Electronics Equipment Integration and Prototype Building

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Lecture - 28
Dimensioning of electronics components

Hello, I am getting back again from where I left last time. In my last lecture, I had talked about how to make a solid model and that one was a very very simplified component which was supposed to match one round bush along with one more structural member. So, we had a round portion and then there was a structural member.

So, if you see the focus there was how to make a model based on two known dimensions; one is the diameter of the spindle.

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If this were to be a spindle, if that this were to be a spindle, I had to check the diameter so that that was a part of jack and on top of that there was a jazzy structural member which was sitting there. Seen that know, there is a structural member which was sitting there. So, I had to make a oak like thing which sits here and then we make this instantly at that point I also tried to cover saying the model which we make should consider a few of the alternatives downstream. In that case it was about how it can be fabricated directly with the facilities we have available. So, I took it to our what do you call my colleague who is who operates the prototype shop.

What he has told me is sir in case you are having a small number of quantities, this sort of multiple operations are difficult and so on, instead I will make a simpler way. So, he has made it and then I have shown you the completed pictures and all that. While the focus there was only two things; one is how does the process result in certain things including the allowances, clearances, a crude about of fit.

I will right now, I will ignore the fit business a little crude thing is about the where the tolerances are given for the parts. Only variation is saying while making the solid model consider the activities downstream, including how it is going to be manufactured. Obviously, very large numbers things are made in one way. I have given you the example of saying, there will probably make it of a non-ferrous casting after that subjected to sandblasting or shot blasting, so that the flash was removed with the minimum number of operations.

The only place which is critical is where the bush has to fit the plunger of the hydraulic jack, all other dimensions are variable. I mean are amenable to larger tolerances. (Refer Time: 03:30) now, this lecture, I will talk about something which is a little more specific with our electronics items.

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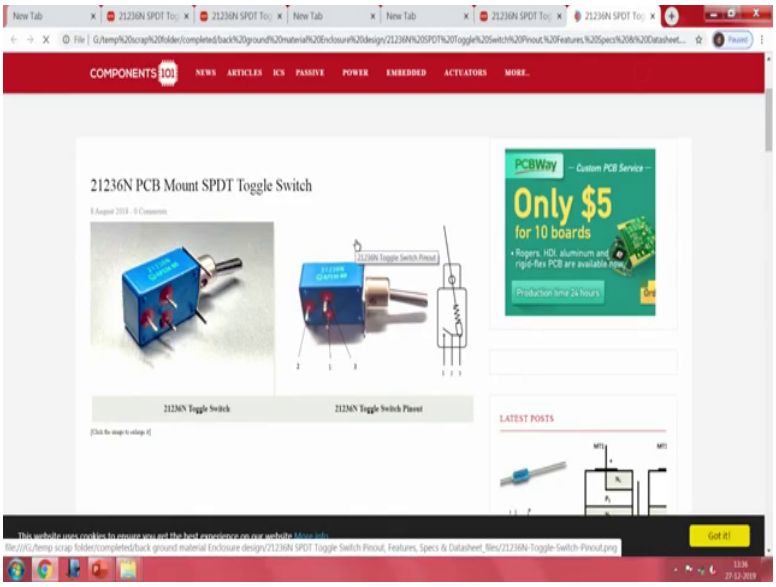

And if you see here, this looks like a very what I say simple unobtrusive toggle switch. Nothing what do you call earth checking or anything except two important things, as a electronics engineers we are interested mostly in this pin out, you have seen this know.

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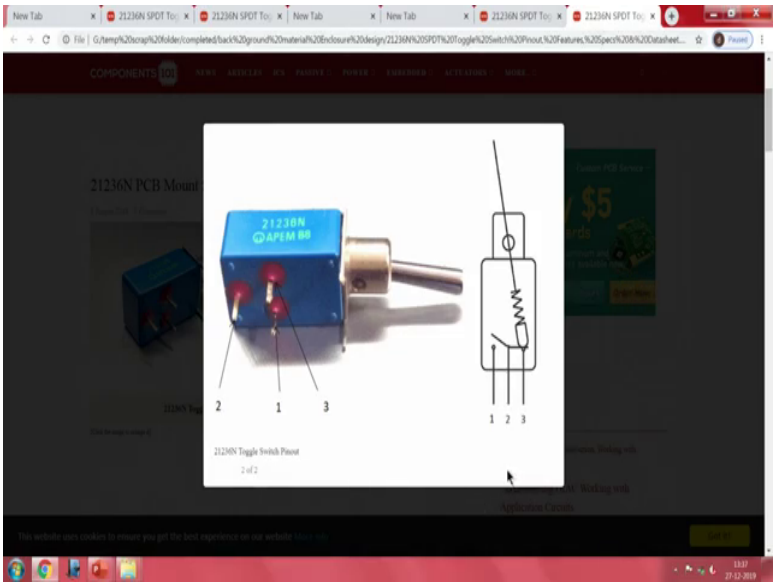

This pin out 1, 2, 3 saying depending on the position, in this case have you seen here this one is physically it seems to be reversing. Meaning, if I put the toggle this side bottom things are connected. If I put the toggle this side the other two things are considered. Why this is, it depends on the type of mechanism inside; schematically they have just explained here saying if you have it if you connect it up generally we expect that these two are connected and if you push something down the bottom ones are connected, in contrast this is slightly different.

