Three-Dee

RIGID-II

M A N U A L

Version April 2016

Jan Henseleit

C A U T I O N!   I M P O R T A N T!

Read this manual carefully before open any bags.

Index

Safety Precautions:

A remote controlled model helicopter is not a toy. Keep strictly out of reach for children. A model helicopter will only perform reliably if assembled properly and regularly maintained after each flight.

Keep sufficient safety distance from the model. Always assume technical failure could happen at any given moment, which may cause the model to become out of control.

Only apply original spare parts in case of repair. Such may be acquired directly through me. Sloppy assembly or repair work, as well as lack of experience in mastering a remote control, may cause the model to become out of control and become a lethal hazard. The enormous rotating energy of the main blades impose a permanent threat to anyone in the vicinity of the model.

Careless handling may cause any given sort of lethal injuries or property damage. Therefore, refrain from overflying pedestrians and vehicles by all means.

Safety is the highest commandment within the scope of your sole responsibility.

The particular hazards involved are explicitly mentioned here, due to the fact that neither the manufacturer nor the seller of these kit products has any influence on their use and operation.

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Jan Henseleit.

Three-Dee RIGID – II (700 – 800)

TDR-II is the successor of the TDR - composed with a revolutionary architecture of the core mechanic for 700 to 800mm main blades.

Based on the possible drive power and tail boom length, this model helicopter actually has an 800mm dimension. Due to the stretched slant aerodynamic canopy, the model appears much smarter. With such design, it is not apparent that the tail boom length was constructed to accommodate up to 800mm main blades.

Far more versatile than the old TDR, this new design offers a tremendously broad spectrum of setups and applications. The helicopter achieves very high flight velocities. Therefore it is predestinated for elegant and wide aerial maneuvers. The structure of the TDR-II mechanic is extremely firm and stiff. Therefore it will also cope with any given 3D strain.

Furthermore, the core mechanic is suitable for scale model application, due to the robust gear unit with a large variety of transmission ratios. The TDR-II core mechanic features compact construction with minimum outer dimensions. Therefore, in many cases it is possible to assemble it into the dome of a scale fuselage. The bottom of the fuselage remains empty, thus featuring space for scale gimmicks.

The basic concept of the 2-step gear with slanted gear wheels was maintained. However, the gear was adapted to the present demand of elevated motor power. The application of very aero dynamic canopies is extremely important for speed flight. This leads to a complete new solution for the arrangement of components in the TDR-II. The Motor is now positioned at the rear of the main rotor shaft and the flight batteries were rearranged from the bottom of the model to the front tip. This leads to the compact slant and firm core mechanic, making it advanced crash proof due to its structure.

The necessity to integrate all servos in such manner, avoiding them to bulge out on the sides, lead to the development of a complete new swash plate linkage: the (**LDS**- **L**inear **D**rive **S**ystem) featuring maximum linearity even with large collective and cyclic pitch amplitude.

Servo horns are now replaced with gear wheels, which drive the swash plate accordingly by gear rods. Herewith, it is now possible to enable unbiased cyclic amplitudes even under high collective pitch conditions.

The demand for absolute zero backlash within the pinion tooth rod combination is accomplished by adjustable pre tension. Combined with the new fanged extremely flat swash plate (?), composed with large diameter ball bearing, renders an unparalleled rigidity of the main blade linkage.

The ideal Servos for this helicopter are servos that allow slightly more travel than usual servos. Such is commonly provided by programmable servos. They provide programmable enhanced travel distance. Please also refer to specifications.

However, alternative blade grip linkage positions also enable the use of standard servos.

A variety of motor pinions offer a broad spectrum of transmission ratios. Ratios between approx. 9:1 up to 15:1 are available in fine gradation. This offers the possibility to cover setups between speed flight and scale modeling.

Both gear stages comprise a pair of gear wheels in brass and heat proof PEEK. The transmission gear is dimensioned for Power peaks up to 15KW. The PEEK main rotor shaft gear wheel has an impressive height of 35mm.

The tail rotor shaft is driven by an 8mm wide tooth belt. The belt is kept under permanent and constant tension with a damped suspension strut.

Even under peak load, the complete mechanic performs very silent. At no point does it give the impression to have reached any performance limit. It converts any given motor power effortlessly into flight speed without the usual cranking and creaking gear noises.

The tail boom is of high value fabric. It has a rigid profile similar to that of an airplane wing, made of very light carbon fiber. During speed flight in a slanted upward position, this profile renders the lowest possible air flow CW values. The tail boom is 50mm tall and 26.5mm at the widest part. Transmission belt and tail linkage rod easily fit into the tail boom.

The two very light and slanted tail fins join at the bottom. They are of such enormous stability that they serve as a third tripod leg upon use of the retractable landing gear.

The batteries are accommodated with a rapid exchange system. A battery set may be exchanged within seconds at the front side of the core mechanic module. Batteries ranging from 12S to 16S, split into 2 individual packs, will fit into the exchange system. Please refer to the specifications for maximum dimensions of batteries.

The main rotor shaft is made of a hollow shaft 15mm in diameter with a 2mm wall thickness. The intermediate shaft has a 12mm diameter and 2mm wall thickness. The robust blade shaft has a 10mm diameter. All shafts are hardened.

The main rotor head is designed for continuous 2700 RPM. It includes adjustable blade shaft damping. Readjustments are swiftly possible on site with a simple 3mm rod. Disassembling the main rotor head for such purpose is history. In total, the TDR-II surprises with many extraordinary solutions, making this helicopter something very precious.

In the basic version, the TDR-II is shipped with a glass fabric canopy and standard landing gear. The more valuable carbon fabric canopy and the retracting landing gear are available as options. With an appropriate setup, the TDR-II is an extremely fast trainer and will achieve up to approx. 265 Km/h in horizontal flight and with retracted landing gear.

Upon pulling upward after overflying, it converts the forward velocity into such tremendous heights that you can't believe this is a helicopter you are flying.

Another very interesting aspect is the fact that you may convert the TDR-II into a TDS (pure speed machine) later on. All you need to replace is the tail boom, the canopy and the battery accommodation.

TDS prototypes have been very successful at the IRCHA 2015 speed contest (first and third place!). The contest was attended with an improper quick and dirty setup because of the lack of time for any better setup. The average speed recorded in accordance to FAI rules was 285 Km/h. No sky-diving down from orbit.

The TDS options will be available later, after finalizing the TDS development. The simple conversion between the two models is because the core mechanic module remains identical. Of course, the TDS will also be available as a complete helicopter.

Technical specification and RC set up recommendation:

Name	**TDR-II**
Manufacturer and sales	Henseleit Helicopters
Main blade diameter	1600mm to 1800mm
Main blade size	700mm to 800mm
Recommended main blades	700mm to 760mm / approx. 63mm width / 190 to 240g Blade grip width 12mm (optional with 14mm with removed screw socket washers)
Tail blades	105mm to 125mm carbon blades
Empty weight of mechanics incl. canopy	2.4kg
Takeoff weight	5.6kg to 6kg, depending on applied motor type and battery
Length from canopy tip to fin tip	1450mm
Total height	350mm
Maximum width of landing gear	200mm
Maximum width of canopy	110mm
Recommended motor	**KONTRONIK** **PYRO 800-48** (the perfect motor for this helicopter. It runs very smooth and efficiently. It has a strong torque moment and will perform with a reasonably good flight time. The power is more than enough for 98% of all applications. Even the achievable maximum velocity will hardly be less than with a P850 competition type motor, due to the perfect aerodynamics of the TDR-II. **PYRO 850-50-Competition** (only recommended for speed contest application.) I offer both engines as special editions with matching shafts. The 8mm shaft is reduced to 23mm length, measured from the bearing plate.
Recommended ESC	**KONTRONIK Cool KOSMIK 200 HV** I offer this KOSMIK as special edition with rounded edges on the outer cooling fins.
Transmission ratios with available pinions	13Z 14.66 : 1 14Z 13.61 : 1 15Z 12.71 : 1 16Z 11.91 : 1 17Z 11.21 : 1 18Z 10.59 : 1 (Perfect for PYRO 800-48 with 14S) 19Z 10.03 : 1 20Z 9.53 : 1 (Perfect for PYRO 850-50 speed setup with 14S) 21Z 9.08 : 1 All pinions have a bore diameter of 8mm. Reduction sleeves for 6mm motor shafts are available as option.
Transmission between main and tail rotor	1 : 4.88
Transmission intermediate shaft to main rotor	2,684 : 1
Recommended main rotor RPM	1300 to 2300 RPM (All round and 3D) 2000 to 2600 RPM (Speed)
V-max. at straight horizontal flight	Up to 265 Km/h with PYRO 850-50 Competition at 14S, retractable landing gear and X 713S main blades.

Recommended swash plate servos

Strong and fast, high-quality HV digital servos are in standard size.

If they are programmable servos, whereby travel is extendable, actuating forces between 150 N/cm and 200 N/cm are definitely sufficient. In the case of standard servos without extendable travel, I recommend servos with a minimum of 200 N/cm torque force. The servo exit shaft needs to be compatible with a Futaba pinion. Servo horns are not needed because special gear wheels are mounted onto the servo exit shaft. I recommend the use of programmable servos in order to fully exploit the benefits of the new fanged(?) linear swash plate linkage system. Such programmable servos with do-it-yourself travel determination usually come with a larger travel to start with. Ideal travel is approx. +/- 55° at 100% End Point Settings in your transmitter before connecting your FBL System. Presently, only a few vendors offer such servos. However, there are movements on the market and I am sure that a greater choice will be available soon. Such servos provide several advantages. A soft start upon power up is only one advantage as it reduces stress on the entire linkage system if you power up before the blades are properly aligned.

Recommended HV servos are listed actually on our website - see the TDR-II/technical data. Of course, non-programmable servos are applicable as well. In that case, the linkage of the blade grip is positioned further to the middle.

Recommended Flybarless System

The absolute, most-perfect match is the Mikado V-Stabi NEO for this helicopter.

It is an all-in-one solution, precisely as I always wished for. In connection with the V-BAR remote control it is even possible to recalibrate parameters literally on-the-fly. There is nothing faster and more convenient. Due to the enhanced aerodynamics, the helicopter may pick up speed very swiftly even at low RPM. Therefore, it is important to invest in a good flybarless system in order to avoid early contact with physical limits.

The TDR-II will absolutely perform stable with the NEO basic setup for 700-size helicopters. Due to the enhanced suppression of nose-up pitching, high velocities at low RPM rates are no problem at all.

Recommended batteries

The TDR-II is designed for 12S to 16S battery systems. They have to be split up into two individual battery packs. The total weight of both batteries should not be less than 1.6Kg or exceed 2.0Kg in order to maintain a proper tail balance pivot. The maximum accommodating size of the batteries is 45 X 60 X 160mm or alternative 50 X 50 X 160mm. If the batteries are shorter than 160mm, the width dimension may be the maximum of 62mm;(add semi-colon) the maximum height is 50mm. If you are unsure, please convey your battery dimensions and I will check it in my CAD system for you.

Recommendation

2 pcs	Gens Ace B-65C-4400-7S1P	(sporty flight style approx. 1650g)
2 pcs	OptiPower 7S 4400	(sporty flight style approx. 1650g)

General information for the assembly (very important!)

Before you start, you should try to get an overview of the assembly by scrolling through the manual. It is recommended to assemble the helicopter next to your computer. You can also print the manual.

Please start at the beginning of the manual and keep with the sequence of the assembly instructions. It makes no sense to start in the middle of the manual. You can become easily stuck and lose track. Before starting a new assembly group, first read the whole chapter description and then start mounting. **It is not sufficient to view only the images because the text contains important instructions that have to be considered in any case.**

The assembly groups are packaged in nine separate plastic bags. Each plastic bag is labeled with the name of the assembly group. Bulky or long parts are packaged separately. Complex assembly groups with a great number of small parts are separated into several smaller bags. These bags are consequently numbered. Bags contain parts that can be clearly identified and not additionally labeled.

In every stage of the assembly, please open only the bags you need. The bag's label consists of two digits separated by a hyphen (e. g.: 6 - **I**). This is bag **I** of the assembly group *linkage and servo mounting* (6). The first digit specifies the assembly group and indicates the first digit of the order number of the parts of the assembly group (the order numbers of all parts of this group start with 06).

The Roman digit following the hyphen (e.g.: – **I**) numbers the corresponding bag of the assembly group. The instructions always tell you which bag you have to open at a certain moment. The parts of one bag generally belong together, so that you keep an overview.

The biggest mistake would be to open all bags at once. In the parts list of each chapter, you can find all parts of the according assembly group. Sometimes there are screws inside, which have to be used later to fix different assembly groups together. This is always described.

Attention! The drawings and 3D animations in the manual show a right-hand rotation MP(what is MP?). Left-hand rotation on this helicopter is theoretically possible, but would need some modified parts. Right-rotation helicopters are mainly used worldwide. The differences to left rotation are minimized due to the excellent flybarless systems.

Some parts of the helicopter are already pre-assembled. Nevertheless, this manual contains detailed instructions for these parts. These instructions may be helpful in case you have to disassemble or to change parts. There is **no** need for you to check the pre-assembled parts or to disassemble or tighten them! Also, the screws are secured with Loctite already if necessary.

Attention! Screws, which need to be tightened with **L**octite,(add comma) are marked with a red "**L**". Use the blue Loctite (medium strength) or a similar product. Especially with the small grub screws, do not use too much **L**octite. Otherwise, you may have problems unscrewing the grub screws.

It is not necessary to tighten all screws of the electric helicopter with **L**octite because they do not get loose depending on the kind of stress. The lens-head screws can especially be hard to unscrew if using **L**octite because of their small hexagon.

In general, all grub screws and threaded link balls, as well as the 0911 screws of the tail centre hub, have to be degreased and tightened with Loctite. The hex socket screws allowing attachment of the gears to their corresponding flange also have to be tightened with **L**octite because the plastics sets after a certain time and the screws may thus become released.

Attention! Parts that you need to pay extra attention to are marked with a red "**!**". You will also find notes for these parts in the text. Important screw tightening is marked with the recommended force. If a torque wrench is used you can be sure about the correct tightening.

In case some items do not fit, do not use excessive force. Re-think why it may not fit together and see if a little reworking might solve the problem. If you cannot solve the problem on your own, please contact me.

Have a look at the carbon-fiber reinforced parts. Use a strip of flexible sandpaper to chamfer the sharp edges if necessary.

Attention! When sanding Carbon fiber, use a fitted dust protection mask!

The helicopter consists of numerous screws and small parts. It may therefore occur that a part is missing or that the screws are not shaped correctly or that they are rejects. Unfortunately, we are not able to check every single screw. In these cases, please send us a short e-mail and we will immediately deliver the spare part.

You will find a bag with some special tools and special grease for the gears. A small extra bag (Reserve Parts) containing some established replacement screws is also included there. Some replacement parts are available if a screw is missing or a part is defective.

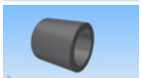
All in all, the assembly is not very demanding and does not require, besides some basic technical understanding, any special skills. Please take your time and work diligently to avoid problems that later on might be more expensive and time-consuming.

Now I wish you a lot of fun assembling the helicopter!

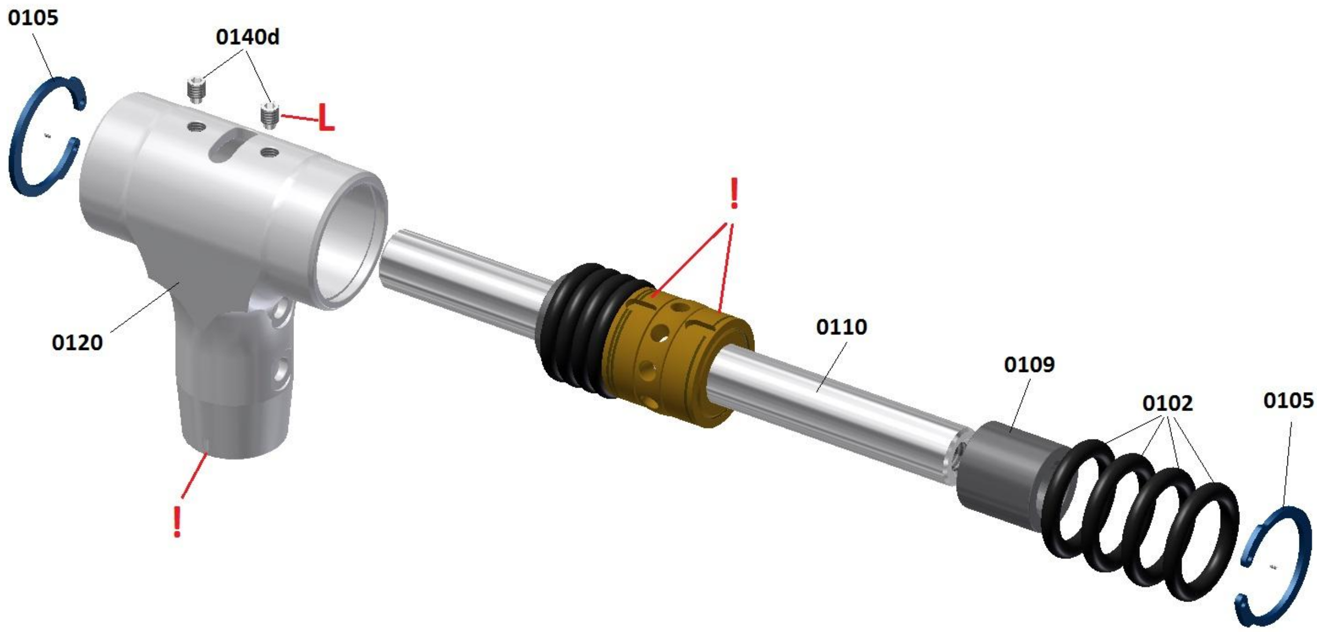
	0140a	Straining screw R-L-thread	1
	0140b	Thrust nuts R- thread	1
	0140c	Thrust nuts L- thread	1

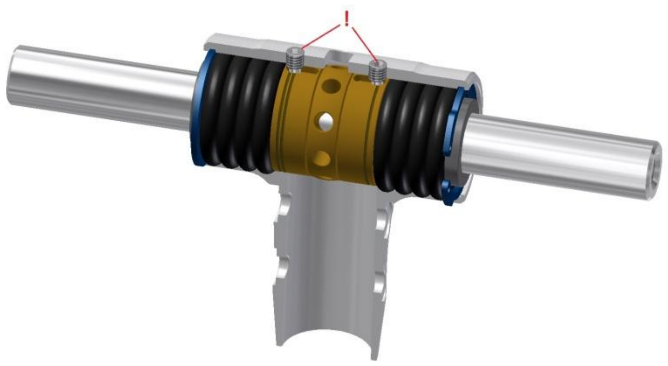
Fasten both thrust nuts 0140b and 0140c to the collar of the straining screw 0140a. Beforehand, apply some of the lubricant “DRY FLUID HELI” onto the threads. (Done before delivered) (Shake well before use) The lubrication is indispensable. Otherwise the threads will damage upon clamping under pressure.

Attention! The nut 0140b with a <u>single</u> puncture has a right-hand thread. The nut with <u>two</u> punctures has a left-hand thread. There are no markings on the straining screw. Find the matching threads by careful insertion. Preferably start with nut 0140b (right-hand thread). This will conclude the left-hand turns on the opposite side. (note the direction arrows). The milled grooves of both nuts need to be perfectly aligned by slightly unscrewing one of the nuts. A slight deviation between both gaps to the collar is irrelevant.

	0102	O-ring 14x3 NBR80	8
	0105	C-clip Seeger - JV-20	2
	0109	O-ring inner bushing	2
	0110	Feathering spindle 10x109	1
	0120	Center hub	1
	0140d	Grub screws M3x4	2

Adjustable feathering spindle damping





General function description:
The image to your left shows the assembly structure of the adjustable rotor head damper. The center part is displayed in a sliced manner for better understanding. Both of the thrust nuts are resting at their inner position close to the collar. In this position, all O-rings are relaxed.

The straining screw can be rotated with a 3mm pin through the slot on the top of the center hub 0120. The straining screw 0140a will push both thrust nuts outwards. The O-rings are squeezed axial and supported by the C-clips 0105 of the center hub. This will increase the tension onto the O-ring inner busher 0109 and the damping gets harder.

Both of the grub screws plunge into the slots of the thrust nuts and thereby prevent the rotation of the thrust nuts together with the straining screw.

Attention! Both of the grub screws may not insert to the bottom of the slots (also refer to the following assembly instruction).

First, apply some lubricant onto the O-rings 0102 and the O-ring inner bushing 0109. You may use a viscose bearing grease or the enclosed “DRY FLUID GEAR” (Shake well before use). The inside of the center hub 0120 should also be greased at the O-ring seat.

Attention! The center hub has a little milled groove on the outside of the main rotor shaft entry. This groove is necessary to center the swash plate dog(?) later on.

Position the center hub in front of you so that you see the milled groove. Only assemble the left C-clip 0105 with C-clip pliers or a set of nose pliers tooled to fit into the clamping holes of the C-clip. C-clips are punched out of sheet metal. They always have one sharp-edged side and one rounded-off side. Assemble the sharp side facing outward so that the O-rings will have their seat onto the rounded side. Once the C-clip has correctly snapped into its groove, it is movable in circles. Now turn the open side of the C-clip into the rotational direction of the main rotor shaft / center hub as displayed in the drawing. (If you look at the center hub from the top, it turns clockwise to the right)

Now, push four O-rings from the open side of the center part all the way to the averted opposite C-clip. Then insert the pre-assembled straining screw unit into the center part in such manner that the trust nut with left-hand thread (2 markings) shows to the left. Both milled grooves of the two trust nuts should now be aligned with the two M3 thread bores in the top side of the center hub. Then the next four O-rings are inserted and the second C-clip is assembled as displayed in the drawing.

Both of the O-ring inner bushing 0109 are now inserted from left and right all the way through the O-rings until the stop. Finally, the feathering spindle 0110 is inserted and aligned roughly to the middle.

The shaft usually has a tight fit in the jacks. Retain the averted opposite jack so that it will not be pushed out again while inserting the feathering spindle.

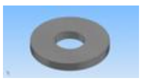
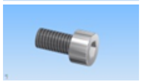
Now align the two grooves for the grub screws 0140d with their threads in the top of the center hub. Perhaps you might need a thin sharp tool to accomplish alignment. Carefully insert the grub screws 0140d into their M3 threads with a slight touch of **L**octite.

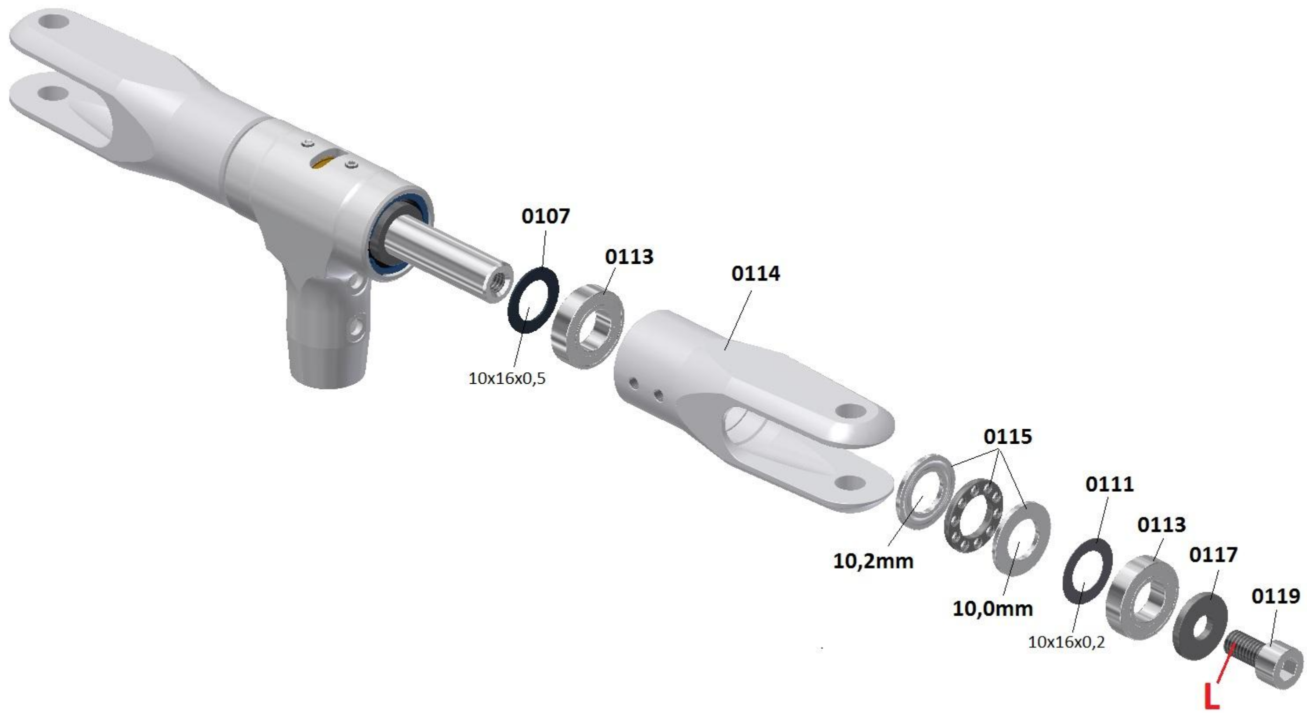
Attention! The grub screws should not be inserted aslant to avoid damage of their short thread. Now carefully screw the grub screws to the bottom stop of the grooves. At the bottom, the grub screw will be nearly level with the top of the center part.

Attention! Now the grub screws needs to be reversed exactly by one turn, equivalent to 0.5mm lash between the tip of the grub screws and the bottom of the grooves! This is very important. The blade shaft including damper unit must have enough clearance to avoid clamping nuts from hitting the grub screws during flight. Should this tend to happen, the grub screws will be forced out and damage the threads of the center hub.

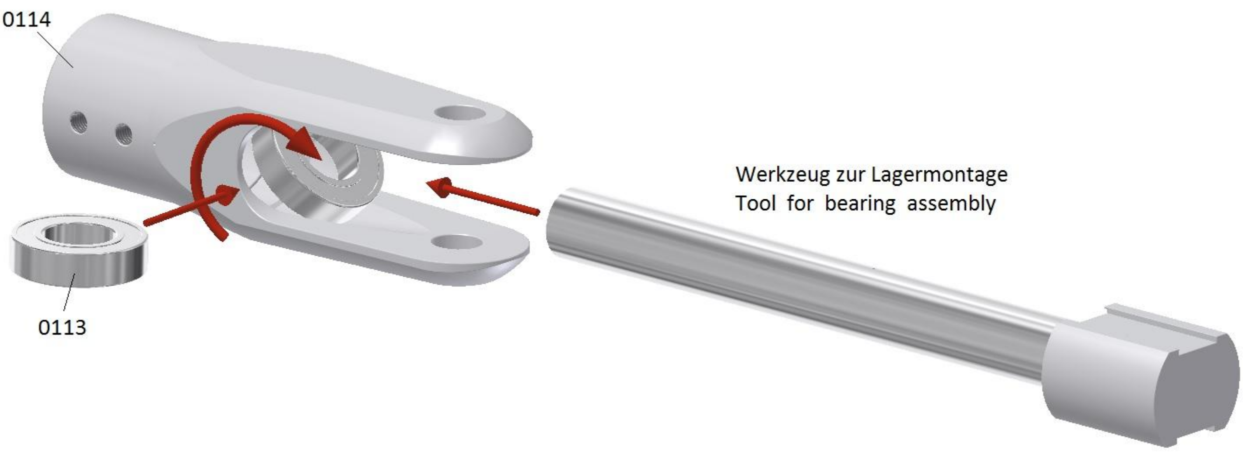
The assembly section bag contains a little bag inscribed with “rotation lock.” It contains a 4cm silicon shaft with 3mm in diameter. Later on, you will need 7mm of this silicon as rotation lock for clamping screw 0140a. Details will be referred to in the chapter “adjustments.”

Blade holder

	0107	Spacer washer 10x16x0.5	2
	0111	Spacer washer 10x16x0.2	2
	0113	Radial bearings 10x19x5	4
	0114	Blade holder	2
	0115	Axial bearing 10x18x5.5	2
	0117	Washer 6x16x2	2
	0119	Hex socket screw M6x12 -10.9	2



First assemble the blade holder with all bearings. Attention! To avoid any mistake it is important to follow a specific sequence. Both of the radial bearings 0113, which are pointing toward the center hub, are pressed into each blade holder. If necessary, expand the blade holder with hot air. Make sure not to insert the bearing aslant. Now insert the axial bearing 0115 through the fork of the blade holder. Apply enough lubricant onto all parts of the axial bearing in advance (viscose grease into hollow side of ball cage). Pay attention to the correct sequence as displayed in the drawing. Each ring has to be inserted laterally through the fork. At the beginning of the fork where the bore of the blade holder begins, the rings are swiveled into rectangular position and pushed into the bore. Make sure the rings do not swivel by 180° and carefully reassure that the grooves of the rings always point to the bearing balls. This procedure can be simplified with the aid of a pin inserted from the other side, onto which you may align the rings. The first ring to be inserted has a 10.2mm inner diameter. Then the ball cage follows with its hollow side pointing toward the center hub. Then you insert the ring with an inner diameter of 10.0mm, followed by the spacer washer 0111 (10x16x0.2) and finally the radial bearing 0113.



Attention! To avoid aslant insertion, the final radial bearing should be assembled as follows.

After the axial bearing 0115 and the spacer washer 0111 are inserted, shove the bearing laterally between the forks as displayed in the drawing and swivel by 90°. You will find an assembly pin in the tool bag. The assembly pin can be pushed through all bearings. This reassures alignment of the radial bearing into the correct axis, avoiding aslant insertion. In case the assembly pin is thwarted after the first bearing, you will need to rearrange the spacer washer 0111. Center the spacer washer for passage of assembly pin.

If the radial bearing does not enter the blade grip without force, expand the blade holder with hot air. Remove the assembly pin afterward and repeat this procedure with the second blade holder.

Finally slide both blade holders onto the feathering spindle. However, the spacer washers 0107 (10x16x0.5) need to be inserted beforehand between the O-ring inner bushing 0109 and the pre-assembled blade holder.

In case the pre-assembled blade holders do not properly slide onto the feathering spindle, the predominant cause would be a displacement of spacer washer 0111. In such case, use a pin to align the spacer washer with the rest of the bearings and rings seated within the blade holder.

Now, secure the blade holder with washers 0117 and hex socket screw 0119. Tighten both screws 0119 with Allen keys. The screws have their seat at the stop of the washers.

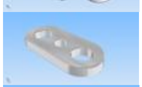
Attention! Only tighten the screws very slightly to begin with. The axial lash of both blade holders needs to be checked first. Pull both blade holders apart forcefully. Measure the distance between both edges of the blade holders with the inner beaks of a caliper. Subsequently, push both blade holders together forcefully and repeat the measurement with the inner beaks of your caliper. The difference between both readings should not exceed 0.3mm. Should this be the case, add washers (10x16x0.1) equally on both sides. The washers are found in an extra bag. Finally tighten both screws 0119 forcefully (**14Nm**) with two Allen keys.

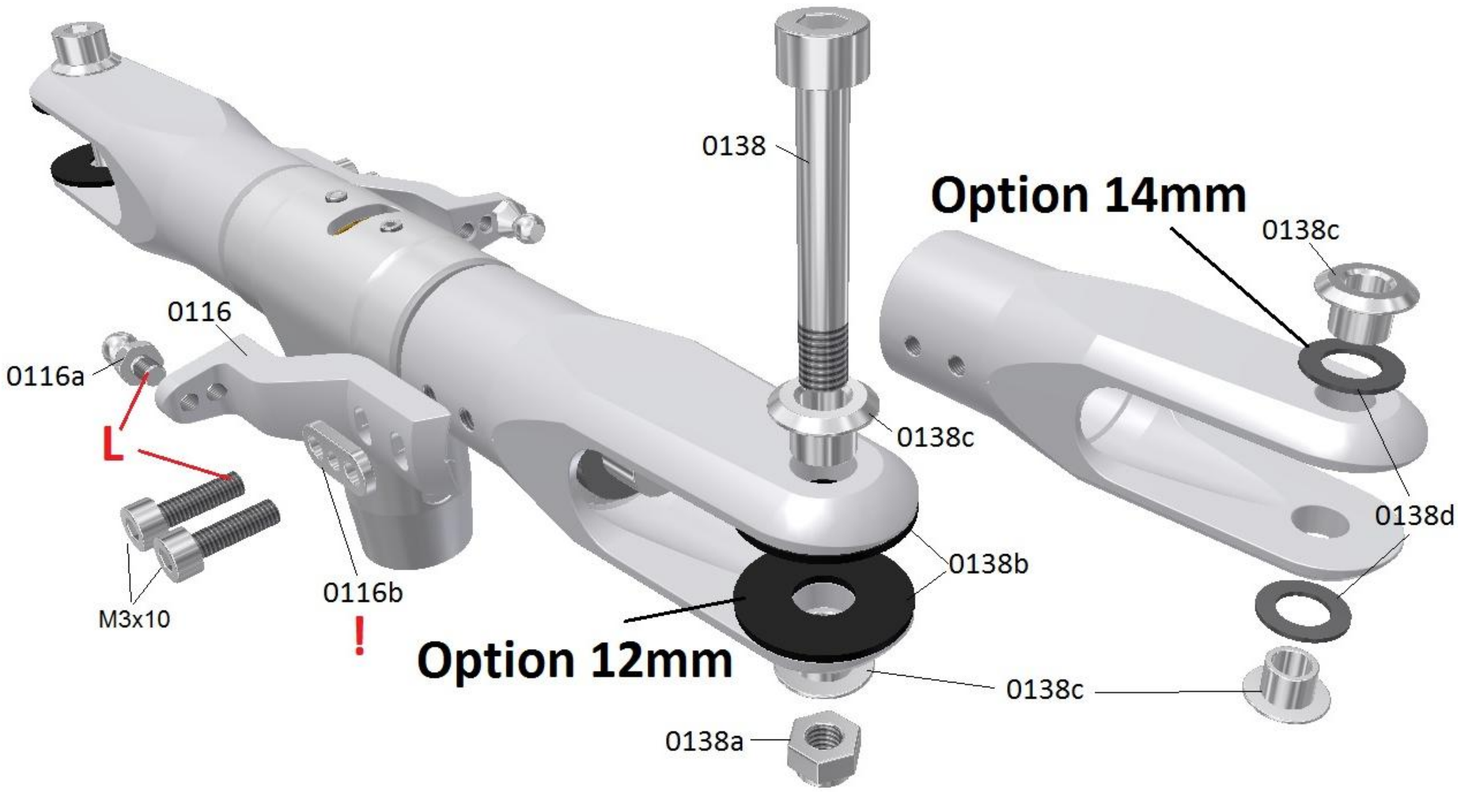
Attention! After tightening, the blade holders must still turn freely. If that is not the case, remove one set of washers. Upon release of both screws, one screw will release first. Carefully remove the blade holder unit of the first release screw. To obtain a tight grip onto the feathering spindle without damaging it, you would need a special shaft wrench. If you do not have such a tool, I recommend to remove the other blade holder with the attached feathering spindle from the center hub, in order to access the second washer. Avoid clamping nuts to slip away from the grub screws 0140d. Do so by carefully pushing the feathering spindle out of the center hub with the assembly pin. The assembly pin will serve as replacement for the feathering spindle and keep all parts in position until the spindle, including blade holders, is reinstalled.

Attention! The screws 0119 are of high-grade steel and may only be replaced by original spare parts. The use of conventional screw types bears the danger of tearing.

Please note! The basic adjustment of the rotor head damping will be outlined later on.

Do not try to pull the feathering spindle out of the bearings from the bent side after crashing. Always try to use the side that remained fairly straight. Check on the first visible bearings 0113. The other bearings usually never take any damage. Turn the inner ring of the bearings with a finger and check for smooth movement. These two bearings may be extracted without removing all other parts of the blade grip unit. Push the old feathering spindle back into the damaged bearing until the bottom of its inner ring. Then pull the bearing out by swiveling the shaft sideways to get some grip on it from the inside (if needed expand blade holder with hot air). You may also use an 8mm spindle to push the bearing out by seating the spindle onto the inner ring of the bearing through the fork side. Do not slide the blade holder units with violent force onto the new feathering spindle. Sand down the new spindle if needed, with some fine-grade emery linen, while it is rotating in a manual drill tool.

	0116	Pitch arm	2
	0116a	Threaded ball stud M3x4 - 6mm	2
	0116b	Mounting plate	2
	0138	Blade bolt M5x 33 - 10.9	2
	0138a	Nyloc nut M5	2
	0138b	Spacer for rotor 7x20x1	4
	0138c	Blade bolt bush	4
	0138d	Washer 7x12x0.7	4
	M3x10	Hex socket screw M3x10 (for 0116)	4



Before you assemble the pitch arms 0116 and the blade bolt bush 0138c, you should make some basic decisions for your desired setup. The assembly of the blade bolt bush 0138c depends on the use of either 12mm or 14mm blade roots (view the drawing above – 12 or 14mm option). In the case of 12mm main blades, the bushes 0138c are inserted directly into the bore of the blade holder 0114 without any washers.

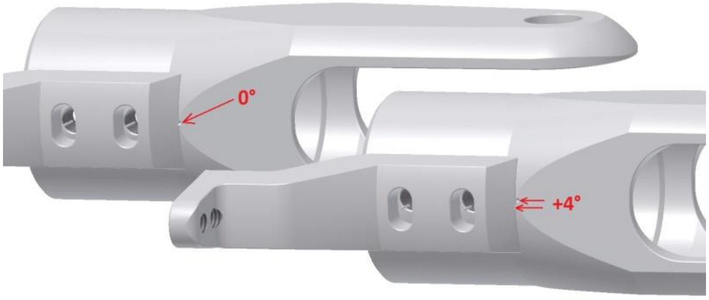
Attention! In case the bushes do not easily fit, avoid applying force onto the fork without support. Otherwise, the fork will bend. Use the special tool pin, which already had the purpose of assembling the bearings in the blade holder. The flat aluminum mold with milled grooves serves as support between the forks. Position the flat mold with grooves centered under the bores in such manner that the bushes have clearance while inserting them.

The 12mm option is concluded by the blade bolt bush 0138c protruding 0.7mm toward the inner side of the fork limbs. These protrusions will serve as accommodation for the spacer for rotor 0138b later on, preventing displacement of the spacer upon insertion of main blades.

The 14mm option is concluded by lifting the blade bold bush 0138c with the spacer for rotor 0138d before pressing them into the blade holder bores. In case the bushes slip out easily, you may secure them with a drop of Loctite. However, if the bushes are not insertable with manual force, you may use a rubber hammer or parallel vice. Never do so without the tool pin between the forks as described above. Protect the blade holder with paper when putting it onto a table, to avoid scratching the aluminum surface. Do not insert bushes askew!

The next issue is the position of the pitch arms:

Do you intend to operate your helicopter with an all-round setup comprising symmetric blades and symmetric pitch magnitudes (suitable for universal applications of normal flight, precision flight, 3D and speed between +/-12° and +/-15°)? Or is it your wish to perform a pure speed setup comprising asymmetric blade profiles with asymmetric pitch magnitudes (i.e. +16°/-8° as maximum and minimum pitch values) whereby the total pitch travel may be reduced for the sake of higher resolution and more control precision?



To enable pitch presets of +/-4°, the pitch arms 0116 are equipped with slots. The markings are placed in alignment, providing an all-round setup with 0° preset. For a pure speed setup, it is recommended to swivel the blade grip arm down to the stop of the M3 screws. This equates a preset of +4° at leveled swash plate.

Upon later adjustment of the collective pitch travels to i.e. +/-12°, the pitch values will result in 16° positive and 8° negative. So, despite of the elevated positive pitch value, a delicate pitch management with high resolution is maintained. More than -8° pitch is not even necessary for auto rotations.

Attach the pitch arms to the blade holder as individually desired and tighten the M3X10 hex socket screws in accordance to the mentioned possibilities (use **L**octite).

Attention! The mounting plate 0116b has a slight curve on one side. This curve corresponds to the curve of the pitch arm.(two words) Imperatively pay attention to make sure that these curves match toward the correct side of the pitch arm. Tighten the screws properly (**1.5Nm**). If you want to be absolutely sure that the pitch arms will not dislocate even under maximum strain, it has proven reasonable to apply some **L**octite between the blade grip and the seating of the pitch arm. This will improve the adhesion to the pitch arm.

Finally, attach the threaded ball stud 0116a to the outer threads of the pitch arms, if you have chosen the recommended programmable servos, which allow increase of travel (use **L**octite).

If you are not using programmable servos and desire pitch values exceeding +/-12° or +16°-8°, please use the middle thread of the pitch arm.

You may also attach the ball stud 0116a provisionally without **L**octite, if you are still unsure about the choice of servo travel and pitch values. After testing your FBL system, you may then determine the final position of the ball stud.

In general, the outer position renders the highest resolution with the most precise linkage, minimum linkage force and minimum lash. This is in particular very important for a speed setup, because the linkages are subjected to extremely high forces at high RPM rates. Do not use the inner position at all.

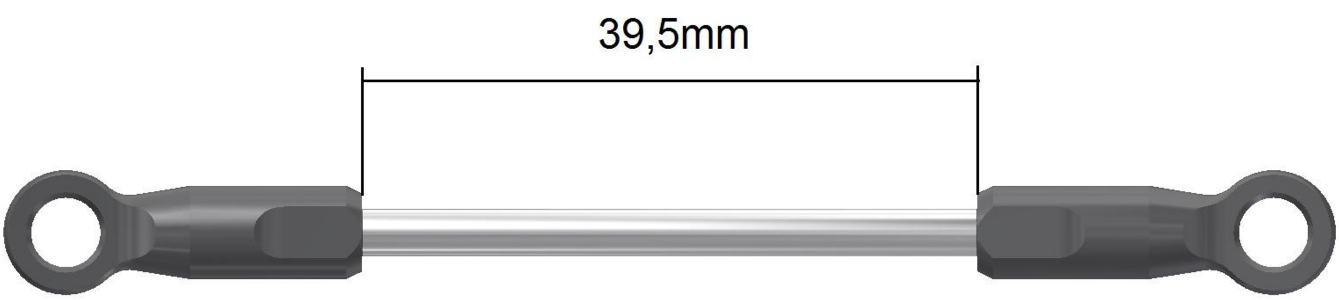
Attention! Do not use an open-end wrench to tighten the ball stud. Use a socket wrench in order to not damage the external hex.

Attach the blade bolt 0138 / 0138a and spacer 0138b slack to the bores, not releasing them, and set the completely assembled main blade head aside.

Attention! The bolts 0138 are of high-grade steel fabric and may only be replaced by original spare parts. Standard bolts bear the great danger of tearing.

Push rod for blade control

	0121	Ball link reinforced	4
	0122	Stud bolt M3 - 58mm	2
	0136	Hex socket screw M4x6 / 10.9	4



Screw the ball links 0121 on the stud bolt 0122. The distance for using the outer control should be 39.5mm. If the middle position is used shorten the distance moving the ball link a half rotation, final distance then is 39.25mm.

A total rotation of the ball link means 0.5mm moving. As the parts a totally symmetric starting position doesn`t matter. The exact adjustment will be described and done later.

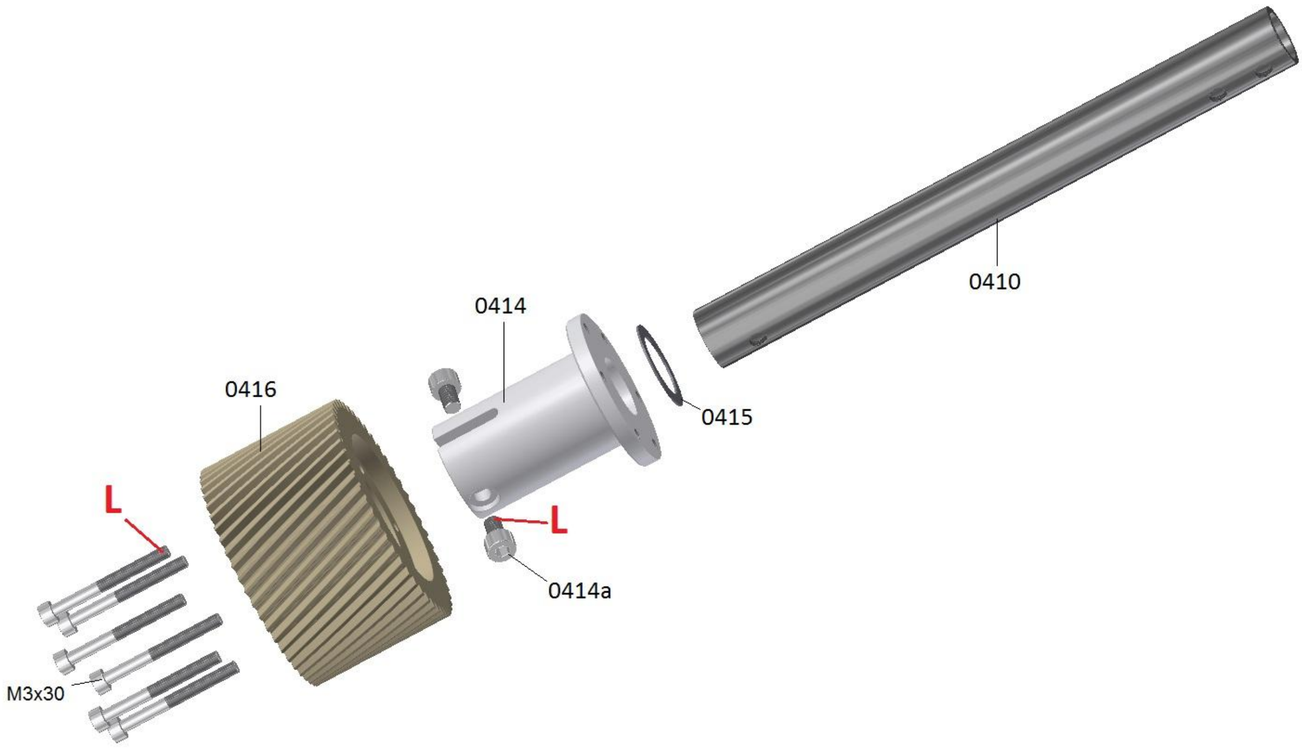
The four hex socket screw 0136 will be needed later to fix the rotor head on the main shaft.

Caution! Hex socket screw 0136 has high hardness and must be changed to an original spare part only. Standard screws bear the great danger of tearing.

Main shaft unit

Main shaft gear flange

	0410	Rotor shaft 12x15x151	1
	0414	Main shaft gear flange	1
	0414a	Hex socket screw M4x6 / 12.9	2
	0415	Spacer washer 15x21x0.5	1
	0416	Main shaft gear 51T	1
		Hex socket screw M3x30 (for 0416)	6



The PEEK gear wheel 0416 is manufactured with a tight fit. This secures a tight seat on the flange 0414 if warmed up while operating. Therefore, it has to be warmed up with a hot air gun or in the oven up to 140F to 160F. It will then easily slide onto the flange and rotate to position with mounting holes. Align the gear wheel with the mounting holes and let it cool down first.

Pay attention to carefully tighten the M3x30 screws step by step cross over, to avoid uneven tension. Here you must also use **L**octite. Eventually re tighten the screws a little more (**1.5Nm**) because the synthetic material tends to settle a little.

Slide the flange onto the main shaft side with a single M4 bore, as shown in the drawing. Now firmly tighten the hex socket screws 0414a (M4x6 steel grade 12.9) with an Allen key (**6Nm**). The flange should be held by the clamping friction and not the shearing force of the screws!

Apply **L**octite in such a way that nothing will spill into the gap between the main shaft and flange. Otherwise, it could get tough if a disassembly is needed. Apply the **L**octite directly into the M4 threads and wipe any remains on the surface of the main shaft. Upon insertion of the screws, any surplus **L**octite will be pushed into the hollow of the main shaft, where it will not bother. Do not forget the spacer washer 0415 (15x21x0.5mm) on the top end and lay the unit aside for the moment.

Swash plate

	0400	Swash plate	1
		Countersunk head screw M2,5x6 DIN 965-A2 (for 0400c)	4
	0400d	Bearing shell heat resistant	1
		Phillips screw M2,5x8 (for 0400d)	4
	0400e	Ball	1
	0400f	Threaded ball stud M3x4- 6mm	2
	0400g	Threaded ball stud M3x4- 6mm (special-elevator)	1
	0400h	Threaded ball stud M3x4- 4mm (hex socket)	2

Apply grease to the ball 0400e from the outside and to the bearing shell 0400d from the inside. Use the enclosed “DRY FLUID GEAR” (shake well before use). Insert the ball into the top of the shell. Then insert the bearing shell through the bore of the inner swash plate ring from the bottom. Secure with the four M2,5x8 cross-head screws.

Attention! Make sure that the flattened sides are aligned toward the milled pockets of the inner ring. The pockets may not be covered. Gently tighten the screws very lightly; otherwise, the bearing shell will be deformed and the ball movement gets hard. Definitely use **L**octite to fix the position of the screws. If the ball has radial lash with the inserted bearing shell, you may tighten the screws a little more to eliminate any lash. However, the ball must not be clamped. A slight axial lash of the ball has no influence on the control precision.

Don't forget to secure the ball studs 0400f and 0400g with **L**octite to the outer ring.

Attention! Do not use an open-end wrench to tighten the ball studs. Use a 5.5mm socket wrench in order not to damage the external hex.

The ball stud 0400g has a slant shape and is meant to connect the elevator rod later on.

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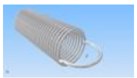
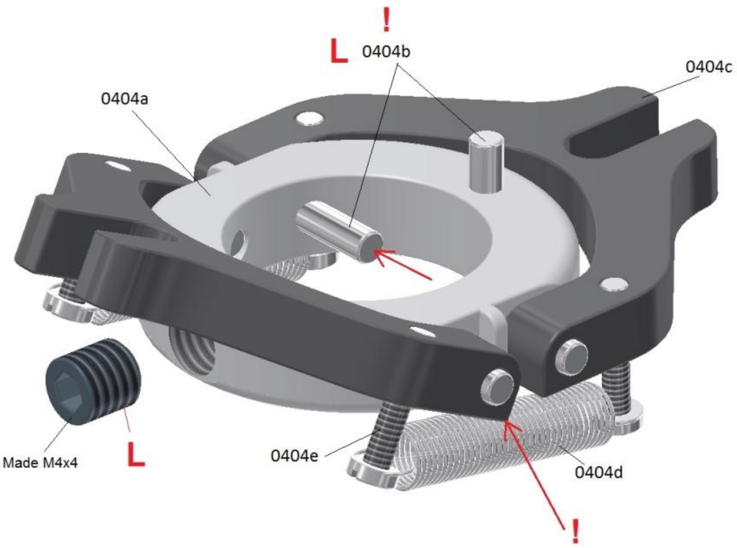
Swash plate fork

	0404a	Clamping	1
	0404b	Bearing pin 2x8	5
	0404c	Fork	2
	0404d	Tension spring	2
	0404e	Phillips srew M1,6x8	4
	0404e	Grub screw M4x4	1



The swash plate dog will be positioned right under the center hub later and clamped with an M4x4 grub screw. The pin protruding vertically upward from the swash plate dog meshes into the little milled groove at the bottom of the center hub. This simultaneously serves the purpose of anti-torsion and precise positioning. The forks are suspended swiveling on pins, serving two purposes. First, to enable a greater pitch magnitude by avoiding a blocking of the linkage joints. Second, to easily remove the linkage rods from the ball studs of the pitch arms without bending them. This is easy after folding up the forks.

The downward folding angles of the forks are limited with stops. The springs 404d settle the single-sided edges of the catch forks onto the stop (see the bottom arrow in the drawing).

Attention! Please proceed with the assembly of the four pins 0404b for the forks 0404c as follows: Insert all four pins into the clamping ring 0404a from the inside into the pin bores. Insert them just far enough so that the forks are still mountable to the clamping ring.

Attention! Install the forks so that both of the edges (see the button arrow in the drawing) point toward the bottom. The rounded sides should both point to the top so that both forks have a free swivel angle upward.

