Introduction

Congratulations! You have just purchased the new V4 Contra-Rotating Propeller Drive System, which has been specially designed for use in f3a pattern competition.

This new Drive has benefited from feedback and hard won experience from f3a competitions all over the world, and from some of the world's best pilots. It represents the culmination of several years of continuous improvement in design, performance, reliability, durability, and usability, which have resulted in significant advances in the following areas:

1. *Performance* – The V4 Drive uses a helicopter motor which is designed to run efficiently at part throttle. This results in a very linear throttle response during the mid range, which gives the pilot more precise control of the throttle, and makes it easier to more precisely adjust flying speed through maneuvers. The motor is also capable of delivering 2,000W continuously, and up to 3,500W intermittently. This is more power than any other Drive system, single or double prop, available today.
2. *Weight* – The V4 Drive is more than 200g lighter than a similarly configured V3 Drive. The all-up system weight, including Drive, Motor, Spinners, and Props is 600g. This compares favorably with any single, or double prop system now in use.
3. *Durability & Reliability* – The face width of the gears in the V4 is more than twice the face width of the gears in a V3 Drive. Also, the planet gears run on oversize needle bearings, and the main bearings have more than double the required load capacity. This increases the durability of all gears and bearings in the system to be as long as the life of the Drive.
4. *Size* – The V4 Drive has a considerably smaller package size than the previous V3 Drive. It is small enough to fit in the space used by any existing single prop system.
5. *Serviceability* – The V4 Drive can be completely disassembled using common tools. No special tools are required. The Drive itself can be disassembled and removed from the plane without having to remove the motor. The gearset can also be disassembled without having to remove either the Gearcase assembly, or the motor from the plane.
6. *Maintainability* – The V4 Drive can fly up to 200 flights before it needs regreasing, and when it does need regreasing, it can be regreased through a hole in the driveshaft using a syringe of grease. This hole is accessed by removing the front spinner bolt, and the front spinner. The rear spinner and both props remain installed, and there is no need to disassemble the Drive.
7. *Sound Quality* – The V4 has eliminated the syncopating rhythm sound that is commonly heard with Contra Drives, and due to the lower gear ratio, it is also noticeably quieter in the air when flying with higher pitch props. The Drive is also 2db to 4db under the current 94db f3a sound limit.
8. *Backwards Compatibility* – The V4 will bolt into an existing V3 Drive installation without having to reposition the carbon fiber fuselage plate. Also, the stock motor shaft is delivered "extra long", so that it can be shortened to appropriately match the spinner to the nose of their plane.
9. *Forward Compatibility* – There is no need for an adapter manifold to fit a new motor, so it is easy to fit different motors. Also the 4,500W gearbox power rating allows considerable margin for the V4 Drive to be able to take advantage of future improvements in battery and motor technology.

10. *Manufacturing Build Quality* – The Drive and both spinners are all CNC machined, with critical tolerances held to +/- 0.01mm. (+/- 0.0004") The Drive itself is anodized black, and the spinners are available in a range of colors to match paint schemes. (Red, Black, Purple, Gold ..)

Specifications

1. Gear Ratio – 7:1
2. Drive Mass, including Motor, Propellers and Spinners, but excluding Mounting Plates and Rubber Mounts – 600g +/- 10g
3. Propeller Mass – 50g +/- 5g
4. Spinner Diameter – 82mm
5. Spinner Length – 85mm
6. Propeller Diameter – 22" (558.8mm)
7. Maximum Drive Wattage – 4,500W
8. Maximum Motor Wattage – 2,000W Continuous, 3,500W Intermittent (5 sec max..)
9. Propeller Balance – Within 0.05g at the tip in two perpendicular directions

What Comes in the Box

Your Drive comes complete with all of the things that you need for a successful installation:

1. The Drive, Spinner Sections, Front Hub, and Prop Nuts.
2. Motor – Typically an outrunner helicopter Motor, (some Drives are sold separately..) and four motor mounting bolts.
3. User Manual – You are reading it right now.
4. Tools – A Front Hub Puller for removing the front hub if it gets locked onto the driveshaft, and Hex Keys for M4 & M3 Socket Head Cap Screw Bolts. These are high Strength hex keys, and should be the only hex keys used on the Drive. This will avoid "cam-out" when tightening the bolts.
5. Mounting Plates – A carbon fiber fuselage plate, a carbon fiber motor mounting plate, and a carbon fiber rear support plate.
6. Needle bearing for rear support with rubber mounting grommet.
7. Rubber Mounts – These are Budd Engineering "Soft" Mounts. Stiff mounts are not recommended. They will cause unacceptable vibration at full throttle .
8. A 10cc Syringe of Rheolube 347A Grease from Nye Lubricants Inc.

Removing the Drive from its Box

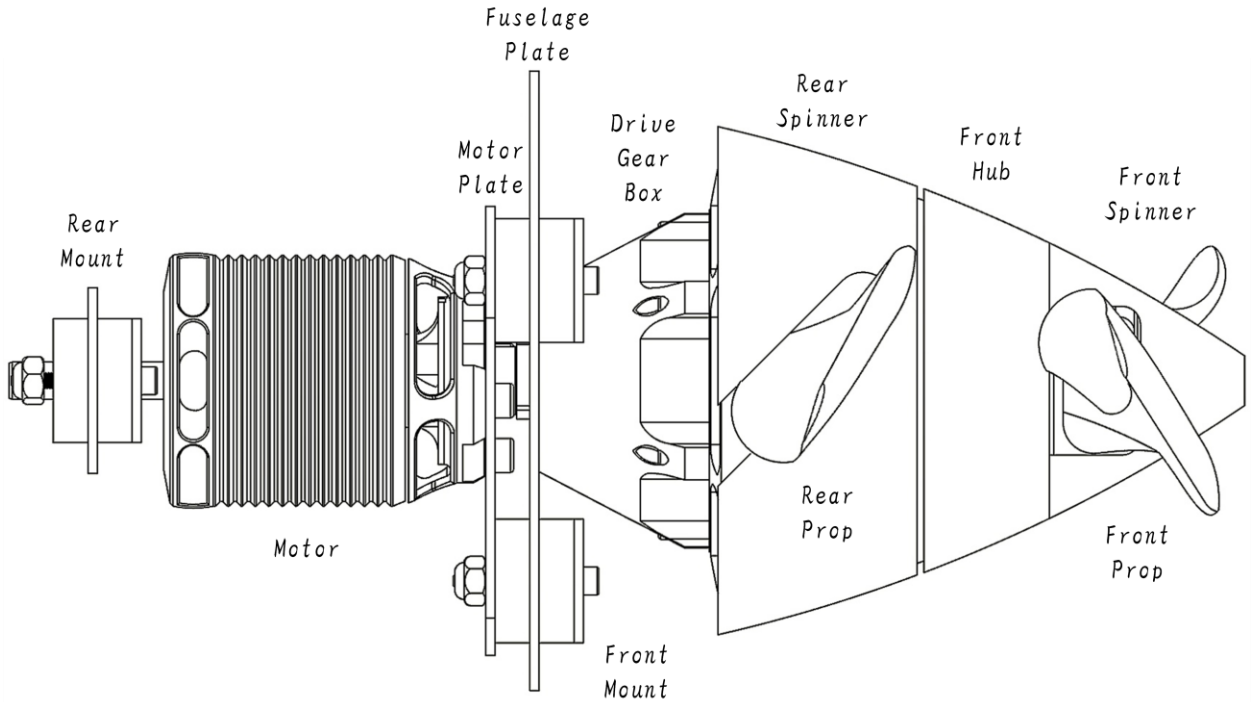
The Drive and Motor are held together with a cardboard insert that protects the system during shipment.

