Electronics Enclosures Thermal Issues
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Lecture - 33
Manufacturing Video

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So, the work piece that we have going to machine here today is this it which is liquid based cooled cold plate, and this is ah vertical machining center which we are going to mount at on this is a CNC machine and this is a carriage on which we have mounted the work piece.

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And in this we have a turret here.

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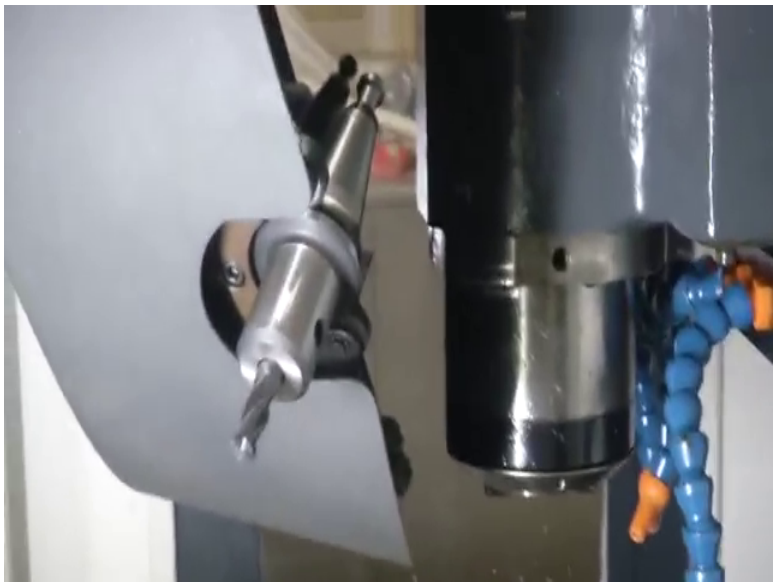

And these are all the tool test station different tool station, this is the tool which we are going to machine the work piece and (Refer Time: 01:00).

So, usually the machines comes in this format and it will be closed we cannot actually see the machining with a normal camera. So, we have we should not usually overwrite the safety features to see the machine. So, but for the sake of this dry run we have open

this window here, now as you can see the bed is moving towards the right hand side if you see it see the markings that where we have the coordinate system.

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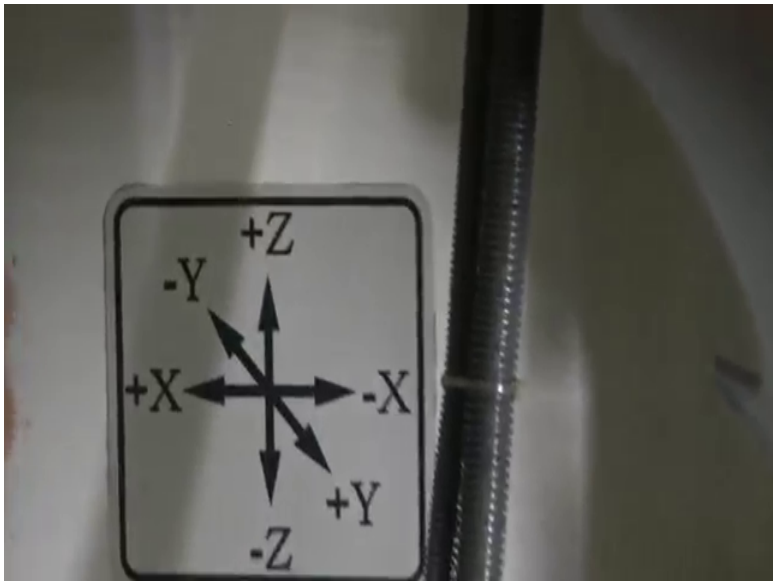

Which is x y and z where x is minus on the right hand side, why is this because in the conventional machining or drawing features we take origin as this and x axis plus, plus x will be on the right hand side, but since the bed or the carriage is moving towards the right hand side x or this point will be going towards the plus hands plus of this work piece.

