



INSTRUCTION MANUAL

For prosthetists trained to fit the Utah Arm

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U3

INSTRUCTION MANUAL

ACKNOWLEDGEMENT

The first Utah Artificial Arm was developed at the University of Utah by the Center for Engineering Design, directed by Dr. Stephen C. Jacobsen.

The original technology has been further developed by Motion Control, Inc., with the second generation Utah Arm 2 released in 1987, and the third generation Utah Arm 3 released in 2005. Each new version of the Utah Arm has represented a significant advancement in prosthetic technology.



Dr. Stephen C. Jacobsen, 1981.

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A. Overview

THE U3 – ONE STEP CLOSER TO NATURE

At first glance the U3 looks very similar to earlier Utah Arm models, but advances in technology allow more input and control options, and make the U3 easier to adjust for both wearer and prosthetist. Here are some of the important differences you'll find in the new Utah Arm 3:

- **TWO microprocessors allow SIMULTANEOUS elbow and hand function**

The U3 allows the wearer to reach and grasp for an object at the same time, producing a more natural movement than what was possible before. Sequential control is also available.
- **Computer Interface for configuration & adjustment**

The U3 uses a similar microprocessor technology introduced by Motion Control in the ProControl 2. The Computer Interface is easy to use and allows the prosthetist or the wearer to make adjustments easily. It also helps with the fitting and training process because it shows the wearers' input signals in real time.
- **The Utah Arm 3 Computer Interface software is a Windows Version User Interface and includes the following features:**
 - Enables new control options and inputs (see below)
 - Works on any Windows OS, including Win XP
- **Set-Up Wizard**

Guides you through the setup process step-by-step, OR, make changes directly to adjustment screens or summary screen.
- **AutoCal® feature**

(Optional) Automatic adjustment of Hand gain and threshold.

- **Electric Wrist Rotation**

- Hand/Wrist switching by co-contraction.
- “Fast Access” Wrist available.
- “Auto Switch Back” will return to hand automatically after 10 seconds of relaxation.
- Push or pull switches are still available for wrist control (see Chapter 4- Connections).

- **Batteries:**

The new U3 batteries are reconfigured to operate any terminal device used without having to modify the TD. See TD Options below.

- **Variety of input choices:**

The U3 can operate using any of the following to accommodate a variety of fitting needs, and can use separate inputs for hand and elbow.

- Motion Control dual-site EMG preamps with standard or snap-type electrodes
- Motion Control single-site EMG preamp with standard or snap-type electrodes

“Alternate Inputs:”

- Motion Control Force Sensor
- Motion Control Linear Potentiometer
- Motion Control Touch Pads

- **Multiple TD Options:**

- Motion Control Hand (or ProHand)
- Motion Control ETD- Electric Terminal Device (or ProETD)
- OB Hand (8E 37)*
- OB Sensor Hand (8E 38=5)*
- OB Greifer (8E 32=12)*
- (*Ultralite Centri Hands* will be available in the future.*)

**Warranty coverage is at the discretion of the TD manufacturer.*

External Parts of the Utah Arm 3:

(SEE FIGURE 1.1)

1. Ground Electrode
2. Outer Socket
3. EMG Electrodes (with Spacers)
4. Humeral Wire Harness (details on p. 34)
5. U3 4-pin Computer Interface Connector (on left side)
6. Battery Pack
7. Battery fuse
8. Forearm Cover
9. ON-OFF Switch for Arm
10. Lamination Collar and Coaxial Connector and/or Electric Wrist Rotator
11. Motion Control ETD - Electric Terminal Device - Standard version
12. ETD safety release lever
13. Motion Control Electric Hand - Standard version
14. Hand ON-OFF Switch
15. Forearm Cover Screws (2)
16. Lock Override Button (on right side)
17. Humeral Rotator Clamp Band and Friction Adjustment Screw

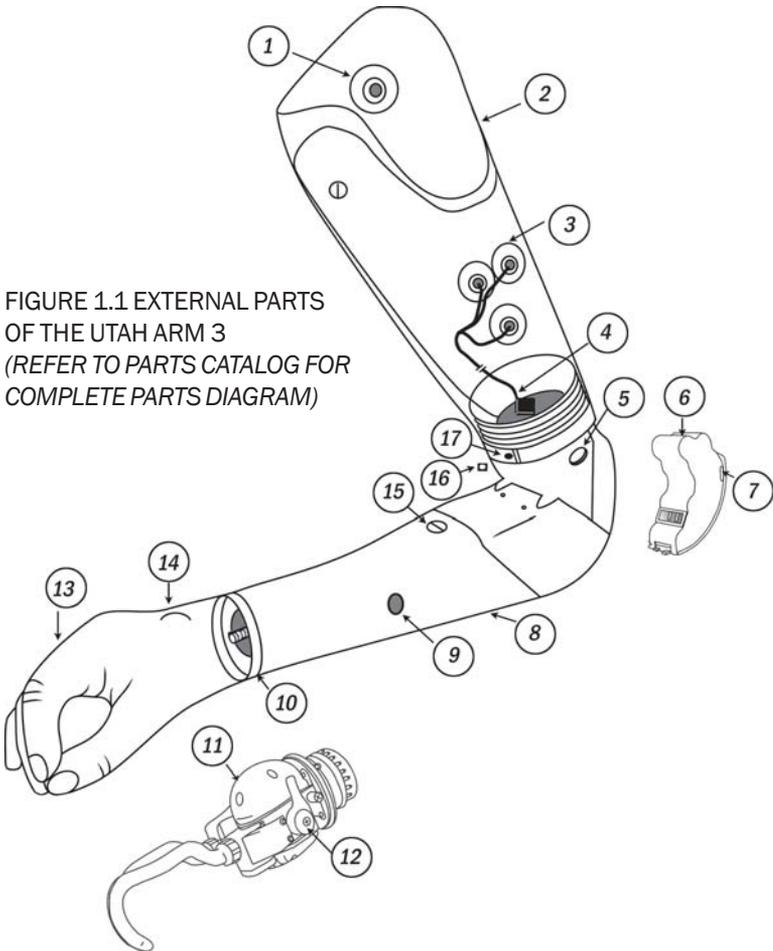


FIGURE 1.1 EXTERNAL PARTS OF THE UTAH ARM 3
(REFER TO PARTS CATALOG FOR COMPLETE PARTS DIAGRAM)

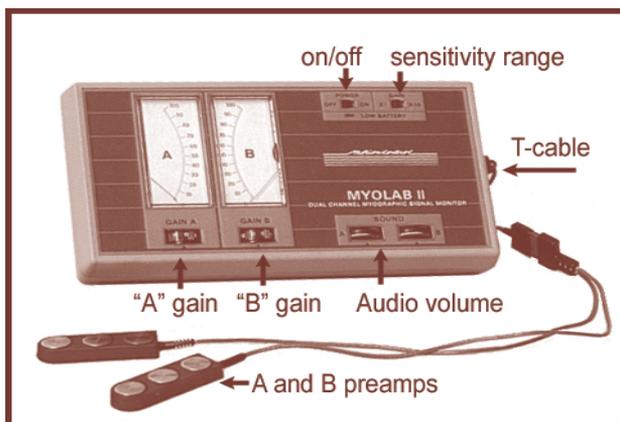
Before fitting:

Before fitting the Utah Arm 3 to a patient, you may want to operate it yourself to familiarize yourself with its function.

Using the Preamplifier Set (e.g., Myolab preamp set or alternate input, e.g. Linear Potentiometer) you may operate the U3 yourself. You can then verify all the functions described in this manual, and experiment with how their adjustment effects the control of the elbow, hand and wrist.

B. EMG Testing and Training

Motion Control's Myolab II EMG Tester/Trainer is recommended to test for the best control muscles. The Myolab II provides enough sensitivity to test and train muscles with EMG signals even below the 5 microvolt minimum for Hand Control in the Utah Arm 3. Before probing for EMG electrode sites, examine the patient for problem areas such as unhealed wounds, scar tissue, painful areas, and restricted range of motion.



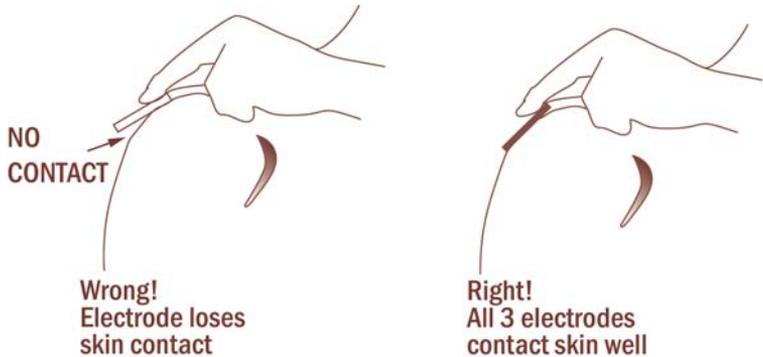
1. Basics of EMG Testing

a. **Proper Alignment.** Align the electrodes along the general direction of the muscle fibers. For very dry skin, or very hairy skin, moisten the skin slightly with water to improve the EMG signal by lowering skin resistance.

b. **Good Contact.** All the electrodes on the preamplifier must be in good contact with the skin, as shown in Figure 2.1. Hold the electrodes on the skin for a few seconds to establish good contact between skin and electrodes.

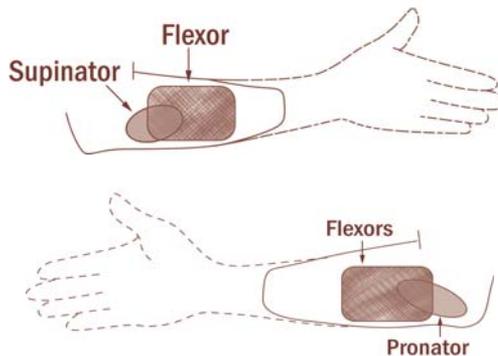
B. EMG TESTING AND TRAINING

FIGURE 2.1



c. **Evaluate all Potential Sites.** All of the remnant muscles which could be used for control sites should be evaluated before fitting the prosthesis. Begin EMG testing with the most distal of the remnant muscles. Likely sites on the forearm for EMG control sites are shown in Figure 2.2.

FIGURE 2.2 FOREARM EMG SITES FOR PROCONTROL/PROHAND FITTINGS



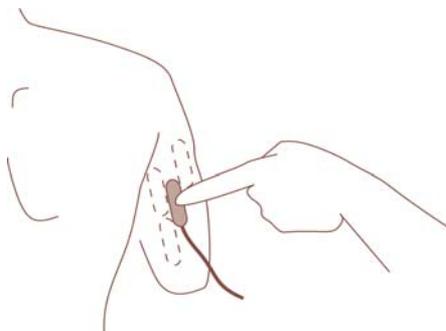
For each potential control site, palpate the muscle as the patient contracts it and place the preamplifier over the belly of the muscle. Touching the muscle may help give the subject more sensation of the muscle contraction.

NOTE: Unilateral amputees may be aided in learning to contract a particular muscle in their remnant limb by mimicking the same function in the sound side arm, e.g., flexing the sound side elbow and contracting biceps muscles simultaneously in both the remnant arm and the sound arm.

While holding the electrodes over the muscle, instruct the patient to “contract-hold-relax” in about a three second sequence. A smooth and even contraction is desired, without strenuous effort, with relaxation after each contraction. Systematically move the preamplifier by about one-half inch (1 cm.) increments testing the entire remnant limb wherever muscles exist.

d. **Mark Location of Sites.** When a potential control site is identified, mark the best electrode location on the skin, and also mark the total area in which an adequate EMG signal is obtained (see example in Figure 2.3). This will be important in locating electrodes in the prosthetic socket. Identify all potential EMG control sites in this manner.

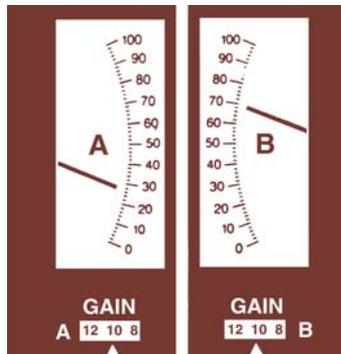
FIGURE 2.3 EXAMPLE: MARKING LOCATION OF BEST TRICEPS EMG



e. **Important Note: Optimal Sites.** The best pair of EMG control sites are the two muscles which generate the *greatest difference* between them. Two muscles which involuntarily co-contract, will tend to cancel each other's signal (see Figure 2.4). However, *voluntary* co-contraction is desirable,

to activate the elbow unlock. (See below). If co-contraction cannot be prevented, consider using the “First-Over” control option. See Section 5, “Selecting the Control Input.”

FIGURE 2.4 DIFFERENCE BETWEEN TWO MUSCLES SHOWN ON THE MYOLAB II.



2. Co-contraction Training

To train patients to co-contrast and unlock the elbow, instruct the patient to first relax, then contract both the control muscles simultaneously in a quick but light strength co-contraction, followed by relaxation (much like “snapping” the fingers quickly).

- a. Using the Myolab II to monitor activity of the appropriate muscles, have the subject perform the following sequence for practice:
 - **Step 1:** Gradually contract the “A” muscle. Maintain a contraction for one second and then relax.
 - **Step 2:** Gradually contract the “B” muscle. Maintain a contraction for one second and then relax.
 - **Step 3:** Quickly co-contrast both the “A” and “B” muscles lightly (about 20 to 30 microvolts), then relax both.
 - **Step 4:** Repeat Step 1.

b. Also practice using the User Interface and the computer [Switch Control Screen] to give the patient biofeedback to help train their ability to contract quickly and simultaneously. Check to be sure that good EMG signal differentiation still exists for the muscle pair selected (or change the control method to “first-over”).

3. Final Site Selection

Choose the final muscle sites only after a reasonable period of training and practice, ideally with the patient actually wearing the entire prosthesis. The minimum criteria are:

a. To operate the Hand in the Utah Arm (or the ProControl System), the difference between the “A” and “B” muscle signals must be at least 5 microvolts. The “first-over” control method does not require this difference, but does require that the desired muscle contract first.

To measure the EMG signal magnitude accurately, set the gain dial on 10 and the gain switch on X1 (refer to the Myolab II instructions for more details). To operate the elbow in the Utah Arm, approximately 15 microvolts EMG signal is needed.

b. Co-contraction: For Unlocking the Utah Arm: The two muscles must be capable of co-contracting quickly and simultaneously to at least 5 microvolts.

c. The muscle EMG signals should be controllable, without spasms or quivering.

d. Contraction of the muscle should not induce pain.

e. Electrode placement in the prosthesis over scar tissue should be avoided, due to the danger of tissue breakdown. In some cases, low profile electrodes can be used over scar tissue, but such cases should be followed closely to be certain the skin and/or scar breakdown does not occur. Snap

electrodes in a gel liner is now possible, which may be more gentle on fragile skin.

Note: The “First Over” control mode may be preferred when a high level of co-contraction causes interference between A and B EMG’s.

C. ELECTRODE AND PREAMP INSTALLATION AND HANDLING

1. Electrode Installation:

A total of three electrodes are used for each muscle EMG signal, two sensing and one ground, and may be either high or low profile stainless steel disks (provided in the Arm Kit), or snap-type electrodes.

FIGURE 3.1: HIGH PROFILE, LOW PROFILE AND SNAP-TYPE ELECTRODES



- **Use the high profile electrode:** For better electrode contact on softer, fleshy areas, and where the skin may pull away from the electrode.
- **Use the low profile electrode:** For intimate-fitting sockets, suction-fit sockets, over scarred or fragile skin, or boney areas.
- **Use the snap-type electrode:** Usually for roll-on gel liners, but may also be used in firm sockets. Use with snap-type electrode leads.

2. Installing electrodes in the socket:

a. Drill the holes in the socket with a .20" (5mm) bit.

