Introduction
Congratulations! You have just purchased a Contra-Rotating Propeller Drive System, which has been specially designed for use in f3a pattern competition.

Contra-Rotating Drive systems for full scale airplanes have been known since World War II, but since then, despite their many advantages, they have only seen occasional use in certain military applications. This has been for two reasons.

1. When Contra-Rotating Propeller Technology was being developed the jet engine was also being introduced, and while Contra-Rotating Propeller Systems had efficiency advantages over jet engines, jet engines held out the promise of more performance, and airplanes that could fly faster than the speed of sound.
2. In the commercial airline industry the ability to fly with jets at great heights and with less cabin noise also won out over the efficiency benefits of Contra-Rotating Systems.

Benefits
However, for pattern flying the advantages that a Contra-Rotating System can offer are considerable. These advantages are as follows:

1. Contra-Rotating Propellers eliminate the gyroscopic effects that exist when flying with a single propeller. Gyroscopic effects will cause the airplane to yaw whenever the elevator is applied. The more elevator that is applied, the greater this yawing effect is. Contra-Rotating systems don’t have this effect, so there is no yawing of the airplane whenever the elevator is applied, and consequently no mixing is required to remove it.
2. Contra-Rotating Propellers significantly reduce the maximum torque that goes into the fuselage of the airplane. With a single propeller system the torque that goes into turning the propeller also reacts out against the motor mounts, and the fuselage of the airplane, so if the motor is generating 5 N.m of torque to turn the propeller, the motor is also trying to rotate the fuselage with this same 5 N.m of torque. Whereas, with a Contra Rotating System the torque is divided by the gear ratio of the gearbox, so if the Drive is using a gearbox with a 10:1 gear ratio, then the torque into the fuselage is only 0.5 N.m. This means that an airplane with a Contra-Rotating Propeller System won’t change aileron trim on the downlines, or when entering a spin, or when coming in for a landing. With a single propeller system all of these situations will require different amounts of trim, which all need to be mixed in. However, with a Contra-Rotating Propeller System the trim never changes so no mixing is needed.
3. Contra-Rotating Propeller Systems eliminate the P-Factor effects that tend to yaw an airplane when the thrust line doesn’t coincide with the flight path of the airplane. This effect reverses when the airplane is flying inverted, so while right thrust in the motor can compensate somewhat when the airplane is flying right side up, rudder to throttle mixing is needed to compensate when the airplane is flying inverted. With a Contra-Rotating System no right thrust in the motor is required, and consequently no mixing is needed.
4. Contra-Rotating Propeller Drive Systems have two propellers that provide twice the braking power that a single propeller system provides. Also, since Contra-Rotating Drive Systems have propellers spinning in opposite directions, each prop generates an equal but opposite braking torque, which
eliminates the aileron trim effect that is so often seen on downlines when motor braking is used with single propeller setups.

5. Contra-Rotating Propeller systems are 15% to 20% more energy efficient than equivalent single propeller systems. This is because the air passing through the blades of the propellers is accelerated twice in order to generate thrust, instead of a single time as it is with single propeller systems. This means that each of the two propellers in a Contra-Rotating System is doing half the work that the propeller in a single propeller system needs to do so they can do their work with fewer viscous losses, and fewer losses due to radial air flow along the length of the propeller blades.

6. The air that goes through the first propeller in a Contra–Rotating System acquires a rotational twist, which is then cancelled out by the reverse rotation of the second prop. This has two benefits. The rotational energy in the air is recovered as useful thrust, and the air exiting the rear propeller flows straight back over the fuselage without rolling the airplane by blowing against the wings, stab, and rudder. This eliminates the need for any mixing of rudder to throttle.

