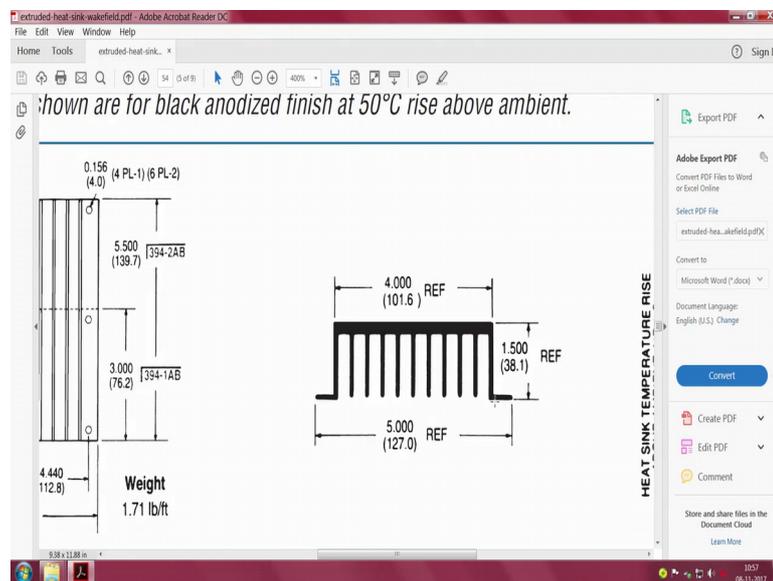


Electronics Enclosures Thermal Issues
Prof. N. V. Chalapathi Rao
Department of Electronic Systems Engineering
Indian Institute of Science, Bangalore

Lecture – 29
OTS standard profiles

Maybe in the next lecture I will try to show you something which is based on these things I wanted to start you start and show you how this is.

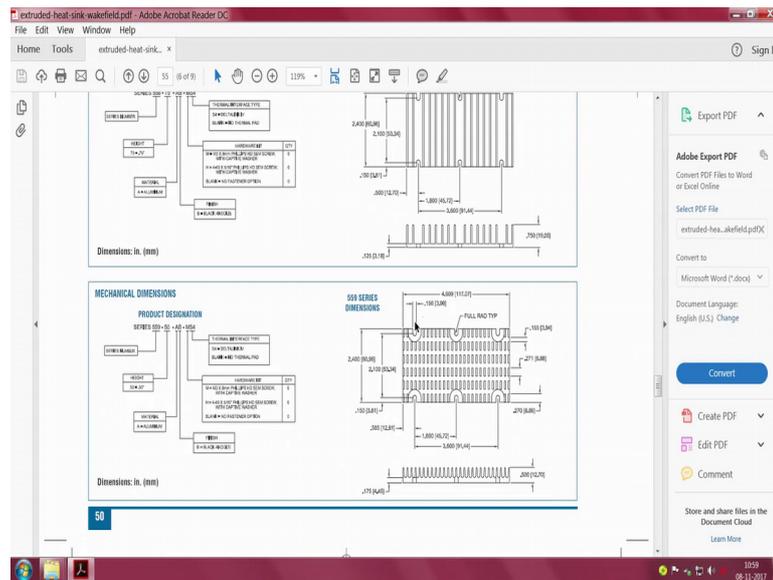
(Refer Slide Time: 00:25)



This profile can be made into a drawing, I have another monitor there I will try to do that. The advantage of this is once you know the prior art or saying what the others are doing you will have approximately an idea to start, I am not advocating copying anything. Secondly, if these are all standards which you need to endure typically it could be (Refer Time: 00:49), typically it could be industry standard suppose you want to buy a PLC.

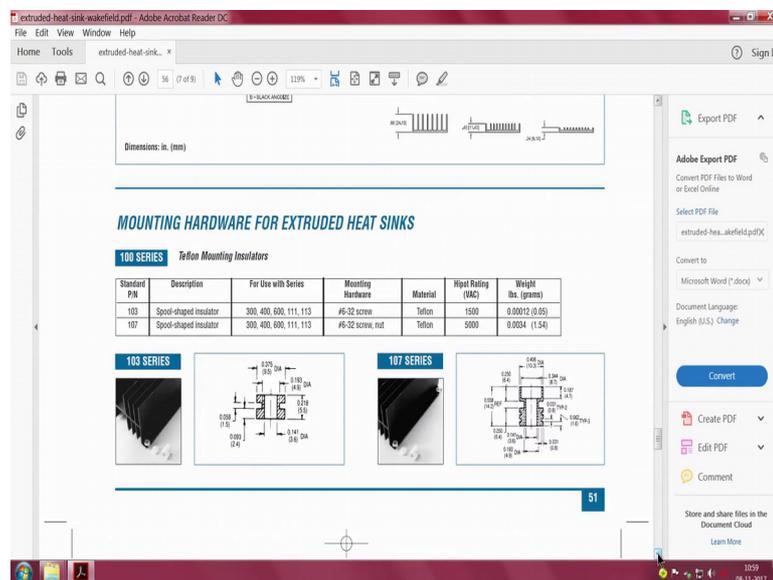
So, so many numeric controls things are there you will notice that all of them look a little like each other a little especially yesterdays lecture if you remember I have shown you how the leads are taken inside. So, we have you know some lugs and all the lugs and all are standardized. So, you have sprayed lugs you have regular you know full hole then you have sort of crimping type, and the way they lugs are attached to the wiring and all that.

(Refer Slide Time: 02:23)



See if you can think of something you can probably it is already existing there. So, you just need to now we have heat sinks for.

(Refer Slide Time: 02:38)



Any device you can think of know mounting hardware.

(Refer Slide Time: 02:41)

EXTRUDED HEAT SINKS FOR DC/DC CONVERTERS

S37 & S47 SERIES Heat Sinks for "Quarter-Brick" DC/DC Converters

| Standard Part | Footprint Dimensions In. (mm) | Height In. (mm) | Fin Orientation | Number of Fins | Forced Convection Thermal Resistance at 500 FPM (°C/W) |
|---------------|-------------------------------|-----------------|-----------------|----------------|--|
| S37-45AB | 2.28 (57.9) x 1.45 (36.8) | 0.95 (24.1) | Horizontal | 8 | 2.1 |
| S37-45AB | 2.28 (57.9) x 1.45 (36.8) | 0.45 (11.4) | Horizontal | 13 | 2.3 |
| S37-24AB | 2.28 (57.9) x 1.45 (36.8) | 0.24 (6.1) | Horizontal | 14 | 4.2 |
| S47-45AB | 1.45 (36.8) x 2.28 (57.9) | 0.95 (24.1) | Vertical | 11 | 2.2 |
| S47-45AB | 1.45 (36.8) x 2.28 (57.9) | 0.45 (11.4) | Vertical | 20 | 2.1 |
| S47-24AB | 1.45 (36.8) x 2.28 (57.9) | 0.24 (6.1) | Vertical | 22 | 3.5 |

Material: Aluminum, Black Anodized

• Mounting slots accommodate two hole patterns: 1.86" x 1.02" and 2.00" x 1.20", fitting the vast majority of quarter-brick converters on the market. • Designed for optimum use in forced convection applications. • Vertical and horizontal fin configurations available in a variety of heights. • Back enclosed finned standard. • Integral thermal interface pad option eliminates need to order and install pad separately. • Choosing a single part number with the hardware kit option provides everything necessary to keep your converter cool.

MECHANICAL DIMENSIONS

S37 SERIES DIMENSIONS

S47 SERIES DIMENSIONS

DC, DC convertors somewhere else know will show you about what is called a brick ok, your seen here quarter brick converters on the market. If you are only if you are in the military hardware you will probably come to this is you know items saying, what is a brick? And what is a brick power supply? Permit me to a go back a little, yeah seen very, very interesting mounting slot accommodate two patterns something, something. So, many inches fitting the vast majority of quarter brick converters on the market, these are all typically something which is used in the aircraft industry I do not know how they thing is available I mean.

So, another important thing you have seen here what is written here which is very, very critical. If you see here the heat sinks are I mean the fins are horizontal and you see about the same dimension, but in this case the fins are in the vertical direction. So, it is for you to now know decide which is the one that will what you call in the final configuration you do, though it is quite possible that in case you have forced convection you can overcome all this, but even in the case of forced convection still, if it follows the natural gravity especially in static installations, it is very critical which direction the thing has been made.

