**Electronic Packaging and Manufacturing**
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**Lecture - 08**
**Area Array Packages- I**

Welcome back to this course on Electronic Packaging and Manufacturing. We were continuing or we were discussing about first level packaging over the last few lectures and today we will continue with that. So, if you recall last time we had just started we had talked about the different plastic and ceramic packages, and we are also looked at several configurations of the interconnects or the leads that come out from these packages.

So, today we will start off from there and continue discussing some of those.

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So, today we start off with this one which is called peripheral packages, then area array packages and then we will introduce to a very common and important type of package and interconnect technology known as Pin Grid Array or PGA. So now, what is the peripheral package let us talk about that.

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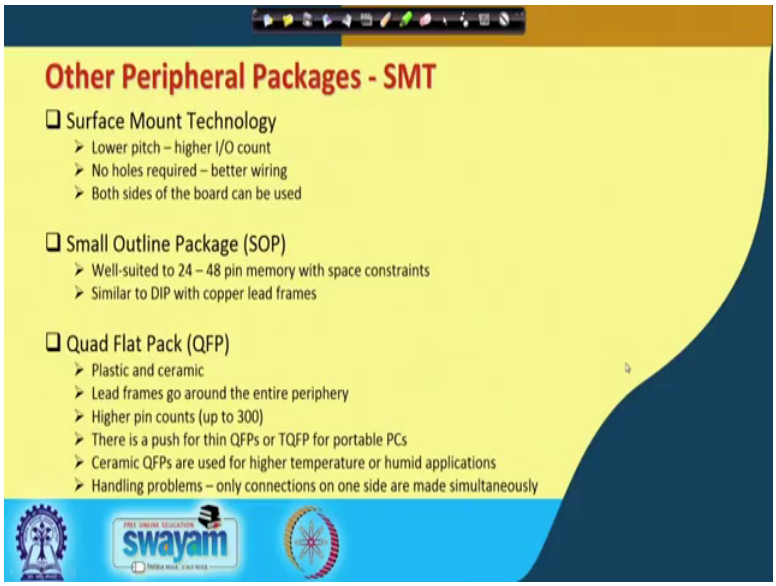


So, peripheral package if you talk about it, now again let us go back to what is the peripheral package? You have the you know the plastic encapsulated or the ceramic encapsulated chip carrier and the interconnects come out from the periphery from the sides. So, that is a peripheral package.

So now, other peripheral packages one is, called surface mount technology remember we talked about through hole or pin in hole technology and the surface mount we said was one where the interconnect does not penetrate through the board or into or go into a hole, but it just kind of makes the junction or the connection with a landing pad on the motherboard. So, that was a example that we talked about.

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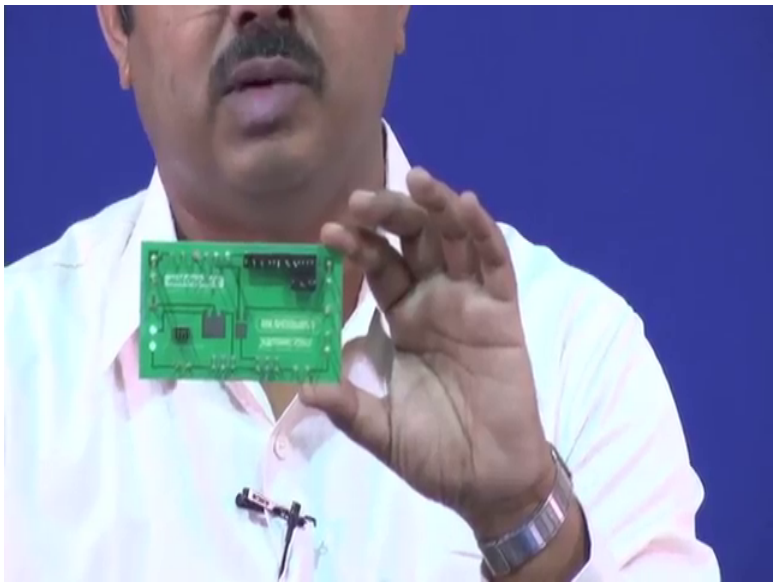

So, to do that, I have kept a I brought a small sample with me to illustrate these example of surface mount technology. If you can zoom in on this prop what you see here is, you see this area this is the place where the chip carrier with the chip comes; and then on the top and bottom especially on the top here as well as on the top here what you see are these landing pads ok.

