SENSE IT

Making the Custom Cable for the NXT

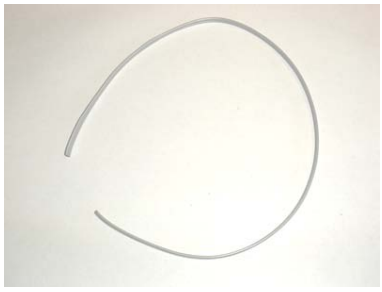
Description

In order to use the LEGO MINDSTORMS kit in this project, a custom cable must be created. This guide will take you through the process step by step.

Materials

- One NXT

- One 4-5 meter length of 6-conducter data/phone cable (RJ12) (Order from www.iofast.com)

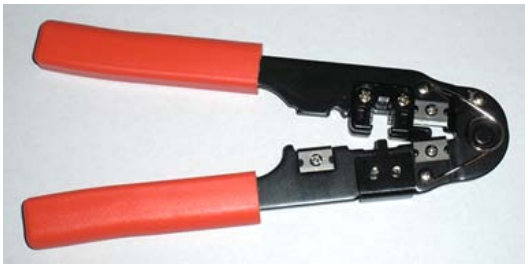


- Three 0.5 meter lengths of 6-conducter data/phone cable (RJ12) (Order from www.iofast.com)

- Six NXT plugs (Order from http://www.mindsensors.com)

- Two 1280 mm LEGO connecting leads

- One telephone (RJ12) plug crimp tool (Order from www.iofast.com)



- One flat metal needle file

- Six male and six female D-sub connectors (Order from www.iofast.com)

- One D-sub crimp tool (24 – 28 AWG) (Buy at Radio Shack or order from www.radioshack.com)

- One pair of scissors
- One pair of needle-nose pliers
- One pair of 20-28 AWG wire strippers
- One slow motor
- Electrical tape

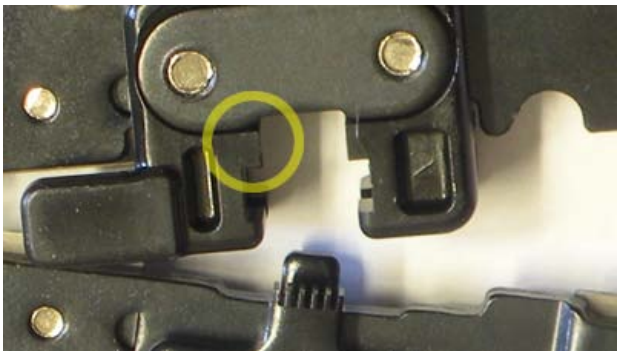
Procedure

1. **Modify the RJ12 Crimper to Work with NXT Plugs**
   The standard telephone plug crimping tool that you can find in most hardware stores does not work with the NXT plugs. This is because LEGO made the plugs for the NXT identical to phone plugs with one difference – the latch is placed off to one side instead of the center. Here is a view of the plug from the back:

Note that the latch is on the right side. Now look at the crimper:

There is a space in the center for the latch from a regular RJ12 telephone plug, but the NXT latch will hit against the right side and won't fit into the crimper. The only way to solve this problem is to file away the extra material on the right so that the NXT plug will fit.

Now look at the other side of the crimper:

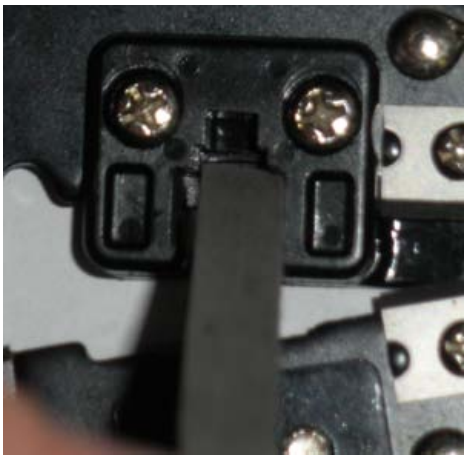


Since the front part of the latch actually sticks out in front of the plug a bit, the portion on the upper-left side of the crimper will have to be removed so that the plug will be able to fit all the way in.
First, let's start with the back side.

Using the metal file, rub away the material on the upper-left side until it is flush with the rest of the left side. You will also have to remove a bit of material from the top metal part, which will take a bit of work.

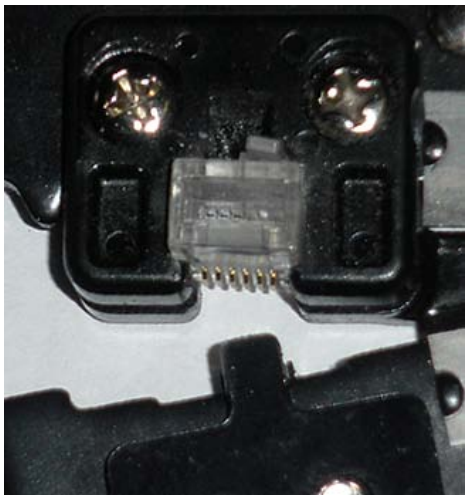
When you are finish, it should look like this:

Next, let's remove the material from the front side.

