Enclosure Design of Electronics Equipment
Prof. N V Chalapathi Rao
Department of Electronic Systems Engineering
Indian Institute of Science, Bangalore

Lecture - 42
Heat sink enclosures

Hello, allow me to continue a little more of the book reading session; as I would like to call it; as I said again are text books are slightly oriented towards analysis of an existing situation and things have been simplified; saying in the case of especially our enclosures, if you need to do something, you should start with a set up already. One setup is how we are enclosure is going to look like or what it is the concept say. Second setup is given a certain choices, each choice can be analysed logically up to its end; saying these are all the consequences of your choice.

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So, at this point now allow me to show you a very beautiful something; something only thing you will notice is; it is a phone and it is a desk phone. Why it is in my hand is; it is broken and somebody gave it to us saying kindly fix it; this is about the maximum amount of twist it has and then this I need not tell you. Only thing is; this is made probably the design must have been in the late 80s and we could lay our hands on it after

it broke in the 90s.

Two things you will notice about it is; first is though it is supposed to be used in a relatively benign environment, still there is a chance of our misuse you understood. If something has been made and then inside somebody has forcefully broken it and then it is made by; I do not know it was probably it came along with a swiss tell subscription. So, I collect all these old items and then in case it drops, in case somebody stitches and all this first thing that will happen is; it will break.

So, to prevent it what we thought was simple indoor use also know need to put up with this and added to that, it has several features in it. First of all, in the case of this items a phone is a phone is it not, but it is a novelty. The best handset has not been made yet, it is still being made and handsets for each feature are very much required. Now, if you carefully because the camera will not catch, if you see this sections all these sections know in this case have been made out of plastic. Again, I will use the word loosely I will use the word, but I mean it is a polymer; strength is limited somebody has to do design of the polymer.

Now, as we go down or go up in the that one the novelty element is there and tremendous amount of aesthetics to catch that is the trend that is going on and the ergonomics is also involved in it. One of the ergonomic may consideration is easy to hold and the marketing part of it is made the technologies is fairly simple; inside I will call it simple, I will say it is established and you can licence it and do whatever you want.

But you see it has so many elements in it, there is a small something for a cradle this is what is the designer sparaghetti; this is the designer's sparaghetti; you get it? And then you see a small yellow nob is there, this instantly is a little like the hearing aid thing I have. So, it is possible for us to increase the volume and all that and then a very prominent switch is here, this side saying I can take it on and off the hook by press of a button and in this case slightly more functionality is there and then something which is not very good; is this. I am not able to recollect that name RJ what number, we have a connector here and this connector directly goes to the line which is provided by the telephone company.

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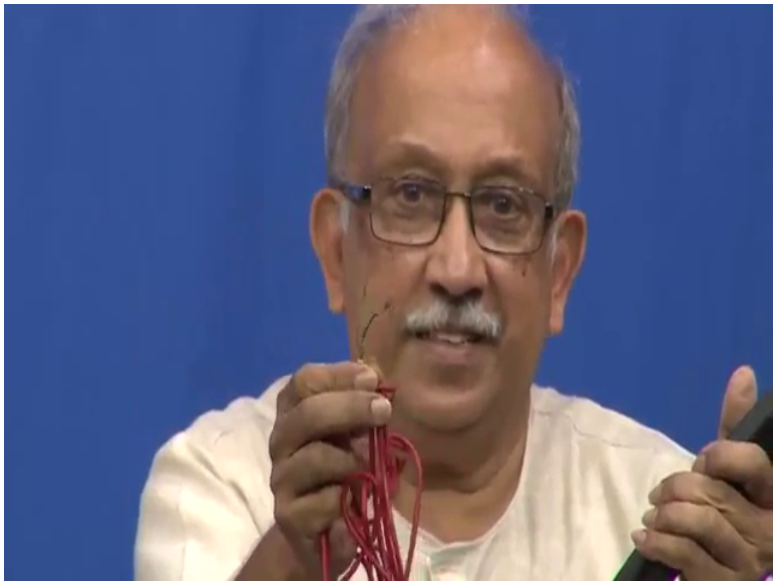

I will stop here because I am getting into details of the product which is not directly immediate relation to us.

