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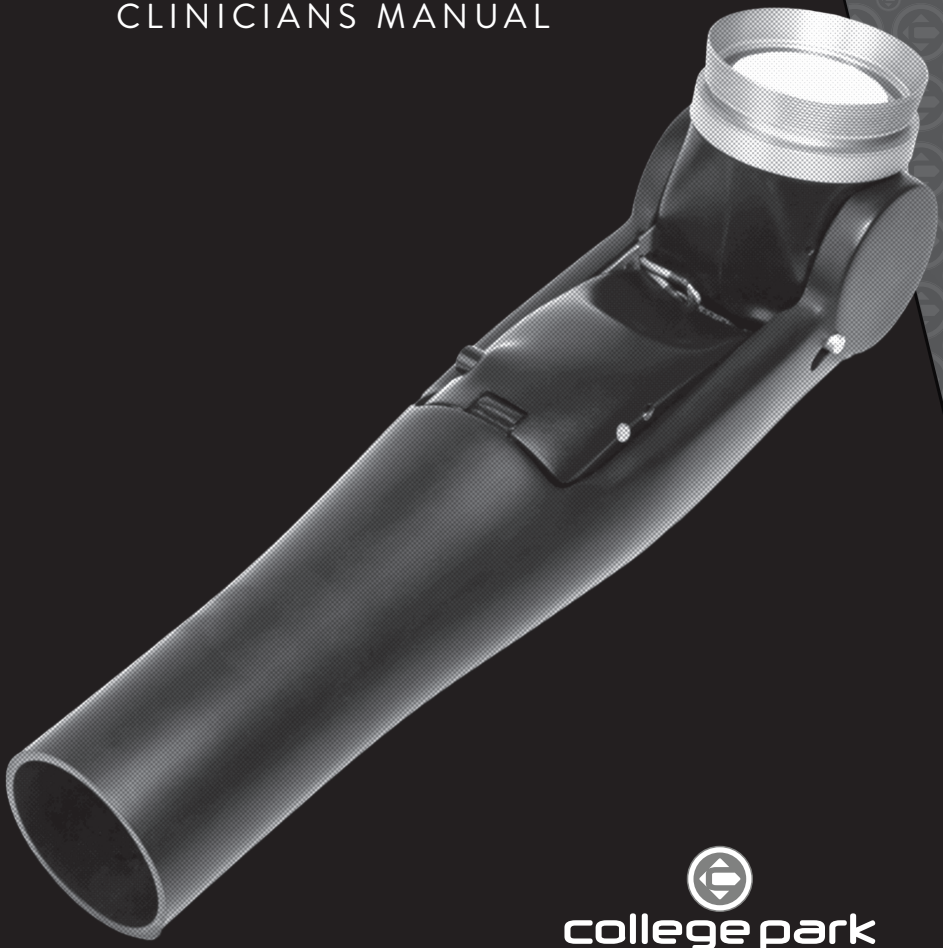
BOSTON® DIGITAL ARM

