The Input Connector Board

1. Organization of the Board

The standard input connector. Figure 1 shows the top of the connectors used to attach input cables to the Input Connector Board. A four-wire ribbon cable enters each connector. The first wire (darker in this photo) is the positive power connection and the second wire is the negative. Thus, if you place a plug unto the wrong receptacle, you may not generate a signal where you need it, but no harm will be done. Finally, no matter where you plug in, the wires will always point toward the hole in the center of the Input Connector Board.

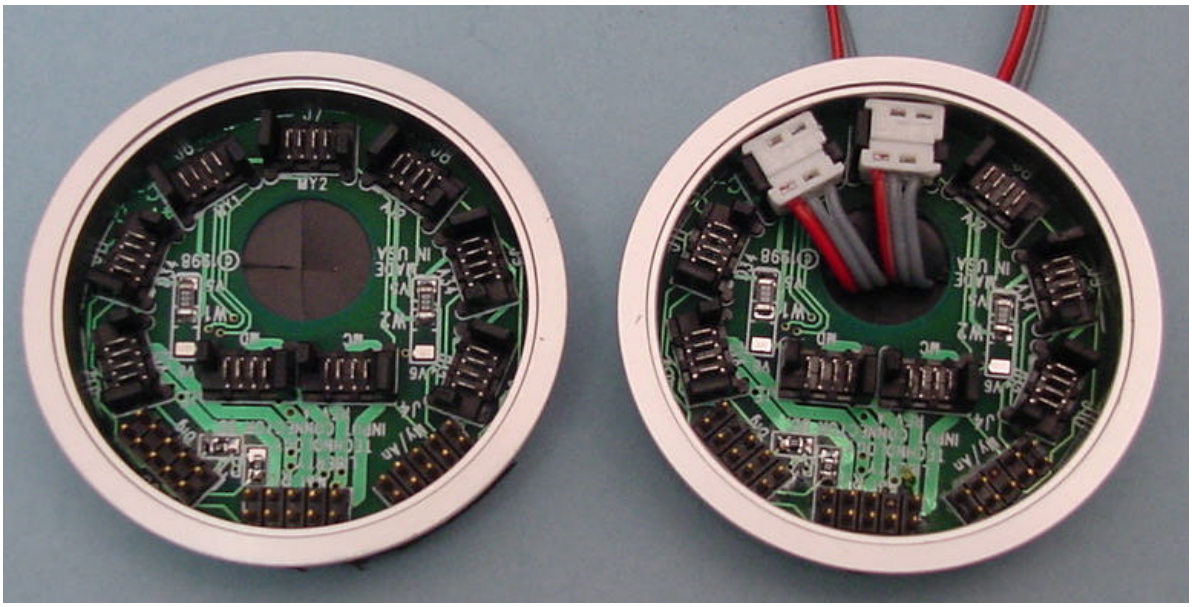

Figure 1. Making connections to the Input Connector Board. On the left you can read the labels MY1 and MY2. On the right, the connectors from the preamplifiers are passed up through the rubber seal and pushed in place. The wires block further view of the labels.

The connection points. There are nine plug receptacles on the Input Board with short labels. Study Figure 2 and Table 1 where the labels are identified. Two receptacles are primarily used for myoelectric inputs, two are for proportional analog signals, two are for on-off digital signals, and two are used to connect motors for shoulder locks or vibratory feedback. The remaining connector is for passing a pair of extra or spare signals around the elbow and all the way to a connector on the distal end of the main circuit board.

Labeling of connectors. On all but the simplest configurations of a Boston Arm System, the connecting cables to the Input Connector Board are labeled during assembly. This means that you can unplug the various connectors to route wires without fear of forgetting where the plugs go afterward. If you need to undo the connectors, check first to be sure labels are in place. The discussion below is mainly for users who are planning to try several configurations with a particular client.

