Other KoP Item Resources

Last Updated: 05-19-2017

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Sensing

AMT10 Encoder

What Is It?

An encoder is a sensor and an essential part of the motion control feedback loop. The encoder can be used to provide precise position, rotation and speed feedback information for your robot. It can be used to measure the rate and count of rotations, how fast a shaft on your robot is turning (RPM), as well as how far something connected to the rotary shaft has traveled.

Teams have used these encoders in the past on the wheels of the robot to monitor speed, precisely control wheel movement and to count wheel rotations. Additionally, the encoders have been used on lifting mechanisms to control lifting speed as well as measure the lift height.

The AMT10 encoders, donated by CUI Inc utilize capacitive technology to measure rotary motion. Using the DIP switch on the back of the encoder, these encoders can be quickly and easily set to any one of 16 different resolutions, allowing for maximum versatility within your robot design. Additionally, the encoder has an index pulse (Z), occurring once per rotation. This index pulse is ideally suited for determining motor or shaft RPM.

CUI's AMT10 encoders were made available through *FIRST* Choice and additional AMT parts/ accessories are readily available through Digi-Key Electronics at www.digikey.com.

Photo: CUI, Inc.

How are They in the Kit of Parts?

There were/are a limited number of these encoders available in the *FIRST* Choice part of the Kit of Parts system. For spare or additional encoders, please visit DigiKey.

Datasheet

View technical specifications and drawings for CUI's AMT10 encoder series here.

Installing the Encoder

Need help mounting CUI's AMT encoder? Watch the video below with step-by-step instructions that demonstrate the simplicity of mounting the AMT10 series encoder to a DC motor.

FAQs

Have questions about CUI's AMT encoder series? Check to see if these frequently asked questions about the product and technology might have your answer.

Suggestions?

If you have any helpful tips or tricks in using this item in *FIRST* Robotics Competition applications, please send them to frcparts at firstinspires dot org. Thank you!

navX-Micro Robotics Navigation Sensor

Measuring Motion/Orientation & Improving Auto and Teleop Software

The Kauai Labs navX-Micro Robotics Navigation Sensor provides a way to measure motion and 3D orientation of any object (for instance, your robot chassis or a robotic arm).

navX-Micro can help improve autonomous and tele-operated robot software by adding intelligent features including:

- Driving in a straight line
- Rotating automatically to a specific angle
- Field-oriented drive
- Automatic Balancing
- Motion Detection
- Collision Detection

navX-Micro is both a self-calibrating Inertial Measurement Unit (IMU) and an Attitude/Heading Reference System (AHRS) and it's designed specifically for *FIRST* Robotics Competition and *FIRST* Tech Challenge control systems.

Inertial Measurement Unit (IMU)

navX-Micro is an Inertial Measurement Unit (IMU), and includes 6 sensors which measure inertial motion: 3 accelerometers measuring acceleration (in units of Standard Gravity [g]) and 3 gyroscopes measuring Rotational Speed (in units of degrees per second).

Additionally, through a process called "Motion Processing", navX-Micro combines the 6-axis inertial sensing data to create a measurement of relative 3D orientation.

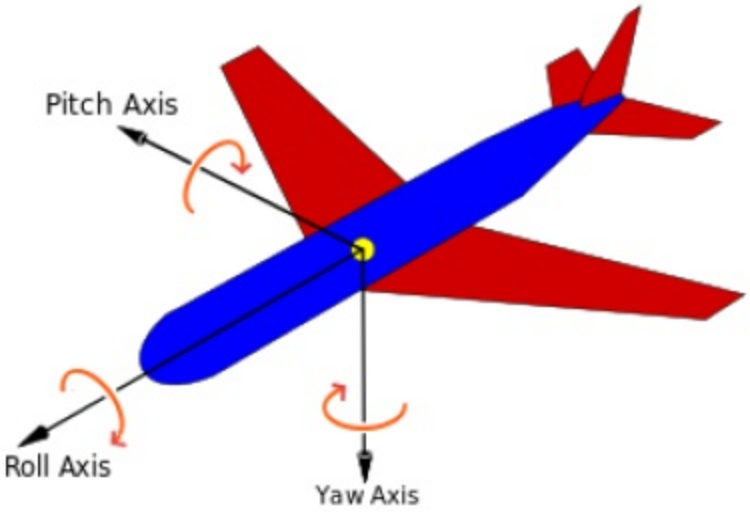


Figure 1 Measuring Orientation with Yaw, Pitch and Roll Angles

IMUs are typically used to measure aircraft orientation, but are also very useful for controlling a robot. IMUs measure rotation of an object around the Z-axis (known as "Yaw"), the X-axis (known as "Pitch") and the Y-axis (known as "Roll").

Pitch and Roll angles are absolute (tied to the earth's surface); 0 degrees means "flat" with respect to the earth.

However, IMU Yaw angles are relative. Unlike "North" on a compass, IMU Yaw angles are not tied to any direction. Therefore, your robot application must decide where 0 degrees is. Usually, *FIRST* Robotics Competition robots treat the "head" of the field (the direction the driver faces) as 0 degrees.

For more information on yaw, pitch, roll and other concepts please visit the navX-Micro Concepts and Terminology page.

Digital Compass & Attitude/Heading Reference System (AHRS)

navX-Micro also includes 3 magnetometer sensors, which measure magnetic fields (in units of Tesla). By measuring Earth's magnetic field, navX-Micro provides a digital compass which is an absolute way to measure the Z ("Yaw") axis.

Other KoP Item Resources

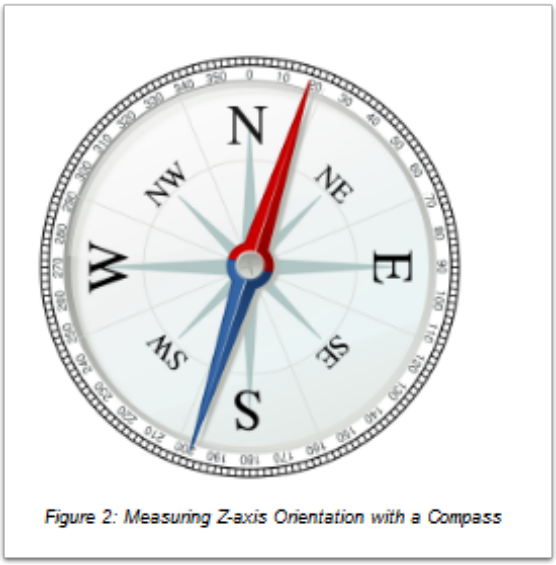


Figure 2: Measuring Z-axis Orientation with a Compass

By fusing the digital compass with the IMU, navX-Micro can create a measurement of absolute 3D orientation.

Note: Earth's magnetic field is actually very weak when compared to the magnetic field generated by a nearby motor; for this reason it can be difficult to get accurate digital compass readings on a FRC robot. For this reason, using the navX-Micro AHRS is an advanced feature best suited for teams who have the time to learn about how to calibrate the navX-Micro digital compass and also how to deal with magnetic disturbances.

roboRIO Hardware Installation

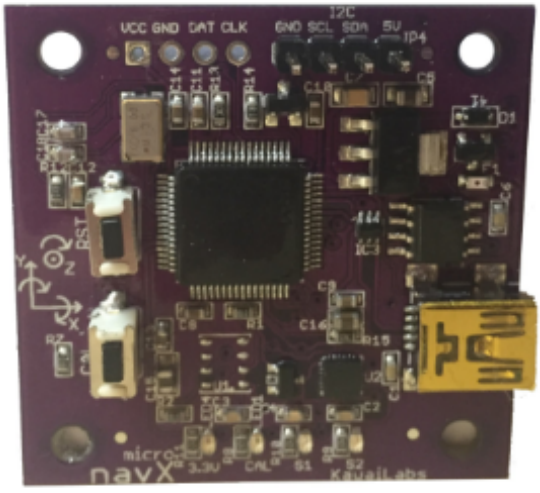


Figure 3: *navX-Micro Circuit Board*

The navX-Micro can be easily connected to a National Instruments roboRIO using either USB or I2C. An optional enclosure to protect navX-Micro can be purchased or printed on your 3D printer.

USB

Figure 4: *USB Mini-B Cable*

The simplest way to connect navX-Micro to a RoboRIO is via USB. This connection requires a USB Mini-B type (Male) to USB A type (Male) cable.

I2C

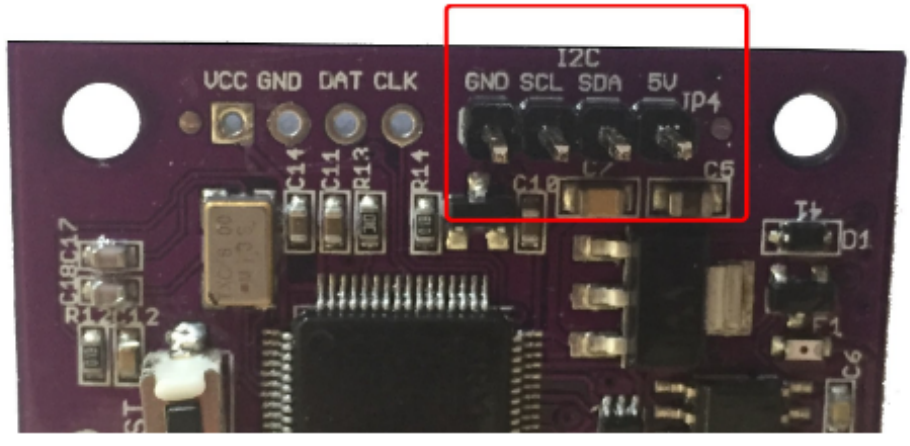


Figure 5: *navX-Micro I2C Connection*

Alternatively, navX-Micro can be connected to a RoboRIO via I2C. This connection requires a 4-wire cable .1” female headers on each end; a 4-wire cable is included with each navX-Micro.

Enclosure

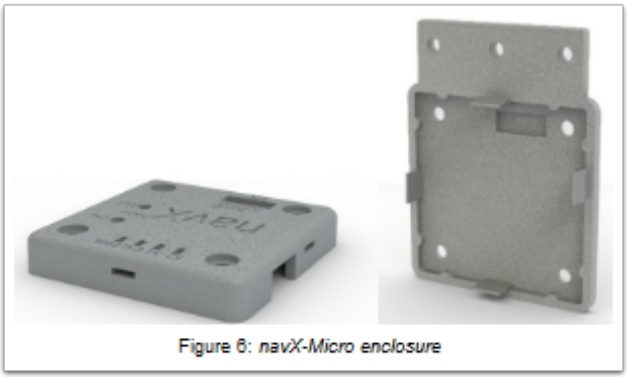


Figure 6: *navX-Micro enclosure*

An enclosure is recommended to protect the navX-Micro circuit board from excessive handling, “swarf”, electrostatic discharge (ESD) and other elements that can potentially damage navX-Micro.

Visit the navX-Micro Enclosure page to download a 3D-printable design file (or purchase an enclosure).

roboRIO Software Installation

navX-Micro is compatible with the navX-MXP Robotics Navigation Sensor, so if you already use navX-MXP on your robot, there will be no change required to your software to use navX-Micro. You can also use navX-Micro side-by-side with navX-MXP. A common reason for doing this is to use navX-MXP for Robot Drivetrain orientation, and navX-Micro for orientation information for a camera that rotates, or for a robotic arm or other appendage that moves up and down to measure tilt angle.

To access navX-Micro from your RoboRIO robot application, install the navX-MXP Libraries for roboRIO.

FIRST Tech Challenge: Android Software Installation

navX-Micro is also compatible with the FIRST Tech Challenge Android-based control system. If you wish to use navX-Micro with a FIRST Tech Challenge robot, install the navX-Micro Libraries for FTC Android.

Using navX-Micro

Many example programs are available for navX-Micro in C++, Java and LabVIEW. Visit the navX-MXP Examples page for a description of each example program and details on how to use it with your chosen programming language.

