iRobot DEXTER Hand Maintenance and Repair Manual for ARM-S and DRC Versions

7/8/13

Rev 2.0

DEXTER Hand Repair Manual

1. So You Broke a Tendon…

Luckily it's not too hard to replace a tendon. Just follow the steps outlined below and you should be manipulating things again in no time.

Sourcing the tendon material:

Additional tendons can be sent to you by iRobot if necessary. Please contact ARMH_Support@irobot.com. If you plan on stringing your own tendons the material can be found below. Upgrades have been made between ARM-S and DRC versions whichi have increased the tendon diameter, strength, and abrasion resistance. Unfortunately, the DRC tendon will not fit in the ARM-S hands.

ARM-S Version: PN: 38-141-699-01 from www.basspro.com

DRC Version: PN: MAG802500GN rom www.baspro.com

The current tendon material specified by iRobot is a small Spectra braid. While extremely strong in tension, the braid is susceptible to abrasion. This is the most common cause of failure. When replacing the tendon, it is important to note where the breakage occurred and check for any sources of abrasion there.

Required Tools

- Small Tweezers
- 2.5mm Hex Key
- 3mm Hex Key
- Sharp X-acto knife or razor blade
- Needle
- Tendon Material (see above)

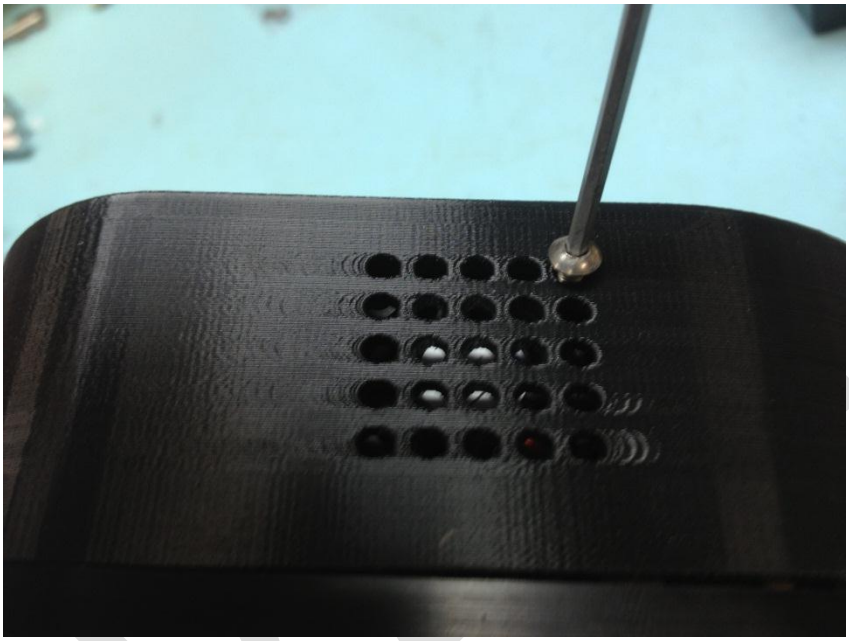
1.1. Removing the Back Housing

Perform this work only in an ESD safe environment!

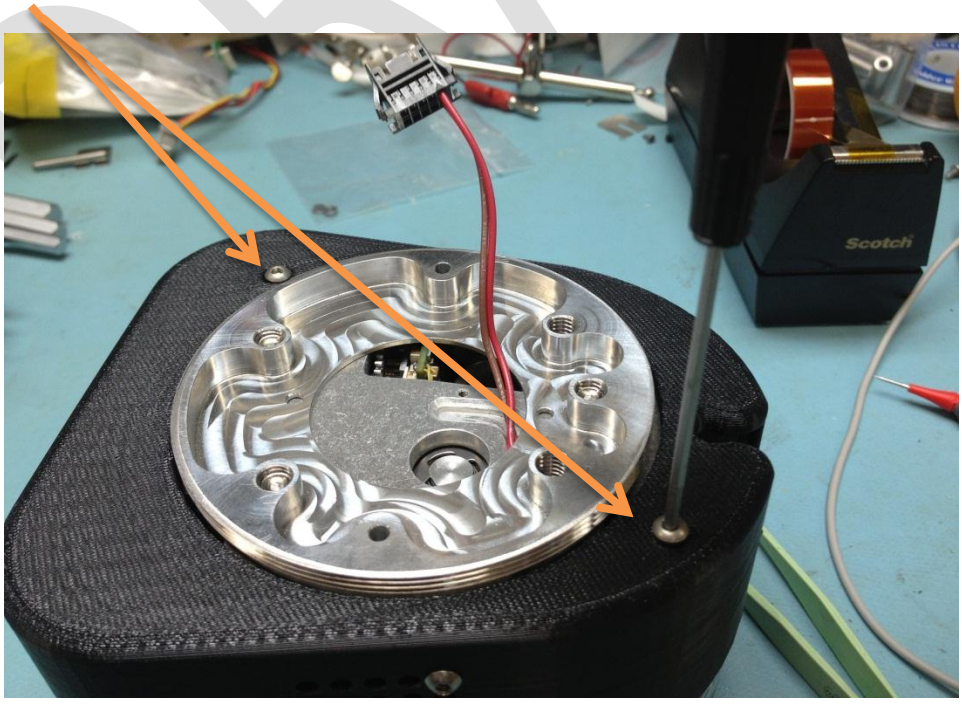
ARM-S Version

Remove the Ethernet cable and disconnect the power cable

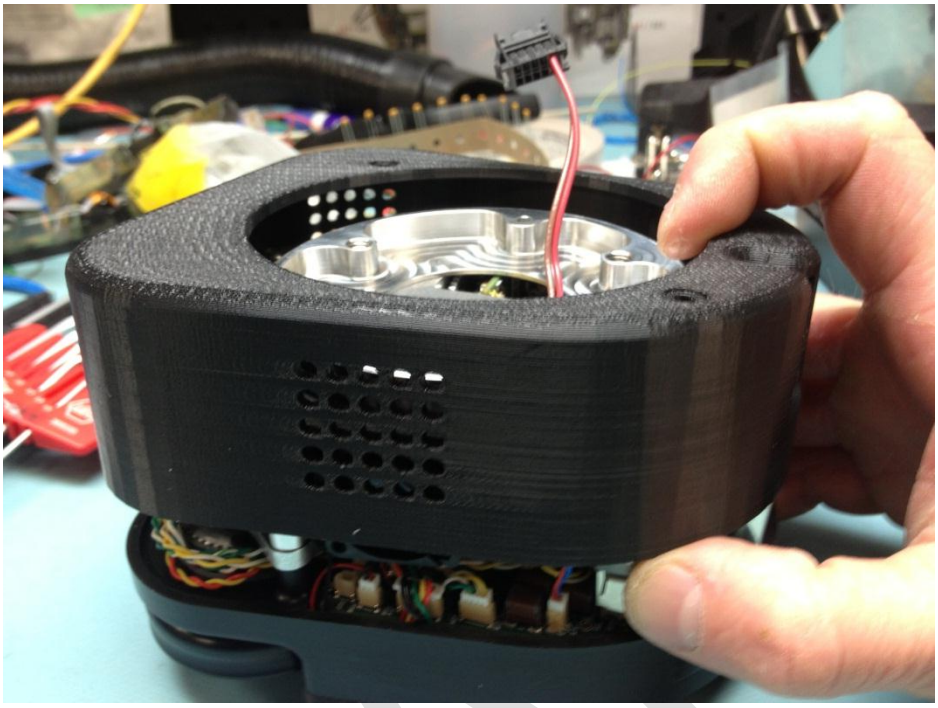
Remove the two (2) long M3 screws holding the fan in place



Remove the two (2) short M3 screws holding the housing on



In an **ESD SAFE** environment, carefully lift off the housing. It may require a little finesse as it can get held up on the power connector pictured here.

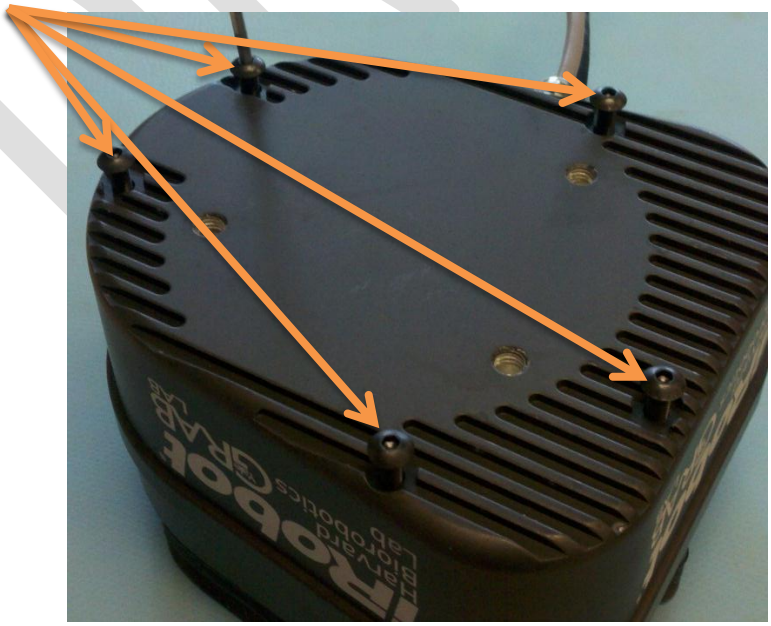


Unplug and set aside the fan.

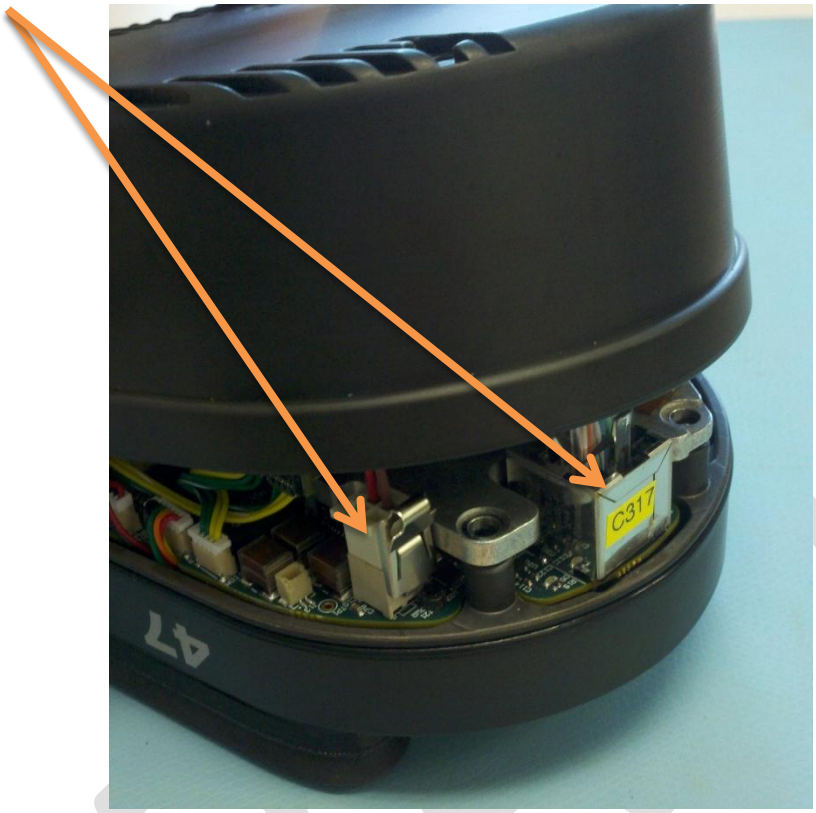
DRC Version

Disconnect both the power and Ethernet cables

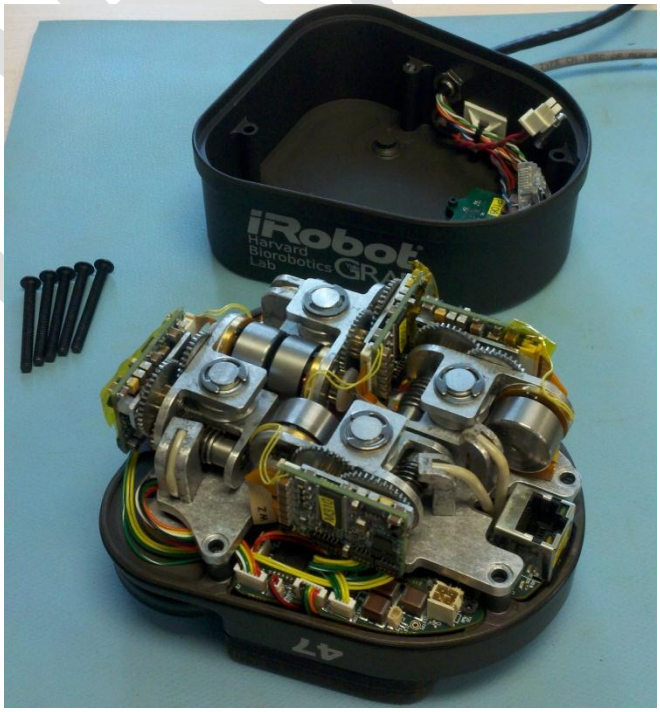
Remove the five (5) long M3 screws holding the back housing on



In an **ESD SAFE** environment, carefully lift off the housing unit you can see the power and Ethernet plugs. It may require a little finesse as the cables are rather short.