So, this is a surface mount technology, the inter connects are going to come and get connected on these pads on the motherboard alright. So, this is an example of surface mount technology that we were talking about in this first bullet. So, surface mount technology with peripheral packages ok. Lower pitch higher I O count, no holes required ok. So, that is the main thing no holes required and the other thing is both sides of this board can be used. Now I can also I mean this one is a different case where there is branding on the other side, but you could have used the other side of the board as well to have more surface mount components on them.

So, both sides of the motherboard can be used unlike a through hole or pin in whole package, where you have a hole cutting through the motherboard and therefore, only one side you can insert the interconnects only from one side of the board. So, again this brings goes back again to the discussion that we were having in the last class, that the real estate or the surface area that is available for placement of components is limited

because the size of these electronic components are becoming smaller and smaller so, the size of motherboards are also becoming smaller.

So, therefore, now if I can use both sides of the motherboard to you know mount these components, then it saves me a lot of area; technically it can probably cut it into half that is just in that is an ideal case, but yeah it does help us reduce the overall surface area; if I can go on double sided motherboard ok. There is something called SOP or Small Outline Package which is well suited for 24 to 48 pin memory with space constraints.

So, this is very similar to a dual inline package except that it is smaller in size and then lead frames are made of copper. And then there is something called quad flat pack I think we saw a picture in the last class, where you have which can come in both plastic and ceramic and you have these leads coming out from all four sides; hence the quad. And flat pack is because it is more of a in a flattened structure alright. So, there is a push for thin quad flat packs now for portable PC's especially in your laptops and now tablets and all, this thin really thin quad flat pack components are becoming more and more predominant ok.

Again compared to plastic if you have hot and harsh conditions humid conditions etcetera, the ceramic quad flat packs are used in such conditions, where the environment is humid, it is hot and the environmental conditions are harsh. So, now let us talk about let us let me show you another small board over here ok.

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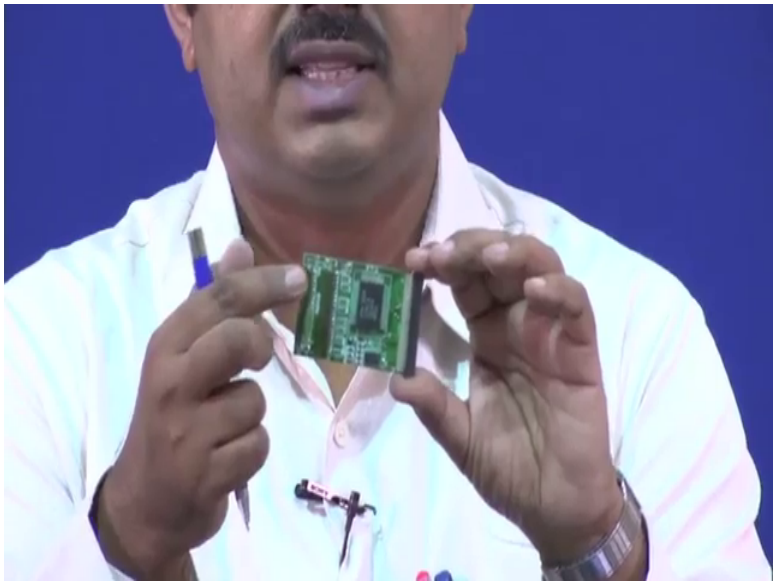

If you can please zoom in one, this one this motherboard has a variety of components, the first one I would like to mention is this big one over here. So, this as you can see is a quad flat pack. You can see these connections coming out on all four sides right, you have these leads coming out from all four sides right left top bottom clear. The other thing that, I want you to notice is this is an example of a plastic package this black colour this is a moulded plastic ok. The chip, the silicon chip is inside and then it is completely moulded or encapsulated in this plastic chip carrier ok. With these leads coming out from all four sides which in turn are connected on the motherboard, this is also surface mount technology as you can see these are not pin in holes the surface mount.

And the other thing I would like you to notice is, these leads are all gull wing type. Gull wing remember it goes like this and then over here the L shape. So, here if you see these connections; so, all of these as it comes out there is a shoulder it takes a right angle bend, again a right angle bend in the form of a gull wing and it is then connected to the motherboard ok. The other one this small component that you see at the bottom is kind of a dual inline package, but however, this also has gull wing type leads.