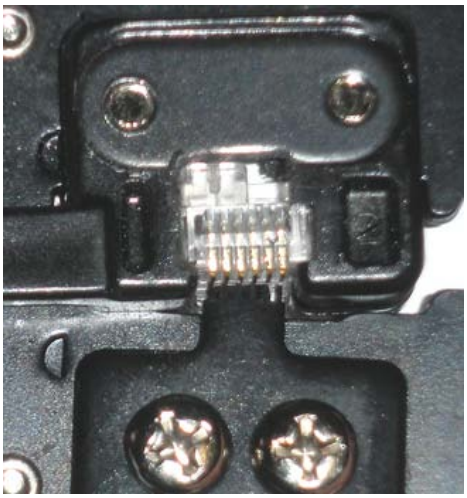


Be careful! If you remove too much material, the crimper will not work correctly and will actually damage your plug. The best way to go about this is to remove some material and then try to put the plug in. If it won't go, then file some more and try again.

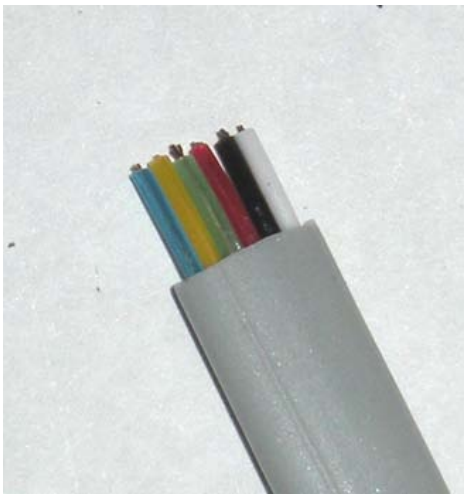
Keep repeating this process until the plug fits in snugly with a bit of a push.



Make sure the plug goes all the way in so that the crimper's teeth will line up with the plug's blades. (Don't push the teeth in yet! Just make sure they line up.)



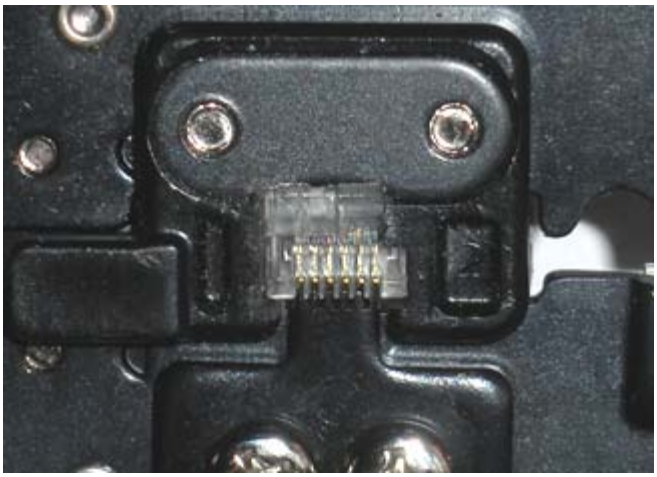
2. **Prepare the RJ12 Cables**
   Take one of the three half-meter lengths of RJ12 telephone cable, and strip about a centimeter of the outer insulation from each end using the crimp tool.



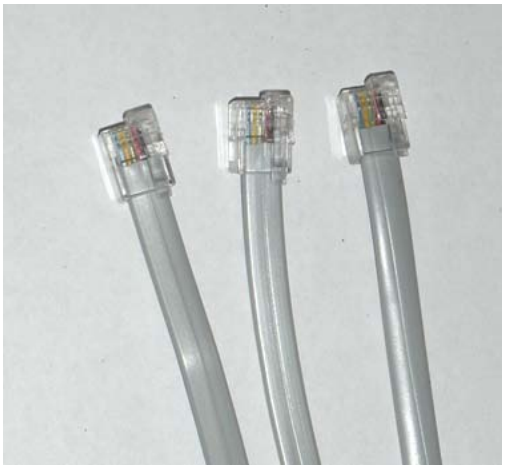
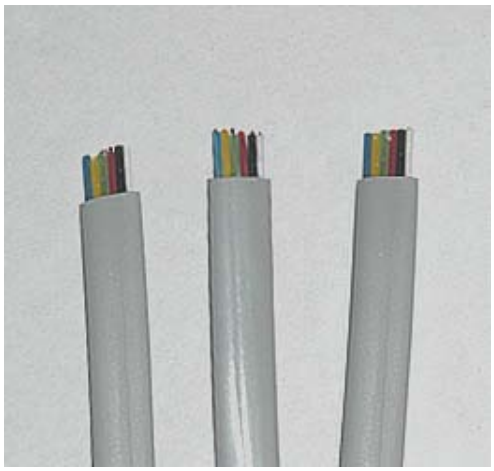
Now load an NXT plug into the crimper and insert one of the stripped ends of the wire into the plug so that the white inner conductor is underneath the plug's latch, which is on the right side.



