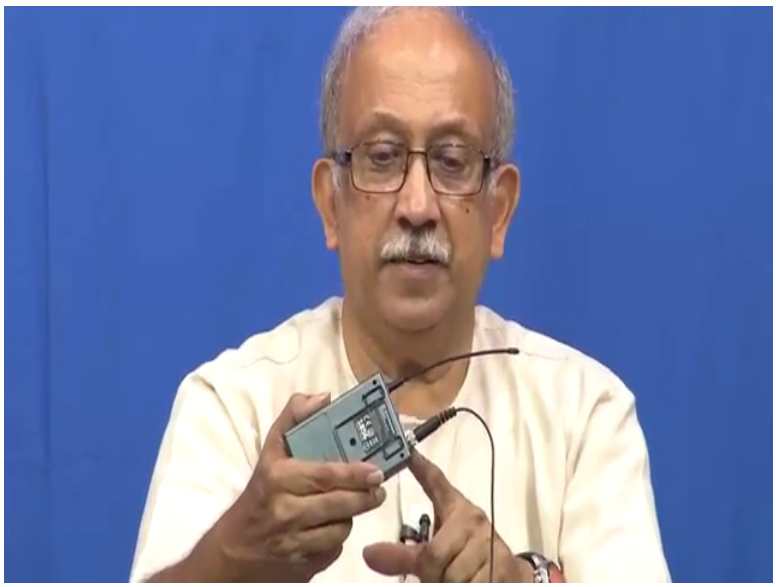
**Enclosure Design of Electronics Equipment**
**Prof. N V Chalapathi Rao**
**Department of Electronic Systems Engineering**
**Indian Institute of Science, Bangalore**

**Lecture - 47**
**Connectors (multi way) and CoAx**

Allow me to continue from where I left off in the last lecture. The last lecture was about a very important thing that is about the connectors. As I have explained to you earlier, all any circuit or anything will end up invariably with manageable small sub assemblies. So, I will start with something which is directly connected here; which is this, wireless receiver. You notice that, inside the equipment you have several subsystems and all that; one or two things stick out of it. One of them is this microphone and then we have a very firm connector here. Then we have this antenna and then you also see, we have several switches and all which are connected here.

(Refer Slide Time: 01:05)

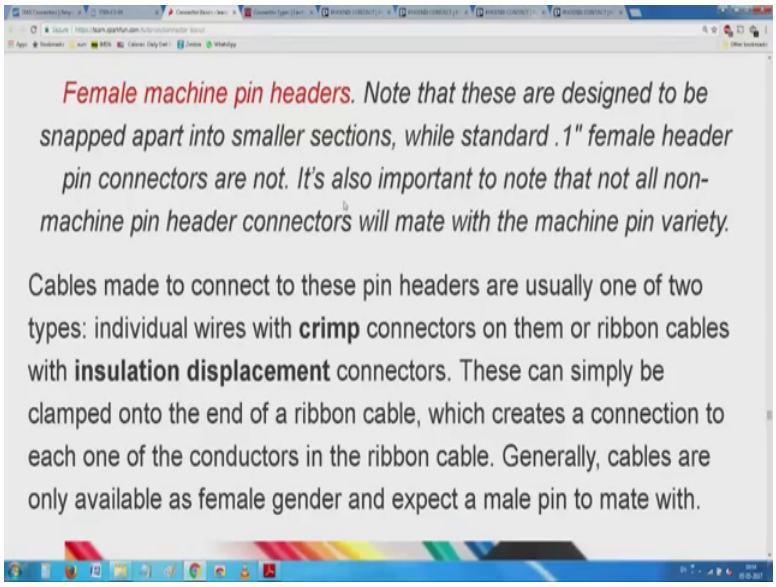


Same thing here, some of them are something which you set all the time, something these are all press once (Refer Time: 01:18) and then synchronize and so on.

So, the lecture started with several types of connectors where subsystems have to be attached together. So, if you see the attachment of various things here; both sides you have connector termination. If you see the; this is little like I am sure you have seen it in several places, a little like your headphone or cordless I am sorry hands free. So, this

whole thing comes in a plug, it is called a 3.5 mm banana; I did not know why it is called a banana plug. On this side, there is a receptacle and then I had explained to you about various things related to this.

(Refer Slide Time: 02:13)




Nothing now changes over, if you can look at the monitor; I left you here last time saying we have this female machine pin headers; snapped a part into smaller sections.

(Refer Slide Time: 02:36)


And then later on, I left you here saying we have various types of connectors; crimp-type cables. The advantage of the crimp-type cables is, you have small socket pin switcher;

either free inserted or you take them out, attach it to a cable and then push it into this headers. You see here, there is a small plug here which ensures that it does not come out; especially when you put it here.

Advantage is it gives a fantastic positive connection and then you can have rating of your choice. Disadvantage is however, it is a very elaborate time consuming and expensive procedure; meaning all of them come in a reel or in a role and then individually you have to take this cable and then ensure that everything sits perfectly inside. In spite of machine operations and all that cutting the cable to length still has a issue. Sometimes, you may need about this much length, this is approximately 400 mm. Sometimes, it may just need a little less only 390; 400 will end up with the kings and if you make it very short 380; it may not reach and will lead to cable tension.

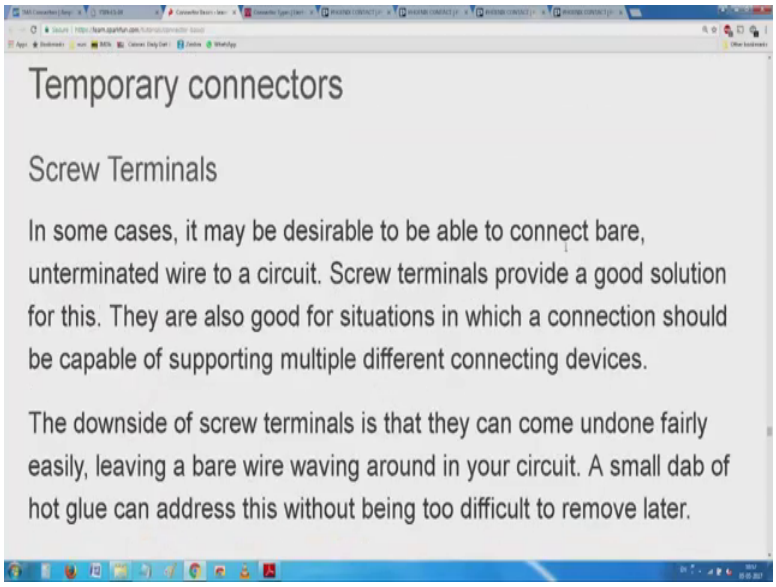
So, in general especially in places like inside our system units and all that; we have ended up with this insulation displacement ribbon cables; maintaining of the ribbon cable is that the ribbon is flat to start with.

(Refer Slide Time: 04:25)


So, routing it and making it and all that; it comes relatively easy there are little a few advantages and disadvantages. Advantage being, it being flat as I had explained to you earlier; if you just push one of these on to this flat cable, the pins or the sockets are I mean generally in this case; it is a socket soccer pins are usually mounted on the other side PCB, it automatically cuts through the insulation. If you have a insulation like this;

this thing will go inside and then make sure that it meets perfectly, probably it is offset and so on. So, if you see here it has including this polarizing tabs and depending on the current density; usually two row are convenient.

(Refer Slide Time: 05:48)



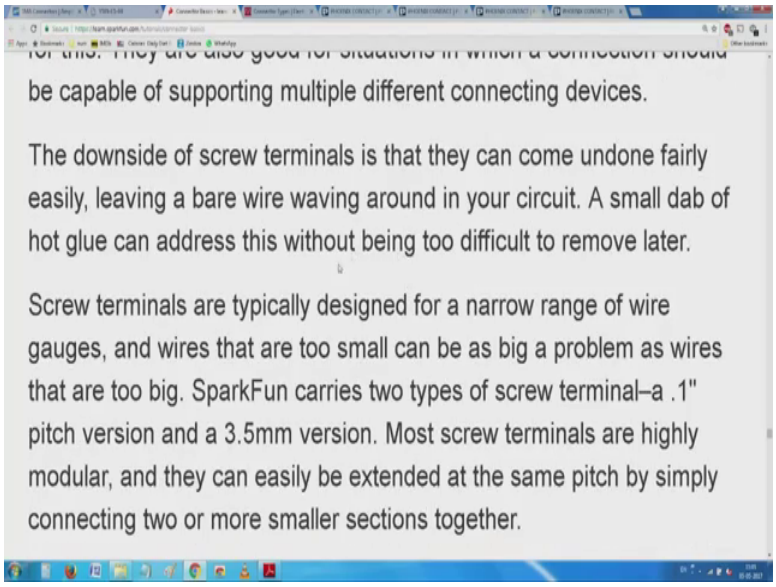

Further down, if you come this is one way of attaching known things, but you will notice that a lot of times; this connecters cannot be permanent. I have given you an example of the car cable harness that you have inside the car. So, it is a beautiful cable harness and then if you remember I mean just ignore the very old models things over the last maybe 15, 20 years. Most of the things that you are likely to add including loudspeakers, not the boom boxes you attach at the back and then several other things including power windows, including lot of these, what you call audio and all these; pre crimped harnesses are already installed. And generally as much as possible, they try to at least within one category of equipment; they tried to make them interchangeable.

So, if you were to buy another audio system; you just knew to pull it out of the consol which is there on the dashboard and then push the other one and miraculously the connectors meet and we are in business. That is why, I have used a very what you call loaded word; reality is things have been changing and it is not as easy as it sounds, but still a good attempt is made. At any one time generally, the lot of people do not like what is supplied by the original car manufacturer. They would like to have their own choice,

so if you buy an audio system; the one that is fitted in the car, generally people do not like it because they would like a preference.

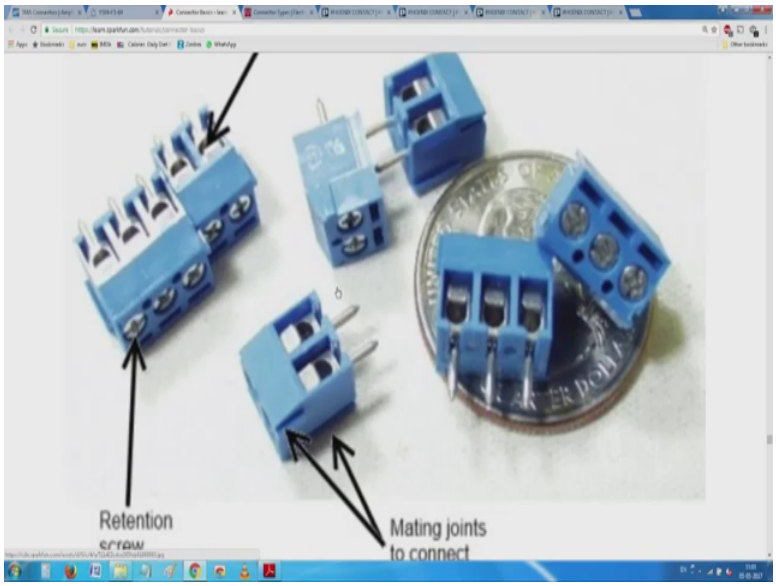
Now, in this case we will end up having temporary connectors; it may be desirable to be able to connect there and terminated wire to a circuit. Only the other day, we have installed a huge deep well pump, so the deep well pump comes with their own cables and depending on the type of installation; we need to connect bare unterminated wires which come from the well outside into the box. There the smallest have been the screw terminals for a good solution for this; they are also good for situations in which a connection should be capable of supporting multiple different connecting devices.

(Refer Slide Time: 08:36)



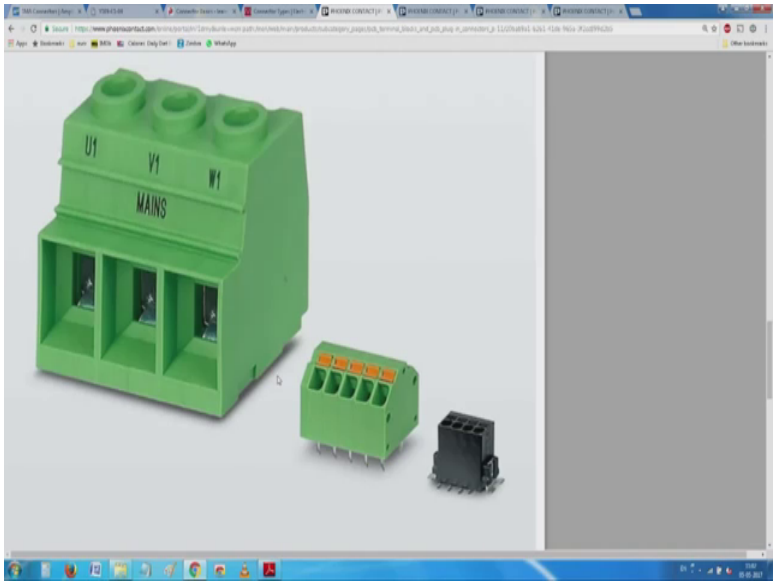

So, you would have probably seen it behind your audio speakers and all that. You have a small opening then you have something to what you call loosen it a little, you have an opening you have something to make the opening and then inside you can put more than one or two wires. And in the case of power connectors, there what I called lugs which are terminated, which need to be assembled here. Downside of screw terminals is that they can come undone fairly easily leaving where waving by a what you call a bare wire waving around near circuit and dab of hot glue and addresses; so, this is a matter of detail how to prevent this thing here.

