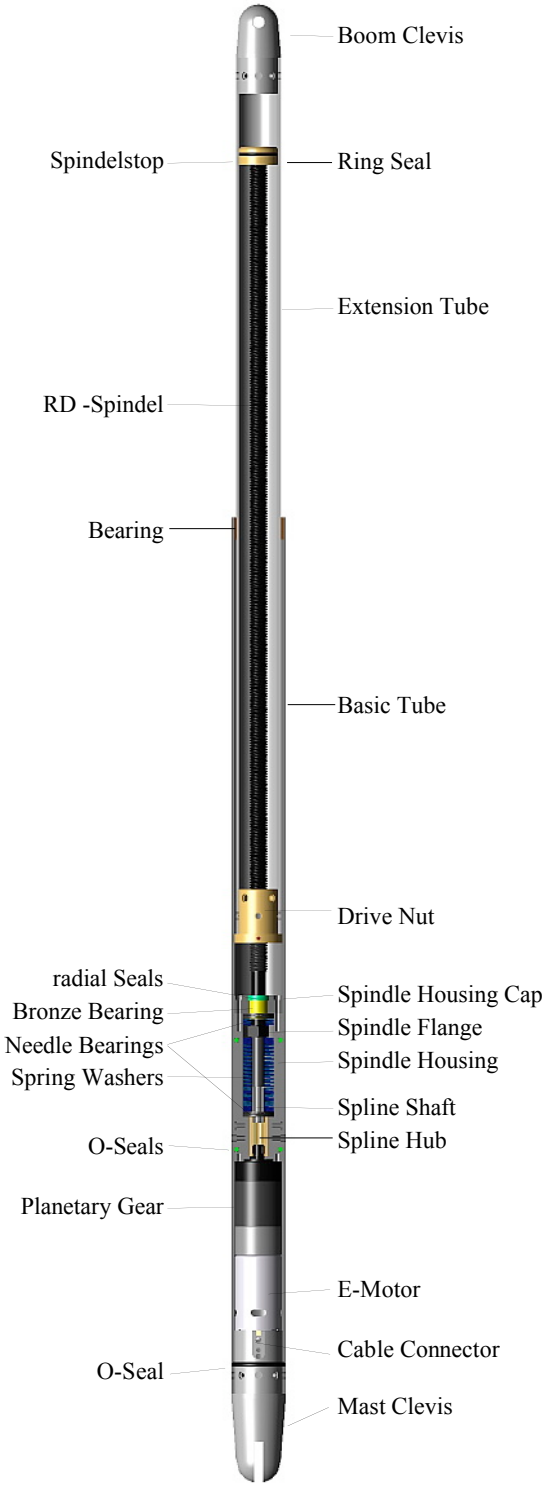
Boomtrim BTE - Instructions *2/9/05- beta*



Life Marine knows ...
about the problems sailors are faced with when having to check for a malefunction or replacing a broken part on a sailing trip. Usually you need an immediate repair, specially when you are away from home. Rather than sending the complete unit back for repair which is costly and can be even difficult in some countries we encourage you to demount the BTE and send us an e-mail with a description of what you have found.
In spite of its very rugged construction, the BTE can be demounted with some simple hexagon keys within minutes.

Maintenance
Normally the BTE doesn't need much care, except it had been subdived for more than a few minutes. But it is good practice to demount and check it inside, as every other gear on board once a year.
Check the spindle for dirt and put some grase on it also.
To ease remounting the unit and preserving the seals, spray some silicon oil or Teflon dust inside the tube.
Keep it protected against water, dust and salt, so grease all rubber seals before remounting.

You need to demount the BTE ...
- to change the spring washers to adjust to a heavier boom
- to replace the extension arm for a smaller or longer one
- to add or remove a planetary stage
- to check the unit if it had been extensive under water
- to locate any malefunction and replace a part

Tools
All you need to demount the BTE models, (except for the motor which you would not get together again) is a set of metric hex wrenches or bits in sizes:
2mm, 2.5mm, 3mm, 4mm, 5mm, 6mm and 10mm
The clevis pin bolt screws have a small metal post in the middle of the screwhead that prevents a normal hex driver from engaging. Depending on you model, you'll need either a pair of 5 mm or 6 mm hex bits with pin holes (tamper-resistant form).
For the electric socket inside use a #1 flat blade screwdriver and a #1 Phillip for the motor cable connection which also holds the clevis to the motor.