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So, kindly have a look at the monitor; yesterday I left you with a little bit of reading about using aluminium or standard enclosures which are also IP65 rated. Now the same

manufacturer, he gives very good; you see that I am sorry, I think I should put my hand there. This is an aluminium enclosure where loosely the word heat sink is used, but mechanism is provided for affective heat transfer across the thing. Today's lecture within the next maybe 1 hour, I will see how best I can do and then one or two samples which we have had this is something we tried to make; I will get back to it later on full screen.

So, you see here yesterday's thing was about using a simple aluminium exclosure, but using a extrusions which if you put end caps and necessary things you have a very good; something which can be used straight away, no problem you see here.

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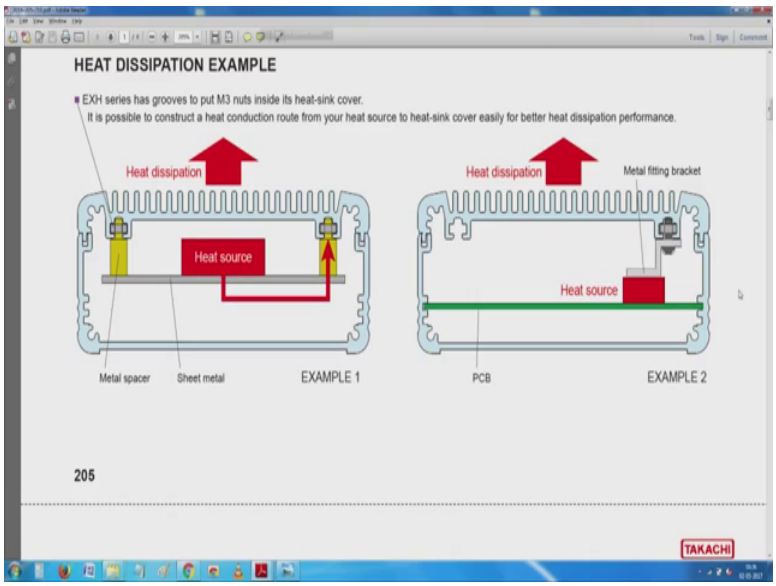

Slowly this is the crux of the problem, I may get back to this depending on the argument I am trying to make. One of the thing you will notice is you see there; you see that beautiful red coloured thing. I expect that is the device which uses full heat transfer mechanism they use (Refer Time: 07:05) word they do not use radiator. Allow me to get a little what you call, put a small comic relief; there is no radiator in a car honestly. The one you see in the front is a heat exchanger, what it does is all the what you call hot water which comes from the engine is passed on to the in and then after that; there is a ram air or the air draft which comes in that cools it solely by convection.

So, it is no I will not even call it a converter it is just a simple heat exchanger. Similarly the concept of a fan belt, I think maybe last 40 or 50 years domestic cast do not have a fan belt anymore. They have a belt anyway and the fan is run electrically and that is how things have changed, a little also in the what you call perception of the public and then the old text books. But people have; it is not as if know we throw way the old thing, the theory is valid only thing is that the nomenclature is a little ancient.

Like talking about a motor bike which is a 3.5 horse power motor bike, long ago maybe just at the end of the second world war; one taxation started typically 100CC was considered 1 horse power. I do not know what it is right now have a 100CC bike which gives 10 brake horse power and then the slowly that hits me this is related to taxation, b is related to brake horse power which is even that they have removed and then now it is called either p s or something. So, I will stop here promise to stop here I will get back to the reading.

So, if you look at my monitor; one of the first things you will notice here is seen that. So, that there is a basic heat source; this heat source can be any series pass element or any switching element which invariably has some amount of inefficiency. Though switching is a switching transistor suppose to switching 0 time; we all know the issue of briefly before in between on and off states, it will still in be the linear region well heavy current is passed through.

So, unless extra carry is done heat source inside equipment is real. So, my students have asked me saying to explain more about it later on maybe in another this thing I will talk about it, I will stick here only to standard enclosures which are available from several sources; except I would like to acknowledge the good white paper they have published about it to explain. But then it is not a universal explanation for everything, except that here if you see these; small nuts have been put inside this groove, inside its heat sink cover has put grooves small minor because I may being more fabrication and mechanical drawing person. You will notice that it shows slightly different way, actually if you were to push the nut inside in the you know across the faces, then you will not see three lines here, but let it pass.