Specifications
1. Drive Mass, excluding Propellers and Mounting Plates, but including Adapter Manifold – 275g
2. Propeller Mass – 70g each +/- 5g
3. Spinner Diameter – 82mm
4. Spinner Length – 85mm
5. Propeller Diameter – 22” (558.8 mm)
6. Maximum Wattage – 3500W
7. Continuous Wattage – 2500W

Main System Components
Your Contra Rotating Propeller System has the following main system components:

The Contra Rotating Drive Unit
This is the part of your system that contains the planetary gearbox, the spinners, and attachments for mounting the propellers. In order to attach this Drive to your motor you will need to disassemble the Drive Unit, and bolt the rear Gearcase Housing onto an Adapter Manifold that is attached to the motor.
**The Propellers**

Each propeller is fabricated with carbon fiber and epoxy, which makes them very light, and very stiff. Propeller weight and stiffness are important in a Contra-Rotating Propeller Drive System because it’s necessary for each propeller to maintain proper distance from the other. Also, there are turbulent forces that buffet each prop as the front and rear blades pass each other. This is because this happens twice per revolution, and consequently turbulent forces impact the propeller blades at twice the frequency of the spinning propellers. So, in order to avoid critical resonances, the resonant frequencies of the propeller blades must be twice that of an equivalent single prop. Fortunately however, the propeller rpm in a Contra-Rotating System is less than that of an equivalent single prop system, but this still doesn’t fully compensate for this effect. For example; if a single propeller system spins at 6,000 rpm, and a Contra Rotating System spins at 4,000 rpm, then the Propellers in the Contra-Rotating System have to be as stiff as a propeller in a single prop system that spins at 8,000 rpm.

The propellers come as a set that includes both front and rear props. The rear prop is pitched to rotate in a clockwise direction, whereas the front prop is pitched to rotate in the opposite counterclockwise direction. Also, each propeller is designed so that it can only fit on the front or the rear, whichever is appropriate for each propeller. This means that it is not possible to incorrectly assemble either prop.

**The Motor**

Your Contra Rotating Propeller Drive System does not come with a motor. This must be provided by you. The System is compatible with either the Hacker C50 Competition Motors, or the Neu f3a Motors. Each motor is fitted to the Drive with an Adapter Manifold that is specific to each motor.

**The Motor Adapter Manifold**

There are two Motor Adapter Manifolds available. One for Hacker C50 Competition Motors, and one for Neu f3a Motors.
In the case of Hacker C50 Motors, the Manifold is used as a spacer to maintain the correct axial distance between the motor and the Drive Unit. The Motor Mounting Screws pass through the Adapter Manifold and attach directly to the motor.

In the case of Neu f3a Motors, the Adapter Manifold is attached to the motor first with four 4mm cap screws and the Contra Drive Unit is then bolted to the Manifold.

In both cases the Adapter Manifold aligns to a cylindrical datum on the motor, and with a cylindrical datum on the Drive Unit. The alignment between the Adapter Manifold and the Drive Unit is maintained with an O-Ring that is compressed between both assemblies. This ensures that the Pinion Gear on the Drive Unit is properly aligned with the pinion gear on the motor. This is important to prevent binding during operation.

**The Electronic Speed Control**

Your Contra Rotating Propeller Drive System does not come with an Electronic Speed Control. This must be provided by you. Many Speed Controls will work, but it is recommended that the Control that is used be rated for at least 90 Amps.

**Installation**

Assembling and installing your Contra-Rotating Propeller Drive is not difficult, but it does require you to disassemble the Drive Unit in order to do so.

The first step is to remove the front and rear Spinner assemblies as follows:

One important thing to note is that the nut holding the rear propeller has a left-hand thread, so it will be necessary to turn it in the opposite direction when removing it. Once the Spinners have been disassembled, the next step is to remove the six Torx button head screws on the face of the Spinner Backplate. A T10 Torx wrench is provided for this purpose.