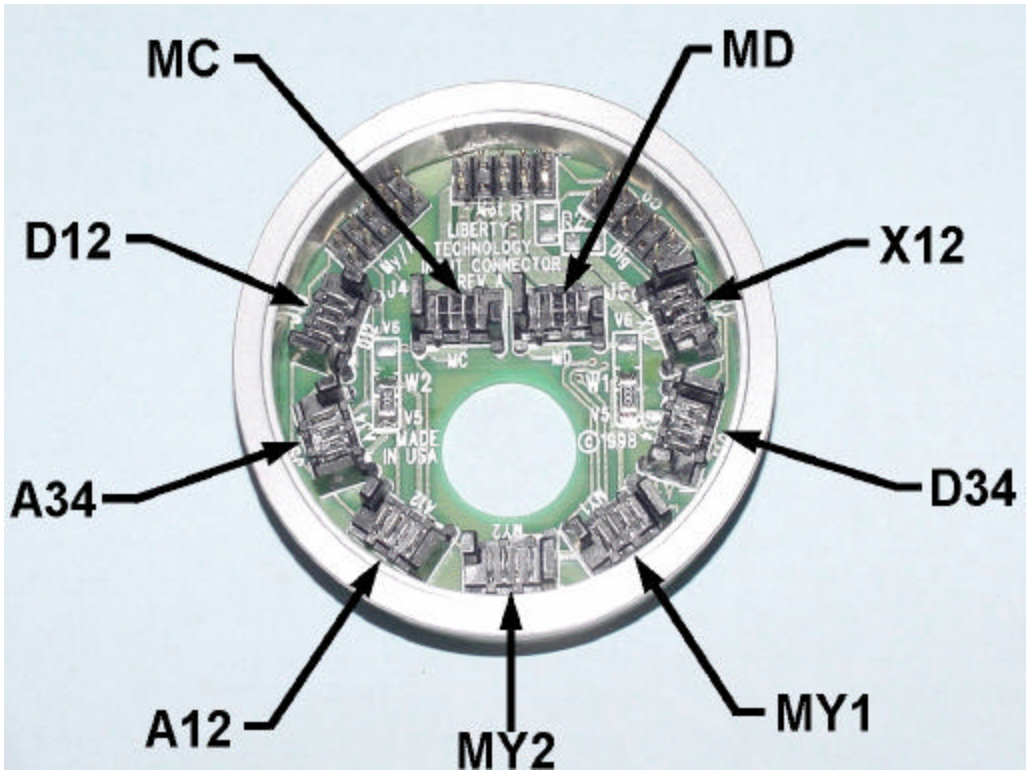

Figure 2. Connection labels. The labels here are those used in Table1 below. In most cases the cables that attach to a particular connection point will also have the same label.

Table 1. Receptacle Pin Assignments

Label	Pin 1	Pin 2	Pin 3	Pin4	Purpose
MY1	+ 5.0V	0.0V Ground	Analog 5	Myo Input 1	myoelectric input #1
MY2	+ 5.0V	0.0V Ground	Analog 6	Myo Input 2	myoelectric input #2
A12	+ 5.0V	0.0V Ground	Analog 1	Analog 2	analog inputs 1&2
A34	+ 5.0V	0.0V Ground	Analog 3	Analog 4	analog inputs 3&4
D12	+ 5.0V	0.0V Ground	Digital 1	Digital 2	digital inputs 1&2
D34	+ 5.0V	0.0V Ground	Digital 2	Digital 4	digital inputs 3&4
MC	(+12V)*	0.0V Ground	Motor C 1	Motor C 2	output to motor C
MD	(+12V)*	0.0V Ground	Motor D 1	Motor D2	output to motor D
X12	+ 5.0V	Remote On	Extra 1	Extra 2	to XTR on circuit board

* 12V here only if requested

2. Connecting Input Devices

Connecting myoelectrode preamplifiers to MY1 and MY2. The preamplifiers for the Boston Digital Arm provide proportional control. They come in three styles. When it is convenient, the miniature preamplifiers are placed in the socket in direct contact with the control muscles. Alternatively, they may be placed into the wiring that connects the Input Board to separate metal electrodes. For a hard socket, three shielded wires from the preamp terminate in lugs that accept the 4-40 studs used on LTI cavity-back metal electrodes. Finally, three shielded wires from each preamp can be supplied with

snaps to connect to the metal electrodes in a roll-on sleeve. The first myoelectrode is connected to MY1 and the second myoelectrode to MY2.

Connecting LTI Touch Pads Ô to A12 and A34. Touch Pads are analog devices that provide proportional control. These force-sensing resistors (FSR's) are used in pairs to control multiple devices or singly to activate a device selection scheme or to operate a force-sensitive servo. With more than two pads, the first pair is connected to A12 and the second pair to A34 using a BE341 Cable, Two Touch Pad Plugs. Often a pair of Touch Pads connected to A12 will operate the terminal device, while a single pad connected to A34 with a BE340 Cable, One Touch Pad Plug will operate the elbow by using a force servo. Touch Pads must be mounted in a certain way. (See Input Devices, Touch Pads.) These sensors are almost exclusively used with frame sockets for shoulder disarticulation patients. (See Chapter Frame sockets for use with Touch Pads.)