So, here it shows as if it is shown in a very different way; this you should see while that

is not the issue here. Two things you need to see you will notice is; this there is a metal conductive spacer for; obviously, various reasons; they have not explained too much of it and you see here very beautiful word, the word sheet metal is used. This is where I keep insisting sheet metal does not necessarily mean; only mild steel sheet which is in the raw or zinc plated condition.

Heat sinks can be; I mean sheet metal can be aluminium, also in this case this heat source is directly in contact with the a spreader. It is actually a spreader what it does is it will try to spread it all along and all along the length, this is where you know little bit of what you say you need to think about it. If there were only; four small heat bridges like this and all partially making a contact; conduction is not very good. But to understand the mechanism this is clear, so one thing is heat source is mounted on a conductive plate and there are bridges which are mounted here which will go up and transfer the heat as much as possible to this.

So, if I go to the right; this seems to be slightly better you have seen that you know red point as a heat source as before; except that it is mounted on a printed wiring board and then a metal fitting bracket which is nothing but a bridge sits across it. This is where the beauty of it is; if you see, this may be slightly intentional there may not be what you call unintentional also. It can be long towards the full length of it as you long, so sir can I have the camera on this.

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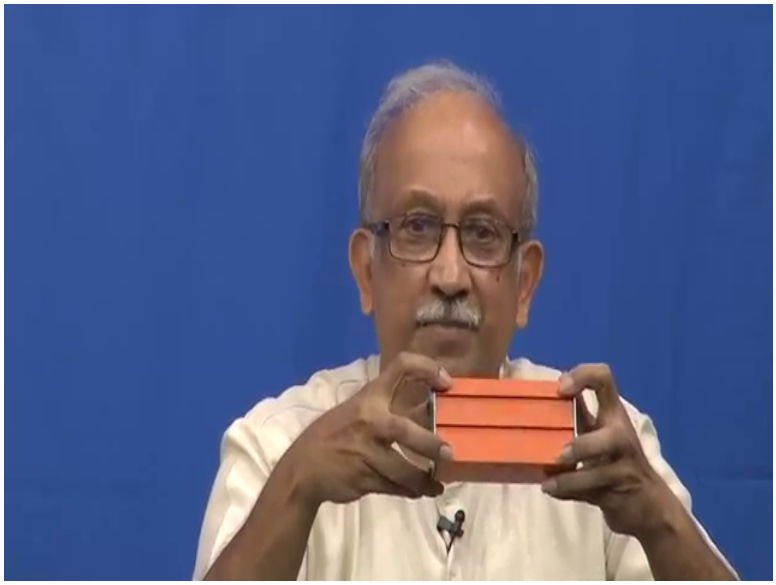

Supposing, this is the cross section and then I have a printed circuit board here and then I want you (Refer Time: 13:14) of surface for this. So, on the PCB here there is no restriction, no saying I have only four spaces in the corner; four spaces in the corner, ok in some condition, but not in all conditions. So, in this case the things like you know mosfets and all can be mounted on a small conductive surface and then maybe it can come out then spread all along the length and all along the length, we can have; now go back to my this thing. This can be the practical length and then I can have this screws which will sit neatly inside this; what you call grude nuts and then have much more contact and then building on this because of the convenience and then from here to here we have something called the effectiveness of the heat sink. The temperature keeps going down, so while this is not the ideal thing depending on your; this is where the calculations workout saying what is heat transfer coefficient and what is the mechanism and then is it natural labotical sucklation or is it.

