Aluminum Extrusion Design

Product Designer's Guide to Ordering Aluminum Extrusions

Momentum Manufacturing Group

Engineered Extrusions

Introduction

No longer tethered to standard shapes and limited characteristics of traditional materials, product designers are limited only by the scope of their imagination when working with aluminum extrusions.

One of the most challenging facets of working with aluminum extrusion is requesting a quote (RFQ). Arguably, it is also the most important step, influencing which vendor you choose and affecting the manufacturing process, your budget and timeline, and the ultimate results. If your RFQ doesn't answer all the questions the extruder needs, the manufacturer can only provide a ballpark estimate. Your estimate could increase or decrease dramatically once the "finer points" are provided.

Additionally, without all the details, there is a lot of back-and-forth between you and the extruder. Depending on how quickly you need an estimate, this back-and-forth may stretch your timeline.

This guide provides ten key questions extruders ask when they receive an RFQ for a custom aluminum extruded part or component. If you are an engineer, designer, purchasing agent, or responsible for obtaining quotes, this guide will help you tackle common challenges in sourcing custom aluminum extrusions, reduce frustration, and maximize the accuracy of your quotes.

1. Which Alloy?

Your extruder will want to know the alloy requirement to start your order. Aluminum, like many metals, has limited usage in its purest form. Hence, it is alloyed with other elements, such as magnesium, silicon, or zinc, to produce a variety of characteristics. So whether you need corrosion resistance, increased strength, thermal conductivity, or improved formability, there is a proper "mixture" to achieve the desired results.

For example, the 6xxx series is the most popular alloy class, offering good strength, extrudability, and machinability. Series 7xxx has very high strength and is most often used for aircraft components, while the 5xxx series offers excellent saltwater corrosion resistance, making it ideal for marine applications. See the reference table at right.

ALLOY SERIES	ALLOY	PROPERTIES	APPLICATIONS
1XXX	Pure	Low strength, excellent thermal/electrical conduction and corrosion resistance, highly reflective	Fuel filters, electrical conductors, radiator tubing, lighting reflectors, decorative components
2XXX	Cu	High strength, relatively low corrosion resistance, good elevated temperature strength	Aircraft skin, aircraft fittings and wheels, ballistic armor, forged and machined components
3XXX	Mn	Medium strength, good formability, good corrosion resistance	Storage tanks, beverage cans, home appliances, heat exchangers, pressure vessels, siding, gutters
4XXX	Si	High castability, high machinability, high fluidity, low ductility	Variety of castings, including large casting, filler metal (2xxx, 3xxx, 5xxx and 7xxx used for castings)
5XXX	Mg	Medium strength, good formability, excellent marine corrosion resistance	Interior automotive, appliance trim, pressure vessels, armor plate, marine and cryogenic components
6XXX	Mg, Si	Med-high strength, good corrosion resistance, easily extruded	Exterior automotive, automotive profiles, railcars, piping, marine, screw stock, doors and windows
7XXX	Zn	Very high strength, prone to stress corrosion, poor corrosion resistance	Aircraft construction, truck trailers, railcars, armor plate, ski poles, tennis rackets
8XXX	Li	Very high strength, low density	Aircraft and aerospace structures, foil, heat exchanger fin stock

2. What Temper?

Depending on the composition of your alloy, aluminum can be further strengthened and hardened using quenching (cooling), heat treatment, and/or cold working techniques. The temper designation appears as a hyphenated suffix to the basic alloy number.

For example, 6060-T4 indicates the use of 6060 alloy and a T4 temper (extrusion is heat-treated after being extruded and then naturally aged). The goal of air and water quenching is to reduce the temperature of the extrusion within a specified timeframe to meet hardness requirements and minimize distortion. Thermal treatments in controlled, multi-zone ovens accelerate the aging process and enhance other alloy properties. Such techniques enable designers to achieve desired mechanical properties using a more easily extruded, less expensive alloy. See a list of standard tempers at right.

