

BIODEX MULTI-JOINT SYSTEM - PRO

SETUP/OPERATION MANUAL

850-000
850-000-10
850-000-30



BIODEX

Biodes Medical Systems, Inc.

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BIODEX SYSTEM PRO



This manual contains installation and operation procedures for the following Biodex products:

- #850-000 Biodex Multi-Joint System, PRO
- #850-000-10 Biodex Multi-Joint System, JPN
- #850-000-30 Biodex Multi-Joint System, w/o CMP

NOTE: All or some of the following symbols, cautions, warnings and notes may apply to your Biodex PRO and correspond to this operation manual:

Symbol	Meaning
	Attention, consult accompanying documents.
	Symbol signification: Attention, se référer à la notice.
	Warning: Injuries to health may result from incorrect or excessive training.
	Attention, incorrect ou extrême entraînement peut aboutir des lésions au santé.

NOTE: Circuit diagrams for this product are available upon request.

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INTRODUCTION

Congratulations, you've made an excellent choice!

By selecting the Biodex Multi-Joint System you have acquired the most advanced, versatile and reliable technology ever developed for testing and rehabilitation of the human musculoskeletal system. You've also joined the Biodex team of satisfied customers who benefit from unsurpassed product education, customer service, promotional and clinical support.

With your new system, you can offer testing and rehabilitation services for the knee, ankle and hip plus the shoulder, elbow, forearm and wrist. Modes of operation for exercise and testing include Isokinetic, Passive, Isometric, Isotonic and Reactive Eccentric. What's more, you'll be able to test and exercise over the broadest range of speeds available today. Biofeedback is provided by the high resolution color graphics monitor to encourage patient compliance with exercise protocols.

You'll also appreciate the Windows-based Biodex Advantage Software touch screen package that comes with your system. Our patient database prompts quick and easy retrieval of patient information while Windows flexibility makes protocol selection and patient setups a snap. The wide variety of output reports allows numeric and graphic information to be printed in a number of different formats. Third party payers and referring physicians receive information that is complete but not overwhelming.

The versatility of the Biodex Multi-Joint System facilitates effective treatment of a broad range of patients and pathologies. If you add the Back, Lift and Work Simulation options, your Biodex Multi-Joint System is transformed into a comprehensive clinic. The future certainly looks bright for you and your patients! Thank you for allowing Biodex Medical Systems, Inc., to be a part of it.

NOTE: PRODUCT ENHANCEMENTS AND MODIFICATIONS

Due to on-going product enhancements and modifications, the Biodex Multi-Joint System you have purchased may differ slightly from the system depicted in the photographs and illustrations used in this manual.

BEFORE PROCEEDING



Before you get started with any of the setups described in this manual, there are a few preliminary points to consider which will help ensure safe and smooth operation of your Biodex Multi-Joint System.

- This system should be operated only by qualified personnel.
- Ensure that all system wiring and cables are routed away from any area where they might be stepped on or rolled over by wheeled equipment.
- For testing and exercise patterns in which the positioning chair will be used, we suggest the chair be set to its minimum height before allowing a subject to mount or dismount. It may also help to have a fixed location from which all subjects approach and leave the chair.
- Be aware that use of Biodex technology requires professional expertise for discerning appropriate treatment techniques. Each subject's unique situation should be taken into account before beginning any type of testing or rehabilitation program. Be sure you fully comprehend the operating instructions, as well as the considerations, both physical and clinical, discussed throughout the manual before attempting to set up a subject for testing or exercise. Practice setups and positioning with a healthy subject before attempting to set up an injured patient.
- Instructions for each of the patient setups provided later in this manual assume that the clinician is starting with the system in its neutral position, as illustrated in Figure 1.1.
- To assist our users and stimulate interest in developing protocols, this manual contains a "Clinical Applications" section where appropriate. These comments come from the clinical experience of our users as well as from published journals.
- The setups presented in this manual are intended to cover most patient protocols. However, because the Biodex Multi-Joint System is so versatile and adaptable, you may find additional setups possible. It is suggested that the clinician try the setups presented herein before attempting any setup improvisations (especially for testing applications). If you do use a pattern that deviates from the manual, be sure to fully document it in your "Patient File" notes.



CAUTION: *Placing your hands or fingers between the dynamometer input shaft (or attachment) and the mechanical ROM stops may result in serious injury.*

NOTE: Service should be provided by qualified personnel only. Please do not attempt installation or repair on your own. Call Biodex Customer Service first, they'll be glad to help.

For additional technical advice, service or educational information, contact Biodex personnel at the following address:

Biodex Medical Systems, 20 Ramsay Road, Shirley, New York 11967-4704.

In New York and Int'l, (631) 924-9000, 1 (800) 224-6339 (Customer Service), FAX: (631) 924-8355

AVANT TOUTE APPLICATION



Avant d'appliquer les montages décrits dans cette notice, plusieurs consignes aideront à obtenir une utilisation sûre et facile de votre système BIODEx.

- Utilisation de ce système doit être limité au personnel qui a les qualités requises.
- Vérifier que tous les câbles et cordons suivent un trajet qui ne traverse ni une zone de travail ni une zone de déplacement des pièces mobiles.
- Pour les mouvements d'examen ou d'entraînement nécessitant une chaise accessoire, régler la chaise accessoire à sa position la plus basse avant de faire monter ou descendre le patient. Dans certains cas un accès fixe à la chaise peut être utile.
- La technologie BIODEx nécessite une expertise professionnelle pour choisir la technique thérapeutique appropriée. La situation de chaque patient doit déterminer le programme de rééducation. S'assurer de bien comprendre la présente notice ainsi que le contexte clinique associé avant d'appliquer la technologie pour l'examen ou la rééducation d'un patient. S'entraîner à faire des montages avec des sujets sains avant d'en faire avec un patient.
- Les indications pour les montages spécifiques fournies dans les pages qui suivent prennent comme point de départ le système dans sa position neutre montré à l'image 1.1.
- Pour aider nos clients à développer leurs protocoles, cette notice contient certains passages sur des applications cliniques. Ces textes tiennent compte de l'expérience des utilisateurs BIODEx et des informations publiées mais ne peuvent pas remplacer le jugement clinique.
- Les montages présents dans la présente notice couvrent la plupart des protocoles. Toutefois les nombreuses possibilités du système BIODEx permettent d'autres montages. On conseille d'utiliser les montages de la notice avant de réaliser des improvisations, surtout pour les applications d'examen. Si vous utilisez un mouvement différent de ceux traités, notez-en les détails dans votre dossier patient.



ATTENTION: Placer vos mains ou doigts entre le dynamomètre données (ou attachement) et le mécanisme ROM arrêts peut résulter dans une blessure sérieuse.



Figure 1.1. The Biodex Multi-Joint System - PRO positioning configuration.

1. CONTROLS AND ADJUSTMENTS

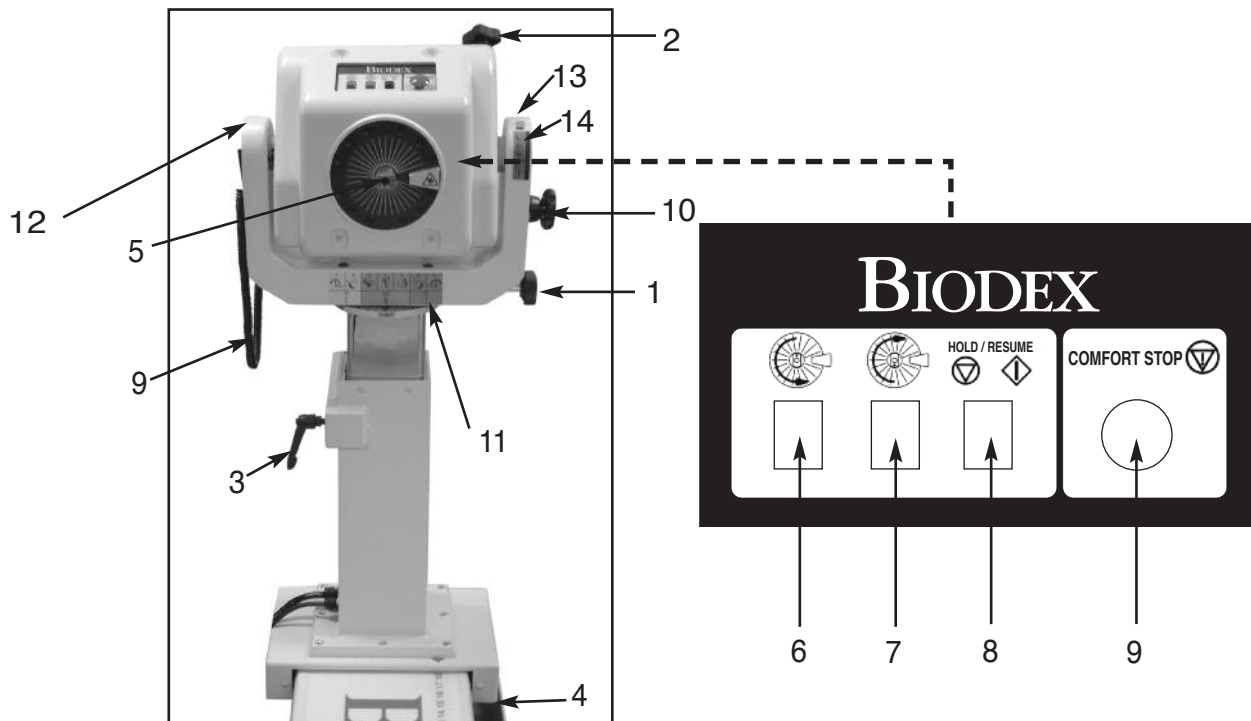


Figure 1.2. Dynamometer positioning controls and adjustments.

1. Dynamometer Rotation Knob
2. Dynamometer Tilt Knob
3. Dynamometer Height Lever
4. Dynamometer Foot Pedals (travel)
5. Shaft Red Dot (on dynamometer shaft)
6. Rotate Counterclockwise Button
7. Rotate Clockwise Button
8. Hold/Resume Button
9. Comfort Stop
10. Dynamometer Locking Knob Storage
11. Dynamometer Position Color Code Label
12. Dynamometer Yoke
13. Dynamometer Tilt Scale
14. Dynamometer Tilt Key

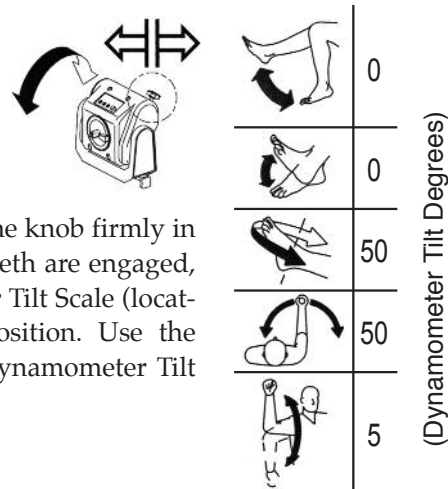
DYNAMOMETER

(Refer to Figure 1.2.)

Dynamometer Rotation: To rotate the dynamometer in a horizontal plane, loosen the Dynamometer Rotation Knob by turning it counterclockwise. You may now rotate the dynamometer in either direction. To secure the dynamometer rotation position, tighten the knob in a clockwise direction and ensure that the dynamometer teeth are engaged. Use the Dynamometer Rotation Scale, located on the base of the dynamometer directly beneath the yoke, to note the new position.



Dynamometer Tilt: Permits rotation of the dynamometer on a vertical plane allowing the shaft axis to tilt upward or downward from the horizontal position. To tilt the dynamometer, support the dynamometer with one hand. With the other hand, loosen the Dynamometer Tilt Knob in a counterclockwise direction. You can now gently push or pull the dynamometer to the desired position. Tighten the knob firmly in a clockwise direction, and ensure that the dynamometer teeth are engaged, to secure the dynamometer in place. Use the Dynamometer Tilt Scale (located on the yoke) to note the new dynamometer tilt position. Use the Dynamometer Tilt Key (located on directly beneath the Dynamometer Tilt Scale for a quick reference during patient set-up.



Dynamometer Height: The dynamometer can be raised or lowered over a range of 14". Loosen the Dynamometer Height Handle by turning it counterclockwise and simply apply hand pressure to the top or underside of the dynamometer to respectively raise or lower it. Retighten the handle to lock the dynamometer in position. Use the Dynamometer Height Scale, located on the dynamometer mounting post, to note the new dynamometer height.



NOTE: The weight of the dynamometer is counterbalanced by a pneumatic assembly in the mounting post. When the locking handle is loosened, the dynamometer may tend to gently rise or fall, depending on the weight of attachments affixed to the dynamometer shaft. After proper height is established, always secure the locking handle.

Dynamometer Travel: The dynamometer Foot Pedals allow the dynamometer to move along the travel in a horizontal plane left or right of the positioning chair. To move the dynamometer, press down on either foot pedal and slide the dynamometer to the desired location. Release the foot pedal to lock the dynamometer in place. To ensure stability, check that the dynamometer is fully locked in a detent (i.e., try to shake the dynamometer). Use the Dynamometer Position Scale on the travel to note position.



Shaft Red Dot (dynamometer shaft): The small red dot on the end of the dynamometer shaft provides an index for proper alignment of attachments on the dynamometer setup. When affixing any attachment to the dynamometer shaft, position the attachment so that its dot for the side to be exercised aligns with the dynamometer shaft red dot. Failure to properly align the dots may result in a reduced range of motion.



Point Rouge Sur L'Axe Du Dynamometre.

Le point rouge situé sur l'axe du dynamomètre fournit une indication pour l'alignement correct de l'accessoire pendant le montage. Positionner l'accessoire de telle sorte que le point rouge de l'accessoire s'aligne avec le point rouge du dynamomètre. Un mauvais alignement peut entraîner une réduction de l'amplitude.

Rotate Clockwise/Counterclockwise: The Rotate buttons atop the dynamometer allow the dynamometer shaft to be moved by pressing (and holding) the Rotate button corresponding to the direction the shaft must turn. This function of the Rotate buttons has no effect on the range of motion limits previously established in Setup Mode.

Hold/Resume: Stops shaft rotation. Press this button a second time to resume the test or exercise session. One Hold/Resume button is located atop the dynamometer next to the Comfort Stop. A second Hold/Resume button is activated by a hand-held remote located to the right of the control panel on the Clinical Data Station (CDS) cart.



Comfort Stops (Dynamometer, Remote): These buttons provide the subject with the ability to instantaneously terminate exercise in any mode. Depressing either the large red button atop the dynamometer or the hand-held remote button causes immediate cessation of dynamometer shaft rotation.



The principal purpose of this control is to guard against moving the subject into a portion of the range of motion that, for any reason, is contraindicated. It should be noted that activating a comfort stop after the onset of discomfort will result in a stoppage of movement while the subject is still in the undesirable portion of the range. Should this occur in Isokinetic or Isotonic mode, with concentric contractions selected, the operator should immediately press the Stop button on the control panel, then press Start to free the shaft and allow rotation toward a more comfortable point in the subject's ROM. (With the shaft free, the operator should manually place the subject in a position such that the limb will not move in the direction of gravity.)



CAUTION: *Extra consideration is required for resuming dynamometer shaft rotation in the Passive or Reactive Eccentric mode as the patient may be assisted further into a painful portion of the ROM. In this case, remove the patient immediately from the attachment by releasing the Velcro® cuff.*



ATTENTION: *Redoubler de précautions pour reprendre la rotation de l'arbre du dynamomètre en mode Passif ou Réactif Excentrique. Le patient pourrait se retrouver assisté encore plus loin dans la partie douloureuse de l'amplitude du mouvement. En pareil cas, retirer le patient de l'accessoire en détachant la manchette en Velcro®.*

L'objectif principal des ces commutateurs est d'éviter au sujet d'entrer dans une amplitude de mouvement contre-indiquée quelle qu'en soit la raison. L'utilisation de l'arrêt d'urgence peut laisser le sujet à l'intérieur d'une amplitude inconfortable: dans ce cas, il faut des uite passer en mode isocinétique ou isotonique; appuyer sur les boutons stop et start dans l'ordre sur le panneau du contrôleur pour libérer l'axe de rotation et placer le membre dans une position confortable; il faut tenir le membre pour cette manipulation pour contrôler les effets de gravité.



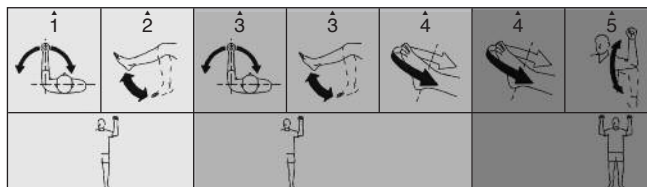
ATTENTION: *Une attention particulière doit être appliquée avant de remettre en marche le dynamomètre dans le mode passif ou excentrique puisque le patient peut être porté à nouveau dans une amplitude douloureuse.*

Educating the subject about the use of the Comfort Stops (prior to exercise) also serves to improve confidence and motivation by reducing apprehension regarding the equipment.

NOTE: *As a safety precaution, the system will not function in any mode if the Remote Comfort Stop is not connected to the dynamometer.*

Dynamometer Position Color Code

Label: Located on the Dynamometer Yoke Pivot Plate, the Dynamometer Position Color Code Label helps the user to quickly position the dynamometer according to the pattern selected. Rotate

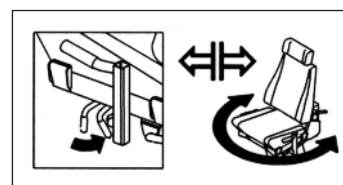


the dynamometer to the yellow color code positions when setting up to test or exercise the patient's left side. Rotate the dynamometer to the blue color code positions for right side testing or exercise. Patterns that use the same positioning for both sides utilize the green color code areas.

POSITIONING CHAIR

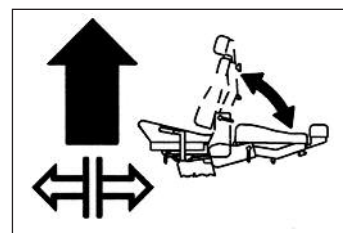
(See Figure 1.3.)



Seat Rotation: The positioning chair offers 360 degrees of rotation in the horizontal plane with detente settings at 15-degree intervals. To rotate the seat in either direction, turn the Seat Rotation Handle toward the rear of the seat. The Seat Rotation Handle is located beneath the seat between the forward receiving tube and forward buckle. While holding the Seat Rotation Handle, swivel the seat to the desired position. Release the handle to lock the seat in place, making sure the seat sets in the appropriate detente. Note the seat rotation position on the Seat Rotation Scale, located beneath the seat on the seat post.



Chair Foot Pedals: The Chair Foot Pedals allow fore/aft adjustment of the positioning chair in relation to the dynamometer. To move the chair along the travel, press down on either foot pedal and slide the chair to the desired location. Release the foot pedal to lock the chair in place. To ensure stability, check that the chair is fully locked in a detente. Use the Chair Position Scale, located on the travel, to note the new position.

Seatback Tilt: This adjustment allows the user to select any of five seatback angle settings: 85, 70, 55, 40 and 25 degrees. To adjust the seatback tilt, pull up on one of the Seatback Tilt Handles, located on either side of the lower seatback frame. You may now adjust the seatback to the desired angle. Release the handle and ensure that it locks into the selected detente. Record the new seatback tilt angle from the Seatback Tilt Indicator, located at the bottom on either side of the seatback frame.



Seat Height: The motorized seat may be automatically raised or lowered over a range of 14 inches. To adjust the seat height, step down on the  or  Seat Height Foot Switches, located at the rear base of the chair.

NOTE: The seat may be raised or lowered with the subject seated. Ensure, however, that all wires are clear and the patient is not strapped to any attachment before you begin to raise or lower it.

Seatback Fore/Aft: Crank the Seatback Fore/ Aft Handle, located at the back of the seatbase, in a counterclockwise direction to move the seatback forward on the seat. Crank the handle in a clockwise direction to move the seatback toward the rear of the seat. Record the new fore/ aft position from the Seatback Fore/ Aft Scale, located along each side of the seat frame near the back belt buckle.

Cervical Support: To reposition the Cervical Support, use one hand to hold the support so it will not slip down. With your free hand, turn the Cervical Support Locking Knob in a counterclockwise direction until loose. Lift up or push down on the support until the desired position is achieved. Turn the locking knob in a clockwise direction until tight to secure the support in place.

NOTE: Be sure to support the Cervical Support with one hand before loosening the locking knob. If you do not support the Cervical Support, it may slide down and pinch your hand as you loosen the knob.

Stabilization Straps: The Positioning Chair is fitted with a Thigh Strap and buckle (secured toward the front on each side of the seat frame), a Pelvic Strap and buckle (secured directly beneath the Seatback Tilt handle on the seat back frame,) and a pair of Shoulder Straps and buckles (secured toward the back on each side of the seat base) To secure any strap, lift the buckle handle, insert the strap into the buckle and pull until tight but not uncomfortable for the patient. Press the buckle handle all the way down to secure.

Receiving Tubes: There are four receiving tubes located on the seat. Two are positioned at the front of the seat, left and right of center. The remaining two tubes are located one on each side of the seat. These tubes receive the T-Bar, Limb Support Pad and Footrest. Each receiving tube has a locking knob. To loosen the knobs, turn them counterclockwise. To tighten the knobs, turn them clockwise.

Stabilization Handles: Located on the side receiving tubes, these handles can be used by the patient for added support, stabilization, and consistent hand positioning during exercise and rehabilitation sessions. They should not be used during test session. These stabilization handles are also convenient for the clinician as a means to pull or push the chair fore or aft on the T-base.