Make sure the cable is pushed all the way into the plug and then squeeze the crimper down on the plug. If you look at the other end of the crimper while you do this, you will see the crimper's teeth push in the blades of the plug into the wires inside.

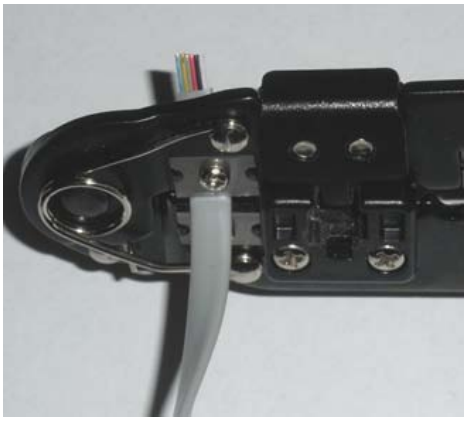


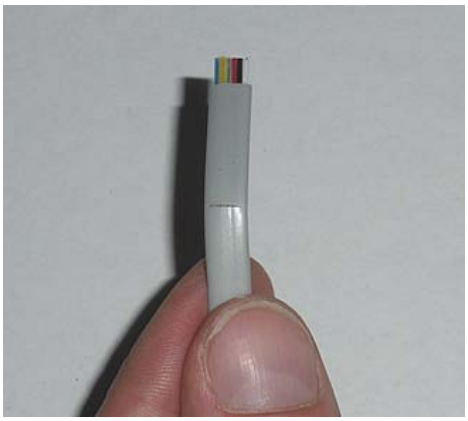
Carefully pull the plug out of the crimper, and repeat this process for the other two half-meter cables. When finished, you will have three cables each with an NXT plug at one end and stripped insulation at the other.

Now take the 4-5 meter cable and strip about 2 inches of the outer insulation from both ends.

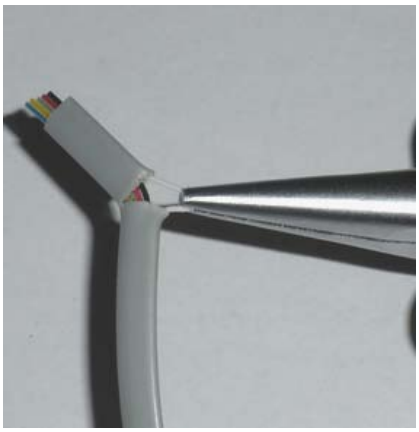
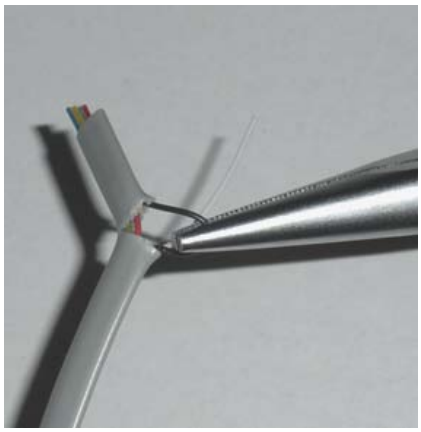
3. **Replace Pairs of Power Conductors**
   Take the stripped end of one of the half-meter cables and use the crimper to cut a small slit about an inch down from the previous stripped point. (Be carful not to cut too deep – if you cut through the insulation of the inner conductors, you'll have to cut off the cable at that point and try again.)



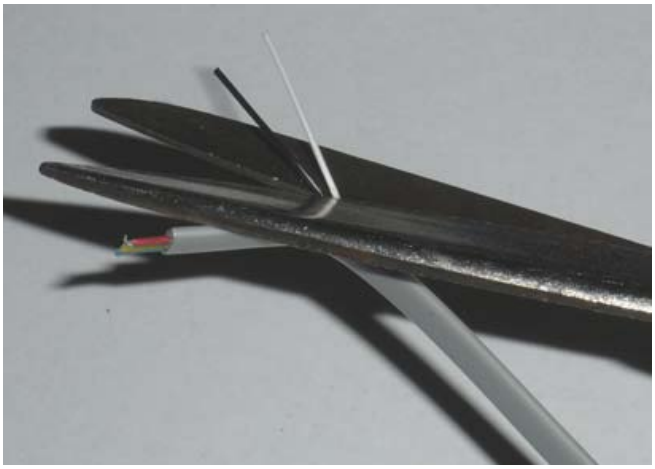


Using a pair of scissors, carefully cut the side of the insulation on the side of the white inner conductor and pry the cable open so that you can see the white and black inner conductors.

Use the needle nose pliers to pull out the white and black conductors from the insulation.