TYPICAL EXTRUSION TEMPERS	PROCESS APPLIED
F	Extruded and air cooled
O	Fully annealed
H	Strain-hardened & strengthened through cold working
W	Solution heat treated
T1	Cooled from an elevated temperature & naturally aged
T2	Cooled from an elevated temperature, cold worked & naturally aged
T3	Solution heat treated, cold worked & naturally aged
T4	Solution heat-treated & naturally aged
T5	Cooled from an elevated temperature & artificially aged
T6	Solution heat-treated & artificially aged
T7	Solution heat-treated & overaged/stabilized
T8	Solution heat-treated, cold worked & artificially aged
T9	Solution heat-treated, artificially aged & cold worked
T10	Cooled from an elevated temperature, cold worked & artificially aged

3. What Specifications Need to Be Met?

When designing a product, there are established design standards based on the product's use and industry application. ASTM, AMS, and ASME are among the most widely used specifications for aluminum extrusions.

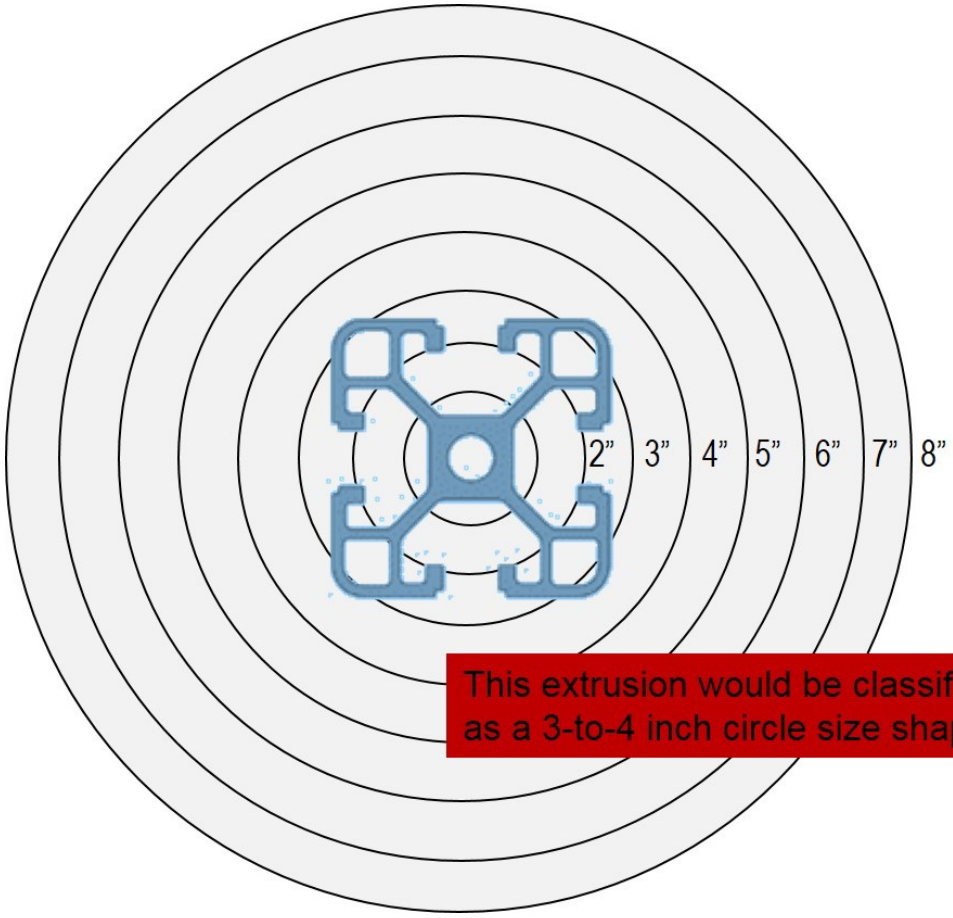
The American National Standards Institute (ANSI) oversees all these “standards-developing organizations." Your extruder will need these standards to ensure the proper alloy, temper, and tolerances are correct.

Aluminum handrails must meet specific size, length and strength specifications.

4. What Size & Shape Are Needed?

A common measurement of an extrusion profile is its circumscribing circle diameter (CCD)—the diameter of the smallest circle that entirely encloses an extrusion cross-section. Most common profiles are less than 8" in diameter, but a few extruders can produce extrusions with a larger CCD, some as large as 18".

