Getting Started With Versaplanetary Gearboxes

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1 Introduction

This is meant to be a guide to give people a starting point for using Vex Versaplanetary gearboxes. It is not meant to be comprehensive documentation, Vex has done a great job of including extensive documentation on their website.

1.1 Background

Versaplanetary gearboxes were developed by Vex Robotics in 2013 and have been very useful in FRC designs for their ability to have large reductions in a small package as well as the ability to quickly change gear ratio by swapping, adding, or removing stages.

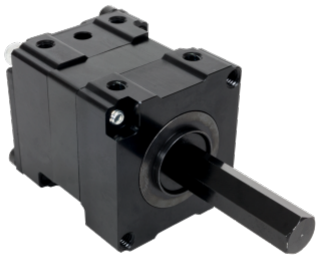

Figure 1: Versaplanetary Gearbox

1.2 Planetary Gearboxes

A planetary gearbox has 3 essential parts: a sun gear, planet gears, and a ring gear. This allows for a large reduction while taking up a small volume. A few drawbacks of of planetary gearboxes in FRC is that there is an efficiency loss of ˜10% per stage. Another drawback is that the small size of the teeth on planetary gears makes them more prone to breaking when compared to other spur gears used in FRC.

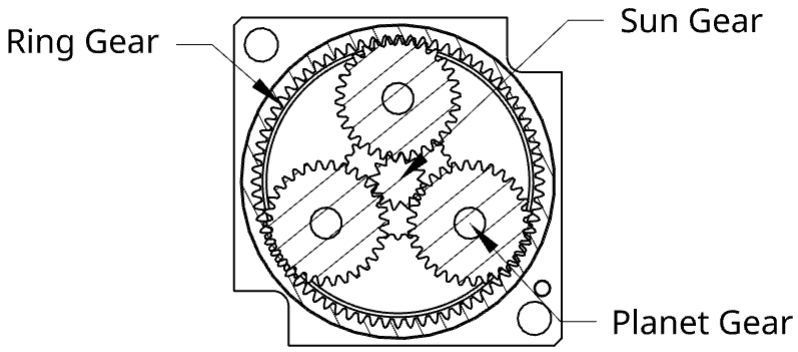

Figure 2: Section view of a Versaplanetary gearbox

1.3 v1 vs. v2 Versaplanetaries

In 2016 Vex released a second version of the Versaplanetary with screws that are installed from the "back," which is makes it much easier to swap motors without taking apart the entire gearbox. **The v1 & v2 input and output blocks cannot be mixed and matched - A v2 input block must be used with a v2 output block. Ring gears and gear kits are compatible between v1 & v2**

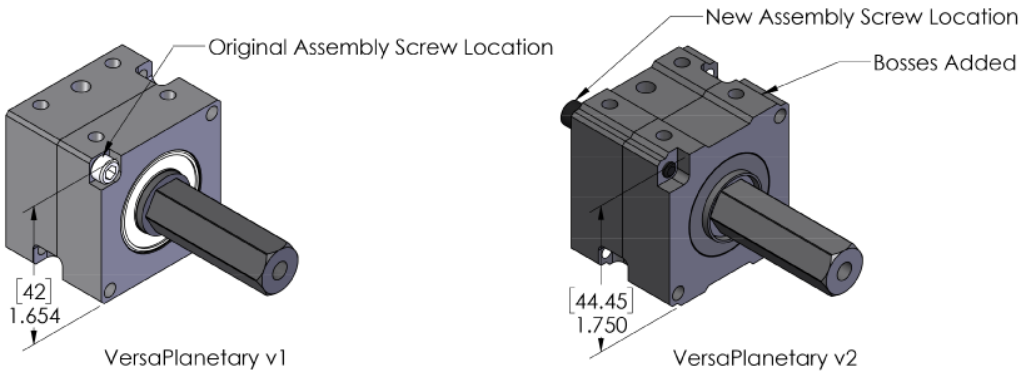

Figure 3: Comparison of v1 & v2 gearboxes

2 Load Ratings

When designing mechanisms that use Versaplanetaries, it is important to reference Vex's published load ratings to ensure that the reduction you are planning to use doesn't break under load. There are many different tables for various output shaft configurations, but the most common use case for Versaplanetaries is using a 1/2" hex output shaft.

In general, higher torque motors such as CIMs, NEOs, and Falcons cannot be run with high 2 stage reductions, while lower torque motors such as the BAG Motor or 775pro are within rating up to the maximum 2 stage reduction (100:1). Adding a 3rd stage can be useful, but there are much fewer configurations that are within load ratings.

2.1 Additional reduction

It can be useful to add an additional reduction to a Veraplanetary, for example, driving a chain and sprocket. This can be useful for: (1) reducing shock loads on the gearbox, and (2) reducing the necessary reduction within the Versaplanetary, allowing designs to be well within load ratings.

3 Assembly

Vex has great documentation on assembling Versaplanetaries in their user guide, but there are a few things that should be emphasized:

- Order of stages in multi-stage gearboxes:
  The higher reduction stage should be placed closer to the motor, higher reduction stages are easier to break and should be placed where they experience lower torque.

- Matching carrier plates to gear sets:
  Carrier plates are designed with specific spacing for their specific reduction. It is easy to mix up sun & planet gears with the wrong carrier plate. Ensure that the gears in each stage are meshing properly.

- Motor shaft coupler assembly:
  The motor shaft coupler needs to be oriented correctly with the input coupler. It is also important to leave a small gap between the input coupler and the motor plate.

Figure 4: Shaft coupler assembly

- Checking for jams:
  Make sure to check the gearbox is free spinning before you power it. It might be necessary to use a 1/2" wrench to spin the gearbox if the reduction is large.

- Use grease!

4 Known Problems

- 10:1 Stages:
  The sun gears on 10:1 stages are extremely small and are easy to break, even when within load ratings. Only use 10:1 reductions for light load applications if possible. A 10:1 reduction on an intake roller would probably be fine, but using a 10:1 reduction on a higher reduction mechanism such as a large arm (where shock loads can be common) is generally a bad idea.

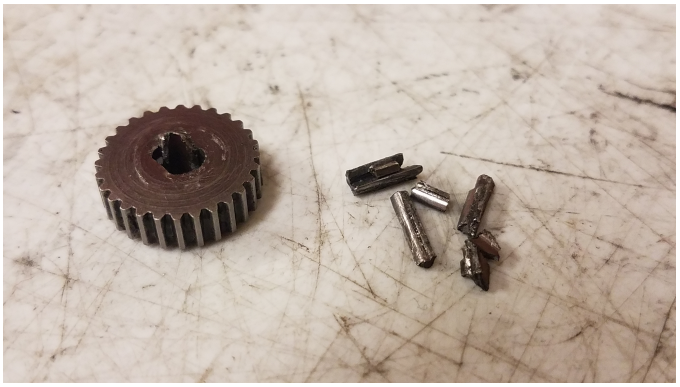

Figure 5: Broken 10:1 sun gear

- Output shaft snap ring groove wear:
  The area behind the snap ring groove on the output shaft can wear down allowing the snap ring that retains the shaft to move out of place. This can cause output shaft to lose engagement with the rest of the gearbox.

Figure 6: Extremely worn output shaft

- Loose carrier plate pins:
  If the pins in a carrier plate are not flush or are able to move around, they should be pressed into place and secured.

Figure 7: Carrier plate with loose pins