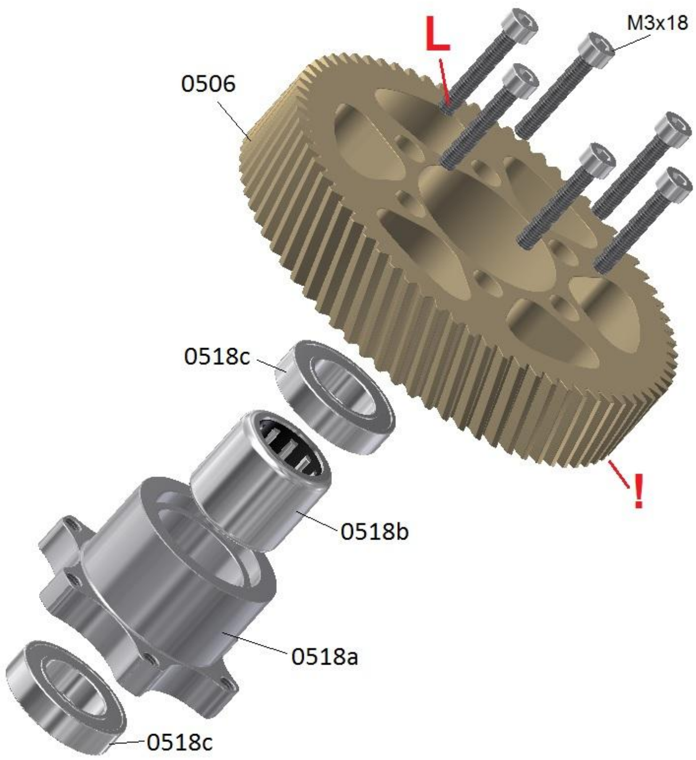
After positioning the forks, push the pins a little further so that the forks stay in position. However, the pins should still protrude toward the inside as much as possible. Now apply high-tenacity **L**octite on the inner protrusions of the pins and push them toward the outside. In their final position, the pins should not at all protrude toward the inside of the clamping ring. This procedure prevents **L**octite from seeping into the bores of the forks, because the pins are only supposed to be affixed to the clamping ring. Swiftly remove the surplus **L**octite on the inside of the ring. Shove the ring onto the main shaft provisionally to check that none of the pins are still protruding toward the inside. This would make it impossible to slide the dog onto the main shaft. Subsequently remove the ring from the shaft, while making sure the pins are not dislocated due to handling. Set the dog unit aside and let the **L**octite dry off first.

Pin number 5 is glued into the axial bore. The pin has to be flush with the bottom side of the ring. It will then protrude approx. 3mm on top. Insert the screws 0404e (M1,6x8) into the forks from the bottom so that they flush with the top side of the forks. Finally, carefully hook in the tension springs 0404d.

The clamping and the rotor head will be assembled to the main shaft later.

Chapter – 3 Intermediate shaft unit (Assembly Group 5)

	0506	Gear wheel heat resistant 71T	1
		Hex socket screw M3x18 (for 0506)	6
	0518a	One way drive flange	1
	0518b	One way drive -12x18x16	1
	0518c	Bearing 12x21x5	2



In general, we have already press fitted the one-way drive 0518b together with bearing 0518c into the one-way drive flange 0518a. It is advantageous to use a special press fitting tool.

The one-way drive has an imprinted arrow showing the operating direction, in which the one-way drive will drag the shaft.

Before press fitting, make sure this imprint shows upward. In addition, pay attention that the one-way bearing is pressed approx. 0.1mm below the shoulder edge. Expanding the casing with hot air will simplify press fitting.

In case of a damaged one-way drive, please send us the complete flange so that we can replace the one-way bearing for you.

Attention! The PEEK gear wheel 0506 is manufactured with a tight fit. This guarantees a tight seat on the flange 0518a if warmed up while operating. Therefore, it has to be warmed up with a hot air gun or in the oven up to 140F to 160F.

It will then easily slide onto the flange and will be able to be rotated to position with the mounting holes. Pay attention to carefully tighten the M3X8 hex socket screws step-by-step cross over, to avoid uneven tension.

Here you must also use Loctite. Eventually retighten the screws a little more (**1.5Nm**) because the synthetic material tends to settle a little.

	0510	Intermediate shaft 8x12x91.5	1
	0516	Intermediate shaft pinion	1
	0516a	Hex socket screw M3x4 / 12.9 (for 0516)	2

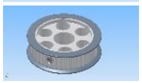
Slide the brass pinion 0516 onto the intermediate shaft 0510 in accordance to the drawing then tighten fast with both M3X4 hex socket screws (**2Nm**).

Attention! Pay attention that the wide flat surface is located at the longer end of the shaft (see drawing).

The pinion is supposed to be held by the clamping friction and not the shearing force of the screws!

Avoid spilling **L**octite into the gap between the pinion and shaft to keep the pinion demountable.

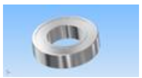
Do so by applying a bit of **L**octite directly onto the M3 threads of the intermediate shaft (see red circle). Clean the shaft on the outside before assembling the pinion. Surplus **L**octite will be pushed into the shaft where it is not a bother.

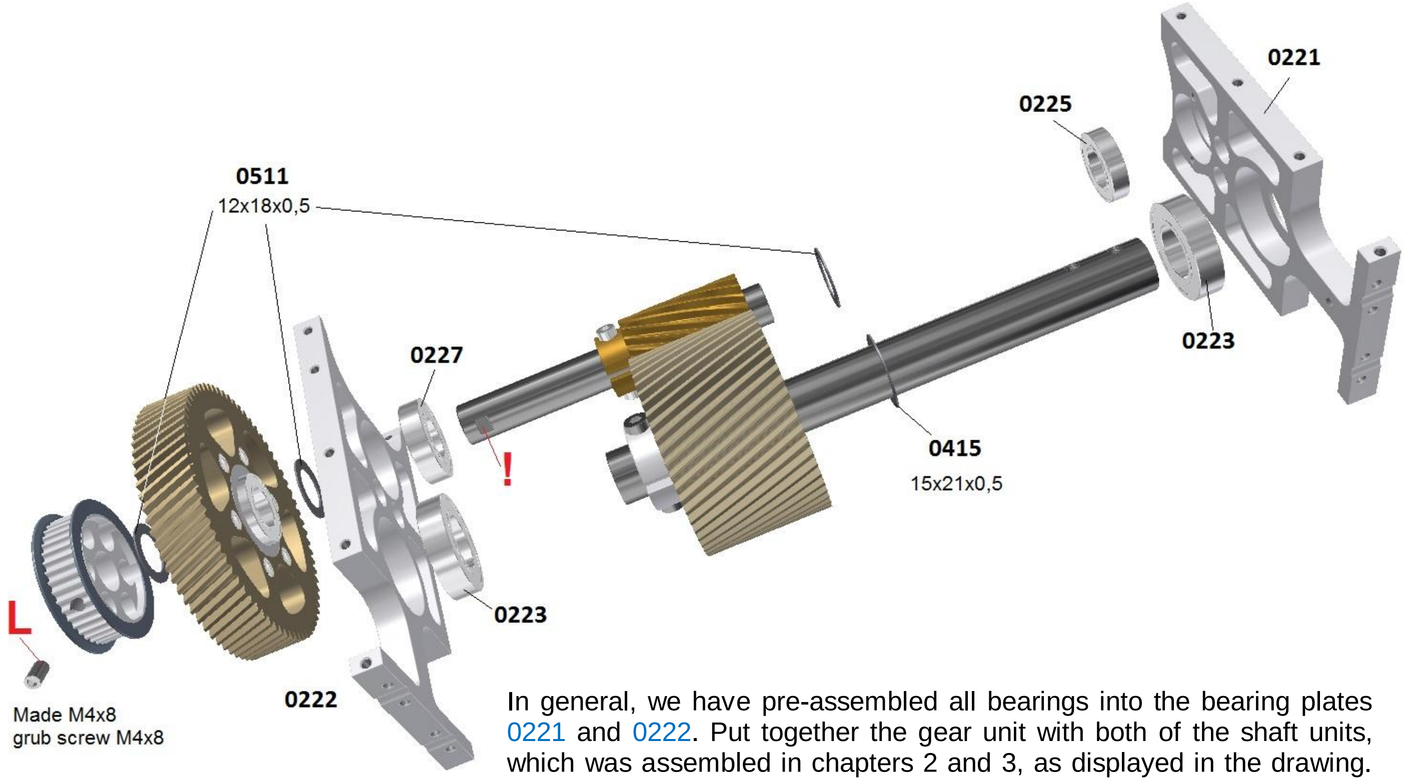
	0511	Spacer washer 12x18x0.5	3
	0522	Toothed belt disc intermediate shaft - 40T	1
		Grub screw M4x8 (for 0522)	1

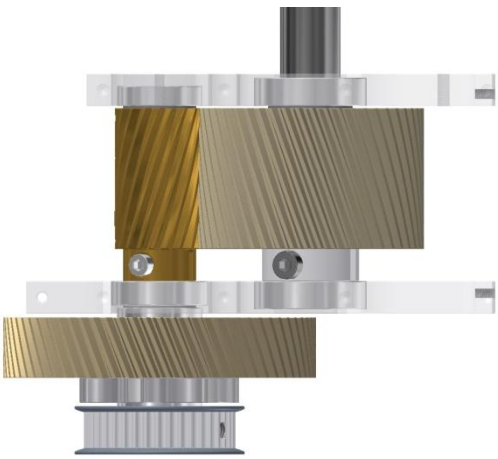
Put aside both units, including three of the washers 0511 and the belt wheel 0522, for the moment. The belt wheel will be assembled later, when the units are fixed to the mounting plates.

Chapter – 4 Chassis (Assembly Group 2)

Pre mounting of the gear

	0221	Upper bearing plate	1
	0222	Bottom bearing plate	1
	0223	Bearing 15x28x7	2
	0225	Bearing 12x21x5	1
	0227	Bearing 12x24x6	1





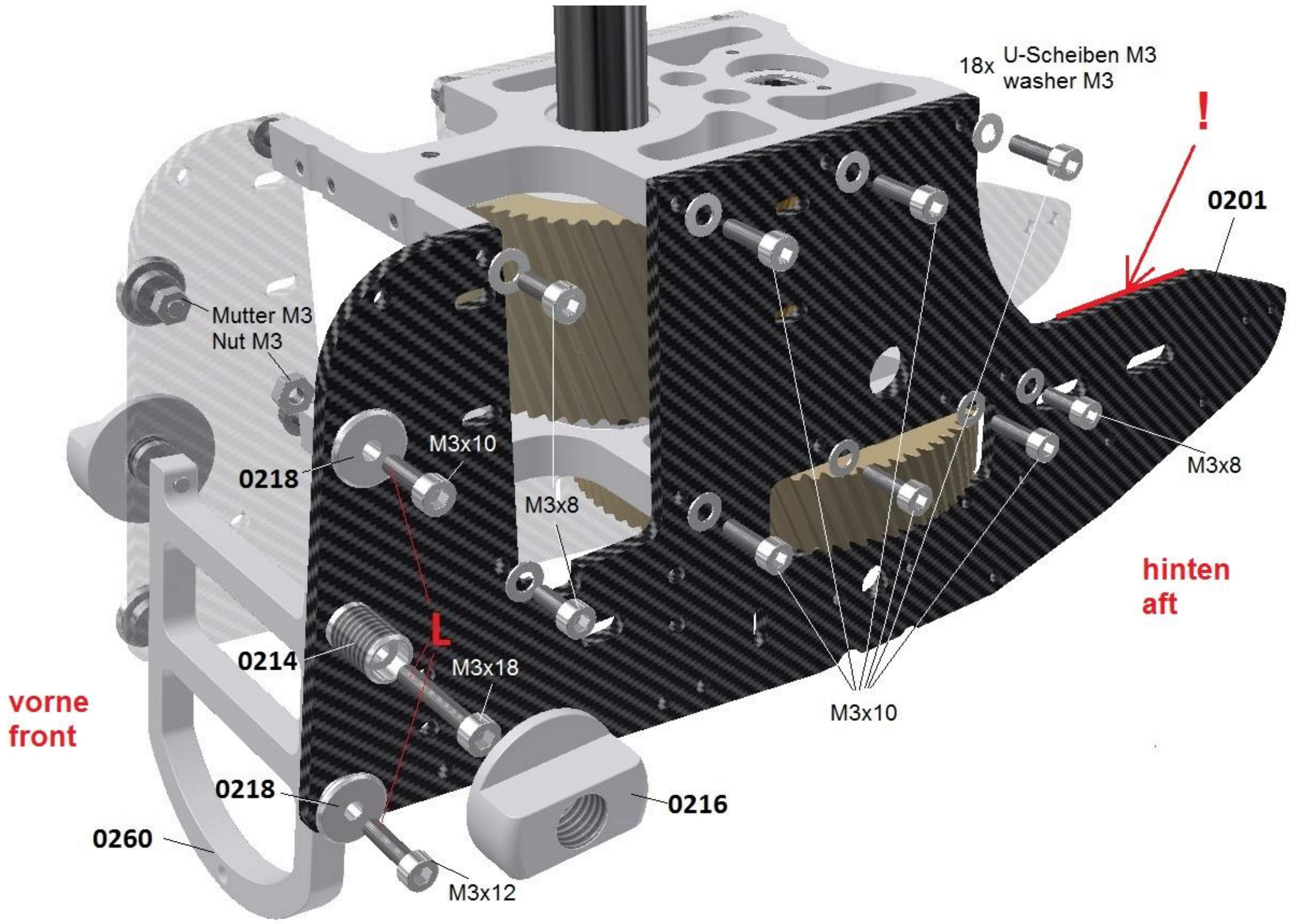
In general, we have pre-assembled all bearings into the bearing plates 0221 and 0222. Put together the gear unit with both of the shaft units, which was assembled in chapters 2 and 3, as displayed in the drawing. Implicitly regard the correct positioning of the bearing mounts, including the corresponding washers. The bottom bearing plate 0222 is the longer one of both. The press-fitted bearings are flush with the top side, whereas, on the upper bearing mount 0221, all bearings are flush with the bottom side.

Slide the intermediate shaft, with the brass pinion from the top, into the 12mm bearing 0227 of the bottom bearing mount, down to the stop. A spacer washer 0511 (12x18x0.5) is inserted from the bottom onto the protruding shaft before sliding on the one-way flange with the intermediate gear wheel. Thereafter, another spacer washer 0511 (12x18x0.5) follows. Eventually the belt wheel is attached, with its hollow side projecting to the one-way flange. Squeeze the complete unit, eliminating any axial lash, before you tighten the grub screw M4X8 firmly with a well-suited tool. (Apply a little Loctite only to the grub screw but not into the thread of the belt wheel)

Attention! The grub screw must have its seat on the flattened section of the intermediate shaft. Finally, slide the corresponding spacer washers onto the upper ends of the intermediate and main shaft before you assemble the upper bearing plate.

Assembly of chassis frame and gear unit

	0201	CFK - carbon side frame	2
		Washer M3 small (Chassis frame connection)	24
		Hex socket screw M3x10 (Chassis frame connection)	18
		Hex socket screw M3x8 (Chassis frame connection)	6
	0214	Battery holder - threaded bolt	2
		Hex socket screw M3x18 (for 0214)	2
	0216	Battery holder- nut	2
	0218	Battery holder - mount pin	4
		Hex socket screw M3x10 (for 0218 top)	2
		Nut M3 flat (for 0218 top)	2
		Hex socket screw M3x12 (for 0218 bottom)	2
	0260	Stiffening frame	1



Screw the pre-assembled gear unit between both frame sides 0201. The drawing above displays a view onto the left frame side respective to flight direction (both sides are identical).

Attention! Before attaching the left chassis panel, I recommend to deburr the sharp inner edge of this carbon panel as marked with a bold red line. Use a file or an emery block and preferably work a nice rounding into that edge. (DANGER! Carbon dust / use suitable respiratory protection) This section will be the leadout for the motor cables later on, so sharp edges would pose a threat of fraying the cables. Additionally, a sliced silicone tube will be applied later, for further protection of the cables.

Clean the panel thoroughly before assembly.

Start by attaching the left frame side to the bottom bearing plate 0222 of the gear unit. Regard to use 10mm M3 screws for the middle three frame holes, while the front and the rear hole only need 8mm screws (**no** Loctite is necessary). The two roll servos will not properly fit on the front side of the bearing plate if you use a longer screw in the front. Insert all screws with a washer but do not tighten yet. The panels should remain movable a tiny bit.

Washers are punched out of sheet metal. Therefore, they always have sharp burr on one side, while their edges are slightly rounded on the other side. Observe the washers attentively and slide them onto the screws with the sharp edges facing toward the frame, when the screw is tightened. This will serve the purpose of supporting the screws with tension when they are fastened. In general I recommend not to use **L**octite on any screw engagement related to the frame and the bearing plates. The screws will be under enough tension not to release. In case of a rare instance whereby a single screw should release by itself, nothing will happen because there are more than enough screws. Without **L**octite, it will be much easier to disassemble the chassis in case it is needed. Without Loctite the chance if the screw head snapping off and the bolt being stuck in the bearing plates are reduced.

Now also attach the right chassis frame in the same way to the bottom bearing plate 0222. After that, the upper bearing plate 0221 is fastened, still keeping the screws loose for a tiny bit of release. Here only the single M3 screw at the front is 8mm long. All other screws are 10mm.

With the corresponding bores of the chassis front, now attach the stiffening frame 0260 together with the threaded bolt 0214 and the mount pin 0218 of the battery holder.

The upper mounting pin is only fastened with a flat M3 nut to the chassis frames. Use **L**octite for all of these screws. Once these screws are also in place, start fastening all screws gradually in intervals. All parts should level equally. The screws of the bottom bearing plate and the stiffening frame may now be fully fastened (**1.5Nm**). The screws of the upper bearing plate should only be fastened enough to keep them from moving.

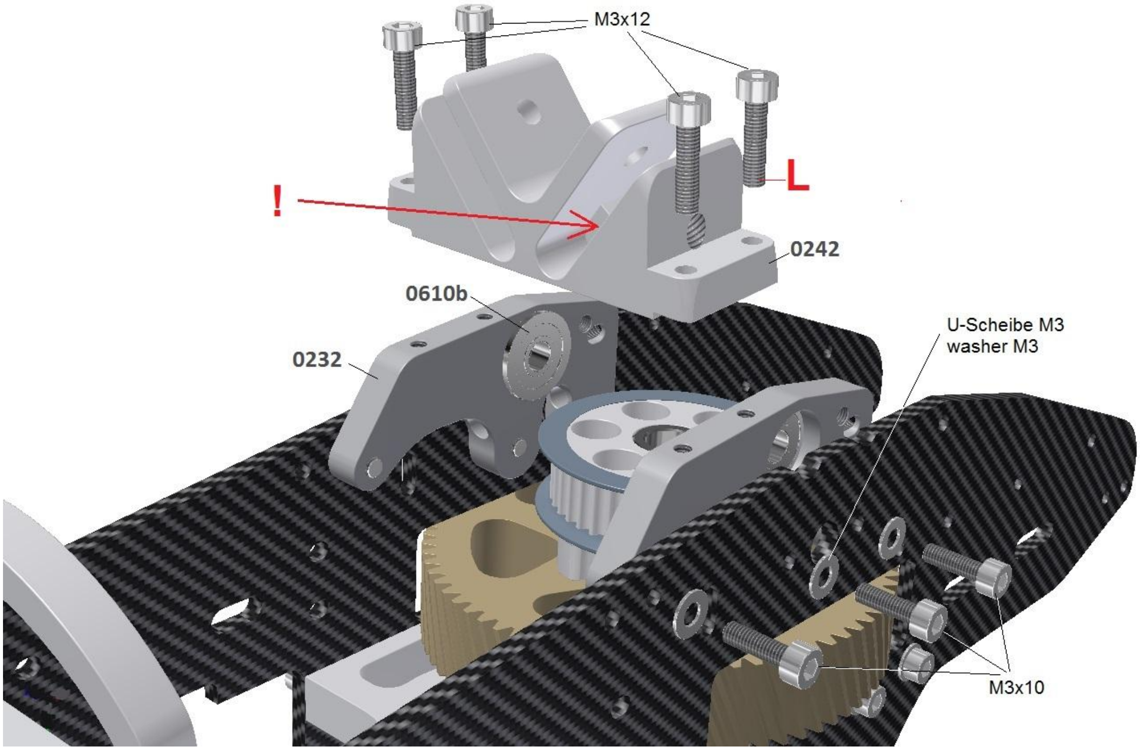
The nuts 0216 are tightened loosely to the bolts 0214. Later on they serve the purpose of fastening the battery holder.

Now check to see if the main shaft has axial lash. Push and pull the shaft forcefully. If substantial lash is detected, use the depth gauge of your caliper to ascertain the lash dimension. Compare the distance between the upper edge of the main shaft and the upper bearing plate under a pushed and pulled condition. If the lash exceeds 0.2mm, add washers.

To add washers, release the upper bearing plate and remove it upward. Add washers between the main shaft gear flange 0414 and the upper dome bearing 0223 and reinstall the upper bearing plate again. Do not add too many washers. The screws should not fasten under tension. Now also fasten these screws tight (**1.5Nm**).

After a few flights the bearings may settle. Perhaps it will be necessary to add washers later on. However, axial lash up to 0.2mm is absolutely noncritical.

	0232	Bearing plate	2
	0610b	Flanged bearing 5x13x4	2
	0242	Skid holder	1
		Hex socket screw M3x12 (for 0242)	4

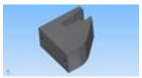


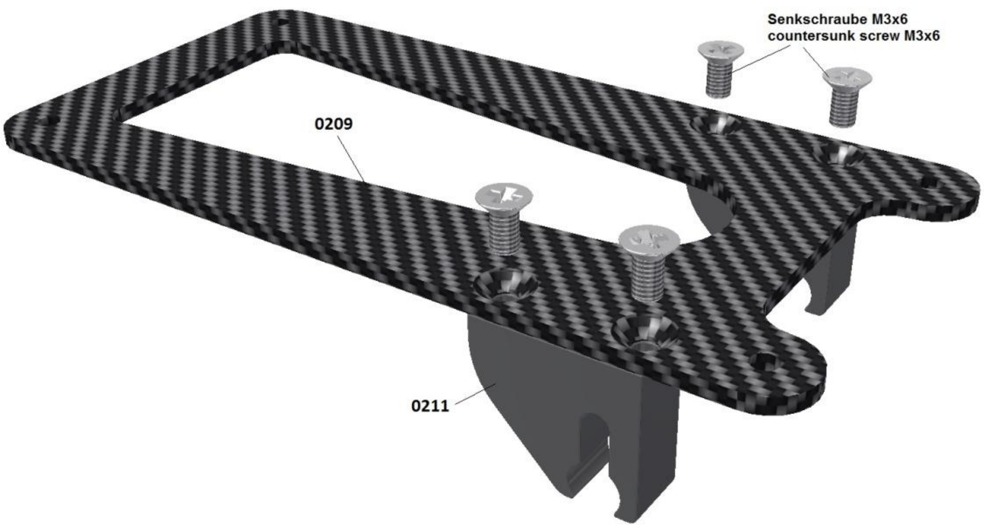
The flanged bearings 0610b are already press fitted into both bearing plates 0232. Use the remaining M3X10 screws and washers to assemble these bearing mounts as displayed in the drawing above. The flange of the bearings always faces toward the inner sides. Initially, just tighten the screws lightly (here also no **L**octite is needed).

Attention! Now attach the skid holder 0242 with the collar edge (red arrow) facing toward the front. Later on, this collar edge serves as a stop for the optional available retracting landing gear.

The skid holder has a recess at the mounting side, which should center itself between the bearing plates 0232. Fasten the M3x12 screws step-by-step and cross over so that both of the bearing plates are able to align. Afterward, all screws for fixing the bearing plates 0232 are only tightened slightly. (They need to be released again later on) The rest of the screws in the skid mount bag may be set aside. They will be needed to fasten the skids later on.

Controller supporting plate

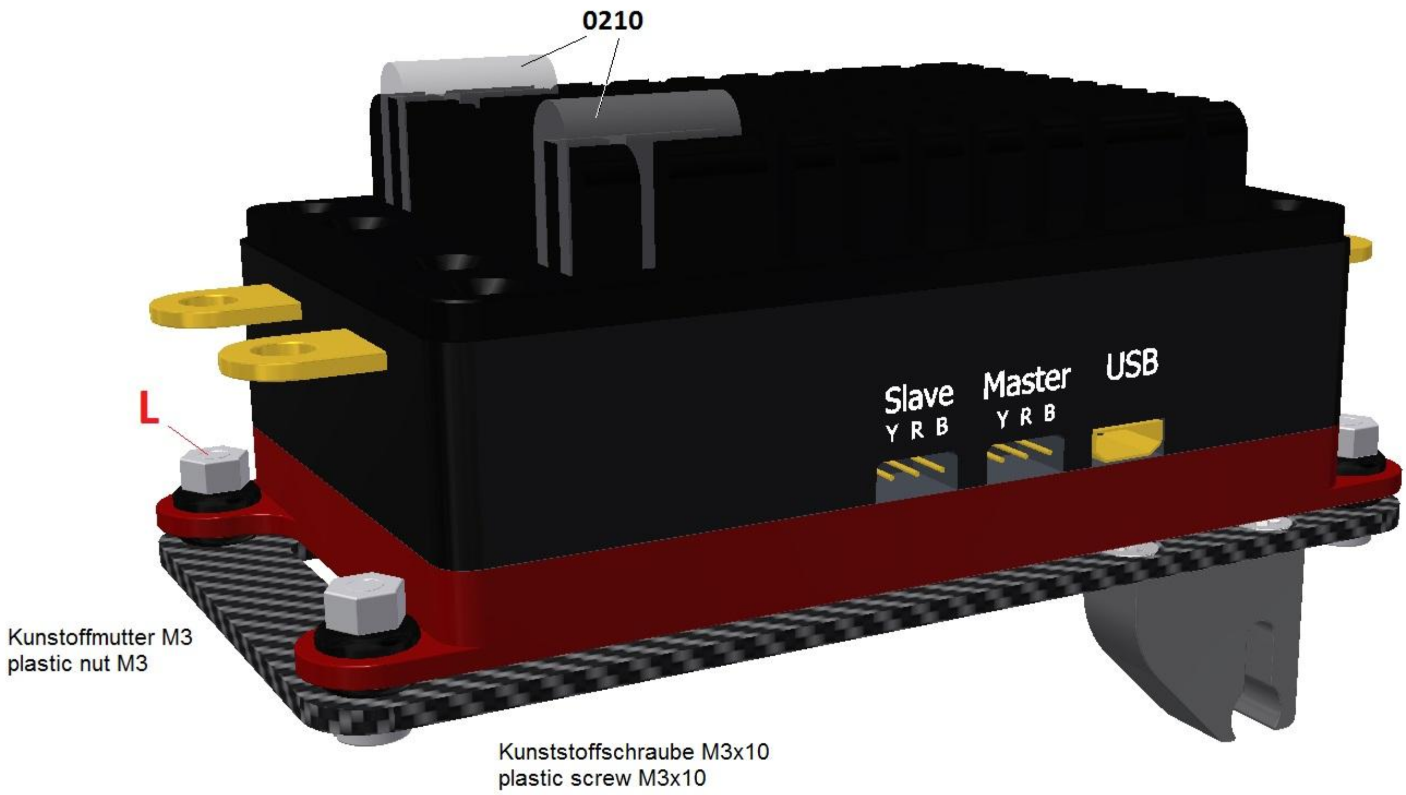
	0209	CFK-Controller supporting plate	1
	0210	Silicon support for KOSMIK ESC	2
	0211	Holder for controller	2
		Countersunk-head screw M3x6 DIN 965-A2 (for 0211)	4
	0212	Controller holder axis 6x58 / M3	1
	0213	O-ring 6x2 (for 0212)	2
		Hex socket screw M3x8 (for 0212)	2
		Plastic screw M3x10 (for ESC mounting)	4
		Plastic nut M3 (for ESC mounting)	4
		Lense head screw M4x8 (for ESC cable)	5
		Nyloc nut M4 (for ESC cable)	5



Fasten both of the holders 0211 to the controller supporting plate 0209 with the four M3x6 screws. The screws will cut threads into the tight bores of the plastic mounts.

Attention! Tighten with care, so not to damage the plastic threads.

Assembly the KOSMIK ESC



The KOSMIK ESC is attached to the carbon supporting plate 0211 with four M3 plastic screws. The screws are inserted from the bottom. The plastic nuts are secured on the top with hot glue or silicone.

Both of the battery connector tabs face toward the front (see drawing).The procedure of connecting the cables will be dealt with in a later chapter. Set aside the oval head screws and nuts meant for this purpose.

The ESC axis 0212 will also be assembled later on.

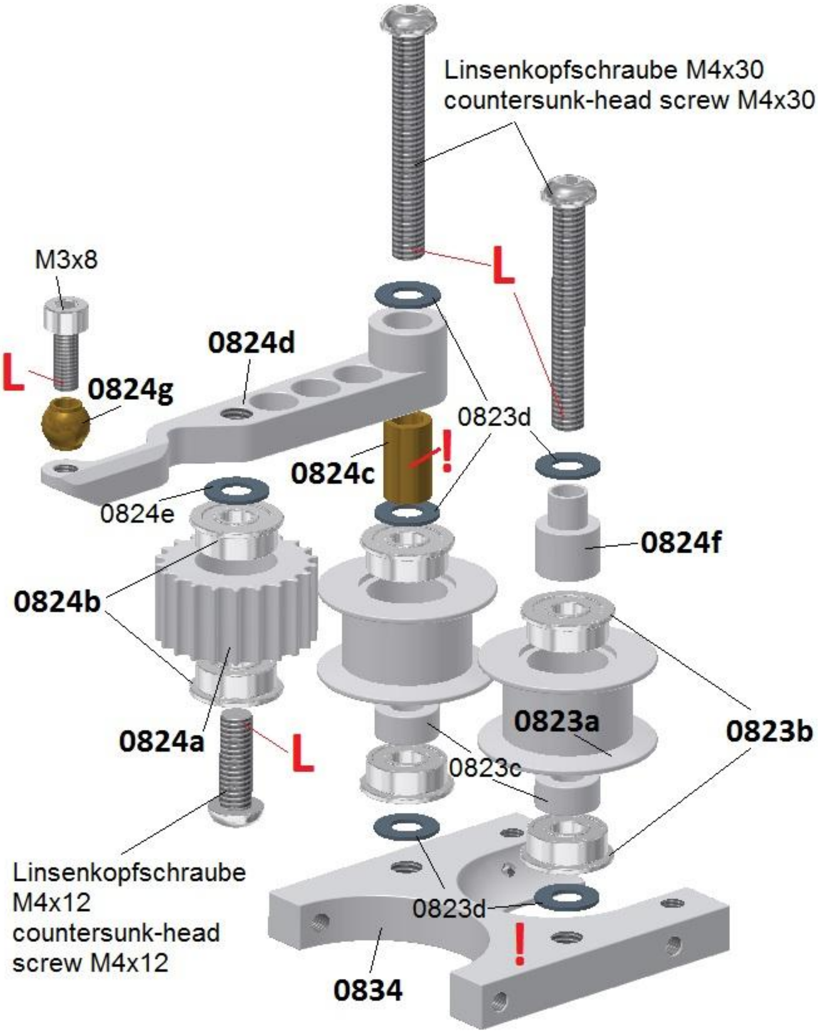
Both of the sliced silicone tubes 0210 are tucked onto the second cooling fin from the outer. They support the ESC against the canopy later on, because the ESC is pivotable on the ESC axis 0212. The silicone keeps the ESC unit in place.

If at any instance you intend to fly the helicopter without a canopy, the ESC must be secured with a rubber band. They can be attached in the slots of the battery holder side frame 0206.

Chapter 5 **Tail boom mount and tail belt redirection** **(Assembly Group 8)**

Tail belt redirection

	0823a	Idler pulley	2
	0823b	Flanged bearing 4x10x4	4
	0823c	Spacer - flanged bearing	2
	0823d	Spacer washer 0.5x4x8	5
		Lense head screw M4x 30 (for 0823abcd)	2
	0824	Belt tensioner	1
		Hex socket screw M3x8 (for 0824 front)	1
	0824a	Toothed belt disc - belt tensioner -22T	1
	0824b	Flanged bearing 4x10x4	2
		Lense head screw M4x 12 (for 0824ab)	1
	0824c	Bearing bush - belt tensioner	1
	0824d	Arm - belt tensioner	1
	0824e	Spacer washer 4x8x0.5	1
	0824f	Bearing stud - belt tensioner	1
	0824g	Ball - belt tensioner	1
	0834	Bearing Plate	1
		Hex socket screw M3x18 (for 0834 back)	2



Assemble the tail belt redirection unit according to the drawing.

Attention! Regard the correct position of bearing plate 0834. It has a milled circular groove on one side, which serves as exposure for the tail boom later on. The circular groove has to face toward the rolls.

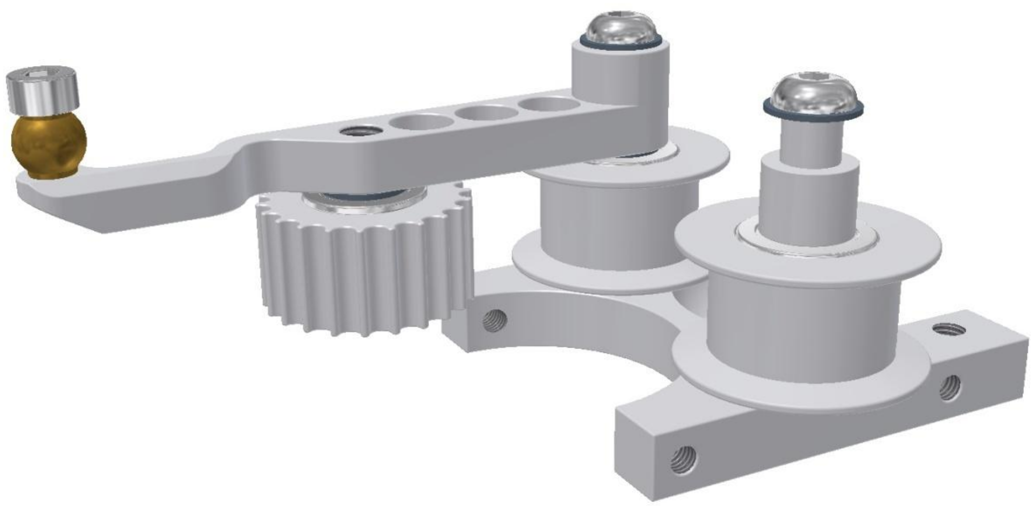
Press the flanged bearings 0823b and 0824b into the idler pulley 0823a and into the toothed belt disc 0824a. A spacer flange 0823c is inserted between the bearings of the idler pulley.

Attention! Apply some DRY FLUID GEAR to the flange 0824c before assembling it with the belt tensioner arm 0824d. The washer 0823d, which is located above and below the idler pulley, has sharp burr edges on one side. It is advisable to have the rounded sides of the washer facing toward the idler pulley to avoid friction between them. Insert the washer above the bearing stud 0824f with the sharp edges facing up toward the screw head.

The bottom flanged bearing of the toothed belt disc 0824a is sunk recessed. The lense head screw M4X12 is inserted from this side and does not protrude.

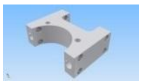
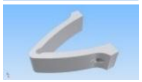
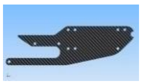
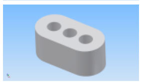
The brass ball 0824g is carefully fastened with M3X8 screw. Secure all screws with Loctite!

After assembly, check to make sure all three rolls are smooth running. The arm must also be smooth and movable. It could help to settle the bearings of the rolls by pushing them axial in both directions with force after assembly. They will also run in a little during operation.



The belt tensioner 0824 is not yet suspended and should be set aside for later. Both of the hex socket screws M3x18 will be needed in the next assembly step.

Assembly of the tail belt redirection unit with the tail boom plates

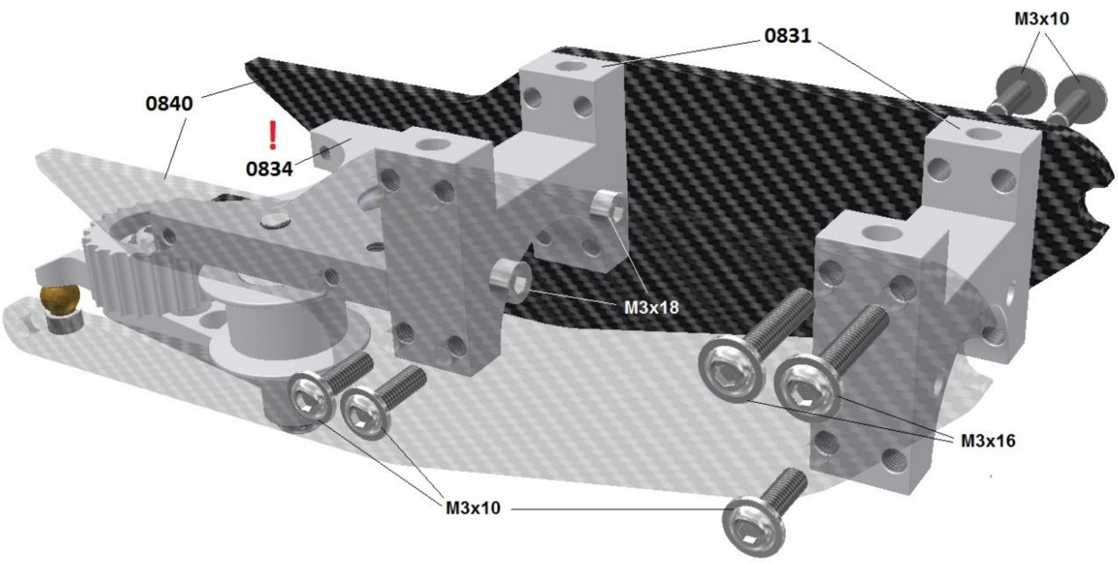
	831	Tail boom - clamping top	2
	832	Tail boom - clamping bottom front	1
	833	Tail boom - clamping bottom rear	1
		Hex socket screw M4x35 (for 0832 and 0833)	4
		Lense head screw M3x10 (for 0831 bottom)	6
		Lense head screw M3x10 (for 0831 right-top-back)	2
		Lense head screw M3x16 (for 0831 left-top-back)	2
		Lense head screw M3x20 (for 0831 right-top-front)	2
		Lense head screw M3x25 (for 0831 left-top-front)	2
	0840	Tail boom - support plate	2
		Lense head screw M3x16 (for 0840 front)	2
		Nyloc nut M3 (for 0840 front)	2
		Lense head screw M3x20 (for 0840 - 0834 side)	4
	0842	Distance bush	6
	0843	Spacer - tail boom support plate	2

In general, the complete tail boom unit, including the tail belt redirection unit, is fastened to the chassis with lense head screws. This is concluded by the aerodynamic shaping of the canopy. In particular, the rear and lower clearance of the canopy to the chassis and the tail boom adaption panel 0840 is extremely narrow.

In such areas, there is no space for high screw heads with additional washers. For this purpose, special lenshead screws with large support surface find application here. To maintain a structured overview in this assembly section, all screws are of mentioned type, even if not necessary in some instances.

The disadvantage of these screws compared to regular hex socket screws is their smaller and shallower 2mm inner hex, causing a hex wrench to slip or slither easier. Therefore, it is important to use a high-quality tool for these screws. In the bag with special tools, you will find a **TX 8 Bit**, which you can use with a socket wrench that has a quarter-inch hex. This bit fits perfectly into the socket hex of the countersunk-head screws without lash. This tool will not slip or slither so quick. However, it is still important not to hold the tool aslant and to push it firmly into the socket hex while fastening. Do not apply **L**octite on these screws under any circumstance.

The use of **L**octite poses a great threat, that you will never be able to release these screws again without damaging the socket hex. In such a case, the screw head will have to be removed by cutting a slit in the head with a small circular saw and using a screwdriver.



Initially, plate 0834 of the preassembled tail belt redirection unit is only attached loosely with both hex socket screws M3x18 to the front clamping top 0831 (it should remain movable in the lash of the bores).

Note: due to the very smooth surfaces of the tail boom, surfaces of the upper clamps are sandblasted. This will improve the frictional adhesion between the tail boom and the clamps.

Fasten both of the tail boom clamps loosely to both of the 3mm tail boom support plates 0840. (Do not use **L**octite)

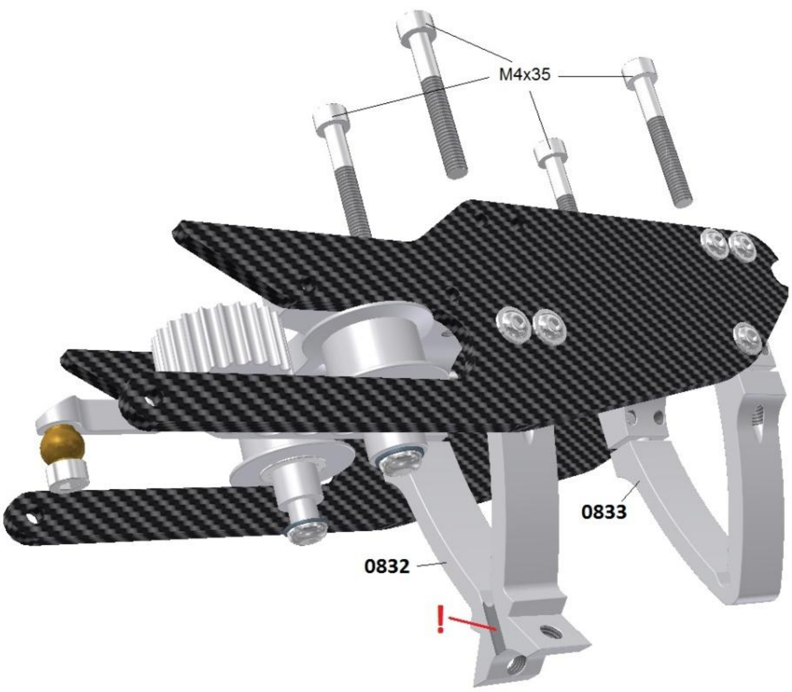
Now pay very good attention to the correct screw length of the countersunk-head screws in respect to their specific hole positions. Fasten the screws light enough to keep the blocks swiveling between the panels at their bore lash.

The bottom three M3x10 screws are applied mirror inverted on the averted opposite side (not visible in the drawing) just as the three on the front side (plate displayed transparent).

However, different screws are used on the upper rear side (in the drawing on the right side). Two M3x16 screws are used on the front side. They will protrude approx. 5mm into the rectangular milled free space of the block. On the opposite side, two M3x10 screws are used, which will not protrude.

After both side panels are attached, the two hex socket screws M3x18 can now be tightened. You may use a long M2.5 socket head wrench. To reach the screw heads of the front block, slide the key through the bores of the rear block. Squeeze both plates 0840 with your fingers, so that the plate 0834 will properly align to the side flanks of the block.

The lense head screws are fastened in a later assembly section.

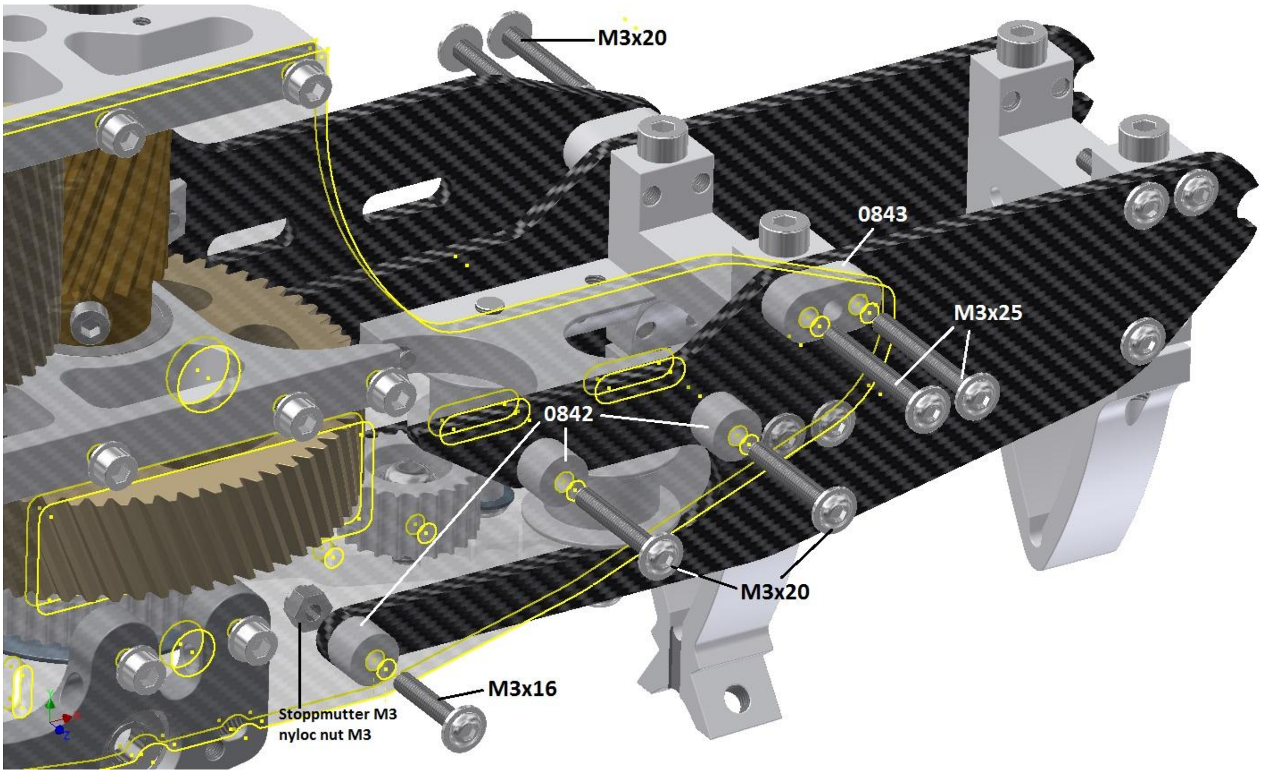


Attach both of the lower tail boom clamps 0832 and 0833 according to the drawing. The hex socket screws M4x35 are inserted from the top through the appropriate bores into the clamping blocks 0831 without using Loctite. For now they are only finger tightened into their threads.

Attention! The front clamp 0832 has a little groove marking on one side. The clamp has to be mounted in such a way that the marking shows to the front.

The conical dovetail-shaped bifurcation serves as junction point for the skids later on. Alternatively, it serves as stop for the legs of the optional retractable landing gear.

Mounting the tail boom fixation unit with the chassis



Slide the pre-assembled unit into the core mechanic from the rear. The left chassis frame is displayed transparent with yellow outlines to improve the visibility of the individual bores (see drawing above).

Respectively, on each side of the unit, three round 6mm thick distance bushes 0842, as well as one elongated spacer 0843, are inserted. The pre-assembled tail boom unit now has a symmetric seat between the panels of the core mechanic.

The different lense head screws are inserted into their individual bores according to the drawing. All screws on both sides are of equal length, except those that are inserted through the elongated spacer 0843.

The M3x16 screw in the front is secured with a Nyloc nut from the inner side. The next two screws located more to the middle have a length of 20mm. They penetrate the outer chassis panel, distance bushes, and the frame of the tail boom adapter. Eventually, they engage with the threads recessed into the side of the bearing plate.

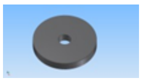
The rear of the right chassis panel is also fastened with M3x20 screws, whereby on the left side, M3X25mm are applied. They will protrude approx. 5mm into the space of the front clamping block.

Preferably, start on one side and draw the screws in through the distance bushes one by one. If you try to position the distance bushes all at once, they will dislocate each time you move the unit.

Attention! Initially fasten all screws loose to align the unit without any pretension. Only until all screws are inserted, start fastening step-by-step, in turns and in several stages. Please also consider fastening the screws of the preassembled tail boom adapter of the previous assembly section.

Pay attention to the upright rectangular use of the socket wrench as mentioned earlier. Push the wrench into the hex of the screws with force to avid slithering, while giving them the final tightness (**1.2Nm**)

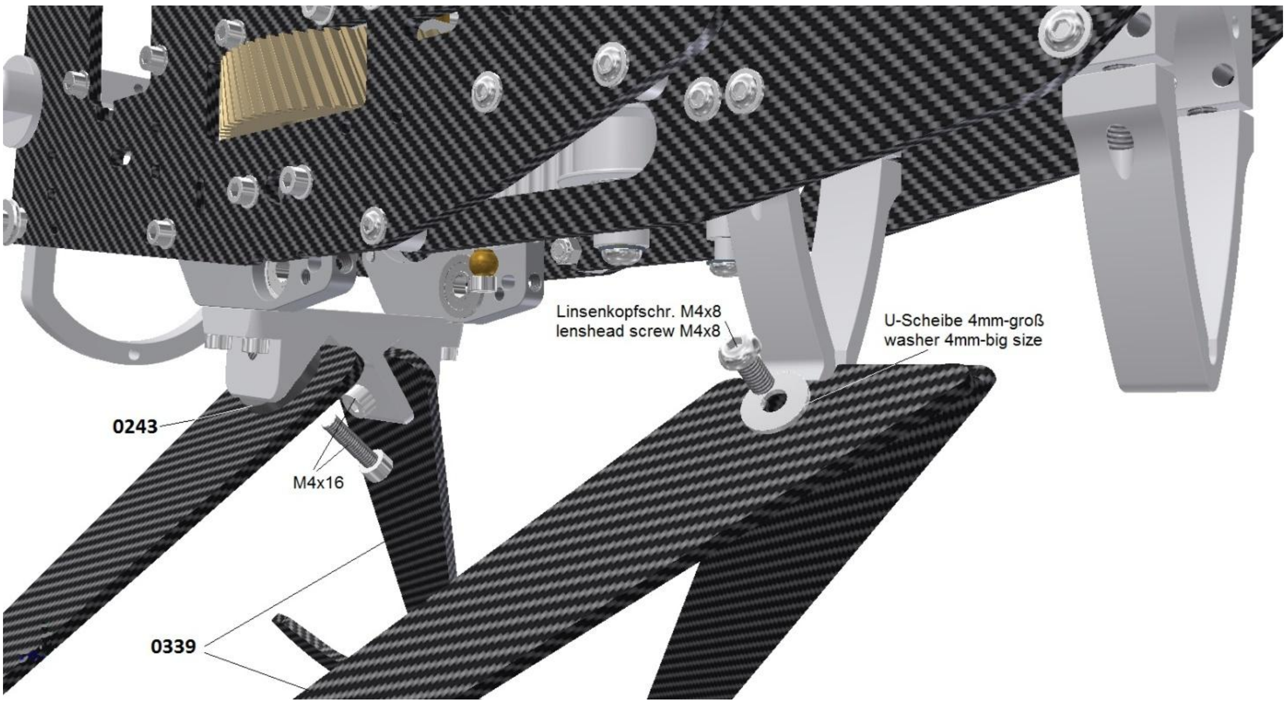
Assembly ot the skids

	0339	Skid	2
	0243	Washer for skids	2
		Hex socket screw M4x16 (for 0339)	2
		Lense head screw M4x8 (for 0339)	2
		Washer M4 large (for 0339)	2

Attention! I strongly recommend the use of the standard skids at the beginning, even if you intend to use the optional retractable landing gear. The skids are attached within 2 minutes, and converting to the retractable gear is just a matter of few minutes.

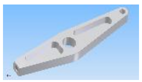
The first reason for my advice is of practical concern. It is convenient for all further assembly steps to place the mechanics upright on your workbench. This only works with the installed tail if you initially attach the retractable gear. However, for the sake of simplified handling, the tail should be installed when most of the work on the mechanics is done.

