FRC Hardware Standards

Learn about all the hardware a typical FRC robot consists of.

- 10-32 Hardware
- 1/4-20 Hardware
- Shafts
- Bearings and Bushings
- Plastic Washers
- Standoffs
- Gussets

10-32 Hardware

10-32 is the most common fastener size used in FRC. It provides a good balance of strength, weight, and ease of use, making it suitable for many robot assemblies.

What Does 10-32 Mean?

- **#10** refers to the screw diameter.
- **32** refers to the number of threads per inch (TPI).

This makes 10-32 a fine-thread fastener that provides good holding strength in aluminum.

Common Hardware

10-32 hardware includes:

- Socket head cap screws
- Button head screws
- Nylock nuts
- Washers
- Tapped holes in aluminum

Common Lengths

Typical lengths used in FRC include:

- 1/2"
- 3/4"
- 1"
- 1-1/4"
- 1-1/2"

The correct length should allow full thread engagement without excessive exposed threads.

Typical Tools

- 5/32" hex key or T-handle
- 3/8" wrench or socket for nuts
- #21 drill bit for tap holes
- 13/64" drill bit for clearance holes

Why FRC Teams Use It

- Strong enough for most robot assemblies
- Easy to tap into aluminum
- Widely available from FRC vendors
- Compatible with many commercial robot components

Key Idea

10-32 hardware is the standard fastener system for many FRC robots because it provides reliable strength while remaining compact and easy to work with.

1/4-20 Hardware

1/4-20 hardware is commonly used in FRC for high-load applications where additional strength is needed. The larger diameter provides greater thread engagement and improved resistance to stripping.

What Does 1/4-20 Mean?

- **1/4** refers to the major diameter of the screw (0.250")
- **20** refers to the number of threads per inch (TPI)

This makes 1/4-20 a coarse-thread fastener that is durable and well-suited for structural applications.

Common Hardware

1/4-20 hardware includes:

- Socket head cap screws
- Button head screws
- Nylock nuts
- Washers
- Tapped holes in aluminum

Common Lengths

Typical lengths used in FRC include:

- 1/2"
- 3/4"
- 1"
- 1-1/4"
- 1-1/2"
- 2"

The correct length should allow full thread engagement without excessive exposed threads.

Typical Tools

- 3/16" hex key or T-handle
- 7/16" wrench or socket for nuts
- #7 drill bit for tap holes
- 17/64" drill bit for clearance holes

Why FRC Teams Use It

- Stronger than 10-32 hardware
- Better for high-load applications
- Less likely to strip in aluminum
- Common for structural and mounting applications

Key Idea

1/4-20 hardware is used when additional strength and durability are needed. Its larger size makes it ideal for high-load joints and structural connections.

Shafts

Shafts are rotating elements used to transmit torque through a robot’s mechanisms. In FRC, different shaft geometries are used depending on how securely components must transfer motion and how much load the system experiences.

Common Shaft Types

1/2" Hex Shaft

- Most common FRC shaft type
- Torque is transmitted through flat faces
- No slipping when used with matching hubs
- Easy to assemble and align

3/8" Hex Shaft

- Smaller, lighter hex shaft option
- Used in compact or low-load mechanisms
- Easier to package in tight designs
- Lower torque capacity than 1/2" hex

1/2" Round Shaft

- Smooth cylindrical shaft
- Requires keys, pins, or set screws for torque transfer
- Can slip if not properly constrained
- Used when free rotation or simple pivots are needed

Spline XL Shaft System

Spline XL is a high-torque shafting system used in FRC for demanding applications.

Key Features:

- Multiple splines (teeth) around the shaft
- Very high torque capacity

- Prevents slippage under heavy load
- Allows precise, repeatable component alignment

Why Teams Use It:

- Handles extreme drivetrain loads
- More robust than hex shafts in high-stress systems
- Reduces wear from repeated high-torque cycles
- Improves long-term reliability

How They Relate

- **Round shaft → simplest, lowest torque transfer (needs retention features)**
- **3/8" hex → compact, moderate torque, space-saving option**
- **1/2" hex → standard balance of strength and usability**
- **Spline XL → maximum torque capacity and reliability**

As load requirements increase, teams typically move from round → smaller hex → 1/2" hex → spline-based systems.

Common Applications

- Drivetrains (1/2" hex, Spline XL)
- Intakes and rollers (3/8" and 1/2" hex)
- Elevators and arms (1/2" hex, Spline XL)
- Light pivots and mechanisms (round shaft)

Key Idea

Shaft selection depends on torque, packaging, and reliability needs. 3/8" hex is a compact option, 1/2" hex is the standard, round shafts require additional retention, and Spline XL is used when maximum torque capacity and durability are required.

Bearings and Bushings

Bearings and bushings support rotating shafts and reduce friction between moving parts. They are essential components in nearly every FRC mechanism.

Bearings

Bearings use rolling elements, typically balls, to allow shafts to rotate with very low friction.

Advantages:

- Very low friction
- Smooth rotation
- High efficiency
- Excellent for high-speed applications

Common FRC uses:

- Drivetrains
- Rollers and intakes
- Arms and elevators
- Gearboxes

Bushings

Bushings use a smooth surface that the shaft slides against rather than rolling elements.