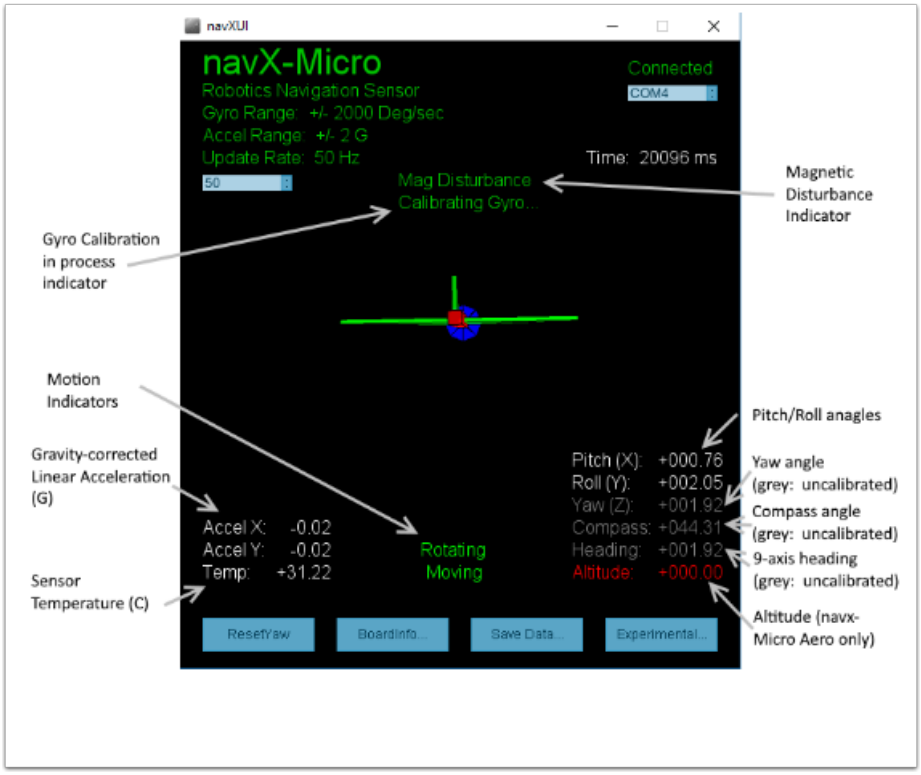
Video Processing Latency Correction

Using the Kauai Labs open source Sensor Fusion Framework (SF2) you can also use navX-Micro to correct for video processing latency. Sample code for this feature is available on the SF2 Examples page.

IMU Calibration

navX-Micro includes both factory-calibration as well as startup calibration and continuous re-calibration. Although navX-Micro self-calibration is very easy to use, learning how navX-Micro self-calibration works is very important to help ensure the best results.

Learning More



Other KoP Item Resources

To learn more about how navX-Micro works, you can use navXUI, which runs on a Windows PC connected via USB to the navX-Micro and demonstrates all of the navX-Micro features. navXUI also provides a way to save navX-Micro data to a file so you can analyze it. navXUI can even run simultaneously with your roboRIO robot application

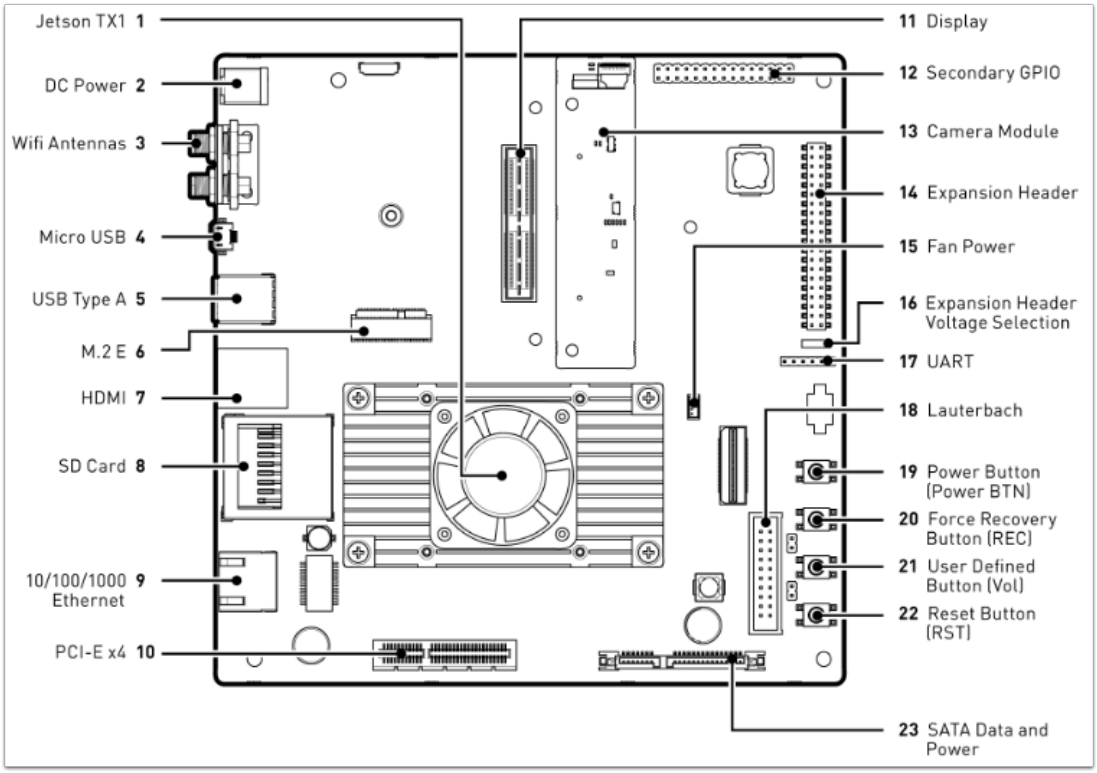
Getting Help

If you have trouble with navX-Micro, please visit the navX-Micro support page; you can join the navX-Micro newsgroup or contact technical support for help. If your question is more general about the FIRST RObotics Competition control system, please check out the Control System section of the *FIRST* Forums.

Jetson TX1 Developer Kit

Here are some resources for using the Jetson TX1 for *FIRST* Robotics Competition.

Jetson TX1 Developer Kit Line Art



Instructional Videos

Getting Started

1. Unbox your Jetson and get setup (see video below).
2. Join our Embedded Developer Program and download JetPack to get the latest software and tools.

Unboxing the NVIDIA Jetson TX1 Developer Kit

Get an inside view of the new NVIDIA Jetson TX1 DevKit. It is the newest member of the Jetson platform., with even more performance and power efficiency than its predecessor, the Jetson TK1.

Embedded Deep Learning with Jetson

Watch this free webinar to get started developing applications with advanced AI and computer vision using NVIDIA's deep learning tools, including TensorRT and DIGITS.

OpenCV on NVIDIA Jetson: Episode 1: CV Mat Container

Learn to work with mat, OpenCV's primary container. You'll learn memory allocation for a basic image matrix, then test a CUDA image copy with sample grayscale and color images.

Double Your Deep Learning Performance with JetPack 2.3

Learn how to double your deep learning performance with JetPack 2.3. This all-in-one package bundles and installs all system software, tools, optimized libraries and APIs, along with providing examples so developers can quickly get up and running with their innovative designs. Key features include TensorRT, cuDNN 5.1, CUDA 8 and multimedia API.

For more video tutorials, visit us here.

Documentation

Note: Some downloads require NVIDIA Embedded Developer Program membership. Not a member? Join the Embedded Developer Program for free here.

- Jetson TX1 Developer Kit Product Sheet PDF
- Jetson TX1 Developer Kit 3D CAD Step Model
- Multimedia Guide

- Jetson TX1 Thermal Design Guide

NVIDIA Jetson Community

Have questions or issues about your Jetson TX1 Developer Kit?

Visit our Jetson TX1 Developer Forum

1. If you aren't already a member, join now. * Be sure to include your FRC team number.
2. Click on "Create Topic"
3. Make sure to explain that you are from FIRST Robotics. A community member or seasoned NVIDIA person can help with your issues.

GitHub Resource

Explore code samples, tutorials and more on our Getting Started with Deep Learning GitHub Repo.

More Information

For more information, visit:

- NVIDIA Jetson and FIRST Robotics page
- Jetson Wiki

Pneumatics

FESTO Solenoid Valve

Basic Valve Data

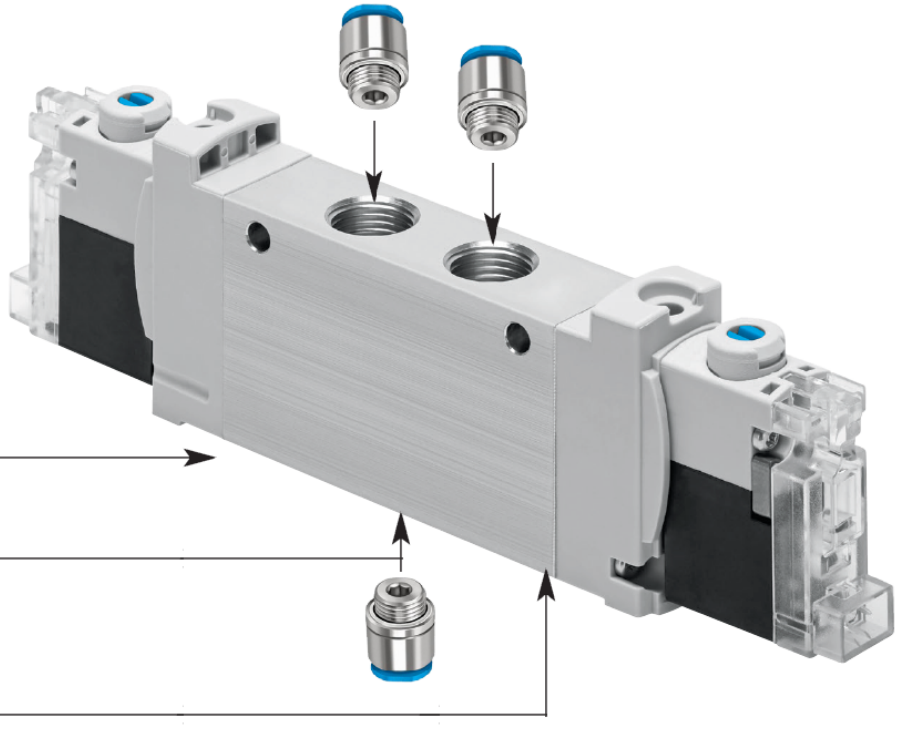
The VUVG-LK10-B52-T-M7-1H2L-S is a 5/2 dual solenoid piloted valve. The valve has M7 ports and is operated with a 24V DC signal. The maximum air flow is 13.4 cfm. The weight of the valve including the fittings and cables is 0.2 lbs.

Typical Pneumatic Connection
The pneumatic connection for typical cylinder would be as follows:

Port 4 - To cylinder back end (insert fitting here)
Port 2 - To cylinder front end (insert fitting here)

Port 5 - Exhaust from port 4 (to atmosphere)
Port 1 - Pressure supply (insert fitting here)

Port 3 - Exhaust from port 2 (to atmosphere)



Electrical Connection

Attach one end of each cable to a +24V DC signal and the other to a 0V DC signal.

When the valve is switched on the LED will turn on.

Wiring

- Red: +24V DC
- Black: 0V DC

Operation

To extend the cylinder, activate coil 14 for at least 30 mSec. To retract cylinder activate coil 12 for at least 20 mSec. Following the activation time the coil can be deactivated without switching positions. Verify that both coils are not activated simultaneously. A minimum of 25 psi should be supplied Port 1.

Manual Override

To operate the valve without electrical current depress the blue button for a temporary time or depress and turn to maintain the activation. The valve will not return to original state unless it receives an electrical signal at the coil or manual override operation.

