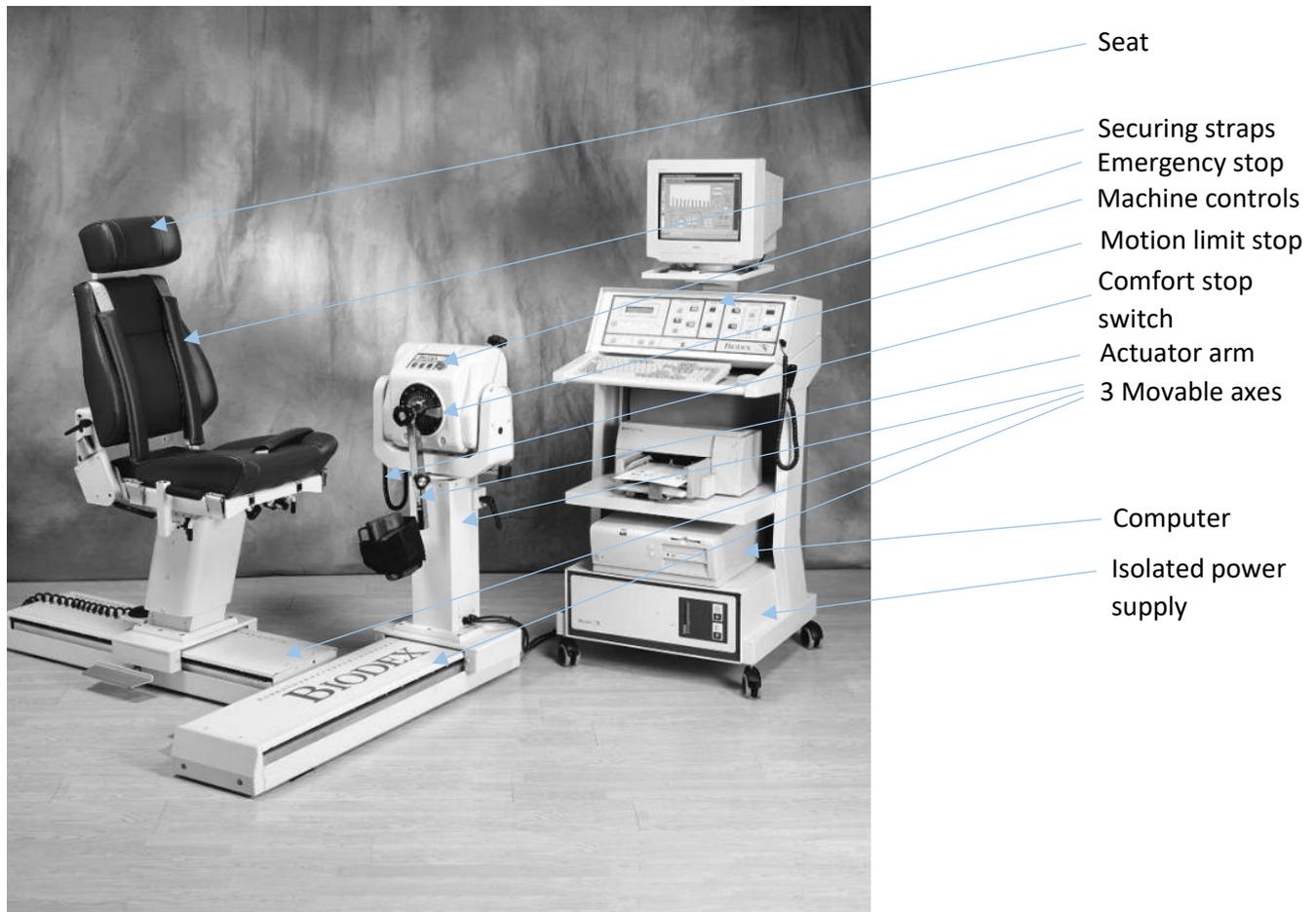




Standard operating procedure Biodex System 3 dynamometer



Introduction

Do not use this equipment unless you have been trained and are competent to do so

This procedure is in addition to the manufacturer's operating manual.