Advantages:

- Simple and inexpensive
- Lightweight
- Resistant to dirt and debris
- Compact design

Common FRC uses:

- Low-speed pivots

- Lightly loaded mechanisms
- Simple rotating joints

Common Bearing Sizes

Typical FRC bearings include:

- 1/2" hex bearings
- 1/2" round bearings
- Flanged bearings

Bearings are often press-fit into plates, tubes, or bearing blocks.

Bearing vs. Bushing

- **Bearing:** lower friction, higher performance, higher cost
- **Bushing:** simpler, cheaper, and better for low-speed applications

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Key Idea

Bearings provide smooth, efficient rotation for most FRC mechanisms, while bushings offer a simple solution for lower-speed or lower-load applications. Choosing the correct support method improves reliability and reduces wear.

Plastic Washers

Plastic washers are low-friction spacing components commonly used in FRC to reduce wear, prevent metal-on-metal contact, and fine-tune alignment in assemblies. West Coast Products (WCP) offers commonly used versions designed for FRC mechanisms.

What They Do

Plastic washers are placed between moving or clamped components to:

- Reduce friction between metal parts
- Prevent scratching or galling of aluminum surfaces
- Act as precise spacing shims
- Improve smoothness in rotating assemblies

Why Teams Use Them

Compared to metal washers, plastic washers:

- Are lighter
- Reduce wear on aluminum and steel parts
- Provide smoother sliding surfaces
- Help eliminate binding in tight assemblies

Common Applications

- Shaft assemblies with gears, sprockets, or pulleys
- Bearing stacks and spacing control
- Pivot joints in arms or linkages
- Low-friction interfaces in sliding mechanisms

Material Properties

Plastic washers (such as those from WCP) typically:

- Have low friction surfaces
- Compress slightly under load for fine adjustment
- Do not corrode or seize like metal-on-metal contact
- Wear faster than metal but are easily replaceable

Best Practices

- Use plastic washers where parts rotate or slide against each other
- Avoid over-compressing them in high-load structural joints
- Combine with proper spacers for precise alignment
- Replace if they become excessively worn or deformed

Key Idea

Plastic washers are used in FRC to reduce friction and wear while improving spacing accuracy in moving assemblies, making mechanisms smoother and more reliable over time.

Standoffs

Standoffs are rigid spacers with threaded ends or through-holes used to separate and support two parallel components at a fixed distance. They are commonly used in FRC to build compact, lightweight assemblies.

What They Do

Standoffs:

- Maintain a fixed distance between plates or components
- Provide structural support without adding bulky brackets
- Allow fasteners to pass through or thread into both ends
- Help keep assemblies rigid and aligned

Common Types

- **Threaded standoffs:** Threads on both ends for bolting into components
- **Through-hole standoffs:** Bolts pass through the entire length
- **Hex standoffs:** Easier to grip with a wrench during installation

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Common Applications

- Electronics mounting plates
- Sensor and controller stacking
- Gearbox and mechanism spacing
- Lightweight structural supports between plates
- Compact multi-layer assemblies

Materials

- Aluminum (most common in FRC)
- Steel (higher strength, heavier)
- Plastic (light-duty or electrical isolation)

Aluminum is preferred for most mechanical applications due to its strength-to-weight ratio.

Best Practices

- Use the correct length to avoid preloading or flexing parts
- Ensure threads are fully engaged on both ends
- Avoid over-tightening, which can strip threads in softer materials
- Combine with washers when needed for surface protection

Key Idea

Standoffs create precise, rigid spacing between components, allowing FRC teams to build compact and organized assemblies while maintaining strength and alignment.

Gussets

Gussets are flat structural plates used to reinforce joints between two or more components, typically at corners or intersections of extrusion in FRC robots.

Purpose

Gussets:

- Strengthen 90° and angled joints
- Reduce flex in structural frames
- Distribute load across multiple fasteners
- Improve rigidity without adding much weight

Custom Gussets

Custom gussets are designed by teams and usually cut from sheet material.

Common materials:

- 5052 aluminum (most common)
- Polycarbonate (for light-duty or flexible use)
- SRPP (for lightweight structural applications)

Characteristics:

- Fully customizable geometry
- Can be optimized for weight and packaging
- Require CAD, machining, or sponsor manufacturing (laser/waterjet/CNC)

Vendor Gussets (WCP and Similar Suppliers)

Vendor gussets are pre-designed and pre-cut parts from suppliers such as West Coast Products.

Characteristics:

- Standardized hole patterns (often 0.5" spacing compatible)
- Fast to integrate into designs
- Consistent strength and manufacturing quality
- Reduce design and fabrication time

Typical features:

- Pre-drilled patterns for 1/2" or 1x1 extrusion
- Multiple angle options (90°, 45°, L-brackets, etc.)
- Lightweight pocketed designs

When to Use Each

- Custom gussets → when optimizing weight, packaging, or unique geometry
- Vendor gussets → when speed, simplicity, and reliability are more important

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Key Idea

Gussets reinforce structural joints in FRC robots. Custom gussets provide maximum design flexibility, while vendor gussets offer fast, reliable, and standardized solutions for common structural connections.