(Refer Slide Time: 09:28)




So, if you go down you see here tremendous what you call variety of these connectors are available now. You see one part if it, is the one that goes into the printed circuit board. The other part of it is where this one I was talking to about, if you open this a screw a little; we can put anything into that circuit. So, we have I will see if I can punch the phoenix things; you have seen here, these are the typical terminal blocks; you have seen that it is a beauty.

(Refer Slide Time: 10:21)



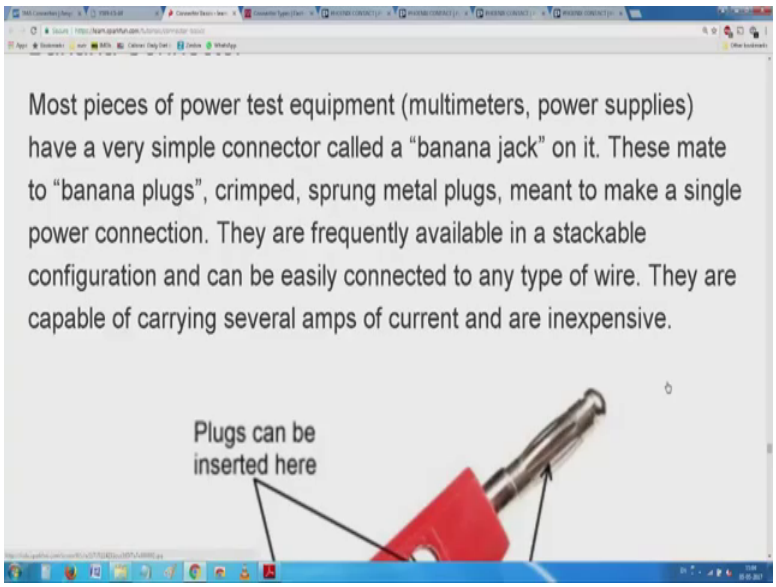
In English world places know here we have the RYB system of a designating three phase wires, but then this is; obviously, German where the use the word UV and W and you see here already it is pre; I would say indicated or coded or something.

So, all sorts of options are available and then the main thing here is it is not as if you push up bare wire into this. You have matching terminations which are crimped on to the wire and then it is pushed inside. So, this is typically one of those beautiful systems; similarly I will go back again; retention screw which hold the wire in place in the modular connectors on the sides of the individual units and blah blah blah and all that.

So, if you go to any of these trade catalogues they are almost interchangeable because the pitch is fixed and then there are enough techniques about how to assemble it on to the printed circuit board and then there are multiple very very complicated stacked things 3 level is fairly common. 1 and 2 is normally used three level also is available; meaning you have a level 1, level 2, level 3. So, 3 of the things which you can do; they are very useful for panel builders, those big electrical control panels invariably you have wiring ducts, it is a cable tray.

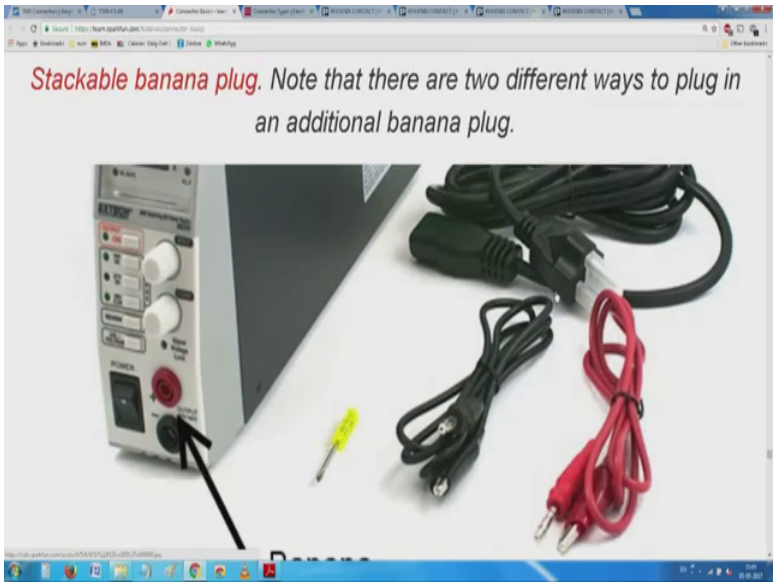
So, you take all the wires and then there is a designation and finally, depending on if it is a power thing, you if it is the power carrying conductor you need to terminate in a proper dowell and then put inside and tighten it; in the case of normal PCB things it is not that critical.

(Refer Slide Time: 12:46)



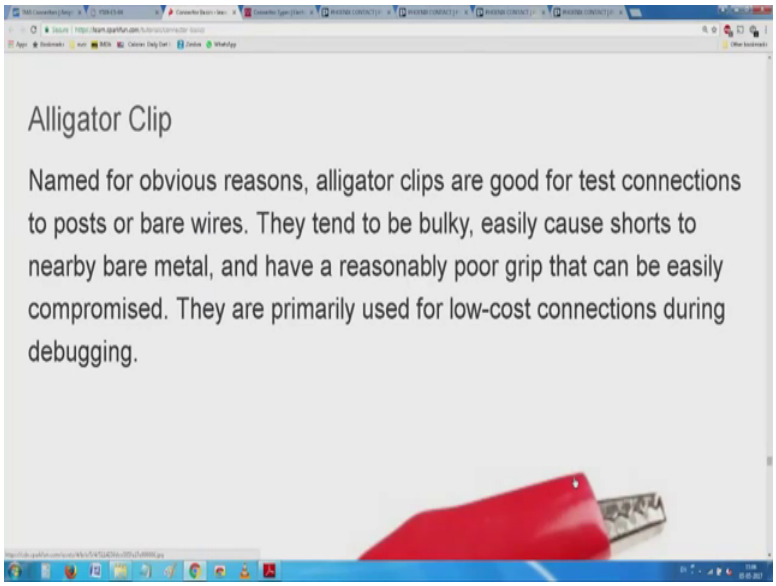
But then good preparation is a must, as I have explained it should not be hanging on and the air. We have also seen this, I do not know the reason why it is called a banana this is made to plugs crimped sprung metal plugs and so on available in a stackable, that can easily be connected.

(Refer Slide Time: 13:10)



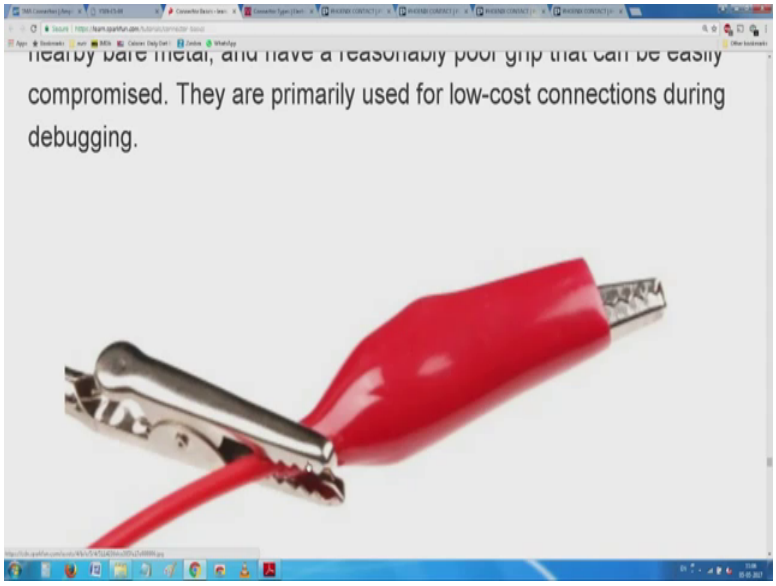

You see here, this is the beauty of it the thing; is if you have to provide a connector like this at the end. If you have to make it anything which can take multiple sizes and all that chances off, its failure are little high and once it fails the role equipment needs to be repaired installed. On the other side, if you use this type of a floating contact which is also split; we have a very good chance of replacing it. All you need to do is; I am sure you have seen these various other things, we just need to discard it and buy a new one and then rarely you repair it. And then you see ingenuity has made that we can insert another plug here or we can insert another plug here and it goes on like this without anything.

(Refer Slide Time: 14:26)



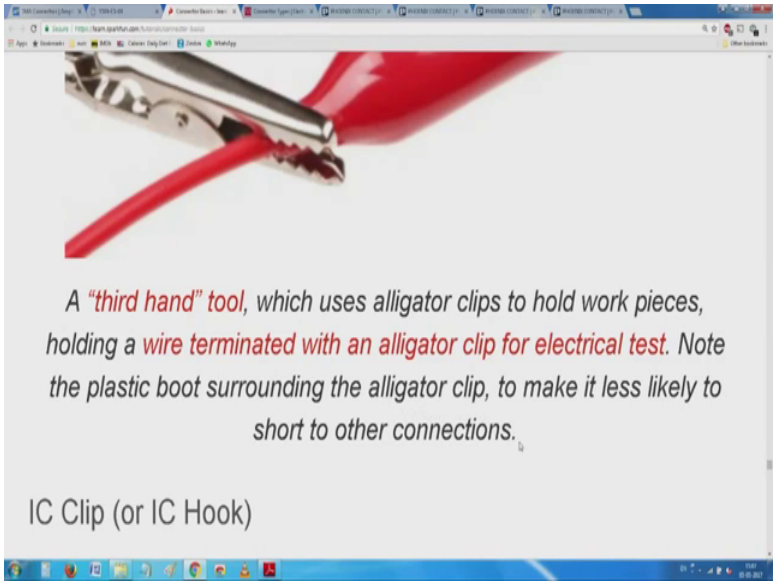

And then you see the beautiful combinations of; there is a crocodile clip, you are getting very organic we talk about bananas and crocodiles. Sorry this part of the world I am familiar with crocodile probably it is called alligator, are good for test connections to post for, bare wise easily called short circuits nearby bare metal and all that. With all that risky business of; if you have this alligator teeth, make sure that it does not touch each other; though they do come with a safety shroud here.

(Refer Slide Time: 14:56)



To make this visible and opened one is given here this is not how it is used, just only to show you how it is used. Two very good; I mean very nice thing you need to observe here is, first of all it can grip well as a beautiful spring here which are little similar to the clothes specs that you have. And then other side there is a nice crimping system available and this is also come with this shroud, have you seen this.

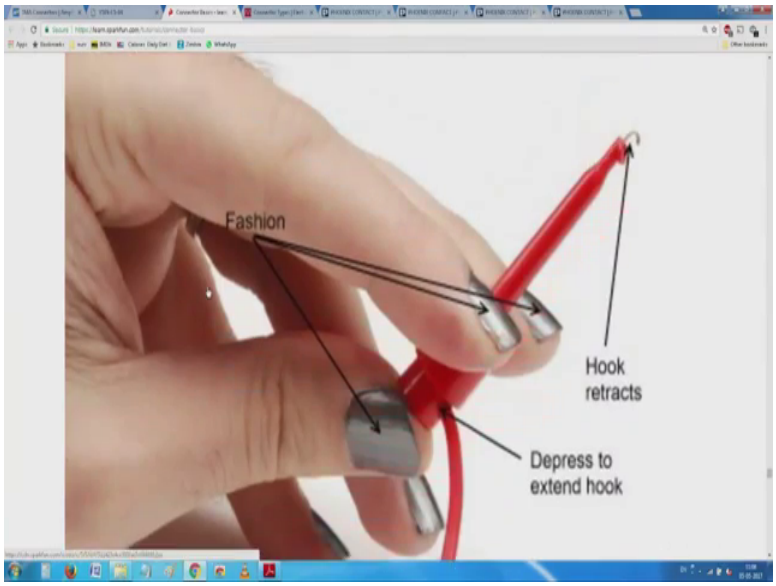
(Refer Slide Time: 15:40)




The shroud will ensure to make sure as I have explained here, wire terminated with the alligator clip for electrical tests, the plastic boot surrounding the alligator to make it less likely to short to other connections. And if it is a something which is used for normal testing, generally they are made with probably silicon or other materials which flex easily without snapping. A little more expensive, but compared to PVC while there it will costlier is more flexible.