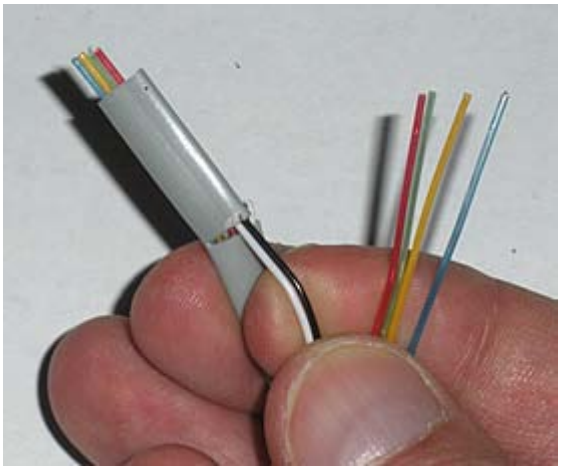
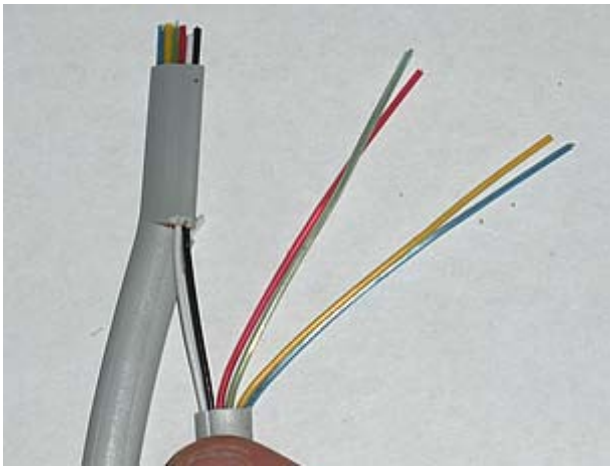




Cut the white and black conductors using the scissors or a wire cutter.

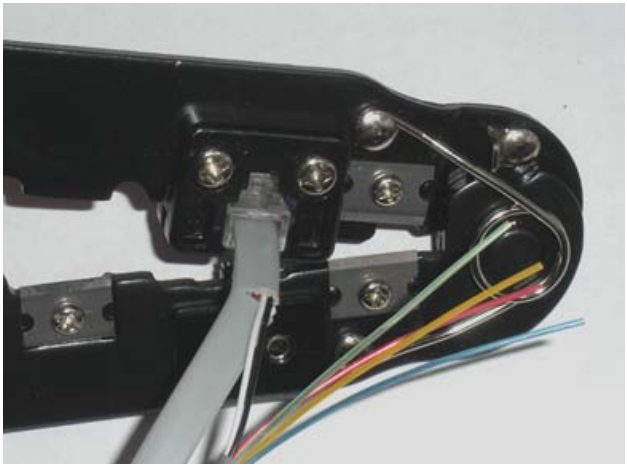


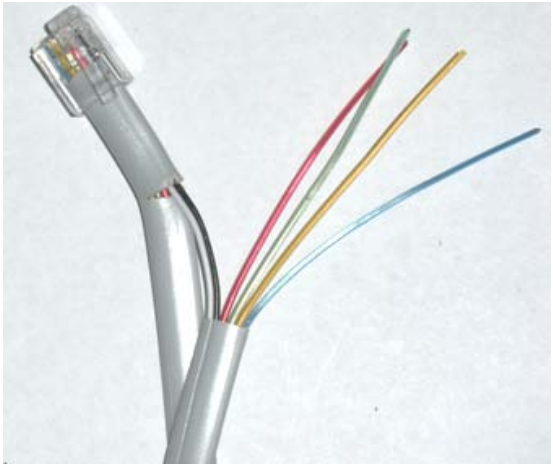

Repeat this for the other two half-meter cables.

Now take one end of the 4-5 meter cable and separate the conductors into three pairs: white-black, red-green, and yellow-blue. Take the white-black pair and slide it into the insulation of a half-meter cable where the previous pair of conductors had been. Push the pair all the way up until they are flush with the other conductors.

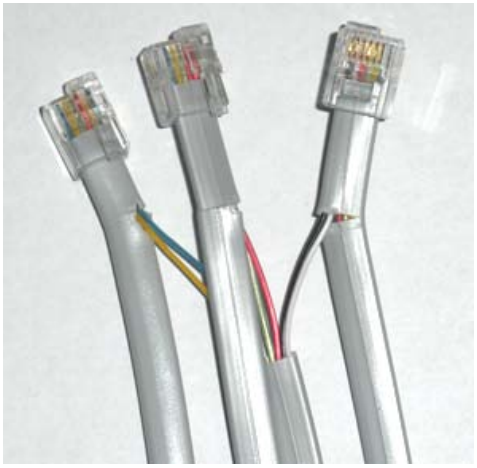



Load an NXT plug into the crimper, insert the half-meter cable into the plug with the new replacement conductors under the latch of the plug (on the right side), make sure the conductors are pushed all the way in, and squeeze the crimper on the plug. One the blades of the plug have been pushed in by the crimper, carefully remove the plug.