The cardboard insert is removed by removing the Front Spinner Bolt, the front Spinner, the two Prop Nuts, and the Front Hub.

The Drive unit is not permanently attached to the motor rotor shaft. For shipment purposes it is just loosely assembled. It can be removed by just pulling the motor and the Drive unit apart.

System Components

Your Contra Rotating Propeller System is comprised of the following components:



V4 Contra Rotating Drive

1. The Motor – Typically, this is an outrunner helicopter motor with a KV in the range from 800 rpm/V to 950 rpm/V
2. The Drive – This is the primary gearbox assembly. It clamps onto the motor rotor shaft with a collapsible collet that is attached with an M4 cap screw bolt inside the Drive. The rear hub (not shown ..) on the front of the Drive must be removed in order to get access to this M4 cap screw bolt.
3. *The Rear Spinner* – The rear spinner is held on with the rear prop nut. The prop must be installed first before the rear spinner is installed.
4. *The Front Hub* – The front hub supports the front prop. It is locked on to the Drive driveshaft with a collapsing collet. (not shown ..) There are spacer shims under the front hub collet that are used to adjust the spacing between the rear hub and the rear spinner. Different brands of props can have different hub heights, which might require adding or removing these spacer shims.
5. *The Front Spinner* – The front spinner is held on with an M4 socket head cap screw that screws into a threaded hole in the Drive driveshaft. (not shown ..)
6. *Motor Mounting Plates* – Carbon fiber Fuselage Plate, Motor Plate, and Rear Support.
7. *Motor Mounts* – Budd Engineering front and rear rubber mounts. (“soft” durometer ..)

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 there are turbulent forces that buffet each prop as the front and rear blades pass each other. This happens four times per revolution, and consequently these turbulent forces impact the propeller blades at four times the frequency of the spinning propellers. So, in order to avoid critical resonances, the resonant frequencies of the propeller blades must be four times 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.

The rear propeller 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 either the front or the rear, whichever is appropriate. This means that it is not possible to incorrectly assemble either prop.

The Motor

The motor is typically an outrunner helicopter motor that has been modified for use in a Contra Drive application.

The modifications that have been made are typically as follows:

1. The motor rotor shaft has been extended 25mm out from the rear of the motor. This shaft extension is then supported with a needle bearing that is mounted into a carbon fiber rear support plate.
2. A second front bearing has been added. The outer race of this second bearing is supported by the carbon fiber motor mounting plate so that axial loads can be transferred from the bearing inner race, through the bearing balls, into the outer race, and into the motor plate.
3. A brass spacer tube has been installed between the front and rear bearings. This is so that axial loads can be transferred from the rear bearing to the front bearings. This transfers all axial loads to the two front bearings, and prevents any axial loads from being supported by the rear bearing.

The Motor Rotor Magnets are resistant to temperatures up to 150C, and the Stator Winding is resistant to temperatures up to 300C. However, the grease inside the bearings will likely fail at a lower temperature, so it is recommended that the outside motor case temperature be kept to less than 80C.

The Electronic Speed Control

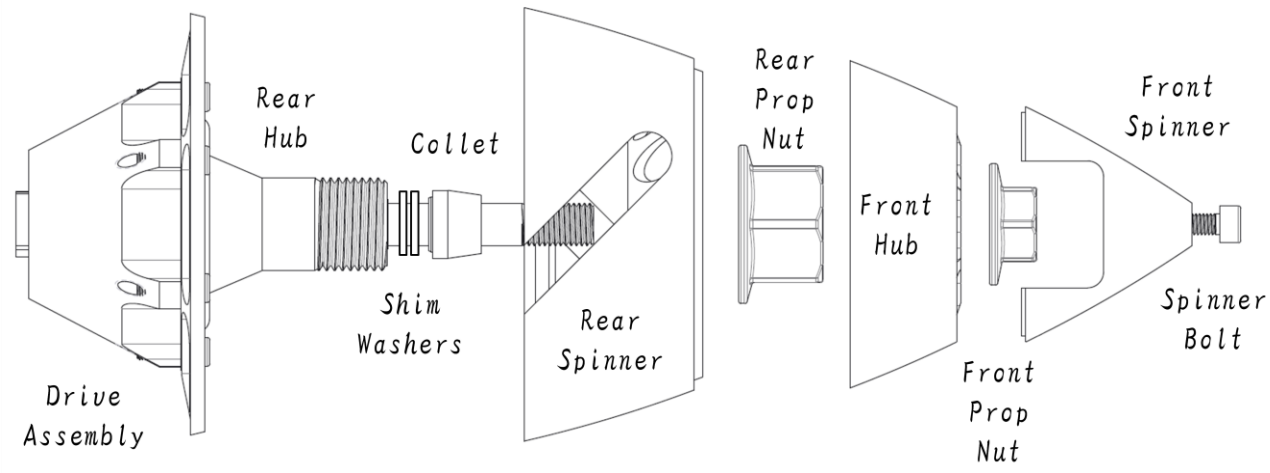
Your Contra Rotating Propeller Drive System does not come with an Electronic Speed Control. This must be provided by you. Many Speed Controls will work, but they must be capable of working with brushless outrunner motors, and they must be capable of handling up to 100A intermittently.

Speed Controllers that have been tested are the Jeti MasterSpin Opto 99, the Jeti Mezon 90, 95, & 130, and the Castle 80HV. My favorite is the Jeti Mezon 130 Lite. It runs ice cold. It has lots of braking power, and it has a BEC that I use to run my RX, my servos, and I keep a small backup Lipo charged as well.

Installing the Drive on the Motor

Assembling and installing your Contra-Rotating Propeller Drive on the motor is not difficult, but it does require you to disassemble the Drive Unit.