If you have the what you call the facility to get all these machining done and you see here this heat this profile seems to be having 36 mm width, and 57 mm length. And in in connection this is same 36 mm and 57 mm now we need to check now in the extrusion

direction. So, this extrusion direction the direction is like this understood know it is like this in this case the direction is like this.

So, you will need to select the proper extrusion one way. Secondly, otherwise know you can go to these people at least for solve small runs and if you are not competing on price anyway you know who can beat you at the price thing. So, you can always procure it from this standard suppliers advantage of the standard suppliers are most of them are alternate supplies are available.

(Refer Slide Time: 06:04)

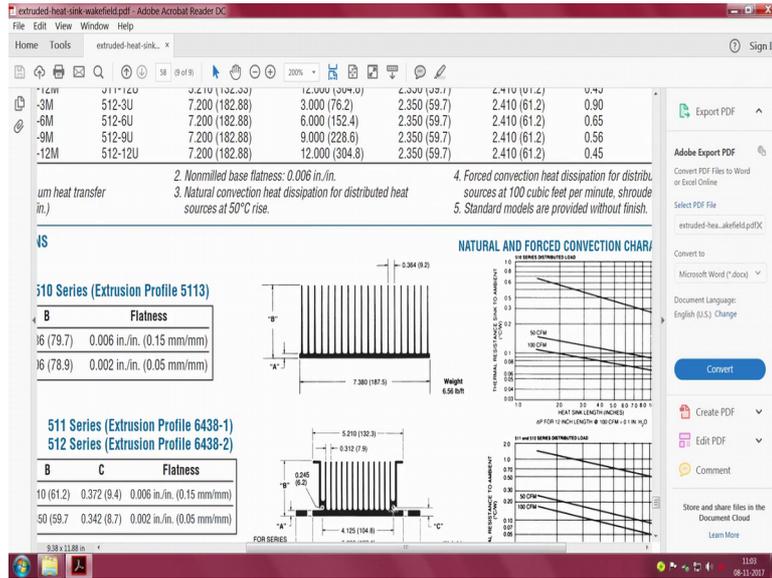
Wakefield-Vette
HIGH FIN DENSITY HEAT SINKS FOR POWER MODULES, IGBTs, RL

510, 511 & 512 SERIES

| Standard Catalog P/N ⁽¹⁾ | Milled Base ⁽¹⁾ | Nonmilled Base ⁽²⁾ | Base Width in. (mm) | Length in. (mm) | Height | |
|-------------------------------------|----------------------------|-------------------------------|------------------------|--------------------|--|---------------------------------------|
| | | | | | Milled Base ⁽¹⁾ ("M Series") in. (mm) | Nonmilled ("U" Series) in. (mm) |
| 510-3M | 510-3U | 7.380 (187.452) | 3.000 (76.2) | 3.106 (78.9) | 3.136 (79.6) | |
| 510-6M | 510-6U | 7.380 (187.452) | 6.000 (152.4) | 3.106 (78.9) | 3.136 (79.6) | |
| 510-9M | 510-9U | 7.380 (187.452) | 9.000 (228.6) | 3.106 (78.9) | 3.136 (79.6) | |
| 510-12M | 510-12U | 7.380 (187.452) | 12.000 (304.8) | 3.106 (78.9) | 3.136 (79.6) | |
| 510-14M | 510-14U | 7.380 (187.452) | 14.000 (355.6) | 3.106 (78.9) | 3.136 (79.6) | |
| 511-3M | 511-3U | 5.210 (132.33) | 3.000 (76.2) | 2.350 (59.7) | 2.410 (61.2) | |
| 511-6M | 511-6U | 5.210 (132.33) | 6.000 (152.4) | 2.350 (59.7) | 2.410 (61.2) | |
| 511-9M | 511-9U | 5.210 (132.33) | 9.000 (228.6) | 2.350 (59.7) | 2.410 (61.2) | |
| 511-12M | 511-12U | 5.210 (132.33) | 12.000 (304.8) | 2.350 (59.7) | 2.410 (61.2) | |

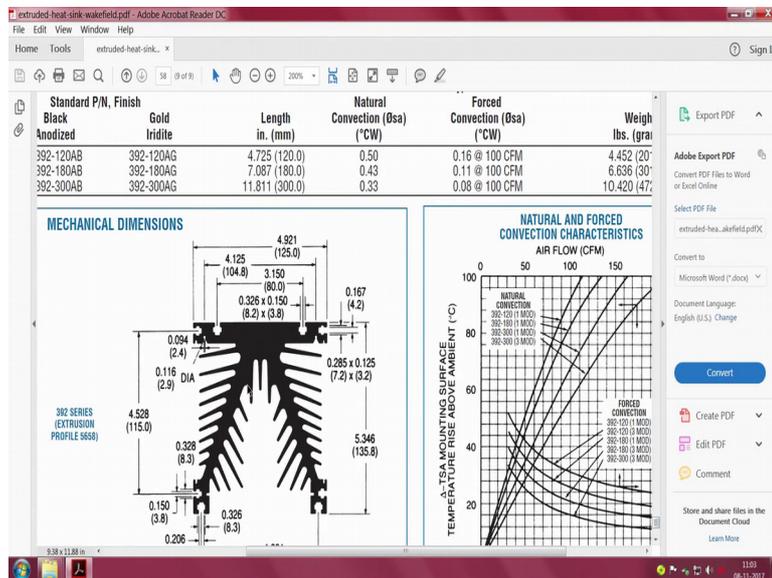
So here for power modules IGBTs, relays ha these are something else called the bonded fin heat sink, which I suggest now you read up before I repeat you read up.

(Refer Slide Time: 16:19)



Seen here know again well I want call it a goof, there are you see we have this beautiful thing know meant for force conviction, but of a different configuration and you see here we have a mounting system.

(Refer Slide Time: 06:27)



Here and we have another mounting hole here and instantly if you were to mount any power semiconductors likely that you will only stick to this region if you stick to this region.

So, the whole thing has been fairly optimized total area is optimized these profiles you need to it is easy for a starting point hum here directly you will fit for you know minute he has given then power dissipation. So, that particularly industry know it uses that what you call LFM or in this case know the cubic foot per minute it gives. So, that could be liter per minute or something here now it is cubic foot per minute.

(Refer Slide Time: 07:30)

511 AND 512 SERIES

| Series | A | B | C | Flatness |
|-------------|-------------|--------------|-------------|----------------------------|
| 511-U 512-U | 0.250 (6.4) | 2.410 (61.2) | 0.372 (9.4) | 0.006 in./in. (0.15 mm/mm) |
| 511-M 512-M | 0.220 (5.6) | 2.350 (59.7) | 0.342 (8.7) | 0.002 in./in. (0.05 mm/mm) |

Dimensions: in. (mm)

511 Series (Extrusion Profile 6438-1)
512 Series (Extrusion Profile 6438-2)

Diagram showing dimensions: 0.240 (6.1), 8.290 (209.3), 0.302 (7.6), 4.195 (106.8), 5.000 (127.0), 7.200 (182.9)

Weight: 511: 4.53 lb (2.05 kg), 512: 5.13 lb (2.32 kg)

392 SERIES High Performance Heat Sinks for Power Modules, IGBTs & MOSFETs

| Standard P/N, Finish | Gold Iridite | Length in. (mm) | Thermal Resistance at Typ Natural Convection (0sa) (*°C/W) | Con |
|----------------------|--------------|-----------------|--|-----|
| 392-120AB | 392-120AG | 4.725 (120.0) | 0.50 | 0.1 |
| 392-180AB | 392-180AG | 7.087 (180.0) | 0.43 | 0.1 |
| 392-300AB | 392-300AG | 11.811 (300.0) | 0.33 | 0.0 |

MECHANICAL DIMENSIONS: 4.921 (125.0)

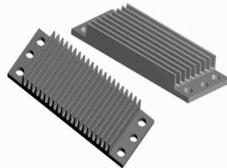
So, you see here if you see these they has given a very convenient picture for us know to even understand. I will see if I can enlarge it that you see what you have in the front, we have a pen for comparison then I am not very sure this looks a little like an IGBT switch, then I am not very clear what it is and the very critical thing to observe is you see these two mounting holes, here these two mounting holes most likely fit these two miraculously.