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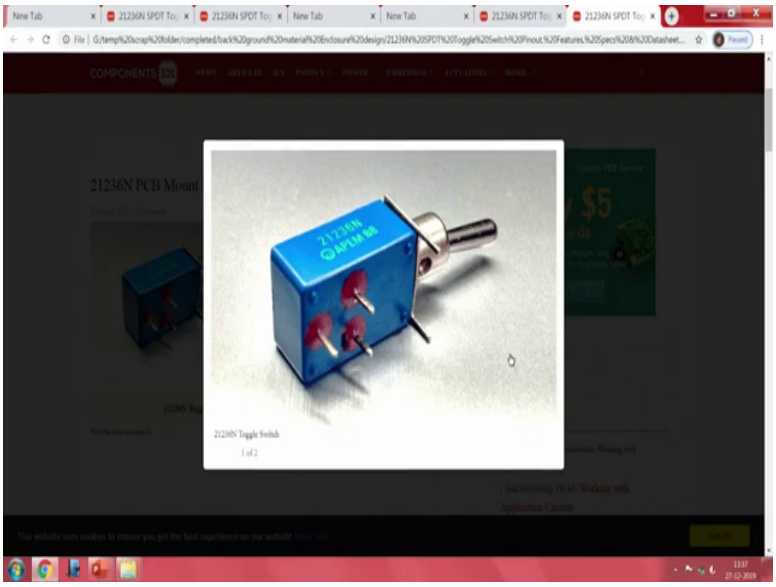

Now, if you further go down, if you see the base of the switch you have seen something which is very different. Here 1, 2, 3 are there, 1, 2, 3 are designated here, 2 is a middle point. So, the common point is shown here and these are designated here and added to that you notice also two more small legs are here. This is the crux of what we need to consider now onwards.

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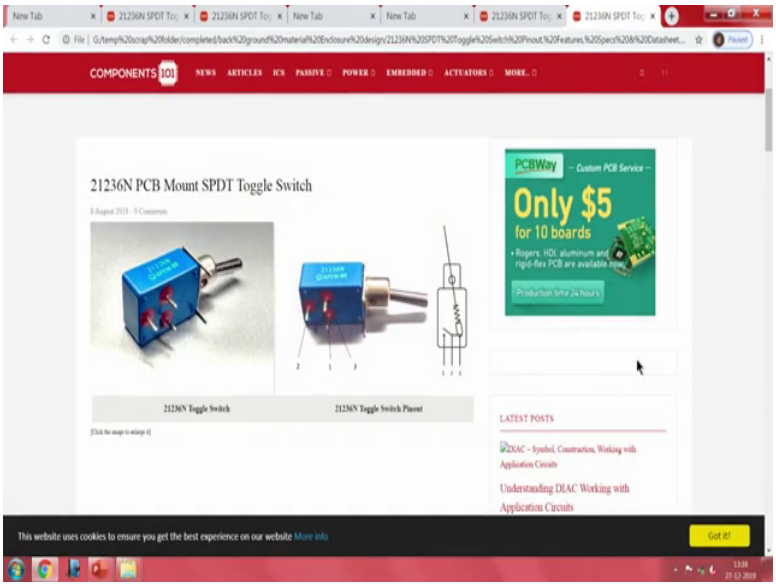

What happens here is if you see the function of the switch in this particular case it is very very simple. Seen this.

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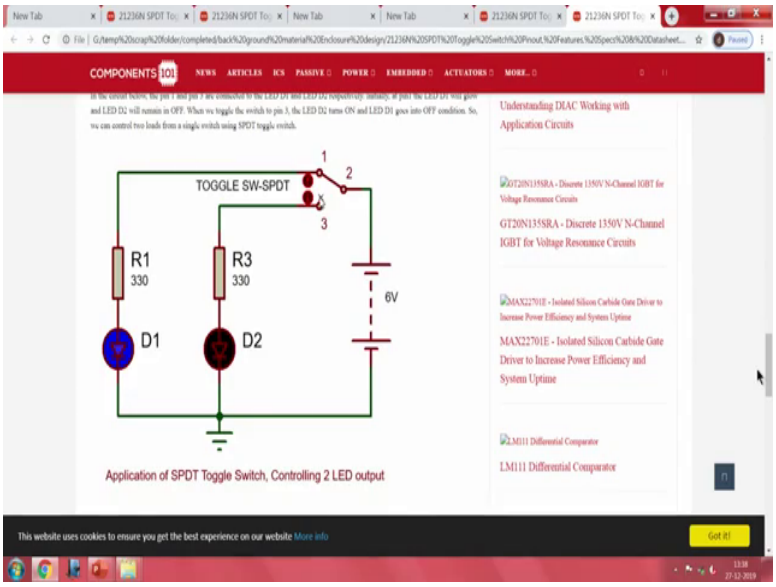

If you operated here this what you call diode is you know getting operated, this diode is getting operated here. Now, the issue is while electrically this thing is very much valid, when the moment you go onto an enclosure, one of the first thing you will notice is this the way that has to be mounted and the way it has to be used in a actual physical things, vary a little, bit here.