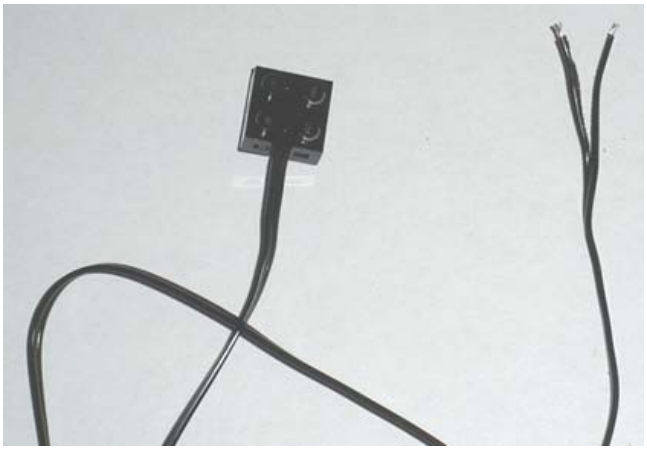


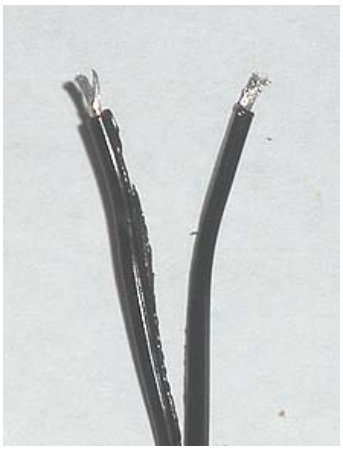
Repeat this for the other two pairs of conductors (red-green and yellow-blue) and the remaining half-meter cables.



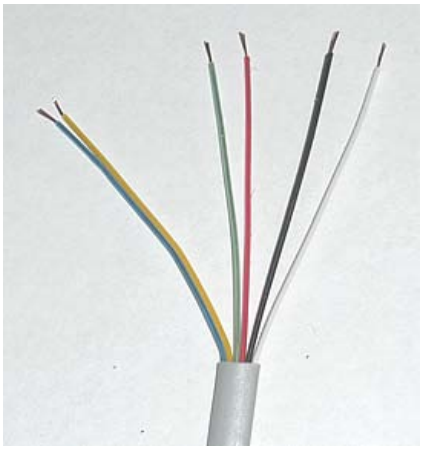
Plug the cables into the NXT to make sure everything fits correctly.

4. **Prepare the Motor Cables**
   Take two 1280 mm connecting leads and cut them in half. Using a pair of scissors, cut down the middle of the insulation of one of the half-leads to separate the conductors. Using the wire stripper, strip about 2 mm of insulation from each end. Repeat this for two more halves so that you have three leads with a LEGO connecter at one end and stripped conductors at the other.

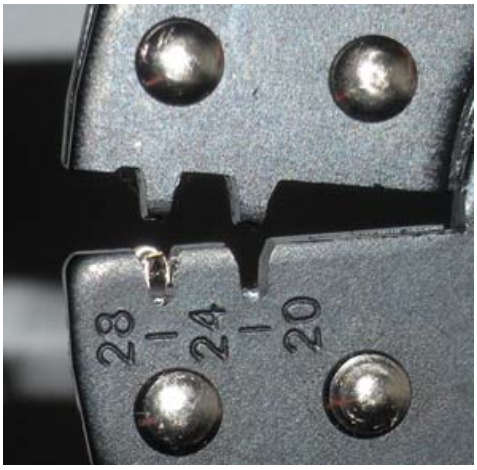




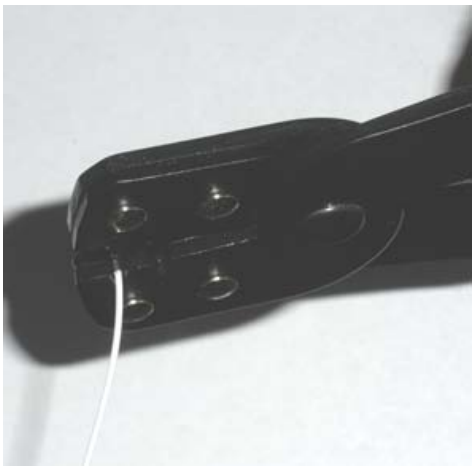
   Use the wire stripper to strip about 2 mm of insulation from each of the conductors at the other end of the 4-5 meter RJ12 telephone cable.

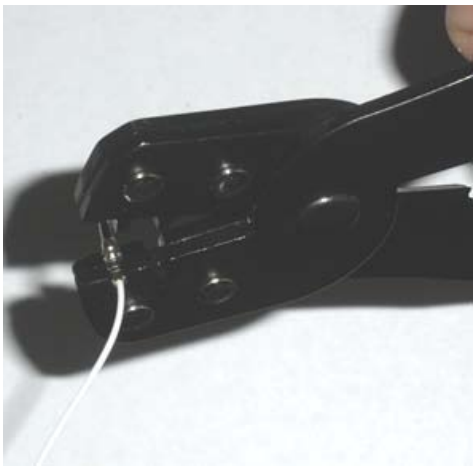


5. **Attach D-sub Connectors**
   Load a female D-sub connector pin into the 24-28 AWG slot of the D-sub crimper. Be sure to insert the pin so that the opening is facing down. Squeeze the crimper slightly to secure the pin in place.