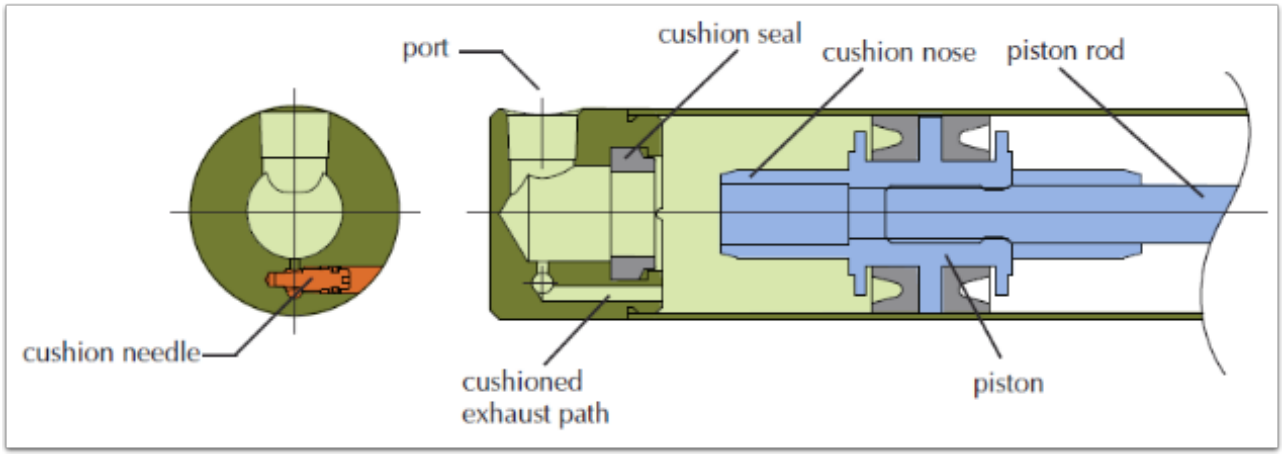
Position & Speed Control Options for Pneumatic Cylinders (from Clippard)

Pneumatic cylinders' speed and power advantages make this technology a valuable player in many applications. Where they can fall short is the controllability of position and variable speeds. Electronic drives and motors have the advantage of better controllability, but usually come with more complexity and a high price.

Here are a few ways to better control the position and speed(s) of your pneumatic actuator.

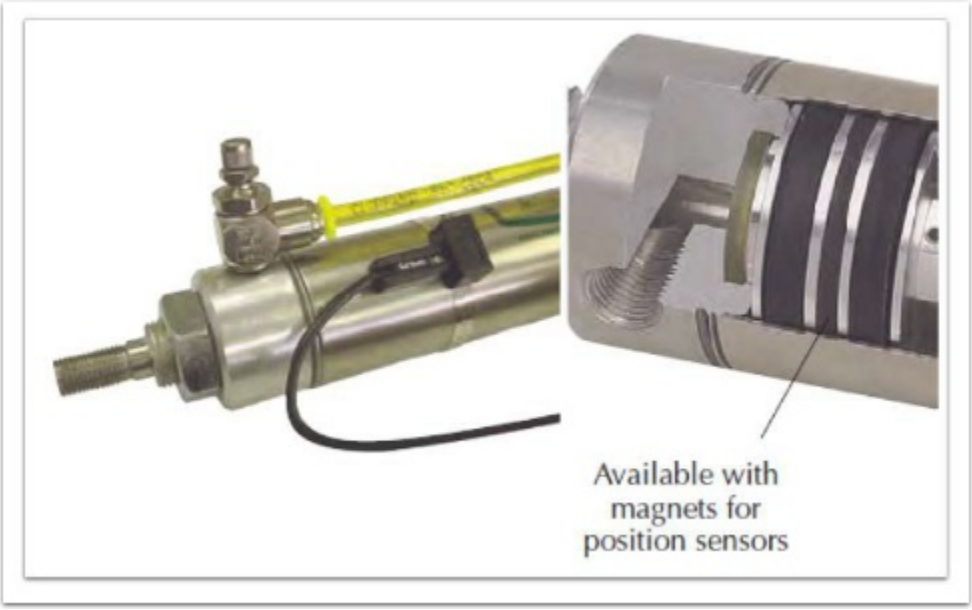
Cushion Cylinders

This option allows the cylinder to slow down at the end of stroke. It is valuable for reducing vibration and noise common with sudden metal to metal stops.



Magnetic Cylinder Pistons

Magnetic Cylinder pistons offer the ability to detect stroke position with reed or GMR switches. Knowing the position of the cylinder can allow the users to switch exhaust flow paths or pressure to vary speed or direction.



Flow Control Valves

Flow control and needle valves allow adjustment of the speed of a cylinder.

Quick Exhaust Valves

The primary function of a quick exhaust vale is to increase cylinder speed. This also enables the use of smaller directional valves and longer control lines.

Pilot Operated Check Valves

These valves provide control functions with cylinders and with other control circuits.

Software

IBM Bluemix

IBM's Bluemix enables FRC teams to explore ways to develop applications. Java, Web, Mobile, Node Red, IoT, Cognitive computing, and other technologies are available through the IBM Bluemix platform for exploration. Check out the "Library" page under the resources tab on blue mix and get started.

The code provided to FRC teams (in each team's registration account) allows 12-month access to IBM's Bluemix cloud computing platform. This allows you to explore and create applications using the Bluemix platform.

How to Get Started

Create a Bluemix account.

- Go to the IBM ID creation site to create an account (either click the link or use the QR code below).

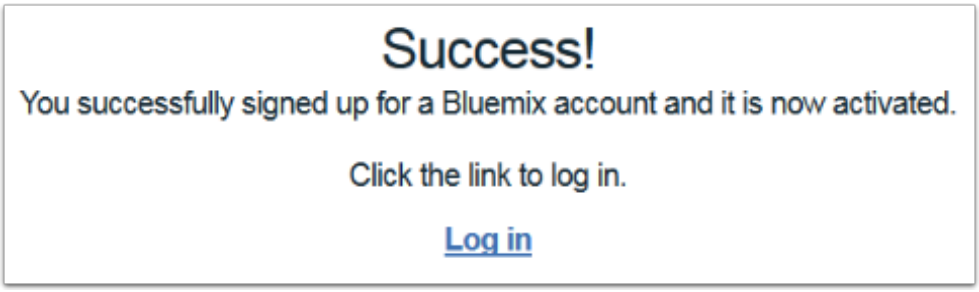
- This initial account will be valid for 30 days and allow access for 2GB of runtime and memory to run apps. The code generated in the following steps extends your account for an additional 365 days.

Confirm your Bluemix account.

- Check your email for a validation link from "The Bluemix Team."
- Click on the "Confirm Account" button.

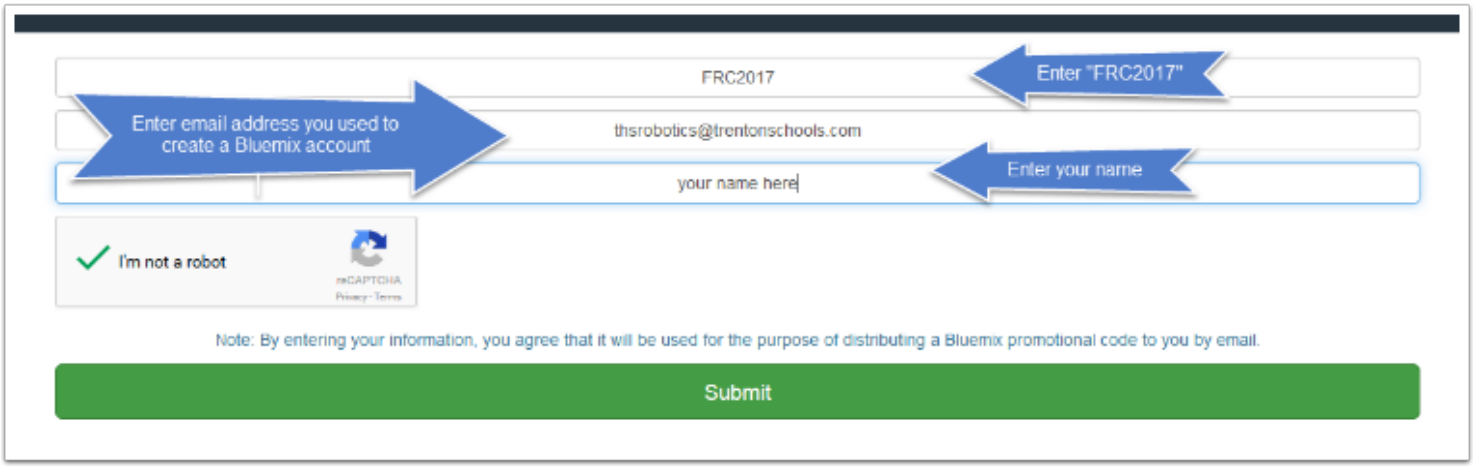
Verify account was created.

- You should see the message below in your browser if your account was created successfully.

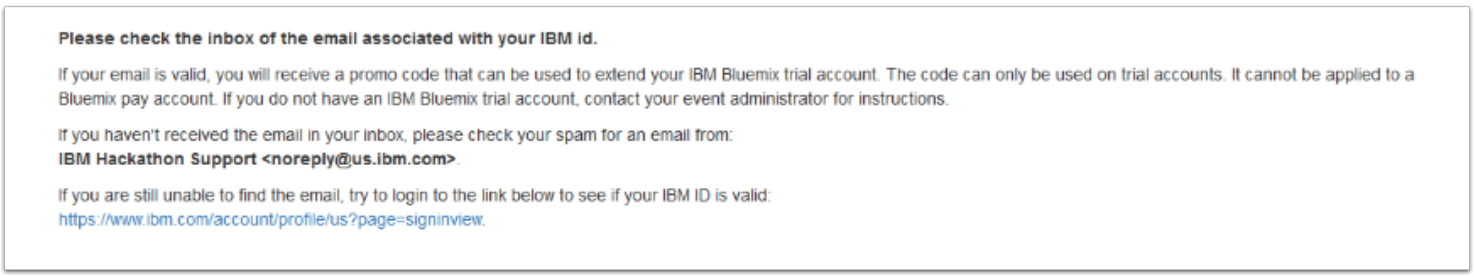


Generate an extension code.

- Go to this website and generate a code to extend your account to 12 months.
  - Event Name = FRC2017
  - IBM ID = The email address you used to create your Bluemix account
  - Team name = Your name, Team Number or the name of your FRC team.



- You should be directed to a page with the following message.



Obtain your specific code.

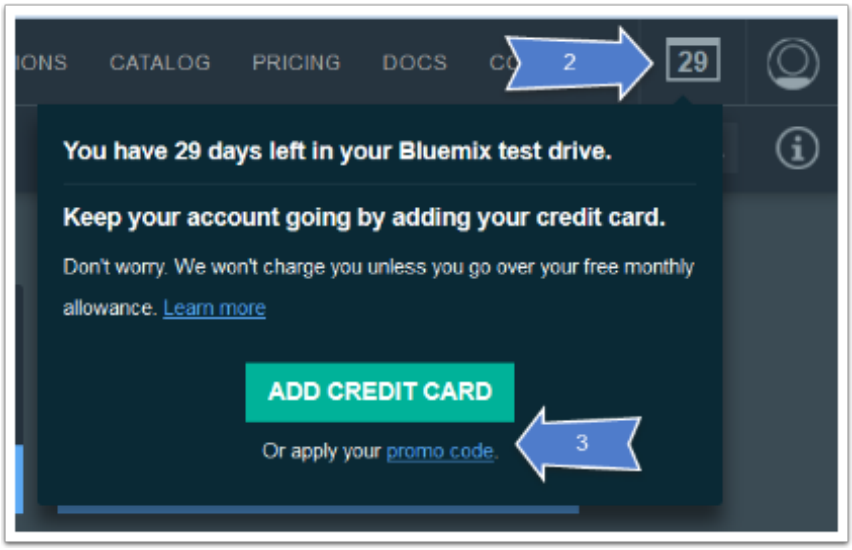
- Open your email and find the promocode in the email sent to you from *IBM Hackathon Support.*

Log in to Bluemix.

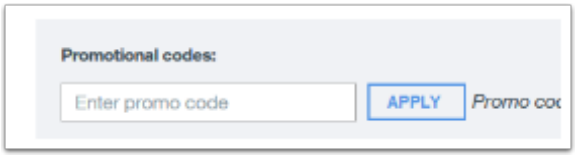
- Log into your new Bluemix account here : https://console.ng.bluemix.net/

Apply code.

- Select the box in the upper right corner that has a number. This number represents the number of days left in your free trial period. We are going to extend your account for an additional 365 days It is labeled with the blue #2 arrow below. This will open another window for you to click on “promo code.”