The larger the shape, the more expensive the extrusion, and achieving shape accuracy is reduced. Additionally, if a shape is hollow, the container diameter will need to be slightly larger than the shape to extrude accurately. Providing your aluminum extrusion supplier with a detailed drawing of the shape will help determine the proper container size.



5. How Straight?

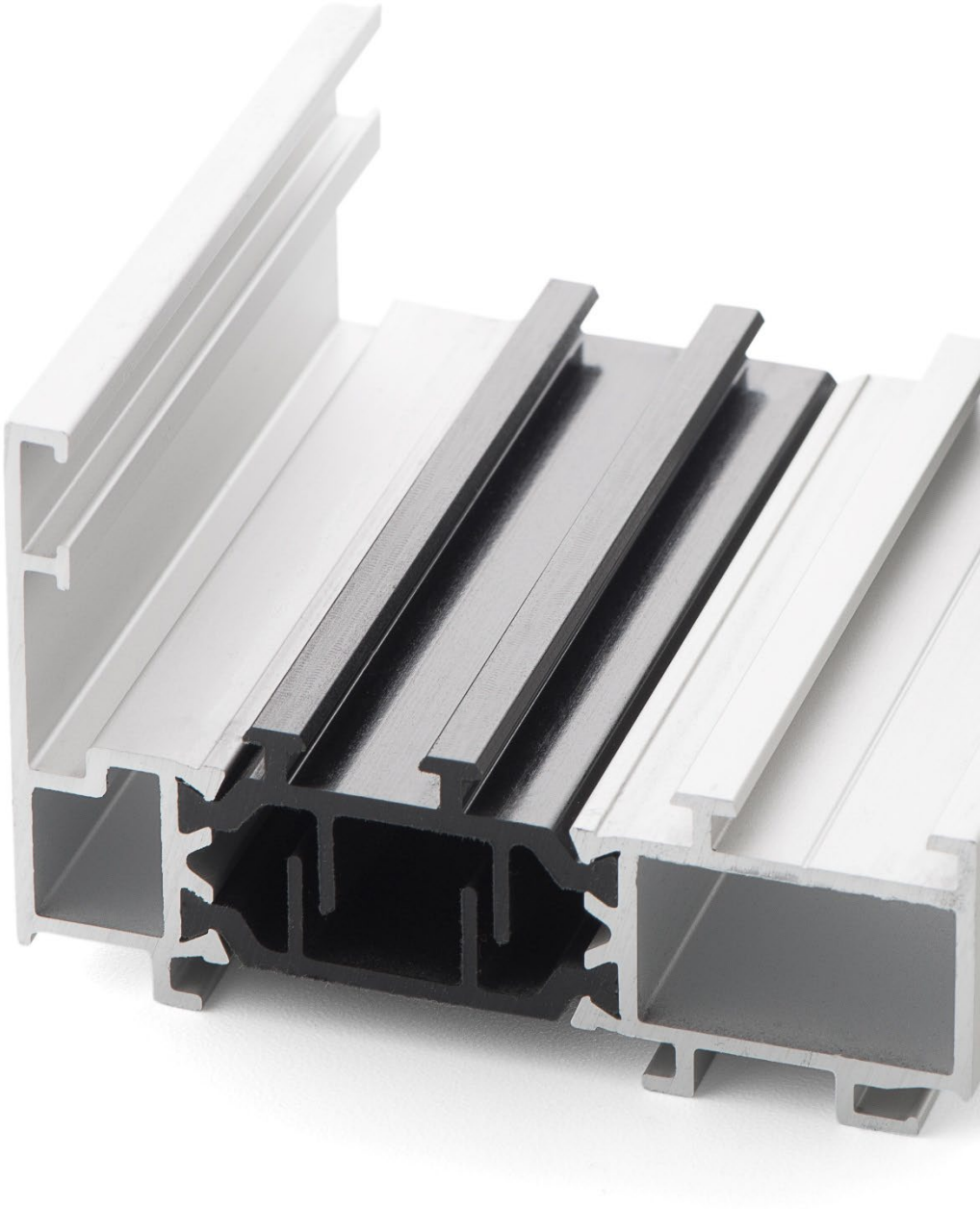
Aluminum extrusions are typically produced in “reasonable" straight conditions, which means a certain amount of bow and twist occurs when an extrusion comes out of a press. The Standard Aluminum Association tolerance for straightness is .0125" per foot. When a tighter tolerance for straightness is required, the manufacturer can adjust the press force and speed, the quench (cooling) rate, and perform additional stretching operations to meet more stringent requirements.

