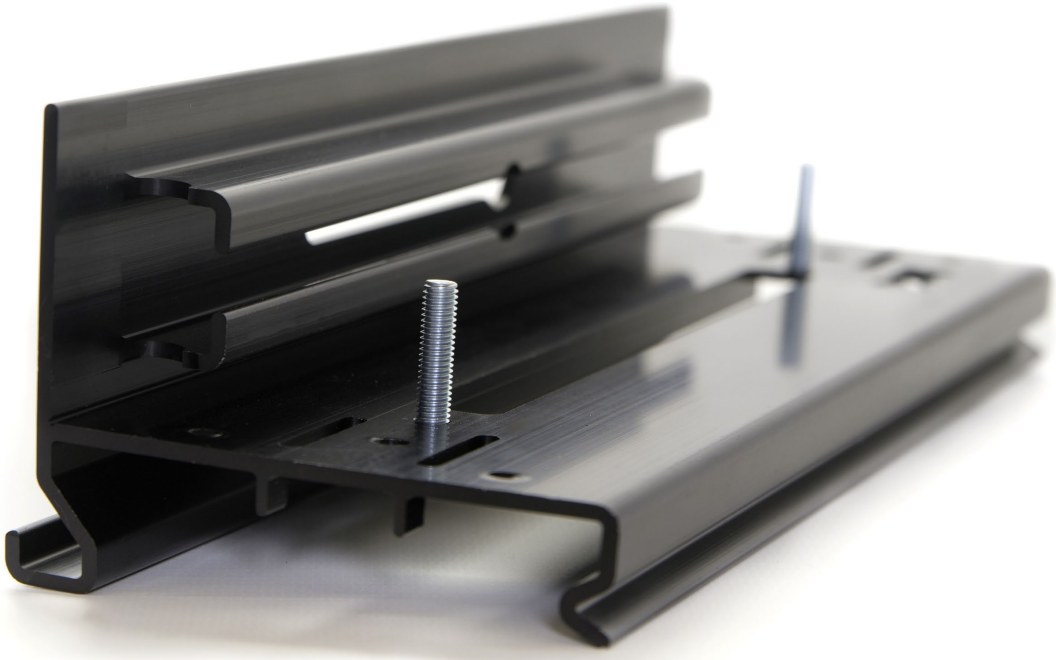
Aluminum Extrusion Design

6 Mistakes Designers Make and How to Avoid Them

Introduction

Today, more and more designers across a number of industries are using aluminum extrusions in their products for two reasons. First, aluminum offers many unique properties, such as its high strength-to-weight ratio, corrosion resistance, and electric conductivity, to name a few. Second, aluminum extrusions give designers opportunities to create complex shapes that combine functions that would otherwise require the production and joining of several different parts.



So how do you ensure you get the most out of the aluminum extrusion process and ultimately get the shape and performance you want?

When designing for aluminum extrusions, practitioners need a good background in alloy properties, relative material and tooling costs, proper tolerancing, and the latest manufacturing techniques.

Unfortunately, little time is spent on the extrusion process in design and engineering school. This lack of knowledge leads to some common design mistakes aluminum extrusion manufacturers see when they receive a new profile design.

This guide addresses six of the most common design issues and provides guidance to design engineers when designing for aluminum extrusion.

1. Incomplete Drawings

Are you guilty of sending your extruder a Solid Works drawing with no details asking for a quote?