Read the risk assessments RA01, RA02, RA03, RA04, Metabolic testing and for any additional equipment used such as ergometers before starting work.

These documents are kept in the folder alongside the machine and on the laboratory safety website.

Biodex System 3 dynamometer

This dynamometer is used for static and dynamic training and testing. The Biodex can operate in Isokinetic, Passive, Isometric, Isotonic and Reactive Eccentric modes. It can be configured to exercise the majority of muscles in the body. Force data can be recorded on an external computer.

Pre operation inspection

- Check the condition of all items of equipment for damage or misuse, report any concerns to the laboratory technician

- Check the condition of all cables and connections before turning the dynamometer on. Do not use the equipment if you find any damage
- If you wish to record test data contact the laboratory technician
- Do not use the equipment if there are any signs of damage to the electrical supply cables or connections
- Make sure that the equipment is clean, wipe any soiled areas with a soft cloth or tissue moistened with detergent solution before use and between participants

Precautions

WARNING:

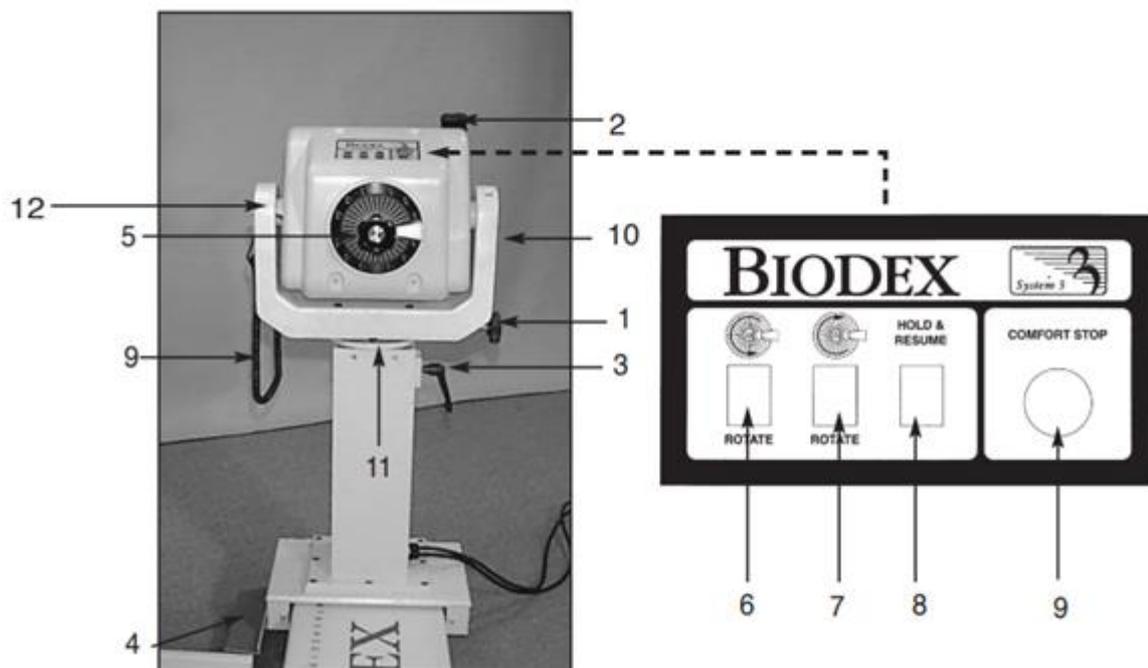


- Never try out a new machine configuration on any person. Always check the full range of motion is safely within the range of motion of the participant by hand before setting up the test
- Always check the motion limit stop prevents possible overextension of joints. Software can malfunction and harm the participant
- Screen participants as described in risk assessments RA01, RA02, RA03 and RA04
- Make sure the participant is aware of how the equipment works and that they can stop the test if they feel any discomfort. Demonstrate the participant comfort stop button and emergency stop