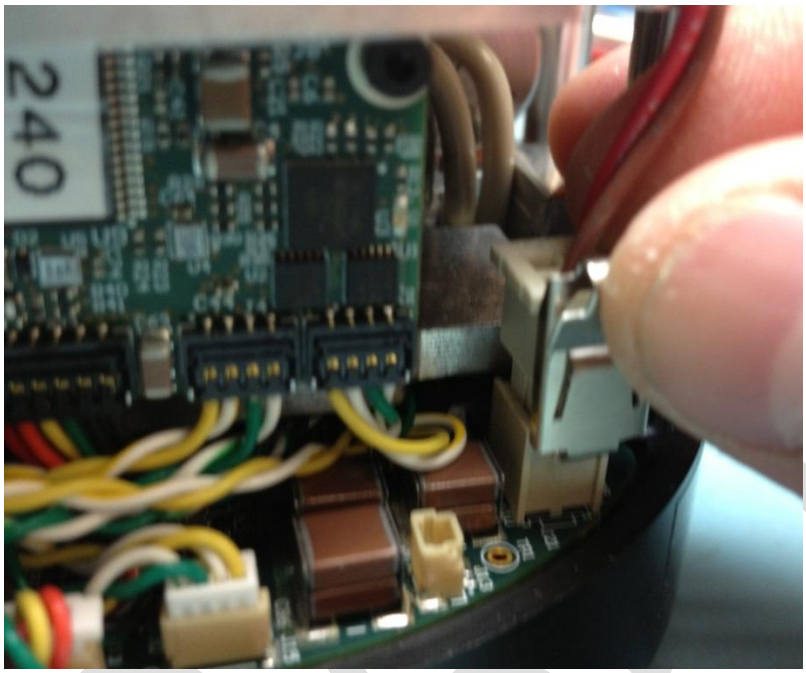
Uplug to ethernet and power connectors, lift off the back housing, and set aside.



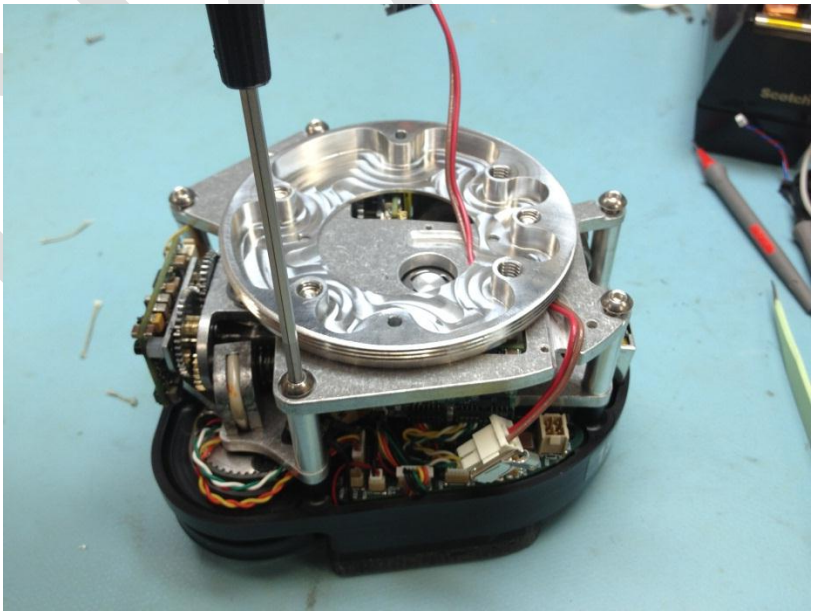
1.1.Removing the Load Plate (ARM-S version only)

Perform this work only in an ESD safe environment!

Remove the Power Cable by depressing the metal clip



Loosen fully but do not remove the five (5) long M4 screws – they will hold the spacers in place.



Lift off the load plate and set aside while holding all the spacers in place – this will make reassembly much easier.

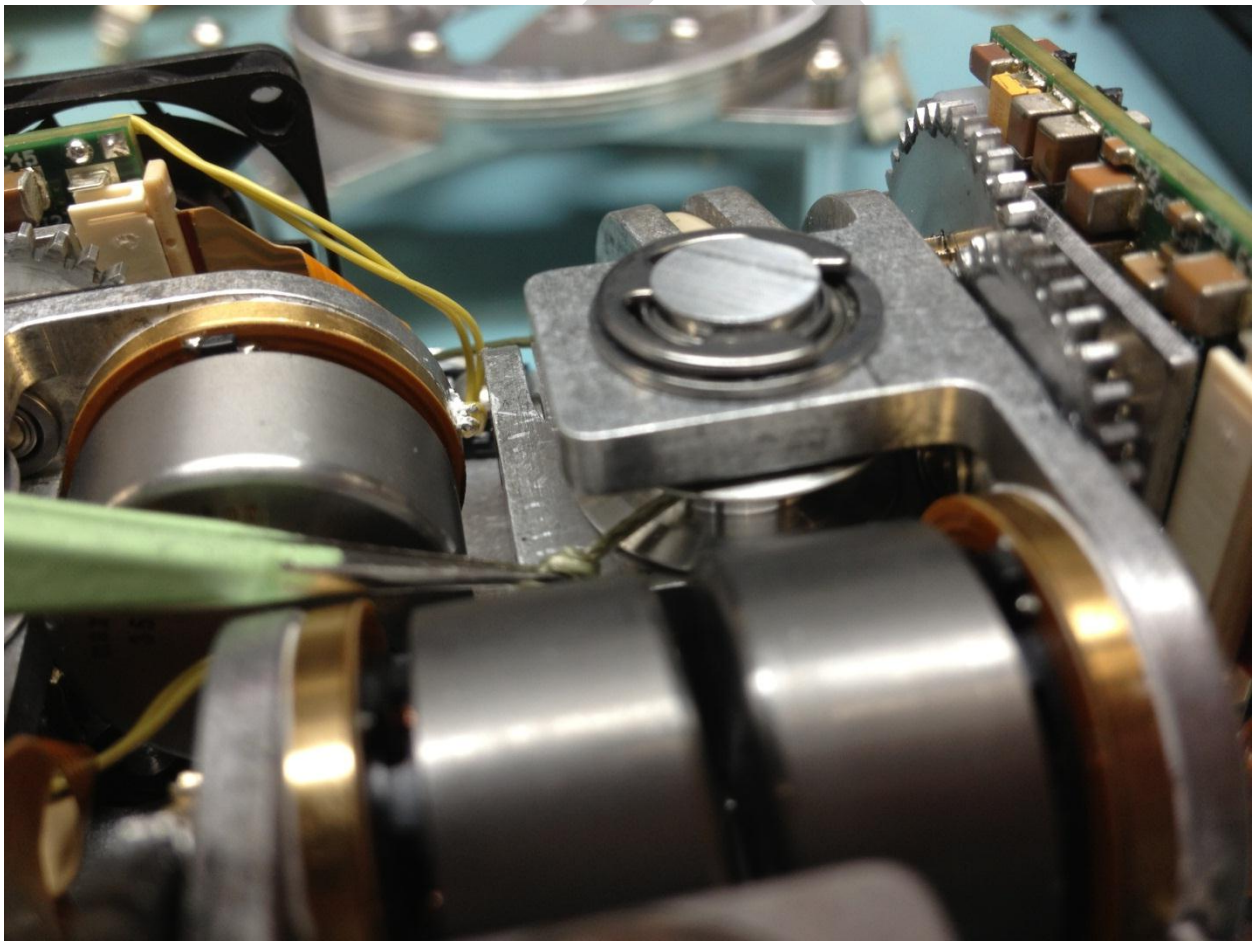
1.2. Un-winding Remaining Tendon

Un-spooling an re-attaching an Existing Tendon

First, determine if there is enough tendon material on the drum to make a new loop. To do this, select velocity control mode and reverse the actuator until all but (4) wraps of material are spooled off. Pull the tendon material out through the base and up past the finger. If there is approximately (4) inches of material beyond the fingertip, then a new loop can be made. **See sections 1.5 and 1.6**

Completely Removing a Tendon

If the remaining length of tendon is not suitable for re-use, it must be completely removed before installing a new tendon. To do this, reverse the actuator until all the tendon is spooled off the drum. Using tweezers, pull the on the knotted piece of tendon until there is enough free to cut the knot off. The tendon can then be pulled free.



1.3. Installing a new Tendon

1.3.1. Cutting the right length

Tendon length is important to the proper function of the actuator. Too little tendon material and it could slip off the drum. Too much and the tendon can become bound up in itself.

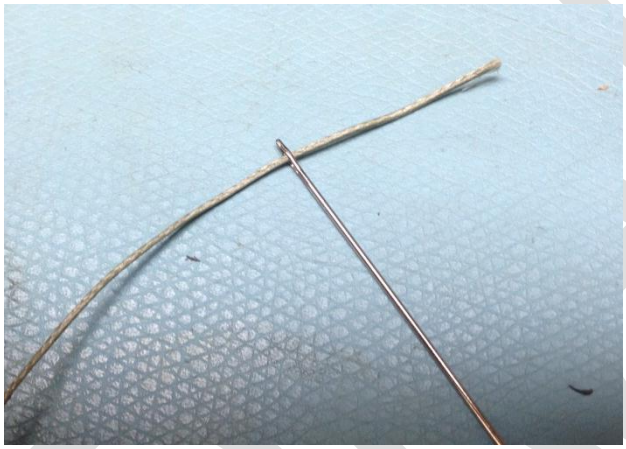
Main Tendons: 24” after loop is made

Antagonistic Tendon: 14” after loop is made

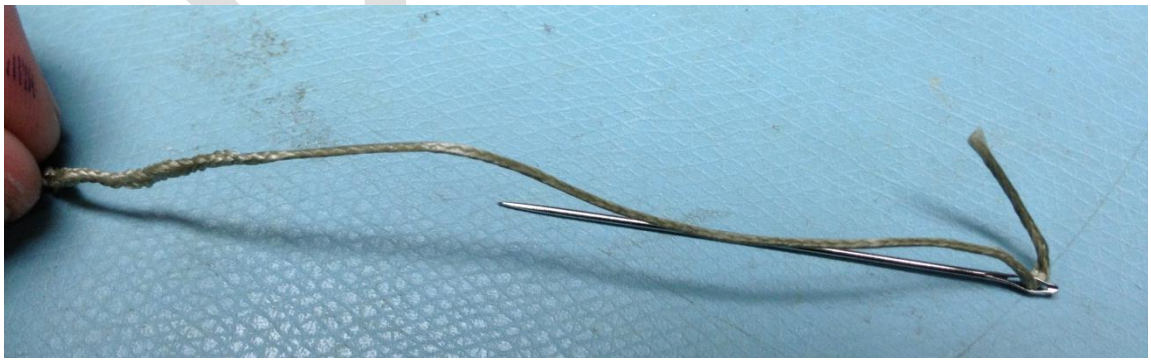
1.3.2. Making a Loop

The process of making a robust loop in the tendon material is quite simple and, with a little practice, very quick.

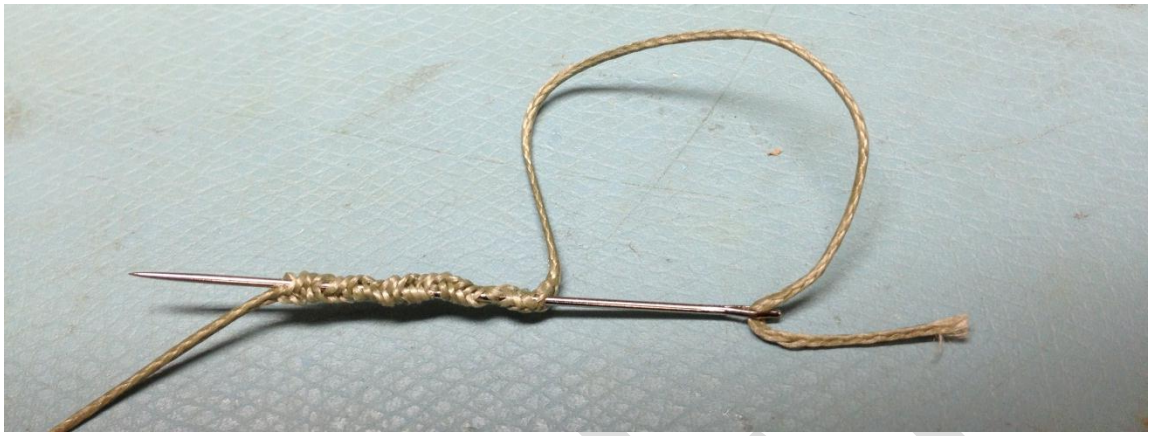
The material must first be threaded through the eye of the needle this is easiest if the material is drawn tight and a fresh, clean cut made.



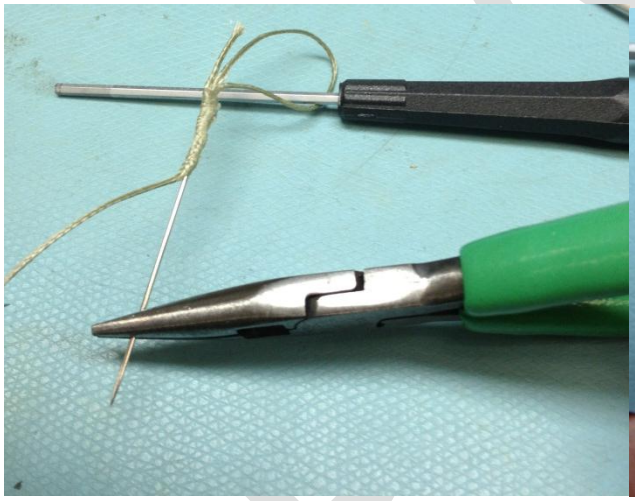
Draw the tendon taught and locate an area approximately ½ inch longer than the needle. Here, you will begin to bunch up a 1” length of the material, making it easier to pass the needle through the middle.

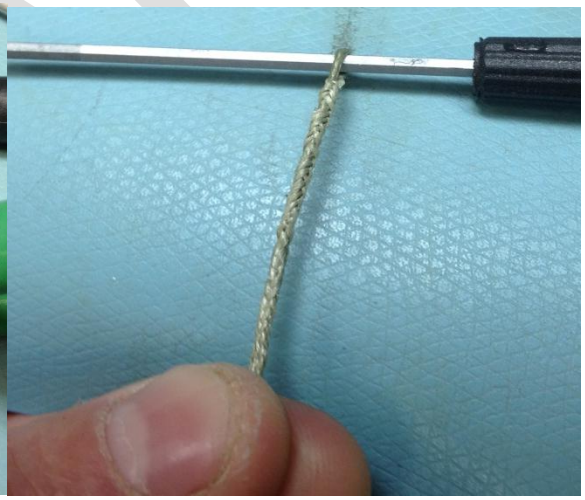


Pass the needle through the braids of the material, making sure about an inch is woven through.