- Click on “promo code” (arrow #3)
- Enter the code that was included in the email sent to you. (see screen shots below)



- Click "apply." This will extend your trial period for an additional 365 days

Learn

- Bluemix landing page: https://console.ng.bluemix.net/#/store

Other KoP Item Resources

- IBM Bluemix youtube playlist: https://www.youtube.com/playlist?list=PL78F74113FAACEA34
- Bluemix Docs for all the Bluemix Services : https://console.ng.bluemix.net/docs/
- IBM Developerworks recipes : https://developer.ibm.com/recipes/
- Student Hackaton Starter kit: https://developer.ibm.com/students/hackathon-starter-kit/
- Boiler Plates: https://console.ng.bluemix.net/catalog/?category=blueprints

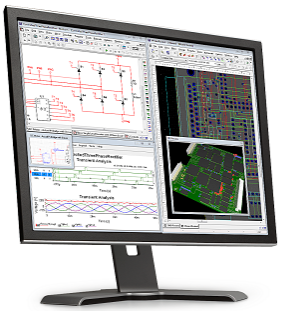
Share

Make something cool, and let us know by tweeting #IBMFIRST

Multisim, Ultiboard, and Statechart Module

All FRC teams can use the FRC LabVIEW serial number included in their Kick Off Kit to activate Multisim, Ultiboard, and Statechart Module. These are all great tools that can help you during build season. See below to learn more and download.

Use Multisim and Ultiboard to Prototype, Test, and Build Circuit Boards



Multisim is an industry-standard, best-in-class SPICE simulation environment. It is the cornerstone of the NI circuits teaching solution to build expertise through practical application in designing, prototyping, and testing electrical circuits. Learn more about Multisim here.

Ultiboard enables efficient layout and routing of PCB designs. Integration with NI Multisim allows seamless transfer of schematics to layout. Learn more about Ultiboard here.

More technical resources for Multisim and Ultiboard.

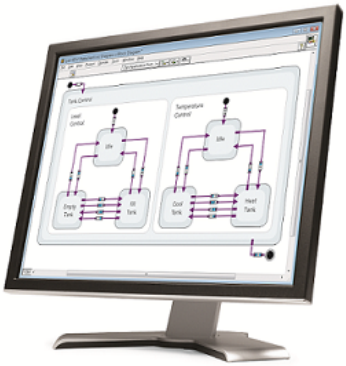
Expansion Board Developer Guide for roboRIO

Download Multisim & Ultiboard

Note: If you'd like to use these tools before FRC kick off, you can download from the link above and use it for a 45 day trial.

Use LabVIEW Statechart Module to Simplify Code with High Level Abstraction

Other KoP Item Resources



Statechart Module is a LabVIEW add-on that provides a high level of abstraction for designing applications using states, transitions, and events. This helps to keep code organized, scalable, well documented, and easy to read. You can deploy these applications to roboRIO. Learn more about State Chart Module here.

Download
LabVIEW Statechart Module

Motors

Bosch Seat Motor

Specification Sheet

2016-12-21_spec_sheet_-_Bosch_FRC_motor_6_004_.pdf

CAD File

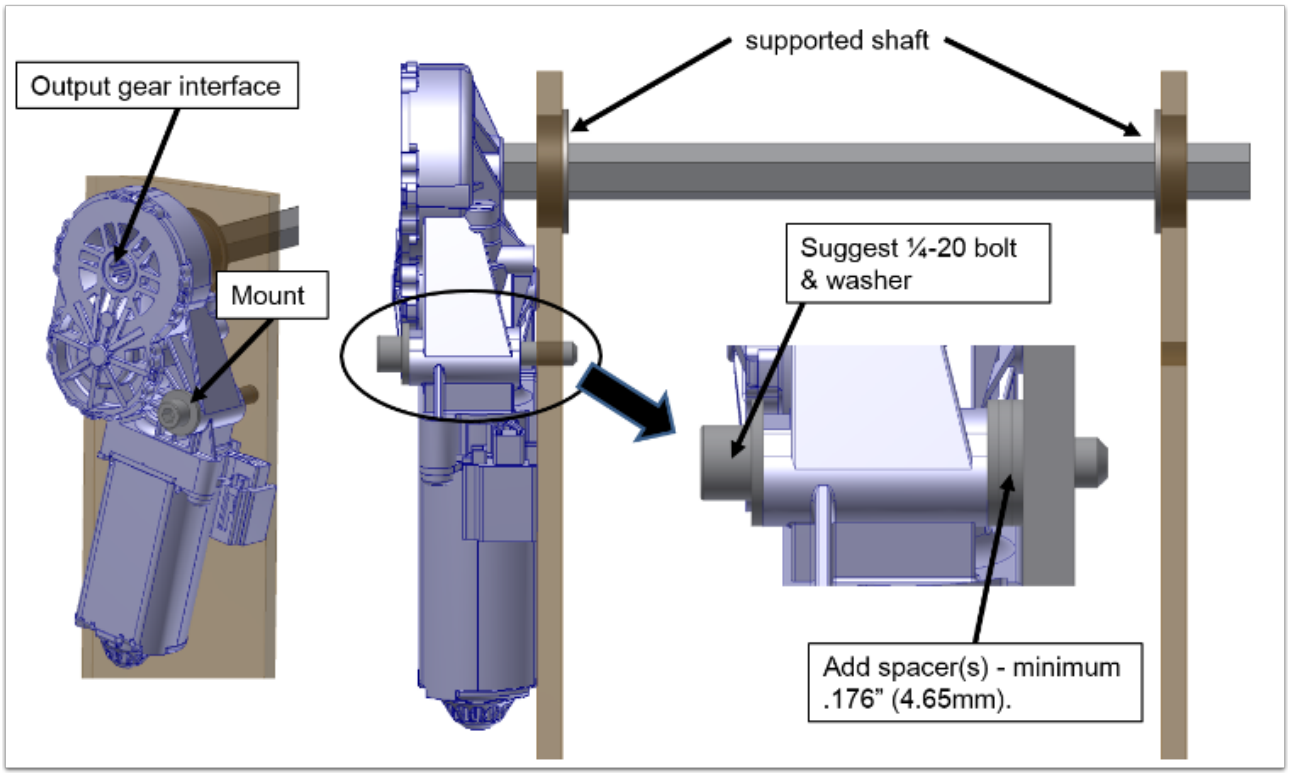
FRC_Bosch_motor_V2_6_004_RA3_194-06.zip

Motor Mounting & Shaft Support: Suggested

Motor relies on two solid mounting points:

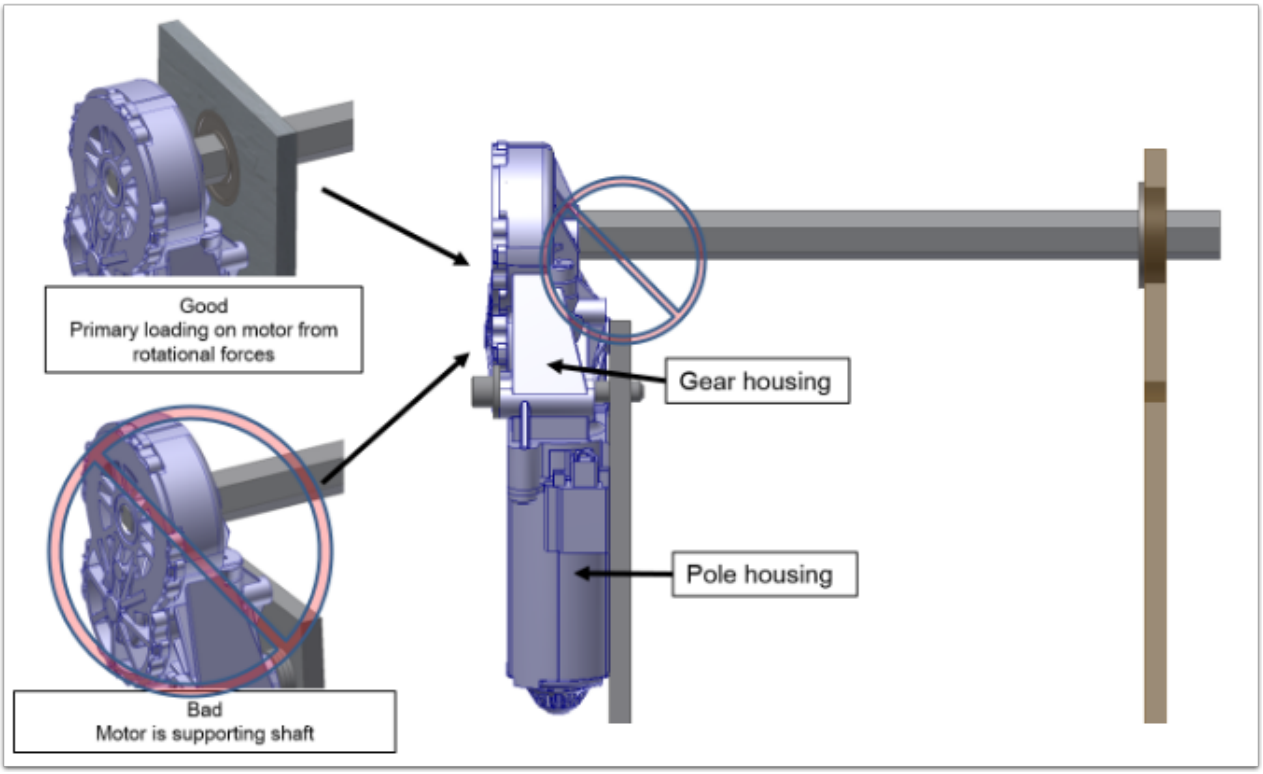
1. output gear interface and
2. oval mounting hole.

Make sure shaft is fully supported and does not rely on motor as support. A ¼" bolt fits very well in the mount slot but make sure you use a washer to help distribute the bolt clamping load.



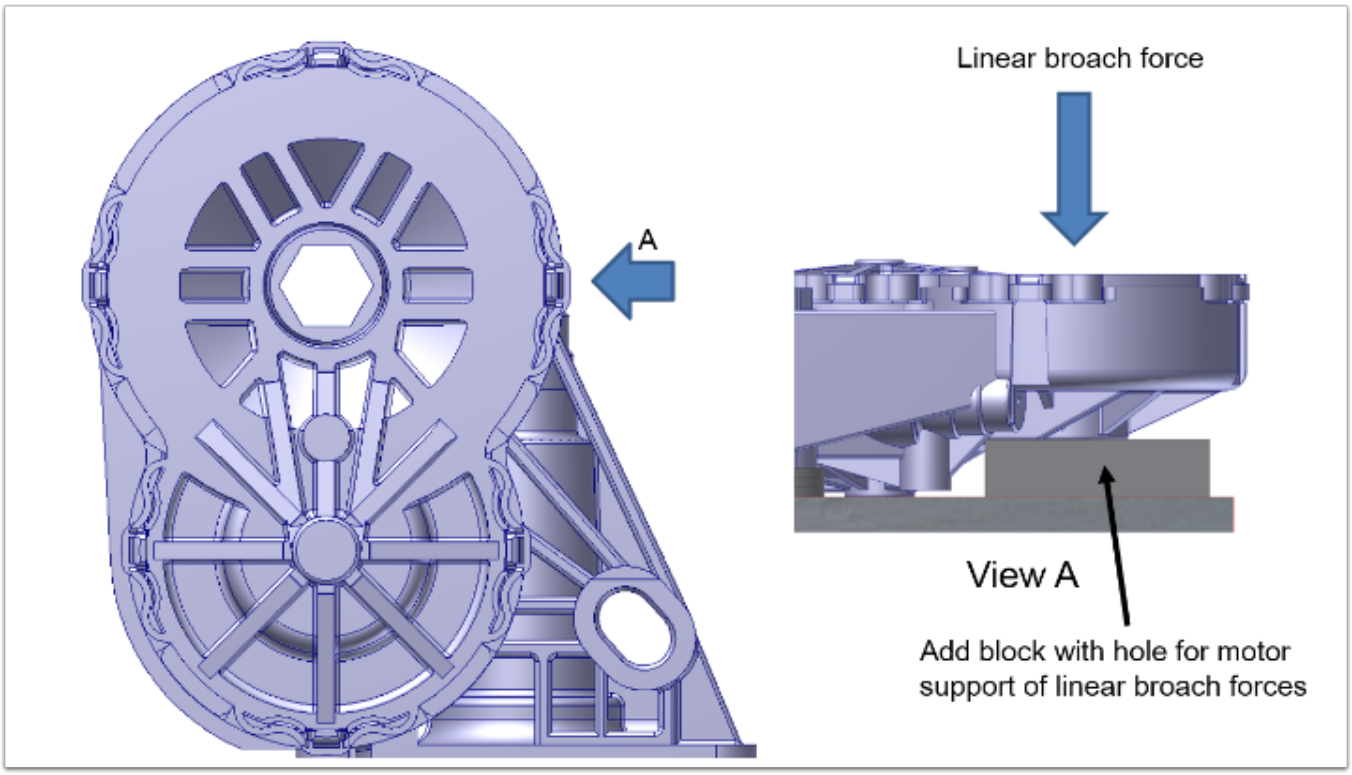
Motor Mounting & Shaft Support: Things to Avoid

Avoid mounting in any other way such as clamping or bracing the pole housing/gear housing, etc. Also, minimize multidirectional loading on the motor by fully supporting the shaft so external loads on the motor are primarily in the rotational direction.