- Read the manual (APPLICATION/OPERATION MANUAL) before use
- This machine has several parts connected by cables. Care should be taken to avoid tripping over cables while reconfiguring the machine. Before the participant arrives make sure the cables are clear of their path to the machine.
- Participants should not be left unattended at any time when using the machine
- The participant should always have access to the comfort stop button
- Make sure the test sequence is complete before removing the participant from the dynamometer.
- Make sure there are no obstructions to the motion of the dynamometer head and attachments such as items left lying on the machine before turning on

Configuring the dynamometer

The Biodex is highly configurable, and it is not in the scope of this SOP to cover all possibilities. Here is how to go about a general configuration.

Positioning the dynamometer head



1. Rotation knob: Loosen counter clockwise to rotate the head. Note the head rotates until it hits a stop. Do not force the head past the stop.
2. Tilt knob: Support the head. Loosen counter clockwise to obtain the desired tilt of the head.
3. Height knob: Loosen counter clockwise to release the head and push gently up and down to obtain the desired position
4. Foot pedals: Press down to release the linear slide and push the whole assembly to the desired position on the track. Release the pedal to lock in place.
5. Red dot for orientation of dynamometer shaft
6. Button for counter clockwise rotation
7. Button for clockwise rotation
8. Hold/Resume button
9. 2 x Comfort stops
10. Transport lock
11. Position scale
12. Yoke

Positioning the chair



Figure 1.7. System 3 Seat Back Brace installed and ready for use.

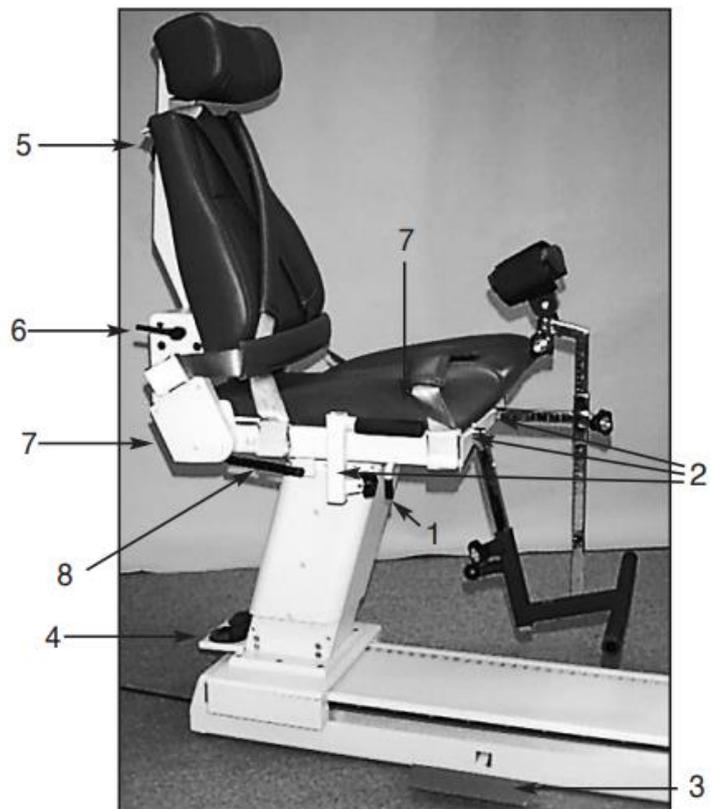


Figure 1.3. Positioning Chair adjustments.