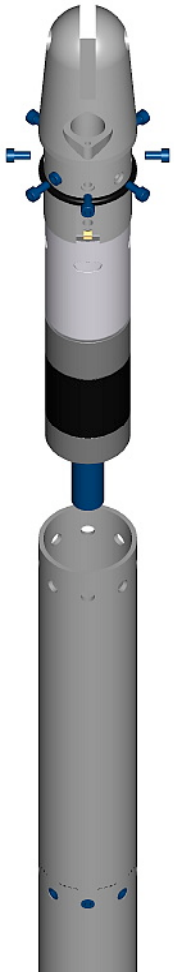
getting it apart ...

At the housing you see three sets of eight M-5 socket hex bolts which are lead through clear holes of the tubes into the mast and boom clevises at the ends and another set which fixes the spindle flange housing. Actually there is a fourth set holding the drive nut which you cannot see now. When mounted between mast and boom, the load is lead from the boom clevis over the extension arm and its drive nut to a spindle which is held by flange between disc springs in the flange housing. The spindle housing itself is fixed by the second set of bolts to the basic tube (the bigger one) that passes the forces then to the mast clevis. All bolts are to hold axial forces by their heads only.

removing mast clevis motor and gear ...

If you want to check for electrcal contacts only, you'll need to demount only the upper part of the Boomtrim.
After removing the first set of the M-5 bolts, pull the mast clevis which is connected to the motor and planetary gear in one piece out. While pulling, you might feel some elastic resistance due to a rising vacuum inside.

Pull gently, because the clevis is fastened to the motors electrical contacts with two tiny sheet metal Phillip screws. Due to construcional needs this is the sole critical connection of the unit.

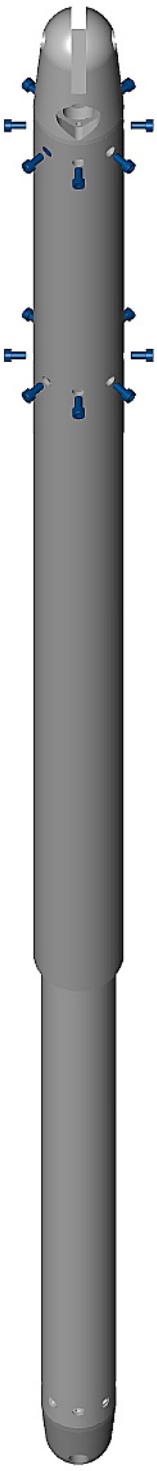


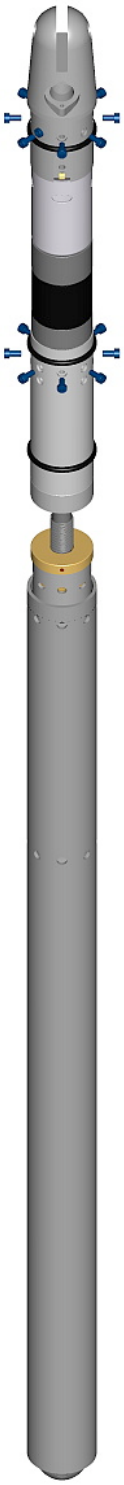
removing all ...

If you want to add or remove a gear stage or alter the dampening characteristic of the Boomtrim, you have to demount the spindle housing and the extension arm also.

To ease this, put the the smaller boom clevis upright to the ground and unscrew **both** upper bolt sets. Then press the basic tube downwards. With some counterforce due to the friction of the sealings you will set the inner components free.
Because the spline hub of the planetary gear is only plugged into the spindle housing, don't turn it over after you have pulled it out. It would come off.