Connecting the LTI Linear Transducer to A34 for servo operation. The positional servo is a popular control choice for the transhumeral amputee because the biceps and triceps muscles are left free to control the terminal device myoelectrically, while the servo *independently* controls the elbow. The BE235 Linear Transducer is an analog device and is connected to A34. The transducer may also be used to as a source of variable voltage to operate other devices. It is usually connected to A34 whenever it is used. (Technically, only input A3 is used by the transducer. LTI can provide a special cable that also uses A4 if another analog input is needed.)

Connecting Switches to D12 and D34. Another popular input option is to use switches to control one or more prosthetic devices. Switches are digital (on-off) and are connected to D12 and D34. If one device is to be controlled by a switch, use D12. If a second device requires a switch, use D34. The four popular Otto Bock switches are connected using a BE230 Switch Adapter Cable that plugs into D12 or D34. While switches can be wired directly to the white input plugs, all LTI non-Bock switches are offered in "Bock compatible" versions. This means you can try several varieties of input switch either from LTI or Otto Bock without unplugging at the Input Board. As used with the Digital Arm, a switch is a logical device. It generates a positive voltage or logical 1 on a particular line or no voltage, a logical zero. Used this way, no current flows as would happen in operating a motor directly. The four wires on a BE230 Cable are + or logic 1 on wire 1, – or logic zero on wire 2, and the two output lines on wires 3 and 4.

Many switches are dual-action. For instance with the Bock 9X18 Dual-Action Pull Switch, you pull a little to activate motion in one direction and pull harder for motion in the opposite direction. The first switch position creates a logical 1 on line 4, and the second a logical 1 on line 3. When a dual-action switch is used to generate a single signal for device selection, the pull-hard position is used. It generates a digital 1 on line 3. Signals on line 2 or 4 are ignored by the program.

Connecting a remote on-off switch to X12 and D34. At times it is impossible for a user to access the on-off switch on the battery. In such a case a switch can be placed elsewhere to put the elbow into deep sleep or to bring it fully alert again. Of course, the switch on the battery will still be needed when it is time to recharge, but for the rest of the time the remote switch will conserve power almost as well as

turning the unit off at the battery. The remote on-off feature is built into the standard Boston programs, but the connections are customized to suit the user. Usually two plugs go to the Input Board from a Bock four-socket connector. The preferred switch then becomes the 9X25 Rocker Switch. You will need a BE345 Cable. One plug will be labeled X12 and the other D34. For a remote on-off on the forearm, see the Forearm Chapter.

3. Removing Connectors

Avoid pulling the wires to unplug the cables. Small prongs displace the insulation on the wires and squeeze the copper strands tightly to make the electrical connections. When you pull the wires, you may open this connection and cause intermittent operation. The right way to remove a plug is to pry upward, first on one side and then the other to release the hidden plastic snaps that hold it in place. A sharp pointed tool is best for this. Note that these connectors are "keyed" (not symmetrical) to assure proper alignment, so when reattaching them, make sure that the cable faces the center hole. This will align the plug.

4. Sealing the Input Board.

The Input Board is held in place by an O-ring that also acts as a seal to prevent sweat and dirt from entering the area with the plugs. It is also important to seal the area where the wires pass through the rubber backing on the Input Board. This area should be sealed with silicone tub sealant or equivalent. It is easy to forget this because you will not want to do it until you are sure that there will be no further changes. But it *must be sealed* before releasing to the user!

Figure 3. Seal the hole where the wires pass through the rubber backing. Use silicone tub seal or equivalent.

5. Adding the Cover Board

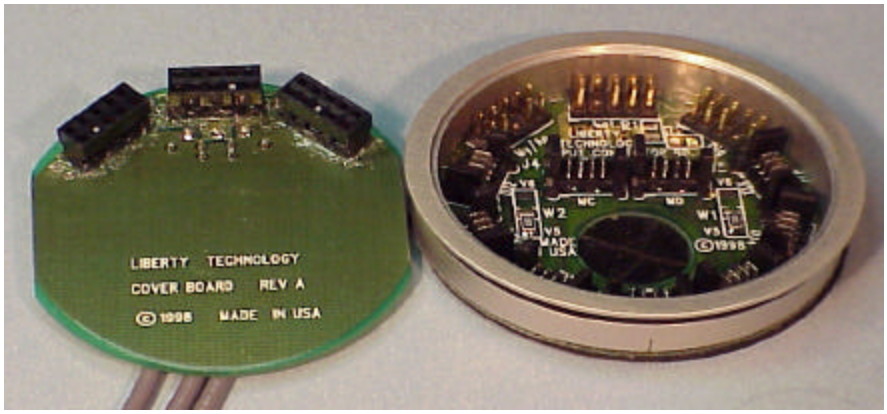

Figure 4. Cover Board before assembly onto the Input Board. (The alignment marks in Figure 6 may make it easier to see when to push the two pieces together.)