CLINICIANS MANUAL



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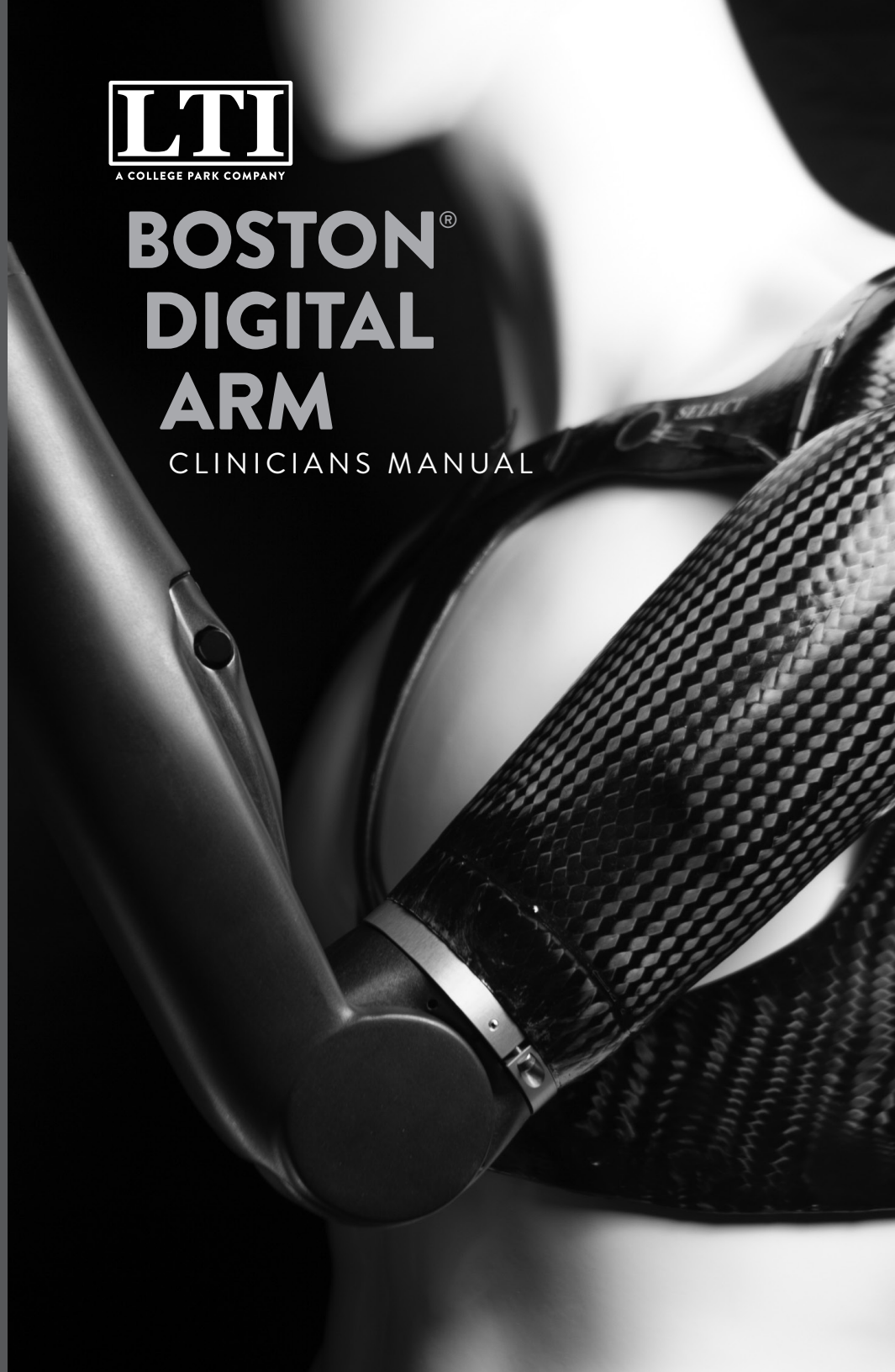


Thank you for purchasing a Boston Digital Arm System. Please reference the following instructions for setting up, wiring, laminating, attaching devices and proper orientation of your new arm. Please reference the software instructional CD for software set-up programming.

WARNINGS

Your safety and the safety of your patients is very important. Please read the following safety warnings and review with your patients thoroughly.

1. Never allow your Digital Arm to be immersed in water. If your prosthesis does become immersed in water, power it down and remove it immediately and contact your prosthetist.

2. Your Boston Digital Arm system does not require any additional lubrication. Adding lubrication will damage the arm and void the warranty.

3. Do not attempt to disassemble your Digital Arm, aside from removing the battery. The Boston Digital Arm is a very precise medical device and any modifications can harm the system and will void the warranty.

4. Your Digital Arm is built tough enough to survive a fall. If you land directly on the arm, the system will break the free swing lock by design to ensure your safety. If this happens, contact your prosthetist as soon as possible.

5. Sweat contains salt and can be very corrosive and can damage many components. If sweat begins to run down inside your prosthesis, contact your prosthetist for ways of avoiding any damage.

Contents:

Batteries & Charging

Upon receiving your Boston Digital Arm System, remove the arm from the box, insert the battery into the forearm and connect the battery to the battery charger to ensure functionality of the device.

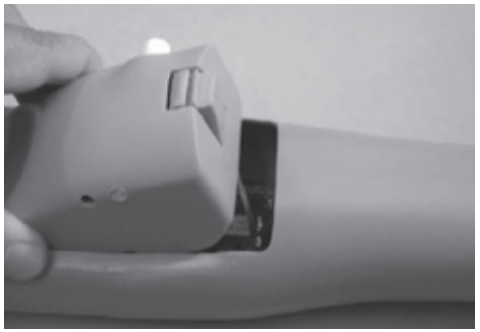
The Battery

The Boston Digital Arm System is supplied with a removable Lithium-polymer battery (BE360+). This battery supplies 2000 mAHr at 11.1 volts (nominal) for the elbow and 7.4 volts (nominal) for the terminal device(s). For most users, one battery will last an entire day depending on the prosthetic components, condition of the battery and the frequency of use.

Battery Installation and Removal

Batteries can be removed and replaced as necessary. To remove a battery simply push the lock lever toward the elbow and gently lift the front of the battery. Grasp the front of the battery continue to lift until the battery is removed.

