Electronics Equipment Integration and Prototype Building

Prof. N. V. Chalapathi Rao
Department of Electronic Systems Engineering
Indian Institute of Science, Bengaluru

Lecture - 33
Practical detailing

I wanted to continue with the concept of making solid models as part of equipment design traditional, mechanical solid models concentrated a lot on, how to make it make mechanical parts ready? Generally, which refer to the fabrication part, typically machine shop occasionally about other processes which are related to mass manufacture including CNC manufacture and so on.

In contrast, electrical design or electrical or electronic design automation tool CDA concentrated a lot on how to layout a printed circuit board at the other way is saying in case you have a schematic diagram how to interconnect all the things as per the necessary interconnections. And make sure of what is called signal integrity saying the signal reaches the intended portion in the 2 very important things are there; one is, that from a source to a other destination point or the interconnection point it is unique meaning if point A has to be connected to point B and it should be a specified connection.

In the simplest sense it can be as simple PCB trays by which the 2 points are connected by a small copper trace. That is simplest things you can talk about most complicated is when you have multi layers, meaning you have layer 1, layer 2, layer 3, layer 4. Usually, layers in between the layer 2 and 3 can have all the necessary inter connections and the other 2 can be ground planes alternatively they can have ground planes inside and the various circuit elements outside. And this leads to a lot of capacitances and what do you call stray parasitic elements.

So, EDA tools traditionally have made sure that the interconnection is perfect including impedance matching there (Refer Time: 02:58) that made the loss or unwanted EMI Electro Magnetic Interference. However, when it comes to our designing front panels and items we come out with a slightly different consideration, one of the considerations is you still have to

have the components which are used everywhere there. Now, if you look at my monitor there you will see a lot of these switches just have a.

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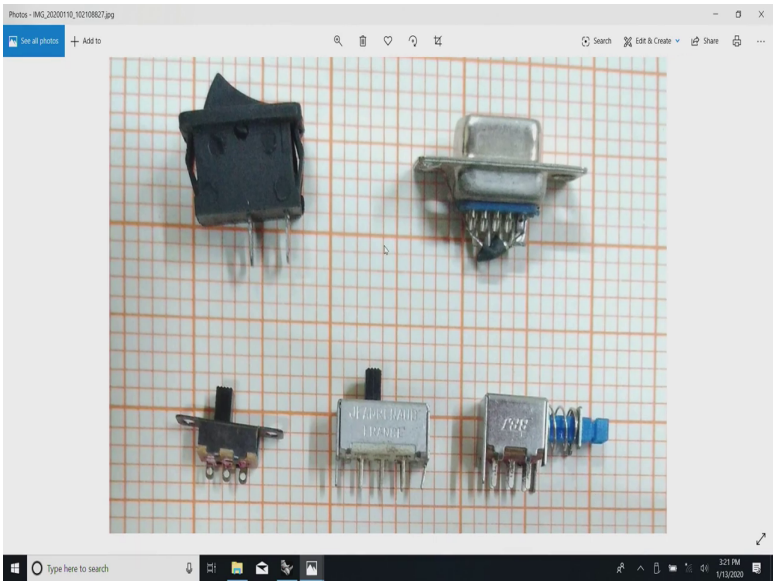

See here, if you see here you will notice that one of the first thing is, is you still have all these physical components.; obviously, one of the important points of this is that it though it looks as simple as thing that just if you say a very simple switch in this case there only just 2 what do you call terminations in one position they are both connected and alert that not connected is about the simplest you can think about.

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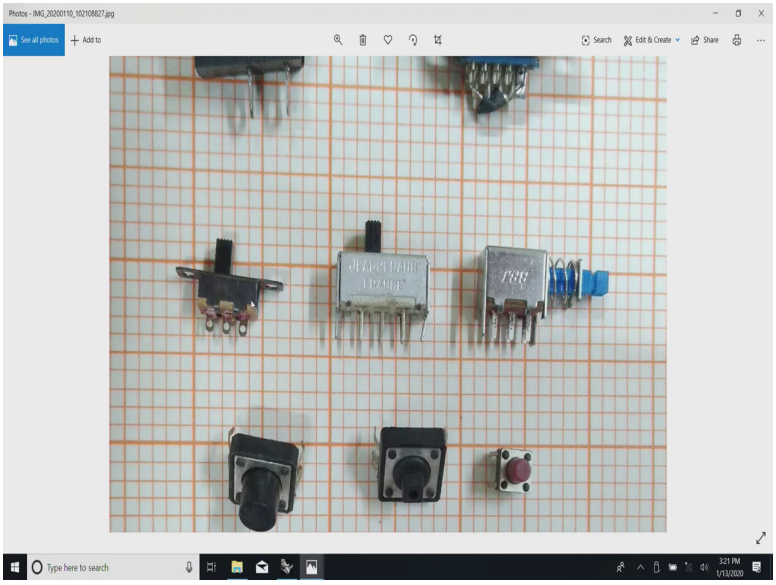

And something which is a little related to this is probably another type of a slight switch in which you have a central point and then intuitively we expect that you know this 2 are connected in this position, in the other position these 2 are connected.

So, in the old electrical purlins we used to call it a single pole double throw meaning it has position 1 are and position 2. While it is very easy to talk about it like this and all that physically when you want to fix it on to a in equipment suddenly you end up with lot of other considerations. And those considerations are often left to a another type of a designer typically a what is called a design draftsman? What the design draftsman is over experience they know what has to be done.

So, if you see these 2 look a little similar, when see these 2 switches nothing very what you call nothing great about it except, that as before this has 3 contacts and this has 3 contacts.

Now, comes the important point where we can add the value to it by creating certain, what we call elemental just like you have geometric primitives. Primitive electronic blogs which are not part of the EDA tools, but are very useful for us when making a electronic design, specifically related to the packaging.

So, if you see the left slide switch while in principle it is similar the way of mounting it is that there are 2 small holes here and probably you need to fix it onto a fascia panel a front panel or fascia panel. Moment you fix it to the fascia panel you end up with the optional. How do you take a connection? You see here these terminations here are meant for soldering. So, this one has a small beyond beside this specified width they had a small hole here, so that depending on your type of wiring and so on. We try to pass a small wire through this and try to solder it and usually by default all these wires that are used here are insulated wires it is a small portion of it is insulation is removed.

Typically, if it is the very simplest thing like the usual PVC wires in short connections and all the even today it is preferred to have single core by which insulated. So, you pass the core through that small slot, I have a small slot here. So, the wire is pass through that and you just solder it, while soldering is another technique you can pick it up in the other design things in this case the termination option is very very important. In the earlier lecture I showed you how many types of terminations are available.

Now, looking back again into this if you have a large number of them while it is convenient at one level another level is the other option here is you see here. We have 3 terminals things which need to be soldered, the advantage of this is here you can use a printed wiring board. And the moment you have printed wiring board it is conventional not to stress the this the circuit what you call the contact elements when you operate this thing and that also 2 more mounting holes are given here. The advantage of this mounting holes is there ensure that once you solder all these things onto a printed wiring board this is very firm and the stress does not come on to the connections here.

See the difference that one talks about mounting it here and then attaching what you call some wires here. In this case automatically the these elements go and sit inside a printed

wiring board and both options are that one of the options. So, just insert it and then bend it over to make sure that while removing it is easier, alternatively you can also solder this thing.

Hence, the way of this the way this the metallic load caring element is made is a slightly different from it and something, which is somewhat reasonably related to this is you will notice that on the printed wiring board itself, there are no insulators the one side of that depending on the type of this thing it is generally exposed. But the thing to note here is that those tracks are traces are not going to change.

So, once your design particular spacing and then once you design a particular what you call conductor, width and all that it stays and if the manufacturing processes is in proper control these things will stay like that. And their behavior especially with the respect of the parasitic elements is very much predictable and calculated calculatable. And once upon a time when frequencies were very low saying the maximum could be maybe 100 kilo Hertz and all that there is not much of an issue, but right now printed circuit boards are being used for gigabytes and even higher, I mean for gigahertz and even higher.

So, the moment you have these higher things the layout and calculating the way these electronic circuits work become important that is where EDA tools have started concentrating on the electrical elements of it. Now, you will see the while those two are very very real you see here another small thing has come in this case just operating this plunger this way and that way puts it in different conditions and you will see this.

Here we have a same thing probably inside this circuit, inside the layout is probably the same here except that you have a push button here. Now, the moment you have a push button, the push button has 2 valid states one out and one in and the moment it is in you need to bring it out. So, do not pull it out. So, you have a spring and there is a device to take it out.

The moment you have a little more complexity has come saying it is the momentary push button saying you push it and you release it or is it a toggling type meaning if you normally said in one position if you press it goes in and stays there, if you press again it will come out like this. Now, in these cases suddenly the device which is visible here saying do you have a

only a plunger is visible. Now, do you have to add a key top to it you can add a key top and further what has happened is that the printed wiring board is in this plane, I will loosely I will call it a horizontal plane while the panel can be here is can be in the vertical plane.

So, you need to once again you keep coming back saying, so many other options are there and now you see other case. In this case because that one was a very large device in this case this is a standard key and here the thing being it is very very small the moment it is small and there is no for no option for you to have a toggling mechanism. Meaning you do not press it and leave it there, there is only one way of operating it is a momentary on you press it and release it follow the move you just press it and release it.

