

# BEST Robotics Incorporated Tether System Box Assembly

(revision 1.3, 21Aug2001)

This document describes how to assemble the three boxes used in the tether system – the RCVR (receiver) box, the Robot box, and the Tether box.

In general, each of the three boxes consists of a plastic box, a PC (printed circuit) board with components on it, and some hardware (screws and nuts) to hold it together.



Figure 0, the mounting hardware

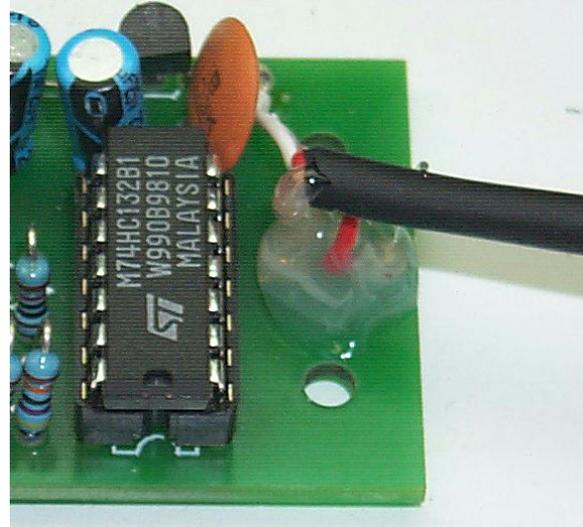
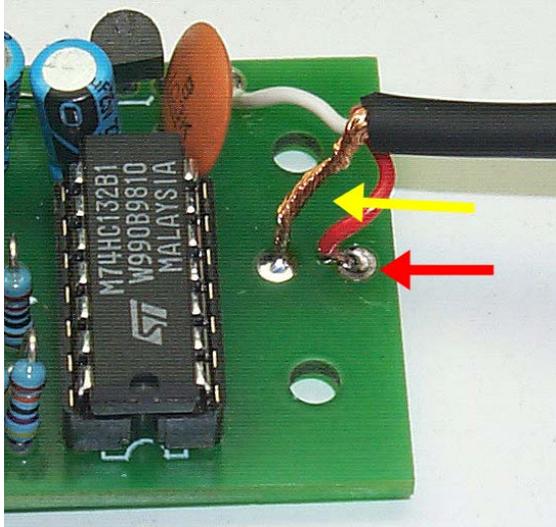
Figure 0 shows the mounting hardware used for the three boxes. On the left is the hardware used in the RCVR box, in the middle is the hardware used in the Robot box, and on the right is half (4 of each are needed) the hardware used in the tether box. Note that the #2 hardware (2-56 x 3/4" screw and 2-56 nut) is smaller in diameter than the #4 hardware (4-40 x 3/4" screw, etc.).

You will need a small flat bladed screwdriver for the mounting hardware and a small Phillips screwdriver to fasten the boxes together. I found finger grip on the nuts was sufficient but you may want to use needle nose pliers or a small wrench. A nut starter will be helpful but is not required.

## General Hints & Notes

Before you begin assembly you need to QC the PC boards. Some may have been damaged in shipment. Typically, some of the small gold pins to which you will connect the ribbon cable may be bent. You can carefully straighten them with needle-nose pliers.

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Figures 0.5A & 0.5B, cable insulating with hot glue

Figure 0.5A illustrates another problem discovered while assembling the boards. The bare copper shield of the cable, the top (yellow) arrow, should have been pulled all the way through the hole before being soldered. Not all were. In the case of figure 0.5A, if the cable shifts the shield wire could move and short to the adjacent PCB board land, the bottom (red) arrow, or to the nearby integrated circuit. This must be corrected. Either re-solder the shield, pulling it all through the hole in the PC board and trimming the excess, or use hot glue to both insulate the shield wire and hold it in place as shown in figure 0.5B. Be careful not to glue things in the way of the mounting hardware, which will be in the nearby holes.

Note that the color of the cable's insulation and the insulation of the wires within the cable may differ from these photos (we used several different types of cable). Also note that the cable is longer than previous years and has a 6 pin DIN plug on its end instead of a 3.5 mm stereo jack. The tether box will now plug directly into the team's controller without using the "buddy cable" with the DIN plug and 3.5 mm stereo plug.