Remove the needle and begin to pull both ends of the tendon while taking care to keep the loop at the end open. This process is sometimes easier if you place a dowel pin in the loop beforehand. With a sharp knife, cut the free end of the tendon off, then draw the lines tight.



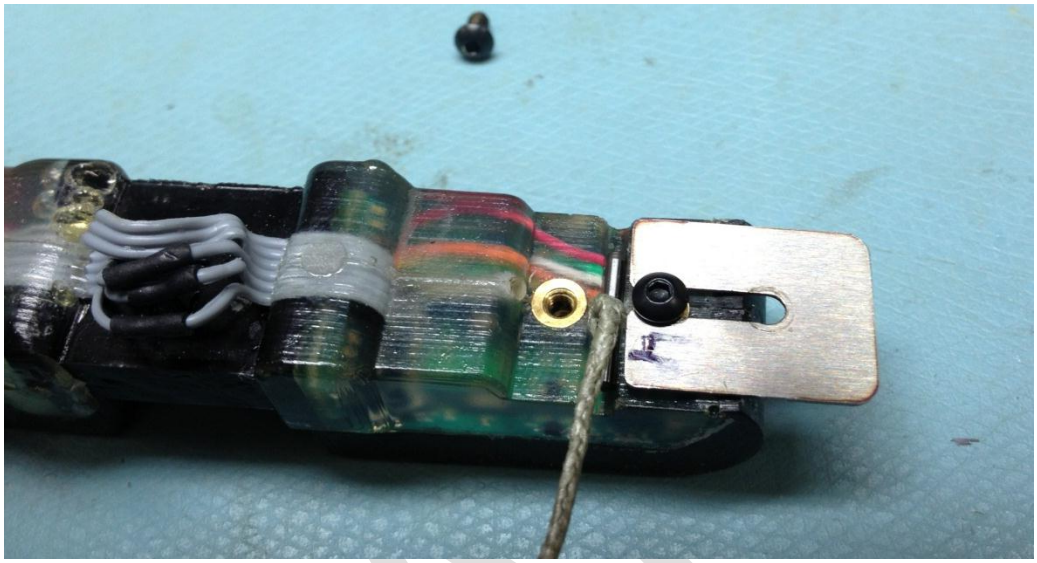


The constricting nature of the braid under tension (like a finger trap) will keep the loop from pulling through. Done!

1.3.3. Attaching the Tendon to the Fingertip

Loosen the (2) M2.5 screws holding the fingernail on. Then completely remove the screw closest to the flexure joint.

Slide the fingernail open and remove the dowel pin holding the tendon in place.

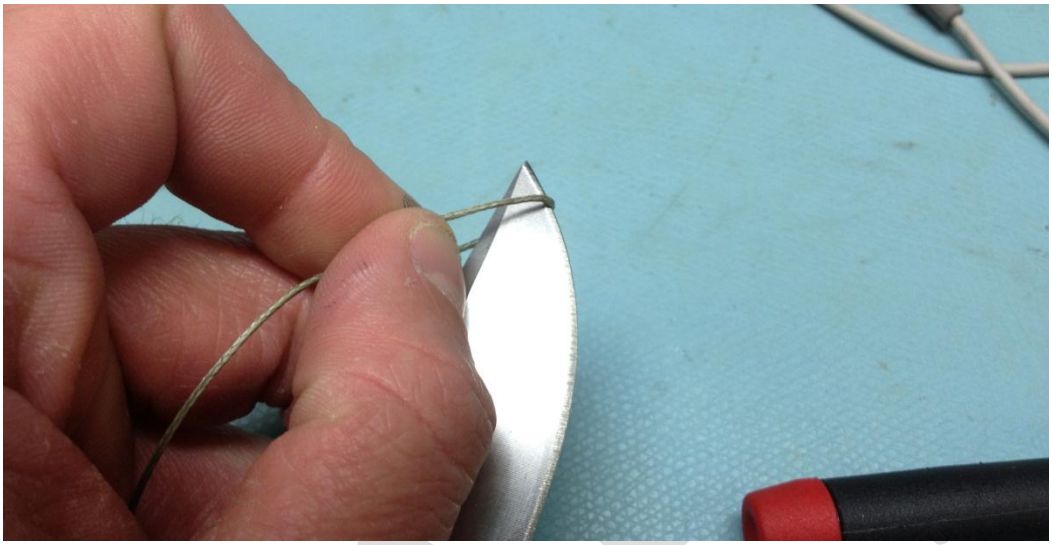


Slip the dowel pin through the loop in the new tendon and place it back in the groove.

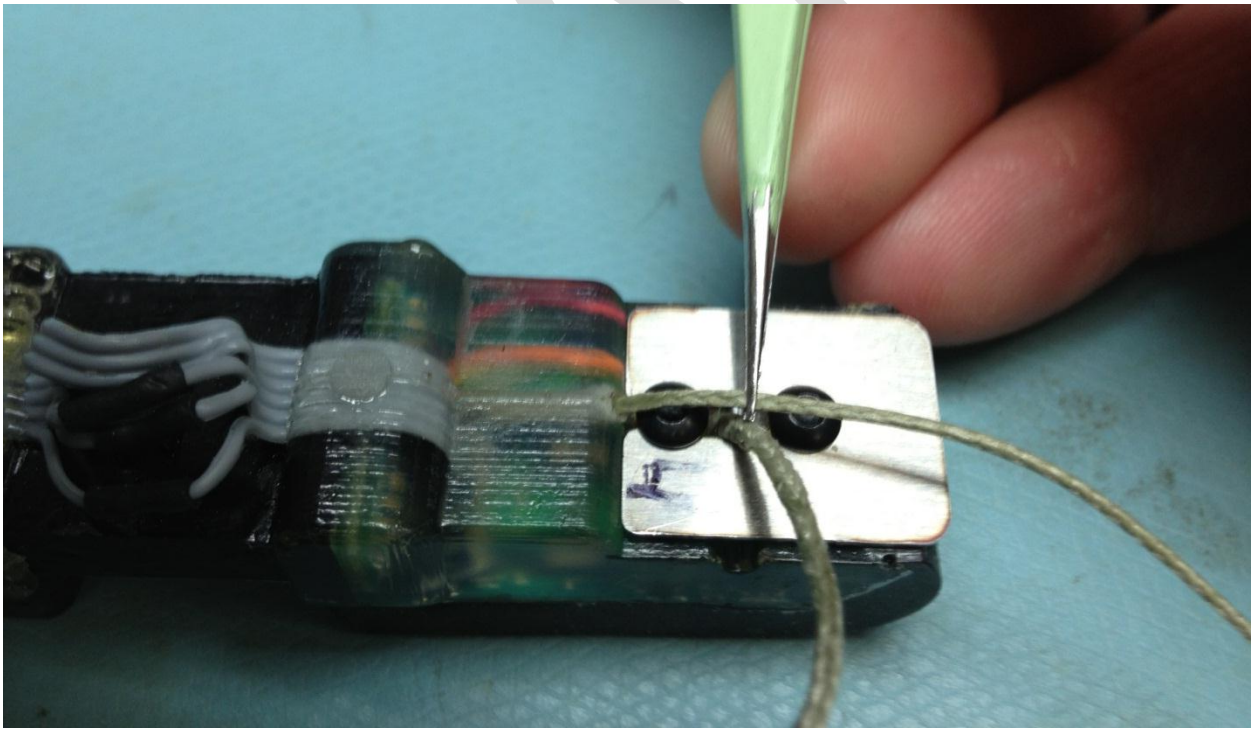
Slide the fingernail back into position and snug down the (2) M2.5 screws holding it in place, taking care not to pinch the tendon under the edge of the fingernail.

1.3.4. Feeding the tendon through the finger

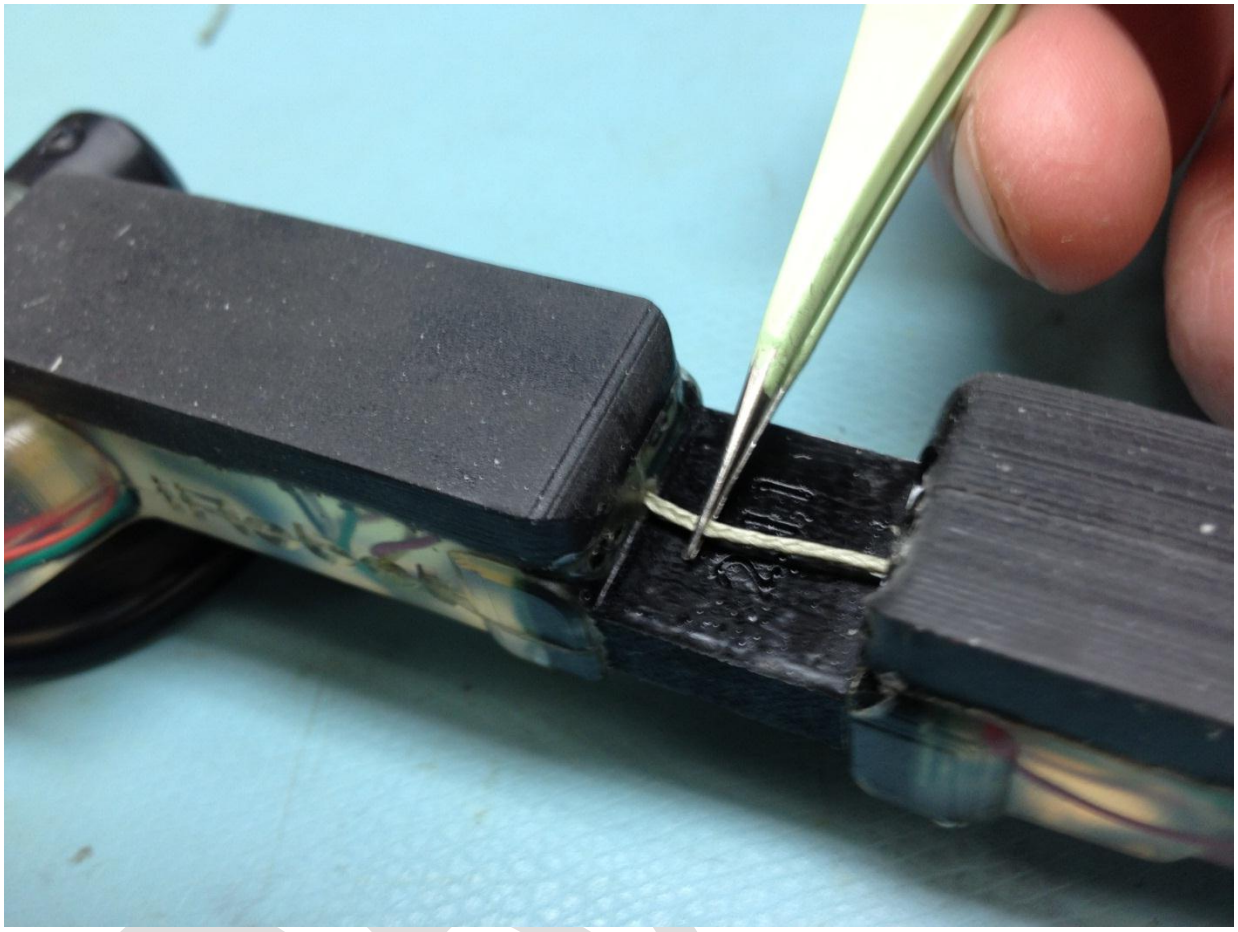
The single **most important** step in threading the tendon through the finger is having a good clean cut, with no frayed strands at the end. A nice cut with a sharp knife will dramatically reduce your frustration with this process.



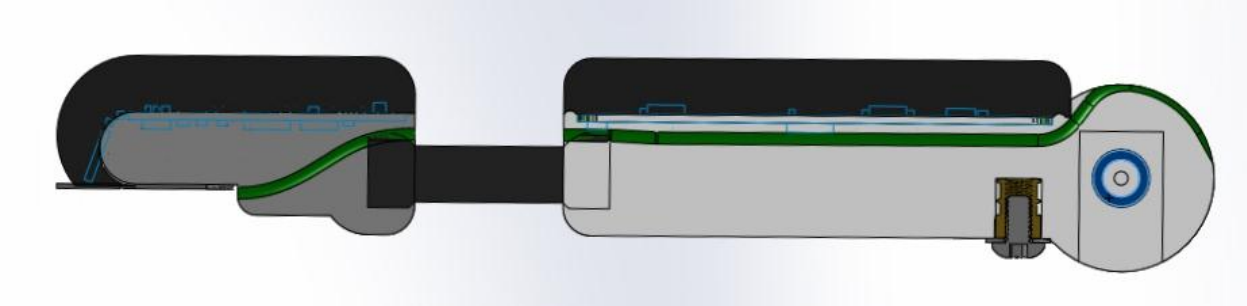
Using tweezers, feed the tip of the tendon through the distal link.



Once through, grab the tendon again at the flexure joint and using tweezers begin feeding it through the proximal link. Occasionally you may have to make additional cuts to remove a frayed end.