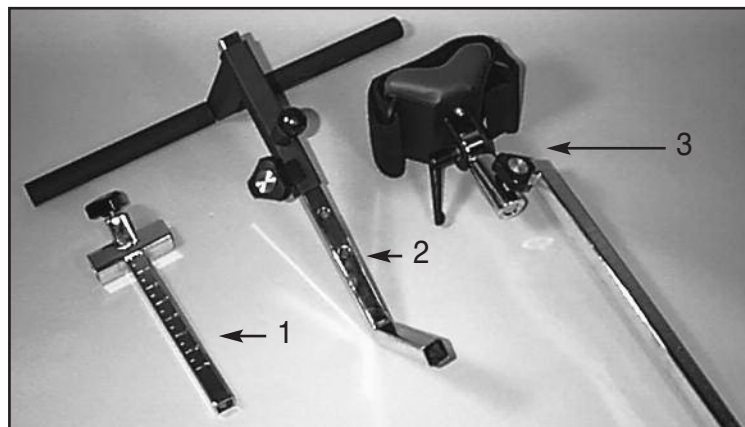
Figure 1.3. Positioning
Chair adjustments:

1. Seat Rotation Handle
2. Receiving Tubes
3. Chair Foot Pedals
4. Seat Height Foot Switches
5. Cervical Support Adjustment Knob
6. Seatback Tilt Handle
7. Seatback Fore/Aft Handle
8. Stabilization Handles



Figure 1.4. Positioning Chair
attachments:

1. T-Bar Adapter
2. Footrest
3. Limb-Support Pad



SEAT BACK BRACE

The Seat Back Brace is designed to provide added stability when the seat back is used in a lowered position at zero degrees seat rotation for side lying, supine and prone patterns (particularly of the hip). The Seat Back Brace is adjustable and simple to use. Once installed, set-up takes only seconds.

INSTALLATION

(See Figures 1.5 - 1.7.)

1. Ensure the seat back is in the up position. Rotate the seat to 0 degrees on either side of the seat rotation scale.
2. Line up one rod-end swivel of the Seat Back Brace with the clevis on the seat back and insert the clevis pin.
3. Release the seat back handle and lower the seat back to "10" on the seat back tilt scale.
4. Loosen the seat back brace locking knob. Extend the lower part of the brace and insert the rod-end swivel into the trolley mount clevis. Insert the clevis pin.
5. Position the patient per protocol, then lock the Seat Back Brace locking knob to secure. Be sure to loosen the seat locking knob when adjusting the height of the seat or the position of the seat back.
6. To rotate the seat to the opposite 0 degree position, disconnect the lower end of the back only. Repeat steps four and five.



Figure 1.5. Attaching the Seat Back Brace to the Multi-Joint System seat back clevis.



Figure 1.6. Attaching the Seat Back Brace to the Multi-Joint System trolley mount clevis



Figure 1.7. Seat Back Brace installed and ready for use.

THE CONTROLLER (Located at the bottom, rear, of Computer Data Station)

(See Figure 1.8 - 1.9)

Main Power Switch

Controls main power supply to controller, computer and dynamometer. Contains a circuit breaker to protect against extreme power surges. Breaker is reset by turning the Power Switch OFF (0) and then ON (1).

NOTE: It is not necessary to turn the system OFF each day. Use the Dynamometer and Computer Power Switches described below for daily shut-down. Use the Main Power Switch only if you intend to shut the system down for an extended period of time.

Dynamometer Power Switch

This switch controls power to the dynamometer. In the ON position, power to the dynamometer is enabled. In the OFF position, the dynamometer is on Standby.

Computer Power Switch

Controls power to the computer and peripherals (including printer and monitor). In the ON position, power to computer, monitor and printer are ON. In the OFF position, power to the computer, monitor and printer are OFF.

NOTE: Be sure to properly exit and close down the Biodex Advantage Software application and Windows Programs before turning off the computer.

CPU ON/OFF Switch

Use this switch to turn the CPU ON/OFF.

Status/Diagnostics Panel (LEDs)

This panel provides information to assist in troubleshooting of dynamometer/control panel problems. In the event of a system malfunction, always be sure to record which LEDs light before attempting to correct a problem or restart the system. Contact a Biodex Service Representative whenever the status panel indicates a malfunction.

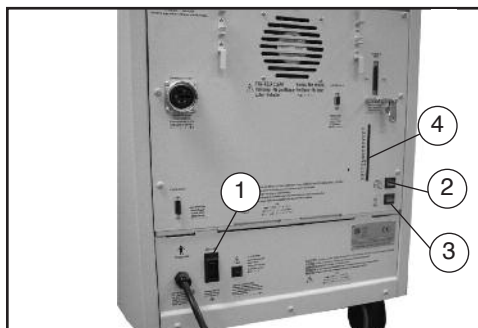


Figure 1.8.



Figure 1.9.

Figures 1.8 and 1.9. The Biodex Multi-Joint System Controller front panel (left) and rear of unit (right).

1. Main Power Switch
2. Dynamometer Power Switch
3. Controller Power Switch
4. Status/Diagnostics Panel (LED's)
- 5 CPU ON/OFF Switch

DYNAMOMETER ATTACHMENTS

Figure 1.10.

Shoulder Attachment

(Insert in Shoulder/Elbow Adapter)

Patterns:

Shoulder: Ex / Flex
Ab / Ad
Diagonals

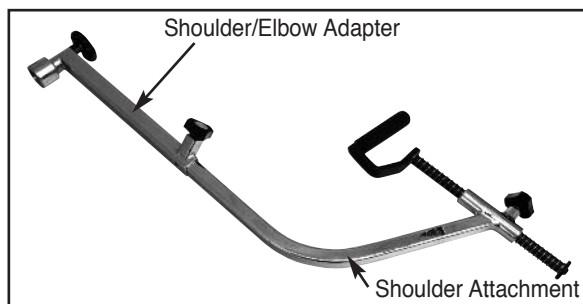


Figure 1.11.

Shoulder/Elbow Attachment

(Insert in Shoulder/Elbow Adapter)

Patterns:

Shoulder: In / Ex Rotation
Elbow: Ex / Flex (remove cuff)

NOTE: Only one Shoulder/Elbow Adapter is supplied.
The same adapter is used with the Shoulder Attachment and Shoulder/Elbow Attachment.

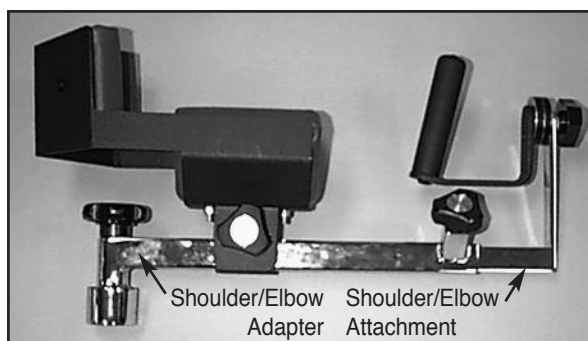


Figure 1.12.

Knee Attachments (Left and Right)

Patterns:

Knee: Tibial In / Ex Rotation
Ankle: Plantar / Dorsiflexion
Inversion / Eversion



NOTE: Ensure finger guard is in place when using this attachment.
See Figure 1.16.



NOTA: S'assurer que le doigtier est bien en place lorsqu'on utilise cet accessoire. Voir figure 1.16.

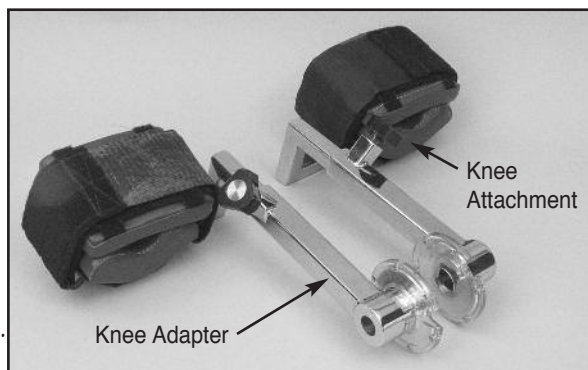


Figure 1.13.

Wrist Attachment

Patterns:

Wrist: Ex / Flex
Radial / Ulnar Deviation
Forearm: Pro / Supination

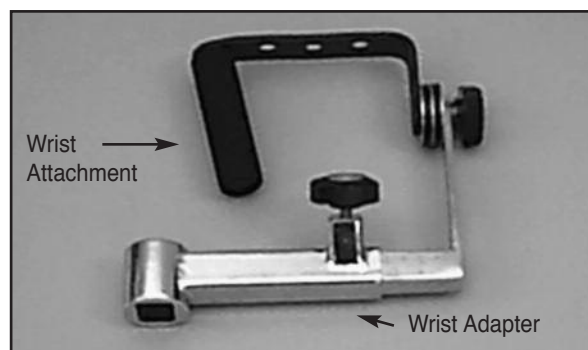


Figure 1.14.
Hip Attachments (Left and Right)

Patterns:

Hip: Ab / Ad
Ex / Flex



NOTE: Ensure finger guard is in place when using this attachment. See Figure 1.16.



NOTA: S'assurer que le doigtier est bien en place lorsqu'on utilise cet accessoire. Voir figure 1.16.

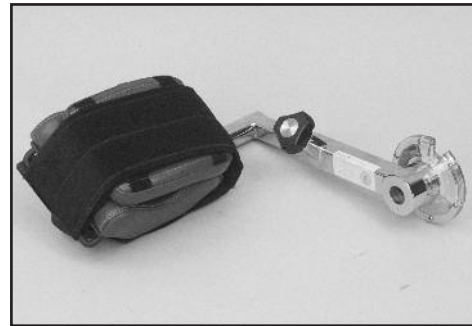


Figure 1.15.
Combination Ankle Attachment

Patterns:

Ankle: Plantar / Dorsi Flexion
Inversion / Eversion

NOTE: See "Using The Combination Ankle Attachment (next section).



Figure 1.16.
Finger Guard positioned correctly on dynamometer for Knee and Hip attachments.

Patterns:

Knee: Ex / Flex



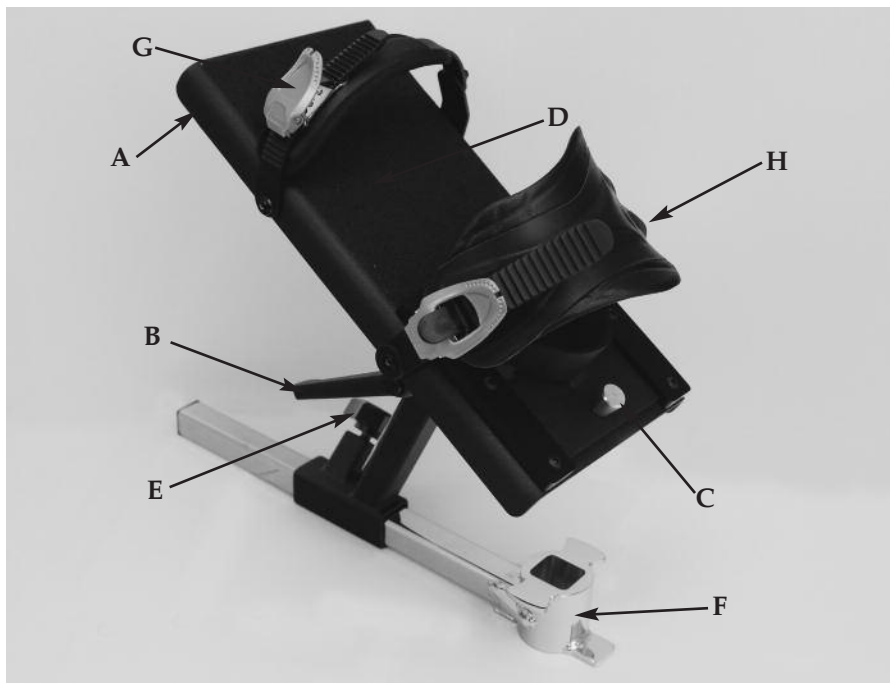
CAUTION: Placing your hands or fingers between the dynamometer input shaft (or attachment) and the mechanical ROM stops may result in serious injury.



ATTENTION: Placer vos mains ou doigts entre le dynamometer données (ou attachment) et le mécanique ROM arrêts peut résulter dans sérieux blessure.

USING THE COMBINATION ANKLE ATTACHMENT

(See Figure 1.17.)



- A. Footplate Rotation Lever
- B. Footplate Tilt Lever
- C. Heelcup Release Buttons
- D. Footplate
- E. Adapter Locking Knob
- F. Ankle Attachment Adapter
- G. Toe Strap
- H. Ankle Strap

Figure 1.17 The Combination Ankle Attachment adjustment mechanisms.

The Combination Ankle Attachment (#830-331) is color-coded to facilitate set ups for all ankle patterns. To prepare the attachment for use, simply line up the appropriate color coded position tags for footplate tilt and rotation with the red dots on the attachment shaft and Footplate Rotation Lever.

The footplate color codes are as follows:

White "P" to Red Dot: Plantar/Dorsiflexion
Green "I" to Red Dot: Inversion/Eversion

Adjusting The Footplate

Footplate Rotation: The Footplate Rotation Lever is located on the underside of the footplate at the toe end. Pull the lever and hold it back while you rotate the footplate until the desired color-coded position tag aligns with the lever. Release the lever and ensure that the appropriate footplate peg is secured in the lever's notch.

Footplate Tilt: The Footplate Tilt Lever is located on the underside of the footplate just above the color-coded position tags. Loosen the lever and tilt the footplate to align the color-coded tags per test or exercise protocol by aligning the white "P" with the red dot for plantar\dorsiflexion or the green "I" to the red dot for Inversion\Eversion. Tighten the lever to secure the footplate in place.

Heel Cup Position: To facilitate alignment of the subject's axis of rotation with the dynamometer shaft, it may be necessary to raise or lower the patient's foot on the footplate by adjusting the heel cup position. The Heel Cup Release Buttons are located on the top side of the footplate at the heel end. Squeeze the Heel Cup Release Buttons together and slide the support cup to the desired position. Release the buttons to lock the heel cup in place.

Toe and Ankle Straps: Once all adjustments to the footplate have been completed, secure the patient's foot using both the foot and ankle straps. To secure the toe and ankle straps, thread each strap through its respective buckle. Pull up on the narrow end of each buckle to ratchet the strap tight. Pull up on the wide end of each buckle to loosen the strap.

2. OPERATION



CONSIDERATIONS FOR SAFE OPERATION OF YOUR BIODEX MULTI-JOINT SYSTEM

1. The clinician should always be present during testing or exercise sessions. Do not allow subjects to test or exercise by themselves.
2. Range limits should always be set after the subject is positioned according to protocol and before switching to a test or exercise mode. Limits should never be set at points that are beyond the safe maximum allowable range of motion for the individual subject.

Always assume that previously set limits are inappropriate for successive subjects, or for successive joints on the same subject. Limits should be canceled by pressing Set-up, Start and Set-up again at the completion of each test or exercise session.

3. Range of motion limits should be set so that the mechanical stop on the attachment or fixture will not contact the mechanical stop on the dynamometer. Metal-to-metal contact of these parts during operation will override the system's normal deceleration function (cushion), causing harsh impacts at ends of ROM.
4. Always educate subject as to function and use of the Comfort Stop buttons. Always place the hand-held remote Comfort Stop (on black coiled cord) in the subject's free hand before the start of any test, exercise or biofeedback session.
5. During setup, check subject positioning and ability to complete range of motion (slowly) prior to securing stabilization straps. Ensure that both the positioning chair and dynamometer are securely locked in detentes before allowing subject to move through ROM.
6. Before beginning any test or exercise session, always inform the subject that the input arm will now be able to move.
7. Always keep the surrounding area free of equipment and other personnel, especially when the passive mode is to be used. Check for clear, unobstructed path of movement pattern (through complete ROM).
8. Do not operate equipment that has malfunctioned until it has been serviced by a qualified technician or use has been approved by a Biodex Service Representative.
9. Use equipment only with recommended power supplies, grounding, and surge suppression. (Refer to Biodex site survey or contact Biodex Service Department for specifications).



CAUTION: *Placing your hands or fingers between the dynamometer input shaft (or attachment) and the mechanical ROM stops may result in serious injury.*



POINTS À RETENIR POUR UN FONCTIONNEMENT SÉCURITAIRE DE VOTRE SYSTÈME BIODEx

1. Le clinicien doit toujours être présent durant les séances de test ou d'exercice. Ne pas permettre aux sujets de se tester ou de s'exercer seuls.
2. Les limites d'amplitude doivent toujours être fixées après avoir positionné le sujet suivant le protocole et avant de passer à un mode de test ou d'exercice. On ne doit jamais régler les limites à des points qui dépassent l'amplitude du mouvement maximale permmissible pour la sécurité du sujet dont il s'agit.

Toujours partir du principe que les limites fixées précédemment sont inappropriées pour les sujets qui suivront ou pour une succession d'articulations chez le même sujet. Il faut annuler les limites en appuyant sur Réglage, Départ, puis Réglage à nouveau, à la fin de chaque séance de test ou d'exercice.

3. On doit fixer les limites de l'amplitude du mouvement de telle sorte que l'arrêt mécanique de l'accessoire ou de la fixation n'entre pas en contact avec l'arrêt mécanique du dynamomètre. Tout contact métal sur métal de ces pièces en cours de fonctionnement désactive la fonction normale de décélération (coussin), entraînant des impacts durs en fin de course.
4. Toujours veiller à bien informer le sujet de la fonction et de l'utilisation des touches Arrêt confort. Toujours placer la télécommande Arrêt confort (avec cordon extensible noir) dans la main libre du sujet avant le départ de toute séance de test, d'exercice, ou de biofeedback.
5. Durant le réglage, vérifier le positionnement du patient et sa capacité de se mouvoir (lentement) dans toute l'amplitude du mouvement, avant de fixer les sangles de stabilisation. S'assurer que le siège de positionnement et le dynamomètre sont tous deux bien verrouillés dans leurs crans d'arrêt avant de permettre au sujet d'évoluer dans l'amplitude du mouvement.
6. Avant d'appuyer sur la touche Départ, toujours informer le sujet que le bras de saisie peut maintenant se déplacer.
7. Garder en tout temps la zone environnante libre de tout équipement et d'autres personnes, surtout lorsqu'on utilise le mode passif. S'assurer d'une trajectoire libre de tout obstacle pour les évolutions dans toute l'amplitude du mouvement.
8. Ne pas faire fonctionner un équipement qui a subi une panne avant qu'il n'ait fait l'objet d'un entretien par un technicien qualifié, ou que son utilisation n'ait été autorisée par un agent du service après-vente de Biodex.
9. N'utiliser l'équipement qu'avec les alimentations électriques, la mise à la terre et la protection contre les surtensions préconisées. (Se reporter au sondage sur les installations de Biodex ou communiquer avec le service après-vente de Biodex pour le cahier des charges.)



ATTENTION: Placer vos mains ou doigts entre le dynamomètre données (ou attachement) et le mécanique ROM arrêts peut résulter dans sérieux blessure.

READYING THE SYSTEM FOR USE

1. Turn the main power switch on the back of the controller to the ON (I) position.
2. Ensure that the dynamometer and computer power switches are set to the ON (I) position.
3. Upon power up, a message will be displayed on the monitor that the system needs to be initialized. Initialization consists of a self-test during which the firmware checks to ensure that the dynamometer and associated hardware are working properly. Initialization must be performed any time the system is turned ON following system shut-down or an interruption in power supply.
4. Remove any attachments from the dynamometer input shaft and select <OK> to proceed with initialization. The dynamometer input shaft will turn fully clockwise and then counter-clockwise. If any problems are encountered, the system will display an error message. If all circuits and phases of the Biodex Multi-Joint System dynamometer and hardware are working properly, no error message will be presented and the display advances to the Dynamometer Operation screen. The message "Set ROM Limits" should now be displayed in the System Status window at the top of the screen. The system is now ready for use.

NOTE: Should a coded initialization error message be displayed, contact Biodex Customer Service.

Shutting Down the System at the End of the Day

At the end of your day, switch the computer and dynamometer power switches, located on the back of the controller, to the OFF position. If the Biodex Multi-Joint System will not be used for an extended period of time, you may also want to switch the controller OFF via the Main Power switch on its rear panel.

NOTE: You must exit both the Biodex Advantage Software and the Windows program prior to shutting down the system. Failure to do so may result in lost or damaged files. To quit Windows and shut down your computer:

1. Close the Biodex Advantage Software application by selecting the <X> in the top right corner of the screen.
2. Select the <Start> button at the lower left side of the screen to access the Start menu.
3. Select the <Shut Down> to bring up the Shut Down window.
4. Select <Yes> to shut down the computer. A screen message will be displayed when it is safe to turn the computer OFF.

Following is a general guideline for use of the Biodex in each of its operating modes. These guidelines are of a mechanical nature and do not reflect use of the computer software. They are presented only as an example to help familiarize you with the mechanical aspects of equipment setup and each of the various modes of operation.

MODES OF OPERATION

The Biodex Pro offers several modes of operation. These are selected via the Advantage Software package. A brief review of each mode follows.

Biofeedback Operation

Biofeedback Operation incorporates all the functions that, in earlier versions of Biodex Multi-Joint Systems, were controlled by the front panel. In this mode, clinicians can set up and begin patient exercise without entering patient-specific data such as name, address, weight, etc. When Biofeedback Mode is selected, all settings default to match the last biofeedback session. Patient exercise data is displayed on the graph in real-time but cannot be printed or saved.

Isokinetic Mode

In this mode, the dynamometer acts to control velocity, allowing the subject to accelerate up to, but no higher than, the maximum speed value selected for each direction of shaft rotation (accommodating resistance). The subject may freely decelerate or change direction of movement at any point within the range of motion.

The following general procedure is provided to help clarify use of Isokinetic mode.

Isokinetic Mode Clinical Applications

1. The Isokinetic mode may be used at higher speeds in order to simulate functional or sports activities. It can also be used early on in the rehabilitation process to prevent compression and translation in the knee joint.
2. The Isokinetic mode may be used with differing bi-directional velocities to simulate functional activities or place the focus of the activity on one specific muscle group.
3. There is a 15-degree physiologic overflow in strength on each side of the end ROM (30° total carry-over) with a limited range of motion strengthening program performed isokinetically (Halbach, 1985).
4. Choose con/ecc or ecc/con to isolate one muscle group.
5. Exercising at a specific speed has shown strength gains which overflow to both faster and slower speeds. However, there is enough research to demonstrate that by exercising at every 30 degrees/second, physiological overflow will occur with regards to specific strengthening at each speed exercised (Davies, G.J., 1987.)
6. In the Isokinetic mode, the Force-Velocity relationship of muscle dictates that as speed of contraction increases concentrically, the muscular tension (and therefore torque) decreases. (Davies, G.J., 1987.)
7. A velocity spectrum is recommended which will start the subject at either a high or low speed, depending on the pathology and status of the subject, and progress to other speeds. Varying the number of repetitions (i.e., less reps at slow speeds, more reps at high speeds), will help keep the work performed consistent over the range of the velocity spectrum.
8. Exercising at higher speeds has shown excellent benefits for endurance gains. This will limit compression on joints, tension developed in the muscles and tendons, and generally allows the subject to do larger numbers of sets or repetitions, which transfers to daily activities.
9. Keep in mind the stretch shortening cycle. It has been found that an eccentric contraction performed before a concentric contraction results in a more forceful concentric contraction than a concentric contraction performed alone (Duncan, P., et. al., 1989). High speed contractions followed by slow speed contractions will simulate an isolated plyometric activity.