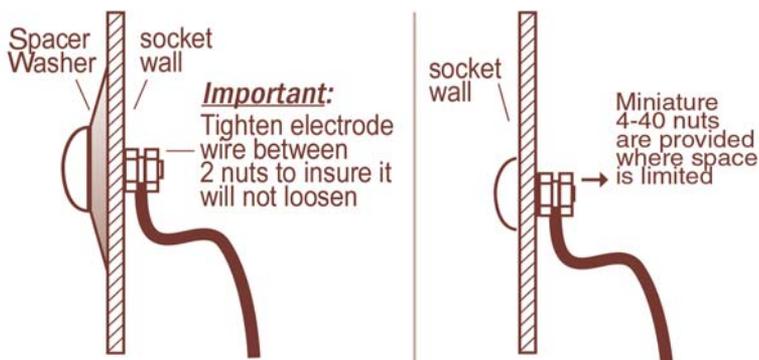
b. Never grip the electrode edge with pliers; it will scar the edge, which will scratch the wearer's skin. If you need to hold the electrode firmly, use adhesive tape, with the sticky side against the electrode surface. Clean off with alcohol later.

c. The electrodes may be used with or without the plastic Spacer Washers. The Spacer Washer is designed to eliminate sharp edges from the electrodes and to improve electrode contact after some atrophy occurs in the residual limb. It is not intended as a "spring tension" device (See Figure 3.2).

d. The electrode may be used without the Spacer Washer (in an intimate fitting socket). The electrode disk will then be flush with the inside socket wall (See Figure 3.3).

e. Normal electrode spacing: 1 3/8" (35mm) apart (center to center).

FIGURE 3.2 ELECTRODE WITH SPACER WASHER, AND WITHOUT SPACER WASHER (NOTE RELIEF IN SOCKET WALL).



Allowable exceptions to normal spacing:

WIDER SPACING (3" max.) (e.g., to prevent perspiration from shorting between electrodes).

Drawback: The EMG signal may diminish with wider spacing. Test with the Myolab II.

CLOSER SPACING (5/8" min.) (e.g., to fit into a short socket)

Drawback: Perspiration is more likely to short between electrodes.

MULTIPLE ELECTRODES may be used (e.g., where one electrode may pull away from the skin). Connect electrodes together with the green wire included with the electrode set.

3. Snap Electrode Installation

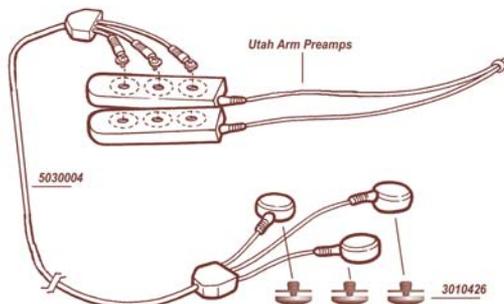
Reported advantages of roll-on type sockets with myoelectric systems:

- Improved electrode contact, even after moderate weight gain or loss by the wearer.
- Improved suspension, due to the suction maintained by a well-fitting roll-on liner.
- Improved wearer comfort, especially with problem skin, e.g., scar tissue, etc.

FIGURE 3.3. UTAH ARM PARTS REQUIRED FOR USING SNAP-ON ELECTRODES.

(Order 2 ea.): Cable adaptor with snap connectors for preamplifier (p/n: 5030004)

(Order 2 sets): Snap type electrodes (p/n: 3010426) /set of 6



For more detailed instructions on using a gel liner with snap-type electrodes, visit www.UtahArm.com/srfaq.htm, or call Motion Control.

A FEW PRINCIPLES TO BE FOLLOWED WHEN USING SNAP ELECTRODES:

- a. The snap ends should be protected as much as possible.
- b. Avoid tugging and flexing the wires as the socket is donned.**
- c. Once installed, the snaps and cables should be held in place as securely as possible (this will prevent disturbance of the EMG).
- d. Avoid any motion of the snap connection as the socket is moved during use of the prosthesis. If cables are exposed, you should supply a protective cover or sleeve over the cables, e.g., an elastic compression garment may make a convenient cover.

4. Preamplifier Handling Precautions:

The preamplifiers used with the Utah Arm are very sensitive electronic devices, thus they require proper handling to avoid damage by static electricity.

- a. Discharge yourself to the ground (center) electrode, or black plastic back, before touching any other part of the preamp, each time they are handled.
- b. Avoid working on the socket with static-producing equipment (buffers, drills, etc.), after the preamps have been installed. If the preamps could receive a static discharge, remove them.
- c. Do not tug or jerk on the preamp connector wires, especially when disconnecting them. Be sure to pull on the connector, not the cord.

d. Do not place the wires where they might be pinched during assembly of the sockets, or other situations.

e. The electrodes should be connected to the preamp with the wire set supplied with the Utah Arm fitting kit (An optional long set, 16" [40.6 cm] is available).

5. Connections:

a. 4-40 Screws, nuts and lock washers provided are used to fasten the wires to the preamps and electrodes. A set of miniature nuts is also provided.

b. Avoid a location where the preamp must be bent or twisted, i.e., locate them on a flat surface formed by fitting and/or sanding, if necessary.

c. Avoid a location where the outer socket could rub the wires or connector. If the socket rubs over the preamp or wires, cover it with duct tape.

Note: If the socket or frame is laminated with carbon fiber, it is conductive. Insulation of the electrode from the socket is essential. Check for sharp edges on back of electrodes shorting to outer socket. (Use heat shrink tubing over the electrode threads; use heavy duct tape over the nuts).

d. STANDARD CONNECTIONS: The factory settings in the U3 Arm will operate the Hand in this manner:

“UP” = A Channel = Open Hand/Wrist Clockwise

“DOWN” = B Channel = Close Hand/Wrist

Counterclockwise

6. Testing Wires:

a. Perform the continuity test on all the electrode-to-preamp connectors, to insure no wires were accidentally broken, or improperly connected. Set the multimeter on “ohms” and zero the meter; you should measure close to “0” ohms for each wire. (See Figure 3.4) Also test between the ground of the preamp, and both sensing electrodes. You should read infinite ohms, indicating no accidental shorts have occurred. (Fig. 3.5)

FIGURE 3.4 TEST ALL THREE WIRES TO EACH PREAMP FOR CONTINUITY, AND MAKE CERTAIN ALL NUTS AND SCREWS ARE TIGHT.

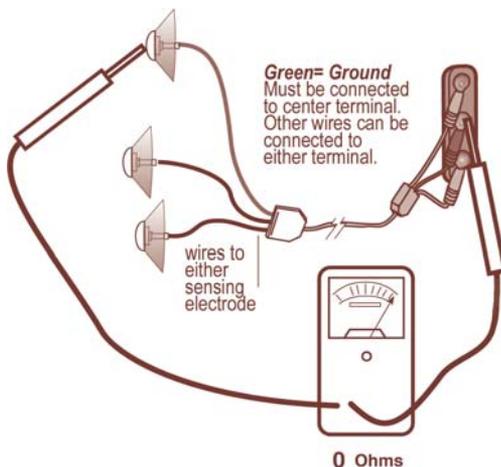
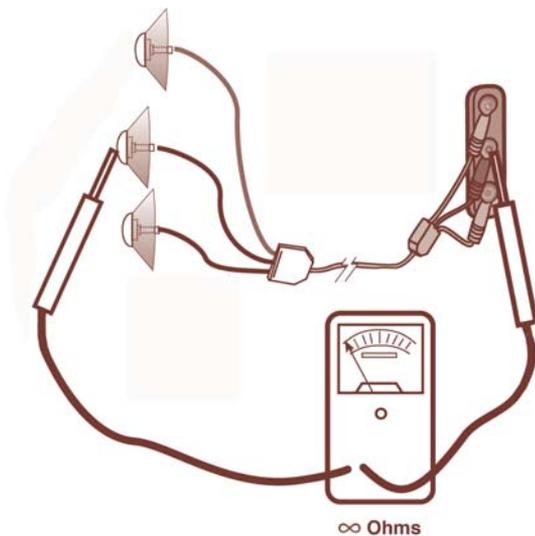


FIGURE 3.5 TEST ALL WIRES FOR AN ACCIDENTAL SHORT TO GROUND.



7. Insure Adequate Grounding:

Always use two ground electrodes, connected with wires to the center input of each preamp.

The Ground electrode does not need to contact the control muscle. Position them over fleshy, non-muscle skin areas, and on generally opposite sides of the remnant limb, to insure ground contact on at least one electrode throughout the full range of motion of the prosthesis.

8. Prevent Moisture Damage:

a. Avoid moisture from perspiration (or any other source) on or into the preamps.

b. Holes in the socket which could leak perspiration to the preamps must be filled in.

c. If a drain hole or pull-sock is necessary in the bottom of the socket, it must drain the moisture to the outside, not into the space between the inner and outer sockets.

d. If an outer socket is not covering the preamps, they must have a moistureproof cover and protection from blows or other damage.

e. We DO NOT recommend potting the electrode studs with RTV silicone. The silicone can insulate the electrode threads, resulting in loss of signal.

9. Sweat Damage Prevention:

(for high sweat and humid climates)

The following steps are strongly recommended for all Utah Arm wearers who have the possibility of dripping sweat into their socket, or into the elbow itself. Sweat can cause damage over time, by corroding connectors and wires, and causing electrical shorts.

- a. Protect the connectors and joints at the top of the Utah Arm. Fill all the connectors with silicone grease provided– it prevents water from entering the connector. Also, run a bead of the silicone grease around the mating surface of the Elbow Cap, then screw the Cap tightly into place.
- b. If the wearer produces excess perspiration (hyperhidrosis), precautions must be taken. Antiperspirant preparations and/or absorptive axilla pads may help, or a prescription for a strong topical antiperspirant, e.g., DrySol, may be needed.
- c. Prevent sweat from dripping into the forearm and collecting in the lock strip slots. Preventive Step: Send the Utah Arm (forearm only is required) to Motion Control and we will drill a small hole at the base of the Forearm Structural Piece, which will allow sweat to drain out of these slots.
- d. Prevent sweat from dripping into the interior of the socket, and down to the connector area. Preventive Step: Seal the frame and socket together at the axilla with RTV silicone, so that sweat cannot drip into the inside of the socket. Also, make a large enough hole into the side of the base of the socket so that a highly absorbent sponge or a synthetic chamois cloth (available at camping stores) could be placed in that space, or a “sweat band” like a tennis player wears, could be worn around the socket. The wearer could then squeeze out the sponge or sweat band during the day.

Notes:

FIG 4.1 DETAIL OF FOREARM CONNECTION SYSTEM

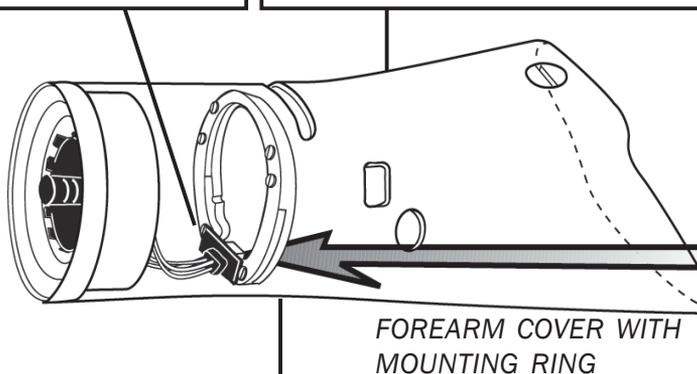
**FOREARM COVER
WIRE SET**

Connector automatically mates when Forearm Cover is installed.

Wire Set installed in Forearm Cover automatically makes all connections for Hand and Wrist. (See Fig. 1.2)

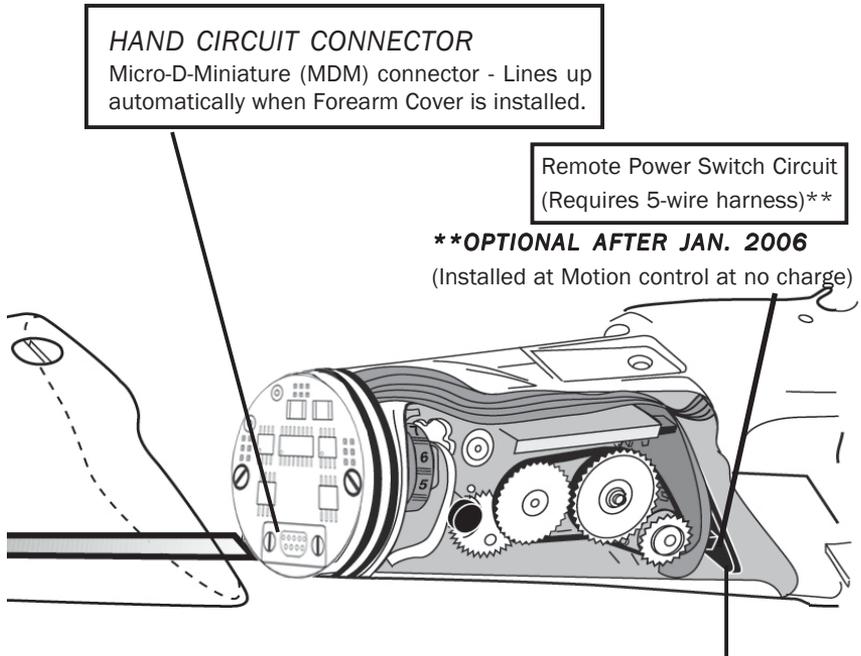
ADJUSTABLE FOREARM LENGTH

- **Shorten up to 1 inch (2.5 cm)** - remove Wrist Lamination Collar, bond the Lam. Collar with Siegelharz (roughen surfaces, clean w/ solvent, then bond).
- **Shorten up to 2 inch (5 cm)** - send to Motion Control for factory modification.
- **Lengthen up to 2 inch (5 cm)** - install an Extension (p/n 3010067-Cauc. or 3010068-Blk)

**FOREARM COVER WITH
MOUNTING RING****WIRE SET**

The distal end of the Forearm Cover Wire Set is accessed by disassembly of the coaxial connector/lamination collar.

The ring mechanism which mounts at the proximal end of the Wire Set is not removable.



HAND CIRCUIT CONNECTOR

Micro-D-Miniature (MDM) connector - Lines up automatically when Forearm Cover is installed.

Remote Power Switch Circuit
(Requires 5-wire harness)**

****OPTIONAL AFTER JAN. 2006**

(Installed at Motion control at no charge)

USING A REMOTE POWER SWITCH:

1. Connect one of the remote power switch options (see p. 35) to the 5-wire harness. (Touching an electrode in the "Electrode kit" is equivalent to activating a switch.)
2. Slide both Dip Switches on the Remote Power Switch Circuit (see diagram) to the left. To switch the power on or off, hold the switch for 1/4 second.
3. If a longer switching time is desired, slide DIP switch #1 to the right side. Now the remote switch must be held continuously for 3 seconds to switch the power ON or OFF (preventing accidental switching).