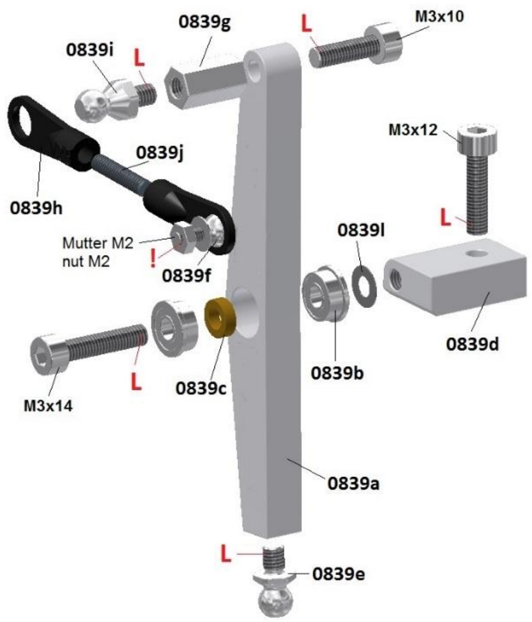
Second, I consider it inevitable to do the maiden flights with standard skids. During the initial adjustments, you may be taken by surprise, resulting in a rugged landing. If you have to concentrate on the retracting gear during a phase whereby the helicopter is not yet properly adjusted, accidents are bound to occur. The retractable gear provides a secure footing at vertical touchdown. However, it does not forgive any horizontal movement in particular toward the front, because it immediately entangles with the soil. The helicopter will tilt if one of the legs sinks into soft subsoil. Respectively, the standard landing gear is totally insensitive toward all of these issues.



Attach the skids 0339 in the slits of the front skid holder. The 3mm-thick plastic spacer washers 0243 are inserted into the slits from the outside of the skids. Initially arrest the skids loose with the M4x16 screws. Now, provisionally tighten both M4x35 clamping screws of the bottom front tail boom clamping. The clamping should have contact with the upper clamping block. Now align the rear bores of the skids with the bores of the clamping. Because of tolerances, there may be some offset. However, the flexibility of the skids will compensate such offset. Tighten the skids slightly at the rear. Finally tighten both of the front screws so that the skids are clamped between the flexible forks. The rear screws remain slightly tightened for now.

Tail lever redirection unit

	0839a	Tail servo lever front	1
	0839b	Flanged bearing 3x7x3	2
	0839c	Spacer 3x5,5x1,8	1
		Hex socket screw M3x14 (for 0839abc)	1
	0839d	Axis support	1
		Hex socket screw M3x12 (for 0839d)	1
	0839e	Threaded ball stud M3x4 - 4mm	1
	0839f	Threaded ball stud M2x5 - 3mm	1
		Nut M2 (for 0839f)	1
	0839g	Threaded ball stud extension	1
		Hex socket screw M3x10 (for 0839g)	1
	0839h	Ball link - 15mm	2
	0839i	Threaded ball stud M3x4- 6mm	1
	0839j	Stud bolt M2,5x12	1
	0839l	Spacer washer 3x6x0.2	1



Press both bearings 0839b, including spacer 0839c, into lever 0839a first. The shorter ball stud 0839e is attached to the bottom of the lever. Apply Loctite to all threads in this assembly section. The tail servo redirection lever is designed asymmetric and has some milling groove on one side.

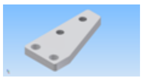
These grooves are located on the averted side of the drawing. Eventually the lever is attached to its axis mount block with the M3x14 screw. Consider the appropriate position of the bend and do not forget washer 0839l. The longer ball stud is attached to the upper side of the lever with ball stud extension 0839g and M3x10 screw.

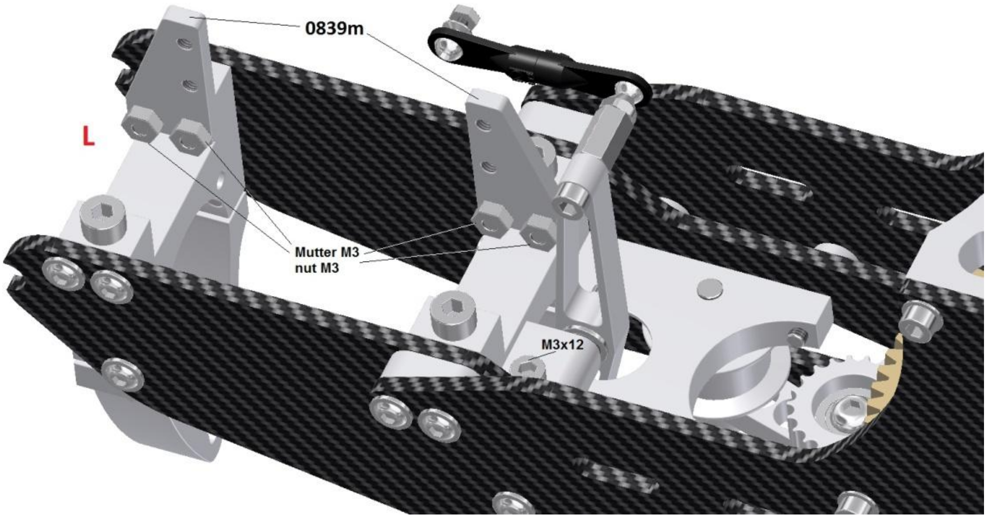
Both ball links 0839h are connected by stud bolt 0839j.

Screw both ball links to their stop until the stud bolt is not visible any more. Both ball links have letter imprints on one side. These imprints should be adjusted in opposite facing directions.

The ball stud 0839f with M2 nut is meant for a later assembly section. It needs to be attached to the tail servo before connecting it to the ball link. Whereas, the ball link with imprint facing outward may already be connected to ball stud 0839i.

Tail servo support

	0839m	Tail servo support	2
		Nut M3 flat (for 0839m)	4
	0839n	Servo mounting plate	2
		Lense head screw M3x12 (for 0839n)	4

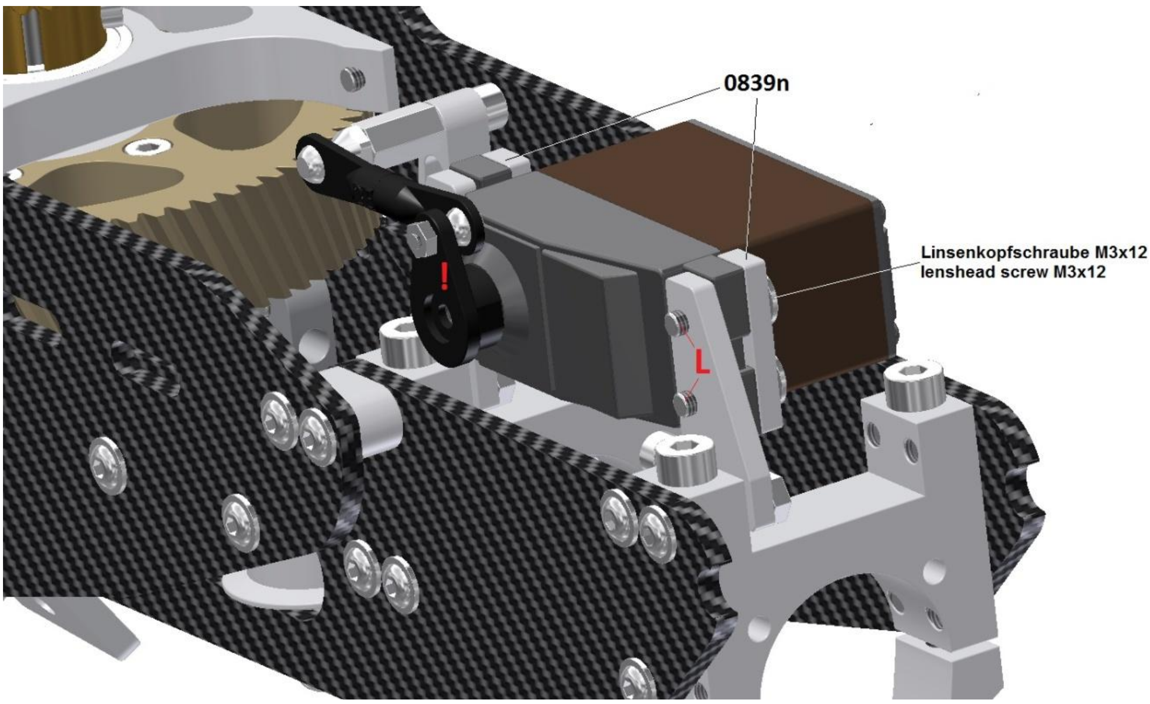


First stick both of the servo supports 0839m onto the protruding screw threads, located on the left chassis side. Secure them with the flat M3 nuts and use a tiny bit of Loctite.

Please remember to unscrew these nuts first, before you unscrew the lense head screws from the chassis side. These nuts tend to act like counter nuts.

Now attach the tail lever redirection unit to the right rear corner of the tail push rod redirection unit with M3x12 (use Loctite).

To obtain rectangular alignment, press the axis mounting block 0839d into the corner between panel and tail boom clamp.



Attach the tail servo with the M3x12 lense head screws and servo mounting plates 0839n to the tail servo support 0839m (use **L**octite) Do not insert the usually used metal sleeves into the rubber damper. The screws are inserted directly through the rubber dampers. Tighten the screws equally in such a manner that the dampers are not squeezed more than 1mm.

The ball stud 0839f is attached to the servo horn with the M2 nut (use **L**octite), facing the ball towards the servo. Its distance from the servo axis center should be between 10mm and 11mm. Initially the servo arm is attached provisionally to the servo axis. Later on the middle position will be detected when the servo is attached to the FBL system.

Chapter 6 Linkage and Servo Mounting (Assembly Group 6)

Explanation of the Linear Drive System (LDS)

Unlike conventional helicopters, the swash plate linkage is now realized by a linear drive for the first time. The background of this design is to avoid angle errors that arise in the conventional systems, particularly in the maximum collective pitch regions, where the servo levers distort cyclical deflections.

For example, if you initiate a cyclical roll deflection at maximum or minimum pitch, the servo lever is moved from its already very strong angled position toward an almost stretched position to the linkage, which is attached to the swash plate. In contrast, the other servo horn deflects back toward the center position so that its effective radius, and thus the path of the rod, becomes greater again. This can indeed be partially compensated electronically. However, the use of long servo horns cannot be avoided if you want a large collective span combined with an adequate additional cyclic deflection. This will come about with the following disadvantages.

First, the effective servo force declines with increasing servo horn length and simultaneously the lash is increased. The servo forces are usually declared in Ncm. A servo with a specified power of example 300Ncm (equivalent to approximately 30kg force at a linkage radius of 10mm) with a customary servo horn linkage radius of 20mm, will have 15kg force left at the linkage point.

Since our current high-voltage servos are extremely fast, it is reasonable to place the point of linkage closer to the servo axis. There the forces are greater and the lash is reduced. Then of course, the servo has to travel a corresponding larger rotational angle to achieve a greater travel distance. This can be realized with tooth rods in a linear system. Of course a servo vendor could come up with the idea to produce a servo with linear output.

There were some attempts in the past. However, the travel and forces we need are not attainable with customary servo housing dimensions. Such a servo would be so large that it would barely fit into any common model helicopter. I have dimensioned a large enough robust linear drive located on the outer rim, which performs independent of the applied servo type. To fully exploit this system, it is required to choose servos that offer more travel than standard servos. This opportunity is given by all programmable servos, which offer increase of travel with an external software tool.

The servos should be reprogrammed to travel a distance of approx. +/- 55°. This refers to a 100% travel setting in your remote control and connecting the servo directly to your receiver without any FBL system in between. You will find detailed information for this procedure in the following chapter.

In my **LDS** System, the servo horns of the roll servos are replaced by 26T module 1 pinions, which drive a flat-shaped tooth rod. The module 1 tooth rod is guided on a spring steel axis. To eliminate any lash between pinion and tooth rod, the spring steel axis has a mechanism to preset an adjustable tension onto the spring steel rods. The tooth rod is slightly pressed onto the pinion, enabling absolute lash free performance. The elevator servo has a similar linkage device. However, due to space saving requirements, the elevator servo drives a little belt, which again drives a pinion axis and the pinion drives the elevator tooth rod. The elevator tooth rod has a round shape, because the actual linkage rod to the swash plate is guided through the hollow intermediate shaft. This appears cumbersome at first, but it works perfect. To intercept the belt tension of the elevator drive, the little belt wheel on the elevator servo is supported by a counter bearing. The Elevator belt wheel and aileron pinions have a gear tooth grip radius of approx. 13mm. Compared to a conventional servo horn link radius of 18mm, the linear servo drive of the TDR-II would need 25% less servo thrust force to provide similar conventional linkage performance. This construction leads to a very compact structure of the core mechanics, which allows the use of narrow, sharp pointed, very aerodynamic canopies. The height of these canopies does not exceed the height of canopies of conventional similar-size helicopters.

In order to utilize standard servos as well, the blade grip linkage allows linkage points to be further inward. The middle linkage point of the blade grip arms represents the geometric conditions comparable to any other given helicopter, whereby the advantages of the linear system do not cease to prevail. Due to the linearity of the tooth rod linkage, the pitch angles may be determined without pitch gauge by simply measuring the stroke with a caliper. A later chapter reveals a table with angles related to stroke in mm and depending on the position of the blade grip linkage.

Before you calibrate the system, you should decide over your priorities. You will achieve the greatest precision, least lash and greatest servo travel force with the outer blade grip linkage position. This will require programmable servos and feature +/-15° pitch with an additional 10° cyclic deflection.

With standard servos you will accomplish +/-12° pitch and approx. 8° cyclic on the outer position. This would be a suitable adjustment for hardcore 3D at approx. 2000 to 2200 RPM. In general, it is a good start with standard servos unless ~~if~~ you desire high rates of climb and cyclic reactions at low RPM, and you would prefer to use the middle blade grip junction.

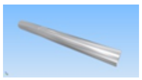
If you prefer faster, wide area performance or even speed flight ambitions, then you should definitely only use the outer linkage. This type of performance demands more precision and steadiness in the linkage than large cyclic deflections. Even the demand of 16° collective pitch for a pure speed set up is possible on the outer linkage and standard servos, if you can spare the equivalent negative pitch value. Here the opportunity is given to preset the blade grip arms by 4° to zero pitch. This will permit an asymmetric distribution of a pitch range, quoting a limited total of 24°. Per the example, +16° and -8° should suffice for a pure speed setup.

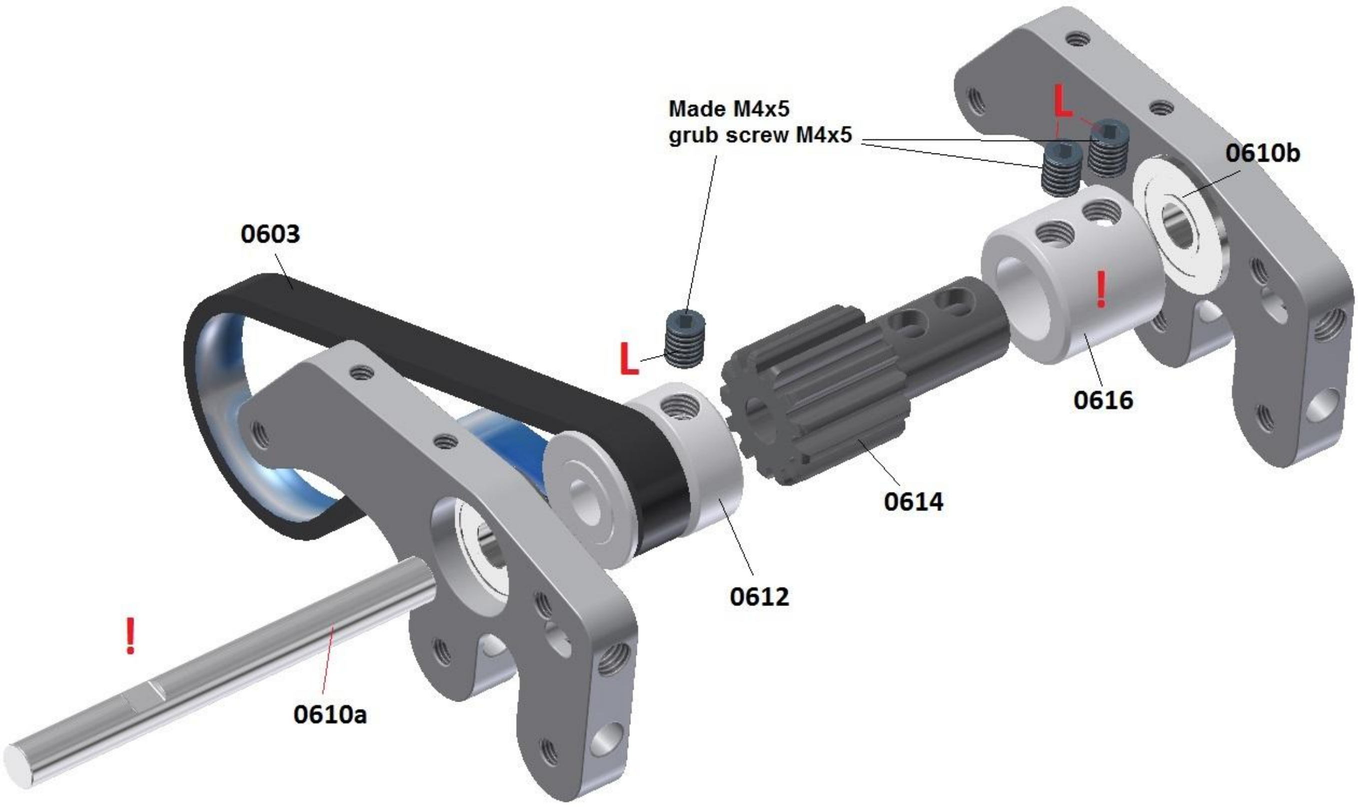
A typical, all round system setup comprising of approx. +/-15°, will react much more sensitively to the slightest pitch deflections at very high RPM rates. Hovering will be more difficult to maintain proper altitude.

It should be evident now that the TDR-II offers a large variety of individual setups for your personal preferences. I fly my TDR-II machines with programmable servos set to 55° travel at a 100% remote control setting, regardless if Sport/ 3D or speed setup.

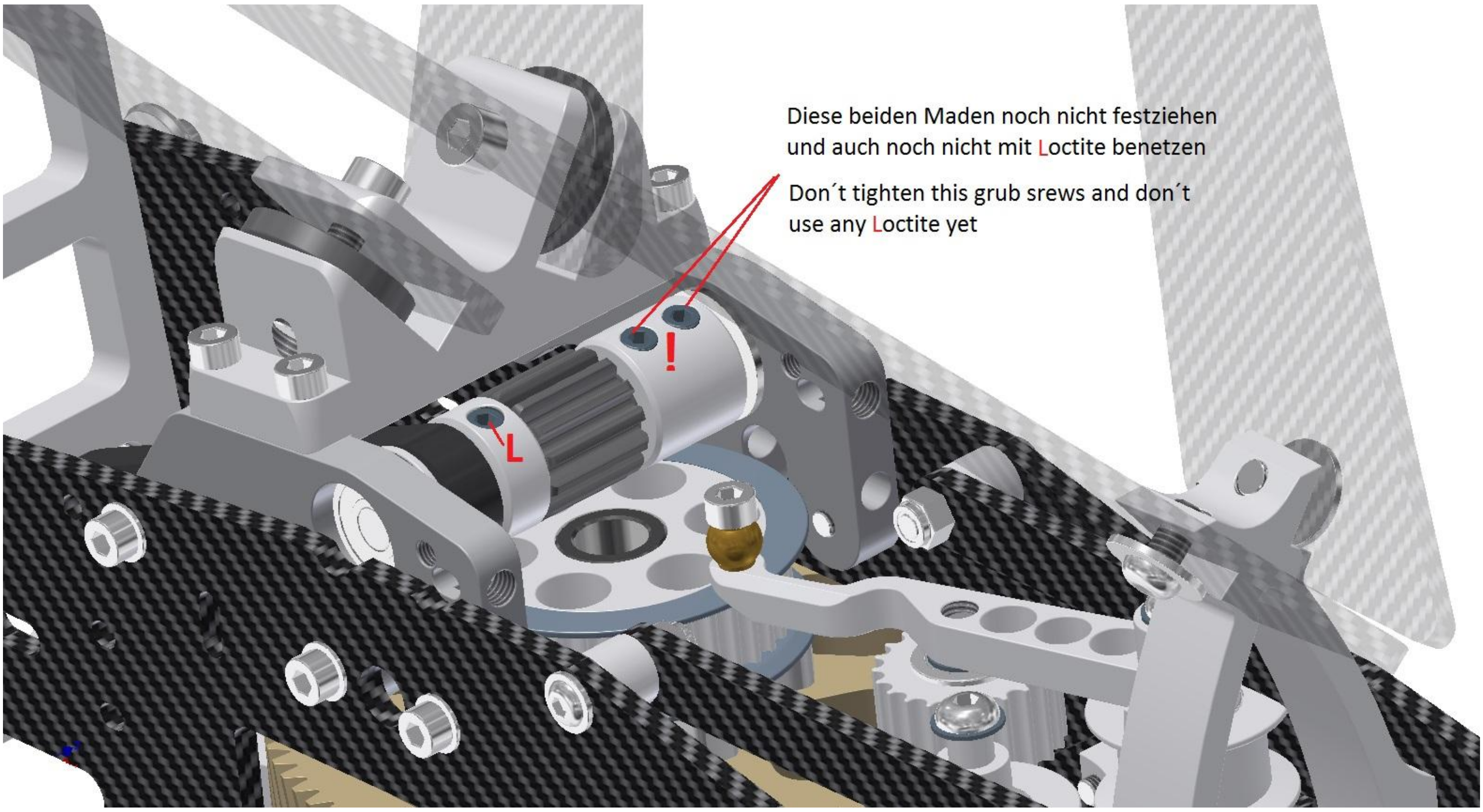
My Sport set up is set to +/-15°, which requires a delicate touch on the pitch lever. I reduce the collective values to +/-13° in my FBL system for rough 3D applications at higher RPM rates. My speed machine has the FBL reduced by 24° total pitch range with asymmetric +16 and -8°.

Gear wheel shaft – Elevator linkage (Bag 6-I)

	0603	Belt - elevator servo S3M 186UG	1
	0610a	Gear shaft - elevator linkage	1
	0610b	Flanged bearing 5x13x4 **(already mounted in part 0232)**	2
	0612	Toothed belt disk 13T	1
		Grub screw M4x5 (for 0612)	1
	0614	Gear - elevator linkage 13T	1
	0616	Locking ring	1
		Grub screw M4x5 (for 0616)	2



The detailed diagram above displays the sequence of the elevator linkage parts, which are located between both of the bearing mounts at the bottom side of the chassis.



Attention! Please consider the following procedure:

At first, slide the locking ring 0616 onto the gear 0614 so that all thread bores of the grub screws are aligned.

Attention! Initially the grub screws are just inserted slackly into their threads and without applying **L**octite.

Slide the gear shaft 0610a, as displayed clearly on the previous page, from the outer left side through the bearing 0610b (in view of the mechanic from the bottom rear as in the diagram above). Then slide the toothed belt disk 0612 together with the belt 0603 onto the shaft.

Attention! Bear in mind the position of the shaft's flattened section. It is required to align the flat section with the grub screw thread of the belt wheel 0612 later on.

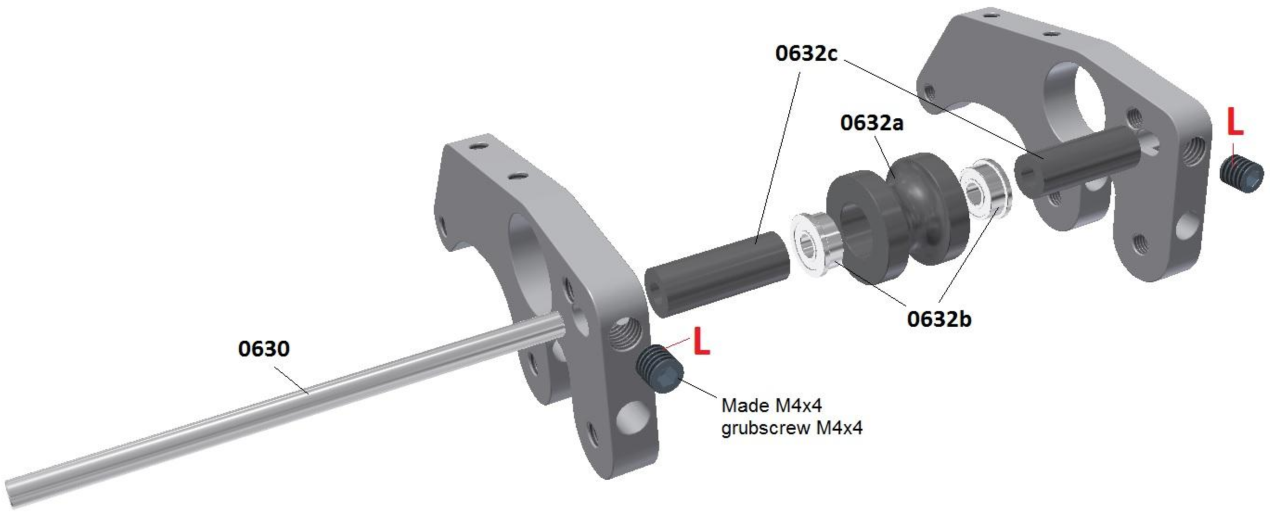
Consecutively, the pre-assembled unit consisting of a locking ring and gear is now also slid onto the shaft. Then the shaft is inserted into the bearing of the bearing plate on the opposite side. The shaft aligns with the outer sides of the bearings on both sides.

Tighten the grub screw of the belt wheel 0512 as soon as it aligns with the flattened section of the shaft. Initially only tighten slightly to allow leveling of the flat surface. Release the grub screw again a tiny bit and try to move the shaft back and forth in axial direction. The shaft will only move 0.5mm to the edge stop of the milled flat surface. This is a simple method to check the correct alignment. Bring the shaft back to its middle position and fasten the grub screw tight with **L**octite.

For now we are done with this assembly section. The two grub screws of the pinion clamping ring 0615 are tightened later on, when the position of the swash plate is calibrated.

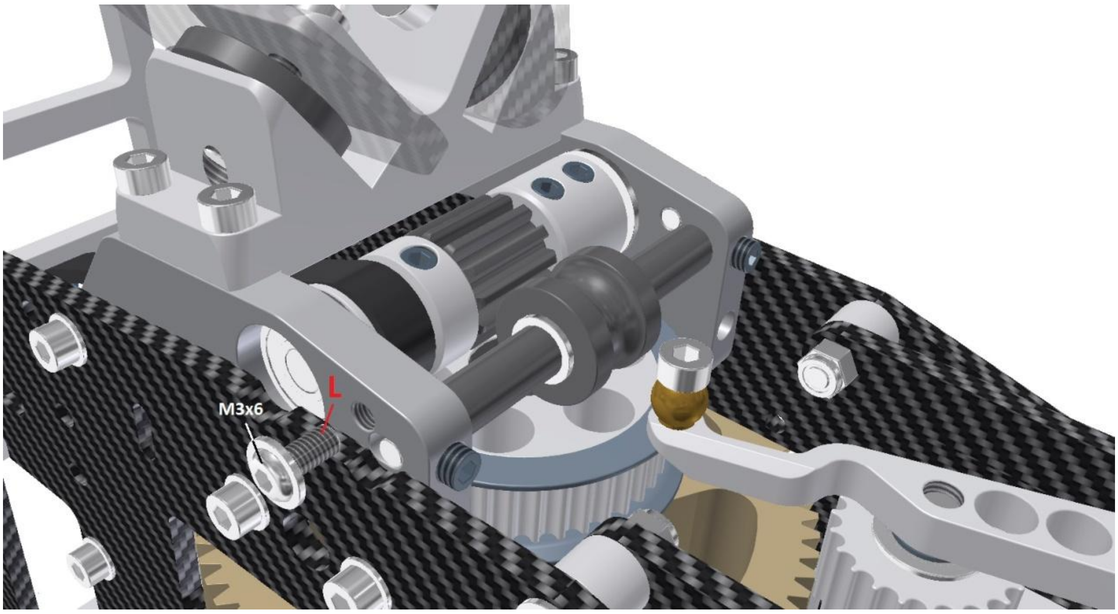
Elevator linkage rod (Bag 6-II)

	0620	Toothed rack- elevator servo	1
	0622	Elevator linkage rod M3- 102.5mm	1
	0624	Anti-twist for swash plate	1
		Hex socket screw M3x10 (for 0624)	2
	0626	Ball socket fork	1
		Grub screw M3x12 (for 0626)	1
	0628	Ball socket (already mounted at swash plate)	1
	0630	Shaft for elevator toothed rack guide 3x 58mm	1
		Grub screw M4x4 (for 0630)	2
		Lense head screw M3x6 (for 0630)	2
	0632a	Roll guide for elevator servo linkage	1
	0632b	Flange bearing 3x7x3	2
	0632c	Spacer	2



Both flange bearings (3x7x3) 0632b are pressed into the roll for roll guide 0632a. The shaft for elevator tooth rack 0630 is now slid through the slots of the bearing mounts. All parts are assembled on the axis as displayed in the drawing above. The procedure is similar to the previous assembly section.

Initially the grub screws are not treated with Loctite. This happens later when the shaft for the elevator tooth rack pre-tension is calibrated. Insert the grub screws approx. half way into their threads. The axis should remain movable back and forth in the slots.

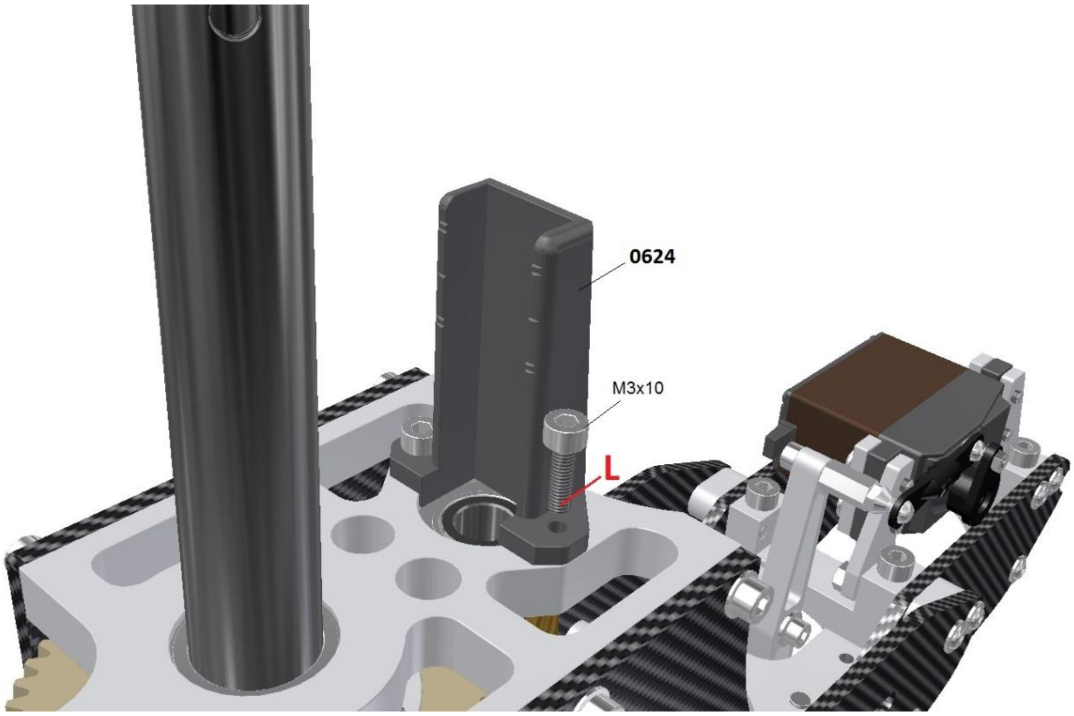


Tighten the M3x6 lense screws on both sides with very little **L**octite.

The screw heads cover the slots partially. They secure the shaft for the elevator tooth rack from slipping out sideways.

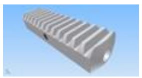
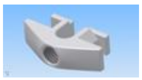
We have pre-assembled the toothed rack 0620 as well as the elevator linkage rod 0622 and the ball socket fork 0626 with high tenacity **L**octite.

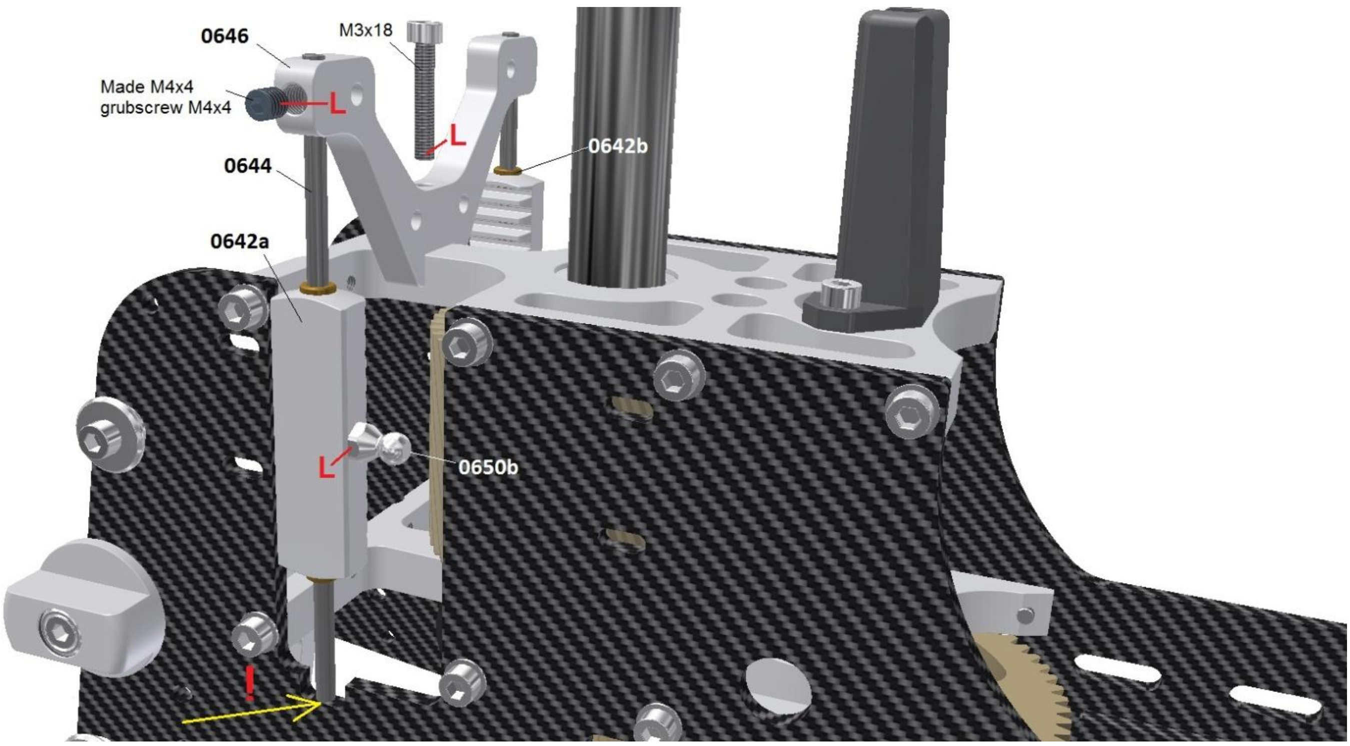
Insert the M3X12 grub screw only a few thread turns and set the nick linkage unit aside for the moment.



Finally assemble the anti-twist for swash plate 0624 above the intermediate shaft on the upper bearing plate. (Use Loctite)

Roll linkage rod unit (Bag 6-III)

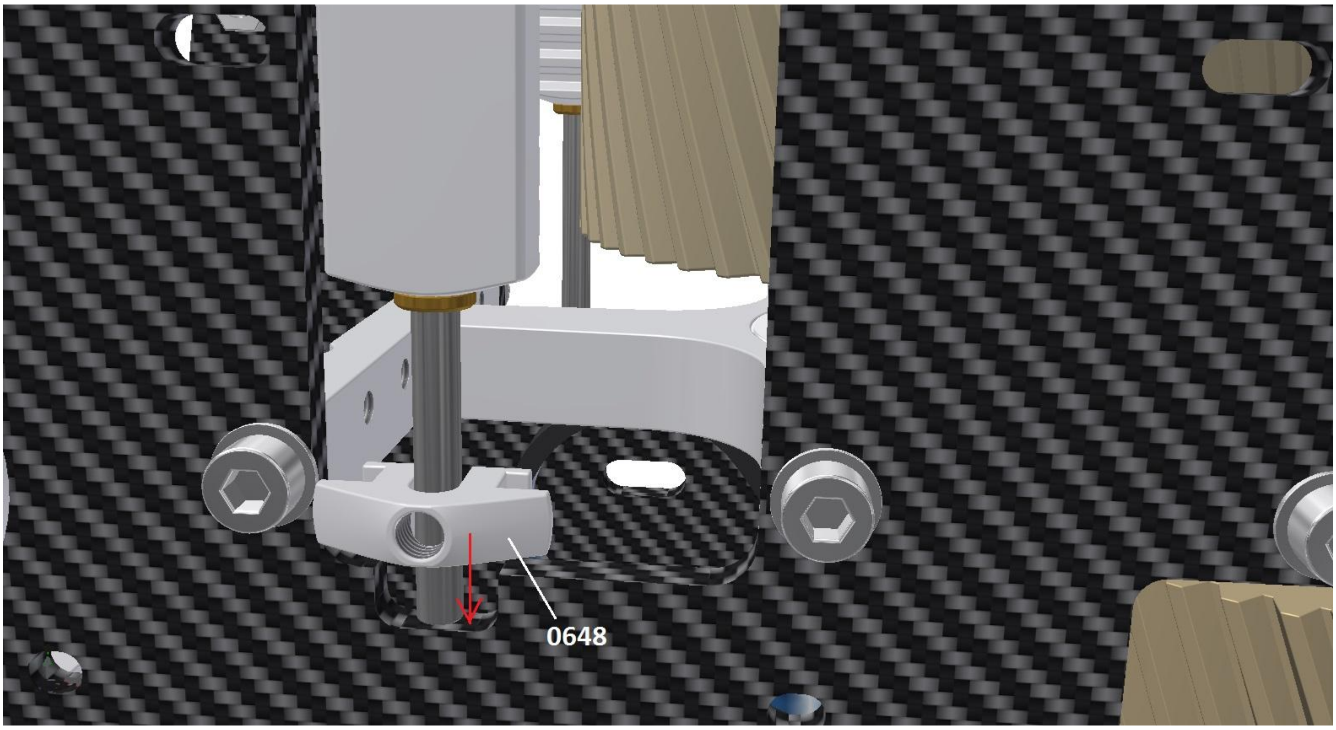
	0642a	gear rack - aileron servo	2
	0642b	gear rack bush - aileron servo	4
	0644	Toothed rack guide rod 3x 97mm	2
		Grub screw M4x4 (for 0644)	2
	0646	Support for gear rack guide	1
		Hex socket screw M3x18 (for 0646)	1
	0648	Pusher for gear rack guide rod	2
		Grub screw M3x6 (for 0648)	2
	0650a	Ball link - 19mm	4
	0650b	Threaded ball stud M3x4 - 6mm	2
	0650c	Stud bolt M2,5x25	2



The toothed rack bushes 0642b have been press fitted by us into the toothed rack 0642a. Attach a ball stud 0650b respectively into each of the threads of the toothed rack (use **L**octite). The support for the toothed rack guide 0646 is attached onto the upper bearing plate from the top and fastened with the M3x18 screw (use **L**octite).

Now slide the toothed rack guide rod 0644 from the top into the respective bores of the shaft mount and then through the toothed rack. Initially push them to the stop of the carbon chassis panel.

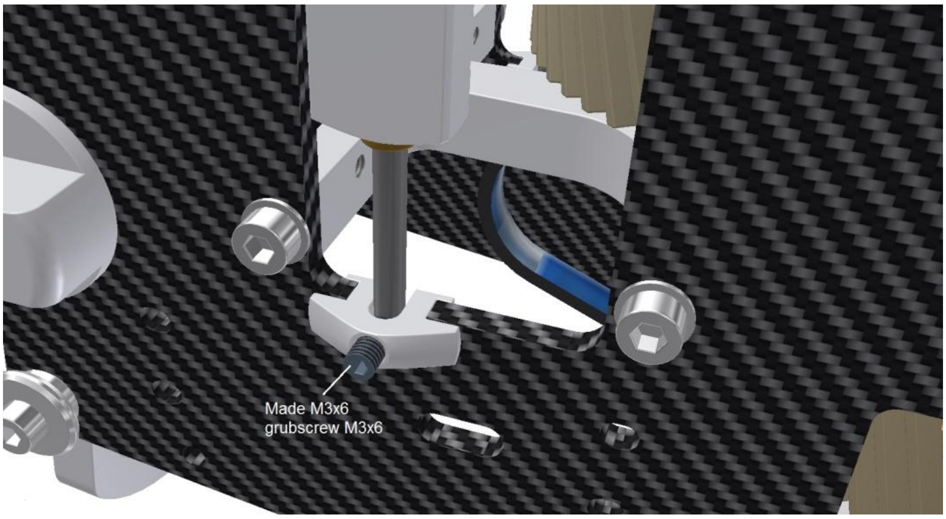
Attention! Pull the shafts up again approx. 0.5mm. They should not touch the carbon panels anymore and have a free pivot on the bottom, before you tighten the M4x4 grub screws with a little **L**octite.



Move the pusher for toothed rack guide rod 0648 into their respective recesses on the chassis panel. They have two slanted chamfers on their bottom side as spacers for the radius of the recess in the chassis panel. Level the adjuster so that its upper edge is aligned parallel to the edge of the large recess in the panel. If you push the rod from the side, it should have a free pivot in the slot of the adjuster without clamping. If needed, level the adjuster until the shaft has a free pivot.

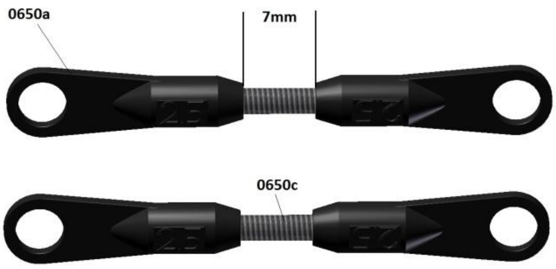
Carefully trickle some runny CA glue into the gaps of the U-shaped junctions on the inner sides of the panels. The CA glue will spread by capillary attraction.

Attention! Be thrifty with the CA glue and apply in steps. The CA glue should not seep into the slot of the adjuster, otherwise the rod will get stuck.



The M3x6 grub screws are first inserted with slack and without Loctite. They should touch the rod but not push them.

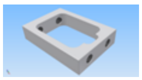
The adjustments are done later after assembling the roll servos. Grease the tooth rod as well as spring shaft with DRY FLUID GEAR.

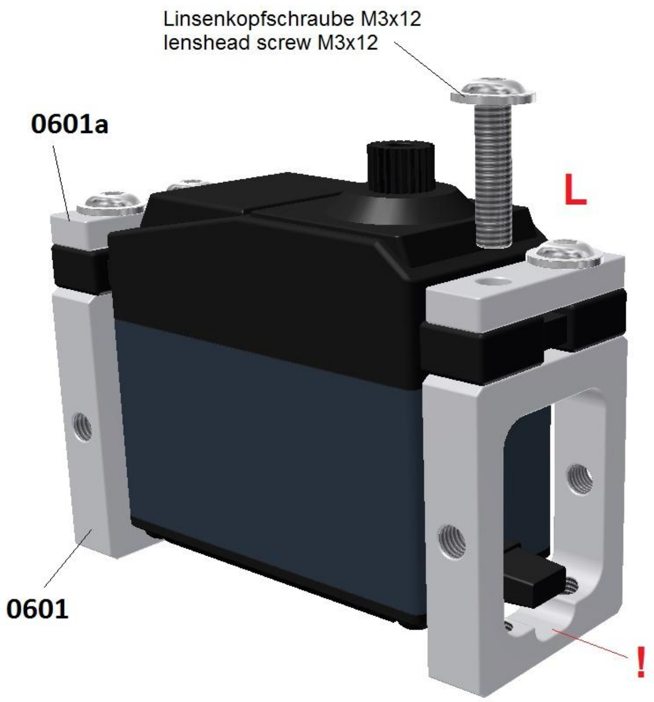


Attach the ball links 0650a onto the stud bolt 0650c and adjust a distance of 7mm between their shaft.

Grease the thread rods a little to ease the joint attachment.

Elevator servo frame assembly (Bag 6-IV)

	0601	Servo mounting frame	2
		Washer M3 small (for 0601)	4
		Hex socket screw M3x8 (for 0601)	4
	0601a	Servo mounting plate	2
		Lenshead screw M3x12 (for 0601a)	4
	0601b	Carbon-flybarless support	1
		Countersunk-head screw M3x6 (for 0601b)	2



Attach both of the servo mounting frames 0601 to the elevator servo. Do not insert the metal sleeves that are usually used into the rubber damper. The screws are inserted directly through the servo mounting plates 0601a and then through the rubber dampers.

Attention! The recess for the servo cable has to face downward.

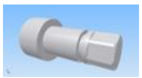
Attention! Before you tighten the servo screws, you need to check to see if the body of the servo protrudes beyond the frame mounts. Set the servo including frame mounts onto a panel and check for enough space under the bottom of the servo. Bear in mind that the servo will settle further 0.5mm downward, after tightening the screws.

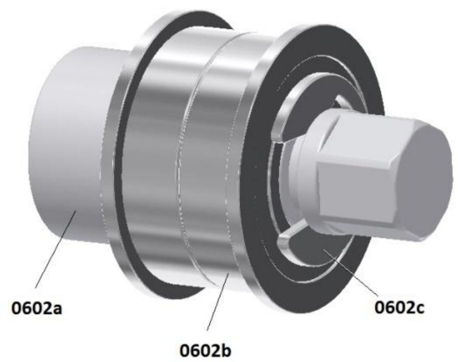
If the servo protrudes beyond the bottom or if the gap is less than 0.5mm, please add some of the black 1mm plastic supports 0660 between the servo and servo mount frame. You will find them in a separate bag of assembly section 6.

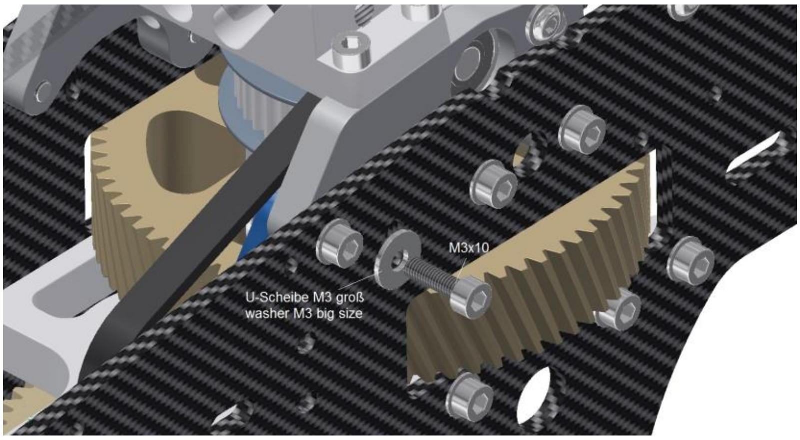
Do not squeeze the rubber dampers more than 1mm when you tighten the screws. Check the distance equality on all four corners with a caliper before and after tightening the screws (use Loctite).

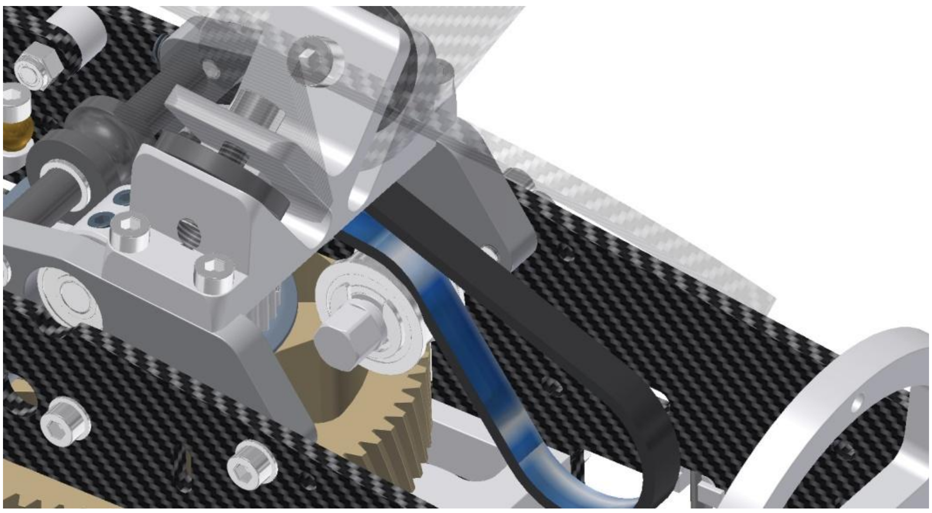
	0660	Servo support 1mm	8

Elevator servo assembly (Bag 6-V)

	0602a	Belt tensioner stud	1
		Washer M3 large (for 0602a)	1
		Hex socket screw M3x10 (for 0602a)	1
	0602b	Flanged bearing 8x16x5	2
	0602c	C-Clip DIN 6799 A2 - 6mm	1
	0605	Toothed belt disc - elevator servo - 26Z	1
	0607a	Counter bearing flange - elevator servo	1
		Washer M3 large (for 0607a)	1
		Hex socket screw M3x10 (for 0607a)	1
	0607b	Bearing 12x18x4	1





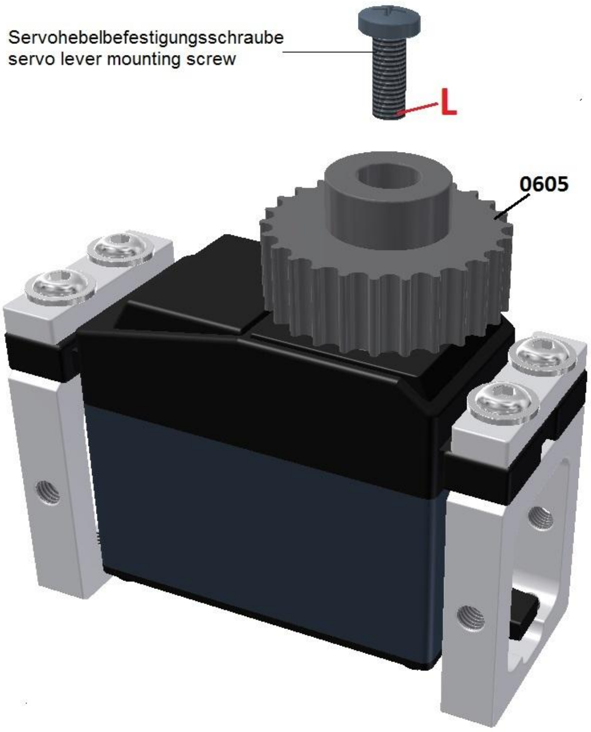


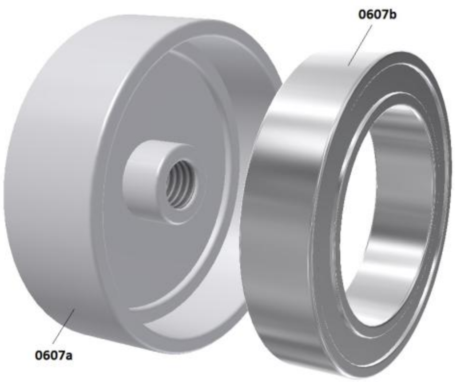
Assemble the belt tensioner in accordance to the upper left drawing. Slide both of the flanged bearings 0602b onto the stud 0602a with flange facing outward. Secure with C-clip 0602c.

As shown in the drawing to the left, the belt tensioner is attached to the inner side of the chassis panel below the belt. For this purpose, there is a slot hole in the panel.

No Loctite is needed for the M3 screw (drawing above) because the tilt torque of the screw is kept under permanent tension by the belt tensioner. The screw will not release (do not forget the large washer).

Slide the tensioner to the stop of the slot hole, down into the direction of the intermediate pinion. Tighten the screw only slightly for now.





The bearing 0607b (12x18x4) has to be pressed in the counter bearing flange 0607a, until it is completely inside the flange.