So, that is why it is pointed as minus x and minus y on the other side. So, these this is the these are the different tool station as I showed, and this is the carriage this has this machine also has coolant system.

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Water jet there are three different water jet cool coolants in the machining while machining that will be on. So, just for this safety that we have not turned it on now since, we are doing a dry run this is the homing operation where wherever the work work bed is or the tool station is first the tool will move in the safe from the position to the safety position.

That will be the home position of the tool from a wherever the z value is it will move to the 0 and wherever the bed or the work station is that will move to the home position x y and z are 0 at this position.

So, now we are making a water channel for this, so as we can see we are only showing the dry runs here a sense normal machining takes I mean has to be with the safety precautions of coolant and feed we are not giving any feed or we are not switching on the coolant here. So, we are only making a dry run for this water channel making. So, the now the spindle is on according to the code which is feeded to the machine and it is taking the path which is given as per the Cartesian coordinate format.

In the conversional milling machine only we can move the work piece towards the two station, but in here the tool also moves towards the work bed, but in both the cases work piece will only move take the x and y directions in here the z is direction is taken care by the tool.

Now, as we can see we are trying to achieve here the two triangle finish ah, but we are only showing it in dry run. So, as we can see it is we are doing a dry run here. So, for the given material we cannot actually change the feed and as well as the cutting speed, it purely depends on the material property of the work piece which we are going to machine.

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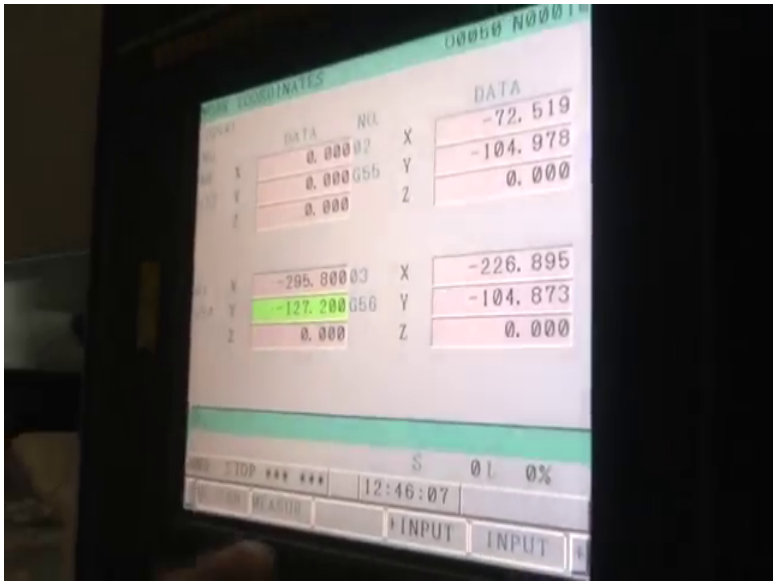

So, this is a human machine interface where we can input all the data.

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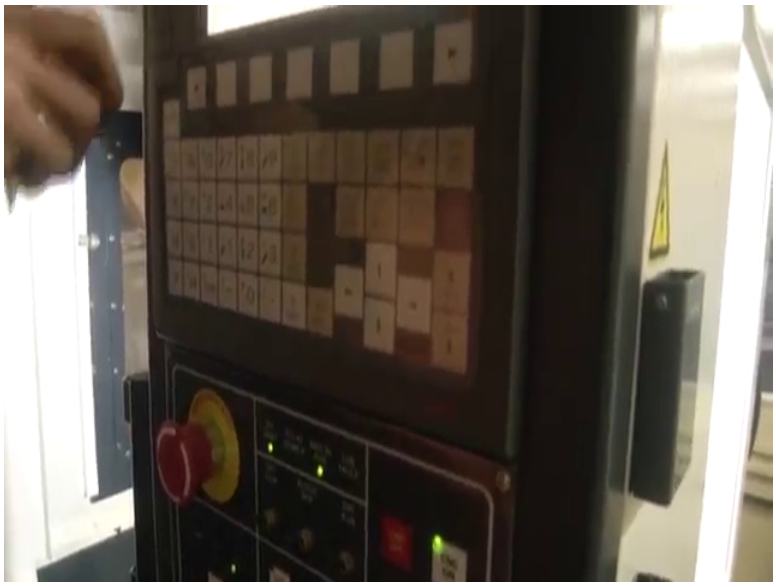

Which are g codes and m codes.