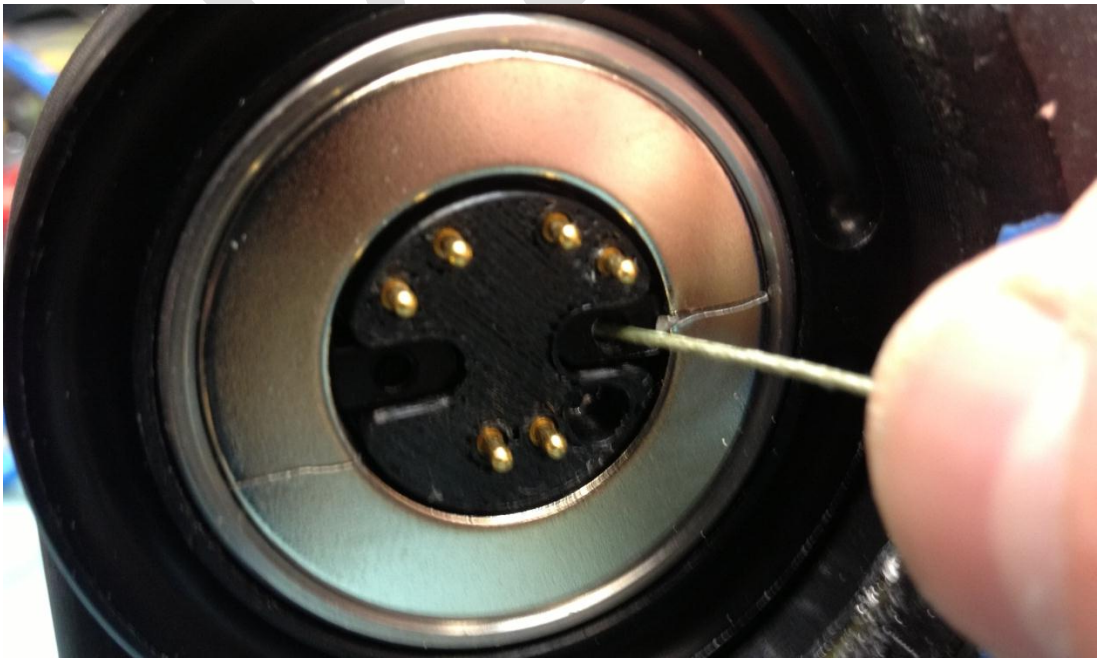
The guide curves sharply at the base of the finger and may require some finesse to pass the tendon through. Hold the tendon as close to the guide as possible so the line won't bunch up. Pictured below is a cross section of the finger.



1.3.5. Feeding the tendon through the base

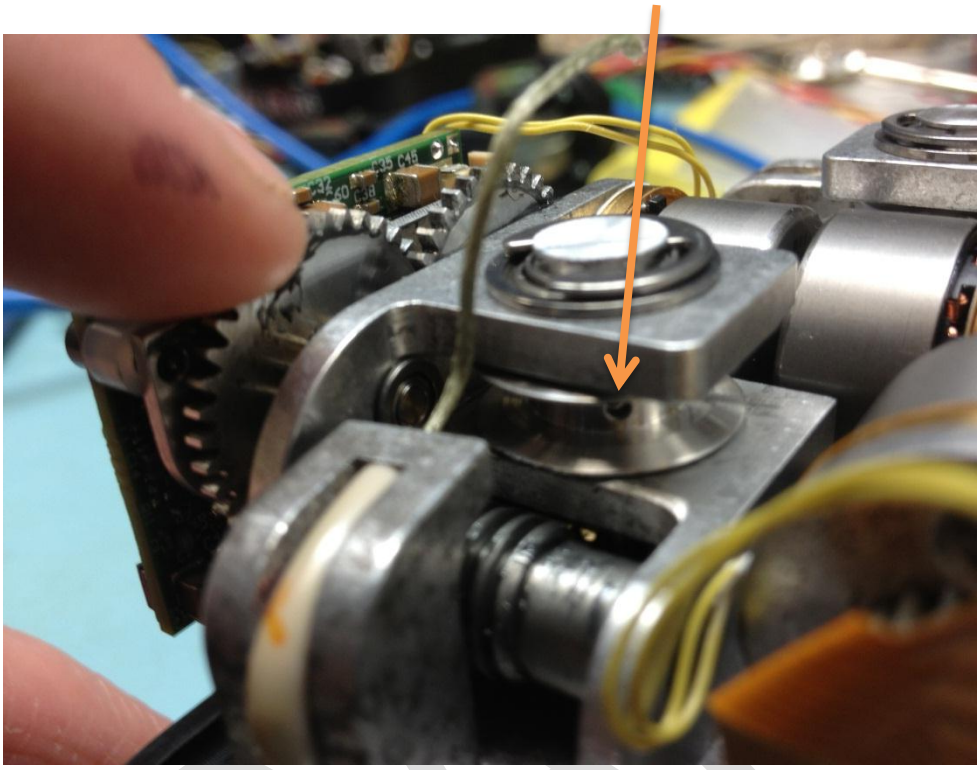
With a clean cut on the end of the tendon, begin feeding it through the hole in the base of the finger at a slight angle towards the pivot.

The tendon should emerge at the correct actuator inside the palm. If you cannot feed it through, or it doesn't appear at the actuator, you will need to try again and may wish to remove the finger to do so.

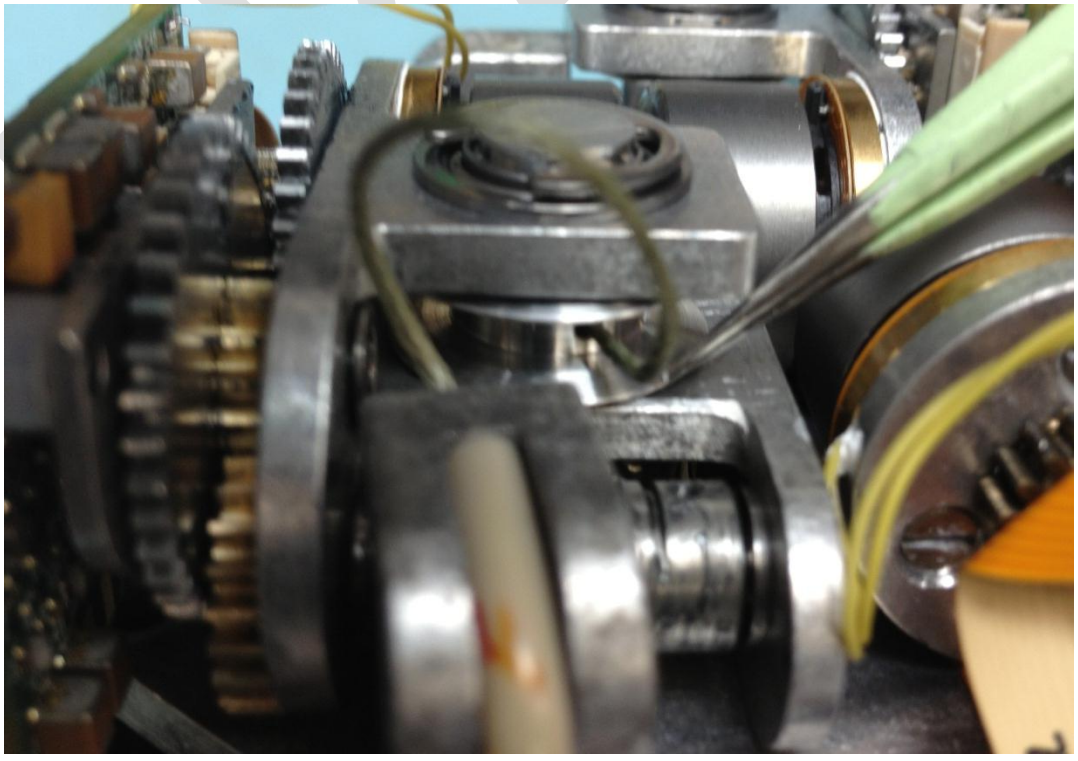


1.3.6. Feeding the tendon through the actuator and tying a knot

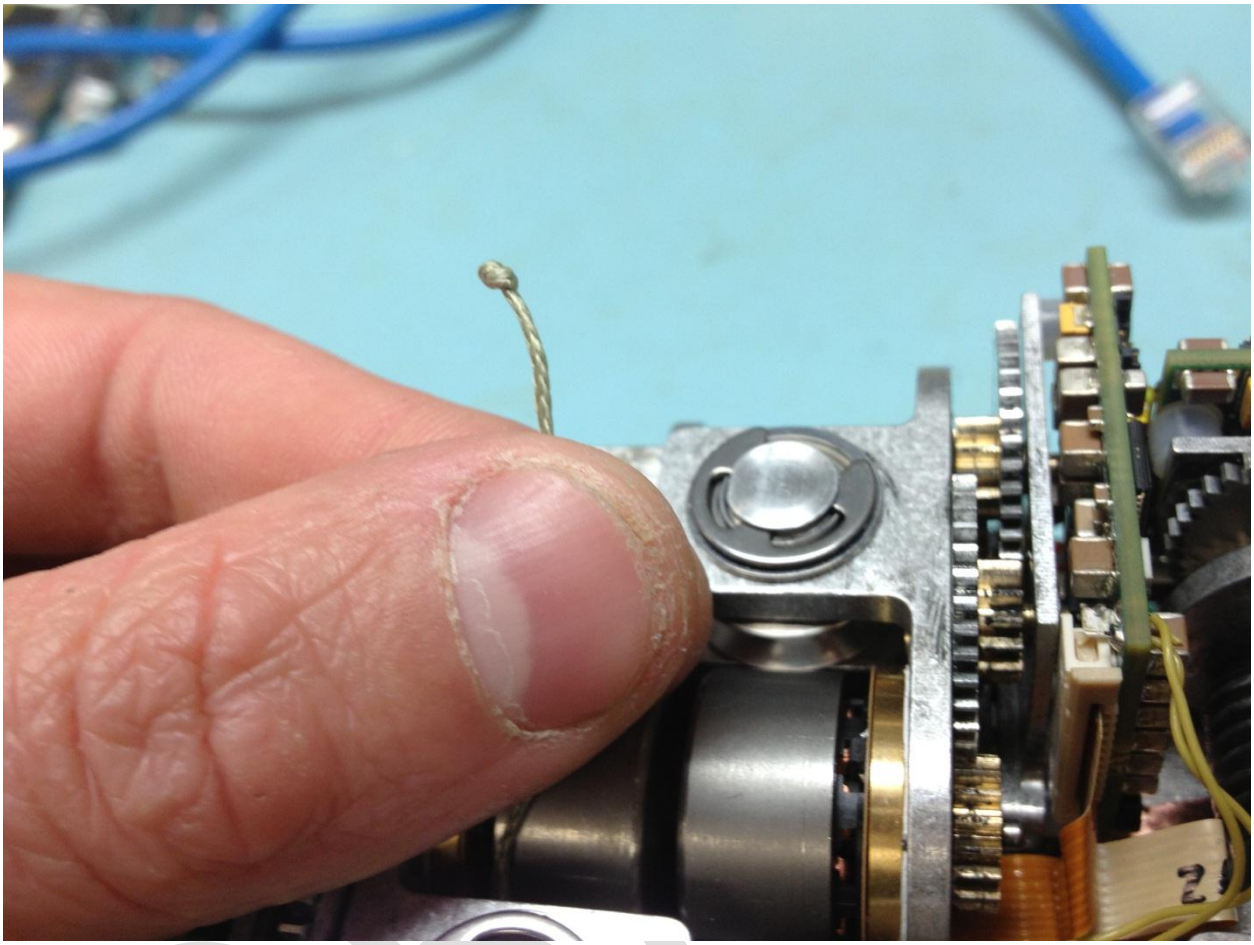
Rotate the actuator by spinning the large spur gear to make the hole in the drum easily accessible.



Feed the tendon through the drum and pull from the other side until a few inches has emerged.



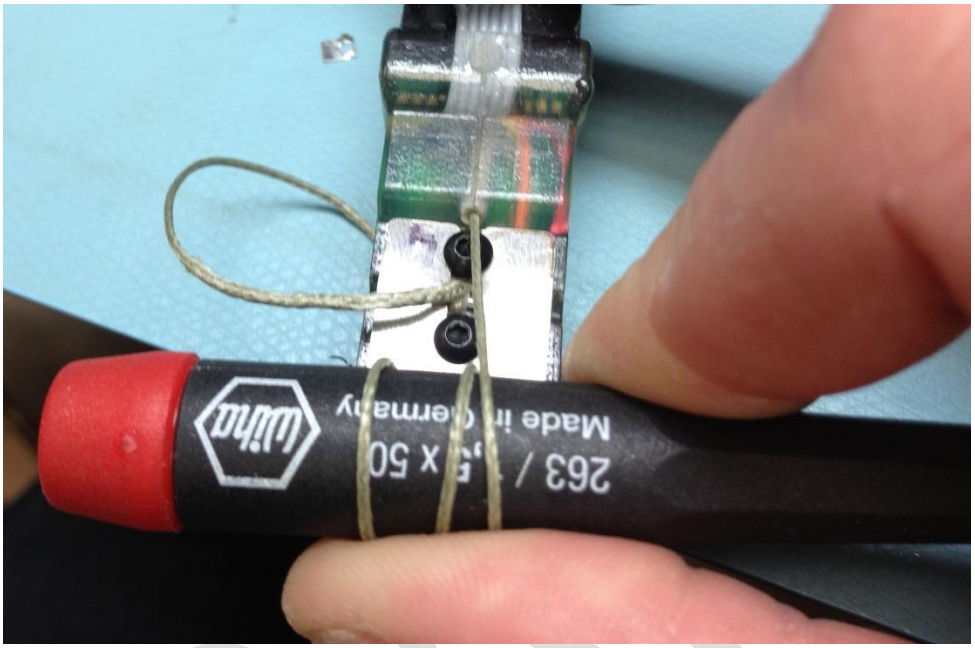
Tie a simple overhand knot and remove the excess with a sharp knife.