So, usually there will be some way of knowing the feedback with the signal as been the connection has been established because it does not have a stable on condition. Normally it is one of the things say that normally it is off or normal it is on and when you press it other things can happen and the button itself has the all other things you can probably have a small square top or a key top or you can have it exposed.

So, if you look at look back at these things you see here this one by design has been made to big made to look big, it is big and the same thing here in this case it is been made a little small and there seems to be some small opening also here. So, probably a key top option is there and the same thing there is that now available in miniature variant. So, all these type of very large number of things including what I originally started are reality in design.

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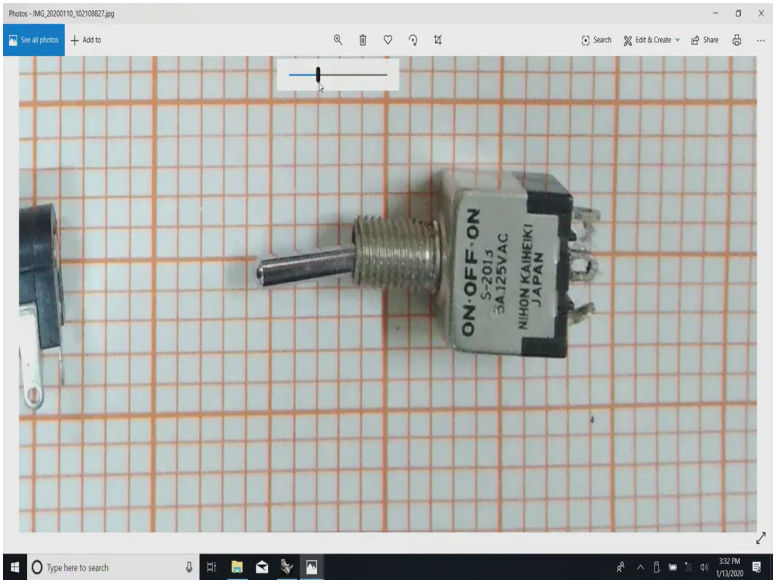

You will see here this is slightly different from what I had shown you earlier. In that case, I had shown you printed wiring pants and in this case the similar switch, but it has soldering provision. And typically all these small things very rarely there you know connector is used directly things are soldered here and probably the soldered points are mounted on the printed wiring board by some mechanism, very rarely you have a separate connector and all that.

However, when you have large connectors you end up with a provision of having a something which comes to a bulkhead, something here is plugged in something here is plugged in and so on and where serviceability and quick changes involved. In this case most probably the whole subsystem is discarded.

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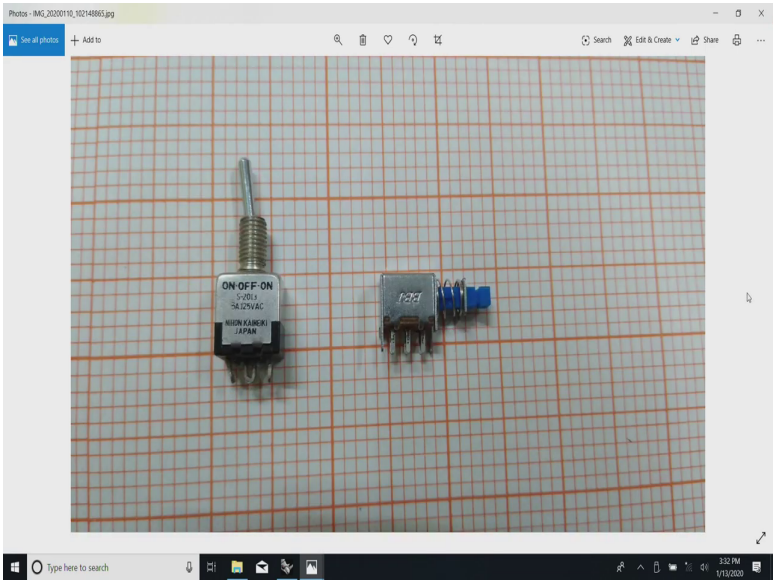

Well this looks quite easy and nice when we come to now, how we integrate all these elements? Little closer look about the same thing slightly closer look.

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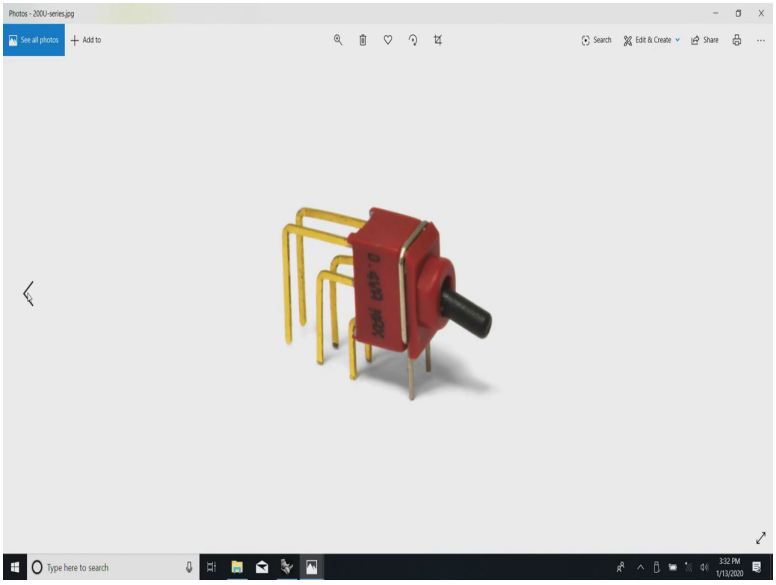

This what I have been showing you earlier I will just keep it because you have seen it too many times.

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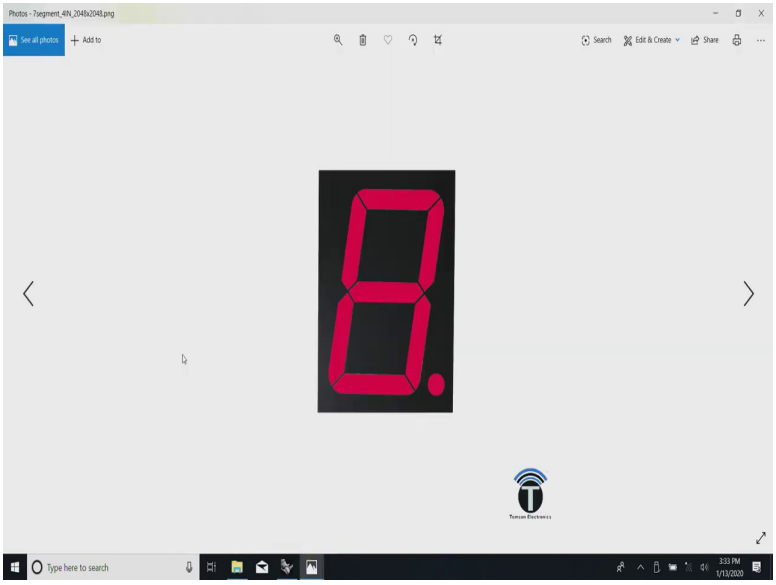

Now, when we come to such of these devices these pose is slightly I would not call it a problem you need to deal with them slightly differently, because this is not the just what is visible there; what is visible beyond that this one is the basically, the interaction or you know part of the mission interaction is this displays which comes back. And contrary to are normal what you call routine this thing not all the time you have a beautiful flat display which has all those things there is a even today they are very very expensive.

Compared to that if you use these things like this several places imagine those all the small items you have in the house. For example, you have a blender at home or you have the good old microwave and then you have let us say a dishwasher and all these things, they continue to have this type of elements. You have seen here you continue to have this what is called the basic 7 segment display with a dot there.

So, can be used certainly not be used generally this sometimes if there in there stuck together they are used as a decimal element, so the decimal can be on. However, if it is going to be used for a clock application instead of a single decimal point you probably have two have them by which that will show the spacing between the hours minutes and seconds.

This is the way these things are wired and the way these things are used is slightly different, the first thing being. Since this is being part of the one of the important elements in the front panel you need to take special care and how do you where do you locate them, how these are related to the other items and so on.

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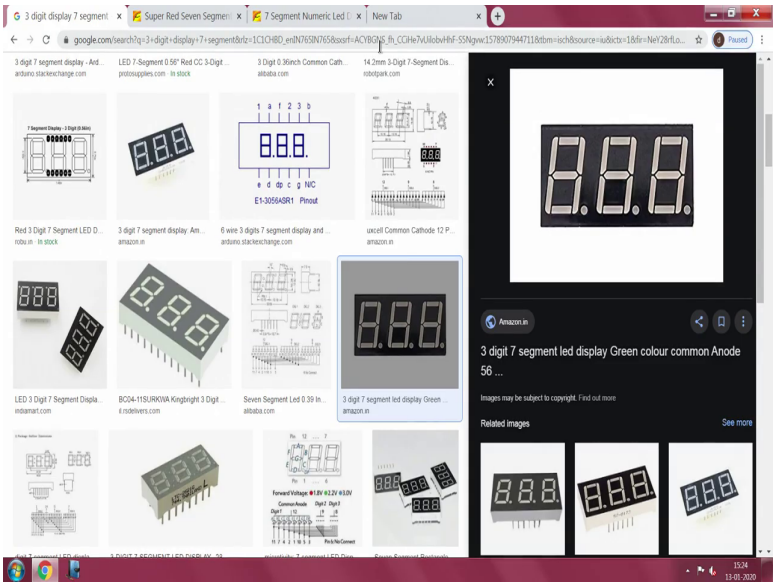

So, I have just given just like that I have given a search of how many things are available; one of the first things which you will see is that.