So, here you will see that the interconnects are coming out from only two sides not all four ok. I will just hold it for a few more seconds for you to have a closer look alright. And then the other thing I would like to mention is then you see a number of these sorry these small-small packages, these are also all dual inline packages as you can see, but definitely with less number of pins or interconnects alright.

So, this is something I wanted to show you as a examples of quad flat pack some packages go by both dual inline packages, quad flat pack packages as well as plastic moulded packages. So, remember classification can be in terms of material plastic or ceramic, it can be in terms of type of interconnects and we saw gull wing interconnects also right.

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So, peripheral packages again some pictures as you can see, dual inline package we discussed it last class, small outline package and Quad Flat Pack package QFP ok. And especially the small outline and quad flat pack and even dual inline, is something or examples that we saw in this small you know card that I mean I cannot call it a motherboard that way, it is a small circuit card that I brought.

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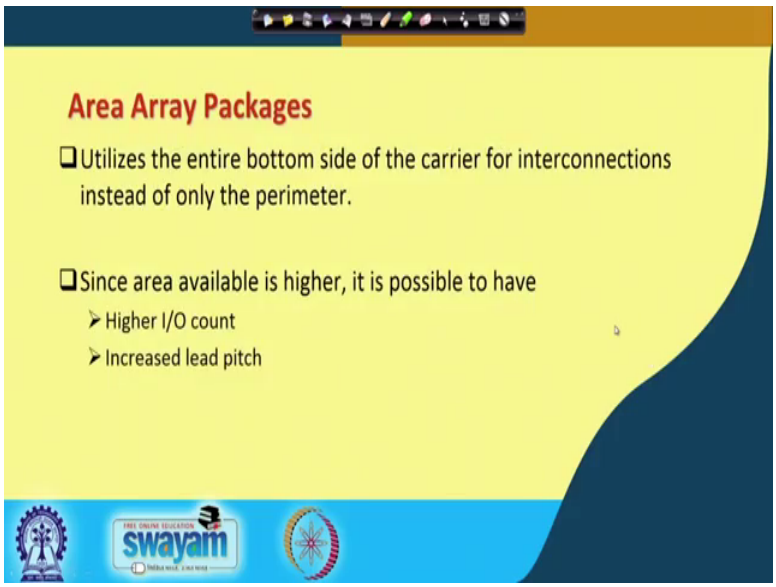


Let us move on to the next slide, the next one is the area array packages. Now what is an area array package? It means that the entire bottom side of the chip carrier is available

for interconnections instead of just the perimeter. So, what does it how does it help us? It helps us in having higher interconnect count an increase lead pitch. So now, you do not have to accommodate all the leads only along the four edges, you have more surface area. So now, your pitch can go up given the number of interconnect for a given number of interconnects.

But however, given that in the reality given that we are all greedy and we want more and more features in our system in our devices, in reality what happens is when you have area available, you tend to get more and more interconnects into it instead of keeping the interconnects same and increasing the pitch, but again both is possible both are possible I am sorry. So, let me try to draw this.

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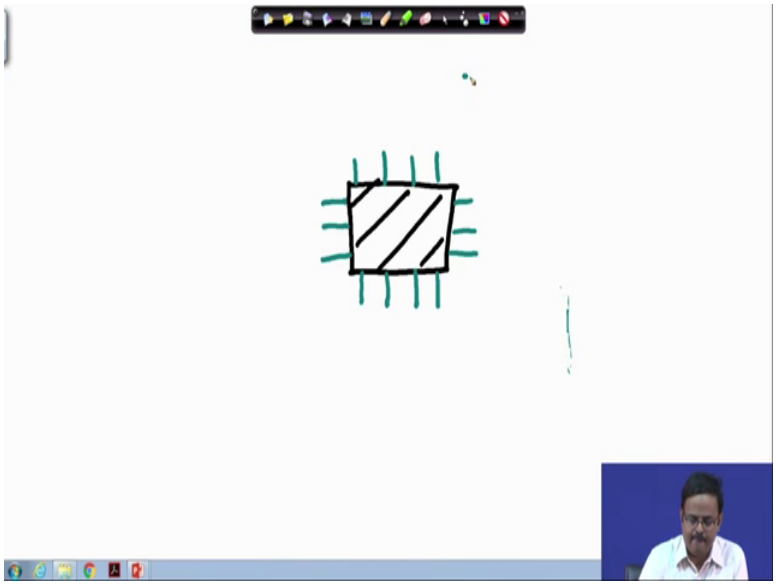

So, earlier if this was my package, then my interconnects were only coming out from the sides right. If it is quad flat pack it was from all four sides, if it was dual inline or small outline it was only from two sides. But now what is happening is, with area array packages I am sorry.