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

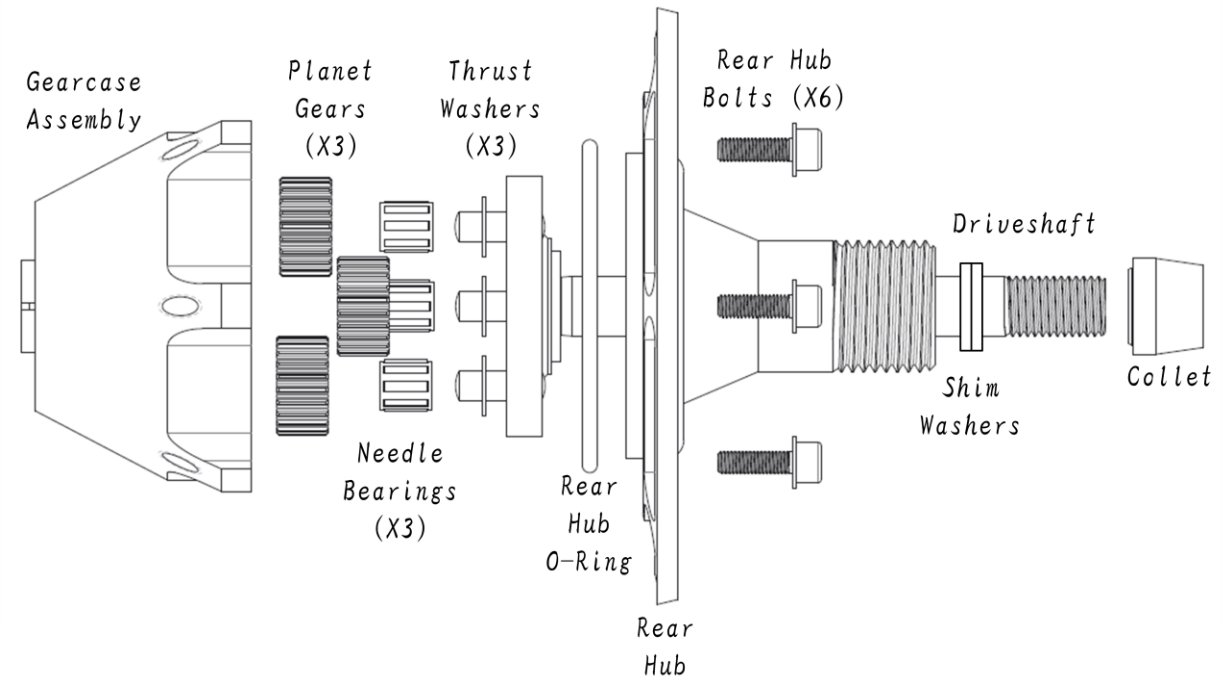


Spinner Removal

One important thing to note is that the nut holding the rear propeller (Rear Prop Nut ..) has a left-hand thread, so it will be necessary to turn it in the opposite, clockwise direction, when removing it. Also, watch out for the Collet. It can easily drop off and get lost, and there are shim washers underneath it that can do the same.

Once the Spinners have been disassembled, the next step is to remove the six M3 socket head cap screws on the face of the Rear Hub. They are used to compress a spring washer, so loosen them all evenly to prevent the rear hub from distorting.

Now it will be possible to pull the Rear Hub away from the Gearcase Housing and disassemble the Drive as follows:



Contra Drive Disassembly

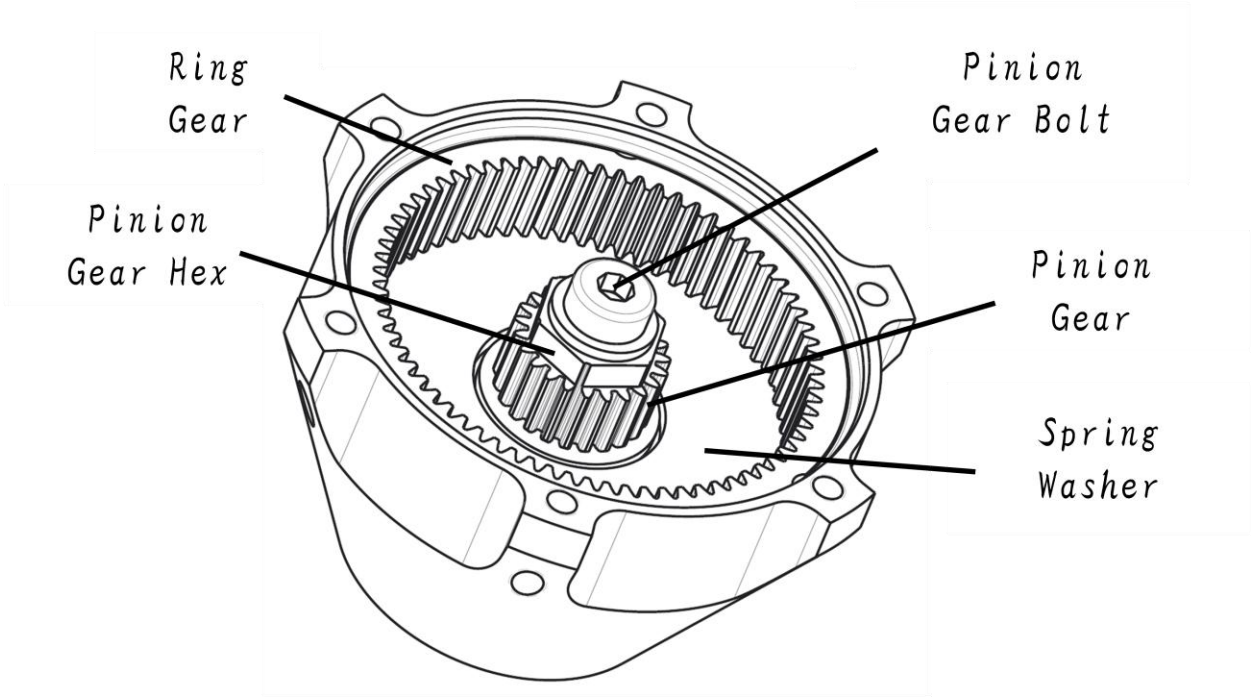
The parts shown are as follows:

1. *Planet Gears* – There are three planet gears that slide over the Needle Bearings.
2. *Needle Bearings* – There are three Needle Bearings that slide over the dowel pins on the Driveshaft.
3. *Thrust Washers* – There are three Thrust Washers that slide over the dowel pins on the Driveshaft. The go on first before the Needle Bearings.
4. *Rear Hub O-Ring* – There is an O-Ring that stretches over the ledge on the underside of the Rear Hub. This seals the joint between the Gearcase and the Rear Hub.
5. *Rear Hub* – The Rear Hub bolts to the front of the Gearcase Assembly. It holds the Driveshaft, and the Driveshaft Bearings.
6. *Rear Hub Bolts* – There are six Rear Hub Bolt Assemblies that are used to bolt the Rear Assembly to the Gearcase Assembly. They are used to compress a spring washer, so loosen them all evenly to prevent the rear hub from distorting.
7. *Shim Washers* – There are typically two Shim Washers. These are used to adjust the spacing between the Front Hub and the Rear Spinner. Different brands of props will have variation in their hub height, which can cause the gap between the Front Hub and the Rear Spinner to vary, and these Shim Washers can be used to correct for this.
8. *Driveshaft* – The Driveshaft turns the Front Prop
9. *Collet* – This is a tapered Collet that is used to lock the front Hub to the Driveshaft when the Front Prop Nut is tightened.

The Planet Gears, Needle Bearings, Thrust Washers, and Rear Hub O-Ring do not actually have to be disassembled, but they may come apart anyway, and they are shown in the illustration in case this happens. Make sure to reassemble all parts in the order shown.

At this point all of the components, except the Gearcase Assembly, can be carefully put aside, (preferably on top of a clean rag …) and the Gearcase Assembly can be assembled to the motor.