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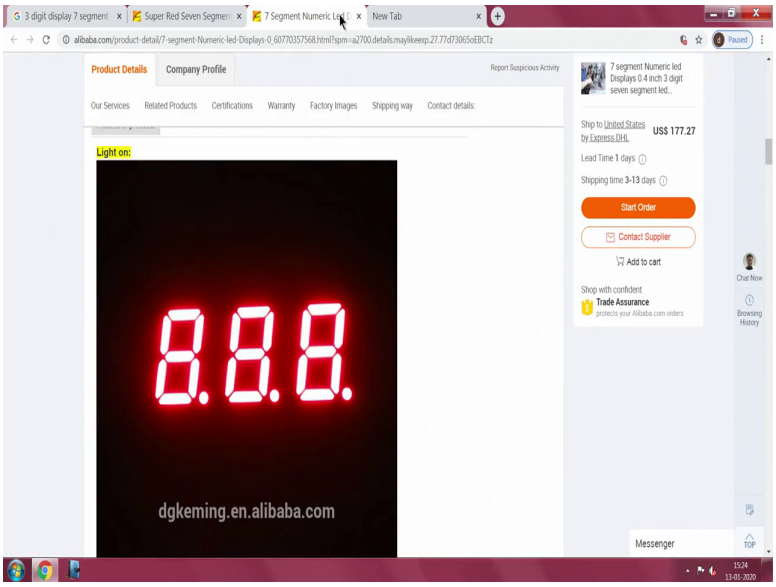

When it is on, it is bright, it is clear. So, other than the just lay out and thinks about a 2 or 3 other features that also they are saying you need to probably when it is dark you need to dim it and you can for the first time you have a way of changing things including the color.

So, if you see the latest split this is in fact, they have gone one step further they have removed all these things they have do not no more you have a LED filter glass to allow the light to go in and out instead these are just hidden behind the regular panel and somewhere in one corner they shine through the case, there the case is made a little smaller. I mean the skin is made a little thinner and you can see these things easily.

Now, whatever the dot and all I have shown you makes very make sense. Now, comes the important point saying if you now need to attach it to their front panel you need to now decide on how much of this needs to be shown.

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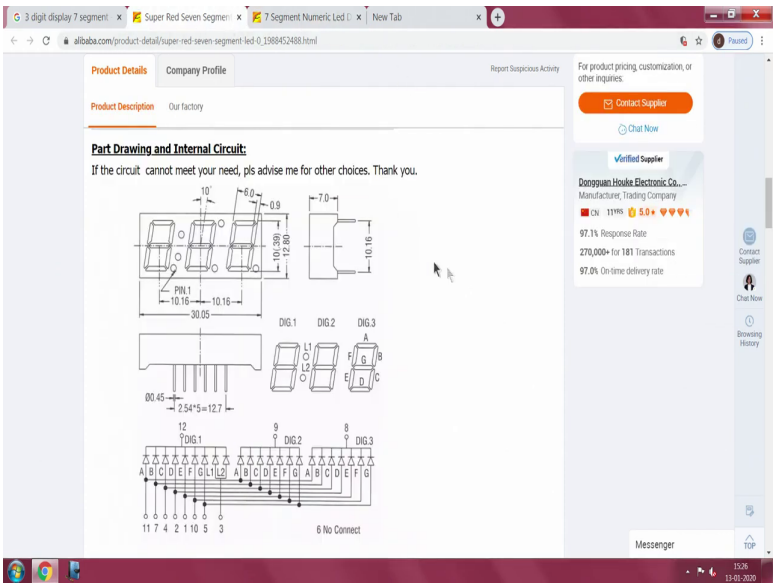

Earlier they uninitiated used to just mount a few of them and try to make a small opening of maybe say 15 mm by 35 mm and you just keep it there stick a glass the stick a any red acrylic into that.

One of the slight problems is by the time these things the panel is ready and they are available for you to say, it does not give such a good impression. Because, if you stack one more the spacing between this becomes very very critical. You have seen both versions are in this case

this is a this is that minute or separator between the and this one is the other what you call various types of pins and so on. Anyway you can see all these things.

Now, in this case how do you mount it is also critical. If you remember I had come back to you earlier and I told you that 0.1 inch is the standard which has been the spin spacing typically follows 0.1 inches which is nothing, but 2.54 mm.

And the way even these case dimensions and all are created, if you just follow the standard way of mounting in there is exactly whatever the spacing is there the next half pitch is here. So, you can stack them horizontally when you stack them horizontally they read well without any problem. And now comes the important point, now when you want to use the I will say the mechanical part of design automation electronic design automation, we need in this case three very important things. One of them is the pin what you call location or we they call it I mean they call it pad or this thing then the total footprint what is the total area it is required, so that you can place it comfortably on the printed wiring board and the visible portion of it.

Now, the moment the visible portion of it comes we need to now interact between these things board, the front panel layout then the printed wiring board inside and tremendous amount of wiring if it is a complicated board. While in our case is relatively simple if you take a thing like a new, modern camera.

Next time just randomly go and check on the internet about what is there inside one of these new DSLRs. You will notice that while electronics is very complicated and all that it is in all places there are all around the everywhere there are electronics. And these things have to follow based on the ergonomics and based on, how the thing is going to look like. So, we see that all these elements need tremendous control. So, I will at the moment I will concentrate on how to create a solid module for this. So, we have a device here.

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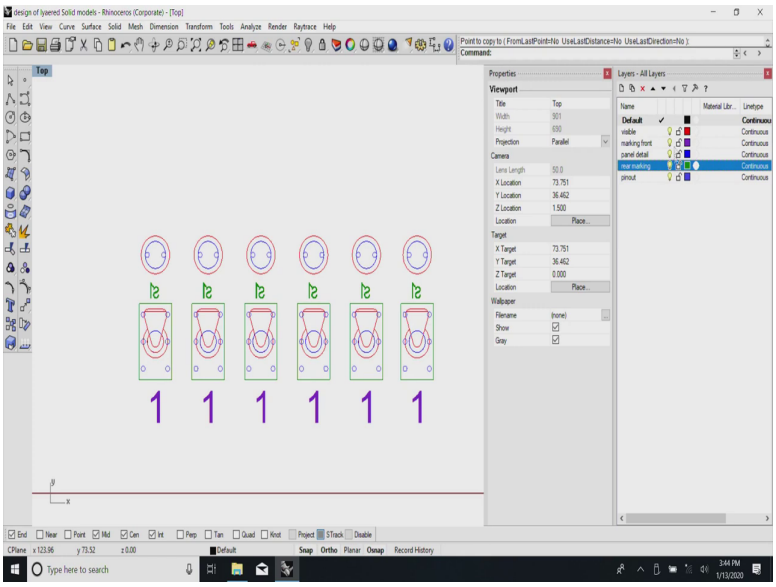

Now if you go to the other this thing here I if you remember, can you please remember this? I started with this saying this is a one of the switch elements to show a that a simple demonstrating device which will show you how to show what is the difference between binary to decimal demonstrator, this I have shown earlier.

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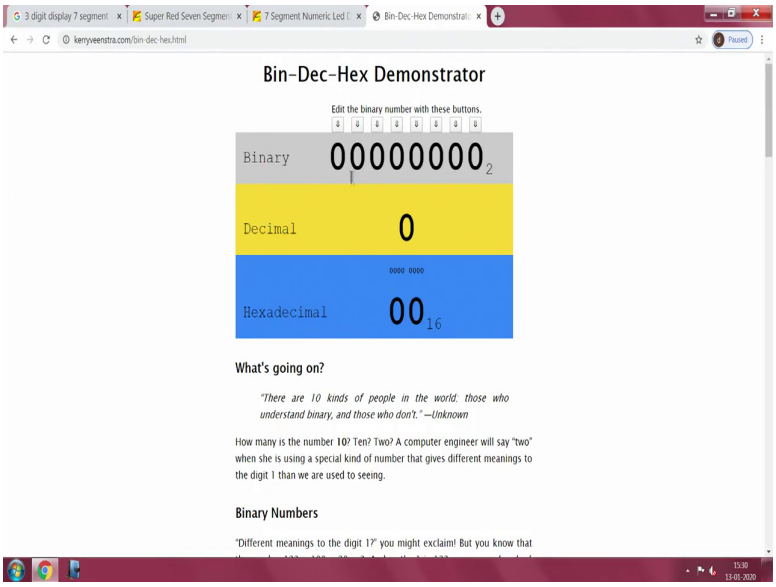

So, on a pc it is very easy to do this is, but this is very very simple thing, here what is what is being done is the top row these things represent. The top row represents the various type of buttons in fact, now the word buttons is used which is the binary code and then it is going to be, it will going to display the decimal equivalent for it.

So, similar thing I am trying to show you there see using common things. In this case for example, I want to show a number 16 it is very easy I know by my normal this thing this is 2 to the power of 1, 2, 3, 4, 5, 6, and all that. So it is starts with first element is, what you call 1 then I mean 2, 4, 6, 8 all the way.