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

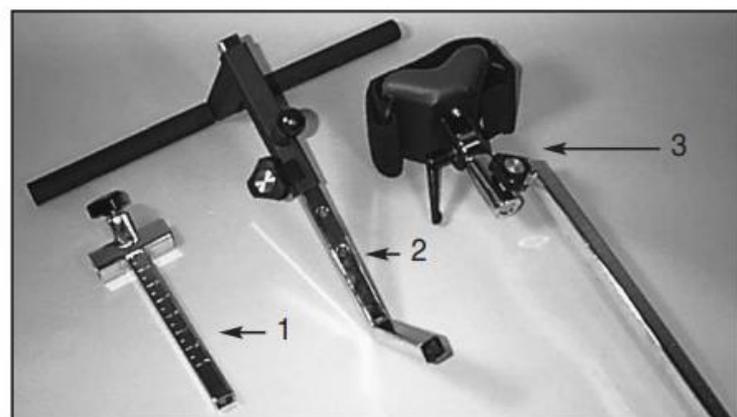


Figure 1.4. Positioning Chair attachments.

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

1. Rotation handle: Loosen counter clockwise to rotate the head.
2. Attachment receiving tubes
3. Foot pedal: Press down to release the linear slide and push the whole assembly to the desired position on the track. Release the pedal to lock in place.
4. Height pedals: Adjust the motorised seat up and down.

5. Cervical support adjustment knob: Support the seatback with one hand and loosen counter clockwise. Adjust as desired.
6. Seatback tilt lever: Support the seatback with one hand and loosen counter clockwise. Adjust as desired.
7. Seat depth handle: Loosen counter clockwise. Adjust slide to adjust as desired.
8. Stabilization handles: Hand grips for participant to grab during exercise

The control panel

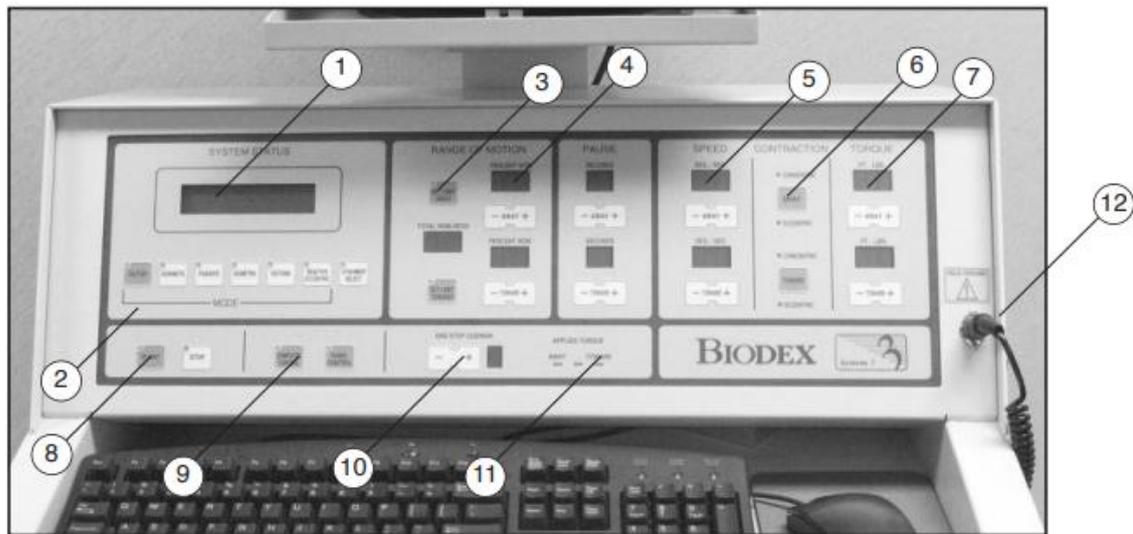


Figure 1.8. The Biodex System 3 Control Panel.

