)

So let us have look at some of these pictures for example this is atypical this how a typical analog module looks like let us look let see what it contains so for example you will find that there are some analog signal terminations probably here and there are some bus ports probably here difficult to see this inside the you will have you know these typically this is an analog so support several channels so there has to be any conversion typically you don't put is not that if you have 16channels you will require 16ADconverters you will take 1 AD converter and the AD converter is so fast that it will first convert this channel then this channel then this channel then this channel and so on.

So it will multiplex the AD conversion so you have multiplex AD conversion at the same time you need to ensure that although you are taking the values one after the other but you would like to ensure that the values that you are taking finally all belong to the same time instant in the process so you use XK YK ZK all of them are at K time instant so for that you need simultaneous sample-and-hold where you take the value simultaneously using sample and hold circuits and you hold them and then they D converter mix them up and you also have various output drivers especially for output model modules so this is the basic these are the basic thing that analog i/o module will contain and of course some logic for synchronization then you have a different kind of i/o modules which are called distributed or sometimes called remote i/o modules.

(Refer Slide Time: 08:08)

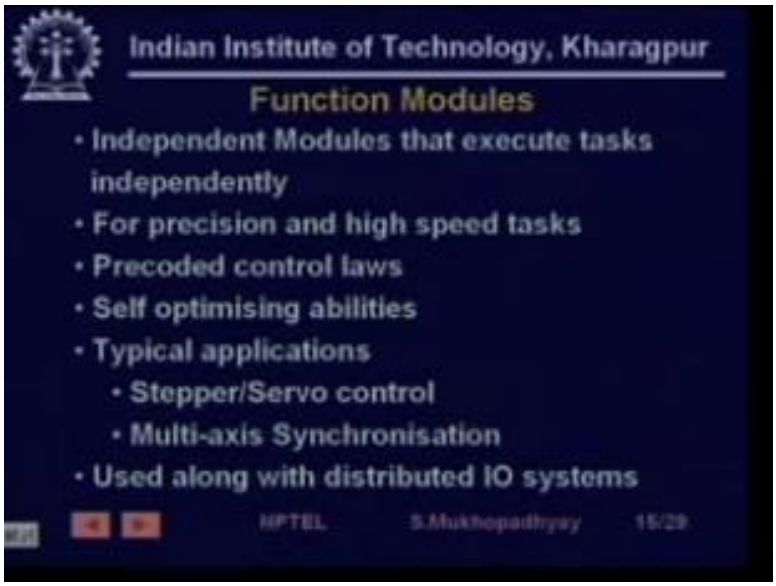
So these are actually intelligent field mountable i/o devices so you actually put the i/o module right there on the machine and from there you draw a wire or you connect it to a network or you take an input-output concentrator and connect several local distributed I/O use and then make one digital communication back to the PLC the advantages are mainly in savings in cabling costs I might have mentioned before that cabling costs are an on a not insignificant part of any

industrial automation project so and they actually cause inconveniences industrial environment they are difficult to maintain sometimes may get cart etc.

So savings in cable costs and maintenance costs are significant then there they are sometimes especially where when they are on the network they are actually programmable from a parameter is a bill from a processor or a programmer they have because they generally communicate with the processor over the first of all they communicate with the processor infrequently because they can there they are actually intelligent themselves and they can do much of their work, secondly they often communicate with using digital communication protocols which are much more reliable so you have much improved data integrity your cost of cable etc comes down.

So typically used for applications like you know very close positioning with analog digital encode ads which requires frequent sampling frequent slow output generation very difficult to do it with the central processor because it will get loaded high speed counters which needs to count high speed events like you know fast-moving shaft angle pulses some specific loop controllers temperature control loop etc where you just need to download the set points from the central processor and the basic loop works on the distributor I/O module. So this main processor is not bothered with that so that is distributed I/O of generally getting more and more popular now these days