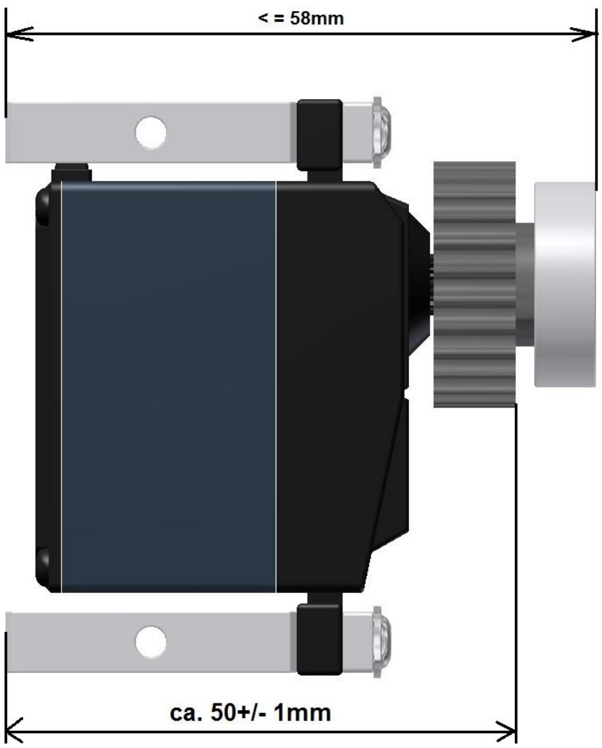
Attach the toothed belt disc 0605 to the servo shaft with the enclosed servo horn attachment screw. No specific positioning is needed on the toothed servo shaft. The fine calibration of the elevator servo is accomplished later on by the pinion shaft of the elevator linkage.

Attention! You may only use servos with Futaba compatible 25T multi tooth shafts.

The annular gear rim of the belt wheel is executed to have a very tight seat on the servo shaft. Before pushing the belt wheel on the servo shaft, swivel it back and forth a little, until you feel the teeth engaging. Only then, should you push the belt wheel to the stop and tighten the screw with **L**octite.

In case your servo comes with a shaft screw that does not fit into the bore of the belt disc, you may use a M3x8 hex socket screw. You will find one in the reserve part bag, of course preconditioning that your servo shaft has a M3 thread.

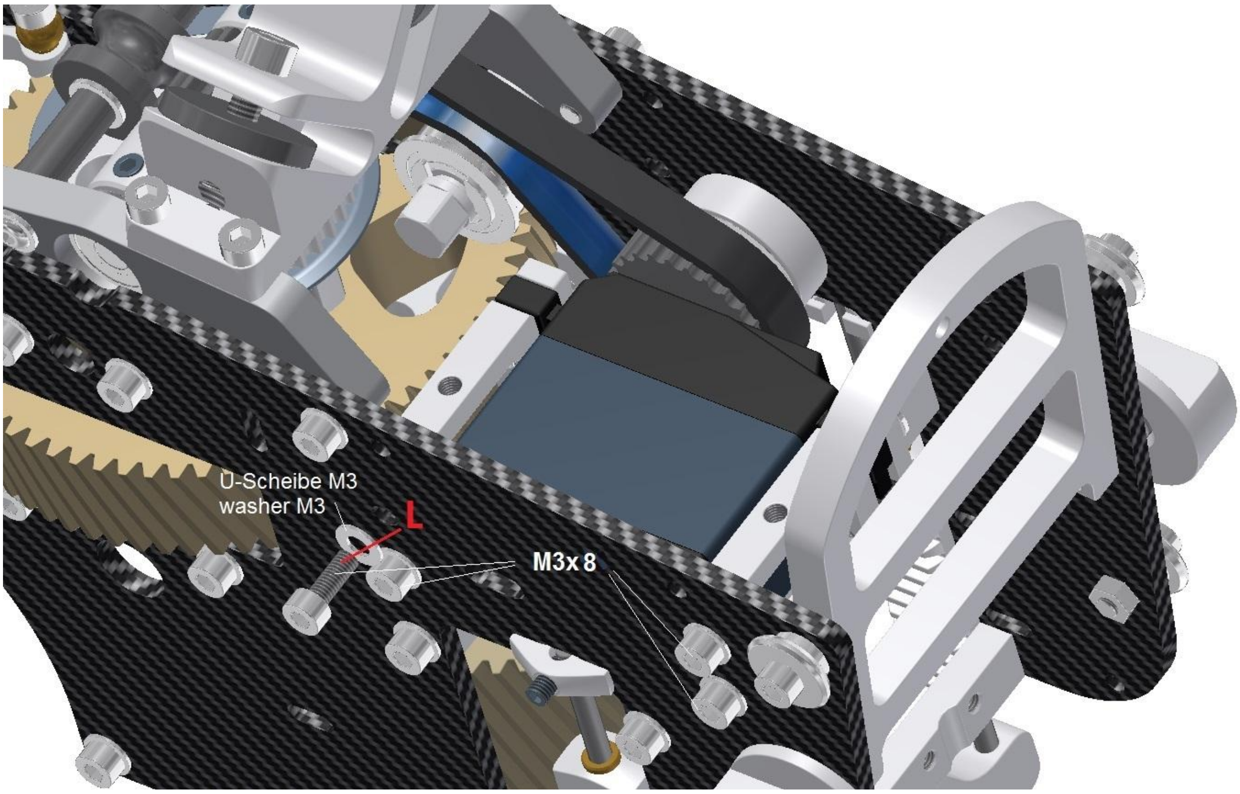
Otherwise, you will need to grind the original screw. In any case, the screw has to sink onto the bottom of the recessed bore so that the belt disc sits tight. The little protruding stud on the counter-bearing flange has to fit into the counterbore of the toothed belt disc.



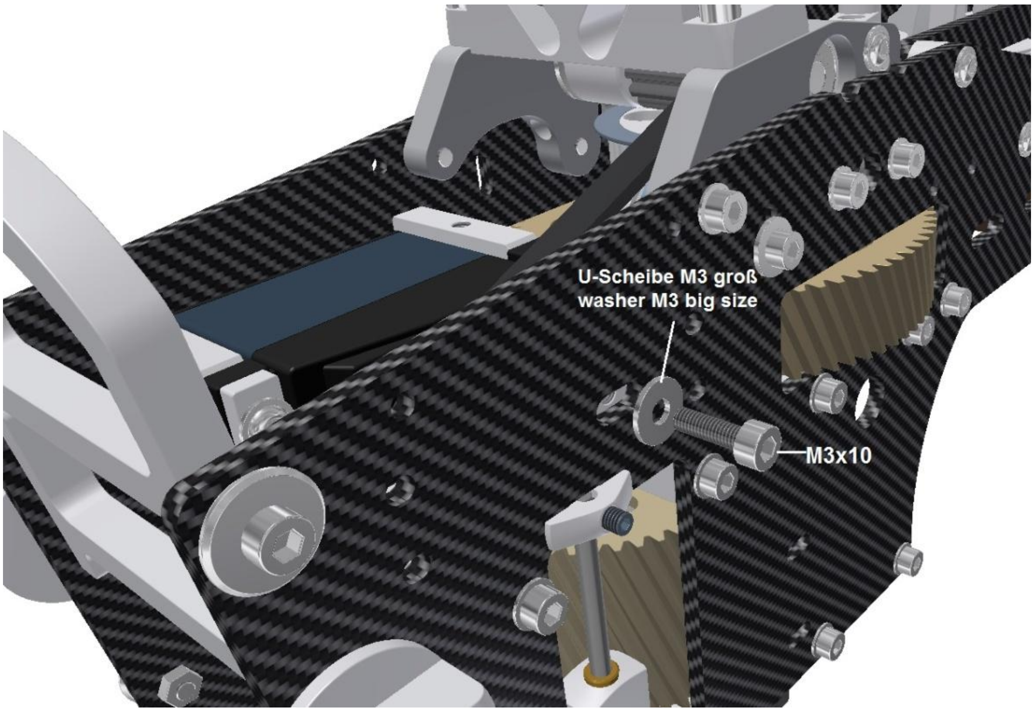
Measure the distance between the frame bottom and the top side of the belt disc. It should account to 50mm +/- 1mm. If the distance is less that 48mm, you can adjust with the 1mm plastic supports between the frame and chassis panel.

Now slide the pre-assembled counter bearing onto the projecting shaft of the belt disc. The complete unit including support adjustments and counter bearing should be less than 58mm (left drawing). This is required to insert the unit from the bottom between the panels in the next assembly step.

Please also align the servo frame mounts so that they are parallel to each other and to the servo housing.



Lift the belt up to merge it with the belt disc. Arrange the servo cable beneath the servo, leading to the front. Now fit the servo unit between the chassis panel and tighten both servo mounting frames. The four assembly bores are actually little slots. They compensate slight differences in the servo mounting width. Make sure the frames are positioned upright while tightening the screws (with **L**octite), to avoid aslant seating. Minimum offsets will be equalized by the rubber dampers.

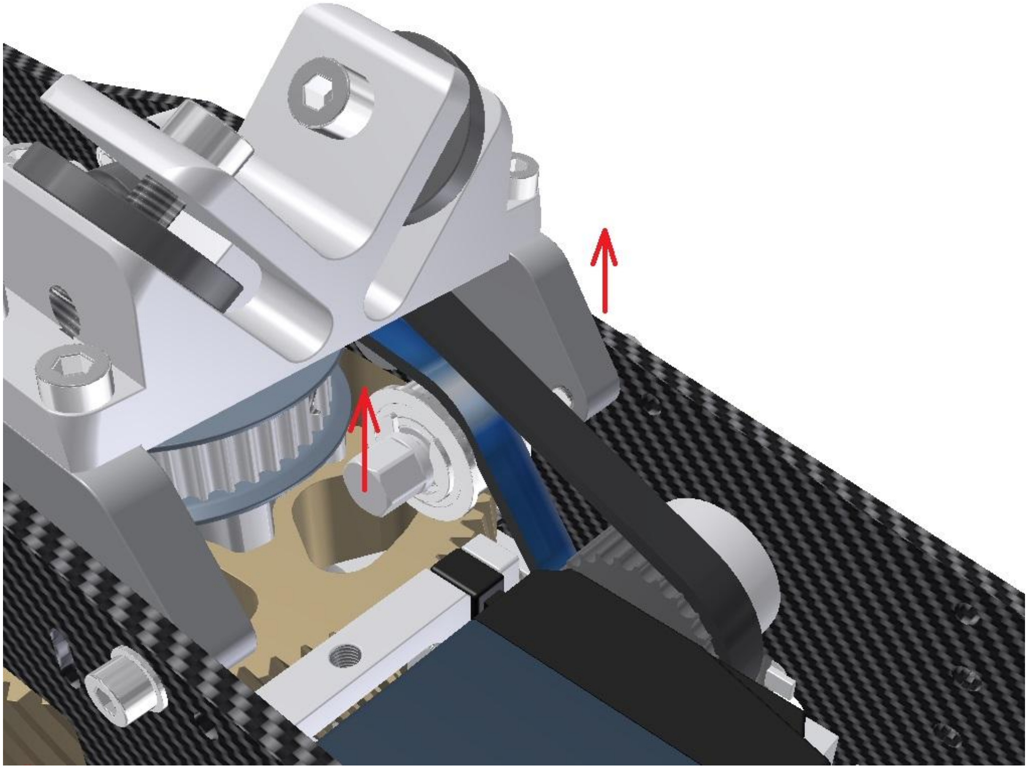


Before setting the belt tension, the counter bearing is tightened with the large washer and M3x10 screw, to the averted opposite side. The slot for this screw offers enough space to all sides. Subsequently, the screw will align with the thread of the counter bearing without tension.

Attention! Under no circumstances use **L**octite on this screw. Release of the screw will then be impossible because the counter bearing is stuck to the screw. The screw will not release by itself. Arrest the counter bearing slightly while tightening the screw. The abutting face of the counter bearing is shaped slightly conical. Upon tightening the screw, the outer rim of the bearing touches the panel first. It will then act as a cup spring and lock the screw.

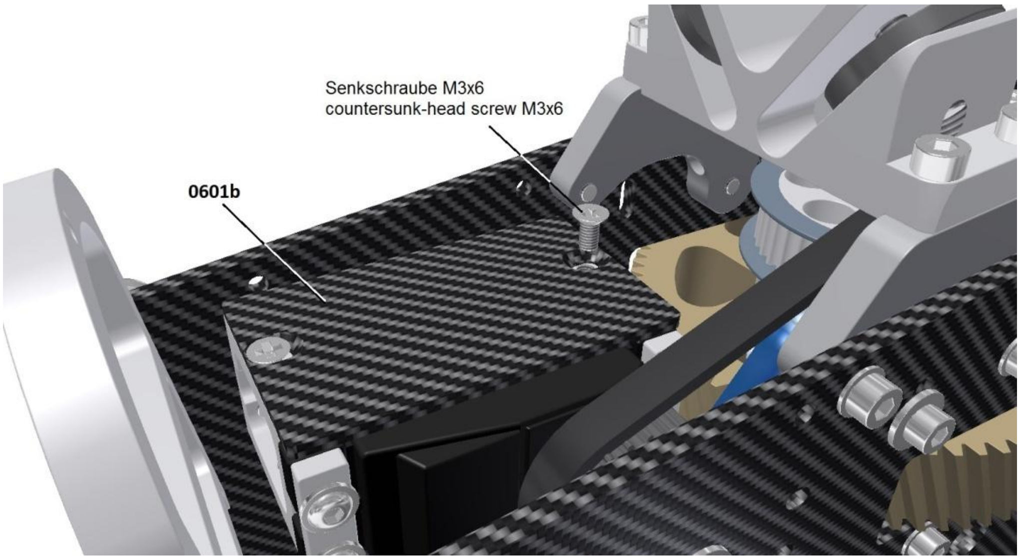
Depending on the servo dimensions, the belt will not always ride in the middle of the belt disc. This has no negative influence, even if the belt protrudes with an offset of 0.5mm over the edge. The final positions cannot be determined before all servos are connected. The elevator servo needs some movement until the belt position settles. Should the belt position be too far out and closing up to the panel, you may add another two of the 1mm frame supports between frame mounts and panel. This will reposition the servo toward the belt.

For modifications, first release the belt tensioner, then counter bearing, and finally the screws of the frame mounts. Reassemble in the reverse sequence.



To adjust the belt tension, please proceed with the following steps.

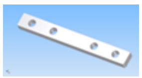
Wrap your pointer finger under the hex of the belt tensioner and support your thumb on the skid mount. You may also use a ring wrench. Simultaneously insert an Allen key into the screw on the outside of the panel. Untighten the screw slightly then forcefully pull the tensioner up against the belt from both sides, while you tighten the screw again. Lock the hex with a ring or open wrench to give the screw its final tightness. The belt may sit relative tight.



Attach the FBL panel 0601b with two M3x6 screws onto the servo frame mounts (use **L**octite). To compensate tolerances and avoid screws from protruding above the FBL panel surface, two slots are recessed into the panel.

This panel is aligned to the main rotor shaft in right angles. The use for your FBL system is inevitable. Further details later.

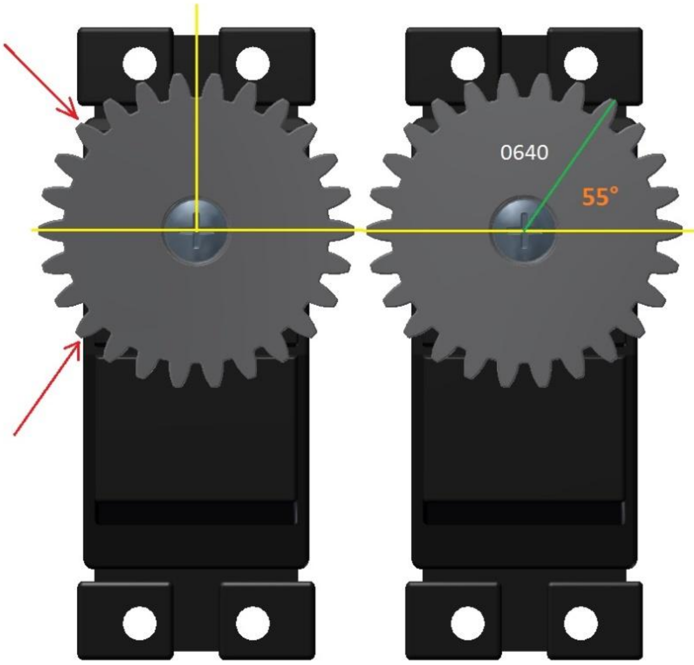
Roll servo assembly (Bag 6-VI)

	0640	Gear - aileron servo 26T	2
	0654	Servo support	2
		Lense screw M3x12 (for 0654)	8

Both of the aileron servos need to be prepared for a precise mechanical adjustment.

The more conscientious you are as you work on this now, the lesser you will be concerned with electronic corrections later. In the best case, you will not have to trim or adjust anything in your FBL system anymore. This is ideal to exploit the best FBL performance. This particularly well accomplished with the **LDS** System.

Attention! Only servos with Futaba compatible 25T multi tooth shafts may be used.



Unlike the elevator servo, the belt disc 0640 should be mounted very accurately onto the servo shaft. As displayed in the diagram, one tooth in rectangular position to each of the servo sides. This is possible due to the even count of 26 teeth. However, a tooth gap points into both long sides of the servo.

The 25 teeth on the servo shaft and 26 teeth on the pinion enable a very fine adjustment by repositioning. With conventional servo horns, you hardly ever achieve accurate positioning. This works much better here.

Proceed as follows:

Connect both aileron servos directly to your receiver without any FBL system in between. Use the receiver channels for aileron or elevator (no pitch or throttle). All trims on your remote need to be in neutral position. Turn the remote on and allow the servos to engage into neutral position. Keep the remote on so that the servo shafts will not change their position again.

Now plug the pinion onto the servo shaft provisionally. Observe the position of the pinion very accurately (see diagram above). While repositioning the pinion only, push it slightly onto the servo shaft—just enough to get a good grip for observation. Determine the best possible adjustment by repositioning the pinion tooth by tooth, until two teeth are obviously in rectangular position to the servo long sides. Depending on the tendency, you will determine whether to reposition in one or the other direction.

To obtain reference for a sense of proportion, you may also take an aim at both of the teeth, which are closest to the long side of the servo body (see red arrows). This will improve the estimation by sight. However, this preconditions the leveled seat of the pinion and accurate aim from the top. Once you have determined the best possible position, press the pinion down to the stop and tighten with a servo horn screw (use **L**octite).

Indicate both of the outer teeth in rectangular position with a visible waterproof marker. You will need their position upon installing the servos in the next step.

The following section refers to all customers who have purchased programmable servos as I suggested.

Continue keeping one servo hooked up to the receiver and apply full stroke with your remote stick.

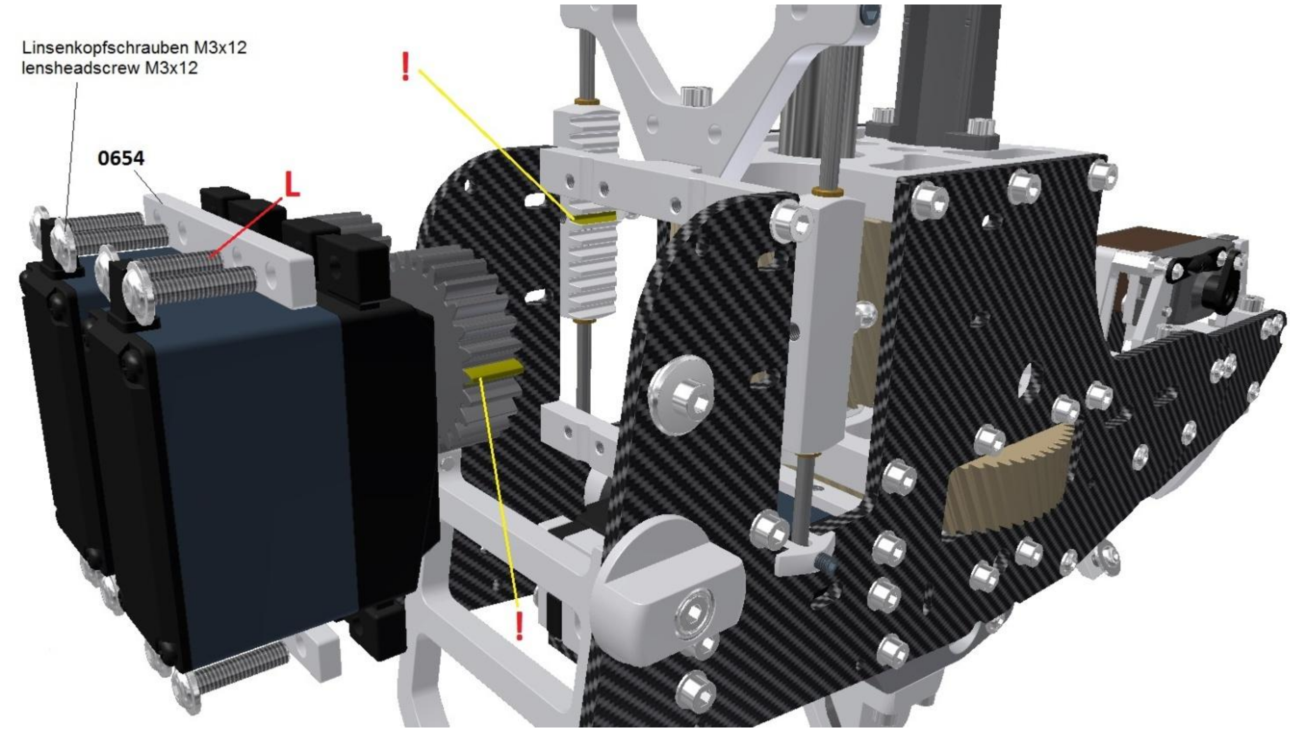
Attention! Travel has to be adjusted to 100% for both directions in your remote. No mixer and no expo are to be set.

The angle of the pinion from tooth to tooth is approximately 14° (360/26). Without programming, the pinion will progress approx. three teeth similar to standard servos. This will be around 45° and varies from vendor to vendor.

Now attach the servo to your programming tool. Increase the travel value to both sides equally until the servo progress has reached four teeth (55°) (see the angle between green and yellow line in the diagram last page). The test is done as usual without any FBL system in between.

For Futaba servos, the travel is to be set to approx. 125%

Once you have determined a suitable value, you may attach the second aileron servo as well as the installed elevator servo to your programming tool and adjust to the same value. You don't need to verify this any further.

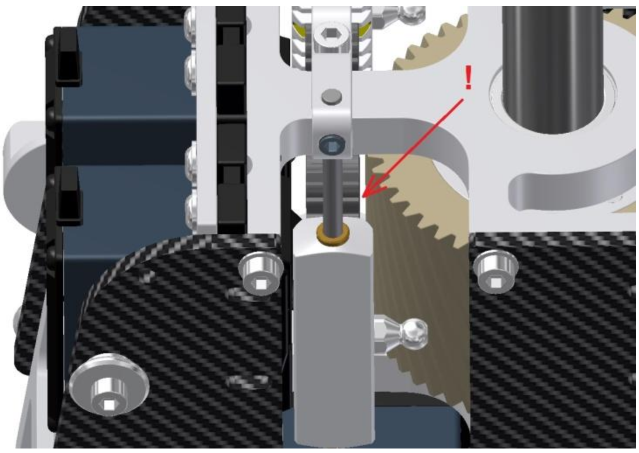


Now insert the aileron servos from the front. The previously marked teeth have to engage with the middle gap of the tooth rods (both are marked yellow in the drawing). The middle gap of the tooth rod is easy to identify. It is adjacent to the linkage ball.

Slide the screws through the servo supports 0654 and initially fasten them slack into the threads of the bearing mounts. The strips should touch the rubber dampers equally and without pressure (definitely use **L**octite here).

Do not make use of the metal sleeves that came along with the servos. Tighten the screws step-by-step and reinsure a balanced seat of the strips. The rubber dampers should not be squeezed more than 1mm.

This is equivalent to two full turns on the M3 screw. Mark your hex wrench and make half a turn on each screw for each step.



Viewed from the side, the servo-gear must not necessarily engage with the middle of the tooth rod. They are fabricated broad enough and will tolerate aberration.

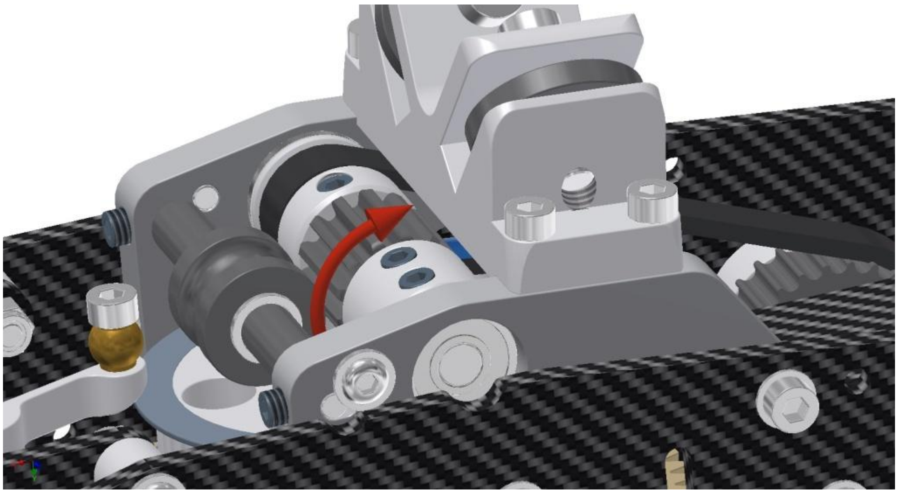
Attention! Check for a minimum clearance of 0.5mm between roll servo gear and the main shaft gear wheel. They may not have contact under any circumstance. Should this be the case, gain some distance by adding a set of 1mm plastic supports between servos and the bearing mount.

Apply some **L**octite to both of the M3x6 grub screws of the tooth rod adjusters 0648 (also see page 42). Adjust the tooth rods to engage with slight press contact onto the servo pinions. This eliminates any lash. Check the press contact by turning the tooth rod back and forth on its axis. They should barely wobble any more. From this point you may further increase the contact pressure by half a turn of the grub screws.

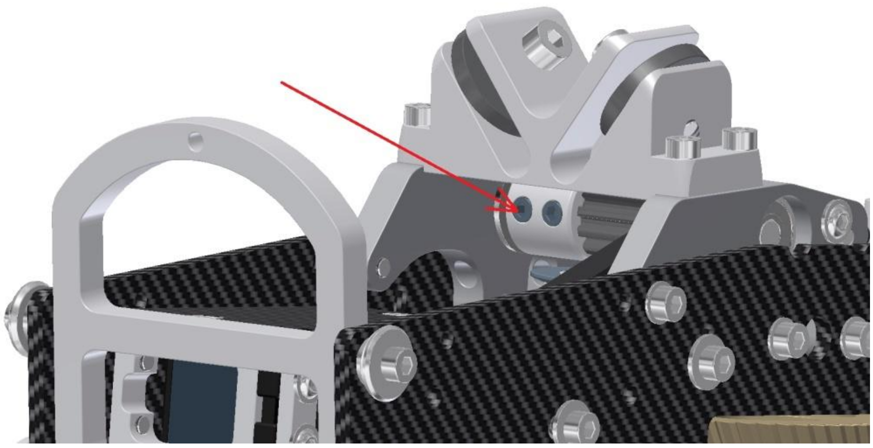
If you try to turn the gear rack around its longitudinal axis, it should not appreciably twist any more.

Swash plate linkage

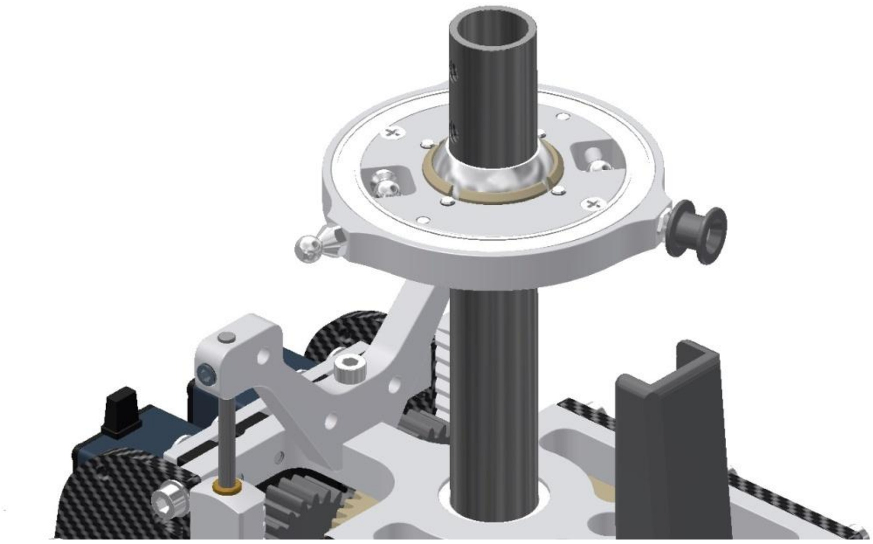
Connect the elevator servo to the receiver without any FBL system in between, just like you did with the roll servos previously. Turn the remote on and allow the servo to approach center position. Keep everything turned on during the next steps.



Check both grub screws of the elevator gear clamping ring for slack seat. The clamping ring should be turnable on the shaft. Adjust the position of the elevator gear with clamping ring so that both grub screws face toward the front.

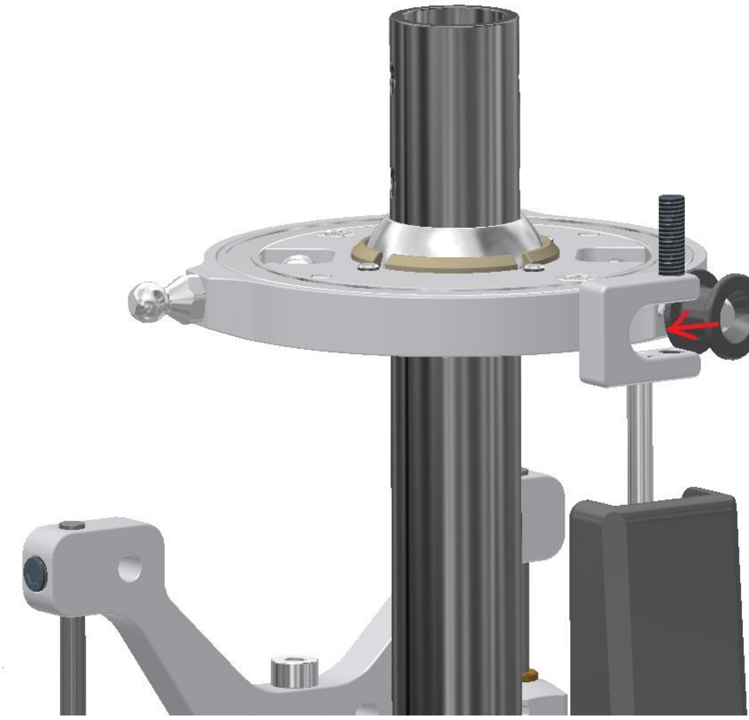


The image to the left displays the approximate position of the two grub screws (see red arrow).

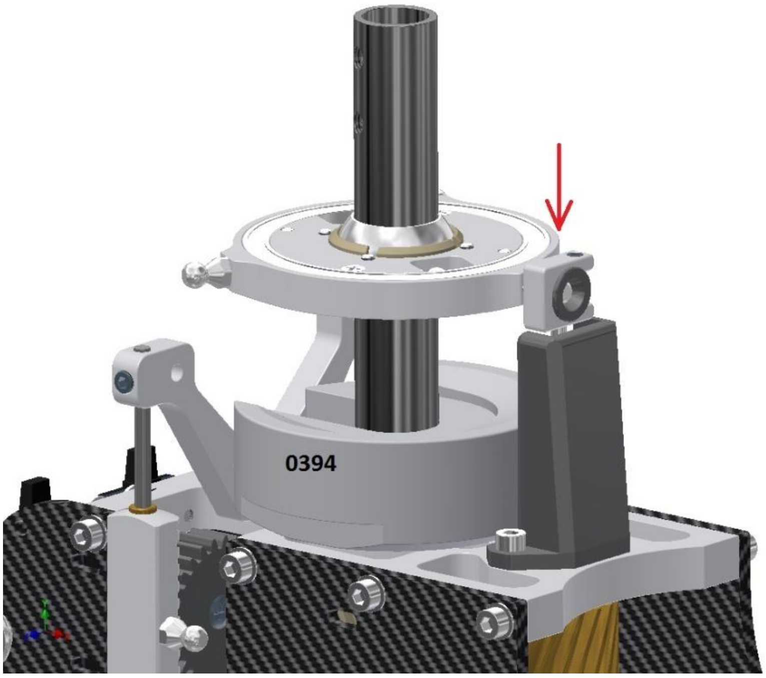


Check to see if the swash plate slides effortless along the main shaft. Do not insert the ball aslant. Sometimes some burr remains may occur on the M4 threads of the main shaft. Carefully remove such burr without damaging the main shaft or the M4 threads.

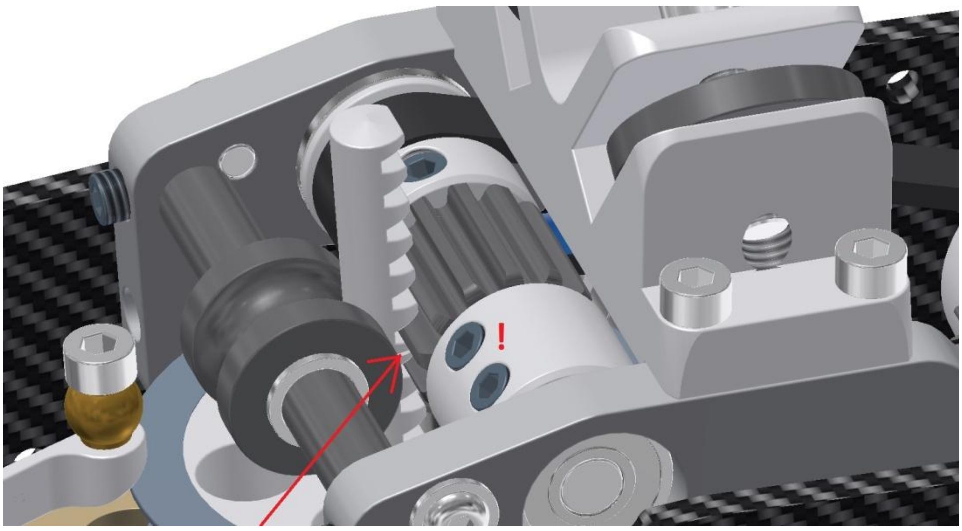
DRY FLUID GEAR is applied to the main shaft once the swash plate slides effortlessly. The swash plate is now installed.



Slide the elevator linkage rod into the hollow intermediate gear shaft from the top. Viewed from the rear, the open side of the fork joint should face to the right. Apply some DRY FLUID GEAR onto the round gear rack beforehand. After that, turn the swash plate clockwise so that the joint merges with the u-shaped fork. Press them together with your thumb and pointer finger without bending the rod. Thereafter, the M3x12 grub screw is inserted all the way until it is flush with the bottom of the fork. The elevator linkage is now well secured. Faintly apply some **L**octite onto the last three thread windings of the grub screw. Maintain removability. As the fork will be sliding inside the swash plate lock later on, the joint will not slip out of the fork without grub screw anyway.

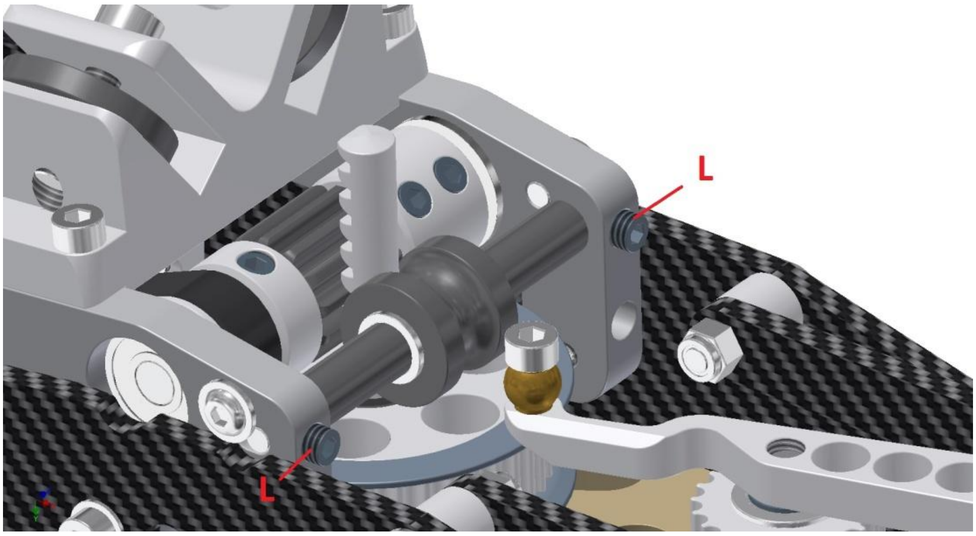


Now place the 21.5mm thick swash plate gauge 0394 (which you will find in the tool bag) below the swash plate, milled recess facing upward. Slowly push the swash plate with elevator linkage downward until the fork slides into the swash plate lock. At the verge of sinking the fork into the lock, you will feel a slight resistance. This is the moment when the round gear rack touches the elevator gear. Observe the core mechanic from the bottom and check to make sure the tooth rod properly meshes with the elevator gear. If the teeth are facing toward the gear, it will usually do so by itself. Now push the swash plate onto the gauge. It should rest equally from all sides.



The tooth rack has a circular marking punched into the middle of one tooth. When the swash plate rests on the gauge, this marked tooth should flush with the center of the elevator gear or gear shaft.

Attention! At this position, both of the grub screws should be accessible for a screw wrench. If this is not the case, pull the rack up again until it disengages with the pinion. Depending on the direction you want to reposition the grub screws, adjust the pinion one tooth forward or backward. After reinserting the tooth rack, the grub screws should now be accessible.



The spring steel shaft of the guiding roller is adjusted with two grub screws on the fore side of the bearing mounts. When the roller exerts slight pressure onto the elevator gear rack, any lash will be eliminated.

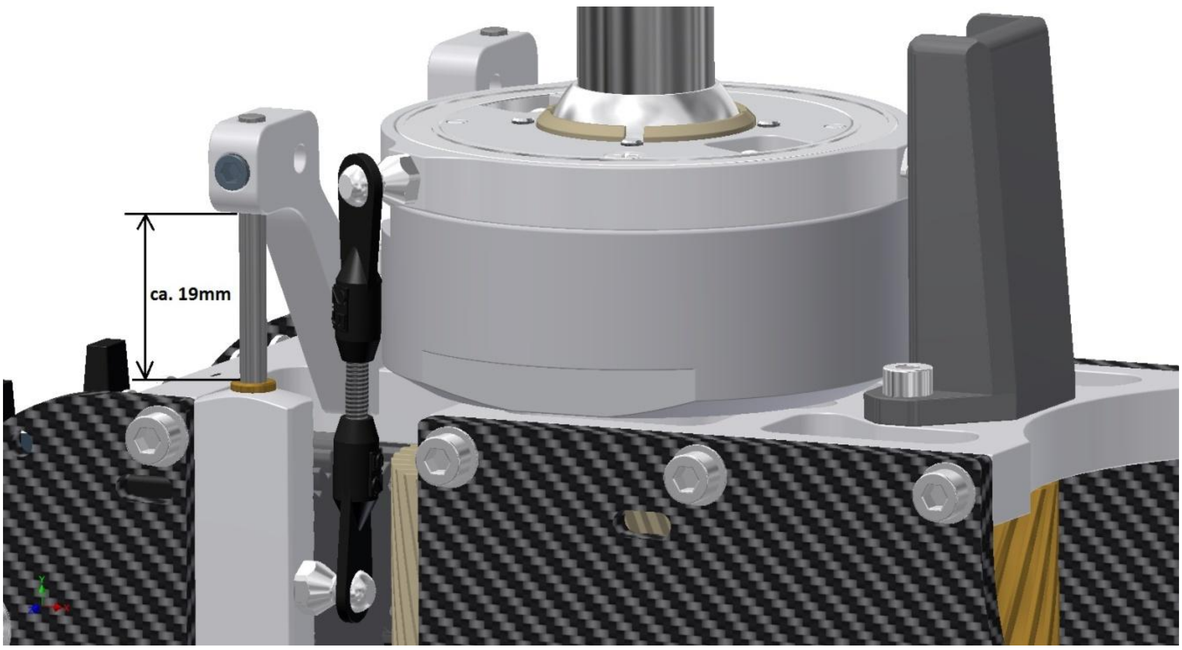
For this purpose, tighten both of the grub screws in steps equally (use **L**octite), while sliding the elevator rack up and down. At a certain point you will feel the teeth jerking slightly. This is OK, but the gear rack should not run too tight. The elevator gear will run in once in use.

Return the elevator servo back to center position with your remote and keep the swash plate leveled onto the gauge. Now slightly tighten one of the grub screws of the elevator gear clamping ring. Remove the second grub screw, apply some **L**octite, and return it back into the thread of the clamping ring and tighten slight at first.

Attention! Only apply **L**octite onto the grub screw and not into the thread bore. Thereafter, also remove the second grub screw and reinsert after applying some **L**octite. Tighten both grub screws step by step. For the purpose of infinite variable fine adjustment, the elevator gear shaft does not have a recessed flat surface. Therefore, the elevator gear needs to be fixed by adhesive friction. This will be the case if both grub screws are well tightened.

Attention! It is vitally important never to forget this clamping procedure after modifications or other assembly tasks. You finally may remove the elevator servo plug from the receiver.

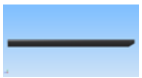
Connect both aileron servos to the receiver and allow them to approach neutral position. The tooth rods should be in correct neutral position as you have calibrated previously. Now, both of the aileron linkages will be adjusted properly.

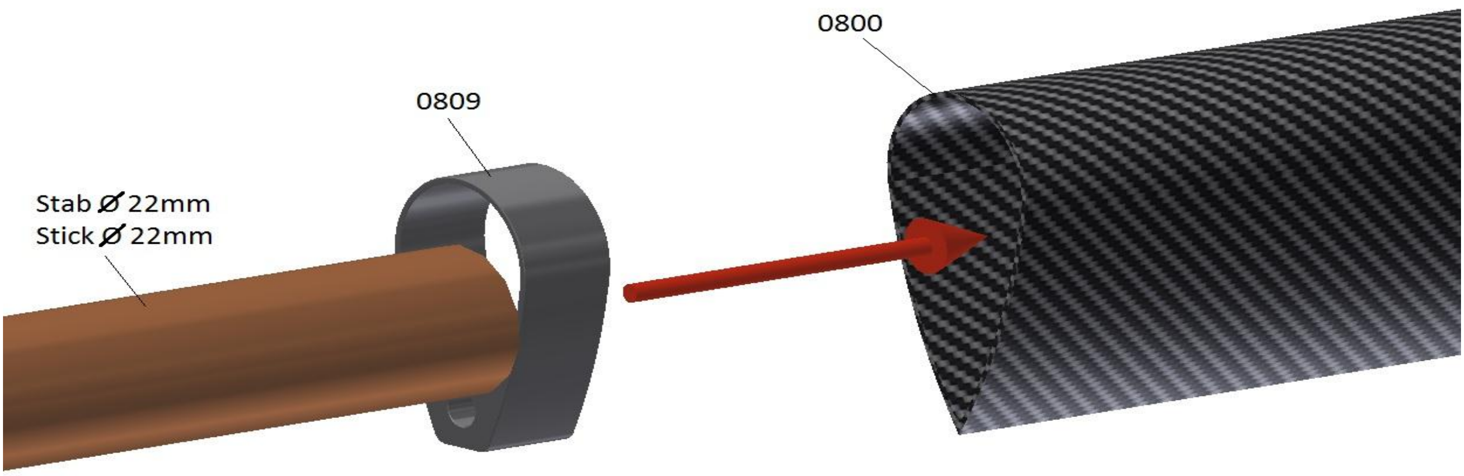


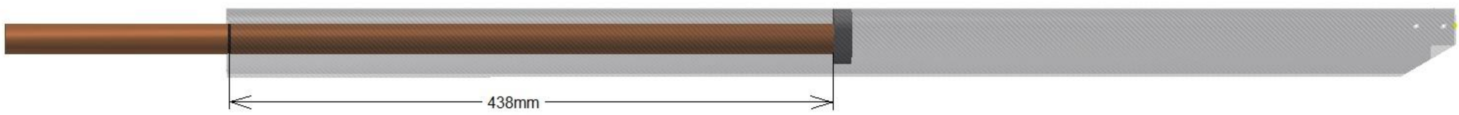
It is assumed that positioning and calibration of the aileron pinions was executed correctly. If so, the distance between tooth rod guiding jacks and the upper as well as the lower stop will be approx. 19mm +/-1mm on both sides. Now just simply adjust both linkages so that the swash plate will rest on the gauge equally on both sides. The joints will mesh easier with the linkage balls if the imprinting of the joints faces outward. Perhaps you may need a half turn of the joints for precise adjustment. In that case, the joints will also fit from the other side.

Finally, you may unplug the servos and remove the gauge under the swash plate. The calibration of your FBL system will now be a piece of cake, because your swash plate mechanic is perfectly trimmed.

Chapter 7 TAIL BOOM ASSEMBLY

	0800	Carbon-tail boom - 890mm	1
	0801	Carbon-tail push rod 4x 845mm	1
	0801a	Ball link - 19mm	2
	0801b	Stud bold M2,5x25	2
	0801c	Heat shrink tube - 80mm long (for 0801)	1
	0809	Tail linkage guide	1

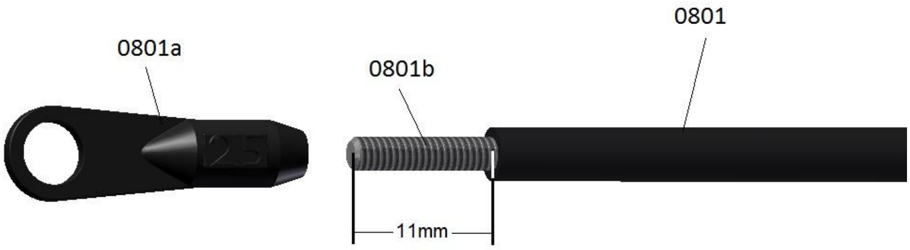




The tail linkage guide 0809 is shipped pre-assembled into the center of the kit tail boom 0800. The procedure is displayed in the diagrams above, in case you have to replace the tail boom. For this purpose, a rod or shaft with a diameter of 22mm is best suitable to position the rod guide in the tail boom.

You may, for example, purchase a 22mm copper tube from the hardware store. Apply a marking at 438mm to indicate the center position of the rod guide.

Keep the 22mm tube pushed to the bottom of the tail boom so that it will permanently abut with the front of the guide 0809 and not slip through it.



To begin with, slide the 80mm heat shrink tube 0801c onto the tail push rod 0801.

Position the tube in the middle of the rod and shrink it (not displayed in the drawing). It serves the purpose of a protection for the rod whilst moving in the linkage guide 0809. Apply some grease onto the heat shrink after shrinking it.

It is quite an ordeal to screw the ball links 0801a onto the stud bolt 0801b the first time. I recommend to turn them in and out once, before gluing the ball links onto the bolt. Arrest the ball links with a pair of pliers or a vice on the end to be glued later. It doesn't matter if the threads are damaged here.

Glue and attach both of the stud bolts 0801b into the tail rod with runny CA glue from both sides. The threads have to emerge 11mm out of the rod 0801. Do not insert the thread rods with force into the rod, in case the bore should be too tight.

The carbon rod is fabricated out of thin and long fibers, which will split up if force is exerted from within. Carefully enlarge the bore with a round file or grind the end of the thread rods from the outside with an electric drill tool.

After the CA glue has cured, screw and attach only one ball link to one end of the rod. Keep a clearance of 3mm between the end of the joint and the fore side of the carbon rod. Then insert the tail rod into the tail boom and draw it through the 5mm bore of the tail rod guide 0809.

Check the correct position with a torch. Make sure the tail rod does not accidentally slip under the rod guide bore or through the large opening above, which is reserved for the belt only.

Tail boom stickers

For better handling, it is advisable to affix all stickers and adhesive labels to the tail boom before attaching it to the core mechanic. Clean the tail boom beforehand. Petroleum-based solvents such as brake cleaner may be used to degrease the surface.

It is convenient to start with the text label. First, set a mark 220mm from the tail boom rear, preferably with a stripe of tape affixed vertically. The tape should not cover any of the surface meant for the text label.

Apply horizontal marks in the same manner, 23mm from the bottom of the tail boom on both sides of the text label (see red lines). The label has a length of 360mm. You have two marks for your orientation. The text label is affixed dry without any soap or water. It must fit promptly. Any free-handed attempts bear the risk of irregularities. Both of the marks are needed for precise application. On such length, any slight irregularities are permanently eye-catching and will look miserable.

Enclosed with your kit is the text label in your desired color. It is not recognizable, however; it is rolled up together with two stripes of 360mm length and 15mm height. There is a transparent cover sheeting on the letters and the circumjacent foil has not been removed because very often the filigree letters do not retain well on the wax sheet upon removing the foil around the letters.

It is better to remove the complete sticker from the wax paper together with the transparent cover sheet.

In order for you to identify the front and back side, I have marked the beginning of the text with a black marker line (at the location of the H from Henseleit Helicopters).

Take the stripe with both hands from the left and right side after removing the wax sheet. Then close up to both of the horizontal markings with the bottom of the text label. Bear in mind the 220mm distance from the rear. A few mm offset in this direction does not matter anyway—it is never possible to see both text labels simultaneously. Carefully set the label onto the tail boom and sweep it on. Then remove the transparent rip-off foil.

Now start to remove the needless foil around the text label from the tail boom, at the other end (where the S is located of Henseleit Helicopters). Release one corner with your finger nails to get a grasp on the foil and carefully remove it. Observe how the foil separates from the letters. Should any of them lift off, push them down with a sharp object.

Usually this works well because the letters stick to the tail boom far better than to the wax sheet. If the letters tend to lift off easily, give it another stronger sweep across the complete sheet. At the end, you need to remove sheet remains from the closed parts of the letters O, P and R. Preferably, you would remove the remains with a needle, by pricking it into the remains and lifting them away.

Repeat the complete procedure on the other side of the tail boom. In contrary to the diagram, the text label does not propagate from the front to the rear, but rather the other way around. This means that the black line marking on the text label is located at the 220mm position and the end of the text label points to the front side of the tail boom.

Attaching the upper tail boom stickers.

Prepare a vessel with clean water and add a trace of liquid dish soap. Moisten the tail boom with this solution of water and liquid soap. Remove a sticker and dip it into the vessel with solution before affixing it onto the tail boom. This will establish the means to reposition and readjust the stickers once they are placed onto the tail boom. The stickers are marked with little grooves respectively on the middle of both ends. These grooves are to be aligned with the seam of the tail boom. The other relevant distances are shown in the diagram.

The rear sticker has a clearance of 15mm to the end of the tail boom. All further stickers maintain a clearance of 35mm to each other so that sticker no. 6 shortly ends in front of the canopy seat.

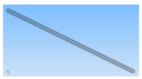
Sweep the stickers with a finger or a soft tissue to remove the solution from under it. Tiny bubbles will disappear by themselves after a few days.