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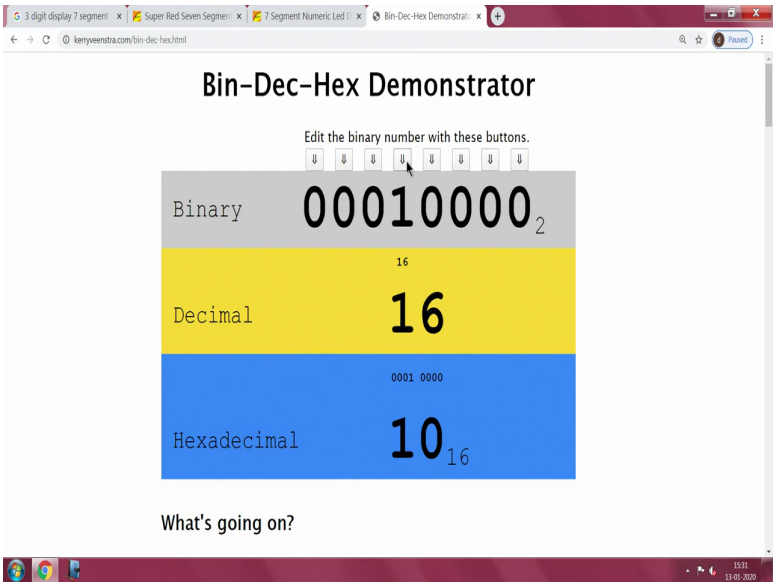

So, if I press on they will see 16 has displayed.

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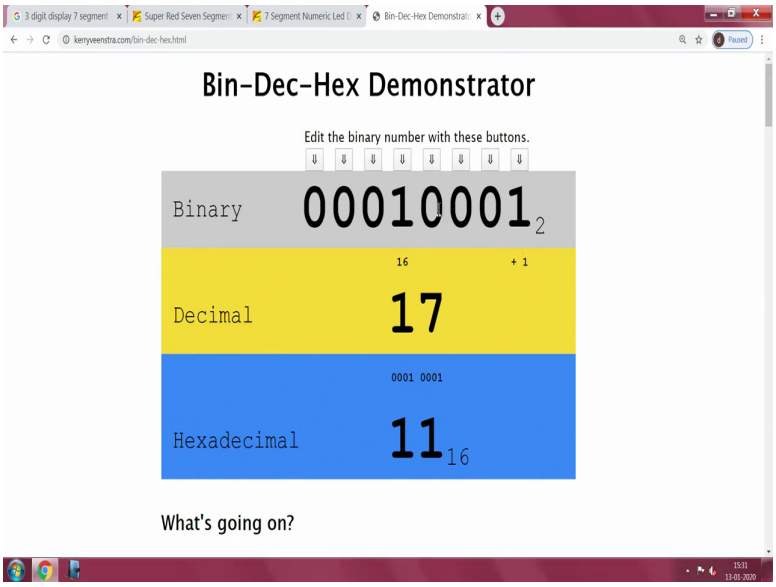

Now, 2 things are there let us say now I want to make 17. I just need to enable the last digit and you see what has happened here 16 plus one has appeared here.

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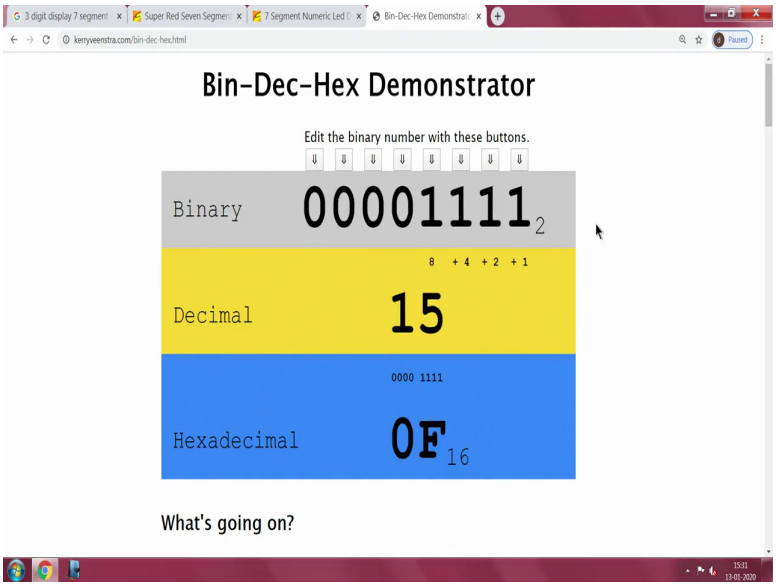

And let us say I need to show 15. I need to remove all these things and you see the way these things have changed at the bottom nothing it just said somebody is clever enough to make a beautiful flush program which I have found it useful. So, anybody who is interested in this probably can have a look at it. Now, if we were to make this using a small demonstrating kit like an Arduino or anything that is where I wanted to show you on the other side.

Now, if you are going to look at it here if you remember last time when I left I left you with this saying I have here this particular this whole device, I can put it wherever I like. And in this case I have not said the grid to the 0.1 inches grid, so then very easy for me to copy and paste things. Let us say it is there here I now copied neat. I have got 6 instances of this.

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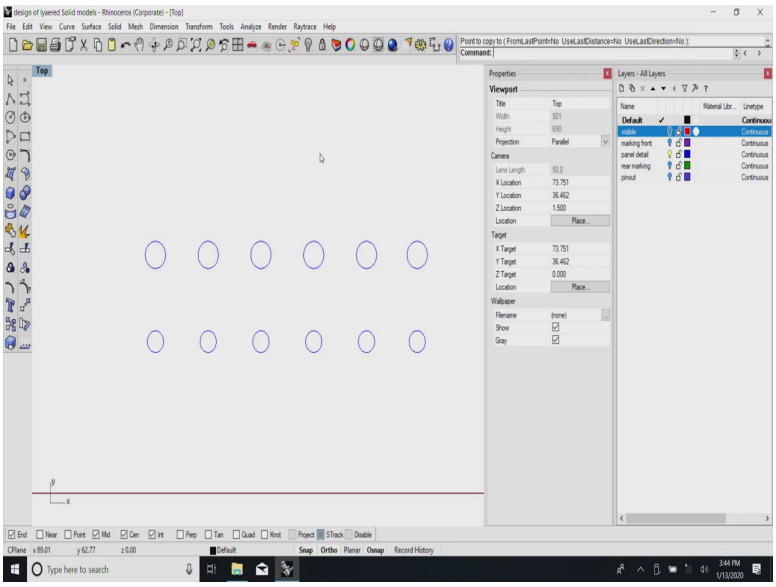

Now, comes my this thing saying if you had to fabricate a panel like this hear all I have to do is switch off unwanted things and I have all the necessary details. In this case that bottom 4 whole show me the switch mounting, a top 4 whole show me the LED which has to be operated. At this point this where I wanted to show you.

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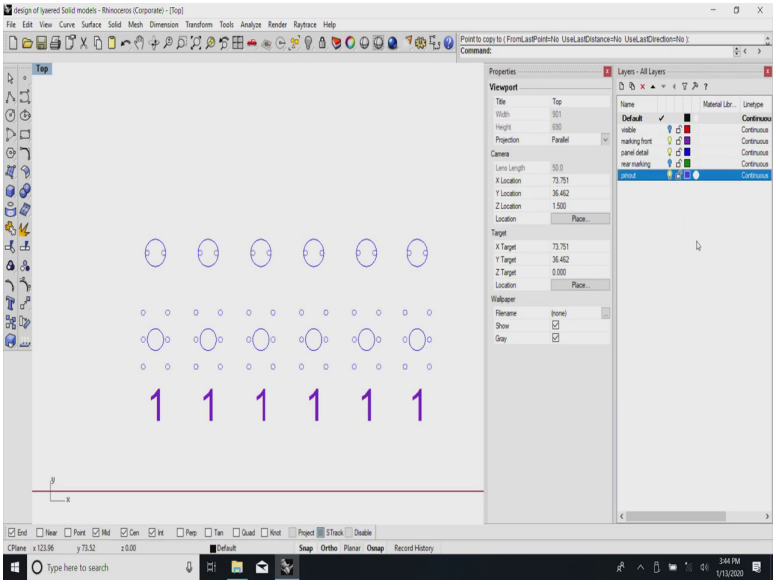

Now, seen here I only picked the openings, but then that whole thing all the necessary detail including what is the marking that is required, including how the pinout is all of it comes there in this place.

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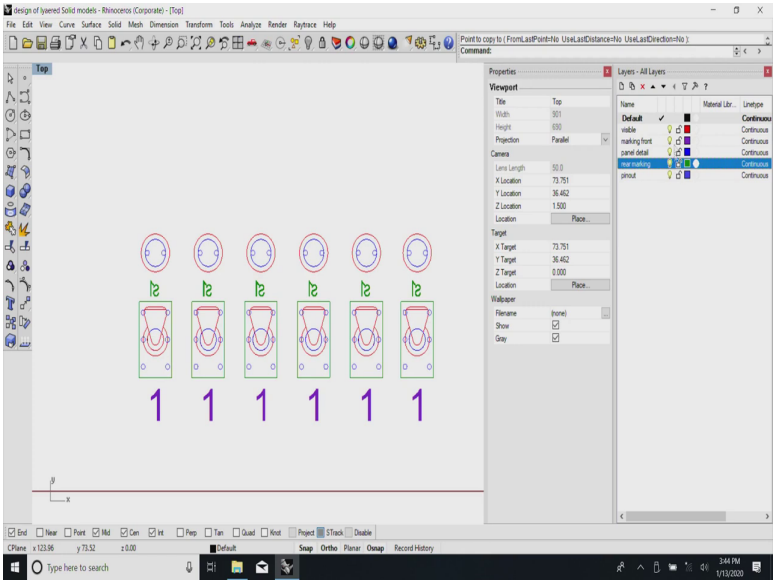

So, it is very easy for us to lay out the front panel by just looking at all the visible portions only and miraculously the pinout and all that end up here.