Connecting the Cover Board on the Drive Unit to the Input Board. Three cables are required to bring power to the Input Board and to direct signals back to the Main Circuit Board below the Drive Unit. Figure 4 shows the Cover Board next to the Input Board. It should be obvious that all three connectors must line up perfectly before the plugs will fit over the pins. You may find that it is easier to see what you are doing if the Input board is pulled loose from the Turntable during this installation.

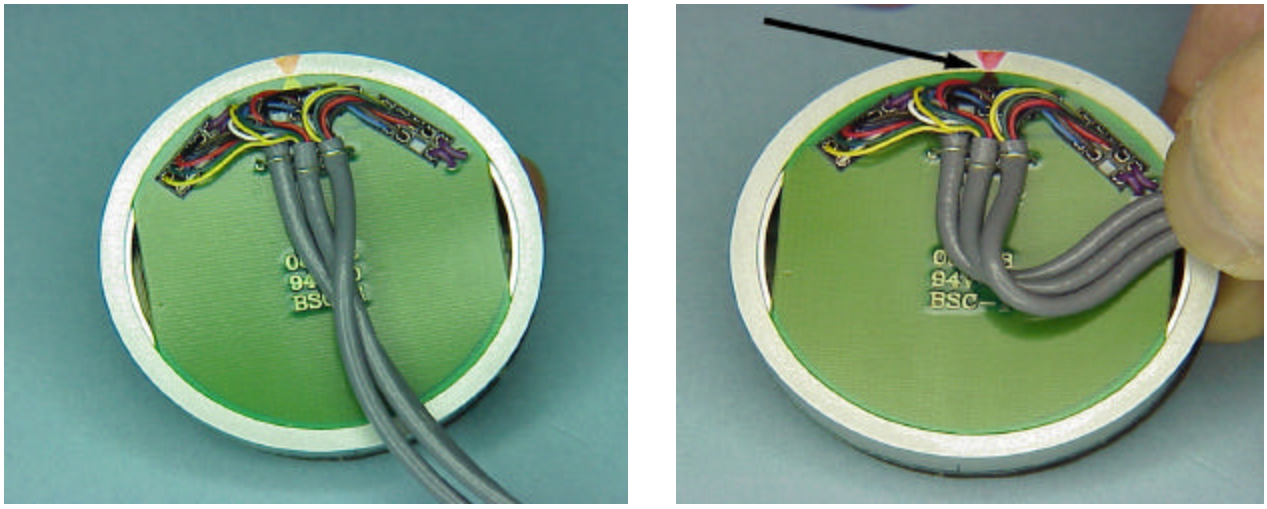

Figure 5. The photo on the left shows a simple twist in all three wires on the Cover Board. The photo on the right shows what happens when the board is rotated. The twist avoids having the wires bunch up during humeral rotation. A mark (see arrow) may bn added to assist in aligning the Cover Board and Input Board.

Disconnecting the Cover Board from the Input Board Assembly. This must be done carefully to avoid damaging the connectors or the boards. The Cover Board must be pried loose and removed. Place a fingernail or small screwdriver under the edge of the board and carefully work it around the perimeter slowly prying the edges up *evenly*. Gradually, the plugs will loosen, and you will be able to separate the two components by lifting the Cover Board straight away from the Input Board.

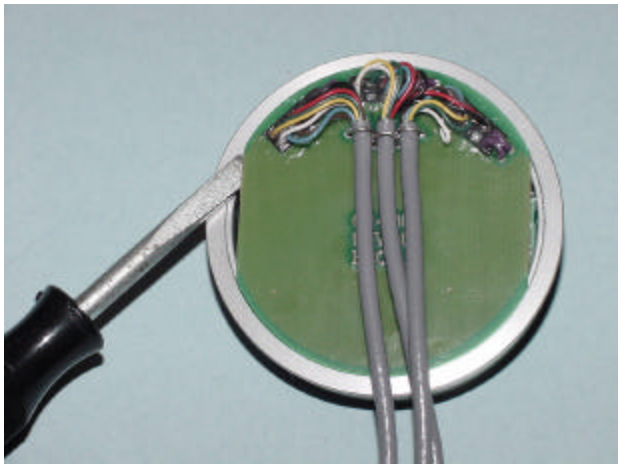

Figure 6. Carefully pry the Cover Board from the Input Board assembly. Pry first on one side and then on the other to avoid bending the connector pins.