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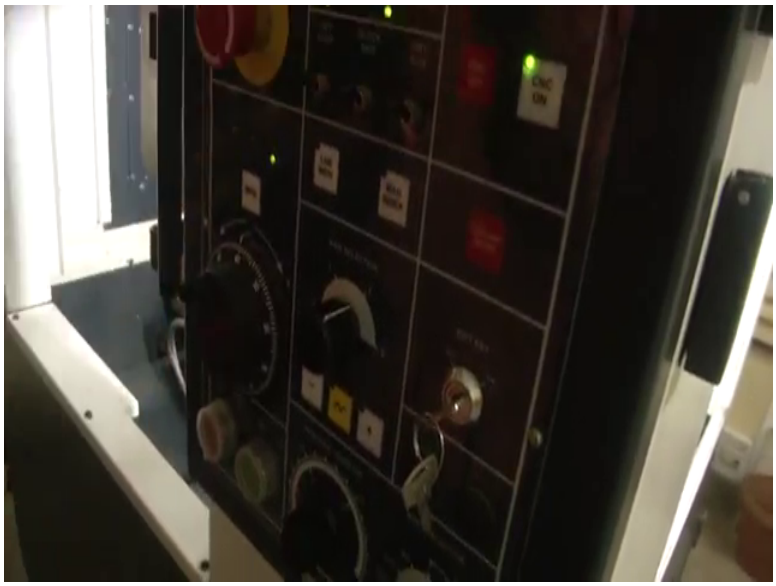

Which are understandable by the machine and we also input the offset values in the offset panel ah I mean window here. So, so once we take the x y and z offsets, we go to the offset window and we make we measure x and y to make the offset as 0.0 comma 0, for x and y and we manually input the z value which is shown in the z position, which is the machine z value this is the work offset which input at this value g 54, g 54 is a standard g code where we are taking the offset value for.

So, where we input x y, x 0 and y 0 and we will give we will press measure and it will take the values which where the tool exactly positioned yet, this will be the x 0 and y 0 for this work piece now. So, as you can see now the program has been feeded to the human machine interface here and we will be running this.

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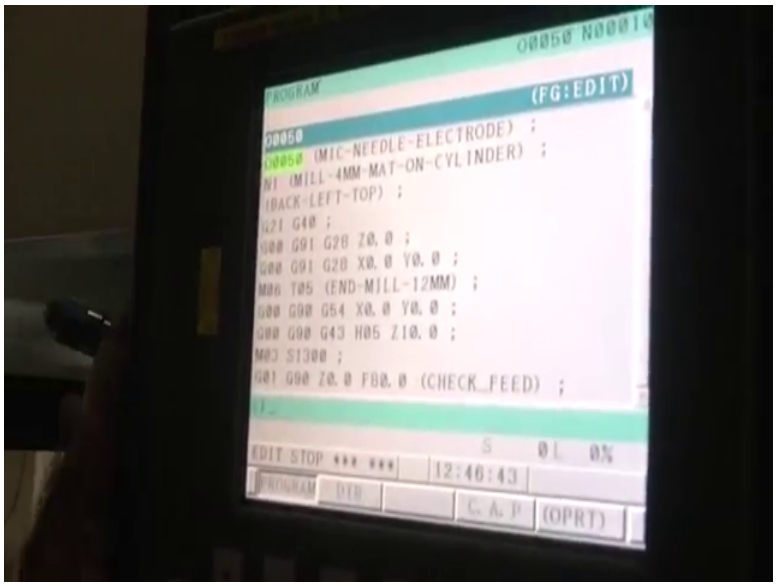

G code and m codes in auto ors manual sorry single auto mode where single, single auto refers to one line at a time and auto refers to the whole block at once, in single auto we have to keep pressing for each and every line for the machining, but in the auto mode all the operation happens at once the one block and then the machine stops for the next input.