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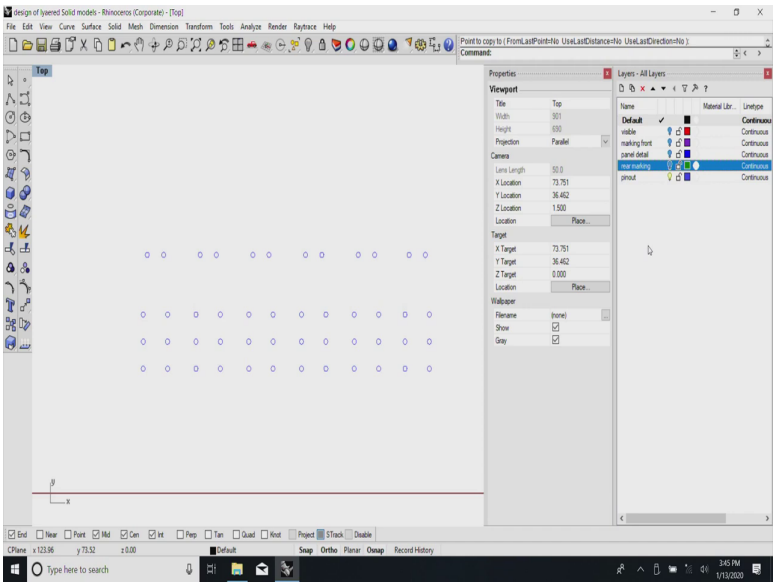

Now, even if I switch off all these things, I have the pinout drawing. Imagine here at this point I have the display to be added here.

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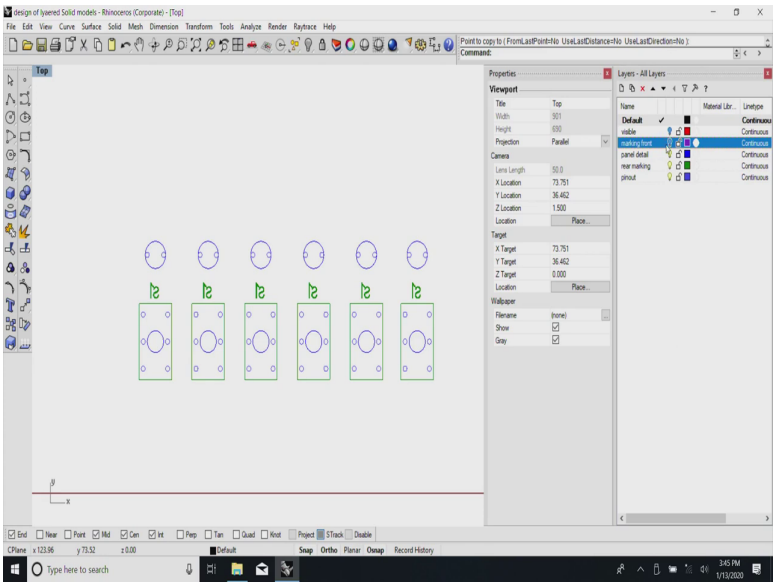

So, I am coming back to the original thing what I have told you earlier, what we need to do is make all these things at least at 1 time and if you make it modular enough and you make all these layers on and off. You can export and keep these things as elements for a long time, you will never need to go back and refer to the manufacturers catalog and several of them are directly pin compatible and so on.

So, then later on, down the line 10 years from now if any servicing is required, so even for servicing or preparing the manuals and all that whatever the details you have created can easily be duplicated at that time. And having done this have exported this and kept it.

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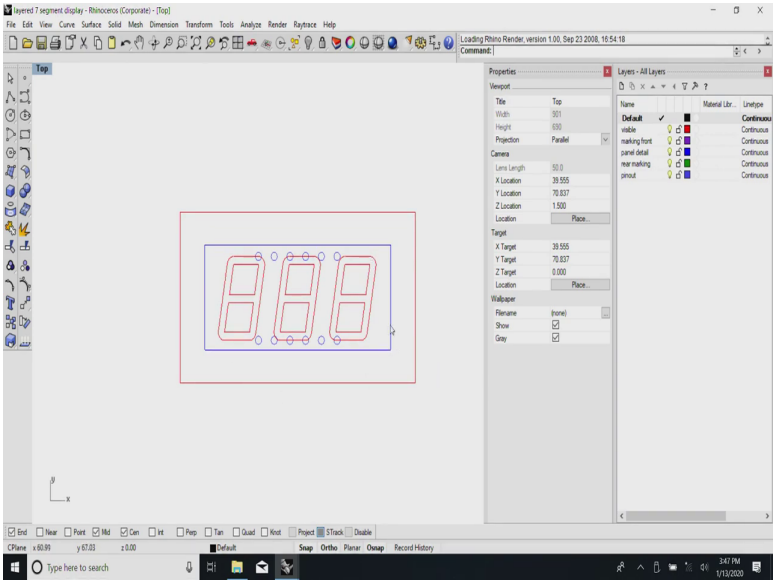

Now, I will open another instance using all the information that was available in the other drawing. I have created another component which I have I will be calling a 7 segment display. Here you have seen 2 or 3 things which have done; one of the first thing is other than just creating the things which are available there.

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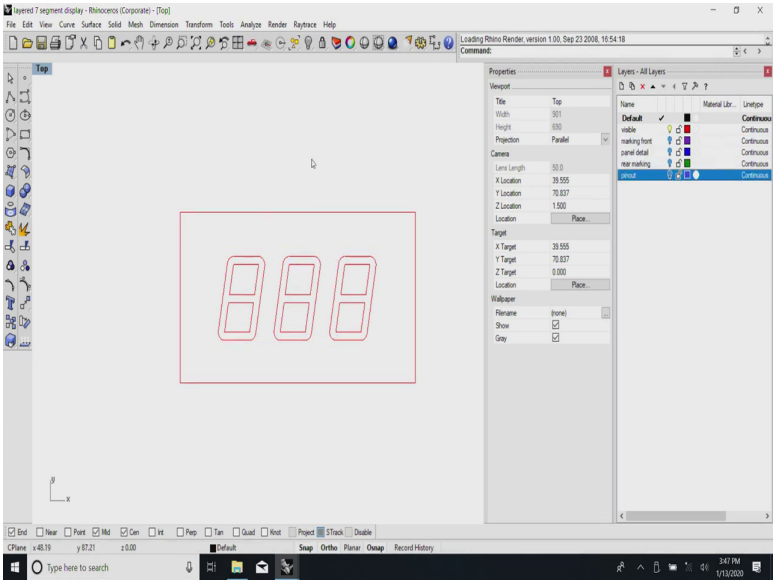

One more, further thing I have created saying I need to add a bezel and the glance to it. So, here this bezel is slightly bigger than the just the component that was available. Now, this determines how the final equipment is going to look seen that know how much extra space and all that.

Now, this is very easy for me I have created this I will now not save it ok. I will go and insert it into the thing here saying I can import it directly from there.

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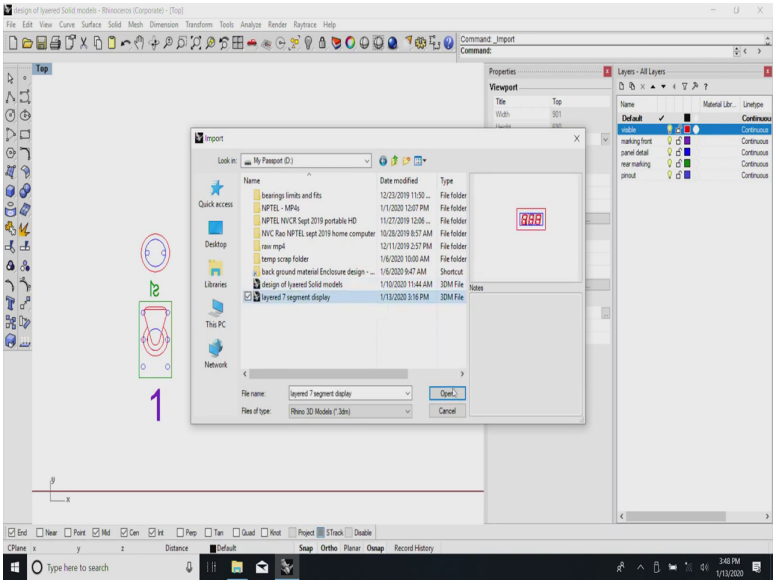

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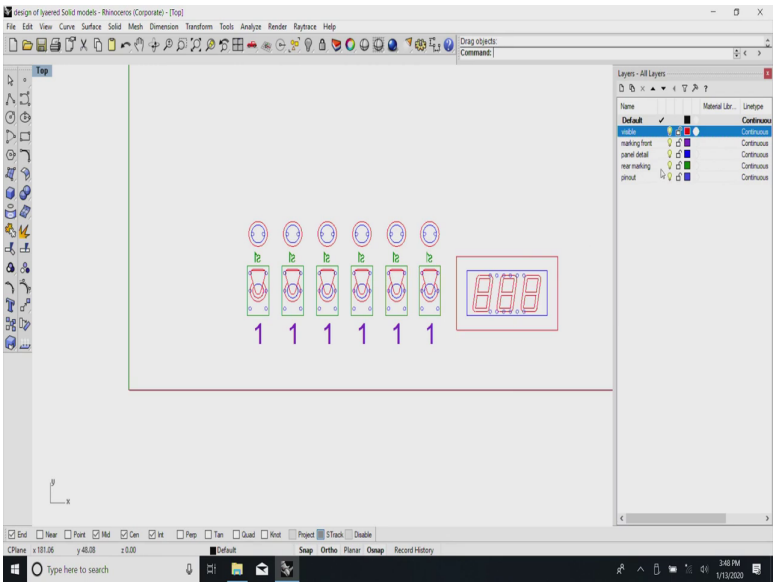

See here, that was created at some other place, I am able to import it here directly. Now, it is very easy for me to position it wherever I like and the have you noticed we have.

