

# Boston Digital Arm System Software Guide

## Myoelectric Hand & Wrist, Servo Elbow

The Boston Digital Arm System has a very versatile controller with many set-up and adjustment options. This tutorial is designed to demonstrate the types of graphical user interface screens found on this system and to help guide prosthetic professionals through the set-up process. The screens you see may differ slightly, depending on the control strategy chosen.

The prosthetic system will come with the requested control strategy already loaded. This can be changed as necessary once further evaluation has been completed if it is determined that a different control strategy would be more appropriate for the patient. Please set the system up and get familiar with the software before your patient is scheduled for fitting to assure that everything is working properly.

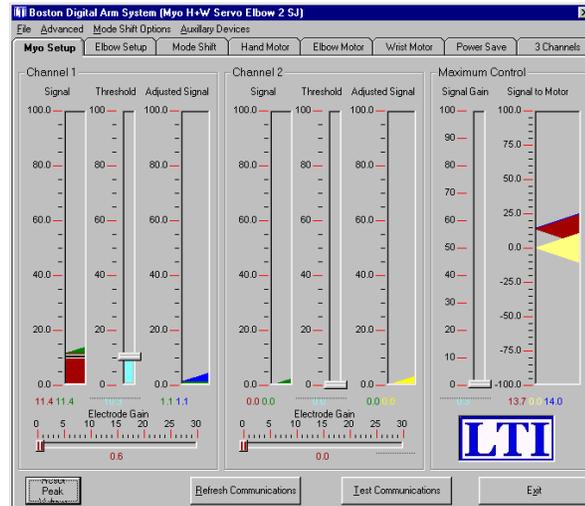
For the following discussion, we will assume that a preliminary evaluation has been completed and the patient's myoelectric sites have been identified.

The first screen is the *Myo Setup*. The primary purpose of this screen is to display the patient's myoelectric signals and make adjustments for threshold and gain. Additionally, this is where more output gain can be applied to operate the prosthetic motors at full speed.

### Patient Evaluation:

1) With the prosthesis fitted and the electrodes in place, have the patient relax and observe the (red) *Signal* level on Channel 1. This "relaxed" signal is actually unwanted noise and must be eliminated. To do this, raise the *Threshold* lever located to the right of the signal bar graph until it is at approximately the same height as the red signal level itself. As this is done, you will notice that the (green) *Adjusted Signal* to the right of the lever will decrease to approximately zero. This graph represents the filtered signal being used to direct the prosthetic motors.

2) Once this has been completed for Channel 1, repeat the process for Channel 2. This completes the threshold adjustment. However, since the patient's relaxed signal level may change over time as they complete physical therapy training, these levels could change and the threshold setting may require re-adjustment in the future.



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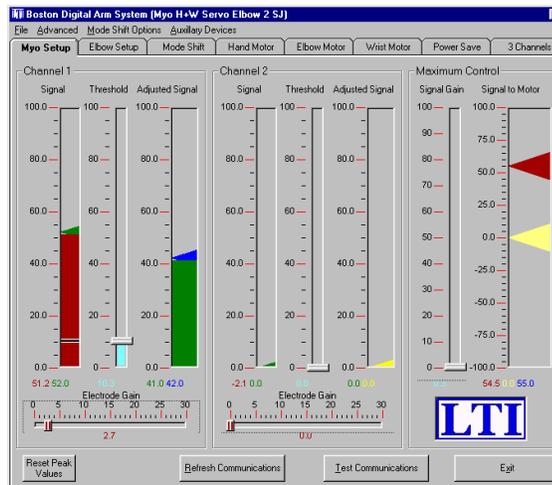
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3) The next step is to set the gain for each channel. Below each channel's bar graph is a slider labeled *Electrode Gain*. As the patient flexes their muscle associated with Channel 1, the red/green signals will increase. With a strong muscle contraction, but not over exerting, the patient should be able to achieve an *Adjusted Signal* (green) signal level of at least 50%. If they cannot, then slide the *Electrode Gain* lever to the right until the *Adjusted Signal* level reaches 50%. Typically this *Electrode Gain* adjustment should be in the range of 1-5.