The inside of the Gearcase assembly looks like this:



Gearcase Assembly Without Rear Hub

You should be able to see these components:

1. *Pinion Gear* – The Pinion Gear has a hex shape machined into its top surface. This is so that you can use a wrench to hold the pinion gear when you tighten the Pinion Gear Bolt. If you don't do this the Pinion Gear will turn, and it will not be possible to tighten the bolt.
2. *Ring Gear* – The Ring Gear is held in the Gearcase with an o-ring. It is possible to remove the Ring Gear by rapping the Gearcase Assembly on a hard surface, but it is not necessary to remove the Ring Gear when you are installing the Drive onto the motor.
3. *Pinion Gear Bolt* – There is a collapsible collet underneath the Pinion Gear that collapses down onto the motor shaft when the Pinion Gear Bolt is tightened. This is how the Gearcase Assembly is attached to the motor shaft.
4. *Spring Washer* – The bottom of the Gearcase is actually a steel spring washer that covers up the main bearings and the grease reservoir. When the Rear Hub is bolted to the Gearcase, the Ring Gear is pushed against this Spring Washer, which deflects and creates a residual compressive force that holds the Ring Gear in place while the Drive is under load.

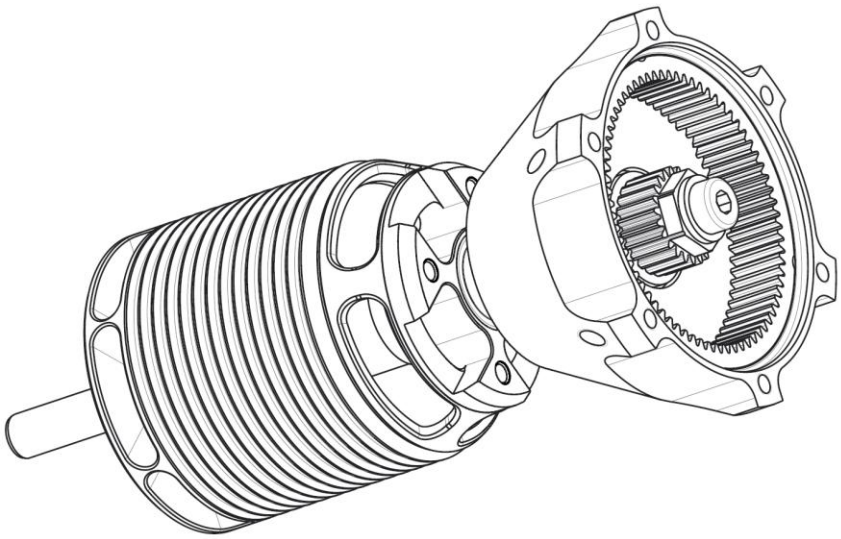
Begin by making sure that the pinion gear bolt is loose, and then push the Gearcase Assembly on to the motor shaft until it bottoms out.

Use a wrench (spanner ..) to hold the Pinion Gear using the Hex Shape that is machined into the top of the Pinion Gear.

Use the supplied Hex Key to tighten the Pinion Gear Bolt. It is necessary that this bolt be tightened properly. It must not be loose. The recommended tightening torque is 3.0 N.m.

Also, do not tighten the Pinion Gear Bolt when the Drive Assembly is not installed on the Motor Rotor Shaft. This will cause the collapsible Collet to deform, and it will likely be damaged.

Your Drive should now look like this:



Gearcase Assembly Mounted on Motor

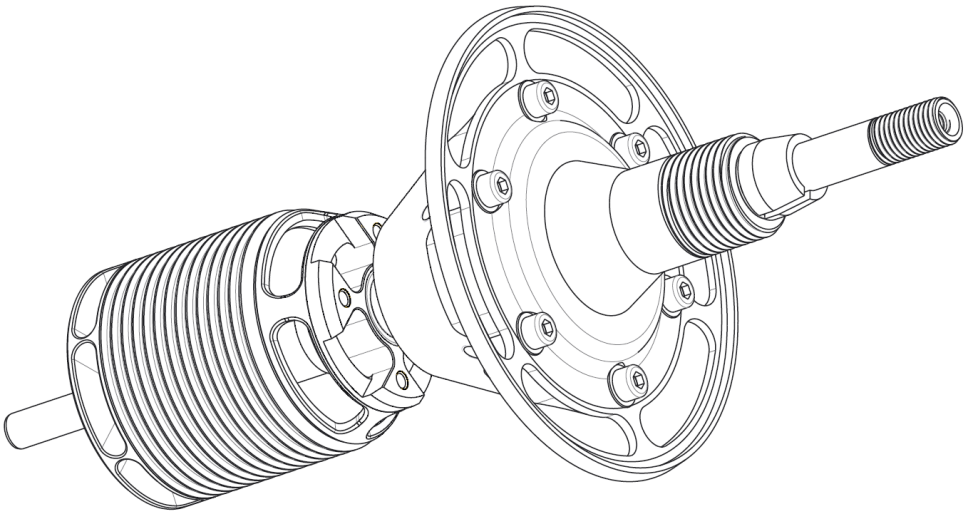
This is how the Gearcase Assembly is attached to the motor. It is now possible to bolt the Rear Hub Assembly onto the front of the Gearcase Assembly.

Make sure that that the Planet Gears, the Needle Bearings, the Thrust Washers, and the Rear Hub O-Ring are properly assembled, (See illustration “Contra Drive Disassembly” for details ..) and bolt the Rear Hub Assembly to the front of the Gearcase using the six Rear Hub Bolts.

The Rear Hub compresses the Spring Washer as the Rear Hub Bolts are tightened, so tighten them all evenly a little at a time to prevent distortion of the assembly.

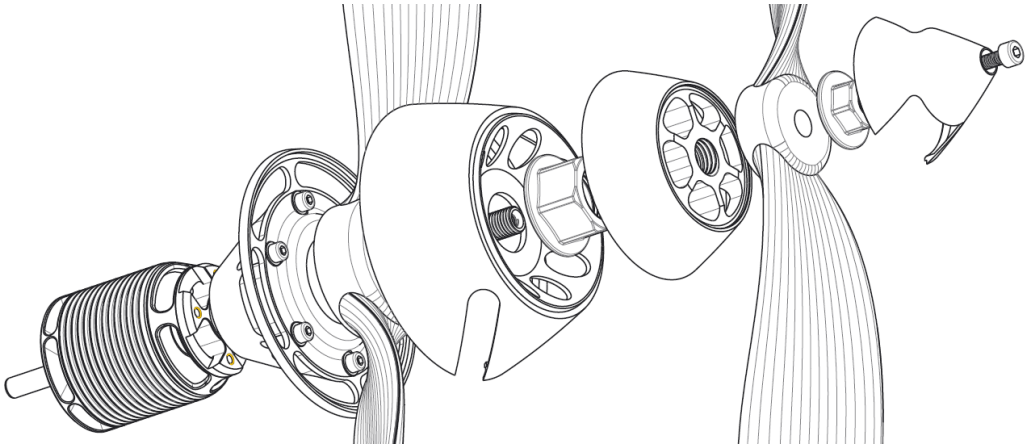
Make sure that the bolts are properly seated by checking for any gap between the Rear Hub and the front of the Gearcase. There should be no gap.