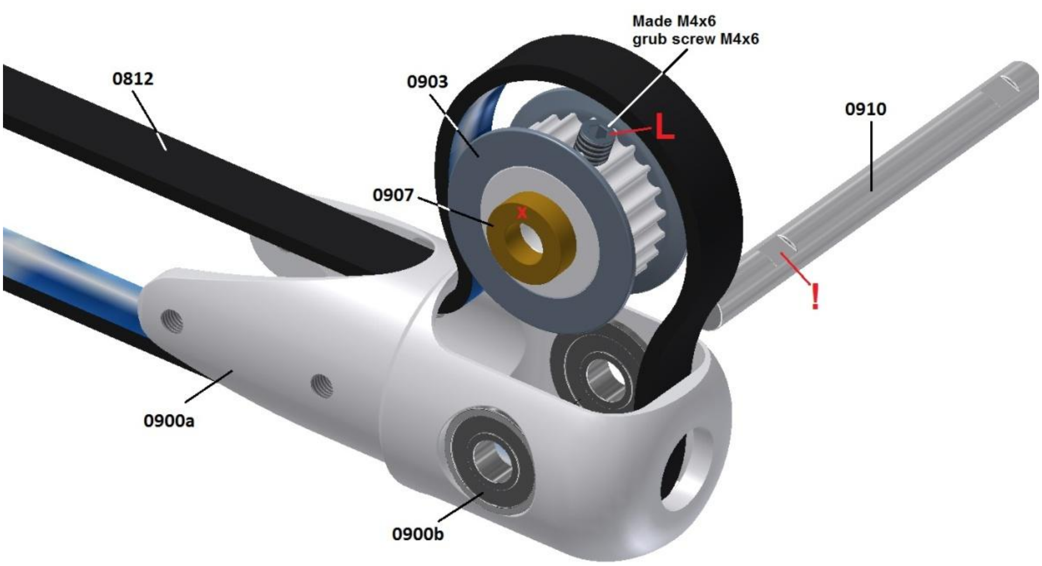
TAIL ROTOR

(Assembly Group 9)

Tail rotor housing

(Bag 9-I)

	0812	Tail belt S3M-2100 - 8mm depth	1
	0900a	Tail rotor gear box	1
	0900b	Flanged bearing 5x13x4	2
	0903	Toothed belt disc - tail gear - 22T	1
		Grub screw M4x 6 (for 0903)	1
	0907	Spacer 5x10x 3	2
	0907a	Spacer washer 5x10x0,1 / 5x10x0.2	2
	0910	Tail output shaft	1



Both of the flanged bearings 0900b come prepressed with Loctite into the bearing fittings of the tail gear box 0900a. In case you need to exchange these bearings in the future, I recommend to heat the box well. Mount the belt 0812 into the tail gear box from the front side, first. Then form a large enough loop to the upper side, without any sharp dents onto the belt. The belt disc 0903 is inserted into the gear box from the top, with respectively one brass spacer 0907 on each side. Shove the tail shaft 0910 into the gear box from the right side and then through the belt disc including the spacers, as displayed in the drawing. The shaft flushes with the outside of the left bearing.

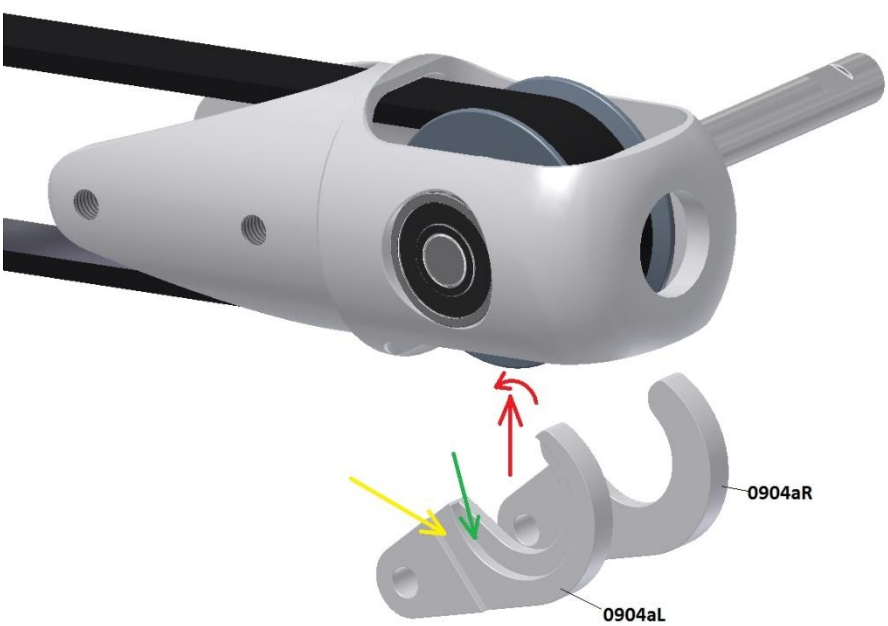
Attention! Have in mind to position the recessed surface for the grub screw, with larger distance to the shaft end, to the correct side. It should also be aligned to the bore of the grub screw. Do not insert the grub screw yet. Check if the belt disc has axial lash by moving it back and forth. If you notice considerable lash, you can compensate with the enclosed 0.1 or 0.2mm spacer washers. Pull the shaft back a little until a washer fits between the fore side of the left spacer 0907 and the flanged bearing (also see red cross in the drawing).

Now screw the grub M4x6 with **L**octite (strictly only applied onto the thread of the grub screw and avoid any seeping into the thread bore of the belt wheel) into the thread until it touches the shaft slightly. Twist and turn the shaft in the belt wheel, while continuing to tighten the grub slowly. You have to make sure that the grub screw sinks into the recessed flat surface and not accidentally onto the round surfaces right beside. Once the grub has properly meshed with the recessed surface, while slightly tightening it, release the grub a little again and push the shaft to the left until it hits the stop of the recessed surface. In this position, the grub is given its final tightness.

Attention! Please tighten this grub screw very gently only because too much force will bend the tail shaft a little, causing vibrations later. Wipe any surplus **L**octite from the teeth of the belt disc before pulling the belt toward the front.

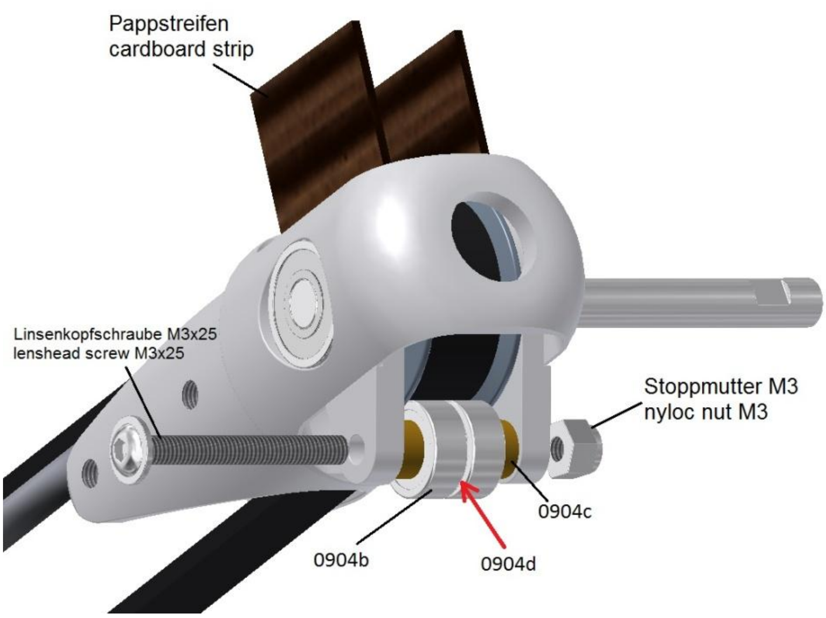
Belt pusher disc (Bag 9-II)

 0904aL	Belt support flange - left	1
 0904aR	Belt support flange - right	1
 0904b	Bearing 3x10x4	2
 0904c	Spacer 3x6x2.75	2
 0904d	Spacer washer 3x6x0.5	1
	Lenshead screw M3x25 (for 0904 a,b,c,d)	1
	Nyloc nut M3 (for 0904 a,b,c,d)	1



Push both hook-shaped belt support flanges between the belt disc and the flanged bearings, from the bottom of the gear box. Swivel them (red arrow) so that the milled edge (yellow arrow) fits parallel to the bottom side of the gear box. Keep in mind that the flanges are manufactured mirror-inverted (0904aL and 0904aR) with a circular recessed shoulder edge (green arrow).

Press the hooks onto the belt disc while pushing them upward and simultaneously swivel them around further and further. Press the hooks with their circular recessed edges onto the flange of the bearings. To keep them in position for the moment, use the enclosed square cardboard pieces as a provisional fix. Tuck them between the belt disc and hooks from the top of the gear box.



Insert the M3x25 lense head screw from the left flange 0904aL.

Draw both spacers 0904c, as well as both bearings 0904b and the washer (3x6x0.5) 0904d onto the thread shaft of the M3x25 screw and between both flanges. The M3x25 then penetrates the right flange 0904aR. Have in mind to keep the milled edges (yellow arrow) paralleled correctly at the bottom of the gear box.

The complete belt support unit is now clamped by the Nyloc nut from the right side. Eventually the seat of the belt support unit is tight and you may remove the cardboard stripes.

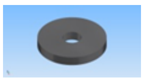
Do not mind a little play of the belt support because the bearings get pressure under load so that it will move to the end stop.

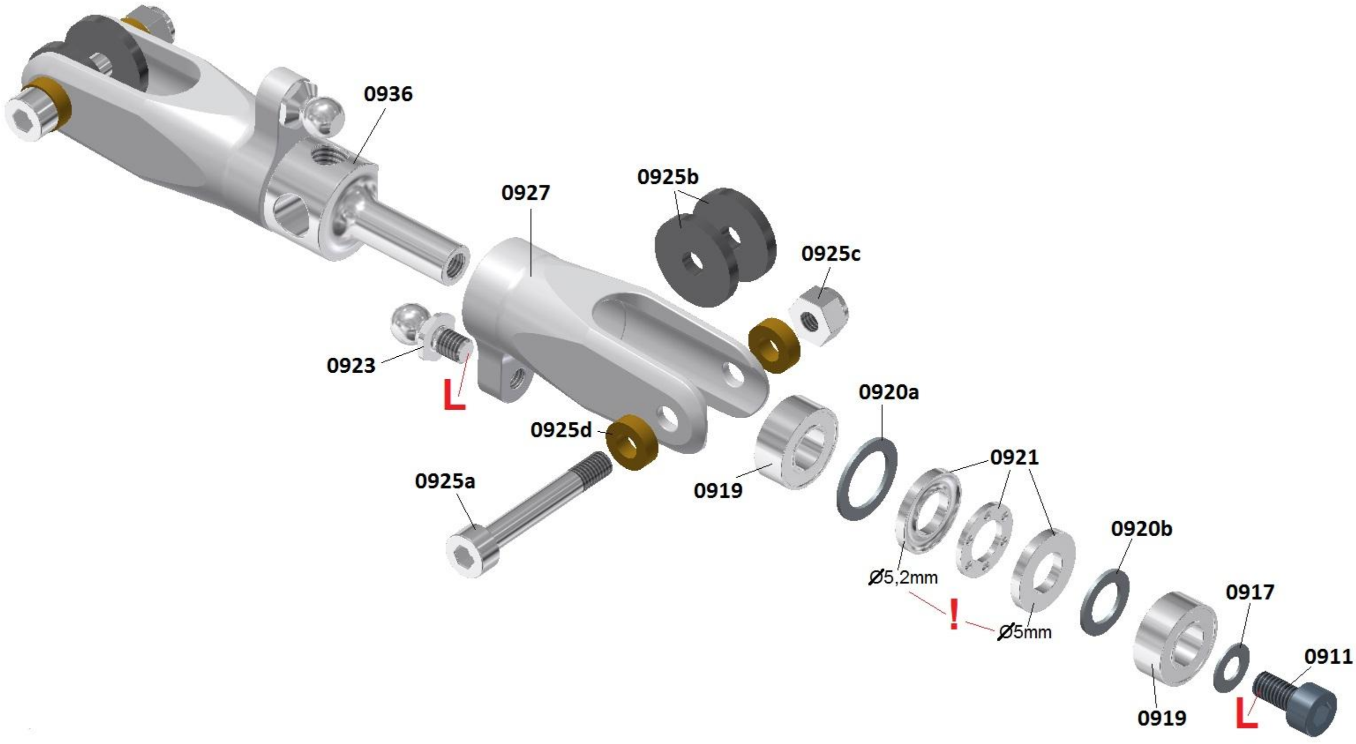
Tail pitch slider (Bag 9-III)

	0915a	Tail pitch rod	2
	0915b	Pin for tail pitch rod	2
	0915c	C-clip DIN 6799 A2 - 1.5mm	2

The sleeve of the pitch slider is chamfered with both bearings. Therefore, this unit is only available complete, under the part order no. 0916. The tail pitch rod 0915a, as well as the pins 0915b and the C-clips 0915c, are individually available. In case of a crash, usually only the tail pitch rod may break.

Tail rotor hub with tail blade holders (Bag 9-IV)

	0911	Hex socket screw. M3x6 - 10.9	2
	0917	Spacer washer 3x6x1	2
	0919	Bearing 5x10x4	4
	0920a	Spacer washer 7x10x0.5	2
	0920b	Spacer Washer 5x8x0.5	2
	0921	Axial bearing 5x10x4	2
	0923	Threaded link ball M3x4 / 4mm	2
	0925a	Hex socket screw M3x21	2
	0925b	Spacer for tail blade	4
	0925c	Nyloc nut M3	2
	0925d	Compensation weight 3x6x2	4
	0927	Tail blade holder	2
	0936	Tail rotor hub	1
		Grub screw M4x 4 (for 0936)	**1**



The assembly of the tail blade grips are done in the following procedure:

First. push the radial bearing (5x10x4) 0919 into the blade holder 0927 until it stops. The bearing has to be pushed to the recess in the rear (expand the blade grip with heat if needed). It is followed by the largest of the three spacer washers (7x10x0.5) 0920a.

Thereafter, insert the three greased parts of the axial bearing 0921 in correct order. First the ring with the larger 5.2mm bore, then the ball cage and finally the ring with 5mm bore. Make sure the rings do not swivel 180° upon inserting them. Perhaps you make use of a pin and draw the parts over the pin into the blade grip. The circular milled groove of the rings must always face the ball cage. Then comes the spacer washer 0920b (5x8x0.5) followed by the second axial bearing 0919.

Attention! A faulty assembly may lead to blocking blade holders later on.

The complete pre-assembled blade holder is now slid onto the rotor hub 0936. If the blade holder does not slide all the way to the flange of the hub, the cause in most cases will be that the spacer washer 0920b has slipped sideways. Try again after centering the spacer washer with a pin.

The complete unit is then screw tightened with screw 0911 and washer (3x6x1) 0917 to the tail rotor hub 0936.

Attention! For the purpose of attaching the unit to the tail rotor hub 0936, exclusively only use the special screw 0911 (M3x6 hardness 10.9). Fasten this screw tight with **L**octite.

After assembly, the blade hubs have a remaining axial lash of a few tenth millimeter on the hub. This is meant to prevent the bearings from clamping. This has no disadvantages for the common flight practice. The centrifugal forces pull the blade holders to their outer stops.

Enclosed are appropriate 1.5mm plastic washers to fasten 5mm tail blades 0925b. If possible, please do not use any other washers. The screws 0925a, for the purpose of fastening the tail blades, are only tightened fast enough to keep blades swiveling lightly. Only use this particular sized shaft screw. Any other normal screw with a complete thread will cut its way through the thin sleeves of the bore.

Fasten the link ball 0923 to the blade holders with **L**octite and assemble the tail blades later so that the link balls are positioned forward into the direction of rotation.

Attention! The complete hub 0936 is attached to the tail shaft in such a manner that the recessed surface points to the gear box. Secure the grub screw M4x4 with **L**octite. Avoid spilling any **L**octite into the bore, otherwise the hub will glue to the shaft (also see the diagram on the next page).

While you are fastening the grub screw, pull the tail rotor hub 0936 as far out as possible, within the bounds given by the two stops of the recessed flat surface of the shaft.

Attention! Keep in mind that the tail blades of the TDR-II rotate in the opposite direction to most of the other existing model helicopters. If you observe the tail blades from the right side respective to the forward flight direction, they rotate clockwise. I have done this with all my helicopters ever since the beginning.

This is important to know, considering the pulling direction of the belt and the location of the belt pinch. The upper belt stream is the loaded side (working stream), while the lower belt stream is the relaxed side (empty stream).

The belt pinch, as well as the belt tensioner up front in the core mechanics, must generally operate on the relaxed side of the belt (empty stream).

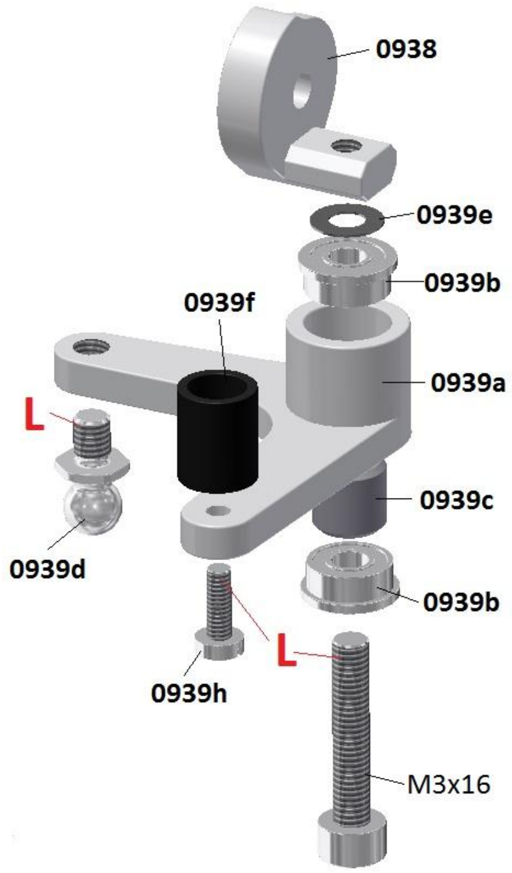
The supposed negative influence on the tail performance, due to tail blades rotating downward with the downdraft of the main blades, is a pure myth—at least with model helicopters. The velocity of the main blade down draft is minor compared to the velocity of the tail blade tips. “Myth effects” would be obsolete anyway, while performing inverted flights.

The first advantage of this chosen arrangement is the trajectory of any mowed lawn to the rear of the helicopter. This prevents the tail boom from getting dirty and the second advantage will remain a secret!

In case the tail pitch slider does not slide smoothly on the tail shaft, this is most often due to the pitch rod 0915a, which is still dragging on the ball links. In such case, use a pair of flat pliers to carefully squeeze the assembled arms a little from the outside. This will help them to adapt better to the ball links. Apply runny DRY FLUID HELI to the shaft and the ball links (shake before use).

Bell crank (Bag 9-V)

	0938	Bell crank support	1
	0939a	Bell crank	1
		Hex socket screw M3x16 (for 0939a)	1
	0939b	Flanged bearing 3x7x3	2
	0939c	Spacer	1
	0939d	Ball link M3x4 / 4mm	1
	0939e	Spacer Washer 3x6x0.2	1
	0939f	Plastic sleeve	1
	0939h	Lenshead screw M2x6	1



First, press both flanged bearings 0939b including the intervening spacer 0939c, into the bell crank 0939a.

Fasten the plastic sleeve 0939f with the M2x6 lenshead screw 0939h into the 2mm bore of the bell crank.

Attention! Tighten the screw carefully with Loctite in order not to damage the fragile plastic thread. On the other hand, the sleeve must sit tight.

The ball link 0939d is fastened to the M3 thread of the bell crank from below with Loctite.

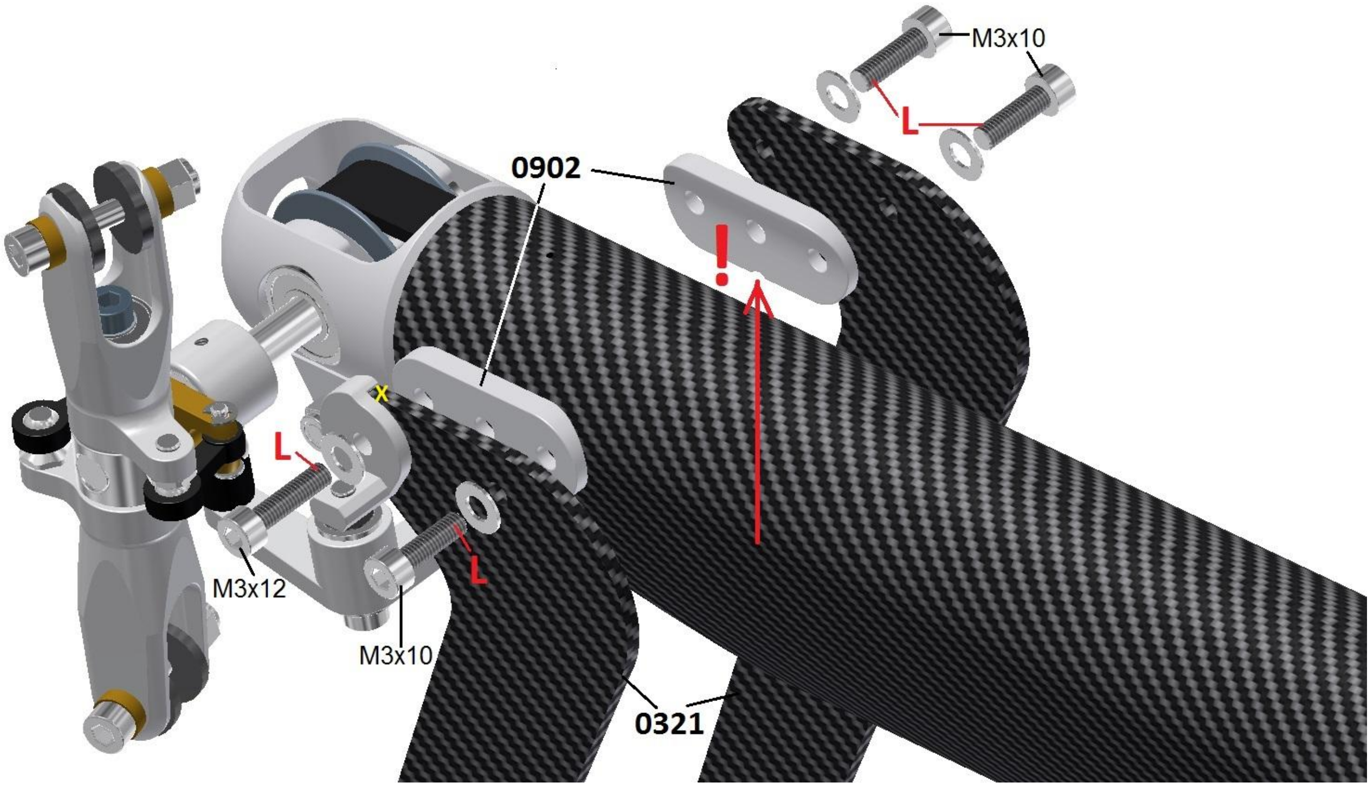
Eventually, the complete bell crank unit is attached to the bell crank support 0938 with an M3x16 screw. Don't forget washer 0939e and to make use of Loctite.

Assembly the tail gear on the tail boom (Bag 9-VI)

	0321	Carbon vertical stabilizer	2
	0321a	Tip protection - left	1
	0321b	Tip protection - right	1
		Hex socket screw M3x8 (for 0321)	1
		Nut M3 flat (for 0321)	1
	0902	Support for vertical stabilizer	2
		Hex socket screw M3x12 (for 0900a)	1
		Hex socket screw M3x10 (for 0900a)	3
		Washer M3 small (for 0900a)	4

Start with applying your chosen stickers to the right and left side of the vertical stabilizer. Keep in mind that the stickers are cut differently on the upper edges. The bell crank support 0938 is attached to the right stabilizer and it should not sit on the sticker.

Use the soap and water solution to apply the stickers. They will need precise positioning. Be vigilant about centering the holes of the stickers precisely to their respective bore in the fin. Align the stickers equally to the rims of the fin. The stickers are cut slightly smaller than the fins, so nothing should bulge over any edge.



Draw the belt through the tail boom from the rear. Help yourself with a cord or a wire with a hook on one side.

Attention! The belt may not be bent sharp under any circumstances, to prevent the Kevlar fibers from damaging.

Slide the tail gear box into the tail boom and align all four thread bores of the gear box with the fastening bores of the tail boom. In case one of the fastening bores does not fit, adapt carefully with a round file.

Initially attach the left fin with two washers and M3x10 screws to the tail boom.

Attention! The support 0902 has a concave shape to one side, which has a semblance to the profile of the tail boom. It is extremely important to insert the clamp correctly. For this purpose, the clamps are marked with tiny milled grooves (see red arrow), which definitively need to point downward.

Use **L**octite for all screws of the gear box. However, initially only tighten the screws lightly, to keep the fins movable back and forth a little. Now proceed in the same manner, with the right fin. The bell crank support 0938 is attached with the slightly longer M3x12 rear screw.

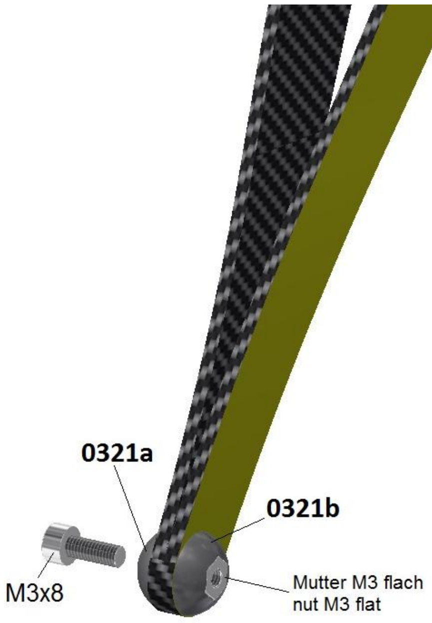
Start with the front M3x10 screw to get the fin into position. Then draw the bell crank with its plastic sleeve 0939f around the ball link 0939d of the pitch slider, before you tighten the fastener with M3x12 screw. Now, provisionally press both fins together at the bottom and observe if the outlines match. Otherwise straighten them out before you tighten the four screws well (**1.5Nm**).

Tighten the longer screw M3x12 by fixing the crank first. Keep in mind that the crank should be rectangular to the boom tail axis. Move the crank by hand in both directions to verify that the tail pitch slider slides easily onto the shaft (look also on page 60 in the middle)

By pivoting the crank support you can vary the depth of the ball stud in the plastic sleeve. This influences the smooth going of the system.

Attention! Keep in mind that the ball must be always 2/3 in the ring, also in both final positions of the crank, not to jump out of the bushing. The occurring sheer forces must not be underrated. Depending on the blades, they can be 5kg easily. Now also tighten the last screw and be careful not to move the crank during operation.

Finally use a drop CA glue at the yellow "X" marker position for an additional support. Due to the capillary action, it will run automatically into the gap between the stabilizer and support plate.



Press both stabilizers together at the bottom tip and screw-tighten them with both tip protections 0321a and 0321b. They protect the tip and prevent sinking into softer grounds.

One of the protections has a round recess for the M3x8 screw and the other has a hex recess for the nut.

Please do not apply any Loctite here. It is not possible to get a proper hold of the nut to release this screw connection. Furthermore, it absolutely does not need to be secured with Loctite. Due to the tension created by the fins, they act as spring clips between the bolt and nut.

The double fin in the rear has several advantages. It is very narrow and highly rigid at the same time. Upon installing the optional retractable landing gear, the rear fin serves the purpose of a third mainstay.

No resonance on any RPM occurs and so vibration is reduced in the whole helicopter.

Assembly of the tail boom into the main mechanic

	0307	Rubber strap for canopy	5

I recommend to roughen the carbon of the tail boom a bit where both of the top tail boom clamps will be mounted (red marked fields) so that they do not slip easily later.

You will find five black rubber straps 0307 in the bag "miscellaneous parts". These are segments cut out of a bicycle tube. The rubber straps are needed later on, to secure the canopy at the rear transition to the tail boom. They are strapped over the rear edge of the canopy and strongly prevent the canopy from opening and releasing itself.

The solution is very simple, keeps aerodynamic smoothness and is barely visible. The bike tube rubber is very robust and if sharp edges are not involved, it does not easily tear. The 20mm broad rubber belts tend to glide well on the tail boom, because bike tubes are dusted with talcum powder at the inner surfaces.

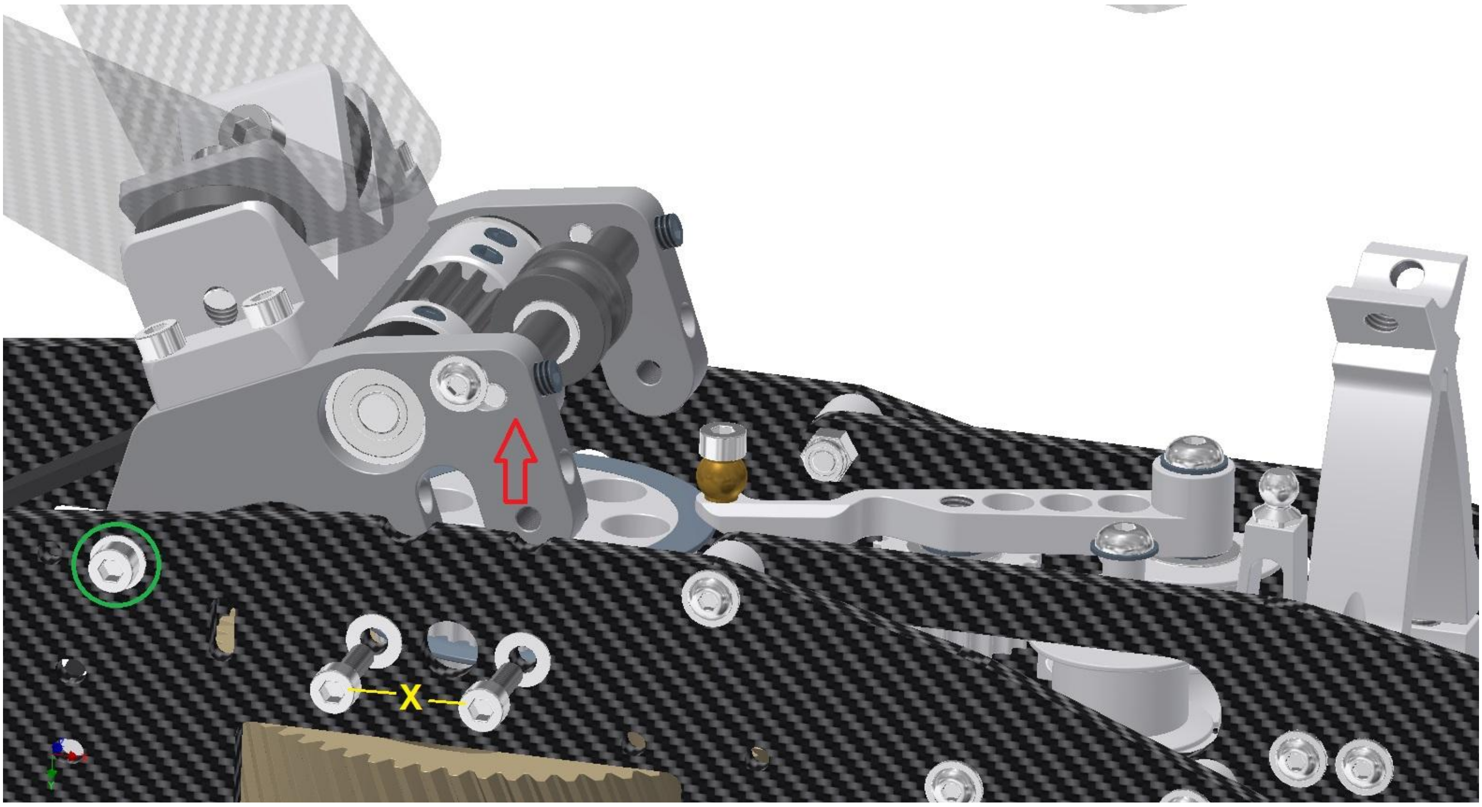
Due to wear and tear, such rubber belts have a limited life cycle and need to be replaced once in a while. Therefore, it is handy to position several such rubber belts as reserve onto the tail boom. This precaution avoids the complete removal of the tail boom just to replace a simple rubber belt.

As the elongated rear of the canopy binds to the tail boom far behind the tail boom clamps, there is enough space to keep reserve rubber straps visually hidden under the canopy. Therefore, slide all five rubber straps onto the tail boom from the front side. The first one should be positioned right in front of the first decorative sticker.

All further rubber straps are positioned in such a manner that the last one has approx. 80mm distance to the fore side of the tail boom. The rubber belts come folded with a crease on each side. The simplest way to thread them onto the tail boom, is by matching one crease with the sharp bottom edge of the tail boom then stretch the rubber with two fingers and pull it over the bulged top side. Once on the tail boom, they are easy to slide.

To look more like a model helicopter, the complete tail boom should now be attached to the core mechanic.
You may have asked yourself how to draw the belt around the belt wheel, which is located in the bottom middle part of the core mechanic, in particular because the elevator gear rack and the gear shaft of the elevator linkage are in your way. It would have been possible to attach the tail boom before assembling the tooth rack and elevator linkage unit; however, the handling of the mechanic and permanently turning it back and forth would have been inconvenient and uncomfortable.
I would like to point out an approach on how to attach and detach the tail boom without a complete removal of named parts, because this may be necessary once in a while.

Proceed in the following way:
Pull the swash plate all the way up with your hands. Swivel it toward the front until the round gear rack of the elevator linkage slips out of its gear and guide shaft. Do not worry; nothing will happen as long as you do not move the elevator servo and gear shaft of the elevator linkage while the gear rack is without grip.
Upon reinserting the gear rack, it will grip with exactly the same tooth as it left behind during extraction. The grip position will only alter if the pinion shaft or the servo was moved in between. In such cases, the gear rack will mesh with any other pinion tooth so that the position of the swash plate changes. To be on the safe side, you may mark the last tooth that meshed with the gear rack with a marker. This will require precise observation of the tooth rack and gear shaft while pulling the swash plate up.
The gear shaft with its gear does not need any readjustments. It will move freely within its slots when the gear rack is removed. It will resume the same position at the grub screws after reinsertion.



Again remove both of the screws of the right and left bearing plates of the elevator linkage shaft. They are marked with a yellow X in the drawing. The front screw, which is marked with a green circle, is only released slightly to enable a swivel of the complete unit, including skids. The skids will need detached at the rear.

The swivel movement as displayed in the drawing will suffice. Tighten the front screws a little again to keep the complete unit in this position. In this position, the elevator servo belt is still under enough tension to avoid any mismatch of the belt tooth grip. This could only happen if you swivel the unit further to the front.
In case you have assembled the optional retractable landing gear, it will have to be removed to gain some space for swiveling.
That's it; we are done. You are now prepared to continue with tail boom assembly and drawing the belt into position.

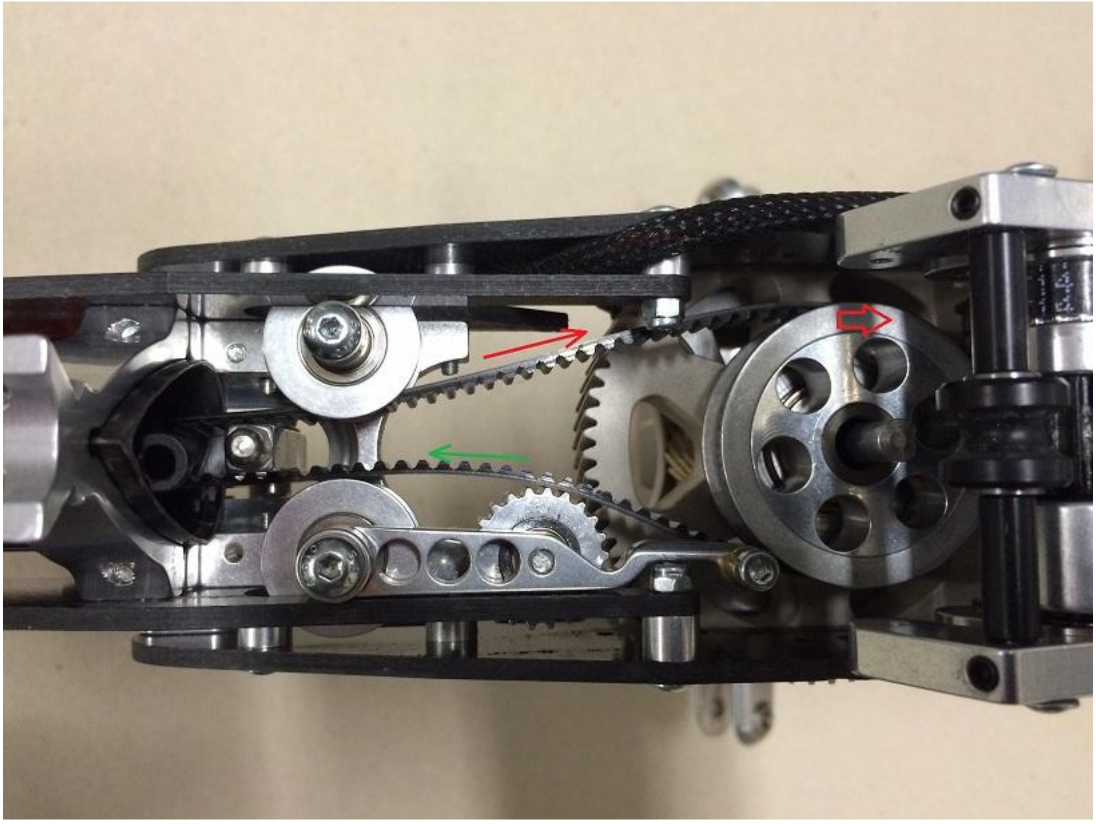
Turn the core mechanic and tail boom upside down then pull the belt toward the front out of the tail boom and align it in such a manner, that it runs straight without being twisted.

The imprinted arrows signify the moving directions of the belt strands. The red arrow signifies the working strand of the belt and the green arrow signifies the relaxed strand. If you pull the belt into the direction of the red arrow, the tail blades must rotate in the correct direction (clockwise at the front view).

Viewed from front toward the beginning of the tail boom, turn the belt loop 90° counter-clockwise (see the circular red arrow) so that the belt loop will attain a horizontal position. The drawing shows the belt in vertical position.

Now draw the belt through the tail boom clamps without changing the present horizontal position and push the tail boom through both clamping blocks toward the front (release the screws to attain a gap of 3mm between the upper and lower tail boom clamps).

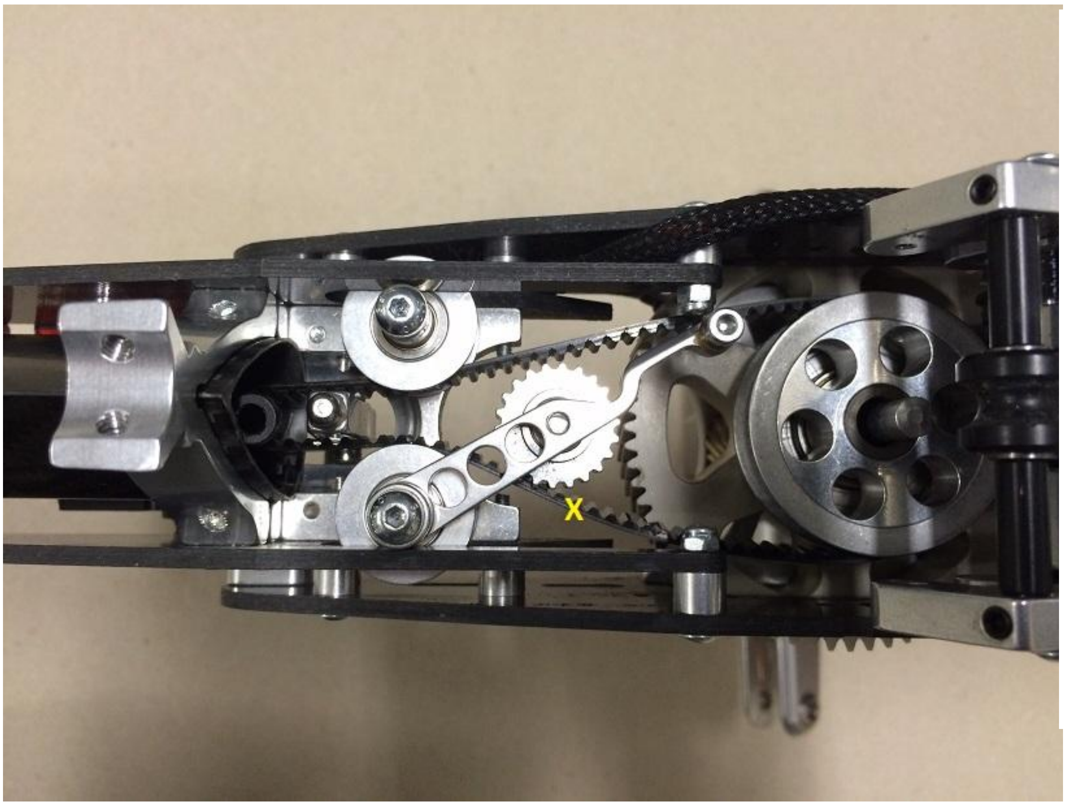
Attention! The belt must now be lifted over the reverse bell crank lever so that the belt runs on both sides of the lever.



Push the tail boom through the clamping blocks until the stop created by the crank lever. Often, drawing the belt across the belt disc will suffice (see drawing).

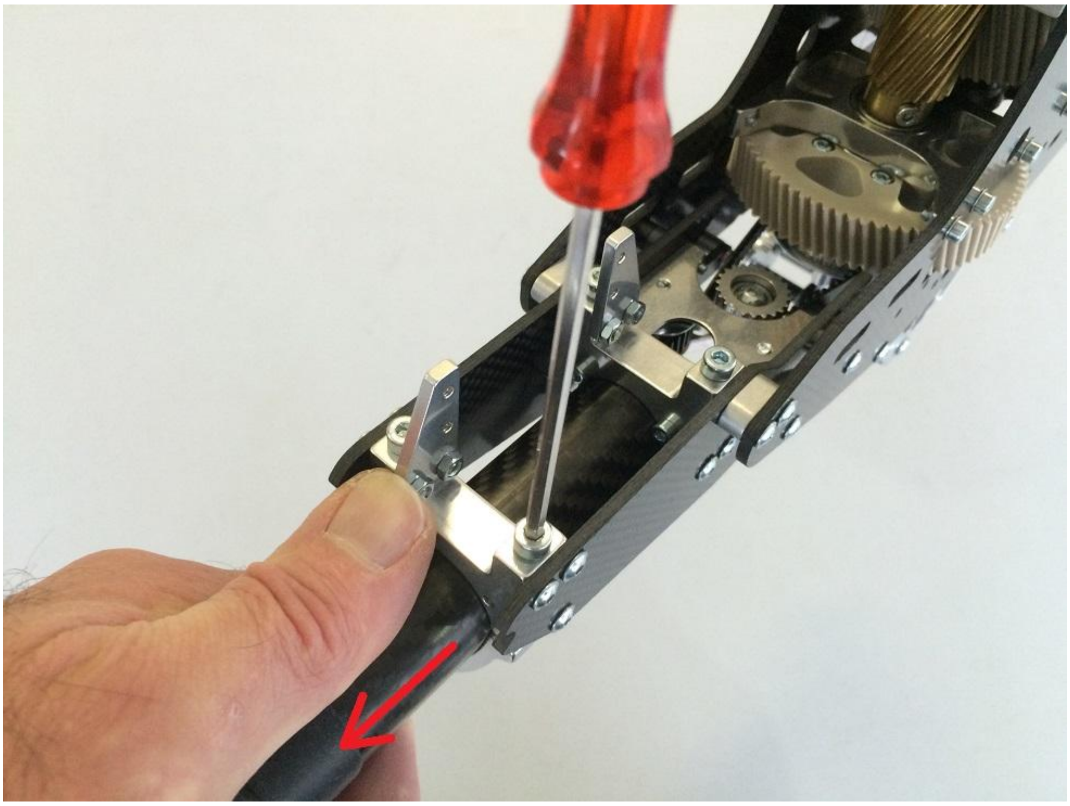
If you need more length, you may release the support of the crank to move a bit forward.

Here again, the working strand of the belt is marked with a red arrow and the relaxed strand with a green arrow. If you move the gear wheel of the intermediate shaft, the tail blades must rotate into the correct direction as previously described.

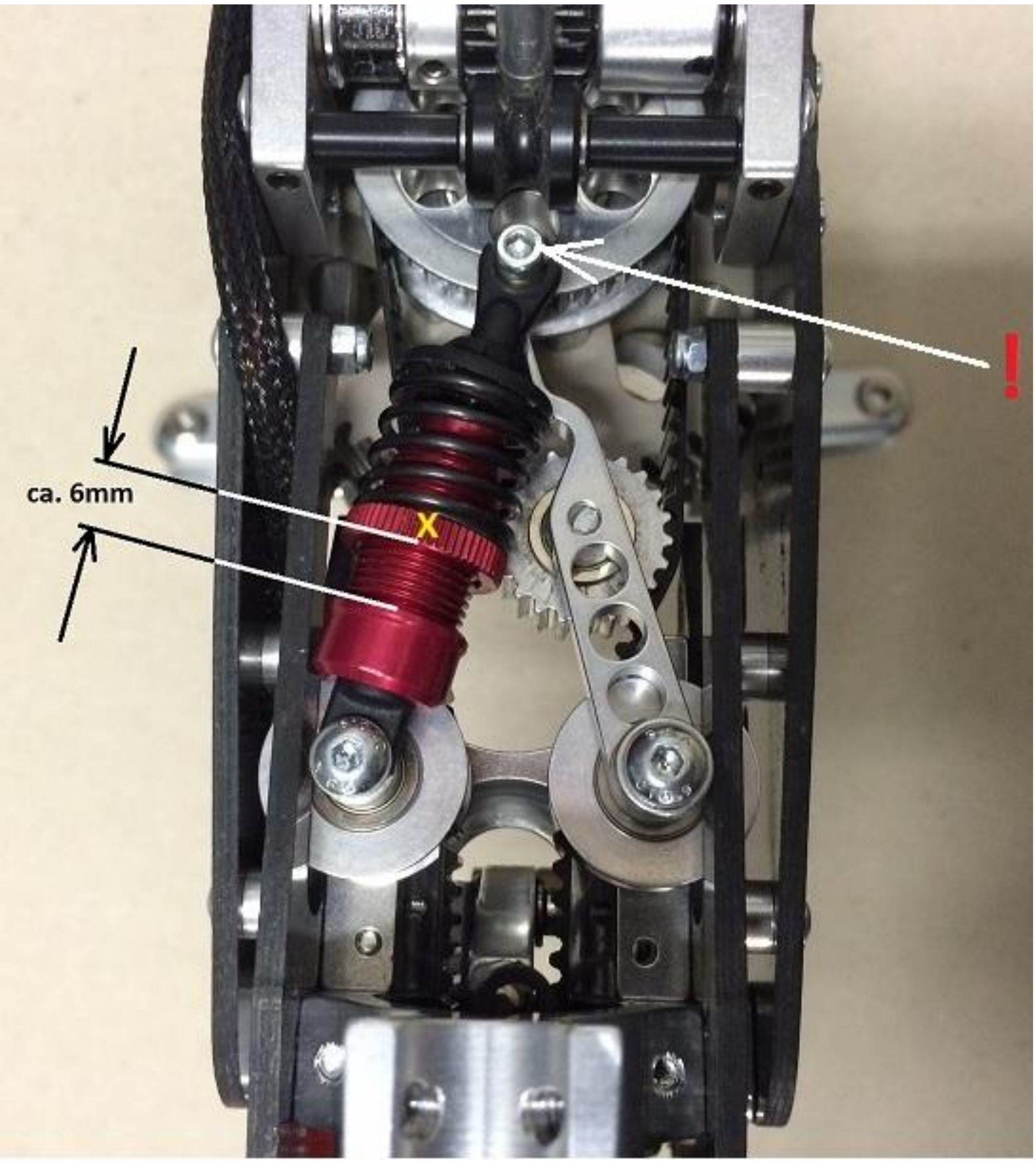


Now push the belt (where it is marked with a yellow X) toward the bottom in order to lift the idler pulley across the belt and swivel it into the middle. Leave the idler pulley loose in this position for the moment.
The belt tensioner will be assembled only after the tail boom has pre-tension and is clamped tight.

Before proceeding, revert both bearing mounts back into the original position and tighten all screws. Do not tighten the skids in the rear yet. Push the swash plate down and make sure the tooth rack attains its original mesh position.



Now apply pre-tension to the belt and clamp the tail boom tight. The best way to get there is by gripping the tail boom with your hand and simultaneously pushing with your thumb as hard as possible against the upper clamping block. This pushes the tail boom toward the rear and applies pre-tension to the belt.
With the other hand, tighten the four clamping screws. Loctite is not necessary here. Tighten the four screws carefully and cross over step-by-step until both clamping blocks nearly touch each other. Maintaining an equal gap of 0.3mm on all sides is okay.
The Tail Boom will settle in after a few flight and the clamps can then be closed completely.
Now you may fasten the skids at the rear again. Draw all four reserve rubber fastenings toward the front stop.



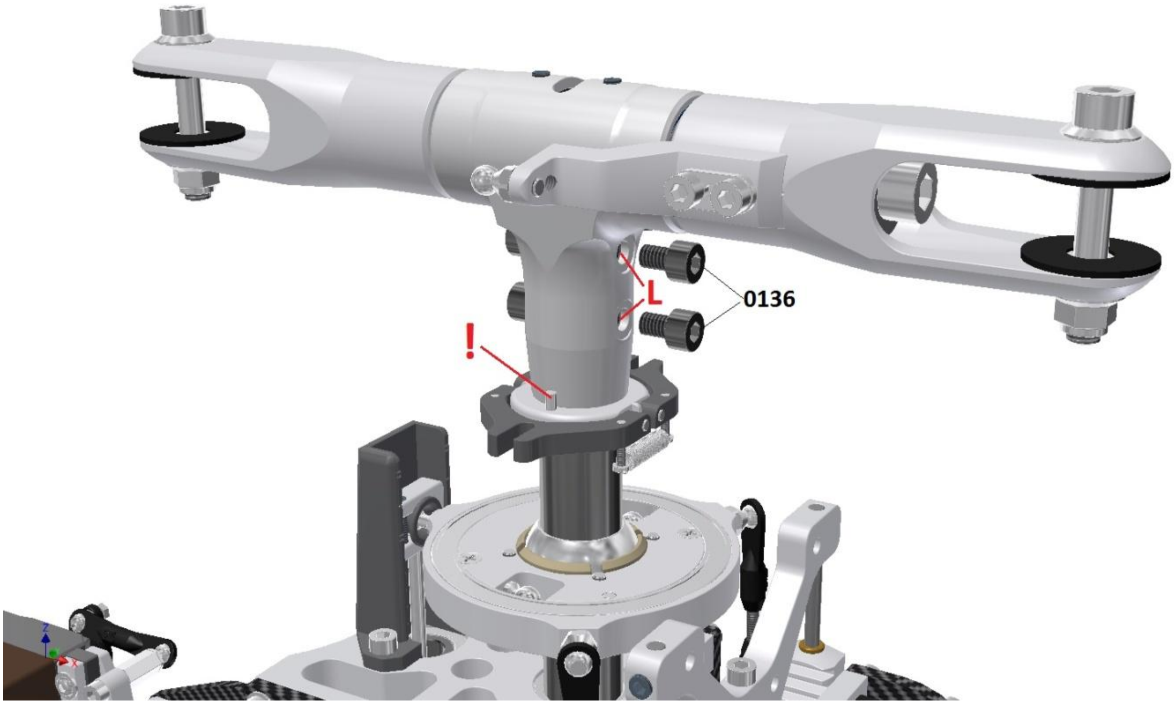
Relax the spring of the spring damper completely by turning the knurled screw (yellow X in the drawing) back to its stop. First insert the spring damper at the front (white arrow) by pushing it against the ball. Then push the lever of the belt tensioner toward the belt so that the spring tensioner will also fit onto the rear jack above the belt pulley when compressed. The knurled screw is then moved about 6mm forward against the screw.

Attention! The position of the front suspension ball should now be approximately in the middle of the mechanic. The segment of the belt that conveys from the large belt wheel to the little belt wheel of the tensioner should nearly run parallel along to the chassis panel. This will indicate the ideal belt tension.

Attention! Please consider keeping the cable path of the tail servo away from the tension pulley side. During flight, the pulley may swing outward through the recess of the inner carbon plate 0840.

Chapter – 9 Final Assembly

Assembly of the rotor head and the swash plate fork to the mail shaft



First, degrease the main rotor shaft in the upper 40mm region then slide the swash plate fork down to the swash plate. Eventually assemble the main rotor head.

Now **tightly** fasten the four hex socket screws 0136 (M4X6 strength class 10.9) with an angled Allen key or torque momentum wrench (4**Nm**).

The rotor hub must have grip with the force of friction and not the sheering force of the screws! Make use of **L**octite in such a manner that it will not spill into the gap between main shaft and hub. If not, it will become very difficult to remove main shaft in the future. It is best to apply **L**octite directly into the threads of the main shaft and wipe any remains on the outer surface of the shaft. The screws would push any surplus **L**octite into the hollow part of the shaft, where it causes no harm.