Installing a battery is the reverse process. Place the rear of the battery into the forearm first, align the two slots on the battery with the pins inside the forearm frame. Once in position lower the forward edge of the battery until it engages the locking tab and secures the battery in place.

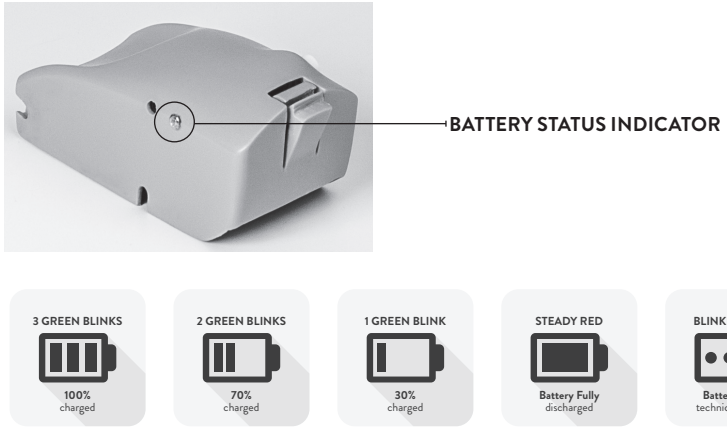


Battery Charger

Boston Digital Arm Systems are supplied with a Fast Charger (BE366+) for the Lithium polymer battery. The BE366 Fast Charger is recommended for daily use and will assure that the battery will receive a full charge and provide maximum running time.

Battery State of Charge Indicator

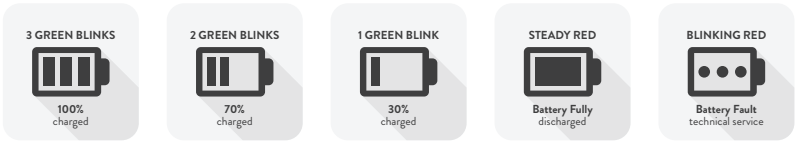
The Boston Arm Lithium battery (BE360) is equipped with a state-of-charge indicator. This indicator tells the user how much life is left in their current battery. To activate this feature, depress the battery on-off switch to turn the battery on and view the indicator light through the lens on the side of the battery. The number of blinks at turn-on indicates the state of charge.



Charging the Battery

The battery should be recharged regularly, typically daily (depending on use). If the battery discharges to the point where the elbow "low battery" alarm sounds, the system turns off immediately and requires battery charging or replacement. Battery may be charged in or out of the prosthesis.

To recharge the battery, turn the prosthesis off and insert the recharge plug into the receptacle located next to the state of charge indicator. Plug the charger into an electrical outlet and observe the light on the charger.



A full charge can take up to 75 minutes depending on the battery's state of charge.

Batteries must not be over-discharged. This can occur when leaving the battery on indefinitely when the prosthesis is not in use or due to self-discharge due to lack of use. This can cause permanent damage to the battery.

Alternate use of (2) BE360's supplied with each arm every month to keep them in good condition. Leaving one battery in storage will lead to a self discharge condition requiring service or replacement.

Terminal Device Power Board

The Boston Digital Arm System (BE300) was designed to operate the elbow and accommodate electric hands, Greifers, electric terminal devices, multi-articulating hands and wrist rotator.

The Boston Arm Lithium battery BE360+ has a 7.4V 5+ Amp output capable of supporting the high current demand of multi-articulating hands.

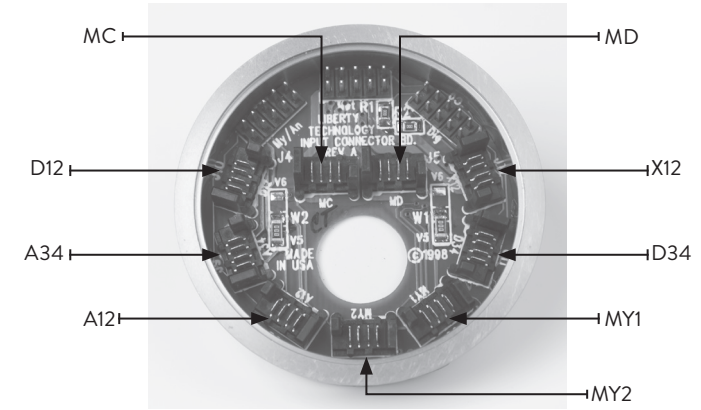
The Input Connector Board

There are 9 plug receptacles on the input board. Each receptacle has a corresponding label which describes which type of input it accepts. The table below lists the label name, the purpose of that receptacle, as well as the functions of the 4 pins on each receptacle.