Hello I had like to now point out to you how liquid cooling takes place in the case of high power equipment it is counterintuitive, but liquid cooling is actually quite good and better, but the thing is maybe around 2 to 5 kilowatt after that 5 kilowatt thing it sort of becomes compulsory, because you can have compact systems and the heat cooling part or sending away the heat to the ambient can be handled separately hence we end up with some sort of fluid and unlike a forced air circulation liquid has some advantages.

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So, you see here this is a sand casting after it comes from the, what you call the mold. Green mold process we need to finish it on all the directions do we really need to finish it. Yes because finally, when this goes for pressure dicasting, then have a reference including where to start the machining and which is critical and which is not critical.

So, you have here a cavity on the other side, then you see here this one is a motor feed if you want smooth surfaces you require to fit.

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The motor feed, so you have here a cutter and this cutter.

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You need to keep changing the cutter and then you see here this surface finish is not very good, and then you will see here you see on these points all these points you know lot of air pockets have been there right now it does not affect us really because it is outside and in case of the thing it is a problem.

But still we have a beautiful surface here. So, you have all these the cutter what you call this is an end mill. And actually it is a shell end mill it is both a side and face cutter type of thing ok.

So, you will see here we have chips here we have everything here and then, most important here is how do you clamp the device how do you run the machine this clamping and all is very critical even a small vibration in it completely destroys the whole what you call finish of it.

In production if the units are maybe up to a few 100 and individual batch numbers are very, very small saying it a 10 and so on. And all that you have no choice, but to go for this gravity casting slightly improved versions are there you know by which you can get a slightly better finish, depending on the type of mold you make sometimes it is possible for us to use our first job itself for digitizing the final operation.

So, you take this first to sample and then put it in a digitizer, it scans all the surfaces usually there will be a small ball like thing and this whole thing can be directly converted

into a 3 D model. Once the 3 D model is made repeating it will be very, very easy next to sand casting what we get we just need to put it in a CNC machine. And if you start with someone reference corner and four other corners then the whole machine, we can program it such that somebody need not sit here and keep on adjusting it and dimensions are reasonably guaranteed.

So, thank you from here now we will go onto the actual application or where the thing is used. Hello say this is typically a power electronics setup you see.

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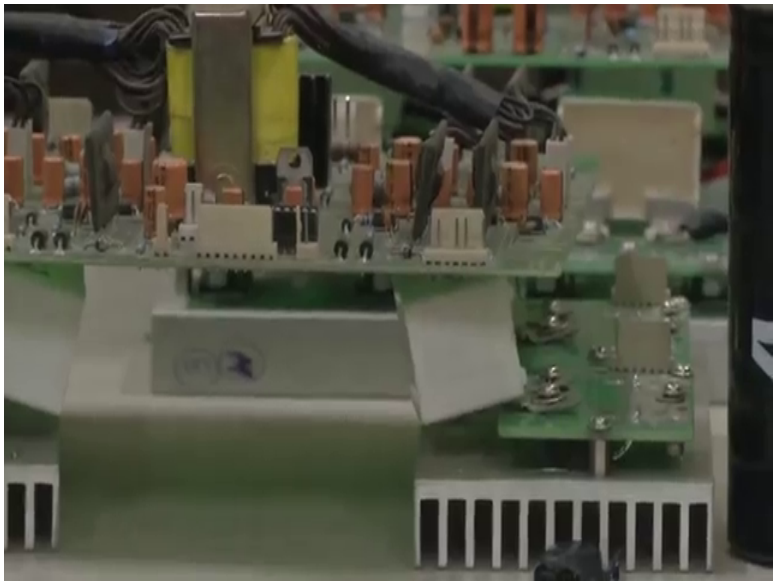

Here that our students have been trying various drive circuits and at the bottom of it this is probably one of those switches which form part of the minimum six you require whenever you want to make a three phase inverter

So, you have a switch here and you say you have these heat sinks and all that, but this is only a simple experimental setup when you are talking about 100 kilowatt drive even if you talk about a what you call 90 percent efficiency, you still end up with 10 kilowatt loss it maybe transient, but then how do you get rid of those large numbers like that.