Your Drive should now look like this:



Drive Assembly Mounted on Motor

At this point, the Spinners and Propellers can be installed. The Propellers and Spinners are assembled as follows:



Assembling Props & Spinners

When assembling the Propellers and Spinners, the following guidelines must be followed:

1. It is important to remember that the Rear Prop Nut has a left-hand thread, so you need to reverse the direction when you tighten or loosen it. Clockwise is the appropriate direction for loosening.
2. The Rear Prop Nut requires a 22m spanner. It is recommended that a closed end box spanner wrench be used to avoid scratching the anodized coating on the aluminum Spinners.
3. When tightening the propeller nuts, do not hold the propellers near the tips, because the tips are fragile, and they might crack and break when you apply tightening torque.
4. The best way to mount the propellers is to ask a friend to hold both propeller blades while you tighten the Prop Nuts. This will distribute the tightening reaction torque across both blades instead of just one.

5. Do not over torque the Propellers Nuts. Doing so can cause the blades to crack or split. There is a bearing spacer tube in the front hub that can also get crushed.
6. Care must be taken to avoid over torquing the M4 bolt that holds the Front Spinner on. This is because overtorquing this bolt will elastically deform, and ovalize both the Front Spinner and the Front Hub. The M4 Spinner Bolt has a locking patch that creates a frictional thread locking torque when it is 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 it will not come loose or fall off during flight.
7. Finally, do not use Loctite thread locking compound on either of the Prop Nuts. This will make it impossible to remove the Prop Nuts after the propellers start to slip.

Maintenance

The following advice is offered:

1. Do not use Dry Lubricants like Molybdenum Disulfide. This is because dry lubricants will plate out on the running surfaces of bearings, potentially causing clearance issues.
2. Do not use any grease other than the recommended grease. (see below for recommended grease..)
3. Loctite is not needed for the M3 Socket Head Cap Screws that attach the Rear Hub to the Gearcase Housing, because these bolts are spring loaded by the Spring Washer.
4. Do not use Loctite on the Propeller Nuts. Doing so will make it impossible to remove the nuts once the propellers start to slip.
5. Do not use Loctite on the M4 Pinion Gear Bolt. Doing so will make it impossible to remove this bolt once it starts to slip.
6. Loctite should be used on the bolts that attach the Motor Plate to the front of the Motor.
7. 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 bearings, causing them to fail prematurely. Use a dry clean rag, or paper towel instead. This will leave a protective film of grease.

Recommended Bolt Torques are as Follows:

1. M3 Socket Head Cap Screws – 1.0 N.m (142 oz.in)
2. M4 Socket Head Cap Screw for Pinion Gear – 3.0 N.m (425 oz.in)
3. M4 Socket Head Cap Screw Spinner Bolt – Just enough to overcome frictional torque of the locking patch.

Grease

The recommended grease for the V4 Drive 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. This grease will not fling off due to centrifugal forces when the gearbox is spinning.

Do not use any other kind of grease. Greases that are not suitable for high speed rotating mechanisms will not properly distribute inside the gearbox during operation, and you will not achieve the advertized number of flights between greasing intervals.

There are instructions on the Nye Lubricants Inc. website that will help you locate a supplier of this grease in your region. The appropriate website link is: http://www.nyelubricants.com/contact-us

You can also find it by doing a Google search using terms like: “Rheolube 374A Grease”.

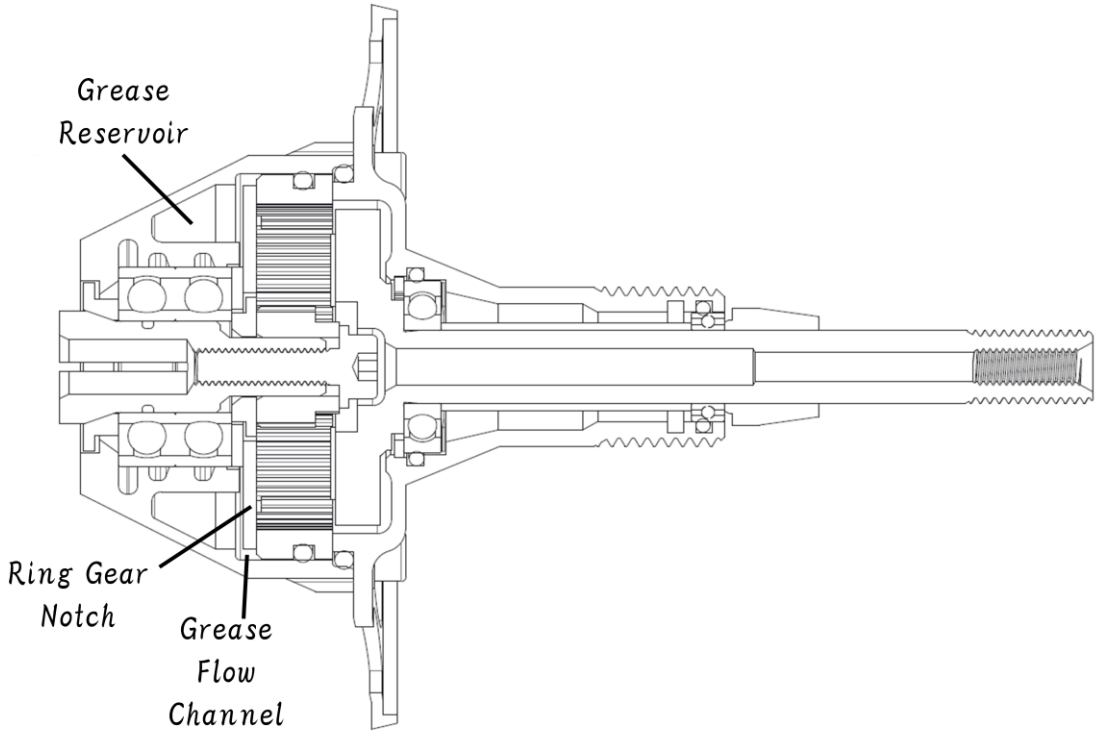
Maintenance Intervals

The Drive has been designed with a “Grease Reservoir”, which is located underneath the Spring Washer. This reservoir has been packed with grease, so there is no need for you to add any additional grease. The grease in this reservoir will last for 200 flights before the Drive needs to be regreased.

During this time the grease in the reservoir will be fed into the gearset by centrifugal force from the spinning Gearcase Assembly. There are grease channels that have been cut into the bottom surface of the Ring Gear that facilitate this. Grease will exit from these channels and then be taken up, and be distributed by the gear mesh.

If there is more grease inside the gear mesh than there is in the reservoir, centrifugal force from the spinning Gearcase Assembly will reverse the flow, and grease will migrate back into the reservoir.