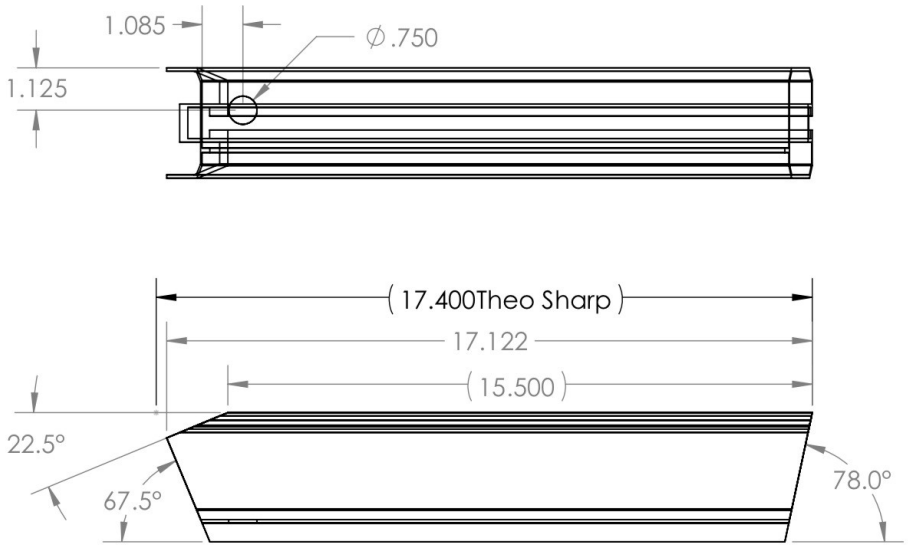
Too often aluminum extrusion manufacturers receive rough profile sketches that provide very little of the information needed to produce a cost estimate or design review. Precise measurements are necessary to understand the component's dimensions and shape and determine the proper container size needed for producing the extrusion die.

When this information is unavailable or unclear, it results in a quote that is inaccurate. Without all the details an extruder can only provide a ballpark estimate. Once the “finer points" are provided your estimate could go up or down dramatically.

Additionally, without all the details the result is a lot of back and forth between you and your manufacturer.

Depending on how quickly you need an estimate, this back and forth may stretch out your timeline.

What can you do to avoid issues?
Keep dimensions readable, traceable to the feature and uncluttered. While CAD drawings are ideal, providing your manufacturer with detailed, annotated drawings with defined scale will eliminate much of the back and forth that happens with incomplete drawings.



If two dimension lines show up close together, either put a note on one dimension to clarify what feature it refers to, or apply dimensions in a logical flow. And, indicate “exposed surfaces” on your design drawing so the extruder can give them special attention and protect the finish during both extrusion and post-extrusion handling.

Some additional recommendations to improve the quoting process.

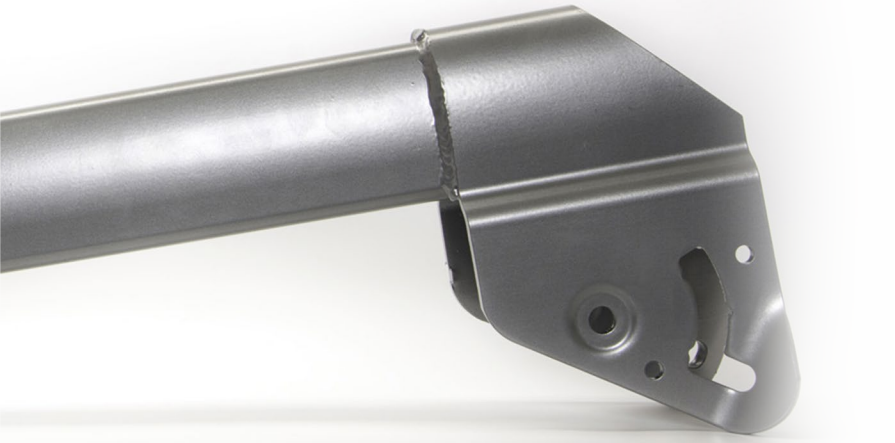
When ordering Aluminum Extrusion Lineals, without Fabrication:

- Send a DWG AutoCAD file of the profile so you and your manufacturer can review the design together and get a weight per foot using AutoCAD.
- Always include specifications for coatings.
- Include quantities and shipping requirements.

When ordering Aluminum Fabrication:

- Send a DWG AutoCAD file of the profile.
- Send a PDF showing dimensions, tolerances and any post secondary operations and call outs.
- If the shape is complicated, such as requires compound miter cuts, cutout shape locations in relation to extrusion walls, etc. and include a Solid Works .STP file.
- Include quantities and shipping requirements.

2. Failure to Share the "Big Picture



If you received a drawing for this part, would you know if the alloy indicated was appropriate? Would you be able to accurately assess the profile to ensure it would withstand a required load amount, if you had no idea how it was going to be used?

Designers often fail to share full product details with their aluminum extrusion manufacturer, such as how an extruded component will be used in relationship to other parts and its functional requirements, e.g. load bearing component, exposure to heat, etc. These details are critical for the extrusion engineer to determine the proper alloy, temper and other factors.

