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User Guide

Spinnaker 4K and 4K-XT

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Contents

Tables

Figures

About This Guide

This guide explains how to operate and maintain the Spinnaker mover device.

The Spinnaker is used to move containers to and from other devices within an automated laboratory system. Such devices may include storage units, such as hotels, stacks, and incubators, as well as operational devices, such as imagers, readers, dispensers, washers, and shakers.

This guide provides information only for the Spinnaker. For information regarding other devices or system automation software, refer to the relevant manufacturer's instructions.

Related Information

This guide is to be read in conjunction with the following documents:

- The *Spinnaker Unpacking Guide*.
- The *Spinnaker Installation Guide*.
- The *MoverTeach User Guide*.
- The *Momentum User Guide* (if the Spinnaker is being integrated into a Momentum system).

Alerts and Notices Within This Guide

The following typographical conventions are used to identify important information within this guide:

Bold text indicates the name of a button, switch, or other control with which the user is being instructed to interact. (For example, "press the **Motor On** button.")

UPPERCASE text indicates the name of a mode or state in which a device or other component must be placed to ensure proper operation. (For example, "before continuing, ensure that main power is OFF".)

Bold, italicized text emphasizes important information which users must read and understand.

> ***TIP*** *Statements prefaced with this caption provide helpful information relevant to the current topic.*

NOTICE Failure to observe statements prefaced with this caption may result in damage to the system or other property.

CAUTION! Failure to observe statements prefaced with this caption may result in minor injury.

WARNING! Failure to observe statements prefaced with this caption may result in serious injury or death.

Contacting Customer Support

When contacting the Customer Support Group, be prepared to provide the following information:

- A clear description of the issue.
- The type and model of Spinnaker involved.
- The Spinnaker's serial number.
- Any errors or warning messages observed.
- The operating system of the computer used to control the Spinnaker.
- Details on how to reproduce the problem, including specific steps and the circumstances surrounding the issue.

The Customer Support Group can be contacted by telephone, fax, or e-mail during the hours of 8am - 5pm, Eastern Standard Time (EST).

Phone and Email

Telephone: 289-313-1869
Toll-free (Canada and the U.S.): 800-365-7587 (when prompted, select Option Three)
Fax: 905-332-1114
Email: services.labautomation@thermofisher.com

Mailing Address

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Burlington, Ontario, L7L 5Z1
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Safety

This chapter explains how to work safely with and around the Spinnaker.

CAUTION! Failure to adhere to the information provided in this section may result in injury or property damage.

Intended Use

CAUTION! Using the Spinnaker in any other way than as described below may create a safety risk and could compromise the warranty agreement.

The Spinnaker is used to move containers to and from other devices within an automated laboratory system. Such devices may include storage units, such as hotels, stacks, and incubators, as well as operational devices, such as imagers, readers, dispensers, washers, and shakers.

The Spinnaker is intended for indoor use in an environment that meets the specifications provided in Table 2 - Environmental Requirements on page 7.

Hazardous Materials

The Spinnaker may only be used to handle radioactive, chemical, biological, or other hazardous materials after a full risk analysis has been completed and all resulting safety requirements have been implemented.

If used to handle hazardous materials, the Spinnaker itself may become contaminated. Be aware of this when working with the Spinnaker and ensure that all local government, industry, and facility safety regulations are observed.

CAUTION! Do not use the Spinnaker to handle substances that are highly combustible or explosive, or which release combustible or explosive gases when exposed to the air.

Unsuitable Containers

Do not use the Spinnaker to handle containers described by one or more of the following characteristics:

- The container exceeds the Spinnaker's maximum payload when fully loaded. (See Table 1 - Physical Parameters on page 7.)
- The container is taller than 50 mm (2 in.).
- The container cannot be easily grasped by the Spinnaker fingers. For example, containers which do not have walls on two sides or which have irregular walls. Also, containers that are too soft or which may warp easily when exposed to heat.
- The container sticks to other containers when stacked or when wet.

Safety During Handling and Installation

While transporting, installing, or otherwise handling the Spinnaker, ensure that the following requirements are met:

- At least two people are required to carry the Spinnaker.
- When lifting the Spinnaker, grasp the base and ensure that the back and arm are supported. When setting it down, use care

to avoid trapping fingers beneath the base.

- Do not lift the Spinnaker by its arm. This may cause damage.
- When moving the Spinnaker to a new location, ensure that the shipping locks are installed. (See the *Spinnaker Installation Guide*.)

Safety During Operation

When working with or around the Spinnaker, ensure that the following safety requirements are met:

- Only trained and authorized personnel may work with or around the Spinnaker.
- In addition to any other personal protective equipment required by local government, industry, and facility regulations, impact-rated safety glasses must be worn at all times while working with or around the Spinnaker.
- When working with or around the Spinnaker, do not wear loose clothing or jewelry, long, unbound hair, or anything else that may be easily caught by the Spinnaker while it is moving.
- The Spinnaker is a fully automated device that may move at any time while under the control of Momentum or a similar system automation management application. Remain outside the Spinnaker's workspace when it is in operation.
- Ensure that the Spinnaker's control puck is positioned within easy reach and outside of the Spinnaker's workspace.
- If the Spinnaker is being operated without having been secured to the supporting surface (such as during a demonstration), the master speed setting must be reduced to 20% or less.
- If the Spinnaker's workspace includes guarding, ensure that it is in place at all times while the Spinnaker is in operation.
- Do not attempt to handle the Spinnaker while it is under the control of Momentum or a similar system automation management application. Doing so may result in injury.
- A fully populated random-access hotel or sequential-access stack can weigh significantly more than when empty. Use care when moving a populated hotel or stack, and do not attempt to load one beyond its maximum capacity.

Halting Operation

If a safety risk or other concern requires that the Spinnaker immediately stop operation, remove power to the motors that control its movement by pressing the **Motor Off** button located on the control puck. The Motor On button goes dark and the Spinnaker is no longer under motor control.

Safety Requirements for Third-Party Integrators

If the Spinnaker is being integrated into a system by a party other than Thermo Fisher Scientific, that integrator must ensure that the following safety requirements are met:

- The integrator must ensure that the system automation management software that will oversee the Spinnaker's operation is fully compatible with the Spinnaker and capable of ensuring its safe and proper use.

- The integrator must train operators in the Spinnaker's proper use and maintenance.

Specifications

This chapter provides a physical description of the Spinnaker.

Working With the Spinnaker

To understand the tasks described in this guide, users must recognize the different parts of the Spinnaker.

The following diagram identifies the parts of the Spinnaker as they are referred to in this guide.

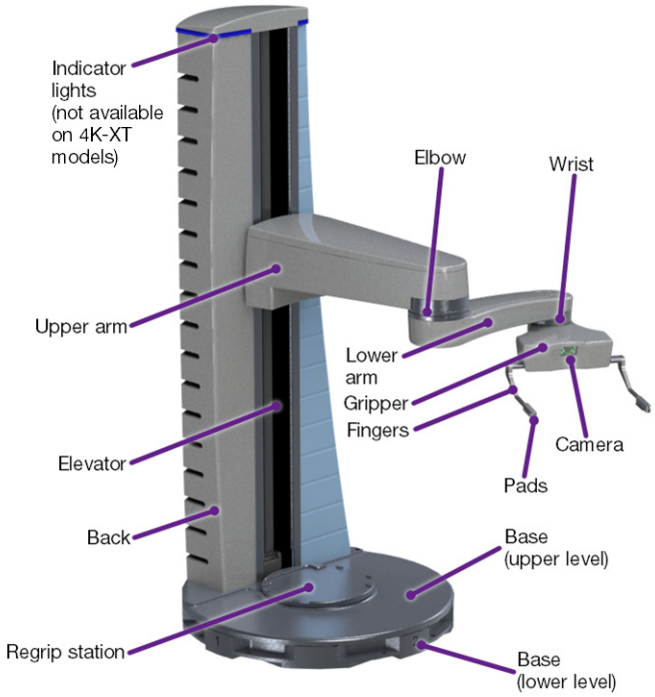

Figure 1: Spinnaker Diagram

Design Summary

The following tables provide the Spinnaker's physical parameters and requirements.