The Passive Mode

The Biodex Passive mode allows the dynamometer to provide continuous motion at constant velocity, with direction changes occurring only when range of motion limits are reached.

In Passive mode, the dynamometer initiates motion when the Start button is pressed, requiring no active participation by the subject.

Passive Mode Clinical Applications

1. The Passive mode is frequently used post-operatively for the benefits of continuous passive motion, which assist with nourishment of the joint.
2. The Passive mode may be used isokinetically in the agonistic direction and then passively in the antagonistic direction or vice versa.
3. The Passive mode may be used to exercise or test isokinetically. Subjects that cannot meet the speed, will be passively moved through this portion of the range.
4. The Passive mode may be used for passive stretching. When this is performed, the torque limits in each direction should be set low. If the subject feels uncomfortable, they may resist the motion and the unit will stop, e.g., if the clinician is trying to increase knee flexion the subject will be passively flexed. If at any time the subject is uncomfortable, they may resist the flexion movement and isometrically exceed the Toward torque limit. This will stop the unit. The Pause buttons can also be used to hold the patient at the end ROM corresponding to the direction the pause is set.
5. For knee, shoulder flex/ex, ab/ad, and lumbar movements, ensure torque limits are set to overcome limb weight.
6. Passive motion may be used to warm-up and cool-down a subject, stretching ROM, and to perform contract/relax protocols. Used during rest periods, passive motion can help prevent muscles from "tightening up" before the next set of repetitions.
7. By instructing the subject to move the limb at a speed that will keep the Away and Toward Applied Torque Indicator ON and the middle Applied Torque Indicator OFF, the Passive mode can be used to provide biofeedback and stimulate joint and muscle mechanoreceptors to improve proprioception.
8. In the case of poor muscle strength, passive mode allows for active assistive motion which will initiate or continue motion of the subject.
9. Contract/Relax may be performed in the Passive mode. Range of motion limits are selected to include the entire range the subject should be able to achieve that day. It is recommended that the Limit Set buttons are set no more than five degrees outside of the beginning range. Percent Range dials are then decreased to an appropriate level so that the entire range is comfortable. The subject is placed on the unit with the comfort stop in hand. As the subject is passively moved in one direction, they exert force in the opposite direction. The torque limit in the opposing direction must be set low enough so that the subject exceeds the limit and performs an isometric contraction. At this time, the clinician slightly increases the range of motion using the Percent Range dial in the appropriate direction. The procedure is repeated for as many cycles as desired.

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10. Immediately post exercise, some subjects exhibit joint effusion. Application of ice while moving passively at 20 degrees per second has been reported to reduce post exercise swelling and discomfort. This may also be done in conjunction with electric stimulation to further assist edema control.

Isometric Mode

In this mode, the dynamometer maintains zero velocity at any selected point in the range of motion. Significant change in joint angle and overall muscle length does not occur.

Isometric Mode Clinical Applications

1. The Isometric mode may be used pre- or post-surgery with discretion.
2. The Isometric mode may be used near a painful range for strength carryover into the painful range. Overflow has been found to be plus or minus as much as 10 degrees.
3. Isometric holds can be checked for quality of contraction. Monitoring these can help set goals and monitor progress.
4. The Isometric mode can be used very effectively to initiate contractions submaximally. Make sure to stabilize other body parts to prevent compensation. Relaxation can be assisted by the application of heat, cold, or biofeedback.

Isotonic Mode

In this mode, the dynamometer requires the patient to meet a minimum selected torque limit in order to move the input arm. Thus, speed is variable but torque is constant.

Isotonic Mode Clinical Considerations

1. The Isotonic Mode may be used concentrically or eccentrically to train a selected muscle group.
2. Torque limits may be set independently (in each direction) for agonist/antagonist muscle groups in order to focus the activity on one specific muscle group or compensate for dominance in strength of either the agonist or antagonist muscle group.
3. In this mode it is possible to set a “pre-load” for the patient to overcome prior to movement. This ensures that the patient is performing the contraction with a minimal amount of force.
4. Concentric/concentric isotonicity can be completed before concentric/eccentric movements. This improves safety for the patient as the limb will not be forceably moved into any portion of the range of motion should the patient not have ample neuromuscular control.

The Reactive Eccentric Mode

In this mode the dynamometer responds to torque exerted by the patient by moving in the opposite direction of the applied torque.

In Reactive Eccentric or mode, the Torque buttons on the Control Panel are used to specify a window of desired human force output. To initiate shaft motion, the subject is required to meet a minimum torque threshold corresponding to 10% of the Torque button setting. If the subject exceeds the torque limit value selected for either direction of motion, the shaft stops rotating until the subject's force output is reduced to within the desired range. The subject is therefore required to exceed a specified torque value to achieve motion, and to keep torque output at the specified level to continue movement.

Low torque limits require greater neuromuscular control. Setting a torque limit of 20 ft-lb will require 2 ft-lb of force to initiate motion and 20 ft-lb to stop, resulting in a window of 18 ft-lb. Setting the window at 100 ft-lb results in a window of 90 ft-lb.

Reactive Eccentric mode allows for direction changes at *any point* in the range of motion.

Reactive Eccentric Mode Clinical Applications

1. The Reactive Eccentric mode may be used to perform submaximal or maximal eccentrics.
2. The Reactive Eccentric mode may be used to work on proprioception. When torque limits are set, the subject must exert at least one-tenth of the torque limit to keep the shaft moving. If the subject exceeds the limits, the unit will stop.

Low torque limits require greater neuromuscular control. Setting a torque limit of 20 ft-lb will require 2 ft-lb of force to initiate motion and 20 ft-lb to stop, resulting in a window of 18 ft-lb. Setting the window at 100 ft-lb results in a window of 90 ft-lb.

3. At higher velocities the stretch reflex is more active than at lower velocities.
4. It is possible to generate 30-40% more force eccentrically than concentrically. (Set the torque limits appropriately.) In that the stimulus for strength gain is contraction intensity, it is suggested by some research that eccentric contractions will result in significant strength gains. (Knuttgen, H.G., et. al., 1971; Komi, P.V., 1972).
5. There is patient specific eccentric speed above which muscular force will not increase. (Knuttgen, H.G., et. al., 1972).
6. Eccentric contraction involves a "training" of the non-contractual elements of muscle so that the muscle "learns" to function in a higher force environment. (Komi, P.V., 1972).
7. In eccentric exercise, the force increases as the velocity of contraction increases (up to a certain point) which is in contrast to concentric exercise in which the force decreases as the speed of contraction increases. (Davies, G.J., 1987.)
8. It has been suggested that eccentric exercise produces the greatest force in the least amount of time (Komi & Cavanaugh, 1977).

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9. Eccentric contractions enhance muscle force production and are less costly metabolically than concentric contractions (Bosco & Komi, 1979, Asmussen, 1953).
 10. Eccentric rehabilitation is usually performed no more than two times a week secondary to delayed onset muscle soreness.

ADDITIONAL CONSIDERATIONS

1. Very often clinicians use the following progression during the rehabilitation process: Passive mode, isometrics, multi-angle isometrics, sub-maximal eccentrics, concentric isokinetics.
2. Electrical stimulation may be used in conjunction with any of the tests or exercise modes on the Biodex.
3. Consider ending a rehabilitation set by work or time, especially if the goal is to improve endurance.
4. Giving a subject copies of their rehabilitation reports can help with motivation.
5. Submaximal exercise prevents neural dissociation, promotes articular cartilage nourishment and proprioception, and retards muscular atrophy.
6. Delayed Onset Muscle Soreness (DOMS) is not usually apparent until one to two days after treatment. Work submaximally to minimize and develop protocols accordingly.
7. The Biodex Multi-Joint System is a versatile piece of equipment, making it difficult to document every possible setup position. If a non-documented position is used, document it. If it becomes a position that is used often, send the information to Biodex.

PROPER TESTING TECHNIQUE

1. Verify calibration at least twice a month. If you are going to use your data in court or for research, calibrate and verify before a test is performed.
2. Be consistent in warm-up procedures, commands, setups and instructions, (i.e., Four total repetitions, first one at 25% effort, next at 50% effort, then 75% effort and, finally, 100% max effort.)
3. Each patient should perform trial repetitions before each speed to become familiar with what to expect.
4. Be sure to familiarize the subject with the equipment before testing to eliminate a learning curve. It is recommended that the patient perform two or three exercise sessions on the system prior to testing.
5. Use proper stabilization techniques, making every attempt to restrict motion only to the area of interest. Body parts on either side of the joint(s) being rehabilitated or tested should be firmly secured. Studies have reported significant differences in data generated with and without stabilization. Uncontrolled movement leads to testing errors. If you add or remove stabilization devices, document it.

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6. Axis alignment of the dynamometer shaft with the subject's anatomical axis of rotation is crucial to ensure that during testing and rehabilitation the pattern performed is consistent with the proper biomechanics of the joint. Correct alignment also helps eliminate stressful loading of the joint and recruitment of other muscle groups.
 7. Use standardized setups. If you use an unconventional setup, document it.
 8. Make sure to set the correct anatomical reference angle. The internal goniometer of the software is based on this reference angle, and is important for later data interpretation.
 9. Verbal and visual encouragement should be consistent.

NOTE: Allowing a patient to view the monitor during a test may cause the patient to change force output based on perception. For testing consistency, it is recommended that the patient not be allowed to view the monitor.

3. SETUP AND POSITIONING

The following section details the Biodex Multi-Joint System setup and positioning for each of the standard test and exercise patterns. Included is information on both mechanical and anatomical aspects.

It is suggested that clinicians who are not familiar with the Biodex Multi-Joint System read the preceding chapters and practice each setup with a healthy subject before attempting to position any person for actual testing or exercise. Instruction can also be gained through the use of the AVIs in the Advantage Software Program.

While the following setups are standard, it should be noted that other positioning setups are possible. The Biodex Multi-Joint System is extremely versatile and can accommodate to many test and rehabilitation needs. If you find a new setup to be especially useful in your practice, be sure to document it and pass the information along so it can be included in our database.

NOTE: All attachments have “R” (right) and “L” (left) designations. In the case of the ankle and wrist attachment, R&L are together (R L). Proper range of motion is ensured by aligning the dynamometer shaft red dot with the appropriate designation for the side to be exercised or tested.

NOTE: Check the dynamometer, gimbal and seat for proper positioning before each testing, exercise or biofeedback session.

NOTE: When performing bilateral testing, make sure the length of the attachment is equal on both sides to assure validity and reliability of results.

KNEE: EXTENSION/FLEXION



Figure 3.1

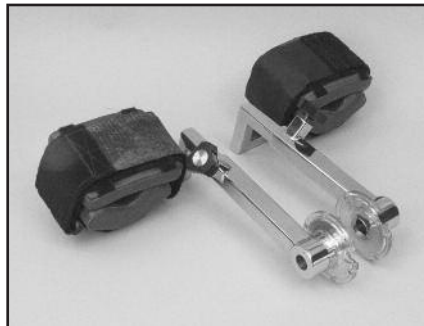


Figure 3.2.

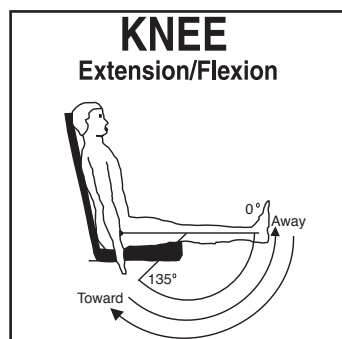


Figure 3.3.

Quick Reference

Dynamometer Orientation: 90°

Dynamometer Tilt: 0°

Seat Orientation: 90°

Seatback Tilt: 70 - 85°

Axis of Rotation: Axis is through the lateral femoral condyle on a sagittal plane.

Ready Position: Full Flexion

Parts Needed

Dynamometer: Knee Attachment (left or right)

Positioning Chair: No additional parts required.

KNEE EXTENSION/FLEXION

Because of multiple factors such as stability through mostly ligamentous and muscular support, the bearing of high forces, and the fact that it is located between the body's two longest lever arms, the knee is one of the most commonly injured joints in the body. The knee is also the most commonly tested and rehabilitated joint on the Biodex Multi-Joint System.



CAUTION: *Placing your hands or fingers between the dynamometer input shaft (or attachment) and the mechanical ROM stops may result in serious injury.*



ATTENTION: *Placer vos mains ou doigts entre le dynamomètre données (ou attachement) et le mécanique ROM arrêts peut résulter dans sérieux blessure.*



NOTE: *Ensure finger guards are securely in place.*



NOTA: *S'assurer que le doigtier est bien en place lorsqu'on utilise cet accessoire.*

Setup and Positioning

(Starting Movement: Away/Extension)

1. Seat patient on chair.
2. Rotate chair to 90 degrees.
3. Rotate dynamometer to 90 degrees. Slide dynamometer along travel to position outside leg to be tested or exercised.
4. Attach knee attachment to dynamometer. Align dynamometer shaft red dot with red dot on attachment.
5. Move patient into position.
6. Align patient knee axis of rotation with dynamometer shaft. Raise/lower seat or move patient toward/away from dynamometer to fine adjust.
7. Adjust knee attachment so that it is proximal to medial malleoli. Secure with strap.

NOTE: Moving the pad proximally has been demonstrated to decrease anterior tibular translation.

8. Stabilize patient with shoulder, waist and thigh straps.
9. Set ROM stops.

Opposite Side

1. Unstrap patient's knee from attachment and thigh strap.
2. With patient remaining in chair, slide chair back away from dynamometer.
3. Press Hold button to retain dynamometer shaft position. Remove attachment. Get knee attachment for opposite side.
4. Rotate dynamometer to 90 degrees on opposite side. Slide dynamometer to opposite side of patient.
5. Attach knee attachment to dynamometer. Align dynamometer shaft red dot with red dot on attachment.
6. Move patient into position.
7. Align patient knee axis of rotation with dynamometer shaft. Raise/lower seat or move patient toward/away from dynamometer to fine adjust.
8. Adjust knee attachment so that it is proximal to medial malleoli. Secure with strap.
9. Stabilize patient with shoulder, waist and thigh straps.
10. Reset ROM stops.

Clinical Applications of Biodex Operating Modes

Isokinetic Mode

1. The isokinetic mode may be used at high speeds to simulate functional or athletic activities.
2. The isokinetic mode may be used for bi-directional velocities (i.e., during early ACL reconstruction rehabilitation, the hamstrings may be worked at low speeds and the quadriceps at high speeds. At end stage rehab, the quads may be worked at low speeds and the hamstrings at high speeds).

Passive Mode

1. The passive mode is frequently used post-operatively, especially with anterior cruciate ligament repairs, abrasion arthroplasties, and total knee replacements, for the benefits of continuous passive motion.
2. The passive mode may be used to move the limb in one direction and concentrically assist or eccentrically resist in the other direction (i.e., in early rehab for ACL reconstructions, the limb may be moved passively through partial range extension. The subject may then assist or resist flexion with voluntary effort).
3. The passive mode may be used for active-assisted exercise (i.e., a subject status post medial meniscectomy may be moved passively through a range where voluntary effort cannot be exerted and may assist in the parts of the range where able).
4. The passive mode may be used to do eccentric/concentric contractions. After an ACL reconstruction, the hamstrings may be worked eccentrically and concentrically through limited range and then through the full range. At end stage rehab, the quadriceps may be worked at the end of the range, both concentrically and eccentrically, to decrease an extensor lag.

Isometric Mode

1. The isometric mode may be used with pre- or post-operative subjects or when pain is a factor.

Isotonic Mode

1. Prior to performing traditional isotonics on weight equipment, a patient can perform various contractions isotonicly to ensure proper muscular function.
2. Since a pre-load is required, gravity and momentum play a minimal role in exercise. This ensures patient compliance.

Reactive Eccentric Mode

1. The Reactive Eccentric mode may be used maximally or submaximally to replicate functional activities. The role of submaximal eccentrics has been greatly overlooked. With ACL reconstructions, the hamstrings may be worked through full range of motion eccentrically with submaximal effort.
2. Specific areas of weakness in a range of motion such as quadriceps extensor lag may be worked eccentrically at the last 30° of extension with submaximal effort.
3. Submaximal eccentrics may be used to protect injured or grafted structures (i.e., post-operatively, subjects may exercise in the eccentric mode with the torque limits set very low. If the subject were to exceed the set torque limit, the input shaft would stop).

Additional Comments

1. The pause may be used for passive stretching or to perform contract/relax for the facilitation of motion. This is especially important after a total knee replacement when early motion is crucial. The pause may also be used when working in the passive mode to do eccentric or non-reciprocal contractions.
2. All modes may be used in combination with electrical stimulation.
3. With anterior cruciate ligament rehabilitation, pay close attention to tibial pad placement. Research has shown that while working the quadriceps, less stress is placed on the ACL when the pad is placed in the proximal position. For hamstring work, place the pad in a more distal position.
4. Subjects may be worked through only a partial range using the percent setting in Biofeedback. This is important to assist with focusing on range of motion specific weakness.
5. When treating the knee, total leg strength should be considered, especially the strength of hip abductors and adductors.
6. It has been found that most ACL injuries occur during deceleration, therefore, eccentric exercise is an important part of the rehabilitation process.
7. Because a subject is proximally stabilized, very little substitution will occur. Proximal stabilization lends itself to joint isolation.
8. The seatback of the positioning chair may be adjusted to accommodate any hip angle the clinician finds appropriate. Typically, a 70° incline will place the hamstring and quadriceps in an optimal length-tension relationship allowing for improved muscle output.
9. Increasing speeds (180°-300°/sec.) decreases anterior tibial translation, and joint compressive forces. Important applications for rehabilitating anterior cruciate injuries and patellofemoral dysfunction.

ANKLE: PLANTAR/DORSIFLEXION (SEATED)



Figure 3.4.



Figure 3.5.

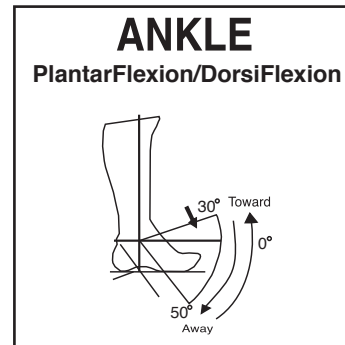


Figure 3.6.

Quick Reference

Dynamometer Orientation:	90°
Dynamometer Tilt:	0°
Seat Orientation:	90°
Seatback Tilt:	70 - 85°
Footplate Tilt:	0°
Footplate Code:	Red dot to P/D
Knee Flexion:	20 - 30°

Axis of Rotation: In neutral position, axis passes through the body of talus, fibular malleolus, and through or just below the tibial malleolus.

Ready Position: Full Plantarflexion

Parts Needed

Dynamometer:	Ankle Attachment
Positioning Chair:	Limb-Support Pad, T-Bar, Footrest (optional)

ANKLE: PLANTAR/DORSIFLEXION (SEATED)

The ankle joint or talocrural joint is really three joints (tibiotalar, fibulotalar, and tibiofibular) formed by the superior portion of the body of the talus fitting within the cavity created by the combined distal ends of the tibia and fibula. The subtalar joint is the articulation between the talus and calcaneus.

Motions of the ankle are rarely true single plane motions. This holds for dorsiflexion/plantarflexion, which usually occurs in conjunction with other movements.

Setup and Positioning

(Starting Movement: Toward/Dorsiflexion)

NOTE: For both ankles, the limb support pad is positioned in the positioning chair front right receiving tube.

1. Seat patient on chair.
2. Rotate chair to 90 degrees.
3. Set seat back tilt to 70 - 85 degrees.
4. Install Limb Support Pad (with T-Bar) in the positioning chair front right receiving tube. Angle support toward chair. Place pad under distal femur and secure with strap.

NOTE: Because the origin of insertion of the gastrocnemius is above the knee, the extent of ankle dorsiflexion will generally increase with increased knee flexion and decrease with knee extension. Positioning should be recorded for valid comparisons and reproducibility.

NOTE: For exercise, the footrest may be inserted in the left chair front receiving tube if desired. Use of the footrest provides a stable base for the patient to push off and may cause the system to record artificial peak torques.

5. Rotate dynamometer to 90 degrees.
6. Set dynamometer tilt to 0 degrees.
7. Attach Ankle Attachment dynamometer.
 - Place Ankle Attachment input tube on dynamometer so that P/D engraving faces outward then rotate footplate so that P/D aligns with the dynamometer shaft red dot.
 - With attachment tube horizontal, press Hold.
8. Raise dynamometer to align axis of rotation.
9. Move patient into position and align patient ankle axis of rotation with dynamometer shaft.
10. Strap foot to footplate.
11. Stabilize patient with appropriate straps.
12. Set ROM stops

Opposite Side

1. Press Hold to retain dynamometer shaft position.
2. Unstrap patient's ankle and leg.
3. With patient remaining in chair, slide chair away from dynamometer.
4. Place limb support in the opposite receiving tube .
Angle limb support toward patient (switch with footrest if needed).
5. Place limb support pad under distal femur and secure with strap.
6. Slide dynamometer in front of ankle to be tested.
7. Move patient forward and secure leg in limb support with foot on footplate.
8. Align patient ankle axis of rotation with dynamometer shaft.
9. Strap foot to footplate.
10. Stabilize patient with appropriate straps.
11. Reset ROM Stops as needed.

Clinical Applications of Biodex Operating Modes

Isokinetic Mode

1. The isokinetic mode may be used at bi-directional velocities. This is especially important at the ankle complex where the muscular strength is unbalanced. Many clinicians work the plantarflexors at slower speeds and the dorsiflexors at higher speeds.

Passive Mode

1. The passive mode may be used after a period of immobilization for the benefits of continuous passive motion.
2. The passive mode may be used to perform non-reciprocal contractions (e.g., many times the plantarflexors are considered to be the more essential muscle group to be rehabilitated after injury. The plantar flexors may be worked both concentrically and eccentrically in the passive mode.

