Electronics Equipment Integration and Prototype Building

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Lecture - 30
Electronics to Mechanical interfacing

I will now continue with where, this so called Solid modeling is useful for us in laying out electronic equipment. One example I had shown you earlier was a small bush which was part of some support for an what you call chassis which is connecting with a plunger of a hydraulic jack. There typically, it is a purely machine shop process orientation and utility of the item and we have not used any stress analysis or anything. It is all about what are the available materials; how to make drill a hole on one side and the groove on one side and use it like that.

And then, if you have to make it in a very large quantity, then the other things will come saying how to do value engineering of the component. Imagine this bush is to be supplied along with the jack, then that value engineering people will suggest how to make various alternatives including you can probably take a 2 or 3 millimeter some raw material and form it in one shot you form it and you pack it along with the that remaining thing it is useful. Now, in this case since we are the electronics people and we are curious in trying to make use of this for making such units.

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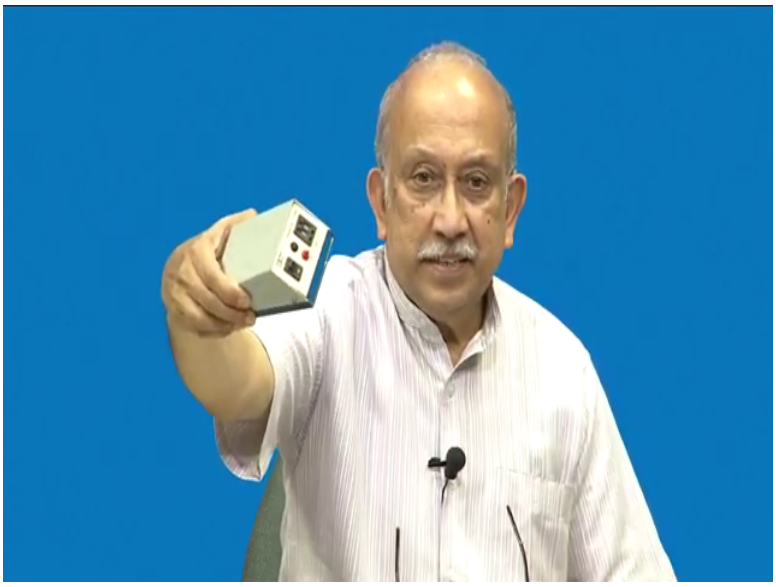

I am trying to share with you the our own experience in making these things, not long ago means around 20-30 years back, we had to separately do various things including one side is a circuit design and somebody else is takes the circuit design and makes a useful enclosure with it considering all the other things.

But right now once the this new cat techniques have come end, it is accessible to all. It is much easier for somebody who is a little beyond that what you call simple circuit design and then, go on to actually make a small prototype, so that he can demonstrate it to his colleagues. So, last time, when I was searching for it, I was sure telling you about the various types of data that is available with respect to each component and we can make a solid model of any of these items.

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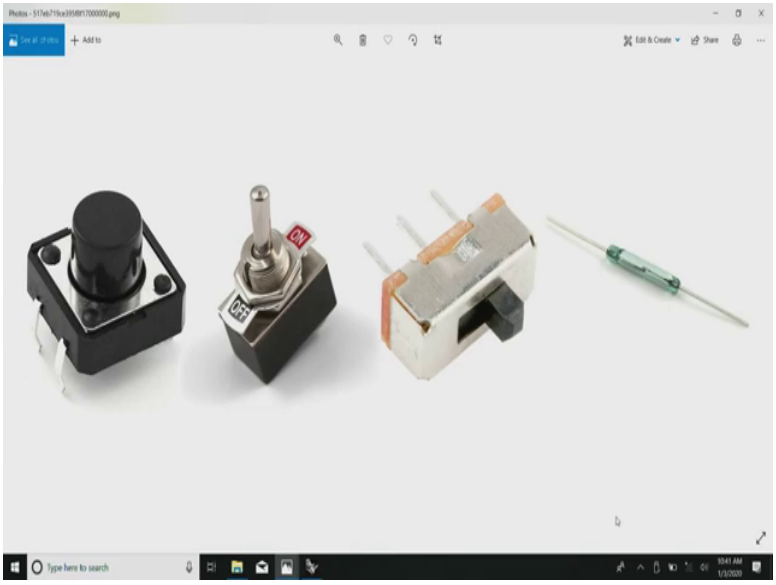

Now, if you look at my this other monitor, last time I stopped here. If you remember saying the 3 types of I mean three groups of entities which are associated with any of these things. Electrical part, we know, the electrical part is this. The inside, what is the connection and something which is related to mounting of it ok.

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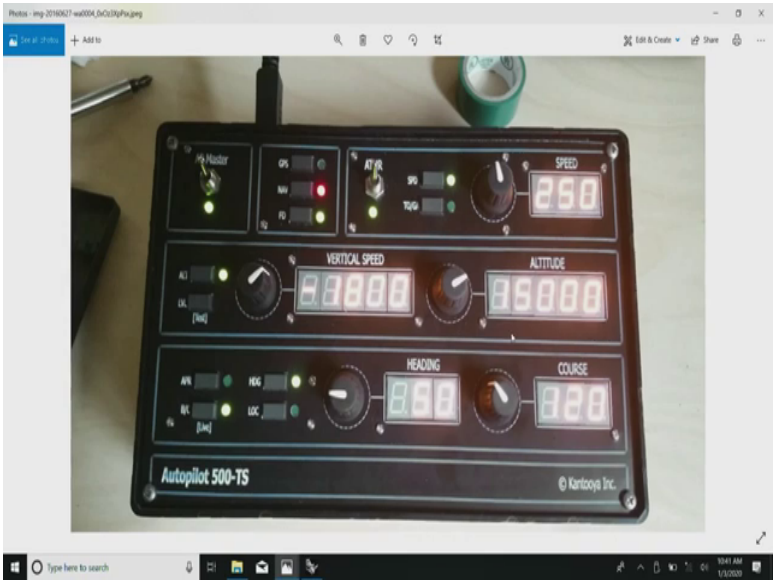

Then, the one that is visible on the part front is the one that determines the actually the final product like this. Seen here, this product we have for our convenience I can show you know there are other certain switches and we can maybe switch it off and switch it on and there are rotary elements and then, there is a display element.

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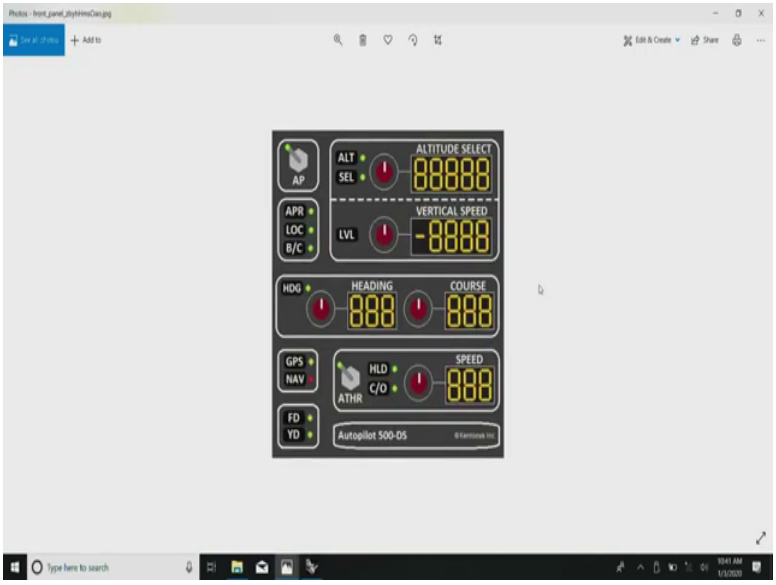

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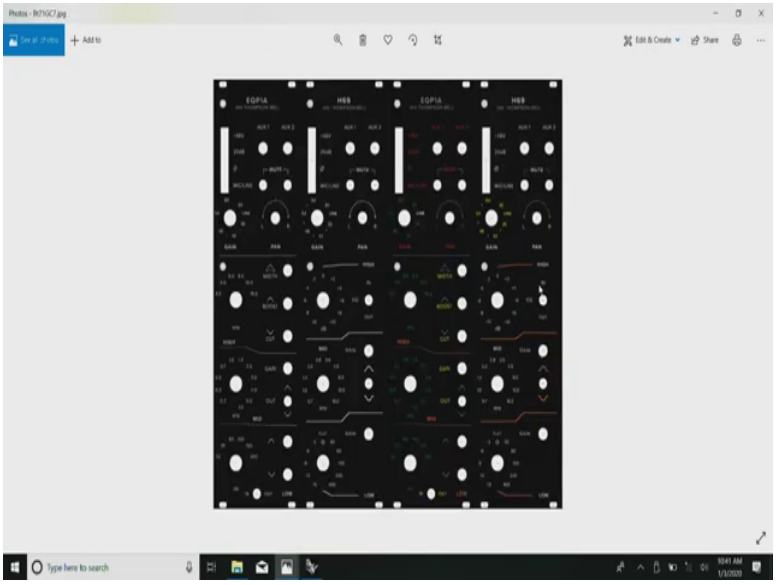

This is a real item. This is probably just a simulation and this is typically a front panel that needs to be fabricated. At this point also there again two points are there; one is saying yes, certain openings and all we have several openings here and then, you have several graphics associated with it.

