Measuring and Marking

Learn how to properly mark materials to be cut.

- Introduction to FRC Extrusion
- How to Measure Accurately with a Tape Measure
- Hole Layout Using a Single Datum (Plates + Center Punching)
- Scribing and Marking Tools
- Tolerance and Why ±1/32" Matters

Introduction to FRC Extrusion

Rectangular aluminum extrusion is used in FRC to build robot frames and structural mechanisms. The strength, stiffness, and weight depend on both size and wall thickness.

Common Extrusion Sizes

1" × 1"

- Small, lightweight structural member
- Used for mechanisms and compact structures

2" × 1"

- Most common FRC structural extrusion
- High stiffness in the 2" direction
- Used for drivetrains and main frames

2" × 2"

- Heavy-duty, very rigid
- Used for high-load structures
- Heavier, used only when needed

Wall Thickness (WCP Options)

West Coast Products (WCP) commonly offers:

- **0.063"** — Lightweight, lower strength
- **0.090"** — Balanced strength and weight (most common)
- **0.125"** — Maximum strength and stiffness

Thicker walls increase strength but also add weight.

0.5 Inch Hole Spacing

Many FRC designs use a **0.5 inch grid pattern** when drilling extrusion.

This means holes are placed every half inch (0.5", 1.0", 1.5", etc.) to create consistent mounting locations.

This system:

- Matches CAD layouts
- Improves alignment between parts
- Makes fabrication repeatable and accurate
- Helps standardize robot construction

Key Idea

Different extrusion sizes and wall thicknesses control strength and weight, while the 0.5 inch grid system ensures accurate and repeatable assembly.

How to Measure Accurately with a Tape Measure

Accurate measurement is critical in FRC fabrication. Small errors can cause misaligned parts and poor assembly fit.

Reference Edge (Most Important Rule)

Always measure from a consistent, known reference point. For FRC extrusion, this should be the **factory-cut end of the tube**.

This ensures every measurement starts from a true, flat surface.

Using the Tape Measure

- Seat the hook firmly on the factory edge
- Keep the tape straight and tight
- Read at eye level to avoid parallax error
- Use the smallest increment you can reliably read

Offset Measurement Method (High-Precision Technique)

For improved accuracy in tight tolerance work, you can use an offset method:

- Align the **1 inch mark** of the tape with the factory edge
- Read the measurement from that point
- **Subtract 1 inch from the final value**

This reduces small errors caused by hook movement or wear.

Using a Speed Square for Marking

A speed square is used to create accurate 90° layout lines.

How to use it:

- Place the square’s fence against the factory edge
- Mark your measured point
- Draw a straight line across the extrusion using the square edge

This ensures:

- Square cuts
- Accurate drill lines
- Proper part alignment

Common Mistakes

- Measuring from a damaged or non-factory edge
- Forgetting to subtract the 1 inch offset
- Letting the tape twist or sag
- Drawing marks without a square

Key Idea

Accuracy comes from using a consistent reference edge and controlling measurement error through either direct reading or a properly applied offset method.

Hole Layout Using a Single Datum (Plates + Center Punching)

Accurate hole placement in FRC depends on using a **consistent datum** and properly marking drill locations before cutting.

Using a Datum for Hole Layout

A datum is a fixed reference edge used to measure all features from.

For plates, the best datum is usually:

- A straight factory edge of the material

All hole locations should be measured from this same edge:

- Measure X distance from the datum
- Measure Y distance from the datum
- Do not switch reference edges between holes

Using one datum ensures:

- Holes stay aligned in a grid
- Parts match CAD layouts
- Errors do not accumulate across measurements

Marking Hole Locations

Once measurements are made:

- Mark each hole location clearly with a pencil or scribe
- Use a combination square or speed square to ensure straight layout lines when needed
- Double-check critical dimensions before punching or drilling

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Center Punching

A **center punch** is used to lock in the exact drill location before drilling.

Why it is used:

- Prevents the drill bit from “walking” (sliding off the mark)
- Improves accuracy on metal surfaces
- Creates a small indentation that guides the drill bit

How to use it:

- Place the punch directly on the marked point
- Hold it steady and perpendicular to the surface
- Strike firmly with a hammer to create a visible dent

Best Practice Workflow

1. Choose a single datum edge
2. Measure all hole positions from that datum
3. Mark each point clearly
4. Use a center punch on every hole location
5. Drill carefully, keeping the bit centered in the punch mark

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Key Idea

Good hole accuracy comes from consistent measurement from the same datum and center punching every mark before drilling.

Scribing and Marking Tools

Accurate layout work in FRC depends on clearly marking where cuts and holes will be made. Scribing and marking tools help create precise, repeatable reference lines before drilling or cutting.

Pencil and Marker

- Used for general layout on metal and plates
- Easy to see and quick to apply
- Best for rough or medium-precision marking

Limitations:

- Can be thick or imprecise
- Marks can wear off during handling

Scribe

A scribe is a sharp tool used to scratch fine lines into metal surfaces.

Advantages:

- Very high precision
- Permanent marking (does not wipe off easily)
- Thin, accurate lines for hole centers and cut lines

Best use:

- High-accuracy hole layout
- Critical alignment features
- Final marking before center punching

Combination Square

A combination square is used to mark straight, perpendicular lines.

Uses:

- Drawing 90° lines from a datum edge
- Checking squareness of parts
- Extending measurement marks across a plate or extrusion

Speed Square

A speed square is used for quick and accurate right-angle marking.

Uses:

- Fast layout on extrusion and plate
- Marking cut lines
- Checking alignment during fabrication

Best Practice

- Always measure from a single datum first
- Mark lightly before final scribing
- Use a square tool to ensure all lines are perpendicular
- Double-check critical marks before punching or drilling

Key Idea

Good fabrication starts with good marking. Scribes and squares turn measurements into accurate, repeatable reference lines that prevent errors during drilling and cutting.

Tolerance and Why ±1/32" Matters

> "Measure twice, cut once"

What Is Tolerance?

Tolerance defines how far a part can deviate from its intended dimension while still working correctly.

Example:

- 10.000" ± 1/32"
- This means the part can be slightly larger or smaller and still be acceptable

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Why ±1/32" Matters in FRC

A tolerance of **1/32 inch (0.031")** may seem small, but in robotics it can:

- Prevent holes from lining up correctly
- Cause shafts or bearings to bind
- Create misalignment in drivetrains or elevators
- Stack into larger errors across assemblies

Small errors add up when multiple parts depend on each other.

When Tight Tolerances Are Needed

Tight tolerances (like ±1/32") are important when:

- Aligning bearing holes
- Mounting shafts or gears
- Building drivetrain frames
- Connecting pre-cut or CAD-matched parts

When Loose Tolerances Are Acceptable

Looser tolerances are acceptable when:

- Mounting non-critical brackets
- Creating sensor mounts with adjustment
- Working with slots or oversized holes
- Designing parts that need adjustability

Best Practice

- Measure twice before cutting or drilling
- Use the same datum for all features
- Center punch hole locations before drilling
- Drill pilot holes before final sizing when precision is critical

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Key Idea

Tolerance is not just a number—it is what determines whether parts fit together correctly or create assembly problems. In FRC, ±1/32" can be the difference between a smooth assembly and a misaligned mechanism.