So, all you need to is buy this and do a little bit of calculation on the glasses especially switching glasses, mount all of them mount 3 4 5 6 of the (Refer Time: 08:21) and then probably you can even mount something back to back attach a proper fan I loosely use the word fan and you are in manufacturing business of whatever devices you want.

(Refer Slide Time: 08:43)

STANDARD THERMAL SOLUTIONS FOR EIGHTH BRICK CONVERTERS

Aavid Thermalloy heat sinks are designed for engineers seeking a complete off-the-shelf cooling solution for industry standard eighth brick converters. Unlike other converter heat sinks, Aavid designs feature thin fin geometry which increases thermal performance and reduces pressure drop. In addition, all heat sinks are ready for mounting with interface material pre-applied which streamlines procurement and assembly.



APPLICATION NEED:

- *Maximum Performance*

FEATURES AND BENEFITS:

- *High fin density has more surface area for heat transfer, despite small foot print.*

I will now take you to another, what you call catalog this is by aavid the thermalloy aavid. So, you see here already know designed for engineers seeking a complete off the shelf solution for industry standard eighth brick converters means it is a one eight of a brick I am not very familiar with what it is probably, if you check again same thing here you see here this is probably mounted facing this direction this is mounted facing this direction.

(Refer Slide Time: 09:29)

APPLICATION NEED:

- *Maximum Performance*
- *Low Pressure Drop*
- *Fits industry standard Eighth Brick modules*
- *Optimal configuration*
- *Simple assembly*

FEATURES AND BENEFITS:

- *High fin density has more surface area for heat transfer, despite small foot print.*
- *Thin fin geometry improves system airflow and reduces fan costs.*
- *Hole pattern fits 1/8 brick DC/DC Converters from top manufacturers like Delta, Emerson and Tyco*
- *Lengthwise and crosswise fin orientations in three fin heights to allow a precise match to the application*
- *High performance QPad3™ interface pad saves time and optional hardware kit provides the complete solution under a single part number*

ORDERING INFORMATION:

| Part Number | Fin Configuration | "H" height | Figure |
|---------------|-------------------|------------|--------|
| 241802891200G | Lengthwise | 6.1 (0.24) | A |

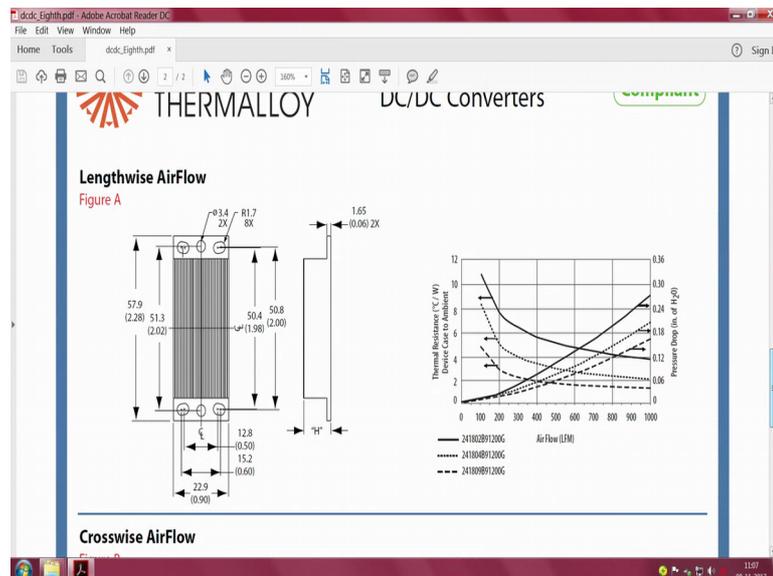
Optional Hardware Kit:
Four M3 x 0.5 x 4 screws with

So, we have high fin density has more surface area, fin geometry improves system airflow and reduces fan costs which very important hole pattern fits one eighth brick DC DC from manufacturer like delta Emerson and Tyco, lengthwise and crosswise fin orientations in three fin heights allow, precise match of the application this is where it is critical if all of them have about the same pitch you can neatly stack one or the other that is where the take thing comes. So, probably you can have two rows and, I am sorry four rows and two columns and you can have all the fins in the same direction.

So, if you see very nicely know that multiple of four in one in multiple of two and the other approximately fits whatever the dimension is which fits the electronic curve what you call things used in the naval as well as aerospace industries typically most aircraft and most naval applications have this. So, you put it inside it matches very well.

So, if you are in the what you call in the packaging field you will probably, when expert in mechanical or electrical one of them, but you can at least seeing all these if you are an electronics engineer you can understand and then you need to have a little bit of overlap saying you have to know what they are working on and what you are working on in its a matter of choosing one and then this is where you tell if you ask me do not attempt to.

(Refer Slide Time: 11:06)

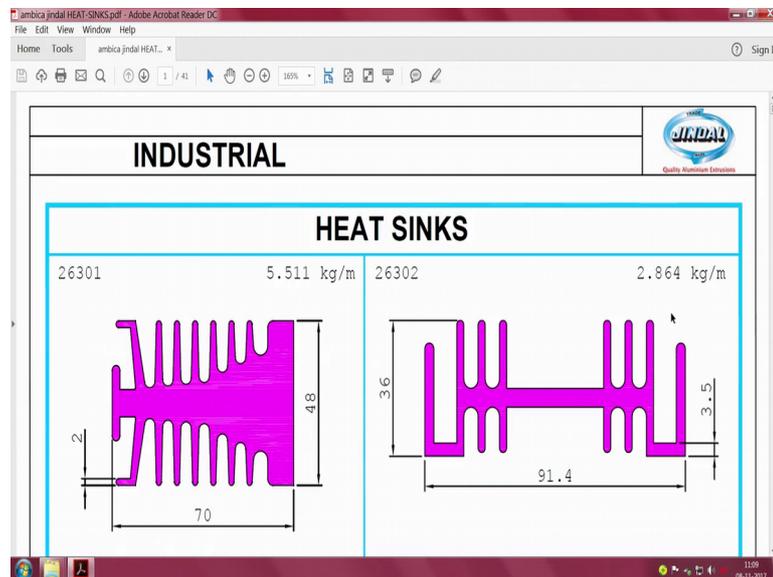


Copy these things because the material itself now is very, very highly developed and you are seen here if you small tricks which they make if you see this mounting dimensions it is an oblong hole, which is small point 4 mm pitch difference is there, and then use it this

way there is a significant difference is there between two centers this one is a what you call I I am not very sure probably it is 15 mm and this is 12 mm.

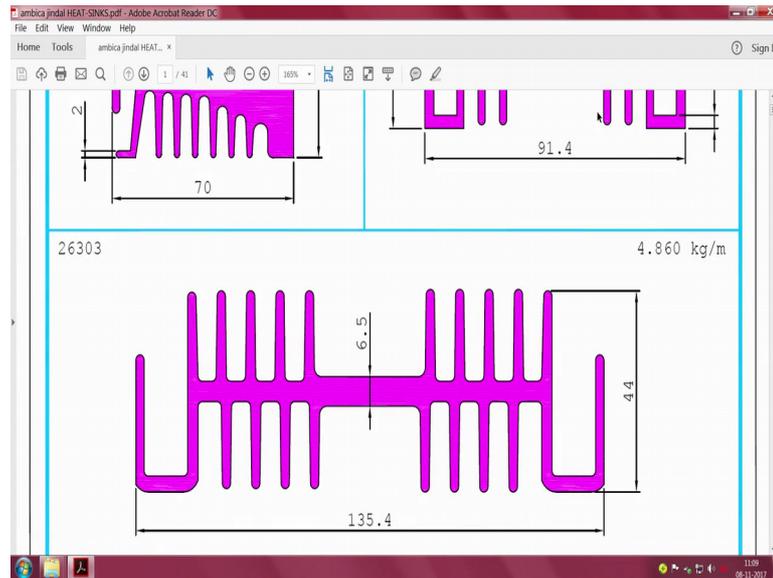
So, depending on your pitch the way you drill and all that all of them now can is equally very well be stacked easily. So, I can move probably the center one could be the standard and all other things know two moments you make, and then it is unlikely they will clash with each other. So, these are all the things which somebody has worked for you and then you can easily I feel now it is very convenient for you to understand these thing. So, now allow me to stop this and see go to since I am making it.