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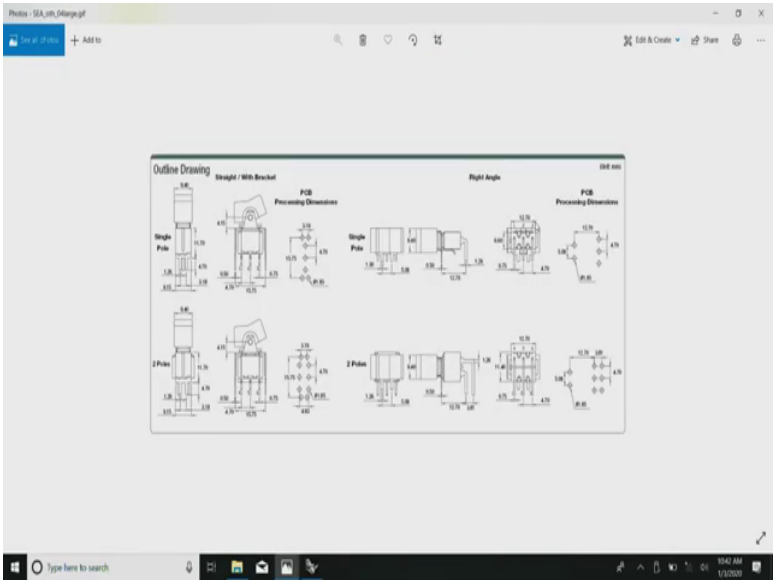

So, now if you remember, I had stopped here last time.

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So, these are details about one particular switch and if I. Now, you have a look at this, what looks like a very simple, simple toggle switch does not I mean nothing great about it except that first thing you will notice is that related again to the various things mentioning earlier. You have the electrical thing inside and the pad or footprint for you to mount it and take connections out of it and here also have you noticed this seems to be at right angle to this to this axis is at right angle.

So, by principle that means, you have a horizontal or a printed circuit board in this plane and another thing which is also very important for you to notice is that there are two mounting legs which is part of this device and this part projects out of the equipment. In this case, because of various considerations the cylindrical portion is that long and thin and if you see

the operation of it, probably after you put your fingers and operate it, it does not take up too much space. So, somebody has done tremendous amount of engineering of these things.

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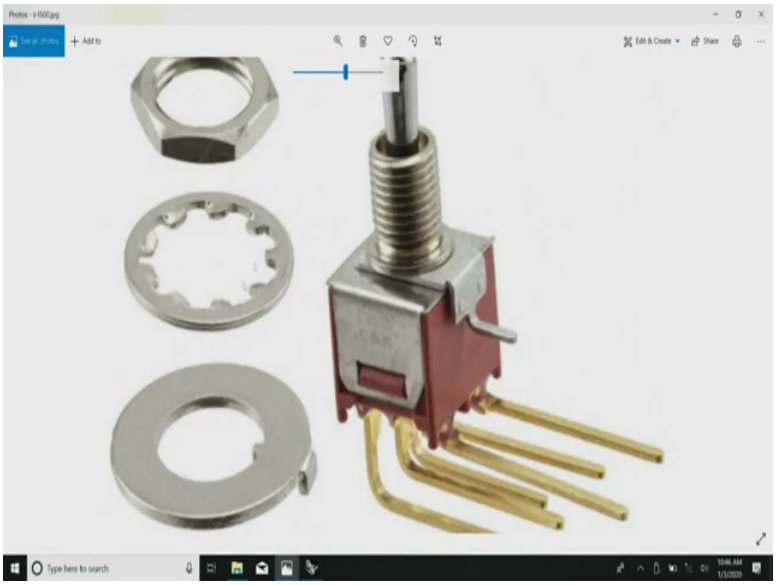

That is the one that I have shown you. And now, you have a look at this the same thing only it is about the same thing except that first thing you will notice here is that mounting detail has changed a little. Seen here, there is one hole I mean one single operation here and then there are these leads and then, here we come to the most important, the panel mounting detail.

So, if you have a panel like this; how do you attach it to this here? So, in this case there is actually a small bezel here. There is a screw they have given here and this is made a little more presentable. And color also is there because of various reasons probably in this case it is a reset and start switch and then, we have various other things here.

Now, related to this is the mountain detail which is shown there. In this case, there is a clear lot of things are here and then, here something else you notice is only in the catalog, they will mention details of something to prevent this bush from rotating. Because in operation it may move or wrongly it can be assembled and especially since you have a screw and nut which is being assembled to this here, this will this is likely to move a little. Hence, you have a very big detail about how to prevent the circular movement of this.

Have you seen this? That is it is necessitate here because this movement is there like this. In contrast, if you go to the other thing; in contrast, if you had gone to the previous switch that device is not there because here we are not assembling it with any circular movement like this; but then, by definition, it also means that by some chance if you push it or if you otherwise mishandle it this whole thing shakes here.

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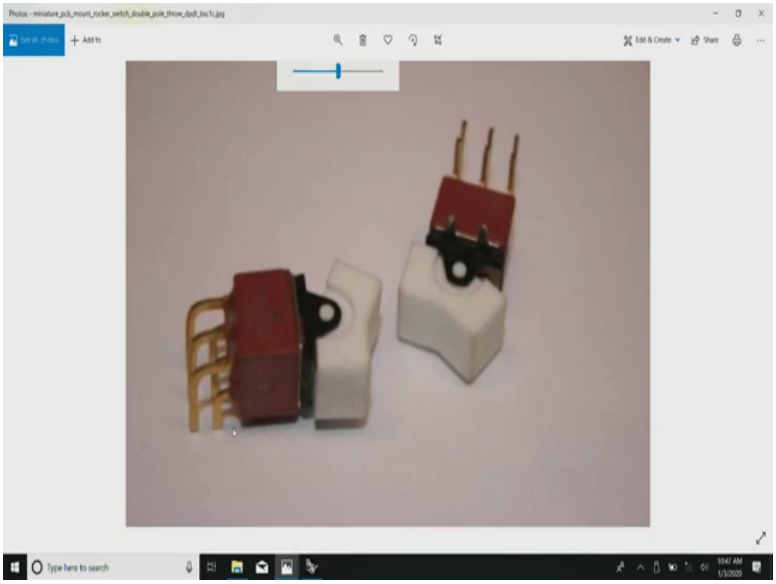

So, all these details become tremendously important. Though it looks as if this is insignificant. You see here these things are mounted; obviously, it is mounted horizontal because this printed circuit board is here and I do not know for a matter of convenience here, actually the manufacture here these things are shown flush; likely, it is just for the what you call photography; they have done actually they project out. So, that directly sits on a printed circuit board which is really a boon to us.

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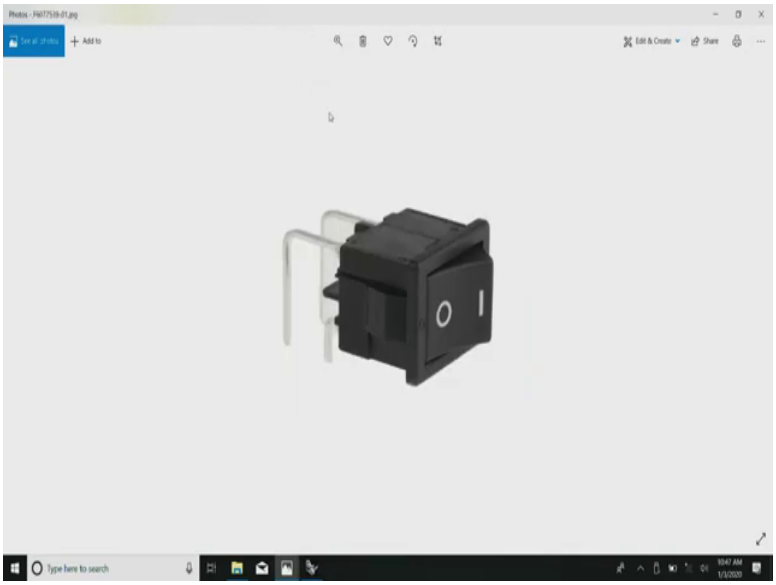

The simple on-off switch; traditionally on-off switches have if you see here, this is same switch as we have here. Can you see here? Same switch as we have here this switch instead as when mounted directly on the panel because there is a bezel here that these things are mounted on the panel, these things are mounted on the panel and connections have been taken

from here. Unlike this in the case of this switch, this switch is directly mounted on the printed circuit board and still you have this lugs to mounted on the front panel.

So, when you have to make a detailed drawing with layers and make a solid model for this, one of the first thing we need to ensure is what is visible on the outside, the visible portion. Then, we also need to ensure that the mounting detail saying what is the exact size of the panel hole, we require and what projects here and one more thing is the details regarding how it sits on the printed circuit board.