Subtractive Manufacturing Option: Hex Broach

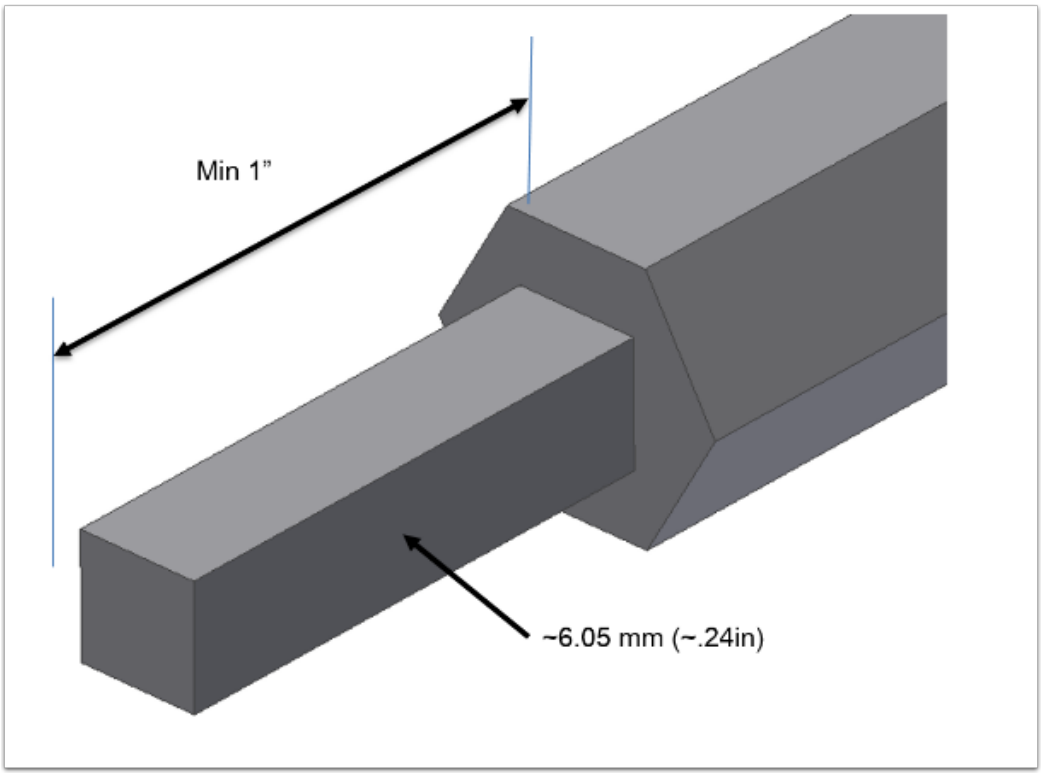
Use a linear broach to cut out a 3/8” hex. Make sure gear is supported during this operation. Do not remove gear. Cover is not meant to be removed and will most likely damage the cover latches which affects motor function and durability.



Subtractive Manufacturing Option: Mill Hex Shaft

Mill square profile from ½" or 3/8" hex shaft stock. Suggest a slight interference fit so there is a solid connection and no gap. Also best to keep at least 1" in length for max interface with plastic motor output gear.

Note: This solution has been known to fail using an aluminum shaft; suggest either for very low torque applications or utilize a steel shaft.



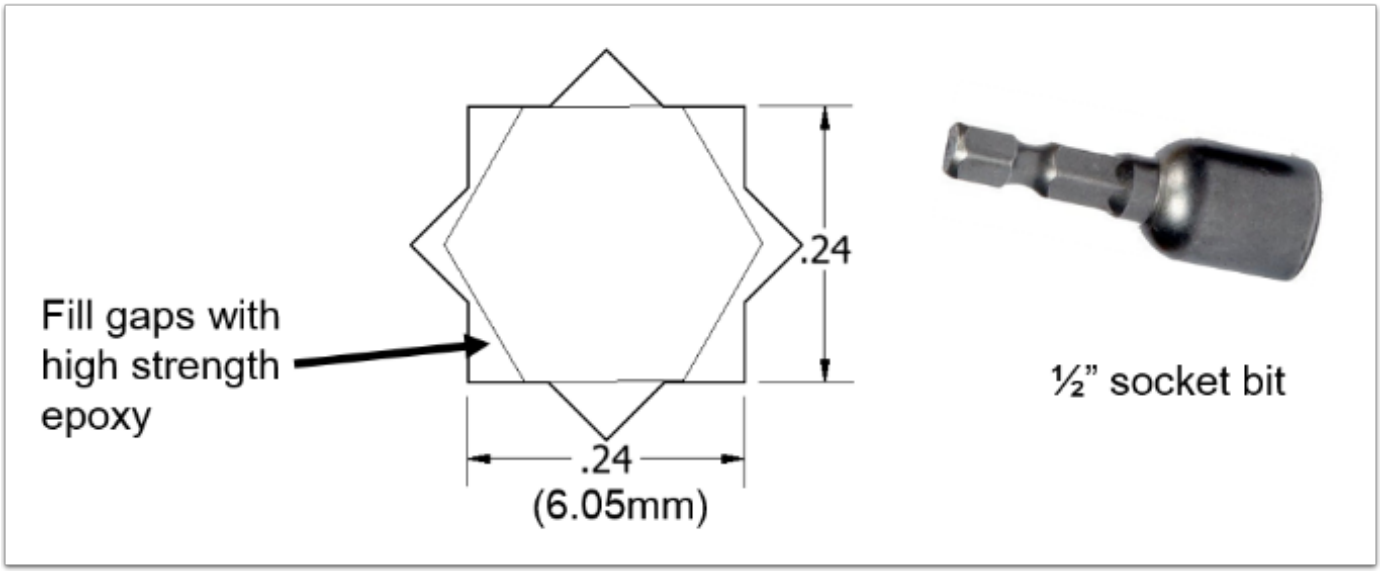
Off-the-Shelf Options for Output Interface

Get Creative. The star output is basically two squares rotated 45°. Here’s a few suggested starting options that you can find at most home improvement stores. Keep in mind these are only suggestions and have not been confirmed yet for durability.

¼” standard square fittings in a toolbox are a tad too big, but with some grinding could be made to fit. With a bit of searching you may be able to find a part with a closer fit.

Utilize a ½” socket bit. It interfaces nicely with ½” hex stock or a 5/16” bolt head/nut. The hex portion will fit snugly in the star interface but will not support the required max torque. Adding JB

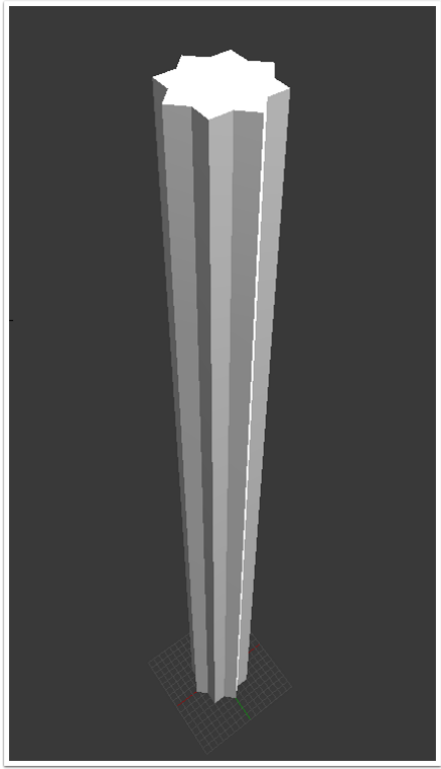
weld or other strong epoxy in this gap is an option. This has not been validated so be sure to leave time to test for durability.



Output Options: 3D Printable Options

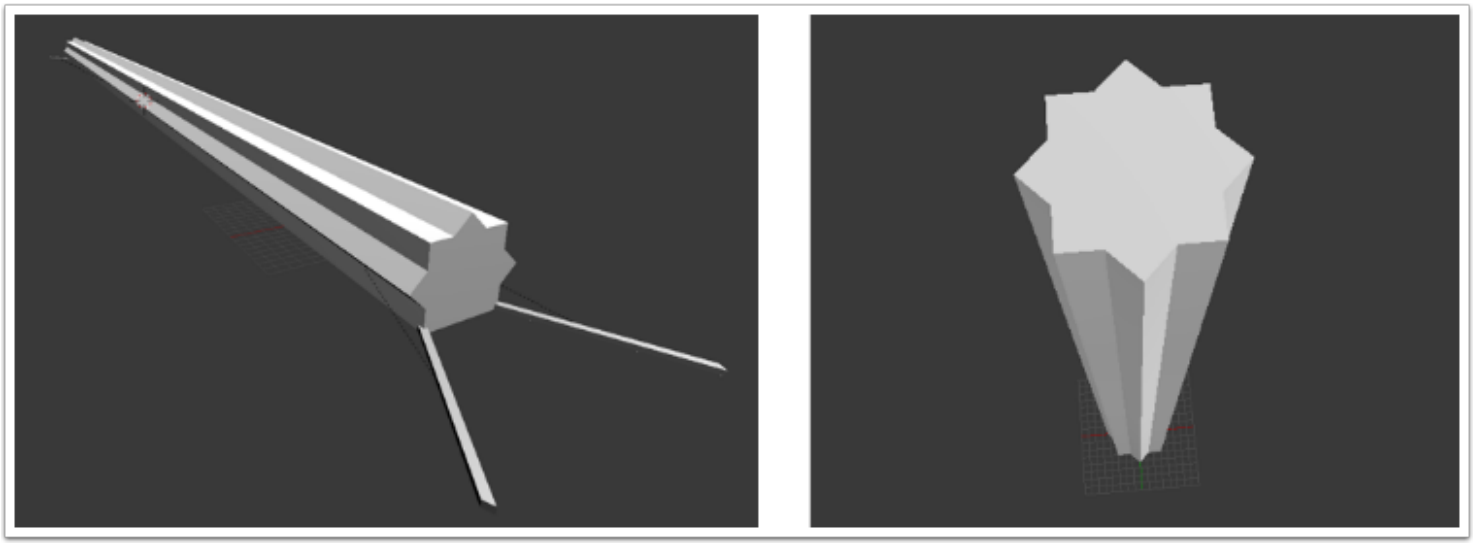
- Teams with access to a 3D printer may also consider printing a custom interface to meet their specific needs.
- Depending on the choice of material, however, this interface may not be as strong as some of the previous options.
- For fused-filament printers, additional care is required to ensure that the final product remains strong without sacrificing dimensional accuracy.
- This shaft can be recreated by drawing two overlapping 6mm squares, and extruding the result.