This Grease Reservoir is shown in this illustration:

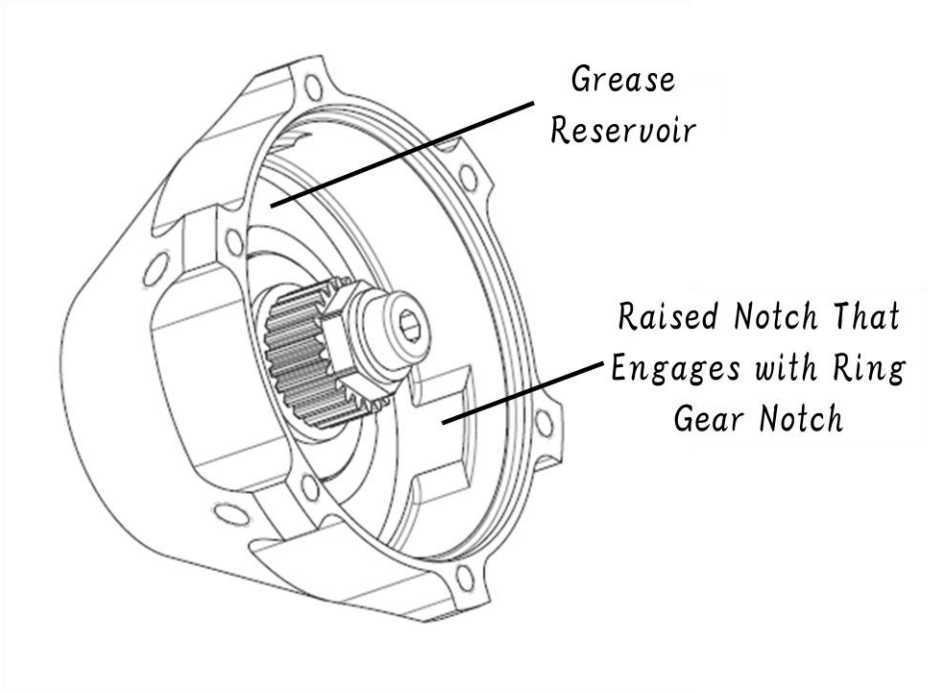


Internal Grease Reservoir

Repacking the Grease Reservoir with Grease

In order to repack the reservoir with grease, it is necessary to remove the Ring Gear, and the Spring Washer. This is done by upending the Gearcase assembly, and rapping it on a hard surface to dislodge the o-ring that holds the Ring Gear. The Ring Gear can then be removed manually, and the Spring Washer should then just fall out.

This will expose the Grease Reservoir as follows:



Grease Reservoir Exposed

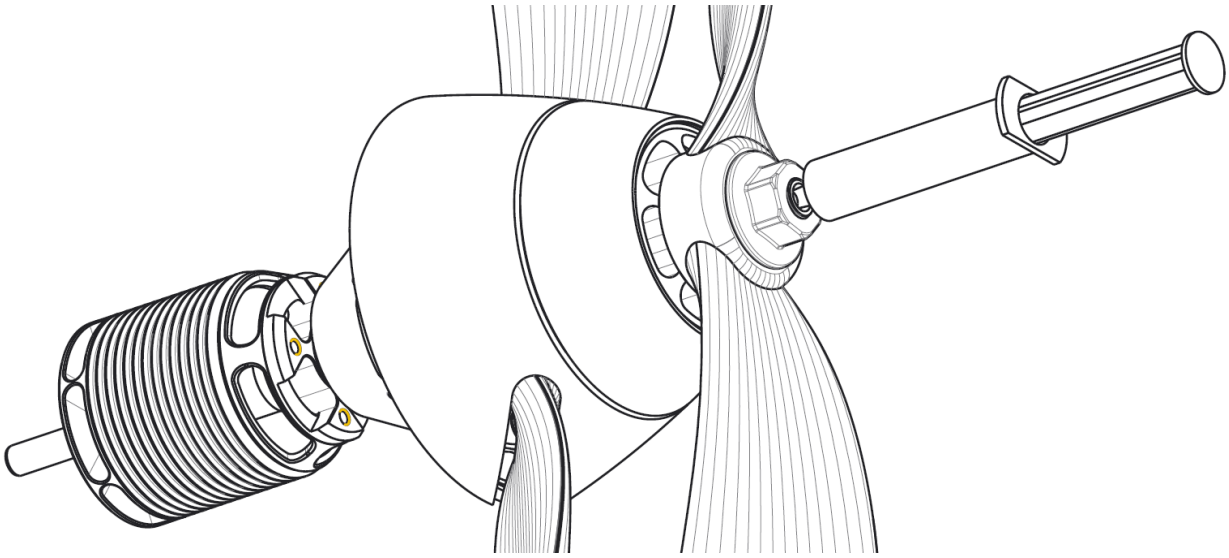
Repack the Grease Reservoir as follows:

1. Clean all of the old grease out with a rag, or a paper towel, and then pack the annular Grease Reservoir with grease.
2. Place the Spring washer back in the Gearcase with the raised outer diameter facing forward so that it will be compressed by the Ring Gear. Do not place the Spring Washer in upside down!
3. There are three notches on the outer diameter of the Ring Gear that are intended to key into the three raised notched machined into the wall of the Gearcase.
4. Insert the Ring Gear with the three notches facing towards the Gearcase so that they will engage properly as the Ring Gear is pushed in.
5. There are also three alignment notches that are visible on the top surface of the Ring Gear that can be used to visually align the Ring Gear properly with the three raised notches machined into the wall of the Gearcase.
6. When the Ring Gear is properly aligned, press it into the Gearcase until the Ring Gear O-Ring is fully compressed, and the Ring Gear is retained in the Gearcase. It should seat on top of the Spring Washer.

External Greasing

It is also possible to re-grease the Drive gearbox without disassembling it. This is done by using the supplied syringe to inject grease into the hollow center of the Driveshaft.

This is shown in the following illustration:



External Greasing

The Front Spinner is removed, and grease is injected directly into the threaded hole in the Driveshaft. No more than 3cc of grease should be injected.

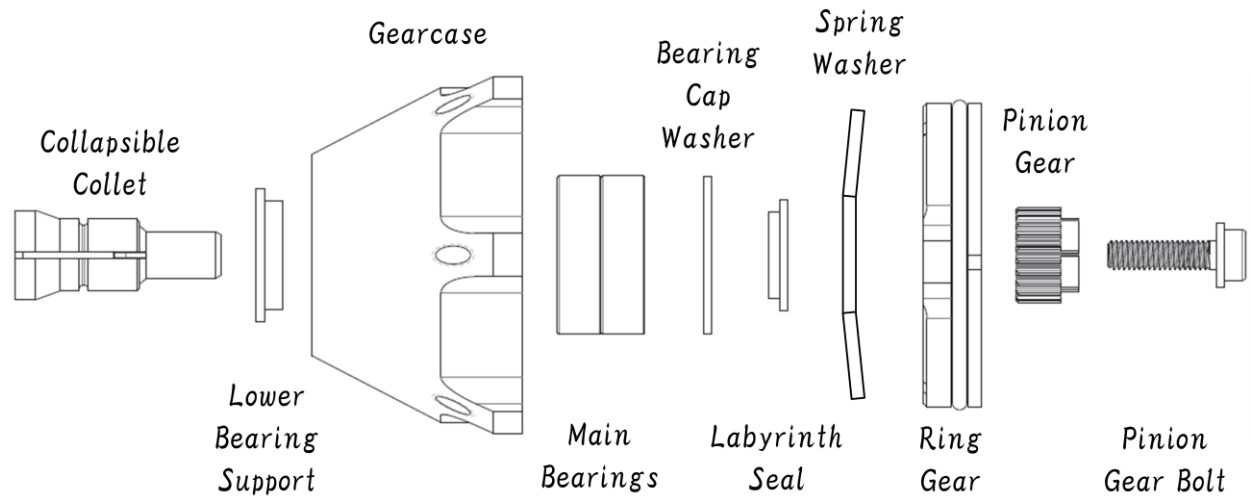
Replacing the Main Bearings

The Main Bearings are sealed, so generally there should be no need to remove them. Also, the Main Bearings are assembled into the Gearcase Assembly with a light press fit, and it is recommended that they not be removed unless they are going to be replaced. In addition, The life of the bearings is expected to equal or exceed the life of the Drive, so replacement should only be needed because of crash damage.