Dip Switch Close Up



Slide both to left
to enable
remote switching

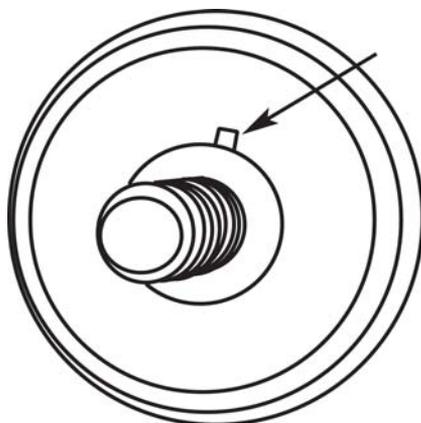
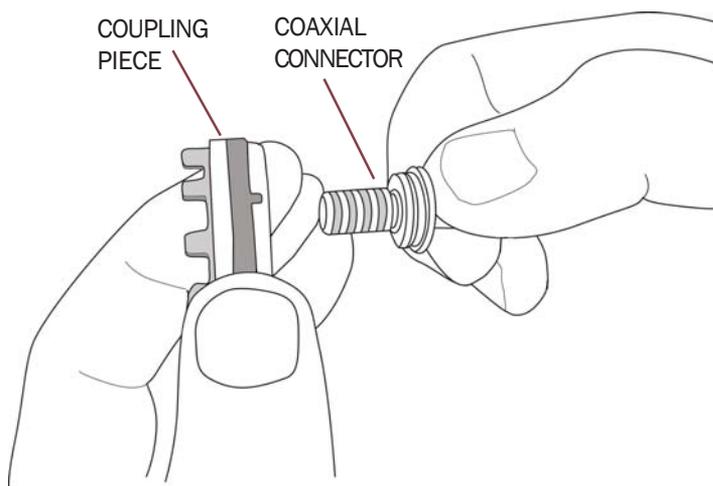
SLIDE **BOTH** SWITCHES TO **LEFT** TO ENABLE REMOTE POWER.

SLIDE **SWITCH #1** TO **RIGHT** FOR 3-SECOND SWITCH TIME.

Installation of a Passive Wrist Rotator

Step 1. Assemble the coaxial connector

Slide the coaxial connector through the center of the coupling piece and line up the square tab on the coax with the slot in the coupling piece.

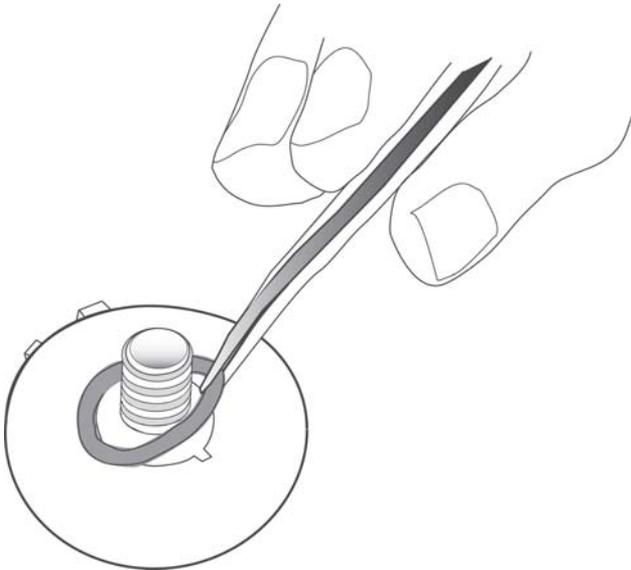


Step 2. Attach the coax ring

Using a small screwdriver or tweezers, press the plastic coax ring around the *inner* base of the coax plug.

NOTE: The plastic coaxial ring has a ridge on the inside and only goes in one way. If you run your finger around the diameter of ring, you should be able to feel a flat side and a rounded side.

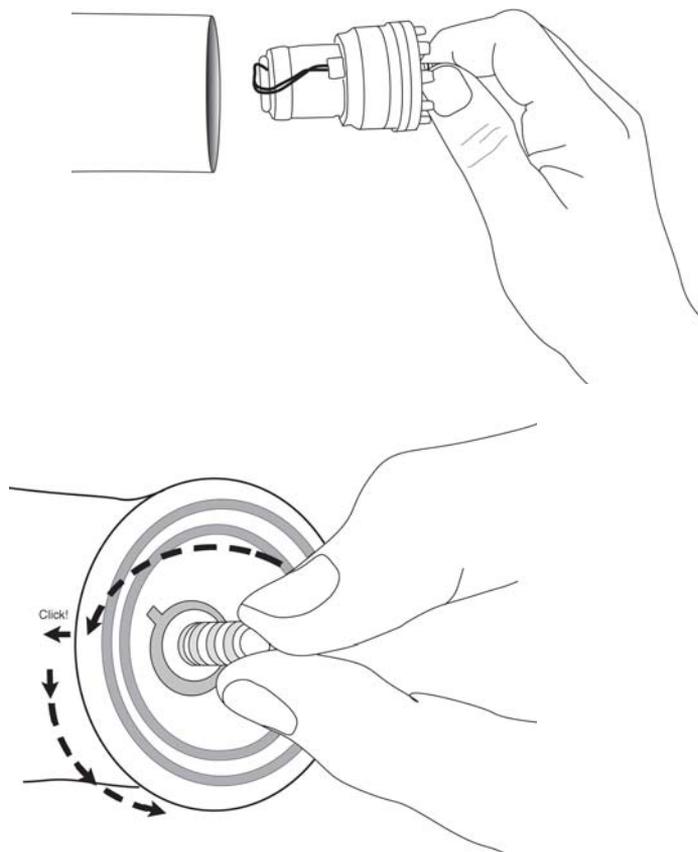
Install the ring FLAT SIDE DOWN.



Installation of Electric Wrist Rotator

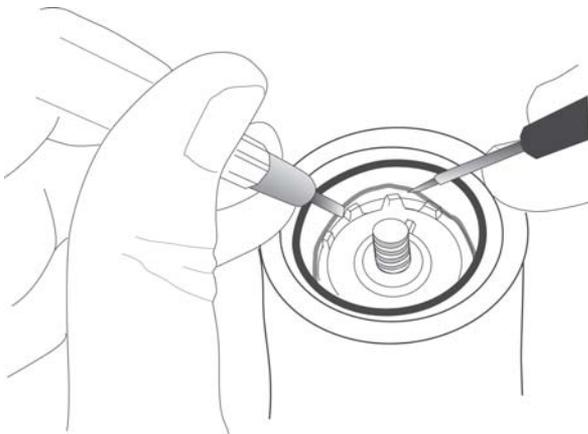
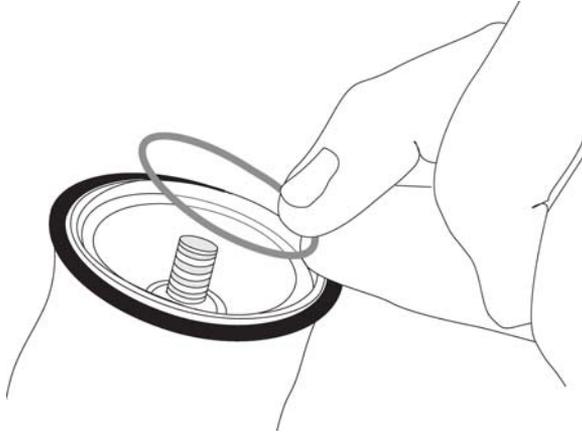
Step 1. Attach the Hand and Wrist control cables

Connect the hand and wrist control cables (see detail on following pages). Put the electric wrist assembly into the prosthesis forearm and make sure it is seated properly in the lamination collar. The wrist rotator has ridges on the outside that will line up with slots in the lamination collar--rotate the wrist rotator until you feel it click down into place, then continue rotating until it feels secure.



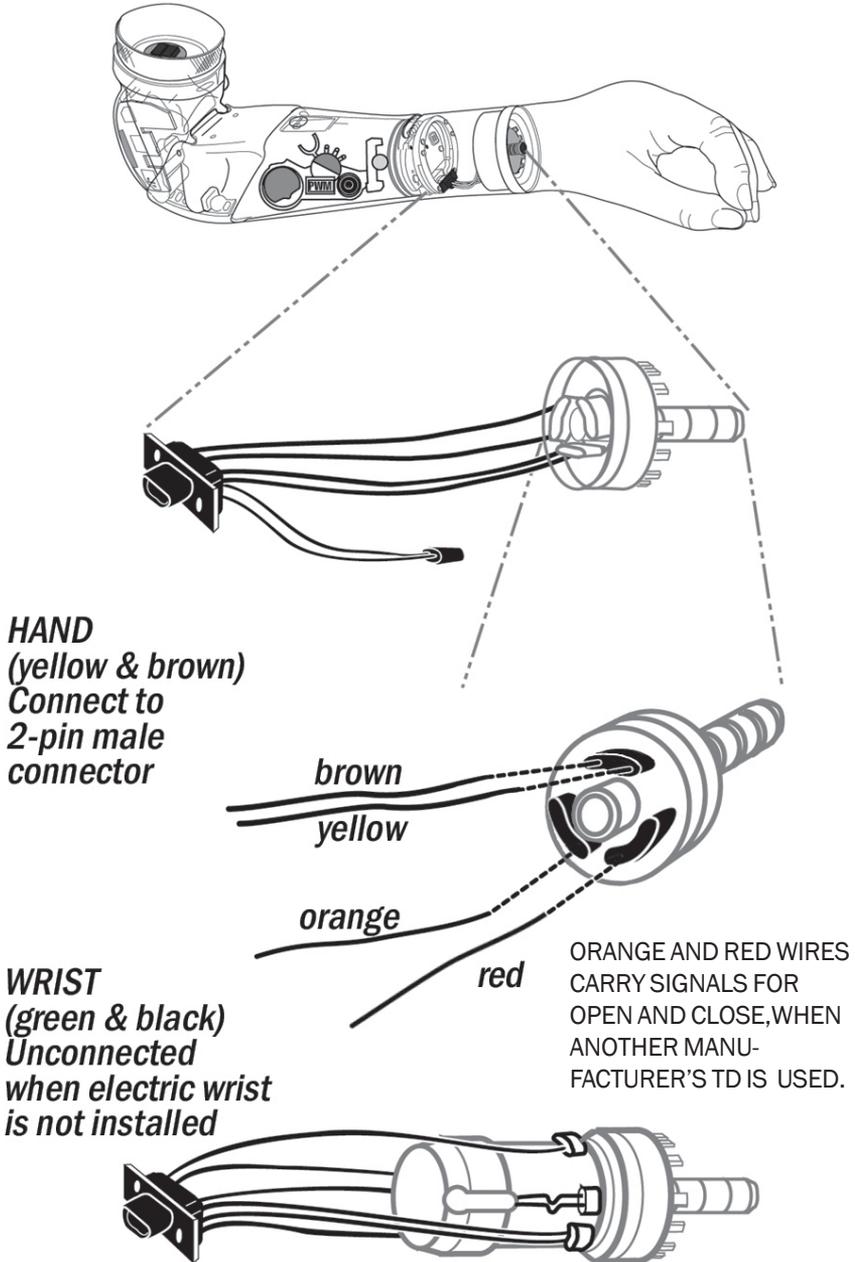
Step 2. Attach the coupling ring

Using a small screwdriver and/or tweezers, press the plastic ring around the *outer* base of the coupling ring. Make sure it sits inside the groove of the lamination collar.



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FIGURE 4.2 DETAIL OF CONNECTIONS OF THE U3 FOREARM COVER WIRE SET- DISTAL END:



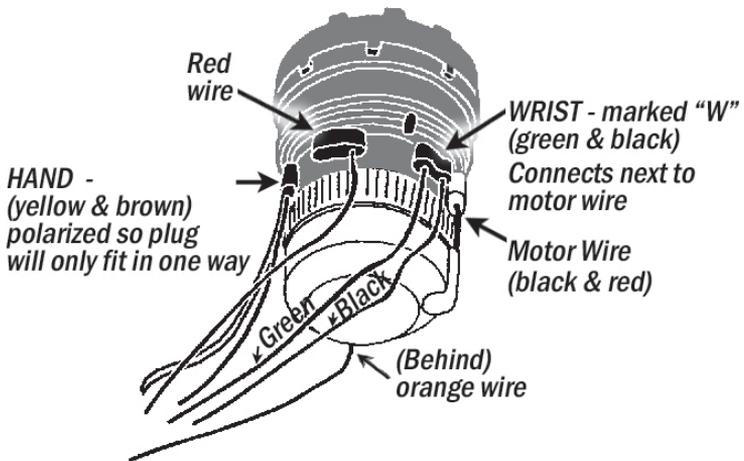
Notes:

The Forearm Cover Wire Set is not to be removed from the Forearm Cover except by Motion Control. The Ring Mechanism is factory installed into the Forearm Cover and is not field serviceable.

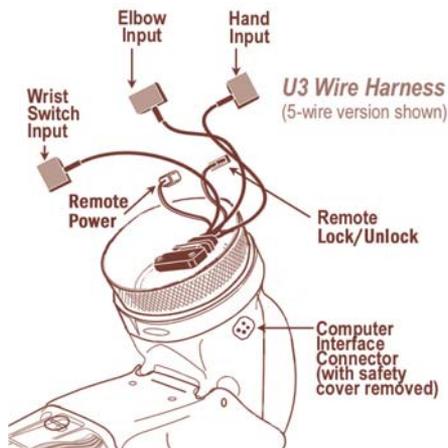
WE NO LONGER RECOMMEND REMOVAL OF THE ELBOW TRANSMISSION FOR ANY FIELD SERVICE. BECAUSE OF THE CHANGES IN THE TRANSMISSION, REMOVAL IS A MORE DIFFICULT OPERATION THAN BEFORE.

IN THE ELBOW TRANSMISSION, THE SLIP CLUTCH (OF UTAH ARM 1) HAS BEEN REPLACED WITH A RESETTABLE FUSE, WHICH INTERRUPTS POWER TO THE MOTOR WHEN IT BECOMES HOT- THIS MAY OCCUR AFTER ABOUT 45 SECONDS OF CONTINUOUS LIFTING AT MAXIMUM LOAD.

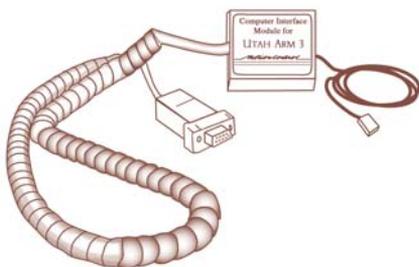
FIGURE 4.3 CONNECTIONS TO OTTO BOCK ELECTRIC WRIST ROTATOR



To make adjustments via the computer and the User Interface, connect the Computer Interface Cable to the 4-pin connector on the U3 elbow as shown in the figure below. Connect a TD and turn the Arm ON.



The Computer Interface Cable plugs into the elbow of the Utah Arm 3, allowing the arm to communicate with the computer.

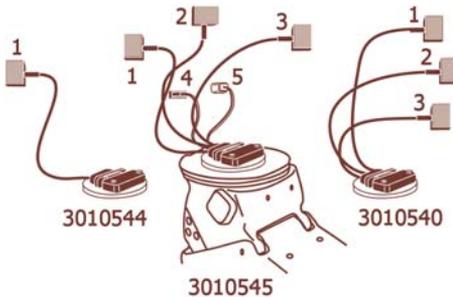


If your computer has no Serial Port, use a Keyspan brand USB/Serial Port adapter #USA19QW. (Motion Control PN:1800075) Be sure to install the software for the USB/Serial Port adapter.

Humeral Connector System:

The micro-D-miniature (MDM) connector system will allow you to connect a one, three, or five-wire harness to the Utah Arm, depending upon the number of control options you desire. **The 3-Wire Harness is supplied standard with the Utah Arm 3**, or if you prefer, when ordering, request the 1-wire or 5-wire harness.

Caution: Never insert any probe into the MDM connector pins. If you deform the tiny hollow sockets in the MDM, the entire Wire Set will need to be replaced.



Humeral Connector System Options:

1. “**ELBOW**” - Connects to EMG Preamplifier Set, or Alternate Inputs: (see below). For “Same Input” set up, the Elbow input is used to control both Elbow and Hand.
2. “**HAND**” - Input for the Hand only. Same choices as for Elbow Input.
3. “**SWITCH**” - Use with desired wrist control switch.
4. “**LOCK**” Cable - 2-pin connector for remote locking and unlocking.
5. **REMOTE POWER SWITCH** (unlabeled)- 4-Pin connector.
(After Jan. 2006, must be installed at Motion Control).