Other KoP Item Resources

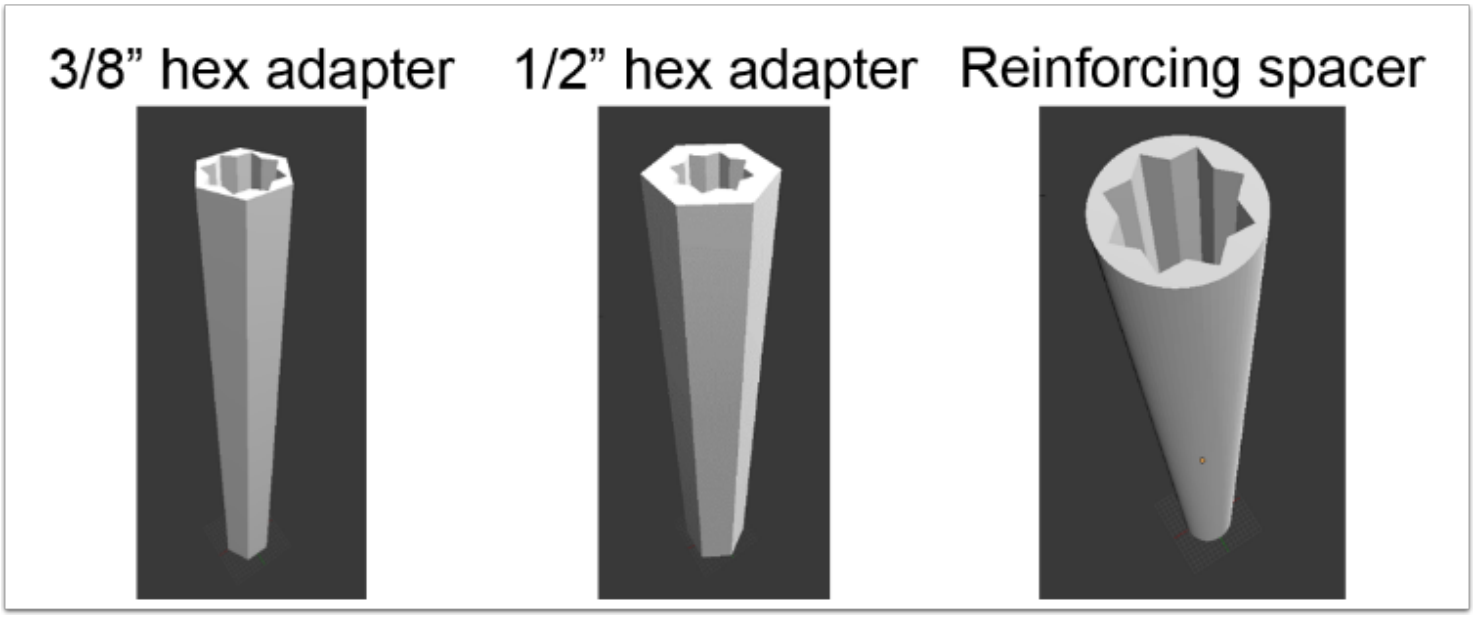


- For printing horizontally, consider removing one of the star teeth; this will allow the spline to lay flat.
- Also consider adding “whiskers” or “mouse ears” where appropriate; these features improve adhesion to the print bed, which helps to minimize warping.
- For printing vertically, remember to use thicker-than-usual print layers; this helps to improve adhesion between layers of the print.
- We recommend printing the spline longer than necessary; any excess length is easy to cut off later.

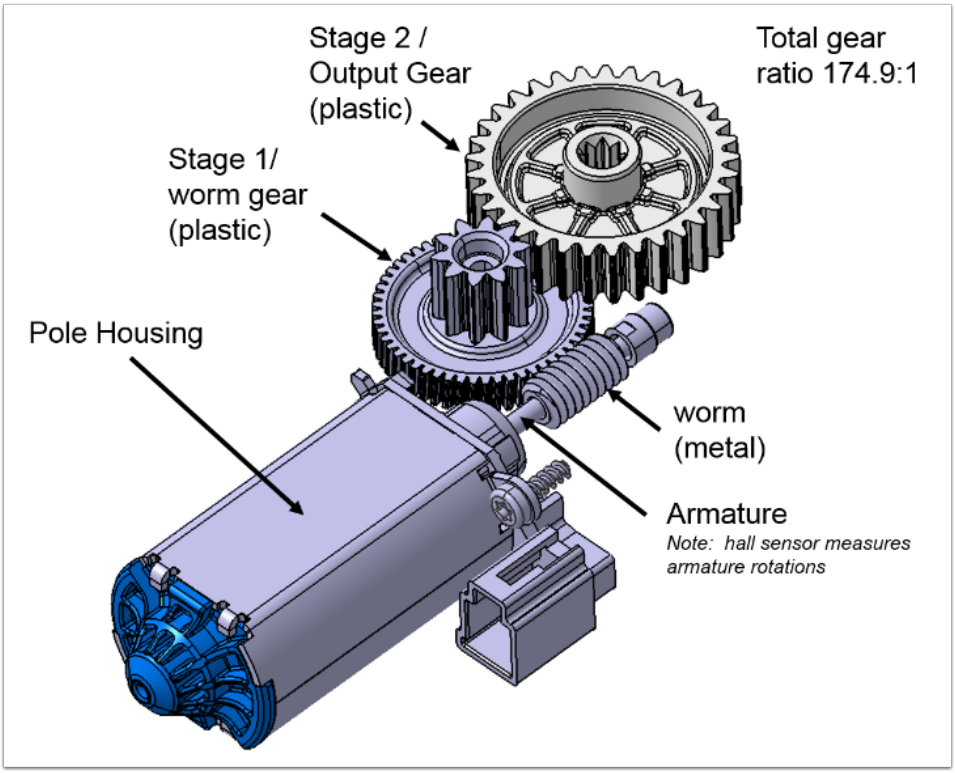
Other KoP Item Resources



- Once you have a functional spline shaft, it's easy to convert that 8-pointed spline into a standard FRC drive shaft.
- These adapters may be recreated by scaling up the original spline profile from 6mm squares to 6.05mm (fused-filament printers may require additional clearance).



Detail: Gear Housing & Gear Cover Removed



Design Consideration Summary

- Make sure there is a tight fit between motor output gear and the interface to what is being driven. Slight interference is preferred.
- Motor has a built in thermal switch if it is overloaded for an extended time. This will reset automatically once internal temperature returns to acceptable limits.
- Avoid multi directional forces on output gear (ie side loading from unsupported shaft). Gears are very robust if forces are primarily in rotational direction.
- Expect there will be a few degrees or more of inaccuracy in sensing angular position due to free play with motor internal gears, plastic creep, and tolerances in the mechanism you are driving.
- Since this is a slow moving motor it is an option is to use bushings instead of bearings for shaft support of the mechanism that is being driven.

Wiring & Connections

APP Powerpole Connectors

PP14 to PP45 (the "small" ones)

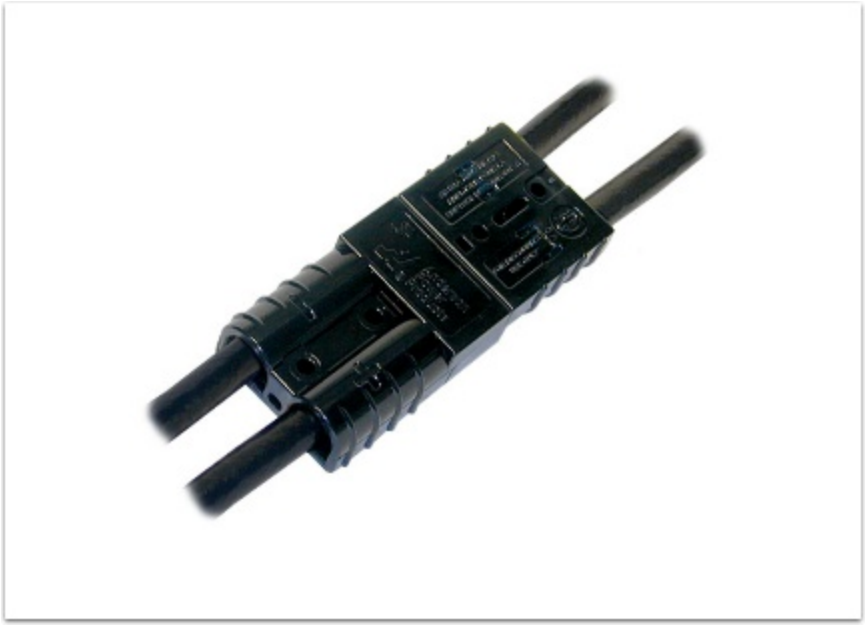
Specification Sheet

ds-pp1545-1.pdf

Assembly Instructions

Powerpole_Assembly_Instructions.pdf

SB50 (the "large" ones)



Specification Sheet

ds-sb50.pdf

Assembly Instructions

SB_Assembly_Instructions.pdf

Connector Crimping & Preventative Maintenance

CRIMPING___MAINTENANCE.pdf

How to Mate a Flat Wiping Contact

See Anderson Power Products' video on how to make a flat wiping contact here.

Mechanical Guides

Linear Motion 101: Guide Wheels and Track

So you've entered the *FIRST*® Robotics Competition, congrats!! But now the real work begins, but don't worry we are here to help. One of the biggest challenges that you may be facing is designing. Designing your robot and laying out the processes and tools that you will need to build it.

Linear motion is likely something you've heard of, but is also likely something you aren't too familiar with. To make a long story short, linear motion and its components are what makes machines move. Whether your robot needs to lift something off the ground or move something from one place to another it all falls into the realm of linear motion.

Basic Components of Linear Motion

Think of components as the ingredients of linear motion!

- Guide Wheel
- Track

This guide is focused on the basics of MadeWell guide wheels and DualVee track so you know everything you need to in order to start building your robot.

Questions and Answers: MadeWell Radial Guide Wheel Edition

So, what are MadeWell Radial Wheels?

Quick answer, they are ball bearing guide wheels that can make just about anything move in just about any environment, quickly.

Longer answer, they are industrial, precision ground guide wheels with 90° vee running surfaces that were designed for linear motion applications. They are made of high quality carbon or stainless steel and were engineered to move heavy loads at high speeds (up to 5.5m/s or about 12mph).

They can move stuff, so what? Why should I care?

Touché! Guide wheels are made to move stuff, but not all guide wheels are created equal. MadeWell wheels are special. Not a unicorn eating rainbow ice cream kind of special, but the kind of special where you can use them in your robot and the tools you use to make your robot.

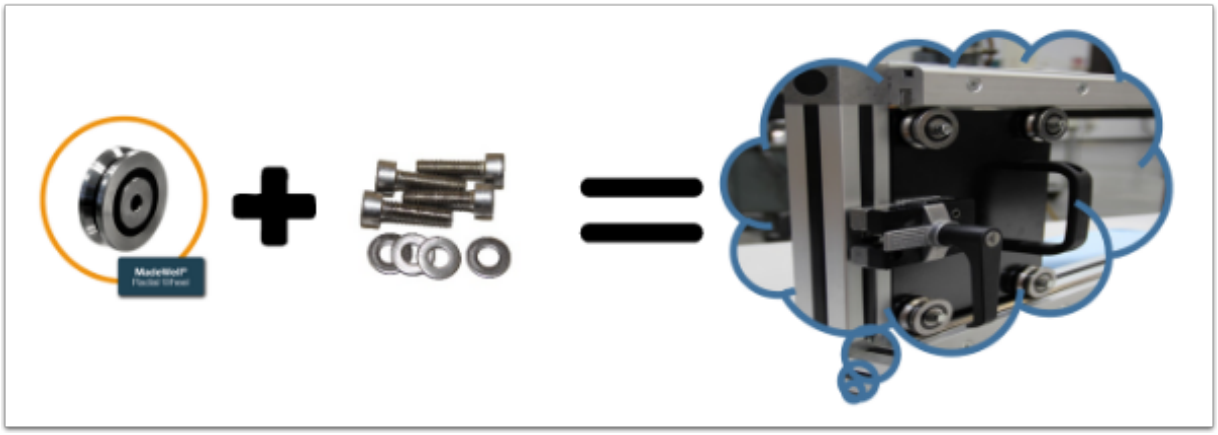
Need some ideas on where we recommend you throw your MadeWell wheels?

Other KoP Item Resources

- Robot work stand
- Robot sliding electronics board
- Workshop
- **YOUR ROBOT**
- Moving element for sliding robot into loading crate for transport
- A bearing guide for cables or wires

Is it hard to attach these MadeWell wheels? I have kind of limited resources and time.

You are in luck my friend, MadeWell wheels are super easy to attach to things. All you need is a simple screw, a washer and a MadeWell wheel.



You said I need a simple screw to mount the wheels……. can you be a little more specific?