The specifications for replacement bearings are: SMR6900-2RS Bearing with C0 clearance, and packed with a grease suitable for high speed running. Two bearings are needed.

C0 clearance is a specification for reduced clearance bearings. This will create a high quality feel that has no bearing endplay in the Drive.

This is an exploded view of the Gearcase Assembly Components:



Internal Gearcase Assembly Components

The Main Bearings can be replaced as follows:

1. Remove the Rear Hub Assembly, the Ring Gear, and the Spring Washer.
2. Remove the Pinion Gear Bolt, the Pinion Gear, and the Labyrinth Seal.
3. Reinstall the Pinion Gear Bolt, and use it to push the Collapsible Collet out of the Back of the Gear Case Assembly.
4. Upend the Gearcase Assembly and rap it on a hard surface to remove the Bearing Cap Washer.
5. Upend the Gearcase on a flat surface again and use a properly sized socket to push on the main bearings until they drop out of the Gearcase.
6. Turn the Gearcase over, and press in replacement bearings. Press each bearing in separately, and make sure to press only on the outer race of each bearing. It is also necessary to press the bearings in without cocking, or twisting them. Do not force them in. The bearings need to be pressed lower than flush with the top surface of the bearing bore. This can be done by pressing on the top of the Bearing Cap Washer.
7. Make sure that both bearings are properly seated in the Gearcase, and then reverse the disassembly of all components. Do not forget the Bearing Cap Washer, or the Lower Bearing Support, and make sure that the Spring Washer is oriented correctly. The cone of the Spring Washer must point up towards the underside of the Ring Gear. This is so the Ring Gear can compress the Spring Washer when the Rear Hub Assembly is bolted to the Gearcase Assembly.

Balancing Propellers

Your Contra Drive propellers are balanced to within 0.05 grams when measured at the tip both along the length of the blades, and across the hub perpendicular to the blades.

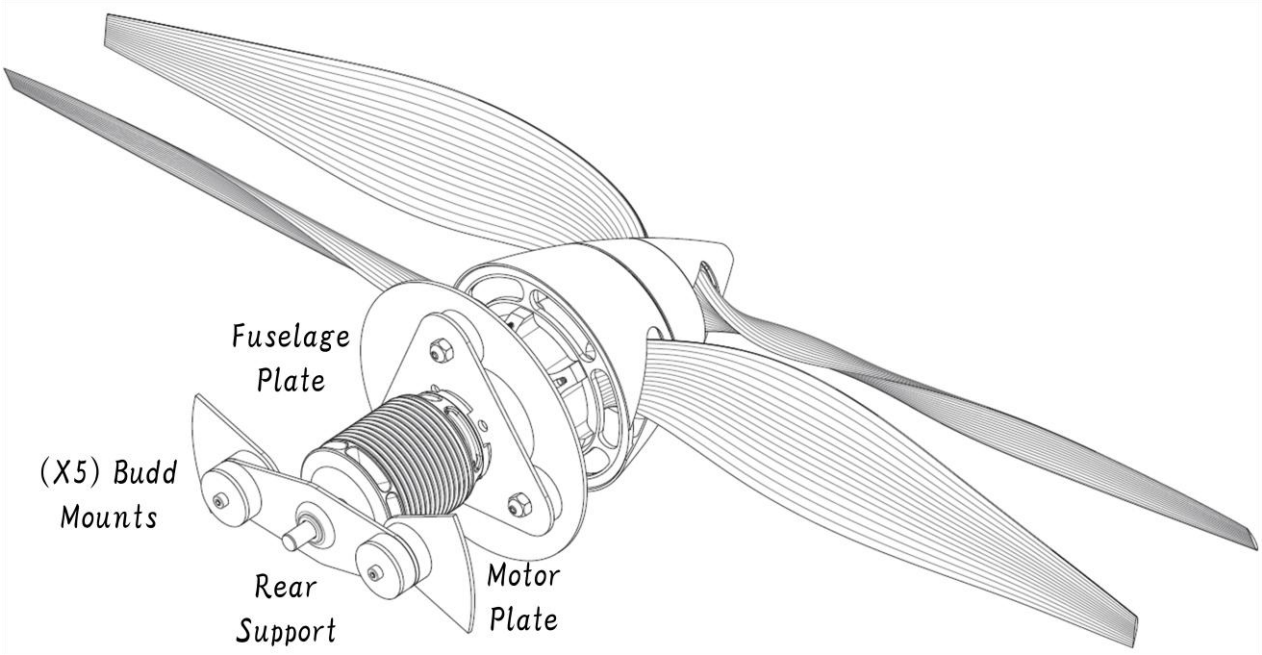
If you need to rebalance the propellers, you can do as follows:

The propeller blades are hollow, and there is access to these hollow chambers through two holes in the center hub. Balancing a propeller can be accomplished by adding a few drops of epoxy through the hub into the hollow section of the lighter blade. Use a syringe with a short flexible tube nozzle to dispense the epoxy, and then flip the blade hard enough to fling the wet epoxy to the end of the blade. If you add too much epoxy, flip the blade in the other direction to redistribute the epoxy back towards the hub. When the propeller is suitably balanced, lay it flat until the epoxy sets.

If you need to balance the propeller across the hub, add equal amounts of epoxy into both blades and set the prop on its side so the epoxy settles around the hub on the lighter side of the propeller.

Installation

This is a 3D layout view that shows a typical installation:



Typical Installation

The parts shown are as follows:

1. *Fuselage Plate* – The Fuselage Plate is trimmed to match the fuselage profile and epoxied into the nose of the plane. Typically, a nose ring spacer is made, and the flange on the Rear Hub Assembly is taped to the nose of the plane to provide alignment and fixturing for the Fuselage Plate while the epoxy dries.
2. *Rear Support* – A rubber grommet (supplied ..) is pressed into the center hole of the Rear Support, and the Needle Bearing (supplied ..) is pressed into the rubber grommet. Two Budd Mounts are then used to attach the Rear Support Assembly to two carbon fiber stanchions that are conveniently epoxied to the inside surface of the fuselage.