Isometric Mode

1. Multi-angle isometrics may be used pre- and post-operatively or after periods of immobilization.

Isotonic Mode

1. In later phases of rehab, perform various concentric contractions to isolate one muscle group only.
2. Set torque limit higher for plantarflexors and lower for dorsiflexors to ensure fatigue time remains constant.

Reactive Eccentric Mode

1. The eccentric mode may be used to strengthen the musculotendinous junction. Many times injuries occur at the ankle secondary to eccentric loading to failure. It may be especially important to rehab athletes in the eccentric mode.

Additional Comments

1. The ankle is known to be unstable in the plantarflexed position, an important fact to keep in mind when dealing with athletes.
2. It has been stated that peroneal and dorsiflexor strengthening may help in resisting an inversion/plantarflexion injury.
3. The gait cycle may be simulated by using the passive mode in this sequence:
 - Subject works eccentric dorsiflexion (heelstrike).
 - Subject works eccentric plantarflexion (midstance).
 - Subject works concentric plantarflexion (toe off).
 - Subject works concentric dorsiflexion motion (swing phase).
4. When rehabilitating the ankle, it is important to consider total leg strength.
5. If swelling is a consideration, the dynamometer may be raised. If cramping of the lower leg musculature is a problem, the dynamometer may be lowered to bring the ankle into a more dependent position to allow enhanced blood flow.
6. Optionally, the seatback can be placed in the horizontal position to allow testing or exercise in the supine position.

ANKLE: EVERSION/INVERSION



Figure 3.7.



Figure 3.8.

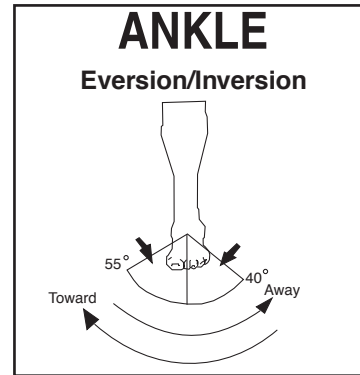


Figure 3.9.

Quick Reference

Dynamometer Orientation:	0°
Dynamometer Tilt:	60 - 70° (shaft up)
Seat Orientation:	90°
Seatback Tilt:	70°
Footplate Color Code:	Red dot to I/E
Knee Flexion:	30 - 45°
Axis of Rotation:	Passes through the fibula malleolus and the body of the talus at an angle of 35°.
Ready Position:	Full Inversion

Parts Needed

Dynamometer:	Ankle Attachment
Positioning Chair:	Limb-Support, T-bar, Footrest (optional)

ANKLE: INVERSION/EVERSION (SEATED)

The ankle is vulnerable to inversion injuries making injuries to the anterior talofibular complex a common occurrence that may be difficult to rehabilitate.

Recurrent injuries to the lateral ligamentous complex have been shown to decrease proprioception of the ankle and athletic performance.

Setup and Positioning

(Starting Movement: Away/Eversion)

1. Seat patient on chair.
2. Install Limb Support Pad (with T-Bar) in chair front receiving tube for side to be exercised or tested. Angle Limb Support toward chair. Place pad under tibia and secure with strap.
3. Attach input tube to dynamometer.
 - I/E engraving faces outward.
 - Right Ankle and Left Ankle are oriented with input shaft straight up. Align shaft red dot with R L.
 - With attachment vertical, press Hold.
4. Install footplate. Red dot to I/E.
5. Adjust the footplate angle to align red dot with "I" marker.
6. Rotate dynamometer to 0 degrees and position in line with limb support.
7. Lower dynamometer all the way down in pedestal.
8. Rotate chair to 90 degrees.
9. Set dynamometer tilt to 60-70 degrees (see label on dynamometer face).
10. Set seat back tilt to 70 degrees.
11. Move patient into position and align ankle axis of rotation with dynamometer shaft.
12. Raise chair as needed to fine adjust axis of rotation.
13. Strap foot to footplate and stabilize patient with appropriated straps.
14. Set ROM Stops.
15. Ensure the subject's lower leg is parallel to the floor.

Opposite Ankle

1. Press Hold to retain dynamometer shaft position.
2. Unstrap patient's ankle and leg.
3. With patient remaining in chair, slide chair away from dynamometer.
4. Place limb support in the opposite receiving tube. Angle limb support toward chair.
5. Slide dynamometer to opposite position.
6. Move patient forward into position and secure leg in limb support with foot on footplate. Align ankle axis of rotation with dynamometer shaft.
7. Strap foot to footplate and stabilize patient with appropriate straps.
8. Reset ROM Stops.

Clinical Applications of Biodex Operating Modes

Isokinetic Mode

1. The isokinetic mode may be set bi-directionally. In the case of a lateral sprain, evertors may be set at relatively low speeds and invertors at higher speeds. Range of motion should be limited as warranted.
2. The concentric/eccentric setting may be used in the later stages of rehab for muscle strengthening.

Passive Mode

1. The passive mode may be used after immobilization for the benefits of continuous passive motion. The passive mode may also be used to assist with neurologic retraining in the first few weeks after injury or surgery.
2. The passive mode may be used in combination with electric stimulation, ice and elevation for acute ankle sprains to help reduce swelling.
3. The passive mode may be used after a lateral ligamentous sprain to evert submaximally and passively invert. Inversion may be limited by ROM settings or using the percent range settings during Biofeedback operation if warranted.
4. The passive mode may be used after lateral ligamentous sprain to work the evertors both concentrically and eccentrically. Range of motion may be limited as stated above.

Isometric Mode

1. Multi-angle isometrics may be performed in the isometric mode. Strength carry-over has been found to be plus or minus ten degrees of the ankle exercise performed. Isometrics may be used to stress either the agonist or antagonist.

Isotonic

1. Set torque limits accordingly to ensure adequate force production throughout the ROM.

Reactive Eccentric Mode

1. The eccentric mode may be used to perform maximal or submaximal activities, develop proprioception, and to simulate function or sports activities.

Additional Comments

1. Ankle inversion injury has been noted to be caused by eccentric peroneal activity to failure.
2. Athletes who have poor static balance have been found to have weak evertors. Evertor strengthening may be helpful.
3. Consider the importance of total leg strength in the process of rehabilitating the ankle.
4. The ankle may be rehabilitated in an elevated position if edema is present.
5. If cramping is a problem, the dynamometer may be lowered to bring the ankle into a more dependent position, allowing enhanced blood flow.
6. The seat tilt may be placed in the horizontal plane to allow testing in the supine position. This may require a slight adjustment of the dynamometer.

HIP: HIP ABDUCTION/ADDUCTION (LYING ON SIDE)



Figure 3.10



Figure 3.11

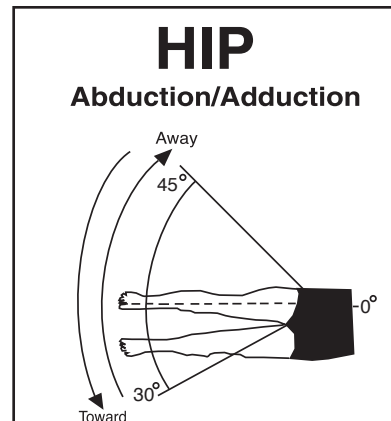


Figure 3.12

Quick Reference

Dynamometer Orientation:	0°
Dynamometer Tilt:	0°
Seat Orientation:	0°
Seatback Tilt:	Fully Reclined
Axis of Rotation:	Superior and medial to greater trochanter.
Ready Position:	Full Adduction

Parts Needed

Dynamometer:	Hip Attachment
Positioning Chair:	Seat Back Brace

HIP: ABDUCTION/ADDUCTION (LYING ON SIDE)

The abductors of the hip are very important in maintaining a level pelvis. When standing on one leg, the opposite pelvis is supported by the gluteus medius, minimus and tensor fascialata. Should there be a weakness, the pelvis may exhibit a drop.

NOTE: Make sure finger guards are securely in place.

Setup and Positioning

(Starting Movement: Away/Abduction)

1. Affix appropriate left or right Hip attachment to dynamometer shaft so that attachment and shaft red dots align. Secure with locking knob.
2. Install Seat Back Brace on positioning chair.
3. Instruct patient to lie on side on positioning chair with hip to be tested on top. Subject should face away from dynamometer with hip axis of rotation aligned with dynamometer input shaft. If desired, opposite limb can be flexed at the knee so that foot can rest on positioning chair.
4. Align dynamometer shaft with axis of rotation for the upper hip. Adjust attachment length so that pad is positioned just superior to the popliteal fossa. Secure attachment strap.
5. Place Remote Comfort Stop in subject's hand. Explain the purpose of the Comfort Stop.
6. Set range of motion limits. Move subject through desired range to check for proper positioning and comfort. Reset range of motion limits, if necessary.
7. Select mode and proceed as required by test/therapy protocol.

Opposite Side

1. Unstrap patient from attachment.
2. Remove Hip attachment from dynamometer and replace with opposite side attachment. Rotate positioning chair 180°.
3. Instruct patient to lie on positioning chair so that hip to be tested is on top. Subject should face away from dynamometer with hip axis of rotation aligned with dynamometer input shaft. If desired, opposite limb can be flexed at the knee so that foot can rest on positioning chair.
4. Align dynamometer shaft with axis of rotation for the upper hip. Adjust attachment length so that pad is positioned just superior to the popliteal fossa. Secure attachment strap.
5. Place Remote Comfort Stop in subject's hand. Explain the purpose of the Comfort Stop.
6. Set range of motion limits. Move subject through desired range to check for proper positioning and comfort. Reset range or motion limits, if necessary.

Clinical Applications

1. The passive mode may be used for the benefits of continuous passive motion after a total hip replacement.



NOTE: Progress hip range of motion only under the direct supervision of a physician.



NOTA: Avancer en flexion seulement sous la surveillance d'un médecin.

2. Many times in cases of degenerative joint disease (DJD) the cartilage in the area does not undergo the absorption and squeezing out of synovial fluid necessary for adequate nutrition. The passive mode may be used to assist this process, especially for older persons who use their joints less frequently and through smaller ranges of motion. The passive mode may also be used as a preventative measure to reduce capsular tightening at the hip.

HIP: EXTENSION/FLEXION (SUPINE)



Figure 3.13.



Figure 3.14.

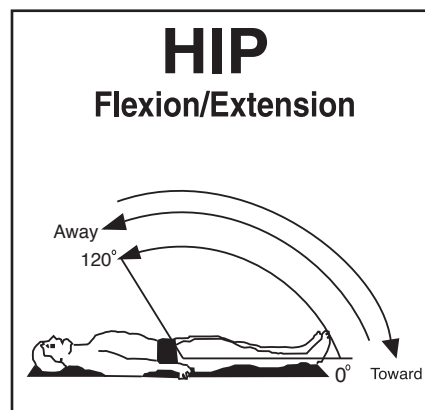


Figure 3.15.

Quick Reference

Dynamometer Orientation:	0°
Dynamometer Tilt:	0°
Seat Orientation:	0°
Seatback Tilt:	Fully Reclined
Axis of Rotation:	Superior and anterior to greater trochanter when limb is in neutral position.
Ready Position:	Neutral Extension

Parts Needed

Dynamometer:	Hip Attachment
Positioning Chair:	Footrest (optional)
	Seat Back Brace

HIP: EXTENSION/FLEXION (SUPINE)

The hip is a multiaxial ball and socket joint which consists of the articulation between the head of the femur and acetabulum of the os coxae.

There are a number of bursae at the hip. The iliopsoas bursa covers the anterior aspect of the hip joint and inflammation may cause anterior hip pain.



CAUTION: *Placing your hands or fingers between the dynamometer input shaft (or attachment) and the mechanical ROM stops may result in serious injury.*



NOTE: *Ensure finger guards are securely in place.*

Setup and Positioning

(Starting Movement: Away/Flexion)

1. Affix appropriate left or right Hip attachment to dynamometer shaft so that attachment and shaft red dots align. Secure with locking knob.
2. Install Seat Back Brace on positioning chair.
3. Instruct patient to lie supine on positioning chair with hip to be tested closest to the dynamometer. Adjust chair and dynamometer so that shaft aligns with the axis of rotation of the hip. The axis of rotation of the hip in this pattern is slightly superior and anterior to the greater trochanter.
4. Adjust Hip Attachment length so that thigh support is just superior to the popliteal fossa. Position pad anteriorly on the thigh and secure by wrapping the padded strap snugly around the thigh.
5. Place Remote Comfort Stop in subject's hand. Explain the purpose of the Comfort Stop.
6. Set range of motion limits. Move patient through range of motion to check for proper alignment and subject comfort. Make sure straps do not impede range of motion. Readjust ROM limits, if necessary.
7. Select mode and proceed as required by test/therapy protocol.

Opposite Side

1. Unstrap patient from attachment.
2. Remove attachment from dynamometer and replace with opposite side attachment.
3. Rotate positioning chair 180°.
4. Instruct patient to reposition and lie supine on chair. Hip to be tested should be closest to the dynamometer. Adjust chair and dynamometer so that shaft aligns with the axis of rotation of the hip. The axis of rotation of the hip in this pattern is slightly superior and anterior to the greater trochanter.

-
-
5. Adjust Hip attachment length so that thigh support is just superior to the popliteal fossa. Secure Hip attachment strap.
 6. Place Remote Comfort Stop in subject's hand. Explain the purpose of the Comfort Stop.
 7. Reset range of motion limits. Move patient through range of motion to check for proper alignment and subject comfort. Make sure straps do not impede range of motion. Readjust ROM limits, if necessary.

Clinical Applications of Biodex Operating Modes

Passive Mode

1. The passive mode may be used for the benefits of continuous passive motion after a total hip replacement.

NOTE: Progress flexion only under the direct supervision of a physician.

NOTA: Advancer en flexion seulement sous la surveillance d'un médecin.

2. Many times in cases of degenerative joint disease (DJD) the cartilage in the area does not undergo the absorption and squeezing out of synovial fluid necessary for adequate nutrition. The passive mode may be used for this problem, especially for older persons who use their joints less frequently and through smaller ranges of motion. The passive mode may also be used as a preventative measure to reduce capsular tightening at the hip.

SHOULDER: FLEXION/EXTENSION (SEATED)



Figure 3.16.

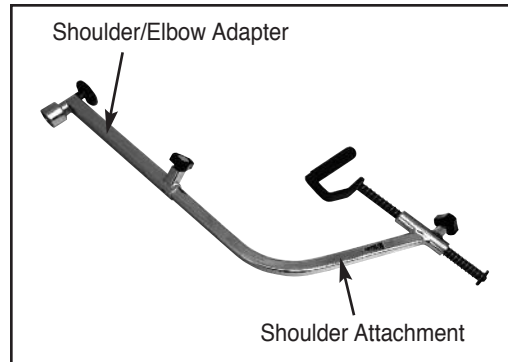


Figure 3.17.

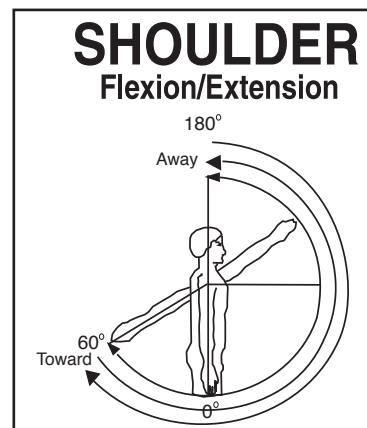


Figure 3.18.

Quick Reference

Dynamometer Orientation:	0°
Dynamometer Tilt:	0°
Seat Orientation:	0°
Seatback Tilt:	70 - 85°
Axis of Rotation:	Compromise axis is acromial process in the sagittal plane.
Ready Position:	Full Extension

Parts Needed

Dynamometer:	Shoulder / Elbow Adapter (remove cuff), Shoulder Attachment
Positioning Chair:	Footrest (optional)

SHOULDER: EXTENSION/FLEXION (SEATED)

Shoulder extension/flexion is a motion that is usually initiated early in the rehabilitation process, however, clinicians must be careful not to cause impingement. An impingement sign is produced when the shoulder is fully flexed and there is jamming of the greater tuberosity against the antero-inferior surface of the acromion. For this reason, the clinician may want to limit flexion range of motion in the early stages of the rehabilitation process.

Setup and Positioning

(Starting Movement: Away/Extension)

NOTE: This pattern may be accomplished with the positioning chair seatback reclined to any position which provides for both subject comfort and proper alignment of the anatomical axis.

1. Seat patient on chair.
2. Attach Shoulder/Elbow Adapter to dynamometer (remove cuff). Insert Shoulder Attachment into Adapter.
3. Align Shaft red dot with R or L and move attachment to almost full extension. Press Hold.
4. Slide dynamometer along travel to position outside of shoulder to be tested.
5. Rotate dynamometer to 0 degrees.
6. Tilt dynamometer to 0 degrees
7. Rotate chair to 0 degrees.
8. Move patient into position. Align patient axis of rotation. Raising dynamometer or tilting seat-back can accommodate various size patients.
9. Check for proper ROM. Keep handgrip loose during motion to allow for the compromising positions of the glenoid humeral joint as it goes through the motions.
10. Stabilize patient with shoulder, waist and thigh straps.
11. Set ROM stops.

Opposite Side

1. Press Hold.
2. With patient remaining in chair, slide chair back along travel.
3. Remove attachment and rotate it 180 degrees. Align Shaft red dot with R or L.
4. Move attachment to almost full extension.
5. Move dynamometer to opposite position. Dynamometer rotation remains at 0 degrees.
6. Rotate chair to opposite 0 degrees.
7. Move patient into position. Align patient axis of rotation. Raising dynamometer or tilting seat-back can accommodate various size patients.
8. Check for proper ROM. Keep handgrip loose during motion to allow for the compromising positions of the glenoid humeral joint as it goes through the motions.
9. Stabilize patient with shoulder, waist and thigh straps.
10. Reset ROM stops.

Clinical Applications of Biodex Operating Modes

Isokinetic Mode

1. The isokinetic mode may be used bi-directionally to focus on one specific muscle group (i.e., in an impingement syndrome the flexors may be worked at a fast speed through a limited range and the extensors at a lower speed).

Passive Mode

1. The passive mode may be used initially for the benefits of continuous passive motion. It has been suggested that early re-establishment of neural pathways without stressing an inflamed capsule is essential.
2. It has been suggested to increase anterior shoulder flexibility in the acute phase of a rotator cuff strain without offering resistance. The passive mode may be used to carry the limb into the flexed position. The subject may be instructed to assist the extensors as the arm is moved in the away direction.
3. It has been suggested by some clinicians that submaximal eccentrics that can be performed in the passive mode may be used to treat subjects with bicipital tendinitis.
4. With adhesive capsulitis, the subject may be placed in the passive mode with a four second pause at end range.

Isometric Mode

1. Isometrics may be used immediately pre- and post-operatively. Multi-angle isometrics are recommended to achieve physiological overflow into that portion of the range which has not been exercised.

Isotonic

1. Set torque limits accordingly to ensure adequate force production throughout the ROM.

Additional Comments

1. With impingement syndrome and anterior subluxation, it has been recommended to initially limit motion to under 90 degrees and progress slowly past this point.
2. It is important to consider that glenohumeral motion requires a coordinated effort between the deltoid and the rotator cuff musculature. Working the anterior deltoid non-reciprocally will strengthen this muscle concentrically and eccentrically.

SHOULDER: ABDUCTION/ADDUCTION (SEATED)

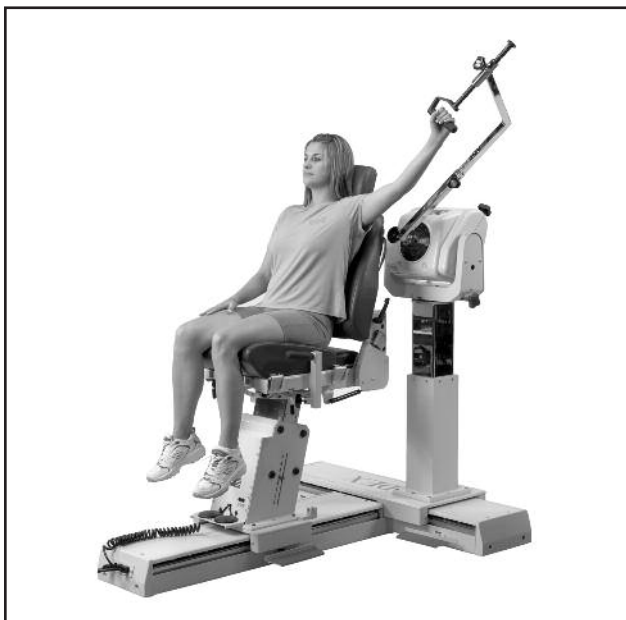


Figure 3.19.

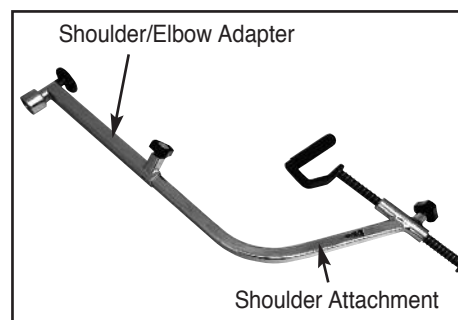


Figure 3.20.

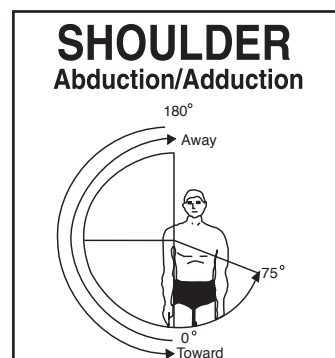


Figure 3.21.

Quick Reference

Dynamometer Orientation: 0°

Dynamometer Tilt: 10°

Seat Orientation: 90°

Seatback Tilt: 70 - 85°

Axis of Rotation: Axis of rotation for this pattern approximates the axis of the acromio clavicular joint, which connects the distal end of the clavicle to the anterior medial portion of the acromial process.