The Velcro you will be putting on the bottom of the three boxes is  $\frac{3}{4}$ " wide with an adhesive back and is not part of the kit. You will be sticking the hook pieces onto the boxes. Give each team 4 matching loop (fuzzy) pieces for their robot. Two will be used to secure the robot box and two will be used for the RCVR or tether box, whichever is being used.

If you come up short on some of the mounting hardware, many items are available locally at building supply stores. If you are short some standoffs, you can replace them with appropriately cut lengths of drinking straw. Be resourceful!

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RCVR Box Assembly



Figure 1, close-up of the RCVR board mounted to the radio RCVR

Figure 1 shows the radio RCVR with the RCVR board mounted to it. Attach the RCVR board to the radio RCVR by carefully aligning the black connectors on the board with the slots in the radio RCVR housing, then pressing the RCVR board into place. When properly seated the plastic of the radio RCVR should touch the green circuit board.

Some finagling is allowed here. If the alignment of the black connectors on the board is slightly off you can bend them gently into position. For more serious misalignment you can carefully heat the solder joints on the RCVR board and reposition the recalcitrant connectors.

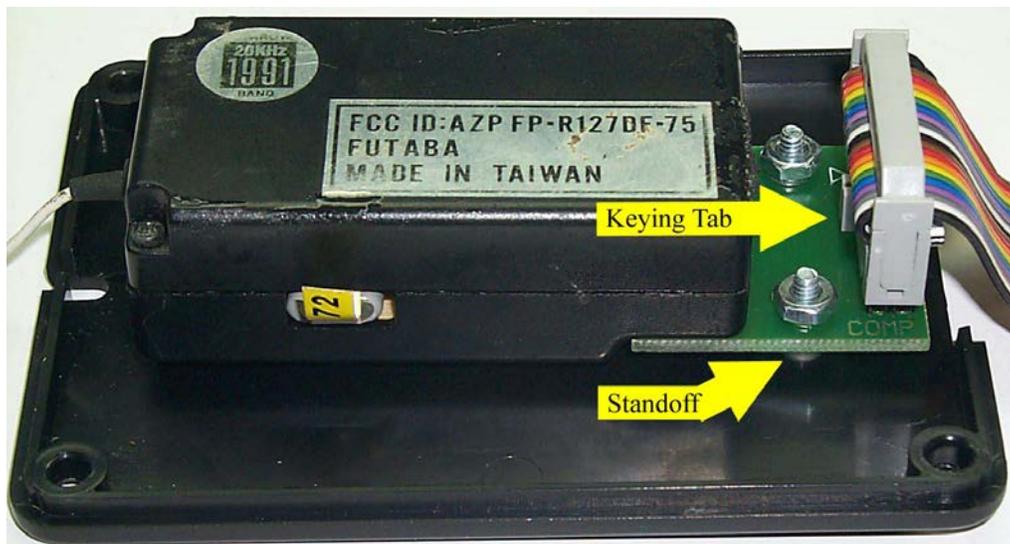


Figure 2, the RCVR board with RCVR and cable mounted to lid

Figure 2 shows the radio RCVR and RCVR board sub-assembly bolted into the lid of the RCVR box. The RCVR box lid is the 4" x 3" one with only two screw holes (in addition to the four holes in the corners for fastening the box together). Orient the radio RCVR and board as shown and fasten the board to the lid using 4-40 hardware with a 1/2" screw. There is a 0.125"

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nylon standoff, barely visible, under the board. Looking at it like this, as you work your way down a screw you will have:

- ◆ A 4-40 nut
- ◆ A 4-40 lockwasher
- ◆ The RCVR board
- ◆ A nylon standoff, .125" long
- ◆ The plastic box lid
- ◆ The 4-40 screw head, ½" screw

Tighten the screws securely, we don't want these boxes coming apart in competition. Just remember that some parts are plastic so don't overdo it.

Attach the ribbon cable to the RCVR board. (Your ribbon cable may be gray.) If you look closely at a ribbon cable connector you will see that it has two keying tabs sticking out on one side. *These two keying tabs go on the side toward the radio RCVR and are barely visible in figure 2.* It is very important that this cable connector be oriented correctly. As a double check after plugging in the cable, the side of the connector nearest the edge of the RCVR board should be smooth (no tabs sticking out).