Now it will be possible to pull the Spinner Backplate away from the Gearcase Housing and disassemble the Drive Unit as follows:
Contra Drive Unit Disassembly

- Front Spinner Collet
- Driveshaft
- T10 Torx Button
- Head Screws (6)
- Wire Spring
- O-Ring
- Planet Gear Bearings (3)
- Clutch Clamp Ring
- Upper Clutch Plate
- Planet Gears (3)
- Ring Gear
- Lower Clutch Plate
- Gearcase Housing Assembly
At this point all of the components except the Gearcase Housing Assembly can be carefully put aside, (preferably on top of a clean rag ...) and the Gearcase Housing can be assembled to the motor using the Adapter Manifold appropriate for whichever motor is being used. In the case of the Neu f3a motor the assembly is as follows:
In the case of the Hacker C50 Competition Motor, the assembly is as follows:

- **M2.5 Cap Screws (4)**
- **Hacker C50 Adapter Manifold**
- **M2.5 Cap Screws (5)**
- **Hacker C50 Mounting Plate**
- **Nylon Bushings**
- **Hacker C50 Motor**
The Nylon Bushings are used to fill the counter bore holes in the Hacker C50 Motor Front Cap. They are pressed flush with the top surface of the Front Cap and then the remaining assembly can take place.

The five M2.5 Cap Screws are used to attach the Mounting Plate to the Hacker C50 Motor Front Cap, and then the Adapter Manifold is sandwiched between the back of the Contra Drive Unit, and the front of the motor. Four M2.5 Cap Screws are then used to screw the whole assembly together.

Note that the Mounting Plate can be attached to the motor first, and the motor assembly can be installed in the plane before the Gearcase Housing is assembled. This makes it easier to assemble the entire unit through the nose of the plane.

An important point to remember is that there is only one access hole through the bottom of the gearcase housing for the M2.5 mounting screws, so the housing must be rotated in order to align this access hole when assembling each screw.

After the Gearcase Housing is assembled to the motor, the Contra Drive Unit can be reassembled. Make sure to re-grease the gears and internal components using the supplied syringe of grease. The recommended method for reassembling the Contra Drive Unit is to pre-assemble all of the components onto the Rear Hub. Refer to the previous exploded view of the Contra Drive Unit to make sure that all parts are included. The Rear Hub Pre-Assembly should look like as follows:

![Rear Hub Assembly](image)

It’s important that all parts are properly aligned. The parts can be held in place temporarily with grease.

As the Rear Hub Assembly is mated with the Gearcase Housing, care must be taken to ensure that the Pinion Gear in the Gearcase Housing meshes properly with the Planet Gears in the Rear Housing Assembly. At all
times the Gears should rotate freely, and if at any time they don’t then the Rear Hub Assembly must be checked to make sure that all of the components are properly pre-assembled.

Once the Rear Hub Assembly is properly meshed with the Gearcase Housing, the six M3 T10 Torx Button Head Screws can be carefully tightened down. However, it’s important to remember that as these screws are tightened the Wire Spring inside the Gearcase Housing is slowly compressing the Clutch Plates and the Ring Gear, so it’s important to tighten the screws evenly and all at the same time. Also, as the screws begin to compress the Wire Spring, it’s necessary to rotate the Driveshaft a few times to align the Ring Gear concentrically with the Pinion Gear before the Wire Spring locks it into position.

The Driveshaft should rotate freely. If it turns roughly, or exhibits roughness, disassemble the Drive Unit and reassemble it. The finished assembly should look as follows:

![Contra Drive Unit & Motor Assembly](image)

Make sure to use the supplied T10 Torx Wrench to tighten the Screws securely to prevent them from loosening during operation. A Hacker C50 Motor Assembly is shown, but the Neu Motor Assembly is the same.

At this point the Spinners and Propellers can be installed. The Propellers and Spinners assemble as follows:
Assembling Props & Spinners
When assembling the Propellers and Spinners, it is recommended that the following guidelines be followed:

1. It’s important to remember that the Nut for the bottom Propeller has a left-hand thread, so you need to reverse the direction when you tighten or loosen it.
2. When tightening the propeller nuts, do not hold the propellers near the tips, because the tips are fragile, and can potentially crack and break when you apply wrench torque.
3. Both Propeller Nuts can be torqued in the same way that Propeller Nuts on single propeller systems are torqued. However, guard against over torquing to avoid damaging the Drive Unit. The maximum torque that should be applied is 30 N.m.
4. Care must be taken to avoid over torquing the M4 bolt that holds the Front Spinner on. This is because overtorqueing this bolt will elastically deform and ovalize the Front Spinner and the Front Hub. In order to prevent this from happening the M4 Spinner Bolt has a Nylon insert that creates a frictional thread locking torque when it’s threaded into the end of the Driveshaft. This means that the M4 Spinner Bolt can be tightened just enough to seat the Front Spinner without elastically deforming the assembly, and without the Front Spinner coming loose and falling off during flight.
5. Do not use Locktite on the Propeller Nuts. Doing so will make it impossible to remove the nuts after the propellers start to slip.

