Common Fasteners

GT Off-Road Racing | Data Acquisition

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# 1.0 Overview

## 1.1 Introduction

The purpose of this document is to serve as a guide for what type of fasteners to use for mechanical projects. It will cover the various fastening methods and some situations in which one might prefer one method over another. This is not a strict guide as all situations and designs are different, this is merely to serve as a guide to maintain some consistency between designs for a few reasons.

1. The team can buy some types of fasteners in bulk to save money
2. Similar tools can be used for assembling/disassembling different components. (i.e. if there are three enclosures on the car for encasing PCB’s it would be silly to have one enclosure with M4 socket head screws, another with 8-32 socket head screws, and another with ¼-20 hex head screws. Ideally you only need one size of wrench/allen wrench to open all of the enclosures on the car.
3. Parts of designs can be reused. If all PCB’s are mounted to enclosures in the same way, the same part geometries that are known to work well can be reused to save time in the design process and cut down on the number of redesigns that would have to occur.

Note that while we try and keep the standard hardware sizes listed on hand, you should always check to make sure we have the size that is needed when placing purchases for that project. If you notice we are running low on a specific size, let the sub-team lead know so that we can be sure to purchase more of that size.

# 2.0 Small Fasteners

## 2.1 Purchasing of Small Fasteners

All of our smaller fasteners are generally purchased in bulk on either McMaster-Carr or in some sort of variety pack from Amazon.

An example of the variety pack of metric fasteners we usually buy can be found [here](https://www.amazon.com/Stainless-Precise-Tapping-Washers-Assortment/dp/B07F75DMHF/ref=sr_1_4?keywords=socket+head+bolt+and+nut+assortment&qid=1571608387&s=hi&sr=1-4).

## 2.2 Fasteners for PCB Mounting

For mounting PCB’s to enclosures, we either use M3 socket head screws, M3 standoffs, or [#2 thread forming screws](https://www.mcmaster.com/90380A011/).

The thread-forming screws work well for very small PCB’s (usually sensor breakout boards). For thread forming screws, the hole in the PCB should be 0.094”. The plastic that the thread forming screws tap into should be 0.0785” in diameter.

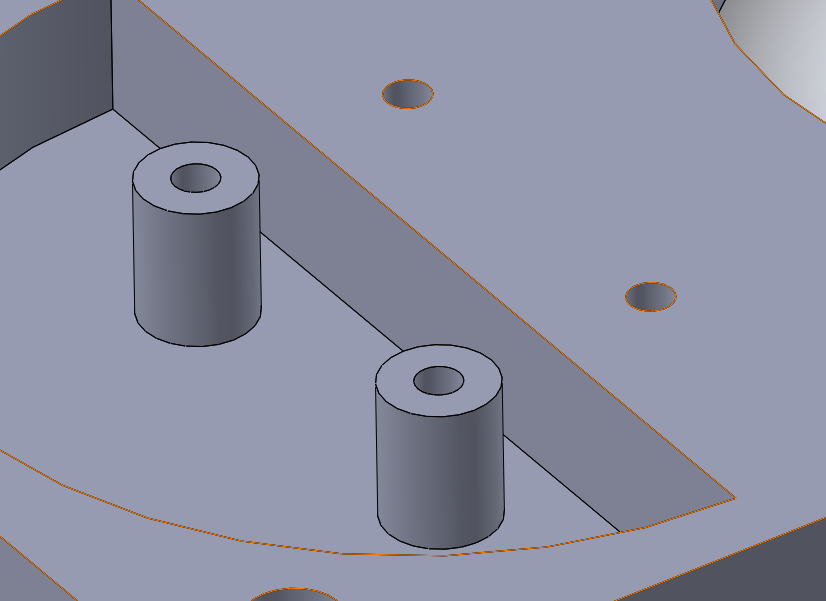


Figure 1. Extrusions to be used for mounting a PCB with thread forming screws.

The M3 standoffs can be either [plastic](https://www.amazon.com/Litorange-Standoff-Threaded-Motherboard-Assortment/dp/B07D7828LC/ref=sr_1_1_sspa?dchild=1&keywords=pcb+standoffs&qid=1598573898&sr=8-1-spons&psc=1&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUEzT1lGMkNEWFVOU1I2JmVuY3J5cHRlZElkPUEwNDExNjA0MlJBUENPR1gyMFhXVCZlbmNyeXB0ZWRBZElkPUEwNTcwODQ3VjhMSTA0VFpFWE5XJndpZGdldE5hbWU9c3BfYXRmJmFjdGlvbj1jbGlja1JlZGlyZWN0JmRvTm90TG9nQ2xpY2s9dHJ1ZQ==) or [brass](https://www.amazon.com/Male-Female-Standoff-Assorted-Motherboard-Assortment/dp/B07M89VRR4/ref=sr_1_9?dchild=1&keywords=metal+standoffs+m3+pcb&qid=1617691279&sr=8-9). Brass should be used when more strength is necessary. Plastic M3 standoffs come in 6mm, 10mm, 15mm, and 20mm. Brass standoffs come in 8mm, 10mm, 15mm, and 20mm. 6mm Brass standoffs can be purchased if needed. M3 socket head screws can be used in place of standoffs if standoffs are not needed. We generally use M3 screws in length multiples of 4mm with 4mm, 8mm, 12mm, 16mm, and 20mm being the most common.