Additionally, by not providing more details to the extrusion manufacturer, designers miss out on valuable insights to make their product or component as production friendly as possible, and more cost efficient. Extrusion engineers, having designed thousands of profile dies, have a wealth of information to share

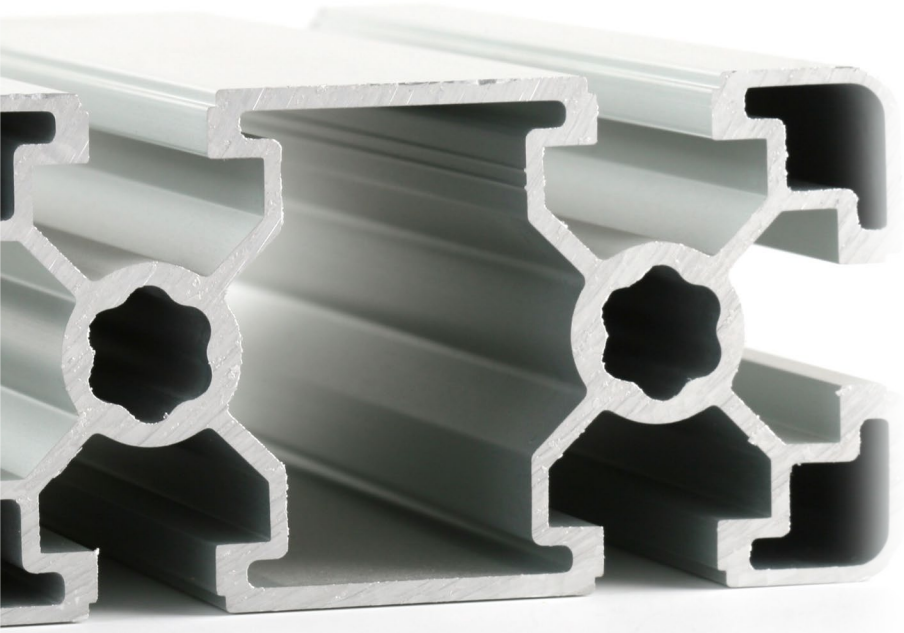
with product designers. By collaborating with your manufacturer, you can discover other areas to optimize, such as delivery, quality, reliability, ease of assembly, testability, and opportunities where standard profiles versus custom can be used.

If confidentiality is a concern, your extrusion provider should be willing to sign a non-disclosure agreement prior to reviewing your drawings.

What can you do to avoid issues?
Share how your part is going to be used, the more information the better. Some critical questions to answer include:

- How will it interact with other parts? Do you have a mating extrusion or component?
- Is the part Safety Critical? Will it be used in an Automotive or Aerospace application, which have specific performance requirements?
- Will the part be under load? What types of stress will the part encounter?
- Will there be critical visual surfaces?

3. Expecting Sharp Corners



Our next issues comes from designers mistakenly believing that all corners will have sharp edges. Unfortunately, the extrusion process cannot achieve razor-sharp corners. The reason for this is that sharp corners generate unnecessary heat, which can translate into tearing on exposed surfaces and/or die breakage when the hot metal is pushed through these areas.

Tearing is more significant with certain alloys, such as 6061 which can get build up on the extruded bearing surface.