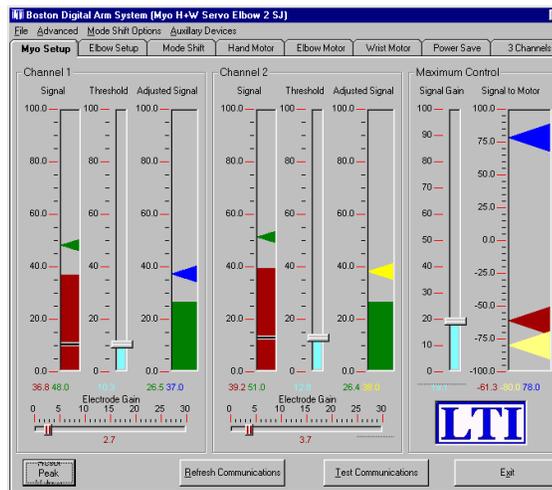
4) Repeat this process for Channel 2.

5) Once this is complete, check to see that a strong contraction of the two muscles produces similar *Adjusted Signal* levels. Click the *Reset Peak Values* box at the bottom of the screen. Then have the patient produce a strong muscle contraction first on Channel 1, then on Channel 2. The maximum *Adjusted Signal* levels will be marked by a blue arrow head. These levels should be similar for a well balanced system. This completes the myoelectric threshold and gain adjustment process. If further gain adjustments are necessary, they will be made elsewhere in the system.



6) The next step is to focus on to the *Maximum Control* section at the right of the screen. With the individual gains and thresholds set for the two channels, the patient now must produce signals strong enough to get nearly full-scale deflection (80% or better) of the *Signal to Motor*. This is necessary to achieve the full speed range of the prosthetic devices. If the patient's muscle signals are insufficient to get 80% *Signal to Motor* in both directions, then increase the gain by sliding the *Signal Gain* adjustment lever up.

7) As a final check, click *Reset Peak Values* at the bottom of the screen. Now have the patient produce a strong contraction for Channel 1 and then for Channel 2. As they relax, check the two maximum *Signal to Motor* markers (blue & yellow) to see that they are similar in level and that they exceed 80%.

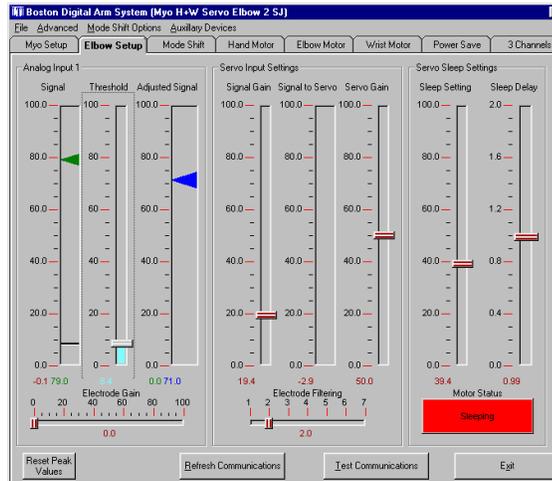


8) This completes the adjustments for the *Myo Setup* screen. Click the *Elbow Setup* tab at the top of the screen to continue.

### Elbow Setup:

The primary purpose of the *Elbow Setup* screen is to display the patient's adjusted myoelectric signals and make further adjustments for elbow control.

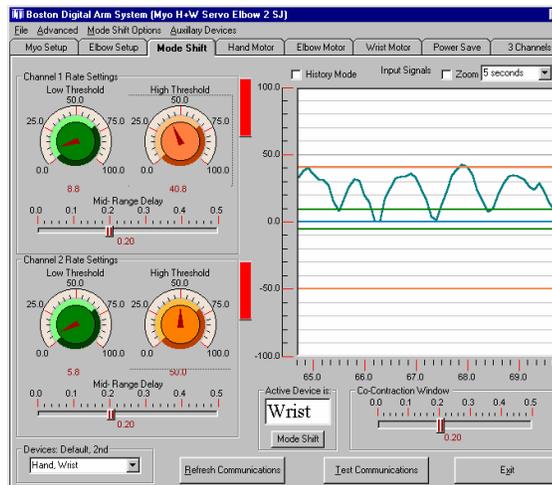
When the servo transducer pauses for a period of time and the elbow "parks", the *Motor Status* block illuminates in red and reads *Sleeping*. As soon as the servo signal is increased so that it exceeds the level at which it parked, the *Motor Status* block changes to green and it reads *Moving*.