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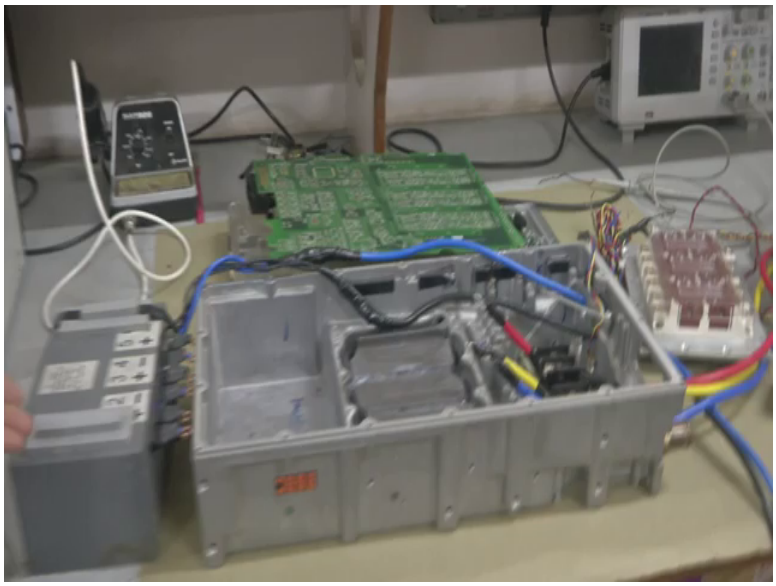

That is where we, now, come to these water cooling.

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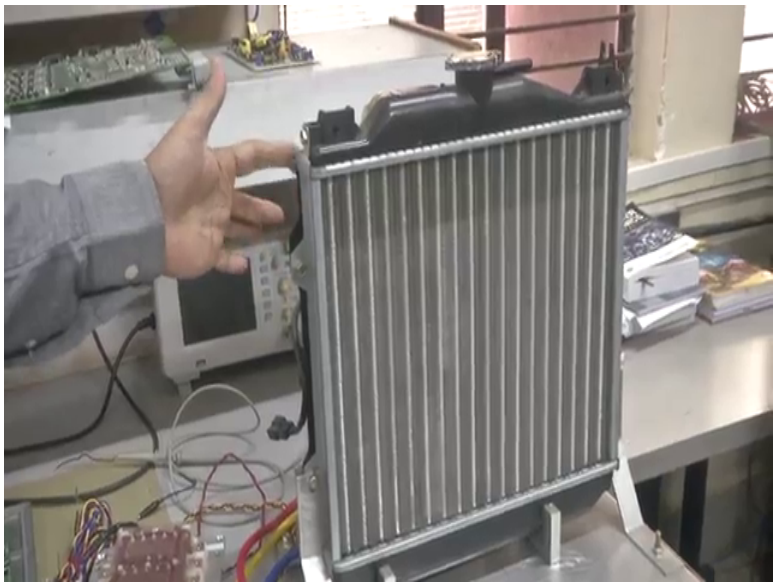

This is what you wrongly call automobile radiator, it does not radiate it is just a heat exchanger.

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From a liquid surface we have these two pipes what you need to observe very well is that there are small parallel tubes here typically to keep the cost low there are aluminum tubes and also their fin and they are closely spaced, and these two important things what you like to see is this is called the top collecting header this is the feeder header.

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This header feeds the water here, and then this header it is somewhat diagonally located. In general in the simple, simple device there is no elaborate other thing the tubes can be

bent like this. And then you see here very, very important thing is already as part of this whole thing this fan is fixed.