The screws 0136 are of high strength and may only be exchanged by original spare parts. Using a conventional screw would result in snapping of screw head off.

Now push the swash plate fork up to the stop of the center hub.

Attention! The little pin protruding upward has to mesh with the little milled groove on the center hub. Now tightly tighten the M4X4 grub screw.

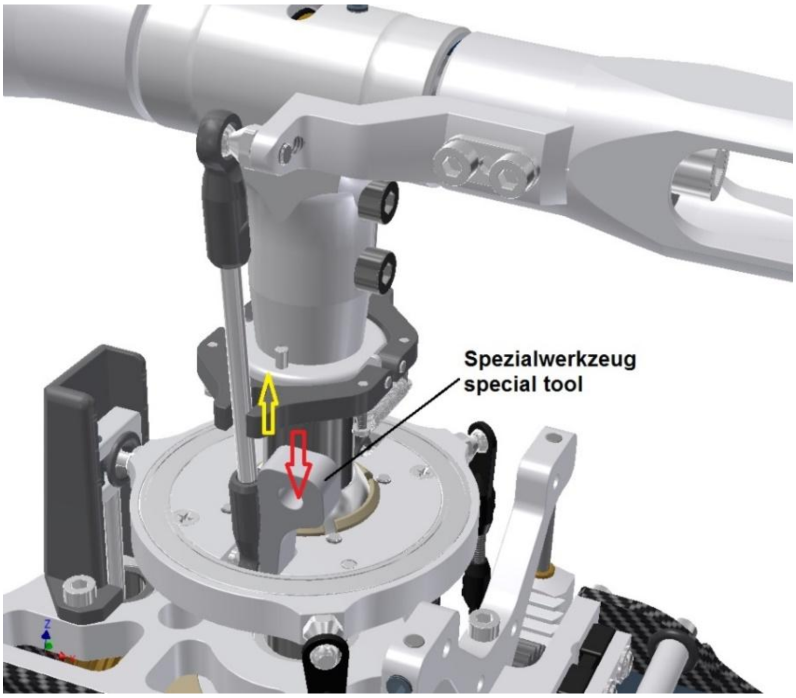
In the bag of special tools, you will find a white, wedge-shaped plastic tool. This tool is needed for the bottom suspension of the main blade linkages in the swash plate.

Start with positioning the bottom joint of the linkage sidewise to the linkage ball in the recess of the swash plate. Press the plastic wedge top down into the remaining gap (red arrow) until the joint snaps onto the linkage ball.

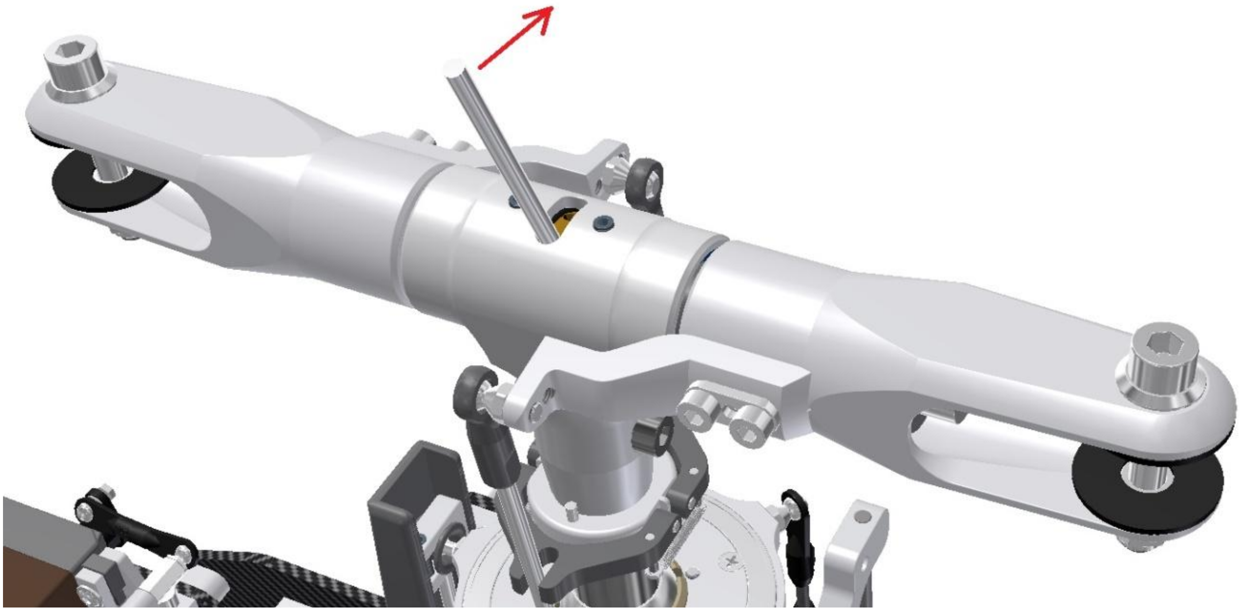
Remove the plastic wedge again. Now fold the movable fork of the swash plate catch upward, (yellow arrow) until you can attach the upper joint to its ball linkage as well.

Subsequently release the fork so that the main blade linkage is guided by the fork. The second linkage cannot be inserted without the foldable fork.

Eventually apply a drop of runny DRY FLUID HELI to all ball joints. The snap-on position of these in-house produced joints is bidirectional.



Pre adjusting the rotor head damping



The damping of the main rotor head is too soft when totally relaxed. Make use of the 3mm pin in the special tool bag to perform basic adjustments for the first few flights.

After a couple of flights, the O-rings will settle. The damper tension may then be increased.

If you have assembled the rotor head as described in the previous chapters, insert the pin into the bore of the slot, which is located on the same side of the anti-torsion pin of the swash plate fork. Turn the straining screw toward the rear (red arrow). It doesn't matter if you have assembled the straining screw unit the other way around because the rotational direction will just be the other way around as displayed in the drawing above.

The size of the slot is dimensioned so that exactly one hole of the straining screw moves on, when the pin is moved from one stop of the slot to the other. There are nine holes on the perimeter of the straining screw. For one complete revolution of the straining screw, the pin must be moved nine times.

The first pre-adjustment viewed from the basic position (thrust nut at the inner stop) will suffice with seven pin steps.

Please consider the following:

A damper adjustment that is too soft will bear the danger of collision between main blades and tail boom (boom strike).

Additionally, the fuselage may be inclined to slight lateral nick movements while hovering. It will swing under the main blades.

A damper adjustment that is too hard will bear the danger of resonances between the main blades and fuselage at low RPM operation. The result may be a very sudden and extreme shaking of the helicopter.

This is particularly critical on the ground (surface resonances) because it may tilt the helicopter. The critical range is usually between 600 and 1000 RPM of the main blades.

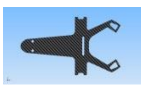
Unfortunately, these RPMs are not avoidable during spin up before flight or spin down after landing. Intercepting with auto rotation may also lead to such low RPM conditions, whereby resonances could already occur during flight. It is important to keep the spin-up time adjusted in the ESC as low as possible. I would recommend no more than 12 seconds.

In case of severe shakeup during the spin down on the ground, a strong negative collective-pitch stroke will help to decelerate the main blades faster. At the same time, the helicopter will be forced towards the ground. Depending on blade length and weight, the resonance behavior may occur in many different ways. It is reasonable to determine harder damper adjustments with a gradual approach.

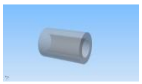
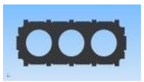
With the adjustable damper, you may swiftly investigate at which point the helicopter will feel best. If you loosen the damper from a harder adjustment, the thrust bolt will move easily, because the O-rings will tend to remain in their position at first. Loosen the thrust bolt a little more than planned and bob the blade grips back and forth until the O-rings relax. Tighten the thrust bolt to the intended position.

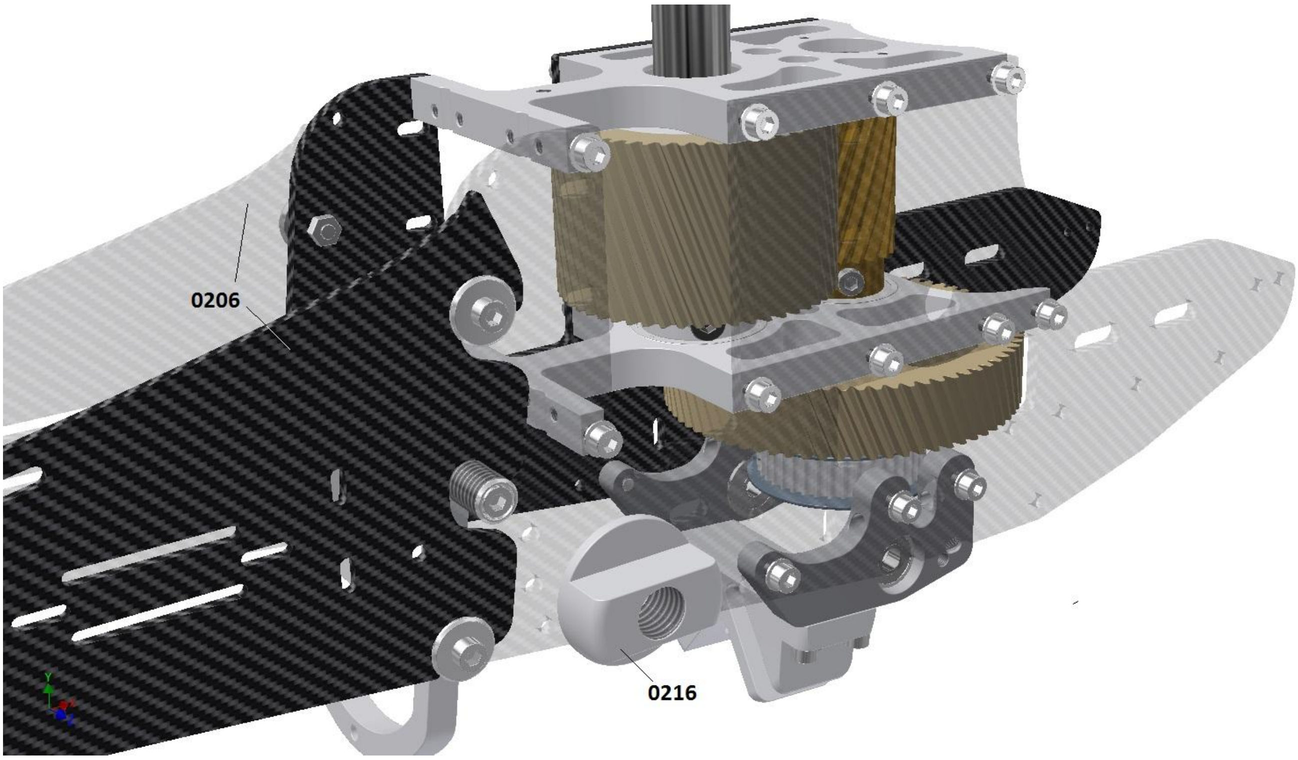
To avoid rotation of the thrust bolt during flight, the thrust bolt needs to be secured. Use the 3mm silicon rod for this purpose. It is found in a bag imprinted with “anti-twist protection” that is among the bags for the rotor head. Cut a 7mm-long piece of this silicone and stick it into the bore of the thrust nut on the side of the slot, to which it will self-loosen. After insertion, the silicone will protrude 3mm out of the thrust nut and level with the top of the center hub. Now turn the thrust nut slightly into the direction “loose” so that it squeezes the silicone slightly against the stop of the slot. This will prevent the silicone from getting lost. Do not squeeze the silicone too much or it will eventually sheer off.

Assembly of the quick exchange battery tray



0204 Carbon - battery holder - canopy support 1

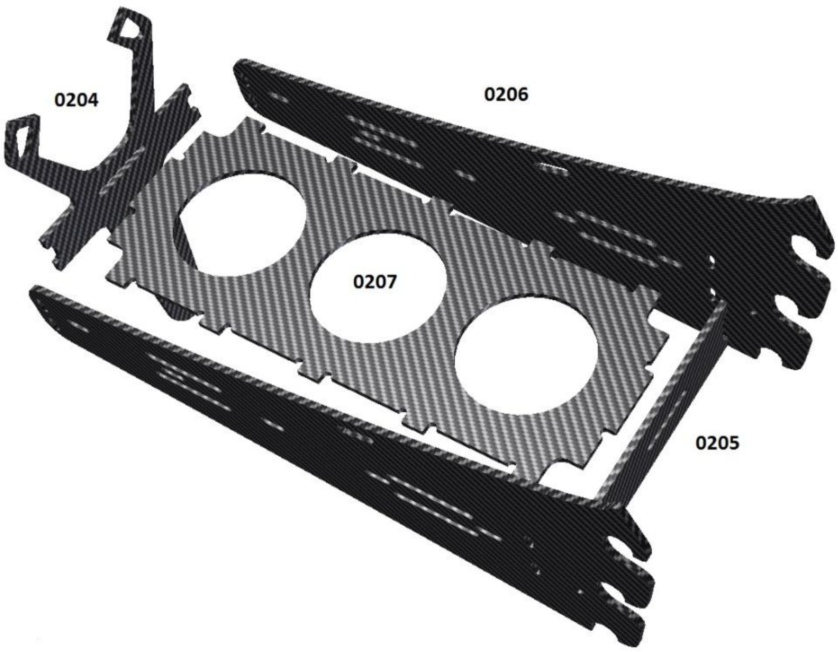
	0204a	Silicone support top	2
	0204b	Silicone support bottom	1
	0204c	Cable tie (for 0204b)	2
	0205	Carbon - battery holder - stop rear	1
	0206	Carbon - battery holder - side frame	2
		Hex socket screw M3x4 (for 0206)	2
		Nut M3 flat (for 0206)	2
	0207	Carbon - battery holder - bottom plate	1



To control the fitting mount of the two battery tray side frames 0206, put them on the mounting pins. Press the frames downward until they rest on the pins and the thread of the bolt. Eventually it might be necessary to readjust the threaded bolt within the play inside its bore. If the hooks are still clamping, rework these positions with a round file.

Attention! Do not file the reliefs too large, because the battery tray should fit without any play on the bolts. To get the best fit, check the fit of the single hooks by placing the frames inclined and hook on the upper or lower pin only. If both hooks move easily, you just have to file out the middle one. A little over-sizing here is uncritical because the main load is carried by the upper and lower pin. The middle threaded bolt is used to affix the battery tray by locking with the battery holder nut 0216.

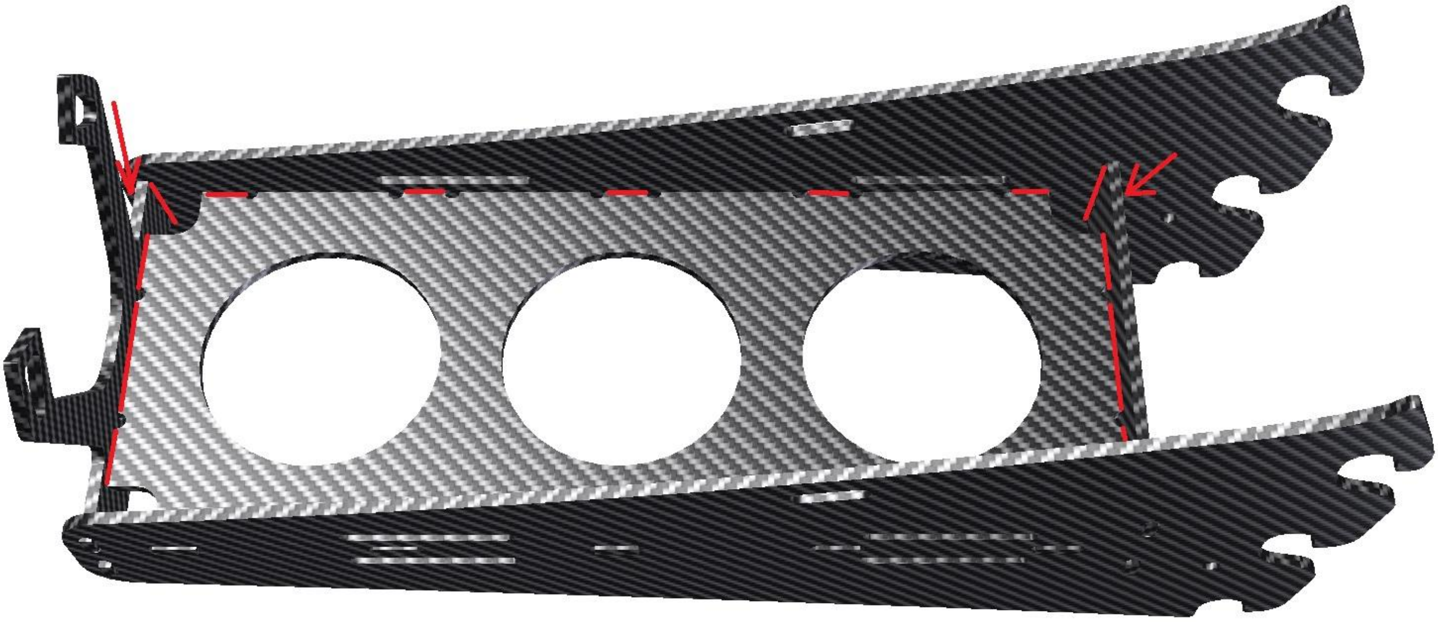
Stick the carbon plates of the battery tray together according to the drawing.



You can secure the two side frames 0206 in the front area directly behind the canopy support 0204 by a rubber band, which is placed over the two plates.

Fix the complete unit onto the pins of the chassis and clamp the two frames 0206 with the two battery tray nuts 0216. The hooks of the plates have to be moved completely downward on their pins so that they are aligned with the chassis plates and sit on the same height.

Due to where the plates are affixed at the chassis the plates are exactly adjusted and rectangular before being adhered together. Look at the mechanic from above and adjust the frames 0206 laterally to be sure there are not inclined. This might be possible because of the play on the pins. If visual judgment is not good enough, place a ruler at frames 0206 and the chassis plate and check the parallelism.



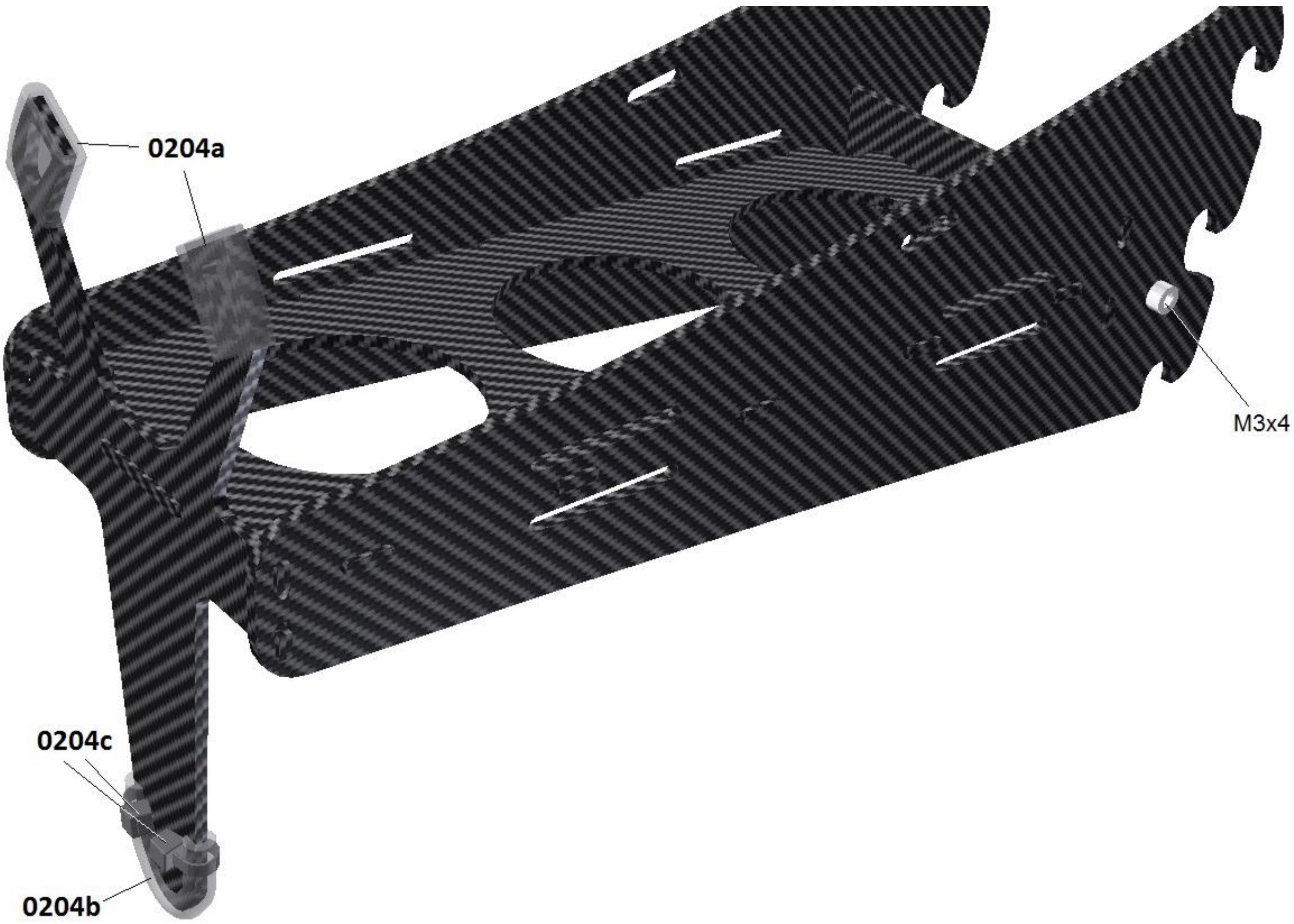
Take low-viscosity CA glue and use it at all red marked positions on the inner side of the tray to the gaps of the mortise joints. At the two front ends of the bottom plate 0207, front and aft, the glue has to be used over the complete length. The vertical gaps of frames 0204 and 0205 have to stick on both sides.

Do the same on the lower side of the frame. Because of the capillary effect, the CA glue enters the small gap, leading to a strong, bonded joint.

Don’t place glue on the outer side of the side plates. This will just lead to poor marks. Avoid using too much CA glue in one place. It may run anywhere you do not want it.

If you want to use a battery pack exceeding the specified dimensions and the gap to the canopy support is not enough, you can abandon the stop rear if necessary. In such a case, please control the space between the servos and the battery, which is important because your receiver should sit here.

Let the complete unit dry at least a quarter of an hour before removing it from the chassis. A white haze is often around the glued areas. You can remove it with a cloth after all glue is dried.



The three silicone tubes are used later on as the front support of the canopy. The two upper supports 0204a made from thick silicone tubes have to be slid onto the two carbon tongues in a way that the end extends 1mm from tip. To prevent the silicone tubes from being cut, please trim the edges of the carbon frame 0204 in this area.

The lower swaggered silicone tube 0204b will only be fixed on one side with the cable tie 0204c in the first step.

Attention! The lock of the cable tie has to be adjusted to the <u>front</u> and the <u>center</u>. Pull the other side of the tube tight around the lower radius of the carbon frame so that there is no kink in the tube. Fix this end with a cable tie as well. Cut the overlaying ends of the cable ties.

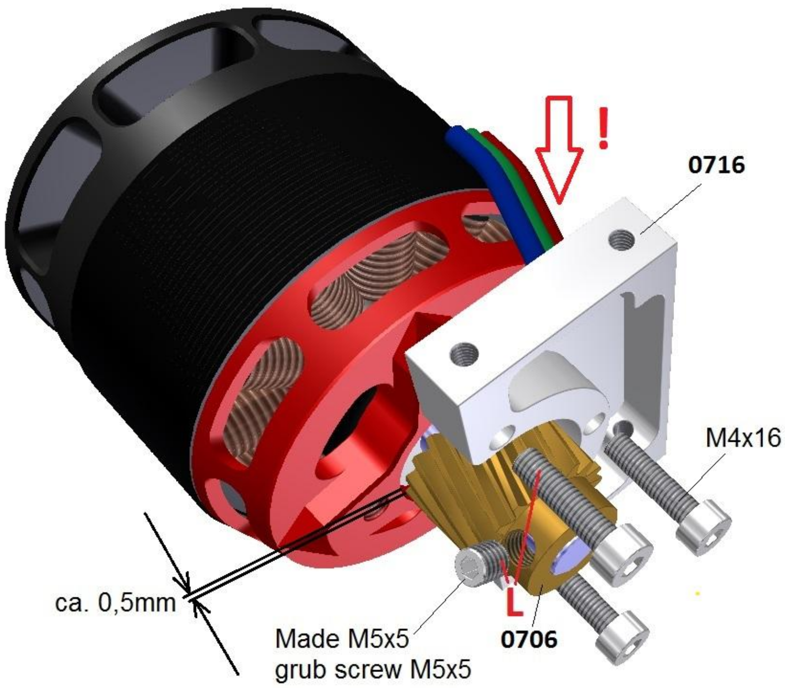
Finally, an M3x4 screw will be placed from outside and screwed from inside with a flat M3 nut (use **L**octite).

Attention! This screw is very important! It is used to secure the battery tray from sliding out of the pins in case nut 0216 is not clamped tight enough or it is loosened in flight. In this case, the head of the screw supports the area of the nut and sliding of the battery tray can be prevented.

During assembly of the battery tray to the chassis frames, the battery tray nut has to be screwed in as far as needed to get the right clearance of 6mm between the face of the nut and the chassis frame, otherwise the battery tray cannot be placed on the pins.

In case the nut 0216 is blocked during tightening by the safety screw, even after the battery tray is completely pushed down to the stop, you can remove the screw again and file the hole oval. The screw can be shifted minimally until it fits.

Motor preparation



First, solder three 6mm plugs to the ends of the motor cables.

Mount the pinion 0706 to the motor shaft with a gap between 0,5mm to 0,8mm to the mounting flange of the motor. This can be easily checked by a feeler gauge, which is placed between the pinion and the flange. If you use the recommended PYRO motor, this dimension should be ok when you pull the pinion up to the stop of the shaft. Tighten the grub screw M5x5 with **L**octite very hard. (Pinions with 13 to 16 T need an M4x5 grub screw.)

Due to the helical gears, the pinion will be pulled downward when running. If the pinion becomes loose it will move to the tension pulley of the tail belt with a displeasing outcome.

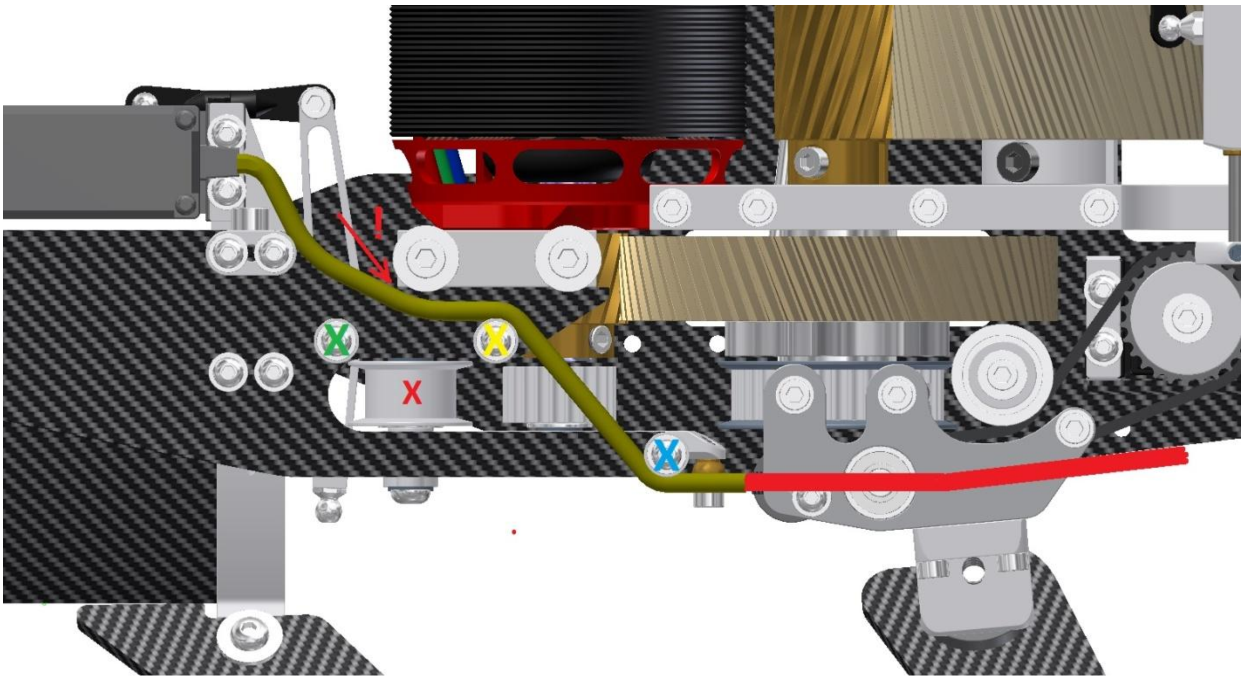
Attention! Screw the motor to the flange 0716. The cable position is shown in the picture (red arrow).

Note: For pinions with up to 19 teeth, you can use the M4x16 screws included with the kit. With 20 teeth or more, you need screws with a head reduced to 5mm diameter to not touch the pinion. These screws will be delivered together with the 20 or 21 tooth pinion.

Routing of tail servo cable

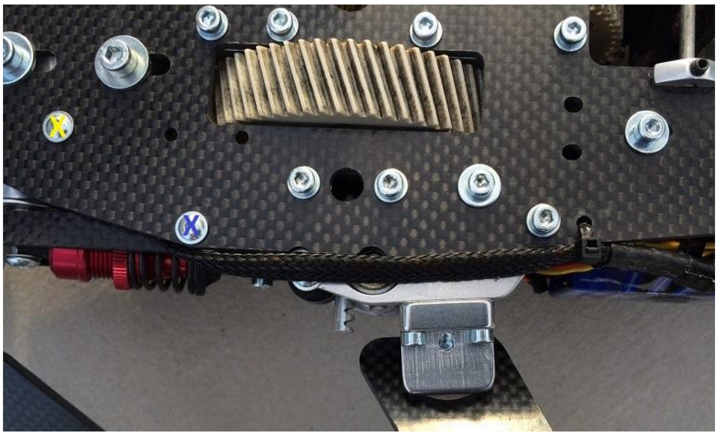
Route the cable of the tail servo inside of the right chassis frame to the front before the motor flange is inserted into the chassis from the top.

See the right side view of the mechanics without the chassis frame for better understanding (view below).



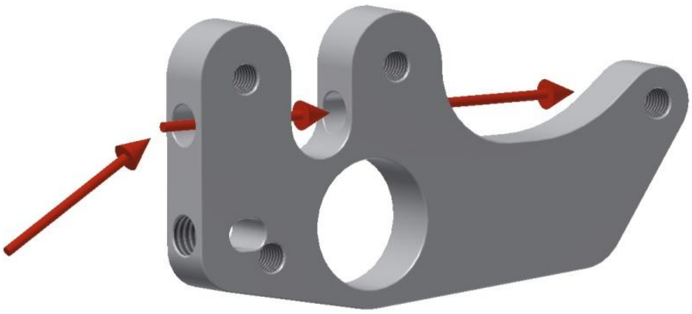
The cable (shown in yellow) will be placed between the outer chassis frame 0201 and the tail boom support plate 0840 and above the two 6mm high distance bushes 0842 (green and yellow cross). Then it is further rooted below the front distance bushes (blue cross) to the front. From there on, the cable will be routed to the outside (shown in red) and then outside of the elevator shaft directly below the chassis frame to the front.

Attention! Do not route the arc (red arrow) too tight to allow enough space to move the motor plate. The cable should also not hang too loose to prevent contact with the idler pulley (red cross). The pulley of the belt clamp sits on the opposite side and therefore is no danger.



In case you want to pull out the cable or reroute it without removing the motor plate, you can proceed as follows: open the lense head screw, fixing the middle distance bush (yellow cross). Pull out the bush downward. Pull the servo connector between the rear sleeve (green cross) and the motor plate and pull it diagonally downward toward the front sleeve.

Place the removed distance bush back again from the lower side so that the cable is above. The picture on the left shows the positions of the middle and front bushes and the cable routing outside the chassis.

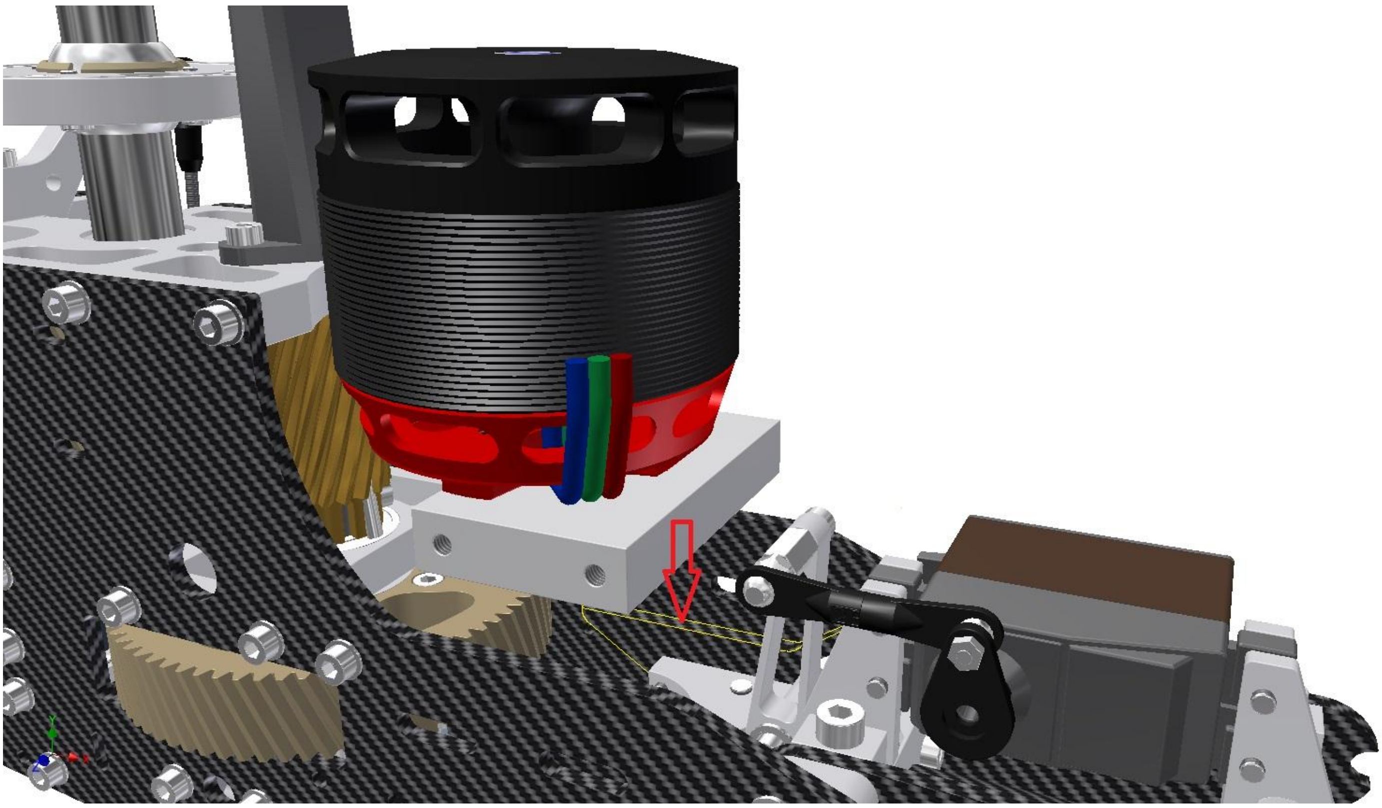


For aesthetics, if you are not wanting a visible routing, there is an alternative possibility existing, but with a little bit more effort. The cable can be routed through the holes of the bearing plate (see picture to left).

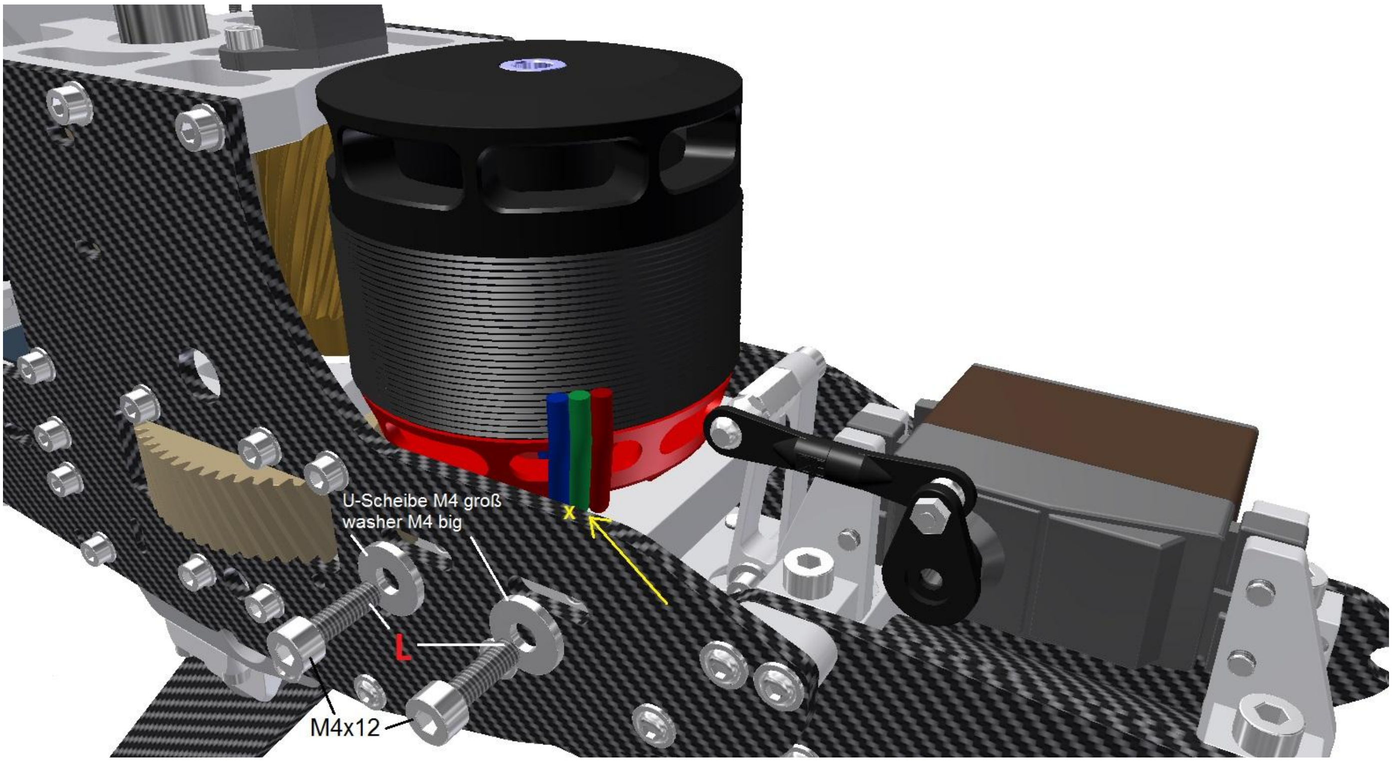
Because of the connector not fitting through the holes, you have to build an elongation cable. You should use a twisted cable, which fits better than a flat cable or by separating the wires and twisting them.

With this method the cable should be routed below the front distance bush and then diagonal upward to the holes of the flange (see red arrows) so the flange can be folded upward for exchange of the belt.

Installation of the motor unit into the chassis



Position the motor plate between the two chassis frames from above. On the tail boom support plate 0840 there is a plane on the top, perpendicular to the gears (see yellow line for better recognition). Pull the motor downward until the plate is touching those chamfers. Pull the plate to the front toward the gear of the intermediate shaft until the gears are meshing and no more movement is possible. Then pull the plate back so there is a little play between the gears.



Initially turn the screws loose with some **L**octite into the threaded holes of the plate. Push the motor in the middle of the plate downward and tighten the screws slightly. Don't forget the large 1.5mm-thick washers.

Hold the motor and turn the intermediate gear slightly back and forth. You should hear a gentle tick-tack. Turn the gear forward and check the play in different positions.

Because of tolerances, the play might vary in different positions. Adjust the play so that in the closest position there is a minimum play. The plastic gear is expanding during use.

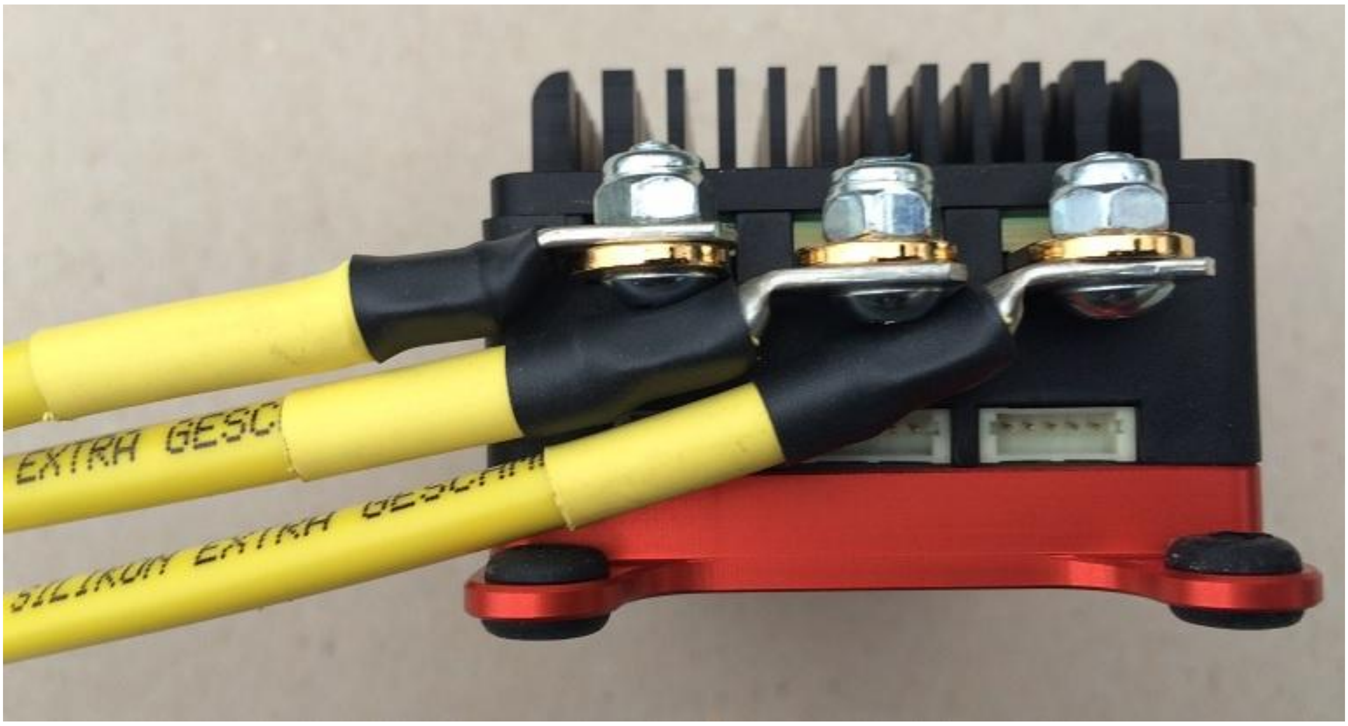
As an example of the play, use the fixed play between the pinion of the intermediate shaft and the gear on the rotor mast. Hold the intermediate shaft and check the play by turning the rotor mast back and forth. The same play should be between the motor pinion and the gear of the intermediate shaft.

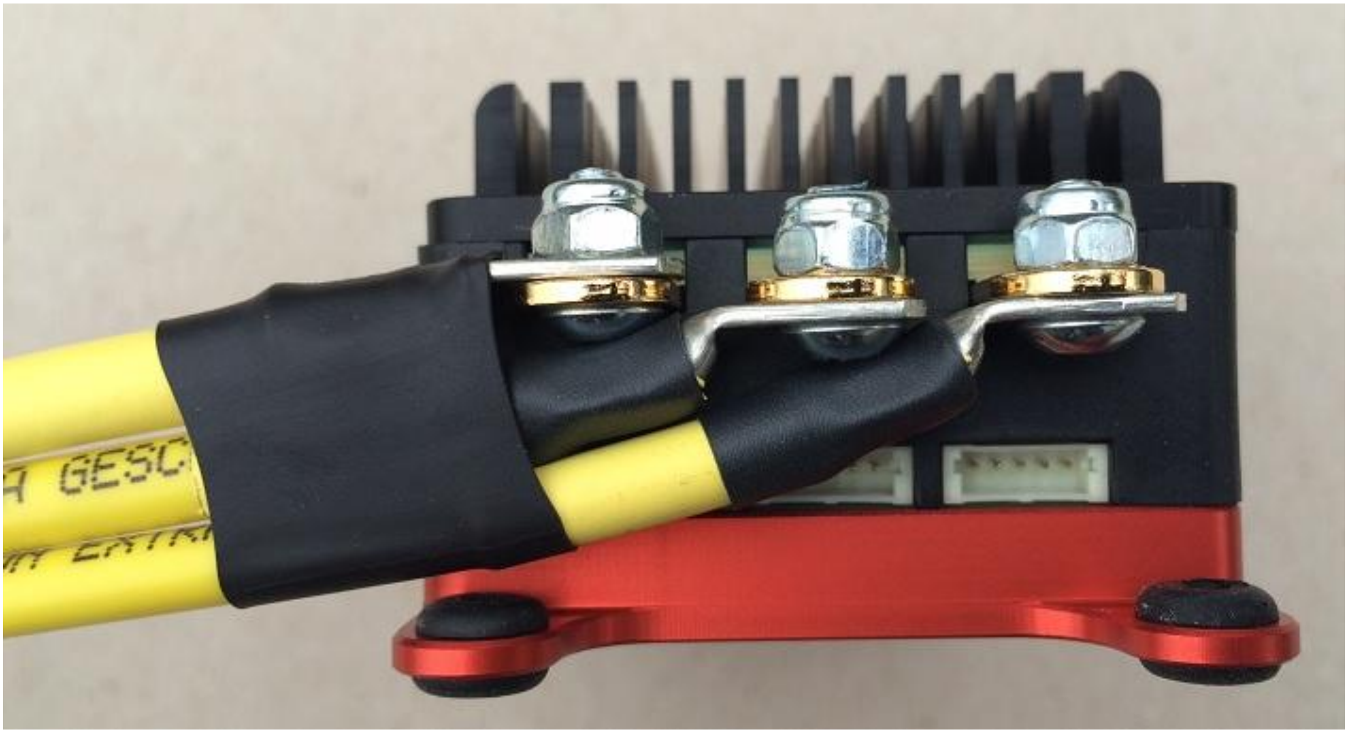
Tighten stepwise and alternating the fixation screws of the motor plate while checking the play again and again. Because the motor plate might move during the tightening of the screws, this measure is necessary. Finally torque the screws tight (**4Nm**).

It is important to press the motor downward to be sure the motor plate is positioned on the chamfers and is not tilting when the screws are fixed.

Attention! Chaffing of the motor cable at the sharp edges of the carbon plates has to be avoided (yellow arrow). You can place a sliced silicon tube at the position marked with an X, which you will also find in the "motor fastening" bag.

Cable connection ESC - Motor

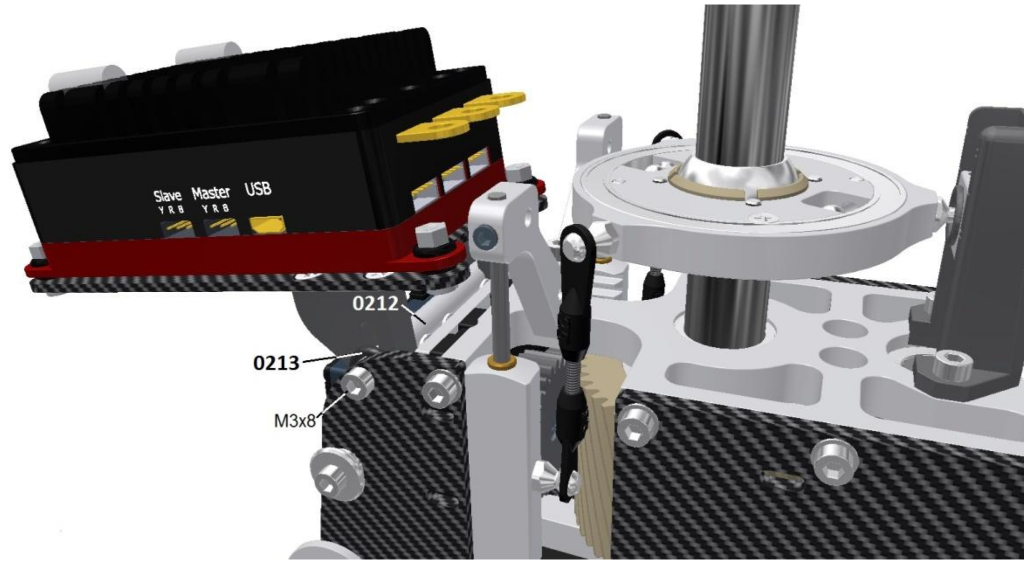




Take the M4x8 lens head screw and the corresponding M4 Nyloc nuts out of the bag for the ESC fixation plate. The original screws from the KOSMIK are far too big.

Bend the cable lugs of the yellow motor cables as shown in the photo with flat-nose pliers and pull over a second shrinking tube above the yellow one. Mount the lugs as shown in the picture to the ESC. The left cable will be screwed above the link and the middle, respectively. The right cable will be screwed below the link. A slight touch of the shrinking tube with the lens head screw of the next cable doesn’t matter, but a high pressure has to be avoided. Start with the left cable; otherwise, you will have no access with the Allen key to the screw head.

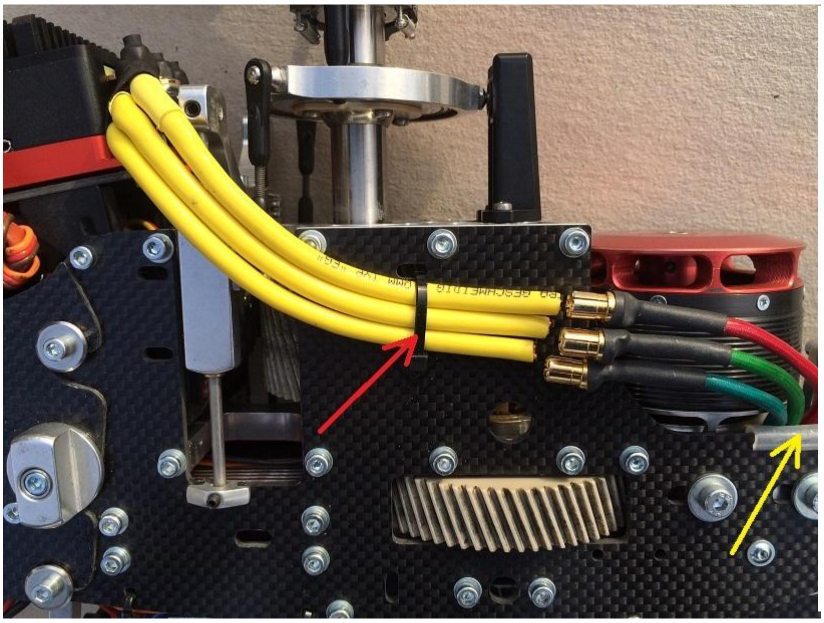
As the 4mm screw has play in the 5mm hole, you can pull the middle cable to the left and push the right cable to the right. You get more space and the lugs will not have to be bent so much. The nuts facing upward should be covered with a short piece of shrinking tube to avoid a short circuit in case they touch the carbon canopy.



First mount the ESC fixation spindle 0212 with an O-ring 0213 on each side with the two M3x8 screws without washers.

Sometimes you have to open one of the two front fixation screws to be able to spread the two chassis frames.

Stick the pre-mounted fixation-plate on the spindle from above. Press strongly from above, and then the two plastic mounts will snap in.