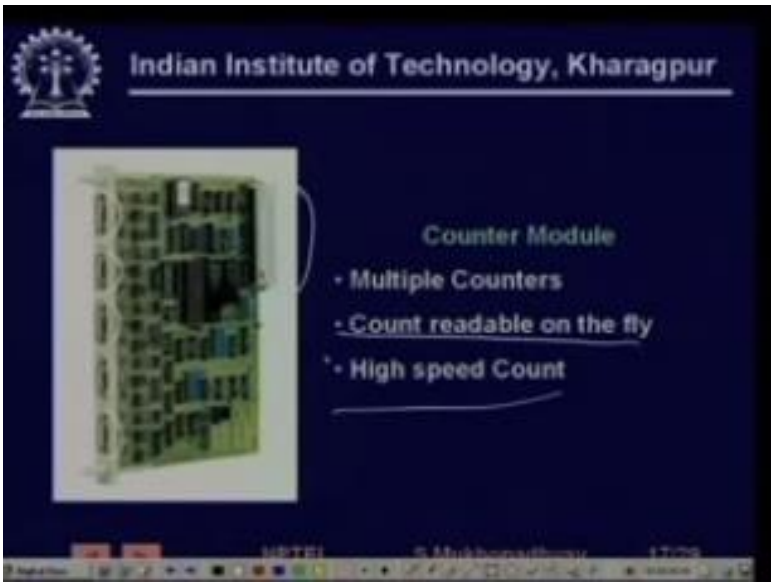
(Refer Slide Time: 10:22)



Then you have some other kinds of modules called function modules these are also these are not sometimes they could also be mounted on the machine and make part of a distributed I/O but otherwise they may be situated on the PLC rack itself but still there they are actually independent modules that can execute tasks independently so basically reducing the center processor load so that it needs to talk to it less often for precision and high-speed tasks and they often have their own logic their own pre coded control loss they have their own you know optimizing abilities it might cure its own way you just have to give it a command that you tune yourself.

So it will it has its own code it will actually tune a control loop and typical application would be safer a stepper server control multi-axis synchronization as we have we will see after just following this will go into the manufacturing the CNC machine control so we will find that there are there are many cases where a precise two-dimensional motion has to be created suppose we are you are actually cutting something along a surface you have to create precise two-dimensional motion so you have to give motions along to axis motion commands and they have to be very synchronized so that is called multi-axis synchronization for such applications typically you use function modules specialized function modules and sometimes there they could be also used with distributed i/o systems to be situated on the machines themselves.

(Refer Slide Time: 11:57)



This is a this is another controller which is a valve control module I chose this because I wanted to show the power transistors on this so you are you can see the power transistors so it has to drive valve means it can is probably a probably a hydraulics servo valve or something or so it has to pull a solenoid create some force so that the piston moves so for that it needs to provide good amount of current so you have the these are the power transistor drives it takes set point from outside so it interfaces to the bus and the central processor gives it the set point and it has its own onboard controller right.

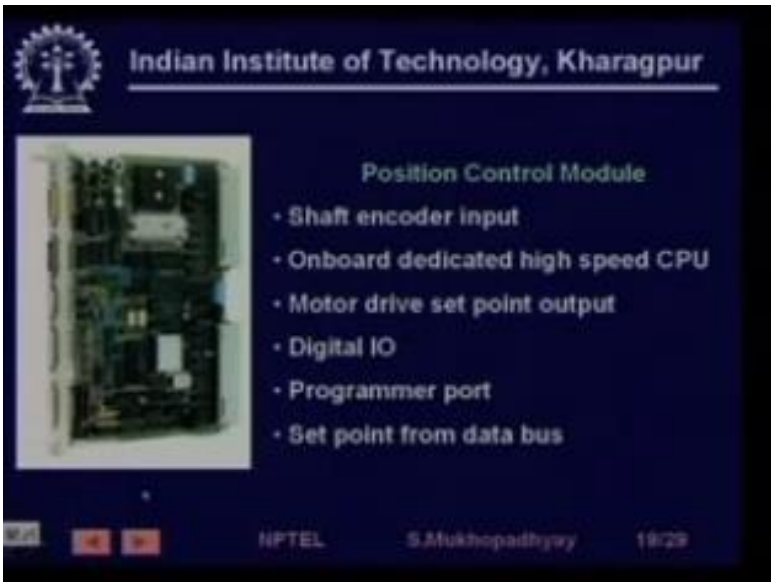
So this is a typical valve this is another picture a counter module you cannot make out much on the picture except for the fact that you can see certain things you know like for example oops we need to go back so you see you can see that for example this is the this module content for thing five counters so you see the count value has to be read on the bus so these have town values have to be read then event signals that is go up this thing has to come so there are probably five counters here on the other hand it also connects to the bus so that these signals can be read generally used for so this so the count is readable on the fly because it contains dual ported RAM and high-speed count.