Table 1: Physical Parameters

Parameter	4K	4K-XT
Measurements		
Height	800 mm (31.5 in.)	1,583 mm (62.3 in.)
Weight	25 kg (55 lbs)	33.8 kg (74.4 lbs)
Total mass (inertia)	21.7 kg (48 lbs)	30.5 kg (67.4 lbs)
Workspace		
Vertical (above supporting surface)	32 - 603 mm (1.25 - 23.75 in.)	32 - 1,353 mm (1.25 - 53.25 in.)
Horizontal (diameter)	510 - 1,194 mm (20 - 47 in.)	
Gripper and Camera		
Absolute max. payload*	350 g (12 oz)	
Distance (closed - open)	73.4 - 131.4 mm (2.89 - 5.17 in.)	
Maximum closing force	20.4 N (73.4 ozf)	
Container type	SBS standard	
Container orientation	Landscape or portrait	
Camera resolution (at default Read location)	0.1 mm per pixel (ToolX and ToolY directions)	

* At maximum speed and acceleration. Greater payloads may be possible at reduced speed and acceleration.

Table 2: Environmental Requirements

Parameter	Value
Max. ambient operating temp.	15 - 40°C (59 - 104°F)
Storage temperature	-20 - 60°C (-4 - 140°F)
Humidity	20 - 80% RH up to 31°C (88°F), decreasing linearly to 50% RH at 40°C (104°F). Max 80% RH non-condensing.
Atmosphere	Office/laboratory environment (clean, low-dust, and dry)
Maximum operating altitude	2,000 m (6,560 ft) above sea-level
Installation location	For indoor use only
Power requirement	100 - 240 +/- 10% VAC auto-switching

Table 3: Movable Components

Parameter	Base	Elevator	Elbow	Wrist
Joint travel	Infinite	4K: 635 mm (25 in.) 4K-XT: 1,385 mm (54.5 in.)	Infinite	Infinite
Maximum joint speed	180 degrees/sec	750 mm/sec	360 degrees/sec	720 degrees/sec
Maximum joint acceleration	360 degrees/sec^2	2,000 mm/sec^2	1,440 degrees/sec^2	2,880 degrees/sec^2
Position resolution	±0.00375 degrees/count	0.005625 mm/count	±0.005625 degrees/count	±0.005625 degrees/count
Maximum holding torque/force	9.2 Nm (43 N)	87.4 N	1.8 Nm (9 N)	2.2 Nm (13 N)

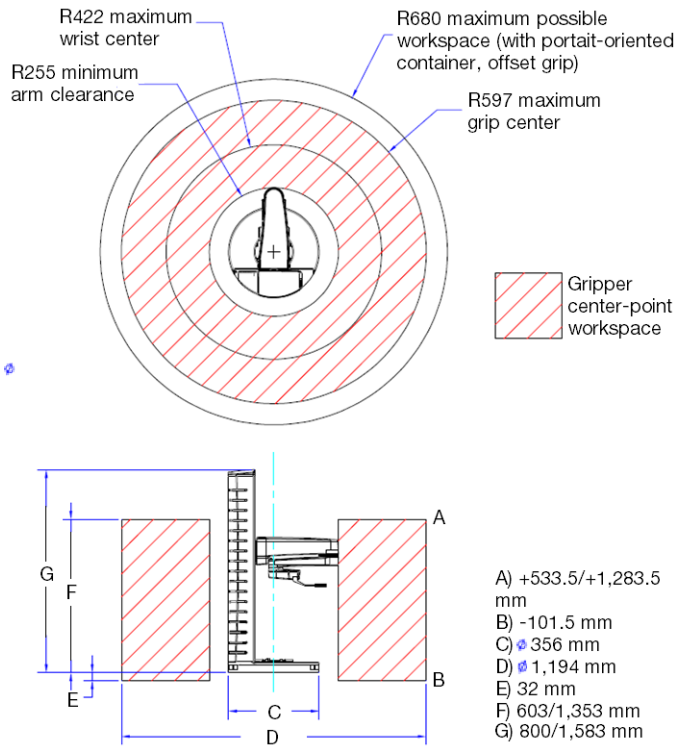

Figure 2: Spinnaker Workspace Diagram

The following table provides the maximum speeds associated with the Spinnaker's operating modes. (See "Understanding Operating Modes" on page 21.)

Table 4: Operating Mode Speed Limits

Parameter	Industrial Mode	Collaborative Mode
Maximum joint speed (%)	100	30
Maximum joint speed (mm/sec)	993	269

The following table provides information for the sequential-access stacks and random-access hotels provided with the Spinnaker.

Table 5: Stack and Hotel Parameters

Parameter	Value
Random-Access Hotels	
Weight (empty)	2.7 kg (5.9 lbs)
Capacity	15 shelves
Sequential-Access Stacks	
Weight (empty)	7 kg (15.4 lbs)
Approximate weight (full)	10 kg (22 lbs)
Capacity	40 microplates

Preparing for Operation

This chapter explains how to prepare the Spinnaker for operation.

At this point, the Spinnaker should have already been installed, configured, and tested. Before performing any of the procedures described in this section, ensure that all installation and initial startup procedures have been completed successfully, as described in the *Spinnaker Installation Guide*.

To prepare the Spinnaker for operation, perform the following procedures in the order in which they are provided.

Energizing the Spinnaker

Before the Spinnaker may be operated using the controlling software, it must be energized using the control puck.

Procedure: If the Spinnaker has not already been energized, do so now by performing the following steps:

TIP For more information about the controls used in this procedure, see “Using the Control Puck” on page 13.

1. Ensure that the Spinnaker’s power and communication cables are securely connected to the ports on the Spinnaker base.

2. Confirm that the Spinnaker’s power cable is connected to a suitable power outlet, and that its communication cable is connected to the correct port on the computer which controls the Spinnaker.

3. To turn on main power and energize the Spinnaker’s internal control modules, set the control puck’s **DC Power** switch to ON (•). The indicator lights at the top of the Spinnaker (4K models only) pulse white for a few seconds, and then glow green. Main power is now ON.

4. Ensure that the **Motor Off** button is not pressed in. If it is, turn it clockwise until it springs back out.

5. Energize the motors by pressing the **Motor On** button. The button glows green and the indicator lights (4K models only) as well as the light on the Spinnaker arm glow blue. The arm should now be under motor control.

6. To confirm that the motors are functional, attempt to gently move the arm by hand. If the arm resists being moved, the motors are functional.

Initializing the Spinnaker

After the Spinnaker has been energized, it must be initialized. This procedure may be performed using either Momentum or MoverTeach.

Using Momentum to Initialize the Spinnaker

Because Momentum manages the entire automated system, initializing the Spinnaker involves bringing the entire system online as a whole.

If only the Spinnaker should be brought online at this time, use MoverTeach to initialize it, rather

than Momentum. (See “Using MoverTeach to Initialize the Spinnaker” on page 10.)