A stretcher can be used to help achieve desired straightness requirements.

6. How Flat?

Naturally occurring bow and twist during the extrusion process can also affect transverse flatness, which is measured across the width of an extruded section. The Standard Aluminum Association tolerance for twist is ½ degree per foot.

If you are attaching or inserting an extruded component into another component (mating parts), flatness is particularly important, and a tighter flatness tolerance should be specified. Remember that the longer the piece, the more bow and twist will occur, and 0% tolerance is not achievable. Therefore, you need to factor this into your design and build in clearance when parts are being joined.



7. What are the Cross-Sectional Dimensions?

Profiles with a uniform wall thickness are the simplest to produce. However, wall thickness within a profile can easily be varied where necessary.

For example, a profile's bending strength can be increased by concentrating weight/thickness away from the center of gravity. Among the factors affecting wall thickness are extrusion force and speed, the choice of alloy, the profile's shape, the desired surface finish, and tolerance specifications.

Providing your manufacturer with your required dimensional tolerances is another crucial input to the estimating process.

8. What Surface Finish?

For many applications, aluminum profiles require no more protection than their naturally occurring, transparent oxide film. However, aluminum profiles can be treated with a wide range of finishes wherever additional protection or an enhanced appearance is desired.

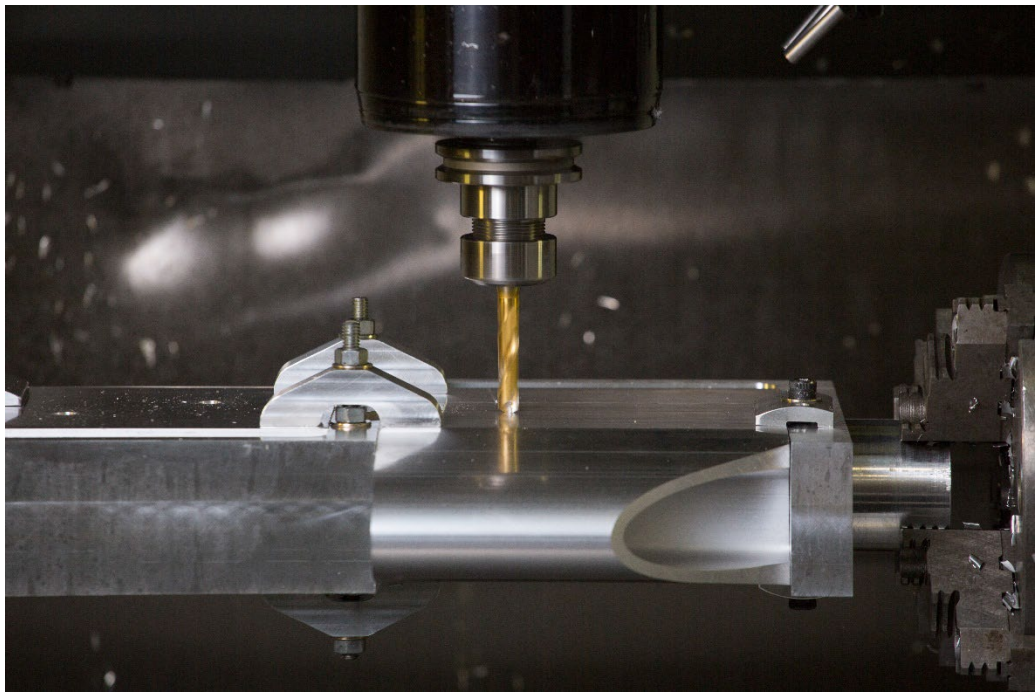
Mechanical finishes, such as buffing, sanding, or polishing, can be used to achieve specific textures. Chemical finishes can be used to give aluminum a frosted or shiny finish. Additionally, liquid and powder coatings can be used to add color or durability.