Ready Position: Full adduction

Parts Needed

Dynamometer: Shoulder / Elbow Adapter (remove cuff), Shoulder Attachment

Positioning Chair: Footrest (optional)

SHOULDER: ABDUCTION/ADDUCTION (SEATED)

The shoulder complex is made up of multiple linkages. These include the glenohumeral joint, acromioclavicular joint, sternoclavicular joint, and scapulothoracic articulation. The glenohumeral joint is the most mobile joint in the body with global freedom. Because of this, stability is sacrificed. Only a little more than 1/3 of the head of the humerus makes contact with the glenoid fossa at any one time.

Abduction/adduction is usually one of the last motions exercised in rehabilitation of the shoulder. The clinician must exercise great care in order to avoid impingement.

Setup and Positioning

(Starting Movement: Away/Abduction)

NOTE: This pattern may be accomplished with the seatback reclined to any position which provides for both patient comfort and proper alignment of the anatomical axis. The seatback and dynamometer tilt must, however, be set to the same angle.

1. Seat patient on chair.
2. Attach Shoulder/Elbow Adapter to dynamometer (remove cuff). Insert Shoulder Attachment into Adapter.
3. Align Shaft red dot with R or L and move attachment to almost full abduction. Press Hold.
4. Rotate chair to 90 degrees.
5. Rotate dynamometer to 0 degrees.
6. Raise dynamometer.
7. Tilt dynamometer to 10 degrees.
8. Move patient into position (patient is facing away from dynamometer). Slide dynamometer along travel to align axis of rotation.
9. Check for proper ROM. Keep handgrip loose during motion to allow for the compromising positions of the glenoid humeral joint as it goes through the motions.
10. Stabilize patient with shoulder and waist straps.
11. Set ROM stops.

Opposite Side

1. With patient remaining in chair, slide chair back away from dynamometer.
2. Remove attachment and rotate it 180 degrees opposite. Align Shaft red dot with R or L.
3. Move attachment to almost full abduction. Press Hold.
4. Rotate chair to opposite 90 degrees.
5. Move dynamometer to opposite position. Dynamometer orientation remains at 0 degrees.
6. Move patient into position (patient is facing away from dynamometer). Slide dynamometer along travel to align axis of rotation.
7. Check for proper ROM. Keep handgrip loose during motion to allow for the compromising positions of the glenoid humeral joint as it goes through the motions.
8. Stabilize patient with shoulder and waist straps.
9. Reset ROM stops.

Clinical Applications of Biodex Operating Modes

Isokinetic Mode

1. The isokinetic mode may be used at bi-directional velocities to stress either the abductors or adductors (i.e., in early rotator cuff rehabilitation, the focus may be placed on the adductors). The adductors may be worked at low speeds concentrically and the abductors at higher speeds concentrically. Set limits as appropriate.

Passive Mode

1. The passive mode may be used initially for the benefits of continuous passive motion. This is especially important post-surgically. It has been suggested that early re-establishment of neural pathways without over-stressing an inflamed capsule is essential.
2. The passive mode may be used to work the adductors early in the rehabilitation, both concentrically and eccentrically. Conversely, the abductors may be stressed in the same way later in rehabilitation.

Isometric Mode

1. Multi-angle isometrics may be performed (i.e., with adhesive capsulitis, subjects who perform an isometric contraction at the end of the range, will develop strength gains in a greater range due to the overflow principle.

Isotonic

1. Set torque limits accordingly to ensure adequate force production throughout the ROM.

Reactive Eccentric Mode

1. The eccentric mode may be used to perform submaximal eccentrics especially in cases of tendinitis.

Additional Comments

1. The pause may be used at end range simply to focus on that portion of the range.
2. The limit set buttons and/or percent range dials, may be used in subjects with impingement syndrome to limit the range of motion to 90 degrees or less.
3. It has been recommended in some cases that a strong supraspinatus contraction be present in the first 30 degrees of motion before other strengthening may begin.
4. It has been suggested that strengthening the abductors is very important in the rehabilitation of acromioclavicular separations.
5. It has been suggested that the force of the abducting musculature is very important in establishing equilibrium at the glenohumeral joint and that the supraspinatus helps prevent downward dislocation of the humerus.
6. It has been stated that the long head of the biceps may act as an accessory shoulder abductor if the glenohumeral joint is externally rotated.
7. For alternate positioning, the seat and dynamometer can be positioned at any 15° of rotation.

SHOULDER: EXTERNAL/INTERNAL ROTATION IN THE MODIFIED NEUTRAL POSITION (SEATED)



Figure 3.22.



Figure 3.23.

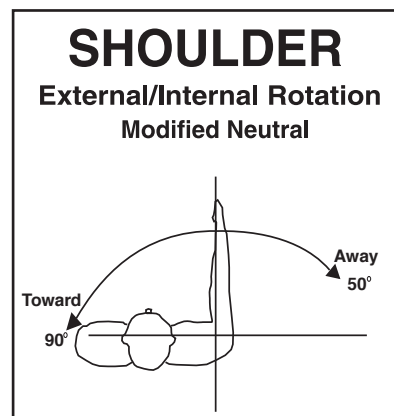


Figure 3.24.

Quick Reference

Dynamometer Orientation:	20°
Dynamometer Tilt:	50°
Seat Orientation:	0°
Seatback Tilt:	55 - 85°
Axis of Rotation:	Axis alignment is longitudinal through the head of the shaft of the humerus in a horizontal plane.
Ready Position:	Full Internal Rotation

Parts Needed

Dynamometer:	Elbow/Shoulder Attachment with Cuff
Positioning Chair:	Footrest (optional)

SHOULDER: EXTERNAL/INTERNAL ROTATION IN THE MODIFIED NEUTRAL POSITION (SEATED)

The rotator cuff is one of the most important structures in maintaining the integrity of the shoulder complex. The stability of the glenohumeral joint depends largely on an intact and functioning rotator cuff. A strong rotator cuff is especially important for a balanced and smooth movement of the upper extremity.

There are several different positions available to set up a subject for testing or rehabilitation of the internal/external rotation movement. Two are presented in this manual: the modified neutral position and shoulder internal/external rotation in 90° of abduction.

Setup and Positioning

(Starting Movement: Away/External Rotation)

NOTE: Attachment must be reversed for Right to Left. Align shaft dot with R or L.

1. Seat patient on chair.
2. Rotate chair to 0 degrees.
3. Rotate dynamometer to 20 degrees.
4. Tilt dynamometer to 50 degrees.
5. Attach Elbow / Shoulder attachment. Align shaft dot with R or L. Secure with locking knob.
6. Move patient into position
7. Raise dynamometer to align patient axis of rotation. If needed, raise chair or adjust seat back tilt to accommodate various patient sizes.
8. Stabilize patient with shoulder, waist and thigh straps.
9. Set ROM stops.

Opposite side.

1. With patient remaining in chair, slide chair back away from dynamometer.
2. Rotate chair to 0 degrees on opposite side.
3. Rotate dynamometer to 20 degrees on opposite side.
4. Remove attachment and rotate it 180 degrees opposite.
5. Reattach Shoulder / Elbow attachment to dynamometer and align shaft dot with R or L. Secure with locking knob.
6. Move chair and patient into position.
7. Adjust dynamometer to align patient axis of rotation. If needed raise chair or adjust seat back tilt to accommodate various patient sizes.
8. Stabilize patient with shoulder, waist and thigh straps.
9. Reset ROM stops.

Clinical Applications of Biodex Operating Modes

Isokinetic Mode

1. The isokinetic mode may be used at bi-directional velocities to stress either the internal rotators or the external rotators. This mode may also be used to replicate function (i.e., the athlete may work the external rotators at lower speeds and the internal rotators at higher speeds to replicate the throwing motion.)

Passive Mode

1. The passive mode may be used initially for the benefits of continuous passive motion. This is especially important post-surgically. Many clinicians are using this early on post arthroscopic surgery.
2. The passive mode may be used to work one muscle group both concentrically and eccentrically, (i.e., after an anterior shoulder dislocation, the internal rotators may be worked both concentrically and eccentrically through a limited range. With a tear in the posterior rotator cuff, the internal rotators may also be stressed initially in this way).

Isometric Mode

1. Multi-angle isometrics may be performed early in the rehabilitation process or to work near painful points in the ROM. In this way, strength gains will be made through a portion of the unworked range.

Isotonic

1. Set torque accordingly (internal rotation high, external rotation low).
2. To increase speed of movement, set torque limits lower.

Reactive Eccentric Mode

1. The eccentric mode may be used to perform submaximal eccentrics for the diagnosis of tendinitis (i.e., this technique may be used in cases of supraspinatus tendinitis).

Additional Comments

1. Subjects with impingement syndrome may best be worked in the modified neutral position and not 90 degrees of abduction.
2. A subject may be started in the modified neutral position and be worked into increasing degrees of abduction as tolerated.
3. Athletes, especially pitchers, may be worked at the 90 degree abduction position and full external rotation since this is a functional position for this group.
4. It has been found that the posterior cuff muscles act to decelerate the arm motion eccentrically during the follow-through phase of throwing. This eccentric motion may be simulated on the Biodex.
5. Some clinicians have thought of impingement syndrome as an ineffective action of the rotator cuff musculature. Use the eccentric mode to work on control.
6. As the glenohumeral joint is externally rotated, the anterior capsule undergoes a wringing which may cause an inflammatory response in the capsule. External rotation may initially be limited with ROM stop buttons or percent dials to prevent this.

SHOULDER: EXTERNAL/INTERNAL ROTATION IN 90° OF ABDUCTION



Figure 3.25.

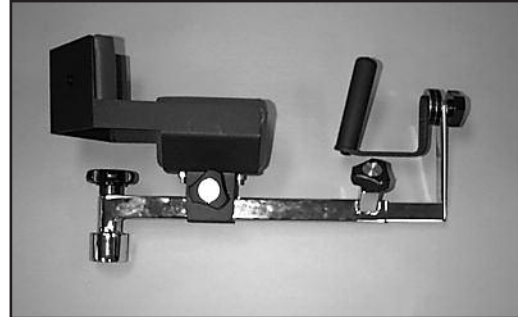


Figure 3.26.

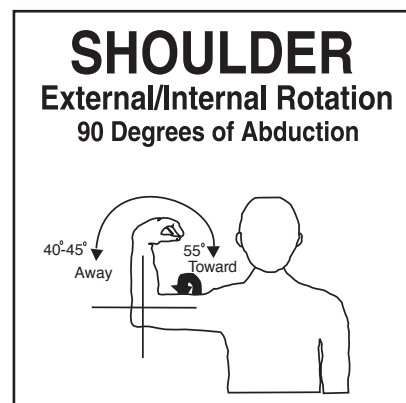


Figure 3.27.

Quick Reference

Dynamometer Orientation:	0°
Dynamometer Tilt:	5°
Seat Orientation:	0°
Seatback Tilt:	55 - 85°
Axis of Rotation:	Axis alignment is longitudinal through the head of the shaft of the humerus in a horizontal plane.
Ready Position:	Full Internal Rotation

Parts Needed

Dynamometer:	Elbow/Shoulder Attachment
Positioning Chair:	Footrest (optional)

SHOULDER: EXTERNAL/INTERNAL ROTATION IN 90° OF ABDUCTION

The rotator cuff is one of the most important structures in maintaining the integrity of the shoulder complex. The stability of the glenohumeral joint depends largely on an intact and functioning rotator cuff. A strong rotator cuff is especially important for a balanced and smooth movement of the upper extremity.

There are several different positions available to set up a subject for testing or rehabilitation of the internal/external rotation movement. The setup for this pattern in 90° of abduction is as follows.

Setup and Positioning

(Starting Movement: Away/External Rotation)

NOTE: Attachment must be reversed for Right to Left. Align shaft dot with R or L.

1. Seat patient on chair.
2. Attach Elbow/Shoulder attachment. Align shaft dot with R or L. Secure with locking knob.
3. Tilt dynamometer to 5 degrees.
4. Rotate dynamometer to 0 degrees.
5. Rotate chair to 0 degrees.
6. Move dynamometer along travel to align axis.
7. Tilt seat back to 55 - 85 degrees. If needed, lower seat or adjust seat back tilt to accommodate various patient sizes.
8. Move patient into position and raise dynamometer to align patient axis of rotation.
9. Stabilize patient with shoulder and thigh straps.
10. Set ROM stops.

Opposite Side

1. Press Hold.
2. With patient remaining in chair, move seat away from dynamometer.
3. Remove attachment and align shaft dot with R or L. Shaft will have to rotate 180 degrees.
4. Place attachment back onto shaft, secure with locking knob.
5. Slide dynamometer to opposite side.
6. Rotate chair to 0 degrees opposite position.
7. Move patient into position. Raise dynamometer to align patient axis of rotation.
8. Tilt seat back to 55 - 85 degrees. If needed, lower seat or adjust seat back tilt to accommodate various patient sizes.
9. Stabilize patient with shoulder and thigh straps.
10. Reset ROM stops.

Clinical Applications of Biodex Operating Modes

Isokinetic Mode

1. The isokinetic mode may be used at bi-directional velocities to stress either the internal rotators or the external rotators. This mode may also be used to replicate function (i.e., the athlete may work the external rotators at lower speeds and the internal rotators at higher speeds to replicate the throwing motion.)

Passive Mode

1. The passive mode may be used initially for the benefits of continuous passive motion. This is especially important post-surgically. Many clinicians are using this mode one day post-op after arthroscopic surgery.
2. The passive mode may be used to work one muscle group both concentrically and eccentrically, (i.e., after an anterior shoulder dislocation, the internal rotators may be worked both concentrically and eccentrically through a limited range. With a tear in the posterior rotator cuff, the internal rotators may also be stressed initially in this way).

Isometric Mode

1. Multi-angle isometrics may be performed early in the rehabilitation process or to work near painful points in the ROM. In this way, strength gains will be made through a portion of the unworked range.

Isotonic

1. To increase speed of movement, set torque limits lower.
2. Set torque accordingly (internal rotation high, external rotation low).

Reactive Eccentric Mode

1. The eccentric mode may be used to perform submaximal eccentrics for the diagnosis of tendinitis (i.e., this technique may be used in cases of supraspinatus tendinitis).

Additional Comments

1. Subjects with impingement syndrome may best be worked in the modified neutral position and not 90 degrees of abduction.
2. A subject may be started in the modified neutral position and be worked into increasing degrees of abduction as tolerated.
3. Athletes, especially pitchers, may be worked at the 90 degree abduction position and full external rotation since this is a functional position for this group.
4. It has been found that the posterior cuff muscles act to decelerate the arm motion eccentrically during the follow-through phase of throwing. This eccentric motion may be simulated on the Biodex.
5. Some clinicians have thought of impingement syndrome as an ineffective action of the rotator cuff musculature. Use the eccentric mode to work on control.
6. As the glenohumeral joint is externally rotated, the anterior capsule undergoes a wringing which may cause an inflammatory response in the capsule. External rotation may initially be limited with ROM stop buttons or percent dials to prevent this.

SHOULDER: DIAGONAL (SEATED)



Figure 3.28.

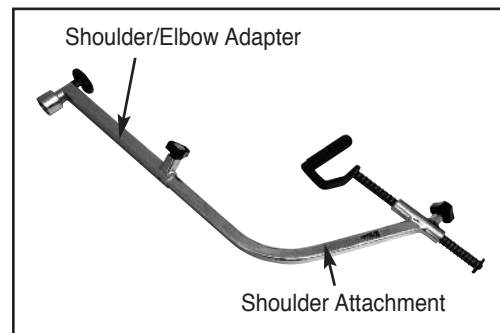


Figure 3.29

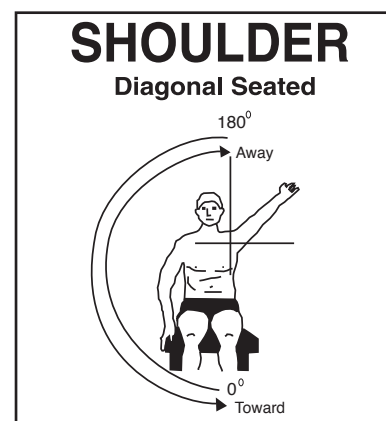


Figure 3.30.

Quick Reference

Dynamometer Orientation:	30°
Dynamometer Tilt:	10 - 35°
Seat Orientation:	0°
Seatback Tilt:	85°
Axis of Rotation:	Off axis through the glenohumeral joint.
Ready Position:	Full Extension

Parts Needed

Dynamometer:	Shoulder / Elbow Adapter (remove cuff), Shoulder Attachment
Positioning Chair:	Footrest (optional)

SHOULDER: DIAGONAL (SEATED)

Setup and Positioning

(Starting Movement: Away/Flexion)

1. Seat patient on chair
2. Attach Shoulder / Elbow Adapter to dynamometer (remove cuff). Insert Shoulder Attachment into Adapter.
3. Align Shaft red dot with R or L. Move attachment to an upright position. Press Hold.
4. Rotate chair to 0 degrees.
5. Rotate dynamometer to 30 degrees.
6. Tilt dynamometer 10 - 35 degrees. Increase or decrease the amount of horizontal abduction by varying the dynamometer height and tilt. A lower dynamometer requires more tilt, which increases abduction.
7. Move patient into position. Slide dynamometer along travel to align patient axis of rotation. Seat back can be tilted to accommodate various size patients.
8. Check for proper ROM. Keep handgrip loose during motion to allow for the compromising positions of the glenoid humeral joint as it goes through the motions.
9. Stabilize patient with shoulder, waist and thigh straps.
10. Set ROM stops.

Opposite Side

1. With patient remaining in chair, slide chair back away from dynamometer.
2. Remove attachment and rotate 180 degrees opposite. Align Shaft red dot with R or L and reattach Shoulder attachment.
3. Move attachment to an upright position. Press Hold.
4. Rotate dynamometer to opposite 30 degrees.
5. Tilt to 10-35 degrees. Increase or decrease the amount of horizontal abduction by varying the dynamometer height and tilt. A lower dynamometer requires more tilt, which increases abduction.
6. Rotate chair to opposite 0 degrees.
7. Move patient into position. Slide dynamometer along travel to align patient axis of rotation. Seat back can be tilted to accommodate various size patients.
8. Check for proper ROM. Keep handgrip loose during motion to allow for the compromising positions of the glenoid humeral joint as it goes through the motions.
9. Stabilize patient with shoulder, waist and thigh straps.
10. Reset ROM stops.

Clinical Applications of Biodex Operating Modes

Isokinetic Mode

1. Seat patient to isolate the muscular surrounding the shoulder responsible for Glenohumeral stabilization.
2. Stand patient to become more functional in the throwing pattern.
3. To isolate the D2 flexors, set select ecc/con. Vary speeds accordingly.

Passive Mode

1. Have patient work with the system in active assist fashion.
2. Have patient light the Force Away indicator at all times to work the D2 flexors.

Isometric

1. Multi-angle isometrics may be performed early in the rehabilitation process or to work near painful points in the ROM. In this way, strength gains will be made through a portion of the unworked range.

Isotonic

1. The Isotonic mode can be utilized to ensure a proper force limit is achieved.

Reactive Eccentric

1. For neuromuscular re-education, vary torque limits and have patient apply the “correct” force to ensure proper attachment movement (to challenge the patient, make various changes to torque limits without patient knowledge - but ensure that correct movement occurs.)

SHOULDER: DIAGONAL (STANDING)

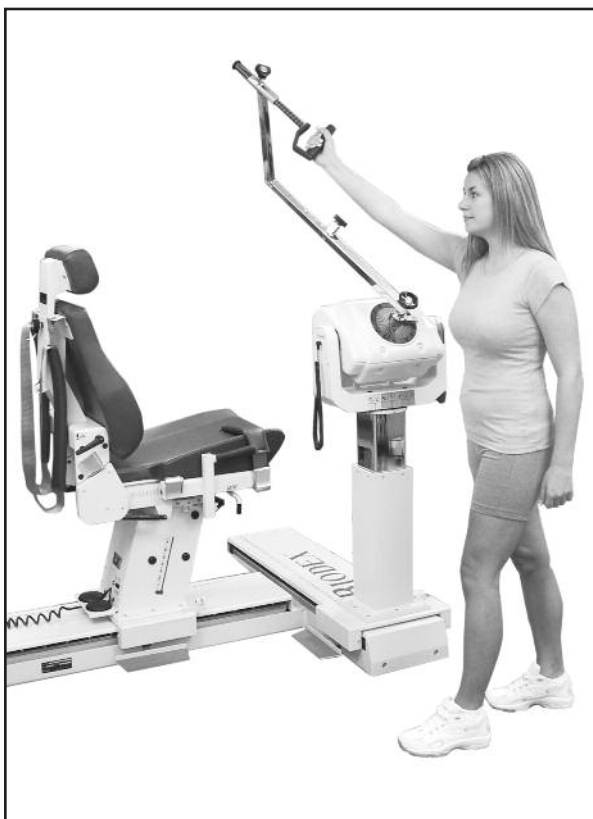


Figure 3.31

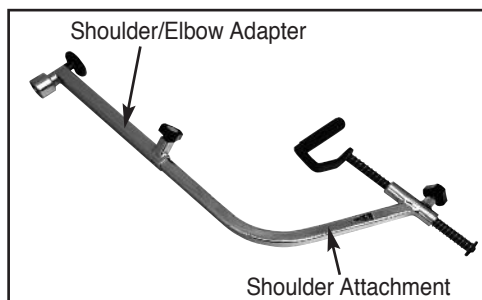


Figure 3.32.

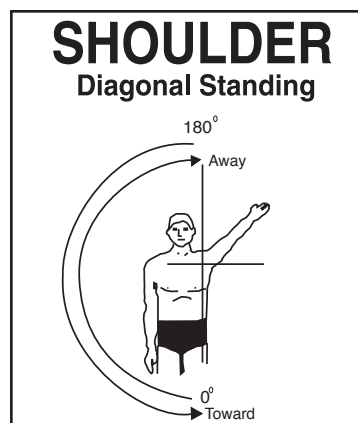


Figure 3.33.

Quick Reference

Dynamometer Orientation: 35°

Dynamometer Tilt: 10 - 35°

Axis of Rotation: Off axis through the glenohumeral joint.