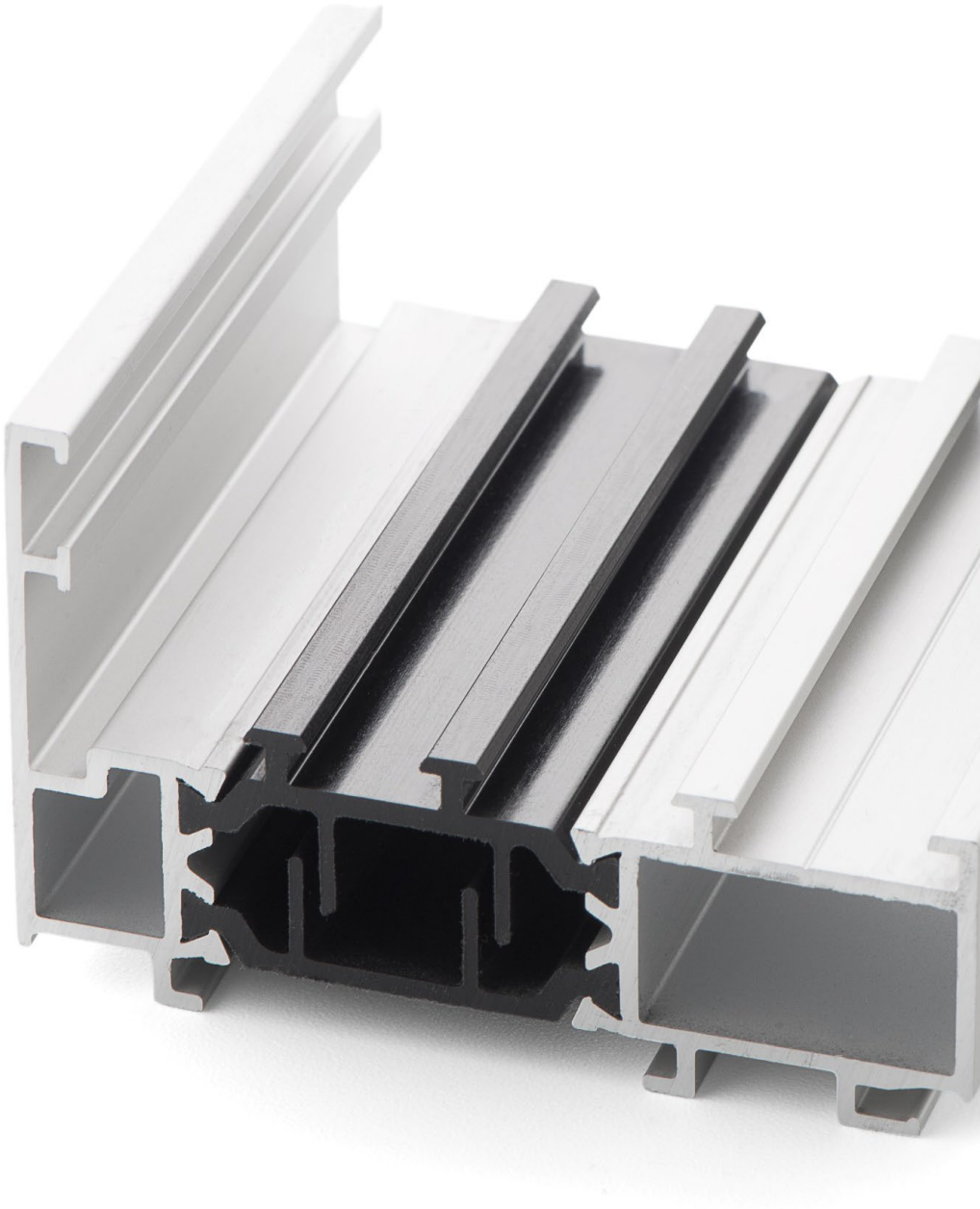
As you can see in this image, there are no sharp corners. By rounding the corners the hot aluminum flows easier, cooler and faster through the die, which translates into greater cost savings.

What can you do to avoid issues?

- Best advise is to design for simplicity. More rounded corners enable less drag on the die and reduce the build up of heat that wears down the surface of the die.

- A radius of 0.5 – 1mm is often sufficient. Take note that when you snap lines in AutoCAD the program does not know to include a radius unless told to.

- If a design requires sharp internal angles, such as a profile to enclose a box shape, this can be solved by incorporating a hollow mold. You can also utilize fabrication techniques to achieve sharp edges, but keep in mind the added cost to do so.



4. Creating Irregular Shapes

When designing for aluminum extrusions, the more unsymmetrical or unbalanced a shape, the less likely it is to remain straight or hold angles and general dimensions. While non symmetrical shapes can be produced, metal flows less readily into narrow and irregular die sections, making distortion and other quality problems more likely to occur.

Similarly are issues with consistency and uniformity of wall thickness. While it is acceptable to have a range of wall thicknesses within a single profile, shapes with uniform wall thickness are the easiest to produce because the aluminum alloy flows through the die at the same speed.