So, the advantage of this is if you go to the manufacturers catalog they will give you information about what is the rate of water flow with given rate of water flow, how much of heat it can dissipate depending on the ambient and so on.

That q these are catalog information this one is approximately square, because if you see that fan is a circular thing this is optimized very well, but if you see the one in a practical car you will notice that it is thin and long the air conditioning things are usually thin and long placed between this. Now, let me come to the actual power devices this is the actual switch.

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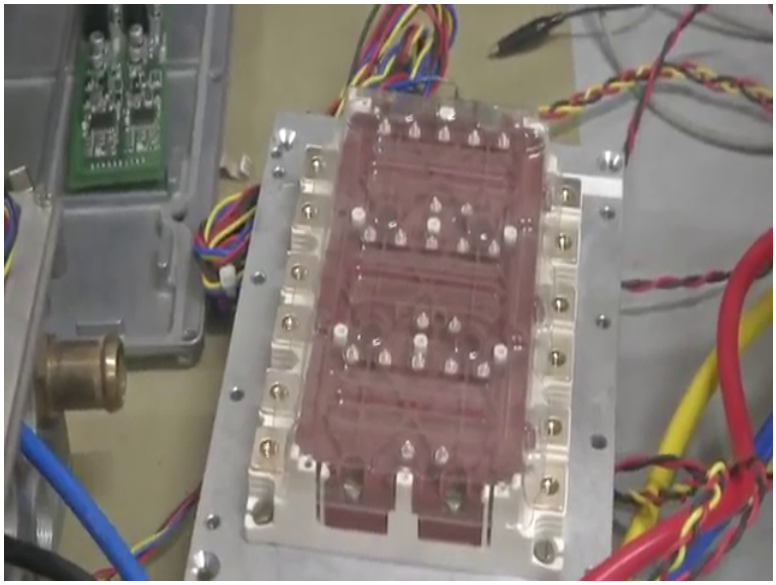

So, you will see a combination of you have seen this things this is a this is a practical switch. So, at the bottom something else is there I will come back to it and this switch if you go back to the electrical schematic requires first of all a dc link this represents the dc link this dc link comes here and ends up in the huge capacitor here ok

Right now because of our practical considerations they have just put it here eventually this will end up with proper connectors here and the critical part of this is this is what I wanted to take a look at it place have a look at it here you have seen this these are all thin channels right thing.

And this is sitting on top of this and directly these things align themselves here, this whole thing is a little like the other devices there what you will notice here is there is a air I mean the water inlet here the water seems to come here ok.

After this you have various types of grooves here and then you see here this one directly sits there inside, moment it sits here this whole assembly is the corresponding heat exchanger where the heater speaked up one, this heat exchanger has this is where I thought I will point out to you see this, this grooves this will go and sit here and it ensures that the water that comes here know neatly goes here and after that it goes here back here and it goes back like this.

So, you have a path like this these the combination of this and this forms the same function as the header that you have here. Ah once it is sitting neatly in place, you will see that everything is taken care off and you get the three phase output here directly and this is the printed circuit board which has been designed.

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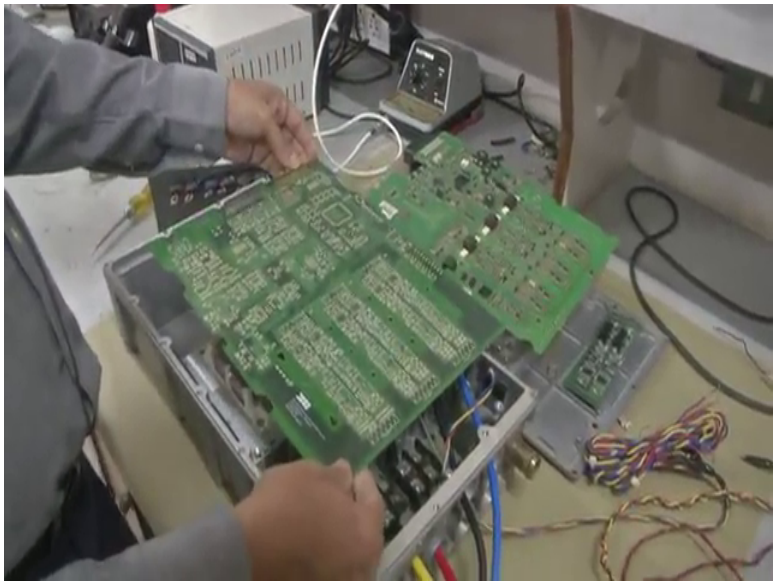