Ready Position: Full Extension

Parts Needed

Dynamometer: Shoulder/Elbow Adapter (remove cuff), Shoulder Attachment

SHOULDER: DIAGONAL (STANDING)

Setup and Positioning

(Starting Movement: Away/Flexion)

1. Attach Shoulder / Elbow Adapter to dynamometer (remove cuff). Insert Shoulder Attachment into Adapter.
2. Tilt dynamometer to 10 - 35 degrees. Increase or decrease the amount of horizontal abduction by varying the dynamometer height and tilt. A lower dynamometer requires more tilt, which increases abduction.
3. Rotate dynamometer to 35 degrees.
4. Have patient stand perpendicular to dynamometer.
5. Align Shaft red dot with R or L. Move attachment to an upright position. Press Hold.
6. Align axis of rotation.
7. Check for proper ROM. Keep handgrip loose during motion to allow for the compromising positions of the glenoid humeral joint as it goes through the motions.
8. Set ROM stops.

Opposite Side

1. Remove attachment and rotate it 180 degrees opposite. Align Shaft red dot with R or L and reattach.
2. Move attachment to an upright position. Press Hold
3. Have patient face opposite way and grasp handgrip.
4. Align axis of rotation (glenohumeral joint).
5. Check for proper ROM. Keep handgrip loose during motion to allow for the compromising positions of the glenohumeral joint as it goes through the motions.
6. Reset ROM stops.

Clinical Applications of Biodex Operating Modes

Isokinetic Mode

1. Seat patient to isolate the muscular surrounding the shoulder responsible for Glenohumeral stabilization.
2. Stand patient to become more functional in the throwing pattern.
3. To isolate the D2 flexors, set select ecc/con. Vary speeds accordingly.

Passive Mode

1. Have patient work with the system in active assist fashion.
2. Have patient light the Force Away indicator at all times to work the D2 flexors.

Isometric

1. Multi-angle isometrics may be performed early in the rehabilitation process or to work near painful points in the ROM. In this way, strength gains will be made through a portion of the unworked range.

Isotonic

1. The Isotonic mode can be utilized to ensure a proper force limit is achieved.

Reactive Eccentric

1. For neuromuscular re-education, vary torque limits and have patient apply the “correct” force to ensure proper attachment movement (to challenge the patient, make various changes to torque limits without patient knowledge - but ensure that correct movement occurs.

ELBOW: EXTENSION/FLEXION (SEATED)



Figure 3.34

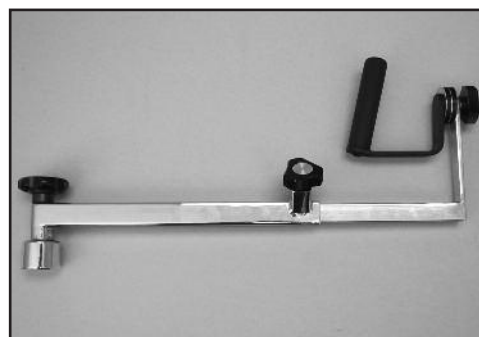


Figure 3.35.

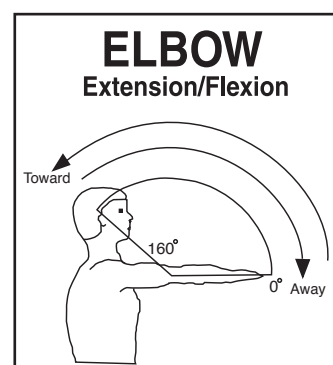


Figure 3.36.

Quick Reference

Dynamometer Orientation:	30°
Dynamometer Tilt:	0°
Positioning Chair Orientation:	0°
Seatback Tilt:	85°
Axis of Rotation:	Passes through the center of the trochlea and the capitulum, bisecting the longitudinal axis of the shaft of the humerus.
Ready Position:	Full Flexion

Parts Needed

Dynamometer:	Elbow / Shoulder Attachment
Positioning Chair:	Limb-Support Pad, Footrest (optional)

ELBOW: EXTENSION/FLEXION

The elbow joint consists of the articulation between the trochlea of the humerus and the trochlear notch of the ulna, the capitulum of the humerus and the facet on the head of the radius and the circumference of the head of the radius and the radial notch of the ulna. Any bony malalignment (such as a fracture) interferes with the critical angles of these articulations making normal movement impossible.

Of special note at the elbow are the tendinous origins of the wrist musculature. The flexor/pronator muscles of the wrist originate at the medial epicondyle of the humerus and wrist extensor group at the lateral epicondyle. These are areas that frequently become inflamed with overuse.

Setup and Positioning

(Starting Movement: Away/Extension)

1. Seat patient on chair
2. Place Elbow/Shoulder attachment onto shaft (remove cuff). Align shaft dot with either R or L. Bring attachment to vertical. Press Hold.
3. Install limb support (angled toward patient) in chair side receiving tube for side to be tested or exercised.
4. Rest elbow on limb support. Limb support pad should be angled back with pad angled slightly downward, allowing full extension. Securing strap may not be necessary.
5. Rotate chair to 0 degrees.
6. Rotate dynamometer to 30 degrees.
7. Tilt dynamometer to 0 degrees.
8. Move patient into position. Slide dynamometer along travel and raise to align axis of rotation.
9. Stabilize patient with shoulder, waist and thigh straps.
10. Allow handgrip to rotate as patient goes through motion.
11. Set ROM Stops.

Opposite Side

1. Press Hold.
2. Unstrap patient from support pad. With patient remaining in chair, slide chair back away from dynamometer.
3. Place limb support in opposite side chair receiving tube.
4. Remove attachment and rotate it 180 degrees opposite. Align shaft dot with R or L. Place attachment back onto shaft and secure with locking knob.
5. Rotate dynamometer to 30 degrees on opposite side.
6. Rotate chair to 0 degrees on opposite side.
7. Move patient into position. Slide dynamometer along travel to align axis of rotation.
8. Allow handgrip to rotate as patient goes through motion.
9. Stabilize patient with shoulder, waist and thigh straps.
10. Reset ROM stops

Clinical Applications of Biodex Operating Modes

Isokinetic Mode

1. The isokinetic mode may be used to work the elbow bi-directionally. In this way job specific tasks, functional tasks, or sports activities may be simulated.

Passive Mode

1. The passive mode may be used to treat inflammatory conditions of the elbow. Many times when rest is recommended it does not mean total immobilization but the elimination of activities that cause pain. The passive mode may be used for the effects of continuous passive motion.
2. The passive mode may be used to perform non-reciprocal contractions, e.g., working the extensors at the end range of motion both concentrically and eccentrically, as it is not uncommon for elbow extension to be compromised after injury or fracture.

Isometric Mode

1. Isometrics may be used when pain or inflammation is a concern. Multi-angle isometrics are recommended.

Isotonic Mode

1. To simulate a functional activity, set the isotonic force accordingly to a patient task.
2. Perform eccentric / concentric movements to do biceps-only exercise.

Reactive Eccentric Mode

1. The eccentric mode may be used to simulate job specific tasks, e.g., the eccentric mode may be used to work the elbow flexors, eccentrically as if the worker were lowering a heavy box.

Additional Comments

1. It has been recommended by some clinicians that the dominant arm should be 5% stronger than the non-dominant arm in recreational athletes and 10% stronger in competitive athletes.
2. Ice may be applied to the site of the lesion while the patient is in the passive mode for approximately fifteen minutes.
3. For cases of capsular tightness. Place the patient in the passive mode. Red range of motion limit set buttons may be set to encompass a slightly greater range of motion than the patient currently is capable of moving. The percent range settings should be reduced to 55% and the patient should be placed on the unit. Slowly and with caution, the percent ROM dials should be turned up. *NEVER EXCEED A COMFORTABLE OR PHYSIOLOGICAL RANGE OF MOTION. ALWAYS HAVE THE COMFORT STOP AVAILABLE.* The pause may also be used for a passive stretch at end range.
4. The elbow is frequently injured by the repeated application of stresses. Throwing injuries commonly occur secondary to throwing too frequently and throwing repeatedly at maximum force. These injuries may be treated by working either passively, isokinetically, or eccentrically at submaximal levels.
5. Position the handgrip to concentrate on specific muscle groups. If desired, keep the handgrip loose to obtain active supination or pronation.

FOREARM: SUPINATION/PRONATION



Figure 3.37.

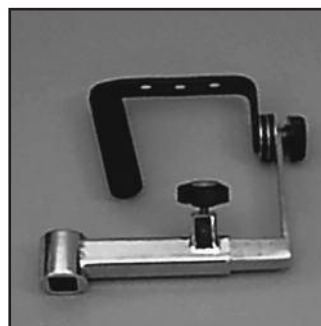


Figure 3.38.

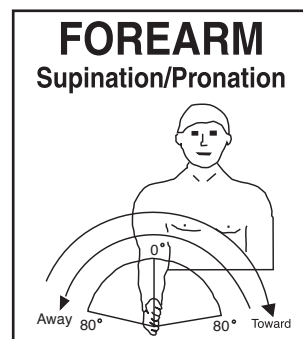


Figure 3.39.

Quick Reference

Dynamometer Orientation:	0°
Dynamometer Tilt:	5° (shaft down)
Seat Orientation:	90°
Seatback Tilt:	85°
Elbow Flexion:	90°
Axis of Rotation:	Axis of rotation for this pattern is the longitudinal line through the center of the head of the radius proximally, and through the center of the head of the ulna distally.
Ready Position:	Full Pronation

Parts Needed

Dynamometer:	Wrist Attachment
Positioning Chair:	Limb-Support Pad, Footrest (optional)

FOREARM: SUPINATION/PRONATION

Pronation and supination occur when the forearm rotates around a longitudinal axis passing through the head of the radius and center of the distal ulna. During pronation/supination, the radial head articulates with the capitellum of the humerus and the radial notch of the ulna. Distally the radius and articular disc of the distal radioulnar joint articulates with the scaphoid, lunate and triquetrum. The radius carries the wrist about the ulna during pronation and supination. Pronation/supination may be a particularly difficult motion to fully achieve after injury secondary to the complex nature of the movement.

Setup and Positioning

(Starting Movement: Away/Supination)

NOTE: Right and Left use same dot orientation for this pattern.

1. Seat patient on chair.
2. Install limb support (angled away from patient) in chair side receiving tube for side to be tested or exercised.
3. Attach Wrist attachment to dynamometer. Align shaft red dot with R L. Handgrip orientation should be up.
4. Rotate Chair to 90 degrees.
5. Slide dynamometer along travel to align patient with axis of rotation. Raise dynamometer, if necessary.
6. Rotate dynamometer to 0 degrees.
7. Move patient into position.
8. Tilt dynamometer to 5 degrees (shaft down).
9. Stabilize patient with shoulder and waist straps.
10. Set ROM stops.

Opposite Side

1. With patient remaining in chair, slide chair back away from dynamometer.
2. Move limb support to opposite side chair receiving tube.
3. Rotate attachment (do not remove) to horizontal. Rotate handgrip to angle up. Press Hold.
4. Slide dynamometer to opposite side.
5. Move patient into position and align axis of rotation.
6. Stabilize patient with shoulder and waist straps.
7. Reset ROM stops.

Clinical Applications of Biodex Operating Modes:

Isokinetic Mode

1. The isokinetic mode may be used at bi-directional velocities in order to simulate functional or sports activities.

Passive Mode

1. The passive mode is important for the effects of continuous passive motion. The passive mode may be used to initiate treatment of reflex sympathetic dystrophy.
2. The passive mode may be used to work a specific muscle group both concentrically and eccentrically, e.g., after a colles fracture, supination may be limited secondary to immobilization. The supinators may be worked both concentrically and eccentrically to gain motion and increase strength.

Isometric Mode

1. The isometric mode may be used to strengthen musculature when pain, instability or surgery is a factor.

Isotonic Mode

1. To simulate a functional activity, set the isotonic force accordingly to a patient task.

Reactive Eccentric Mode

1. The eccentric mode may be used to strengthen the musculotendinous junction. This may be important since the wrist is frequently used eccentrically during functional activities.

Additional Comments

1. At certain times, full range of motion may never be achieved, e.g., if in a colles fracture the distal radial fragment moves toward supination, there may be a permanent loss of pronation.
2. With involvement of the wrist, be careful of shoulder-hand syndrome. Be sure to mobilize the entire upper extremity.
3. If edema is a concern, the dynamometer and multi-support fixture may be raised during rehabilitation.

WRIST: EXTENSION/FLEXION



Figure 3.40.

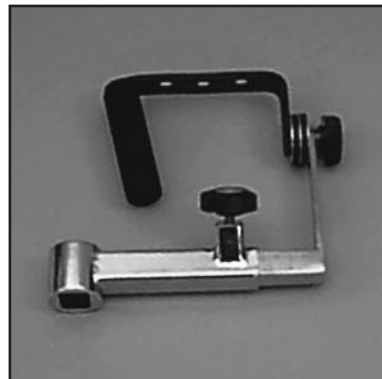


Figure 3.41.

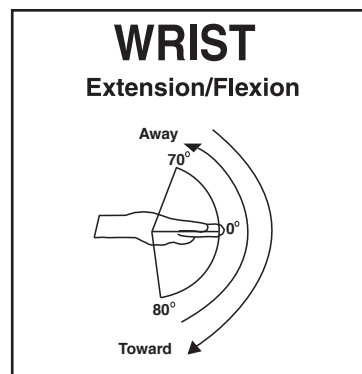


Figure 3.42.

Quick Reference

Dynamometer Orientation: 0°

Dynamometer Tilt: 0°

Seat Orientation: 0°

Seatback Tilt: 85°

Elbow Flexion: 90°

Axis of Rotation: Axis of rotation for this pattern lies between the proximal row of the carpals, at the capitate bone, and the radius at the radiocarpal joint.

Ready Position: Full Flexion

Parts Needed

Dynamometer: Wrist Attachment

Positioning Chair: Limb-Support Pad, Footrest (optional)

WRIST: EXTENSION/FLEXION

The wrist joint consists of the distal end of the radius and the articular disc of the distal radioulnar joint articulate with the proximal row of carpal bones (scaphoid, lunate, and triquetrum.) The carpal bones form a much larger surface than do the radius and the articular cartilage. This allows for adduction/abduction, flexion/extension and circumduction to occur. Movement also occurs between the proximal and distal row of carpal bones. The midcarpal joint adds considerably to flexion and extension of the wrist.

Setup and Positioning

(Starting Movement: Away/Extension)

NOTE: Right and left side use same dot orientation for this pattern.

1. Seat patient on chair.
2. Install limb support (angled away from patient) in chair side receiving tube.
3. Attach Wrist attachment to dynamometer. Align shaft red dot with R L. Handgrip orientation is horizontal to floor.
4. Rotate dynamometer to 0 degrees.
5. Rotate chair to 0 degrees.
6. Set dynamometer tilt to 0 degrees.
7. Move patient into position. Slide dynamometer in front of patient's wrist to be exercised or tested.
8. Align patient's axis of rotation.
9. Stabilize patient with shoulder and waist straps.
10. Set ROM Stops.

Opposite Side

1. With patient remaining in chair, slide chair back away from dynamometer.
2. Move limb support to opposite chair side receiving tube.
3. Rotate Wrist attachment to horizontal (do not remove). Press Hold.
4. Rotate chair to opposite 0 degrees setting.
5. Slide dynamometer to opposite side.
6. Move patient into position.
7. Align axis of rotation.
8. Stabilize patient with shoulder and waist straps.
9. Reset ROM Stops.

Clinical Applications of Biodex Operating Modes

Isokinetic Mode

1. The isokinetic mode may be used bi-directionally to emphasize one particular muscle group, e.g., in cases of golfer's elbow where there is involvement of the flexor tendon at the elbow, the wrist flexors may be worked at low speeds and the extensors at high speeds.

Passive Mode

1. The passive mode may be used for continuous passive motion effects. It may also be used to maintain/increase range of motion, e.g., this is especially important in a colles fracture when regaining range of motion is most difficult.
2. The passive mode may be used in cases of reflex sympathetic dystrophy which frequently develops in conjunction with a colles fracture. These patients may receive sympathetic blocks followed by mobilization and range of motion. The patient may move passively at first and, as tolerated, begin to assist the motion in each direction.
3. The passive mode may be used to work non-reciprocally. In this way the wrist, both muscle groups or one muscle group may be exercised concentrically/eccentrically or vice versa, e.g., in cases of tennis elbow with involvement of the common extensor tendon at the elbow, the wrist extensors may be worked concentrically/eccentrically by having the patient assist wrist extension and resist wrist flexion.

Isometric Mode

1. Isometrics may be used after periods of immobilization or surgery. Isometrics may be used to strengthen musculature after very delicate surgical procedures, e.g., isometrics may be the first step in treating a scapholunate advanced collapse wrist.

Isotonic Mode

1. To simulate a functional activity, set the isotonic force accordingly to a patient task.

Reactive Eccentric Mode

1. The eccentric mode may be used to simulate functional activities. Sub-maximal eccentrics have been used successfully to treat tendinitis.

Additional Comments

1. Whenever there is wrist involvement, it is important to examine shoulder and elbow movements. If there is immobility in these areas, the passive mode may be used to improve ROM.
2. Wrist flexion and extension exercises are frequently performed with the forearm pronated because tests have demonstrated that a greater mean torque can be produced than when in supination.
3. Use of the work tools may be an important adjunct in returning a patient to work.

WRIST: RADIAL/ULNAR DEVIATION



Figure 3.43.

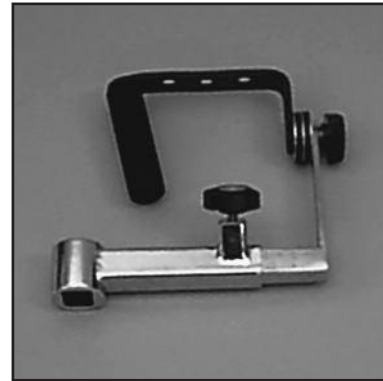


Figure 3.44.

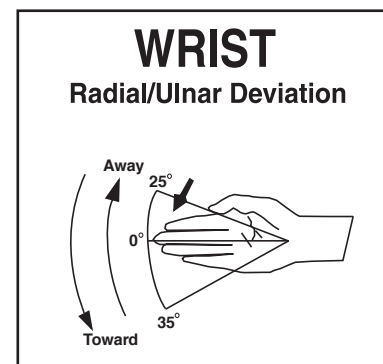


Figure 3.45.

Quick Reference

Dynamometer Orientation:	0°
Dynamometer Tilt:	0°
Seat Orientation:	0°
Seatback Tilt:	85°
Elbow Flexion:	90°
Axis of Rotation:	Axis of rotation for this pattern is at approximate center of capitate bone if viewed from the palmar surface of the hand.
Ready Position:	Full Ulnar Deviation

Parts Needed

Dynamometer:	Wrist Attachment
Positioning Chair:	Limb-Support Pad, Footrest (optional)

Wrist: Radial/Ulnar

Radial/Ulnar deviation involves radiocarpal and midcarpal movement. Ulnar deviation occurs over a greater ROM than radial deviation. Radial deviation is limited by bony contact of the scaphoid tubercle against the radial styloid.

Setup and Positioning

(Starting Movement: Away/Radial Deviation)

NOTE: Right and left side use same dot orientation for this pattern.

1. Seat patient on chair.
2. Install limb support (angled away from patient) in chair side receiving tube.
3. Attach Wrist attachment to dynamometer. Align shaft dot with R L. Handgrip orientation is up.
4. Rotate dynamometer to 0 degrees.
5. Rotate chair to 0 degrees.
6. Set dynamometer tilt to 0 degrees.
7. Move patient into position. Slide dynamometer in front of patient's wrist to be exercised or tested.
8. Slide dynamometer along travel to align axis of rotation. Raise dynamometer, if necessary.
9. Stabilize patient with shoulder and waist straps.
10. Set ROM Stops.

Opposite Side

1. With patient remaining in chair, slide chair back away from dynamometer.
2. Move limb support to opposite side of chair.
3. Rotate Wrist attachment so handgrip faces up (do not remove). Press Hold.
4. Slide dynamometer to opposite side.
5. Rotate chair to opposite 0 degrees setting.
6. Set dynamometer tilt to 0 degrees.
7. Move patient into position.
8. Align axis of rotation.
9. Stabilize patient with shoulder and waist straps.
10. Reset ROM Stops.

Clinical Applications of Biodex Operating Modes

Isokinetic Mode

1. The isokinetic mode may be used at bi-directional velocities to simulate function or to emphasize one particular muscle group.

Passive Mode

1. The passive mode may be used post-surgically in order to gain range of motion. e.g. After surgery to correct a scapholunate advanced collapse, place the patient in the passive mode at the range available and gradually increase as warranted.
2. The passive mode may be used to perform concentric/concentric, concentric/eccentric, eccentric/concentric, and eccentric/eccentric contraction types. It is important to perform multiple contraction types when rehabilitating the wrist since the hand performs such a wide variety of functional tasks.

Isometric Mode

1. Isometrics may be used after delicate surgical procedures or when instability is a concern. The physician and therapist's expertise and the type of surgery that has been performed must be taken into account when beginning any form of exercise.

Isotonic Mode

1. To simulate a functional activity, set the isotonic force accordingly to a patient task.

Reactive Eccentric Mode

1. The eccentric mode may be used to perform submaximal eccentrics or to simulate functional activities.

Additional Comments

1. Swelling may be a concern when exercising the wrist and hand. If so, the multi-support fixture and dynamometer may be raised to keep the hand above the level of the heart.
2. At times, there may be situations where full range of motion cannot be achieved. In a colles fracture, secondary to malalignment during healing, there may be a permanent loss in ulnar deviation. In this case, it is important to work on motions that may have been limited during immobilization such as ulnar deviation.
3. Whenever the wrist is involved, it is important to evaluate the entire upper extremity for lack of mobility and then treat accordingly.

4. USING THE OPTIONAL CLOSED CHAIN ATTACHMENT

PARTS AND COMPONENTS

(See Figure 4.1.)

