Panel building, focussed on dimensions.

“It’s all in the inch…☺”

First of all remember that (nearly) all dimensions in aircraft industry are based on imperial dimensions, so inches.
This is the explanation for seemingly "strange dimensions" when recalculating them to metric.
Several dimensions, if not known, can be guessed when keeping this in mind. They are always parts or multiples of the inch, so 2 inches or 5 1/4 inches or 1/8 inch or 6/8 inch and so on. In fact, keeping this in mind a panel can be build with only a few known dimensions.
Most of my *measured* dimensions are based on a Delta Electronic MFG Co. panel.
There ARE slight differences in panels, based on company and the way they are produced (cutting techniques).

The “DZUS rhythm”….

The REAL basis of all the dimensions are the rails on which panels are mounted in the cockpit (pedestal and overhead mainly, but sure as well on other places.
They are called DZUS-rails, named after ***William Dzus***, the inventor of a special type screw. The quarter turn screw.
So “Dzus” isn’t an acronym and is should not be written as DZUS or D.Z.U.S.

http://www.qtrturn.com/history/wdbio.php (History William Dzus)
http://www.dfcis.com/pa-3500/index.html (Technical about fasteners, dimensions)


William Dzus

These screws, fitting in the rails (Dzus-fasteners), we all know from DIY products (e.g. your DIY wardrobe) can be turned 1/4 of a full rotation and then everything is fixed.....

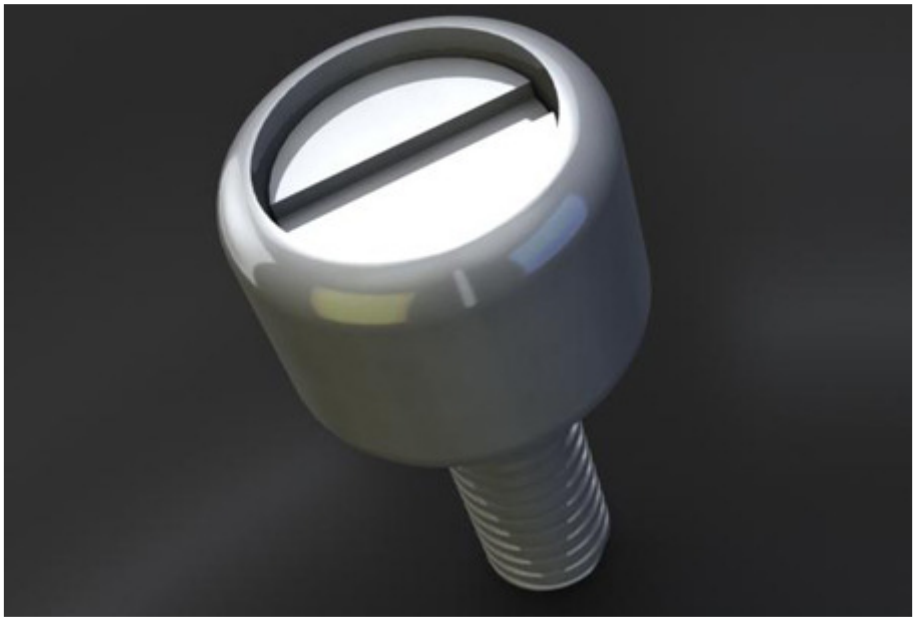
The company which produces them was first Dzus Fastener Co. Inc. and this is now changed to DFCI Solutions, Inc. See link above.

Dzus fasteners

Dzus fastener on "location" (1)
Keep in mind that when fastened, the center screw is in a lower position.
About 1 mm under (!) the level of the outside ring.

Dzus fastener on “location” (2)

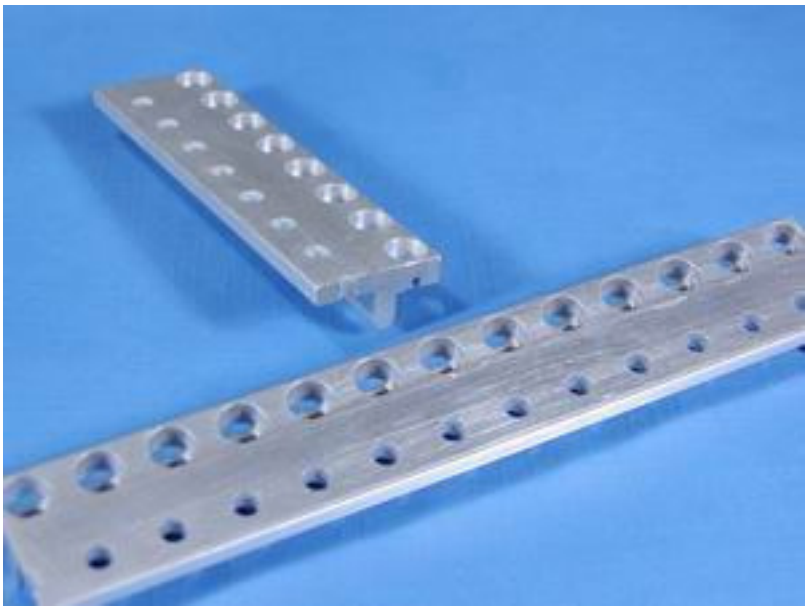
The quarter turn screw which turns “itself” into a thin wire, when rotated.