**Maintenance**

It is recommended that the gearbox be disassembled and re-greased every 50 flights, or after 8 hours of runtime, whichever comes first. The recommended grease is Rheolube 374A from Nye Lubricants Inc. This is a Military Specification synthetic grease that is suitable for high speed bearings and high speed gears.

Grease should be applied to the following locations:

Each location should have a quantity of grease that’s large enough to fit within a 10mm diameter sphere.

The following advice and cautions are also offered:
1. Do not use greases that are loaded with Dry Lubricants like Molybdenum Disulfide. This is because dry lubricants will plate out on the running surfaces of bearings, potentially causing clearance issues, and they will impair the function of the Spring Loaded Clutch, which will cause the Clutch Plates to slip.

2. It is recommended that Blue Locktite be used on the M2.5 bolts that attach the Gearcase Housing to the Motor, or Motor Adapter Manifold, and the M4 Socket Head Cap Screws that bolt the Neu f3a Adapter Manifold to the Neu f3a Motor.

3. Locktite is not needed for the M3 T10 Torx Button Head Cap Screws that attach the Rear Hub to the Gearcase Housing, because these bolts are spring loaded by the Wire Spring.

4. Do not use Locktite on the Propeller Nuts. Doing so will make it impossible to remove the nuts after the propellers start to slip.

5. Do not use solvents of any kind to clean the bearings, or the internal portions of the gearbox. This is because solvents will wash away the grease inside the sealed bearings causing them to fail prematurely. Use a dry, clean rag, or paper towel instead.

Maximum Bolt Torques are as follows:

1. Propeller Nuts – 30 N.m
2. M3 T10 Torx Button Head Cap Screws – 20 N.m
3. M2.5 Socket Head Cap Screws – 10 N.m
4. M4 Socket Head Cap Screws (excluding Spinner Bolt …) – 3 N.m
5. M4 Socket Head Cap Screw Spinner Bolt – Just enough to overcome frictional torque.

Currently the Pinion Gear and the Pinion Gear Bearings, are non-serviceable. Servicing these parts requires a replacement Gearcase Housing Assembly.

**Changing Gearbox Gear Ratios**

Replaceable Gear Sets are available so that the performance of the Drive can be matched to the Plane, the Pattern Schedule, and the available Battery Capacity. A complete Replaceable Gear Set is comprised of the following matched components:

1. A Ring Gear
2. A Driveshaft and Carrier Assembly with Planet Gear Bearings
3. Three Planet Gears

Changing the Gear Set can be accomplished without removing the Motor and Drive Assembly from the plane. First the Front and Rear Spinners and Propellers are removed. (See earlier illustration for guidance …)

The Rear Hub is then removed, and the Gearbox is disassembled as follows:
Swapping Out Gear Sets

The Driveshaft, the Planet Gears, and the Ring Gear are all replaced, and the Drive Unit is reassembled.

Performance Charts

This Chart is a mapping of Contra Rotating Propeller Drive System performance as a function of Motor Type, Propeller Pitch, and Gearbox Reduction Ratio. The purpose of this chart is to help assist in selecting the right motor, propeller, battery, and gear ratio:
## Contra Rotating Propeller Drive System User Guide