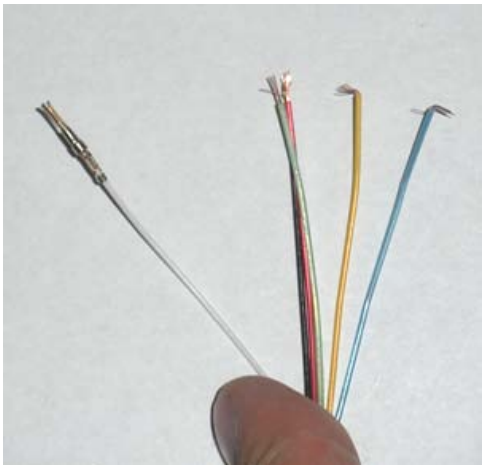


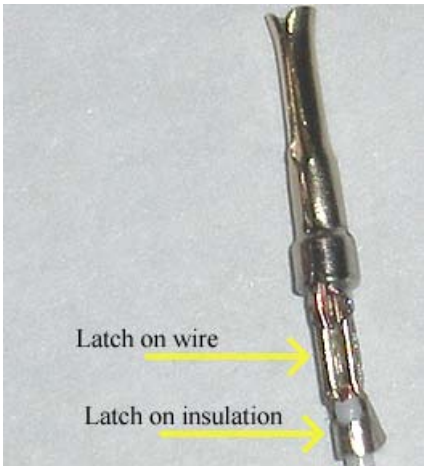
Take one of the conductors from the RJ12 telephone cable and carefully slide it into the pin so that only a very small amount of insulation is inside the pin. Then squeeze the crimper tightly to secure the pin to the cable.





Open the crimper and carefully remove the pin. If everything was done correctly, the back part of the pin should be latched onto the insulation and the thinner section towards the middle should be latched onto the bare wire.

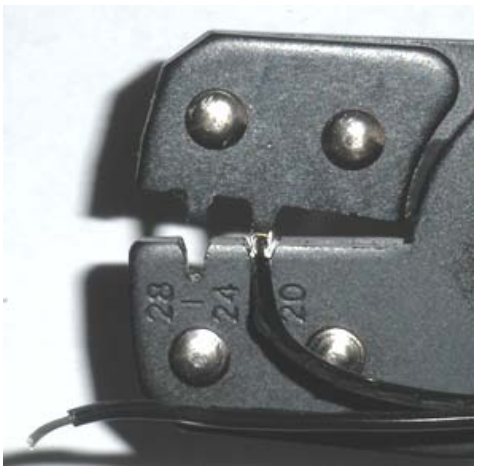


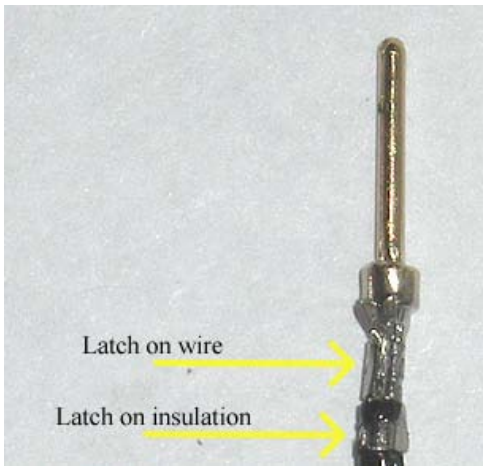


Repeat this procedure for the rest of the RJ12 conductors.

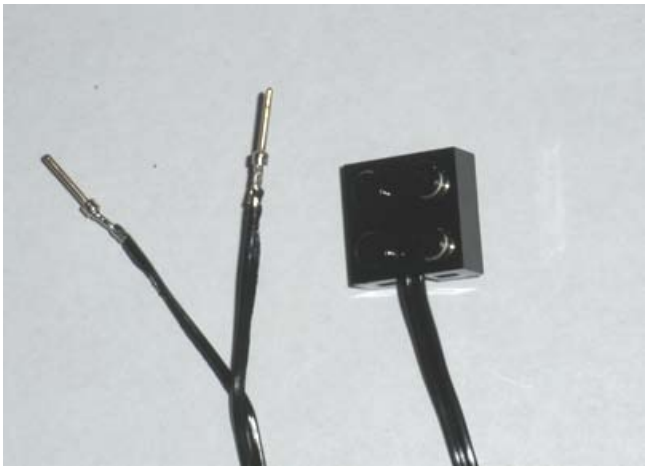
Load a male D-sub connector pin into the 20-24 AWG slot of the D-sub crimper. (If this slot is not available, stick with the 24-28 AWG slot.) Be sure to insert the pin so that the opening is facing down. Squeeze the crimper slightly to secure the pin in place.