Alternatively, Momentum may be used to bring only the Spinnaker online by first deactivating all other devices in the system, setting them to Simulate mode, or selecting to keep them offline if they display an error during initialization. For more information, see the *Momentum User Guide*.

Procedure: To use Momentum to initialize the Spinnaker, perform the following steps:

1. Open Momentum.

2. In the **Run** ribbon, select the **Normal** button. Momentum begins initializing the system, including the Spinnaker and all other devices controlled by Momentum.

3. If the Spinnaker was energized successfully (see “Energizing the Spinnaker” on page 9), Momentum confirms that the Spinnaker is powered and is able to communicate with Momentum. If an error is encountered during this process, Momentum displays a message. If this occurs, correct the error, and then select **Retry starting the device**. If the error was corrected successfully, Momentum continues initialization.

4. After confirming that the Spinnaker is powered and able to communicate, Momentum homes the Spinnaker (that is, moves it to the “Safe” standard location), and then confirms that the jig nest location as well as the nest location(s) of any other device(s) with which the Spinnaker will interact during operation are known.

5. If this is the first time that the Spinnaker has been initialized, the nest locations checked by Momentum during the previous step have not yet been taught and an error message appears. If this occurs, complete the initialization process by selecting **Resume starting**. The process resumes and the Spinnaker is initialized.

Using MoverTeach to Initialize the Spinnaker

Procedure: To use MoverTeach to initialize the Spinnaker, perform the following steps:

1. Open MoverTeach. At this time, most of the features in the MoverTeach screen will be unavailable, and will remain so until MoverTeach has connected with the Spinnaker.

2. In the MoverTeach menu bar, under **Mover**, select **Connect to [Spinnaker Name]**. The features of the MoverTeach window become active and the Motion Database field is populated with information for this Spinnaker. The status bar at the bottom of the screen indicates that power is OFF and that the Spinnaker is not homed.

TIP *As MoverTeach connects with the Spinnaker, the indicator lights on the Spinnaker (4K models only) turn green (communication is occurring), and then blue (the motors are ready for activity).*

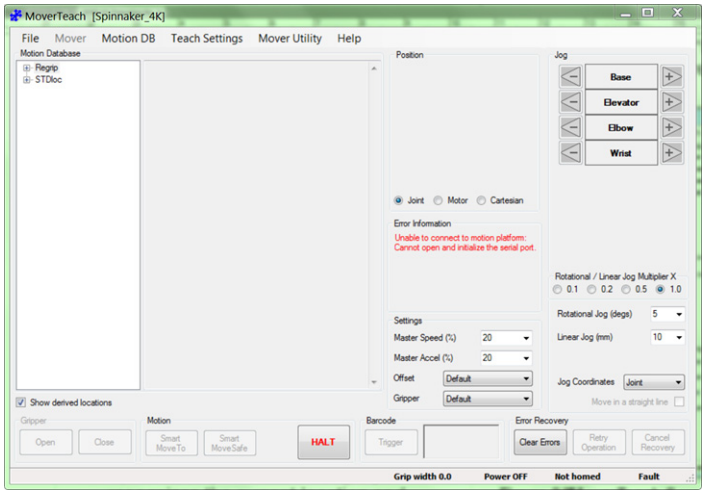

Figure 1: MoverTeach Screen on Startup

3. In the MoverTeach menu bar, under **Mover Utility**, select **Turn Power On**. Each of the Spinnaker's joints moves slightly, and the status bar changes from "Power Off" to "Power On".

4. In the MoverTeach menu bar, under **Mover Utility**, select **Home All Axes**. Each of the Spinnaker's joints moves slightly as it recognizes the current location and orientation of each movable component. The Spinnaker then moves to the Safe location. After this procedure has been completed, the status bar changes from "Not Homed" to "Homed". The Spinnaker is initialized and ready for operation.

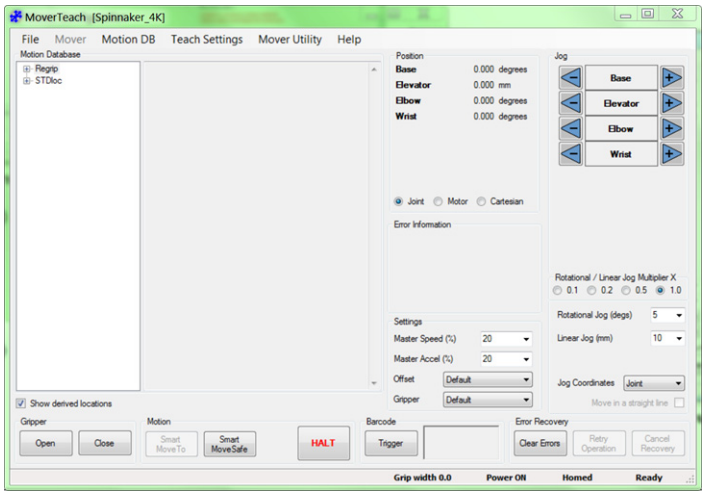

Figure 2: MoverTeach Screen With Mover Homed and Power On

Controlling the Spinnaker

This chapter explains how to control the Spinnaker's operation.

The Spinnaker can be controlled using the following methods:

- Directly, using the Spinnaker's control puck.
- Directly, using MoverTeach.
- Remotely, using Momentum.

The control puck is used to control power to the Spinnaker, while the controlling software (Momentum or MoverTeach) is used to manage its actions during operation.

Many of the procedures described in this guide require users to perform tasks involving both the control puck and the controlling software. For example, to prepare the Spinnaker for operation, it must first be energized (using the control puck), and then initialized (using the controlling software).

Using the Control Puck

The control puck includes the following features:

- The DC Power switch.
- The Motor On button.
- The Motor Off button.

Figure 1: Control Puck

DC Power Switch

To energize the Spinnaker's internal control modules, set the **DC Power** switch to ON (•). To de-energize the modules, press the opposite (unlabeled) side of the switch.

The DC Power switch does not control power to the motors which control the Spinnaker's movement, however, it must be set to ON in order for the controls which do energize the motors to function.

After the switch is set to ON, the control modules are powered over the span of approximately twelve seconds. When the indicator light on the vision camera flashes, all internal modules are energized.

The control modules manage a variety of activity, including communication with the computer, motor operation and positioning, and camera operation.

TIP *When the DC Power switch is set to OFF, the internal control modules lose any*

information that they had acquired during operation.

Motor On Button

To energize the motors that control the Spinnaker's movement, press the **Motor On** button. Pressing this button will enable the Spinnaker to move if the appropriate commands are given.

The Motor Off button must be reset for the Motor On button to function.

Motor Off Button

To de-energize the motors, press the **Motor Off** button. The button will remain pressed in and will prevent the Spinnaker from moving until it is reset.

To reset the Motor Off button, turn it clockwise until it springs back out. Resetting the button will not immediately restore power to the Spinnaker. To do so, after resetting the **Motor Off** button, press the **Motor On** button.

Using the Controlling Software

The Spinnaker's operation is controlled using either Momentum or MoverTeach.

Momentum Momentum is a system automation management application which coordinates the actions of the individual devices in an automated system.

MoverTeach The MoverTeach application is used to control an individual mover, such as the Spinnaker. MoverTeach can be used in conjunction with Momentum or with another system automation management application. It may also be used as a stand-alone tool for controlling a mover.

Most of the procedures described in this guide are performed using the Spinnaker's controlling software, and many may be performed using either Momentum or MoverTeach. In such cases, the procedure varies depending on the application being used, so both versions of the procedure are provided.