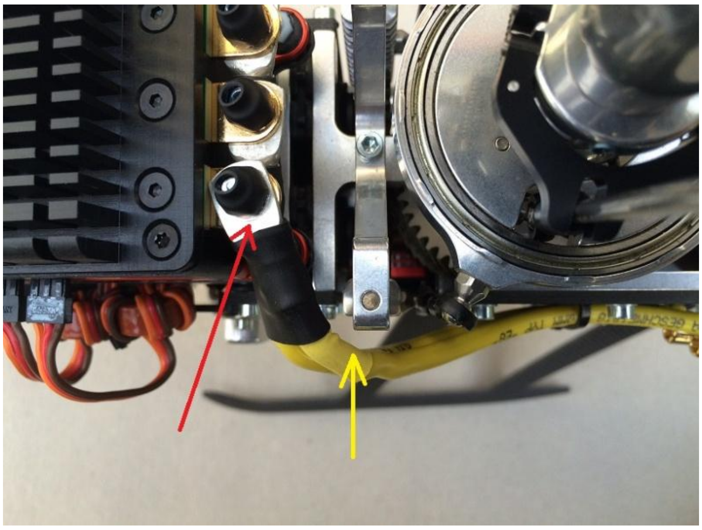
Route the cables as shown in the photos at the left, below. The cables have to be lead close around the corner to avoid the canopy touching them. In the chassis plates, two slotted holes are milled for fixation of one of the cable ties (red arrow) from the tools bag.

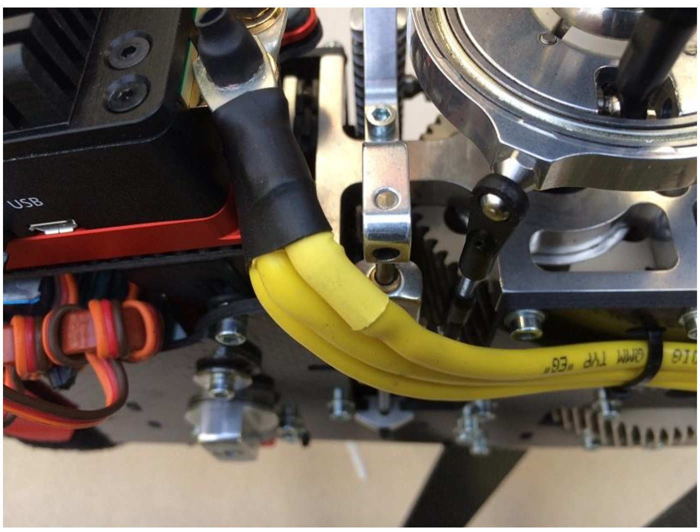
Bend the tip of a cable tie relatively sharp around the corner and insert it in the lower slot. If you move the cable tie upward carefully, the end will come out the upper slot. Now you are able to pull it through.

Don’t fix the cable tie too tight so you are able to reposition the cables to investigate the right length and pull them out again to solder the bushings for the motor plugs. Cut the cables directly in front of the connectors.

First, bend the motor cables as exact as possible into the right position. Add a cable protection (yellow arrow) first. Route the cable in an even arc to the front. The cables can be close to the turning motor bell, but should not touch it at all.

Turn the left lug a little bit to the rear (red arrow – picture at left, below) and bend, especially the top cable, very close backward and at the same time diagonal downward to come close to the toothed rack without hindering the movement of the toothed rack (yellow arrow – picture at left, below).

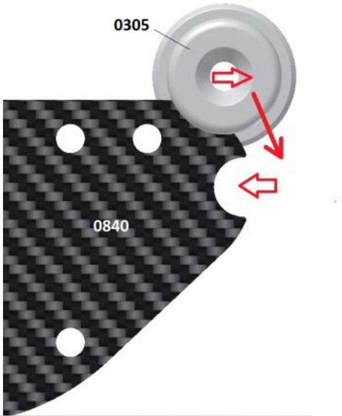




Canopy

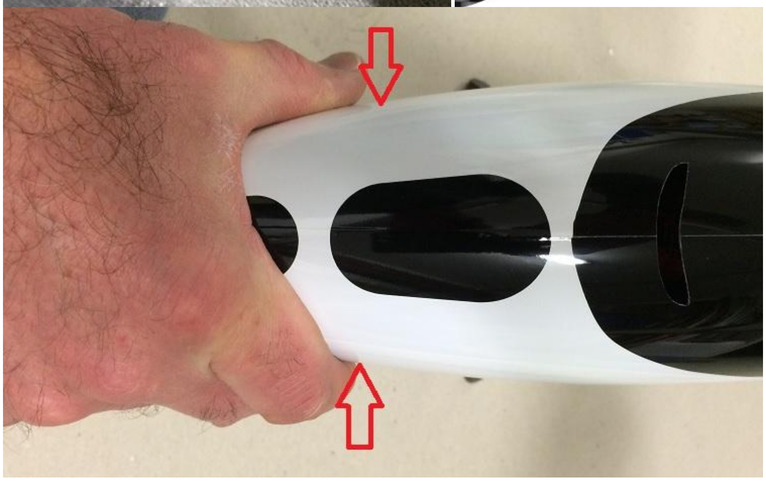
Before starting with the design, the canopy should be adapted on the mechanic. The CFK-canopy, as well as the glass fiver canopy, are of high-quality production. Both are handmade, so some tolerances may occur.
The holes for the M3x8 lense screws to attach the canopy mount 0305 from the inside are already prepared (see picture below). When the flat head of the lense screw is colored more black later on (e.g. with a felt pen), they are nearly invisible.

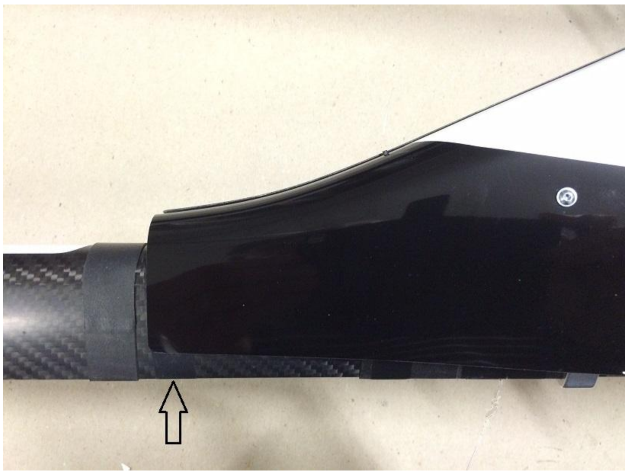
The mounts will be attached without glue first. If there are changes necessary during the adaption of the canopy, the holes can then be easily modified with a small round file to move the mounts into the needed direction.



The canopy mounts 0305 are designed as a conical thread role and slide during the mounting of the canopy on the edge of the inner tail boom fixation plates 0840. By lifting the tip of the canopy, the tail of the canopy is tilting downward and the fixations are locked in the circular reliefs (see red arrows).

The procedure will be explained now in detail. If you know how to do it, the fixation of the canopy will be quick and non-problematic.





First, mount a battery tray to the mechanic, as it is also the front fixation for the canopy.

Attention! While positioning the canopy the rotor should always be turned perpendicular to the mechanic so the control rods are facing forward and backward. Otherwise, you have to spread the canopy extremely wide when positioning.

Take the canopy with both hands at the tail and spread them slightly. Place the canopy relatively low on the front side and place it high above the mechanics on the rear side so the upper top edge of the canopy is sliding above the tappet over the rotor mast. This is easier to do and there is no danger of stripping off the small springs of the tappet. Stripping off the springs will happen easily if you don’t take care; if you lose the second one, you will have a problem!

In case you lose one of the springs, you will find two of that kind in the bag with spare screws.

Push the canopy backward until it is touching the three silicone points of the battery tray. Turn the canopy in this position back and forth so it is properly placed and centered. At the rear, the canopy is positioned slightly above the tail boom. At the position of the black arrow, two layers of duct tape should be wrapped around the tail boom to prevent it from scratches (for this, do not use the cycle rubber—they are too thick).

From this position, press against the nose of the canopy to bend the tongues a little bit backward. The canopy should be pushed back about 3 to 5mm. Press the canopy with the thumb and the trigger finger from the outside. In this moment, the rear sides of the canopy move a little bit together and touch on both sides of the tail boom. If you now lift the nose of the canopy, the tail is tilting downward and the two fixations are locking in the reliefs of the tail boom fixation plates.

Release the canopy and the carbon tongues will spring to the front and the canopy is locked.

Check the correct fixation by moving both canopy sides a little bit up and downward to see if the fixations are correctly locked. The two lower sides are normally slightly spread. They will be pressed together by the safety rubber band.

The safety rubber band is necessary to prevent the canopy from being lost.

This is not only for safety reasons, but also to press the canopy equally to the tail boom and prevent the ends of the canopy from spreading by the airstream during fast backward-flight passages. This would cause the loss of the canopy.

Attention! In case the lower edges of the canopy are below the lower edge of the tail boom, they have to be ground to the same level. This prevents the rubber band from being cut by the sharp edges.

The slipping over of the rubber bands needs to be practiced, but this you should know from other areas of your life. ☺

It works best if you start to fold the rubber up at the side of the tail boom where the fit is loose. You can slip your finger up under the rubber there. Lift it until you can pull your finger completely below the rubber.
Pull the finger toward the lower edge of the tail boom and stretch it so far to allow the rubber band to be pulled diagonally to the front at the lower side over the canopy. Move the finger below the rubber band to the upper side and pull it there over the canopy. Position the rubber band 3mm, overlapping the end of the canopy. You will get a nice watertight end.

Attention! Check during the first mounting of the canopy if the control rods collide with the front edge of the swash plate notch. Even with the swash plate taking the most unfavorable position with the control rods showing forward, an additional 3 to 5mm of space should remain to prevent a collision when mounting the canopy.
You may possibly have to rework and adjust the canopy there. By using a round emery band with emery cloth or a half rounded file, this will work properly.
Turn the rotor head with the mounted canopy and check in all positions that there is sufficient space to the control rod and the fork tappet.

Note: If you are using a fiberglass canopy, it might be necessary to grind the middle joint line so that the joint line cannot be seen through the foil. Take a fine file and file perpendicular to the joint. Sandpaper should not be used because of the flexibility; more material beside the joint will be removed then the joint itself.

Finally, secure the canopy mount 0305 with thin CA glue. A few drops in the gap around the seating area will work. Because of the capillary action, the glue will flow under the mount.

Application of the canopy decals

The foils must not be applied dry to the canopy because they will stick immediately and cannot be repositioned.

The process will only work if you apply water (with some dishwashing liquid) on the foil and on the canopy itself. Because of the slightly greasy water film, the foil can be moved on the canopy surface for a limited time. On the fiberglass canopy, the surface is smoother, so the foil slips better, which eases the positioning. This also increases the work when sweeping out the water, because the foil will move more easily.

You should start smooth the foil with soapy water first on one side and sweep out the water so the foil is better affixed. Start to sweep out the water and folds from there with a soft rag. The position has to be correct from the beginning because as it will become fixed and cannot be moved to the correct position. In this case, pull of the foil completely.

If you did not do this action before, download a video about the application of the foils to the canopy of our first TDR. The procedure for applying the foil is shown in this video. The process is in principle the same for the TDR-II, only the shape of the foil is different and the window consists of four parts instead of three. Because of the shape of the canopy, a single center piece is not possible.

What the comet of the old TDR was are now the aerobatic stripes, which are now separated into three pieces. With some patience, anyone who does not have two left hands can do this job. Anyone who makes some effort will get a canopy that looks similar to a lacquered one, and you have the satisfaction of doing it on your own. Even if have trouble with the first one, the second one will be a lot easier and you do not have to be afraid to lose an expensive painted canopy.

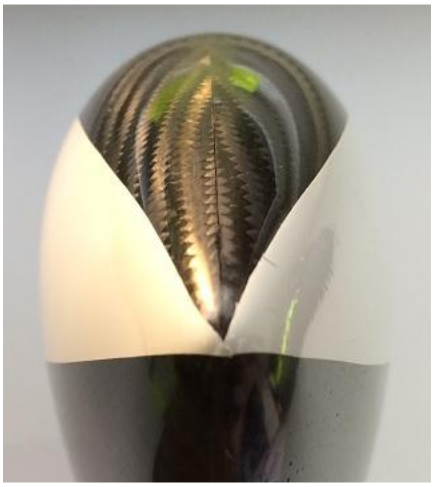
Clean the canopy completely with a sponge with soapy water to remove dirt, grease, abrasive dust, or crumbs.

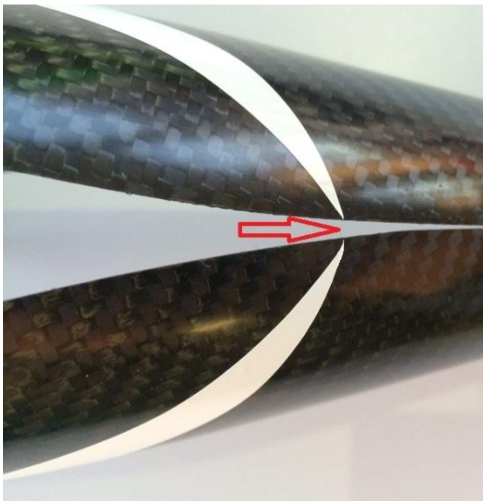
Fill a flat bowl with lukewarm water and add some dishwashing liquid. Always pull just the foil from the waxed paper you want to apply. Don't put the foil together with the waxed paper into the water because the waxed layer will separate from the paper and stick to the bonding surface of the foil and the foil cannot be used anymore. Pull the foil from one corner and pull it directly into the water with the adherent side so that sections of the adherent side do not come in contact and stick together. Pull the foil out of the water and hold it over the bowl so surplus water can flow down.

The area on the canopy that will be bonded should also be rubbed a little bit with a wet sponge.

When pulling of an edge of the foil, take care not to damage the waxed paper so that it sticks to the foil. This might happen is the plotter knife cuts too deep into the paper. Take, for example, a carpet knife and lift the foil carefully at another position with the blade.

With this knife, you can trim later on the overlapping parts of the foil. Wait until the foil dries a little bit before cutting. Squeeze out the water from the middle to the sides. Small air bubbles cannot always be avoided. But don't worry; they will disappear in the next days on their own.

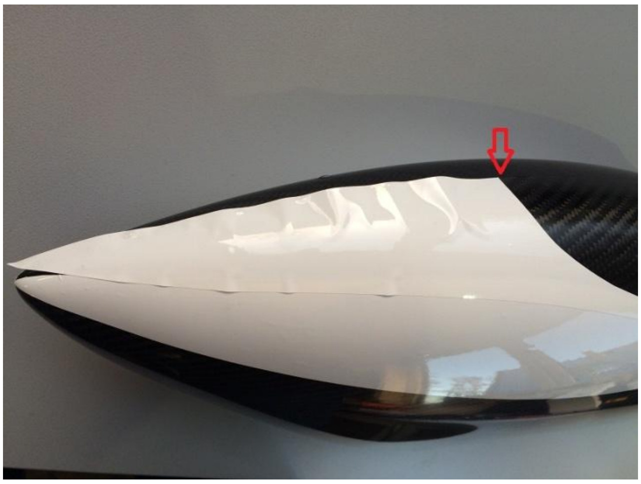


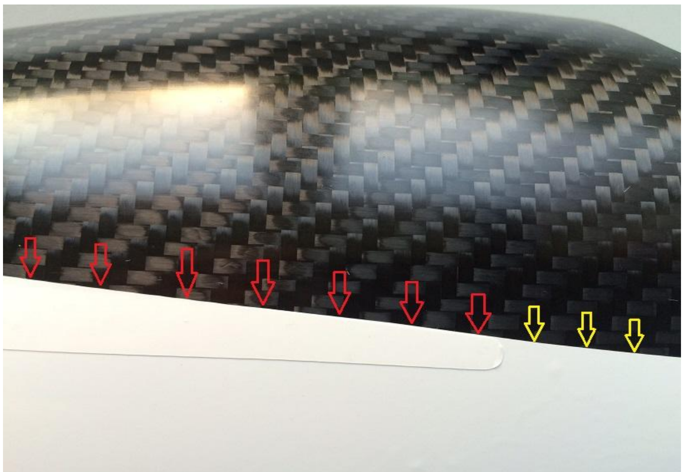


Place the wet (soapy water) lower window side part on the canopy without distorting. Add more soapy water if the foil cannot be moved. The target is to position the foil without tension with the rear tip at the upper edge and with the front tip at the horizontal middle of the canopy tip. In longitudinal direction, the foil can overlap the center line so that the two tips are overlapping.

Start to smooth the foil carefully in the rear area without shifting it. Squeeze out the water with a soft rag carefully.

Continue slowly toward the tip without shifting the foil position. Start in the large middle area and then squeeze out the water to the top and the bottom. Check continuously to see if the tip is in the right position and squeeze out folds carefully. If there are folds in the border area, lift the foil at the front, pull it slightly while squeezing from the back to the front. The foils with normal colors are better expandable—fluorescent colors are stiffer.



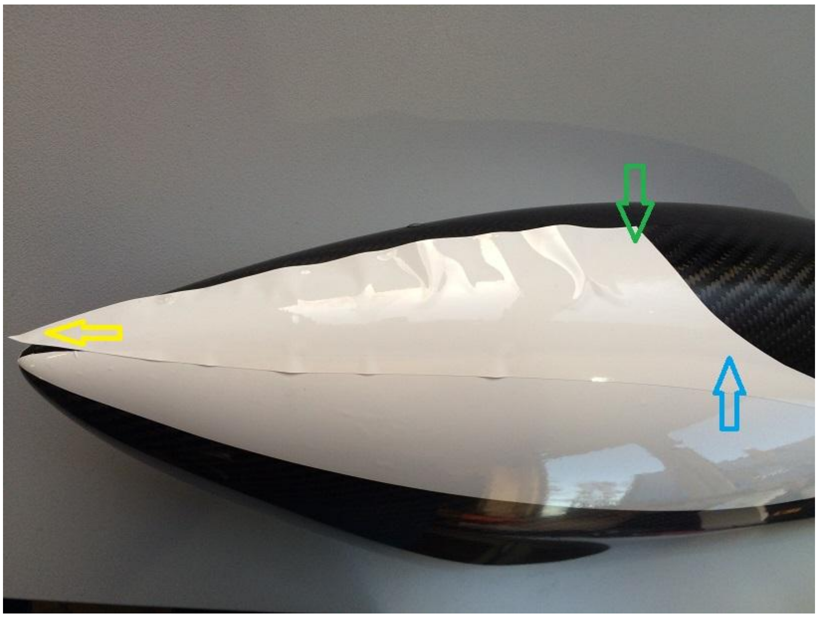


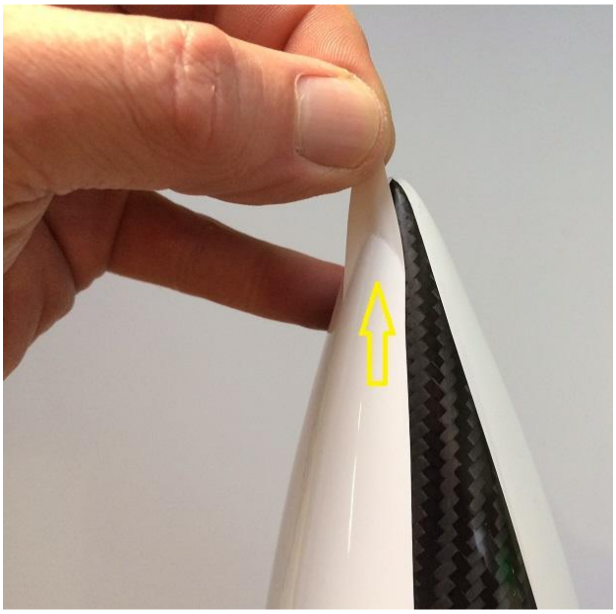
The application of the two upper window foils is the challenging part of the work. They have to be applied on a surface that is curved in both axes. There the foils tend to build folds easily.

Start with positioning the foil at the upper tip (red arrow – left picture) at or slightly above the middle line of the canopy, and ending at the tip of the canopy.

The conical ending tip with the radius at the end should be positioned on the already stuck lower window foil in a way that the upper edge (red arrows – right picture) is initially loose at the upper edge of the lower foil (yellow arrows). The lines are then diverged slowly.

The target is a transition where the complete upper line of the window is a harmonic curve without kinks or interruptions.

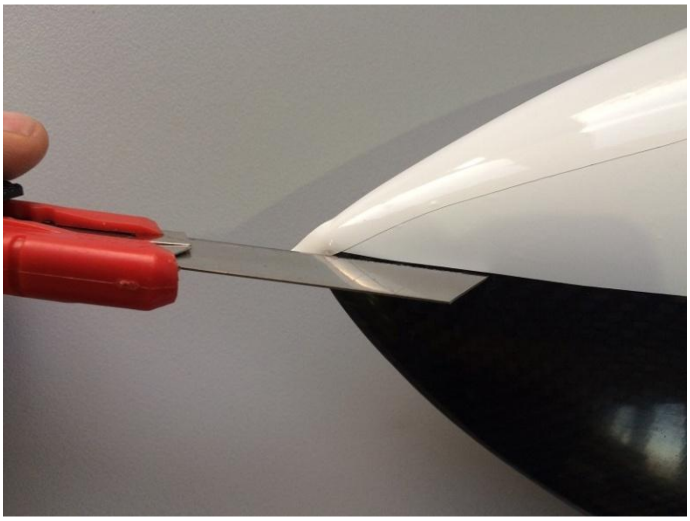


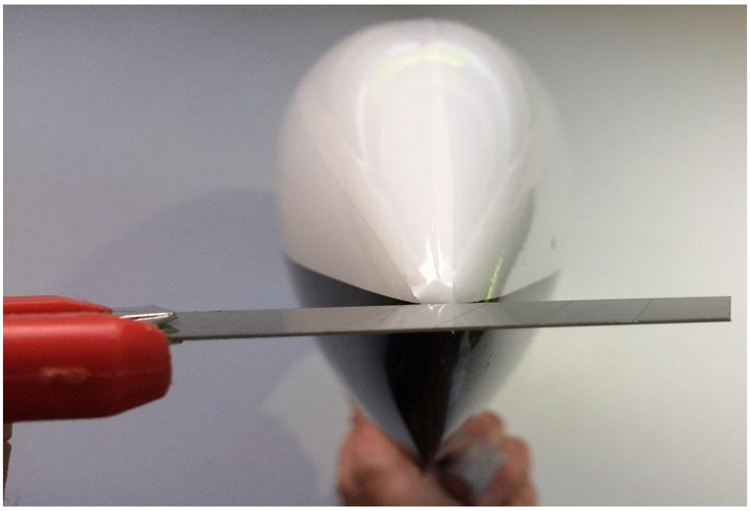


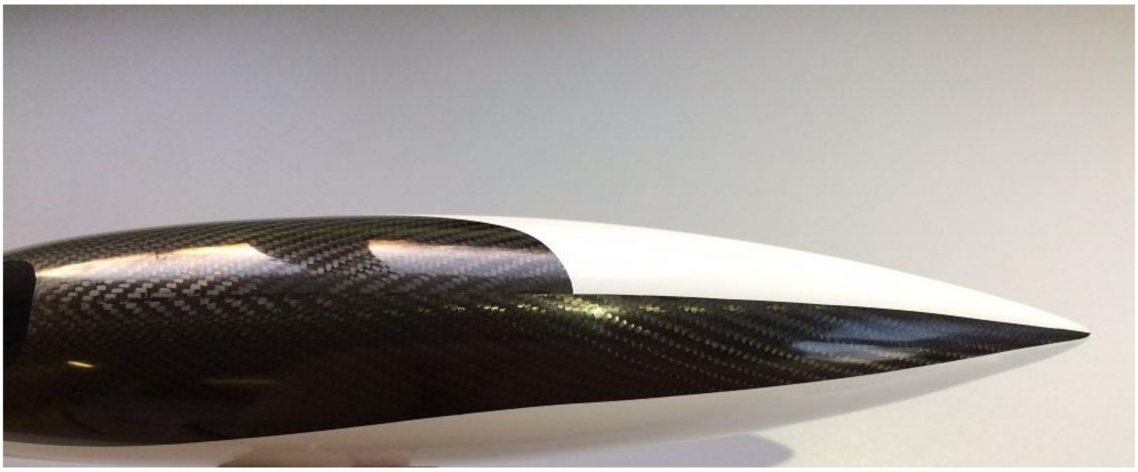
Sweep the foil first in the area of the green and the blue arrow and in-between and make sure it is properly tight. The long rear tip can be carefully stuck and loosely overlapping on the other foil.

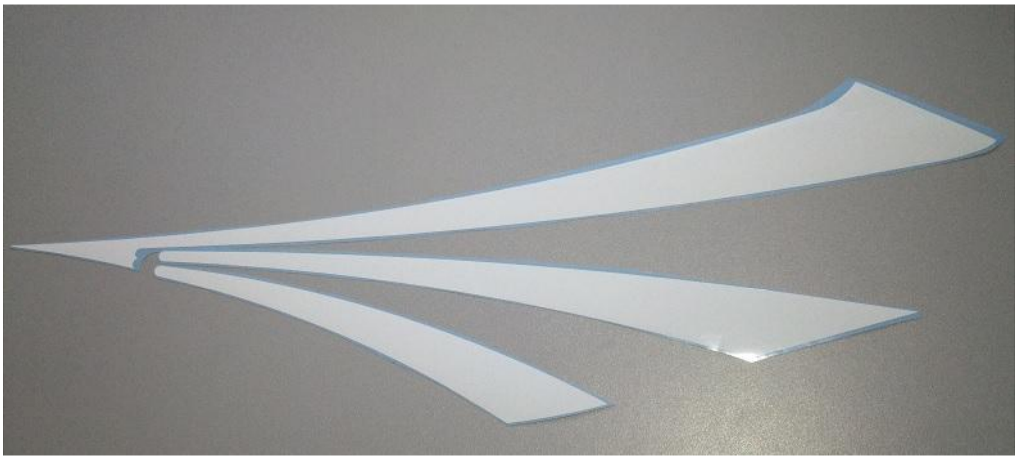
Start to work with the rag to the front, while lifting the foil at the front a little bit and pulling it. Take the tip indirectly as shown in the left picture (yellow arrow), but a little bit more rearward, because you may have to pull strongly to stretch the foil; otherwise, you might stretch the thin tip.

Sweep to the front while pulling at the tip so that the folds become smooth on their own. Take care of the shape of the upper edge of the window. The edge has to be along the center line or slightly above. It doesn't matter if the foil is overlapping a little bit at the front after this procedure. This overlap will be cut later on with a knife (see pictures below).



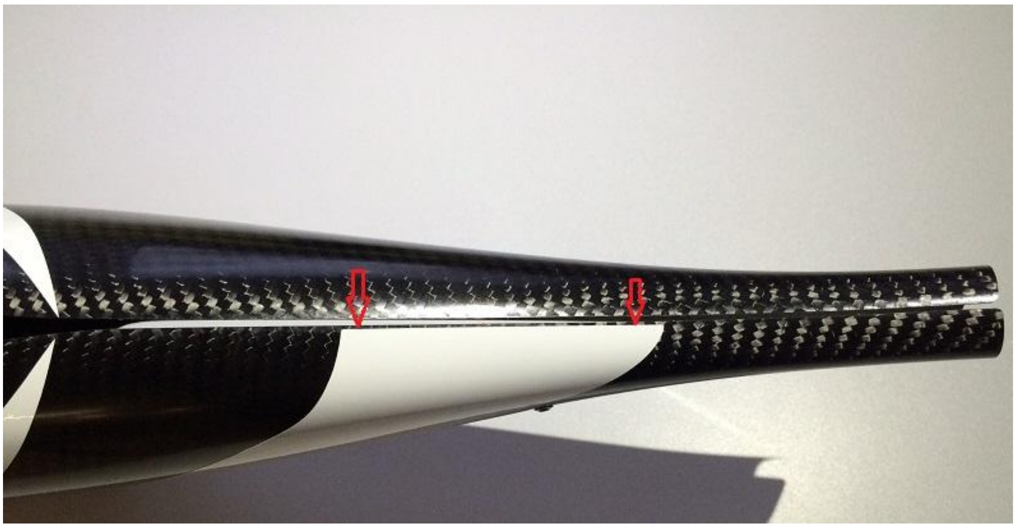






In the left picture, you see the positioning of the aerobatic stripes (in this case, for the left side of the canopy).

The upper stripe is designed with a tip with two reliefs where the two lower strips will be placed. The angle can be varied a little bit. The tips are not filigree, which eases the application.



Start with the upper stripe and place it parallel with the rear edge and flush to the upper edge of the canopy. At the same time, the tip should have a small gap below the window. It is ok when 1-2mm in front of the tip and above the center line is overlapping the tip on the other side.

It is important to lay down the foil with enough soapy water so it can be adjusted with less stress according to the references at the front and the back.

With this way there will be a nice flowing curve from the window, starting at the front with a small gap keep a nice flow as seen in picture.

If you pull strongly somewhere and the foil is sticking to another place on the canopy, there will not be a nice flowing line

With some visual adjustment, you can succeed.

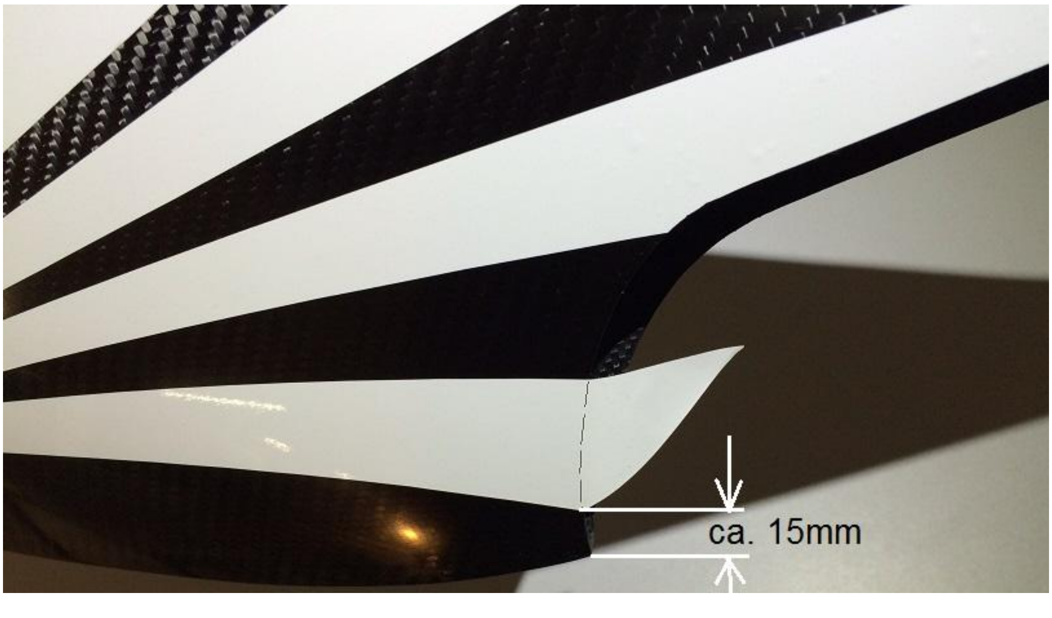
vis

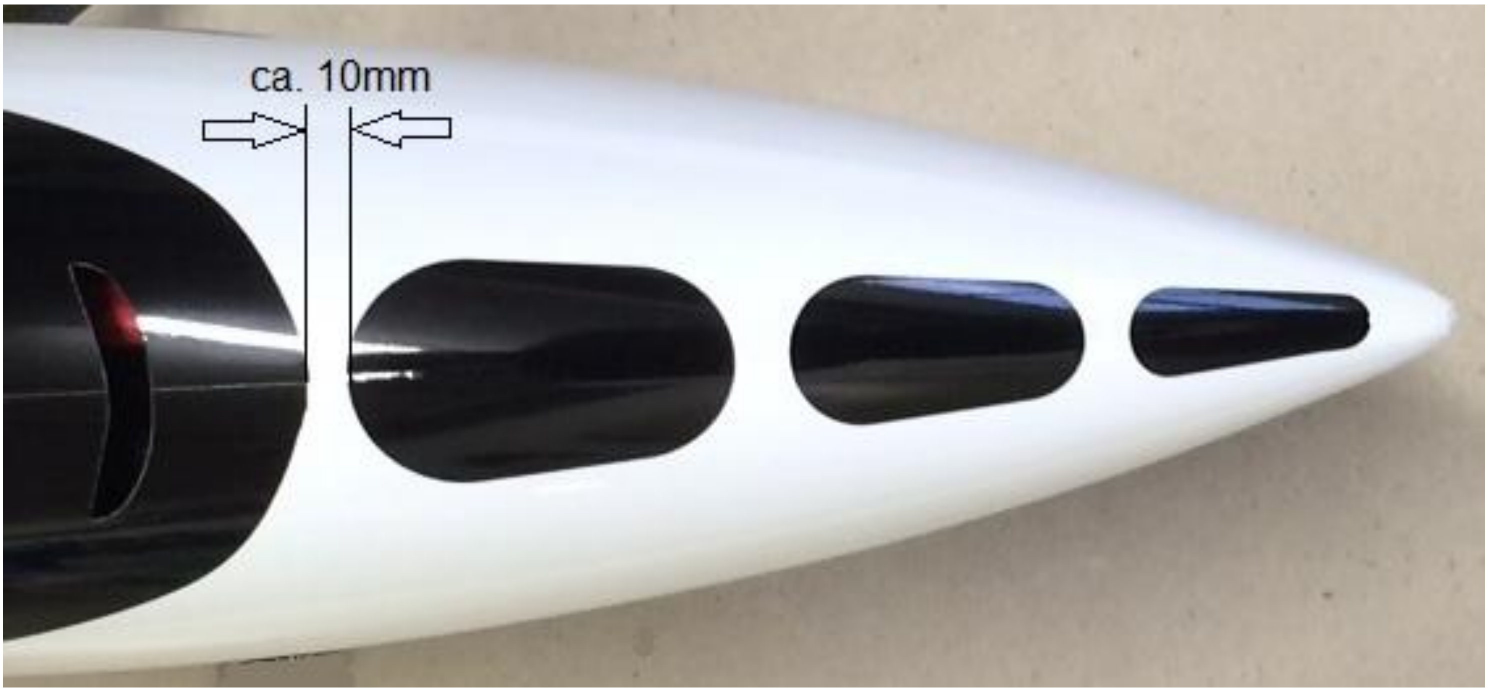
The front position is fixed on its own (see middle picture). The rear point is defined by the tip, which has to be positioned at the edge of the canopy (see red arrow – lower picture).

The overlapping foil will be cut later with a carpet knife when it has dried a little bit. Because of the shape of the foil, it can also be used for the closed canopy of the TDS.

The application of the lower stripe is similar to the middle one.

At the front, it will be placed exactly into the lower relief. The rear lower end will be positioned 15mm above the lower edge of the canopy. The overlapping foil will be cut after drying.





According to personal preference, you can finally apply the three conical rounded stickers to the canopy. These stickers increase the visabilty from the side of the model because of the varying sizes according to the front and the additional contrast.

To ensure the distances and positions to each other, these stickers are covered with a transparent foil. The foil will be pulled off after the placing of the stickers to the canopy.

I also recommend placing these stickers with soapy water to allow a final positioning. The transparent foil should be pulled off after the sticker is adhered properly.

Place the sticker about 10mm from the upper edge of the window and tilt the stripe toward the tip aligned with the center line of the canopy.

Attention! Do not be deceived by the border of the window foil. Use the center line of the carbon canopy if it can be seen through the foil. The joint line of the fiberglass canopy is a little bit out of the center. Use the upper side of the window as reference because of the big width of the canopy in this area; a small divergence will not be noticed. At the middle of the sticker is a little edge cut as reference. Face at the tip from above while positioning the sticker. Because of the small tip in the front of the canopy, the sticker can be adjusted exactly, because small divergences can be recognized easily looking from above.

Chapter – 10 **Installation of the remaining electronic components**

You should take some time for the installation of the missing electronic components, such as the stabilization system, receiver, buffer pack, etc.

Unfortunately, I cannot give universal recommendations, as there are many variants possible due to the used components. There is not one optimal solution.

For this topic, the model builder is requested. I just can give some proposals from my experience and explain what you should take to heart in any case. The RC system is the heart of your helicopter and if you do not work carefully and conscientiously, you might be punished by a total loss.

The TDR-II is an extraordinary design that offers a lot. The only thing the TDR-II is not offering is a lot of space for the remaining RC components. This is the drawback you get for the compact and aerodynamic machine. A Formula 1 car is also very tight.

Nevertheless, you can place common components if you take some time for the positioning and the routing of the cable.

The flybarless system, as the heart of the machine, has a special place on a carbon plate below the elevator servo. This is the only place for it to be!

There is enough space for all common and actual flybarless systems.

I advise against systems where sensors and electronics are placed in two separate housings. This is no longer state-of-the-art because this needs unnecessary space. Nearly all suppliers offer one-piece systems. The optimum equipment for the TDR-II is a modern system with an integrated receiver (all-in-one box).

For common combinations of receiver and flybarless systems, the available space is sufficient.

The receiver should be a handy size. A single line connection to the flybarless system would be an advantage. The reduced number of cables saves a lot of space. Altogether you should only use components you really need and be thrifty with electronic gimmicks to have a clear arrangement.

As a buffer for the BEC, I propose a small 450mAh 2S LiPo that is flat. This can be placed either at the front mechanic frame beside the receiver or below the fixation plate below the ESC. Capacitor buffers are mostly too thick and do not or just marginally fit between the frame and the battery. There would be some space at the side of the mechanics, but the necessary cable rooting at the outside would not look good. I do not recommend ~~to~~ flying without a back-up system because a BEC loss would have fatal consequences. With a small safeguard, you can prevent this from happening.

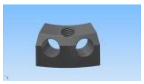
Attention! If you want to use a retracting gear, the space between the elevator servo and the right chassis plate above the belt for the elevator control has to remain free. A picture with the retractable landing gear is shown on the next page. No cables should be routed loosely along the side of the chassis plates; otherwise, there is a danger of damaging or squeezing the cables when changing the battery.

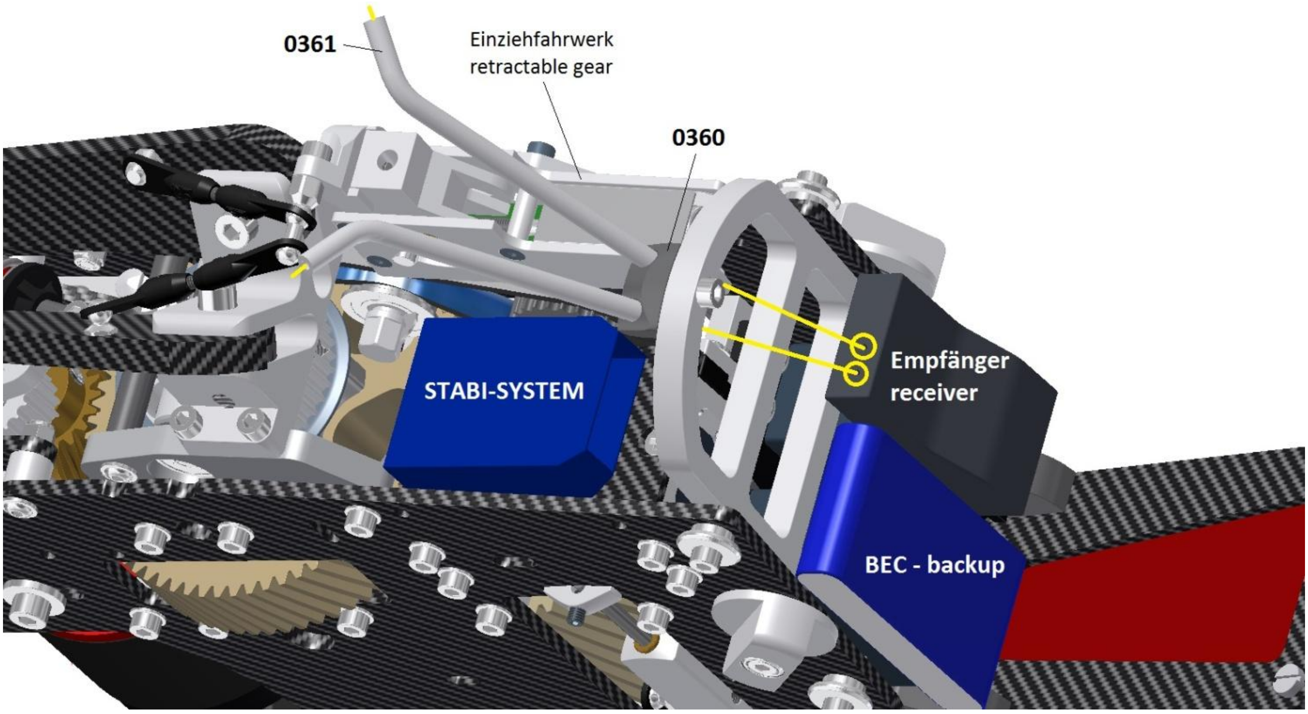
Note: I want to mention at this place that I do not advise the downloading of finished setup files for the flybarless system (a basis system for 700 or 800-class helicopters as a start aid is excepted). The TDR-II has many influencing factors you do not know. A setup for dedicated equipment can be completely wrong for other equipment. This could lead to wrong conclusions while another user says it is working perfectly. According to the used servos, the individual-used pivot point at the blade grip, length and weight of the blades, tail blades, etc., it makes sense to start from a basic setup where the machine is basically flying. Start with this basic setup and adjust the different parameters individually.

Most systems will lead you through the menus for the different basic adjustments with dedicated explanations. Thereby, you get to know your system and will later know which parameters to adjust to get dedicated modifications. Only this way you will learn the correlations and can target for your perfect adjustment.

I will explain the TDR-II dedicated specifics you have to consider during the basic adjustments.

Proposals for arranging the different electronic components

	0360	Antenna tube support	1
		Hex socket screw M3x14 (for 0360)	1
	0361	Antenna tube	2



In the picture above, you can see a proposal for arranging the three needed components. Except for the V-Stabi Neo, all systems should be placed with the connectors to the front. With the Neo, the side with the antenna has to face forward. Then the length of the antenna is sufficient to reach to the end of the antenna tube 0361.

The antenna tube 0360 will be placed according to the drawing into the support 0360, which will be screwed with a M3x14 screw to the lower side of the front frame. Both ends of the tubes will be oriented to the side. They build a 90° angle and look outside at the lower narrow area of the canopy to the left and the right side.

Attention! Especially with the carbon canopy, a correct routing of the antenna is extremely important. The carbon canopy is acting as a shield. The fiberglass canopy is completely uncritical. The non-isolated ends of the antennas should look outside the tubes a bit.

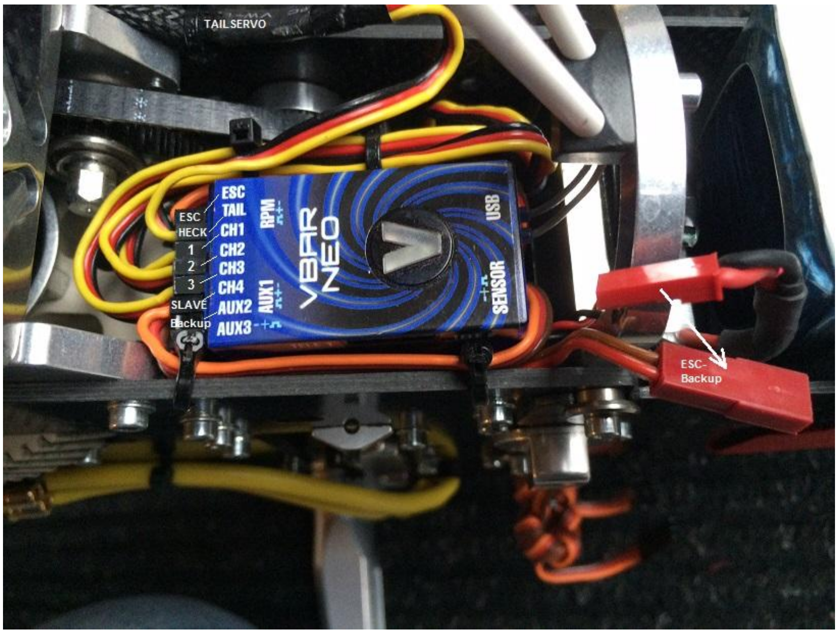
Secure the tubes after adjusting at the support with some hot glue or silicon.

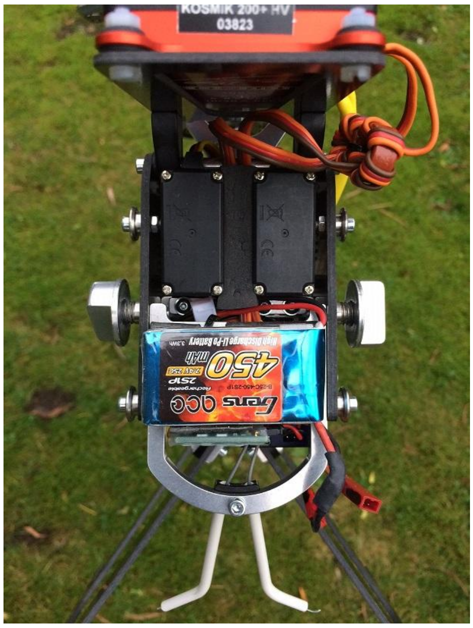
The receiver should be placed upright in front of the front frame with some double-sided tape to a servo. The antennas should face downward and placed to the center dependent on the side of the receiver they are placed.

A short and direct routing of the antennas to the tubes is ensured (yellow lines). Check first if the antennas reach down to the tips of the tubes; otherwise, correct the position accordingly. Also check that the receiver is not placed too far to the top. There must be enough space between the cables to be connected and for the ESC. Take also into account additional space if you want to place the buffer battery, which is placed beside the receiver, below the ESC. Check before fixing if the receiver is not too thick and not colliding with the rear plate of the battery tray.

The buffer battery (BEC-Backup) should be placed at the other servo after the routing of all cables. There is one area on the TDR-**II** where you can route the cables without disturbing and without being visible. This is the gap between the two front servos. You should route the cables of both servos from the exit of the servo between the two servos downward. Then place the cables in large loops in these gaps. The ESC cables can be routed there, but move the Ferrite spools to the end toward the ESC. There is more space available.

Installation example for V-Stabi Neo





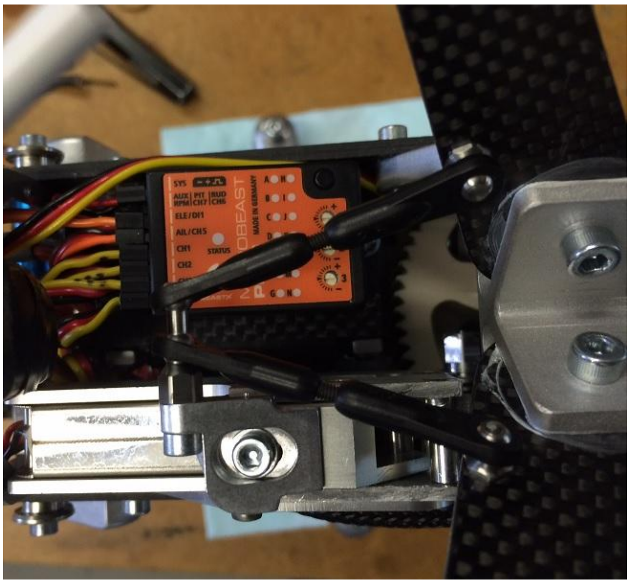
The cable connectors of the Neo with the integrated receiver have to face backward. There is nothing more. This you can see on the right picture where only the buffer battery is placed in front of the front frame.

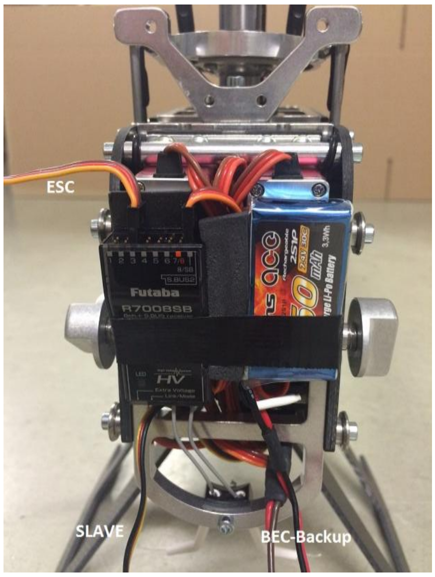
The cables are routed from the connectors of the Neo beside the housing and then to the top between the two front servos. The two ESC cables master and slave are routed up to the KOSMIK. The Ferrite spools are moved to the top and fixed together with a tie wrap.

A stripe of cellular rubber is placed at the gap to prevent the cables from slipping to the front.

The two red connectors are the connection between the 450mAh Backup battery with a free slot at the Neo (in this case AUX2). The AUX3 slot is not used in this case, because it is not needed and has bad accessibility. The AUX1-slot (above AUX2 and AUX3) is used for the retracting landing gear if needed.

Installation of the Beast





You can also see the position and the necessary space for the retracting landing gear on these pictures. The retract mechanics can remain in the helicopter if you do not care about 50g additional weight. Then the exchange between retractable landing gear and skids is even faster. Receiver and buffer battery are placed as shown on the CAD drawing on the last page.

The one who wants to make the effort can also shorten the cables to the right dimension. But take care to rout the cables singular and not directly at the flybarless system to a stiff harness. This will transfer additional vibration to the sensors.

Fixation of the batteries to the quick exchange battery tray

Two single battery packs (see technical data for dimensions) are needed for the TDR-II. The packs have to be connected in series.

Two 7S, or alternatively two 6S, packs with a capacity between 4000 and 5000mAh will be connected separately with Velcro strips to the top and bottom of the battery tray. The Velcro strips will be pulled through the elongated holes below the battery and with the fastener at the top and center of the battery. The red fasteners of the top and the bottom battery should not face to the same side.

In case you use just one battery tray and you have to change the batteries, I propose affixing antislip pads beside the Velcro. These should be minimally thicker than the Velcro itself to secure the battery from moving. Consider the mass of nearly 2.2lbs of each battery, which will have high centrifugal forces during fast pirouettes because of the large distance to the rotor mast. If the batteries are only slightly affixed to and laying on the Velcro or the flat plate, nothing stops them from moving forward until hitting the front plate of the battery tray.

If you use more of the quick exchange units, you can fix the batteries additionally to the Velcro with double-sided tape to the battery tray. The thickness of the double-sided tape has to be bigger than the one of the Velcro. Use two or three layers if necessary. Affix the tape first to the battery tray where you can see how to place them beside the Velcro.

Mount the batteries with the cable to the front. The routing of the cables to the connectors of the ESC is easier and can be clearly arranged. The corners of the battery where the cables exit are rounded, giving more clearance to the canopy. The sharp edges of the rear side do not disturb at the back.

Note: According to the length of the battery, the position might change. Because of their length, most of the larger batteries with 5000mAh have to be placed as far backward as possible.
If they are too far to the front, the three tongues of the front canopy support cannot move backward. This hinders the locking of the rear canopy fixation.

The CG plays no role for the positioning. As long as both batteries are weighing more than 3.5lbs, the CG is in the green area. Even with over 4lbs of battery, the helicopter flies well, even with light nose-heaviness. A light nose-heaviness generally sees no problems, but tail-heaviness can create stability problems during fast flights. The pitch-up tendency of the helicopter is rising with tail-heaviness, while the tendency will be reduced with nose-heaviness.
A plus and a minus cable has to be connected in front of the canopy support. Try to keep the cables as short as possible to prevent additional cable loops, which hinder the positioning of the canopy (see pictures on the next side). It is up to you if you use connectors or directly solder the cables.