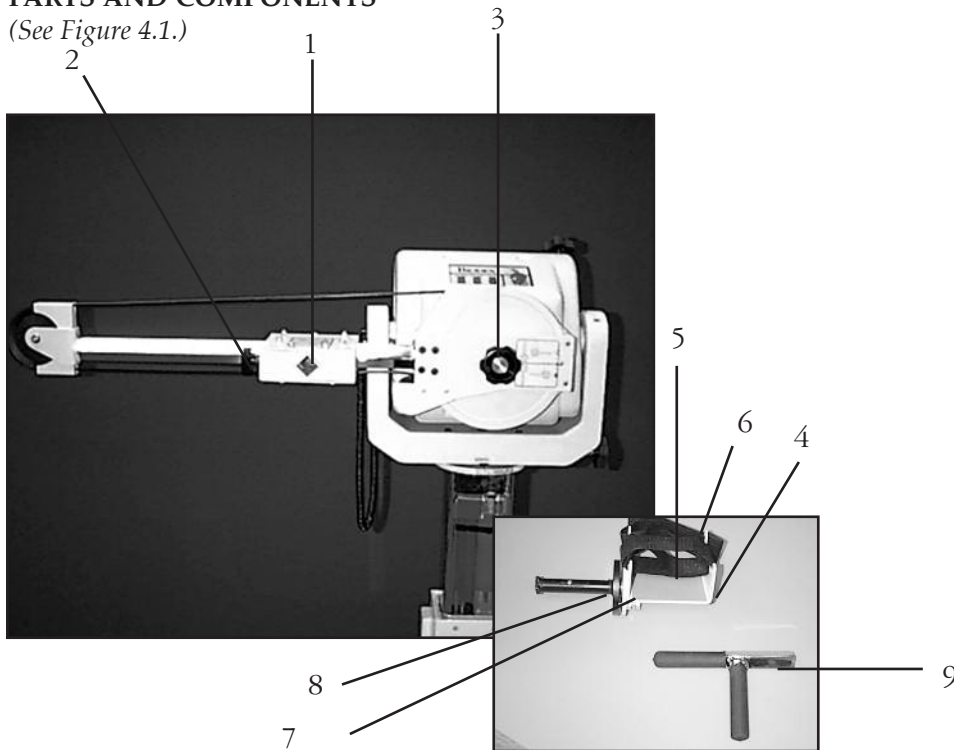


Figure 4.1. Closed Chain Attachment with Footplate and Handgrip.

1. Attachment Receiving Tube
2. Attachment Locking Knob
3. Closed Chain Locking Knob (blue dot/white dot are located opposite locking knob)
4. Footplate
5. Heel Strap
6. Padded Foot Strap
7. Footplate Rotation Pull Pin
8. Footplate Rotation Scale
9. Handgrip with Neutral Handle

INTRODUCTION

The Optional Closed Chain Attachment (#830-520) has been designed to provide early, safe, progressive rehabilitation for both the upper and lower extremity.

Essentially, this device converts rotational motion at the dynamometer into linear motion, allowing closed kinematic chain exercises to be performed on the ankle, knee, hip, shoulder, elbow, wrist and back without eliciting the increased shear forces inherent in open chain exercise. Interchangeable upper and lower extremity attachments afford a wide range of exercise possibilities. As with all Biodex attachments, speed, torque and ROM settings are addressed through the system controller.

The Closed Chain Attachment is designed for use in acute care and early intervention, in restoring ROM, and for limiting shear forces during sub-maximal torque production (especially when exercising the lower extremity).



WARNING: *Do not exceed:*

- 75 ft. lbs. of torque
- ~200 lbs. of force
- 890 Newtons (~100 Nm)



ATTENTION: *Ne pas dépasser:*

- 75 ft. lbs. de torque
- ~200 lbs. de force
- 890 Newtons (~100 Nm)

NOTE: *For additional information on use and care of the Closed Chain Attachment, refer to the Closed Chain Attachment Operations Manual which was supplied with this unit.*

SETUP PROCEDURE

(See Figures 4.2-4.6.)

The Closed Chain Attachment can be used with both Biodex System 3 Pro as explained in the following procedure.

1. Seat patient on chair.
2. Rotate chair to 0 degrees.
3. Rotate dynamometer to 0 degrees.
4. Attach Closed Chain attachment to dynamometer. Align dynamometer shaft red dot with Closed Chain Attachment dots as follows:
 - Closed Chain white dot to dynamometer shaft red dot for horizontal out and vertical down positioning.
 - Closed Chain blue dot to dynamometer shaft red dot for horizontal in and vertical up positioning.

NOTE: *For first time installation only, set the attachment adjustment screws so that they are flush against the appropriate indents in the face of the dynamometer. These four screws are located on the side of the Closed Chain attachment that faces the dynamometer. They are used to provide additional stabilization to the attachment. Use a 1/2-inch open-end wrench to adjust the screws as required.*

5. Insert handgrip or footplate in attachment receiving tube. Secure attachment locking knob.
6. Position chair and/or dynamometer to align patient axis of rotation.
7. Set ROM stops.

NOTE: *Dynamometer/Chair positions and height can be varied to match specific exercise patterns.*

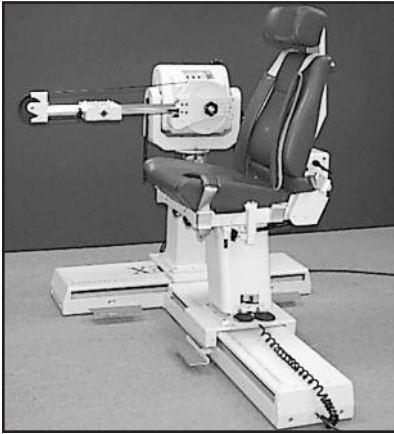


Figure 4.2. The Closed Chain Attachment in horizontal position. Chair and dynamometer are both set to 0 degrees rotation.

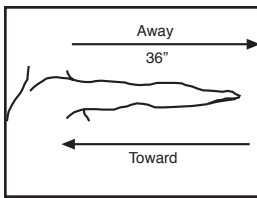


Figure 4.3. Direction of movement for upper body exercise.

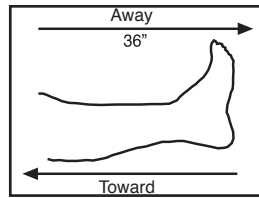
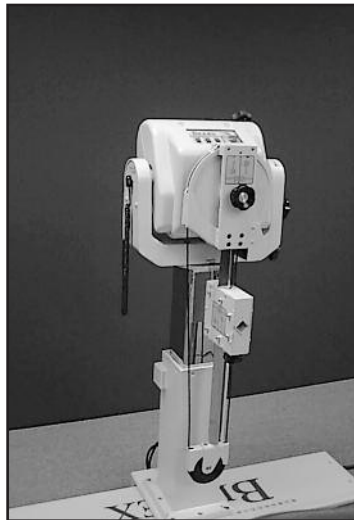
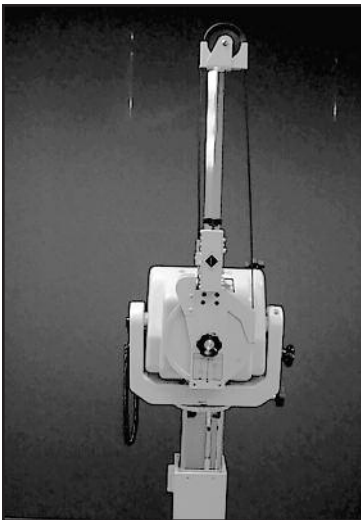


Figure 4.4. Direction of movement for lower body exercise.



Figures 4.5 and 4.6. In addition to horizontal left and right positions, the Closed-Chain Attachment can be used in the vertical up and vertical down positions.

UPPER EXTREMITY EXERCISE

(See Figure 4.7.)

1. For upper extremity exercise, insert handgrip into attachment receiving tube with neutral handle facing up or down, based on the pattern to be performed. Tighten the attachment locking knob to secure the handgrip in place.
2. The degree of elbow and shoulder flexion is easily adjusted by raising or lowering the dynamometer or adjusting seatback or dynamometer positioning fore/aft.
3. Dynamometer tilt can be adjusted if necessary to fine tune axis alignment. Be sure to note the height, position and tilt settings of the dynamometer and chair to ensure reproducibility in future exercise sessions.



Figure 4.7. The handgrip can be inserted with the neutral handle facing up or down based on patient protocol. Dynamometer rotation = 0 degrees, Chair rotation = 0 degrees.

LOWER EXTREMITY EXERCISE

(See Figure 4.8.)

NOTE: The round plate, directly adjacent to the footplate rotation scale, is marked with a “L” for left side and a “R” for right side patient setups. The appropriate letter faces up when the footplate is correctly positioned.

1. Seat patient on chair.
2. Insert footplate into attachment receiving tube. Tighten the attachment locking knob to secure the footplate in place.
3. The footplate can be used in either of two ways: free to rotate or fixed at specific 15 degree increments of plantar/dorsiflexion from 0 degrees to 60 degrees as indicated by the footplate tilt scale.
4. To adjust the degree of fixed ankle flexion, pull out on the footplate rotation pin and rotate the footplate in accordance with patient protocol. Ensure the pin locks into the fixed position hole at the desired setting.

5. To allow the footplate to rotate freely throughout the ROM, pull up on the footplate rotation pin and rotate the plate one half turn so that the pin will not retract into any of the fixed position holes.
6. To stabilize the patient's foot, the padded Velcro® brand hook and loop fastener foot strap is threaded through the middle strap guides and secured over the forefoot. The heel strap is then threaded through the appropriate heel strap slots and secured tightly against the patient's heel.
7. Knee and hip flexion is easily adjusted by raising or lowering the dynamometer or positioning chair or by moving the dynamometer along the T-base so that it is closer or further from the patient.
8. Be sure to note the height, position and tilt settings of the dynamometer and chair to ensure reproducibility in future exercise sessions.

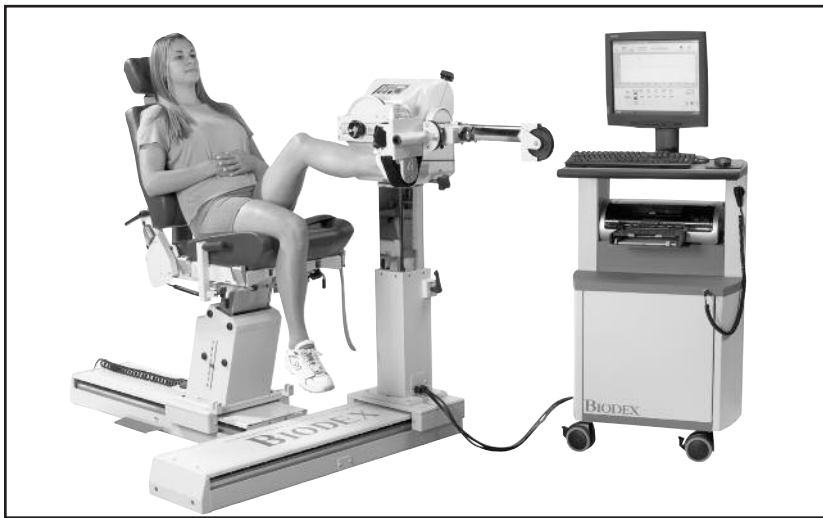


Figure 4.8. The footplate can be set at specific 15-degree increments of plantar/dorsiflexion, or free to rotate. Dynamometer rotation = 0 degrees, Chair rotation = 0 degrees.

APPLICATIONS

(See Figures 4.9 - 4.14.)

The Biodex Closed Chain Attachment is quite versatile and can be used for both upper and lower extremity exercise. Chair/dynamometer positions and height can be adjusted to allow for a variety of patterns. Some commonly used exercise patterns are shown in Figure 4-9.

Knee

Early anterior and posterior cruciate ligament reconstructions, meniscus repairs, patellofemoral pathologies, and total knee replacements benefit from:

- Ability to perform passive ROM with leg in elevated position.
- Increased protection due to co-contraction of hamstrings and quadriceps during closed chain.
- Sub-maximal active or passive range of motion and exercise in a safe, protected position that utilizes co-contraction.
- Minimizing the introduction of increased anterior and posterior translation forces to the reconstructed or unstable joint.
- Functional concentric/eccentric mini squat in a controlled sub-maximal application.

Ankle

- Allows leg musculature to be exercised while maintaining the ankle in a safe, neutral, non-weight bearing position for early plantarflexion and dorsiflexion, ankle sprains and ankle fractures.
- Safe range of motion in strengthening exercises across functional positions, or where ankle instability requires co-contraction for protection.
- Footplate rotates freely or locks into position to protect the healing structures.

Hip

- Provides general lower extremity (hamstring, quadriceps, gluteals and calf) strengthening for total hip replacement.

Back

- Back patients can strengthen entire lower extremity in functional positions through safe comfortable range of motion.
- Dynamic lumbar strengthening can be obtained in standing functional position to perform pelvic stabilization exercises.

Shoulder

- Allows safe exercise of shoulder girdle, pectorals, triceps and serratus in functional positions, utilizing safe, short arc ranges to avoid excessive joint strain.
- Scapular stabilization exercise performed concentric or eccentric.
- Serratus anterior exercised using concentric or eccentric protraction.
- Chest press in limited arc, safe from excessive joint strain.
- Safe, progressive exercise for anterior/posterior dislocations.

Elbow

- Safely load triceps and biceps for treatment of dislocations and ulnar collateral ligament sprains.
- Range of Motion and strengthening exercise with shoulder and wrist in functional positions.

Wrist

- Functional wrist exercise utilizing co-contraction to preserve joint integrity.



Figure 4.9. Knee Extension/Flexion.

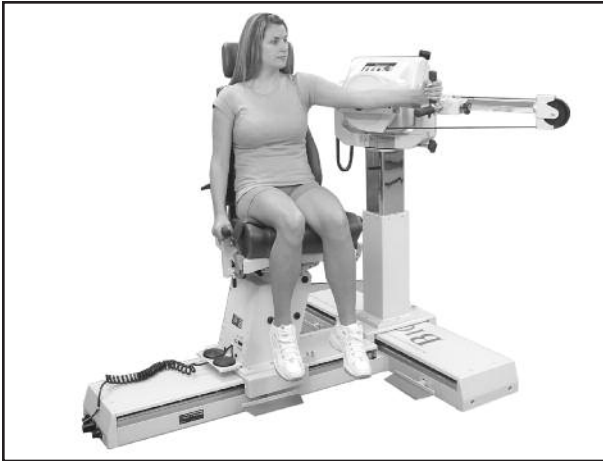
Dynamometer rotation = 0 degrees, Chair rotation = 0 degrees.



*Figure 4.10. Chest Press/Lat Row.
Dynamometer rotation = 0 degrees, Chair rotation = 0 degrees.*



*Figure 4.11. Elbow Extension/Flexion.
Dynamometer rotation = 0 degrees, Chair rotation = 0 degrees.*



*Figure 4.13. Scapula Protraction/Retraction, scapular plane.
Dynamometer rotation = 45 degrees, Chair rotation = 15 degrees.*



*Figure 4.14. Overhead Elevation/Depression
Dynamometer rotation = 0 degrees, Chair rotation = 15 degrees.*

TECHNICAL INFORMATION

Specifications

Speed: 0-36" per second (0-90 cm/sec) @ 450°/sec

Force: Up to ~200 lbs. (890 Newtons)

Stroke: 18" (46 cm) accommodates pediatric to 6'4" (195 cm) patients

Force Conversion: Force (lbs.) = 2.6181 x torque (ft. lbs.)

Distance Conversion: Distance (in) = .08 x degrees of rotation

Velocity Conversion: Vel (in/sec) = .08 x angular velocity (deg/sec)

U.S. Patent #4,907,797

5. REFERENCE MATERIALS

SUGGESTED TEST SPEEDS

<u>Joint</u>	<u>Pattern</u>	<u>Orthopedic Patient</u>	<u>Athlete</u>
Knee	Extension/Flexion	(60), 180, 300	180, 300, 450
Knee	Tibial External/Internal Rotation	(60), 60, 120	120, 180, 240
Shoulder	Abduction/Adduction	(60), 180, 300	180, 300, 450
Shoulder	Flexion/Extension	(60), 180, 300	180, 300, 450
Shoulder	External/Internal Rotation	(60), 180, 300	180, 300, 450
Shoulder	D1, D2	(60), 180, 300	180, 300, 450
Shoulder	Horizontal Abduction/ Adduction	(60), 180, 300	180, 300, 450
Elbow	Flexion/Extension	(60), 180, 300	180, 300
Wrist	Extension/Flexion	60, 120	120, 180
Wrist	Radial/Ulnar Deviation	60, 120	120, 180
Forearm	Supination/Pronation	60, 120	120, 180, 240
Ankle	Plantarflexion/ Dorsiflexion	60, 120	(60), 120, 180
Ankle	Eversion/Inversion	60, 120	(60), 120, 180
Hip	Flexion/Extension	(120), 180, 300	180, 300, 450
Hip	Abduction/Adduction	(120), 180, 300	180, 300, 450
Hip	Internal/External Rotation	60, 120	120, 180

NOTE: Test speeds in parenthesis may be approximate depending on pathology.

LEGAL PRECEDENT FOR BIODEX EVIDENCE

In a Florida court decision, the Biodex System was accepted into evidence as a measure of dynamic human function. This decision establishes a precedent with important medical/legal implications for all rehabilitation professionals. In the future, the testifying therapist need only cite the precedent case number for Biodex evidence to be accepted as valid.

Sue Chestnut, P.T., of Plantation Physical Therapy, testified as a witness for the plaintiff during the trial Larry Beard vs. State Paving Co. The trial convened the week of May 21, 1986 in Broward County Circuit Court, Fort Lauderdale, Florida. Case #81-12431 CH.

The plaintiff had sustained injuries in an automobile accident and was recommended to Chestnut's offices in Plantation, Florida for rehabilitation. Shortly before trial, a work-up on the patient was done on the Biodex System. Evidence introduced indicated that the individual had a functional deficit on his affected side of 50%.

"Biodex evidence was integral to the case," says Chestnut. "The evidence was the only factual measure of his functional ability introduced during the trial."

Chestnut was able to explain to the jury exactly how the Biodex functioned and what it was used for. This included explaining the difference between the Biodex and one of the original Isokinetic devices. The attorney for the defense was familiar with the older system, but the Biodex was new to him.

After Chestnut had outlined the differences to the attorney, neither the presiding judge, Honorable Robert Andrews, nor the attorney had any further question or objection. The evidence was then legally admitted in a United States court of law for the first time.

Evidently, the judge and attorneys were not the only ones impressed with Chestnut's testimony. The jury retired to consider its verdict and returned with a ruling in favor of Chestnut's client.

BIODEX DATA ADMITTED AS MEDICAL EVIDENCE IN COURT

1. Larry Beard vs. State Paving Co.
Broward County Circuit Court
Ft. Lauderdale, FL
Docket No. 81-12431 CH
Judge: Hon. Robert Andrews
2. Gilbert Green vs. Delta Airlines
Federal Court
Ft. Lauderdale, FL
Docket No. 85-6656 CIVJAG
Attorney: David Kratlin, Esq.
3. Grace Monico vs. G.E. Credit Corp.
Broward County Court
Plantation, FL
Docket No. 87-000 75CA
Attorney: Jeffrey Fenster, Esq.

BIODEX

Clinician:

[illegible]

Biodex Phone: 1-800-224-6339	Clinical Education ext. 114	Software Support ext. 120	Service ext. 241
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CURRENT RECORDED NORMATIVE GOALS (ENGLISH UNITS)

JOINT MOVEMENT AND POSITION	SPEED DEGREES/SECONDS	PEAK TORQUE/BW RANGE				FLEX/EXT RATIO		EXT ROT/INT ROT RATIO		ABD/ADD RATIO		DORSI/PLANTAR RATIO		EVER/INVER RATIO	
		MALE		FEMALE		MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
Lumbar Flexion Semi Standing	60	114	121	*	*										
	90	*	*	*	*										
	120	*	*	*	*										
Lumbar Extension Semi Standing	60	150	162	*	*	49	49								
	90	133	139	*	*	59	59								
	120	145	150	*	*	51	51								
Shoulder External Rot. Mod. Neutral	60	13	17	10	13										
	180	11	15	8	12										
Shoulder Internal Rot. Mod. Neutral	60	19	26	14	18			64	71						
	180	17	23	13	17			66	71						
Shoulder Flexion Seated	60	25	34	23	30										
	180	22	29	20	26										
	300	9	12	21	27										
Shoulder Extension Seated	60	28	37	24	31	90	79								
	180	22	30	18	23	83	83								
	300	28	37	17	23	69	81								
Shoulder Abduction Seated	60	20	27	16	20										
	180	18	24	14	18										
Shoulder Adduction Seated	60	32	43	27	35					66	64				
	180	27	36	25	33					53	78				
Ankle Plantarflexion Seated	30	49	65	43	55										
	60	36	48	36	46										
	120	23	31	20	26										
Ankle Dorsiflexion Seated	30	13	17	16	21							26	39		
	60	11	15	15	20							31	43		
	120	9	12	11	14							39	54		
Ankle Eversion Seated	30	13	17	12	16										
	60	9	12	9	12										
Ankle Inversion Seated	30	12	16	14	19									87	81
	60	11	14	12	15									90	80
Knee Flexion Seated	*	*	*	*	*										
	*	*	*	*	*										
Knee Extension Seated	60	86	115	80	95	61	62								
	180	58	75	50	65	72	76								
	300	40	55	30	45	78	79								
Hip Flexion Supine	45	40	52	38	50										
	300	10	13	7	9										
Hip Extension Supine	45	63	82	57	77	64	66								
	300	34	44	28	37	29	25								
Elbow Flexion Seated	60	21	28	20	26										
	120	21	28	34	45										
Elbow Extension Seated	60	21	28	23	30	97	88								
	120	23	30	18	24	93	98								
Wrist Flexion Seated	60	4	7	4	7										
	120	2	4	2	4										
Wrist Extension Seated	60	2	4	2	4	57	57								
	120	2	4	2	4	97	97								

* The Biodex normative database is a compilation of published information to be used as unilateral goals. Peak Torque to body weight is expressed in a range which enables these goals to be recommended for various groups (Prepubescent patients do not apply)

CURRENT RECORDED NORMATIVE GOALS- (METRIC UNITS)

JOINT MOVEMENT AND POSITION	SPEED DEGREES/SECONDS	PEAK TORQUE/BW RANGE				FLEX/EXT RATIO		EXT ROT/INT ROT RATIO		ABD/ADD RATIO		DORSI/PLANTAR RATIO		EVER/INVER RATIO	
		MALE		FEMALE		MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
Lumbar Flexion Semi Standing	60	38.1	40.4	*	*										
	90	*	*	*	*										
	120	*	*	*	*										
Lumbar Extension Semi Standing	60	50.1	54.1	*	*	49	49								
	90	44.4	46.4	*	*	59	59								
	120	48.4	50.1	*	*	51	51								
Shoulder External Rot. Mod. Neutral	60	4.3	5.7	3.3	4.3										
	180	3.7	5.0	2.7	4.0										
Shoulder Internal Rot. Mod. Neutral	60	6.3	8.7	4.7	6.0			64	71						
	180	5.7	7.7	4.3	5.7			66	71						
Shoulder Flexion Seated	60	8.4	11.4	7.7	10.0										
	180	7.4	9.7	6.7	8.7										
	300	3.0	4.0	7.0	9.0										
Shoulder Extension Seated	60	9.4	12.4	8.0	10.4	90	79								
	180	7.3	10.0	6.0	7.7	83	83								
	300	9.4	12.4	5.7	7.7	69	81								
Shoulder Abduction Seated	60	6.7	9.0	5.3	6.7										
	180	6.0	8.0	4.7	6.0										
Shoulder Adduction Seated	60	10.7	14.3	9.0	11.7					66	64				
	180	9.0	12.0	8.4	11.0					53	78				
Ankle Plantarflexion Seated	30	16.4	21.7	14.4	18.4										
	60	12.0	16.0	12.0	15.4										
	120	7.7	10.4	6.7	8.7										
Ankle Dorsiflexion Seated	30	4.3	5.7	5.3	7.0							26	39		
	60	3.7	5.0	5.0	6.7							31	43		
	120	3.0	4.0	3.7	4.7							39	54		
Ankle Eversion Seated	30	4.3	5.7	4.0	5.3										
	60	3.0	4.0	3.0	4.0										
Ankle Inversion Seated	30	4.0	5.3	4.7	6.3									87	81
	60	3.7	4.7	4.0	5.0									90	80
Knee Flexion Seated	*	*	*	*	*										
	*	*	*	*	*										
Knee Extension Seated	60	28.7	38.4	2.7	31.7	61	62								
	180	19.4	25.1	16.7	21.7	72	76								
	300	13.4	18.4	10.0	15.0	78	79								
Hip Flexion Supine	45	13.4	17.4	12.7	16.7										
	300	3.3	4.3	2.3	3.0										
Hip Extension Supine	45	21.0	27.4	19.0	25.7	64	66								
	300	11.4	14.7	9.4	12.4	29	25								
Elbow Flexion Seated	60	7.0	9.4	6.7	8.7										
	120	7.0	9.4	11.4	15.0										
Elbow Extension Seated	60	7.0	9.4	7.7	10.0	97	88								
	120	7.7	10.0	6.0	8.0	93	98								
Wrist Flexion Seated	60	1.3	2.3	1.3	2.3										
	120	.7	1.3	.7	1.3										
Wrist Extension Seated	60	.7	1.3	.7	1.3	57	57								
	120	.7	1.3	.7	1.3	97	97								

6. APPENDICES

EMG/ANALOG SIGNAL ACCESS INTERFACE*

The EMG/Analog Signal Access Configuration Utility (ASA Config) is part of the EMG/Analog Signal Access Interface option to the Advantage Software Program. The utility configures the scale factors and operating modes of the analog signal outputs for velocity, torque and position.