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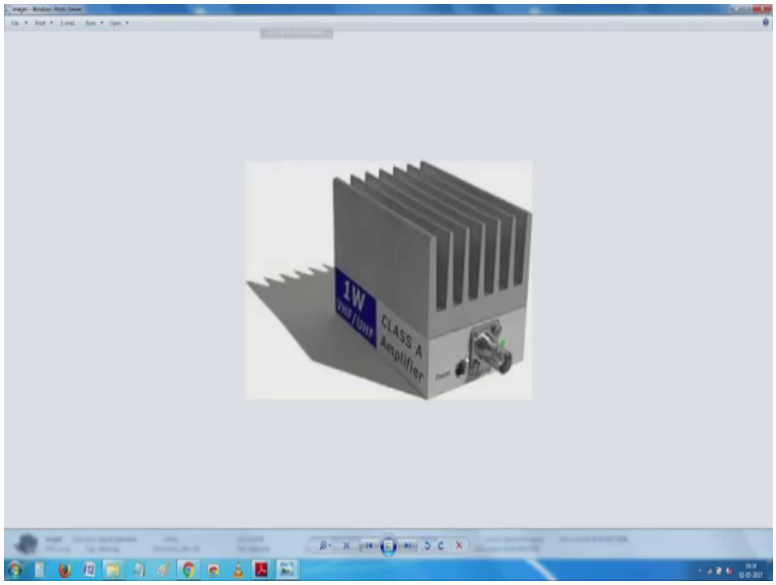

And we have a fan and it is mounted at the heat sink up or heat sink down and so on. This is where all your things come; see here we have here an RF amplifier; is itself uses a heat extrusion, but the bottom of it does not use the heat extrusion.

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See here these are all classical I will not know what it is, it will probably some audio

amplifier or it is a switching this thing and all that.

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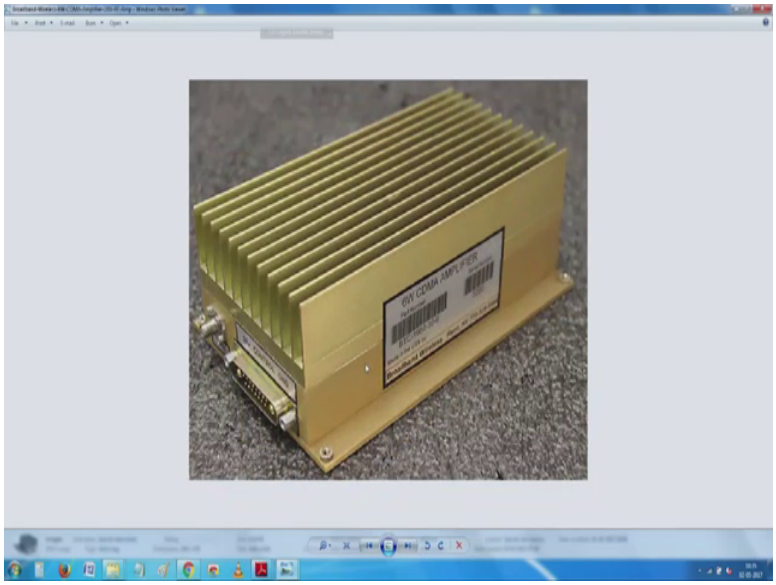

You see now this is a typically what you will find in your mobile phone systems. Two things have you noticed the all thing is an extrusion, including probably the waste plate; I am not able to get the details.

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But the thing is this is what it is all about trying to use a heat sink extrusion, I am sure some of you have seen this common things. These are typically, I have directly taken of the internet, I acknowledge the manufacturers and then I am sure you would like to make use of it. One thing you notice is; this whole thing is an extrusion and all the directions is an extrusion.

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There is a front end have you seen this here, beautifully frontend back panel has been put here except what you need to watch out is; it is not an IP65 related thing. So, generally if you want to mount it in your car or if you have to mount it in your part of your solar installation, you have can you know directly see outputs and then something here shows you what is the thing and all.

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This is the typical; I thought know I will show you, these are all typically RF applications.

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I am very happy that this has come out; you see here now I do not even know whether it is part of a; what is it equipment?

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I mean the equipment is; obviously, an amplifier or some heat dissipating device and then I do not know whether inside a car or; this looks a little like retention mechanism and all.

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Maybe it is from a car audio; this is almost a museum piece old harris used to make all

these things; so, I will stop here at this point.

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And I will try to go back to where we have left. You will notice here that heat from the actual component has to somehow reach the case. Things like this we have unlike the other things I have shown there is just a front panel fitted on both sides and then they have drilled a few; what you call openings and then in a sense; that whole thing has not been modified much. At this point, allow me to show you this beautiful; this is supposed to be a; you guessed it.