For M3 screws, the hole size for the PCB should be 3.3mm in size. The hole size for the enclosure should also be 3.3mm for an enclosure that is machined and for 3D printed enclosures it is best to add 0.3-0.4mm to the hole size because holes tend to print slightly smaller than what they are designed as. So 3.6mm is usually good. If a cutout is added to an enclosure for a nut, it should also be oversized by 0.3-0.4mm so the nut can fit in properly. The hole can also be sized to be the same or slightly smaller (maybe 0.1mm) and the nut can be heat set into the plastic to act as a threaded insert as seen in the picture below. This method should only be used if needed since generally it is easier to not have to heat set the nut.

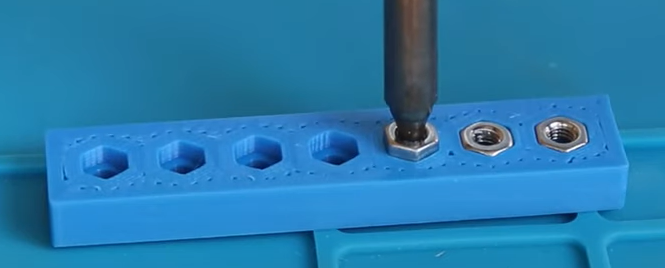


Figure 2. Using a soldering iron to push a nut into plastic as a threaded insert.

## 2.3 Fasteners for Enclosures

For fastening enclosures, it is generally best to use M4 sized hardware. If the enclosure is small, M3 hardware may be used, especially if the screws that fasten the enclosure also secure the PCB. Similar rules apply for M4 hardware, the hole size for machining is 4.4mm and for 3D printing it should be oversized to 4.7mm. Cutouts for nuts should also be oversized by 0.3-0.4mm. We generally purchase M4 hardware in multiple lengths of 4mm, with 4mm, 8mm, 12mm, 16mm, and 20mm being the most common. If there is a need for something outside of these lengths then make sure that it is noted to purchase the specific size that is needed.

## 2.4 Fasteners for Enclosure Mounting

For securing enclosures to the car or to anything else, usually we use ¼-20 sized hex head bolts. We try to keep some standard lengths on hand but don’t have a huge selection. Try to make your designs use a “nice” length of bolt that way we can only keep common lengths on hand. Multiples of ¼” are good and ½” is even better.

If a socket head mounting bolt is needed, or something smaller is needed then M5 or M4 may be considered for the application. If the enclosure if very small (usually for sensors) then M4 should be used.

## 2.5 Nuts

When designing your enclosures, keep the type of nut you want to use in mind. If it is a bolt that will go on the car for competition, you should almost always consider using a nylon lock nut. For most enclosures, the thin style of nylon lock nut can be used for ¼-20, but it doesn’t make a huge difference. We try and keep regular and lock nuts on hand for all sizes of hardware that we commonly use, so if we are running low on a certain size make sure to let someone know.

# 3.0 Large Fasteners

## 3.1 Overview

Large fasteners are used mostly for mechanical assemblies that either go on the car or are used as a testing rig. To my knowledge, our mechanical team prefers to stick strictly to imperial fasteners when designing components, and this practice should be maintained within our sub-team as well if possible.

## 3.2 Purchasing Large Fasteners

Most large fasteners are not purchased in bulk since they are generally more expensive. Once per year our team does a large fastener order, generally sometime at the end of fall or beginning of spring when the car is being assembled. If possible, DAQ should be included in this to save on shipping costs, however due to the nature of our projects this is not always possible. Bolt Depot is where most of our bolts are ordered from, and some that can’t be purchased from Bolt Depot are purchased on Fastenal. These vendors both have associated shipping costs so buying only a couple bolts should be avoided if possible. McMaster-Carr is also a good place to buy large fasteners however sometimes they are only sold in larger quantities.

## 3.3 Typical Large Fastener Sizes

In general, our team uses ¼-20, 5/16-24, and 3/8-24 for our larger size fasteners. If you can stick to one of these sizes, it is probably best.

# 4.0 Other Fastening Methods

## 4.1 Zip ties

Zip ties should be used sparingly but they can be a great option for fastening since they are lightweight and cheap. They are best used for wire management when routing wires on the car and to keep wires bundled together. Zip ties should not be used to fasten an enclosure or any other critical component since they can be broken from the rigors of competition.

## 4.2 Tape

Tape should also be used sparingly. Electrical tape is generally used on connectors that aren’t plugged in to keep the dust out. It shouldn’t be used for much else. Our team uses aluminum tape extensively. It can be used to seal things that need more waterproofing or for cosmetic reasons.

## 4.3 Potting Compound

Potting compound can be used to encase electronics and protect them from virtually anything. However we tend to not use it because it is not very cheap, it takes time to set properly, and it makes it impossible to fix anything that breaks inside of the potting. It is being included here to be thorough.

## 4.4 Welding

Welding is a great fastening method for testing rigs. Designing for welding is covered more in the manufacturing methods document.

## 4.5 Super Glue

Our team uses super glue for some things where it would otherwise be difficult to use a standard fastener. This is best for small plastic parts (usually 3D printed).

## 4.6 Heat Shrink

I don’t know if this is necessarily a fastening method but use it! The heat shrink with glue inside is best as it can provide strain relief for wires and offers waterproofing if it can get a good seal. It is also useful for wire labeling to act as a visual reassurance that wires are plugged in correctly.

# 5.0 Revision History

06/18/2021 (Andrew Hellrigel) – Created first revision of document.