So general use for very high speed count so one could one would have large registers and things like that.

(Refer Slide Time: 13:48)

This is this is a counter position decoder see a most counter modules can easily be used because position decoding is often by counting the shaft angle pulses shaft angle encoder pulses that are coming over a certain period of time or because every pulse will mean a certain small angle rotation so if you want to have shaft angle position decoder it's basically counting pulses so I mean some of this you know some of these can be used for this can be used for either as a counter or as a position decoder so you have pulse inputs you can count or you can read shaft position and both although they will be readable on the fly as we said and for high speed. So this is just you know a give you a feel of the PLC system this is what this is a position control.

(Refer Slide Time: 14:54)

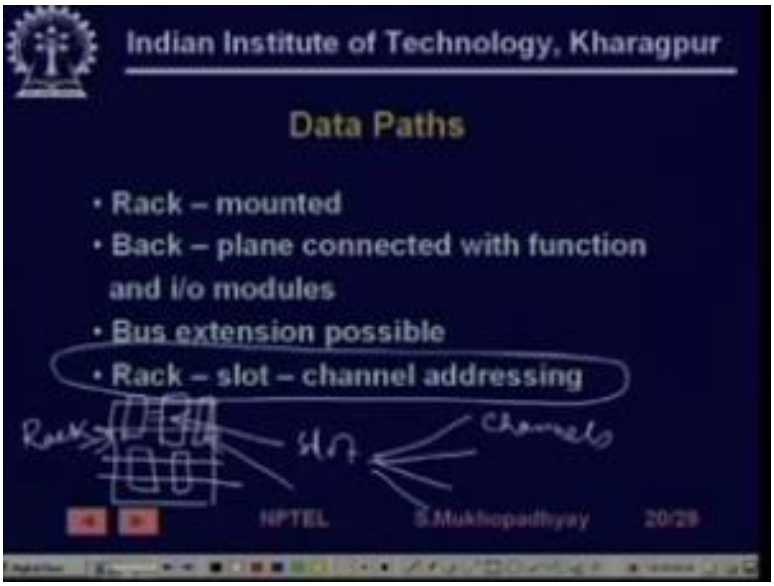


Module so again position control module on board dedicated high speed CPU position control is generally requires very fast computation so you have dedicated high speed CPU by specifically means you have CPU with higher capabilities you used higher order processors when you have low speed controllers you use you know generally you use things like microcontrollers to realize them well here you could use higher-end processor like maybe 68,000and more motor drive so on the on the motor.

So it gives the there is a drive there is there will be a power electronic drive which will be given a set point and that power electronic drive will realize that set point on the other hand it will take its own set point it will take from the central processor it has it has digital i/o depending on what is the final motor various cover example for a for a for stepper motor it is actually driven by digital i/o.

So these are some of these modules which are used in PLC systems it has a programmer port because you need to there are there are large number of parameters which have to be set and set point comes from the database.

(Refer Slide Time: 16:30)



So all these modules how they are connected that is what are the various data paths to understand this you have to understand that the PLC I am sorry this so the PLC is as we say upside that is that is rack mounted right. So there are a number of racks it is like an old mirror there are a number of racks in each rack there are slots so in each slot you can put our modules or you can put CPU modules and in each slot so this is slot this is rack hand in each slot contains several channels right so there could be eight analog channel so channels so this is how I/0 is actually organized it is racks lot channel.