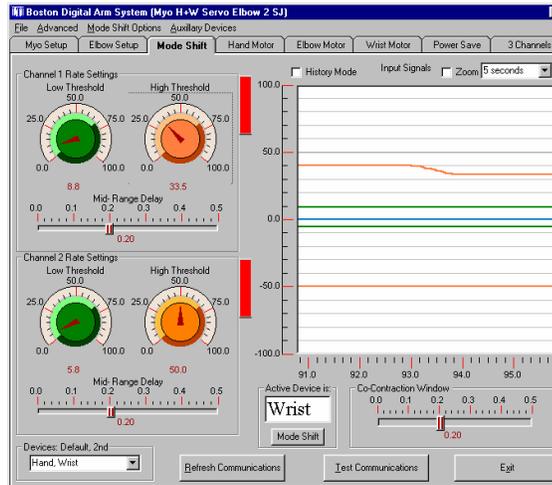
### Mode Shift:

The primary purpose of the *Mode Shift* screen is to display the patient's adjusted myoelectric signals graphically and make adjustments for co-contraction mode shifting. The goal is for the patient to simultaneously activate the two muscles rapidly with a strong contraction. To achieve this, the patient's signals must cross the *Low Threshold* (green) line and then within the time set on the *Co-Contraction Window*, cross the *High Threshold* (orange) line. When this is achieved, the red bar in the middle of the screen will turn green. For a successful co-contraction, both bars (Channel 1 & 2) must turn green at the same time.

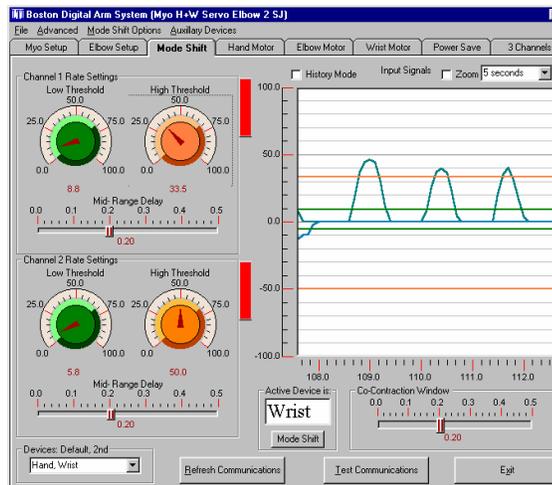
- 1) Have the patient flex each muscle sequentially to see if that there is sufficient signal strength and good signal separation. Then focus on one muscle at a time. Have the patient repeatedly flex the muscle for Channel 1 to see if the (blue) signal is strong enough to exceed the *High Threshold* level (upper orange line). If the signals are significantly higher than the *High Threshold* level, increase this level to avoid inadvertent co-contractions. If the signals are below this line (as in the case shown at the right) reduce this level.



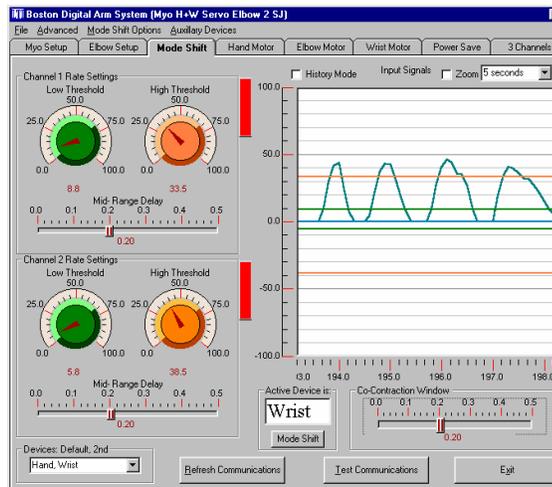
2) These levels are adjusted by rotating the *Low Threshold* (green) and *High Threshold* level (orange) knobs. The corresponding line on the graph will change accordingly (see screen to the right).