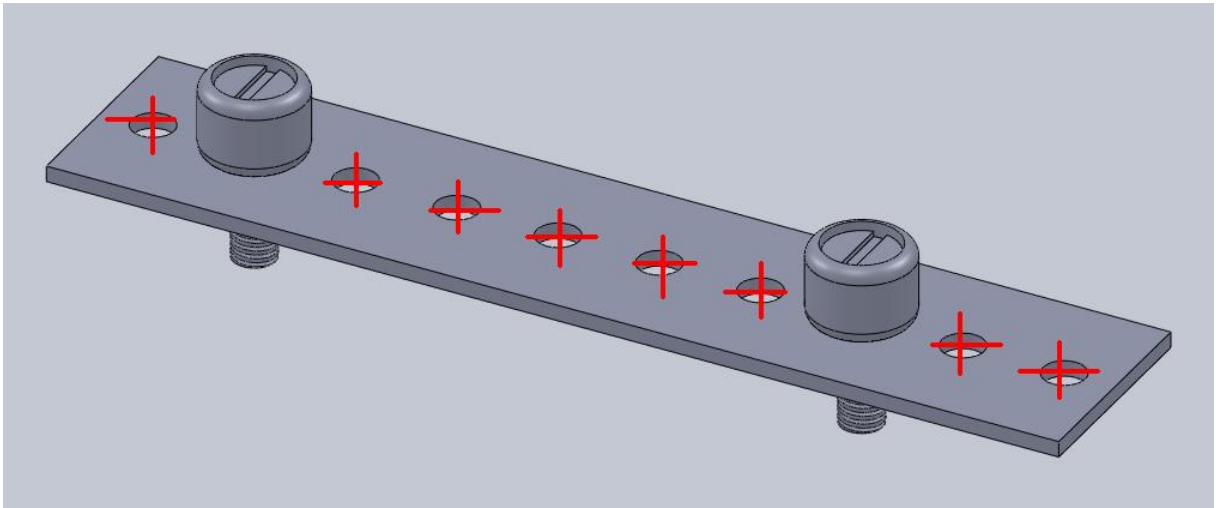
Cockpit builders frequently replace the bottom with the “Dzus mechanism” by a “normal” screw. If fastened the screw is 0,05 “ (1,27mm) lower than the outside ring.
If fastened, the grove in the screw is in a “nose-to-tail” position.

DIY Dzus fasteners

The DZUS rail and it’s relation to the aluminum backplate of the panel.



Dzus rails. Hole diameter is 0,255” = 6,48 mm



Or do it yourself with an (drilled holes) aluminium strip for threaded bolds (see before).
Make only the holes you need !

The centers of the holes in the Dzus rails are 3/8 inch (3/8 ") separated from each other.
3/8 inch = 9.525 mm.

This is really the most important base of all !
This ***"DZUS-rithm"*** dictates nearly all dimensions of panels.
Never ever forget this.


Inpressions of the Dzus rails on the aluminum backplate of a panel

The aluminum backplate:

Thickness:

The backside of a panel is tightened on the Dzus rails with the Dzus fasteners.
The backside is an aluminum plate.
The (imperial) thickness is 1/16 inch so 1,5875 mm.
Metric builders will take 1,5 mm in general.

Height:

The height (of the aluminum backplate) of a panel always MUST be a *multitude (AND a whole (!) number)* of this previous mentioned 3/8 inch, the "DZUS rithm".

So e.g. the most common seen pedestal panels (COMM, ADF) are 7 times 3/8 " = 66.675 mm in height.
For example the Audio Selector panel (also called "Comm-box") is 12 times 3/8 ", so 114,3 mm in height. This is measured from a real panel too.

Keep in mind this is the THEORETICAL height, dictated by the Dzus rithm.
In practice it could be convenient to make the height a fixed amount (e.g. 0,1 mm) smaller for easier fitting of the panels to their neighbours in the North and the South ...
This depends on your capabilities of making exactly straight cuts in the aluminium.