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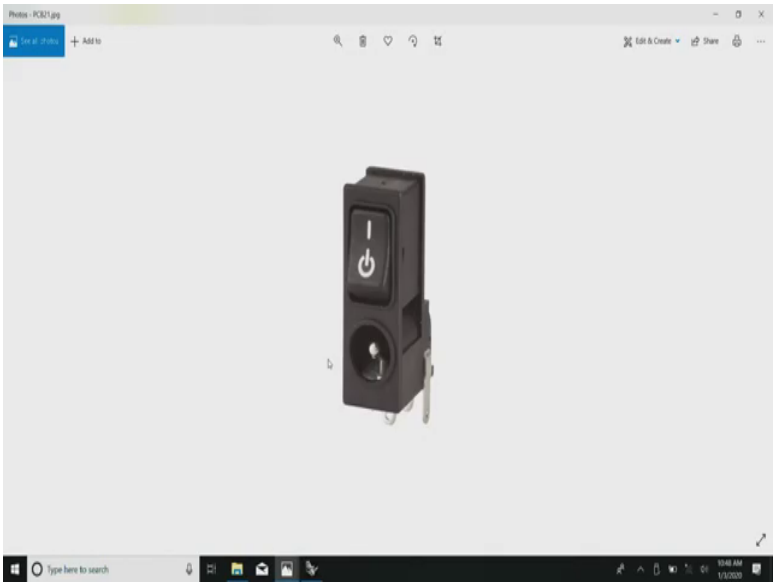

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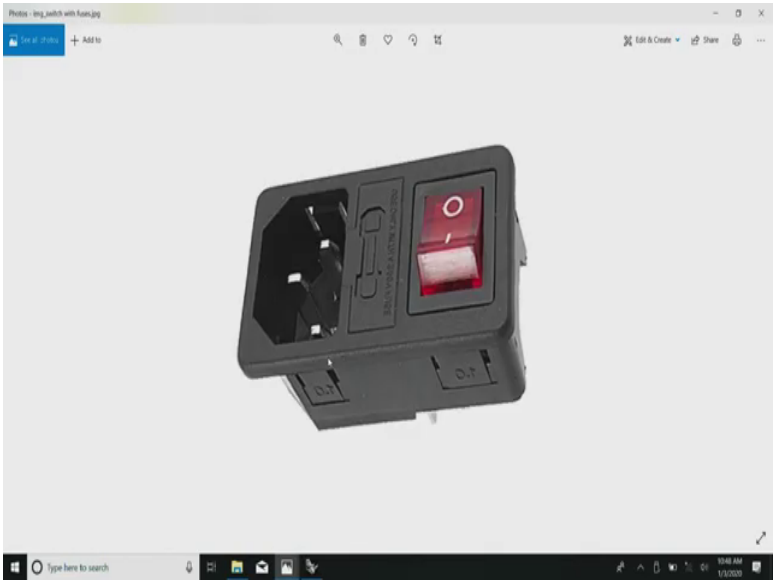

You have seen here. While this looks ok now you have a look at this.

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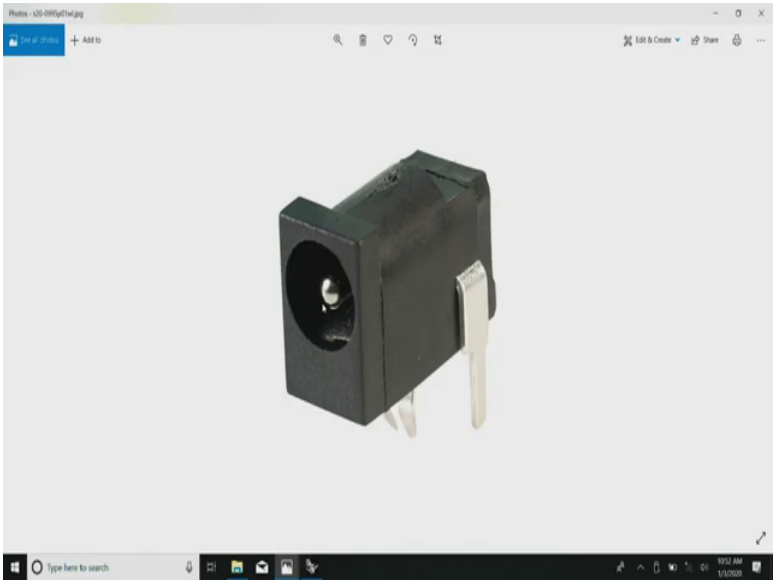

I am sure, you have come across this in all your various projects. This is the basic power supply jack, while it makes a lot of sense if you are directly mounting it on a PCB and then, have it just touch on one of the sides, it makes sense. No problem, you just need to have a hole and then, it just touches here. Now, comes the important thing saying how do you mount it? Not that easy to mount, is it not? There is no reference detail which is useful for us. This in the long run may lead to all sorts of surprises including errors.

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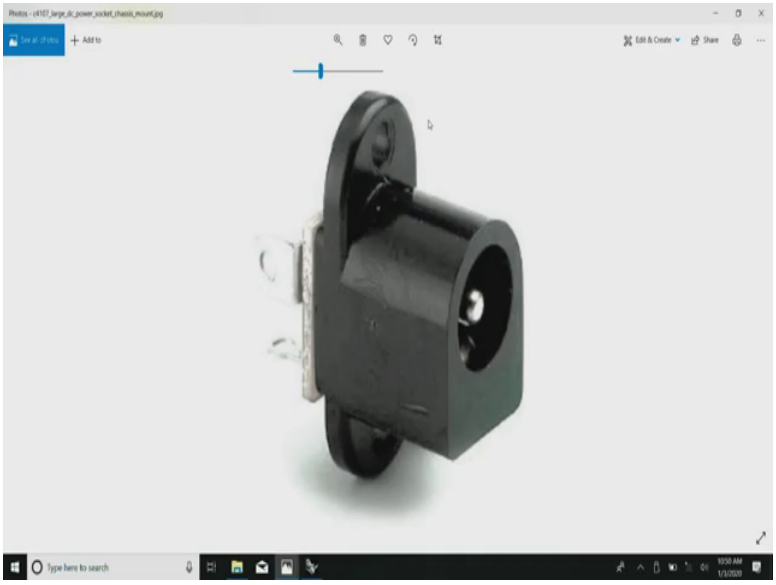

In contrast, if you see the other picture I could get on the internet, you see here. Notice something about this here. The same thing; same input jack except that it has to nice mounting holes. So, device like this is very convenient for you. You can actually depending on the way you wanted, this particular version, this contact arrangement is projecting out. So, the advantage of this is we can probably mount this on the printed circuit board or somewhere and then, take connections from here and this portion can project out. Alternatively, this directly can be mounted on the panel may be behind the panel and then you take wired connections from here.

This detail is extremely important in our prototype making and engineering. Without this detail, you understand, see it looks very insignificant here. After all, it is a connection; why cannot we put it like that? I am sure, you would have faced it everywhere. Even if you take a simple your mobile phone or if you take a so called power bank with batteries that micro USB

connector, it is not firmly mounted there, the part of a PCB and after little use, you will notice that it will look and see where you need to push it inside and as is common, you try it does not go; you reverse it, it does not go; bring it back into the original direction, probably it goes, leaving the small voice crack inside, the.

If there was an arrangement by which it can be mounted properly and all that which is fine in a little more expensive phones and especially, now that DC connector has come that is USBC and most apple or what you call IOS lightning connectors have a very very beautiful arrangement of connecting it. It is expensive of course. So, how you make this detailing is much much more critical.

I hope I made my point saying a thing like this it is unlikely first of all, if we try to shake it either one of this thing gives or this thing gives one of them creates a problem; but this other one it is firmly fixed unlikely that even if you what you call force it or there is some misalignment that this connections do not suffer because of it.

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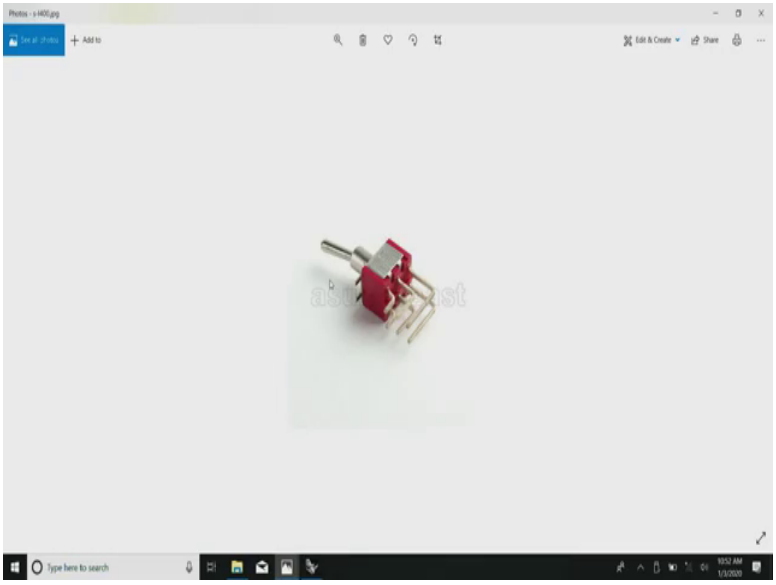

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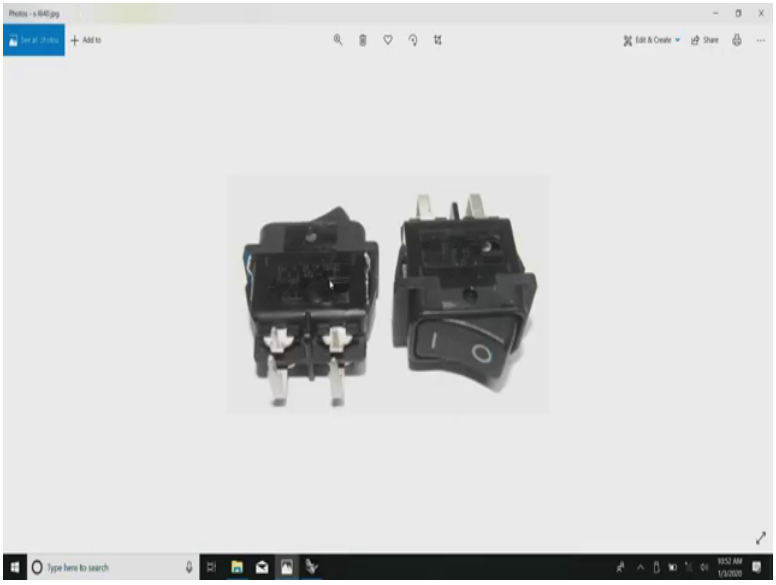

This is that switch which I have shown earlier except that, this is you have mounting of the thing directly on a printed circuit board. You see this point, there is provision for it to be mounted on the PCB. So, these really really really are useful items and now I am sure, all of you have come across this. This is the basic input to most equipment where directly they work from the mains. So, in this case, this is probably it belongs to a printed circuit. I mean not printed circuit, your PC and they there is a fuse rating and all that these are all standard safety devices.