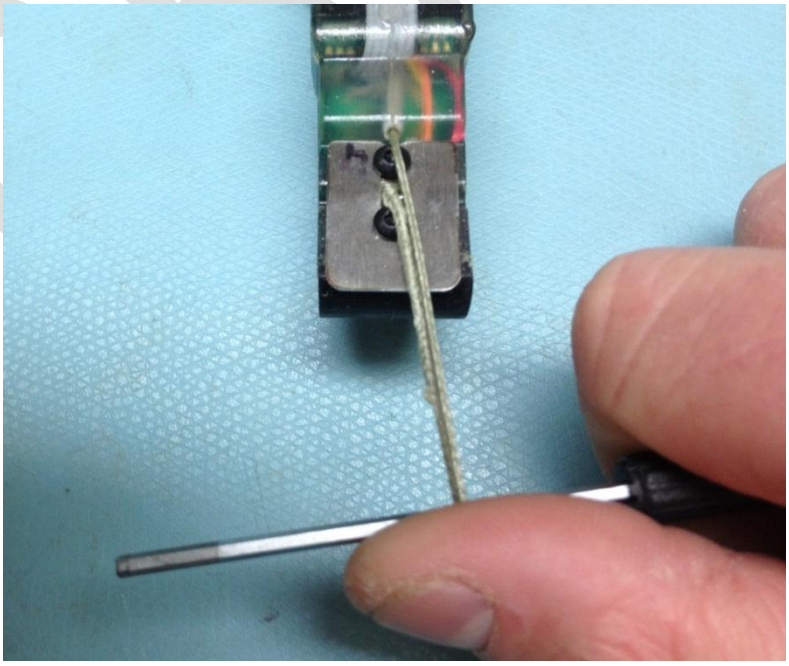
Remove all slack from the line by pulling gently at the line where it exits the fingertip. Pull until the knot is seated in the hole – but do not pull too hard as the knot will come undone.

1.3.7. Spooling in the Tendon

Much like fishing line, the tendon must be spooled on under some load to prevent bunching. I like to wrap the tendon around a screwdriver handle a few times and put pressure on it as I wind it in. Spool on one or two complete wraps under light resistance, then spool on the rest under heavy resistance.

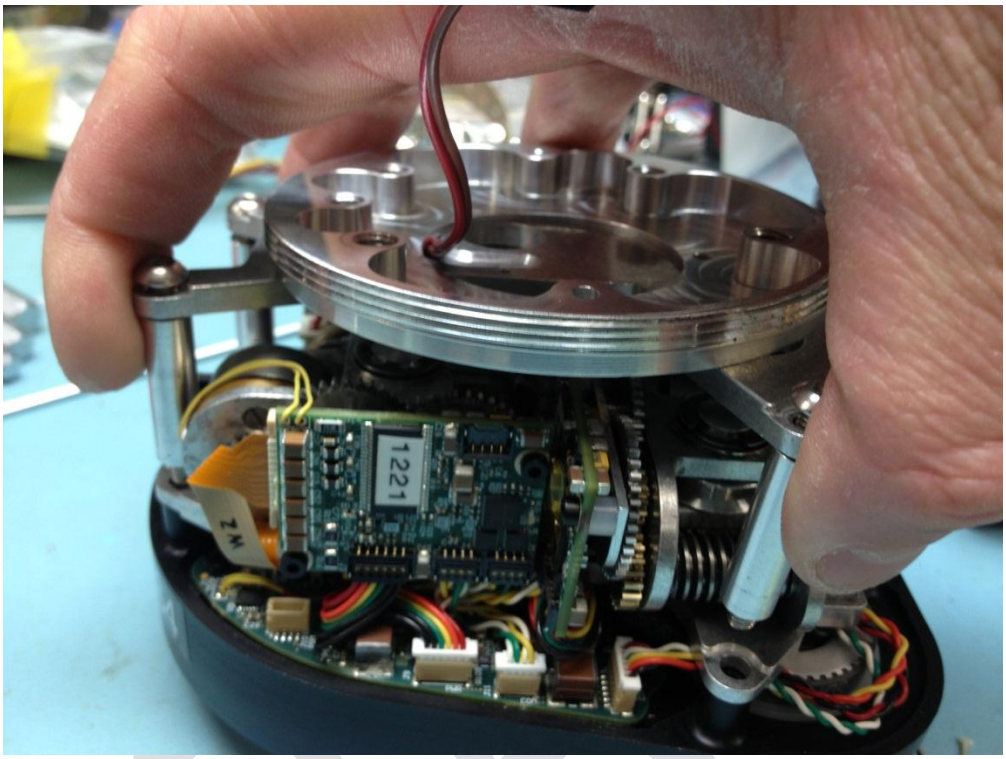


BE CAREFUL NOT TO WRAP THE TENDON AROUND YOUR FINGER!! The actuator is very powerful, and the tendon can easily slice into your finger if proper care is not taken. After most of the slack has been taken up, wrap the tendon once around the shaft of the screwdriver and continue.

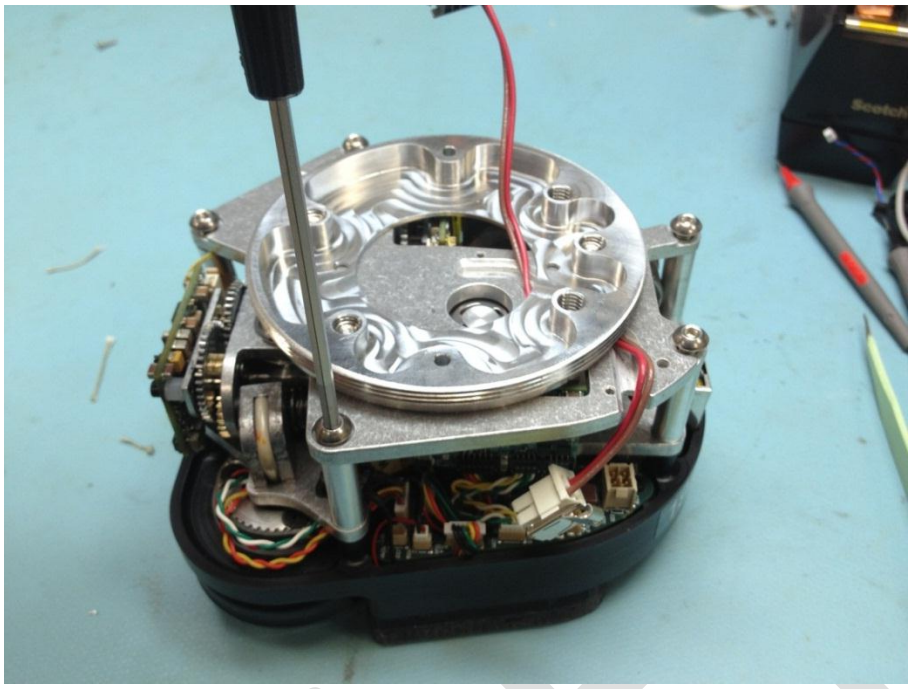


1.4.Reinstall the Load Plate

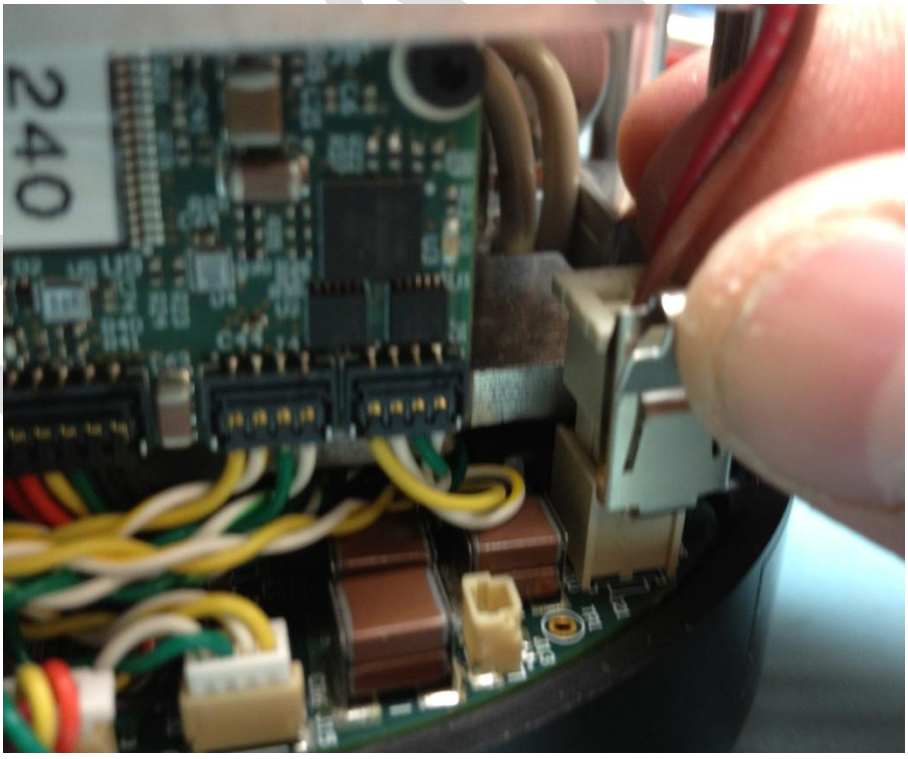
While holding all spacers in place, place the load plate onto the palm taking care not to pinch any wires underneath the screws or spacers.



Ensure all wires are tucked behind the spacers, and then tighten each screw - taking care not to over-tighten the screws.



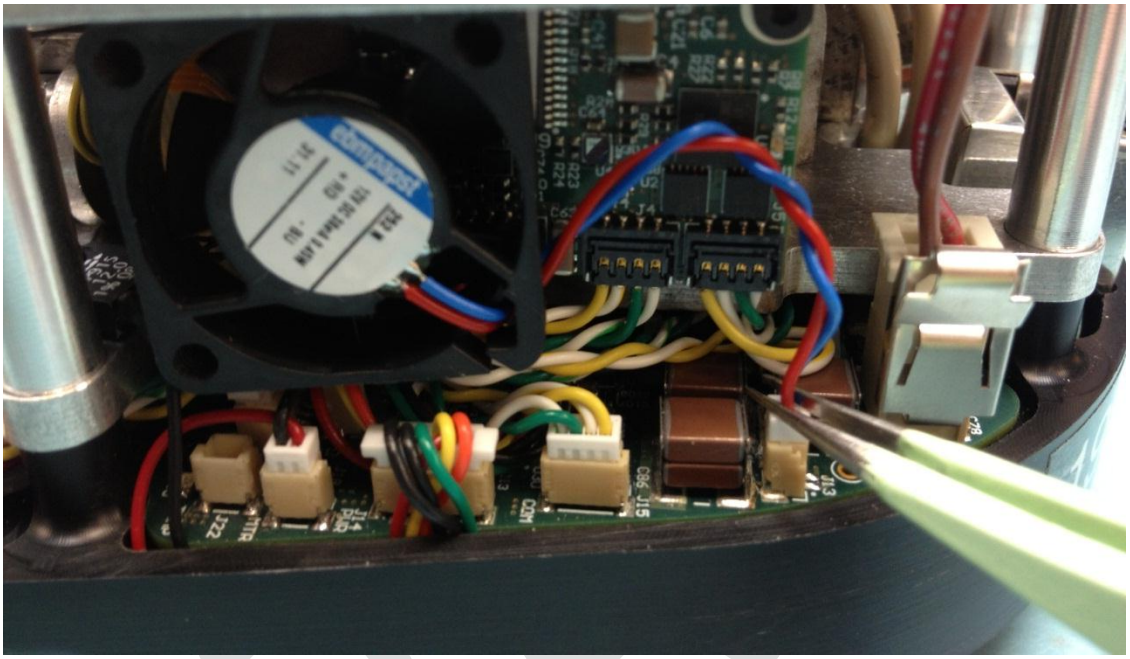
Reinsert the power connector and ensure the clip snaps into place.



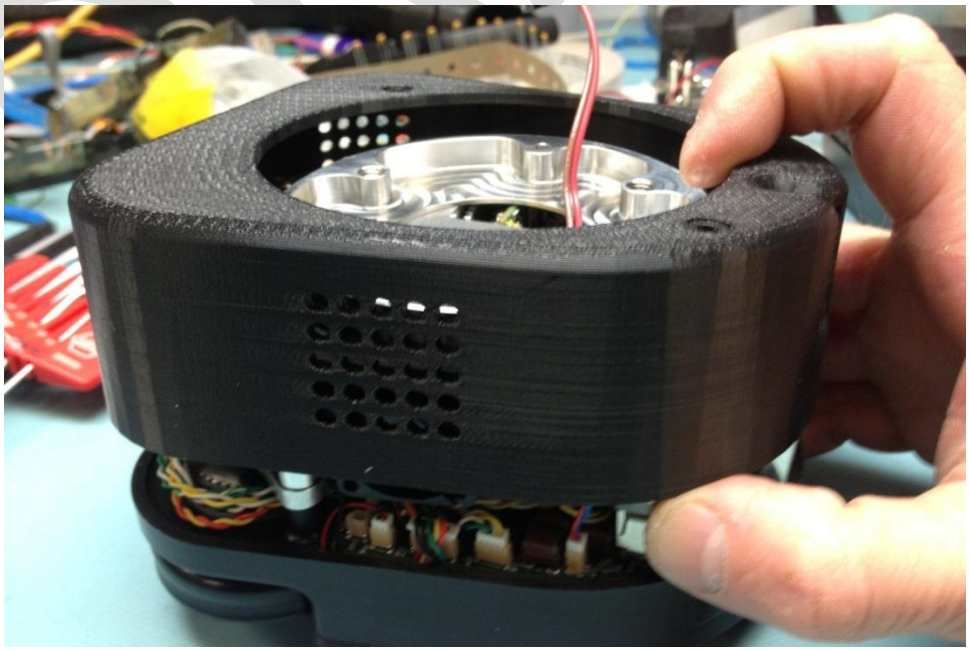
1.5. Reinstall the Back Housing

ARM-S Version

First, tuck in all loose wires and inspect all cable connections to ensure they are securely in place. Place the fan into position with the wires exiting the lower right hand side, and plug it into its connector. Make sure no wires contact the fan blades.