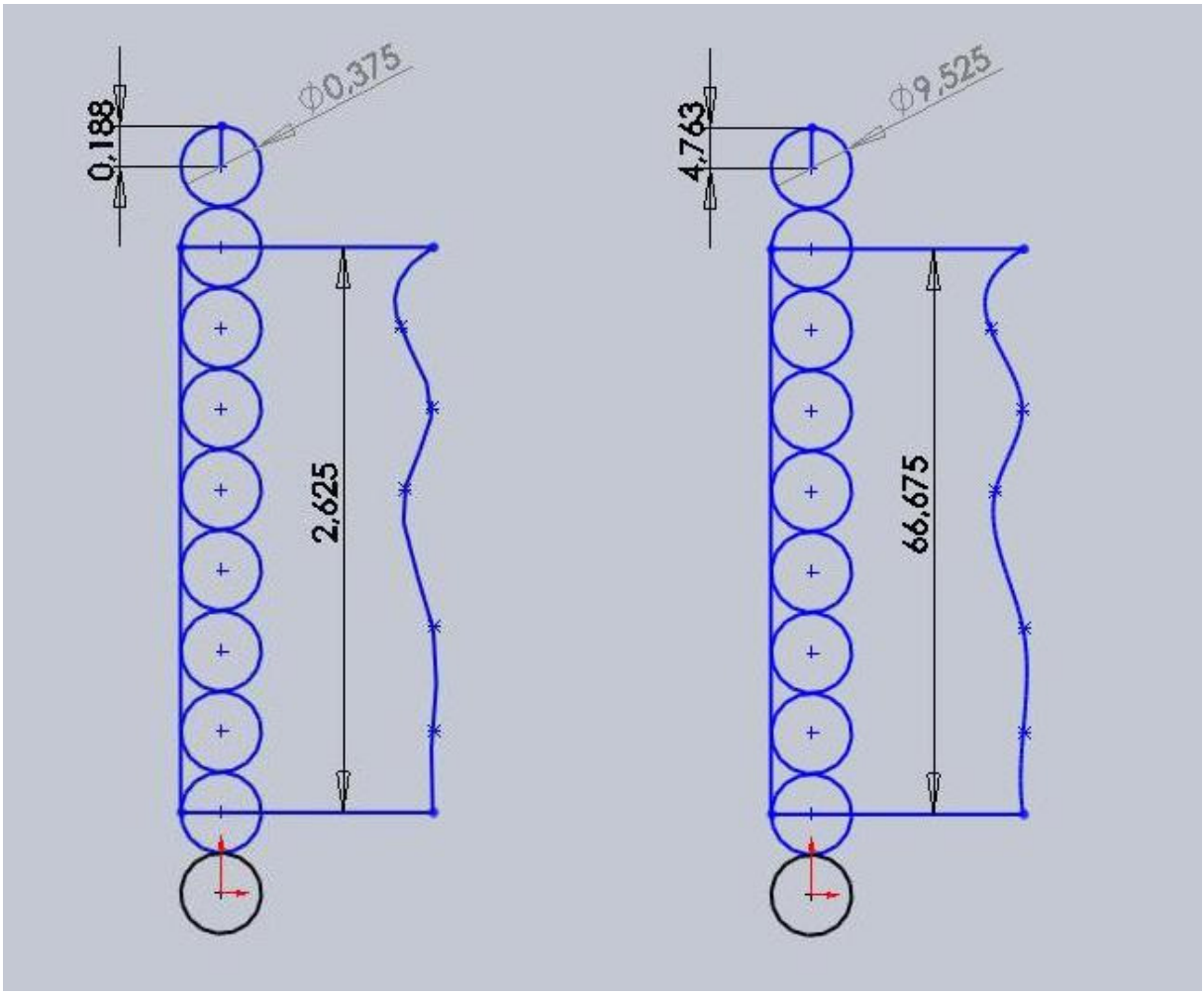
Width :

The width of the aluminum backplate is 5 3/4 " so 146,05 mm.

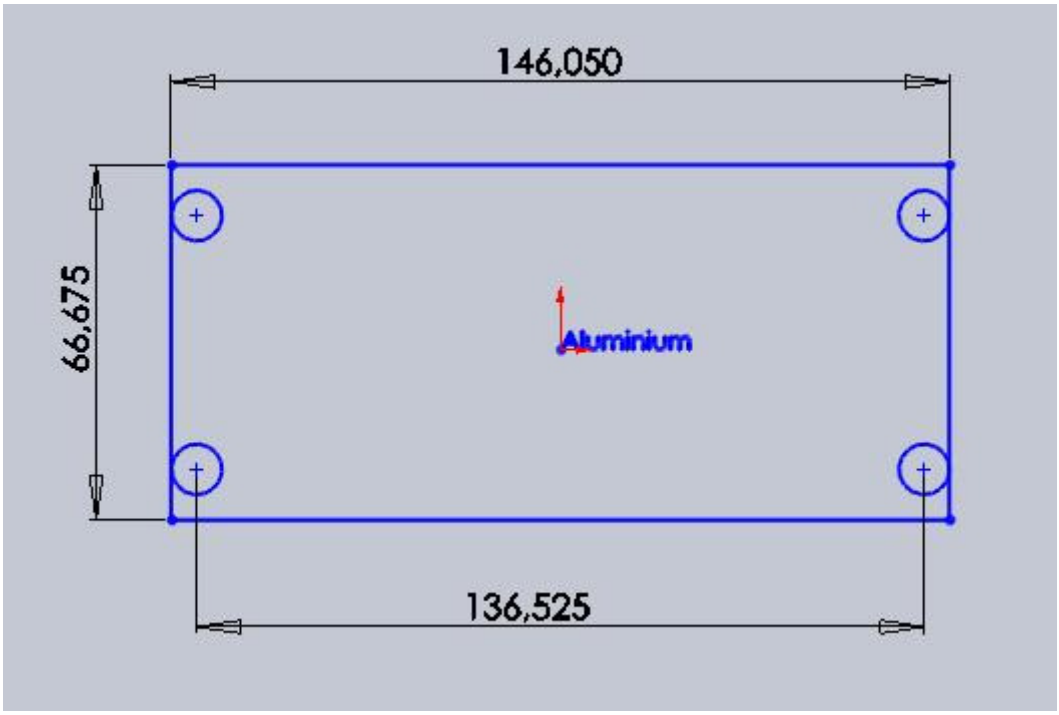
Here the 146.05 mm (is real, measured) width fits to the panel beside it, so when mounting take an extra 0.5 mm before mounting the panel beside it.

This 5 3/4 " width dictates the width of the centers (!) of the 2 Dzus rails from each other:

5 3/4 "minus 1/2 radius of the DZUS screw on the left and on the right =
5 3/4 " - 1/2 x 3/8"(left) - 1/2 x 3/8 (right)" =
5 3/4" - 3/8 " =
43/8" = 5 3/8" = 5.375 "= 136.525 mm: The width of the *centers* of the holes in the rails.



Imperial and metric height



Aluminum backplate (mm)

Don’t forget to round the sharp edges of the 4 corners of the aluminium a little bit.

The Acrylic plate :

The DZUS rail (and the aluminum backplate) and their relation to the acryl / polycarbonate mounting on it will be discussed here.

As we have seen before the Dzus rails dictates the aluminum backplate dimensions. Now we are going to build some acrylic or polycarbonate on top of the aluminum backplate.