Alternate Inputs:

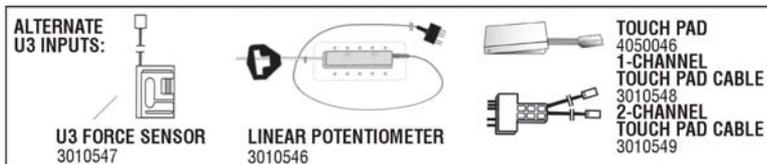
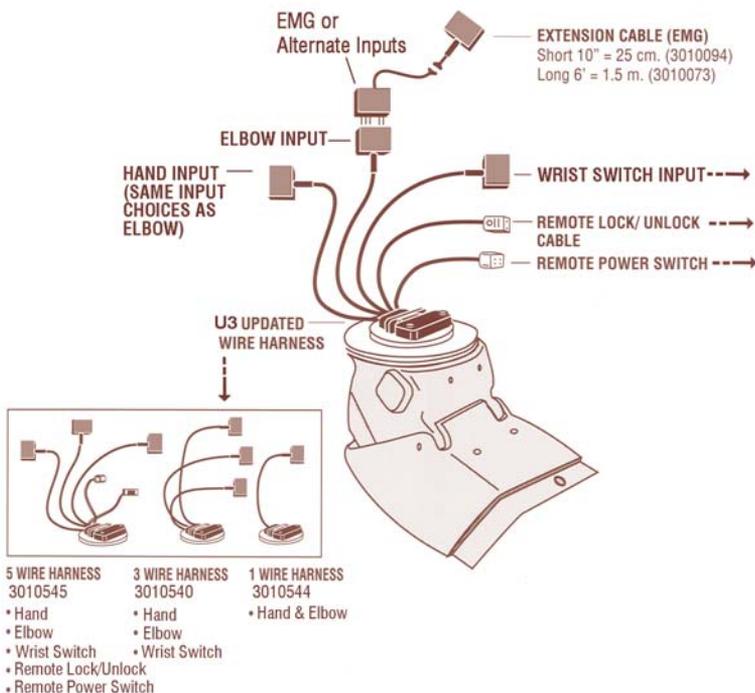


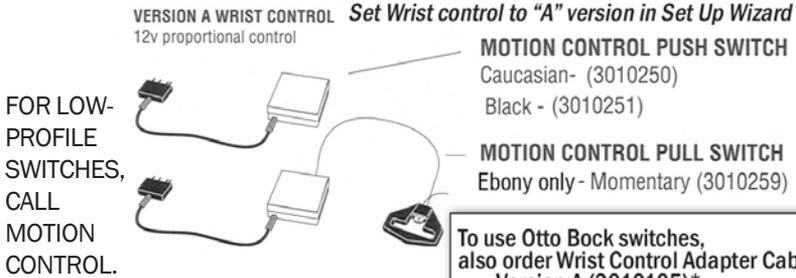
FIGURE 4.6 U3 CONTROL AND SWITCH OPTIONS



Note: After January 2006, installation of the remote power circuit is optional. See pg. 25.

D. CONNECTIONS

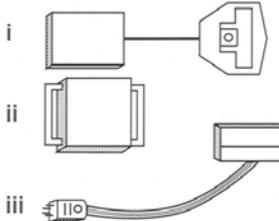
The U3 wrist latches electronically. For momentary function, hold switch for 1-sec. When released, function will return to Hand.



To use Otto Bock switches, also order Wrist Control Adapter Cable Version A (3010105)* OR Version B (3010106)*

SELECT VERSION IN SET UP WIZARD

VERSION B WRIST CONTROL
6v on-off control

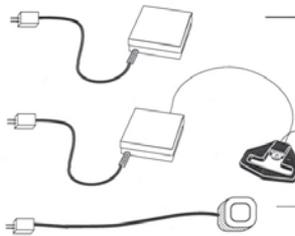


i- **CABLE PULL SWITCH***
Otto Bock (1701023)

ii- **HARNESS PULL SWITCH***
Otto Bock (1701022)

iii- **ROCKER SWITCH***
Otto Bock (1701021)

LOCK/UNLOCK SWITCHES



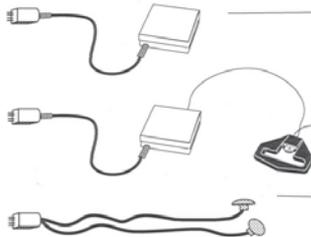
MOTION CONTROL PUSH SWITCH
Caucasian - (3010252)
Black - (3010253)

MOTION CONTROL PULL SWITCH
Caucasian - (3010260)
Black - (3010261)

PUSH BUTTON SWITCH FOR LOCK OVERRIDE (3010108)

Also: **LOCK OVERRIDE ADAPTOR CABLE**
Adapts Otto Bock Switches (3010107)

REMOTE POWER SWITCHES



MOTION CONTROL PUSH SWITCH
Caucasian - (3010254)
Black - (3010255)

MOTION CONTROL PULL SWITCH
Caucasian - (3010262)
Black - (3010263)

MOTION CONTROL REMOTE POWER SWITCH ELECTRODE KIT*
(3010247)

* *Touching the sensing electrode is equivalent to activating a switch. A ground electrode must also be connected to the ground cable.*

E. Software Installation Instructions:

- Insert CD or 3.5” floppy disk into your computer (PC) and double-click on the file named “WinU3&PC2inst.exe.”



- A pop-up window will appear asking if you want to install the program; click “YES,” then indicate where you want the software to be installed on your computer.



- It will automatically load on your “C” drive in a folder named “Motion Control” unless you specify otherwise. Click on “Unzip” to start the download.
- When the self-extractor is complete, you will see a message indicating the software has loaded successfully.



- You will then see two new icons on your desktop labeled “U3 & PC2” and “U3 & PC2 Demo.” Choose the demo to see a demonstration of the software without connecting the Arm parts. Otherwise, choose “U3&PC2” to begin using the software. Note: If you are running other Windows programs while using the Utah Arm 3, your computer monitor may switch to a different viewing resolution. Your normal settings will return when you exit the Computer Interface software.

Note: It is only necessary to load the Computer Interface software onto your system once.



Click on the “U3 & PC2” icon to get started.

To Operate the User Interface:

Note: Be sure the U3 Arm is turned “ON” and a fresh battery is installed.

- When you are prompted to do so, choose a COMM port that the Utah Arm 3 will use to communicate with your prosthesis. The system will quickly verify your communication is working properly and then you will see the Main Menu screen.

- If connection does not occur within 10 seconds, recheck all connections, change battery, and make sure power switch is ON. If all else fails, reboot your computer, with the computer cable disconnected. You can also try reinstalling the User Interface program.



*Click on Utah Arm 3 and
"NEXT" to proceed.*

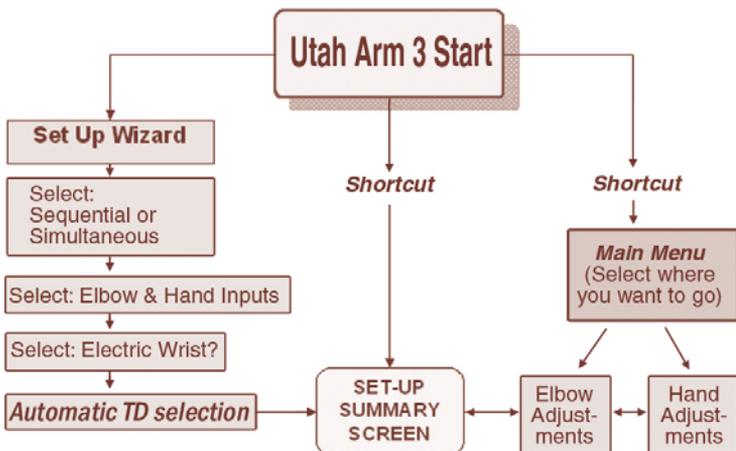
System Set Up

The U3 Computer Interface uses a Set Up Wizard that will guide you through the process of setting up your system, or you may take a shortcut directly to the Set Up Summary screen or the Hand and/or Elbow adjustment screens. Instructions follow for each step in the Set Up Wizard. Users who are familiar with the User Interface may wish to go directly to the adjustment screens.



Choose the Set Up Wizard to customize your system.

FIGURE 5.1. ORGANIZATION OF THE USER INTERFACE SCREENS. YOU WILL USE THESE SCREENS TO CHANGE AND SAVE YOUR ADJUSTED SETTINGS. BUTTONS ON EACH SCREEN ALLOW YOU TO NAVIGATE FROM ONE SCREEN TO ANOTHER.

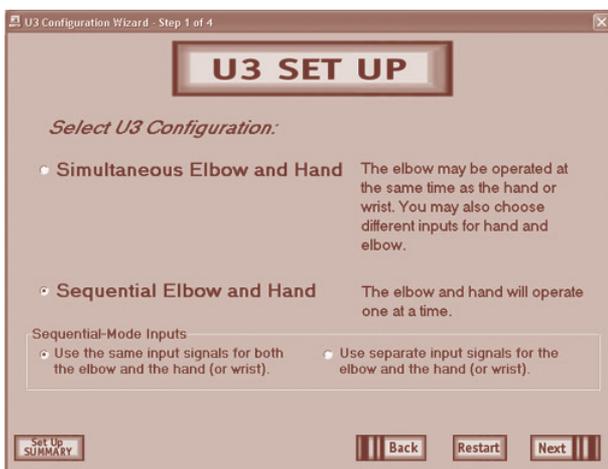


Step 1. Select U3 Configuration

- “Simultaneous” Elbow and Hand control allows the wearer to operate the elbow and the hand (or wrist) at the same time.

Note: This configuration requires separate inputs for the elbow and hand.

- “Sequential” Elbow and Hand control is the same as the U2 operation. That is, control will sequence through the elbow and hand (and wrist, optionally). The elbow must be locked for the hand to operate.

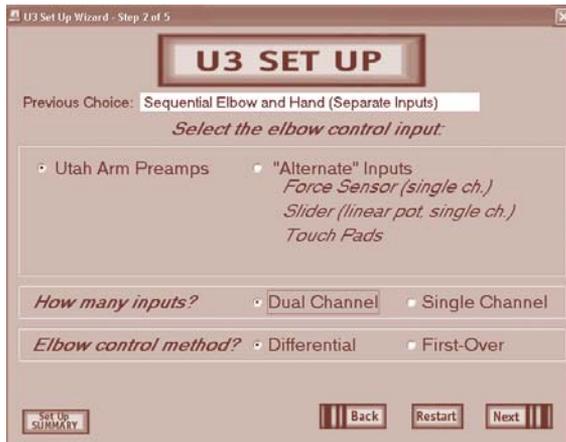


Choose between “Simultaneous” and “Sequential” control modes.

Notice the Set Up Wizard provides a summary of the choices you make as you go along. You may change your selections by clicking on the “Back” button, or go to the Set Up Summary.

Step 2. Select Elbow Control Input

If using EMG control for the elbow, choose “Utah Arm Preamps.” For other inputs, choose “Alternate” Inputs. Indicate if you will be using dual or single channel inputs. Make your selections and click on “Next.” Note: If you chose “separate inputs,” you will also need to specify the inputs for the Hand on the next screen.



With Dual-channel EMG, you may choose “Differential” or “First Over”.

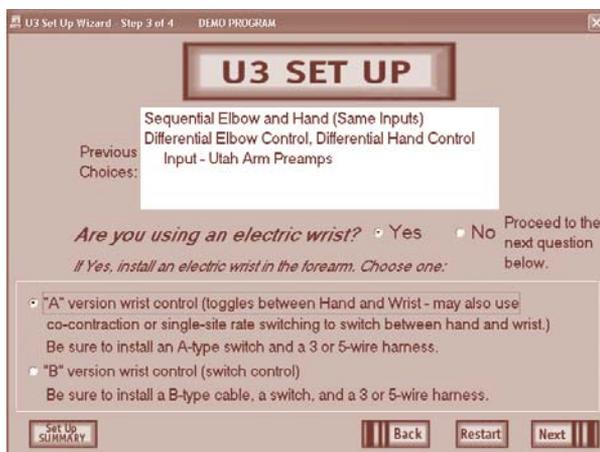
- Differential: Uses the *difference* between the two signals to run the elbow.
- First Over: Runs on the *first* signal to cross over the threshold and ignores the other signal. Best used for wearers who have a lot of co-contraction. The only “downside” for the wearer is, to reverse the direction of the Hand or Elbow, the first muscle must relax below threshold.

Step 3. Hand Control Input

Same as elbow control screen. (Not shown if “Sequential” and “Same Inputs for Elbow and Hand” are both chosen.)

Step 4. Electric Wrist Control option

Indicate whether or not you will be using an electric wrist. If yes, you must specify if you will be using Version A or B. Use one of the switches specified on page 36.



NOTE: WRIST SWITCH OPTIONS ARE DIFFERENT FOR U3 VS. U2.

- Version A Wrist Control - Redirects Hand control to wrist.
Advantage: Proportional, may not require an external switch.
- Version B Wrist Control - Switch activates wrist.
Advantage: Simple, simultaneous.

Note: If you use simultaneous control, then Hand/Wrist switching is possible by co-contraction (or high-rate of a single channel input). In this case, an external switch is not essential, though it might be useful as a backup method. (If a switch is connected, both co-contraction and the switch will cause Hand/Wrist switching.)

Step 5. Automatic Terminal Device Detection

The U3 can be used with 2 types of TDs:

Type 1. Motion Control Hand or ETD (standard version), interchangeable with some Otto Bock TDs– 8E37 Hand; 8E32=12 Greifer (specifically made to use with the Utah Arm).

Type 2. Hands and TDs with In-Hand Controllers, for example, the Otto Bock Sensor Hand (this choice automatically connects a 7.2 v. battery supply to the TDs).

The U3 will “Auto-detect” either type of TD connected, in the 2 seconds after you turn it on. The ‘beep’ heard during this 2 seconds may be turned off in the “Hand Menu; User Settings screen.”

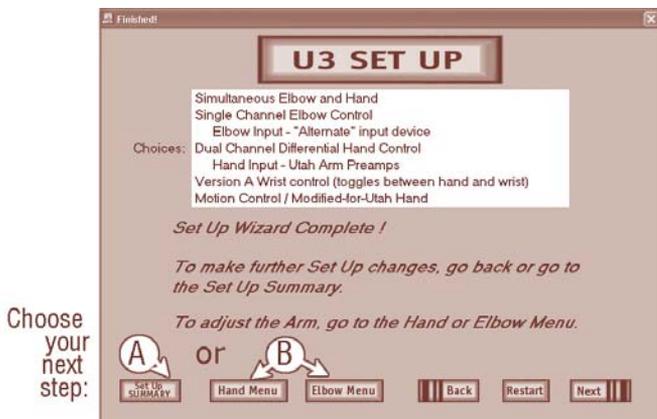
IMPORTANT: Turn U3 power OFF when changing from a Type 1 to a Type 2 Terminal Device.

NOTE: Warranty of non-MC TDs is at the discretion of the TD manufacturer.



Step 6. Set Up Wizard Complete!

This screen shows a summary of all the choices you have made so far. From here you can go to the Hand or Elbow Menu to begin adjustments, or go to the Set Up Summary screen to make changes to your selection.



A. Set Up Summary

Double-Click on any item directly to make changes to your selection.



B. Elbow Main Menu (*Hand menu on p.50*)



Look and Set screens-

Four screens are available: •Elbow settings (for most adjustments); • Lock/Unlock; • Freeswing/Relax Timer; • Save/Recall Settings.

User Settings-

Allows you to change polarity and lock/unlock options.

Hand Menu-

To make adjustments to your Hand control.

Set Up Wizard-

Returns to the Set Up Wizard.