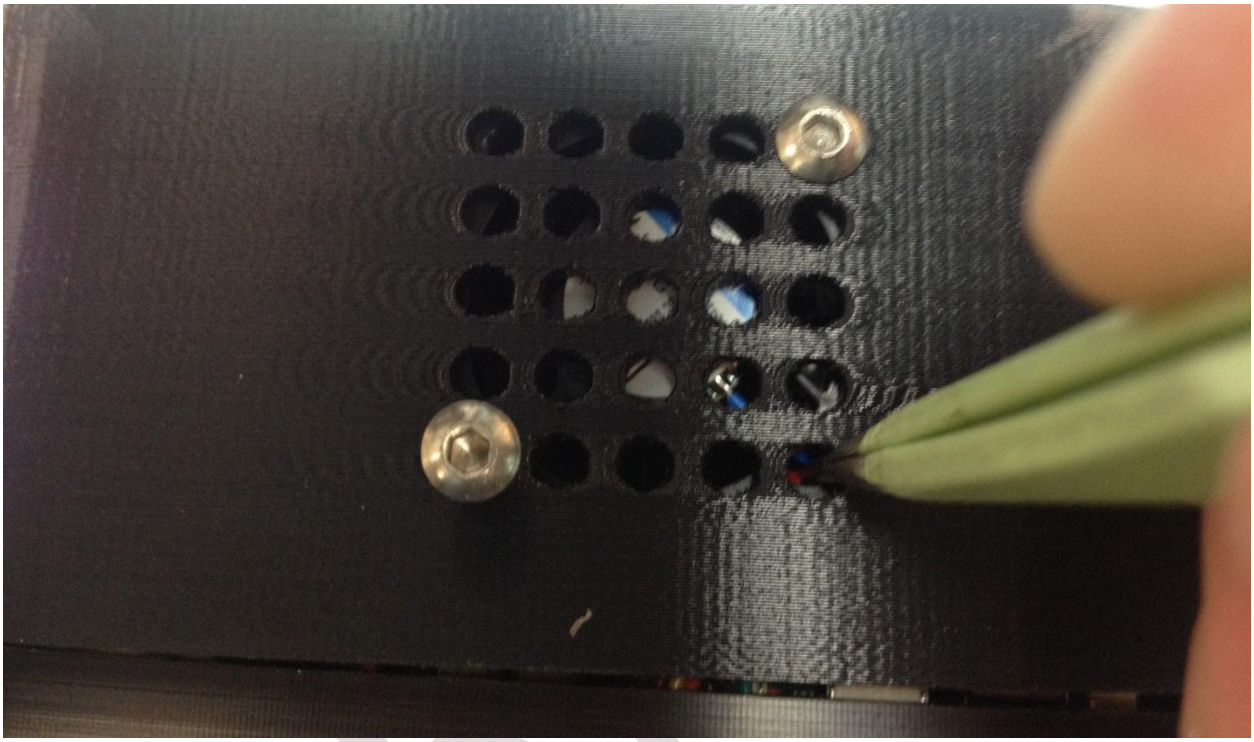


Holding the fan in place, slide the back cover over the load plate. You may need to push the little metal tab on the power connector aside to slide the back cover in place.



Install the (2) short M2 screws that hold the housing on but do not fully tighten them yet.

Next, fasten the fan to the side of the housing with the (2) long M2 screws. This can be a little tricky, but is much easier with a pair of tweezers. Simply insert the screw into the upper right hole and begin turning clockwise while moving the fan into position with the tweezers. Once the screw begins to catch, continue tightening until almost snug.



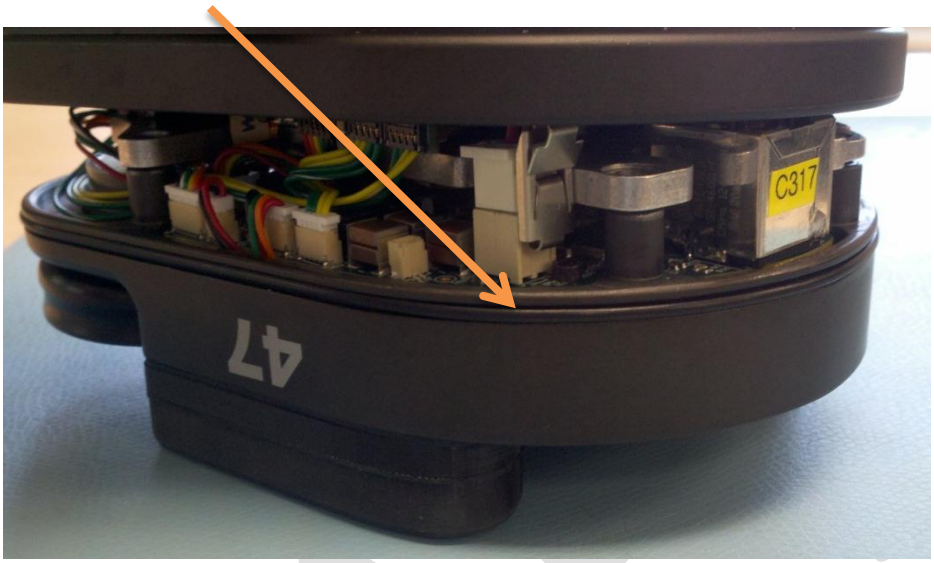
Install the second screw in the same manner tightening until snug. Be careful not to strip the threads in the plastic! If the threads are stripped, the fan will still hold in place, and iRobot will replace the screw with a plas-tite screw at the next required service.

Snug the screws holding the back housing on and you're done!

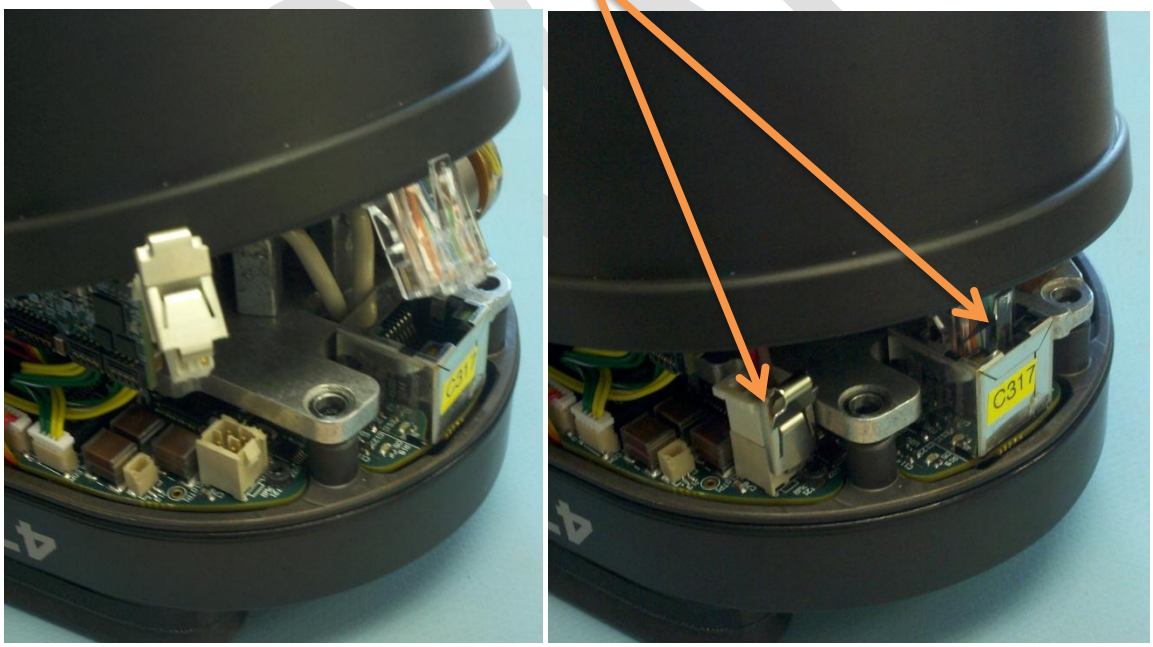
DRC Version

First, tuck in all loose wires and inspect all cable connections to ensure they are securely in place.

Inspect and ensure that the o-ring is intact and seated in the groove around the edge of the top housing.

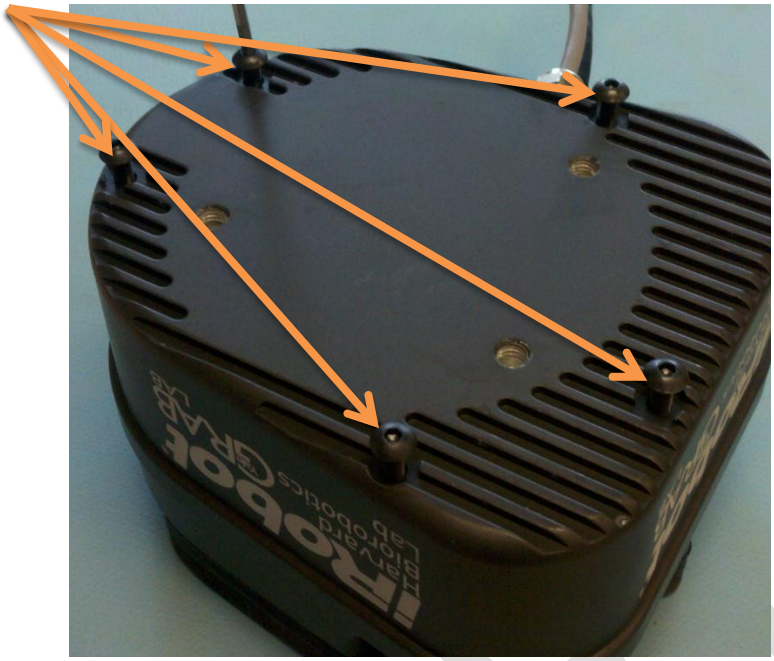


Lower the back housing onto the top housing and plug in the Ethernet and power connectors. They are both polarized and cannot be misplugged.



Slowly lower the back housing until it is fully seated on the top housing and covers the o-ring completely. You may need to gently twist the back housing back and forth to get the alignment just right as this is a very tight fit around the various plugs.

Install the five (5) M3 screws and you're done!



2. I Need to Replace a Finger!

Well, you really broke one. Now What?

Required Tools

- Small Tweezers
- 2mm Hex Key
- 2.5mm Hex Key
- Needle nose pliers
- Sharp X-acto knife or razor blade
- Needle (Provided by iRobot)
- Tendon Material (PN: 38-141-699-01 from www.basspro.com)

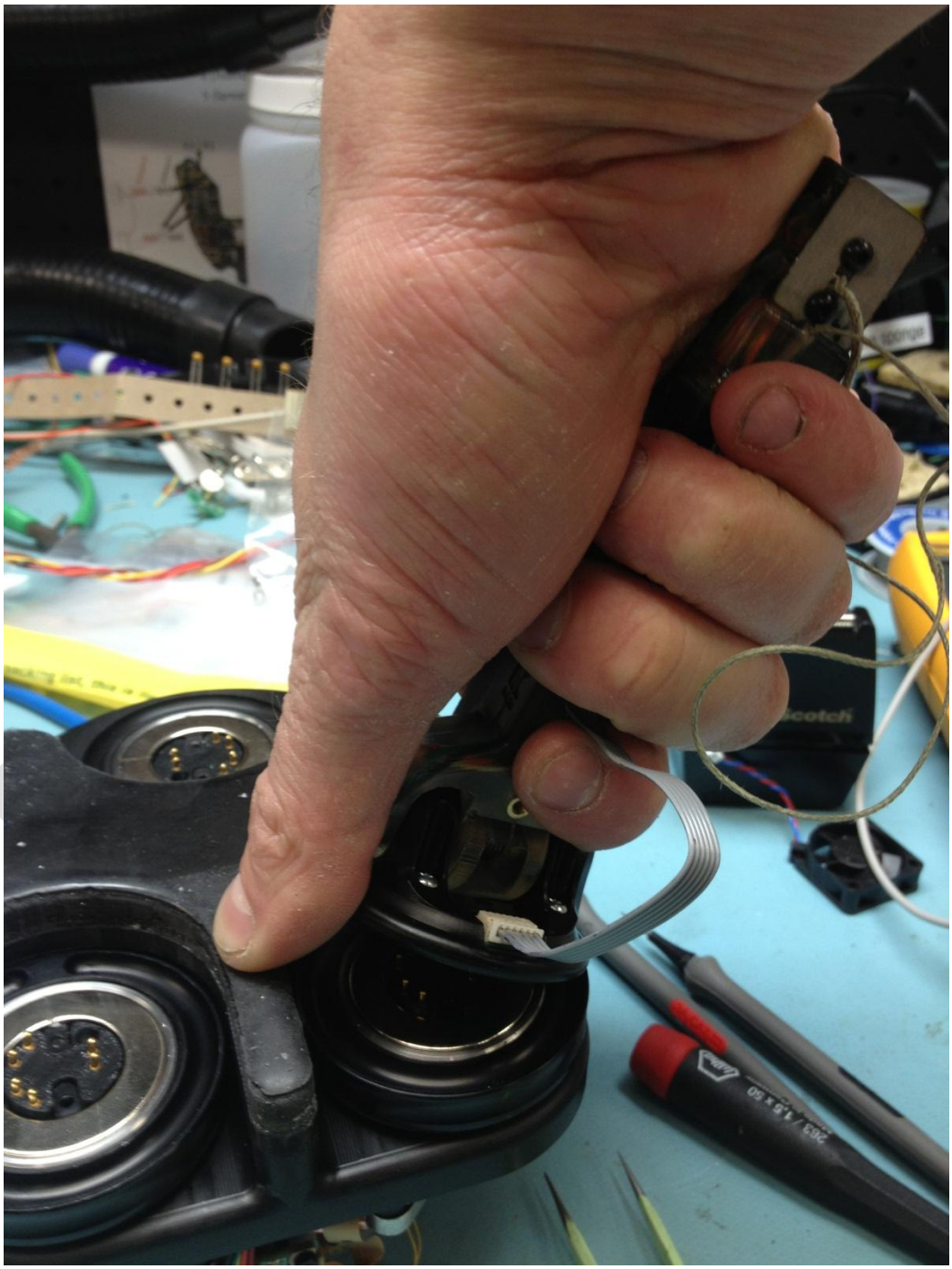
2.1. Remove Back Housing and Tendon

See Sections 1.2 thru 1.4

2.2. Removing the Finger

Stand the finger straight up, get a firm grip on the proximal joint of the finger, and push against the palm with your thumb to pry up the breakaway mechanism in a peeling motion.