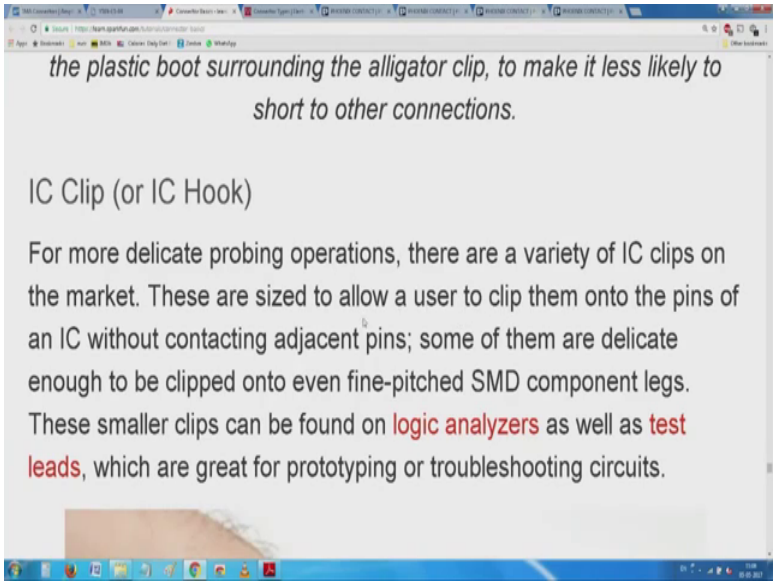
But in wiring generally they have other materials loosely I am using the word wire it; I mean privacy, but I expect that lot of modification has taken place and even the voice set is used in house wiring are not simple.

(Refer Slide Time: 16:37)



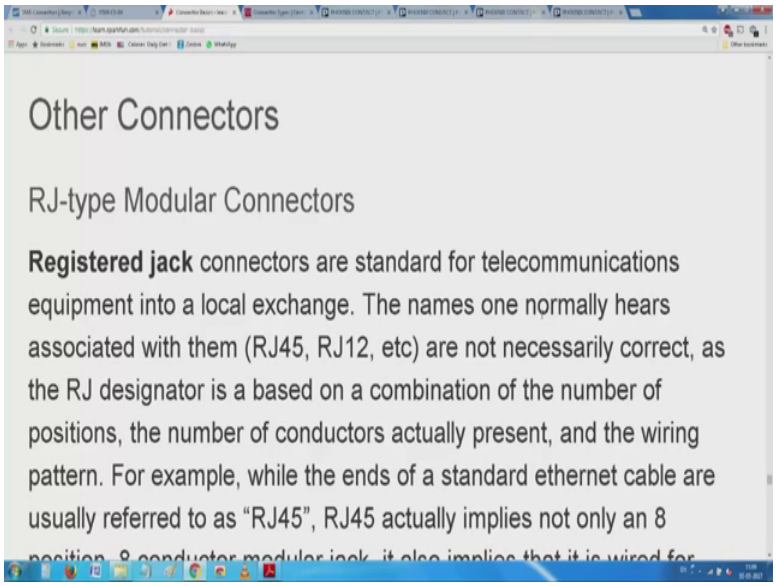

So, again continue having a look at it; I do not know if it is still used after the emulators and all have come. We have the beautiful small hooks, we can put the hook you press here it is a little like the pickle pickers or stuff which we occasionally use for holding something which is deep down.

(Refer Slide Time: 17:06)



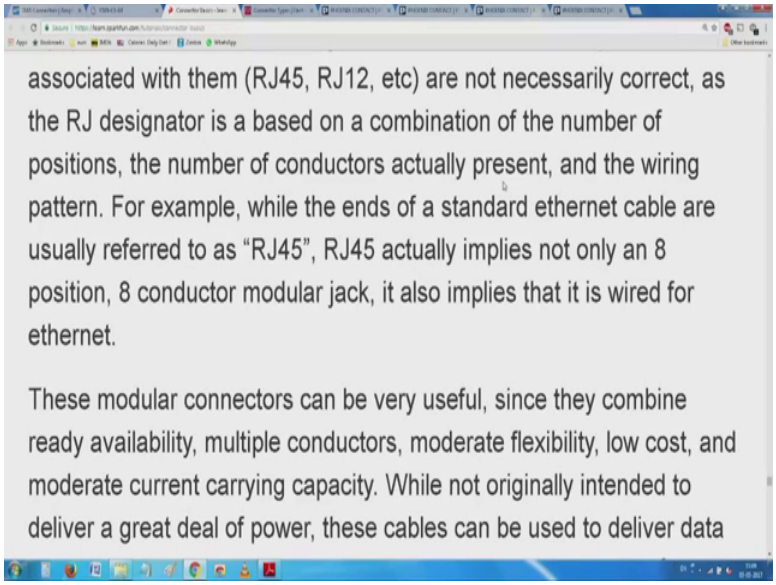

You press something and for more delicate probing operation, the variety of IC clips; these are sized to allow user to clip them on to the pins of an IC without contacting; just smaller clips can be found on logic analyzer, test leads and so on.

(Refer Slide Time: 17:27)




Likely that you have come about it and then now we come to the beautiful RJ modular connectors, a standard for telecommunications equipment into a local exchange. Normally hears are 45 and RJ12, so generally you have seen this here when they say RJ45; it means it is an 8 position, 8 conductor modular jack, it implies that it is wired for ethernet.

(Refer Slide Time: 18:04)

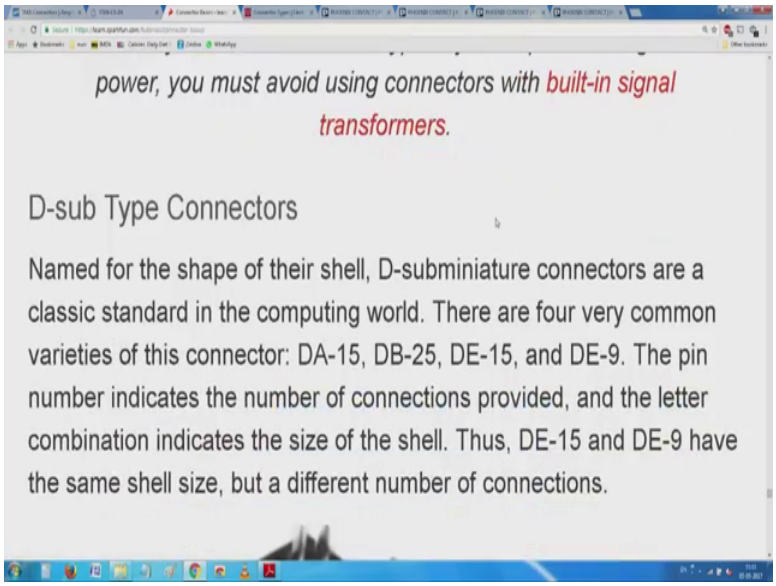


Advantage of it ethernet is that anything will fit anything else, so if you have a laptop or if you have any of these devices; if you have the matching touch chord things fit actually very well and they work.

(Refer Slide Time: 18:26)


So, we have all these combinations of this is what I was trying to tell you is it. Left one is the one how it shows bare and this is the one how it goes inside. I thought, I will tell you up front but then it is already written there because some of the time, there are special small circuit elements; which may have this; though I have not come across this thing as much because most of them are the passive devices what we have, some of them have cross connections. Instant that is; if you have 1, 2, 3, 4, 5, 6, 7, 8; 1 and 2 repeats 1 and 2; another place 1 and 2 are interchanged on the other side; so, the transmitant and received can work.

(Refer Slide Time: 19:27)

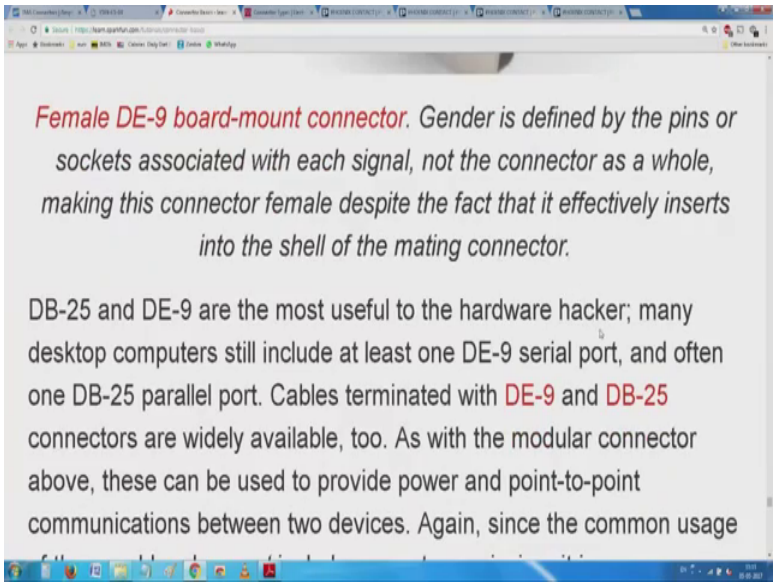



(Refer Slide Time: 19:33)


This is a matter of detail; this thing is related to these connectors, only thing is like all other things; the total number of insertions and all are not very high is what I was trying to mention to you yesterday; this is called the type D, sub miniature connectors or a classic standard in the computer world.

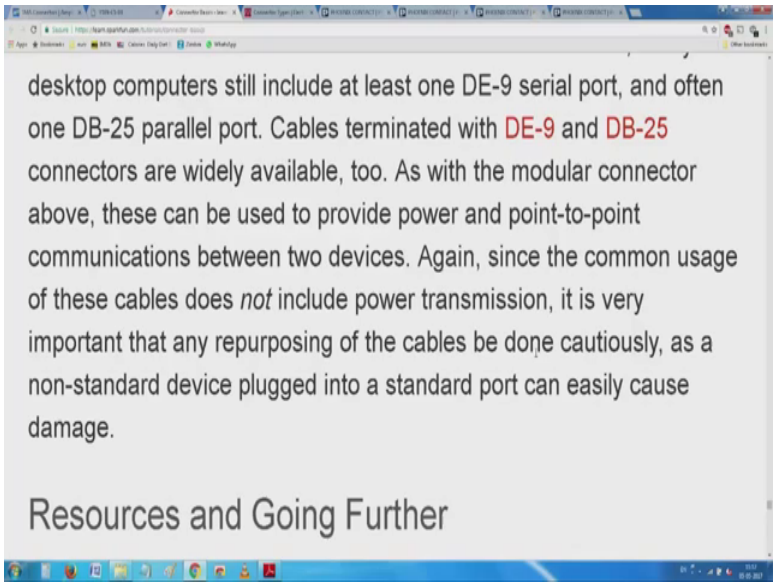
So, you have 15, 25 and 9 the pin number indicates the number of connections provided, it indicates the size of the shell DE and DE 9 has the same shell, different number of contacts and so on.

(Refer Slide Time: 20:08)




So, usually 9 and 25 are about the common many desktop computers it include one serial port and can one parallel port; terminated with connectors are widely available and so on and so on.

(Refer Slide Time: 20:23)



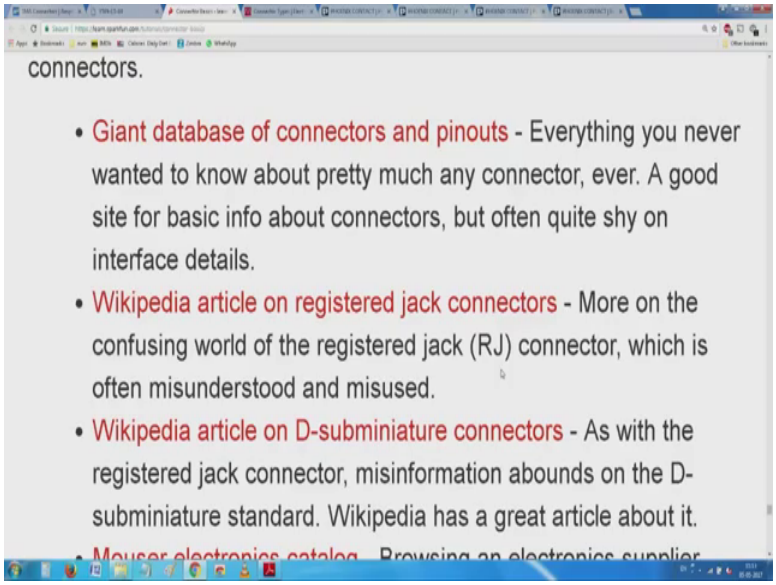

Main advantage is; it is not meant for part repurposing of the cables be done cautiously as a non standard device plugged into a this thing. What they mean repurposing is; if we attempt to rewire them, by assigning a different; what you call purpose compared to what

is the original standard. As said, if you take the side of my PC has a 3 row, I think 15 pin RGB pins; 3 rows, it is fairly standard.