Inputs

LABEL	PURPOSE	PIN 1	PIN 2	PIN 3	PIN 4
MY1	Myoelectric Input#1	+5.0V	0.0V Ground	Analog 5	Myo Input 1
MY2	Myoelectric Input#2	+5.0V	0.0V Ground	Analog 6	Myo Input 2
A12	Analog Inputs 1&2	+5.0V	0.0V Ground	Analog1	Analog 2
A34	Analog Inputs 3&4	+5.0V	0.0V Ground	Analog 3	Analog 4
D12	Digital Inputs 1&2	+5.0V	0.0V Ground	Digital 1	Digital 2
D34	Digital Inputs 3&4	+5.0V	0.0V Ground	Digital 3	Digital 4
MC	Output to Motor C	(+12V)*	0.0V Ground	Motor C1	Motor C2
MD	Output to Motor D	(+12V)*	0.0V Ground	Motor D1	Motor D2
X12	To XTR on Circuit Board	+5.0V	Remote On	Extra 1	Extra 2

Connection Labels

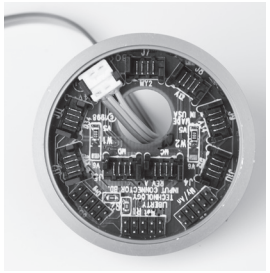


The labels here are those used in the table on the following page. In most cases the cables that attach to a particular point will also have the same label.

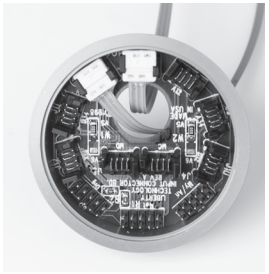
The Most Popular Input Configurations

When attaching cables, note that with the proper orientation, the wires will always face the center hole of the Input Board. The connectors are “keyed” or asymmetrical to assure proper alignment. The connector should snap into place between the two black plastic clips.

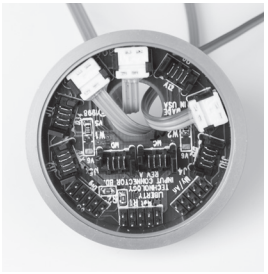
When removing cables, avoid pulling on the wires. Wires that become loose could cause intermittent operation. Using a small, pointed tool such as a small flat head screwdriver, push to release the black plastic clip on one side of the connector and then the other. This will free the connector and allow for easy removal by hand.



Single myoelectrode
Use MY1 only



Two myoelectrodes
Use MY1, MY2



Two myoelectrodes, servo
Use MY1, MY2;A34

Two myoelectrodes, switch
Use MY1, MY2;D12

Single dual-action switch
Use D12

Two Dual-action switches
Use D12, D34

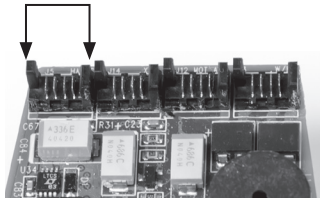
Three dual-action switches
Use D12, D34;A12

Three Touch Pads
Use A12, A34

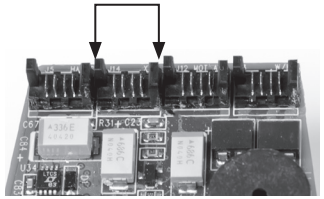
Four Touch Pads
Use A12, A34

Output Cables for Terminal Devices

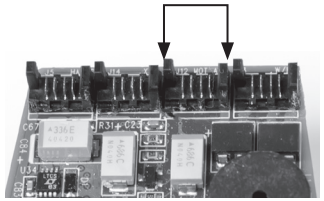
There are four (4) output connectors on distal end of control board defined as shown:



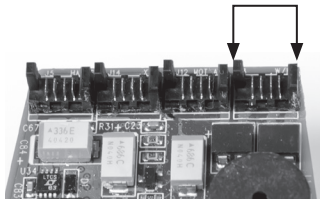
The “HANDS” receptacle is used to attach any 4-wire device requiring both a power input of 7.2V nominal and open and close signals. These are classified as hands with electronics and include Bebionic, Touch Bionic, Steeper Myo-Select and Otto Bock DMC+ and Sensor hands.



The “XTR” receptacle is used for TMR and or Hybrid applications. The BE343 cable plugs in here.



The receptacle, labeled “SERVO”, is reserved for the position feedback from a servo hand and only used with custom configurations.