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What you would not have thought of is; inside there are 4; now, they ubiquitous 18 by 65; 1 8 6 5 0; 4 cells inside of it is not that know; you can just see the back of the cell a little here and the punch line is the whole thing is an aluminium extrusion. Why it is in this case due to various reasons, there is not too much of; I hope I do not destroy; my colleague promised me sir I will open it then I told him no no, I can manage it like that you know you see you see the cells here and then you see the very tiny circuit which actually probably has only one small switching element and then remaining is all occupied by connectors or starting in end of all failure now looks like connectors.

Even after including soldering and all that we have a power switch then we have a USB standard socket and then another side, we have a reset switch and then various types of LEDs and all what I thought no I should insist or showing it you is the whole thing is pushed into a aluminium extrusion, which is I will say the one of the issues in my talk.

Now, getting back to the; I will call it a book reading a kindly show me the these things are. So, you see here in that case you can make it reasonably waterproof by putting some end caps. In this case; it is not just about putting the end caps, we need to ensure that the heat is directly transferred back to the outside case.

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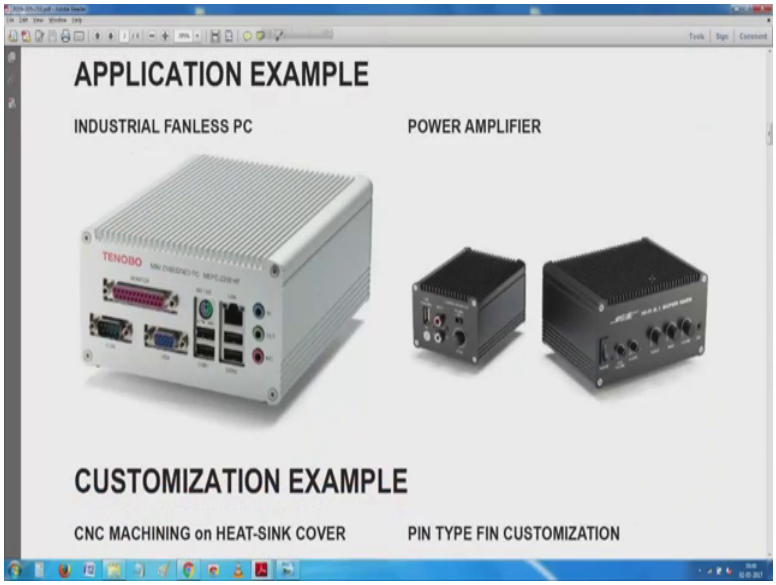

So here several examples have been given here; you see here fantastic. This is what I started with beauty no; industrial fan less PC; those inverters and all which I showed you earlier from the earlier pictures were invariably having some ventilation slots and then there is a small fan also. The positive thing about for stair cooling is it is forced, it is good. So, heat transfer coefficient again I mean; I have one more series of lectures about heat transfer. If you start talking about Reynolds number and all that know, it is for conducting exam.

But in reality we need we are very much interested in finding out in the lowest cost how well we can take out the air. See in those examples invariably there is a fan and then there were heat sinks and then once there is a fan this fan can be used to transfer coming circulate air inside and outside also plus cooling rate is much faster. But imagine a fan like this also sits in your vacuum cleaner and in a vacuum cleaner, we want to suck the dust and gather it all in a dust bag, but we do not want to do that in an electronic equipment.

So, we will put the filter upfront before it sucks air into it, but anyway it does suck air into that. Two things can happen if there is no dust things are fine; if the dust is finer then what you wanted it gets inside and if you make the; that cooling not equal dust collector

very close, you compromise on the floret; pressure differential and floret. This is where designer including know; I will feel engineering because we always have this issue between pure engineering and pure form design.