Do not twist off the finger, as damage to the pogo pins may result.



2.3. Installing the Finger

First, check the magnet and alignment groove for debris. The magnet will pick up small screws and pieces of wire that can interfere with the function of the connector.

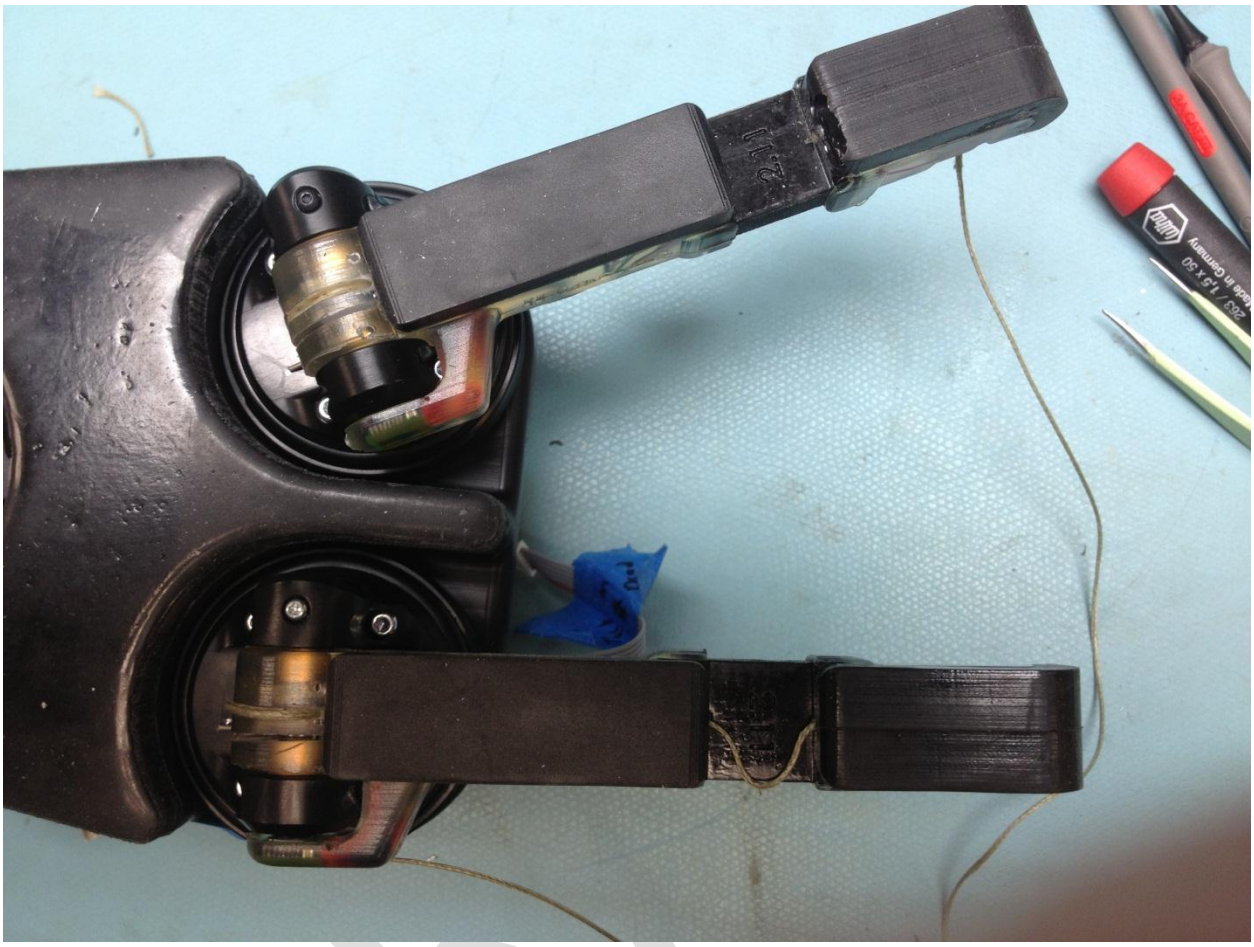
Check the function of the POGO pins, ensuring each one retracts and extends smoothly without binding. Also check to see the plastic POGO protector is fully seated.

When installing the new finger, align it as best as possible before snapping it to the base. If it is not aligned, gently rotate the finger using the proximal joint until the breakaway mechanism locks into place.

2.4.Replace the Tendon and Reassemble

See Sections 1.5 thru 1.7

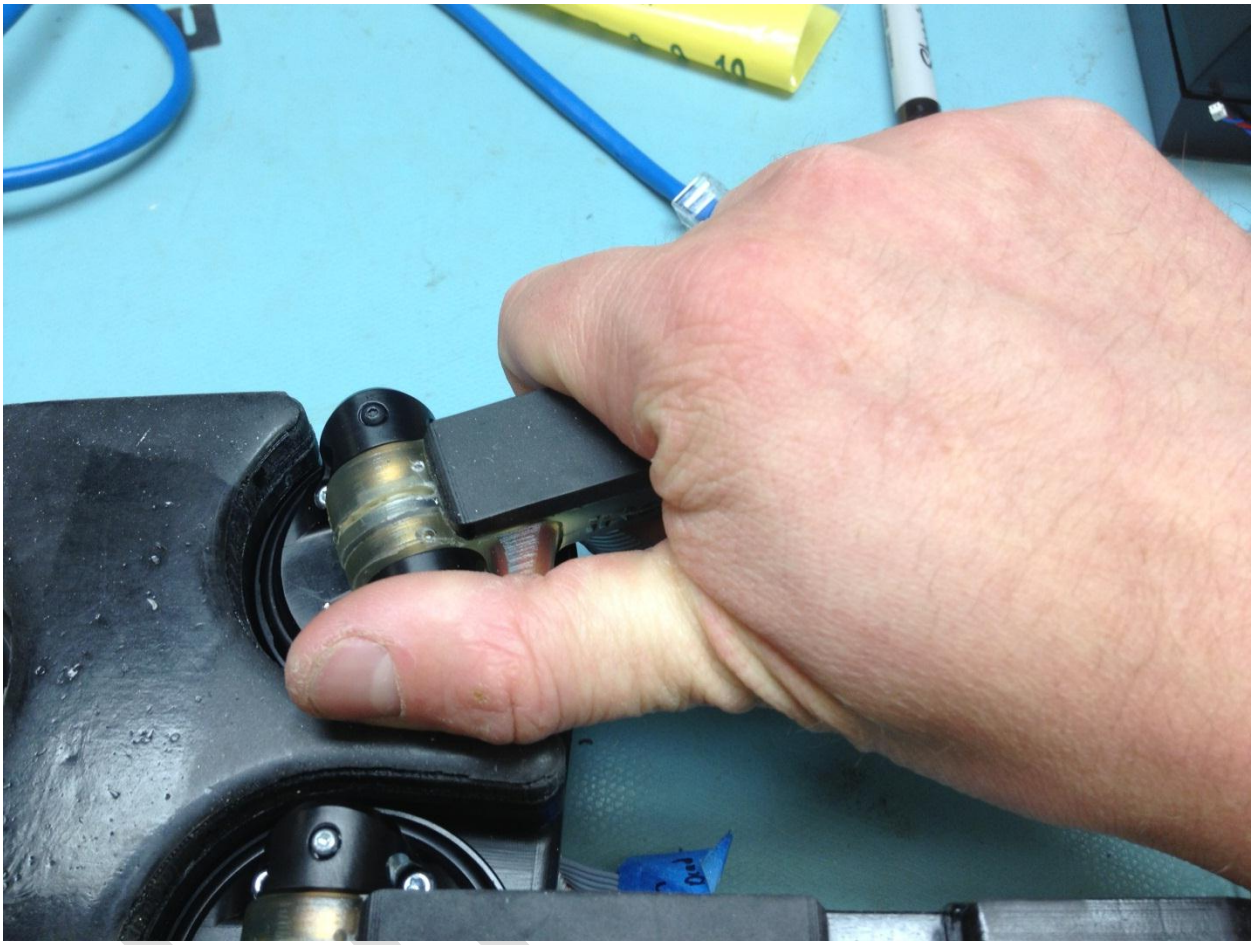
3. My Fingers Aren't Aligned?!



The two rotating fingers are actuated by a timing belt drive system. The nature of the timing belt drive allows a belt to slip a tooth (or several) to prevent damage to either the transmission or the finger. Though it is unlikely, the fingers on your hand may come out of alignment if a large external torque is applied to the finger rotation. The actuator itself is not powerful enough to cause this slipping condition.

3.1. Re-Aligning Your Fingers

Realigning the fingers is an easy procedure. First, reset the finger rotation to the 0 position. Firmly grasp the proximal joint of the finger and apply torque in the reqiored direction of rotation, taking care not to apply force to the distal joint.



3.2.Recalibration

If the fingers are now aligned to each other but the calibration has not been maintained, see steps in the calibration section of the owner's manual.

4. I Can't talk to Something! - or - My Motor Won't Spin!

Required Tools

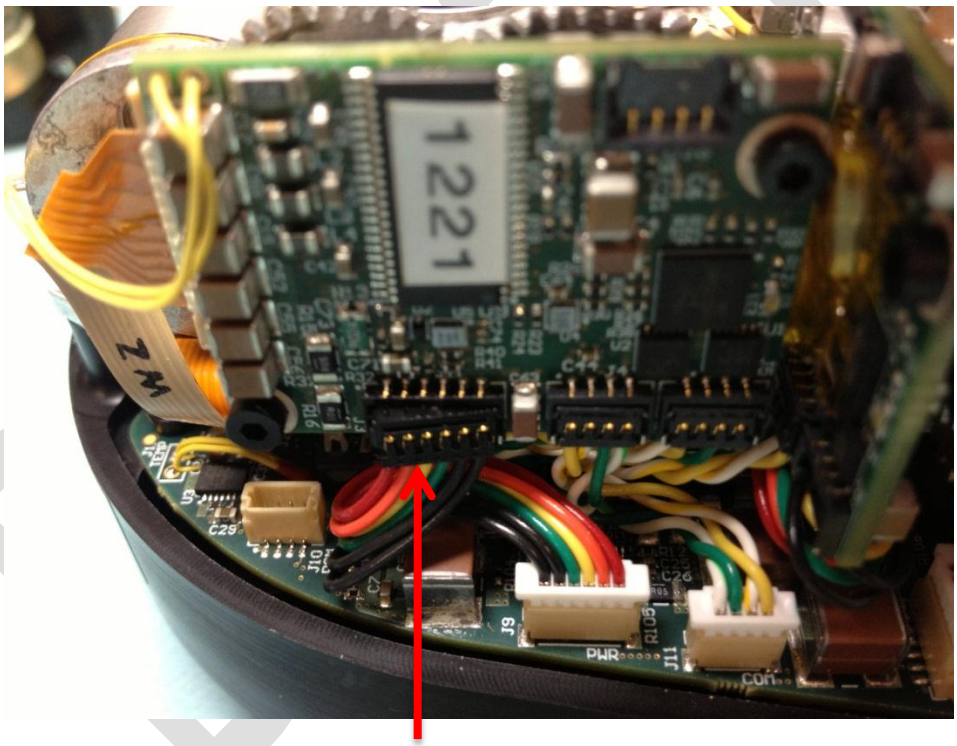
- Small Tweezers
- 2mm Hex Key
- 2.5mm Hex Key
- Multimeter

4.1. Checking Comms & Power Connections

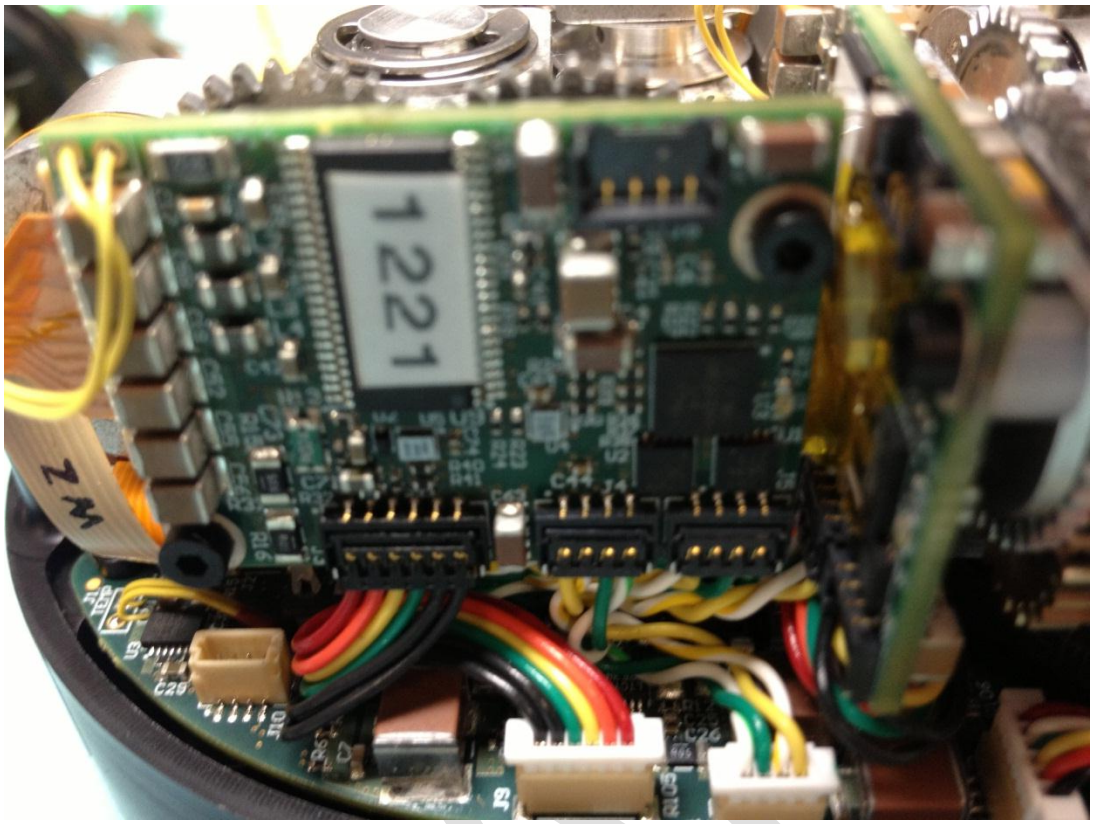
4.1.1. Motor Driver Boards

4.1.1.1. I can't talk to the motor board at all

One of the small black connectors could have dislodged due to an impact or vibration. The cover will have to be removed in an **ESD SAFE** environment and the connections inspected.