With the configuration capability, the analog signals can be custom tailored to provide the best and most appropriate analog data for a wide variety of usages.

Installation and Usage

The ASA Config utility must be installed on the computer, which runs the Advantage Software program. Insert the provided ASA Config utility CD into the CD drive, and it will automatically start the setup installation. If all the defaults are chosen during setup, a shortcut will be created on your desktop called: System -- ASA Config.

The utility cannot be run simultaneously with the Advantage Software application. Typically you must exit the application, run the ASA Config utility to setup the scaling and modes, then run the Advantage Software application to perform your tests and data capture.

All settings performed in the ASA Config utility will be permanently set in the Biodex Multi-Joint System, even if the unit is completely shut down and re-started. The current settings can always be verified by running the utility – it will show the current active settings. Status information on the Biodex Multi-Joint System is shown on the top of the screen for your reference. As long as the status shows ONLINE, the current displayed Analog Signal settings are accurate.

The Analog Signal Access port is an output of analog signals of velocity, torque and position data in real-time directly from the motor control Digital Signal Processor (DSP). In addition to the real-time data, a synchronization pulse is issued whenever the real-time data is updated. The synchronization pulse can be used by the monitoring equipment to know when the real-time data output has changed.

NOTE: For the pin-out definition of the port, please refer to the diagram at the back of this document entitled: EMG/Analog Signal Port Pin Configuration

Analog Signal Resolution Effected By Scale Factor

The analog signals range from –5 volts to +5 volts, resulting in a total range of 10 volts. The System defaults to full scale. Full scale for torque as an example is –512 ft-lbs to +512 ft-lbs, for a total range of 1024 ft-lbs. This results in an output resolution scale factor as follows:

$$1024 \text{ ft-lbs} = 10 \text{ volts,}$$

$$1 \text{ ft-lb} = 9.8 \text{ milli-volts}$$

**Consult with Biodex Customer Service before ordering.*

9.8 milli-volts is well below the signal noise rated for this port, therefore it's not possible to see 1 ft-lb increments on this analog signal. This program provides scaling options separately for all three analog signals, so if typical usage is well below the maximum levels, 1 ft-lb increments can be seen on typical analog monitoring equipment. For example, applying a range of +/- 0 to 64 ft-lbs, the output resolution scale factor would look as follows:

$$128 \text{ ft-lbs} = 10 \text{ volts,}$$

$$1 \text{ ft-lb} = 78.1 \text{ milli-volts}$$

78.1 milli-volts is well above the worse case of signal noise (15 – 35 mV), so increments as low as 1/4 to 1/2 ft-lbs can be seen reliably.

Operating Modes

The Output Frequency, or update rate, controls how frequently the system will change the analog outputs. The best it can do is 2,000 times per second, which is the default. If this high frequency is not needed or may even be causing problems with the monitoring equipment, the update rate can be lowered. Every time the analog signals are output, the synchronization signal is pulsed also. Therefore the update rate controls how frequent the synchronization signal (i.e.: "syncout") is pulsed.

NOTE: Syncout is a Digital TTL pulse which is Active High and has a continuous pulse width of 29 micro-seconds.

The Output Mode selects in what state the analog signal outputs are updated. The options are as follows:

On Always - always output regardless of current operational state

On Timed - turns on analog outputs only for the next fixed period of time (in seconds)

Off (disabled) - totally shuts down the analog signal outputs

Auto, when active - is automatically on only when the system is in an active state, meaning not STOP'ed and not in HOLD

On Go command - synchronizes the analog signal output with the Advantage Software application's GO command, so the output is performed only during the trials exercised

NOTE: Use the <Refresh> button to display the current Remote Access Port setting in effect.

Table Of Scale Range and Factors

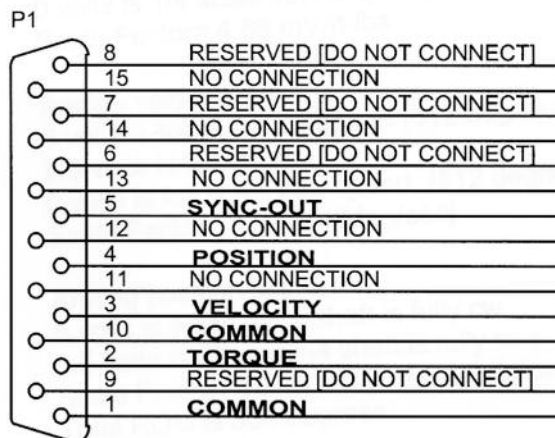
Following is the break down of ranges and the resulting scale factors for all three signals:

Scaling Option	Range	Scale Factor
Velocity:		
0 – 512 deg/sec	-512 to +512 deg/sec	9.8 mV per deg/sec
0 – 256 deg/sec	-256 to +256 deg/sec	19.5 mV per deg/sec
0 – 128 deg/sec	-128 to +128 deg/sec	39.1 mV per deg/sec
0 – 64 deg/sec	-64 to +64 deg/sec	78.1 mV per deg/sec
0 – 32 deg/sec	-32 to +32 deg/sec	156.3 mV per deg/sec
Torque:		
0 – 512 ft-lbs	-512 to +512 ft-lbs	9.8 mV per ft-lb
0 – 256 ft-lbs	-256 to +256 ft-lbs	19.5 mV per ft-lb
0 – 128 ft-lbs	-128 to +128 ft-lbs	39.1 mV per ft-lb
0 – 64 ft-lbs	-64 to +64 ft-lbs	78.1 mV per ft-lb
0 – 32 ft-lbs	-32 to +32 ft-lbs	156.3 mV per ft-lb
Position:		
Full scale (~ 348.6 deg)	12 to 320 degrees	28.7 mV per degree
ROM Only (varies)	Ex: 45 degrees	Ex: 222.2 mV per degree

EMG/ANALOG SIGNAL PORT PIN CONFIGURATION

Pin #	Designation	Description
1	Common	Signal ground
2	Torque	Analog torque signal
3	Velocity	Analog velocity signal
4	Position	Analog position signal
5	Syncout	TTL pulse
6-9	reserved	Do not connect!
10	Common	Signal ground [same as pin 1]
11-15	not connected	

VIEW AS FACING BACK PANEL



REMOTE ACCESS

MAINTENANCE

Cleaning Instructions

With the system turned OFF, wipe down all surfaces with a damp cloth. Mild soap and water can be used to remove stains and scuff marks. Pay particular attention to the upholstery, which can be damaged by exposure to perspiration and other body fluids.

***NOTE:** DO NOT use cleaning solutions containing ammonia or alcohol to clean upholstery. Mild soap and water should be sufficient. Allow the system to dry thoroughly before resuming testing, rehab or exercise sessions.*

A leather cleaner / conditioner can be used monthly on all upholstery.

Hardware

As needed, inspect all locking and adjustment mechanisms for signs of wear or damage.

If you have any questions or need further assistance, contact the Biodex Customer Service Department.

SYSTEM SPECIFICATIONS

Features:

17" Flat Panel LCD Touch Screen Monitor

Multi-Mode operation; Isokinetic, Isometric, Isotonic, Reactive Eccentric and Passive

Concentric speed up to 500 deg/sec

Eccentric speed up to 300 deg/sec

Concentric torque up to 500 ft-lb (680 Nm)

Eccentric torque up to 400 ft-lb (444 Nm)

Passive speed as low as .25 deg/sec

- Passive torque as low as .5 ft-lb

- Isotonic torque as low as .5 ft-lb

Clinical Data Station:

Windows™ based PC (current model)

Windows™ Operating System

Biodex Advantage Software

LCD Flat Panel Touch-Screen Color Monitor with integrated Speakers

Color Printer

Attachments for Ankle, Knee, Shoulder, Elbow, Wrist and Hip

Attachment Cart

Calibration Kit

Manuals and Wall Chart

Operating space: 64 square feet (6 square meters)

220 VAC

Certification:

ETL and cETL listed to UL 60601-1, CAN/CSA C22.2 No.: 601-1-M90 and EN60601-1.

CE conformity to M.D.D. 93/42/EEC

Electrical Requirements

208/230VAC, 50-60Hz, 8 amps

Requires 20A isolated dedicated service

Hospital Grade Plug must be rated for 230VAC, 15 amps minimum

North American Units supplied with NEMA 6-20P

Equipment should have means to isolate its circuits electrically from the supply mains on all poles, simultaneously.

Mechanical Specifications

Total Weight (Pro Configuration): 1350 pounds

Physical Dimensions: CDS Cart: 27 inches wide, 24 inches deep, 66 inches high

T-Base & Chair: 52 inches wide, 65 inches deep, 60 inches high

Attachment Cart: 50 inches wide, 26 inches deep, 50 inches high

Dynamometer Performance Specifications

Torque accuracy is $\pm 1\%$ of full scale (500 ft-lbs)

Torque is factory calibrated

Position range is 330 degrees

Position accuracy is ± 1 degree of rotation

Torque verification fixture is 50 ft-lbs ± 0.5 ft-lbs

Authorized European Community Representative:

PROTHIA

26, rue serpollet

75020 Paris, France

(011)33.1.40.31.60.20



CONFORMANCE TO STANDARDS

This equipment conforms to the following safety standards:

Standard	Edition and/or date
IEC60601-1-2	First edition, 2007

Table 1.1 Safety standards

Accompanying EMC Documents

This medical electrical equipment needs special precautions regarding EMC and needs to be installed and put into service according to the EMC information provided in this manual.

- Portable and mobile RF communications equipment can affect medical electrical equipment.
- Use of accessories, transducers and cables other than those specified, with the exception of accessories, transducers and cables sold by the manufacturer of this equipment, as replacement parts for internal and external components, may result in increased emissions or decreased immunity of the equipment.
- The System 4 Multi Joint Device should not be used adjacent to or stacked with other equipment. If the System 4 Multi Joint Device is used while positioned adjacent to other equipment, it should be observed to verify normal operation in the configuration in which it will be used.

List of Cable Accessories

The list in Table 1.2 includes all accessory cables supplied with the System 4 Multi Joint Device for which the manufacturer of this equipment claims compliance to EN 60601-1-2 when used with the System 4 Multi Joint Device.

Cable Description	Part No.	Cable Length
Motor Power Cable	Biodex #830-210-E752	10ft
Dyna Sensor Cable	Biodex #830-101-E700	10ft
Power Input Cable	Biodex #850-111	10ft
CDS Pwr Input Cable	Biodex #835-210-E721	15ft

Table 1.2 System 4 Multi Joint Device cables


DECLARATION OF CONFORMITY

Emissions

Manufacturer's declaration electromagnetic emissions		
The System 4 Multi Joint Device is intended for use in the electromagnetic environment specified below. The customer or the user of the System 4 Multi Joint Device should assure that it is used in such an environment		
Emission test	Compliance	Electromagnetic environment
RF emissions CISPR 11	Group 1	The System 4 Multi Joint Device generates RF energy only for its internal functions. Therefore, its RF emission is very low and is not likely to cause any interference in nearby electronic equipment The System 4 Multi Joint Device is suitable for use in all establishments other than domestic and those directly connected to the public low-voltage power supply network supplying buildings used for domestic purposes.
RF emissions CISPR 11	Class A	
Harmonic distortion EN 61000-3-2	Class A	
Voltage fluctuations and flicker EN 61000-3-3	Complies	

Immunity

Manufacturer's declaration electromagnetic immunity			
The System 4 Multi Joint Device is intended for use in the electromagnetic environment specified below. The customer or the user of the System 4 Multi Joint Device should assure that it is used in such an environment.			
Immunity test	IEC 60601-1-2 Test level	IEC 60601-1-2 Compliance level	Electromagnetic environment – guidance
Electrostatic discharge (ESD) IEC 61000-4-2	± 6 kV contact ± 8 kV air	Contact ± 6 kV Air ± 8 kV	Floor should be wood, concrete or ceramic tiles. If floor is covered with synthetic material, the relative humidity should be at least 30%
Electrical fast transients/burst IEC 61000-4-4	± 2 kV for power lines ± 1 kV for input/output lines	Power ± 2 kV Signal ± 1 kV	Mains power quality should be that of a typical commercial or hospital environment
Surge IEC 61000-4-5	± 1 kV differential mode ± 2 kV common mode	± 1 kV diff. mode ± 2 kV com. mode	Mains power quality should be that of a typical commercial or hospital environment

Immunity test	IEC 60601-1-2 Test level	IEC 60601-1-2 Compliance level	Electromagnetic environment – guidance
Voltage dips, short interruptions and voltage variations on power supply input lines IEC 61000-4-11	< 5% UT (> 95% of dip in UT) for 1/2 cycle 40% UT (60% of dip in UT) for 5 cycle 70% UT (30% of dip in UT) for 25 cycle < 5% UT (> 95% of dip in UT) for 5 sec	< 5% UT (> 95% of dip in UT) for 1/2 cycle 40% UT (60% of dip in UT) for 5 cycle 70% UT (30% of dip in UT) for 25 cycle < 5% UT (> 95% of dip in UT) for 5 sec	Mains power quality should be that of a typical commercial or hospital environment. If a better mains power quality is required, it is recommended that the System 4 Multi Joint Device is powered from an uninterruptible power supply
Power frequency (50/60 Hz) magnetic field IEC 61000-4-8	3 A/m	3 A/m	If image distortion occurs, it may be necessary to position the System 4 Multi Joint Device display further from sources of power frequency magnetic fields or to install magnetic shielding. The power frequency magnetic field should be measured in the intended installation location to assure that it is sufficiently low
Conducted RF IEC 61000-4-6	3 Vrms, 150 KHz to 80 MHz	3 Vrms, 150KHz to 80 MHz	Portable and mobile RF communications equipment should be used no closer to any part of the System 4 Multi Joint Device, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter. Recommended separation distance: d = 1.2√ P 150 KHz to 80 MHz d = 1.2√ P 80 MHz to 800 MHz d = 2.3√ P 800 MHz to 2.5 GHz where P is the maximum output power rating of the transmitter in watt (W) according to the transmitter manufacturer, and d is the recommended separation distance in meters (m). Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey, ^a should be less than the compliance level in each frequency range. ^b Interference may occur in the vicinity of equipment marked with the following symbol: 
Radiated RF IEC 61000-4-3	3 V/m, 80 MHz to2.5 GHz	3 V/m, 80 MHz to2.5 GHz	
<p>Note 1. UT is the a.c. mains voltage prior to application of the test level.</p> <p>Note 2. At 80 MHz and 800 MHz, the higher frequency range applies.</p> <p>Note 3. These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflections from structures, objects and people</p>			
<p>^a Field strength from mixed transmitters, such as base stations for radio telephones and land mobile radios, amateur radio, AM or FM broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the System 4 Multi Joint Device is used exceeds the applicable RF compliance levels above, the System 4 Multi Joint Device should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the System 4 Multi Joint Device.</p> <p>^b Over the frequency range 150 KHz to 80 MHz, field strengths should be less than 3 V/m.</p>			

Recommended Separation Distances

Recommended separation distances between portable and mobile RF communications equipment and the System 4 Multi Joint Device system. Table 6

The System 4 Multi Joint Device is intended for use in the electromagnetic environment in which radiated RF disturbance are controlled. The customer or the user of the System 4 Multi Joint Device can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communication equipment (transmitters) and the System 4 Multi Joint Device as recommended below, according to the maximum output power of the communication equipment.

Rated maximum output power of transmitter [W]	Separation distance according to frequency of transmitter [m]		
	150 kHz to 80 MHz $d = 1.2\sqrt{P}$	80 MHz to 800 MHz $d = 1.2\sqrt{P}$	800 MHz to 2.5 GHz $d = 2.3\sqrt{P}$
0.01	0.12	0.12	0.23
0.1	0.38	0.38	0.73
1	1.2	1.2	2.3
10	3.8	3.8	7.3
100	12	12	23

For transmitters rated at a maximum output power not listed above, the recommended separation distance d in meters (m) can be estimated using the equation applicable to the frequency of the transmitter, where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.

Note 1. At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.

Note 2. These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

Operating Temperature

Do not expose the equipment to a temperature change of more than 5° F (3° C) per hour.

Limits of low and high operating temperature ranges are 59° to 86° F (15° C to 30° C).

GENERAL PRODUCT WARRANTY

A. Warranty

BIODEX MEDICAL SYSTEMS warrants that all products covered hereby shall be free from defects in workmanship and materials and shall conform to published specifications or other specifications accepted in writing by BIODEx for:

<i>Description:</i>	<i>Parts:</i>	<i>Labor:</i>
Controller	1 year	1 year
Dynamometer	1 year	1 year
Clinical DataStation	1 year	1 year
Printer	1 year	1 year
Cables	1 year	1 year
Adjust. Positioning Chair	1 year	1 year
Attachments	1 year	1 year
Threads	1 year	1 year
Knobs	1 year	1 year
Upholstery	60 days	60 days
Straps	60 days	60 days
Pads	60 days	60 days

under normal use as prescribed in the operator's manual. The foregoing warranty does not apply to any products which have been subject to use other than as specified as standard operating procedure in the system manual, neglect, accident or modification. BIODEx's sole obligation to buyer hereunder for products failing to meet aforesaid warranty shall be, at BIODEx's discretion, to replace or repair the non-conforming product (parts and labor) or issue buyer credit for the purchase price of the non-conforming product where within warranty period:

1. BIODEx has received written notice of any nonconformity and
2. After BIODEx's attempts to remedy such nonconformity, BIODEx has determined that the nonconformity is not a result of improper use, accident, repair or other misuse by buyer.

Any replacement product shall carry the unexpired term of the warranty which was applicable to the replaced product or a period of 30 days, whichever is longest.

BIODEX MAY RETAIN THE RIGHT TO VOID ALL SYSTEM WARRANTIES IF PAYMENT IS NOT RECEIVED AS PRESCRIBED IN TERMS OF PURCHASE.

EXCEPT AS SPECIFICALLY PROVIDED HEREIN, THERE ARE NO OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

IN NO EVENT SHALL BIODEx BE LIABLE FOR LOSS OF PROFITS, INDIRECT, SPECIAL, CONSEQUENTIAL, OR OTHER SIMILAR DAMAGES ARISING OUT OF ANY BREACH HEREOF.

B. Warranty Period

Warranty time period stated in paragraph "A", is from date of invoice (shipment) unless otherwise specified in writing by BIODEx.

C. Repaired or Replacement Products (out of warranty)

BIODEX MEDICAL SYSTEMS, for a period of 60 days, warrants that its standard products repaired or replaced hereunder shall be free from defects in workmanship or materials under normal use as described in the system's Operator's Manual. Warranty period will begin upon shipment of repaired or replacement products. The sole responsibility of BIODEx under this warranty is, at its option, to repair or replace any defective component parts of such products. This warranty does not apply to:

1. Products which have been repaired or altered other than under specific instructions from BIODEx'S Service Department instruction as listed in system's manuals or procedures previously approved in writing by BIODEx Service Department, or
2. Products which have been subject to use other than described as standard use in the system's operator's manual, neglect or accident.

THIS WARRANTY IS NOT TRANSFERABLE (SITE, OWNERSHIP, ETC.) WITHOUT THE WRITTEN PERMISSION OF BIODEx MEDICAL SYSTEMS. WARRANTY IS VOID UNLESS EQUIPMENT IS INSTALLED BY BIODEx PERSONNEL.



Certified Quality Management System

BIODEX

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