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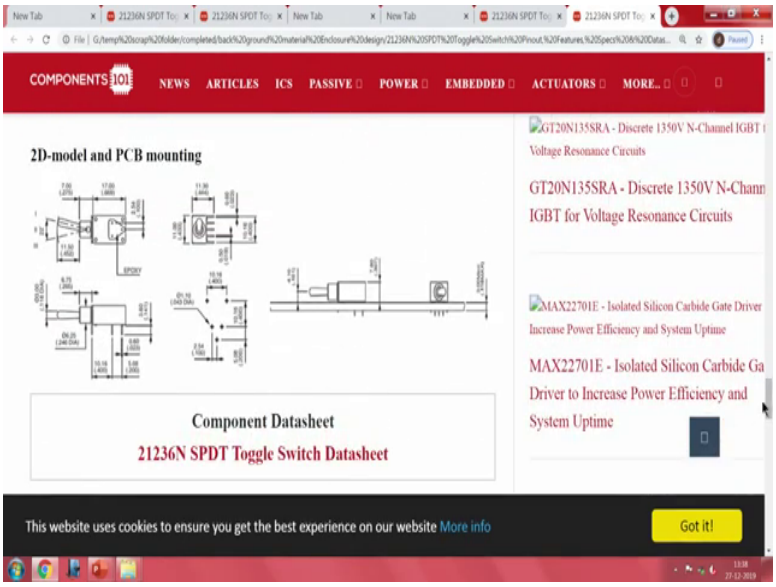

One of the first thing you will notice is if I you remember I have shown you all the pins there, and we know the function of the pins. This is where the very very critical or important thing come saying, all the dimensions are already indicated here saying on the top they are the millimeters in the brackets they are the inch dimensions and then the inch unlike the earlier scheme these are now all decimal inches. This, if you remember was what I had covered in the conventions of dimensioning.

Now, the important thing notice to notice for you here is there is a printed circuit board and the outline everything as look as looking from the side as you would see here. And the outline as you look at it from the top are all given here clearly. And another important thing is you see here something called 2D model and PCB mounting has been explained here.

Now, most of the components and all we have probably follow this convention. Meaning it is more than a model, it is just a drawing which has all the necessary dimension. So, it is obligatory or it is convenient for designers to; now, go ahead and create the full-fledged 3D solid model for this. The advantage of making the solid model is now you can manipulate the solid model in what is called world coordinate or in real space and arrange the things as you would like to make it.

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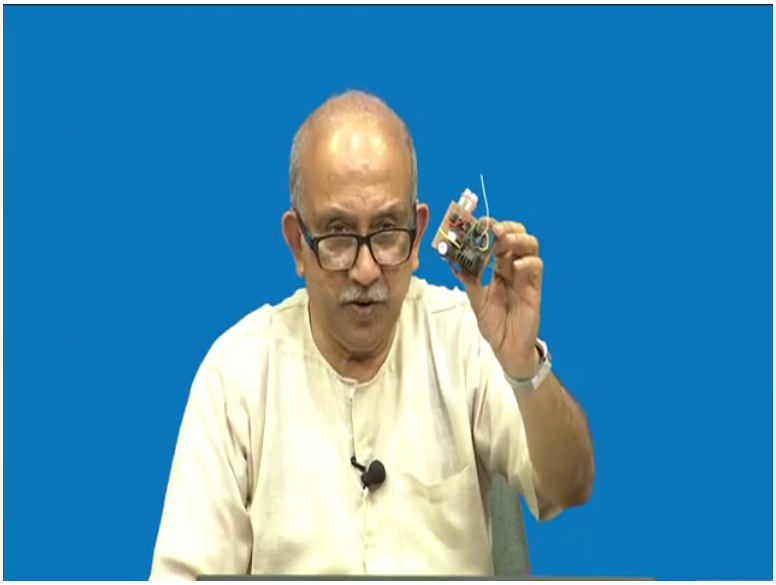

If you kindly now look at this, this small printed circuit board I have here. Intentionally, I have brought something which is not. This is small printed circuit board I have brought it directly from the place where my students you know try to do on a this I will call it a brush bread board. And one of the things you will notice is circuit wise it seems to be working perfectly. Only issue being now how do I can I optimize the total volume in this.

This is where now, I need to have a perfect 3D model of for example, this small component here, this one is a trimmer potentiometer. The trimmer has to, at the bottom of the trimmer you will notice that sometimes all 3 pins are shown, sometimes only two pins are shown.

So, depending on whether you want to put it as a potentiometer or depending on the actual function of it you need to locate these components perfectly. This is where they interface between a enclosure and the contents and the electronics seems to be very very important. You cannot put all of them in a just any available thing around in the box, and then give it to them saying it is ok, it will work here. So, everywhere we have this important thing is this data sheet. Data sheet does not only refer to only the electrical data. It has lot of this mechanical data also covered. Take a look at this.

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Obviously, at least it is made to look like a important to military this thing it may be from a trainer, it may be actually from a toy or anything which right now I will not comment about the concept of it.

Here one of the first things they will notice is these are all a standard switch, standard switch that has been being it is being offered with a protection which you need to keep all the time. For convenience they have put ignition, ignition, ignition. I do not know it can be used for pyro technique. Meaning you see all those fireworks on occasions, generally over the on a waterfront and all that I expect that probably these things are part of such a system.

So, one of the first thing you will notice is if you look at this thing again there are 4 mounting holes here. So, you need the location of the mounting holes. And as if the location of the mounting holes is not sufficient there is a space which is given all around. In this case, it is very very simple. We have 4 screws; 4 holes and very critical thing is on the other hole side are you going to put a simple nut or are you going to put a riveted nut or are you going to put a captive floating nut.

So, this particular component drawing other than what appears on top has something to do with the panel mounting data. And after that is all over at the bottom you come back with, you see all this nice tabs which are used for connection. So, a small thing like your car all these things are attached together in a cable harness. So, all data regarding how these things had to be connected and how it has to be mounted, and finally, how the panel is going to look are all presented here?