So, as for as possible in case you are really assigning the pins and all that make sure not at all damage something on the other side, which you find occasionally. Occasionally you find that somebody brings a laptop; laptops are safe because they are all you know standardized. They bring a small black box, laptop is terminated in the black box and then the black box gives output saying this is a something something sharer and all that be careful. You try it out first and read the manual in case they have given one or in case it is written in a special language, ask the person who has used it whether his project and his laptop continue to work.

Because unwittingly or unknowingly people you know interchange the pins and we end up with a problem.

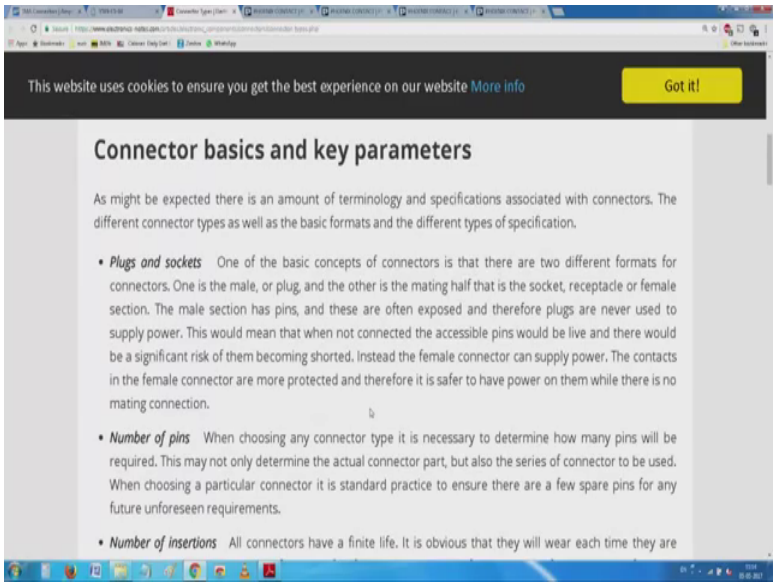
(Refer Slide Time: 21:52)




So, we have this is a beauty I will give you this link; it is from the sparkfun dot com. I find it very comprehensive; it is as good as reading a text book. But since these have you know we have been done parallely; common text books are difficult international electrochemical society has a couple of text books on this you know which know little more advanced this thing saying why what material and so on.

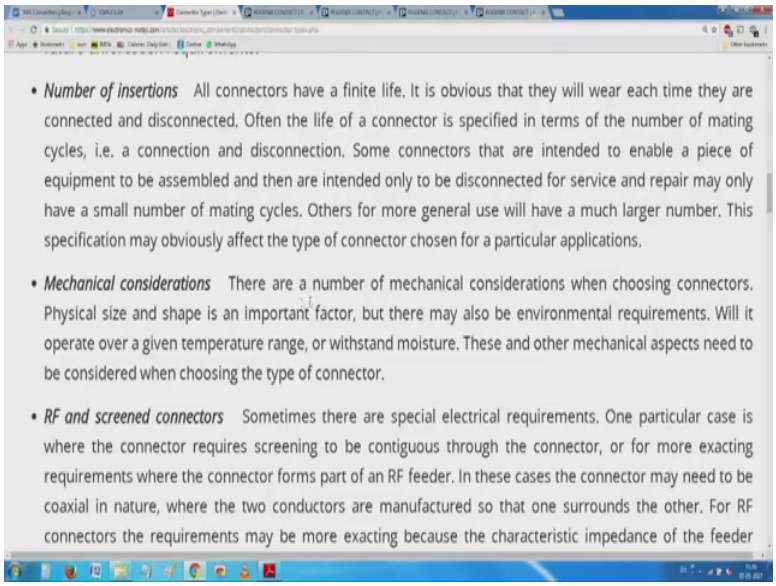
So, we have all this beautiful stuff here and I will stop it here at this point. We will come to other people who have written about it, so leave all the; main thing is why I have what you call avoid a trying to write again which is already written is that like all other books (Refer Time: 23:06) original.

(Refer Slide Time: 22:56)




So obviously, basic concepts is that the plug and socket and when you choose a connector number of pins is critical, I will go a one step further saying before you decide check whether your other end or the other meeting end of it know already has some standard or industry practice what they use.

(Refer Slide Time: 23:30)




One lone example I have given you is the so called connector to connect your projectors and all this or data RGB connection. And now these days slowly everything is being changed to a digital and then in the case we have the HDMI connectors and then in between so many other standards, some of your audio equipment you would have seen even in an optical cable.

Some reason it did not pick up; maybe it is just like the VHS versus beta formats, now both are not there anymore. So, first thing when you want to select a connector; first thing is you just check whether, what is it that is commonly used I will while it is not I will not say, it is a industrial standard; I will say a common practice is very very very critical saying what do others use. Secondly, a few more pins are not bad, so you will be surprised to see basic serial communication what we see probably requires only 2 and then for some technical reason, we have 3 pins you do not need too many of them.

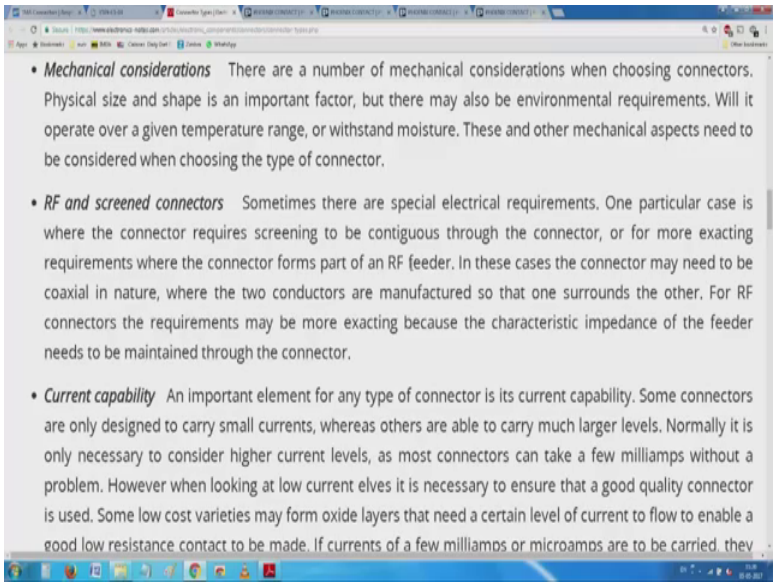
But then if you go to the industry, where the instrumentation and such things are there; then where we will use the current driven connections and then you have the hot standard. So, hot standards are quite different and then their own terminations everything have been already defined. So, the one simple is the way out is leave the cable and then give a designation write somewhere how it is to be connected and a trained person will not do a mistake. Alternatively, you need to take action; so, necessary to determine how many pins will be required, they may not determine the actual connector part, but the

series of the connectors can be used particular connector it is standard practice to ensure that spare pins for any future unforeseen circumstances, requirements.

If you want to increase current carrying capacity; all that you need to do is share 2 adjacent pins; you are in absolutely you are in good luck. So, the current at least initially when the contact resistances and all are about the same they will be shared automatically. This is often on number of insertions and mechanical considerations are still a problem, all connectors have a finite life. They will wear each time they are connected and disconnected; often the life of a connector is specified in terms of the number of mating cycles; I suggest you read it yourself.

So, a connector while basically the electrical requirement is about passing current and then withstanding has certain voltage and then other things is how much drop you can have and so on and so on. Something which often we probably ignore; not ignore equal attention has to be paid off is the number of insertions. If you are in the lab, you may not foresee how many times it is inserted or not we are all very familiar with a relay contacts. We are also a little familiar with the power connectors which used for plugging in that thing, but other electrical somebody has to have an audit of the choice of connectors. So, may being the; what you call packaging or somebody in the packaging field, I suggest you know you ask somebody who is there and number of mechanical size shape and so on.

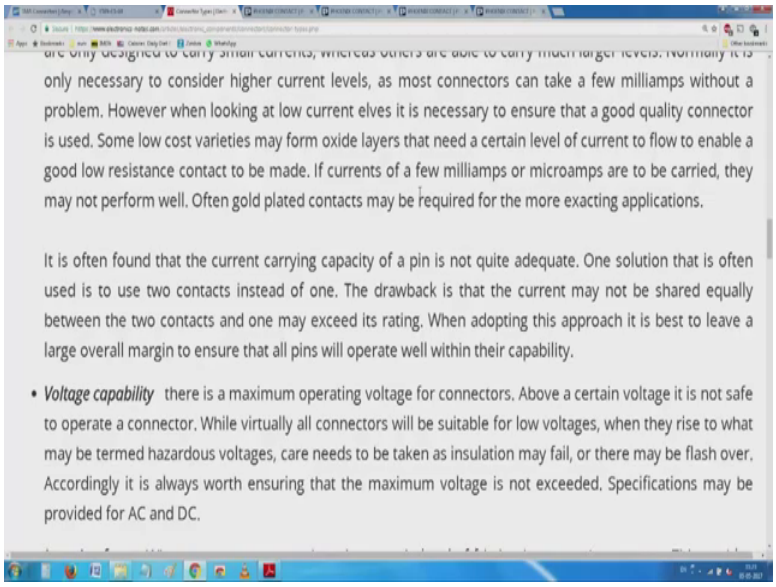
(Refer Slide Time: 28:18)



And then finally special electrical connector requires screening to be contiguous to the connector or for the more exact thing or the connector forms parts of an RF reader. The connector may need to be coaxial in nature, where the two conductors are manufactured so that one surrounds the other. There is something called a characteristic impedance of coaxial, so you have 50 ohms, 60 ohms and 75 ohm also. So, the moment you exceed I feel now around 1 mega hertz; you end up with having to use matched terminations along with the matched cables.

Luckily for us, for each aspect; we have standards and then generally things are under control; obviously, cost is the criteria.

(Refer Slide Time: 29:09)




And then low cause sometimes ends up as cheap; unlike audio where a little bit of fashion also, gold contacts is the gold contact better than a nickel plated; I will say yes and no, but not in all places. A lot of times, the gold plated contacts which they give a cell in audio is probably more as a fashion statement and less as a electrical requirement.

So, kindly hold back; it is for you to check whether it is as enough blocks are they are saying whether they are required or not. But the reality is depending on the application and the thing, the plating the; what you call the cost now are important things. Now, coming back is the current capability; well all the time we are thinking about shape, number of contacts and all that.

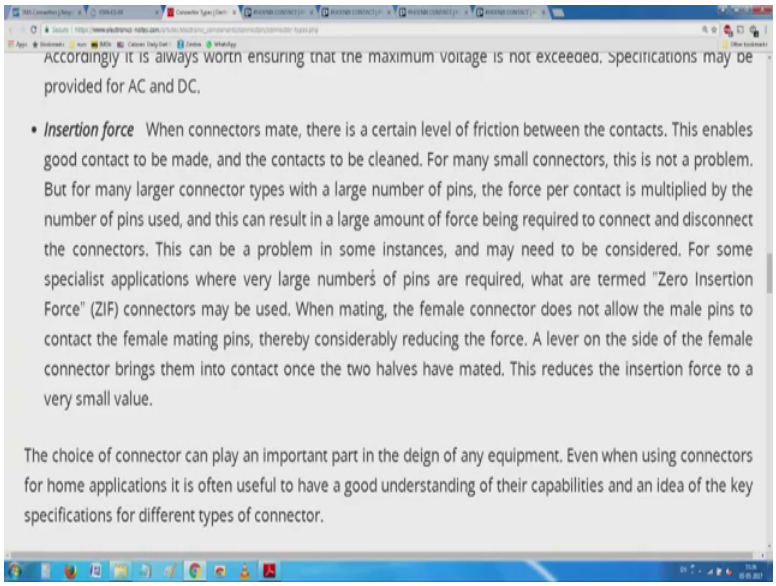
The current carrying capacity is very important, though we may not appreciate how critical it is because small you know nothing add ups a lot. Even in a small things like you know milliamps; eventually add up into 100s of milliamps and the moment anything crosses around 100 milliamps already we come in little sticky situations.