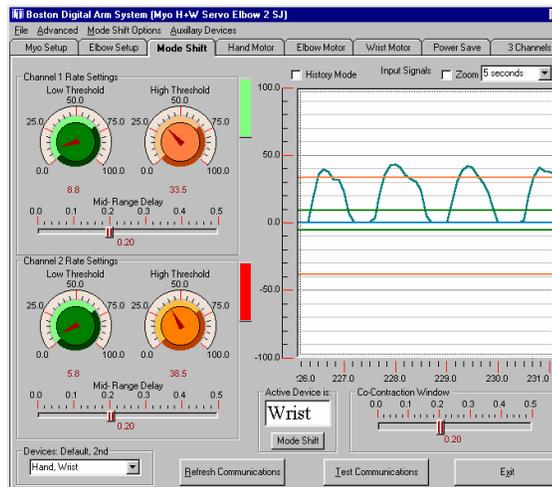
3) Once the threshold levels are properly adjusted, the patient should be able to repeatedly make strong, rapid contractions and exceed the *High Threshold* level (as shown on the screen to the right).



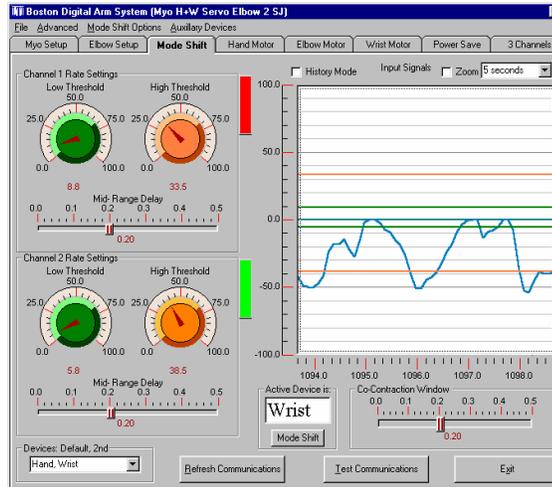
4) If the patient can repeatedly make strong muscle contractions and exceed the *High Threshold* level, but the red bar does not turn green (indicating a successful rapid contraction), then they are not providing the signal rapidly enough. To accommodate them, you must increase the time allowed to achieve this. This is done by adjusting the *Co-Contraction Window*, sliding the lever to the right. Repeat this process until



5) Repeat this process until the patient illuminates the green bar (as shown to the right) reliably.

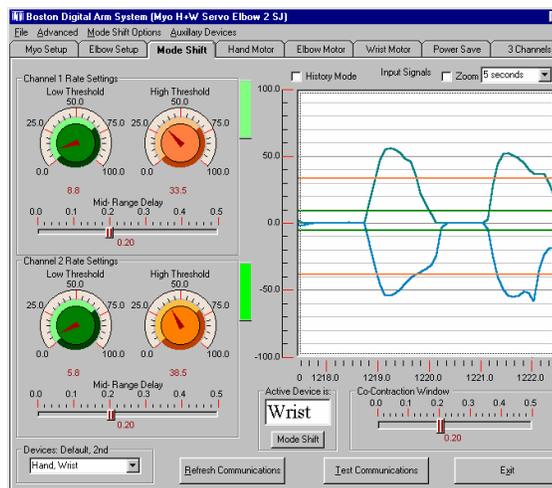


6) This completes the setup for Channel 1, now repeat the process for channel 2.



7) Once both channels have been set up independently, they must be tested together. To do this, have the patient contract both muscles simultaneously. Both green bars should illuminate and the *Active Device* window should display a different device (i.e. hand, wrist).

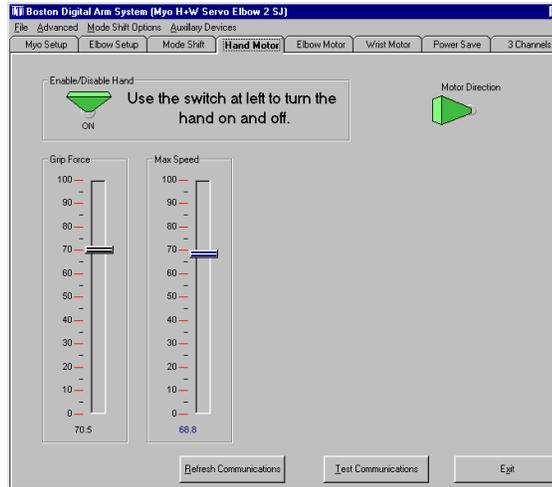
8) The *Mid Range Delay* must be set next. This is the detection period (time in seconds) for the signal to cross between the lower and upper threshold levels. It is often referred to as the “rise time”.