(Refer Slide Time: 12:36)



From our local this thing I wanted to show you that not long ago this is very much current about it. So, if I see you show you some of the lower cost audio professional audio, but lower cost and all that probably this sort of thing know is very, very common.

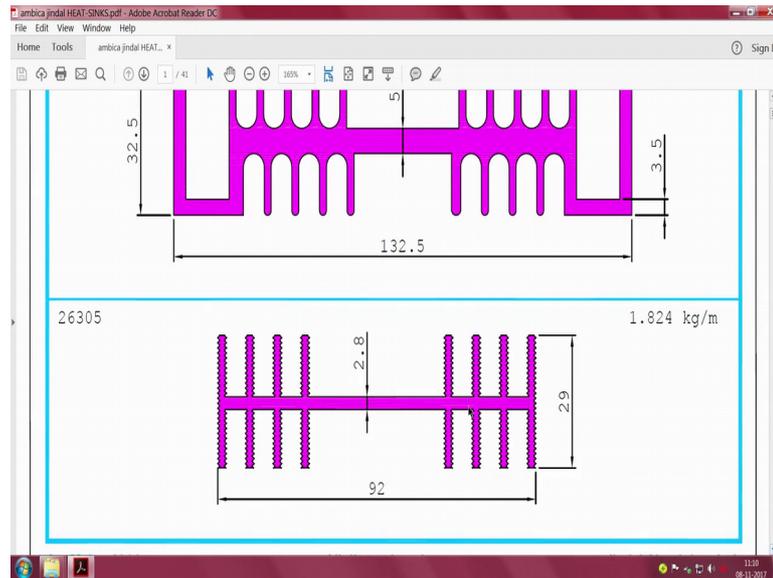
(Refer Slide Time: 13:07)



For them seen that this profile and the one therein this profile are about the same you have two mounting holes. Then beautiful what you call base here 6 and half millimeters wide and this is 135 mm, and then nicely you are if this is inside of the equipment imagine this part of it is the base this portion can be inside the equipment and you can probably mount your power devices here. And then make some arrangement by which know you can probably have a driver pcb and all this whole thing is enclosed from here.

So, if you just cover this portion you take something and just cover this portion its very much easy for you, you have all these many fins and this area for you to dissipate heat which is how you start, so there is a lot of what you call details.

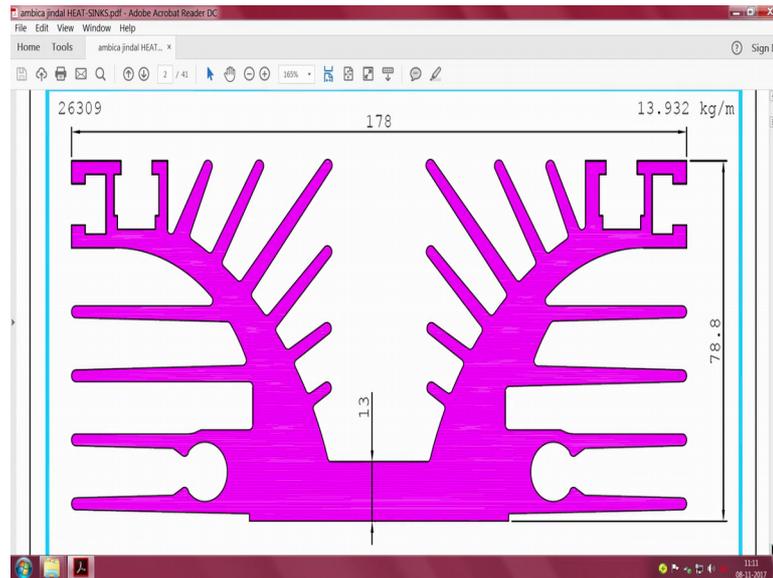
(Refer Slide Time: 14:15)



So many of these are available and same thing here you see this probably somebody has ordered this and you see the difference this has a mounting flange built into it does not have a mounting flange built into it. So, what did they do about it probably in that particular application instead of buying one with the mounting flange instead of buying this with the mounting flanges, it is much better you have 92 mm here and then you take a call on how you mount these things, it can be inside a rack and directly you can have a mounting plate here at the bottom and then the whole thing can be made.

So, we have huge number of manufacturers and things like this I am not very clear if somebody has actually made any calculations or anything what you see here.

(Refer Slide Time: 15:00)



I feel happy when I see such things, so I have two options you have to make one more you know mirror on top and then you put a huge fan, and then the fan as I have explained to you directly know oh hey what happened ha it shows 178.

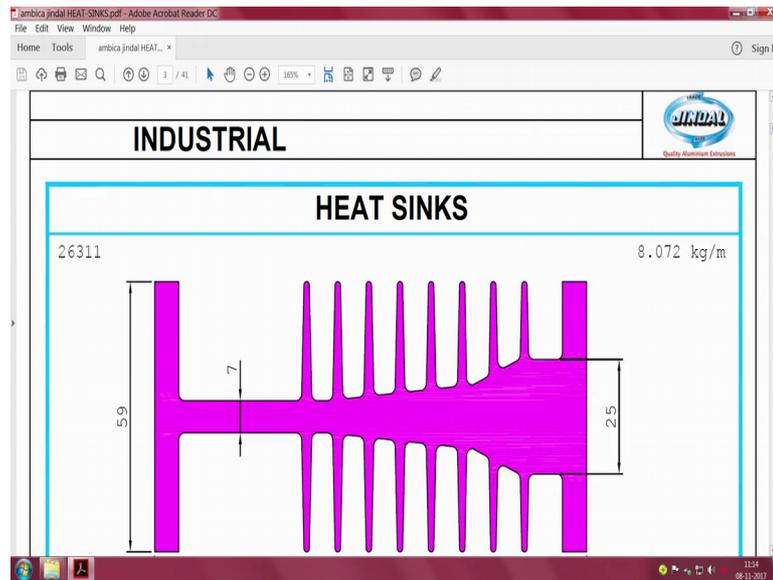
So, there is some mounting holes and so on like that, so if you have a 180 mm are some other equivalent cooler, you just can package the whole thing probably, something which is having a section that is right and having a force aside and then you see the way these have been made this can easily be tapped you put something and tap it once you tap it both sides you can mount it easily and this is used for a nut.

So, this is usually typically some things like that you can you know put a big nut mounted here, otherwise you can put a strip here and depending on the all the proportions have been adjusted for the locally used things some places you have a 6 mm bolt, other places you have a quarter inch there about the same only if you are somebody who was maintain I mean who was found this inside, you know that murphy's always offered work whatever item you have the other matching one will belong to another system.

And if you have a quarter inch nut I am sure you will have a 6 mm screw which doesn't go inside it just keeps you know give a couple of time things and its starts slipping and the river sales if you have a proper 6 mm net chances are you end up with a quarter inch screw which doesn't go inside.

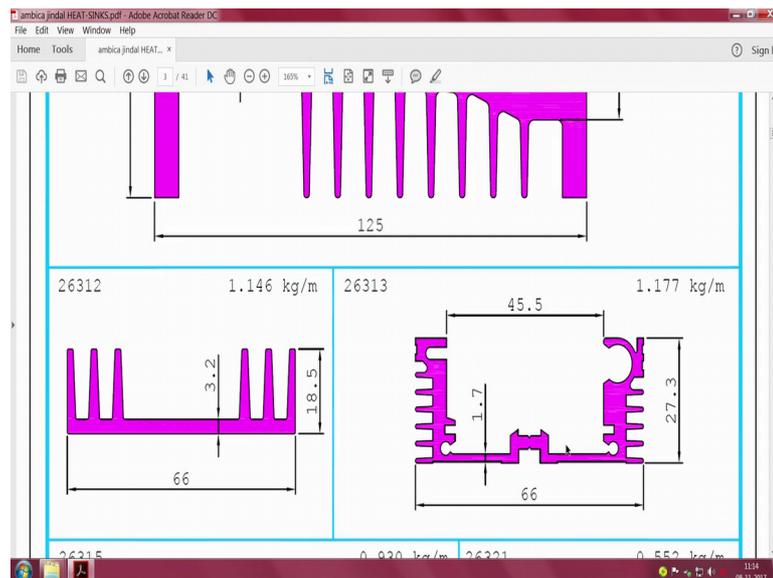
So, if you now go to the catalog this is only the extrusion catalog this is not the people who make the extrusions a cut and mounted for you. So, you can always go back and see what best you can do with this extrusion. So, I will now try to go back to the fifth width of the page and try to take you down and you see here.