So if you want to identify a particular physical signal you have to this is you have to have a rack slot channel addressing which is implemented in various ways by various manufacturers now all these racks must be connected so these they are actually connected at this level by ribbon cables and then from rack to Rack connection is generally achieved okay we will see this is the next diagram.

(Refer Slide Time: 17:53)

So here you are so these are you know this is one rack let us say this is one rack then you can have several racks for you so they are actually connected by what are known as interface units so these are interface modules similarly so you can expand your number of modules sometimes you can put as i was telling that you can put your modules in a different alameda which is different cabinet let's say alameda actually is a cabinet so for that you need to have a special you know special interface unit.

So typically your interface unit will it can be say typical see such distance for reliable data transmission such distance requirements are there at a certain rate so you can go up to something like an100 meters which is a lot and sometimes you can have remote interfacing that is actually you have you may be having your CPU in some that is your basic PLC system in some control room while you have these various interface units in the various shop float switch which could be even you know half a kilometer away and things like that.

So in such cases you need special interface units which are called remote interface units so this is the way that all these elements are actually connected with each other and buses are extended.

(Refer Slide Time: 19:44)

Then all these things that are happening one generally once to get once you get a view of it so to get a view of it you use a man-machine interface and as such PLC modules often work without any without any intervention from human saw so as such they have very little you know MMI capability they do not have generally contain displays by themselves they will probably contain some LEDs which will just indicate whether they're whether they're functioning normally or not but if you want to visualize if you want to monitor what is happening to the various variables is going to trend them show it nicely to it to a to an operator it is possible through the various man-machine interface elements.

So you can have operator panels by which an operator can give commands to a variety of devices some of them may be some of them a mobile then we push button joystick various kinds of you know multifunction input panels various kinds of things similarly it you can see it you can actually connect a pc to a PLC and on which various kinds of visualization software which will nicely show your plant and i know as you know i mean levels of fluids will go up and down it will nice to show you on the screen so such visualization software running on PCs can be used for man-machine interfaces.

Sometimes especially in for power applications you have remote terminal units that is basically the system is working in let us say unmanned stations and from kilometers away you want to get a view of what is happening let us say which of the witch of the transmission lines are on which are off so such a system is called a supervisory control and data acquisition system often called SCADA and so SCADA systems with RT use give gives operators a visualization of what is happening quite far away in unmanned places there also MMI they also have MMI purpose Sometimes you have panel pcs they are special types of pcs with you know touch screen.

So that the operator you know did not type he can just for basically convenience because an operator has to concentration the process and should not be bogged down with you know the it should be as easy for him to give commands as possible so people use you know devices like touch screens in such environments.

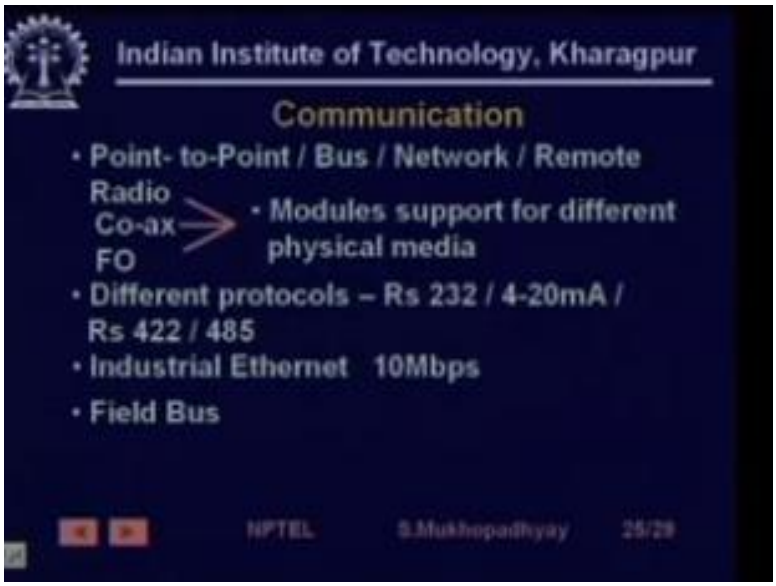
(Refer Slide Time: 22:04)

So for example, these are these are so there could be a variety of you know man machine interface kind of devices which needs to be interfaced with a PLC starting from operator panels to monitors 2 pcs to e boards to printers so all these it is it is it is possible to interface.