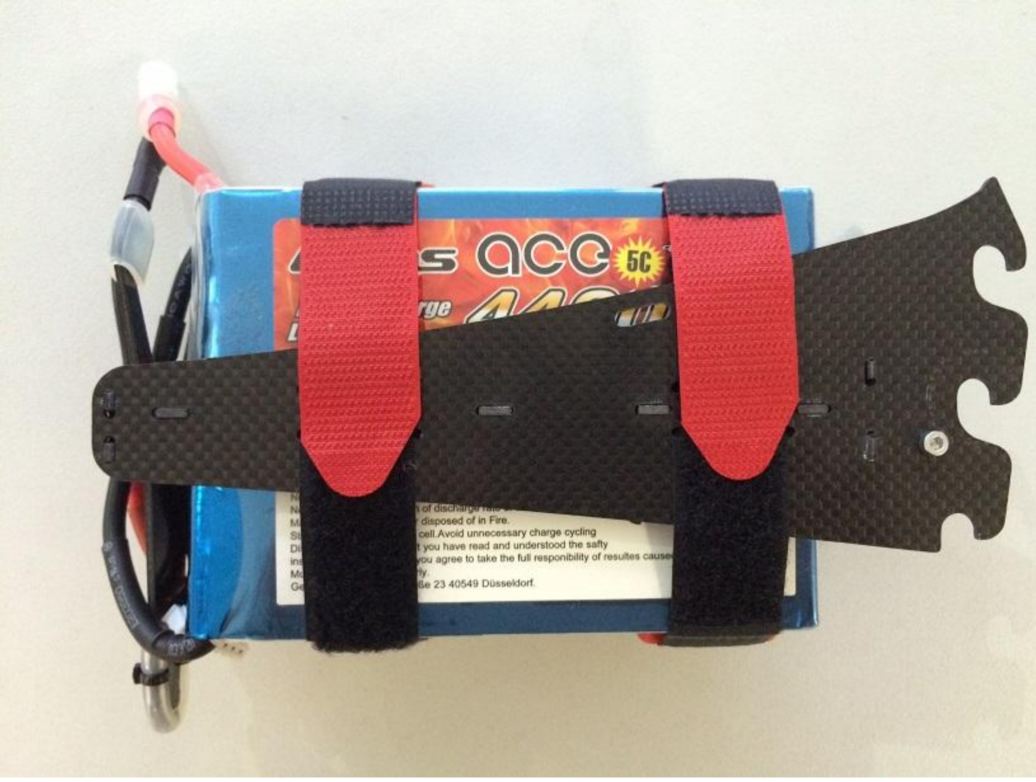
According to the length of the battery cables, the ESC cables have to be adjusted to have a short routing on top of the battery. No connector should be below 6mm diameter.

Attention! Do not mix up the plus and minus poles of the ESC. This would destroy the ESC completely.

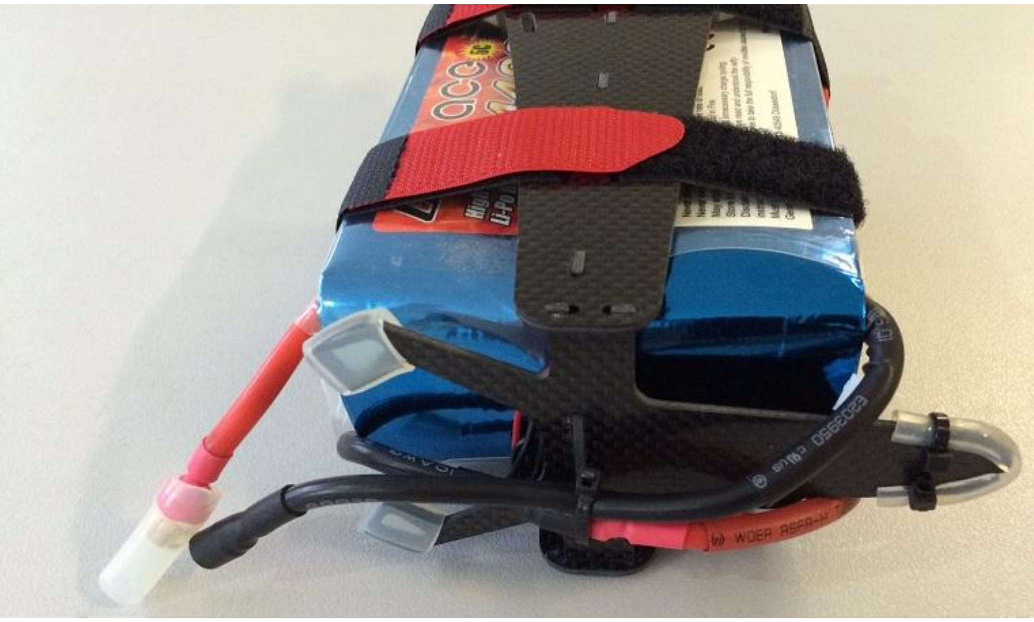
The left picture shows how the Velcro stripes are pulled through the side slots of the battery support. Do it in the same way for the bottom side, so both batteries packs can be fixed independently from each other.

In the first picture on the next page, you will see the Velcro stripe very well from the side view.

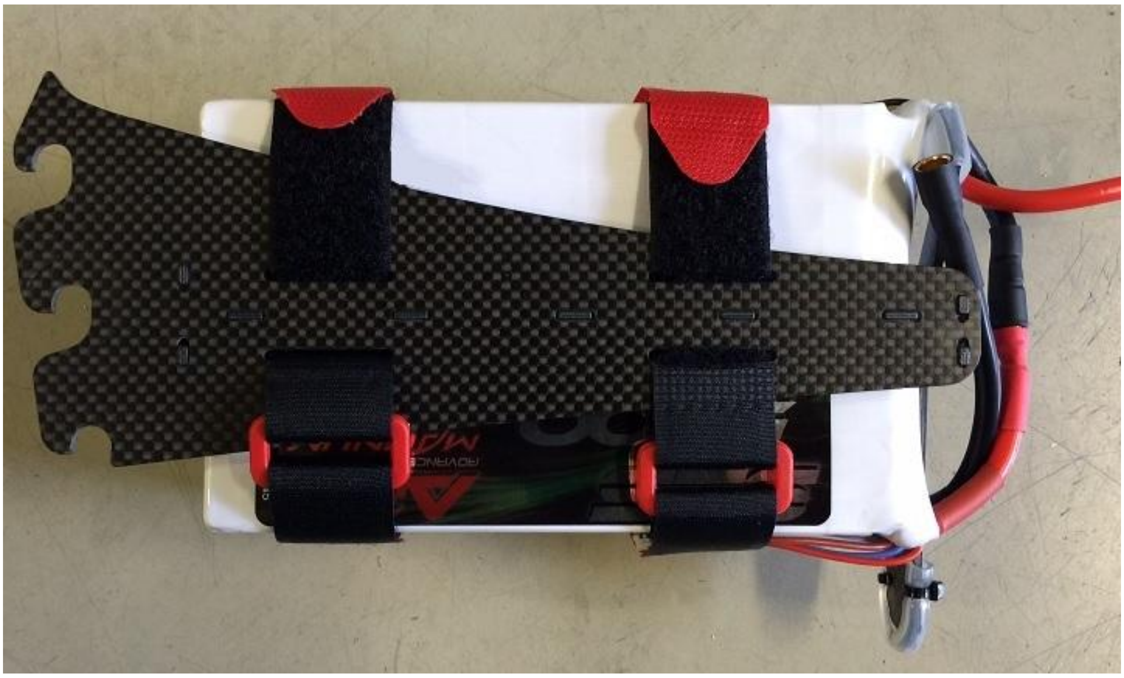
Example: 2 x 7S 4400mAh Gens Ace



On the left side you see an optimized and short cable routing. The feathering tongues of the canopy support have enough space to the rear and are free from cables that could slip between the support and canopy during positioning of the canopy.



Example: 2 x 7S 5000mAh SLS



The cable rooting is ok, but the possible deflection of the tongues is relatively small.
By cutting the white shrinking tube at the cable outlet, you could get a little more space.

Chapter – 11 **Adjustments**

In this chapter, all the basic adjustments are described beginning with swash plate servo – pitch angle, tail servo – tail rotor controls, ESC basic setup, etc.

This chapter is not universally valid because different flybarless systems require different approaches. I just want to make proposals and want to indicate the TDR-II specifics to be considered because of the **LDS** (**L**inear **D**rive **S**ystem). Generally speaking, it is not rocket science and if you use adjustments that are known from your systems, the machine will fly. It is in principle the same, but because of the closer pivot points at the servos, the resulting larger servo stroke, and the linearity of the connection at the end points, some explanations become necessary. A detailed explanation of the **L**inear **D**rive **S**ystems was given at the beginning of Chapter 6 - Linkage and servo mounting. You can read there for an in-depth look at the topic.

Let's start from the beginning:

Connect all servos according to the manufacturer's instructions for the flybarless system. Pull off the provisionary rudder horn of the tail servo to prevent it from running to a mechanical stop. The tail rotor control rod can be linked at the front and the rear if not already done. Turn the ball links to the same angle and the text of both facing downward. Now you can move the front bell crank by hand to check if it moves smoothly. If it is hard to move, the reason is usually the plastic ball links. As already written in the chapter for the tail assembly, you can improve the free movement by pressing the ball links slightly with a flat-nose plier from outside. The ball links have to be placed at the threaded link ball so the bearing surface can adapt to the spherical shape. Most of the time an improvement to the condition beforehand can be fixed quickly. Low-viscosity Dry Fluid can also be added. Especially during the winter at low outside temperatures, a free motion is important because the plastics are tight when they become cold. The tendency is for hard movements when outside.

Switch on your transmitter and the receiver. Use a receiver battery or the buffer battery for the moment and not the flight battery.

Run through the basic setup of the flybarless system until all servos are running in the same direction. This means that when collective input is given, the swash plate should go up (positive pitch) and down (negative pitch). Also check the cyclic functions. The swash plate should tilt in the same directions as you move the cyclic stick on your transmitter.

Keep the collective control stick approximately at the center and move the cyclic controls just slightly to prevent chaffing with the mechanical stops when the displacements are too big.

After a while, you will come to the point where you need to adjust the center position of the swash plate (zero degree pitch). The real position at the blade grip is not of interest at this time—only the position of the swash plate is of interest. Place the swash plate gauge under the swash plate. Move the swash plate downward until the stick is in center position or it is touching the gauge. On some systems, the swash plate travels to the center position without moving the collective stick when you come to the menu point. Check this first without the gauge to be sure the swash plate is not moving downward too far. In this case, the swash plate will be pressed with full power to the gauge and load the servos and control rods more than necessary. The ideal position will be reached when the swash plate is lying all around on the gauge.

According to the accuracy of the pre-adjustments during servo fixation and the neutral impulse of the flybarless system, the positions should nearly fit. If the difference to the ideal position is not too big, you can use the trim function to adjust the swash plate to the gauge. The swash plate has to constantly touch the gauge all around and the gauge can only be moved over a slight resistance.

If the difference is larger, you can adjust the aileron servos by the length of the control rods, but not by more than +/-1mm.

If the evaluator servo is completely out of range, remove the battery. Pull the swash plate completely to the top until the gear rod is moving out of the gear then turn the gear one tooth upward (the swash plate should be positioned downward) or downward (the swash plate should be positioned upward) before pulling down the gear rod again.

The correct adjustment of the swash plate position at center stick position (0°-pitch) is the prerequisite for all of the following. As has already been said, the position of the blade grip is not important at the moment.

The most time spent on setting up a flybarless system if getting symmetrical collective response. Here you can see a the fadvantage of the **L**inear **D**rive **S**ystems. Because of the linearity of the throw of the gear rods in comparison to the resulting blade angle, no angle gauge is needed to adjust the desired values. There is only a negligible deviation resulting from the slightly different angles of the control rods between the swash plate and blade grip. This difference has a slight compensation function for the different efficiency of the rotor during normal flight or upside-down flight. During upside-down flight, the air can be blown away without disturbance of the fuselage. To get the same performance, the collective angle has to be reduced a little. This automatically happens because of the described difference. In the following, you will find a table showing the ratios you can use.

- In the first column, you will find the throw of the gear rod in 0.5mm steps from -7mm to +7mm. (The negative collective area is marked red and the positive area is marked green.)
- In the second column, the respective servo angle is listed. This is for information only and not relevant to further adjustments.
- In the third column, you can see the respective blade angles for the outer position of the ball pin at the blade grip.
- In the fourth column, you can see the respective blade angles for the center position of the ball pin at the blade grip.

The table is limited to an approximate maximum of +/- 15°. This value is reached 1mm earlier if balls are in center hole vice the outer hole. Although the table stops at approx. +/- 15°, you can mechanically get about +/- 17° if desired.

The throw of the gear rod at +/- 7mm collective is the limit; otherwise, there will not be enough throw for the cyclic, which will be added.

For speed pilots who need more than 15° pitch angle, the blade grips can be twisted to add 4° more blade angle to the pitch curve. This 4° has to be subtracted at the negative range.

swash plate movement		servo movement		pitch angle outer linkage		pitch angle middle linkage	
-7	mm	-30.9	°	-14.8	°		
-6.5	mm	-28.6	°	-13.8	°		
-6	mm	-26.4	°	-12.7	°	-14.7	°
-5.5	mm	-24.2	°	-11.6	°	-13.4	°
-5	mm	-22.0	°	-10.6	°	-12.2	°
-4.5	mm	-19.8	°	-9.5	°	-11.0	°
-4	mm	-17.6	°	-8.5	°	-9.7	°
-3.5	mm	-15.4	°	-7.4	°	-8.5	°
-3	mm	-13.2	°	-6.3	°	-7.3	°
-2.5	mm	-11.0	°	-5.3	°	-6.1	°
-2	mm	-8.8	°	-4.2	°	-4.9	°
-1.5	mm	-6.6	°	-3.2	°	-3.7	°
-1	mm	-4.4	°	-2.1	°	-2.4	°
-0.5	mm	-2.2	°	-1.1	°	-1.2	°
0	mm	0	°	0.0	°	0.0	°
0.5	mm	2.2	°	1.1	°	1.2	°
1	mm	4.4	°	2.1	°	2.5	°
1.5	mm	6.6	°	3.2	°	3.7	°
2	mm	8.8	°	4.3	°	4.9	°
2.5	mm	11.0	°	5.3	°	6.1	°
3	mm	13.2	°	6.4	°	7.4	°
3.5	mm	15.4	°	7.5	°	8.6	°
4	mm	17.6	°	8.6	°	9.9	°
4.5	mm	19.8	°	9.7	°	11.1	°
5	mm	22.0	°	10.8	°	12.4	°
5.5	mm	24.2	°	11.9	°	13.6	°
6	mm	26.4	°	13.0	°	14.9	°
6.5	mm	28.6	°	14.1	°		
7	mm	30.9	°	15.3	°		

It is best to measure the swash plate movement at one of the aileron gear rods between the brass guide sleeve and the upper stop where the steel spindle is fixed. First, measure the position at 0° collective, then add or subtract the wanted mm throw. It is best to use a digital caliper rule and set it to 0 at the 0° position. The caliper rule then shows the throw values directly; otherwise you have to do some mental arithmetic.

Attention! I explicitly point out that it makes no sense to use a total throw of more than +/- 7mm (30°). Even these values are at the limit and not practical for people without a fine feeling for the collective pitch management.

With this collective range, it is nearly impossible to hold the height exactly during hovering with high rpm. If you reduce the rpm, it is no problem; if you want to get impressive climb rates with low rpm, this collective range makes sense.

You can do the basic setup like this and reduce the collective range in the transmitter depending on the flight state. You can use high-pitch angles for low rpm and reduce them for high rpm or leave them for a speed flight state.

If you focus more on 3D with middle or high rpm, you should adjust the collective angle no higher than +/- 13°.

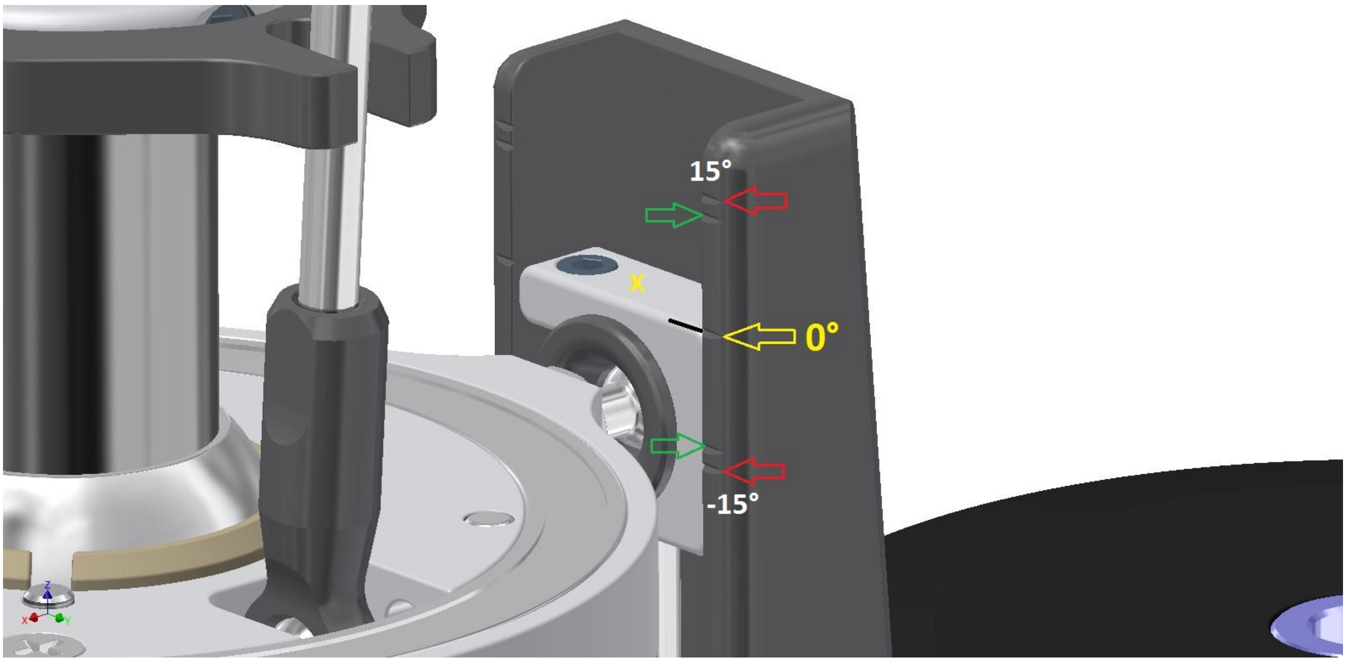
Whether you use the outer or the center hole in the blade grip arm depends on your personal preferences or which type of servos you use (programmable or normal servos).

You will see if you reach reasonable percentage values on your flybarless system, which is in the recommended range of the manufacturer. With programmable servos, you can increase or decrease the servo angles to find the ideal range.

When using standard servos, you have to check for the required maximum collective angle when using the outer position. If necessary, use the center position to get about 2° more collective.

Attention! Do not use the inner position at the blade grip arm!

A small marking at the swash plate anti-twist device is milled to make the adjustments more comfortable (see picture below).



The reference plane is the upper side of the ball socket fork marked with a yellow X. When the swash plate is resting on the gauge, this plane should be aligned with the 0° marking. The red arrows show the 15° position with the outer position at the arm and the green arrows show the 15° position with the center position at the arm.

Attention! When adjusting the cyclic angles, the lower side of the ball socket fork should never be higher than the green marking maximum collective input and maximum elevator forward input are given. ~~Otherwise~~ The lower end of the gear rod can get out of the gear mesh or the ball socket fork can get out of the guide and become blocked at the upper edge.

Next are the cyclic adjustments. Most of the time the flybarless system manufacturer gives a reference angle for the basic cyclic adjustment needed for the system parameters. Often this value is between 6° and 8°.

The swash plate should be at 0° position to perform this setup point according to the manufacturer's manual. Either the swash plate automatically tilts and has to be adjusted to the required value or the requested value has to be adjusted manually.

At the gear rod, you can also directly measure the necessary throw to reach the reference value of the manufacturer. It doesn't make any difference whether one gear rod moves upward and the other downward.

The swash plate stays at its given height; however, you cannot use the values from the table because the swash plate is not moving parallel to the rotor mast up and down, but tilting around its center.

Because of the difference of the swash plate ball positions between the outer ring and inner ring, there is a ratio of exactly 2:1, which means the throw at the blade grip is only half as big as a collective one with the same throw of the gear rod.

Calculate with the following values:

Outer position at the blade grip arm: 1mm throw of the gear rod – corresponds to 1.1° cyclic

Center position at the blade grip arm: 1mm throw of the gear rod – corresponds to 1.3° cyclic

Now you just have to divide the requested value by the degree value and you get the throw to be adjusted.

Example: Required are 8°

- for the outer position the throw of the gear rod is 8°: 1.1° = 7.3mm
- for the center position the throw of the gear rod is 8°: 1.3° = 6.3mm

Finally, you have to adjust the cyclic maximum values, which will be limited by a software "cyclic ring." This means the flybarless system limits the tilt angle when elevator and aileron input is given at the same time. Because of this function, the maximum tilt angle of the swash plate is the same independently on the tilt direction. Therefore, exceeding the maximum mechanical values is prohibited.

Activate this function in any case. Adjust the cyclic values to a maximum of 10mm. This is with the outer position of 11° cyclic and with the center position of 13° cyclic. This is sufficient in any case.

Attention! The measurement of the complete adjustment of the cyclic at the aileron gear rod has to be done with an aileron input only and not with an elevator input.

The front ball pins for a 120° linkage are located in longitudinal direction closer to the pivot point of the swash plate as for the role axis. This is compensated by the flybarless system with smaller throws.

All of these explanations are for you to have the right understanding for the system to show what is important for the basic adjustments.

You can, of course, also perform the adjustments the classical way by using a pitch angle gauge. Take care that the helicopter is standing stable and the blades are exactly at 0° when the swash plate is lying on the gauge. This has to be done when everything is adjusted.

Especially with such stiff system as TDR-II, track differences are negatively influencing the flight stability. Put the TDR-II on a flat, non-slippery surface and mount the rotor blades. Put the gauge beneath the swash plate.

Align the blades as much as possible and orientate the rotor lengthwise to the helicopter. One blade should be above the tail boom. Calibrate the pitch angle gauge on a reference plane for the helicopter perpendicular to the rotor plane, such as the motor or the rear edge of the bearing plate behind the swash plate support. Place the gauge exactly perpendicular to the helicopter longitudinal axis before setting it to zero. Position the display to the front and ~~also~~ use the front rotor blade for the measures.

Position the gauge to the front blade and adjust the respective control rod until the value zero is reached. Tilt the entrainer(?) fork upward to remove the ball link from the blade grip arm without bending it. There is no need to try endlessly because you can also calculate the value. The lead of the M3 rod is 0.5mm, which means the minimum value is a half turn of the rod end, which is a modification of 0.25mm. According to the table, this is a difference of 0.55, respectively, and 0.6mm, depending on the ball position of outer or center. In the worst case, you can get to 0.3° toward your target, which is good enough. Try to get the same accuracy with the other blade. The value of the second blade should correspond to the first blade as close as possible to the desired value. The equality of both blades is of importance.

Please do not squeeze the ball ends from the outside even if they are a little stiff. Because of the high forces, they adapt quickly. Use a little bit of dry fluid; with the capillary effect, it will get into the small gap.

Check a second time by setting the gauge again to zero and measuring both blades again.

It is important that the swash plate is lying exactly on the gauge. The 0.25mm results in a large pitch angle. The accuracy of your work is useless if the swash plate is blurred when the ball link is pressed.

You can also switch on the system and move the swash plate downward until it is lying on the gauge and the servos are slightly growling.

Do not use the dubious method of tilting the rotor blades by 90° so that the blade tips are close together as an indicator. You can do this with a 450-class helicopter, but not at a machine of the 700 or 800 class. The lever forces on the swash plate are horrible for the rods, the ball links, and the servos—besides, this method is not correct.

Switch on your system and move all inputs to the maximum to be sure there are no collisions where control rods or something else at the rotor are chaffing mechanically or hindering the movement.

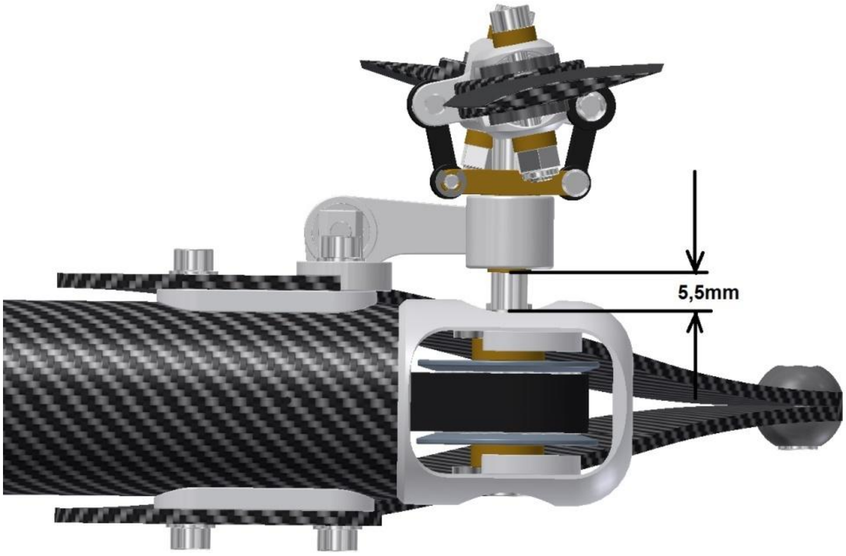
Turn the rotor (best without blades) carefully at a maximum and minimum collective combined with maximum cyclic and check to make sure everything moves freely. Be aware that at 2200 rpm, this happens 36 times a second!

Tail servo adjustment

The adjustment of the tail servo is very simple. There is a menu point in the setup of your flybarless system.

First, bring the servo to the middle position. Then mount the servo arm in a perpendicular upright position. Secure the screw of the servo arm with Loctite.

Mount the short control rod to the bell crank to the ball. There are some servos with unfavorably-designed housings where the control rod comes in contact below the servo arm. If the contact area is small, you can grind the plastic rod end a little bit.



When you positioned the servo to the middle position, you can adjust the length of the control rod.

Adjust the length of the long control rod. The distance between the face of the brass bridge and the face of the collar bearing should be about 5.5mm.

The movement to both sides has to be limited so the brass bridge is slightly touching the stops on both sides.

Check the direction of the tail rotor servos and the swash plate according to the control direction from the transmitter and from the flybarless system.

The swash plate always tilts in the opposite direction as you move the helicopter. At the tail, the control bridge has to move toward the tail gear box if you turn the fuselage counter-clockwise (seen from above) around the rotor mast.

Setup of the ESC and height adjustment

I can give advice for the recommended KOSMIK ESC, but for other brands, please use the instructions from the manufacturer's manual.

Remove the rotor blades before starting to program the ESC so that nothing will happen if the motor should start unintentionally.

I start with the basic programming of the ESC (Mode 4) for the helicopter. Proceed according to the manual. Switch the transmitter and the receiver on to start. You need an adjustment of the throttle channel of 0% to 100% to be able to program the ESC. Since you have to program different throttle curves for each flight state, you can do it right now.

Here are the values and the respective rpm programmed by me. These values are only valid for use of the KOSMIK in combination with the PYRO 800-48, the 18-tooth pinion, and a 14S battery.

Autorotation	0%	Motor off
Idle Up 1	55%	about 1400 U/min
Idle Up 2	70%	about 1800 U/min
Idle Up 3	80%	about 2100 U/min

Set the Idle Up 3 to 100% for programming of the ESC at first. To activate the 100% throttle curve, switch the transmitter to Idle Up 3. Switch on autorotation, which has priority over the others and gives a 0% signal. Now you can start the programming sequence of the ESC. Connect a flight battery and press the button at the side of the KOSMIK housing.

A sequence of beeps will start. Afterward, the ESC beeps one time, then two times, etc. After the ESC beeps four times, switch off the autorotation switch so the 100% signal is given from the Idle Up 3 curve. After the final beep, you can unplug the battery. Now the basic setup is finalized.

Now you can reduce the Idle Up 3 value to 80%.

Two parameters have to be adjusted. The current of the BEC should be adjusted to 8.0 volts if you are using high-voltage servos, and the direction of the motor has to be corrected in case ~~it is~~ running the wrong direction.

Put the helicopter on a table standing stable and free. Switch motor to off at the transmitter and connect the flight battery. Switch to Idle Up 1 and switch off the autorotation. If the rotor head starts turning, the motor is in the right direction and the adjustment is correct. If the motor is turning, but the rotor head is not, the motor is turning in the wrong direction.

See the KOSMIK manual for adjusting the BEC current and the motor direction.

Finally check to see if the ESC fits underneath the canopy. Depending on the battery type that is used, it will be placed more or less tilted under the canopy. The battery height may not exceed 50mm; otherwise, the KOSMIK will not have enough space.

Mount the canopy to check it. The battery tray with battery has to be installed. If you look through the ventilation slot, you can see the ESC. Use a wooden pole (or something similar that does not scratch the surfaces) to lift the front of the ESC toward the canopy to check the play. Remove the canopy and line up the front edge of the carbon ESC tray with a stripe of cellular rubber (stick to the lower side of the plate). The rubber then lays on the battery so that the ESC is just supported toward~~s~~ the canopy by the silicone tubes mounted on the ESC or has just a little play.

Attention! If you want to fly without the canopy, you will have to fix the ESC with a rubber band. There are slots at the side frames of the battery support for that.

Chapter – 12 **Maiden flight and adjustments**

Put the helicopter on a table and have thoroughly check it again before starting the maiden flight

- Did you tighten all the screws, including the one you had to loosen in a later building phase?

- Are all cables routed safely? Are all connectors carefully plugged in and secured if necessary?

- Are all control inputs in the right direction and do the sensors react in the right way?

- Are the tail blades mounted in the correct direction (taking into account that they have to be mounted in the opposite direction than on most of the other helicopters)?

- Is the damping of the rotor head adjusted correctly and secured (a maximum of seven holes for the first flights)?

- Are the springs of the swash plate fork in their place?

- Are all control rods mounted?

Take dry fluid and grease all main gears if you did not do it up until now. You can access the main gear through the gap of the aileron gear rack on the right chassis side. The gear of the intermediate stage can be accessed easily from the outside. To brush the gears in the teeth gaps with the attached small brush is sufficient. The messing pinions will be automatically greased by the gears when they are turned.

Place the canopy and check the clearance of the control rods and the fork of the swash plate fork device.

If you give full collective and at the same time full aileron and elevator rearward, the outer ball of one of the aileron servos will touch the inner side of the canopy. Don't bother, because this state will not be reached during flight. If this should happen, just the canopy will be pushed aside a little and nothing else. Nothing can jump off or hook in.

For the first flights, I recommend rotor blades between 700mm and 720mm length and a weight between 190g and 220g and tail blades with a length of approximately 115mm. This will always work and you will not have unpleasant surprises. All others can be tested when you know the helicopter.

Look for a nice, windless, dry day for the maiden flight. It doesn't make sense to maiden a new model under adverse weather conditions just to come into the air a little bit earlier. There are enough risks during a maiden flight. Always be on the safe side and take care to have enough safety distance between you and the model.

A lot of curious people are not beneficial for your nerves, either.

Make a final servo check at the flying field and check to make sure everything is running properly. Take time when mounting the canopy and check the springs of the swash plate fork device. As described before, turn the rotor crosswise to the mechanics and take care that the canopy is hooked correctly at the rear and the rubber tube is correctly placed.

Attention! I urge and recommend that you do a radio-range test, especially when using the carbon canopy. Look to the manual of your radio. The carbon canopy shields the electromagnetic waves, so it is very important that the antennas are out far enough. With the fiberglass canopy, there are no problems expected because it has no shielding influence.

Do not perform flights without the canopy—the visibility is very bad.

Attention! Place the helicopter on a non-slippery surface such as grass. Rough concrete is also okay because the sharp edges of the skids have enough grip for it, but grass is best for the first flights! Places with a hard or slippery surface or even ice are dangerous. Because of the slipping of the skids, ground resonance might occur and the helicopter could tip over.

Take care that the lower rpm (Idle Up 1) is not adjusted too low (ESC input not below 50%) and the run-up time is adjusted to a maximum of 12 seconds. Later when the helicopter is adjusted, you can approach to the lower borders (?) from above.

Resonance may appear at low rpm because of the high stiffness and the close distance of the CG to the rotor head, especially when everything is new and stiff. After a few flights, the damping O-rings settle and the ball links run in and everything is running smoothly.

The good thing with the TDR-II is that over the complete rpm range between 1,300 rpm and 2,600 rpm, there is no problematic zone. It is smooth, without any vibration or resonance effects. During run up of the rpm on the ground, you will recognize a light shaking between 600 rpm and 800 rpm. Afterward it is running smoothly again. It is important to quickly pass this range during run up. It is less critical during run down without load on the ground. If you recognize that the helicopter is starting to vibrate, reduce the collective to a minimum very fast to slow down the rotor quickly and keep the helicopter on the ground. Sometimes it might happen during autorotation when the rotor is slowing down—the helicopter is shaking until the rpm has completely slowed down. I do not have a general recommendation because this is dependent on a lot of factors. The used rotor blades and the adjustment of the damping are significant factors.

Tighten the blade bolts, but not too hard, so the centrifugal force can align the blades easily, especially during run up when the blades are not yet aligned and shaking may occur. I tighten the bolts just enough so that the blades are not folding because of their own weight when I am holding the helicopter with the rotor mast horizontally. If you shake the helicopter, the blades should fold.

Start the motor and let it run up to Idle Up1. Lift off and get familiar with the helicopter. If the helicopter is still a little bit bumpy at Idle Up1 and is not running smoothly, switch to the next higher rotor speed and then back again so the rotor blades can become aligned properly.

You will have to adjust the tail sensitivity at the different flight states respectively at the different rpms. Consider that the sensitivity can be adjusted at a higher value for hovering than for quick forward flight. This means you can make a final adjustment after you are familiar with the helicopter and able to fly it at a distance and fast.

Don’t be surprised if the tail is oscillating a little bit during the first 10 flights. The reason is that the tail belt is stiff at the beginning and not running smoothly. This will change soon and will improve flight by flight.

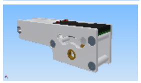
Get used to the appearance during flight and start to increase the distance slowly. Because of the slim canopy, the orientation detection is more difficult in larger distances than with normal helicopters. Additionally, the helicopter wants to speed up. In a short time, it is far away, even if not intended by the pilot. Be careful if you pull up the machine with constant collective position after a fast fly-by. The machine converts speed to height very well and is quickly out of sight, especially during poor visibility because of bad weather conditions. It happened several times to me and the helicopter went into the clouds. This is an extremely uncomfortable feeling. You can prevent this by reducing the collective to 0° or by flying a steep turn slightly pulled up instead of shooting upward vertically.

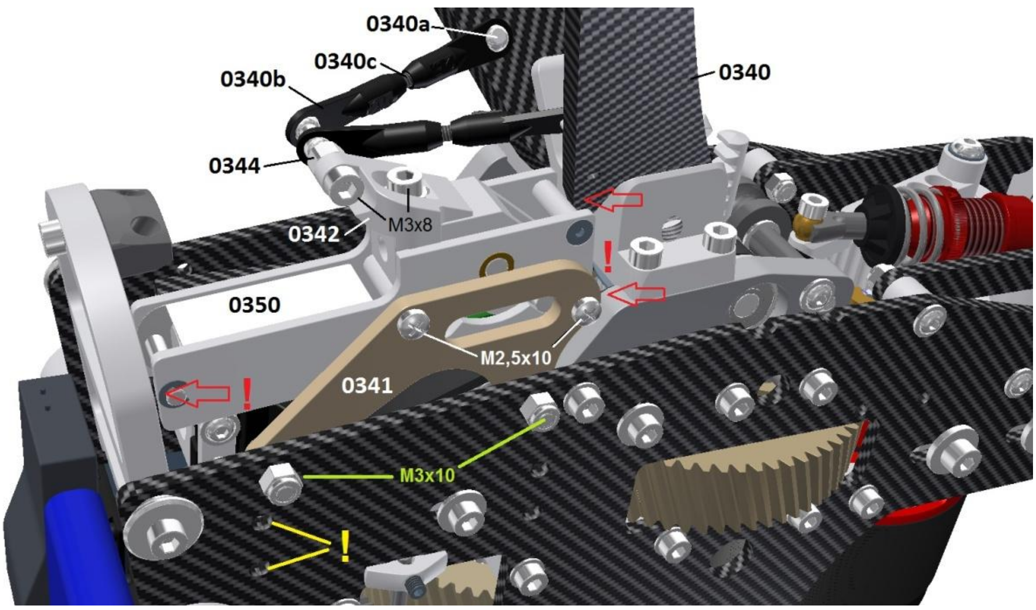
I want to mention that, because of the excellent aerodynamics, the TDR-II will become very fast after a small dive, even at low rpm. This is nice on one side, but on the other side, there is a high tendency of the helicopter to pitch up—to get a high stability at high speed, you also need a high rpm on the rotor head.

The retreating blade does not have enough lift in this case and the helicopter is pitching up. This will get worse the more collective you give. Reduce the collective at fast approaches with low rpm; otherwise, you can be surprised.

Fortunately, there are more and more flybarless systems with a so-called pitch-up compensation. The system, recognized based on the swash plate control with critical states, will be reached and reduces the collective on its own, so the helicopter flies straight and does not pitch up. Don’t be surprised if the helicopter does not climb anymore in horizontal flight with full collective. This is a sign of a reduced collective by the system, so nothing should happen.

Chapter – 13 Retractable gear (optional)

	0340	Folding skid with bearing sleeve	2
	0340a	Threaded link ball M3x4 / 4mm	2
	0340b	Ball linkage 19mm	4
	0340c	Stud bolt M2.5x16	2
	0341	Fiberglass– gear mechanic support	1
	0342	Gear lever	1
	0344	Double link ball M3-inside / 7-14mm	1
	0350	Retract mechanics	1
		Hex socket srew M3x8	2
		Washer M3 small (for the lever 0342)	1
		Lenshead screw M3x10	2
		Loc nut M3	2
		Phillips screw M2.5x 10	2



The retractable landing gear mechanism is a modified one used normally in a fixed-wing model. Instead of the normal gear, the lever 0342, together with the double link ball 0344, will be affixed to the mechanism by an M3x8 hex socket screw (washer for the lever).

In the elongated hole, the lever can be positioned to influence the total travelling distance by modifying the lever length. Position the lever with the front edge aligning with the front edge of the gear mechanism (see red arrow in the center picture).

The landing gear support 0341 will be fixed by M2.5x10 Phillips screws to the landing gear mechanism. The support is produced by fiberglass to get an electrical isolation to the chassis. This isolation provided during different tests a significant improvement of the safety. Unfortunately, the electronics of the landing gear are very sensitive to interfering impulses because of the high current of the power plant, therefore different measures are necessary to prevent an unintentional activation of the landing gear. As an additional measure, a ferrite core should be looped in the cable. The distance between the ferrite core and the tie wrap should be 20mm (see center picture). The cable has to be extended by an extension cable to reach the receiver.

Wrap the cable through the ferrite core so that the first and the last loop become tight as a knot. You also can possibly see this at the cables of the Kosmik ESC. Leave a little space on the core, as you can see in the upper and lower drawing. Stick a small piece of double-sided tape to the core at the side facing the landing gear support (picture below).

Stick the core to the inner side of the chassis between the two small, elongated holes (see yellow exclamation mark on the drawing on the last page). Pull a tie wrap though the first hole from the outside, then through the core and back through the second hole to secure the core.

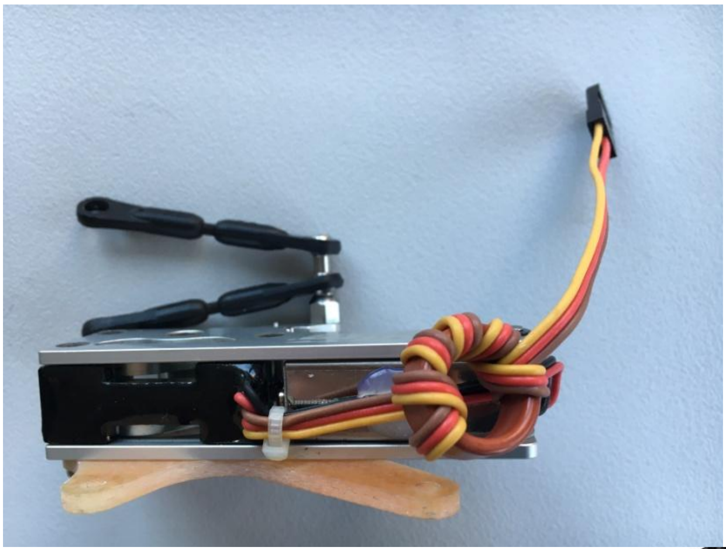
Following this, the landing gear will be screwed to the chassis. Insert the M3x10 lenshead screws from inside through the holes of the support and the chassis and secure them from outside with the M3 nuts.

Attention! Never place the nuts to the inner side. The belt of the elevator linkage will chaff at the nut sticking into the chassis at the rear hole.

Mount the rod ends 0340b using the stud bolts 0340c, keeping a distance of 2.5mm between the two faces of the ball linkage.

Attention! Check to see if the landing gear mechanic is touching the chassis or any other part of the helicopter. The landing gear fits very tight (see red arrows on picture last page).

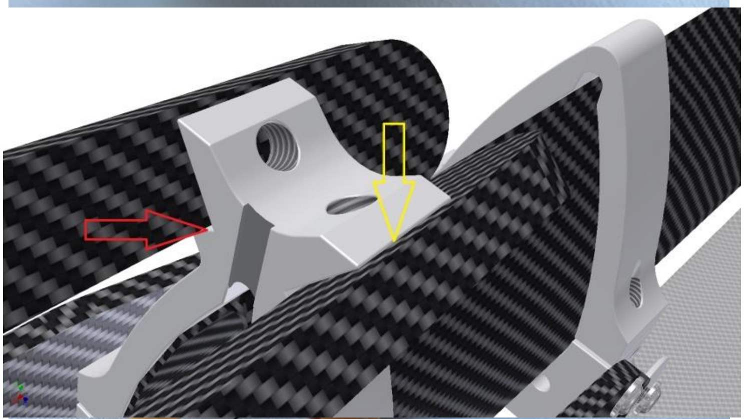
Take an ohmmeter and measure to see if there is an electrical connection between the landing gear and the chassis. You can measure at the edges of the chassis or at the skid support—both are conductive. If there are any contact points, break them with a file or place a piece of tape as isolation between.



The rod ends will be pressed onto the double link ball 0344 with the writing facing to the outside. As one of the levers has to be placed on the inner ball, some power is necessary to press it over the first ball. Take care not to force the landing gear mechanism from the side, but support the landing gear lever 0342 with the other hand.

Mount the two folding skids to the support 0242 with the balls and the two chamfers to the inside.

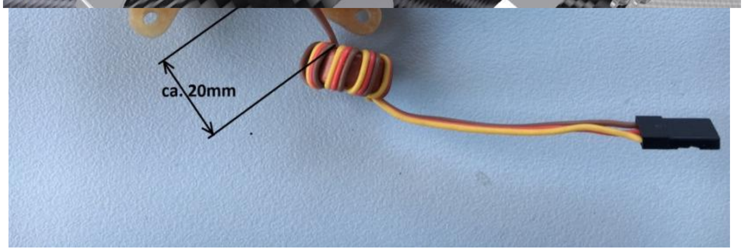
Grease the folding skids in the area of the bearing points on both sides with Dry Fluid Gear. Fix the two folding skids with the M4x16 screws that are also used for to affix the fixed landing gear.



Put some Loctite into the threaded hole, but not on the screw itself. Otherwise, the brass bushing will stick to the screw.

Tighten the screws until the skids are clamped and then loosen the screws until the skids are easily moving over the complete tilting range with minimum play.

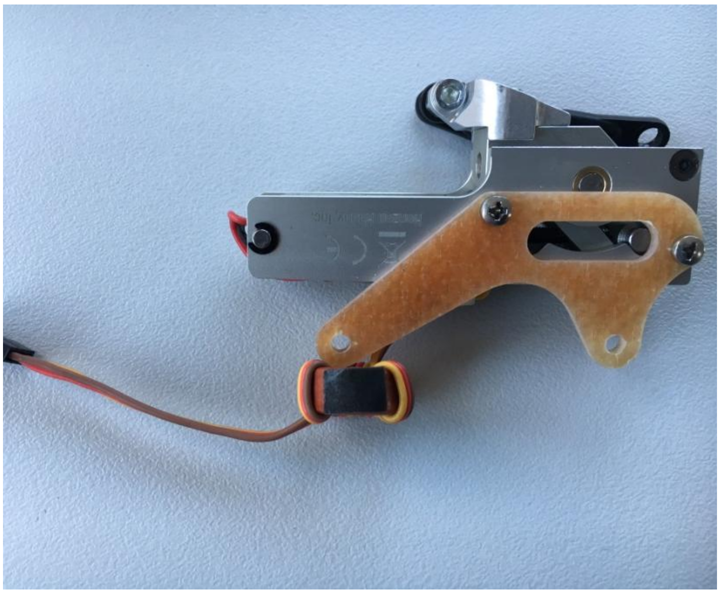
Attention! The skids should not clamp on any position. The small motor of the retract mechanics does not have enough power to overcome such resistance. A little play to the side doesn't matter.



Do not hook in the control rods now. The landing gear lever has to be in the front position as shown on the drawing on the second to last page.

Tilt the skids completely and check to make sure they move to the stop (red arrow). So that they do not catch, they need a little play to the edge of the flange (yellow arrow). In case one skid strikes against the flange and there is a big gap on the other side, loosen the four screws of the skid holder 0242 and turn the holder until it fits.

If both gaps are very tight and there is the danger that both skids will become caught, file a chamfer at the skid in the area of the red arrow so that the skid will slip into the position even when there is contact.



Tilt the skids completely to the front to the stop of the skid holder. Adjust the length of both control rods until both skids are contacting the stops stress free. With some pressure to the rear, the skids can slightly be moved, but that doesn't matter. It is important that in case of pressure to the front, they are contacting the stop without moving forward. Adjust the ball linkage perpendicular to the threaded link ball. It might become necessary to mount one ball linkage the wrong way with the writing to the inside to get a correct adjustment. You need a bigger force to press it on, but that is no problem.

Connect the landing gear to a free exit at the receiver (channel 7 for Futaba / V-Bar Neo AUX1), which you can control from your transmitter by a switch or a slider. Choose a position you easily can reach during flight. Don't choose a position close to the autorotation switch, to prevent an unexpected activation. You can use the retracting landing gear up to a BEC voltage of 8 volts. When blocked, the current is only up to 1 amp, so you do not have to worry about overloading your power supply.

Turn your helicopter upside down on the table. Activate the landing gear to check to make sure it is retracting completely and not getting caught somewhere.

The retractable landing gear has an internal safety logic. After connecting to the power, you have to activate the landing gear twice to get it retracted the first time. This is for safety reasons and prevents the landing gear from retracting when you switch on the power and the switch is in the wrong position.

The next time the landing gear will work after each activation. In the ideal case, the skids touch the rear support without stress. If there is a big gap between the support and the skid, the total stroke is too small. This means the landing gear lever has to be moved a little bit forward. A couple of 10ths of a millimeter may be enough.

The control rods have to be clipped off before and the length has to be adjusted to the new position. If the skid is touching the rear support under stress, the lever has to be moved in the opposite direction backward to reduce the total stroke.

It may happen that both skids are at the same angle. A small difference at the rear has no influence. The front position is much more important because both skids have to be at the front stop when they are loaded so that the load is not on the landing gear mechanics.

The landing gear mechanics also have mechanical locking, so there will not be load on the spindle and the motor itself. The support of the landing gear will be twisted. When activating the landing gear, you can see the bolt moving in the slot of the side plate of the landing gear mechanics, which is angled at both end positions, so the force is not transferred to the threaded spindle of the motor, but by the bolt to the side flanges of the slots.

The circuit board has two micro switches that will be switched at the end positions by the bolt. A logic in the electronics turns the direction of the motor for some milliseconds and the spindle turns back some rounds and stays in a stress-free position until a transmitter command to move in the other direction arrives. Additionally, there is a time-controlled security function. The power supply is switched off after about 5 seconds to prevent the motor from burning through, but I would not lean on that!

Now some hints for the use of the TDR-II with retracting landing gear and some facts to be taken into account.

Train yourself so the activation of the landing gear is as subconsciously as using the autorotation switch. Otherwise, you will be surprised if you need to get the landing gear down fast in case of an engine failure. Some will think about coupling the landing gear with the autorotation switch to get the landing gear down in case of an emergency situation. I would not recommend this. Sometimes it will not make sense to have the landing gear down.

During emergency landings far away from the pilot, it is better to land the helicopter on the bottom edge of the canopy, even if the helicopter will tip over. This could also highly happen with the landing gear down because the landing gear can hook into the ground. Additionally, the skids and the landing gear mechanics could rip out.

The landing gear is able to withstand a hard touchdown of the helicopter if this happens without a horizontal movement. It could happen on soft ground, where one of the skids sinks deeper into the ground and the helicopter tilts. Take care to start and land on flat and not-too-soft ground. Put down the helicopter perpendicular. It doesn’t make sense to use the retractable landing gear for autorotation training. If you are able to master an autorotation properly and land not far away, it makes sense to turn the helicopter 80° and fly the last part of the autorotation backward so the helicopter is good to flare without the tail fin touching the ground. If you touch down with some backward speed, the skids will be pressed against their mechanical stops. In this direction, they are very robust.

Quickly take off with the helicopter when starting and do not let it slide with low load on the skids. If the helicopter is loading the skids, the small motor will not able to retract the landing gear even when accidentally activated. Take off and switch the landing gear first to retracting then in down position and then retracting again. The retracts will then retract with every activation. Start and land generally with low rpm and not with the high rpm.

Hover during maiden flight with a safety height of more than 10 feet and switch then to the next higher rpm. Then switch to the max rpm and back again. Check to make sure the landing gear is going up and down on its own.

This might happen with powerful components with high currents. Unfortunately, the landing gear does not go down from the retracted position, but retracts from the down position. It is the getting down again after getting to the stop by its own.

According to our experience, this never happens at low or moderate rpm, but at high currents and during switching to a higher rpm and an accelerating motor. If the landing gear is reacting sensitive and goes up and down permanently, don't panic and stay cool. Hover close to the ground and wait until the landing gear is completely down to quickly touch down the helicopter. Give some negative collective input to press the helicopter to the ground so the landing gear does not retract any more. In the moment you switch off the motor, the landing gear will not do anything unexpected.

Stay cool if the landing gear does not go down for any reason. Look for a good place to touch the helicopter down with the lowest rpm on the bottom of the canopy. Soft ground and high grass are good for that. Orientate the helicopter horizontally and switch off the motor. Keep the helicopter horizontal as long as possible, until it is tilting. Give some cyclic input to the left at the end so that the fuselage tilts to the left side. This will protect the tail rotor blades on the right side. If you are lucky, nothing will happen except some scratches on the blade tips.

The retracted landing gear give the helicopter an extraordinary elegance, emphasizing a high speed by the optical appearance. The helicopter also becomes faster.

Take into account to perform some flights to get used to the new silhouette because the reference of the landing gear is missing.

Chapter – 14 **Maintenance**

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Overall, the helicopter is very durable and the necessary maintenance is kept within limits.

- Especially in the initial period, check whether there are loosened connections or there are any particular signs of wear that are showing.
- Light wear on the not-yet run-in gears is normal. The tail belt also takes time to break in and become supple.
- Grease the gears and all sliding joints regularly.
- Check whether the tail boom has moved forward during operation.
- Check the backlash of the **L**inear **D**rive **S**ystem.
- Check whether the rotor head damping has changed or dissolved.
- Check all cable connections.

For the care, I recommend the following:

All aluminum parts are left natural. They are polished and not anodized. This has the advantage of being able to maintain the bearing fits exactly. You can also readily polish the parts in case of a crash when scratches are formed. With colored anodized coating, scratches are always very unpleasant, as they catch the eye immediately.

If you have parts that are sometimes no longer beautiful in appearance after a while, you can send them to me so that I can run them through the tumbling grinding machine. After that, they usually look as good as new if the scratches are not too deep.

The drawback with not anodizing parts is the higher susceptibility to corrosion. Specifically, the high-strength aluminum tends to stain when it is handled with wet hands. A simple protection and preservation of value is to polish parts frequently when they are touched from time to time. Metal polish is available in most hardware stores (in the auto parts section). They will then shine like new again and the polish-will provide some corrosion protection.

Chapter – 15 Repairs

This chapter follows shortly