Anodizing is an electrochemical process that converts the metal surface into a decorative, durable, corrosion-resistant, anodic oxide finish. Unlike painting or plating, aluminum oxide is fully integrated with the underlying aluminum substrate, so it cannot chip or peel.

9. Is Additional Fabrication Needed?

One of the key benefits of custom aluminum extrusions is the ability to integrate holes, notches, and surface designs directly into the profile. This eliminates or greatly reduces the need for additional machining and significantly decreases costs.

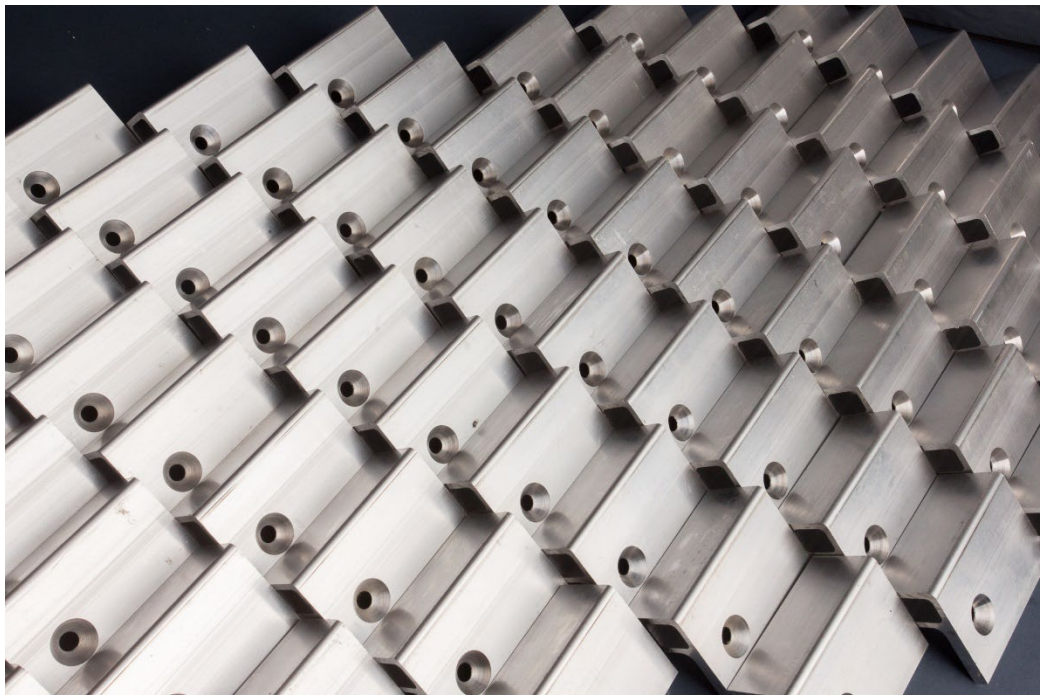
If additional customization is needed, including precision cutting, milling, drilling, hole punching, stamping, and/or machining, you will save money by working with a best-in-class aluminum extrusion manufacturer who has in-house machining and fabrication capabilities.



10. How Many Pieces?

Obviously, the cost to produce 100 pieces will be much higher than the cost to produce 10,000 pieces. For example, a typical setup time might be 4 hours when machining a part. At $75/hr. the setup charge for 800 pieces is $.375/pc. ($300/800) versus $.0375/pc. for 8,000 pieces.

When requesting a quote, include several quantities, including your maximum annual volume, to give you a better view of costs.



Bottom Line

An RFQ provides the information a manufacturer needs to deliver an optimal quote. By including details outlined in the guide and any other information critical to your order, such as delivery location, deadlines, and vendor requirements, you help ensure you get the part you want and a cost estimate that is as accurate as possible.

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.

Today, the best manufacturers also leverage advanced smart manufacturing practices — including real-time monitoring, predictive maintenance, and data analytics — to ensure tighter quality control, reduce waste, and deliver more consistent lead times. When evaluating vendors, it's worth asking how they incorporate these capabilities into their operations.

Momentum Manufacturing Group - Engineered Extrusions has been serving system integrators, OEMs, and other manufacturers throughout the U.S. since 1986, helping them improve their processes, products, 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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