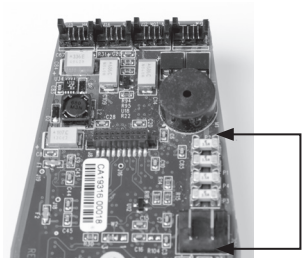


This receptacle labeled W/H (for Wrist/Hand) accepts cables powering the wrist rotator and any hand or gripper without electronics. Both outputs H and W are variable PWM for direct motor control. There are three cables associated with this receptacle:

- Use the BE243 Cable, Bock Hand or Greifer for a simple electric TD with Bock QD, and connect it to the 2-pin connection point on the Bock 9E169 Coaxial Plug.
- Use the BE247 Cable, Hand and Wrist when a wrist rotator is also to be used.
- Use the BE244 Cable, Wrist Rotator if only the wrist rotator requires PWM power as when using a 4-wire hand, gripper or split hook.

Output Fuses

The Boston Digital Arm-Plus has four (4) fuses protecting the motor outputs. If one of these fuses blows, it is an indication of a problem and the entire prosthetic system should be returned to LTI for evaluation



Selecting Cables for the TD and Wrist Rotator

With the Ottobock Quick Disconnect Wrist, cables connect using the Bock 9E169 Coaxial Plug for only a TD or a wrist rotator when 2 functions are required. The table below guides you to order and install the correct connecting cables.

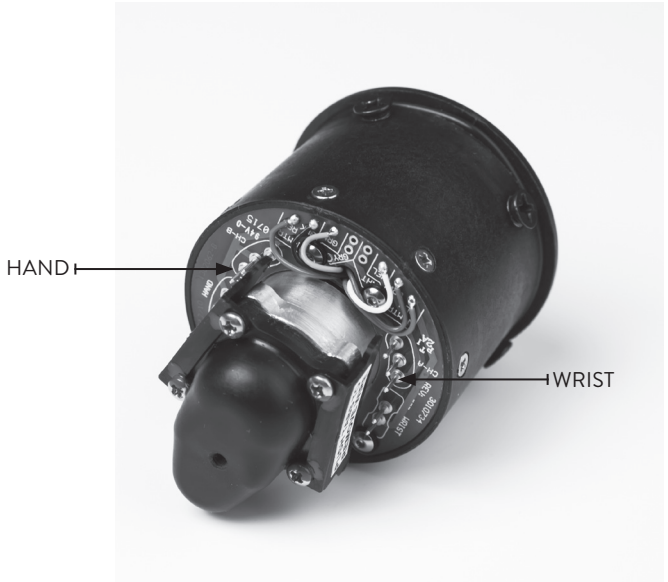
CATALOG NUMBER and DESCRIPTION	RECEPTACLE	DISTAL PLUGS
BE243 Cable, Bock QD, Hand (8E12/*E37) or Greifer (8E32) Only	W/H	Bock 2-Socket
BE244 Cable, BockQD, Wrist Rotator	W/H	Bock 2-Socket
BE247 Cable, Bock QD, PWM Hand (8E37) and Wrist	W/H	(2) Bock 2-Socket
BE343 Cable, Bock QD, 7.2V TD, Sensor Hand (8E38), Greifer (8E33) Bebionic, iLimb Ultra, Quantum, ETD-Pro, etc.	HANDS	(2) Bock 3-Socket

Connections to the Motion Control Wrist Rotator

The BE247 Cable, PWM Hand and MC Wrist Rotator has two 2-socket connectors. The connector labeled WRIST is attached to the posts labeled WRIST. The connector labeled HAND is attached to the post labeled HAND.

When using powered wrist and a hand with electronics, the BE244 cable is used for direct control of the wrist and plugs into the wrist port.

The BE343 cable is used for hands with electronics and has two 3-position connectors that plug into the CHA and CHB ports.



Installation of Motion Control Wrist Rotator into Boston Arm

Components Required:

MC Wrist Lamination
PN:4050231

MC Wrist Rotator
PN:405192 SN:xxxx

The Motion Control wrist rotator is the most commonly used with the Boston Digital Arm System. In the following pages, we will cover the steps necessary to integrate this wrist rotator into the Boston Digital Arm.

Installation

1. Determine the forearm length for your patient.

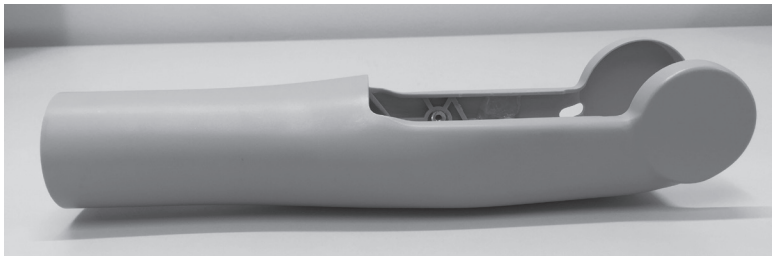
The minimum Boston Arm forearm length is approximately 9 5/8" (with powered wrist rotator. It can be shorter if using non-powered QD wrist.) as measured from the center axis of the elbow to distal edge of wrist lamination.