Because all the connectors that are what I have shown you, the smaller ones are not capable of taking 100s of milliamps; only the power things so the cable switch; now have actually copper conductors, seven copper conductors and all that are capable of taking it. So, at this point you see here if current of a few milliamps or microamps are to be carried; that we have the stuff about good quality connector is used. Low cost varieties may form oxide layers that need a certain level of current to flow, a good resistance. So, we still have this issue of the correct electrical material interface gold to gold and so on.

And reasonable example of a bad contact is I have shown; I mean I were talking about the remote control things and then often toys, especially remote control. You see they have to use a spring at the back and the cells that we use inside to have a tendency to leak. So, that is a real reasonable you know condition for things which do not work properly.

So, I have the stuff about contact sharing current large overall margin, so if you need to carry say 500 milliamps and then normally by definition that contact can take only 400; probably two of them it will work and while both of them may not take 250, so even if it is 200 and the other 300 your over all thing is maintained.

(Refer Slide Time: 32:45)




Then voltage capability; above a certain voltage it is not safe to operate a connector. This is obvious you being electrical people or anybody is there, so voltage is well known about it though there is a small; often people talk about it how can AC be a voltage; AC is a current is it not. To have current flowing, you need a voltage and voltage is from end to end, but between two terminals; there can still be a large voltage difference. So, one example is the mains connectors which I have shown you; over here we have a 230 volt system; the peak of it comes to 390 volts.

So, anytime two of the pins maybe saying around you know that almost 390 answer; you know 390; 230 into root 2 around 300 volts between 2 of the pins; if it is a 3 phase, there may be saying that 400 volts. So, we still have a lot of voltage business here; we will never think of it when we just plug in a connector at the back of our computer including all these what you call for adaptors and so on voltage capability.

Next very very very very important or critical thing is the insertion force, so I will see if I can pick one of the connectors I have here and show; you say this is taken from my computer, which I am trying to see. You see here, it looks relatively safe is it not we have just two pins here and you just need to put the mains and I have explained to you somewhere else usually they send they make like this so that you can use a cable which are shorter or longer; other side the pins may be different and this maybe 110 volt or 230 volt device.

This end is generally a moulded so that if we do not you know accidentally because other point is invariably they are all 19 volts and if it is a 100 watt power supply, more than 5 amps it will be carrying this side is not so much. But the thing you see this is expected to carry 230 into that peak voltage here; that is a lot of voltage and some of them have a capacity input, some of them have other things so that accidentally on load if you connect ot disconnect there maybe sparking here, which shall happen.

You may not intentionally you pull it out, but when you pull it out chances are they are. So, it gives here saying so many something something input is at 100 volts one and half amps, but then at output; it is 5 amps; 20 volts and 5 amps, that is a lot of current passing through essentially a thin cable. The other end of the thin table is terminated in one of these things you see here it looks simple.

But a lot of thought has gone into it, you cannot ignore the amount of thought that has gone into that. So, if you go further the insertion force seems to be critical; we can control voltage and current and so on, there is no issue about this voltages and currents because its manageable. But the insertion forces and those things are not that well known and as luck will have it, sometimes a tremendous force is required.

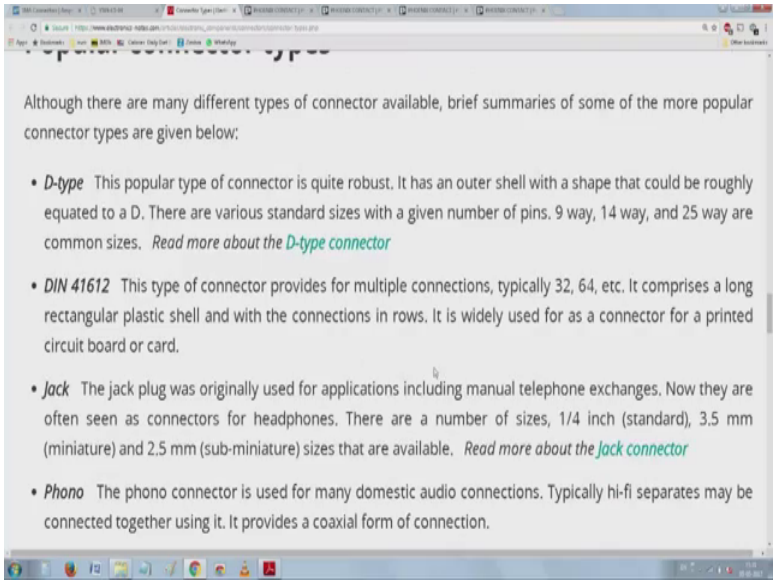
Imagine you have connector which has 96 pins or you have 24 pins and so on and all that and then you have motherboard at the back; motherboard and then you have plug in cards, that is a lot of force and motherboard is far away and then the chunks are little flix; I mean it will what you call flex.

So, if you take DIN of 41612 or DIN of 41617 lot of 31 pins has normally average, so even 64, 62 pins are also there. So, each pin even if you put a few grams a insertion force becomes very very high; insertion force is a very critical issue here. So, the problem with the insertion force is that, while forcing it goes inside because you have a pin here and then other side you have a socket and then there is; obviously, something this design of the way it is made looks very very very critical.

I showed you the electrical line you know DIN type of a socket yesterday; meaning there is a housing which does the guiding pins themselves only take a small piping action. The moment it goes inside, due to heating it should not jump fully. So, on meeting that is removing it back also know is equally critical.

So, somebody has worked or many small connectors not a problem, but larger connector types the large number of pin the force per contact is multiplied by the number of pins use result in a large amount of force being required to connect and disconnect. This can be a problem in some instances may need to be considered, where very large number of pins are required. Because right now this ZIF and all is a probably out of fashion; at one time, there used to be a connector what you call a header used for putting ICs everything where you operate a lever on one side and then it opens you push it inside and close it; they are little out of connection now.

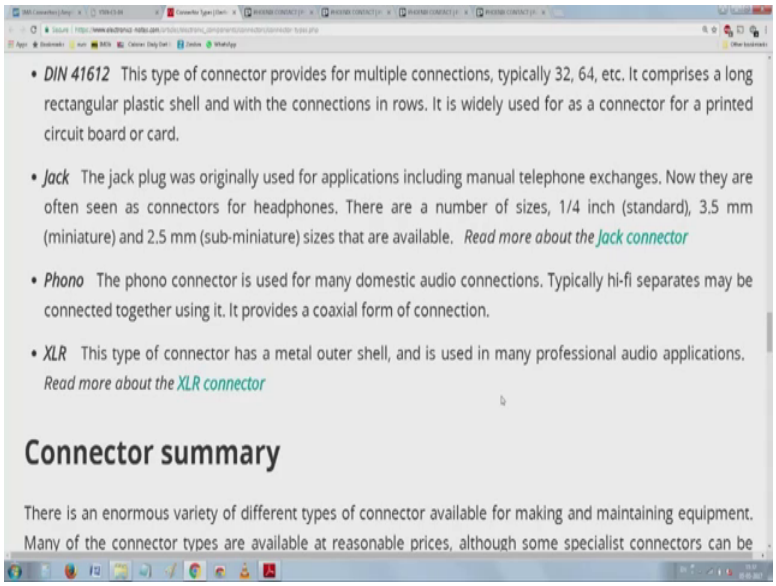
(Refer Slide Time: 39:09)




So, thing is in case that simple flat connectors they behave one way; in case it is circular you need not have a proper key that whole shell need a key. This is where the MIL or the mill standard connectors come; there is a circular thing, there is a key in which a keying thing is there and then the connectors can have various type of dimensions. Once you put it inside usually there is a screw or by net on the outside which locks it in place, I will try to get a fewer samples.

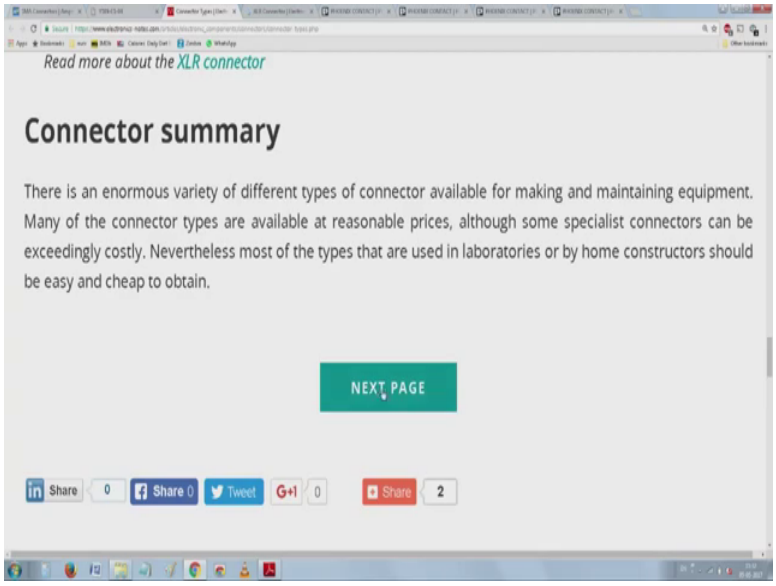
So, as I have already shown you about the so called DIN; then we this D-type I have shown and then DIN 41612; we do not see it very often, but what is called the eurocard. Single euro and double euro card, which is part of the 19 inch rack system; they used to have this. Next we have the professional audio or XLR connectors.

(Refer Slide Time: 40:15)




Advantage being that all professional equipment there is something very; how to tell exotic about it, the function is expected to be nothing should ever happen; meaning whether it is a lip sync going on the screen or you know actually it is a professional presentation; there cannot be an interruption anywhere. On the other side, the chances of misuse and mishandling is very high; that is how this thing called the XLR connector started coming up.

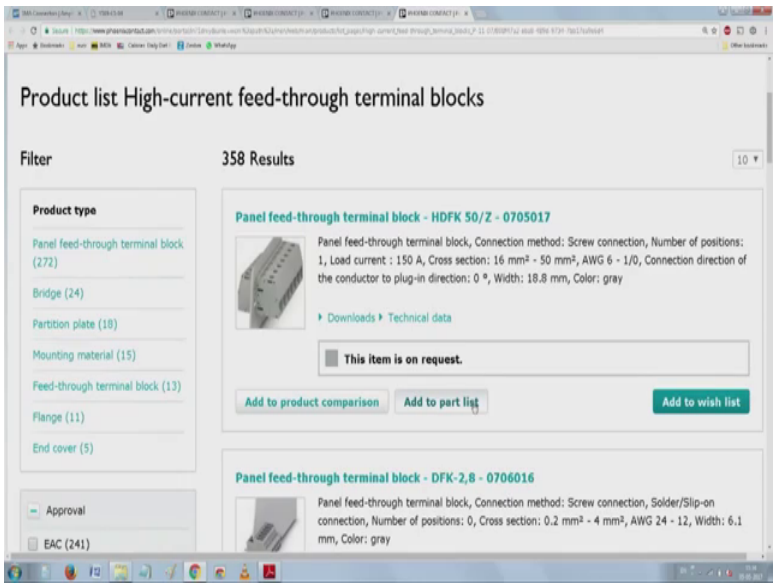
(Refer Slide Time: 40:56)



So, we have a lot of this stuff about you know some D type connectors, mechanical outputs out numbering and then so on and there are large number of stuff about IEC power connectors. I suggest you read it yourself; go to the electronics notes and then read yourself. So, anyway the picture could not be given here; you would have seen this; I will just stop here related to this, they are just too many of them here. I will try to go back to this; little bit of this industrial PCB contacts which are stackable and one of them is this phoenix people; now it is almost universal. Advantage of it is, unlike purely communication equipment wherever you have industrial panels these are used invariably.

Because as I told you we have a cable tray wiring is taken through is and then individually terminate because no two panels are same. So, we have so many of these things here; in this case you see here that we have this nice way of; these are very small these are miniature little big.

(Refer Slide Time: 42:40)

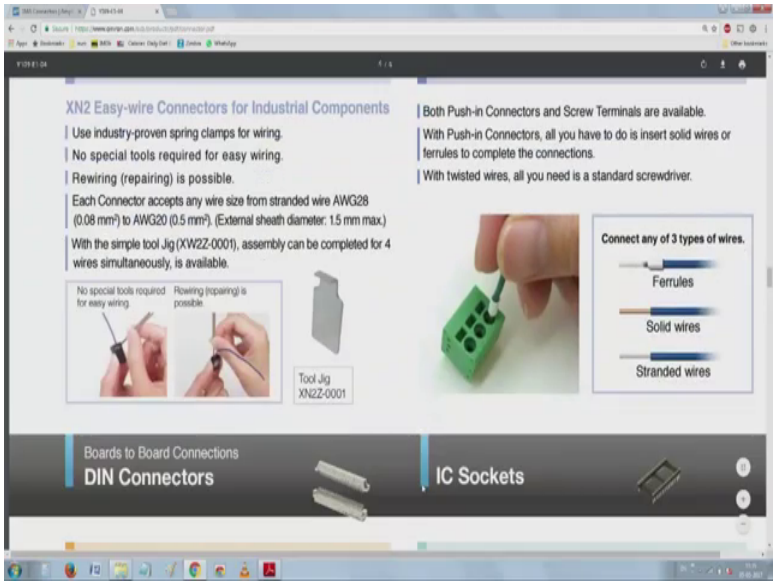



So we have a huge advantage of these how to terminate them, how to make them and so on. Now, we come into fit through terminal box because on one side we have wires being terminated, another side we have another wires being terminated.