### Hand Motor:

The primary purpose of the Hand Motor screen is to make adjustments specifically for this prosthetic device.

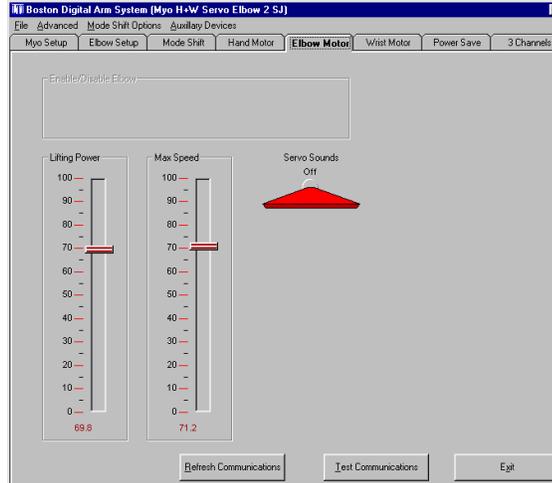
- 1) First, make sure that the hand motor is enabled with the switch located at the upper-left of the screen.
- 2) Set the *Grip Force* to about 70% as a starting point. This should be adjusted downward if a high-definition silicone glove is used to extend the life of the glove. It can be adjusted upward if more grip force is desired.
- 3) Set the *Hand Speed* at 100%. It is rare that patients want less than the maximum hand speed.
- 4) If during assembly, the connections to the hand were reversed, causing the hand to operate backwards (wrong muscles), toggle the *Motor Direction* switch on the right side of the screen to reverse.



### Elbow Motor:

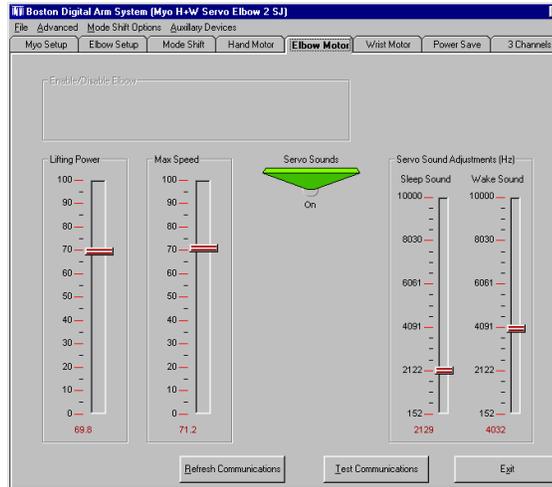
The primary purpose of the *Elbow Motor* screen is to make adjustments specifically for this prosthetic device.

- 1) Set the *Lifting Power* to about 70% as a starting point. This can be adjusted upward or downward as the patient gets more familiar with the system.
- 2) Set the *Elbow Speed* at about 60-70% initially. This will make the elbow slightly less responsive, but generally this is beneficial during the training period. When set at 100%, the elbow completes an excursion in just over 1 sec. As the patient gets familiar with the system and masters the control features, you may want to increase the speed.
- 3) If audible signals are desired for patient training, turn the *Servo Sounds* switch **on**.



4) Switching the Servo Sounds on, will activate another section of the screen. The frequency (in Hertz) of the *Wake Sound* and of the *Sleep Sound* can be set.