Note that the two connectors on the ribbon cable have the cable coming out on different sides. Use the connector oriented as shown in figure 2 so the cable comes out of the connector and goes right out the slot in the box lid. The other connector will work, but you'll have to route the cable back over the connector, which is awkward and loses about ½" of cable length.

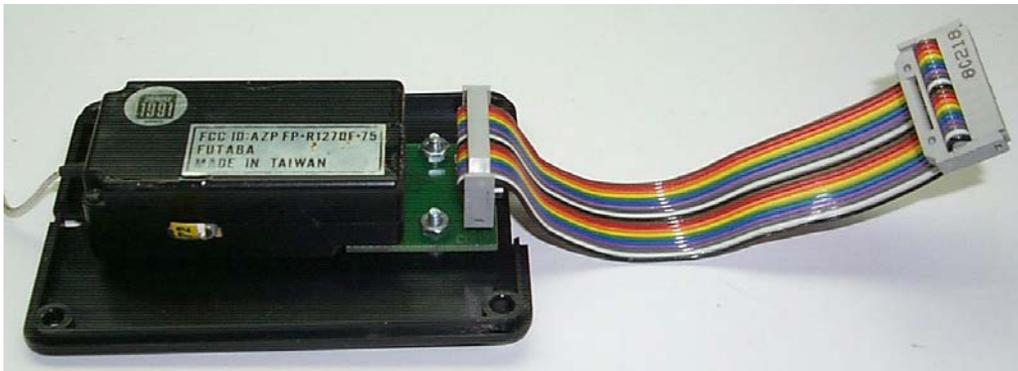


Figure 3, the completed RCVR lid assembly

Figure 3 shows the completed RCVR box lid assembly. Put a piece of foam rubber, about 3" x 2" x 1", in the bottom of the box, put the lid assembly on, and fasten it together using the screws for the box.

Be sure to put the RC frequency number on the outside of the box somewhere. Stick two strips of Velcro, 2" x ¾", the hook (not the fuzzy) part, on the bottom of the box. The teams will put the matching fuzzy part on their robots to hold the box in place. Center the Velcro on the bottom of the box, with the two strips positioned ½" apart and running parallel to the long axis of the box.

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Robot Box Assembly

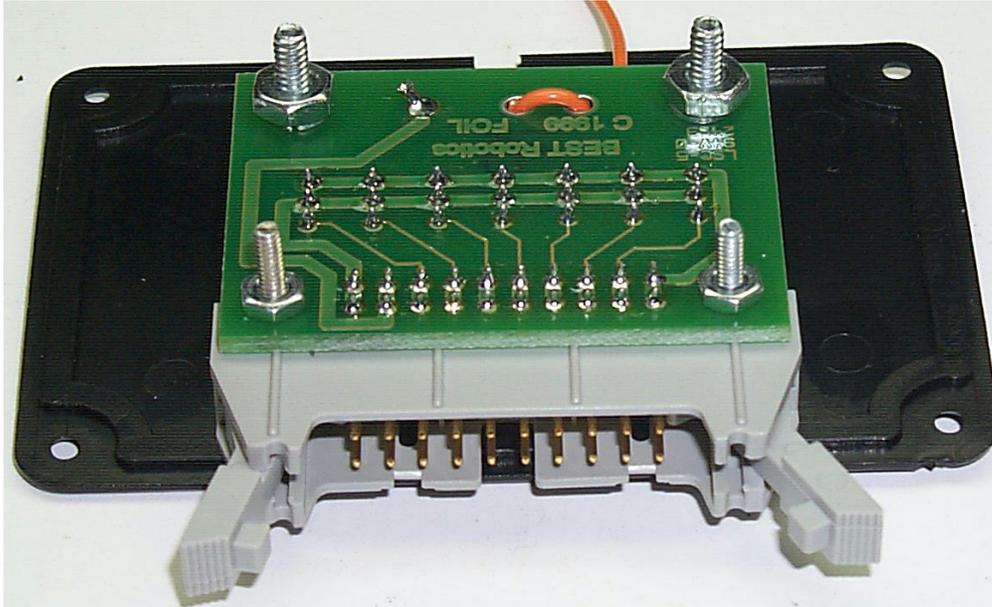


Figure 4, the Robot board fastened to its box lid

Figure 4 shows the robot board fastened to its box lid. This assembly uses two different sizes of hardware. The smaller screws passing through the gray ribbon cable socket are 2-56 by  $\frac{3}{4}$ " long (those nearest the camera in the photo above) and the larger screws farthest from the camera are 4-40 by  $\frac{3}{4}$ " long.