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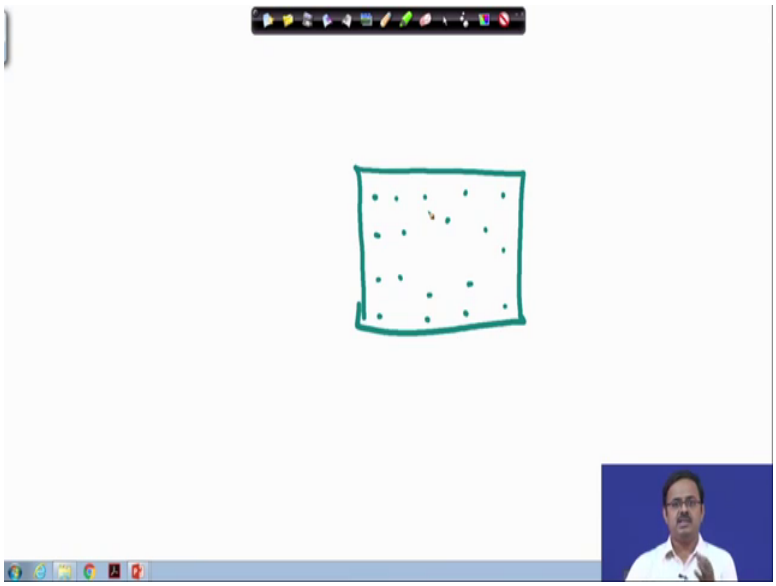

With area array packages if I go for if this is my package, I am sorry I am unable to change the colour to black, but then what happens is this whole area therefore, now becomes available for my interconnections to go out so, on alright. So, this is an area array package, where the underside of the entire chip carrier is now available ok.

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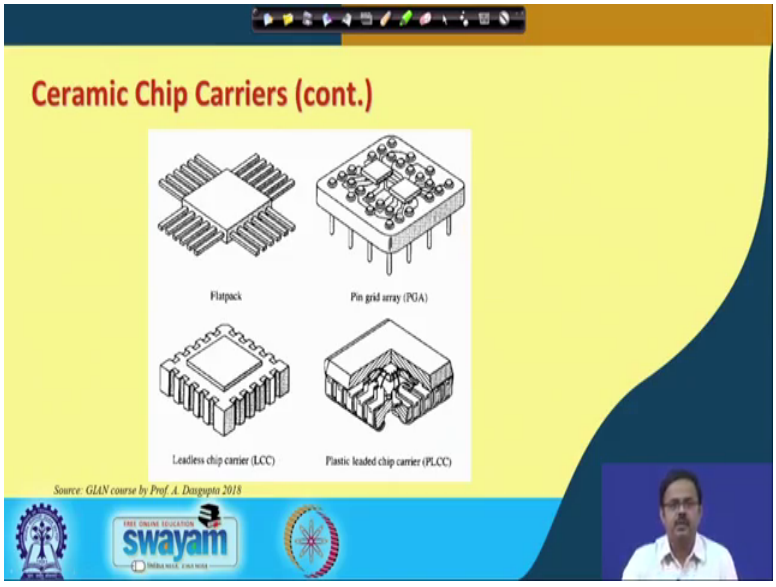


Actually we saw one example if you go back to a slide from a few lectures before over here, this was an example of pin grid array where you could see that the interconnections are coming to different rows not just this is not just the outer row, but there were pins at

the inner side as well. So, we had this seen this before. So now, we are going to talk about that the area array packages.