Of course!

Other KoP Item Resources

RECOMMENDED MOUNTING HARDWARE			
WHEEL SIZE	STOCK CODE	SCREWS	MOUNTING SPACERS
1	W1RX W1RSSX	M5	M5 DIN 433
2	W2RX W2RSSX	1/4"	SAE type A 1/4"
3	W3RX W3RSSX	M8 or 5/16"	M8 DIN 125 SAE type A 5/16"

Okay, so what are the technical specs for MadeWell wheels?

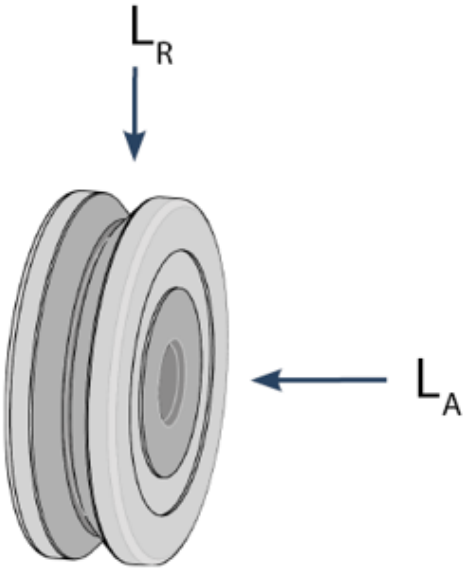
Great question, how do you build anything without measurements, right?

TECHNICAL SPECIFICATIONS									
SIZE	STOCK CODE	MATERIAL	OUTSIDE DIAMTER (D)	WHEEL WIDTH (W)	BORE DIAMETER (B)	VEE RADIUS INSIDE (VRI)	INNER RADIUS (C)	OUTER RADIUS (E)	WEIGHT (g)
1	W1RX	AISI 52100 Carbon steel	Ø0.771 [Ø19.58]	0.274 [6.96]	Ø 0.201 +/-.002 [Ø5.11+/-0.51]	.313 [7.94]	0.012 [0.30]	0.012 [0.30]	10
	W1RSSX	AISI 440C Stainless steel							
2	W2RX	AISI 52100 Carbon steel	Ø1.210 [Ø30.73]	0.383 [9.73]	Ø 0.251 +/- .002 [Ø6.38+/-0.51]	.500 [25.4]	0.020 [0.51]	0.024 [0.61]	38
	W2RSSX	AISI 440C Stainless steel							
3	W3RX	AISI 52100 Carbon steel	Ø1.803 [Ø45.80]	0.551 [14.00]	Ø 0.316 +/- .002 [Ø8.026 +/-0.51]	.750 [19.05]	0.024 [0.61]	0.024 [0.61]	122
	W3RSSX	AISI 440C Stainless steel							

* Values are in inches [millimeters]

What about load capacities?

LOAD RATINGS				
WHEEL SIZE	WORKING RADIAL LOAD CAPACITY L_R		WORKING AXIAL LOAD CAPACITY L_A	
	N	lbf	N	lbf
1	670	151	138	31
2	1500	337	320	72
3	3700	832	800	180



Well, I really like the wheels. Now what?

You can get MadeWell wheels through the Bishop Wisecarver website using your *FIRST* voucher. MadeWell wheels come in either carbon steel or stainless steel and must be purchased in sets of four. Click here to navigate to the website!

Okay, so now that you have a better understanding of how you can use guide wheels in your build let's get you better acquainted with the 1,2, 3s of DualVee track.

Questions and Answers: DualVee Track Edition

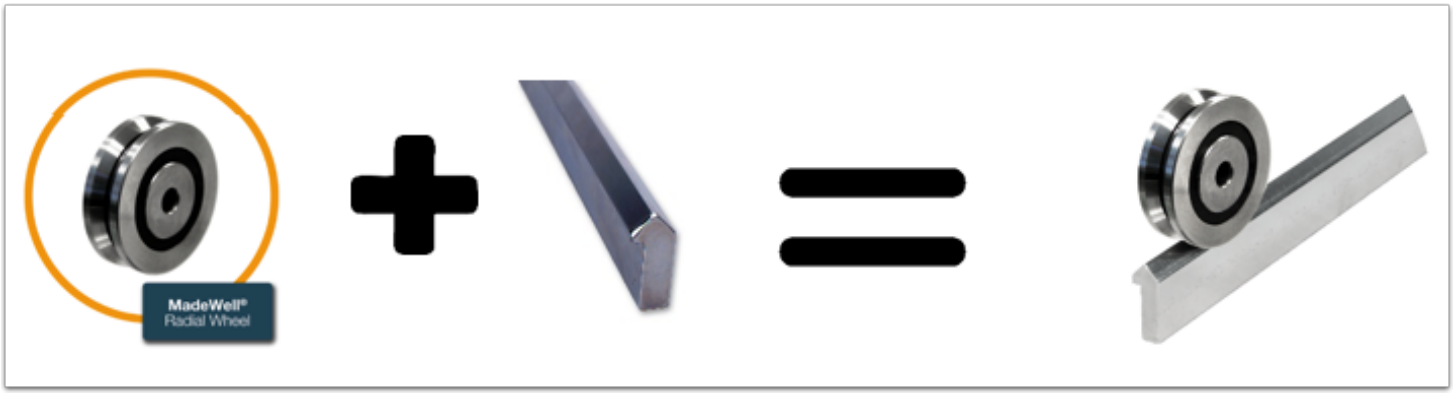
What is DualVee track made of?

DualVee track is made of either AISI 1045 carbon steel of AISI 420 stainless steel and you can get it hardened or unhardened.

I don't get it; how can you use DualVee track with MadeWell guide wheels?

Although DualVee track was designed to work with DualVee wheels it actually is able to be used with any 90° vee guide wheel, which includes MadeWell wheels.

Other KoP Item Resources



Why do I want DualVee Track so much?

Cutting right to the chase, I respect that.

First, DualVee track is induction hardened which is something you really will care about if you are relying on your machine to move accurately and smoothly every time you use it.

Second, DualVee track's design gives it two super flat and super accurate running surfaces. This means that you could have two different wheels running at the same time on the same piece of track!!

Thirdly, DualVee track arrives treated, milled, polished and ready to be cut, drilled and mounted however you need to. Minimal effort for maximum usability!

Wait, how do I cut DualVee track?

The best way to cut DualVee track is to use an abrasive chop saw. I know, there are so many types but to make your life easier an abrasive disk saw will cut right through steel.

If you don't happen to have an abrasive chop saw handy and you also don't have to make too many cuts, a simple hand hack saw will do the job too!

Another way to cut DualVee track would be to use a milling machine and a carbide end mill. Milling machines are really useful for trimming the ends of track to precise measurements.

Since we're talking about how-to, how do I drill DualVee track?

The heat treatment that is used on the vee surfaces of track often goes a little past the vee onto what we call the "track heal." This is the longer surface where you can find the embossed lettering. Most of this area is unhardened. You can drill your mounting holes into this section very easily using HSS (high speed steel) drill bits or just about anything harder like cobalt or carbide.

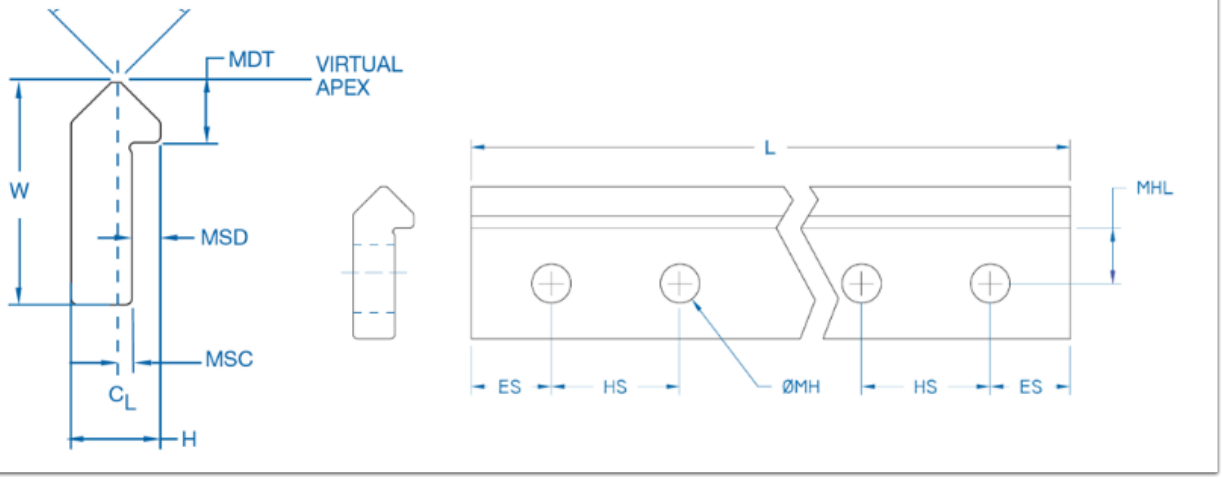
Other KoP Item Resources

To safely drill the rest of the DualVee track, make sure that the track materials are securely clamped in a vise and use a drill press or a milling machine. You can drill through holes in the track and use bolts to attach it to a base or you can drill tap threads into the track and attach it to a base with through holes. You can have it your way, kind of like Burger King.

Keep in mind that when drilling, some of the material may be somewhat harder than the soft treated area. Also, **DO NOT USE A HAND DRILL** (cordless). Safety first, always. Here are some drilling recommendations for your track.

Drilled and Undrilled Dimensions

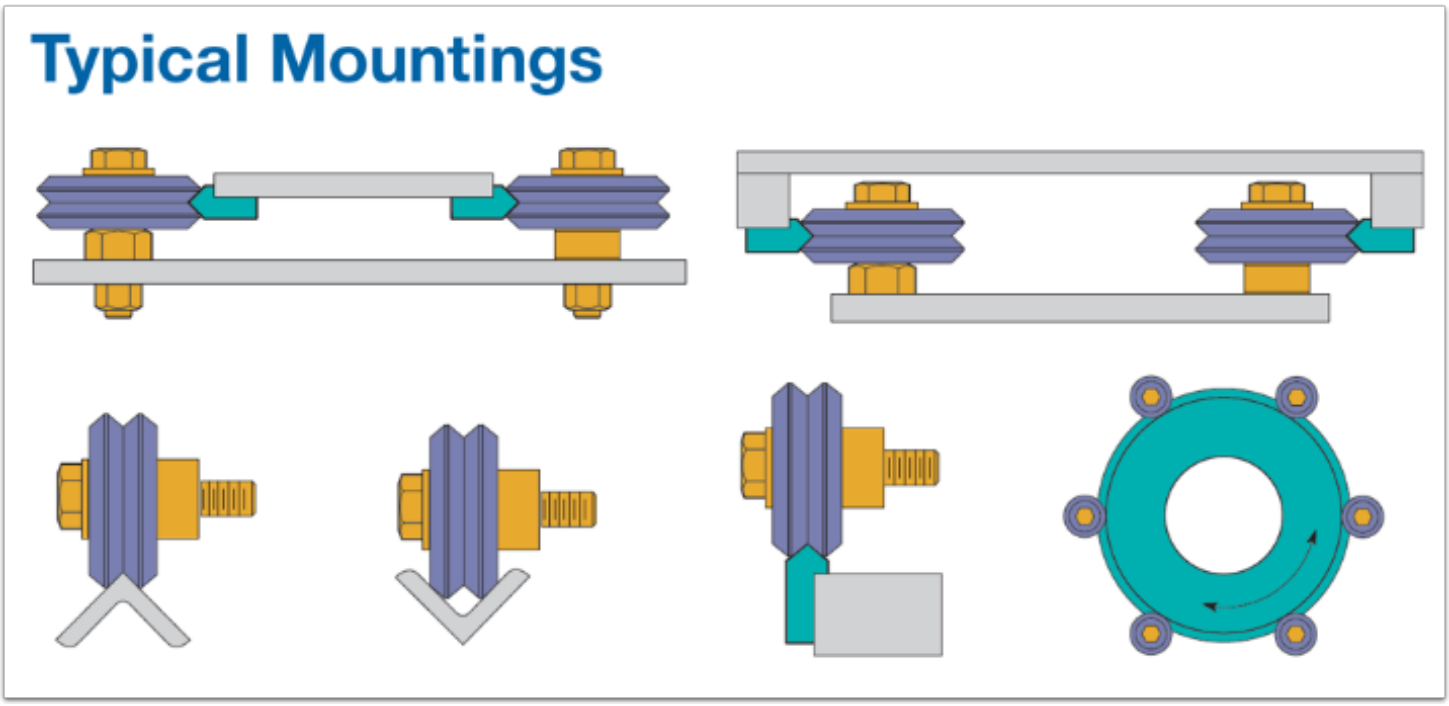
Size	Width	Height	Mounting Shoulder Location	Mounting Shoulder to Center Line	Mounting Shoulder Depth	Drilled Track Hole Dimensions				Weight
						End Hole Spacing	Hole to Hole Spacing	Hole Size Thru (Diameter)	Mounting Hole Location	
	W	H	MDT	MSC	MSD	ES	HS	MH	MHL	(lbs./ft)
1	.437	.187	.125	.031	.062	.250	2.000	.156	.156	.183
2	.625	.250	.187	.031	.094	.315	3.000	.203	.219	.343
3	.875	.343	.250	.062	.109	.375	3.000	.281	.313	.690
4	1.062	.437	.312	.093	.125	.500	4.000	.344	.375	1.100