So, we have a system that is again built up of a small thing like for example, you have a contactor; then you have IO boards in a PLC program logic controller. We end up with this feed through terminal blocks, so you have a bulk head or a something; on one side you turn it as other side you take it off with maintaining all these contacts. So, I am just

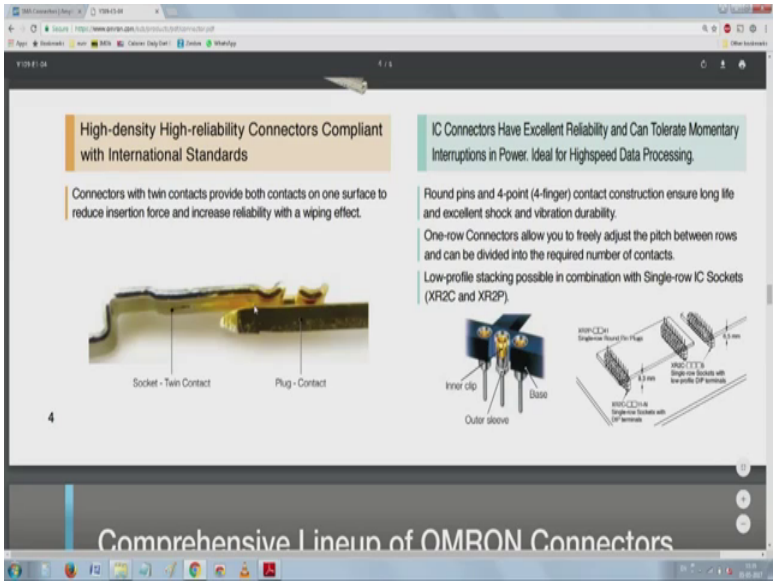
about running out of time, so maybe I should speed it up a little. We have you have seen very large number of; this is what I was trying to tell you about.

(Refer Slide Time: 43:30)




So, whenever I was talking to high reliability complaint with international things, you see here even if you see the inside of the contact.

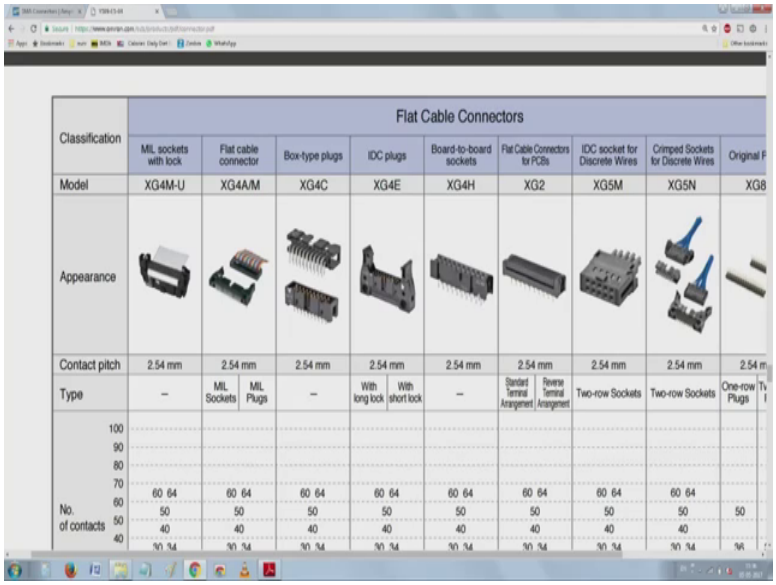
(Refer Slide Time: 43:38)




Here the plug point, then we have the socket point which this is also neatly split here along the length it is split here so we have one contacting here, one more contacting here. Make sure that all conditions things will work and this is the (Refer Time: 44:07) that

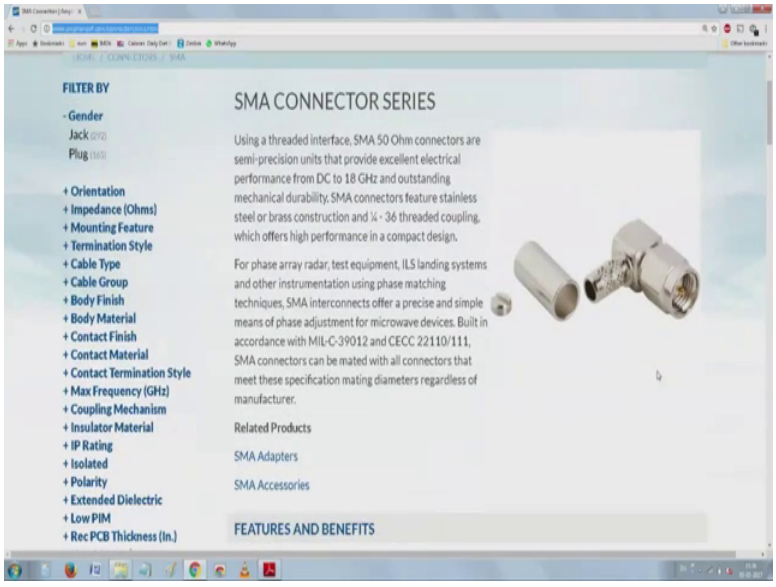
row of forefinger contact construction that is we have machined pins which will go inside; this is where I was talking to you about it is much way beyond the normal things.

(Refer Slide Time: 42:32)




So, we have a large number of these headers and things which are part of the any of the catalogues.

(Refer Slide Time: 44:44)

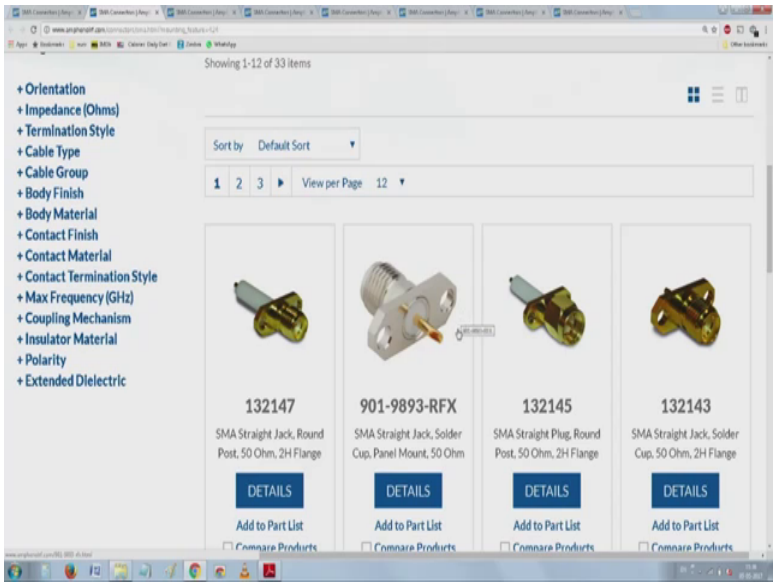



So, we have a huge number of the; this sort of things you would have seen probably on your connectors and all. I will close this window and come into a beautiful reliable contacts which have probably come from professional, I do not like the word war effort,

but I will say aerospace where cost is not the prime criteria, cost is the first criteria. So, over the years maybe just about the war time this SMA connectors have been; you know standardized and invented like this. So, we have this on the other side; huge amount of about orientation, impedance, huge amount of things are available. SMA interconnects offer a precise so on and you see here 18 gigahertz; it is almost like micro wave plumbing.

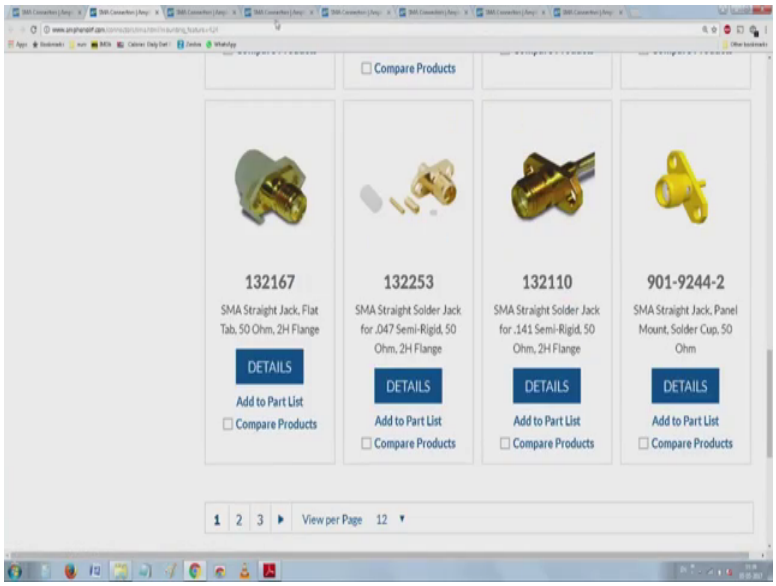
So, and you see the amount of detail that has you know gone inside; there is a ferule like thing here, I mean what you call a rough surface and then when you push it on to the other mating connector; it is there and then the small cap here goes at the back of this so that the soldering and all can be done. And you have so many of them, meaning it is just too big type SMA and then whatever you want is available there. And you see the; if you look at the mounting features, this is what I was trying to tell you yesterday about the bulkhead mounting, front mounting, rare mounting, edge mounting. So, I will see as the windows open; see we have a beautiful connector here up to 26.5 giga hertz; seeing here.

(Refer Slide Time: 46:56)



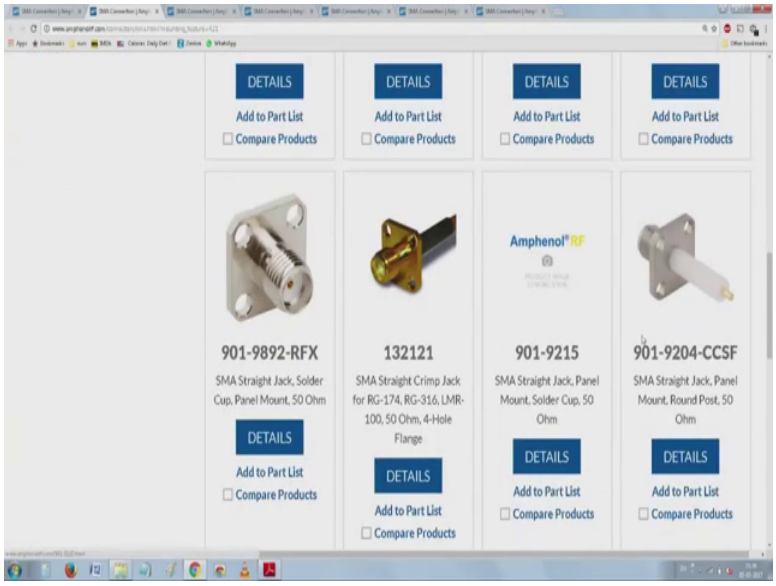

Therefore pins which mount nicely on the PCB, there is something which can be mounted with 2 holes; straight jack, solder cup; see the back termination there is a solder cup; using precise controlled dispenser soldering, you can just put one the inside of the cable and it gets terminated here.

(Refer Slide Time: 47:19)




Then you have 50 ohms; then this is one with mounted with two flanges; seeing that this is a beauty. You just cannot think of a better thing, further go down flange with 4 pins; I am not very clear as to why it is maybe they are just parallel standards and well there they exist there they are very much. So, we have a round post, straight plug and you know all of them; you see here invariably there is a socket here with a thread on the outside.