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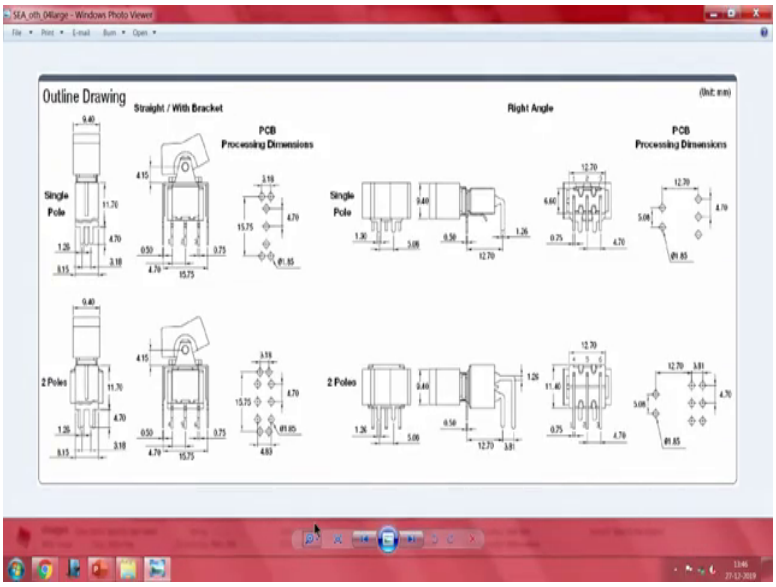

Now, have a look at this. This looks like a very simple toggle switch. So, you have in one option it is straight when it is straight you see here you have the all the holes here like that.

In this only 3 of them are required for this particular toggle switch. And in the case of a single pole, in the case of a single pole if you see we have 3 of them in one line and you have the these are the mounting tags. These mounting tags come here and the actual connection elements come here.

So, if you take a device like this it has several things, one of them is something what appears there finally, at the last is how well the interconnections are the printed wiring board is laid out for it. So, it is for you now to what do you call do that, either you call it concurrent engineering or you call it any other engineering saying you now work with the other

interconnection experts, and you are one of the other persons and see what looks like a very simple.

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It looks very simple, is it not? There is something here this part only is visible, but then you will notice that you also have an outline and spacing between them are required and then also what is the orientation of these things to prevent mislabeling and mishandling usually everything is controlled.

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Now, if you see closer on this you see what will notice? A lot of things. You have seen something here. This is a snap fit onto a panel. Right from the front you can just push it and when you make a appropriate opening for this and then you have this flux here, it is easily field replaceable. So, a device like this when you make the solid model you need to make one part which is visible as part of the front panel and one part which is how the how it sits on the facial panel and finally, a third layer of how this is going to be connected as part of the cable harness.

So, the whole concept of attaching all these things are called the concept of layers. All software starting from the earliest probably auto CAD, I mean auto desk or auto CAD which was very very old the concept of layers and attributes have been built into all these programs. So, whenever you make a small component, minimum what you require is one layer which shows what appears finally, and another layer shows what is the mounting detail like the

(Refer Time: 16:44) units screws and any things snap fit, what is the opening grip, but finally, at the back the electrical part of it.

Often, we do not worry too much about the electrical if it is printed circuit mounted. If it is printed circuit mounted, I mean printed wiring board mounted you will see that the pad layout all of them have been given there. So, relatively part of the work is done. Now, otherwise if it is a regular what do you call thing like best equipment, I can imagine is a aircraft. So, if you see an aircraft cable farm, it is a big serial area really big. Now, you see this this picture shows you the rare portion of the switch.

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So, not every time they are solded. Often, you have a connecting leg, you push it inside this small opening here probably snaps onto a what do you call a cable ferrule or a some other

device. Once you push the ferrule it stays inside alternatively it can also be wired in permanently. So, you can put the necessary things and wire them permanently.

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And now you have if you want to add them together, you see here other hardware is often involved in it. So, this one is a left hand cap, we have a right hand cap and then at the center this thing is there spacer like things there by which groups of things can been easily assembled on to a panel.

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So, all of them have a functionally all these 3 are same, but I have noticed suddenly as I was showing you, we have a simple key which is only way of connecting it has a printed circuit board. In the printed circuit board, it the printed circuit board holds these things.

Sometimes these are available outside directly otherwise you need to put an over lay sheet and through the overlay sheet this thing is pressed. And now if you see this this toggle switch has a very interesting thing at the back multiple options, and you can go and mount it directly with this what do you call a nut and screw arrangement. And there also sometimes they come with the position, what do you call identified as to which is the on and off position.

And one more important thing is you say small a grove here this grove is the one that ensures that you assemble it in only one way. So, instead of a circular hole usually there will be a circular hole with a small step here. So, when you push it into that it sits perfectly.

And this is all which I have covered earlier. These are direct probably the simplest possible slight switch. Fortunately, it has only two positions and this and this is where you need to decide how you how close or how this thing you mounted, how far a parted and how do you group them to farm a front panel on this. And the extreme right is what is called a read switch. Occasionally, these are also used were switching things, but not necessarily out of mechanical thing, it may be a magnetic grade switch, it may be a float switch or it may be a little like when you close something safety thing gets closed. So, normally open, normally close, all type of things are available.

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So, when you are trying to make a panel like this, we come back to the old problem. Is it they check in or they (Refer Time: 20:58) first. So obviously, it is very very real, both are needed. Seen this.