To avoid confusion, ensure that the correct version is being followed, depending on whether the procedure is being performed using Momentum or MoverTeach.

Understanding Limping

The Spinnaker is 'limped' when motor control is removed from the joints, allowing the Spinnaker to be moved safely by hand. This method is useful when the Spinnaker must be moved quickly into a general position or location.

For example, when teaching the Spinnaker the location of a new nest, the Spinnaker may be limped and moved by hand so that the gripper is in the general location of the nest. Motor control is then restored, allowing the precision control needed to move the gripper into the exact position required to place a container in the nest.

Handling the Spinnaker While Limped

When handling the Spinnaker while it is limped, observe the following precautions:

TIP *For an illustration showing the individual Spinnaker parts mentioned below, see* *Figure 1 - Spinnaker Diagram on page 7.*

NOTICE Failure to observe the following precautions may result in damage to the Spinnaker.

- Although the Spinnaker joints will move freely when limped, handle the Spinnaker with care and avoid any sharp, jerking motions.

- When raising or lowering the elevator, grip the Spinnaker's upper arm as close to the elevator as possible. (The elevator is counterweighted, so there will be a small amount of resistance, even when the elevator is limped.)

- When raising or lowering the elevator, do not grip the Spinnaker by the gripper or the lower arm.

- If the elevator joint is limped while the Spinnaker is holding a container weighing more than approximately 250 g (8.8 oz), the Spinnaker arm may begin to lower due to the weight.

- When positioning the gripper and the lower arm, grasp each part as close to its respective joint (wrist for the gripper, elbow for the lower arm) as possible.

Limping the Spinnaker

Using MoverTeach, the Spinnaker's joints may be limped all together or individually, as required.

Limping and Unlimping All Joints Simultaneously

Procedure: To limp all joints simultaneously, perform the following steps:

1. In MoverTeach, ensure that the Spinnaker has been initialized. (See "Using MoverTeach to Initialize the Spinnaker" on page 10.)

2. In the **Mover Utility** menu, select **Limp All Axes**. A warning notice appears. (This notice is a general warning presented for all movers and does not apply to the Spinnaker.)

3. Select the **Yes** button. All joints are limped and MoverTeach's jog controls are disabled.

Procedure: To unlimp all joints at once, in the **Mover Utility** menu, select **Unlimp All Axes**. The Spinnaker is unlimped and MoverTeach's jog controls are restored.

Limping and Unlimping Joints Individually

Procedure: To limp an individual joint, perform the following steps:

1. In MoverTeach, ensure that the Spinnaker has been initialized. (See "Using MoverTeach to Initialize the Spinnaker" on page 10.)

2. In the **Jog Coordinates** dropdown menu, select **Joint**.

3. Right-click on the jog control for the joint that will be limped (base, elevator, elbow, or wrist), and then select **Limp Axis**. The selected joint is limped and the jog control for that joint is disabled.

Procedure: To unlimp an individual joint, right-click on the jog control for the joint that will be unlimped (base, elevator, elbow, or wrist), and then select **Unlimp Axis**. The selected joint is unlimped and the jog control for that joint is restored.

Moving the Spinnaker by Direct Command

Typically, the Spinnaker's movement is overseen by Momentum, which issues commands in accordance with an automated process.

In some cases, however, it may be necessary to control the Spinnaker's movements directly, such as when using MoverTeach to teach it a new nest location.

Using MoverTeach, the user may issue movement commands directly to the Spinnaker.

Understanding Jog Control Types

There are three jog control types available:

- Joint.
- Cartesian.
- Tool.

Each control type is based on a different set of coordinates. The jog controls (located in the upper-right of the MoverTeach window) are used to control the Spinnaker's movement, and change to reflect the coordinates of the control type that is currently selected.

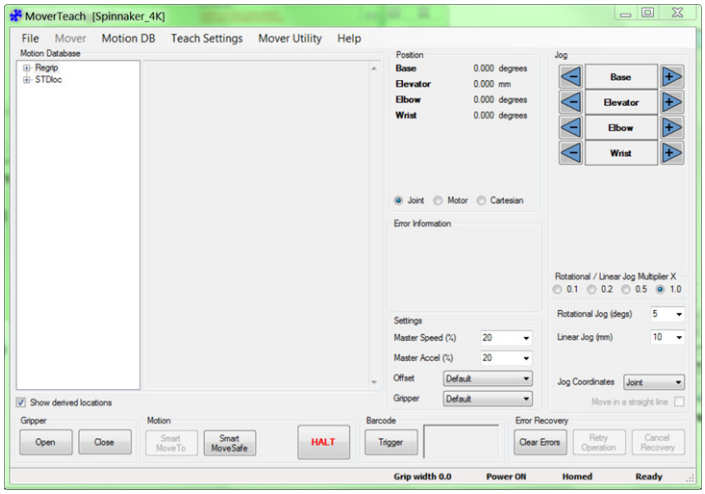

Figure 2: MoverTeach Window

Each jog control type allows the Spinnaker to be moved in a slightly different way, meaning that the ideal control type will vary depending on the situation.

For example, if the Spinnaker must be moved quickly to a general location, the Joint control type would be most useful, whereas the Tool control type is best-suited for smaller, more precise movements.

Joint Jog Control Type

When the Joint jog control type is selected, the jog controls reflect the positioning of each of the Spinnaker's movable joints, and can be used to either rotate or adjust the height of a joint, as applicable.

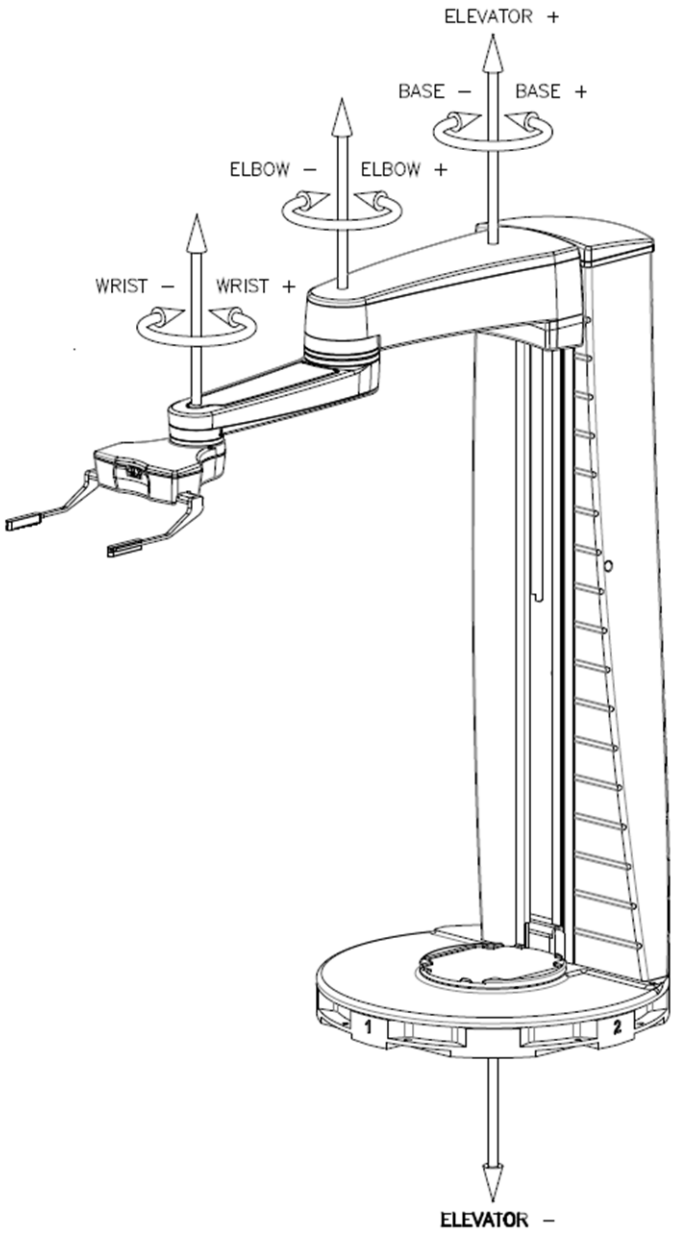

Figure 3: Joint (Jog Control) Movement

The following table provides the Joint jog controls and their impact on the Spinnaker's motion.