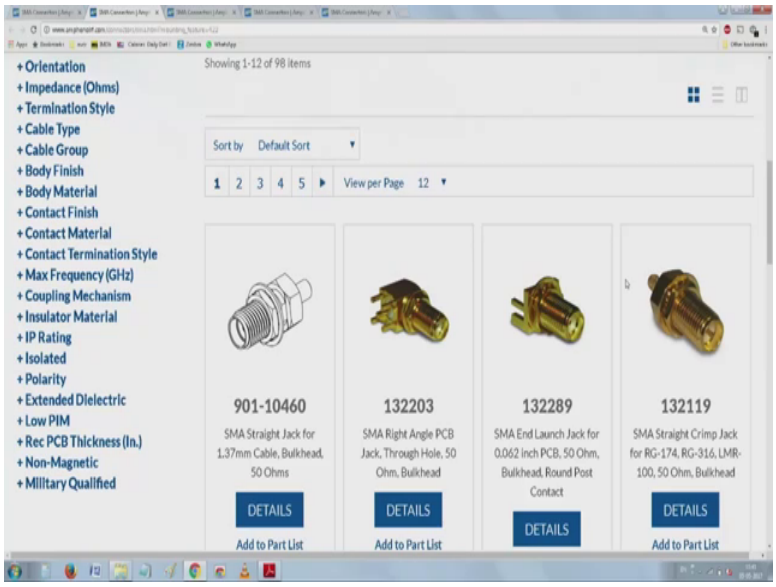
(Refer Slide Time: 47:54)



So, the cable comes with the other end of it, so at the back if you see straight jack, panel mount and they have a beauty of a right angle mount also SMA right angle mount. So, we have huge number of these with the square flange; this is what I was trying to telling you about bulk head mounting.

If you look at the way where there is a continuous thread on both sides; obviously, depending on the position of the flange and all that and depending on this mating thing; these are all mounted from outside a bulk heads. So, if we have a flat plate here; the connector goes here and then you tighten it at the back and you can continue with the whatever stuff you wanted to do it at the back. So, we have beautiful round post at the back and the thread is continued and so on. After you see the next picture, probably you will understand you see here.

(Refer Slide Time: 49:09)

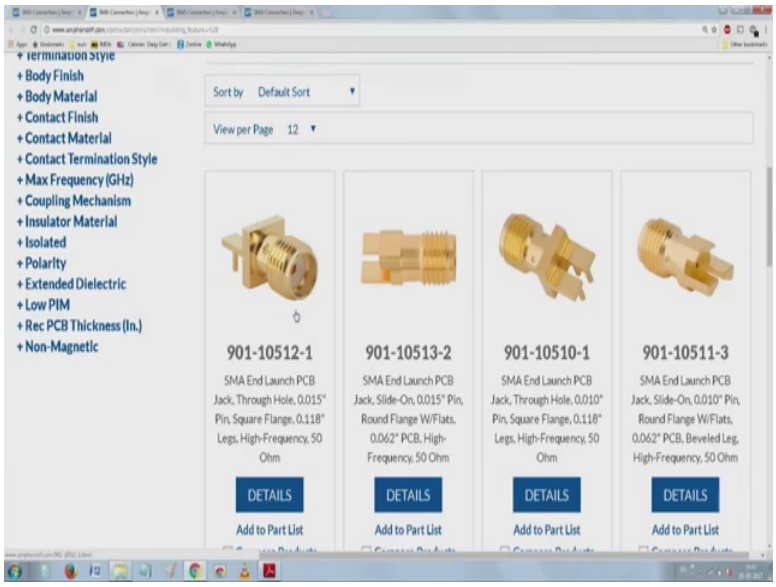



Here something else here completely, so at the back a different style of mounting is there, at the front it is like this; with the cable 50 ohms and then depending on where the washer is and then how do you mount it; you have a choice of mounting gate behind the panel. If the moment you amounted behind the panel, you see here there is a little bit of packing given here and then all the stuff is at the back and then you see here, you have a washer.

This things will make sure that you can; anything you want you probably have already something which is built inside; expensive, but available there. See many many many

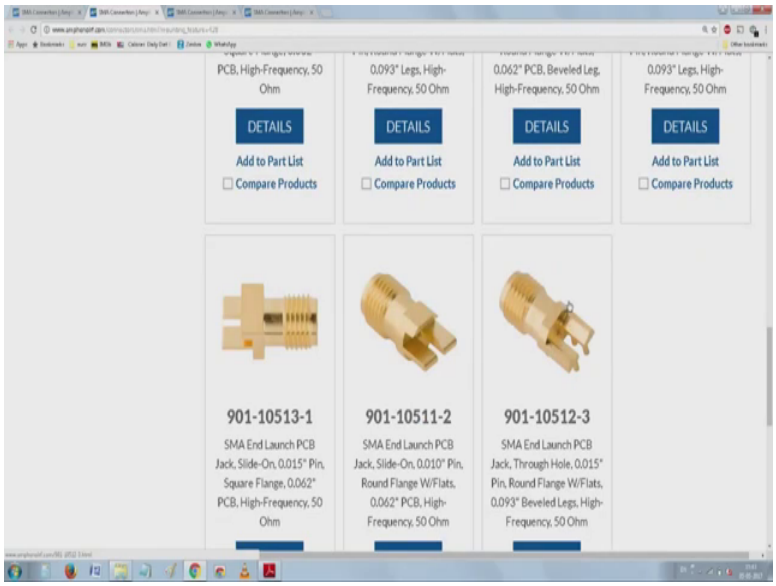
more options; see the small option one of them is you have PCB; the one for about something is stuck and top of the PCB, you can put a connector or you terminated here and then you have a cable and then that cable goes and sits into this and then you can take something out. Then sometimes, I cannot afford to have these extra additional the symbols anytime; there is a joint and something has to be threaded and so on, there is an tremendous loss of signal and the signal integrity is lost.

(Refer Slide Time: 50:49)




So, you have special connectors here you have seen that; PCB jack you have seen this end launch PCB jack. So, if you design the PCB carefully it is possible for you just insert it and then put it through various soldering techniques, we have something which sits extremely well.

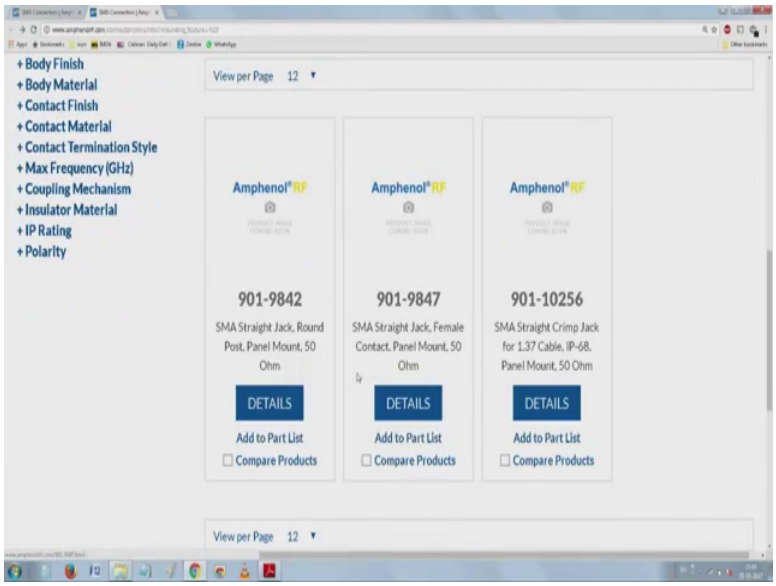
(Refer Slide Time: 51:04)




If you think about it; somebody remember somebody a professional company has thought about it and given you things which you know which are solded here and so on. Which I feel know it is a real wonder, so we have including making things work fast press fit. So, I can push the you know prospect jack which ensures that it just sits inside and why this is required is occasionally you end up with the a machine housing which you have no access for playing around with various types of assembly and so on.

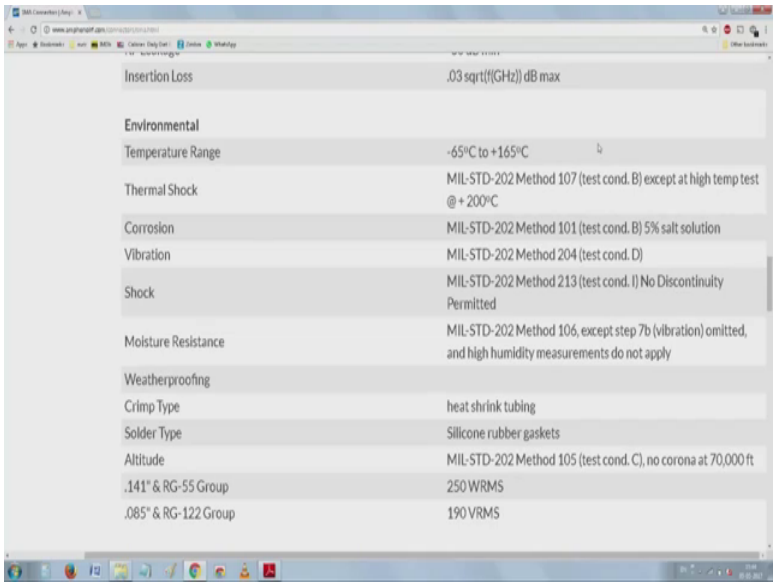
Especially in the case of microwave and all that, there is not too much of thing you can do, it just has to work properly and the chances are you will never be playing around and dissolve ring or anything. So, you have this module, you assemble the whole thing together and sometimes the whole thing is even together it is put on special type of some hydrogen, brazing or something they call; in those conditions they use these press fit panel mount jacks.

(Refer Slide Time: 52:30)




So, if you go on we have all these you know large number of types of cables; type of thing and then if you see the important part is high temperature shock and corrosion and MIL standard MIL STD; that is the reason they are costly.

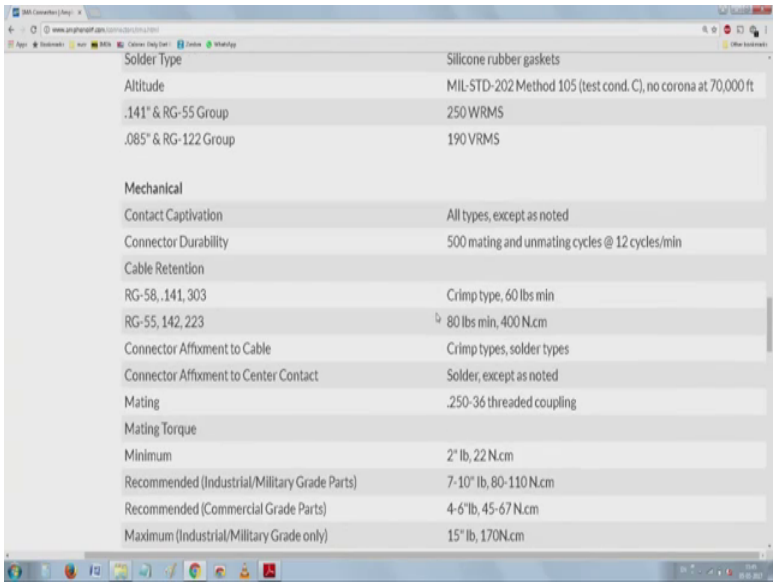
(Refer Slide Time: 52:46)



| | |
|---|---|
| Insertion Loss | .03 sqrt(f(GHz)) dB max |
| **Environmental** | |
| Temperature Range | -65°C to +165°C |
| Thermal Shock | MIL-STD-202 Method 107 (test cond. B) except at high temp test @ + 200°C |
| Corrosion | MIL-STD-202 Method 101 (test cond. B) 5% salt solution |
| Vibration | MIL-STD-202 Method 204 (test cond. D) |
| Shock | MIL-STD-202 Method 213 (test cond. I) No Discontinuity Permitted |
| Moisture Resistance | MIL-STD-202 Method 106, except step 7b (vibration) omitted, and high humidity measurements do not apply |
| Weatherproofing | |
| Crimp Type | heat shrink tubing |
| Solder Type | Silicone rubber gaskets |
| Altitude | MIL-STD-202 Method 105 (test cond. C), no corona at 70,000 ft |
| .141" & RG-55 Group | 250 WRMS |
| .085" & RG-122 Group | 190 VRMS |

But generally off the shelf, they are not as expensive as a full-fledged qualified thing. if it is a full qualified tested thing with a test certificate, it still continues to be costly.