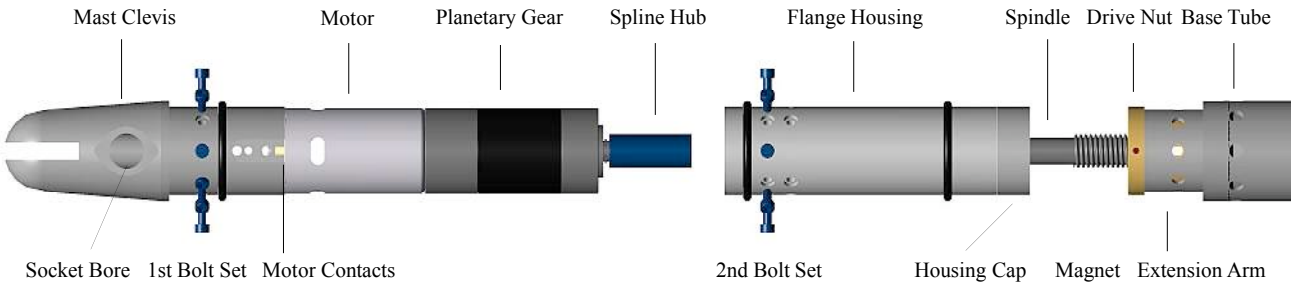
You might wonder why you have to pull all if you just want to alter the gear stages. Well, when you add or remove a stage the gear length will be 14 mm shorter or longer.
To adjust to the different length you need to unset the bolts which keep the housing to a second bore set.





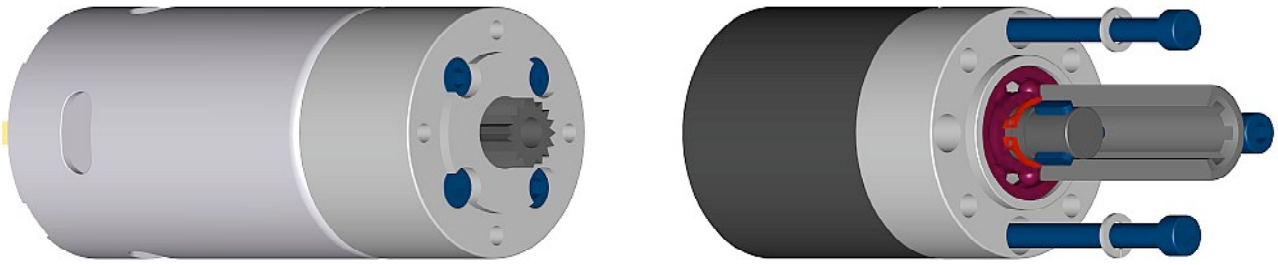
understanding mechanics ...

The mast clevis with the attached motor and the planetary gear drive is plugged into the spindle housing with a spline bore which itself is heat shrinked on the planetary gears output shaft. Inside the flange housing the bore is engaged to a spline shaft hard soldered to the spindle. A flange nut is screwed onto the spindle inside the housing and is held to both sides by disc springs (spring washer). The spindle housing is fixed to the base tube by one of two bore sets, depending on the gears length.



adding or removing a gear stage ...

Why adding ore removing a gear stage you might ask.
Well the planetary gear inside the Boomtrim has a gear transmission ratio of either i = 25 or i = 50 corresponding to a two or three stage version. Due to the different ratio one turns faster but with less torque and vise versa.
For example, if you change from a normal boom to a In-Boom-Furling system which has to be precisely leveled when furling in, you preferabely would use a 3-stage gear, for it moves slowlier and therefore can be leveled mor precisely. Or using a high-tec sail cloth which has less strech than a normal needs to be trimmed with higher precision and requires greater forces to get into optimum shape. Here you would use a 3-stage gear also. But using normal sails perhaps you would like to apply twist to the main sail more swiftly, so you would prefer a two stage transmission. If you need not extra power and normal precision, you should stay with the standard two stage planetary gear.



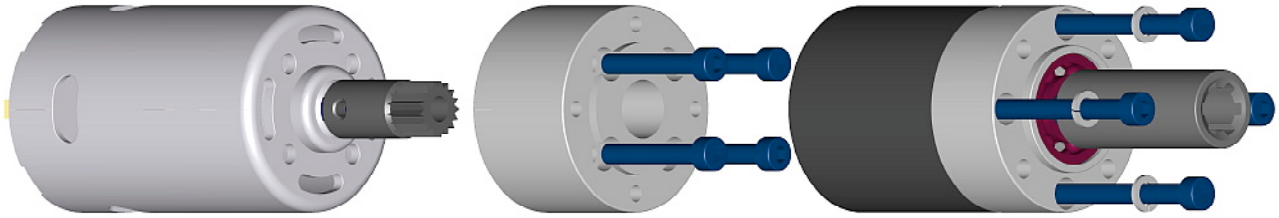
If you want to upgrade from a 2-stage to a 3-stage planetary gear, you need to order a longer housing (51 mm) with its internal gear (the black part) and an additional planetary set. You will also need longer M 5x70 socket hex screws.
Vice versa removing one stage, you have to shorten the internal gear housing 14 mm (the screws also) and remove one planetary set, i.e. three gear wheels on its carrier. If you don't have a workshop where they can lathe down the housing, you have to order the part.
Before remounting, fill some grease into the gear housing. Make sure that all parts are really flush fitted together. Don't apply too much pretension on the screws as there are no axial forces acting on the carriers and spur gears.