Connector Dislodged



Connector Properly Inserted

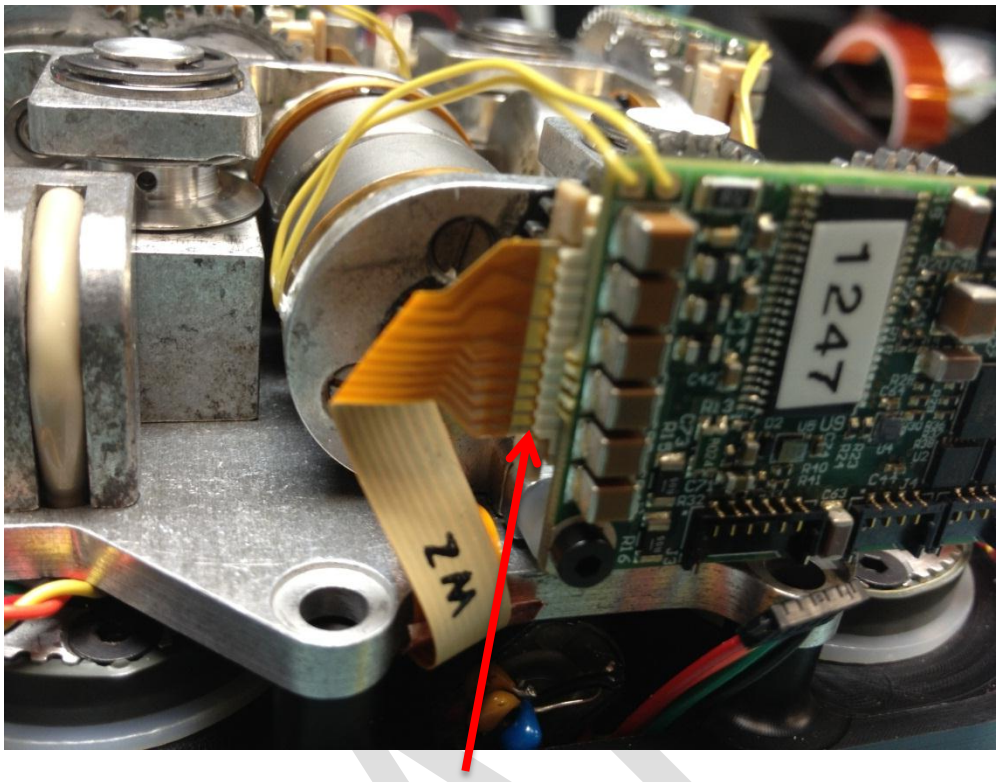
See section 1.2 on removing the back housing.

Looking for bad connections, pulled out pins

4.1.1.2. I can talk to the motor board, but the motor won't spin

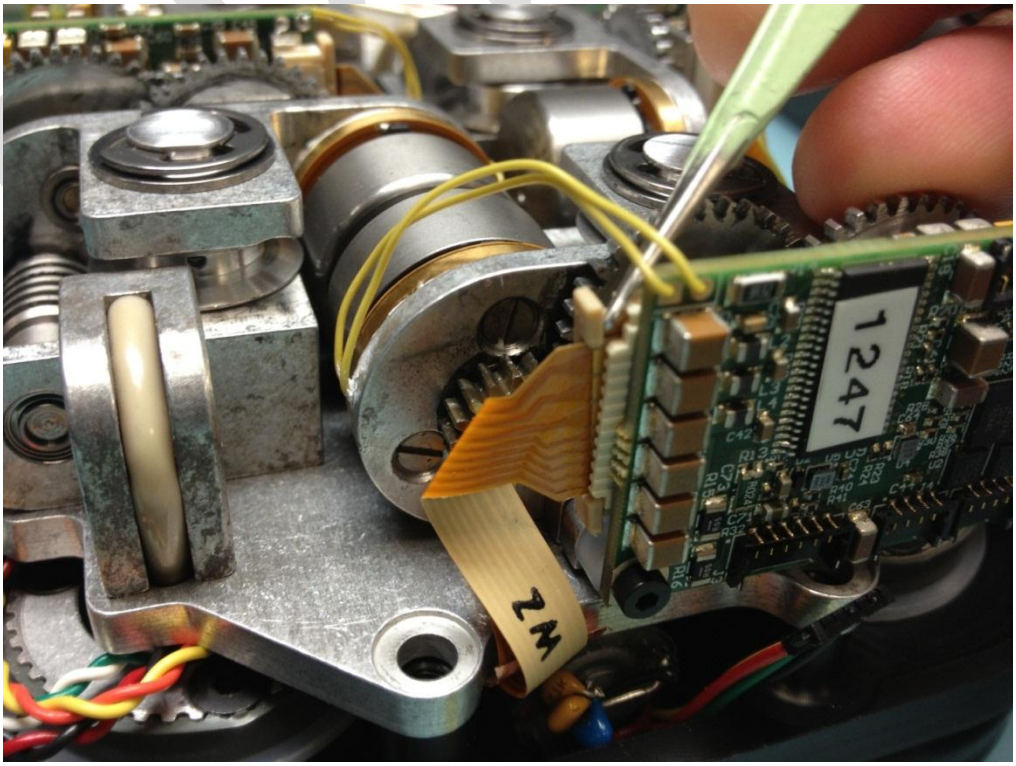
Likely a flex cable has come loose, been cut, or the motor is burnt out. You can measure the coil resistance with a multimeter to help determine the cause.

First, check to make sure the flex cable is fully plugged into the connector. It may look secure, but I find best practice is to reconnect it and check function before proceeding.

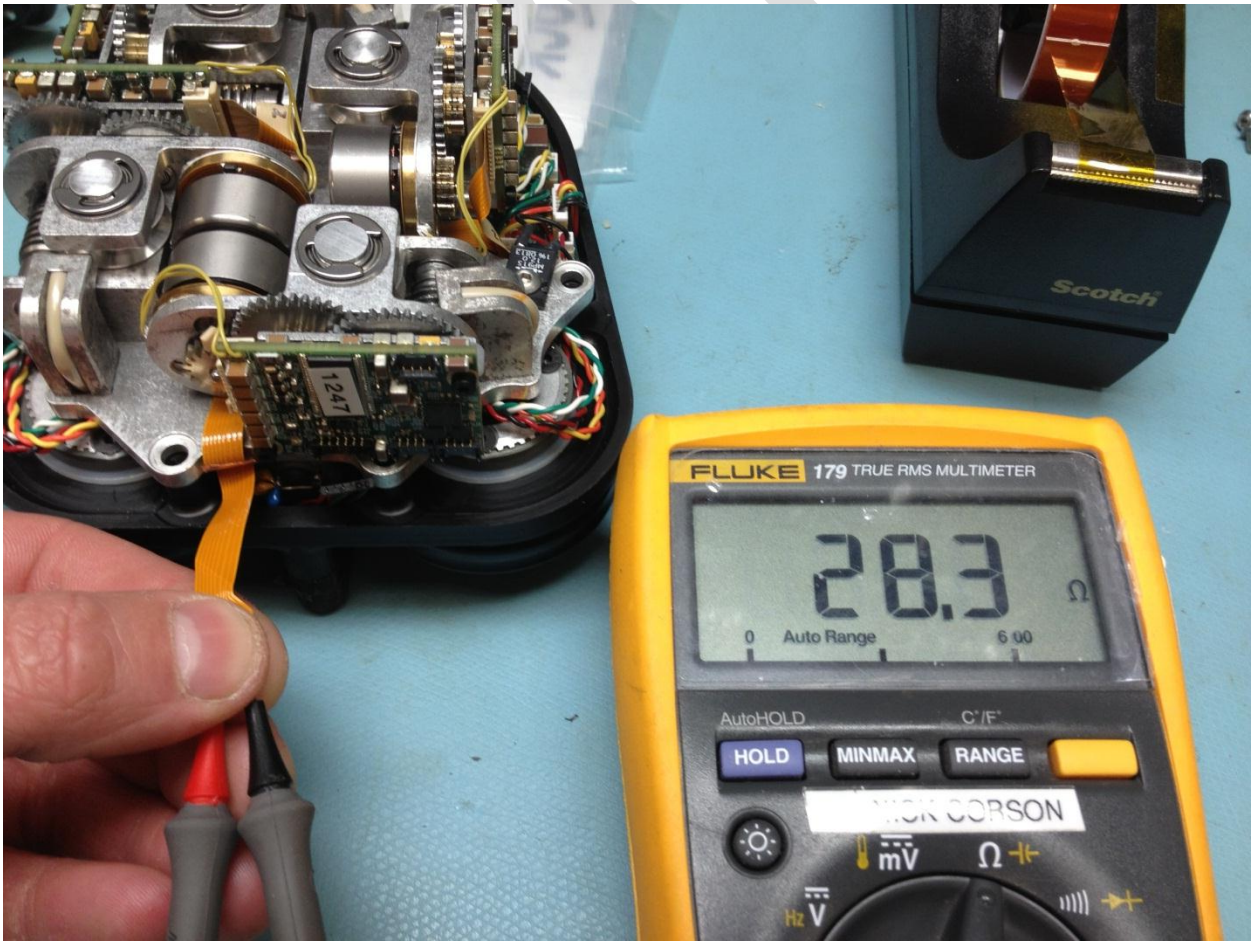


Improperly connected flex cable

If the problem persists, remove the flex cable from the connector. To do this, use a small screwdriver or tweezers to loosen the clip. The cable will fall free.



With the flex cable connector end free, locate the three large traces that provide power to the motor. Using the multimeter, measure the resistance of each of the (3) pairings of terminals. The measured resistance should be somewhere around 28 ohms for each channel. If one or more is a few ohms lower or higher than that, the motor is bad and will need to be replaced.



4.1.2. Fingers – I can't talk to one!

The most likely cause of a finger communications failure is a bent Pogo pin. This can happen if the finger is rotated on the breakaway excessively without being fully seated. To check for bent pogo pins, adequate tendon material will need to be un-wound and the finger broken away. Upon removal inspect the pogo pins for position and spring function. If one has failed, the pogo pin PCB will need to be replaced by iRobot.

On the thumb only:

If there is no power supplied (Red LED not lit) and all pogo pins are intact, a connector may have come loose as a result of impact or vibration. The hand will need to be returned to iRobot and the connector secured.

4.1.3. Tactile Palm

If you can't communicate with the tactile palm, the hand will need to be returned to iRobot for service.

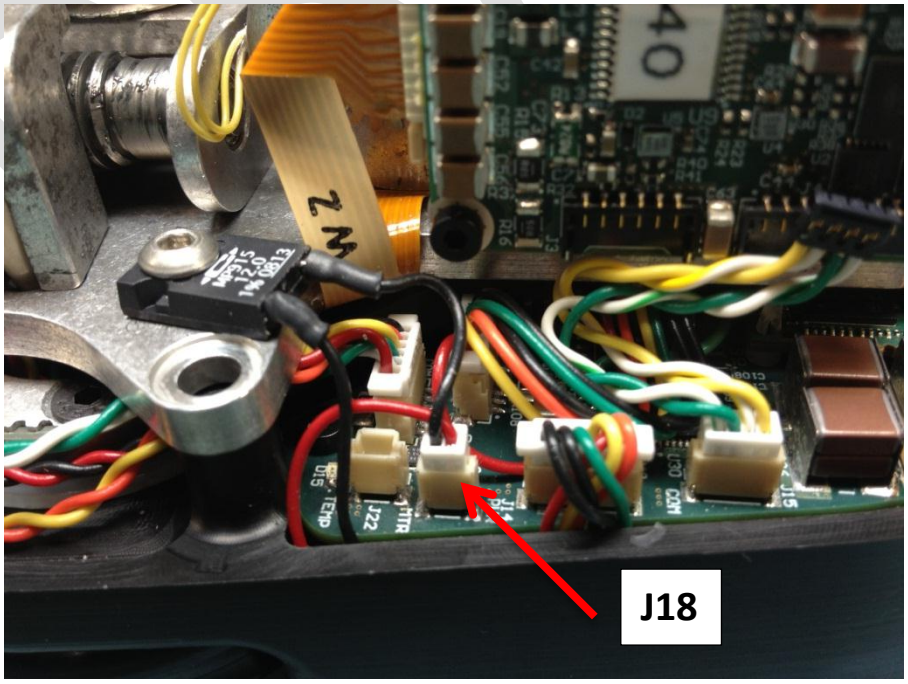
4.1.4. Rotation Motor & Encoder

4.1.4.1. I'm not getting any encoder data

Unfortunately the connector cannot be checked by the user, but it is unlikely it has become disconnected. The hand should be sent back to iRobot for repair.

4.1.4.2. The motor doesn't seem to be spinning.

First, ensure that the connector is seated fully in the correct location (J18). If all software solutions have been exhausted and the connector is fully seated and the problem persists, the hand will need to go back to iRobot for repairs.



4.1.4.3. I hear the motor spinning, but nothing is happening!

This issue has been documented. In most cases a set screw has come loose in the rotation transmission. The hand will need to be returned to iRobot for service.

Technical Support Contact

E-Mail: ARMH_Support@irobot.com

Prior to shipping your hand back to iRobot for repairs please contact ARMH_Support@irobot.com for basic debugging and return instructions.

Shipping Address:

Mark Claffee

8 Crosby Dr.

Bedford, MA 01730