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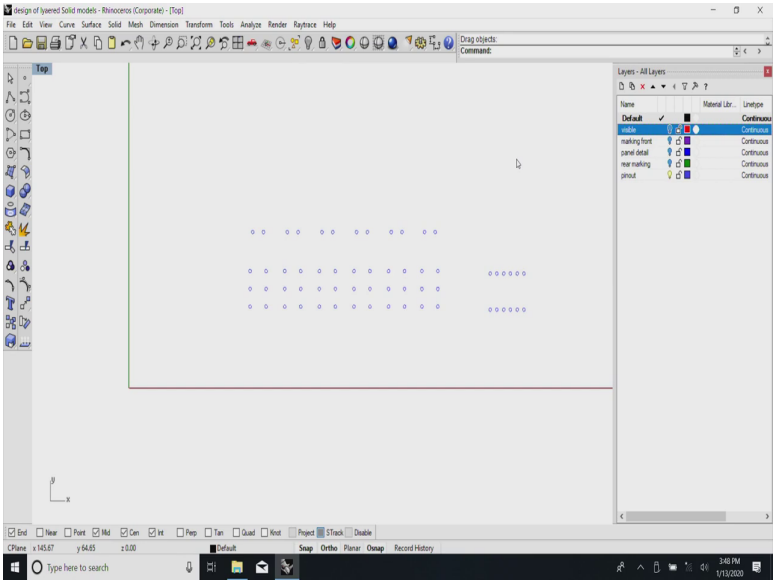

If I follow the same type of thing which I have used here I have also the pinout also selected here. Now, the thing is this particular layer all of the details can be hidden or at best they can be what do you call cleaned up. Once you clean now this particular pinout drying can be directly sent or can be opened by any of the standard EDA programs.

So, there you have a circuit you have a schematic capture after the schematic capture is done next thing comes in saying you now make the layout, how many elements do you require in this case I have just put it exactly in line. So, that I have to remember lead lecture I showed you what is called a digi role. Something equal and to that I have a long thing here on the other side probably I can have the electronics or the electronics can be behind. So, I have my small unit which is ready and they focus in that is that have made a only 1 instance of the switch and only one instant of the display.

Similarly, now if you remember last time and I went here we have a huge amount of connectors which are typically that, so called USB standard. USB type is very good and stable and all that. If I now go and check here allow me to just spend a little time here I need to please if please look at it along with you I will see if I can look at one of these things saying.

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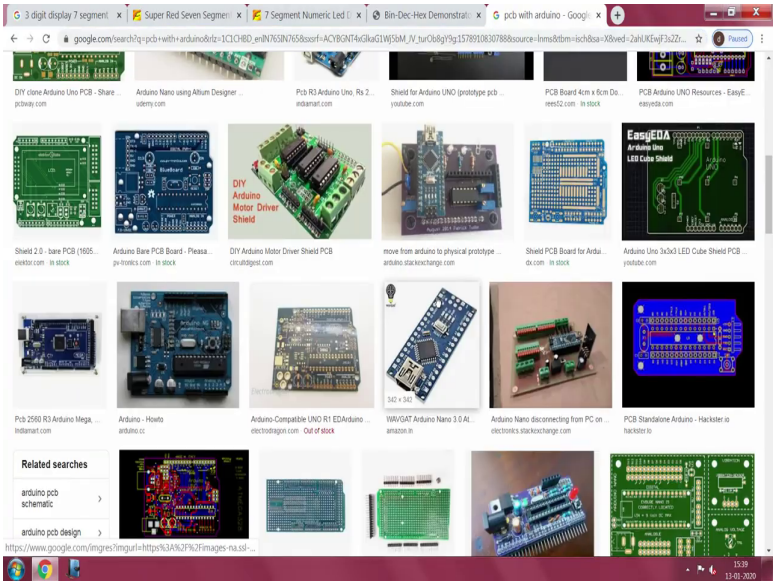

So, many of these are available seen that very nicely.

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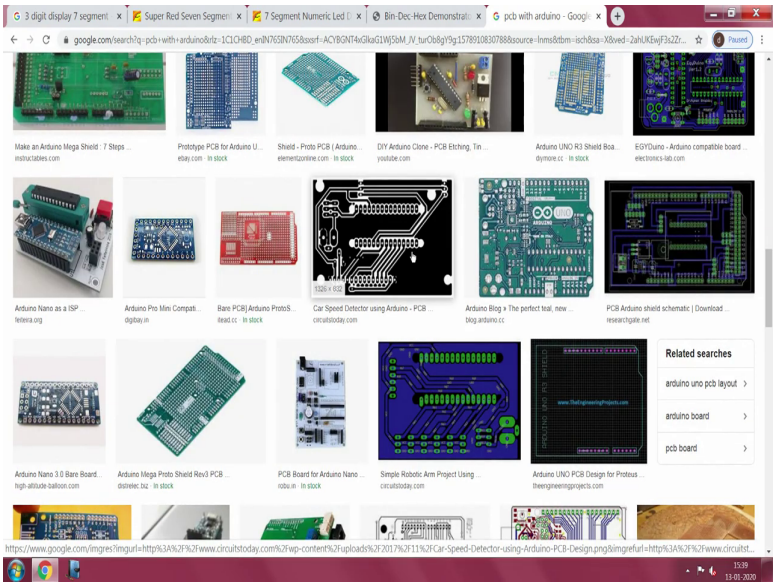

Including we have a very beautiful the printed wiring board is available directly.

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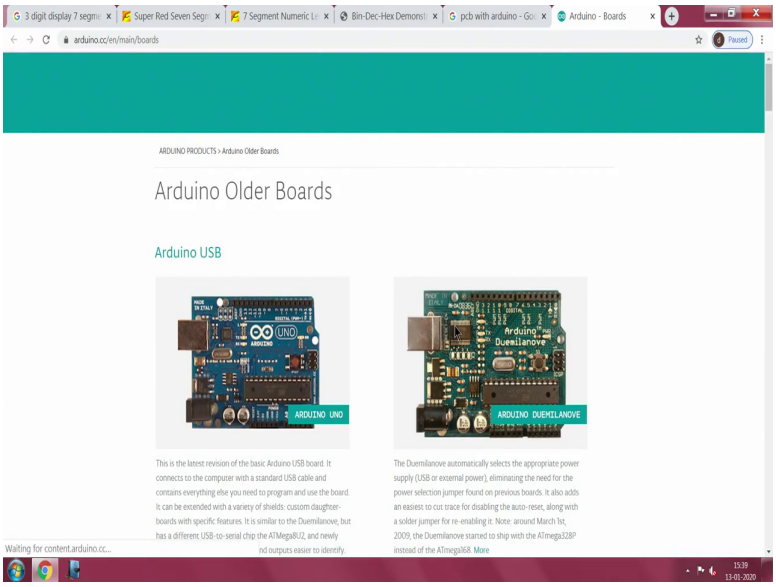

The advantage the way I have been telling you is it is very easy for you to take any of these what do you call tresses here.

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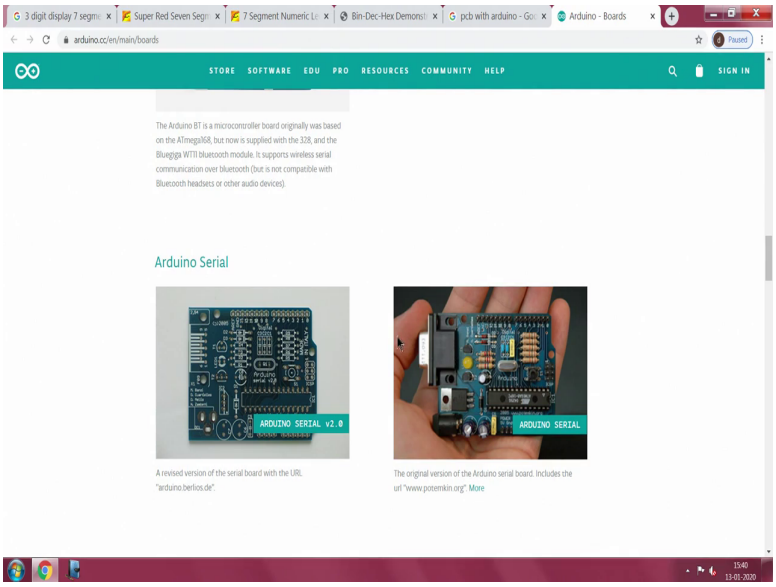

And modified to do anything you want here.