In fact the dimensions are less important here. Everything which fits on top of the aluminum is OK ....:-)
The reason is that the overall dimensions will not change anymore by what we are going to do here.
But ... we want it right.

The thickness of the acrylic plate is 2/8" = 6,35 mm. Most builders will take 6 mm here.

Modification Acrylic to a smaller size than the aluminum:

The height and width of the acrylic plate on the upper side is always smaller (!) than the aluminum plate.
On all sides it's 1/32 " = 0.79375 mm smaller than the aluminum, so take in general 0.8 mm for the metric builders.

This makes the height of the COMM panel (and all “7 Dzus distance panels”):

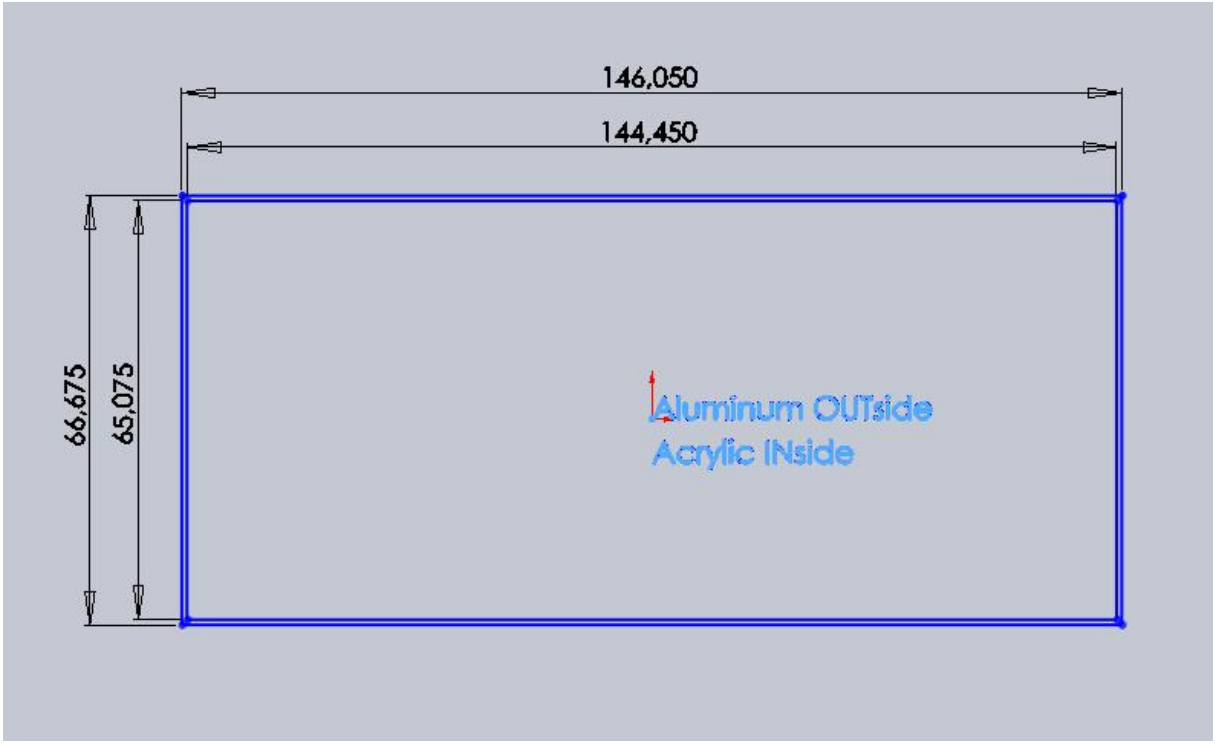
Acrylic height = Aluminum height (= 66.675 mm, see before) minus 2 x 0,8 mm = 65.075 mm.

Acrylic width = Aluminum width (= 146,050, see before) minus 2 x 0,8 mm = 144.45 mm

This makes the height of the Audio Selector panel ("12 Dzus distance panel"):

Acrylic height = Aluminum height (= 114.3 mm, see before) minus 2 x 0,8 mm = 112.7 mm. (Also measured on a real panel).

Acrylic width = Aluminum width (= 146,050, see before) minis 2 x 0,8 mm = 144.45 mm (of course the same as the COMM panel; all panels have the same width).