As with non symmetrical shapes, dies that have an unequal wall thickness can be difficult to produce because the hot aluminum is forced fastest through the widest sections, while moving slowly through the thinner areas. If the thinner sections do not fill properly, the entire part could become compromised and twist during manufacturing. Thus adjustments will be needed to the die and die testing before production, which adds costs.

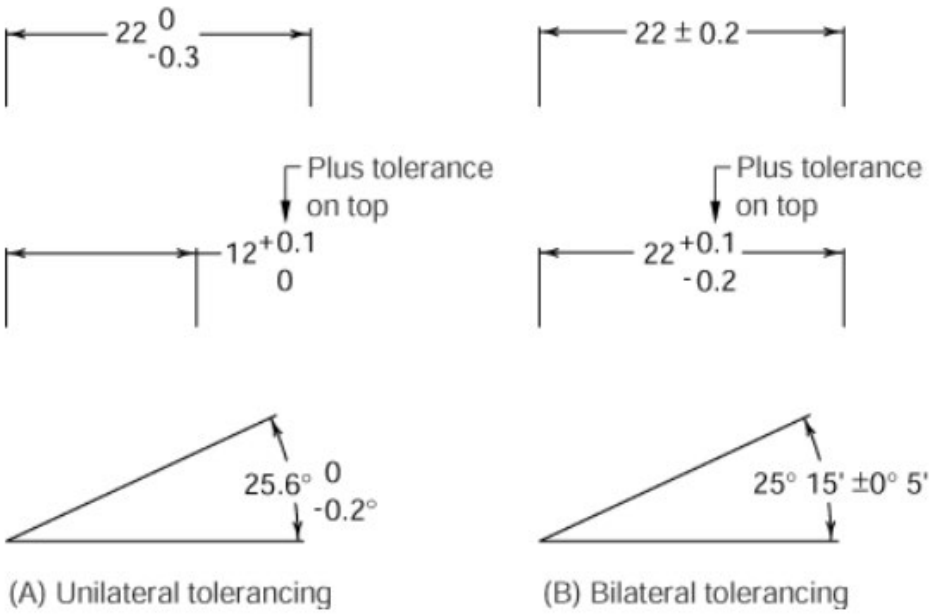
The minimum wall thickness which can be extruded for aluminum is dependent on the extrusion force and speed, the choice of alloy, the shape of the profile, desired surface finish and tolerance specifications.

What can you do to avoid issues?
When designing your profile, remember these general rules of thumb:

- When designing your components, try to achieve as much symmetry as possible.
- Avoid thin walls. Designing a thinner wall to simply save money and weight can often backfire. Most cost savings come from the ease of extrusion.
- Wall thickness tolerances should be approximately +/- 10% of the wall thickness. Minimum wall thickness goes up as the extrusion shape gets larger. In most alloys, for example, a 0.062 inch wall is possible in a 3 inch-wide shape but not possible for one 10 inch-wide. Consult the Aluminum Association Manual for standard tolerances.
- Review your runout surface. Remember the metal is hot when extruded. Look for areas of cupping to occur and long legs sticking out of the extrusion without support. Long legs have a tendency to fall from side to side.
- Alloy plays a major role. As mentioned in issue #3, tearing is more significant with certain alloys. Also, some alloys need to be cooled using water, which will distort the part to a degree.
- If you have concerns about your design, or you are not sure if what you have designed is easily extruded, bring your extruder in early in the design process. In the end you will save time and money by identifying issues before production begins.

5. Inconsistent Dimensioning

Consistency in tolerancing methods is every bit as important as consistency in dimensioning. As a reminder, tolerance is used to control the amount of variation inherent in all manufactured parts, in particularly for mating parts in an assembly. The use of plus/minus (+/-) dimensioning provides the allowable positive and negative variance from the dimension specified. Remember, extrusion tool makers construct tooling at the bottom of the tolerance. This is done so that over time the tooling will wear and you will have a greater die life, thus reducing tooling costs and downtime for tooling replacement.



Some designers may opt to express dimensional data with double minus or positive tolerances, which is also an acceptable style. It is important you select an appropriate style of tolerance specification for your design as it can have a significant impact on product costs. Also, seeing tolerances specified the same way among all drawings will make it easier for the manufacturer to interpret, saving time and reducing errors.

If you have custom specific tolerance specifications, and you have a document that calls that out, be certain to supply that document, or do not call it out on your

document. If it is not sent, your manufacturer will either have to request it from you or have to provide a quote and call it out that your custom tolerances were not used.