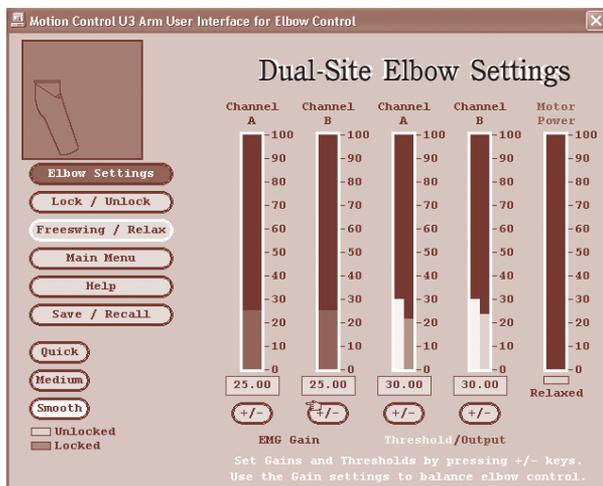
System Parameters-

To change the COMM port and check hardware and software settings.

F. Elbow Adjustments–Dual Site EMG

Begin by clicking on “Look and Set” to advance to the Elbow Settings screen to make adjustments and/or for patient training.

(Dual site EMG shown. See p. 50 for Single site)



The Columns :

1 and 2: A and B Channel Gain - These are the sensitivities of the A and B channels. You can change them to balance flexion/extension sensitivity. (See “To Adjust Gains or Thresholds” below)

3 and 4: A and B Output - For training muscle strength, or strength of output. This helps the wearer to visualize the signal generated by their inputs and to develop better control. Notice that the blue columns (input strength) will reach higher values with higher gain settings. The main purpose of the Gain is to balance the muscle EMG or other input. The purpose of the Threshold is to prevent unintentional motion of the Elbow. The Elbow will not move until the input exceeds the Threshold.

When the control method is set to “Differential:”

5. Motor Power: For training muscle (or other input) difference. The bigger the difference, the greater the motor power. The U3 computes the difference between the A and B input signals to operate the Elbow. This “difference,” after further electronic processing, operates the Elbow motor, and is displayed in the Motor Power column.

The Motor Power can be very useful for training, when the wearer realizes that **the strength of the input difference is what actually makes the elbow move**.

For example, if you are using EMG inputs, if the wearer’s A and B EMG signals contract equally, i.e., co-contract, they cancel out and there is no difference between the A and B EMG Outputs, and thus no movement of the elbow. The wearer must develop enough independence between the two muscles for the Motor Power to reach a value of approximately 10 on the scale to move the elbow.

When the control method is set to “First Over:”

In **First Over Dual Site EMG**, only the *first* muscle to cross the threshold controls the elbow. To reverse directions, the first muscle must relax below the threshold and the second muscle must contract above the threshold. We recommend this mode for patients with a high level of co-contraction.

To Adjust Gains or Thresholds:

Identify the weaker of the two inputs-- less motor power is generated when it fires.

1. Highlight the gain you want to change using the arrow keys.
2. **Raise** the setting by pressing the “+” key on your keyboard (you don’t have to shift– just press the key). Or, **lower** the setting by pressing the “-” key . You will see the

value change in the window below the column (Use the “page up” or “page down” keys to increase or decrease by 10 points at a time).

The U3 immediately changes the value, so the wearer can immediately try the new setting each time you change a value. Repeat this adjustment process until the wearer feels that raising and lowering the elbow require equal effort.

3. To SAVE the value you changed, select the Save/Recall Settings button. The Save/Recall screen will automatically appear whenever you have changed a setting, and go to another screen.

Summary of EMG Settings:

1. **GAINS:** Test for equal effort to raise and lower the elbow. Balance the effort, if needed, with the A and B Gains.

2. **THRESHOLDS:** Test for unintentional motion when the elbow is positioned throughout the working space. Raise the Threshold, if needed.

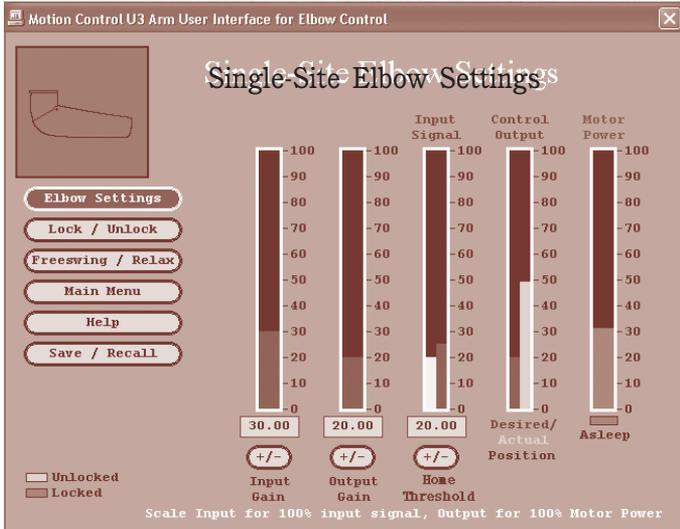
3. **QUICK/SMOOTH SETTING:** Let the wearer experiment with the different options, realizing there is a trade-off between speed and control.

Choose “Quick” for quickest response.

Choose “Medium” for balance between “Quick” and “Smooth” settings.

Choose “Smooth” for jittery muscle signals and added control (but slower).

Elbow Adjustments - Single Channel Input Settings



How “Single Site” control works:

Using the Single Site Elbow control option, increasing the signal raises the elbow and decreasing the signal lowers the elbow. The input signal is proportional to the level of the signal, so slow and fast speed is under the control of the wearer. [You may reverse polarity on the “User Settings” screen, if desired]

HOME THRESHOLD: Determines when the Elbow will start running, as the Input Signal is raised. Its purpose is to prevent unwanted motion of the Elbow from small fluctuations of the input.

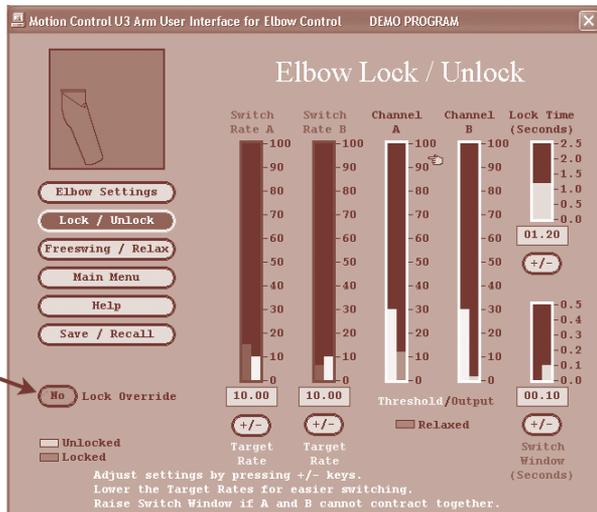
Lock/Unlock - Dual Site Inputs

Use this screen to help train wearer to switch between Hand and Elbow. Input signals are shown to help with training.

Steps To Unlock:

1. Relax until “Relaxed” light goes on.
2. Co-contract (or generate alternate input signal) so both target rates are exceeded.
3. The border of each column flashes GREEN when co-contraction is successful. This feedback may help train the wearer to flash *both borders green* simultaneously.
 - Switch Window: Time allowed between two muscle contractions (or other dual inputs). Increase if contractions are not simultaneous.

Lock Override →
“YES”= Enables lock override button on arm



Target Rates

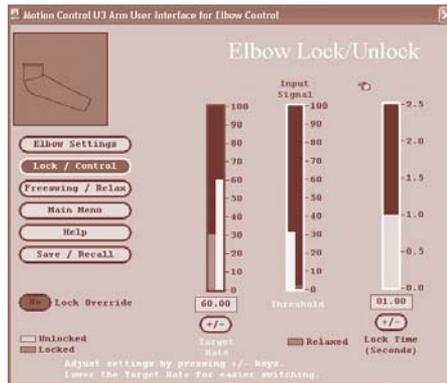
1. Watch the Switch Rate signals as the patient attempts to co-contract to unlock.
2. Set the Target Rate at ~80% of the maximum switch rate signal, for each channel.
3. The wearer should be able to consistently reach the Target Rate. When this occurs, the border flashes green.
4. When both borders flash green unlocking will occur.

Lock Time

Elbow must be held still for this time to lock (suggested starting: 1.0–1.25 sec.). Longer lock time prevents accidental locking. Time can be shortened after a few weeks of practice if the wearer desires.

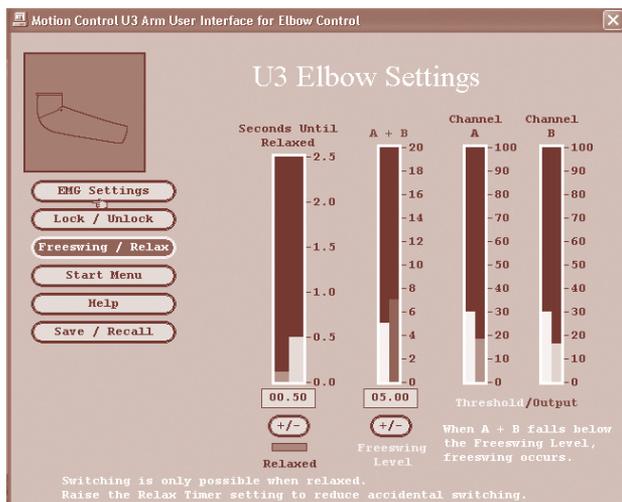
Lock/Unlock - Single Site or Alternate Input

- Same as dual site unlock, except with a single input. Note: To unlock, Rate must be higher than Target Rate for both rising and falling signal, so train the wearer to contract and relax quickly.
- Raise Target Rate, if needed, to prevent accidental unlocking.
- Lower Target Rate, if needed, to allow easy unlocking (suggested starting: 40%)



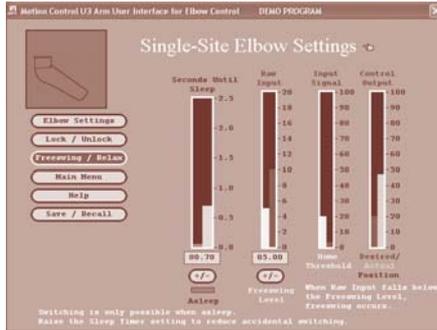
Freeswing/Relax - Dual Site Input

- Freeswing occurs when total muscle signal (A + B) falls below freeswing level.
- Adjust the Freeswing Level so wearer can relax below it, whenever Freeswing is desired.
- Relax Time: Prevents accidental unlock by requiring a pause before unlocking. Input signal must stay below home threshold for this time.



Freeswing/Relax - Single Site Input Settings

Functions are the same as for dual-site inputs.



When you have finished with Elbow Adjustments, return to “Main Menu,” then “User Settings” to make choices below.

User Settings

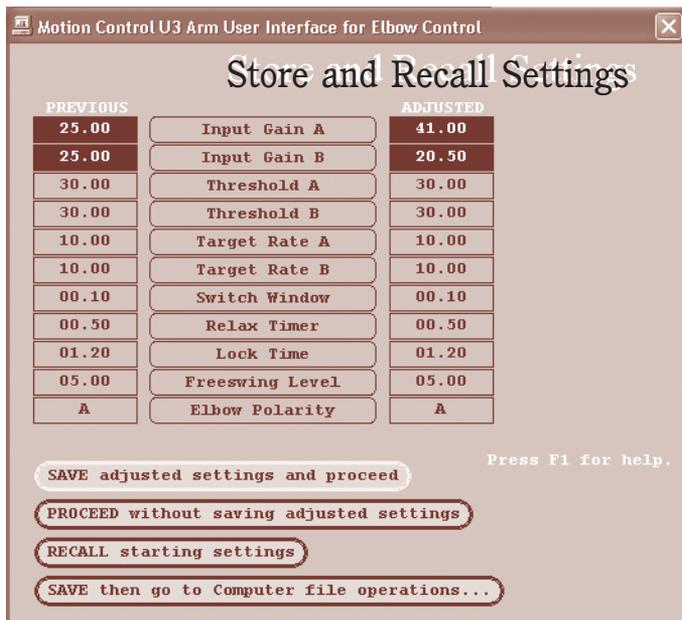
Elbow Polarity - reverses the direction of the elbow.

Lock/Unlock - use the computer to unlock or lock.

Note: User Feedback (beep and buzz) are all enabled on the Hand Menu; User Settings).



G. Store and Recall Settings



PREVIOUS		ADJUSTED
25.00	Input Gain A	41.00
25.00	Input Gain B	20.50
30.00	Threshold A	30.00
30.00	Threshold B	30.00
10.00	Target Rate A	10.00
10.00	Target Rate B	10.00
00.10	Switch Window	00.10
00.50	Relax Timer	00.50
01.20	Lock Time	01.20
05.00	Freeswing Level	05.00
A	Elbow Polarity	A

SAVE adjusted settings and proceed Press F1 for help.

PROCEED without saving adjusted settings

RECALL starting settings

SAVE then go to Computer file operations...

Store and Recall: Automatically comes up every time you exit a screen if changes were made to settings.

The left column, labeled “PREVIOUS”, indicates settings from AutoCal or the last saved settings. The right column, labeled “ADJUSTED”, shows the latest changes you made on the last screen you were on. The middle column shows which settings are being affected.

The buttons at the bottom of the screen give you the following options:

1. SAVE adjusted settings and Proceed-- keeps the changes you made.
2. PROCEED without saving adjusted settings - retains “previous” settings shown in the left column.

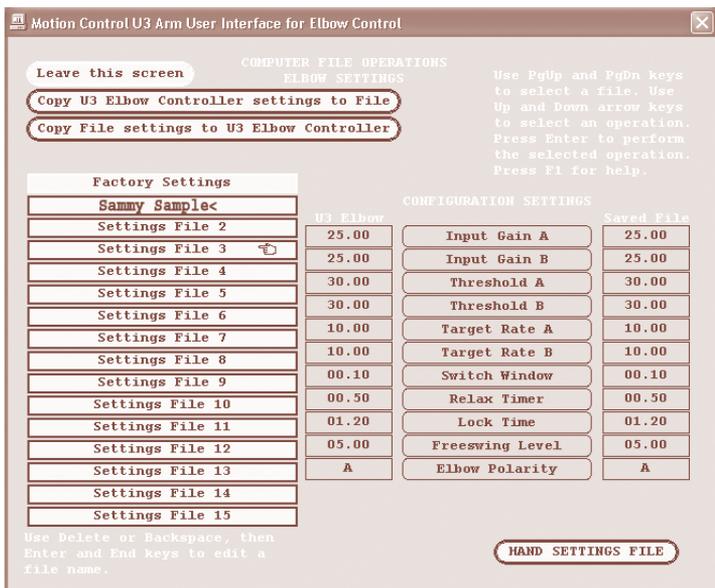
G. SAVING ADJUSTED SETTINGS

3. RECALL starting settings - recalls “original” settings established at the start of session. These are the settings the program reads in from the U3 when the User Interface program is first started.

4. SAVE then go to computer file operations to store the settings in your computer.

Computer File Operations:

To save adjusted settings into permanent memory on your computer. Follow on-screen directions to select a register, rename it, store settings, or retrieve settings. *To retrieve settings, be sure Set Up Wizard has the same configuration as when they were originally stored.*



Computer File Operations:

On this screen you can save the adjusted settings to your computer's hard disk for later use. This can be useful to

compare the settings at the beginning of training with those after training. Or you could save optimized settings, so you can return to them after experimenting with other settings.

How to Save Wearer Settings to Hard Disk

- Use the “Page Down” key to select Settings File 1 and press <Enter>.
- Press delete or use the backspace key to erase the text and type in the patient’s name and <Enter>.
- Highlight the desired operation using the up and down arrow keys (i.e., copy settings from elbow to file or vice versa). Press <Enter> to perform the selected operation.
- When you are finished, go to “Leave this screen” to return to the screen you were previously on, or “Hand Settings” to save your Hand settings file.

Note: When new versions of U3 or ProControl 2 software are loaded, the saved files are lost. Print the settings, or use “Full Feature” save (below) to save permanently.