To compensate for the longer planetary gear, the unit will fit automatically into the second bore set at the flange housing when mounted into the basic tube.

replacing the motor ...

brush commutated motors as the one within the BTE are very robust and economic. But due to wear on the barrel comutator their lifespan is limited to about 3000 hours. That many hours you will never operate a Boomtrim in a lifetime. Paradoxically just little use could shorten the life expectancy of your motor more. The inner parts of an electric motor are mainly of iron, brass and copper which are prone to corrode, specially when in contact to each other and exposed to humidity. Although the Boomtrim is water tight for a limited time (IPX7), it is not air tight. Any temperature difference will exchange air inside and can add small amounts of huminity that dew and can cause corrosion. This is especially true if the trapped humidity is not heated up frequently up when the motor is in use.

As it is seen in the picture below, you have to unscrew the four M 5x70 hex screws of the planetary head first before you can remove the other four screws holding the gear base to the motor. The spur gear which is tugged on to the Ø 6.35 motor shaft is held in place by a M 4 worm screw. Now the motor and the gear are set apart.

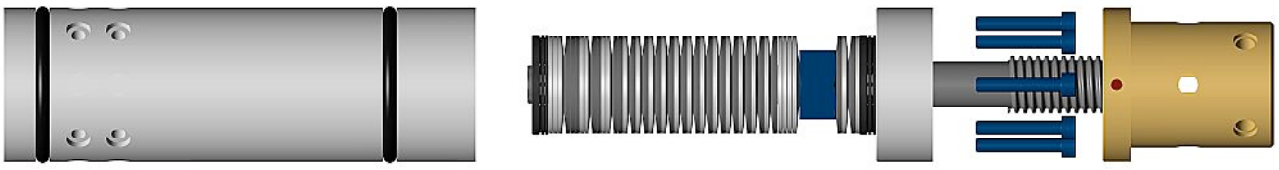


changing the damping characteristics of a Boomtrim ...

falling from top of a wave down can be a hard landing for a boat with a modern flat hull and and it puts considerable forces on a rigid boom vang. This is especially true for yachts with long or heavy Furl-In-Booms, moving through rough seas with sails down and no topping lifts mounted. Such heavy loads need to be absorbed.

Spring washers, also called disc springs are ideal to do that. Different assemblies can be designed to achieve the desired load characteristics. You can change either the number, the strength (thickness) or manner of combination. Putting more of them stacked facing alternate ways (serial) into a column will result in a longer baffle, changing their thickness or packing them parallel gives the stack higher deflection forces.

Thus combining packing and stacking with the right thickness lets you adjust to a wide range of deflectional forces and ways. Even better, due to the friction betweenf the discs while expanding, they act perfectly as shock absorbers.
The picture to the right shows a combination of five spring washers, three are packed (parallel) and two are stacked in serial order.



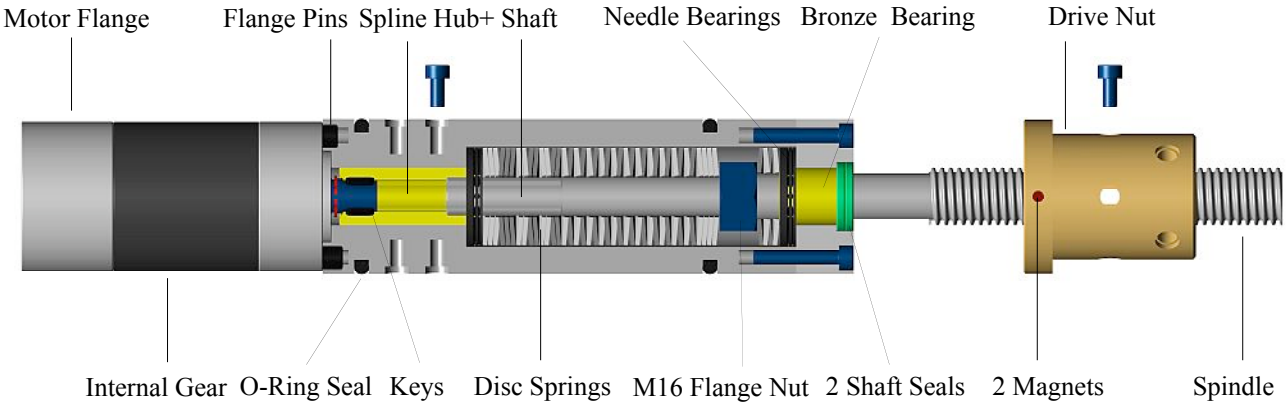
how should I calibrate then ...