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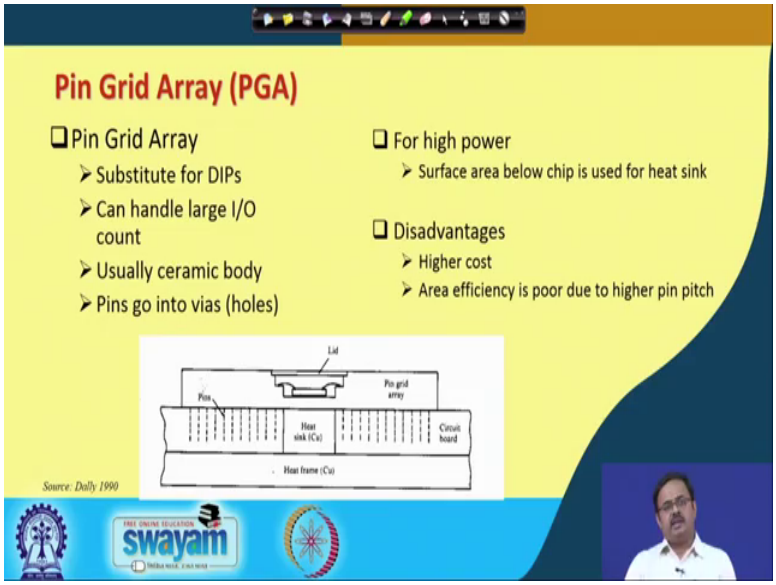


So, the first one that we are going to talk about is something called a pin grid array which we just saw over here. So, the pin grid array is a substitute for dual inline packages or even quad flat pack package is any peripheral package. So, it is usually ceramic body it can be plastic as well. These days plastics PGAs are also possible are available and what happens is on the bottom side, you have this pins coming out ok. Now, if you have pins coming out, then this pins on the motherboard has to go in corresponding holes. And these are therefore, called these holes where the pins go and settle in the circuit board, sometimes it can be directly into the circuit board, but sometimes onto something else called a socket, which in turn is bonded to the circuit board alright.

So, we will see sockets very soon, but pin will array the weight works is it gives you a lot of flexibility. In the sense a lot of surface area in terms of you know a lot of surface area for higher number of interconnects. The second thing is you can remove it typically these are removable, these are not permanent connects typically if you use it with a socket you can remove it and I am going to show you an example very soon ok. The other thing is for the surface area below can be also used as a heat sink as is shown here ok. The drawback is compared to some of the other area array packages that we are going to talk

about later, the drawback of pin grid arrays the pitch is quite high and therefore, the number of number of pins that you can accommodate in a given space is lower.

So, that is why it is said the area efficiency is poor due to higher pin pitch and this is compared to some of the other area array packages that we are going to talk about. So, how does a pin grid array look like?

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Let us look at this picture. An old picture from Intel Celeron and this is the package the underside of the package alright. And then the one on the right hand side is another example a picture of a pin grid array. So now, if you are a little concerned about what this is, this is actually the chip carrier, but the chip carrier itself is a small daughter card ok. I will show that I am probably jumping a little ahead, but I think this is a good point where I can show you an example of how a typical package looks like.

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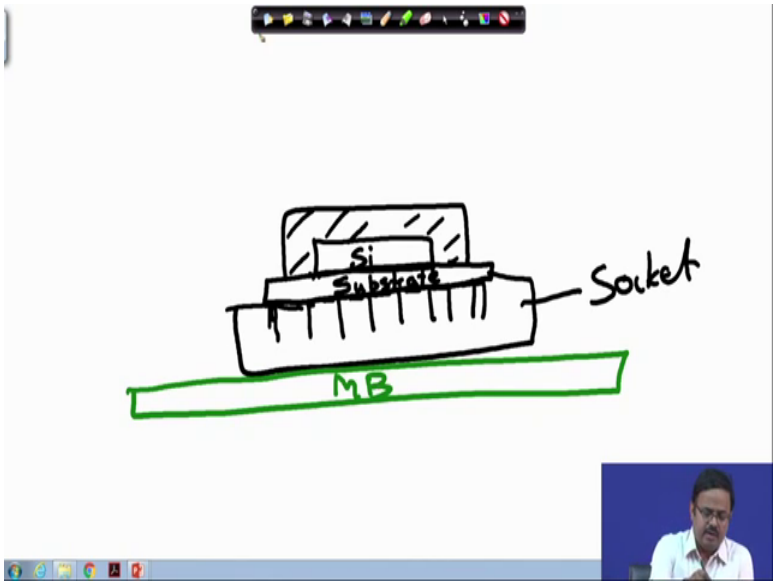


So, let us say if this is my piece of silicon, the silicon is then accommodated in a package like this inside a chip carrier, and then this one is called a substrate. The substrate in turn if it is a PGA goes into what is called a socket, which will has corresponding. This is a socket and then that in turn goes into your motherboard ok.