1. System Status Window
2. Modes of Operation
3. Range of Motion
4. Percent ROM (Away and Toward)
5. Speed
6. Contraction
7. Torque
8. Start/Stop
9. Computer/Panel Control
10. End Stop Cushion
11. Applied Torque
12. Hold/Resume

Turning the machine on

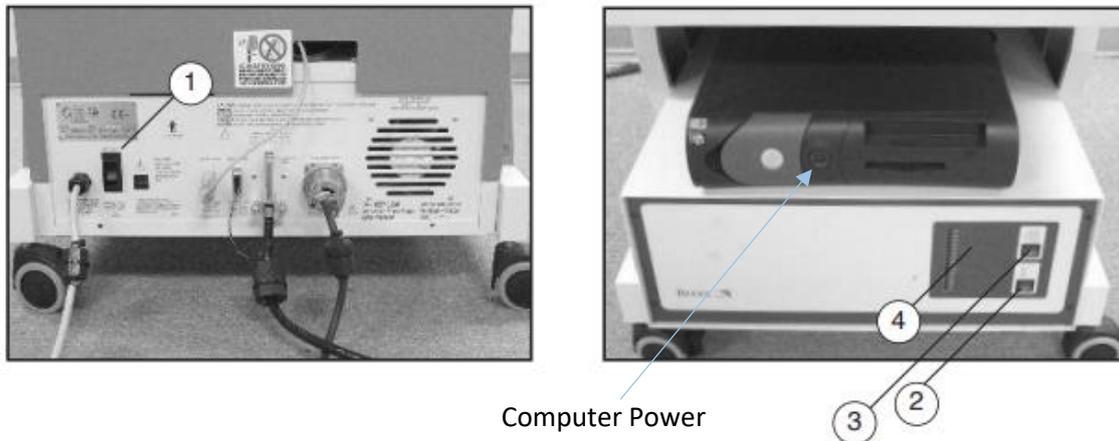


Figure 1.9. The Biodex System Controller front panel (left) and rear of unit (right).

1. Main Power Switch
2. Dynamometer Power Switch
3. Controller Power Switch
4. Status/Diagnostics Panel (LED's)

- Check the electrical connections are secure and undamaged
- Turn the mains electricity on at the wall
- Turn on the main power switch to the rear of the control unit (1)
- Turn on the controller power and the dynamometer power (2,3)
- Turn on the computer power

Setting up before a test

- Turn the machine on
- Once the machine has initialised you should see the message **REMOVE ATTACHMENT, PRESS START** on the system status window. Remove any attachments and press **Start**
- The dynamometer will move to calibrate. When requested to do so on the system status window press **Start**.
- The machine is now in setup mode, the dynamometer shaft is unpowered and the **Set Limits** buttons should flash. This is when we must setup the exercise limits with the help of the participant
- Press **Panel Control**
- Choose and install the correct attachment, align the dots on shaft and attachment then secure with the locking knob
- Press **Select attachment** and cycle through the options until you find the correct entry
- Press any button to accept
- Position and stabilize subject correctly for the intended protocol by adjusting the seat height, seat position and seatback tilt.
- Adjust Dynamometer height, angle, rotation, and position
- Secure appropriate stabilization straps.
- Make sure the anatomical axis of the joint is aligned correctly with the dynamometer shaft.
- Set the Range of motion (ROM)

- Have the participant perform the initial movement of the exercise over the full range of motion then hold their position at the end. Press the relevant **Set Limit** button for the direction, **Away** or **Toward**.
- Have the participant perform the return motion over the full range of motion and hold, press the **Set Limit** button for that direction
- Both buttons should now have stopped flashing

Isokenetic 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. The participant can slow down or change direction of movement at any point within the range of motion.