How to Print Wearer Profiles

To have a printed record of the settings you have used, simply:

- Press the “PRINT SCREEN” key on your keyboard (usually to the right of the function keys).
- Open up a document in MS Word, or any software that can handle graphic images.
- Press “CTRL” and “V” at the same time, or go to the **E**dit menu and select Paste. A picture of your Settings screen should appear. Press “CTRL” and “P” or select Print from the **F**ile menu to print the picture for storage in the patient’s file, or save to disk.

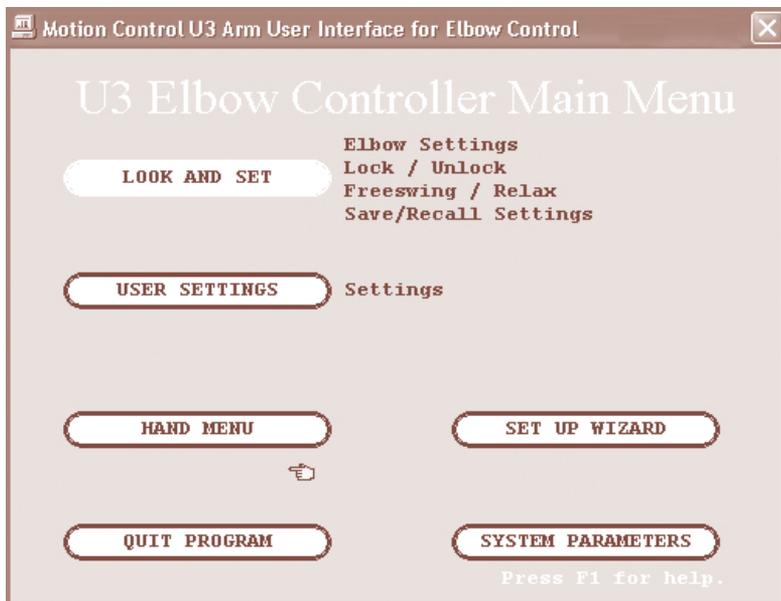
Full Feature Save

This alternative save was added for two features:

- All settings, including Wizard choices are saved.
- Loading new software versions will not erase previously saved settings.

H. U3 Hand Main Menu

The Hand Main Menu is the gateway to the Hand Settings and allows you to choose adjustment screens, or change user settings for the Hand in the same way.



Hand Settings - Dual Site Inputs

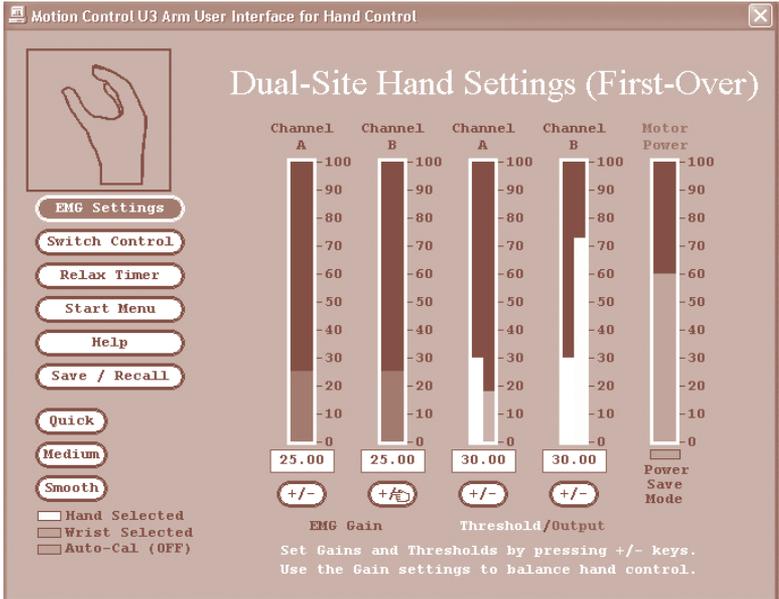
(These settings are chosen in the Set-Up Wizard)

EMG DUAL SITE (STANDARD): Hand power is the **DIFFERENCE** between channel A and channel B inputs.

"FIRST OVER": Hand power is the output of the **FIRST SIGNAL ABOVE THRESHOLD**. To reverse direction, the muscle (or other input signal) must relax. Use First Over when co-contraction of both inputs prevents easy operation of the Hand.

H. HAND ADJUSTMENTS

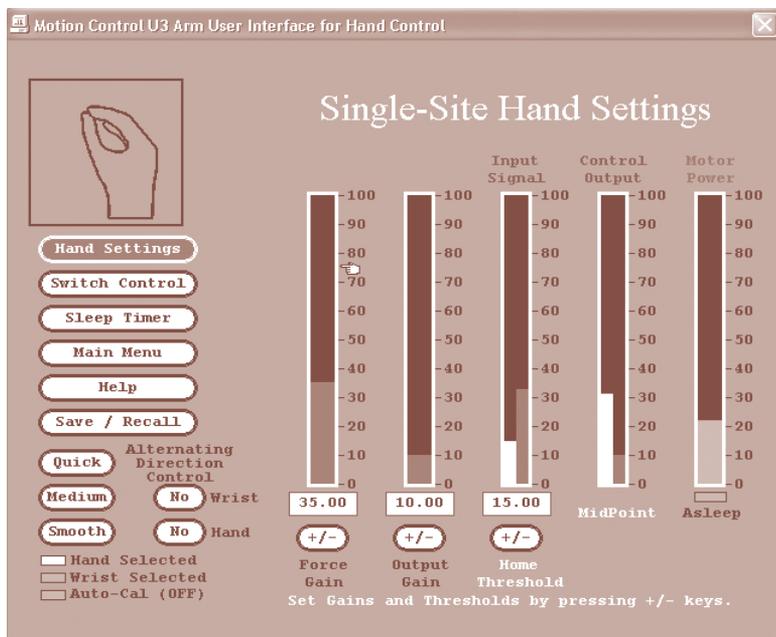
Note: If the Hand on screen is running backwards from the actual TD, press “ALT” + “H” to reverse direction.



Hand Settings - Single Site EMG or Alternate Input

Steps to adjust SS input:

1. Adjust “Input Gain” so that “Input Signal” reaches 100% with moderate effort.
2. Adjust “Output Gain” so that Hand control is optimized.
3. Adjust “Home Threshold” to prevent accidental motion of the Hand.



NOTE: THE SINGLE SITE CONTROL SCREEN IS DISPLAYED IF “SINGLE CHANNEL INPUT” IS CHOSEN IN THE SET UP WIZARD.

How “Single Site” control works:

Using the Single Site Hand/Wrist control option, increasing the signal closes the hand and decreasing the signal opens the hand. The closing power is proportional to the level of the signal, so slow and fast closing speed is under the control of the wearer. [You may reverse polarity on the “User Settings” screen, if desired]

If you have chosen the Wrist Option, be sure the “W” output cable is connected to the wrist rotator (see p. 30 for diagram).

To switch control to the wrist: the wearer relaxes, then contracts and relaxes quickly (and lightly) to switch to wrist mode. The same rapid/light contraction returns control to the hand.

HOME THRESHOLD: Determines when the Hand will start running, as the Input Signal is raised. Its purpose is to prevent unwanted motion of the Hand from small fluctuations of the input.

MIDPOINT: This is the level the signal must fall below to reverse direction. The Midpoint automatically moves just behind the output, so that reversing Hand direction is easy. The wearer has only to relax the Input signal to reverse the Hand direction. This value is not adjustable.

ALTERNATING DIRECTION WRIST CONTROL: Choose “yes” or “no” by clicking on the button. If “YES”, when control has switched to wrist, the direction of the wrist motion reverses each time the Input signal falls below the Home Threshold for a length of time given by the sleep delay (see Sleep Timer screen).

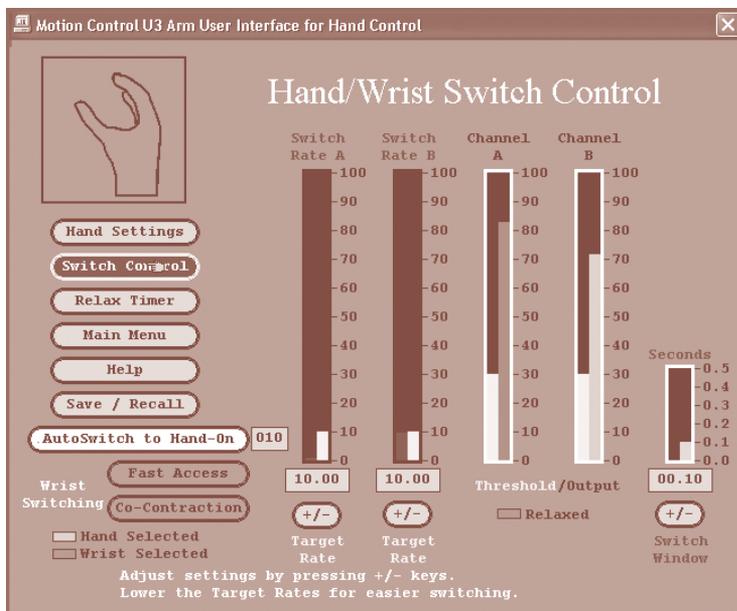
Switch Control (if wrist is installed)

Dual Site EMG or Alternate Inputs

When “separate inputs” are chosen in the Set Up Wizard, the U3 uses co-contraction, i.e., a simultaneous contraction of the two control inputs to switch between Hand and Wrist. “Fast Access” wrist switching is also available, if enabled (simply click on the menu button).

Note: If “same inputs” are chosen for Elbow and Hand in the Set Up Wizard, then co-contraction is dedicated to Elbow unlock.

***Switch Control:** This screen helps you to train a patient to switch between Hand and Wrist functions (if the wrist is installed). You can fine-tune the setting for Switch Rate A and B and the Switch Window (Outputs are also shown here, to help with training). Note: If the Electric Wrist is not plugged into the U3 Wire Harness, the Switch function is not enabled, and thus will not occur.*



In the A and B Switch Rate columns, the wearer's actual Switch Rates are shown (in pink, on the left), along with the Target Rate settings (in yellow, on the right).

In order to switch by co-contraction, the wearer's goal is to co-contraction so that the A and B Switch rates (pink) "jump" up to the Target Rates (yellow) at the same time. If successful at reaching the Target Rate, the border around the Switch Rate graph will flash green. If a co-contraction takes place, the "Wrist Selected" light will turn yellow until the user relaxes below threshold. Then switching will occur.

Hand Selected & Wrist Selected: These indicators light to show which motor the U3 will operate. They change when the switching is successful.

Gray = off

Green = on

Yellow = waiting to relax

The **Switch Window** (last column on the right) is the interval of time allowed between the first input signal threshold crossing, and the second input signal threshold crossing, to be considered a co-contraction. The wearer must learn to contract both control muscles at the same time (co-contraction) and at a quick rate.

Fast Access Switching:

One muscle contraction, performed quickly so the Target Rate is exceeded, will begin operating the wrist rotator. The wrist function will stay in operation until both muscles relax (see “Note” below). This allows the wrist function to also be proportional. If co-contraction is also enabled, then either method may be used to perform wrist rotation. [The Switch Rate border flashing green only occurs when the co-contraction function is enabled].

Note: Switching also requires that the “Relaxed” light comes on. The wearer must relax both Threshold muscles for the length of the Relax Time. (To adjust, see below)

How to use the Switch Control screen to train the patient:

Co-contraction Switching:

Instruct the patient to perform the following sequence:

1. **“Relax both muscles.”** (On the Switch Control screen you can see the A and B EMG outputs drop - they must drop below the threshold on the EMG Output columns.) Then the “Relaxed” light comes on. (The Relax Timer may be changed if needed, see p. 67).
2. **“Then, as quickly as possible, contract both muscles lightly.”** (On the Switch Control screen you can see the A and B outputs rise– they need only rise to the Threshold level for each channel. You will also see the Switch Rate A and the Switch Rate B rise quickly– these columns measure only the quickness of the EMG contraction– so this column rises only during the start of the contraction.)

3. **“Train your muscles so that the A and B pink bars rise up together, and make the blue border flash green.”** Then the Hand and Wrist lights change colors, in the lower left corner, showing that the function has changed .

Fast Access Wrist Control Switching:

Instruct the patient to perform the following sequence:

1. **“Relax both muscles.”** (On the Switch Control screen you can see the A and B EMG outputs drop - they must drop below the threshold on the EMG Output columns.) Then the “Relaxed” light comes on. (The Relax Timer may be changed if needed, see p.67).
2. As quickly as possible, contract the A (or B) muscle enough to exceed the threshold. The Switch Rate A (or B) must exceed the Target Rate for that muscle, then the wrist will turn on. (For feedback, the “Wrist Selection” light will also turn on. If Co-contraction is also enabled, the blue border will also flash green.)
3. As long as either A or B muscles are above threshold the wrist will remain on. The wrist turns off and control transfers back to Hand, when both A and B muscles fall below threshold, and the “Relaxed” light comes on.

To make switching easier for the wearer:

1. **Lower the Target Rate setting on A and/or B.** Select the setting desired, then lower the Target Rate with the “-” key.

Test: Ask the wearer to contract the muscle quickly enough to make the border flash green. Lower the setting until successful.

2. **Decrease the Relax Time** (see p. 67).
3. **Increase the Switch Window.** Do this when the test in Step 1 shows the border flashing green, but the two muscles can not contract simultaneously.

A WORD OF CAUTION: Making switching easier can result in switching “too” easily– then the switching occurs unintentionally. Change the settings only as far as necessary. Also, let the wearer practice with the screens.

“Practice makes perfect.”

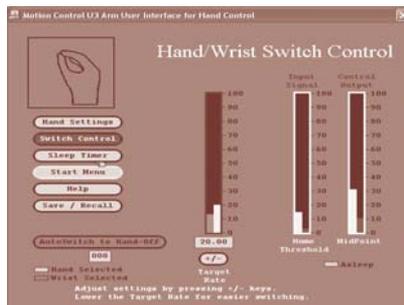
Summary:

- ✎ To switch easier, lower the Target Rate settings. Watch the screen and adjust settings to optimize the patient’s success.
- ✎ The Switch Window represents the time allowed between the two input signals (as they cross the threshold), to be considered a co-contraction.
- ✎ Make the time longer to make switching easier, if the signals cannot be generated simultaneously.
- ✎ Make the time shorter to help eliminate accidental switching during Hand function.
- ✎ If switching cannot be mastered, you may use a Wrist Control switch. See options on p.35.

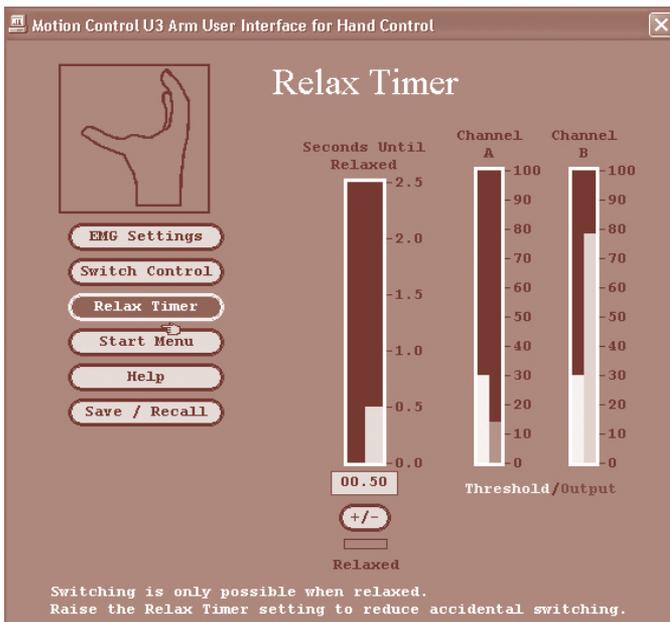
Single Site EMG or Alternate Input Control:

Works the same as dual site, except with a single input. The “Asleep” light must be on for switching to occur.