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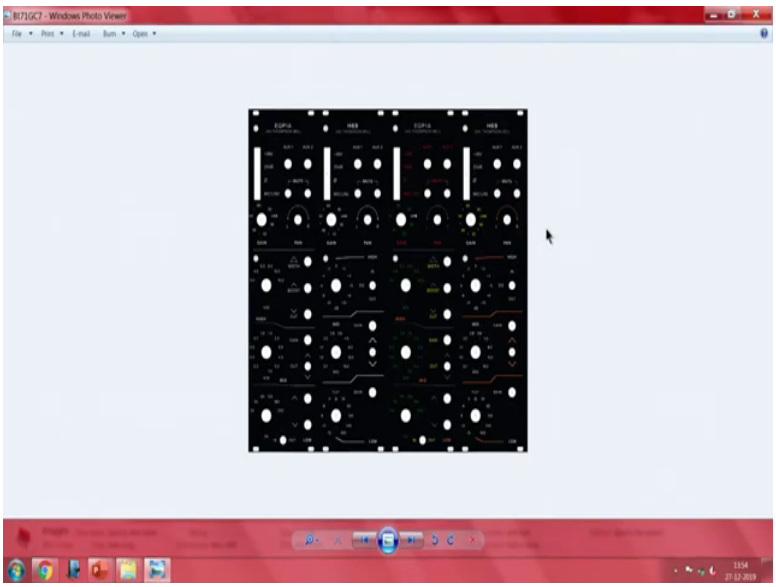

Now, if you look at the front panel here two important things are there, one is all the openings and all which need to align with each other, another is all the graphics that are associated with it. So, when you make a solid model, if you can provide enough space, you can provide all the necessary things as you mount it on a panel and selectively switch on or make visible and make or hide the objects almost ready made things like this can easily be created. Seen this here.

I am not sure whether it is only a mimic display or real, but the thing is these components which are used are the ones that are often used everywhere. I just to give a casual search on,

our ubiquitous USB. So, if you see a very very large number of cables connectors everything are available.

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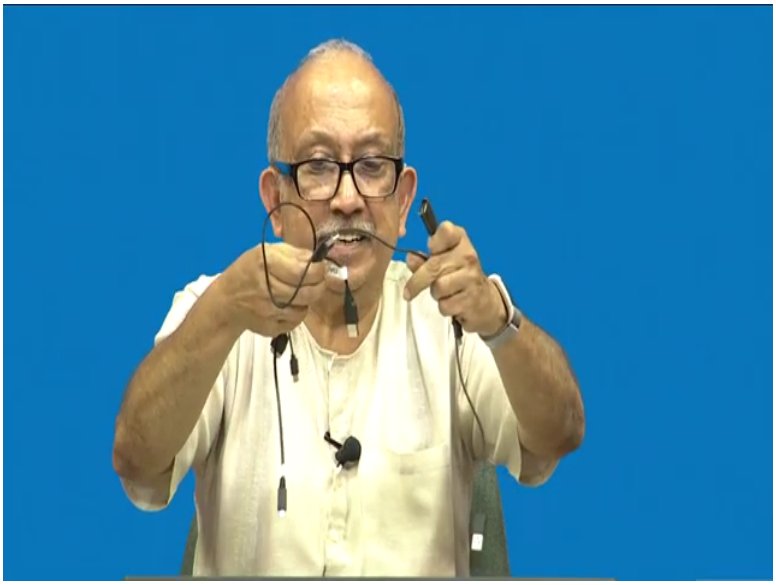

Seen this, I think I am sure some of you would have been thinking that is why I have looking for, yeah, USB extension. So, we have a type A for the present type I will call it I did not know plug, then I will call it a socket. So, it can be used as an extender.

Then we have micro USB long, then we also have a micro USB small. And this is the thing which I am sure some of you are looking for this is called the OTG cable. It is nothing, but it has just have the other the USB socket type and it has the micro USB here. So, I can take a mobile connect it here and connect various types of devices which USB recognizes.

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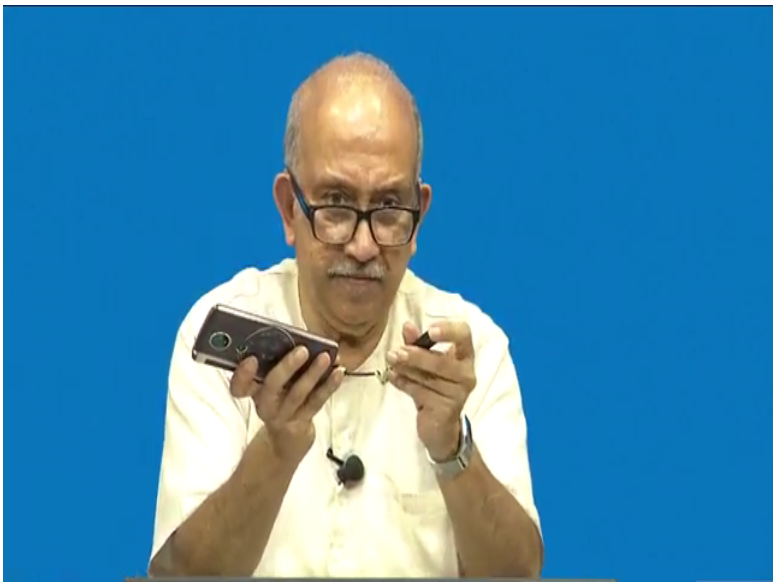

Now, when I casually went and gave a what do you call search on the internet, one of the first thing that has popped up is there is very very large number of hits respect to the mechanical dimensions. Normally, it is likely that either we do not consider them important or somebody else is taking care of it. Here the most important thing what you will notice is you see here something very very important has been marked here.