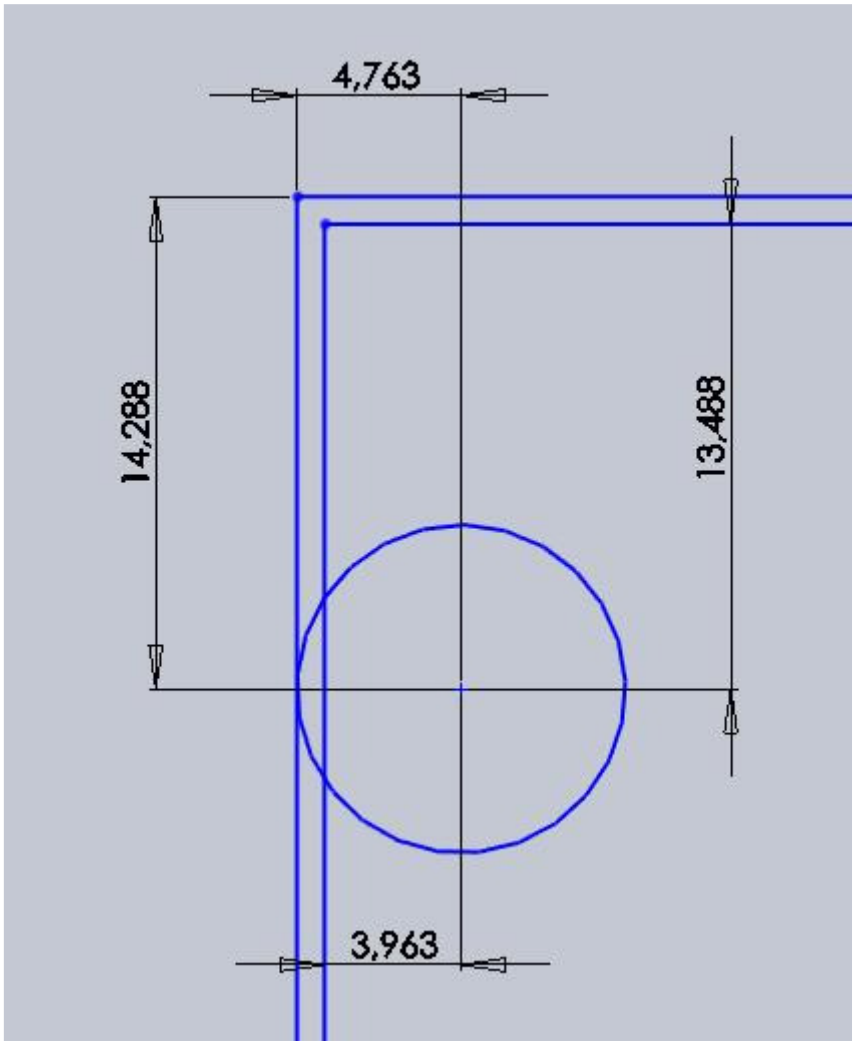
Relation aluminum and acrylic (mm)

The holes for the Dzus fasteners :

In general the center of a fastener is 1 1/2 Dzus distance (3/8 "= 9,525 mm) from the end of the aluminum backplate. From this center we will work on. We are focussing on the distance from the hole to the upper side of the panel.

The outer edge of a Dzus fastener (diameter is also 3/8 ", so the same diameter as the centers of the holes in the rails) is exactly over the outer edge of the aluminum backplate (see picture).
Beneath the 4 tabs in the outer edges of a panel is in fact a Dzus rail hole too. It's not used of course.
Be careful: Since there is 1 hidden Dzus hole beneath the tab one could think that this hole is (not visible) in the mid of the tab.

That's not true. Read on.

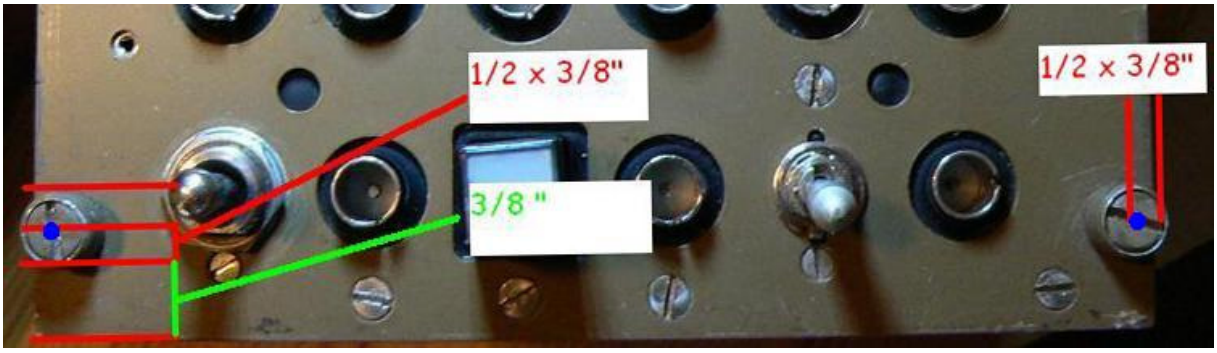


The left upper corner (mm)