(see Relax Timer screen)



Relax Timer - Dual Site Inputs



Relax Timer: To switch between Hand and Wrist, the A and B inputs must first relax, i.e., EMG's or alternate input signals fall below their thresholds. They must stay relaxed for the length of this setting before the U3 will allow a Hand/Wrist switch.

The Relax Time is meant to ensure that quick opening and closing of the Hand is not mistaken for a co-contraction, thus causing an accidental switch.

Fast Access Wrist

The "Relaxed" light must turn on:

- to switch between Hand and Wrist,
- before a Fast Access Switch to Wrist, and
- after relaxing below threshold to return to Hand.

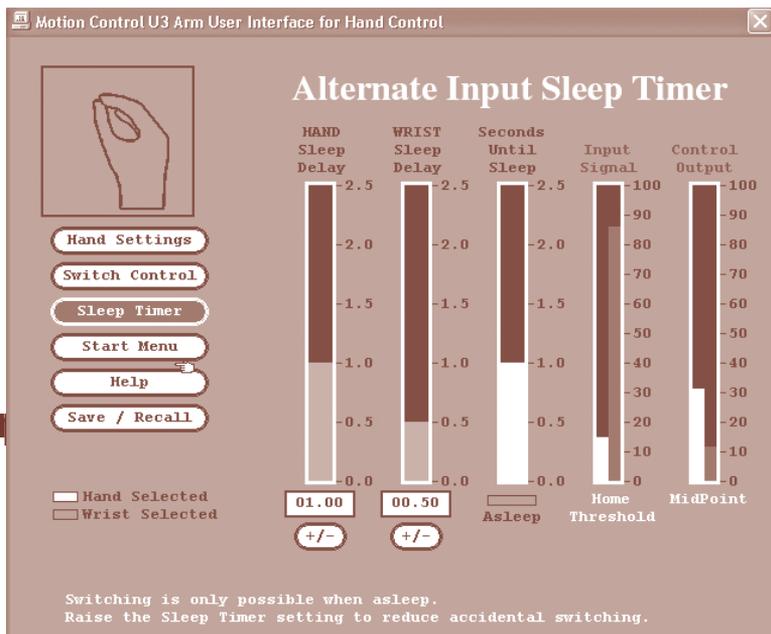
How To Train The Patient & Fine-Tune the Relax Timer:

While training with the Switch Screen, notice the light at the bottom of the screen, labeled “Relax.” This tells you and the patient when the Relax Time has been reached, and co-contraction will switch from hand to wrist. Awareness of the relaxation which is required may help prevent unintentional switching.

However, if during operation of the hand, the patient accidentally switches, you can lengthen the Relax Time in the Relax Time Screen. Boost it to .40 (starting is .25), and then explain to the patient that they must relax until the ‘Relaxed’ light is on, before attempting a co-contraction to switch.

After training for a few minutes with the function of the “Relax’ light, then ask the patient to again test the fast opening and closing, to see if the accidental switching is still a problem. If it is, increase the Relax Time. Test again for accidental switching and train further using the Switch Control screen. Continue this process, with training, until no accidental switching occurs.

Sleep Timer - SS EMG or Alternate



Hand Sleep Delay - sets the length of time the Hand must stop for the Hand to “sleep”, i.e., for the Power to turn off.*

Wrist Sleep Delay - sets the length of time the wrist must stop to go to “sleep.”

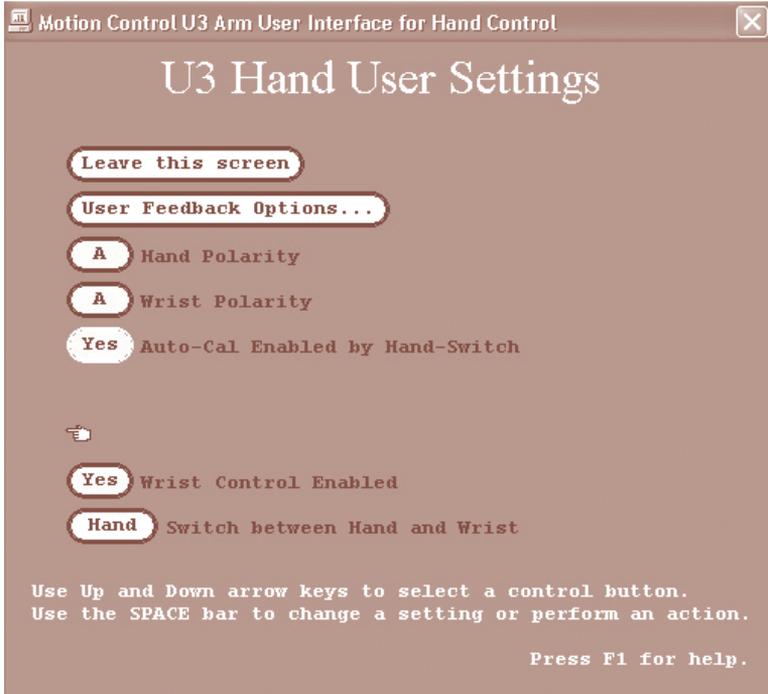
Seconds Until Sleep- Shows actual run time of the Hand or Wrist going to sleep (border flashes green when sleep occurs). This is useful for training.

**A feedback “buzz” may also be enabled to indicate when Sleep occurs (see the User Feedback screen below).*

Alternating Hand/Wrist Control- (see p. 53) When Alternating Wrist or Hand Control is enabled, the Wrist or Hand direction changes after stopping for the length of the Sleep Time.

User Settings for Hand

(ACCESSED FROM THE HAND MAIN MENU)



Settings: *In this screen you can disable or enable Auto-Cal, or electric wrist control. You can also reverse the Hand or Wrist polarity (direction) or manually switch from Hand to Wrist mode.*

Hand Polarity:

With this button you can reverse the direction of the Hand function. Highlight the button, then hit the space bar on your keyboard. The letter in the button will change from "A" to "B". When "A" is selected, the A muscle will close the Hand.

Wrist Polarity :

This button reverses the wrist direction. The ‘A’ in the button indicates the “A” signal will *rotate clockwise*.

The wires to the wrist coaxial connector (see p. 30-31) must also be installed with the “W” facing outwards for these directions to be correct. The Hand wire has a polarized connector.

AutoCal Enabled by Hand Switch:

(see discussion of AutoCal that follows)

If enabled, this triggers AutoCal when the Hand Switch is turned OFF and ON twice within 6 seconds (see p. 64).

Disabling/Enabling AutoCal:

AutoCal can ONLY be disabled or re-enabled in this screen. Click on the AutoCal Enabled button, and the word in the button will change from “Yes” to “No”. Once disabled, AutoCal will not change the settings until you enable it again. Every time the wearer turns it on, the U3 will operate with the same saved settings.

Wrist Control Enabled:

Click on the button to disable or re-enable Wrist Control.

Note: If the electric wrist is not connected, the Wrist Control will automatically be disabled by the U3.

Sometimes you may wish to prevent accidental switching to wrist (while training for Hand control only). With this button you can disable (or re-enable) the electric wrist, if it is connected.

Switch Between Hand and Wrist:

Use this button to manually switch between these two functions, for instance, when the patient cannot perform co-contraction successfully.

User Feedback Options:

Feedback Signals are used to provide feedback to the wearer about the status of their system. Click on any of the buttons to turn the feedback signals on or off, as indicated.

The “buzz” is caused by a vibration of the Hand motor—it may be felt through the socket.

AutoCal® automatic adjustment (for Hand)

- AutoCal automatically sets Gains and Thresholds based on wearer's signals. If AutoCal is enabled, manual settings of gain & threshold are not possible.
- After AutoCal is triggered, the wearer's EMG is measured for (7) seconds. The wearer should open and close the Hand several times within this period.
- Gains are adjusted automatically so that the Range= 0-100% of measured EMG.
- Thresholds are set automatically to 15% above relaxed EMG. Minimum AutoCal Threshold= 31%.

3 ways to start AutoCal®:

(The "AutoCal" option is enabled on the User Settings screen.)

1. **By Hand Switch** - Turn the Hand off--then on again, twice within 6 seconds.
2. By pressing <Alt>+<A> on your keyboard (while connected to the computer).
3. **AutoCal by Power Switch**. AutoCal is triggered for the 7 seconds after the Arm is turned on (wait 2 seconds initially for auto-TD detect).

AutoCal Instructions to the wearer:

[Only if AutoCal is enabled-- see "User Settings" screen]

1. Don the prosthesis, and let the electrodes warm up to the temperature of your skin. Depending upon the pressure of the electrode on the skin, and amount of sweat on the skin, this could take up to 10 minutes.
2. Turn on the Hand Power Switch, then contract the opening muscle, without straining, so that the Hand opens.
3. Relax briefly, then contract the closing muscle, without straining, so that the Hand closes.
4. Open again, and close again, without straining.
5. Relax - try to feel the light vibration generated in the Hand at the end of the AutoCal seven second period. *(See "Feedback Signals" on the User Settings screen)*
6. After AutoCal, test your hand control - open and close the Hand slowly, then quickly. You should be able to vary the speed of the hand by the strength of your contraction. Your maximum speed should be controllable and not jittery. If co-contraction is utilized, test for the ability to switch with co-contraction.

Troubleshooting

When there is a problem with the prosthesis, approach it logically, with the help of the “Basics” section below and the Flowchart on the following pages. For help from Motion Control technicians,

-  Call us at (888) MYO-ARMS or (801) 326-3434
-  Send a fax to (801) 978-0848 OR,
-  Send an e-mail to info@UtahArm.com

If necessary, send us the Arm or the problem component if you cannot solve the problem yourself. Always use the padded case provided to insure there is no shipping damage. Call or fax before returning repairs for a Return Authorization Number.

UTAH ARM TOOL LIST:

Recommended Tools:

- Small screwdriver set
- Voltmeter (V.O.M.)– with probes and alligator clips (any simple one will do– read the instructions and learn how to use it)
- Tweezers– fine point, surgical type
- Alcohol for cleaning
- Cotton swabs
- Allen wrench – 7/64”
- Myolab II with “T” cable (strongly suggested for muscle testing during fitting and follow up)
- Nut driver with 1/4” socket
- Needle nose pliers
- Electrical tape
- Fibre tape or duct tape

Basic Checks:

1. Check the Battery.

- Make sure the battery is charged until the status light turns green.
- Inspect the battery contacts on both battery and holder. Clean with alcohol and cotton swab, if needed.

2. Check the Power Switch.

- Check the switch for the Hand or TD used, as well as the elbow power control. Consult the individual instructions for all TDs. In the U3 Arm, the power does not actually come on for 2 seconds after you turn the Arm on in order to perform the TD Auto-detect function.

3. Check the integrity of all connections:

- Wire Harness for all electrodes, and the Humeral wire harness to the top of the Arm.
- Coaxial connector to TD
- Computer Interface connection to Arm, and:
- Serial port connection to computer

4. Check for Proper Electrode Contact in the Socket

- Confirm location of the electrodes over the optimal muscle sites - retest if needed.
- Look for impressions of the electrodes in the skin. Make sure the skin does not pull away during the muscle contraction.
- Have the patient operate the Hand or Elbow - observe the muscle signals on the Computer Interface (if the electrodes pull away from the skin, the EMG “jumps” suddenly). Use the Hand in all positions.

Define the Problem:

Analyze the Functions of the Prosthesis

Ask the wearer to perform the functions of the Elbow, TD and/or Wrist:

- Flex and extend elbow. Relax to Freeswing.
- Open TD Fully
- Close TD fully & close to full force
- Switch to Wrist (if installed) by Co-Contraction or Wrist Control Switch.

Alternatively, use your own muscles to control the prosthesis using spare preamps with electrodes on your own forearm. Touching the electrodes in the socket may move the Hand, but don't expect good function. When the electrodes are not in contact with skin, interference will operate the hand unpredictably.

DIAGNOSTIC TESTS

[] Free-Swing Test/Balance Load Cell

1. IMPORTANT: Unplug the Preamps from the Arm. You may need to detach the socket from the Arm to expose the connector.

2. **Free-Swing Test:** With a fresh battery, turn the Arm ON. Hold the Arm horizontally and gently flex the elbow back and forth. When free-swing functions properly, you will feel very little resistance, even when changing direction. When horizontal, the Elbow will stay in the position at which you stop it, and will not tend to drive in either direction. If the elbow drives when horizontal, the Load Cell must be rebalanced.

3. **To balance Load Cell**, perform the Free-Swing Test above, then:
- Remove the Forearm Cover, then the belt from the motor.
 - Set the Arm horizontal on the flat surface of the Forearm Structural piece.
 - Turn the power ON. The motor may spin slightly, then when you flex or extend the elbow with your hands, the motor should spin faster or slower. If the elbow locks, unlock with the override button.
 - Find the load cell balance adjustment (on left side of elbow, visible when fully flexed). Remove the protective paper dot.
 - Turn the adjustment slightly, clockwise or counter-clockwise until the motor stops. Note: There is a non-adjustment region on this potentiometer, when the black dot is between the blue and the red dots, i.e., the load cell cannot balance in this region. See figure 6.1 below.
 - Replace belt and forearm cover.
 - Perform Free Swing Test again. If the Arm still will not Free Swing, it requires repair from Motion Control.

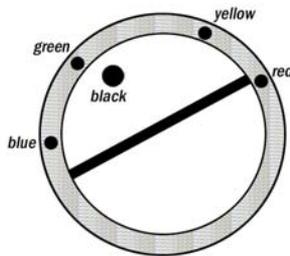


FIG. 10.1 LOAD CELL ADJUSTMENT POT

[] Continuity Test

Refer to the instructions and figures 3.5 and 3.6 in Section 3 "Preamp Installation." To test fuses, use the same technique. Good fuses measure "0" ohms.

[] REPLACING UTAH ARM 3 PARTS

FIELD REPLACEABLE MODULES:

- Battery Pack
- Hand or ETD
- Forearm Cover (including connection system)
- Humeral Connector (5-, 3- or 1-wire harness)

NOT RECOMMENDED FOR FIELD REPLACEMENT:

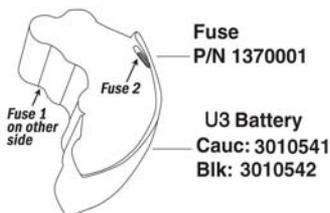
- Elbow Drive Transmission
- Load Cell
- Lock Drive
- Elbow Circuits
- Hand Circuits
- Flexible Connectors

[] Battery Pack FUSE Test

1. Perform a continuity test. Test both fuses. If the fuse resistance is infinite, it is bad.
2. Remove it by prying it out with tweezers.
3. Bend the wire leads on a new fuse, to match exactly the old fuse.
4. Clip the leads to the same length as the old fuse. Then reinstall in the same sockets.

Note: Batteries can be checked without removing the fuses with the U3 Fast Battery Charger.

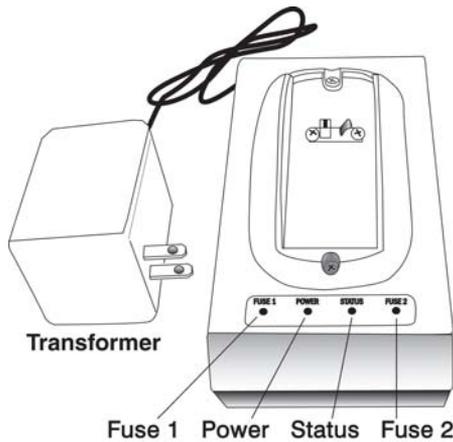
FIGURE 10.2 BATTERY & FUSE (NOTE: THERE IS ONE FUSE ON EACH SIDE OF THE BATTERY)



[] CHARGER TEST

1. Plug the Transformer into a standard 120 volt wall socket. (In other countries, a 220 volt Transformer is supplied.) Connect the transformer to the charger via the mating connectors. All lights should be lit except for Status.
2. Install the battery into the charger. The Status light should light yellow. Be sure contacts are clean and uncorroded.
3. Within 45 seconds after connecting the battery, the status light will turn red when charging.