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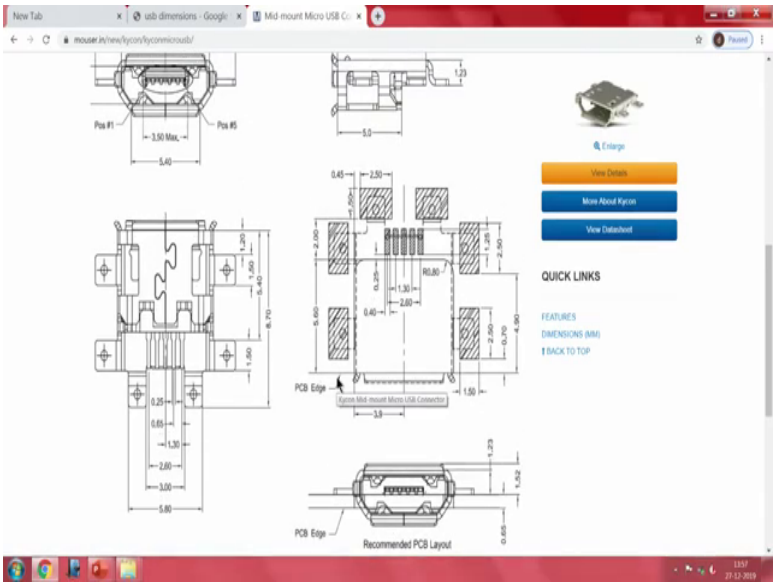

That is recommended way of mounting, if you want the final assembly usable.

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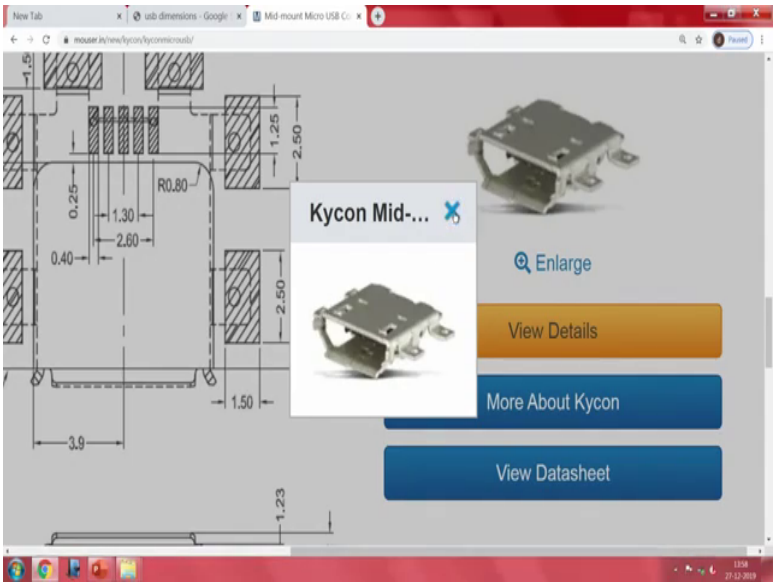

You seen this, it has 1, 2, 3 4 pads for either putting screws or mounting it and finally, at distance from the printed circuit board where you need to this is the recommended distance how you mount it.

So, the dimensions of the pads how much it projects at the back and the footprints of all the other devices are all given here. So, you can solder them or in some rare cases you can even probably put some screws and mount it and all that, this completes only this completes the whole assembly of the device.

So, you will see here other things also they have been given here saying, after you put it on the printed circuit board how much it projects out or in, and then you see the level what

looked like which is on top of the printed circuit board, need not necessarily be there because unnecessarily you will be wasting space.

So, in this case if this is a double sided board both sides of it can have components, the whole profile of this, whole thing can be within whatever has been mentioned here. Probably, this is one of the better devices. Total, the total height everything within that you will be able to peacefully mount the device as you like.

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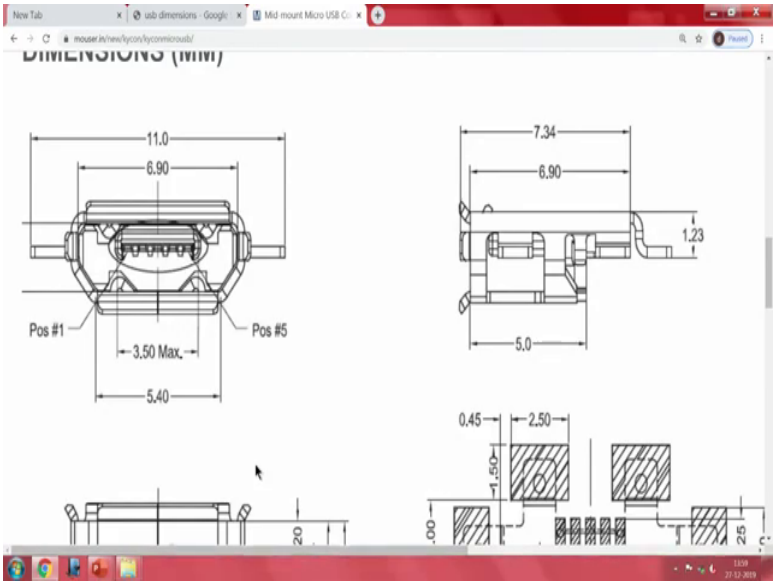

So, if you now go around you will discover that every possible; every possible option everything has been given here and it is visible for us, usable and it has been off late, it has been it is getting a convention that most manufacturers also give us the CAD file if you want. Sometimes the full CAD file is available.