So, these things, it is sort of specified that you require these things and why I meant telling you is they are supposed to be alternate source and replaceable by any other thing. Somebody has extended it to this. I am very very happy about it saying you have a device which can be mounted on the panel and then, you have a power supply here and then, you have this. It is expensive; probably it costs you know 5 to 6 times that of the bear one. But the advantage is

you can leave your power supply in and then, selectively switch it off and switch it on, which I think now it is a real; it is a real wonder for us. Yeah, it looks like I have finished this at this point.

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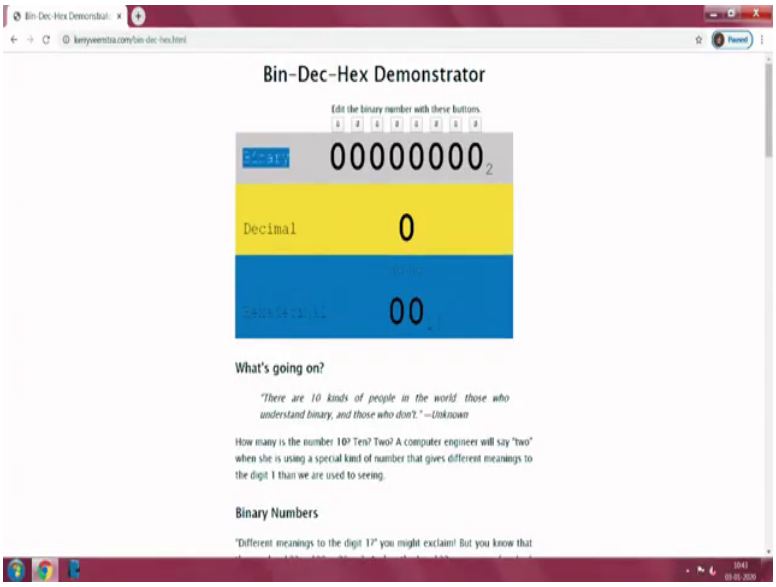

Now, I just saw it; it is about time that I try to use those components and say if we can do something about it and make a practical equipment out of this. This I have just now randomly picked up from the internet. You see this is a very routine useful thing which lot of first timers and people would like to demonstrate things to others try. One of them is saying if you have a binary number and how do you read it or in contrast, if you have a decimal number, what are the binary inputs in it to give?

So, here when 8 bit what you call simple demonstrator is there and to make it this is where the chicken or the egg approach, to make it look very much like the early kits and what you

call logic things including NAND gates and all that, they have made it look in fact a little like a front panel.

As part of looking at like a front panel, you have this row of 8 switches there on top ok. So, the extreme right side one represents 1 and then, it goes all the way up to the 8 of them know. The last one represents the 2 to the power of 8; this thing. So, if you look here, this easy sorry for what you call spending too much time and so on. You can go to that binary decimal hex demonstrator.

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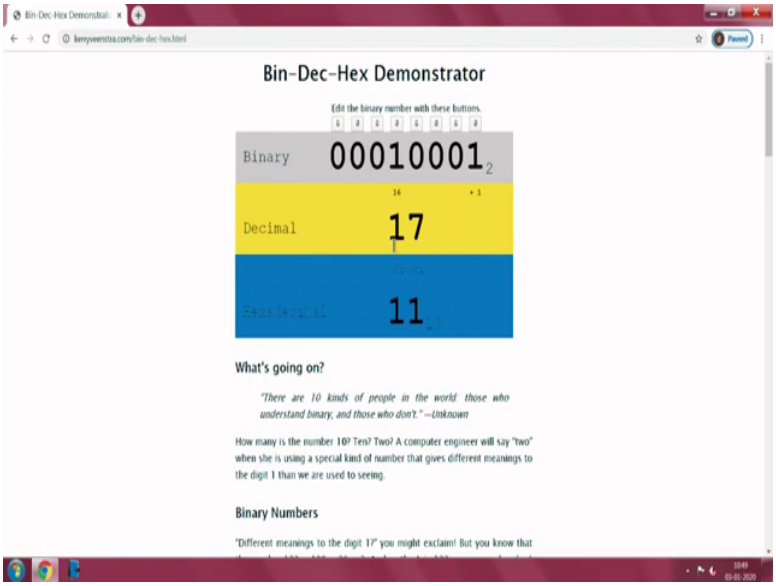

So, imagine if you have a row of these switches and it traditional that that last bit to enable it, we know that equivalent decimal is 1. Good enough; is it not? Now, I randomly take the 16th position. Now, you notice here in the case of is usual binary, you have 1, 2, 4, 8, 16 and so on like that. So, 16 plus 1, 17 is the decimal notation. Now, we come to the very peculiar; do not

be upset, but allow me to repeat this. We probably started with the decimal system because of the 10 digits we are having. Whole thing started with 10 digits thing and in some places like in parts where we leave, the count goes on up to 20.

After 10, we do not have something something you know 10 and 1, 10 and 2 and all that you know; instead, we have numbers which go all the way to 20 maybe because we ended up with the 20 digits. But logically if you take and make things easier probably next back stays hexadecimal. Now, how does hexadecimal come into the place? Because when they started with the keyboard, making 10 was you know lot of not very useful actually; starting with 4 by 4, 16 is very very convenient and you had count starting from 0 to 9 after that a to f. So, 0 to 9, a to f became the standard hexadecimal thing which is used in most kits and everywhere.

So, if you now go back to an 80-85 or 80-86 kit you have in the lab, one of the thing is you will notice this keyboard and you have 0 to 9, after that you have a to f which is slightly different from the keyboard which we use in the telephone. The telephone, we ended up with 12 keys; so, ended up with a hash and star, which they had to use which I will come back to you later. Original dialing phone had only 10, 1 to 9 only was there. Later on, when the DTMF came, it was very convenient for the Dual Tone Multi Frequency to get into this 12 thing. So, it was possible to include hash and the star which was used for something else.

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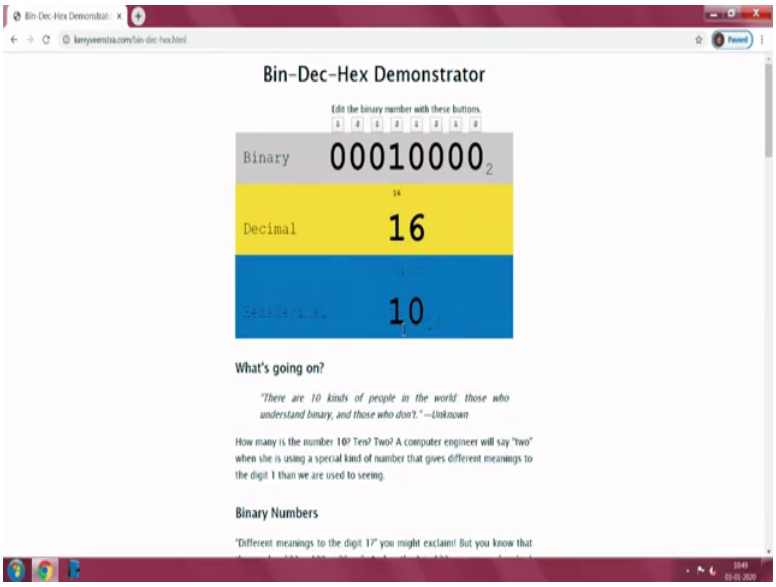

Now, you come back to this hex demonstrator, this is where the last thing comes here. You have seen this. Now, if I disable this in the case of hex, we have 16 plus 0. So, we have this stuff. So, we have this about saying what are binary numbers. Now, why I wanted to show you this is imagine I wanted to now construct something like this, using the various components which I have shown you there.

Obviously, these two need to be on a display. Yes, in this know these to need to be on a display and these two this whole row needs to have some switches and keys and these switches and keys, you should be able to operate and find the status. So, this represents the status of that; follow this represents the status of the keys here.