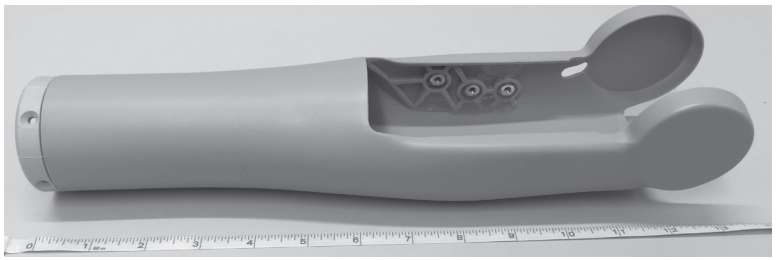
2. Cut and trim forearm to appropriate length. A minimum of 2 1/16" is required from distal edge of control board to edge of cut forearm. This should prevent wrist rotator from contacting the board. (see page 26)

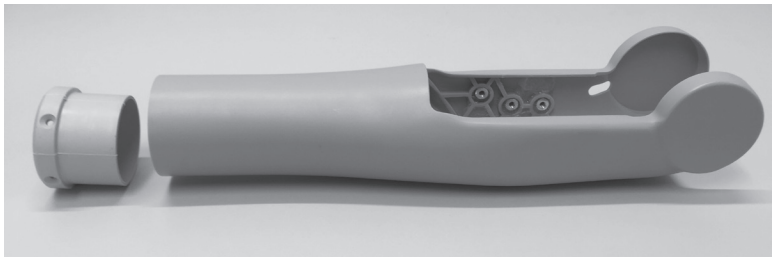
3. Insert the MC wrist rotator into the lamination collar and secure with one mounting screw. Slip the LTI wrist spacer over the lamination collar and perform a dry fit of the assembly in the forearm. Verify the rotator does not contact the distal end of the control board.

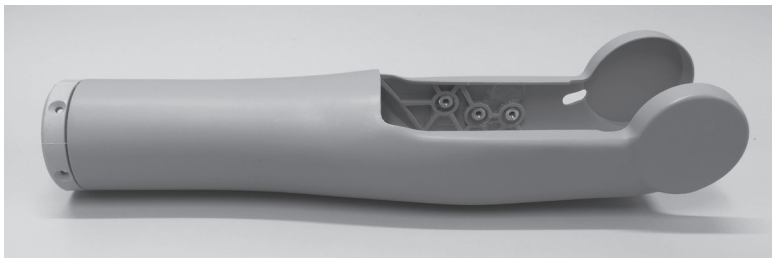
4. Remove and separate the rotator from the lamination collar.

5. Carefully laminate the wrist spacer insert and lamination collar into forearm.



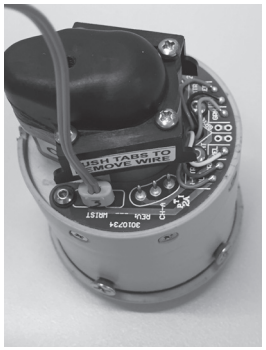






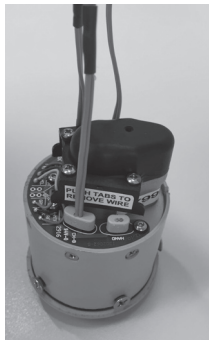
Boston Arm Cable Connections to Motion Control Wrist:

1. Connect (1) BE244 Cable from the Boston Arm “H/W” plug to the “Wrist” position pins of the MC wrist. The curve of the 2-position socket connector should face inward toward the center of the wrist.

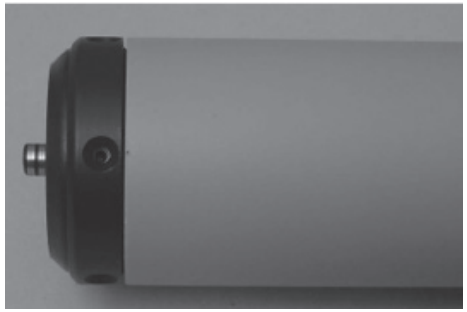


The rotator has 2 connector locks, 1 on each side of the end cap. These are the flat plastic components secured by 2 screws to the end of the rotator. Do not tamper with these screws. Press the locks inward to remove the connectors from the wrist.