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Sometimes your socket may not be there in which case it directly goes; if this is a piece of silicon on my substrate, this is my chip carrier ceramic or plastic. The substrate the pins can directly get into sorry your motherboard.

So, this is what a construction of a typical package with a substrate on the motherboard is, and if you go back to the previous one that we so saw, this is how the substrate into a socket and then in turn into a motherboard ok. Sorry this should be touching each other alright. So, now, what I will do next is, I will show you an example of a pin grid array. So, this pin grid array if you look at it I am taking it out from here, and if I can please zoom in on the probe that I have on my hand. So, here you would be able to see once the screen comes up you will be able to see a pin grid array.

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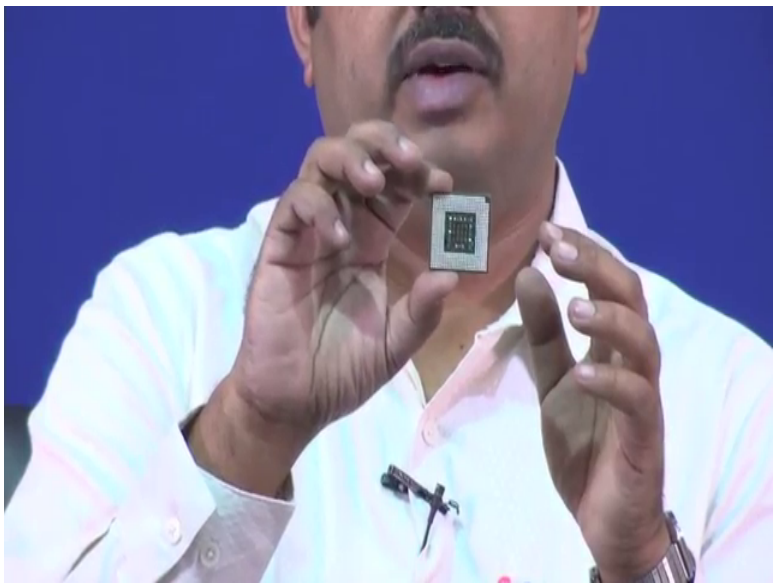

So, pin grid array let me just change it to a side view and so, that you can see the pins ok. So, you can see this spins over here, and on the other side what you see over here is not a typical ceramic or plastic pack in the silicon is inside, but the cover on the package on this on the chip carrier itself you have something called a heat spreader.

So, we will discuss about this later. So, right now do not bother too much about this except the fact that the silicon is sitting somewhere inside, and then interconnects are coming out not from just the periphery of these of the other sides of this package, but from the entire area below the package itself ok. Just below the silicon some part is not used typically, and that is left for what is called some other components what you see we will see we will talk about it later it is called the is called the landside capacitors.

So, these are just capacitors that you can see over here, but otherwise these are the pins clear. Now the other thing this green thing that you can see that is the substrate ok. The

chip carrier the chip carrier at the bottom is actually an organic substrate made of FR 4 which we are going to study in much more details when we talk about motherboard ok. It is not a ceramic it is not a plastic, but it is another piece of small motherboard made of FR 4 or some organic material. Now this one then, how does it make the connection to a motherboard?

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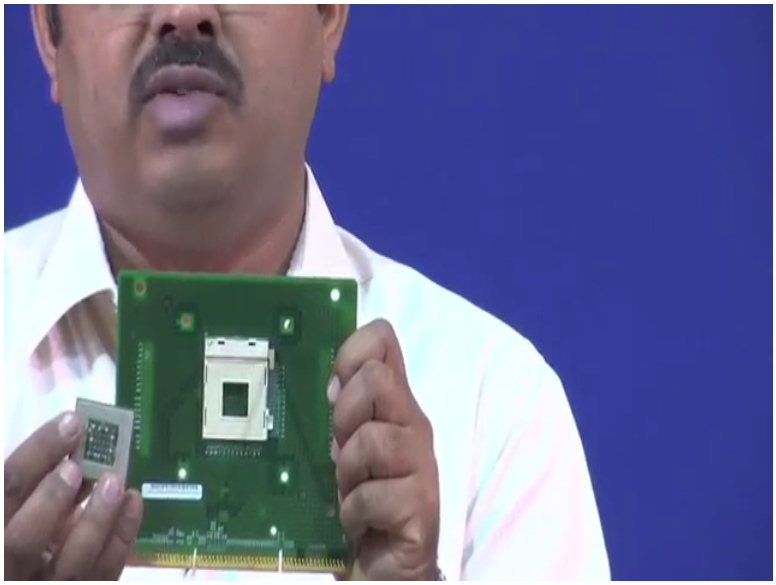