(Refer Slide Time: 17:30)



Diode heat sinks then some other.

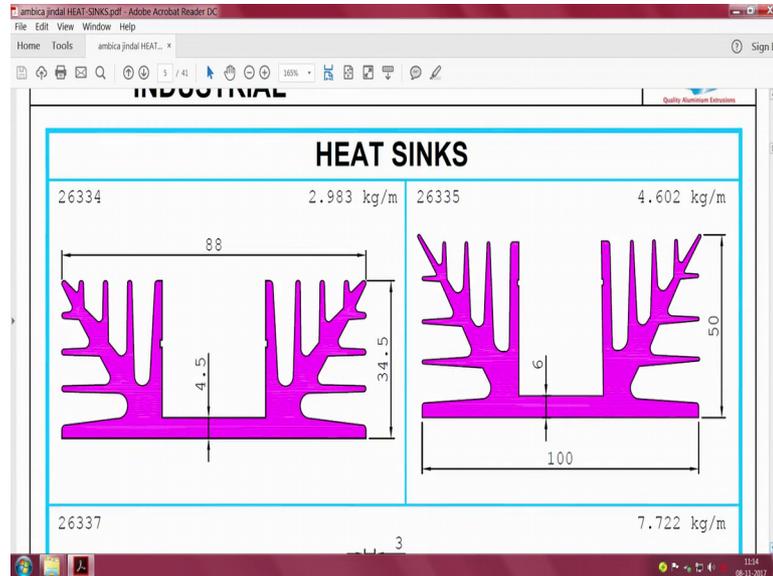
(Refer Slide Time: 17:34)



You know what you call various types of boxes; obviously, here you have a power mounting thing here something else here this looks like a place for a PCB to go inside

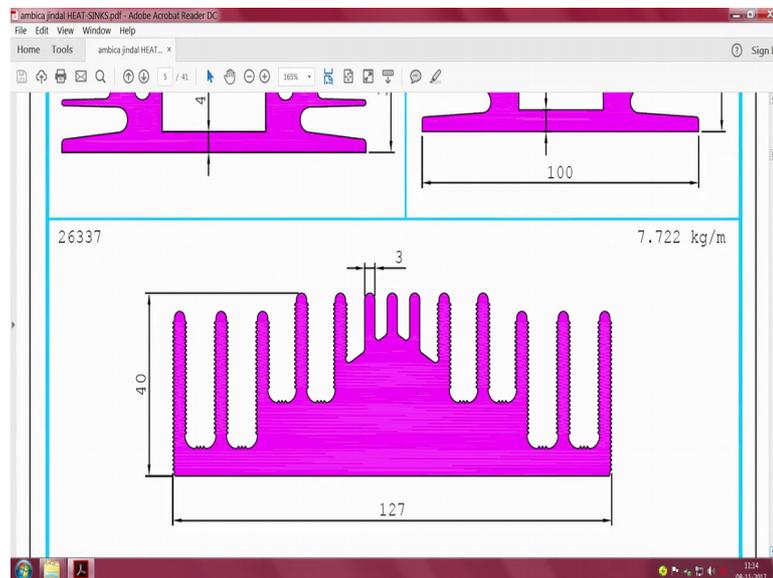
this. So, if you can think of heat it is probably already exist somewhere seen this know anything you.

(Refer Slide Time: 18:01)



Want probably exists somewhere.

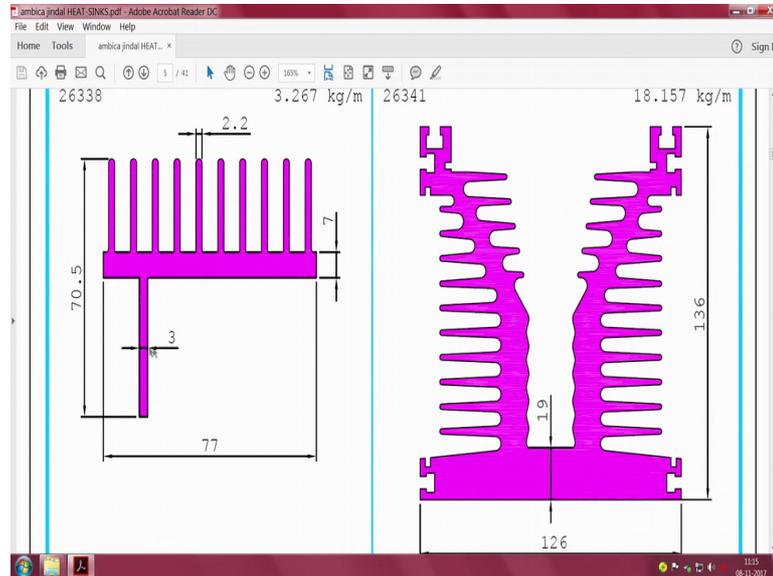
(Refer Slide Time: 18:03)



Getting more and more interesting there is a huge mass of material at the base. So, this is probably made for a specific application from a supplier now if somewhere here if you draw a mean median and then try to make a hole a probably things like a three, and all

that happily go inside here and these are specifically made for some power industries, power industries in.

(Refer Slide Time: 18:37)



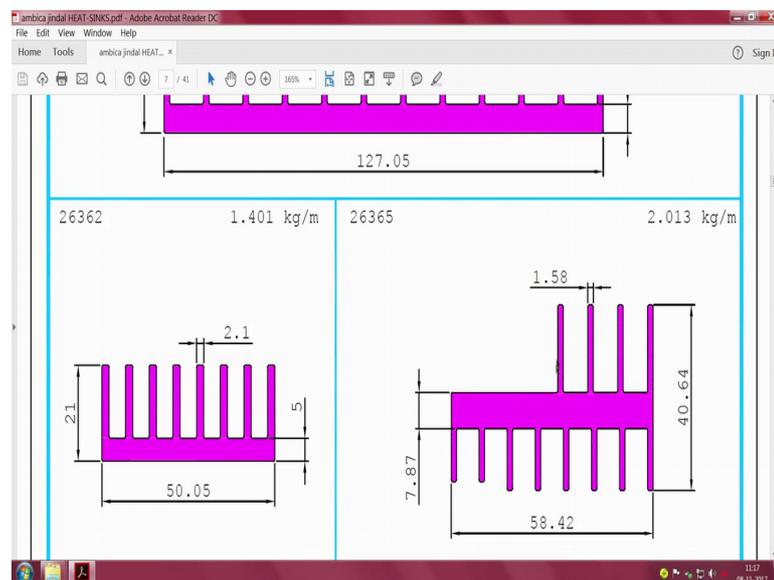
This is one more thing which you commonly seen all our equipment's in all the small equipment's which I have shown you earlier. So, on one side we have a printed circuit board and then we have a all our power devices mounted here there is a plus point in a minus point plus point is that you have a mounting flange minus point is if you see the cross section of this versus the cross section of heat this is not very effective having a big useless base like that is ineffective it have been logical in the same 7 mm were probably made here at 7 mm or, in fact, I would prefer 8 millimeters here.

So, while I won't call it a big bloomer this is probably not the best place to mount your power semiconductor very rarely you need to mount them on the flange here, this flange can be used for holding this or holding a cover or anything ideally, I would probably look at the center point of it and somewhere along this now this could be a place where I will mount the power semiconductor, now how do I mount and how do I do everything know it is for you to use your creative technique.

So, generally what they do is the one more time they mounted in another aluminum block, and probably give a clearance here one of the fins you can what you call give a clearance here and have the aluminum block tap here put a screw outside and then push it here and then in between you provide the necessary heat sink compound.

So, you have power devices mounted on a thermal bridge the bridge can be as wide as you can have and then directly it is in contact, probably put you know minimum of some you know force screws in the for ideal what you call again I will talk about any points, then once you tighten it now this whole basis for you to transfer heat to this. So, what looks very simple is actually you know lot of a depends on your own what you call manufacturing technique and your own design capability things with very small these things are also available you see here.