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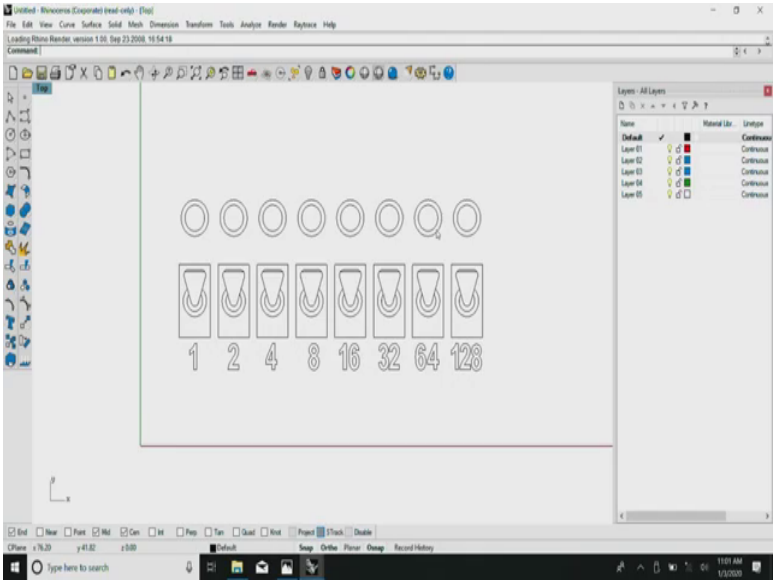

Now, kindly if you see my other monitor here. Sir, just show this monitor. You see here, I try to make this, but due to a small quirk, I put 1 on the extreme left side and 128 at on the right side. Ignore it for the while. But just I wanted to show you that if I were to make a proper solid model for the switch, which is what I had shown you earlier. You remember that I have shown you the that small toggle switch there, if I had to make a proper solid model for that, I need to put this switches as the as I like and intentionally, I had jumbled up the most significant digit to the extreme right; most significant can probably be the left and you have this flowing the other way.

So, with that know making an equipment like that is very very easy by just for you to placing all the components and related to this component is visible portion which is the outside the

opening detail on the facial panel and the wiring at the back. Now, the wiring is required so that you can connect the electronic circuit at the back and have a small demonstratable model.

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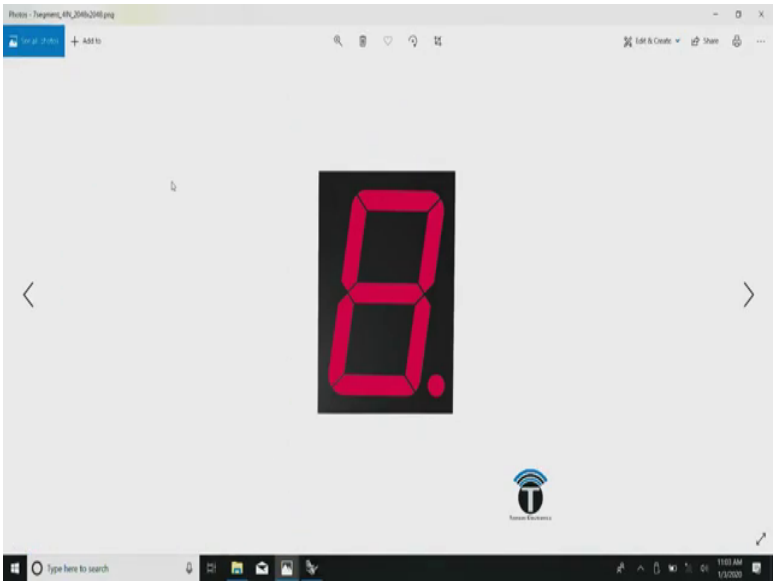

I just started it. Now, I will see if I can go back to where I had left with this things. Just like I had the so much of detail regarding the switch, a lot more detail is needed for mounting a simple thing like this display.

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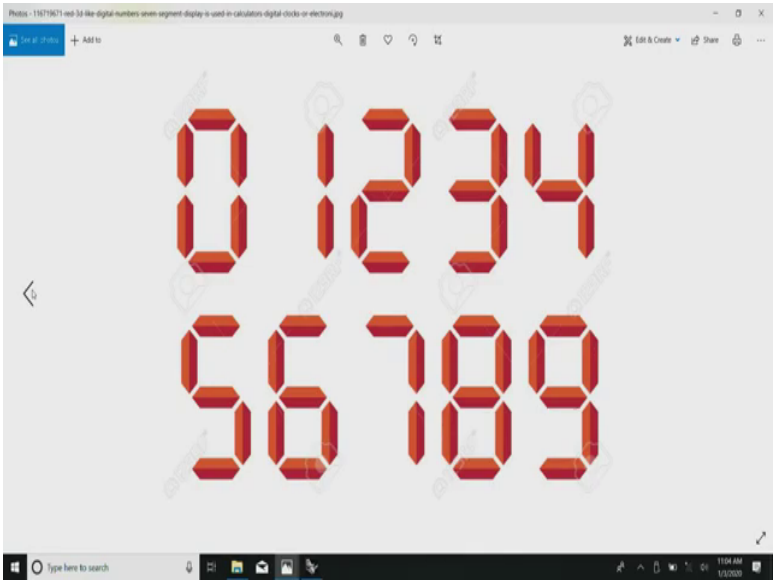

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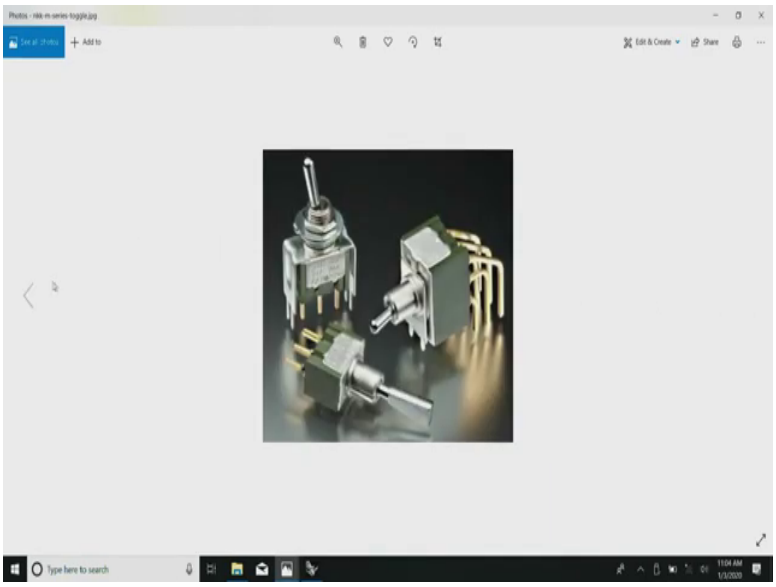

Imagine, I need a display which shows this and a little related to that is saying can we have final thing like this. This is nothing; this is only somebody has made a font which will look like this, the font is not critical. The issue is being actually when we want to make.

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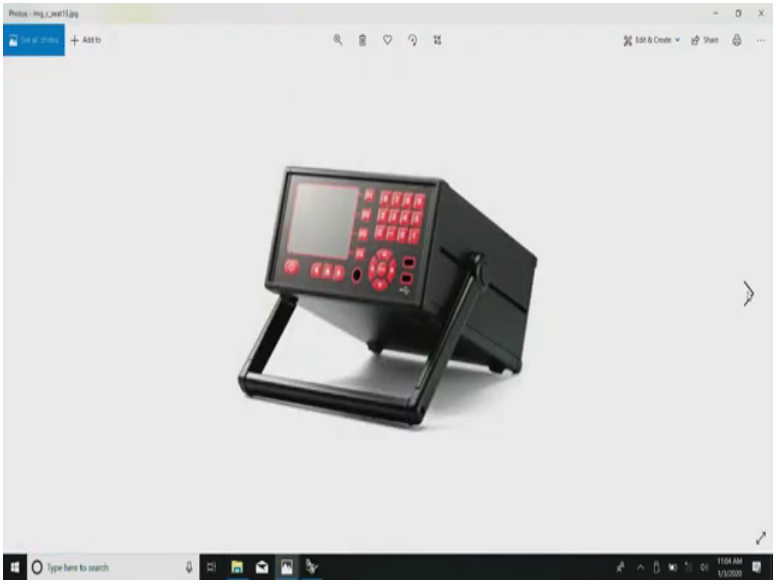

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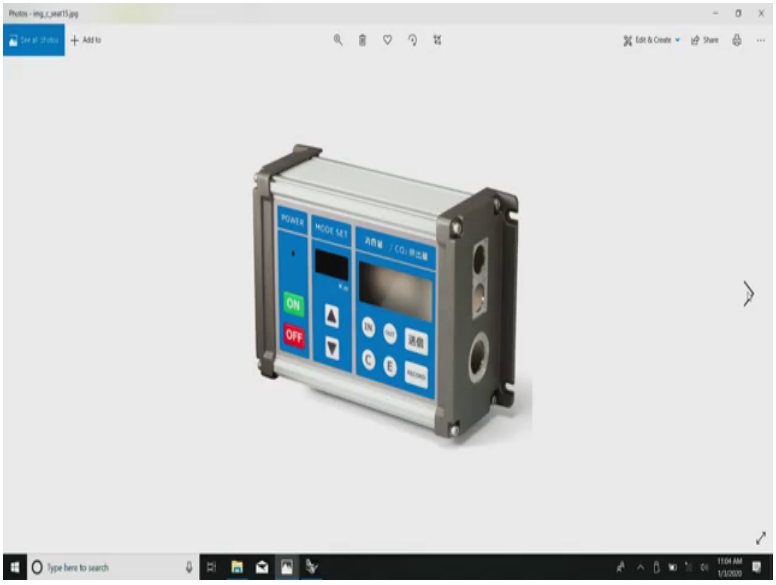

Let us say, I want to make this. You have seen this when the first initial stages have come about saying you have all these connectors.