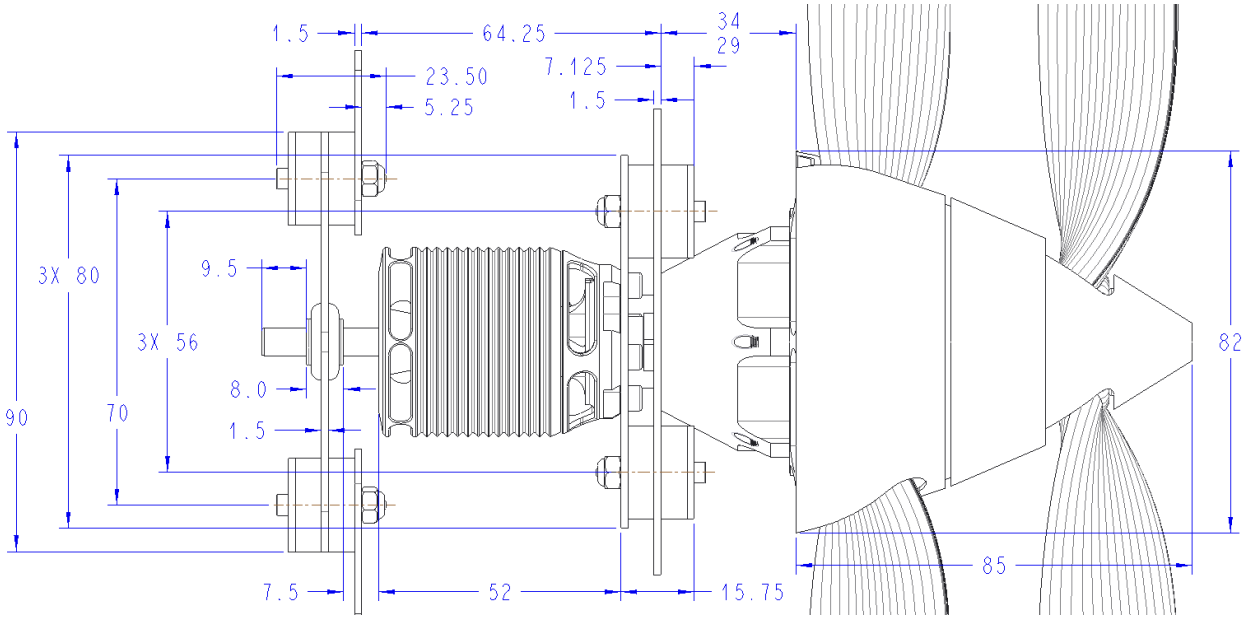
3. *Motor Plate* – The Motor Plate is bolted on to the front of the motor with four bolts. Three Budd Mounts are then used to attach the Motor Plate to the Fuselage Plate. It is recommended that Loctite be used on the four bolts.
4. *Budd Mounts* – Five Budd Mounts are included with the Drive. Three are intended for use with the front Motor Plate, and the remaining two are for use with the Rear Support Plate.

Budd Mounts are supplied with the Drive, because they have been proven to work. They have the right amount of stiffness to properly isolate the airframe from vibration at maximum throttle.

It is possible to use other types of mounts, and many customers design their own mounting devices, but it is important to understand that the mounting arrangement must function properly in order for vibration to be minimized.

If the motor mounting arrangement has not been tuned properly, damage to the Drive and the Motor can result. Specifically, fretting damage to the motor shaft, and pitting of the bearings.

A dimensioned view of a typical installation is as follows:



Dimensioned Installation

All dimensions are in millimeters. The 34/29 dimension is variable because the motor shaft is supplied extra long so that the customer can cut it back to match the Rear Spinner to the nose of the plane.

This can be done with a Dremel grinding cut-off wheel. However, make sure that the motor is properly sealed with masking tape to prevent metal filings from getting inside and sticking to the motor magnets.

If a shaft length less than 29mm is needed, the front motor bearing collet can be replaced with a shorter plastic spacer. However, make sure to avoid any contact between the Mounts and the Drive, or the Motor Plate Bolts and the Drive.

Another 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 is 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. 3mm of clearance is recommended.

Motor Setup

The motor has a kv of 900 rpm/V, and it has 14 poles. The timing should 24 degrees. The PWM frequency should be 8khz to 16khz.

The motor cables are made of non solderable enameled copper wires with solder ends. You must not shorten these cables. The winding will be irreparably damaged.

Setting a Plane Up for a Contra Drive

There are a few things to mention with regard to the setup and flying of a Contra Drive powered airplane.

Down Thrust & Right Thrust

The Motor should be set up with zero degrees of right thrust. Right thrust is not needed because the contra-rotating propellers cancel out the forces that typically cause right thrust to be required in a single prop setup.

Most planes fly well with 0.5 degrees to 0.75 degrees of down thrust, and 0.5 degrees to 0.75 degrees of positive wing incidence. However, the exact numbers to use here will depend on the design of the airframe, and pilot preference.

ESC Electronic Braking

One of the benefits of flying a Contra Drive powered airplane is the powerful braking effect that you get from having two propeller instead of only one.

It is possible to fly successfully without any ESC braking, but typical setups use 25% to 30 % of ESC braking power. It is possible to use much more than this, but if you use much more than 30% braking, the Drive will start making loud flatulent noises on the downlines that may not help with presentation points at contests.

It is also important to note that different props, and different brands of ESC, will also affect the noises that are made when using large amounts of braking power.

Setting up for Landing

The double braking effect causes a plane to slow down very quickly when the motor is throttled back, so additional care should be taken when setting up for landing. Generally you will want to come in little higher than normal, and push the nose down as you come in on final. Initially it might appear that you are

going to overshoot the landing but as soon as you pull the throttle back, the plane will slow very quickly, and you will be able to place the plane at your feet.

Rudder Profile

One of the consequences of using a zero degrees right thrust motor setup is that the rudder becomes considerably more sensitive. This is because the aerodynamic forces acting on the plane when it is flying in a hands-off trim condition are considerably smaller than when right thrust is used.

In some planes this effect manifests as “Yaw Instability” which can prevent the plane from acquiring a good “locked on” feel. A useful analogy is to consider how straight an arrow flies with and without the feathers on the tail. Without feathers, the arrow doesn’t track straight, whereas with the feathers, the arrow tracks straight and true.

There are several methods that have been used to resolve this problem:

1. One solution to this problem that has worked well has been to modify the profile of the trailing edge of the rudder to provide more aerodynamic drag. The most successful profiles have flared the trailing edge out to as much as 25mm. The effect is that the plane locks on and tracks very straight and true. The rudder seems to remain as effective as before, but it is much easier to make very precise rudder corrections without having to worry about releasing the rudder slowly to avoid overshoot when the fuselage yaws back into the line of flight.
2. Al larger rudder fin is probably the best solution. This solution is something that can be considered when designing a new plane.
3. Side force generators on the stab have also been used. This increases the effective rudder fin area without adding drag to the plane, and without having to modify the rudder fin.

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 the 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 Specific to the Contra Drive:

1. ***Use only Carbon Fiber reinforced Epoxy Resin Propellers that have been designed for Contra-Rotating Propeller Drive Systems.*** This is because plastic propellers are too heavy, and they do not have the required stiffness to avoid excessive deflection. This means there is 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.