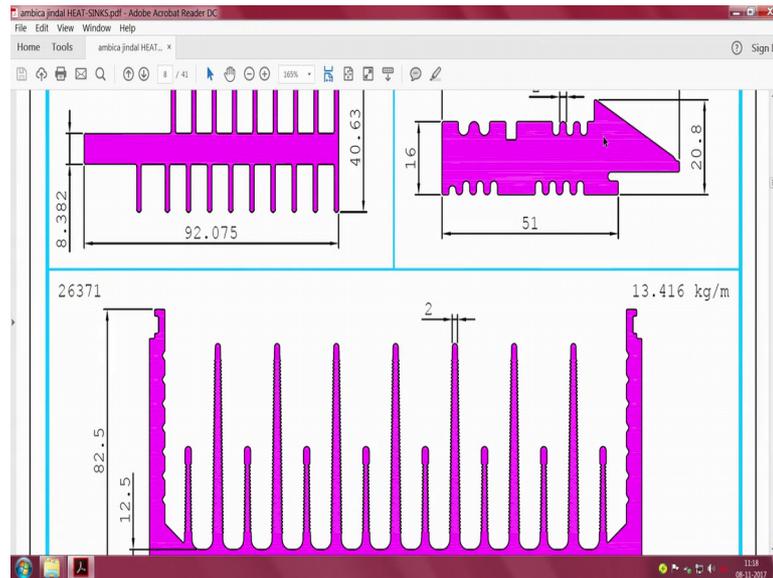
(Refer Slide Time: 20:56)



For example, instead of wasting thing on a flange there they have given something here, now it is for you it is very easy for you to mount some power devices starting probably here and you have fins on both the sides.

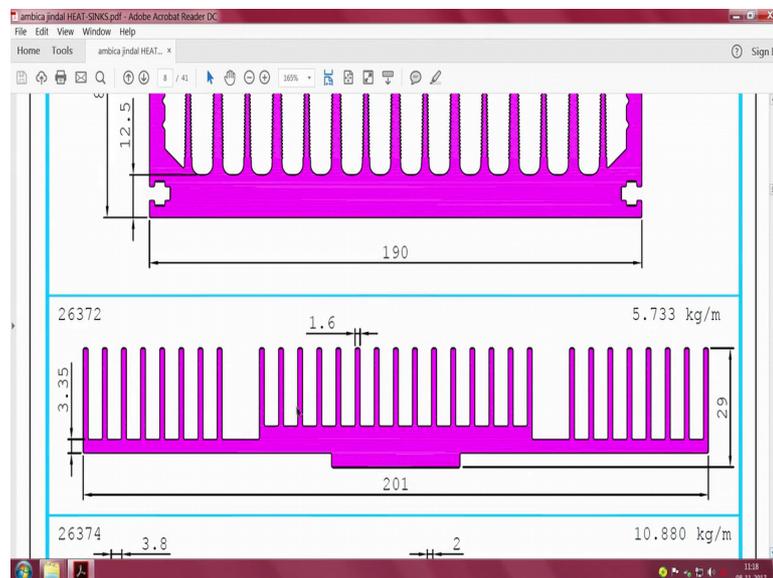
So, they are thin and long generally thin and long means natural convection and then you have a beautiful base here. So, you have a what can be highly effective fin in natural convection if the base is thick you have forced convection. So, oh this is getting more and more this thing it.

(Refer Slide Time: 21:34)



Looks like something from a fantasy movie, but it is not all of them are you know highly functional meant for a particular application. So, so you see here somebody know probably has ordered that.

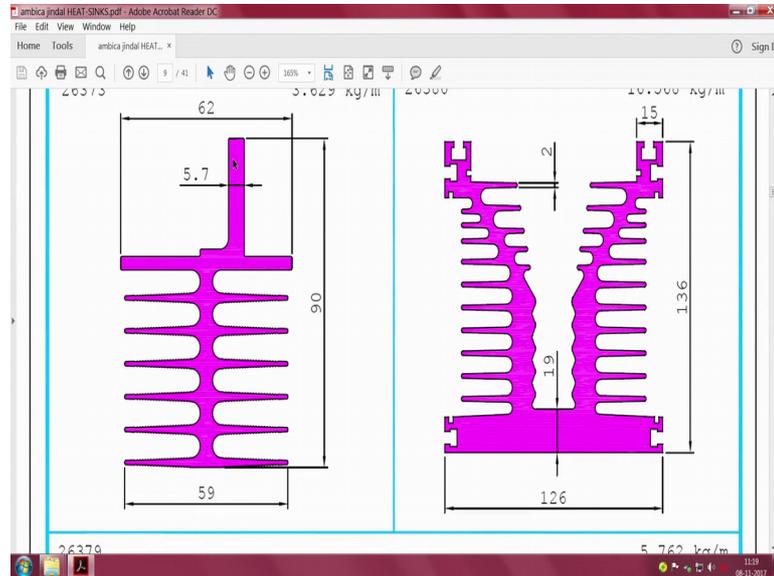
(Refer Slide Time: 21:55)



Oh yeah somebody has talked about it ordered these things here we have a large area of cross section as it goes here maximum these things there after that know something goes here and then they have a huge mounting base also, these are all typically I mean. So, has

optimized it to me lot looks like combination of method of manufacture and combination of other things.

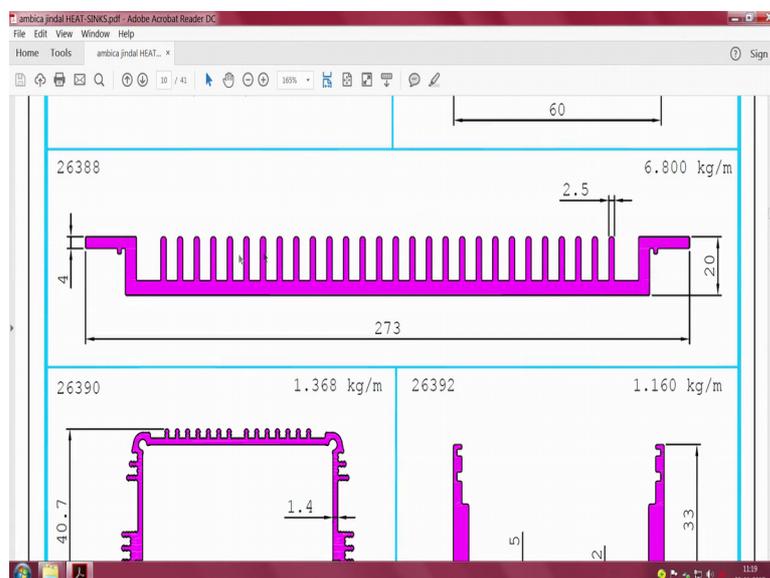
(Refer Slide Time: 22:23)



See here for example, if it were in the center there would have been some advantage why there was sit it is with the other thing what is talking to about how they design.

So, when you talk about design of heat sink it is not just about an equation honestly there is no equation which directly you know pops out a heat sink for you, if you are looking for something like that now you see this is again one more thing meant for a drive.

(Refer Slide Time: 22:42)

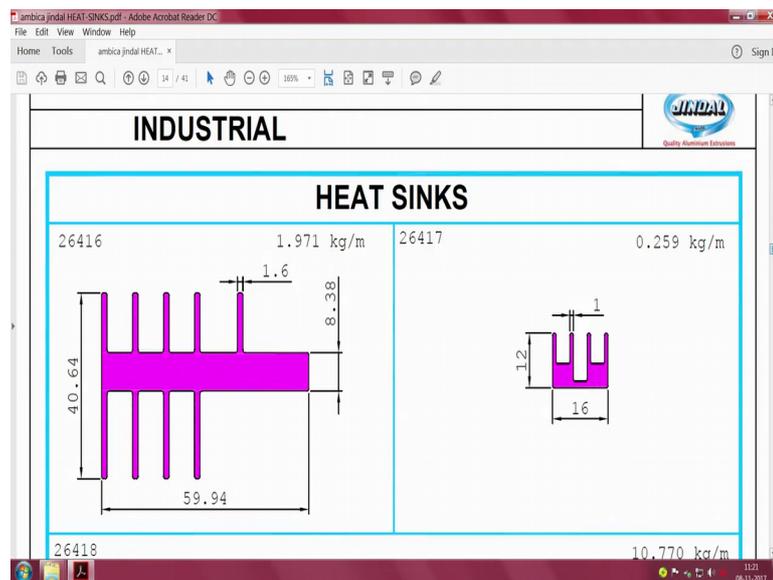


So, thickness is very small here only in 20 mm, but you have this and if you were to keep a nice cover in this you have something which is panel mounted it the thing and then heat sink at the back. So, this is would be my favorite, so if you go down anything you can think of probably exists.