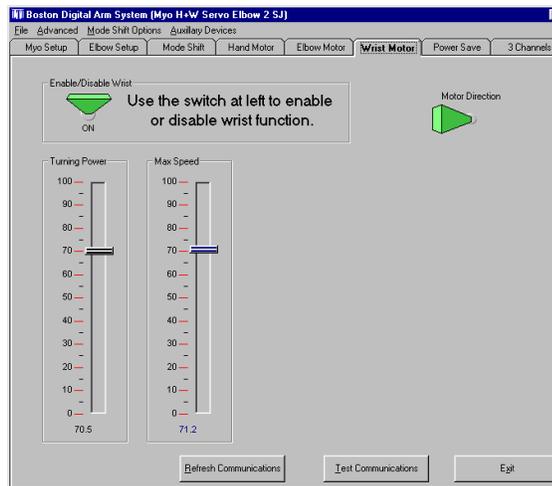
5) The frequency or “tone” of these two sounds should be significantly different so the patient can differentiate between the two. One tone will indicate when the servo system has gone to “sleep” and the other tone will indicate that it has woken up.



### Wrist Motor:

The primary purpose of the *Wrist Motor* screen is to make adjustments specifically for this prosthetic device.

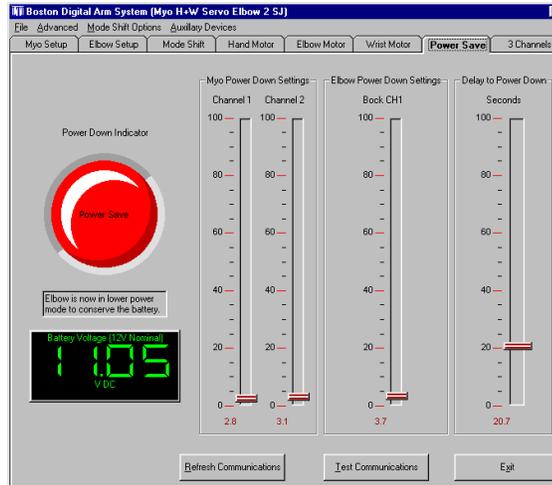
- 1) First, make sure that the wrist motor is enabled with the switch located at the upper-left of the screen.
- 2) Set the *Turning Power* to about 70% as a starting point. This can be adjusted upward if more wrist torque is desired following the training period.
- 3) Set the *Wrist Speed* to 70% initially. Following training, this should be increased to 100% for best performance.
- 4) If during assembly, the connections to the wrist were reversed, causing it to rotate backwards (wrong muscles), toggle the *Motor Direction* switch on the right side of the screen to reverse.



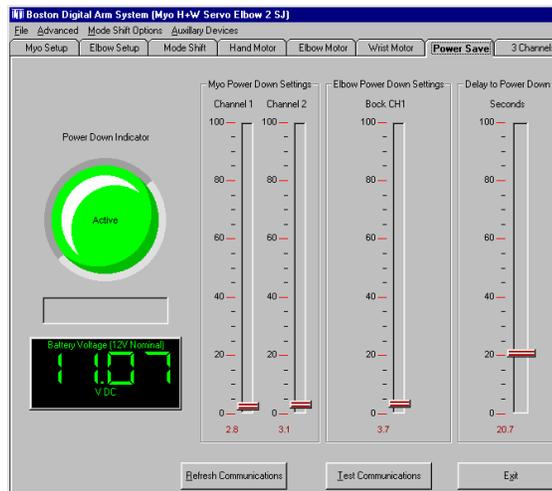
**Power Save:**

The primary purpose of the *Power Save* screen is to make adjustments for setting the way the system powers-down when it is in idle state. This “hibernation” will be undetectable by the patient, but it results in considerable power savings when properly set. The system wakes up quickly so the patient may never know it was hibernating.

- 1) The large red/green light tells what state the system is in; *Power Save* or *Active*.
- 2) The system battery voltage is shown in the digital display.
- 3) As a starting point, set the *Myo Power Down* level to about 5 on both Channels.
- 4) The *Elbow Power Down Settings* should be set at approximately 20 initially.
- 5) The *Delay to Power Down* sets the time delay until the system falls into a sleep state. It should be set at about 20 initially.



- 6) As soon as the system detects any input signals, it immediately wakes up (becomes *Active*) and the green light illuminates. It will stay in this state until all input signals drop down to an inactive level.
- 7) If the system tends to go into the *Power Save* state too frequently, raise the *Delay to Power Down*. If the system never drops into the power down state, lower the *Delay to Power Down* level.



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