Take one of the conductors from a 1280 mm connecting lead and carefully slide it into the pin so that only a very small amount of insulation is inside the pin. Then squeeze the crimper tightly to secure the pin to the cable. Open the crimper and carefully remove the pin. As before, the back part of the pin should be latched onto the insulation and the thinner section towards the middle should be latched onto the bare wire.





Repeat this procedure for the rest of the 1280 mm connecting lead conductors.



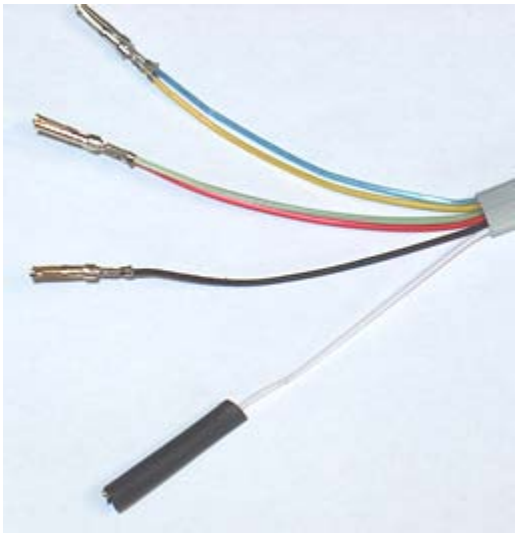
6. **Insulate and Test**

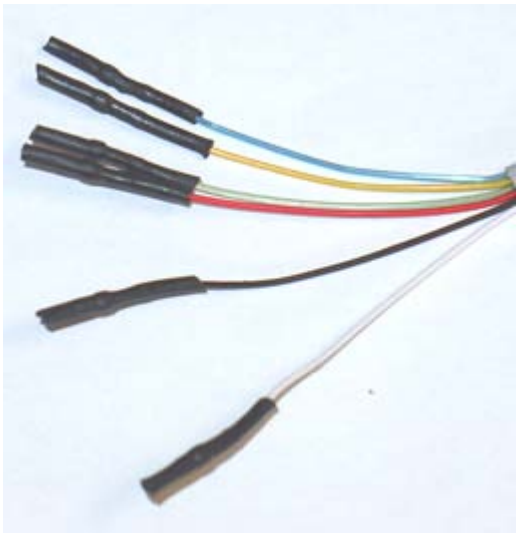
The 1280 mm connecting leads will now easily connect to the RJ12 conductor pairs using the D-sub connectors.

However, if the pins from each connection touch, then a short circuit will result, which will prevent the motor from working. Therefore, each connection must be insulated. This is easily done with heat shrink tubing, which has the added benefit of squeezing the pins on the cable, making then even more secure.

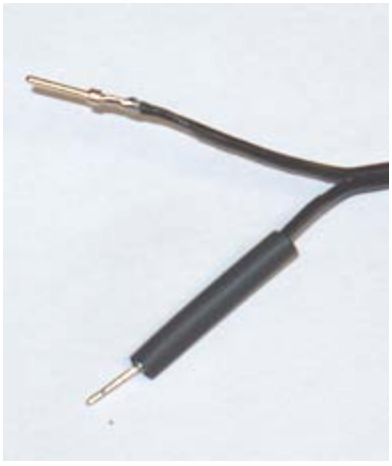
First, cut a tube of heat shrink with 3/32" inner diameter into 12 pieces, each of a length of about 3/4". Six of these pieces will go over the female pins, and the other six will go over the male pins. The heat shrink goes on each type of pin differently.

For the female D-sub pins, place the heat shrink piece over each one so that the end of the heat shrink is flush with the ***end*** of the pin. Apply heat from a soldering iron evenly until the heat shrink has a good grip on the pin.

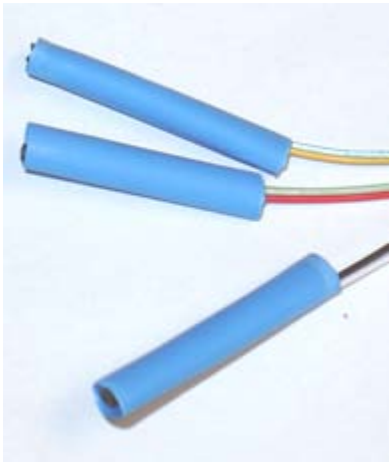


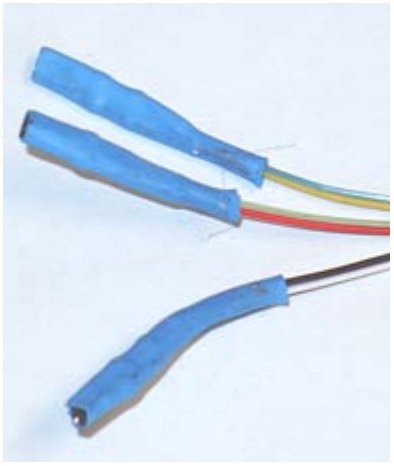


For the male D-sub pins, place the heat shrink piece over it so that the end of the heat shrink is flush with the ***base*** of the pin. Again, apply heat from the soldering iron evenly until the heat shrink has reached its final size.