Now, the second question know I am sure which is there in all your minds, how do we get it I have to have no idea me being an academic. I am happily insulated from reality the reality is I do not know where to buy or anything, but for our requirements or for your requirements, if you are a professional you can always go back to a supplier who will supply these things and luckily in the new economy somewhere around in the world somebody probably stocks these things. Just like you are doing in your hobby electronics things are available it is not as if know.

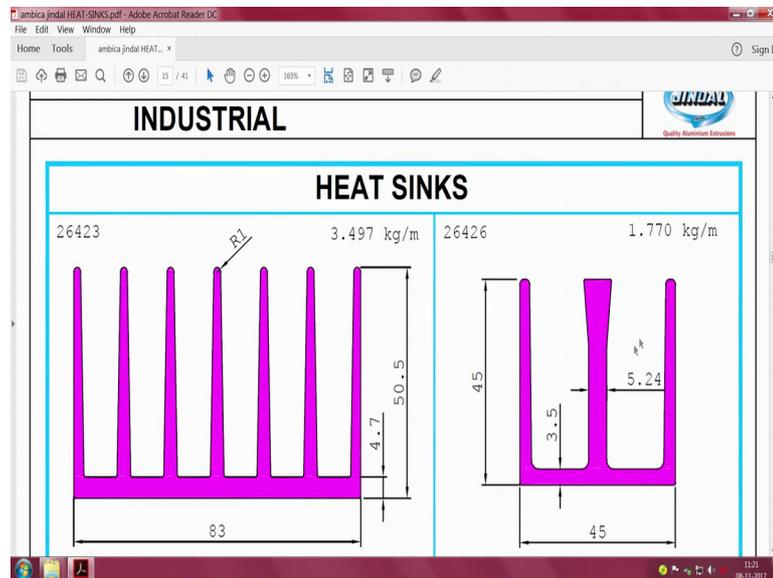
I am not fully insulated from the system and for your first piece probably you can start with maybe take an aluminum block or take another heat sink, and then try to cut fins mill fins and make an optimum size or as I told you look for the prior art and see what else people are using it and then make your things, you can optimize it if the weight is too much you can remove unwanted things. If the heat transfer coefficient is not good then you know they have put these fins and all that and if you still have the patient can make a model and run a CFD analysis very much possible for you to make anything here you see here.

(Refer Slide Time: 24:30)



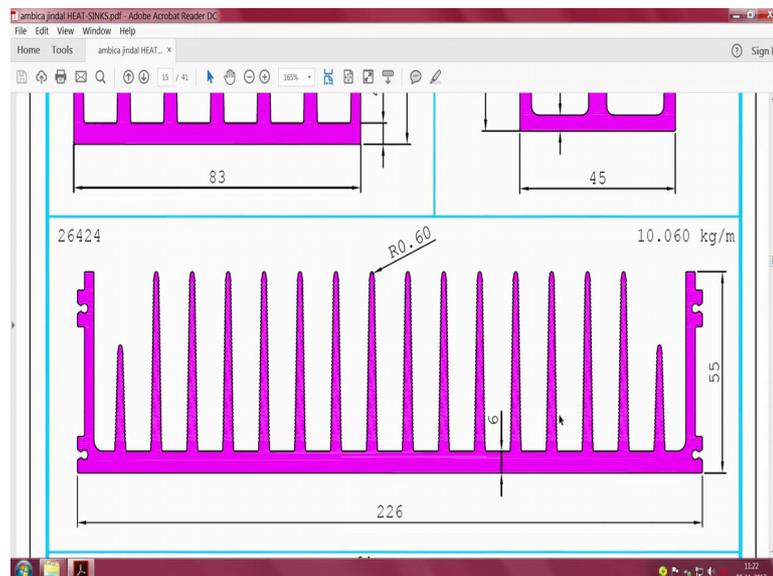
Some are some are simple looking small include some are you know they do look this is something just now I noticed I am not very clear has to why somebody had to make, somebody had to make what looks obviously.

(Refer Slide Time: 25:01)



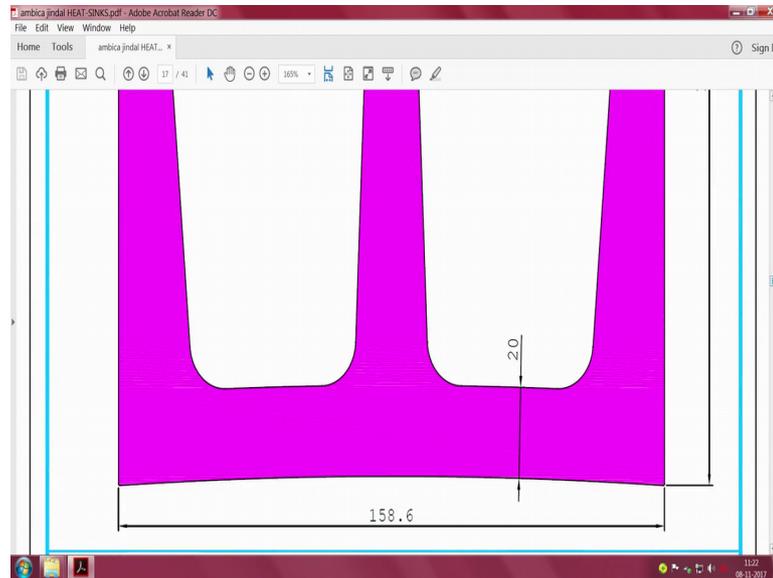
Like a piece of art I do not know what is the function of this are why it is, it has been probably made for somebody I cannot see any logic why at the end of the tip it is wide like that maybe something else also comes here these are of course, you know there mounting holes.

(Refer Slide Time: 25:19)



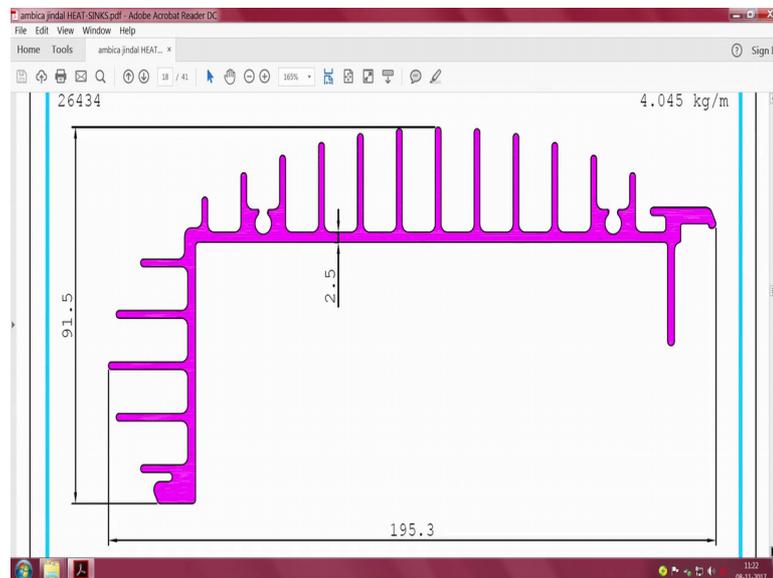
So, I will just quickly I will try to scroll through these are real.

(Refer Slide Time: 25:31)



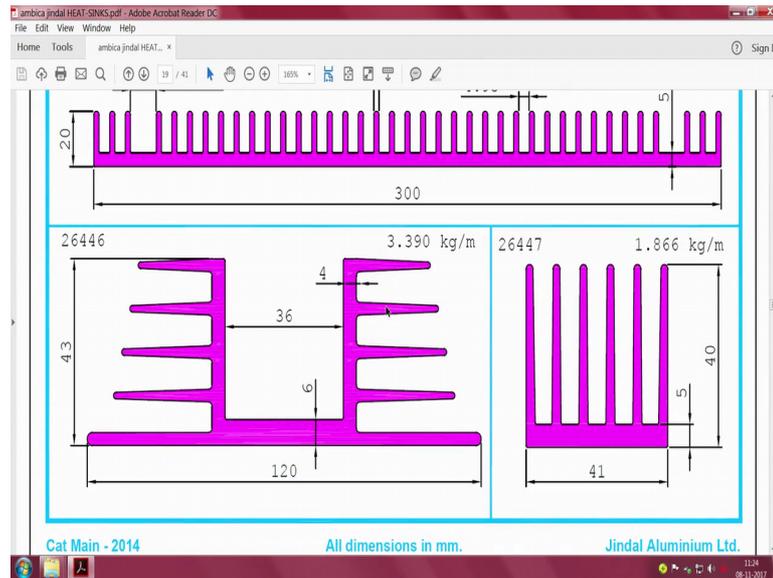
You know beautiful there is a curved monster here. So, it does for you to take a call see why that was made.