Table 1: Joint Jog Controls

Control	Positive (+) Button	Negative (-) Button
Base	Rotates the base counter-clockwise	Rotates the base clock-wise
Elevator	Raises the elevator	Lowers the elevator
Elbow	Rotates the elbow counter-clockwise	Rotates the elbow clockwise
Wrist	Rotates the wrist counter-clockwise	Rotates the wrist clock-wise

Compared to other jog control types, Joint is useful for quickly moving the Spinnaker into a general position, such as turning the base to face the direction of a device, or adjusting the elevator to match the general height of a nest.

Cartesian Jog Control Type

When the Cartesian jog control type is selected, the jog controls reflect the Spinnaker's motion along the three axes of a Cartesian frame of reference (X, Y, and Z), as well as its rotation along those axes (Xrot, Yrot, and Zrot).

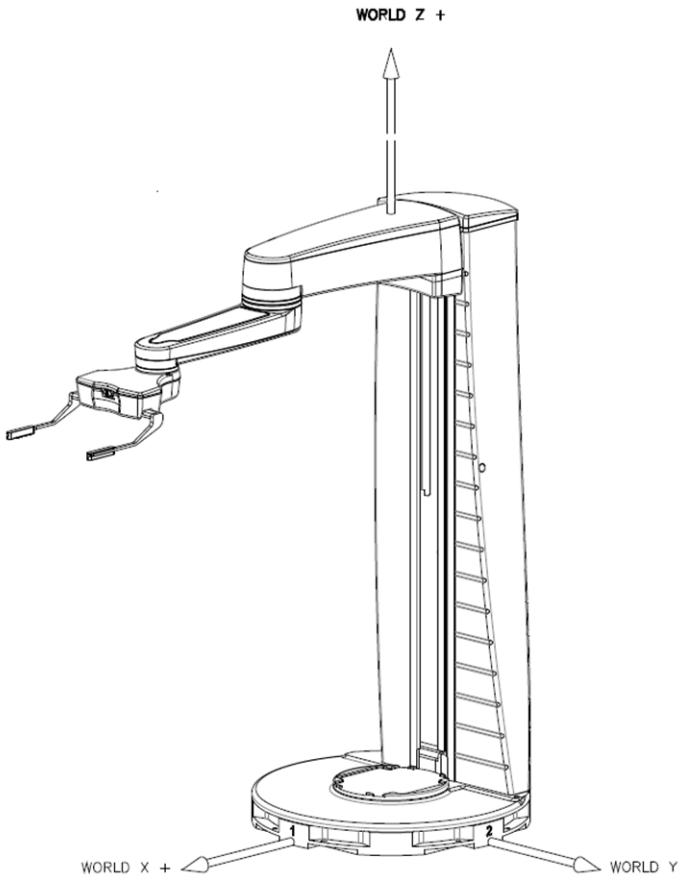

Figure 4: Cartesian (Jog Control) Movement

Each axis stems from a central point of origin. This point is located in the center of the Spinnaker base. Both the central point of origin and the overall frame of reference remain stationary, regardless of how the Spinnaker moves.

For example, the X axis reflects the Spinnaker's forward and backward motion, with "forward" always facing the front of the base's lower level (which does not rotate). The Spinnaker arm is moving forward when it is facing this direction, and backward if it turns to face the opposite direction.

Unlike Joint controls, which reflect the position of each individual joint, Cartesian controls reflect the location of the center-point between the Spinnaker fingers in regard to the central point of origin.

TIP *Although the Xrot and Yrot controls are available in MoverTeach, the Spinnaker is not capable of rotating along these axes. (Though other movers controlled by MoverTeach can.) As such, these controls have no effect on the Spinnaker's motion.*

The following table provides the Cartesian jog controls and their impact on the Spinnaker's motion.

Table 2: Cartesian Jog Controls

Control	Positive (+) Button	Negative (-) Button
X	Moves the finger center-point forward	Moves the finger center-point backward
Y	Moves the finger center-point left	Moves the finger center-point right
Z	Moves the finger center-point up	Moves the finger center-point down
Zrot	Rotates around the Z axis	Rotates around the Z axis
Yrot	N/A	N/A
Xrot	N/A	N/A

Compared to other jog control types, Cartesian is useful for movements that are more focused than those performed using Joint, but not as precise as those performed using Tool. (For example, moving the gripper to the general location of a device's nest, but not necessarily aligning it with the nest.)

Tool Jog Control Type

When the Tool jog control type is selected, the jog controls reflect the Spinnaker's motion along the three axes of a Cartesian frame of reference (X, Y, and Z), as well as its rotation along those axes (Yaw (Z axis), Pitch (Y axis), and Roll (X axis)).

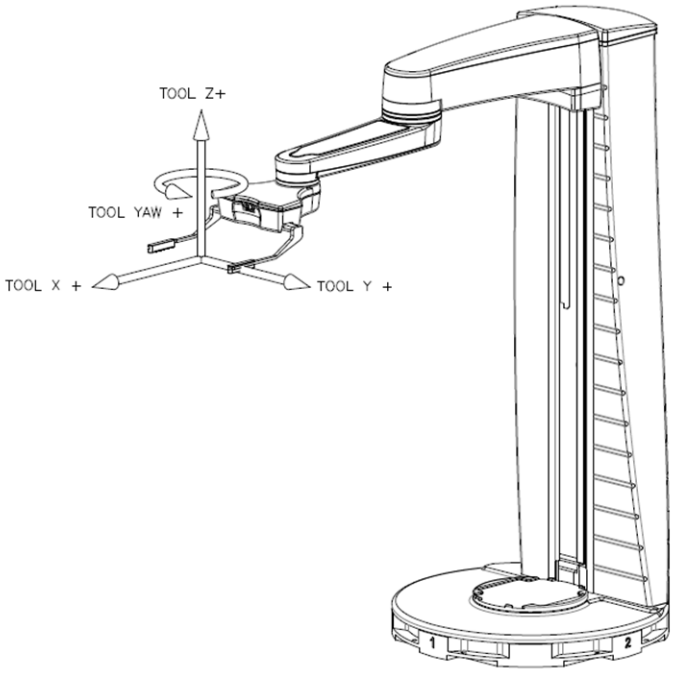

Figure 5: Tool (Jog Control) Movement

As with the Cartesian control type, each axis stems from a central point of origin. However, with Tool, this point is located at the center-point between the Spinnaker fingers, rather than the center of the Spinnaker base.

As such, the Tool central point of origin and the overall frame of reference moves with the finger center-point as the Spinnaker moves. When a

command to move is received, the difference between the current central point of origin and the requested location is calculated. The Spinnaker then moves the finger center-point to this new location. This location then acts as the central point of origin for the next move command.