Remember, all extruders will redraw your print. They do this to fit the extrusion process and points to be measured during the process at the press. When redrawn the CAD operator will call out your Critical to Function (CTF) dimensions.

What can you do to avoid issues?

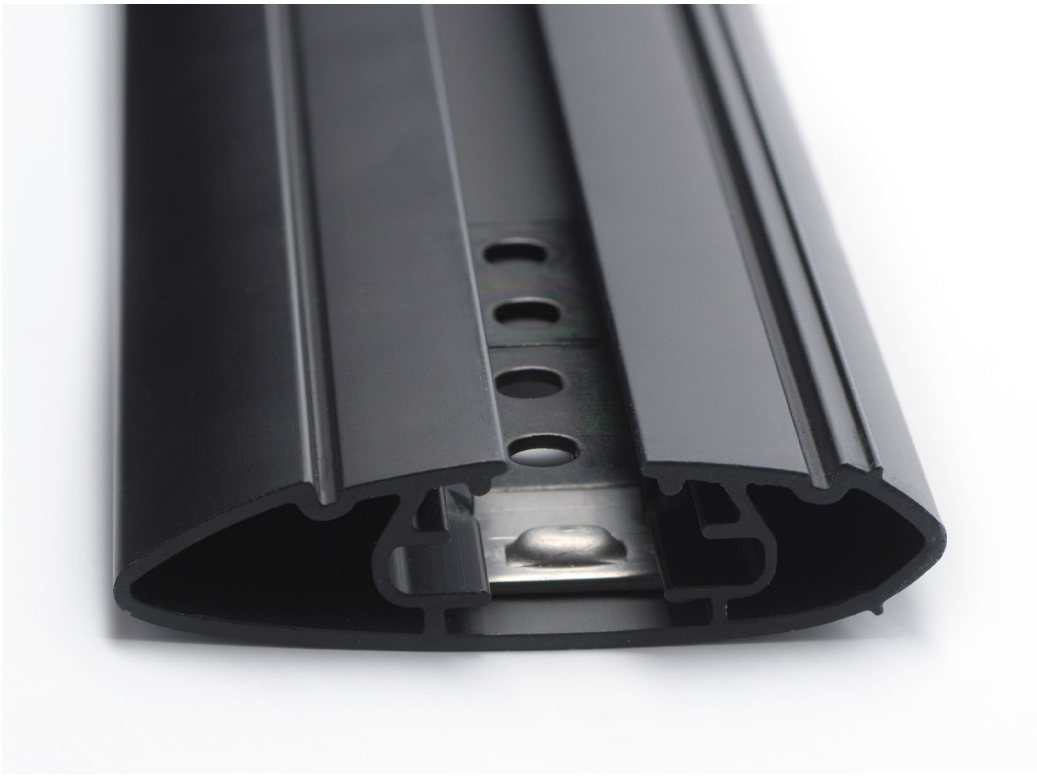
- Consult the Aluminum Association Book for AA Standards. To avoid any confusion, ask your Extruder how they interpret some tolerances and call outs.
- Use plus/minus (+/-) dimensioning to give acceptable level of variation from the specified dimension.
- Use same tolerancing method throughout your designs.
- For fabricated parts, dimension from one side of the part. Dimensioning some features on both sides requires machining both sides of the part to hold tolerances, which adds another machine operation and increases costs.
- Use clear, standard (simple) Geometric Dimensioning and Tolerancing (GDT) call outs with standard Datum call outs. Do not reinvent the GDT handbook. And remember, the more Datums you use for fabrication, the more costly the component.
- Check your anodizing and paint specifications. Please make sure they relate back to a standard that can be easily traced.
- Use tolerance extrusion dimensions that can be easily checked with calipers and other handheld inspection tools. Pick no more than 5 dimensions that are critical to your process.

6. Over Specifying Tolerances

When working with aluminum extrusions it is important to understand the standard levels of acceptable tolerance for characteristics such as straightness, flatness, and twist, as well as cross-sectional dimensions as thickness, angles, contours, and corner or fillet radii. These tolerances are published in the Aluminum Association's Aluminum Standards & Data guide.