(Refer Slide Time: 25:45)



And you see here anything you can think off now somebody had made it and you see there is one more interesting thing, two of them if you keep them back to back they fit miraculously together and you have a beautiful heat sink, and then you will see here we have a nice curvature also here, and probably this forms one what you call I will call

(Refer Slide Time: 27:37)



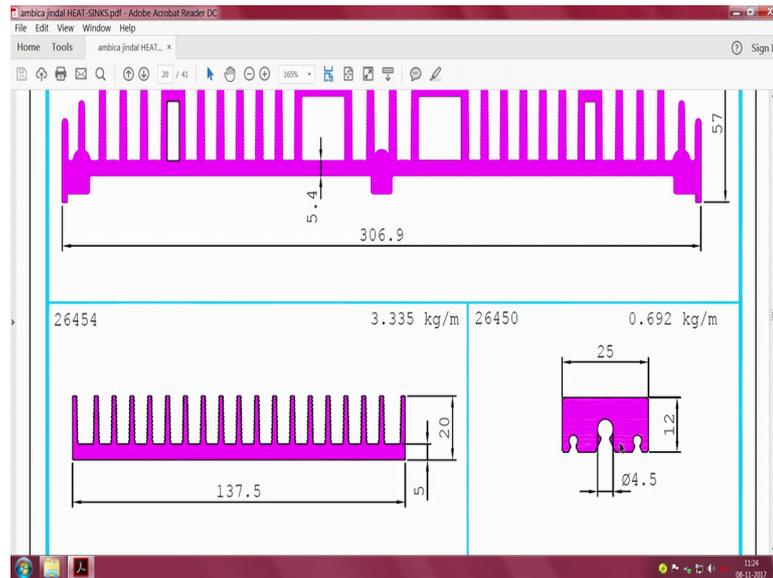
You see here these are all things which mechanical engineers in conjunction with electronic signals probably like it I am sure when once you see this now you think exactly this is what I was looking for.

(Refer Slide Time: 27:59)



So, probably know I will just go through this after that I will stop oh looks very interesting now what it is, but; obviously, there is a good very good use for it.

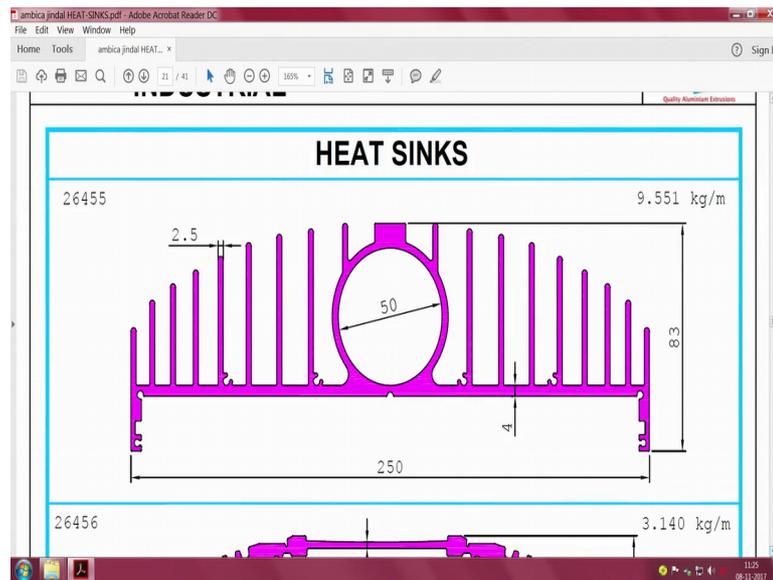
(Refer Slide Time: 28:14)



Some devices for mounting typically things like this know can also be used as heat bridges whatever talking to about. So, this part of it can contact the heat sink wherever we want this part of it has the mounting devices and all that and you can, now try to mount your own what you call devices on both sides and then the whole thing can now you know you, you, you, can probably drill a hole here drill a hole here and then attach it to the heat sink on the other side.

So, this is a beautiful bridge only advantage for you is already this hole come pre extruded. So, you need not do anything can use even a self-tapping screw put a self-tapping screw here, here only here know the actual tapping is required cut it to length and you are in good what you call good company your equipment will be as good as other things this.

(Refer Slide Time: 29:08)



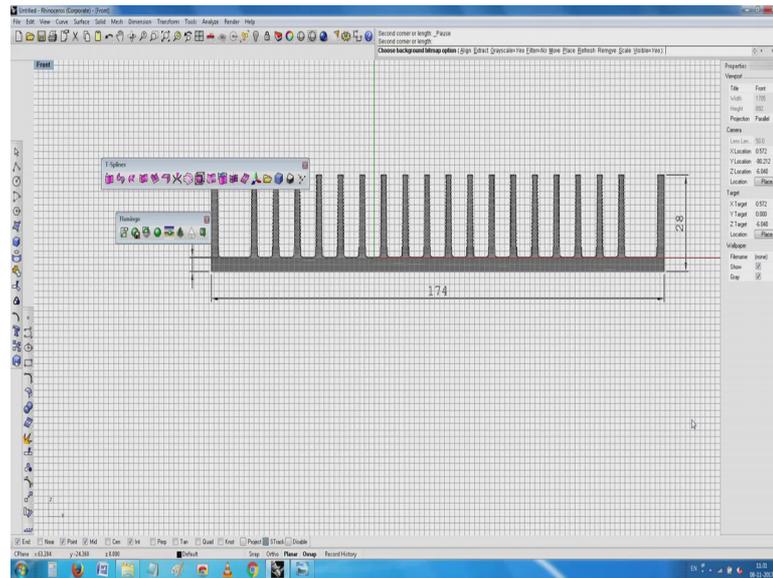
I do not know whether a capacitor goes inside why that particular things have been ordered. So, I suggest you go to the ambika what you call traders go to Jindal catalog and most of the thing that have been made over the years are all available in the catalog, and if you order since tool is existing somewhere somebody else know will be able to make the extrusions for us.

So, permit me to stop here, so that you have a look at it, but my suggestion is please go through all the catalogs and then towards the end of the session when we uploaded I will try to see whether all the links can also be given in a text form, as they were extracted now you, you can use them and since they are all public property and I mean acknowledging that the whoever is provided it has you know spent enough time.

I am using them freely and I expect you also know where you have to I suggest you blind copying will not help because the process of material 6063 most of them use 6063 aluminum mm, it is very different from these structural extrusions very, very different from normal structural extrusions and then randomly. If you take a soft aluminum alloy and then try to mill things out of a milling itself will be our first problem. Secondly, composition will be another problem next the way the thing has cooled down and the heat treatment and the what you call temper t 1 t 2 conditions are very different.

So, they behave very different from the professional heat sinks. So, thank you next session I will see here.

(Refer Slide Time: 31:02)



That heat sink which is on the desktop, it is possible for me to bring it and use it as a element for tracing those thing. So, I just try to maintain the same dimensions 174 and 20 mm here.

And try to recreate this on my screen here once I recreate this profile it is a matter of extrusion, and then after there depending on the our requirements of how to what you call how to configure it will this extrusion face the back or will this form the sides or it will come on the front or it will be directly on top I can reconstruct a whole what you call equipment directly from this.

So, I will stop here thank you, so let us meet again in the next session I will try to complete one of these experiments and then try to show you. And eventually if data is available about what is the length and then what is the thermal resistance of the I will tell you practically how an equipment is made very rarely people start with a fin height and this and you know try to calculate the what you call combined convection.

And what you call conduction and little bit of the thing and try to make things, that is very cumbersome only in maybe if you have a satellite or you have some real mission critical applications like maybe I do not know exactly I am not into armaments very rarely anybody runs these things; however, there are people who do these things so; obviously, in our case we have students who will be happy to do the modeling for us and we can give them also as an exercise and they learn a lot so.

Thank you.