FIGURE 10.3 U3 FAST BATTERY CHARGER



Note: If the status light never turns red, there is a fault in either the Fast Charger or the Battery Pack. Try a different battery pack in the Charger. If the same problem occurs, return the Battery and Charger to Motion Control.

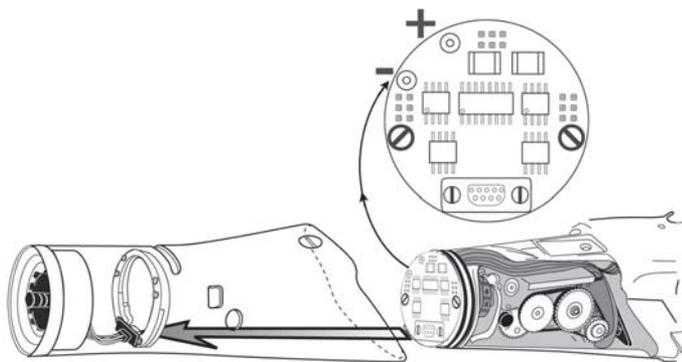
4. If either Fuse 1 or Fuse 2 lights turn red, the fuse is faulty on the OPPOSITE side of the battery pack, i.e., if Fuse 1 light turns red, then Fuse 2 is faulty. Replace the fuse, as described in Battery Pack tests.

[] Jump Start

(When the battery is dead and the elbow is locked).

1. Obtain a fresh 9- volt battery.
2. Remove the Utah Arm forearm cover.

FIGURE 10.4 JUMP START TERMINALS



3. Turn the power switch “off.”
4. Touch the “+” and “-” of the 9-volt battery to the matching terminal on the Hand Circuit. You should hear the lock motor unlock, with a “whirr” sound.
5. Bend the elbow, remove the battery and replace with a fresh one.

If all else fails and the arm will not unlock, return to Motion Control for repair. Be sure to call first and obtain a Return Authorization Number.

CAUTION! DO NOT:

Do not remove the Transmission.

Do not remove the Hand Circuit Boards.

Do not spray oils or lubricants into the Arm.

Computer Interface Problems

1. Basic Checks:

- Make sure you opened the “U3 & ProC2” program, and not the “U3 & ProC2 Demo” on your desktop.
- Check the integrity of all connectors.
- Try different “COM” ports. On the System Parameters screen, select a different COM port from those displayed. If no others are displayed, the program requires restarting or rebooting the computer (see below).

2. Restarting and/or Rebooting:

- Close the program and select “Restart” from you START menu on the desktop.
- Unplug the serial or USB port while you restart.
- Plug in serial or USB port in ONLY after the desktop returns.

3. As a “Last Resort”:

- If you have another program on your computer which uses the serial port inputs, it may not allow the MC User Interface to connect there. The ‘OB Slider’ and Palm Pilot programs have been known to create this problem. Uninstall these programs, then reinstall the User Interface software and try again.

4. “LAST RESORTS: *The Sequel*”:

- If the COM port cannot be changed on the System Parameters screen, it may be possible to change it in the “U3 & ProC2 Demo” program.
 1. Open the “U3 & ProC2 Demo” program.
 2. Navigate to the “Hand Main Menu” or “Elbow Main Menu.”
 3. Open “System Parameters.”
 4. In the COM 1 to COM 8 list change the choice to “COM 4” (Many computers will default to COM 4).
 5. Return to the “U3 & ProC2” program and try to connect again.

5. “SON OF Last Resorts”:

- Call our Technical Specialist Tariq Subhani at 1.888.MYO.ARMS (696-2767).

MOTION CONTROL HAS AVAILABLE A FREE TRAINING VIDEO FOR THERAPISTS (O.T.'S AND P.T.'S) TITLED, "TRAINING THE CLIENT WITH AN ELECTRIC ARM PROSTHESIS." ALSO, FOR PRE-FITTING MUSCLE TRAINING, REFER TO THE END OF THIS SECTION FOR A HOME EXERCISE PROGRAM TO DEVELOP MUSCLE STRENGTH.

ELBOW-FLEXION TRAINING - EMG Dual Site

(Alternate inputs instructions shown in italics)

- 1. Adjust flexion and extension gains on the forearm** (see Adjustments section). For all functions, a Therapy Cable (p/n 3010228) can be installed in the socket, allowing the Arm to be used with the Myolab II to provide visual feedback to the patient and act as a troubleshooting aid for the Prosthetist.

With any Single-Site input, only the right side forearm gain is adjusted.

- 2. Practice elbow flexion and extension.** First go to the Lock/Unlock screen in the User Interface (see p. 51). Change the lock override button to "YES." This enables the lock override button on the arm to override automatic locking. Extension of the elbow is most easily performed by simply relaxing the muscles, controlling speed by the strength of contraction.

With Linear Pot (or Force Sensor) input, flexion speed is controlled by the strength and speed of the pull on the sensor.

Activity: Follow a target with the hand; move the elbow fast and slowly. Also, practice holding in one position steadily.

- 3. Totally relax arm muscles occasionally and check for free swing of the elbow.** The elbow should drop, i.e., extend very quickly, in free-swing. (The Prosthetist can adjust the Free-Swing Level, if required).

LOCK-UNLOCK TRAINING

1. Lock: Instruct the wearer how to lock the elbow:

“Hold the elbow steady at one position (without supporting it externally). The elbow should lock quickly after the motion is stopped.”

(The prosthetist can adjust the Lock Time if needed. Early training is usually easier with a longer Lock Time, helping to reduce inadvertent locking while the wearer is mastering elbow function).

2. Unlock: Instruct in unlocking the elbow:

“Relax the muscles. Then flex both muscles quickly at the same time, then relax, just like when a person ‘snaps’ their fingers. You should hear a faint “whirr” when you co-contract successfully (from the lock motor). Then raise the elbow slightly.”

(The elbow must raise slightly to release the lock).

“If the elbow does not unlock at the first attempt, relax again, then attempt the quick co-contract sequence. Don’t struggle to unlock. Give yourself some time to practice, so you can develop the quickness required to unlock. Remember, contract both muscles quickly, not strongly.”

Adjustment can be made by the prosthetist to make unlocking easier, or more difficult (if accidental unlocking is a problem). Training with the Myolab II will also be very helpful, and is highly recommended. (Delaying unlock training until elbow and hand control are mastered can reduce frustration).

3. Practice lock-unlock activity:

Position the elbow and lock at various positions. (Present a target with a pencil or finger).

Note: Unlocking, followed by a “jump” at the elbow is a common problem, requiring some practice to correct. Try to develop the feel in the wearer for raising the elbow just slightly to release the lock. Practice by presenting a target requiring slight lowering of the elbow below the previous locked position, i.e., lock, then unlock and lower (extend) the elbow, lock, etc. (It may be necessary to lower the forearm flexion gain to minimize the accidental jumping).

TERMINAL DEVICE (HAND) TRAINING

1. After the elbow is locked, the muscles must be relaxed briefly, then control transfers automatically to the Hand.
2. Practice smooth opening and closing, developing independence of the two control muscles.
3. Proper adjustment of the Hand control (by the Prosthetist) will allow opening and closing with equal effort. If desired, a slight bias toward closing may be adjusted, so the Hand tends to close easier, avoiding dropping objects.
4. The arm wearer may practice controlling pinch force by grasping their own sound hand (if unilateral) and feeling the pinch force across the palm. Proportional control of the Hand will allow fine control of pinch force to be developed, as well as control over the speed of opening and closing.

[CAUTION: Be Careful! Grasping delicate objects can cause harm due to the high pinch force of the Hand (~20 lbs.). Wait until your control of the Hand, and the lock/unlock is excellent before you grasp other people!]

TASK TRAINING

1. **Simple Grasping Tasks.** Practice controlling the grip force, gripping objects lightly and firmly. Practice stopping the Hand at full open, half open and nearly closed. Teach the best grips (for the particular T.D.) for eating utensils, especially knives, forks, mugs, etc.

Activity: Grasp blocks, cups, ping-pong balls, table utensils, cans, etc.

2. **Practice Prepositioning.** For a variety of everyday tasks you might perform, practice positioning your shoulder, then elbow, humeral rotator and wrist, for the best performance, then open the Hand and grasp if needed.

3. **Two-Handed Tasks.** Start with simple tasks requiring holding an object to manipulate with the sound side hand (if unilateral).

Activity: Pull tape from a roll, remove a bottle cap, open a soda pop can, butter bread, hold toothpaste tube and unscrew cap, hold padlock and turn the key, etc.

4. **“Grasp and Move” Tasks.** Prepositioning is very important for most tasks. Help the wearer to think through and practice the most efficient positioning of the elbow, humeral rotator and wrist rotator for each task. Working from simple to more difficult, work on the tasks most relevant for the wearer. As much as possible, try to train for the wearer’s specific needs.

Activity: Hold tray; hold mixing bowl; put clothes on a hanger; collate paper, fold and put into an envelope; draw lines with a ruler and pen; cut cardboard with an X-acto

knife; use knife and fork for cutting food (teach proper knife grips for T.D. used); open and close zippers; thread and tie laces; buckles; hand tools: hammer and nails, “C” clamp, vice, hand drill, etc.

General Recommendations & Cautions

1. Turn the power off when changing TDs.

When changing from one TD to another, ALWAYS turn the power switch of the Arm OFF. Turn the Arm back on only after the new TD is securely installed.

2. Turn the Arm off when driving.

When driving an automobile or other vehicle, we recommend that you leave the power OFF! An accidental movement of the Arm could distract you or interfere with your control of the vehicle. Your arm can be used passively to steer, shift or use turn signals.

In addition, some types of electrical equipment can cause the Arm or Hand to move due to electrical interference. For example, Citizen’s Band (CB) radios (especially when transmitting), have the possibility to move the Arm unexpectedly. Even if you’re careful, a neighboring vehicle could have a CB transmitter!

3. Avoid excessive moisture.

Keep your Arm dry! Never allow it to get wet inside – take it off before swimming, bathing, or showering! We recommend that you not wear your Arm when you have to be near water. Be extremely careful around sinks, puddles and rainstorms. When you have to be near water, wear a raincoat or waterproof jacket to cover it.

If you have a Hand, the glove should always be worn. If your Arm does get wet, dry it off as soon as possible and remove the Battery immediately! If water gets inside the Arm, drain it by turning the Arm in all directions and notify your prosthetist or Motion Control IMMEDIATELY! Under these circumstances only, remove the Forearm Cover and air-dry all parts.

Keep Your Cool-- Heavy sweating may result in erratic performance of your Arm. Remember, your body has less surface area with which to cool itself. If you perspire heavily, dry off your skin and the electrodes. If necessary, use an anti-perspirant on your remnant limb to reduce sweating.

4. Avoid Dangerous Situations.

Be careful with your Arm! Dropping or jarring it could damage the mechanism. If you ride a bicycle or motorcycle, or engage in similar activities, be careful and realize the damage which could result. Do not use your Arm in the presence of flammable gases. (In fact, you should probably get the rest of you out of there too.)

5. Avoid dust, dirt and lint.

DO NOT wear your arm to the beach or where sand could get inside of it. When wearing clothes which produce lint, such as sweaters, wear a shirt or blouse underneath to protect the Arm. If you must expose it to dirt, dust, lint, sand, or moisture – cover it with a tightly woven shirt sleeve and wear a protective glove. If dirt could get to the forearm holes, cover them with tape. This will help prevent dirt particles from getting inside the Arm.

6. Avoid extreme temperatures.

Excessive heat or cold may damage your Arm – it shouldn't be left in a closed car in the sun or outside overnight in freezing temperatures. In general, your Arm should only be exposed to temperatures at which you yourself are comfortable.

7. Avoid dyes.

Your Arm can become permanently discolored and stained by many commonly used substances. Dyes from newsprint and fabrics can be transferred; pencils, ballpoint pens, and felt markers, even if not permanent, can cause stains. Clean your Arm off immediately if it is marked in this way. If your Arm includes a Hand, wear an outer glove whenever appropriate to protect both your Hand and Arm.

8. Avoid excessive vibration.

Activities such as operating a power mower, a jackhammer, chain saw or other vibrating power equipment should be avoided with the Utah Arm, particularly those that are also dirty and may involve water.

9. Don't lift heavy weights.

Don't attempt to lift more than 50 pounds with the Arm locked. The Arm may be damaged with loads in excess of 50 pounds.

10. Be alert to interference.

When you wear your Arm in a new environment, notice if any electrical devices can cause the Arm to move. If this occurs, leave the Arm OFF when you are around the interfering device. If electrical interference causes a problem for you, consult your prosthetist.

11. Use caution when donning and doffing.

Always turn your Arm OFF when putting it on or removing it. Exercise caution in handling and donning your Arm as static electricity can severely damage the electronic components when the Arm is not being worn. Whenever you handle your Arm, touch a grounded point first, i.e., a Ground Electrode within the Socket (the electrodes not paired with another). Have your Prosthetist show you the location of the ground electrodes. Static electricity is not usually a hazard while wearing your Arm.

12. Leave the power OFF when not wearing the Arm.

Nearby electrical equipment can cause the Arm to move when the electrodes are not connected to your skin.

13. Respect electricity.

Do not connect the Arm to other electrical devices or fasten it to other machines. The Arm will not insulate you from electrical hazards.

Only connect the Battery Charger to 110 volt, 50/60-cycle power (in the U.S. and Canada). In countries where other power voltages are used, obtain an appropriate A/C adaptor for 220 volt. If you are not sure, ask your prosthetist.

14. Avoid solvents.

Do not expose your arm to corrosive solutions, solvents or vapors.

15. Don't over-adjust or under-adjust.

Do not overtighten the Humeral Rotator. Excessive tightening can break the locking component inside the

Rotator, and in extreme cases, can cause the Arm to separate from the Socket.

16. Always make sure the Forearm Cover Screws are tight.

The forearm cover screws may loosen in the course of normal use. Use a penny to tighten the screws.

17. Use only in strict accordance with the Directions for Use.

Abuse will damage your Arm. Do not attempt to repair your Arm beyond the instructions provided in this manual. Return the Arm to a trained prosthetist or to Motion Control Inc. for repair. Always ship the Arm in the case provided, with the battery pack removed.

Approach daily tasks with the attitude that your Arm is a unique piece of machinery that is a tool to help you accomplish tasks and activities of daily living.

Respect its limitations as well as its capabilities, and it will serve you well.

appendix a.**Technical Specifications of the Utah Arm****Excursion Range:** 135°**Excursion Time:** With Myoelectric Hand TD: 1.20 seconds**Active Lift:** 1 kilogram (2.2 lbs.) in the Terminal Device and using a fully charged Battery**Load Limit:** 22.7 kilograms (50 lbs.), locked**Humeral Rotation:** Quick-Disconnect Wrist: 360°**Weight:** Without Hand: 913 grams (2 lbs.)**Heat Tolerances:**

Operating Temperatures: 0° to 44°C (32° to 110°F)

Storage temperatures: -18° to 60°C (0° to 140°F)

Maximum Current: 4.0 Amps**Quiescent Current:** 50 mA**Battery Specifications:**Voltage: Rechargeable Nickle-Metal Hydride,
1100 mA Hours

Dual Supply, +7.2/- 4.8 Volts D.C. (total 12 V)

Forearm Length: (from rearmost point of the Forearm to the end of the Wrist)

Maximum: 27 cm (10 5/8") (with forearm extensions)

Minimum: 20 cm (7 7/8")

Electric Shock Protection: Class III, Type B 

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