TIP *Although the Pitch and Roll controls are available in MoverTeach, the Spinnaker is not capable of rotating along these axes. (Though other movers controlled by MoverTeach can.) As such, these controls have no effect on the Spinnaker's motion.*

The following table provides the Tool jog controls and their impact on the Spinnaker's motion.

Table 3: Tool Jog Controls

Control	Positive (+) Button	Negative (-) Button
X	Moves the finger center-point forward	Moves the finger center-point backward
Y	Moves the finger center-point left	Moves the finger center-point right
Z	Moves the finger center-point up	Moves the finger center-point down
Yaw	Rotates around the Z axis	Rotates around the Z axis
Pitch	N/A	N/A
Roll	N/A	N/A

Compared to other jog control types, Tool is useful for shorter, more precise motions, such as maneuvering the gripper so that it aligns with the exact location where a container should be placed in a nest.

Choosing a Jog Control Type

Procedure: To choose a jog control type, in the **Jog Coordinates** dropdown menu, select either **Joint**, **Tool**, or **Cartesian**, as needed. The jog controls (located in the upper-right of the window) change to display the selected set of controls.

Displaying Location Values

The values representing the Spinnaker's current location are displayed to the left of the jog controls. There are three distinct sets of values which may be displayed, depending on the current display setting.

Joint The Joint display setting shows either the current degree of rotation or the current height of each of the Spinnaker's four joints, as applicable.

Motor The Motor display setting shows the current positioning of each of the Spinnaker's four motors.

TIP *The Cartesian display setting uses the Cartesian jog control type's central point of origin regardless of the jog control type currently selected. (See "Understanding Jog Control Types" on page 16.)*

Cartesian The Cartesian display setting shows the current Cartesian coordinates of the center-point between the Spinnaker fingers in relation to the central point of origin. (See "Cartesian Jog Control Type" on page 17.)

Only one set of values may be displayed at any given time.

Procedure: To change the display setting, select either the **Joint**, **Motor**, or **Cartesian** option button, as needed.

Controlling the Gripper

If necessary, the gripper can be commanded to open or close the fingers. The gripper controls are found in the lower-left corner of the MoverTeach window.

Procedure: To open or close the gripper fingers, in MoverTeach, select either the **Open** or **Close** button, as needed.

Using the Jog Controls to Move the Spinnaker

In addition to the jog controls themselves (see "Understanding Jog Control Types" on page 16), there are additional control features which will affect how the Spinnaker moves when commanded through MoverTeach.

Linear Jog The linear jog value impacts how far (in millimeters) the Spinnaker elevator moves per movement command. This value also affects motion along linear axes when the Cartesian and Tool jog control types are selected. (See "Understanding Jog Control Types" on page 16.)

Rotational Jog The rotational jog value impacts how much (in degrees) the base, elbow, and wrist joints rotate per movement command.

Jog Multiplier The linear and rotational jog values are multiplied by the selected jog multiplier value. (In most cases, this value is set to 1.0 unless very precise movements are required.)

Ensuring that these values are set correctly before issuing a move command will reduce the risk of a collision.

Procedure: To use the jog controls to move the Spinnaker, perform the following steps:

TIP *Typically, higher linear and rotational jog values are used for longer, more generalized movements, while lower values are used for shorter, more precise movements.*

1. Confirm that the linear and rotational jog values are correct.
2. Confirm that the selected jog multiplier value is correct.
3. In the Jog Coordinates dropdown list, select either **Joint**, **Cartesian**, or **Tool**, as needed. (See "Choosing a Jog Control Type" on page 19.)
4. Ensure that the desired set of location values (Joint, Motor, or Cartesian) is displayed. (See "Displaying Location Values" on page 19.)
5. If the Spinnaker will be commanded to pick up a container during this session, ensure that the fingers are fully open. (See "Controlling the Gripper" on page 19.)
6. For each jog control that will be used during this session, test the related settings by selecting either the control's positive (+) or negative (-) button, and then observing the Spinnaker's movement. Note the direction in which it moves and how much the joint moves, and then make any necessary changes to the settings defined in the previous steps.
7. After confirming the performance of each jog control that will be used during this session, use the controls as needed to move the Spinnaker to the desired location.

Using the Regrip Station

The regrip station is located in the center of the Spinnaker base. (See Figure 1 - Spinnaker Diagram on page 7.)

The regrip station is used whenever the Spinnaker must change the orientation of a container which it is moving.

For example, if the Spinnaker gets a container from a portrait-oriented hotel nest and will be

putting the container in the landscape-oriented nest of a reader, after getting the container, the Spinnaker can set it in the regrip station's portrait orientation, reposition itself to the station's landscape orientation, and then pick up the container before continuing on to the reader's nest.

During runs overseen by Momentum, this process is typically automated and requires no action from the user. If MoverTeach is being used to control the Spinnaker's movement, however, users may need to complete the regrip process manually.

NOTICE If the regrip locations have not yet been confirmed, do so now before continuing. (See "Confirming Regrip Locations" on page 35.)

Procedure: To use the regrip station while controlling the Spinnaker with MoverTeach, perform the following steps:

1. Ensure that the container is located in a nest location that has been taught. (See "Teaching and Healing Locations" on page 27.)

1. In MoverTeach's Motion Database field, expand the **[Device Name]** section and its **locations** subsection for the device where the container is currently located.

2. Right-click the name of the nest where the container is located, and then select **Get Plate Into Gripper**. The Spinnaker moves to the nest, picks up the container, and then moves it to the Safe position.

3. In MoverTeach's Motion Database field, expand the **Regrip** section and its **locations** subsection. Two locations, Landscape and Portrait, are available.

4. Move the Spinnaker to the regrip location that matches the way in which the Spinnaker is currently gripping the container. To do so, right-click either the **portrait** or **landscape** location, as appropriate, and then select **Put Plate Into Nest**. The Spinnaker places the container in the regrip station in the selected orientation, and then moves to the Safe position.

5. Right-click the new location (either **portrait** or **landscape**, as appropriate), and then select **Get Plate Into Gripper**. The Spinnaker moves to the regrip station, picks up the container in the selected orientation, and then moves it to the Safe position.

Understanding Operating Modes

The Spinnaker has two operating modes: Industrial Mode and Collaborative Mode.

Industrial Mode When in Industrial Mode, the Spinnaker may move at up to 100% of its maximum possible speed. Due to the risk of injury when operating at high speeds, this mode is only available if the Spinnaker is connected to a MiniHub or an E-Stop Hub, and requires that the Spinnaker's workspace be equipped with guarding.

TIP *The speed limit imposed by Collaborative Mode applies to the speed of the Spinnaker's individual joints.*

Collaborative Mode Collaborative mode limits the Spinnaker's top speed to the maximum value permissible without the use of guarding. Spinnakers that are not connected to a MiniHub or E-Stop Hub are restricted to Collaborative Mode at all times. Those which are capable of both modes should be set to Collaborative mode

whenever a user is working directly with the Spinnaker, such as during a teaching session.

TIP *When the Spinnaker is in Collaborative Mode, a "Speed restricted" notice is displayed in the lower-left corner of the MoverTeach window.*

TIP *When the Spinnaker is being controlled directly via MoverTeach, its maximum speed when performing all move commands except SmartMoveTo is reduced to 20%. (SmartMoveTo uses the Collaborative Mode speed limit.)*

For more information about the speed limits associated with each mode, see Table 4 - Operating Mode Speed Limits on page 8.

Understanding Vision-Based Operations

Vision-based operations use the Spinnaker's camera to recognize the Smart Jig's target pattern (the white dots on the side of the Smart Jig). This allows Momentum to determine the Smart Jig's location in relation to the Spinnaker.