Such that it can sit on top of it, you see here we have extremely well laid out beautiful highly densely packed printed circuit boards which have been made exclusively for this purpose. You will see here you will see there this is our design.

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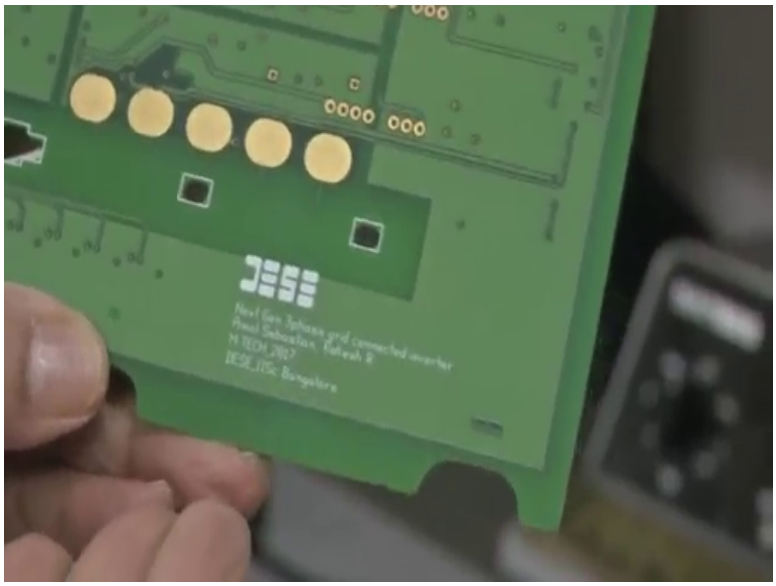

And then even this printed circuit boards if you see carefully you know there is a some reference plane I right now, I will not venture to call it anything, I will not call it a ground plane or anything, but there is a reference plane here and this other thing has all the other populated components.

At this probably this is a populated board and this is the original from which it has started, and boards like this it is possible see other side there is some other operation is possible and leave it here.

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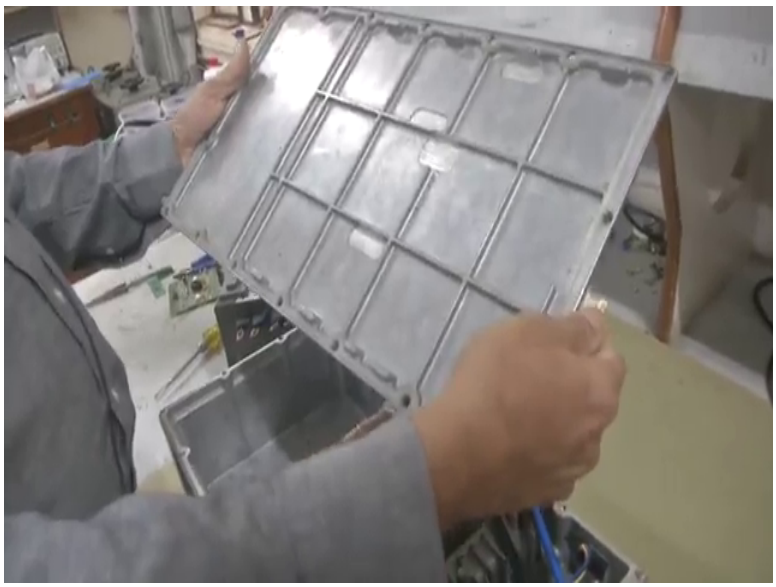

Now, I will take you to the you see this cover and very important thing to notice for you is there is a beautiful gasket here. The advantage of this is the moment you close it fully and this looks a lot like a automobile gear box or something, here also you have a large number of this screws and all that and then and the usual all these you know precautions are there.