(Refer Slide Time: 53:27)



| | |
|---|---|
| Solder Type | Silicone rubber gaskets |
| Altitude | MIL-STD-202 Method 105 (test cond. C), no corona at 70,000 ft |
| .141" & RG-55 Group | 250 WRMS |
| .085" & RG-122 Group | 190 VRMS |
| **Mechanical** | |
| Contact Captivation | All types, except as noted |
| Connector Durability | 500 mating and unmating cycles @ 12 cycles/min |
| Cable Retention | |
| RG-58, .141, 303 | Crimp type, 60 lbs min |
| RG-55, 142, 223 | 80 lbs min, 400 N.cm |
| Connector Affixment to Cable | Crimp types, solder types |
| Connector Affixment to Center Contact | Solder, except as noted |
| Mating | .250-36 threaded coupling |
| Mating Torque | |
| Minimum | 2" lb, 22 N.cm |
| Recommended (Industrial/Military Grade Parts) | 7-10" lb, 80-110 N.cm |
| Recommended (Commercial Grade Parts) | 4-6"lb, 45-67 N.cm |
| Maximum (Industrial/Military Grade only) | 15" lb, 170N.cm |

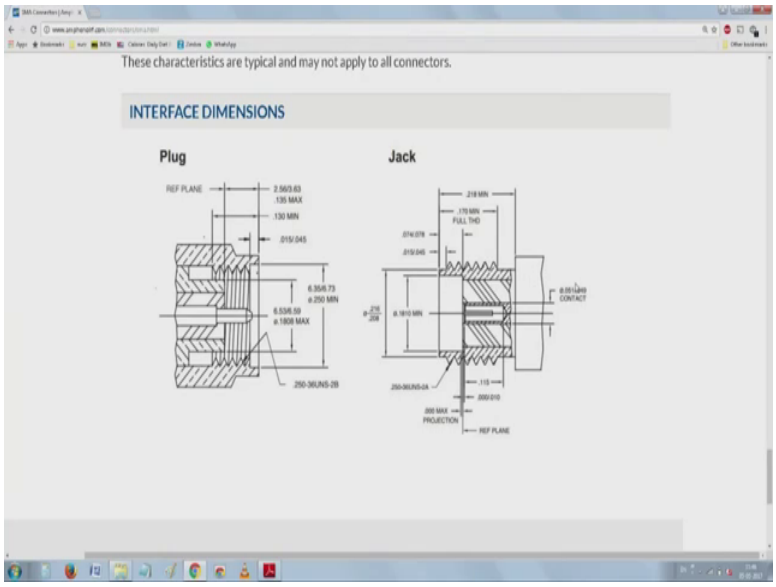
But you have for various things, you have a beautiful thing by which know you can check saying, but you see here still; you still have this little problem. Number of mating and unmating cycles; still limited 500 is not too much of it, but generally it is unlikely that you will exceed it because it is inside some other bigger equipment; eventually outside it will be terminated by then antenna connector or something which has a power connector and so on; is unlikely you will ever end up with making all these things, then connector affixment, crimp style, solder style, reverse polarity.

(Refer Slide Time: 53:59)

| | |
|---|---|
| JACKS | N/A |
| **REVERSE POLARITY SMA SPECIFICATIONS** | |
| **Electrical** | |
| Impedance | 50 Ohm |
| Frequency Range | |
| Semi-Rigid | 0-18 GHz |
| Flexible Cables | 0-12.4 GHz |
| VSWR | |
| Straight Connectors: .141" S/R | 1.05 + .005 f (GHz) |
| Straight Connectors: RG-174 | 1.20 + .025 f (GHz) |
| Dielectric Withstanding Voltage | 1000 VRMS |
| Insertion Loss | .03 sqrt(f(GHz)) dB max |
| Insulation Resistance | 5000 MΩ |
| RF Leakage | -60 dB min |
| Voltage Rating | 375 volts peak |

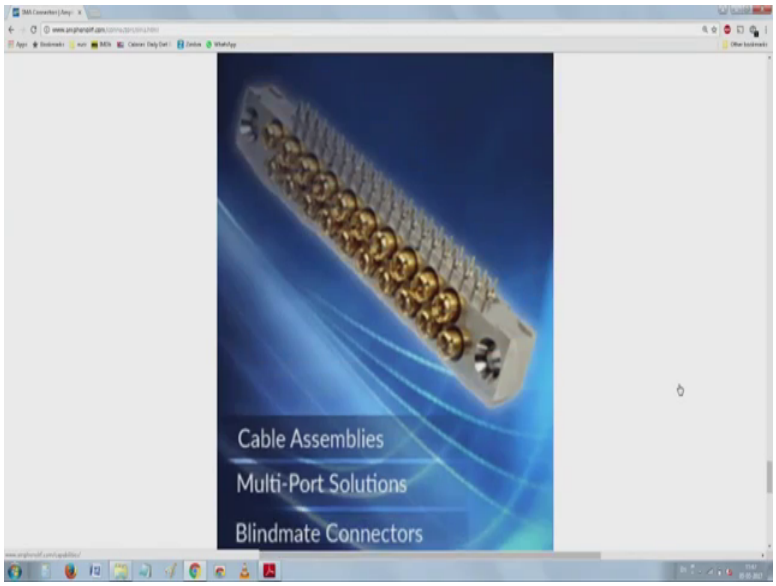
Beautiful flexible cables up to about 10 Giga hertz and then are some may rigid up to 8.

(Refer Slide Time: 54:08)



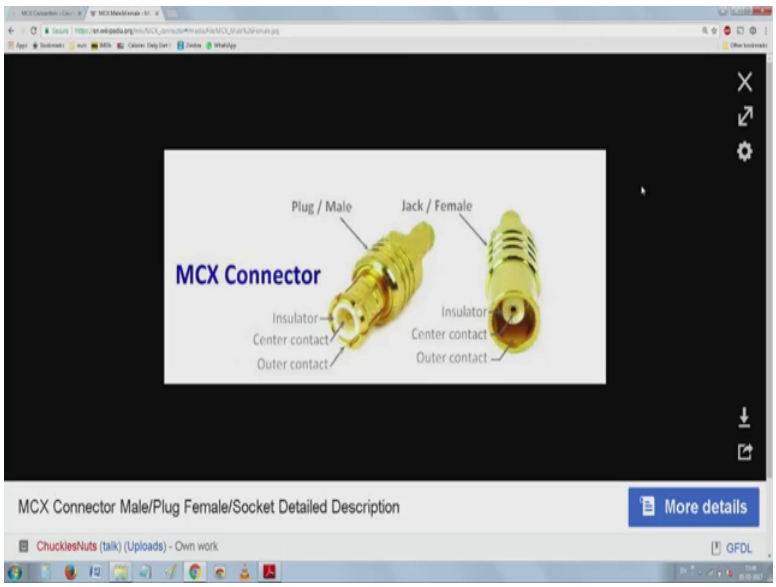

You have the important thing; this thing I think probably know we are coming slowly towards end. I feel happy that; this is the plug end jack dimensions which are actually the standard understood know. Standard meaning you have seen this here 0.51; this is written in inches, I am not familiar with inches, but I expect that it is; I mean something appropriate conversion. The thing is any of this jack and any of this plug is expected to mate reliably without losing that impedance, the characteristic impedance of 50 ohms and then without violating the voltage and current requirements for many other manufacturers.

(Refer Slide Time: 55:14)



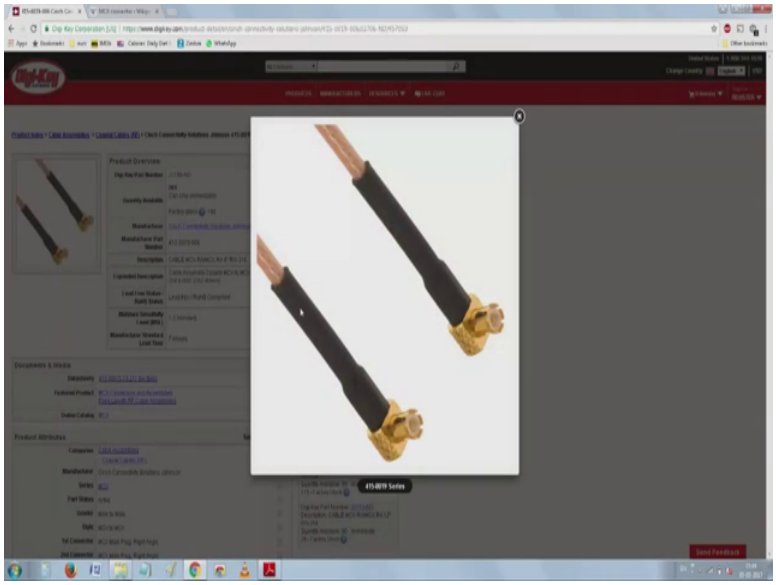

So, all manufacturers this part of it they maintain as a interface standard which I feel; it is I mean it is very very good you have seen this. In fact, there are some which have; all sorts of stuff here, I think this must enough for a lecture; I will try to stop here and see whether I can insert or show you some pictures of our equipment which will uses these small components. Then something a little related is the MCX connectors, I will see with all this confusion; I will be able to hit on the MCX connectors on the web today; bear with me these are tiny tiny tiny tiny as in really really really tiny.

(Refer Slide Time: 56:00)



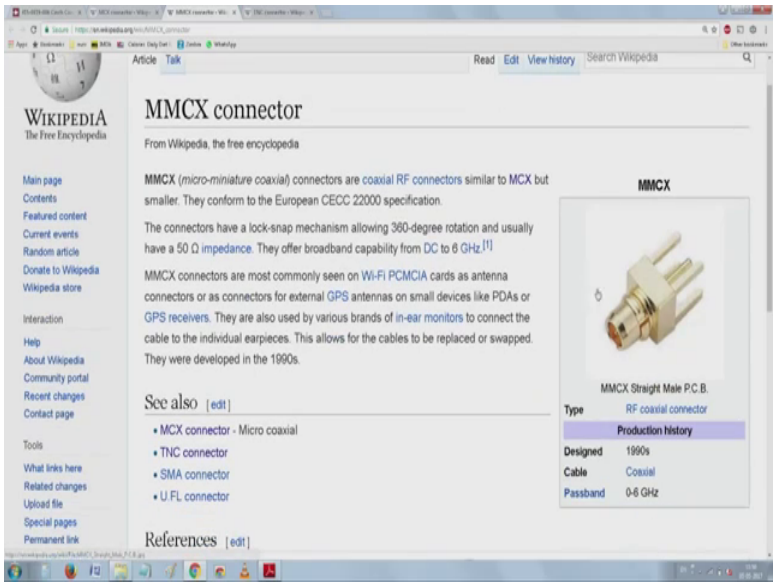
So, you find this occasionally inside micro coaxial, so compared to SMA; it comes to the SNB and then this TNC is what I was talking to you about.

(Refer Slide Time: 56:42)



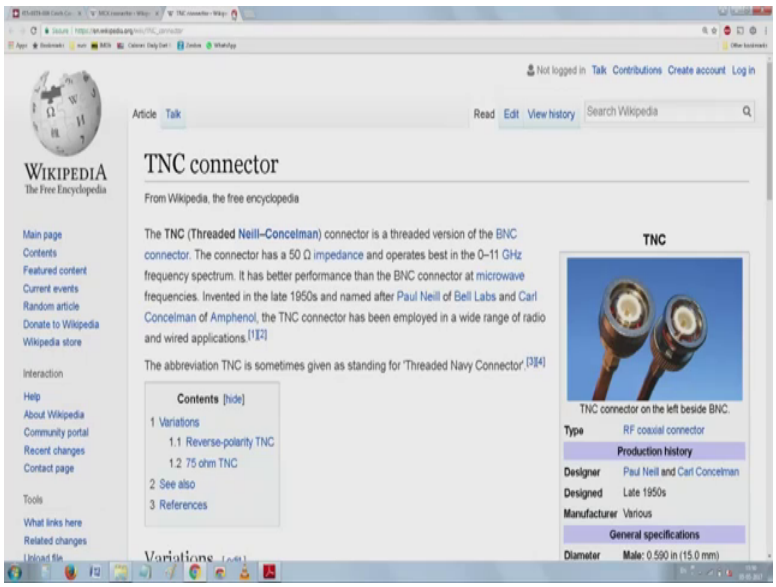
So, you see here they are really tiny, you would have seen some of these; if you have worked with; what I say is these mobile phones and such places it is a really tiny and then that part which has mounted on the printed circuit board, it is I mean you have to see it; I do not have a drawing because of thing I should not give you the thing here. Main thing being it is small extremely small, both you have 50 and 75 ohms and occasionally are very rarely have sends 60 ohms also. They are tiny; 3.6 millimeters is the nominal diameter; 3.6 is very tiny really.

(Refer Slide Time: 57:37)




So, this is where the MCX and then in MCX while the interface has been maintained, the outer dimensions have been even made smaller; so, I will see if I can hit something here.

(Refer Slide Time: 57:48)




You seen here really really tiny things; it is a micro coaxial, I think at this point unless I show you some typical examples; allow me to stop here and get back.

So, if you can think it there is probably a connector available and then you should never try to compromise on it. On the tabletop or on your test bench things work and the moment you change the configuration a little, chances are little get out of hand. To

prevent it, I feel we need to use the professional connectors; even if you are to make one unit for demonstration; I am for your trying to spend more than money in the effort and things and all that and over the time; if your lab can stock all these items, you will be a professional engineer.

So, thank you I will see how well I can continue next time because the connectors is too vast and there is no way I can do justice by giving a simple talk about it.

Thank you.