In Momentum systems, this feature is used when teaching and healing nest locations, as well as during a Pick & Place Test.

Optimizing Conditions for Vision-Based Operations

There are several environmental factors that can impact vision-based operations.

When preparing to perform a vision-based operation, such as vision-teaching or healing, ensure that the following conditions have been met:

- The location should be lit primarily by artificial light, rather than natural light, which may vary.
- The amount of light should be equivalent to what would normally be found in an office or laboratory setting.
- Ensure that the target pattern is uniformly lit. (That is, free of shadow edges and not exposed to significantly brighter light on one side than on the other.)
- Ensure that the target pattern is fully visible to the Spinnaker camera. (That is, not obscured by nest locators or other obstacles.)

Restrictions for Vision-Based Operations

In some cases, a nest location will not be compatible with vision-based operations.

When determining whether a nest is vision-compatible, refer to the following guidelines.

Obscured Nests If the Smart Jig's target pattern is partially or fully hidden from the Spinnaker camera when the Smart Jig is placed in a nest location, that location is not vision-compatible. This issue is common with nests that include guides, locators or other positioning aids that partially or fully obscure the sides of the Smart Jig.

Virtual Nests Nests which do not have physical locations in which the Smart Jig can be placed

are not vision-compatible. Common examples of such nest locations include the following:

- Waste locations where the Spinnaker is to drop a container into a disposal bin after releasing it, rather than placing it on a physical surface.
- Stack locations. (The top of a stack must be taught, but is not itself a physical location where the Smart Jig may be placed.)
- Locations in which the Spinnaker is to hold a container in place, rather than set it and release it. For example, a location where the Spinnaker is to hold a container in front of a barcode reader.

TIP *Although it includes two distinct locations, the Spinnaker regrip station* ***is*** *vision-compatible.*

Multi-Location Nests Individual nests for which more than one physical location must be taught are not vision-compatible. Examples include swap and rotation stations.

Complex Pre-Placement Requirements Nests that require the device to perform a simple action before a container may be placed, such as opening a nest door, are likely to be vision-compatible. However, nests that require the device to perform a series of actions or to receive information before the container may be placed are not likely to be vision-compatible.

Using the Barcode Reader

The Spinnaker camera includes an integrated barcode reader which may be used to identify specific containers by reading (decoding) barcode labels.

Supported Barcode Types

The following table provides the barcode types which the barcode reader can interpret.

Table 4: Supported Barcode Types

Code Type	
1D Codes	
Codabar	NEC 2 of 5
Code 39	Straight 2 of 5
Code 93	Interleaved 2 of 5
Code 128	MSI Plessey
GS1	Telepen
Matrix 2 of 5	
2D Codes	
Data Matrix	

Guidelines and Requirements for Barcode Reading

The following sections explain how to ensure that the barcode reader is able to identify and decode barcodes.

Optimizing Barcode Design

Barcode labels should be designed according to the following specifications:

- For best contrast and performance, print barcodes in black ink and on white labels.
- Labels must use a barcode type that is supported by the Spinnaker's barcode reader. (See "Supported Barcode Types" on page 23.)
- Barcodes should be no longer than 32 characters.
- Barcodes should be large enough to allow adequate contrast between light and dark bands. To ensure that the barcode can be

viewed clearly by the Spinnaker when in the read location, all barcodes should be 5.8 x 33 mm for an eight-character figure (scale as needed for figures with more or less than eight characters).

Figure 6: Acceptable (Top) and Unacceptable (Bottom) Barcode Sizes

- When applying a barcode label to the side of a container, ensure that the label is centered as much as possible. If at all possible, the edges of the label should be 12 mm away from the edges of the container side.

- There must be adequate white space on either side of the barcode pattern. This space should be equal to 6 mm on either side, or ten times the width of the smallest bar in the barcode pattern (whichever is greater.)

Optimizing Reading Conditions

When using the barcode reader, ensure that the following requirements are met:

- Ensure that lighting conditions have been optimized. (See “Optimizing Conditions for Vision-Based Operations” on page 22.)

- The barcode reader can decode labels applied to the container on either a portrait or a landscape side, however, there will be approximately 21 mm difference in distance between the reader and a label on the portrait side of a container versus one on a landscape side.

- The barcode reader will decode up to five barcode patterns simultaneously if they all appear within the decoding window. (See “Positioning for Barcode Reading” on page 24.)

Positioning for Barcode Reading

When capturing a barcode image, the Spinnaker moves to the read location associated with the nest where the container bearing the barcode has been positioned.

Read locations (designated by “.read” in the Motion Database) are extrapolated locations based on the related nest locations, and do not need to be manually taught by the user. (See “Sections and Subsections” on page 27.)

Because an image captured from a nest’s read location may also include the barcode labels for containers in nearby nests, The barcode reader only decodes a portion of the overall image.

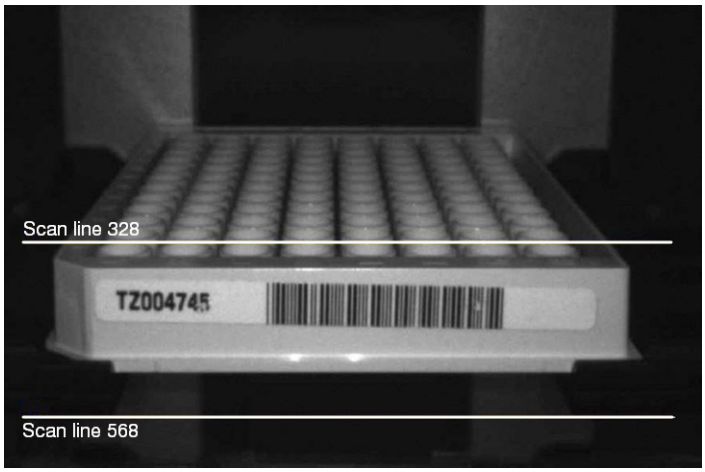

Figure 7: Barcode Reader Decoding Window

This portion is between scan lines 328 and 568. Barcodes that appear in the image, but which are not within the image’s decoding window, will not be decoded. Barcodes that appear partially within the decoding window may be decoded, depending on how much of the barcode pattern is in the window, and the clarity of that portion.

As a general rule, approximately 30% of a barcode pattern must appear within the decoding window in order for the barcode to be decoded.

Triggering the Barcode Reader

Procedure: To command the barcode reader to capture an image, in MoverTeach, select the **Trigger** button found at the bottom of the MoverTeach window.

Testing the Barcode Reader

The following script can be used to determine whether the barcode reader can decode a barcode in a specific nest location:

```
set nest Inst1:nest[1]
smartmoveto ${nest}.read
if $LOOPS == 1
  set FName BarcodeTest_($DATE_NAME)
  setlogfile ${FName}.txt
  logassert
endif
captureimage ${FName}.jpg
targetIndicator 0
set i 1
loop 10
  ReadCode
  if $N_CODES
    echo $i: $CODE[0]
  else
    echo $i: NoCode
  endif
  setexpr i $i + 1
endloop
echo end
setlogfile
```

This script can be executed using MoverTeach's Test Tool.

TIP *If the nest being tested includes both landscape and portrait orientation options, perform a separate test for each orientation.*

Procedure: To use the test script to determine whether the barcode reader can decode a barcode, perform the following steps:

1. In MoverTeach, select **Test Tool** in the **Mover Utility** menu. The Test Tool window appears.

2. Enter the script provide above into the Test Tool's script field.

3. In the script, replace the text "Inst1:nest[1]" with the name of the nest that will be tested.

4. To run the script, select the **Start** button. After a brief pause, the test is completed and the resulting output files are generated.