So, this is the reason we will compromise you as now as I will say aware person; aware with self interest in packaging you need to worry about how to transfer heat across. So, in this case lot of care has been taken, saying you have a old comport you have a VGA port, then you have a monitor, then you have lan and you know to USB and we have the audio and all these things which are expected to be 100 percent compatible with the existing systems

So, if you have mouse keyboard connector and all that no there are all expected to be; I lost my mouse, I got it back. Anyway, I will just put it down here so that you can see my mouse. So, in the second row; you will see the mouse and keyboard; I need not you know keep on repeating it is a PC. So, it has its function just as the one of the things only thing is I am talking about the enclosures. Super bass audio; all built with enclosures which have built in heat dissipation facility on the outside, depending on various things; if I go back to the very very initial stage, the starting point of this.

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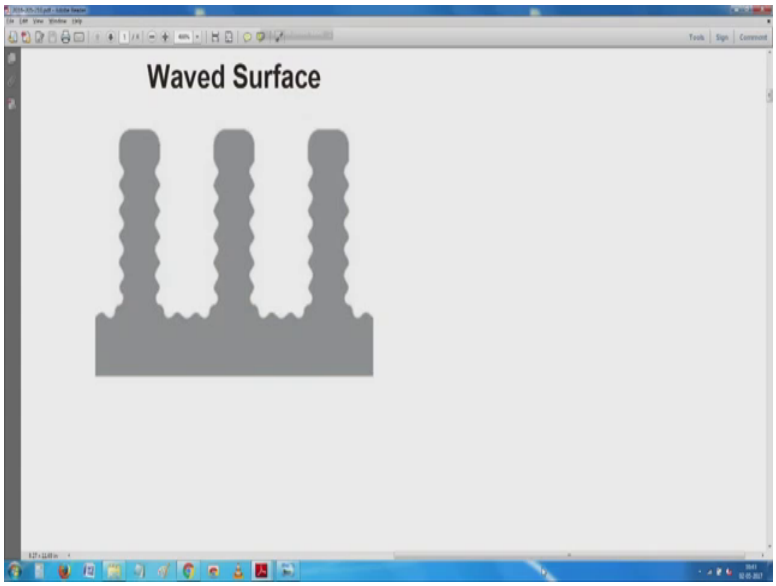

You see here; each heat sink fin has a waved surface construction; for maximum performance. This is a little more emperitical; I mean empirical I do not mean to say that this is high it is real, not as bad as slake oil, but much better than this and then this is where engineering you know makes a little thing. If you are to use it in forced convection; something called the fin effect if has to be considered and you need to have them tapered. If it is natural convection, definitely the total area available will increase dramatically; so, as I go down I have shown you this; examples of this.

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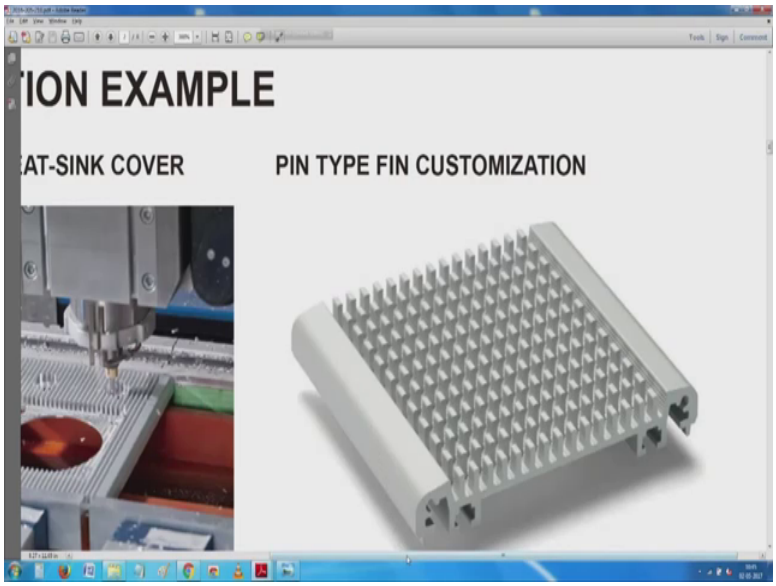

Further you see people have tried to customize and enough analytical correlations are available saying what should be the spacing of the fins and whether you know providing making them in the form of a pin will make sense.