As standard the spindle housing of the Boomtrim contains 40 spring washers for downward forces and 4 washers 16/34 x 1.5 for upward loads. One spring 14/34 x 1.5 has a deflection force of up to 400 Kg when fully flattened. So, a 4-piece packag needs 1.6 tons to be flattened. You can change to thicker washers or alter the assembly as long as the sum of all washers thickness will be a **minimum of 60 mm** (40x1,5 or 30x2) on the downforce side and **6 mm** on the upward side. This is **important** because if you mount less washers, the spindle could sink too deep and damage the Planetary gear to its left. Contrary, if you mount less than 4x1,5=6 mm, the spindle could slide out of the spline hub.

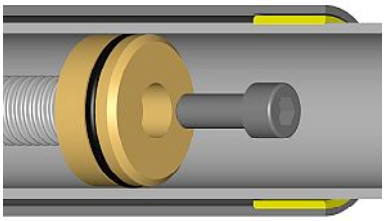
To determine the impact the forces that will act on the Boomtrim when a boat falls down a wave, I would like to use an example what will give you an idea about the natur of impact forces.

Jumping from a 10" cupboard you **bended** knees and muscles will have to absorb 5 times your body weight at landing what is quite possible to handle. But landing with **stiff** knees and only a little more than 1" elasticity, the impact will be 80 times your body weight what your knees won't forgive.

This example shows that it is virtually impossible to calculate the impact on the vang. Whereas we can assume a heigth of a wave and then calculate speed and positive acceleration, we cannot calculate the negative one when the boat dives in. First boats have different hulls, then we don't know which part hits first and how deep it dives.
However it might reasonable to assume an eight meter InFurl boom with a weigth of 200 kg and a steady dive of the hull for 50 cm. Then you would end up at 3,5 tons of impact forces on a 150 cm / 45° mounted vang.
To optimize the spring characteristic fix a sleeve around the extension arm where the basic tube ends and have a look at it after a stormy ride. If it has moved more than 1/2" but less than 1" up, the dampening would be in a good range.



at the end ...



To prevent the extension arm sliding out of the basic tube, which probably never would happen when mounted on a boat, there is a spindle stop at the end. The main purpose of the spindle stop however is to keep the spindle centered. If you have to demount it, you'll need a # 6 hex key to unscrew the M10 socket head bolt. The thread of the bolt is fixed with superglue, so either you have to apply very high torque or you need to heat it up with a torch.
The plastic slide bearing 5055 inside at the end of the basic tube is also fixed by superglue. To get out, heat the tube with a torch.

getting things together again ...

is as easy as it was to demount the Boomtrim. In case you had demounted the boom clevis also, fix it to the extension arm first and align it so that the small magnets in the drive nut flange which are needed for the position marker (if you have one) are aligned with the slot of the boom clevis. Before you fit the mast clevis to the motor, bend the inner cables away from the protruding motor axis that they can't be in contact to it. Be sure that motor and clevis are really flush when put together.
Turn the drive nut with the extension arm firmly onto the flange housing. Then insert the planetary gear spline hub into the flange housing and **only then** screw the cap to the housing. The inner disc springs and the needle bearing could have been a little misaligned, so that under pretension when the cap is already screwed onto the flange housing you could have difficulties to slide the planetary splin hub completely (and flush) into the flange housing.

Watch carefully that both, the gear and flange housing are without any gap, otherwise the distance of the bolt threads wouldn't match the holes of the base tube.

Spray some silicon oil or teflon inside the base tube. Then slide the extension arm from above into the base tube. Turn to align the electric socket to the engraving. While sliding down, take care that the O-Seals are not damaged by the tube edges. Press down until the mast clevis flange sits on the tube. Now you can turn the extension arm (that is why you should have turned it in completely) to the righ (only) until the thread holes are flush to the bores of the tube.
Put all screws on, and relax, you have done it.