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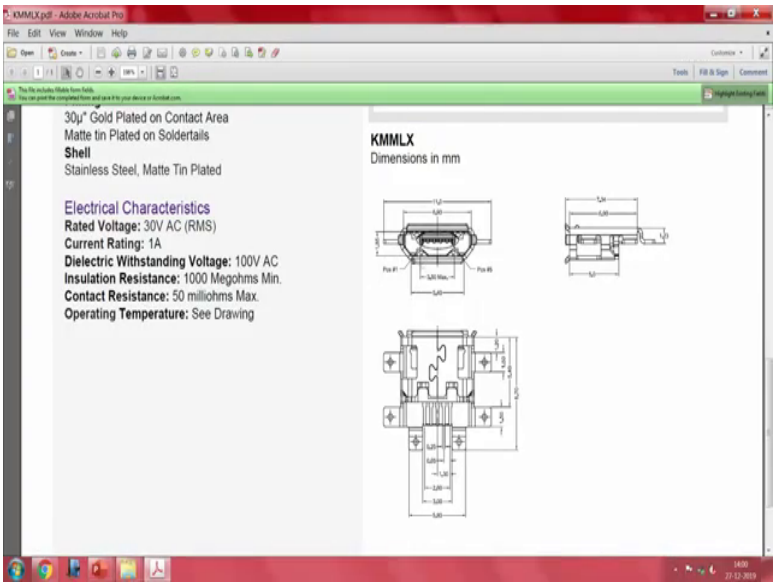

When the CAD file is available it is easy for you to just to you know what do you call use the CAD file directly. Unlikely case it is not given for us.

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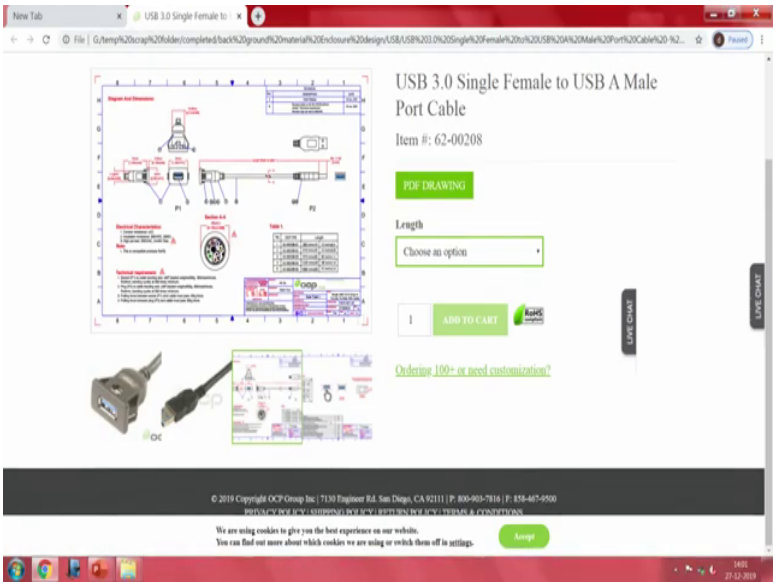

It is we need to go and make the necessary model. So, here if you see here for example, there are they have shown things which are part of the cable. So, imagine I need to take out some connection from here, if I were to use a purely modular approach I expect that there will be a header somewhere on the printed wiring board. So, the small wire which goes from the header and directly it goes onto a panel, the panel will have a bulkhead mounted connector on both sides and from there you take it outside. We end up with extra 4 or 5 potentially problematic pressure connections everywhere.

So, in those cases probably we can take some wired connecter and then directly solder it there and then we can, see here, notice something.

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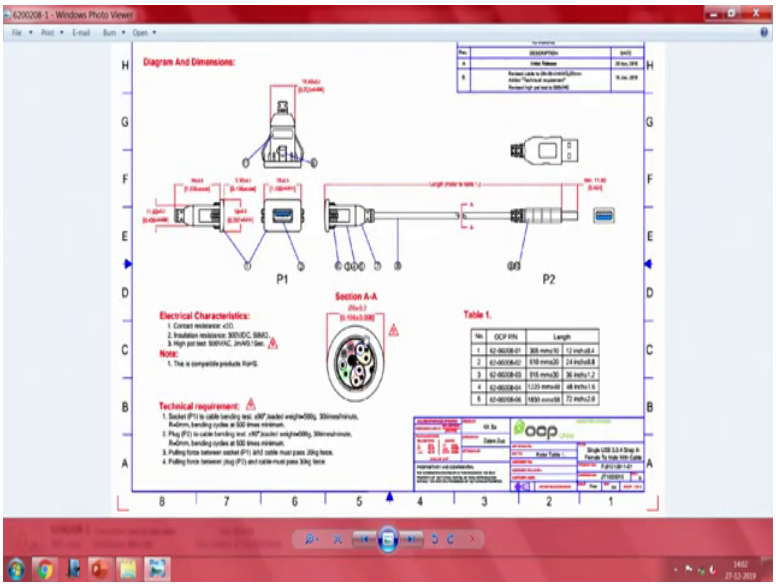

This connections for example, also come with other options, a large number of other cables are also there. I do not know where it is or what is the requirement for these things, but most of the time cables also give you important thing.