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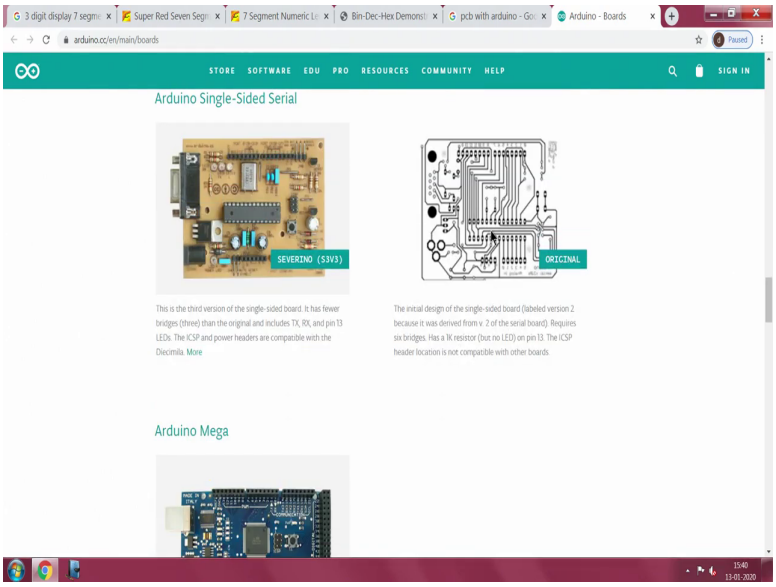

So, if you apply to them things like this are easily available for us. You have seen this, the this things are available. Now, at one corner have you seen you have a beautiful at this corner you have 1 connector it seems to be the 9 pin connector that is exactly the connector which I had taken in the other one. The moment I take these things it is now in case I am building a system.

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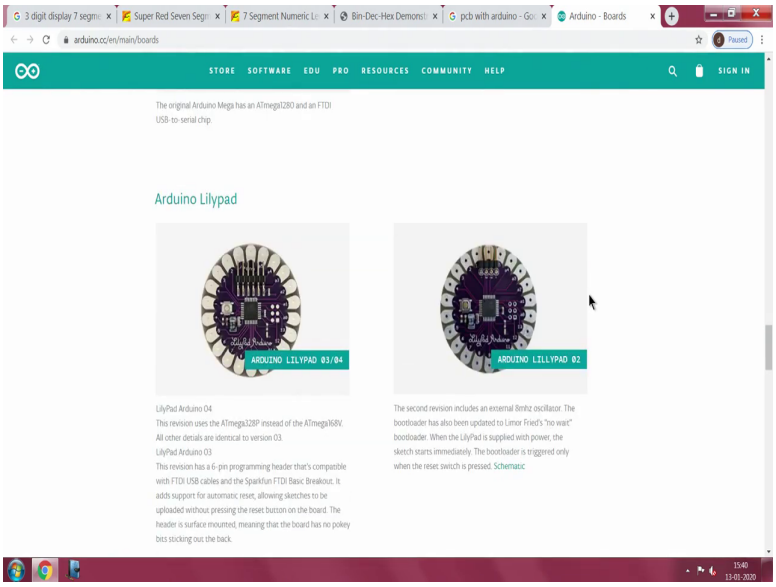

When I am building a system, I can just place anything you see here they have got something called lily pad any of these things.

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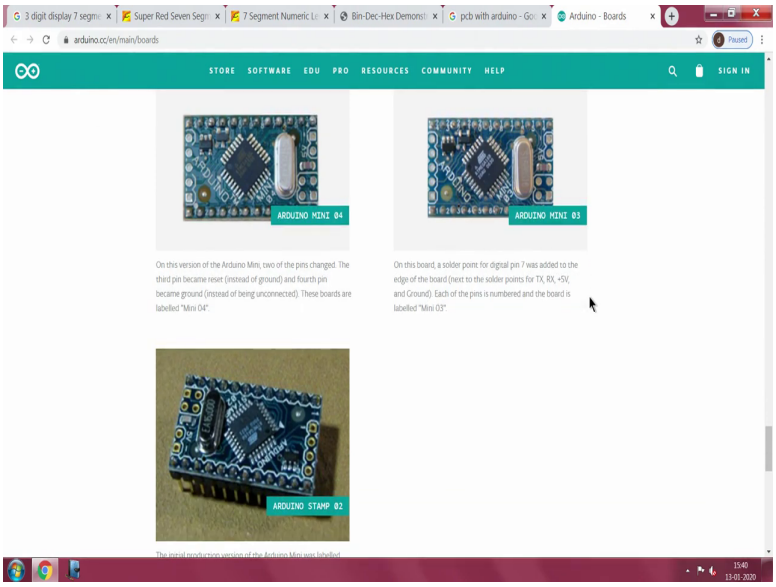

One time, if you make them it is very much possible for you to have tremendous amount of confidence on.

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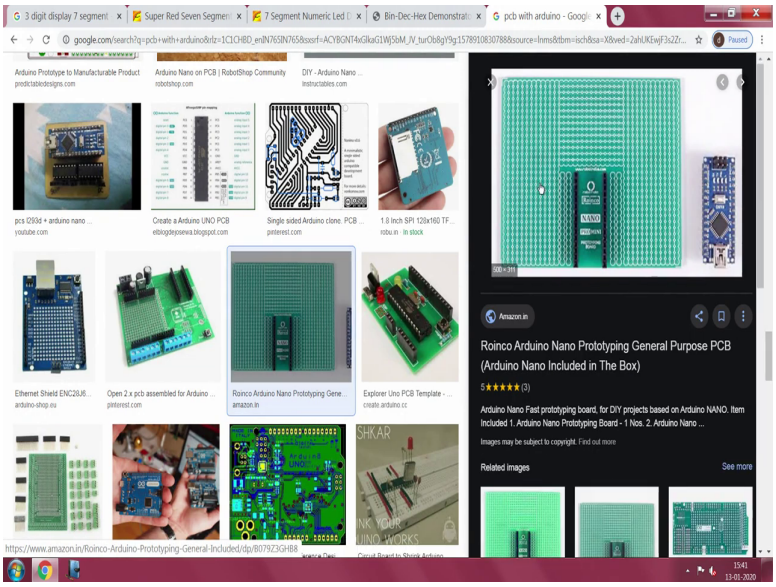

Any of these items you would like to have you can probably start with prototyping. This is a prototyping board and once your prototyping board and all is available.

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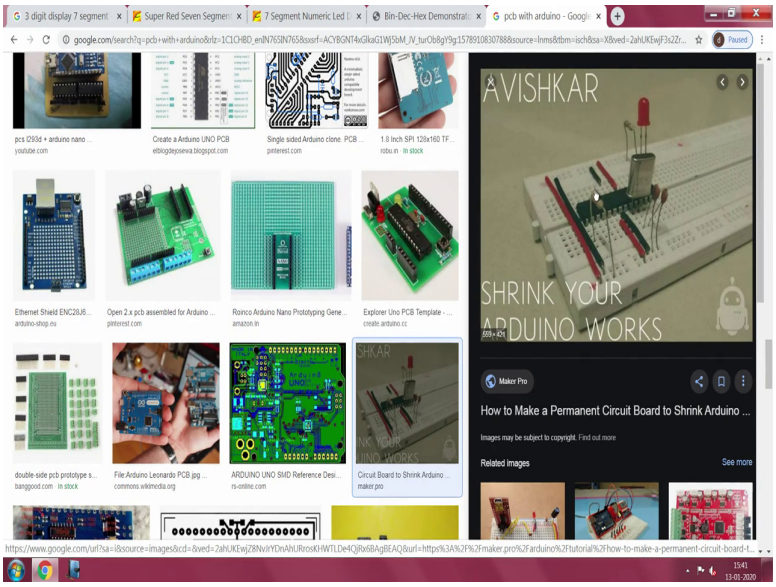

Even before that you have this generally, we call it a wish board, wish you were the one of the earliest we built you can probably try all your things.

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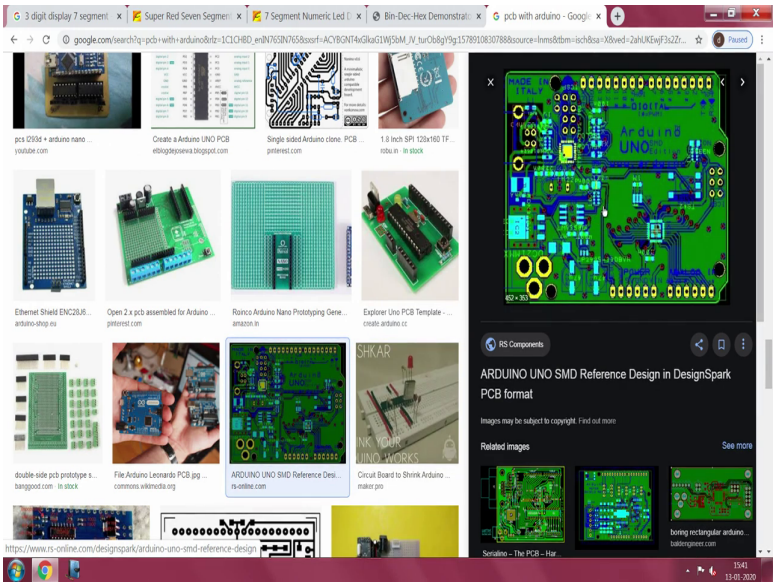

And eventually when you come to making this of course, you know board you can now lay all your things wherever you want.