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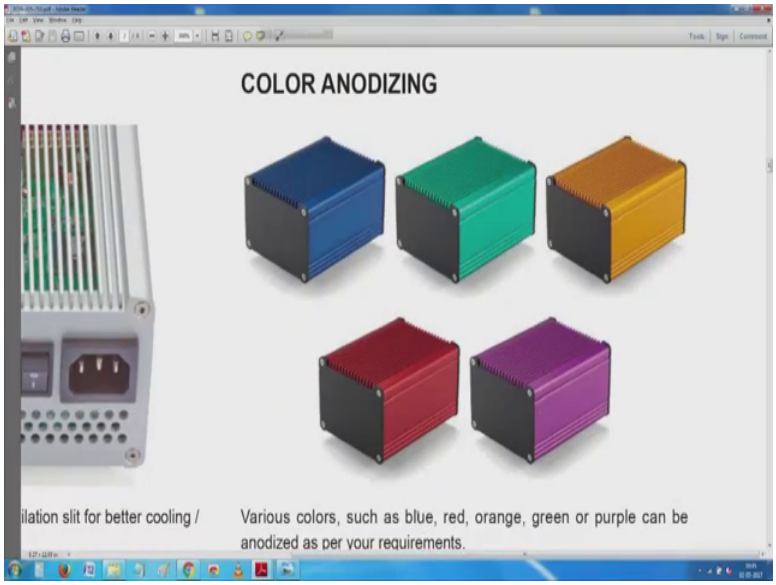

It is yes for some conditions, no for some conditions, so beyond this I suggest know if you are curious about it look up the net or wait for my other things. Can be customized as ventilation slits for better cooling, this I feel no somehow it is a little bit of a fire fighting, but this is real. Contrary to intuitive and what you have learnt in what you call when you are about 7 or 8 years old or in case of our engineers when you are already way into our 17th year; black does not help and in fact, radiation is not colour sensitive with the temperatures we are talking about.

All of them typically have an emissivity which is about the same and then the best emissivity of 0.88 is for one peculiar type of coating on top of it, which happens to be one particular colour. Otherwise to nature and the both infinite vacuum and thing all colours are same, the colours are only for us; same thing about you know I am not getting political or anything.

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They are about the same; you know see here heat sink aluminium enclosures; it is all possible catalogue are geared and most important in the corner; see something in the corner protection classes IP40; 0 is not protected at all against ingress of any liquids or any fluids and any air borne any other materials.

4 is about the size of the openings IP0 does not contain anything IP4 comes all the way down upto; I think it comes to less than 0.6 mm or 0.8 mm; things cannot go inside, I just wanted to show you.

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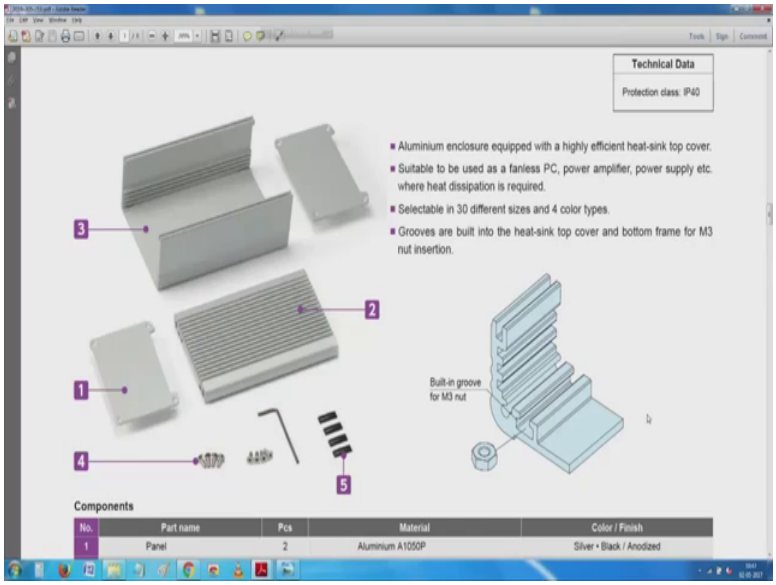

Now, as we go inside little more details I will try to show you here. Aluminium enclosure equipped with a highly efficient heat sink top cover, suitable to be used as a something something. 30 different sizes and colours grooves are built into the heat sink top cover and bottom frame for m 3 nut inversion. This is what I was trying to point out to you at that point, do you see here something.