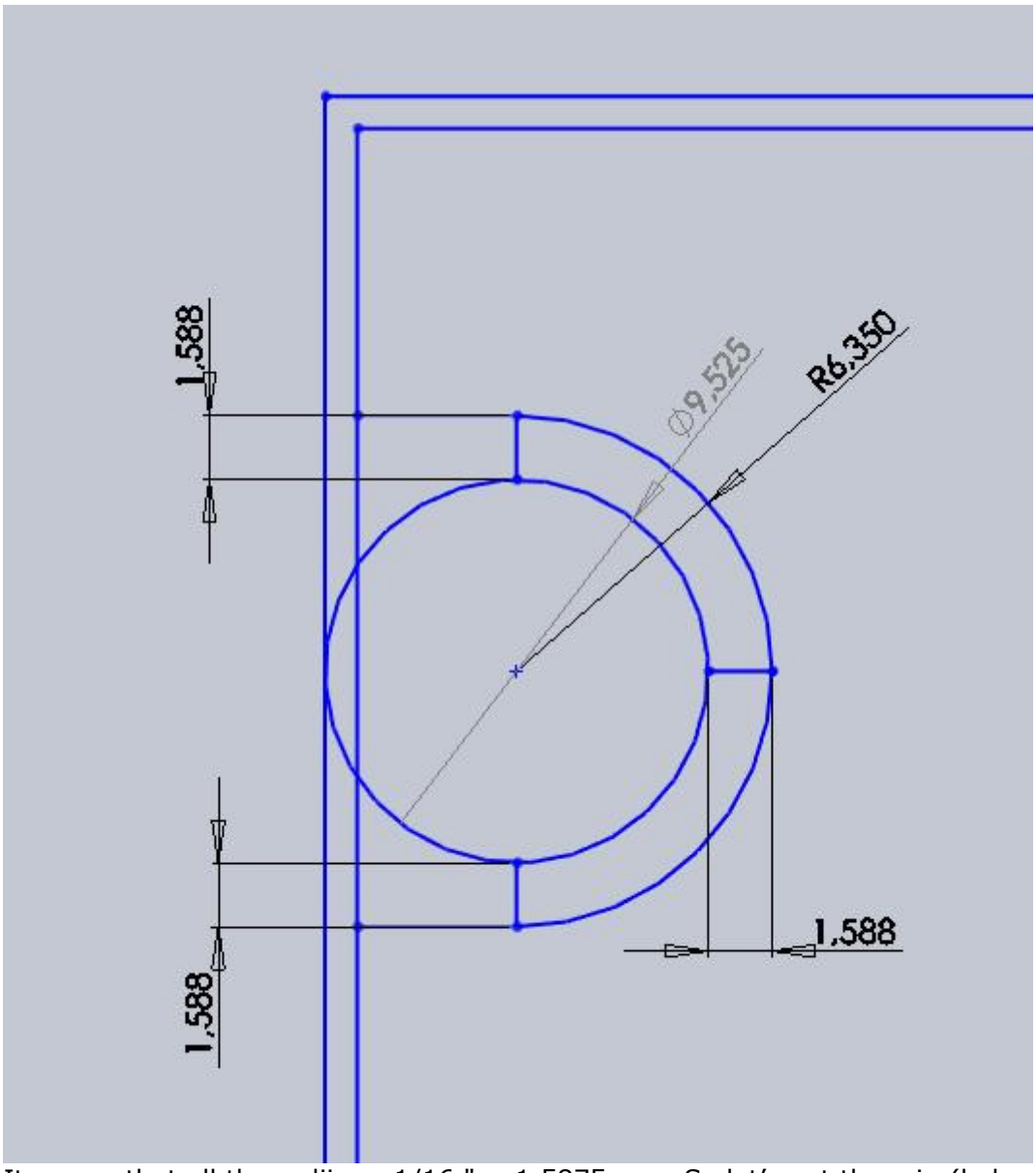
Start thinking at the point of the Dzus fastener hole in the rail which will be used.
On this rail the Dzus fastener with an outer diameter of 3/8 " = 9,525 mm is placed.
Around this fastener there is (air...)space untill the acrylic panel begins.
The diameter of this arc is the diameter of the fastener (9.525 mm) plus on both sides 1/16 inch (1,5875 mm), so 9,525 + 1,5875 + 1,5875 = 12,7 mm = 1/2 inch ! Here they are again..., the inches ....:-).

As said before, the distance from the center of the Dzus fastener till the aluminum backplate edge is 1 1/2 times the diameter of a fastener = 9.525 mm so this makes 14.2875 mm.
We subtract from it: 1/2 diameter of the Dzus fastener = 4,7625.
We subtract from it: the airspace on 1 side = 1,5875.

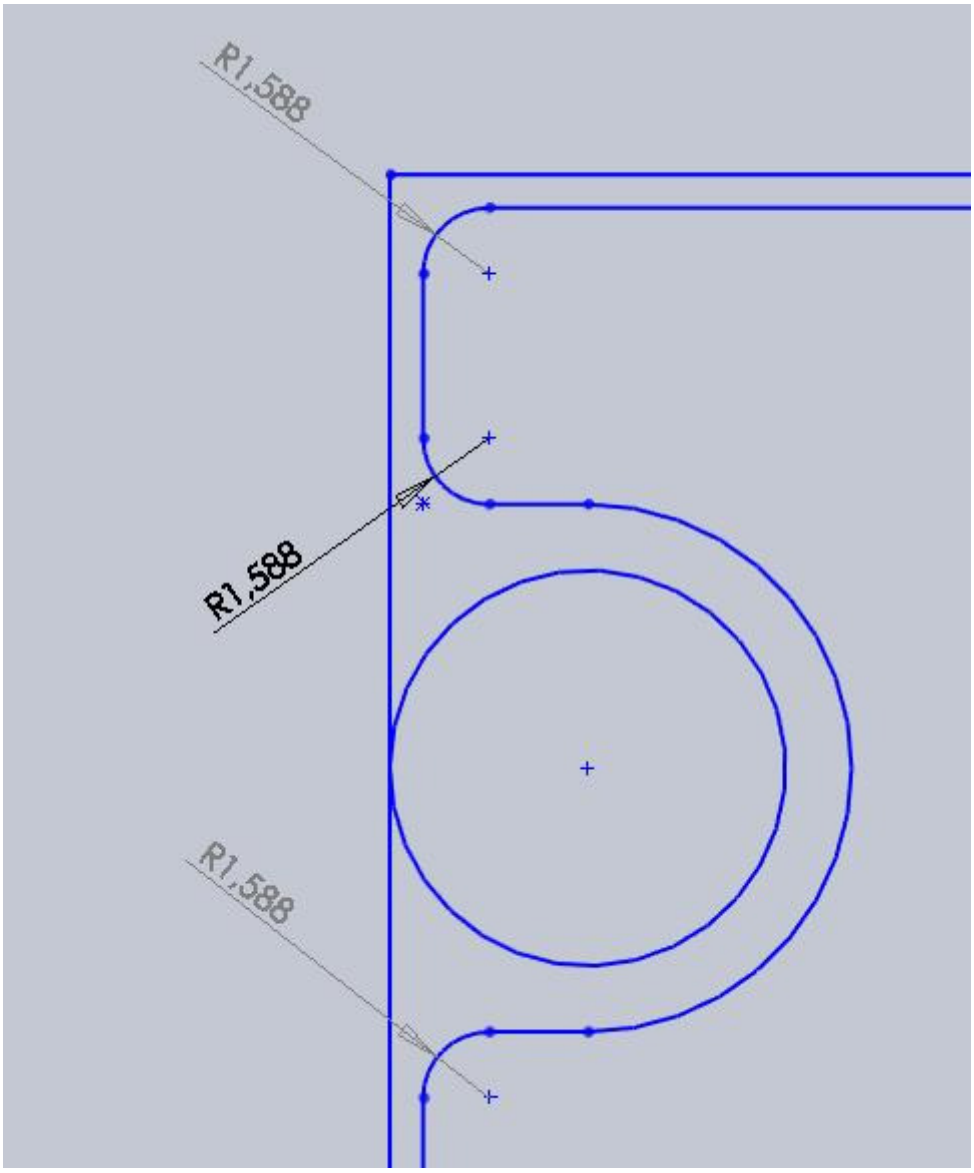
This leaves us with a thickness of the tab of: 14,2875 - 4,7625 - 1,5875 = 7,9375 mm (of course measured in the line of the Dzus centers).