Looking at it like this, as you work your way down a 2-56 screw you will have

- ◆ A 2-56 nut
- ◆ The Robot board
- ◆ The gray connector (soldered to the board)
- ◆ The plastic box lid
- ◆ The 2-56 screw head,  $\frac{3}{4}$ " screw

As you work your way down a 4-40 screw you will have:

- ◆ A 4-40 nut
- ◆ A 4-40 lockwasher
- ◆ The Robot board
- ◆ An aluminum standoff,  $\frac{5}{16}$ " long
- ◆ The plastic box lid
- ◆ The 4-40 screw head,  $\frac{3}{4}$ " screw

One method of doing this admittedly tricky assembly is as follows: Insert the screws into their holes from the top of the lid. The smaller 2-56 screws go in the holes near the edge of the lid; the larger 4-40 screws go in the holes near the center of the lid. Put a piece of cardboard over the screws to hold them in place and turn the lid upside down. Put a  $\frac{5}{16}$ " aluminum standoff on each of the larger 4-40 screws, then turn the robot board upside down and put it onto

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the four screws as shown above. Now put a 4-40 lockwasher on each of the 4-40 screws, followed by a 4-40 nut. Put a 2-56 nut on each of the smaller 2-56 screws. Tighten all the screws securely, but do not overtighten.

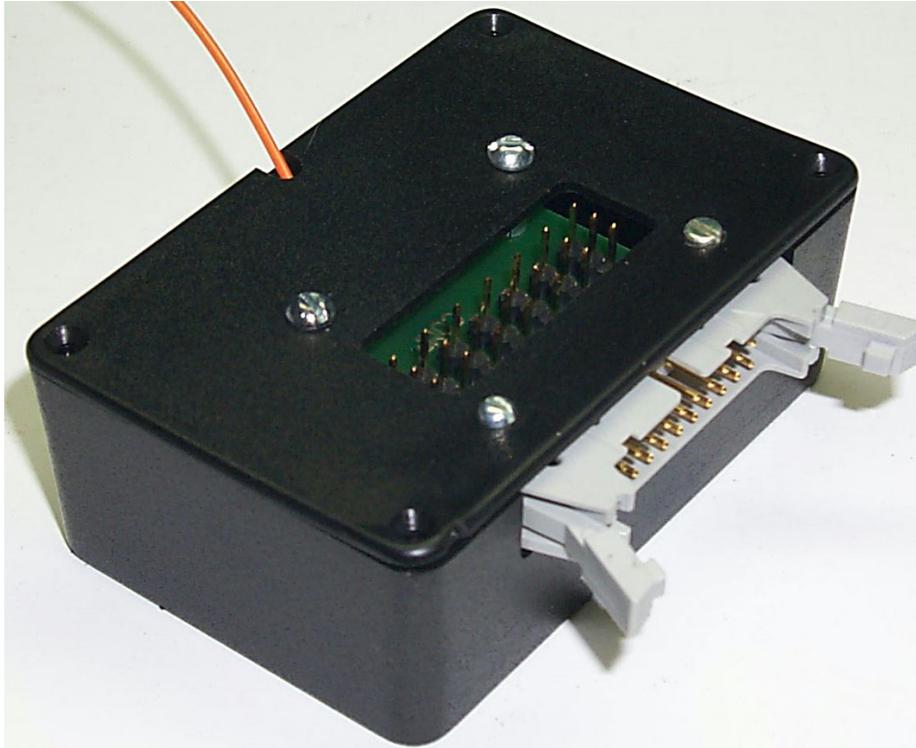


Figure 5, the robot box prior to fastening the lid

Figure 5 shows the robot box with the lid inserted into the bottom. This is the smaller of the boxes, 3" x 2" x 1". There is a slot milled into the bottom of the box through which the gray ribbon cable connector protrudes. There is a small slot milled into the lid through which the wire will pass. After putting the box top and bottom together and routing the wire through the slot, fasten the box together using the screws for the box. (These screws are smaller than those for the larger boxes). Stick two strips of Velcro, 2" x 3/4", the hook (not the fuzzy) part, on the bottom of the box. The teams will put the matching fuzzy part on their robots to hold the box in place. Center the Velcro on the bottom of the box, with the two strips positioned 1/2" apart and running parallel to the long axis of the box.