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You need to do something about it to make sure that eventually, this thing sit comfortable where we want them and then there are lot of, if you have to make a practical some device like this, how do we go about it.

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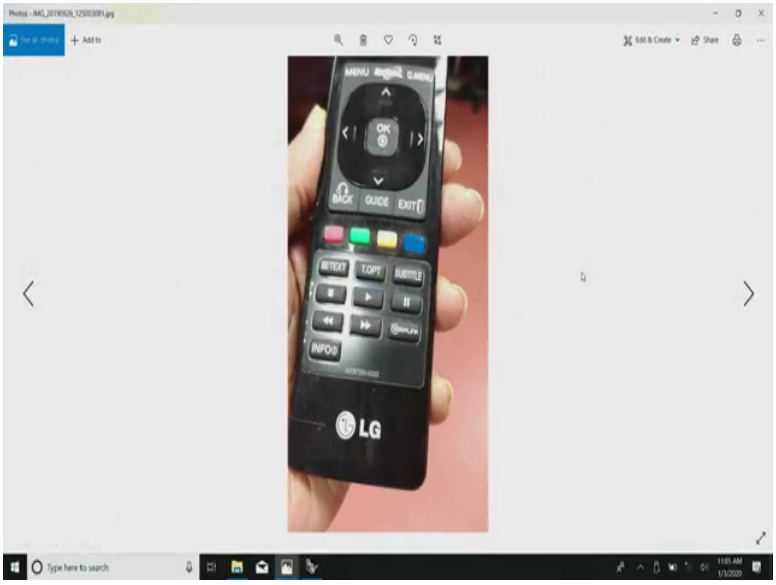

I am just trying to recapitulate where I have left you last.

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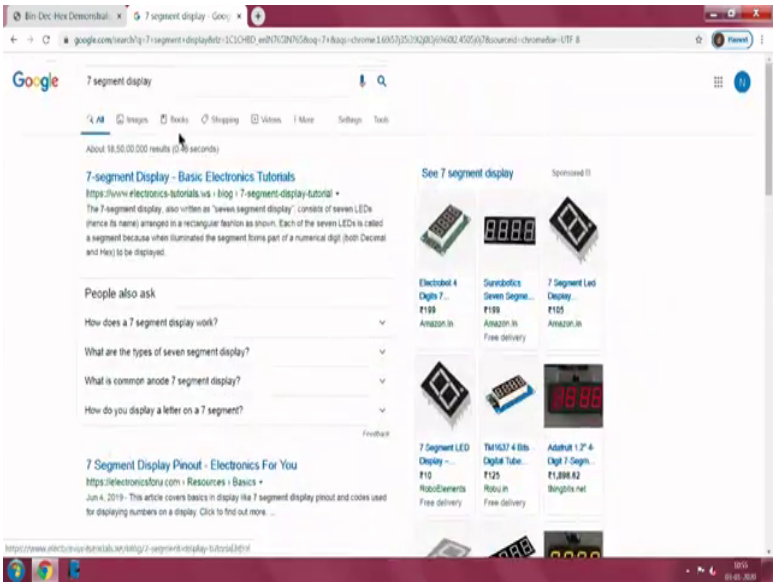

So, if you finally, I mean if you kindly see here, I will say if you can locate it on the this thing here saying we have so many types of this 7 segment displays.

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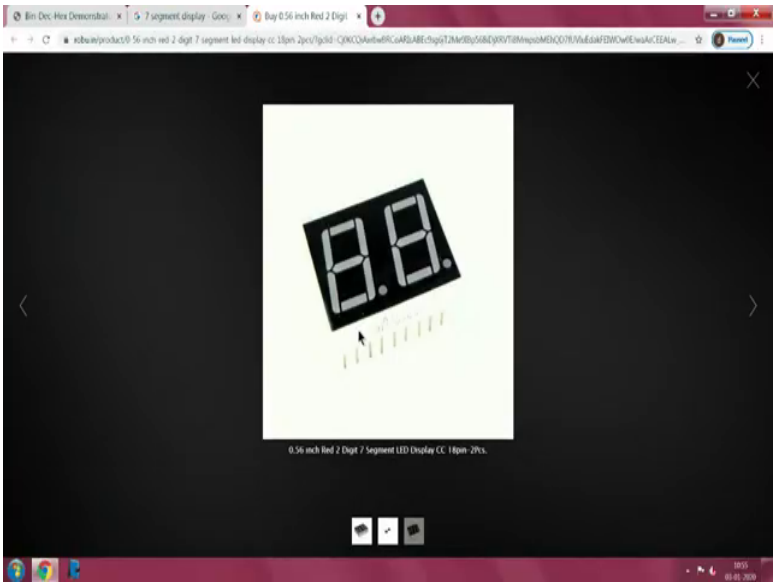

And if you now go to the manufacture of this 2-digit one which we need, in case we are trying to show that this thing what I wanted to show you, you will notice that any detail you want including how to mount it, everything is available from the original manufacturers.

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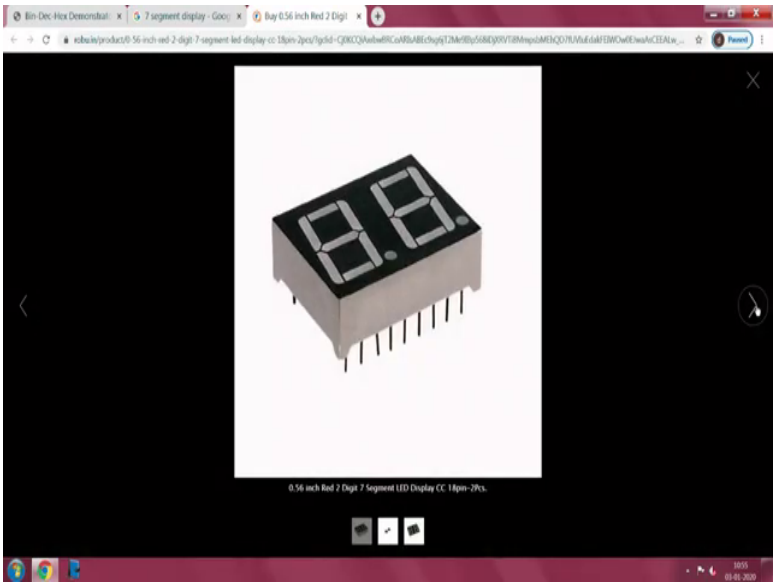

So, in the case of this display, further some other things need to need to be worked out.

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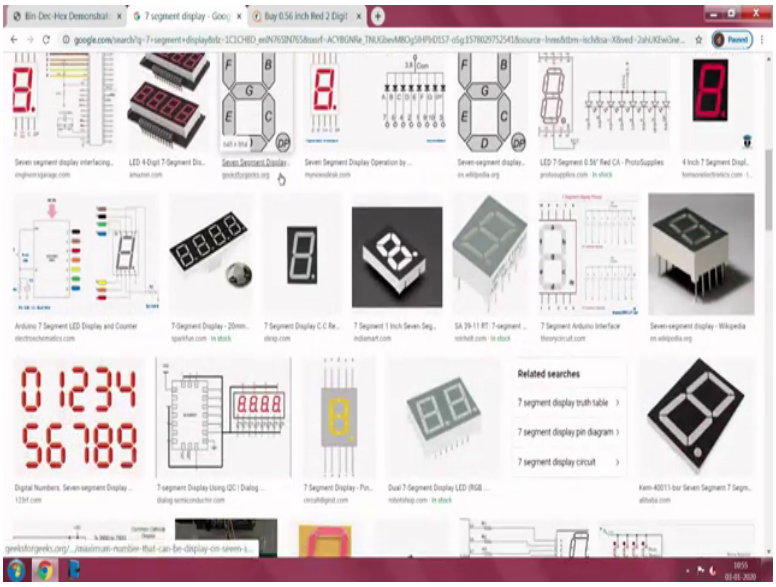

The other things which we need to work out is related closely to mounting and the visible portion of the display.

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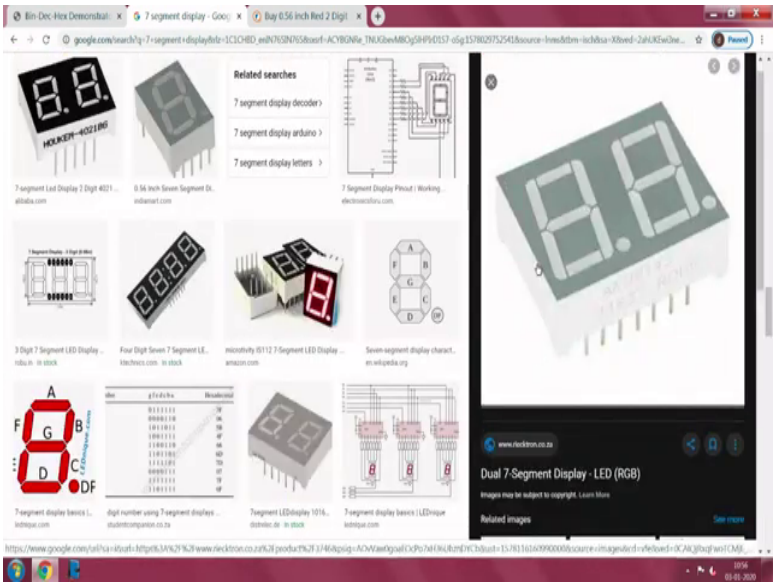

So, one of the things obviously, just now what we have seen is how do we select the number of what you call things, we need.