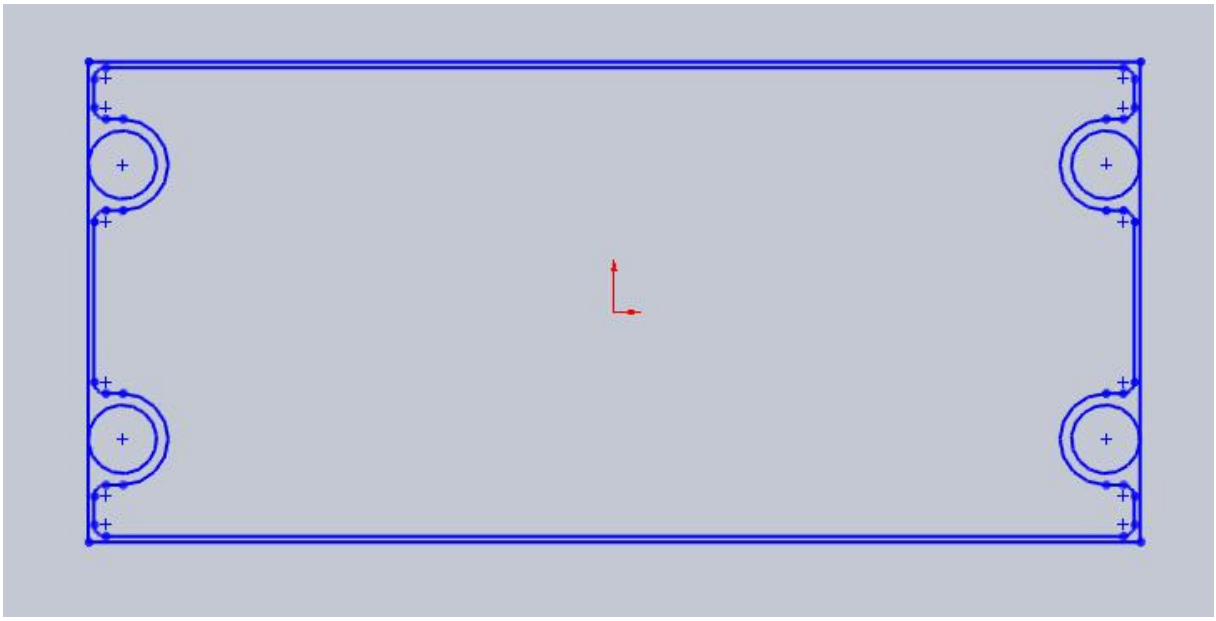
Lower corners.