2. Connect BE343 Cable from Boston Arm “Hands” plug to “CH-A” and “CH-B” positions on the wrist. The curve of both 3-position socket connectors should face inward toward center of wrist.



3. Once cable connections are in place, carefully insert the wrist into the forearm and secure with the 5 Phillips screws provided.



A typical Motion Control Wrist Rotator Installation

Cutting the Forearm to Length

Forearm Wrist Size Inside Diameter - **50mm**

50 mm standard wrist rotator is the only unit compatible with Boston Arm.

Length of Forearm Before Cutting - **14”**

Minimum Length from Center of Elbow Rotation to Distal End of Wrist Unit
(without wrist rotator) - **8 ½ “or (216mm)**
(with wrist rotator) - **9 ¼ “or (235mm)**

Minimum Coupling Collar Distance - **To Bottom of Elbow - 2.80 “**

Minimum Distance Residual Limb - **To Elbow Center - 1.75 “**

Leaving Forearm Attached to Frame

The forearm can be removed from its frame prior to cutting, although it isn't necessary. If cutting the forearm to length with the forearm and frame intact, follow these precautions.

- Stuff the distal end of the forearm (proximal to the desired length) with a piece of foam or a cloth to prevent dust or debris from entering the battery cavity.

- It is also important to avoid subjecting the system to excessive vibration such as that caused by a carbide-tip saw blade or a sanding belt/disk. Generally, a band saw is preferred for this process.

Removing Forearm from Frame

The forearm can be removed from the frame prior to cutting the distal end to the desired length. However, caution must be taken in this process to avoid stressing or distorting the circuit board. The forearm is attached to the frame via an attachment plate. On each side of the attachment plate are two 8-32 x 3/16" flat head screws. Removing these screws will release the forearm from the frame. Take these precautions when removing the forearm from its frame.

- Carefully spread forearm hinge covers to clear forearm frame, free swing button and cross elbow wiring. Slide forearm away from elbow until clear of elbow assembly. (Re-assemble in reverse order)

- Protect the circuit board from dust and debris

- Avoid static electricity that may damage the electronics. It is best to perform this operation on an anti-static mat while wearing an anti-static wrist or ankle strap.

Reattaching Forearm to Frame

Insert the circuit board/elbow assembly back into the forearm. Align the recessed holes of the frame with the corresponding holes on the forearm attachment plates. Apply a small amount of Blue medium strength Loctite #242 to the threads of the 8-32 x 3/16" Flat head screws and reinsert. Tighten using an offset (right-angle) screwdriver.

Sealing the Input Board

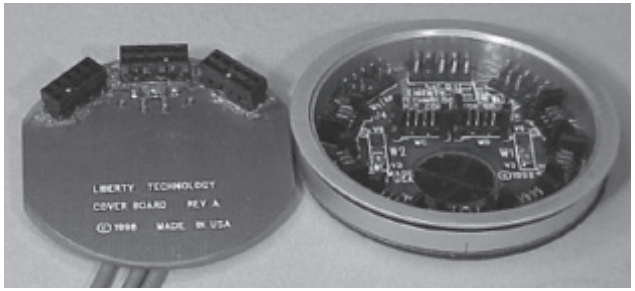
The Input Board is held in place by an O-ring that also acts as a seal to prevent sweat and dirt from entering the area with the plugs. It is important to seal the area where the wires pass through the rubber backing on the Input Board. This area should be sealed with silicone tub sealant or equivalent.

The Input Board must be sealed before final assembly of socket

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

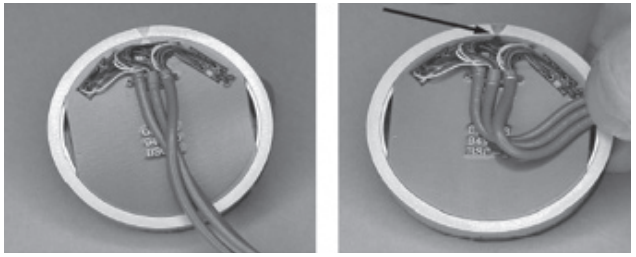
Connecting the Cover Board on the Drive Unit to the Input Board

The Cross-Elbow wiring connects to the input board above the elbow. Figure 4 shows the Cover Board next to the Input Board. To connect, align the three connectors over the three (3) groups of pins. Carefully press together until cover board snaps into groove on input board.



Cover Board before assembly onto Input Board.