The wire coming out of the box is a power connector. It should be connected to the positive voltage lead of the inline connector illustrated in the kit notes. This connector is made from the white power connectors and is not detailed here.

If parts are not available to add the inline connector you can tin the end of the wire and tell your teams to connect it to the screw terminal on the switched side of their power switch, so the power to the box turns on and off along with the rest of the robot.

Label the servo connections on the top of the box using the latest kit notes as a guide. The robot box servo connections are not keyed like those on the radio RCVR so it is important to label both which channel is on each connection and where the black, red, and white (or other color) wires of each servo connector plug in.

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Figure 6, the tether board attached to its box lid

Figure 6 shows the tether board fastened to its box lid. The tether box lid is the 4" x 3" one with six holes (in addition to the four holes in the corners for fastening the box together).

The tether board mounts to the lid using four sets of 4-40 by 1/2" long hardware. There are two screws at each end of the board (in figure 6 one of the nuts is hidden under the ribbon cable).

As you work your way down each of the 4-40 screws you will have:

- ◆ A 4-40 nut
- ◆ A 4-40 lockwasher
- ◆ The Tether board
- ◆ An aluminum standoff, 3/16" long
- ◆ The plastic box lid
- ◆ The 4-40 screw head, 1/2" screw

Again, a recommended assembly method is to put all four screws into the lid, then put a piece of cardboard on top and flip it over. Add the 3/16" aluminum standoffs, board, lockwashers, and nuts. Tighten securely, but do not overtighten.

Attach the ribbon cable to the Tether board. (Your ribbon cable may be gray.) If you look closely at a ribbon cable connector you will see that it has two keying tabs sticking out on one side. *These two keying tabs go on the side toward the components on the tether board.* You can see the tabs in figure 6. It is very important that this cable connector be oriented correctly. As a double check after plugging in the cable, the side of the connector nearest the edge of the tether board should be smooth (no tabs sticking out).

Again, note that the two connectors on the ribbon cable have the cable coming out on different sides. Use the connector oriented as shown in figure 6 so the cable comes out of the connector and goes right out the slot in the box lid. The other connector will work, but you'll

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have to route the cable back over the connector, which is awkward and loses about ½” of cable length.

Put a cable tie through the two remaining holes. This will be the strain relief for the cable with the DIN plug on the end. Make a small loop in the cable (barely visible in figure 6) and tighten the cable tie securely around the cable where it is double. You can trim the cable tie if you like but it is not required.

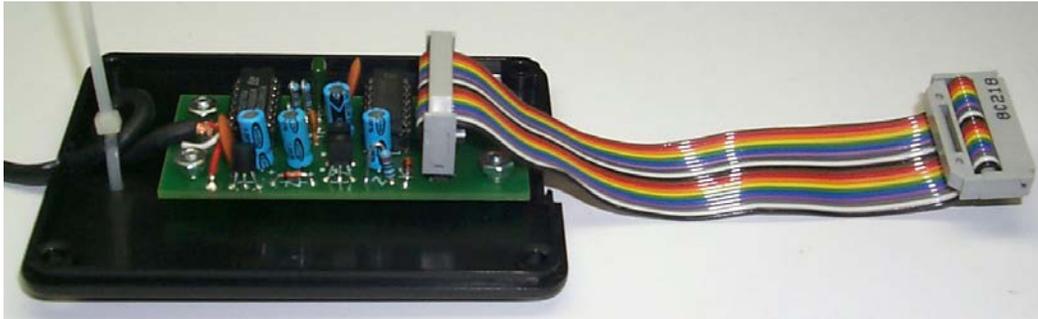


Figure 7, the completed Tether box lid assembly

Put the tether lid assembly onto the bottom of the box and fasten it together using the screws for the box. Stick two strips of Velcro, 2” x ¾”, the hook (not the fuzzy) part, on the bottom of the box. The teams will put the matching fuzzy part on their robots to hold the box in place. Center the Velcro on the bottom of the box, with the two strips positioned ½” apart and running parallel to the long axis of the box.