6. The Most Popular Input Configurations

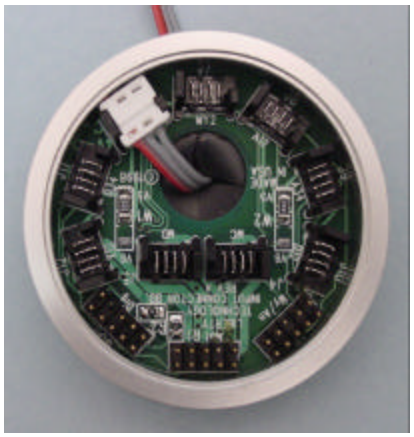

Fig. 7. Single myoelectrode.
Use MY1 only.

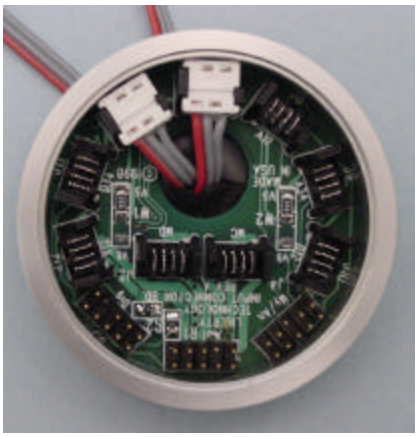

Fig 8. Two myoelectrodes.
Use MY1, MY2.

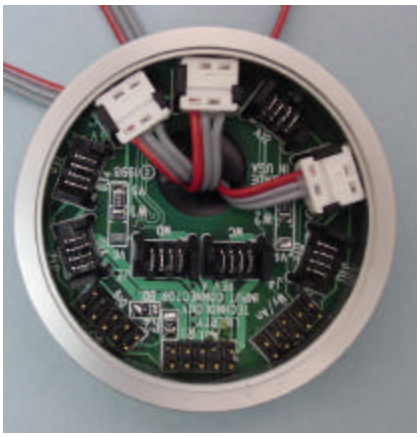

Fig 9. Two myoelectrodes, servo
Use MY1, MY2; A34

Fig 10. Two myoelectrodes, switch
Use MY1, MY2; D12

Fig. 11. Single dual-action switch.
Use D12.

Fig. 12. Two dual-action switches.
Use D12, D34.

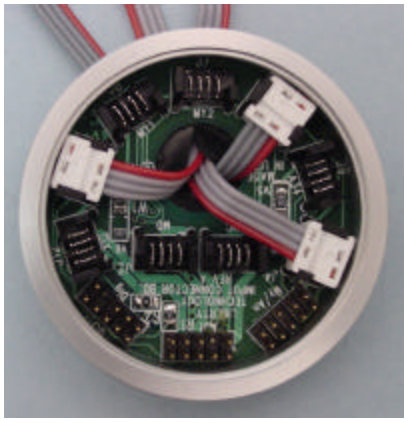

Fig. 13. 3 dual-action switches.
Use D12, D34; A12.

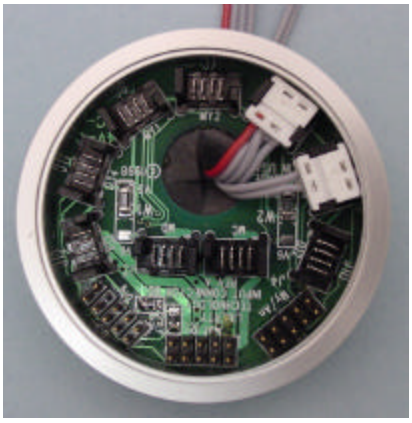

Fig. 14. 3 Touch Pads.
Use A12, A34.

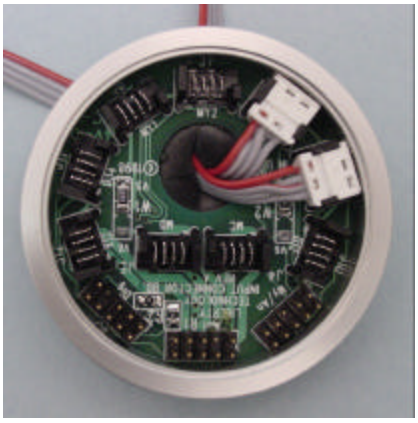

Fig. 15. 4 Touch Pads.
Use A12, A34.