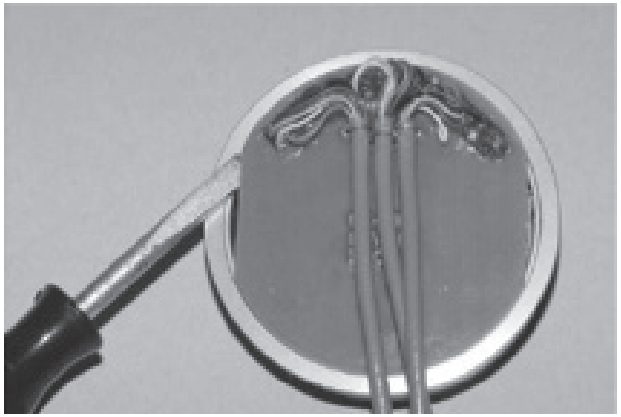
Proper assembly of cover board to Input Board



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 be added to assist in aligning the Cover Board and Input Board.

Reattaching Forearm to Frame

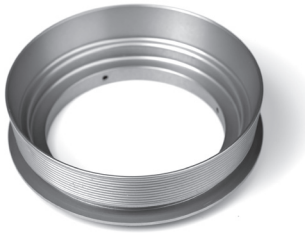
Insert the circuit board/elbow assembly back into the forearm. Align the recessed holes of the frame with the corresponding holes on the forearm attachment plates. Apply a small amount of Blue medium strength Loctite #242 to the threads of the 8-32 x 3/16" Flat head screws and reinsert. Tighten using an offset (right-angle) screwdriver.



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

The Lamination Collar and Clamp Ring

Orientation of the Lamination Collar



Lamination Collar

Humeral Friction Attachment Clamp

Internal Rotation

The humeral rotation stop pins provide a range of 270° for internal and external rotation. The normal range of human motion is 30° externally and 135° internally.

Positioning the input board in the Lamination Collar

Install the Input Connector Board into the Lamination Collar. There are three Connectors with gold pins on the Input Board. Align the middle set with the Triangular mark on the Lamination Collar. Press input board into collar until seated firmly in place.

Attaching the Collar to the Drive Assembly

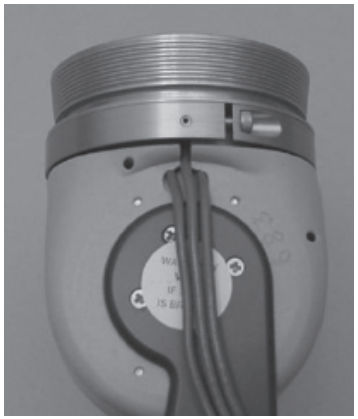
Attach the Clamp Ring to the Lamination Collar and loosely tighten the Clamp Ring Screw.

Position the clamp ring pin near the elbow key slot. Align clamp (with or without socket) on top of elbow unit. Ensure pin fits in the slot. Spread clamp open slightly to allow clamp to fit over groove on elbow.

Plug the Cover Board to the Input Connector Board as pictured below.

Drive Unit with the Lamination Collar and Clamp Ring installed

Regardless of whether an elbow will be a left or right, the wires are always routed up the left side of the Drive Unit where they pass through a slot in the housing that holds the Clamp Ring to the Drive.



The clamp ring is installed with a clamping screw. Just to the left of the clamping screw is a small hole in which the anti-rotation pin is inserted. A small slot on the elbow housing accepts the pin on the Lamination Collar. The Clamp Ring also controls the amount of friction of humeral rotation. Tightening the Clamp Ring Screw increases friction and loosening the screw decreases friction.

Caution: Over-tightening this screw may damage the screw threads. Use small, controlled adjustments until the desired amount of friction is reached.

Attaching To The Elbow

Attach the Clamp Ring and Lamination Collar to the top of the elbow, with the anti-rotation pin seated in the groove of the elbow, where the gray wires reside.

Test the Collar orientation by placing the lamination collar "FRONT" label facing forward. Ensure clamp adjustment is set to minimum friction. Forearm should rotate ~100 degrees medial and lateral. Rotate the Collar accordingly to adjust the amount of internal or external rotation.

1. Remove the electronics from the Lamination Collar as well as the Clamp Ring.

2. Attach the Lamination Collar to the check socket and wrap with fiberglass to secure. The space between the Collar and the check socket may be filled with a paper cup or another suitable spacer. Check the rotation one last time before the fiberglass sets.

3. Copy the orientation in the definitive socket.

Final Adjustment with the User

The humeral rotation is adjusted with a 2.5mm hex key that is supplied with the Clamp Ring. While the user is wearing the prosthesis, adjust the friction until it is most comfortable. This friction can be adjusted as needed.

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