- After completing the Setup mode routine, select Isokinetic mode from the control panel
- The Percent ROM buttons can selectively reduce the total range of motion established during participant setup. Use the Percent ROM **Away** and **Toward** buttons to decrease the percent ROM allowed in either direction
- Set contraction type, use the Contraction Away or Toward button to select the appropriate contraction type for each direction of movement. The contraction type selected for each direction of movement is indicated by the contraction button LED. When using eccentric contractions, the patient will have to apply 10% of the set torque value to initiate motion and exceed the torque limit value to stop. The direction the attachment is moving will determine the contraction
- Set speed. Use the Speed **Away/Toward** buttons on the control panel to set the maximum velocity for each direction of movement.
- Set End Stop Cushion. Use the **End Stop Cushion** button to set the point in each direction of the participant's ROM at which deceleration will begin. The cushion level selected is displayed in the window immediately to the right of the button.
- Inform participant that the test or exercise session is ready to begin and that the dynamometer will now allow for rotation of the dynamometer shaft.
- Press **Start** to begin the test or exercise session. The participant will not experience resistance until meeting or exceeding the pre-selected speed. If the subject movement stops, resistance stops

WARNING:



NOTE: Always be sure the Control Panel settings are correct before engaging this device with the Start button. Set range of motion limits after placing subject into restraints. Have subject move through ROM prior to starting test or exercise. Always reset range of motion limits or press Setup when proceeding from one joint, subject, or attachment to another.

Passive mode

In Passive mode the dynamometer provides continuous motion at constant velocity. Direction changes occur when range of motion limits are reached. In Passive mode, the dynamometer initiates motion when the **Start** button is pressed.

- After completing the Setup mode routine, select Passive mode from the control panel
- The Percent ROM buttons can selectively reduce the total range of motion established during participant setup. Use the Percent ROM Away and Toward buttons to decrease the percent ROM allowed in either direction

- Set Pause. The **Pause** buttons (Away and Toward toggles) on the Control Panel allow the introduction of time delays between each direction of motion
- Set speed. Use the Speed Away/Toward buttons on the control panel to set the maximum velocity for each direction of movement
- Set Torque Limits. The Torque buttons, Away and Toward. If the dynamometer detect excessive torque it will stop moving until the torque is reduced below the limit
- Set End Stop Cushion. Use the **End Stop Cushion** button to set the point in each direction of the participant's ROM at which deceleration will begin. The cushion level selected is displayed in the window immediately to the right of the button.
- Inform participant that the test or exercise session is ready to begin and that the dynamometer will now allow for rotation of the dynamometer shaft.
- Press **Start** to begin the test or exercise session. The system will ramp up to the selected speed.

NOTE: For Passive mode dynamometer speeds of 75 degrees/sec. and higher, you must press the Start button twice for high-speed enable.

WARNING:



NOTE: Always be sure the Control Panel settings are correct before engaging this device with the Start button. Set range of motion limits after placing subject into restraints. Have subject move through ROM prior to starting test or exercise. Always reset range of motion limits or press Setup when proceeding from one joint, subject, or attachment to another.

Isometric Mode

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

- After completing the Setup mode routine, select Isometric mode from the control pane
- Press and hold down the **Towards/Away** Button for the desired direction to free up the dynamometer shaft. While holding down the **Towards/Away** Button, instruct/assist the subject to move the limb to the desired point in the ROM. Release the **Rotate** Button to select the ROM position
- Inform patient that the test or exercise session is ready to begin. Press Start to begin the test or exercise session
- Range of Motion changes are made by holding down the Towards/Away Button and moving the limb in the corresponding direction. Once the desired point in the range of motion is met, the button is released and the attachment locks into position.

WARNING:



NOTE: Always be sure the Control Panel settings are correct before engaging this device with the Start button. Set range of motion limits after placing subject into restraints. Have subject move through ROM prior to starting test or exercise. Always reset range of motion limits or press Setup when proceeding from one joint, subject, or attachment to another.