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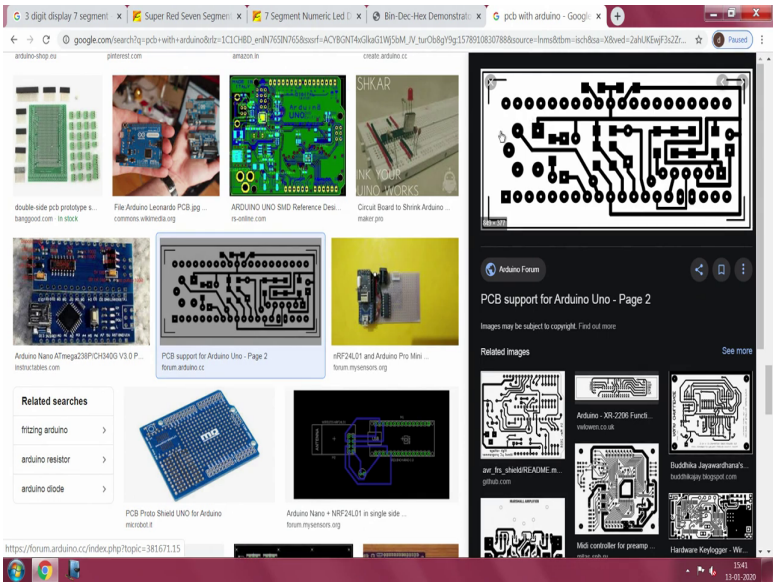

And it is very easy for you to have all sorts of these beautiful things which we need to make equipment. Just like in the case of the electronic components we are talking about the pinout, the area which loosely they call it the, what you call board space or real estate the amount of space that is required.

Similarly, same thing can be used here in case you want to treat that processor board as a special by itself as a subsystem you can calculate the I mean you can make an outline of it minus the dimensions. So, if I now go at this point I will see whether I can still look at it saying almost anything you want it is available here.

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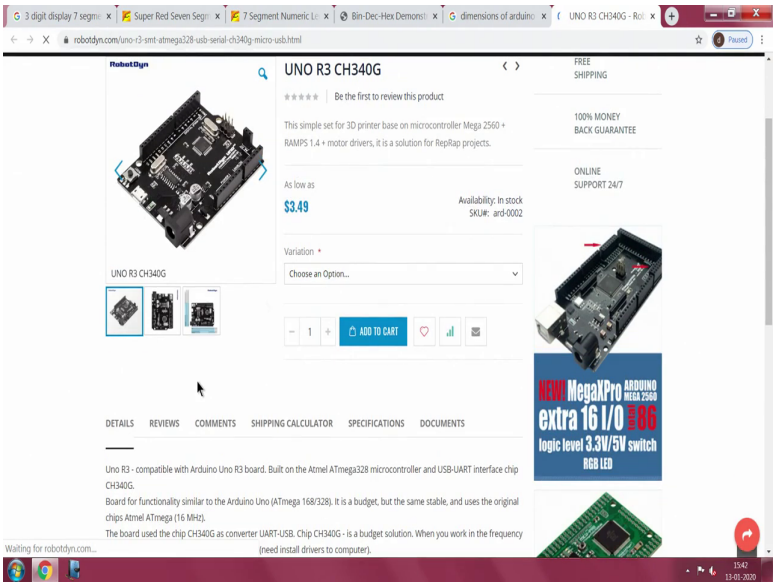

Now, if the whole thing taken from one of these catalogs.

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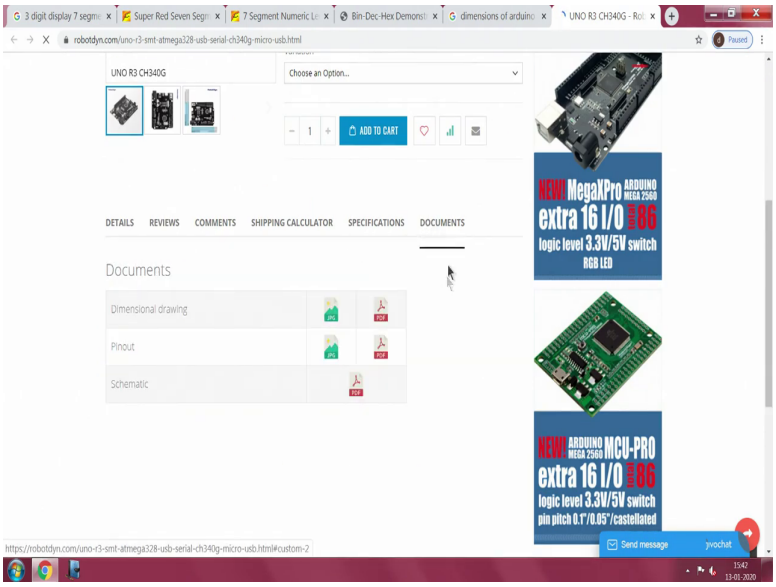

If you can go to this specification, go to the various types of documents. So, you have here a I will open the JPEG you have seen here.

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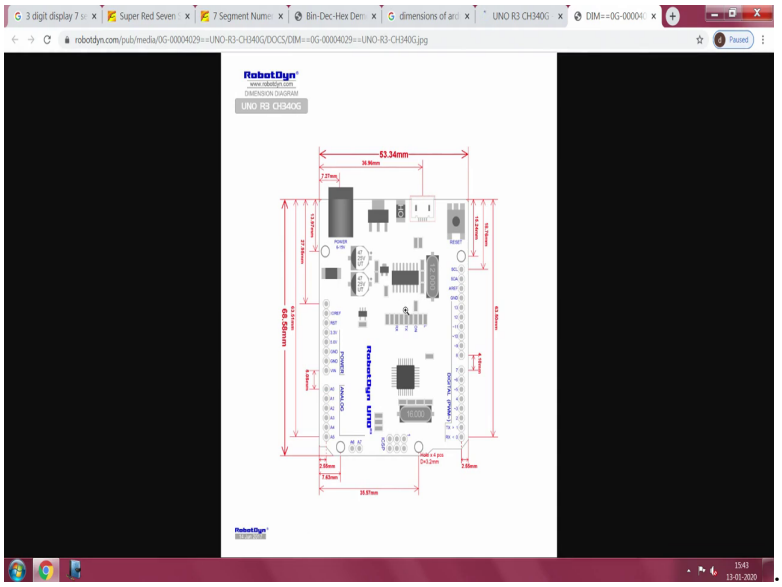

Now, if you see here it is a little like what I was talking to you about except in this case this is a simple 2-D drawing and critical things they have mentioned here saying, what should be outside dimension saying this is approximately some 53 something. And something which is equally interesting you have seen here they have put mounting hole there are 2 mounting holes here, there is a mounting hole, mounting hole here and they have given also hole at 4 places diameter is 3.2 mm.

So, the when you have these things it is very very very convenient and a designer ought to probably make convert these things into what I will call electronic perimeters; electronic design primitives. Now, you can put all these things wherever you want inside a small enclosure and you have a from a very small subsystem to a really working system you can make.

So, I will take a break at this point the point being at one level at the component level you can have things like all the control elements. Typically control element can be a simple switch or a push button and display elements like a, very simple LED or a 7 segment display or a very complicated big mnemonic or I do not know, what they call it these control stations and all that you have a huge control station the whole thing is made as a schematic.

It shows where some gases coming going everywhere and all that whole thing is printed and then everywhere status is indicated such things, they operated the background they have a probably a huge PLC programmable and the whole thing the basic starting element is start with a small 3-D what you call block, which can be moved everywhere and you need to make this only once.

And whenever the pinout strange the installation the instance are shown you is the pinouts where directly in the same plane of the front panel. So, it can be in the front panel otherwise if it is at a right angle you need the right angle, so just we have made.

First you make this all you need to make it as once you need to make it like in the case of display only one simple 3 segment display, I have made using those you can probably build on it and make them much bigger and smaller. So, if you make a something which is rits remains voltage typically they are called 3 and half digit because extreme left is usually something very very simple will be there full things are not needed like this.

And the processors and all which have been optimized for that are available seen that. So, kindly remember in our case in the case of our making electronic enclosures we try to make each element as a 3-D model and this element has both the things the mechanical part, which is used for making the front panel and all that the visible or the what you call aesthetic and functional will have the aesthetic element to which you can organize things. So, that they are error free and the functional pirate which shows various operations and finally, the electronic circuit also.

So, I mean I will say this lecture is unique we are trying to do. Generally they make this and all the wherever, the engineers are working they make it. So, at the moment when you ask for a 3-D solid they generally give you only the physical appearance of it and often without the dimensions.

So, at least you can import those things and then add these things the elements which you would like to have including as I said marking including things like the various connections and thing so on. So, I will stop here.

Thank you. I will connect continue in the next lecture.

So, thank you.