The nut is inserted across flats or across the phase, so technically that picture which I have shown is not correct, where it shows as if the nut is across the corners. The little detail here is when you look for the nut and look for the groove; when they supply the kit; obviously, everything will be there, but friend Murphy is watching and one of them either it drops, it will be discovered only after you fit everything. So, when you are looking for a replacement, you need to check for a nut; which exactly sits in that and here also, if you follow that ISO or if you follow the standards most of the thing there is no problem at all.

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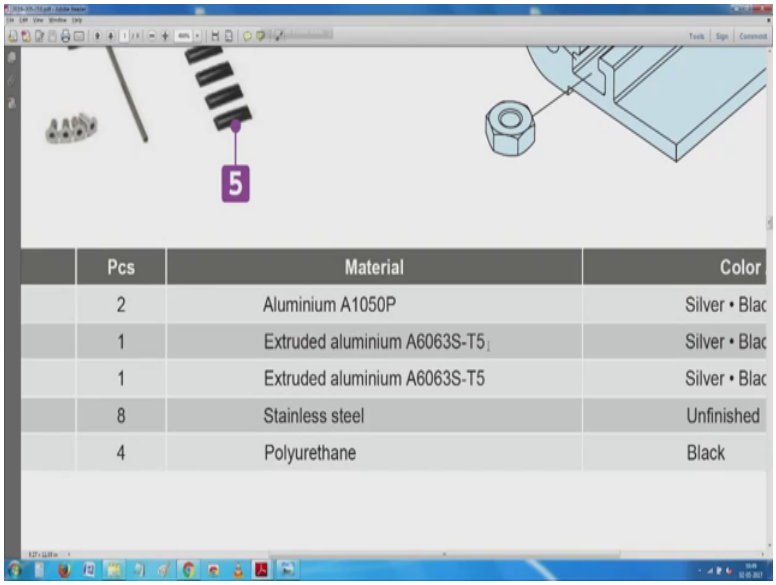

So, we have like before it still comes in the T5 temper and it is a 6063 aluminium material and then there are rubber feet; just for what you call making it complete.

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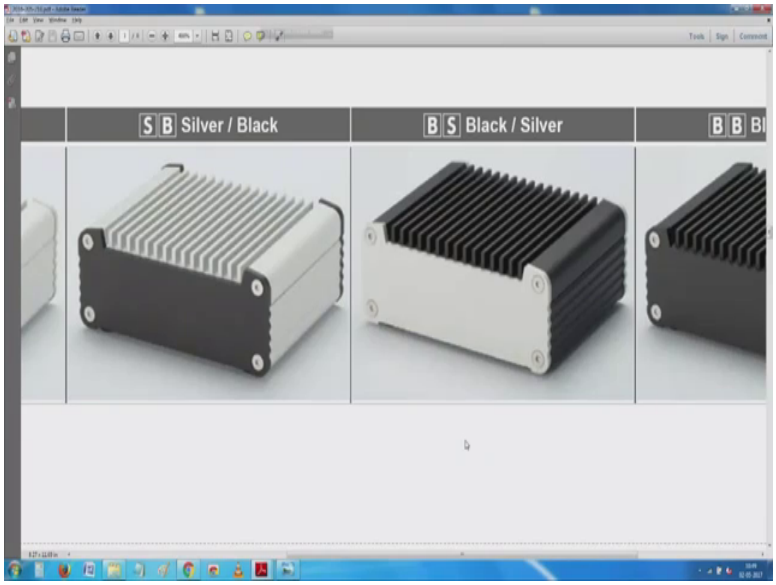

I am just showing you pictures of you know silver colour black, black and silver and all possible reasonable combinations. Because it looks like some people insist on the black or some other reason which I will tell you later, but at this point I would like to say is if

on a black cube machine and then remove the material to ensure good contact and all; at least you know the operation has been carried out. If you use the word the so called silver or natural colour you will not know, whether it has been machined and are not that is one of the reasons why invariably replacement heat spreaders and all that no come with a dark colour; so, we can identify when the machining has been done.