Isotonic Mode

In this mode, the dynamometer requires a minimum set torque to move the arm

- After completing the Setup mode routine, select Isotonic mode from the control panel
- Set Percent ROM. The Percent ROM buttons are used to selectively reduce the total range of motion established during patient setup. Use the Percent ROM Away and Toward buttons to

decrease the percent ROM allowed in the either direction. Do not set the range of motion at the extreme end points

- Set contraction type, concentric/concentric, concentric/eccentric or eccentric/concentric. For Isotonic mode, the system automatically defaults to concentric/concentric movement as indicated by the contraction button LEDs. To alter this section, use the Contraction Away or Toward button to select the appropriate contraction type for each direction of movement. The contraction type selected for each direction of movement is indicated by the contraction button LED. The speed of the eccentric contraction can be controlled (faster eccentric speeds produce greater torque than slower eccentric speeds.)
- Set Torque Limits Toward and Away. In Isotonic Mode, the Torque buttons are used to specify a minimum torque threshold. During the exercise or test session, when this threshold is surpassed by the subject, isotonic motion can occur
- Set End Stop Cushion. Use the End Stop Cushion button to set the point in each direction of the subject's ROM at which deceleration will begin. The cushion level selected is displayed in the window immediately to the right of the button. As a general rule, "hard cushions" (high numbers) are used for testing applications while "soft" cushions (low numbers) are selected for rehabilitation applications. Inform patient that the test or exercise session is ready to begin and that the dynamometer will allow for rotation once the preset torque threshold is obtained. Press Start to begin the test or exercise session.

WARNING:



NOTE: Always be sure the Control Panel settings are correct before engaging this device with the Start button. Set range of motion limits after placing subject into restraints. Have subject move through ROM prior to starting test or exercise. Always reset range of motion limits or press Setup when proceeding from one joint, subject, or attachment to another.

Reactive Eccentric mode

In this mode the dynamometer responds to torque exerted by the patient by moving against the applied force. The Torque buttons on the Control Panel are used to specify a window of desired human force output. The participant is required to maintain torque within the specified range to keep the shaft moving. Reactive Eccentric mode allows for direction changes at any point in the range of motion.

- After completing the Setup mode routine, select Reactive Eccentric mode from the control panel.
- Set Percent ROM. The Percent ROM buttons are used to selectively reduce the total range of motion established during patient setup. Use the Percent ROM Away and Toward buttons to decrease the percent ROM allowed in the either direction.
- Set speed. Use the Speed Away/Toward buttons on the control panel to set the maximum velocity for each direction of movement. More eccentric torque will be performed at higher velocities.
- Set Torque Limits Toward and Away. In Reactive Eccentric mode, the Torque buttons are used to specify a window of desired subject force output. During the exercise or test session, when 10% of the preset torque limit is being applied by the subject, eccentric motion will occur. Reactive Eccentric motion will stop when applied torque is removed or rises above the set amount. The direction the dynamometer shaft is moving during the eccentric contraction is the torque limit you will need to set. To limit eccentric quadriceps, set the toward limit. To limit shoulder external rotators, set the toward limit.
- Set End Stop Cushion. Use the End Stop Cushion button to set the point in each direction of the subject's ROM at which deceleration will begin. The cushion level selected is displayed in the window immediately to the right of the button. As a general rule, "hard cushions" (low numbers) are used for testing applications while "soft" cushions (high numbers) are selected for rehabilitation applications.
- Inform patient that the test or exercise session is ready to begin and that the dynamometer will now allow for rotation of the dynamometer shaft once eccentric resistance meets the specified level. Press Start to begin the test or exercise session.

WARNING:

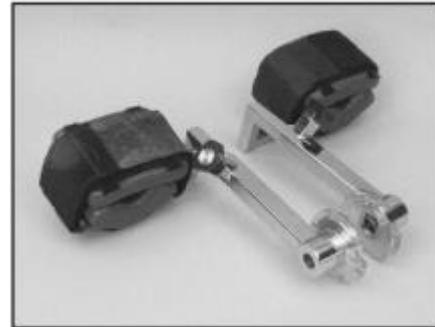
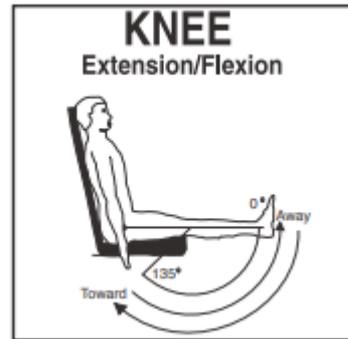


NOTE: Always be sure the Control Panel settings are correct before engaging this device with the Start button. Set range of motion limits after placing subject into restraints. Have subject move through ROM prior to starting test or exercise. Always reset range of motion limits or press Setup when proceeding from one joint, subject, or attachment to another.