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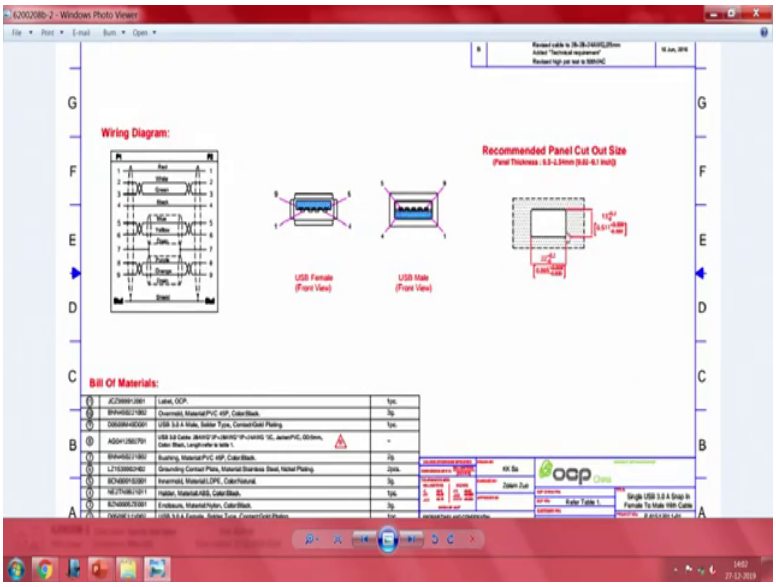

You have seen this one beautiful thing here saying, what should be the dimension of the panel cut out. So, instead of your having to design every time, if you make a solid model which incorporates the female then it incorporates the male the plug type and the socket type, and also recommended these things as per your practice and you see here there are both direct parallel versus complimentary type of connectors are also there. If all these are included in it chances are you will do it extremely well.

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So, you see a very conventional thing here.

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And then have you noticed something here, it is a very beautiful system. This USB thing comes with a wire cable and panel mounting directly. You do not have something which is hanging in there. You just need to make a small opening along with the cable, push it onto the panel, it sits there.

Now, if I were to have a model of this with all those things which I was stacking to it is three-dimensional and it has 3 what you call layers, one layer is visible layer in which you have the outline and you say you can stack them together, next you have the panel cutouts in which you can push inside at the back what can be done with the whole designation. The whole thing like this can be very very conveniently made inside.

So, before I wind up I will just try to show you a cable harness. I will see what pops up. Exactly what I was looking up it. Looks complicated, but then if every switch already comes

with the recommended termination, it is very easy for you to go ahead and make this set of complicated assembly.

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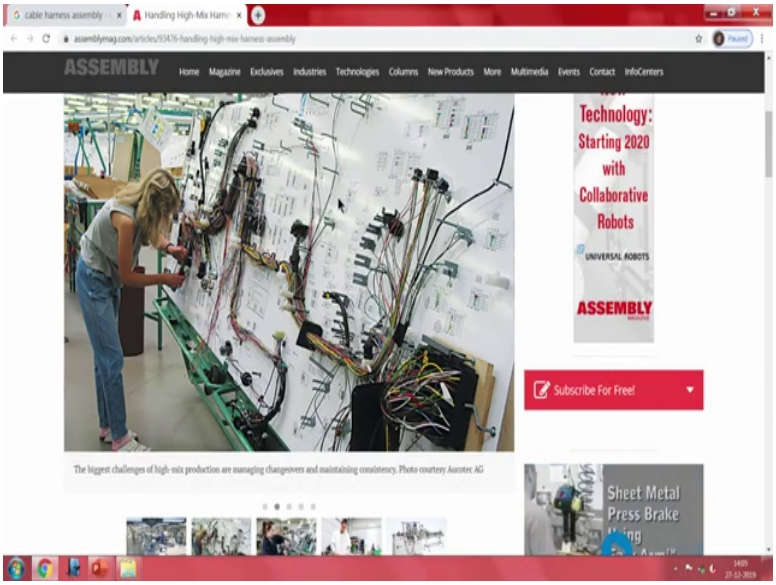

So, one of the first thing you will notice is you seen this. At the end of everything they are not just hanging wires, everywhere you have connectors. So, if you had shown the proper terminations there and put it on layers making a three-dimensional harness is way very very easy. The harness wires and all maybe three-dimensional, but finally it can be made as flat as possible.

Since I am sure several of you have a car or seen the insides of a car, these days cars which have been made let us say last 2 or 3 years they have cable harnesses with every possible connector already mounted on it because the risk of catch making of fire around connections are banned. So, if you want to add a parking camera at the back you just need to drill a few

holes make the camera and just somewhere if you search around in the cable harness there is a connector.

So, you take all this maybe 4 or 5 sensors your camera, probably it has what do you call IR source, all of them there is a connector already fitted in it. Probably somebody has thought about it and designed it. Same thing with the front.

If you want driving what do you call LEDs all the time, probably there is a place for you to plugin and all the things will work. And the key to that is when somebody has made the drawing of individual components, they have probably made with all the details including a place, how the connections can be taken, type of connections, and then a place where you mount it, the panel mounting and then what is visible inside. And any maximum outline which is there. So, you can easily space them as you like, you can put it them on a matrix array you know distribute them and all that, and you have a beautifully working solid model. The key is this solid model and solid model has layers.

So, once you just move all the things surround and adjust it, selectively you can switch on the drilling or panel mounting layer and most important is the front vessel or what do you call graphic can be easily designed including grouping of controls and all that. And you can extract the information and have it as a screen printed or you can have a vinyl or you can have special fabrication facilities where they make the whole thing and give you.

So, at that time you can get the wiring harness, assemble all the components, probably push all the connectors, apply the (Refer Time: 32:57) that graphic and your design is very ready without having to do any iterative things. All the iteration can be done directly using the solid model with the features and by moving around everywhere.

So, I will stop here. And I will continue later; the slightly different example saying how we just mount a few components and then how can I extract the information including the different layers in my next session.

Thank you.