(Refer Slide Time: 23:31)

Then you have to have programming devices and this is a typical programmer, programmer a sort of two types either they could be handheld which you can take to the shop floor and directly program the PLC or they could be tabletop where you have which are of higher capabilities and where you actually develop programs offline and maybe go and just load it there because these have very good program development environments also.

(Refer Slide Time: 23:04)



Finally another very important thing is communication so there are various types of communications available as you have already told for example point to point where you run direct wires from an from an input or output module to the actual device they could be bus communication is actually internal to the to the modules or you could be network communications we're at network or remote this we have already explained communication technology could be communication medium can be various for example it can be radio it can be coaxial channels it can be fiber optic cables.

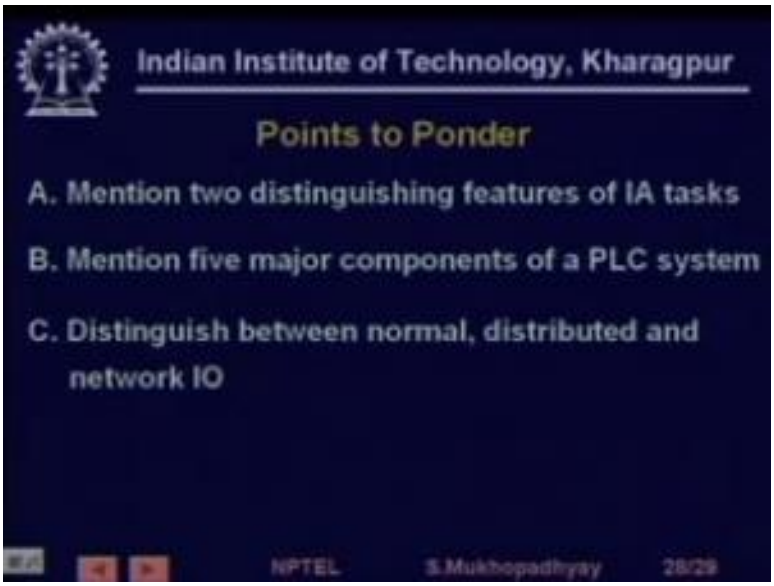
So different physical media maybe supported are supported various protocols are supported for examplers-232 4 to 20 mille ampere current loop for as for 282 485 these are these are point-to-point communication protocols apart from that there could be network protocols for example industrial Ethernet are sometimes used where the computational requirements are well known well understood and you know that due to that is CSMA/CD media access protocol you are not going to get performances is not going to degrade, you have an fieldbus that said that there is a new standard for networking in the industrial environment which we shall be studying it much more detail.

There are other less popular probably I can call them less popular for example the camp bus the canvas is much more popular in in another application environment that automobiles field buses gaining popularity in the industrial environment and some buses could be you know proprietary for example seen seamen's has a as a buzz called scenic which is proprietary protocol buzz.

(Refer Slide Time: 24:57)

The advantages of distributed Network I you are well understood cost saving on maintaining integrity of high-speed signals because digital come basically the advantages of digital communication and the advantages of having an intelligent module near the machine so you can have good sensor Diagnostics false fault can be much more you know monitoring functions can be realized without overloading CPU you can do special function slices like startup so in a sense in such cases the PLC CPU , I really works like a supervisory system and the actual controls system on the spot.

(Refer Slide Time: 25:33)



So you have better centralized coordination monitoring so we have come to the end of the lecture and so we have I hope you have got a fairly a fair idea about what makes a PLC system and as is customary again you have some points to ponder so think of think whether you can mention two distinguishing features of industrial automation tasks compared to let us say a task in a bank with which are also computational asks which also communicate mention five major components of a PLC system we have mentioned more than five so you should be able to mention five and distinguish between normal distributed and network I/O so here we end today thank you very much we will meet again.