Electric Overview

The Boomtrims BTE are powered by one or two 12 Volt electric motors. Permanent-magnet motors have two wire terminals on the motor. You change direction on the motor by reversing the polarity on the terminals. Every electric motor circuit must have some sort of appropriately-sized circuit protection, either a fuse or a circuit breaker, as close as possible to the battery bank. The fuse or circuit breaker must be sized to handle the expected operating load, yet protect the wiring from a very high current draw and/or a short circuit. Remember that circuit protection will not protect the motor from sustained high load usage, which can cause heat build-up in the motor without tripping a breaker or blowing a fuse.

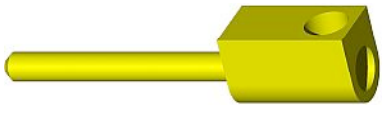
A difficulty is that electric motors draw quite different currents depending on their working load. For example: the Boomtrim will draw without load about 1 A, at maximum efficiency it will draw about 7 A, while at maximum power it will consume already 32 A. At stall it would draw up to 60 A for a very short moment. So, how should the circuit breaker be rated then? To complicate further, a weak batterie and cables that are not appropriately dimensioned can eventually not deliver as many amperes for the circuit breaker to respond. A good way to find out how many amperes the breaker should have is to start with a 20 A breaker and contract the extension arm until the motor stalls. The breaker should respond within 2 seconds. If it does react to quickly or if it trips when you change the motor direction within less than a second wire another five A breaker parallel to the first one and see how it is doing now.

In some cases you want to limit the motor torque because your rig is not suited for such high forces. In that case you would need a slow responding "High Inrush" 10 or 15 A breaker. A normal fast responding breaker would always switch off when the motor starts because this induces a high current flow in the beginning.

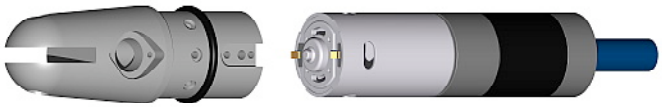
One thing about electric motors that many people are not aware off. are that they (as bulbs principally also) don't care with how many voltage they are operated. When the specifications say 12V then this is just the nominal voltage on which all data is based on. Usually this is the most economic or effecient voltage for that motor wiring. If the work load is either too high and within a less effecient range or the operation time exceeds the limits, they rapidly loose power because they get too hot. Sustained operation can burn the motor wiring then. So, the real limiting factors are heat saturation ability and heat transfer capacity. Boomtrims are designed to operate for short periods of time only.

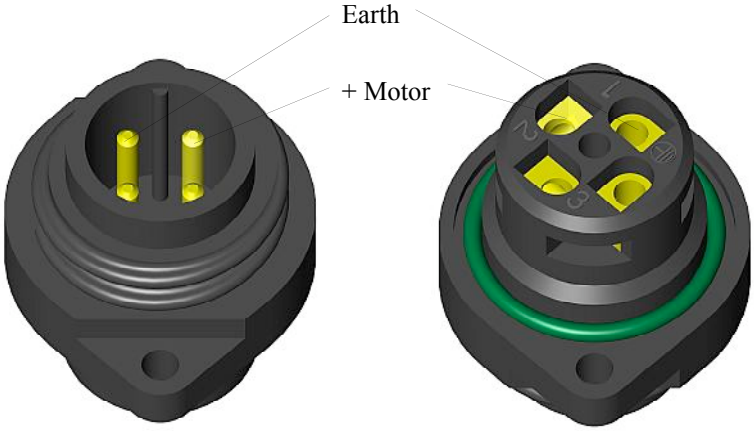
The current-carrying switch, which comes with the Boomtrim handles the full current, there is no solenoid switch for ON or OFF. Therefore the DPDT (double pole-double throw) Centre Off switch which indicates its status by green LED lights, needs to be operated with 12 V and is sensitive to voltage. LEDs draw what they can get and if you don't limit this by a resistor they have a short life. The resistors are standard calibrated for normal battery voltage of up to 14,4 volts.