Attachments and setup for specific exercises

The Biodex is highly configurable with a number of different attachments to enable a wide range of exercises. The attachments are detailed below but only the most common exercise setup is detailed here. Please refer to the manual to configure the Biodex for other exercises.

Knee extension/flexion



- 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
- Attachment: Knee Attachment (left or right)

WARNING:



NOTE: Ensure finger guards are securely in place.

Setup and Positioning

The starting movement for the test described is Away/Extension

- Seat patient on chair.
- Rotate chair to 90 degrees.
- Rotate dynamometer to 90 degrees. Slide dynamometer along travel to position outside leg to be tested or exercised.
- Attach knee attachment to dynamometer. Align dynamometer shaft red dot with red dot on attachment.
- Move patient into position.
- Align patient knee axis of rotation with dynamometer shaft. Raise/lower seat or move patient toward/away from dynamometer to fine adjust.
- Adjust knee attachment so that it is proximal to medial malleoli. Secure with strap.
- Stabilize patient with shoulder, waist and thigh straps.
- Set ROM stops.

Opposite Side

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

All attachments

Ankle



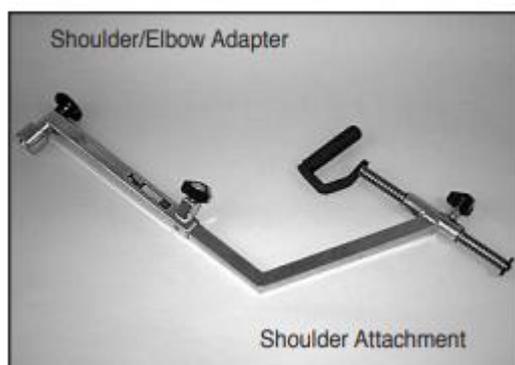
Hip, knee



Forearm, wrist



Shoulder, elbow



Shoulder rotation



Load cell output

An analogue voltage output is provided on a 3.5mm mono jack plug. The output is 0.5V/100N load.

Cleaning

The equipment and the surrounding area need cleaning and sanitizing before and after use and between participants. Use soft wipes and detergent or 70% alcohol solution. Pay particular attention to the areas the participant touches and any spillages especially if taking samples of bodily fluids during the session.

After use

Remove any materials used during testing and return any furniture used to its original location. If you have been testing in an unusual configuration that might confuse or frustrate the next user, return the machine to a more generic configuration.

Training and supervision

Supervisors/line managers should inform users of the risks from the use of the Kin-Com.

Supervisors/line managers should ensure that controls are in place and working and that they are used correctly.

All those using the Kin-Com should be trained and supervised appropriately.

Electrical Safety

Do not use machinery that has obvious damage to body, cable or plug.

All mains powered equipment should have an electrical safety (PAT) testing sticker that is in date. If not, contact the safety officer.

Turn unit off and unplug when not in use.

First Aid

If a minor injury occurs report to a first aider if able to do so. There is a list of first aiders on the laboratory door. There is a first aid box near the telephone.

In case of emergency

Such as a more serious injury. Follow the emergency procedures displayed by the telephone.

Waste

Put all clinical waste which includes anything contaminated with bodily fluids in the bins with the yellow bags. The clinical waste bin should be emptied if more than 2/3 full. Use the bins with black bags for all other waste such as drinks containers.