<table>
<thead>
<tr>
<th>Motor</th>
<th>Prop Pitch</th>
<th>Performance</th>
<th>Gear Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>9.84</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4.148</td>
</tr>
<tr>
<td>14</td>
<td>Contra</td>
<td>Battery (mah)</td>
<td>4,300</td>
</tr>
<tr>
<td>16</td>
<td>Rotating</td>
<td>Speed (mph)</td>
<td>81.3</td>
</tr>
<tr>
<td></td>
<td>Propeller</td>
<td></td>
<td>81.3</td>
</tr>
<tr>
<td></td>
<td>Drive</td>
<td>Current Draw (A)</td>
<td>61.2</td>
</tr>
<tr>
<td>18</td>
<td>System</td>
<td></td>
<td>95.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max</td>
<td>88.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Horizontal</td>
<td>88.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vertical</td>
<td>73.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Static</td>
<td>73.7</td>
</tr>
<tr>
<td>19</td>
<td>Contra</td>
<td>Battery (mah)</td>
<td>4,300</td>
</tr>
<tr>
<td>20</td>
<td>Rotating</td>
<td>Speed (mph)</td>
<td>81.3</td>
</tr>
<tr>
<td></td>
<td>Propeller</td>
<td></td>
<td>81.3</td>
</tr>
<tr>
<td></td>
<td>Drive</td>
<td>Current Draw (A)</td>
<td>61.2</td>
</tr>
<tr>
<td>21</td>
<td>System</td>
<td></td>
<td>95.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max</td>
<td>88.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Horizontal</td>
<td>88.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vertical</td>
<td>73.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Static</td>
<td>73.7</td>
</tr>
<tr>
<td>22</td>
<td>Contra</td>
<td>Battery (mah)</td>
<td>4,300</td>
</tr>
<tr>
<td>18</td>
<td>Rotating</td>
<td>Speed (mph)</td>
<td>81.3</td>
</tr>
<tr>
<td></td>
<td>Propeller</td>
<td></td>
<td>81.3</td>
</tr>
<tr>
<td></td>
<td>Drive</td>
<td>Current Draw (A)</td>
<td>61.2</td>
</tr>
<tr>
<td>19</td>
<td>System</td>
<td></td>
<td>95.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max</td>
<td>88.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Horizontal</td>
<td>88.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vertical</td>
<td>73.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Static</td>
<td>73.7</td>
</tr>
<tr>
<td>21</td>
<td>Contra</td>
<td>Battery (mah)</td>
<td>4,300</td>
</tr>
<tr>
<td>20</td>
<td>Rotating</td>
<td>Speed (mph)</td>
<td>81.3</td>
</tr>
<tr>
<td></td>
<td>Propeller</td>
<td></td>
<td>81.3</td>
</tr>
<tr>
<td></td>
<td>Drive</td>
<td>Current Draw (A)</td>
<td>61.2</td>
</tr>
<tr>
<td>22</td>
<td>System</td>
<td></td>
<td>95.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max</td>
<td>88.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Horizontal</td>
<td>88.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vertical</td>
<td>73.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Static</td>
<td>73.7</td>
</tr>
</tbody>
</table>

**Hacker CSQ-14XL**

<table>
<thead>
<tr>
<th>Motor</th>
<th>Prop Pitch</th>
<th>Performance</th>
<th>Gear Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>9.84</td>
</tr>
<tr>
<td>20</td>
<td>Contra</td>
<td>Battery (mah)</td>
<td>4,300</td>
</tr>
<tr>
<td>21</td>
<td>Rotating</td>
<td>Speed (mph)</td>
<td>81.3</td>
</tr>
<tr>
<td></td>
<td>Propeller</td>
<td></td>
<td>81.3</td>
</tr>
<tr>
<td></td>
<td>Drive</td>
<td>Current Draw (A)</td>
<td>61.2</td>
</tr>
<tr>
<td>22</td>
<td>System</td>
<td></td>
<td>95.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max</td>
<td>88.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Horizontal</td>
<td>88.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vertical</td>
<td>73.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Static</td>
<td>73.7</td>
</tr>
</tbody>
</table>

**February 4, 2011**
Motor Mounts
A set of two generic motor mounting plates are included. These plates are as follows:

1. Rear Fuselage Support Plate
2. Front Fuselage Support Plate

Each Motor Adapter Manifold Kit comes with a set of Front and Rear Motor Plates that are specific to each Motor.