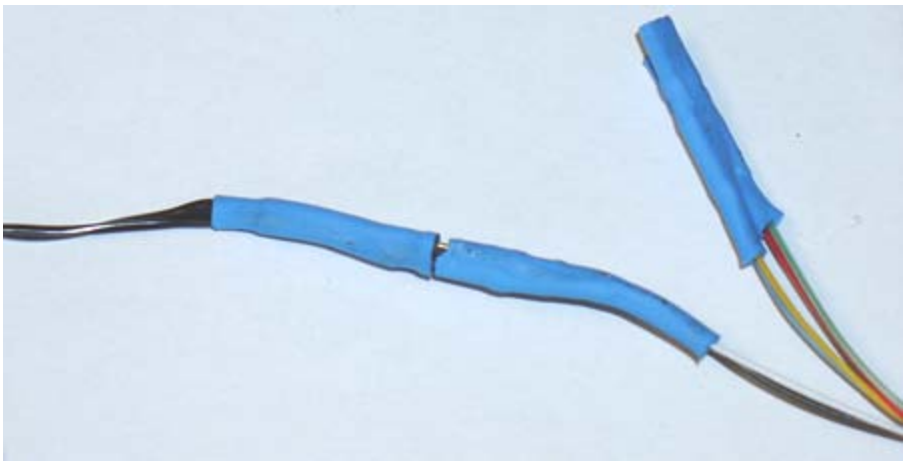
To make each pair of pins even more secure and easier to work with, we're going to add another layer of heat shrink. Cut a tube of 3/16" inner diameter heat shrink into 6 pieces, each 1" long. Place each piece around each pair of pins (black-white, red-green, and blue-yellow for the female pins) so that it is flush with the end of the heat shrink that is already on the pins. Apply heat evenly until it has completely shrunk.

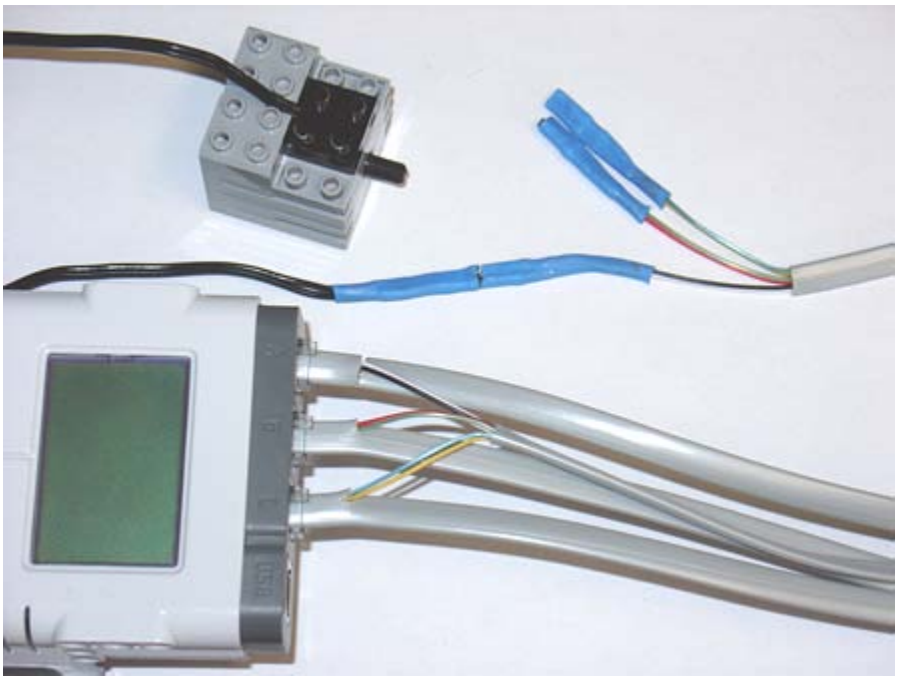




Now you have pairs of pins that can easily be connected and disconnected. This allows you to only use the connections you need. For example, for the Straight Line Challenge, you only need to connect one NXT motor cable, instead of having to deal with all three.

Test the connection by inserting the male pins into the female connectors and running a program on the NXT to make sure the motors are receiving the appropriate power.





If desired, electrical tape or heat shrink may be wrapped around a connected pair of pins so that they will be unable to disconnect. However, the above procedure is recommended so that the pins will disconnect if enough force is applied. This way, if too much stress is being applied to the cable, it will simply disconnect rather than break, which should extend its lifetime significantly. Also, this will prevent students from relying on using the cable to control the boat, since the cable would disconnect if they were to pull too hard on it.