It makes a connection to the motherboard by something called as I was talking about something like a socket. So, you see this is a socket, this is a socket over here, where you have a lot of holes and each hole corresponding corresponds to one of these pins ok.

So, let us see how this is done. I will not take this one this package, this socket and put my pin grid array over here, each of the pins will perfectly fit into the corresponding hole on the socket and then there is a tightening mechanism and then the connections are made ok. So, my package is now fitted onto this socket and I can also take it out. So, you see how nice it is removable.

So, for example, now if your processor goes bad, you can just replace the processor and not have to and not without having to through away the entire motherboard ok. Here also I can give you an example a laptop that I had bought a very thin one of these thin small portable laptops, that suddenly within 1 year of its operation suddenly one day the display was not coming up ok.

And when I took it to some of these service stations, it was just out of warranty; when I took it one of these local stores, they said that they tried out, they first said that here the display is gone I will have to replace that. But, then they said you know what because these thin packages where you really do not go with this socket arrangement socket architecture, and it is directly bonded on the motherboard by some another technology, which we are going to talk about later by another self area or a technology called ball grid array we are going to talk about it in probably the next lecture.

So, because that is a permanent attach it cannot be moved; it cannot be removed and replaced ok. So therefore, you have to through away the entire motherboard including your memory or CPU everything just because the graphics card has gone if the graphics chip has gone bad, and the cost of that is almost very close to the cost of a new laptop computer. So, that is the disadvantage of having this direct bonded attachment, but socket that we give gives you this replace ability feature, but what is the drawback?

You can see the thickness goes up so, much, if you could directly bond this directly on the motherboard it would have been much thinner. But however, because you have the socket on the motherboard the whole stack up becomes much thicker clear. The other thing I want to show you is if you can I do not know how much we can zoom in further, but each of these holes that you see are metalized inside, each of these holes have metallic connections inside.

So, therefore, when the pins go in they form this electrical contact and you see when I move this lever you will see that my package actually the socket actually comes forward actually in this case comes downward. So, I will remove it I do not know if that is visible, as I remove it moves up and then it moves down. So, as it moves down what happens? If this was my pin that went into this socket hole, as the socket hole moves it was first on this in the hole right like this. As my hole moves it forms a connection and that is how these pins and the metalized inside surface of these holes make that electrical connection.

So, this is an architecture of a socket of a pin grid array or PGA very commonly used and I hope through this prop you have been able to understand it better alright. And here you can see those pictures what you saw in the slide right now or in the prop right now is something you see over here.

You see these pins, you see this what I called the landside capacitors on just below the piece of silicon and that is an area we typically do not use for interconnections ok. If I go back a slide sorry here also you see that just below the silicon we typically do not use it. You can use it for heat sink, but these days mostly we use it for you know this land side capacitors and we will talk about this later why this is heat sink and why in this picture or the sample we showed here we do not have a heat sink, but instead have use it for further circuitry. There is some technology that enables us to do that we will talk about that ok.

So, that brings us to the end of this lecture thank you very much, here what we thank you very much for your attention, that is we talked about peripheral packages. We looked at a some of these nomenclatures like SOP DIP QFP which we also did in the last class as well. And then what we did was, we first we saw some examples through the small daughter card that I showed you before in this class, we were able to see how a plastic package looks like, how a quad flat pack looks like, how a gull wing type interconnection looks like and so on ok.

And, then we went on to talk about area array packages, where the interconnections do not just come out from the periphery, but also the underside of the package is used. And the first example of an area array package that we discussed is the pin grid array. And, we saw pictures we discussed about how the construction is and then we also saw a practical example through a prop that I had brought to this class. So, once again thank you very much. In the next class we will continue from here and we will talk about two more area array packages namely ball grid array and land grid array.

Thank you very much.