Dimension drawings of these Motor Support Plates for the Neu f3a Motor are as follows:
Front Motor Support for Neu f3a

Dimension drawings of these Motor Support Plates for Hacker C50 Motors are as follows:
Rear Motor Support for Hacker C50
In all cases the material used is 1.5mm Carbon Fiber Epoxy Laminate.

It is highly recommended that the Front Motor Support Plates be rubber mounted to the fuselage. This is because there can be considerable noise that comes off of the propellers, and this noise needs to be isolated from the fuselage in order to avoid having the fuselage act as a resonant amplifier that makes the noise louder.

There are two choices for rubber mounts:
**Vibration Isolators from Budd Engineering** - These rubber mounts are light, and very compact. They also can take compressive and tensile loads, and they do a good job of controlling the side to side movement of the Drive. Three are required.

**Rubber “Lord Style” Mounts** – These rubber mounts are cylinders of rubber with threaded attachments bonded to each ends of the cylinder. These mounts do the best job of isolating vibration, but the rubber compound needs to be chosen carefully because there is a tradeoff between vibration isolation and side to side movement of the Drive when power is applied. This movement isn’t in response to motor torque. It’s because the motor / rubber mount system has a critical resonant frequency at about half the rpm of the propellers, and as the propellers accelerate through this resonant frequency, small side to side movements are amplified. The recommended rubber mount is part number V10Z 2-304A from [www.vibrationmounts.com](http://www.vibrationmounts.com). Three are required.

An important point to note is that since the braking force from both propellers on a Contra Rotating Drive System is more than double that of an equivalent single propeller system, it’s reasonable to expect that the rubber mounts will compress on the downlines. This means that extra clearance is required between the Rear Spinner and the nose of the plane in order to avoid contact. A minimum of 3mm of clearance is recommended.

Also, since the Gearcase Housing rotates with the Rear Propeller, it’s necessary to ensure adequate clearance between the sides of the Gearcase Housing, and the stationary elements in the nose of the plane. If contact does occur, the motor mounts can be damaged, as well as the rest of the structure in the nose of the plane. One good practice is to make sure that smooth cylindrical part of the Gearcase Housing touches before the mounting lugs do.

**Plane Setup**
The Motor should be set up with zero degrees of right thrust, and a 0.5 degree of downthrust. The only mixes that might be required are as follows:

1. Elevator to rudder for knife edge flight.
2. Aileron to rudder for knife edge flight.
3. Elevator to throttle for downlines

Whether or not these mixes are needed will be plane specific, but other than these, no other mixes should be required.

**Warranty & Liability**
This Contra Rotating Propeller Drive System is guaranteed against manufacturing defects for a period of one year from the date of purchase. Liability is limited to full replacement cost of the product.

**Safety Warnings**
It is necessary to state that this product is intended for experienced hobbyists/modelers, and consequently there is an implicit assumption that the user has prior knowledge and experience with radio controlled model...
airplanes, pattern flying, electric motors, electric motor power systems, as well as general knowledge concerning safety and safe operation of the aforementioned.

The following safety warnings are in addition to the above:

1. **Do not use plastic propellers! Use only Carbon Fiber reinforced Epoxy Resin Propellers that have been designed for Contra-Rotating Propeller Systems.** This is because plastic propellers are too heavy, and they do not have the required stiffness to avoid excessive deflection, and the possibility of exciting resonant frequencies in the propeller blades.

2. **Do not fly with Propellers that have cracks or splits!** Doing can potentially result in structural failure, and/or contact between the front and rear propeller blades.

3. **Do not stand, or sit, in the arc of propeller blades!** Doing so can result in serious injury or death.

4. **Do not over tighten propeller nuts!** Doing so can cause structural failure of the propeller hubs, and/or the propeller blades.

5. **Do not hold propellers near the tips when tightening propeller nuts!** Doing so can cause structural failure of the propeller blades. Instead, hold the propeller blades as close to the spinner as possible. If a propeller splits or cracks while tightening a propeller nut, replace it before operating the Contra Drive Unit.

6. **Do not attempt to repair propellers that are cracked or split!** Doing so can cause structural failure of the propeller blades during operation.