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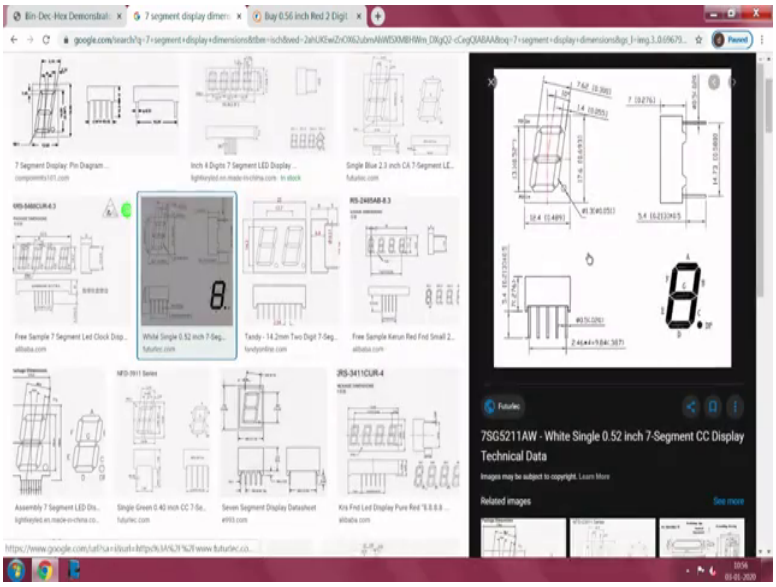

And also, we need to go to this dimension drawing.

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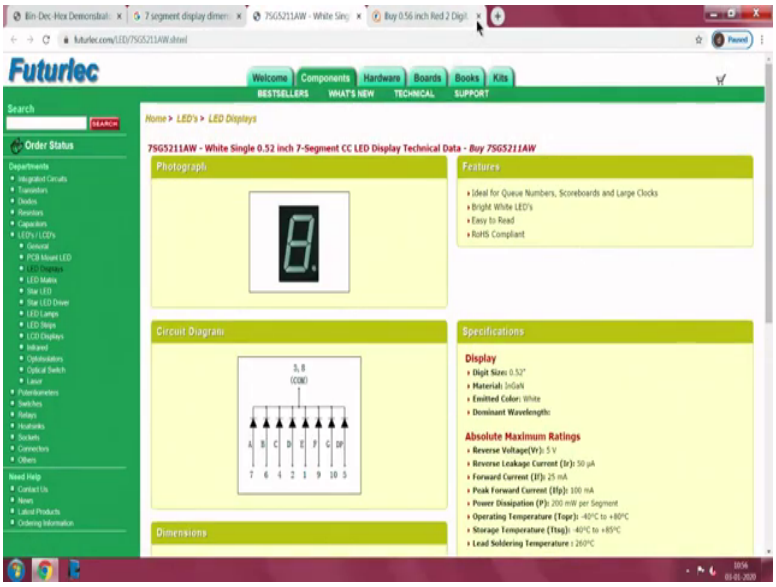

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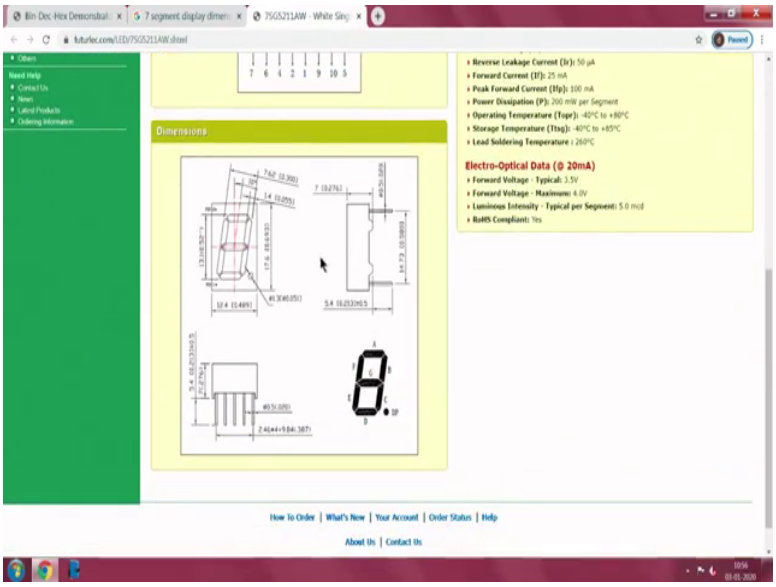

So, if you see here, other than the electric lot about this, dimensions are shown here.

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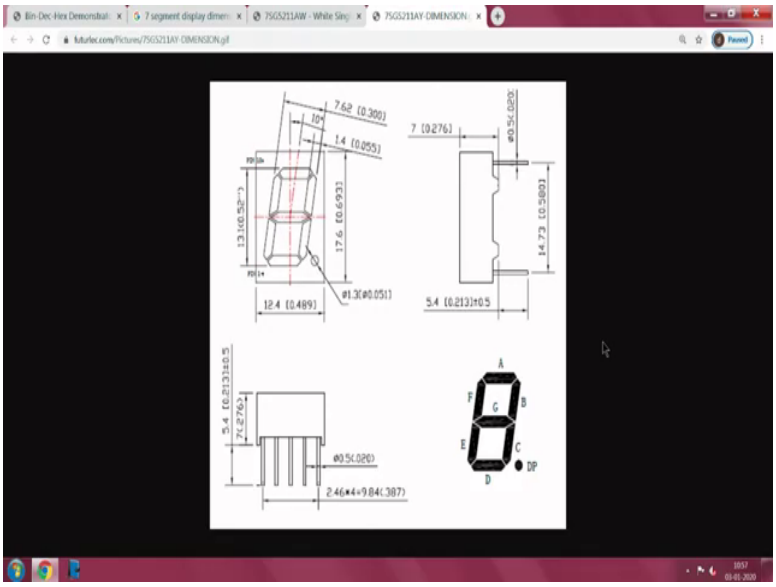

This is where if you remember, I had to also refresh your thing about engineering drawing a little because they show all these things here. Now, we come to some very very important thing saying they have fixed that pitch. Yes, in this; it says 12.5 millimeters and inside in within the brackets, we have the 0.489, meaning that if we were to mount one more thing next to it with a pitch of half an inch 0.5 millimeters, they will fit perfectly and to read the drawing you need to come here. You have seen here. All of them generally, they all directly fit into the general printed circuit board, pitches saying generally the PCB pitches are 2.54 that is 0.1 inch.

So, these things directly go there, occasionally, they also sit in a socket. In the case of if it goes into a socket, there is a slight mismatch is possible. So, lot of these details are inherently built into these devices.

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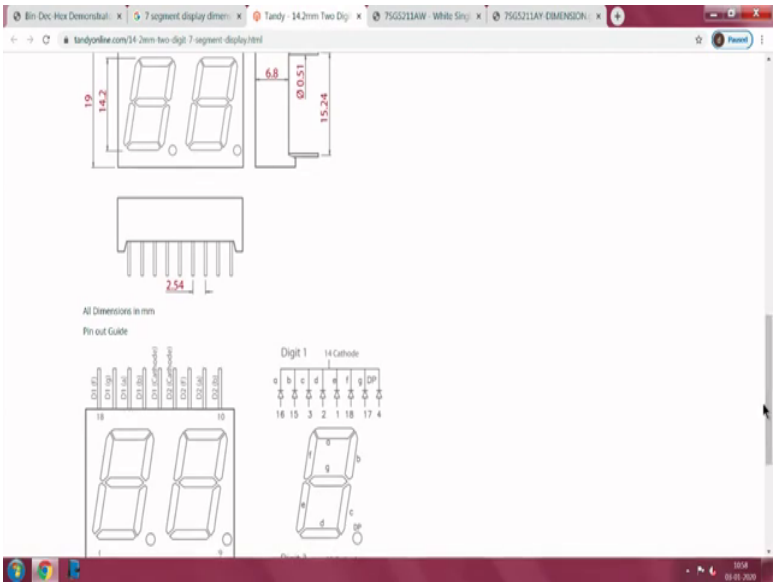

Now, you have a look at this, it is given clearly here that it is 0.5 and 0.1 inch what do you call pitch in which the devices sit. Now, here comes the small, what do you call chances of rounding of errors or how to deal with it and why I chose to select this. The important thing being for some reason 1 point to 7 that is 0.05 and half of it has become the standard PCB pitch.

You understand, it has become a decimal inch standard, it is not 2.5, but 2.54. This being the case all the various mechanical items which will come out and all that still if there PCB mountable, they need to be matched with the that pads and drilling on the PCB. It is also possible for some very peculiar cases to override it. But my own personal take is since the printed circuit board and all the what you call software and rooting software is already

standardized, much better for you to stick to the pads which help you follow the pitch on the PCB.