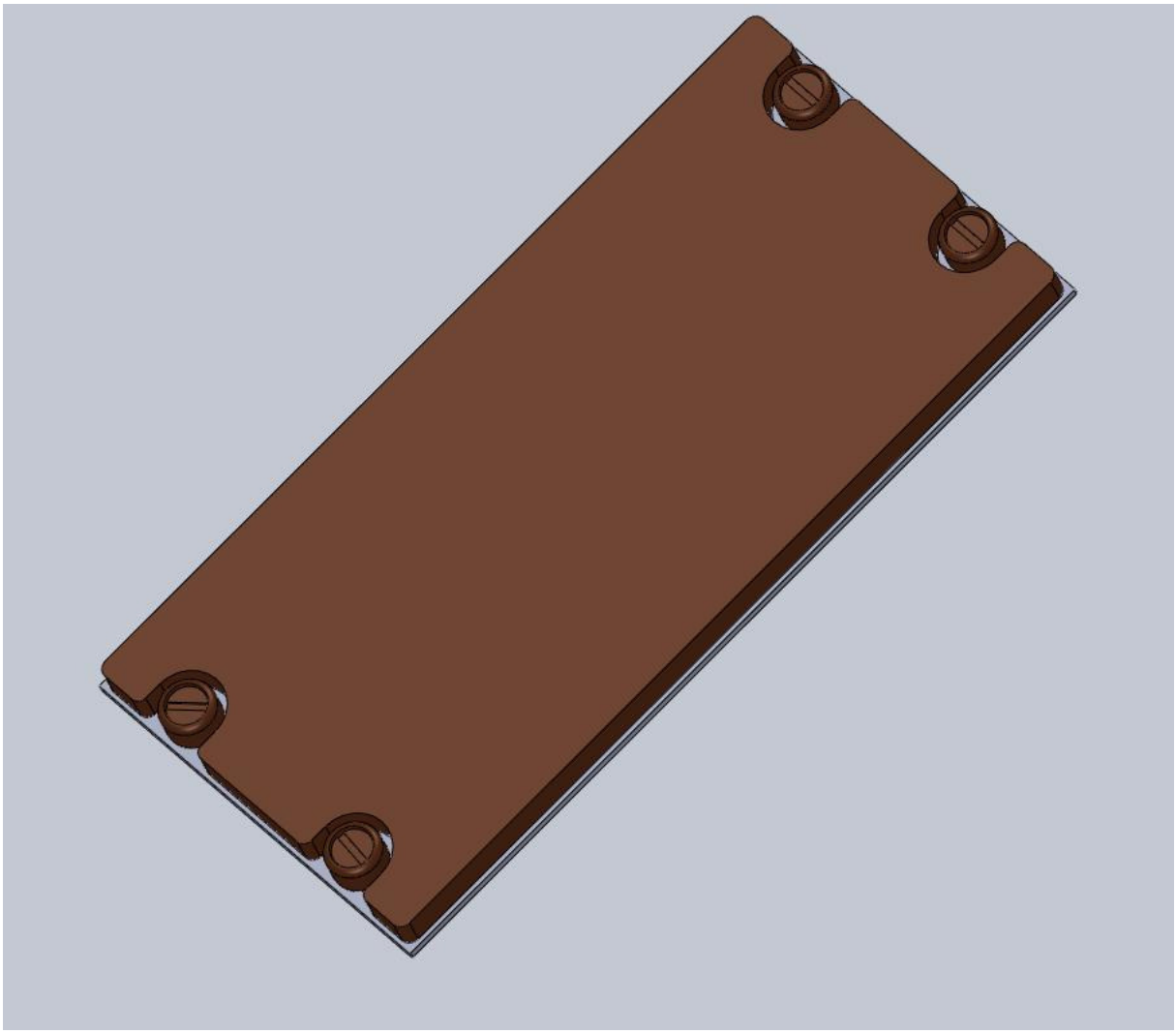
It seems that all the radii are 1/16 " = 1.5875 mm. So let's put them in (below).
Left upper corner (mm)



(mm)



Don’t forget to give a fillet to the sharp acrylic edges. It’s real AND your paint will attach more firmly to the (primed) acrylic.



Panel of aluminum and acrylic ready

In most aircraft the pedestal consists of 3 rows (of 5 3/4 ").
In most aircraft the overhead panels consists of 5 of these rows.

In a B747 there are 3 rows with wider panels, but the total width is again equal (!) to an overhead with the 5 (smaller) rows.
These rows are: 8 5/8 "; 11 1/2 "; and the same 8 5/8 ".

This seems consistent:
5 x 5 3/4 " = 28 3/4 "
8 5/8 "+ 11 1/2 "+ 8 5/8 " = 28 3/4 "
The total width of the 4 "air-spaces" in the situation with 5 rows is now divided over 2 "air-spaces" in the situation with 3 rows. They are wider.

It's my hope that more insight in what's going on with all these dimensions, will make all panel curves and lines (slightly) less mysterious ☺.

Happy building !

March, 2010

Hessel Oosten, The Netherlands

p.s.

I did my best. No guarantees...:-).
Don't start flying with these dimensions, it could be too real ...:-).
Don't laugh about all the unnecessary decimals in the dimensions; they were given to give maximum insight into the calculations.
Thanks to Pim Abrahamsen for introducing me into the mysterious art of dimensioning ☺.

Addendum next page

Addendum / Summary:

1 "		= 25,4 mm
1/2 "	= 0,500"	= 12,7 mm
14/ "	= 0,250"	= 6,35 mm
1/8 "	= 0,125"	= 3,175 mm
1/16 "	= 0,0625"	= 1,5875 mm
1/32 "	= 0,03125"	= 0,79375 mm

A. Panel width *aluminum:*

5 ¾ " = 5,075 " = 146,05 mm

B. Panel height *aluminum:*

3 "Dzus" distances:	3 x 3/8"	= (3,375")	= 28,575 mm
4	4 x 3/8"	= (4,375")	= 38,100 mm
5	5 x 3/8"	= (5,375")	= 47,625 mm
6	6 x 3/8"	= (6,375")	= 57,150 mm
7	7 x 3/8"	= (7, 375")	= 66,675 mm
8	8 x 3/8"	= (8,375")	= 76,200 mm
9	9 x 3/8"	= (9,375")	= 85,725 mm
10	10 x 3/8"	= (10,375")	= 95,250 mm
11	11 x 3/8"	= (11,375")	= 104,775 mm
12	12 x 3/8"	= (12,375")	= 114,300 mm

And again (see before) to make it fit better, reduce it a (very) little bit.

C. Panel width and height *acrylic:*

Subtract from all dimensions above on upper and lower side 1/32" = 0,03125" = 0,79375 mm (in practise so 0,8 mm).
So all dimensions minus 2 x 0,8 = 1,6 mm.
Width: 144,450 mm
Height:

3 "Dzus" distances:	26,975 mm
4	36,500
5	46,025
6	55,550
7	65,075
8	74,600
9	84,125
10	93,650
11	103,175
12	112,700

D. Centers of Dzus fasteners:

½ x the diameter of a fastener (3/8 ") so 3/16" (= 4,7625 mm) from the left or right aluminium edge.