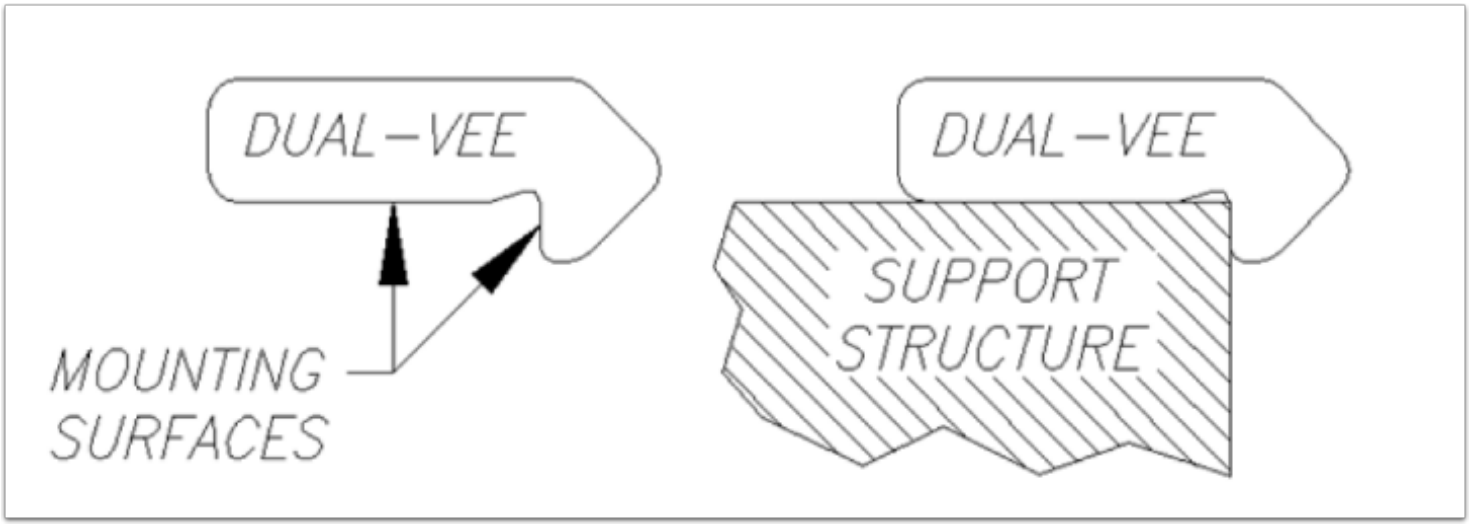
Any other recommendations?

Yeah!! When it comes to mounting DualVee track it truly is dealer's choice. There are number of options including everything from the kind of screw you'd prefer to the mounting orientation of the track. Just in case your drawing a blank on the specifics of how you want to mount your track, here a couple of recommendations to get you warmed up.

Other KoP Item Resources

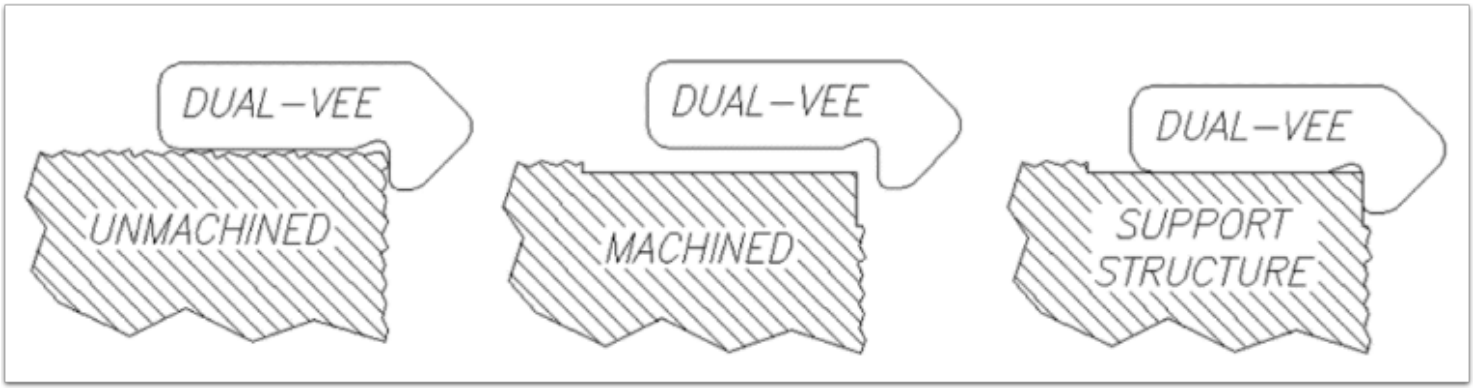


DualVee track is designed with an integrated shoulder and mounting surface. These surfaces are to be utilized when mounting DualVee track to your support structure or in your case, robot frame.

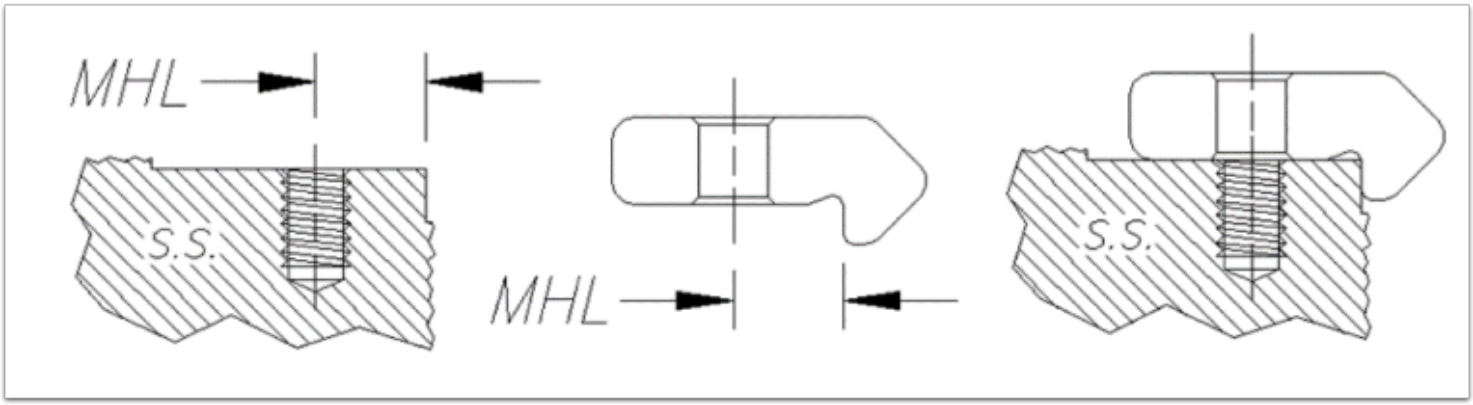


Pay special attention to the track mounting surface because small variations in things like flatness, parallelism and even perpendicularity may result in your wheel not running the way you want it to. Our recommendation is to use a machined register on the support structure (robot frame) in the track mounting locations.

Other KoP Item Resources

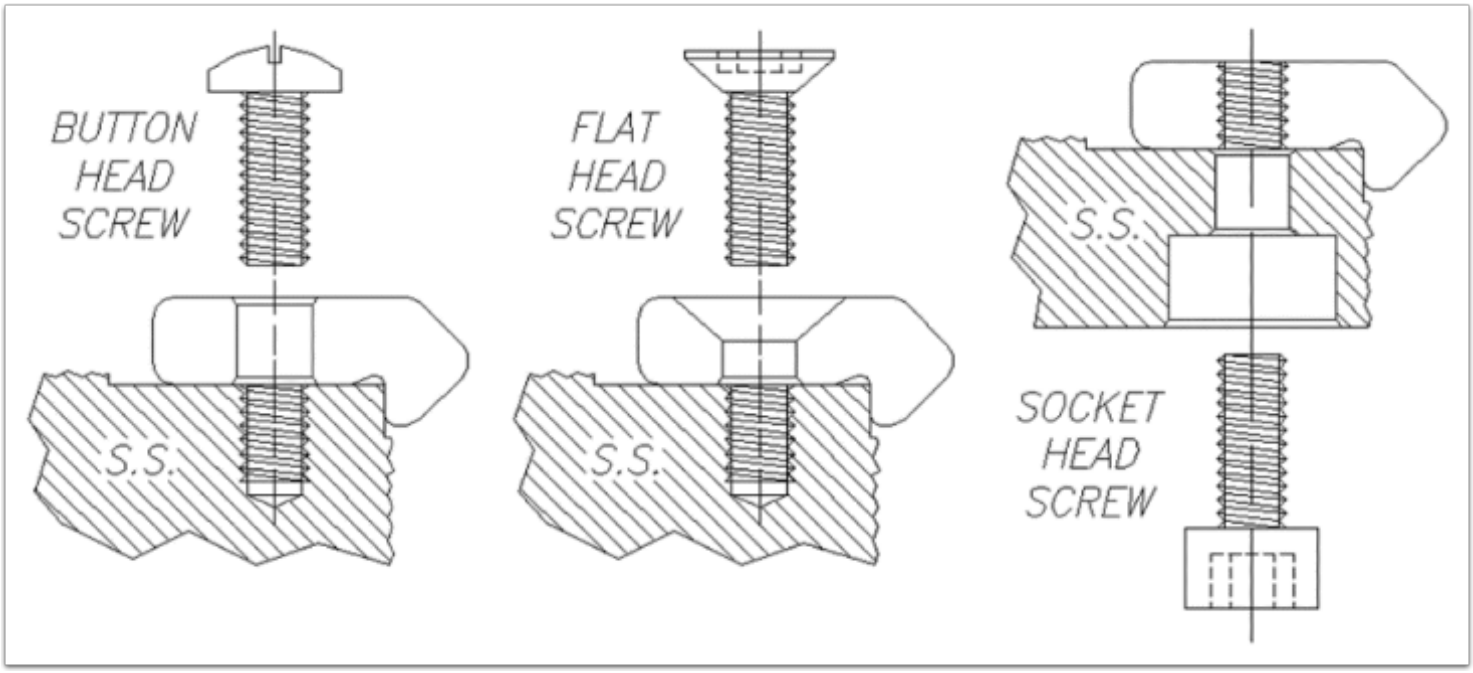


Machining for the track mounting fasteners can also be completed during support member machining. Through hole locations have been standardized on all sizes of DualVee track with dimensions originating from the locating soldier. The catalog dimension “MHL” can be referenced for support structure design.



Custom fasteners and hole locations other the ones specified in the catalog “MHL” can be accommodated for a variety of fastening methods. Common DualVee track hole and fastener combinations include clearance holes for screws, through holes with countersinks, and through threads.

Other KoP Item Resources



Other

FIRST Bumper Logo

1. Iron setting on high
2. Thin cloth in between transfer backing and iron
3. Apply pressure and iron in a circular motion
4. Check by peeling back. If it comes off cleanly, you're done; if not, keep ironing checking frequently.