I will just leave it here and then inside this lecture is not about the power electronics certain thing, this lecture is about that there are one portion of this which is the where the heat is exchanged from these devices through a I will loosely use the word cold plate this again if I remove it a little here this is probably you have no other choice, but to make it out of injection molding.

It is a nonferrous high pressure injection molding then there is a gasket here and this gasket goes and sits here and the whole thing sits inside this forms the, that part of it where the heat is picked up the heat exchanger where the heat from the hot devices is picked up.

Next you have this water cooling I mean the water channel here and afterwards you have the corresponding heat exchanger where heat is exchanged to the ambient, and the moment you seal it and then you see here this comes with special type of connectors, which I feel know are equally important here you see here some of these are sort of industry norms norm.

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Means saying it does not compulsory anything everybody follow similar norm. So, that whole thing can be directly made into compatible devices.

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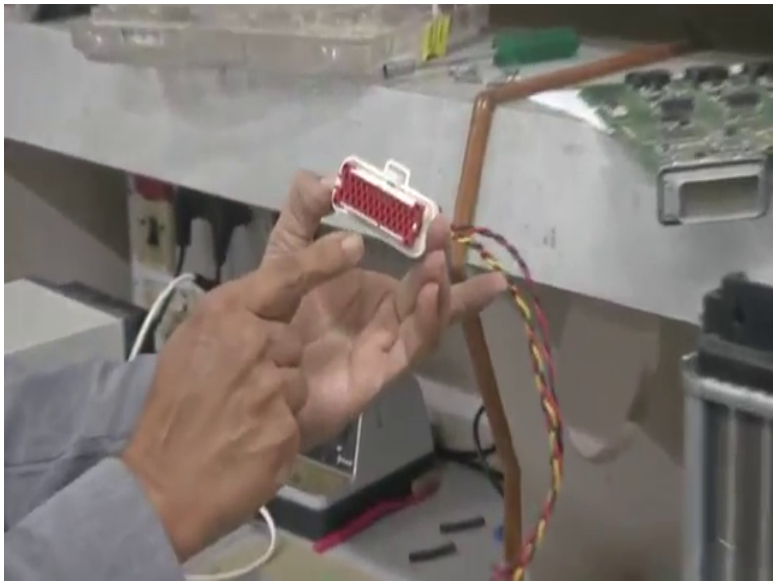

So, corresponding thing for this is this you see here we have a beautiful connector here. And then only things that are required for purposes of study have all been there this is a shell connector and then I do not know whether it is meant for it I will not risk of putting it in you know taking a chance, but still let me just put it close enough and see whether it mates and so on here.

Very rarely they use it this also you know has a corresponding one more what you call another what you call cable relief channel and all that usually you know, they will be only a few cables here water and then this is the control line and with this we are ready and then you see here this capacitors and all already come here as it is they all come with marking.

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And there the pcb means something else, it does not mean printed circuit board it means some other hazardous it is rohs compliant device. So, it does not have those hazardous chemicals inside, and then one more time permit me to gently lift it and show you the other side.

Now, can you see here we have a small they call add one here we can remove this plastic piece, and then after that we have access to these connectors and all this side ok.

Similarly, if you see this here see this here there is a cavity and then there is water which comes here you know which makes a form here and these thing are all made for this that is exactly what you have been saying that now, after we go there down our that a manufacturing engineer.

He will now see how will whether, we can create all these small channels and this mostly we are not attempting this is it, it is too complicated for us we will not be denting any of these things here. So, I just wanted to show you the various types of operations and things here so.

Thank you.