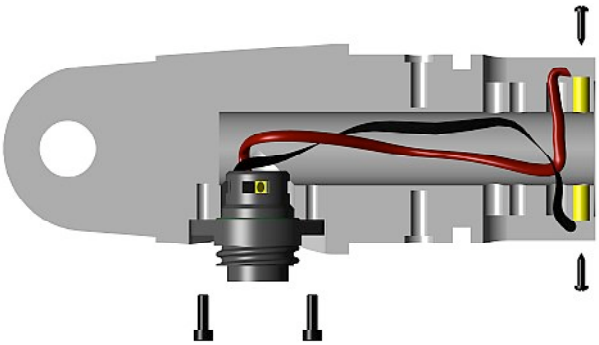
To inspect the cables inside the clevis, unscrew the Phillip #1 at the motor contacts and pull the clevis from the motor. Detach the Electric socket and pull it out together with the cables. Now you can push the socket contacts out. If you detect any corrosion on the pins or inside the pin holes, clean it up and/or use the remaining other ones.



Keep in mind that the positive pin # 1 is at 1 o'clock just right to the key at the clevis socket and at 11 o'clock on the cord socket.
The positive red cable inside the clevis should connect to the motor contact with a red dot near to it.







Another possible failure could happen when one or two of the isolating white (here yellow) small plastic sleeves which are holding the Phillip #1 screws are not in place, thus causing contact between cable and clevis.

Use some superglue and put them into the bore **with the motor flange slid in**, so it can't slide in too deep.

tracing faulty contacts ...

If the Boomtrim doesn't move when you press or lever the paddle switch, and the arrows on the switch don't show a green light backlight, see if the breaker is set to "On". Next, press the panic button (if you have one). If nothing did change, I would check now for the boats main switch (sorry).
If breaker(s) and main switch are set ON, check the cables at the switch for looseness or corrosion and put a bulb or an electric tester between the incoming contacts of the paddle switch to see if there is a current. If there is no current, you have to trace the cables for continuity from the battery up to here.

If you see a green light while moving the paddle, go for the cord socket at the mast which connects to the boomtrim socket. The contacts are numbered 1-3 and earth; but this is hard to see. If you eyes are good enough, earth is a circle with three parallel lines and one perpendicular on top of it and should be connected to the negative voltage. Pin #1 is for positive current. In case of a BTE-2 model with two motors, contact 1 and contact 3 are positiv and earth and #2 are negativ. If the protection caps have not been screwed on the plug and socket properly or you have the sockets fixed tight but with water trapped inside, corrosion will occur resulting in less conductivity or complete failure. When you contacts are corroded you can change to the other two pins when they look better. Get your tester or bulb cables into the cord socket contacts and check for current.
If your tester or bulb signals, unscrew the two 2 mm socket hex bolts and pull the socket off the clevis. If the cables are in place and clean you have to unmount the clevis and look for a failure inside. Beside foul contacts a short circuit could have happenend inside the clevis. There are some sharp edges which you cannot reach to smooth (although the cables cannot move very much). Also the backward motor axis could have worn a cable if it was not bent inward while mounted.
Unscrew the first set of hex screws near the clevis and pull the clevis with motor and gear slowly out. After turning the Phillips screws off, pull the motor from the clevis. Now you can free the cables from inside the clevis. If you don't find anything, put a current directly to the motor contacts. The motor itself is not reparable, the housing is pressed to fit and it would be hard to get it together again. If the motor is foul contact you dealer or Life Marine for a replacement.
Before remounting, see that the red cable is on the contact with the red dot on the motor housing.

If the incoming pins of the paddle switch are under current, butthere is none current at the outcoming contacts while triggering the paddle, the switch is defect and you have to replace it. If the panel receives but does not release current at the output cables, please refer to the wiring diagram next page. You should then bypass the panic button including the time relay wiring. By narrowing your search you should be able tracing to the faulty component.

Note: if you have a Panic-Release switch, pole reversal at the motor or wiring to it would cause a malefunction. For safety, the time relay is pole sensitive and can only switch to one direction, - that is forward, to open the leech when the button is hit, only if the wiring is correct.

What wire do I use ...

accepting a 10% voltage drop and assuming a distance from battery to panel and cord socket of 10 m, a BTE-1 with a current consumption of 30 A (at maximum power) requires a cable gauge of:

$$\text{Cable Area sqmm} = \frac{\text{Length m (2 x distance) x Current Consumption}}{\text{56 (copper resistant constant) x 1,2 (10\% of 12 Volt)}} = 8{,}9 \text{ sqmm or Ø } 7{,}8 \text{ mm}$$

That matches a Ø 10 mm cable or 6 AWG (13,3ø)

If you use cables with less gauge, you have to install a breaker with a smaller rating.