The movement it follows there, now you need to calculate back and see how do you mount the devices also on the front panel. You understand know? If you are to mount them also or the front panel, you need to adjust for the pitch. Alternatively, which is generally what is preferred is you do not try to mount them at two places; you go, you do not put it directly on the front panel. Also, have you know fixed it on a PCB with the pitching problem. So, instead usually have a window and in the case of displays and all that you have a window which goes over that. You understand?

You have a nice usually a red what you call specifically LED filter window is stuck on top of it and inside the panel, you need to give sufficient gap such that all the pitch and accuracies and mounting in accuracies will take care of these things.

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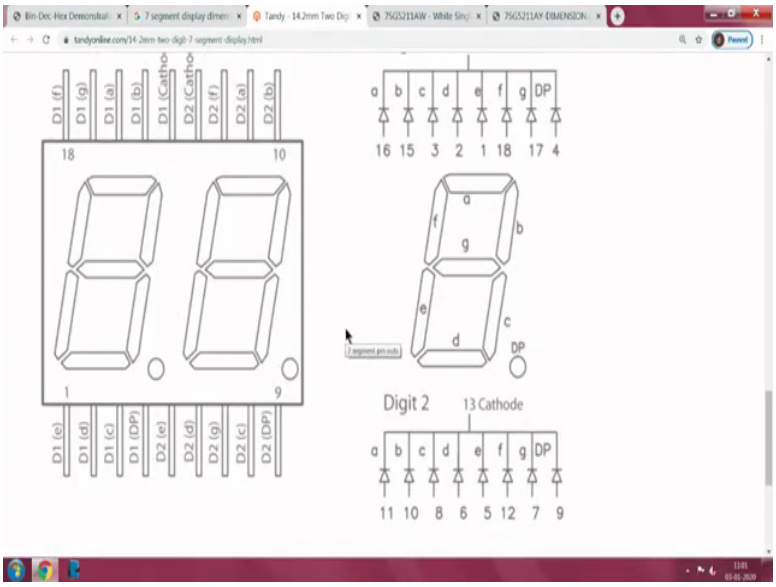

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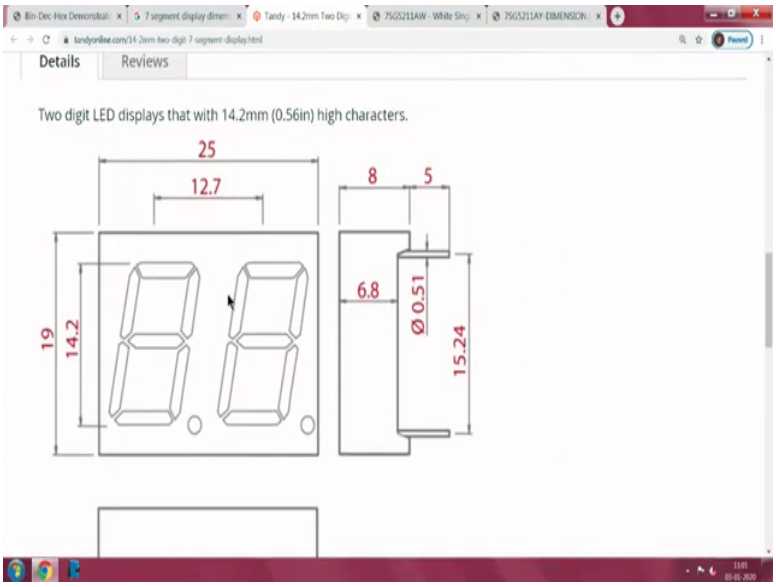

Now, to make it, when you make an opening for this and take care of all these drawings whatever dimensions have given, loosely they have given 25 millimeters and you can probably stack them and then, if you see once again, the pitch is exactly half an inch, the width is a little less than an inch; width is pitches half an inch. So, succeeding things if you stack them together with that same 1 inch width, now you will know in the end how much this whole thing occupy. So, let us say for the present I take 3 of them as a standard. You understand, I have a 6 digit or if I have an 8 digit display, I need to multiply it by this switch and then, I know what is the gap that is around. 19 typically represent 3 quarters inch and from the little problem about this parallax and this window things, generally this space that is left here is also left here and the space which is left between the things are also left here.

So, you make a red bezel which is a little bigger than this and your equipment is ready. Now, I come back to the original thing. When we make these solid model for this, you need to

probably read various dimensions here. One of them is you take the mounting and how much it projects beyond this and this is where the front panel comes. You probably need to make the a line here representing where the front panel starts.

So, in case, you have a proper opening, this can go into the front panel. In case, you do not have an opening or the front panel also has a small window in which a when I will sticker is there representing the front is also stuck on this. If all these details somehow you can include in your model, things are fine. You will be able to just assemble them randomly take it there.

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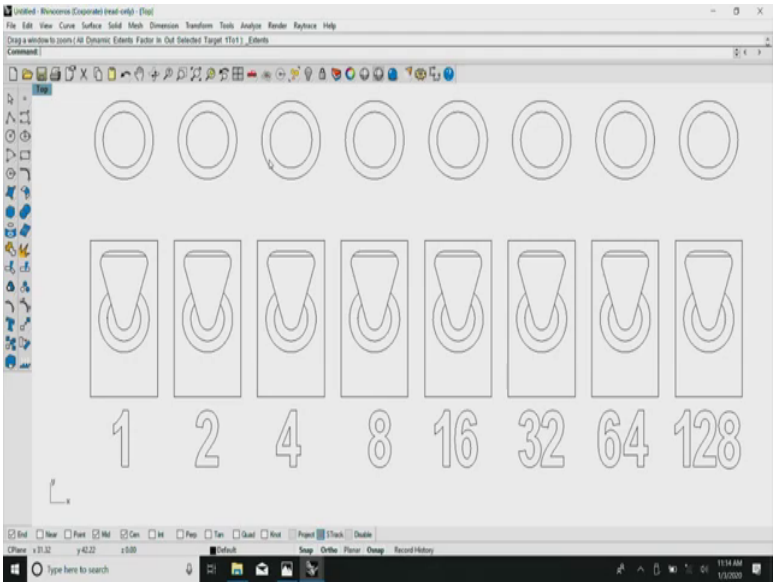

Now, if you look back again to my this other monitor, where I have got this working, represent the keys in which I need to operate. The top represent the status of a saying is that honor of LEDs. Now, it will be very convenient for me if I can make the that small toggle switch along with the indicator on top, along with the designation on top and while the

mechanical things need not be editable. The text if I can make it editable, it is easy for me. I just need to put it and then, that text can be used as a placeholder.

Using such once I make this placeholder, I can modify them as they like. See this now, I can modify this and I can make it into anything. In this case, I have put it like this, instead I can make it saying I can change the text. Of course it is not in a editable mode here. So, if it is an editable mode, it is very easy for me.

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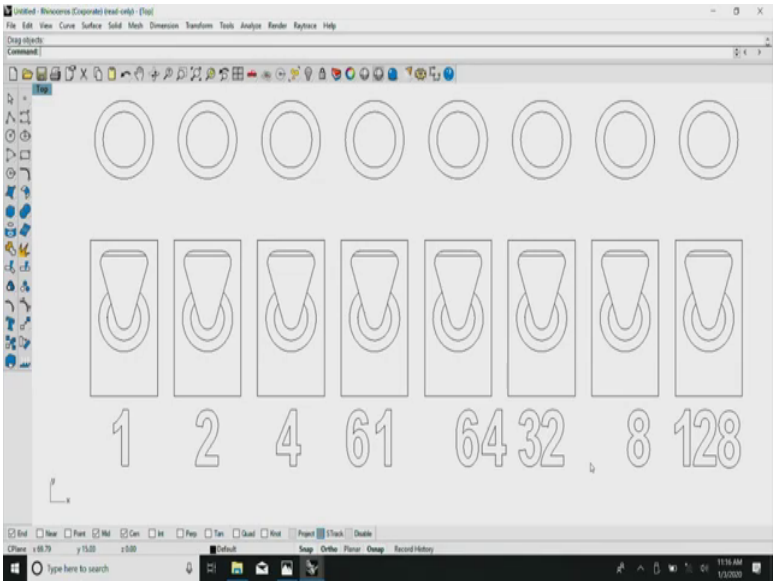

Right now, I can just randomly interchange these things. Do not look at it; do not like at the reading. Just put them as we like the what I would like to say is if you create all this once or if you have somebody else helping you and like me, if you have interns and students who are working with you. You can ask them to create it because they learn in the process and they help you also.

So, if all you require is groups of these items which you need to stack. In fact, physically you do not even need to stake any of the devices; only one device you need. You put it here and then, there are now programs which will extract the bill of materials from this, you can order it and this is where it probably helps the production people also. If they also have these items, very easily they can go ahead and start production.

So, I will stop this session here and continue actually with taking one of the switches taking the dimensions and then, completing this one of the model. So, that two things can be done, using the same what you call the blocks or these things have created, I can make a cardboard model and the same thing can be used for also making a workshop sheet metal work or same thing can be used for cutting it with laser print or with a any other thing and finally, I have a product which can be ruggedized. It can be also these details can be transferred to a standard enclosure and everything all based on a very simple solid model which I have created.

So, thank you. I will continue again next time.