While standard industry tolerances usually provide adequate precision for most applications, extrusions can be produced to closer-than-standard dimensional tolerances. However, extrusion costs generally increase with tighter tolerances, as well as the number of tolerance settings. So, even if you give +/- 3mm for tolerances, but you tolerance every feature on the drawing, your part is going to cost considerably more.

Therefore, carefully consider the application of your part or product when setting tolerances. For example, for assembly parts if dimensions do not fall within a certain range of values they will not fit together. Replacement parts must also be a duplicate of the original part within certain limits of deviation.



What can you do to avoid issues?

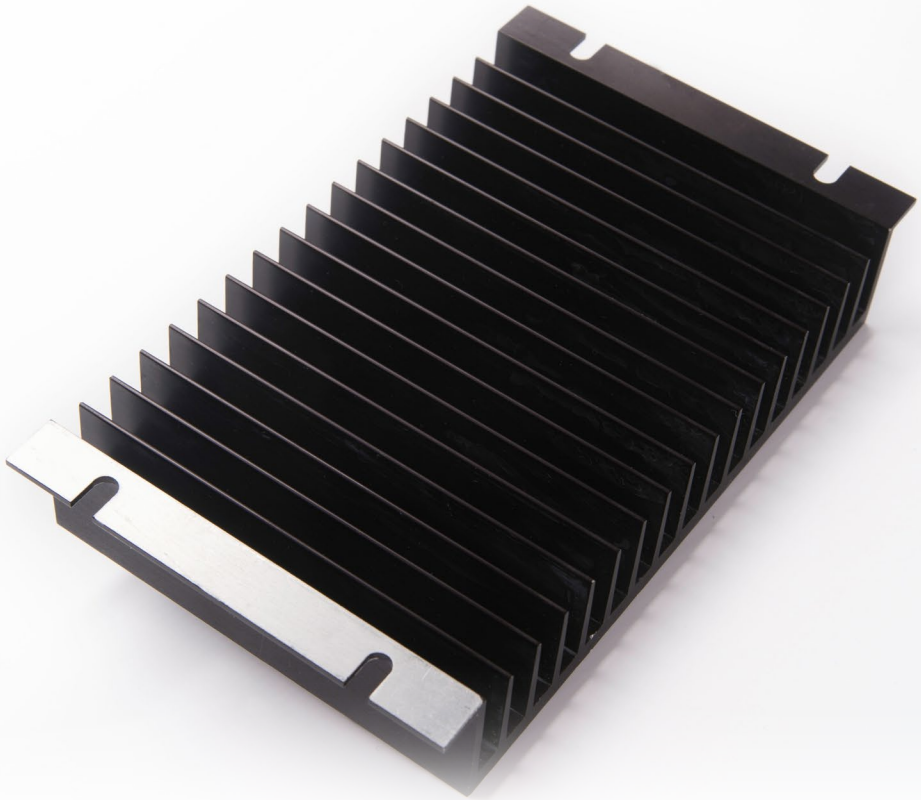
- A rule of thumb is NOT TOLERANCE ANYTHING that doesn't absolutely have to have a tolerance. Aluminum Association standard tolerances will be applied wherever tolerances are not specified.
- Consult the Aluminum Association's Standards for Extruded Aluminum. The tighter your tolerances against standards the more costly, and possibly impossible the part becomes to make.
- Pay close attention to the default settings in your CAD programs. Using the default numbers on your drawing program when the decimal setting is three or four places out means every dimension shown appears to require the highest precision.
- Always identify your Critical to Function (CTF) tolerances, such as areas where you are mating hardware.
- As always, your aluminum extrusion manufacturer is a valuable resource to you. If you have concerns or questions about what tolerance to set, just ask.

Conclusion

Choose an experienced aluminum extrusion manufacturer for your next project.

Manufacturing custom extrusions takes years of dedication and experience. You need a combination of talented engineers, tool builders and manufacturing staff to produce consistent quality parts and components every time. Momentum Manufacturing Group Engineered Extrusions has been serving system integrators, OEMs and other manufacturers throughout the U.S. since 1986, helping them improve their process, product and bottom line.

Contact us today about your next project. We have the best people, processes and machinery to meet the most demanding industry requirements, while delivering shorter lead-times and consistent quality for even the most complex extruded aluminum shapes.



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