The test script generates two output files:

- A report file detailing the results of the test. The file is named "BarcodeTest" followed by the date and time that the test was performed. (For example, "BarcodeTest_(20160808_1429).txt)".)

- The image file captured during the test. The file is named using the same convention as the accompanying report file. (For example, "BarcodeTest_(20160808_1429).jpg)".)

These output files are generated at the following location:

C:\Program Files (x86)\Thermo Scientific\Mover Framework.

Shutting Down the Spinnaker

Procedure: To shut down the Spinnaker, perform the following steps:

1. Ensure that the Spinnaker is in the Safe location. (See “Moving the Spinnaker by Direct Command” on page 15.)

2. In MoverTeach, under the **Mover** menu, select **Disconnect**. Communication with the Spinnaker is ended and many of the MoverTeach features become inactive.

3. Close MoverTeach.

4. At the Spinnaker control puck, remove power to the Spinnaker’s motors by pressing the **Motor Off** button. The Motor On button goes dark and the Spinnaker’s indicator lights (4K models only) change to red with a green background, indicating that there is an error, but that the Spinnaker still has a communication link with the computer.

5. Remove main power to the Spinnaker by setting the **DC Power** switch to OFF. The indicator lights (4K models only) go dark and the Spinnaker is shut down.

Teaching and Healing Locations

This chapter explains how to teach new locations to the Spinnaker, and how to heal previously taught locations.

Understanding Locations and Teaching

A location is a point in space which the Spinnaker has been taught and to which it can move. A location may be a point where the Spinnaker performs an action, such as placing a container in the nest of a device, or it may be one of several points along the route which the Spinnaker takes while moving to such a location.

Teaching is the process of instructing the Spinnaker about a location. It is one of the first actions performed with a Spinnaker after it has been integrated within a system.

Both Momentum and MoverTeach may be used to teach locations to the Spinnaker.

Using Momentum to Teach the Spinnaker

Momentum features a vision-assisted teaching process (vision-teaching) that uses the Spinnaker's built-in camera to recognize the location of a nest or other position where the Spinnaker should perform an action, such as placing or retrieving a container.

Requirements for Vision-Teaching

To use Momentum to teach the Spinnaker new locations, the following conditions must be met:

- The Spinnaker has been installed, configured, and tested. (See the *Spinnaker Installation Guide*.)
- The Spinnaker has been added to Momentum's list of devices. (See the *Momentum User Guide*.)
- If teaching the location of a nest other than the jig nest, the device containing that nest has been added to Momentum's list of devices. (See the *Momentum User Guide*.)
- The Spinnaker has been initialized and is ready for operation. (See "Initializing the Spinnaker" on page 9.)
- The nest location has been confirmed to be vision-compatible and conditions for vision-based operations have been optimized. (See "Understanding Vision-Based Operations" on page 22.)

Vision-Teaching New Locations

Procedure: To vision-teach a new location, perform the following steps:

TIP *For more information about navigating in Momentum, see the Momentum User Guide.*

1. In Momentum, select the **Profile** button in the **Editors** section of the **View** ribbon. The Profile Editor appears in the Main window.

TIP *If teaching the jig nest location, select the Spinnaker while performing the following step.*

2. In the Profile Editor, select the icon for the device containing the nest location(s) that will be taught.

3. Select the **Teach** button in the **Movers** section of the **Devices** ribbon, and then select **Teach with Vision**. The Teach Wizard appears.

4. In the wizard's Getting Started screen, begin the teaching process by selecting the **Next** button. The Ready Spinnaker (step 1 of 4) screen appears.

TIP *For more information about preparing the Spinnaker for operation, see "Initializing the Spinnaker" on page 9.*

TIP *If the location being taught is part of another device that must be initialized, Momentum will also confirm that this device is ready, and will prompt the user to correct any issues detected.*

5. Confirm that the Spinnaker is ready for operation (initialized) by selecting the **Start** button. Momentum confirms that the Spinnaker is ready, and prompts the user to address any issues detected. When the Spinnaker is ready, the Place Smart Jig (step 2 of 4) screen appears.

6. Place the Smart Jig in the location that is being taught, as instructed in the Place Smart Jig screen. Be sure to observe specific instructions regarding landscape versus portrait orientation and the direction which the target pattern must face.

TIP *If teaching the location of a jig nest installed on a curved base plate, one of the random-access hotel or sequential-access stacks nearest the jig nest must be moved to allow room for the Spinnaker when taking an image of the Smart Jig. (The hotel or stack that must be moved depends on the jig nest's orientation.)*

7. After placing the Smart Jig, in the Place Smart Jig screen, select the **Next** button. The Target Light (step 3 of 4) screen appears and Momentum limps the Spinnaker.

TIP *When positioned correctly, the brightest (central) portion of the target light should be centered upon the target pattern.*

8. Gently maneuver the Spinnaker arm (see "Limping the Spinnaker" on page 15) so that the light from the camera's two blue indicator LEDs (located in the center of the gripper, between the fingers) illuminates all of the dots in the target pattern.

9. After positioning the Spinnaker's arm, select the **Next** button. The Image Acquisition screen appears and displays a progress bar. During this process, the Spinnaker's camera takes a picture of the Smart Jig and Momentum uses this image to calculate the Smart Jig's location. After this process is completed, the Success screen appears.

10. Depending on the type of device involved, the Success screen displays one of the following messages:

    - If teaching with a device that includes multiple nests, the Success screen indicates whether additional nest locations must be taught at this time. (See "Vision-Teaching Multiple Nest

Locations" on page 29.) To continue with teaching these locations, select the **Next** button. The Target Light screen for the next nest location appears. (Repeat the previous steps until all necessary locations have been taught.)

- If teaching a single nest location, or if all necessary nest locations have been taught, select the **Finish** button. a notice appears prompting the user to remove the Smart Jig from the location. Do so, and then select the **OK** button. Momentum restores motor control and moves the Spinnaker to the Safe standard location.

After a new location has been taught, it must be tested to confirm the teaching process' accuracy. (See "Testing a Newly Vision-Taught Location" on page 29.)

Vision-Teaching Multiple Nest Locations

Many devices have multiple nests. Although each of these nests is recognized as a distinct location, it may not be necessary to teach each nest individually. Depending on the nature of the device, after certain nest locations have been taught, Momentum may be able to calculate the locations of the remaining nests.

When teaching the nest locations for a newly installed device with multiple nests, the Teach Wizard will indicate which nests must be taught manually.

The following table provides examples of different multi-nest arrangements and the corresponding nests that must be taught manually.

Table 1: Teaching Multiple Nest Locations (Examples)

Nest Arrangement	Nests Taught Manually	Example Devices
Two or more nests, irregularly spaced or arranged independently	Each one independently	Source and destination nests of an acoustic pipettor
Straight-line array of nests	Top and bottom, or multiple straight-line segments (top, middle, bottom)	Hotel or extra lid storage
Rectangular array of regularly spaced nests	Four corners	Deck of a pipettor or the shelves of a storage device arranged in columns and rows

Testing a Newly Vision-Taught Location

After a location has been taught, the accuracy of that location must be confirmed. This is done by having the Spinnaker move the Smart Jig from a starting location to the new location. The user then confirms that the Smart Jig has been placed correctly in the new location.

Typically, the Smart Jig's nest is used as the starting location for the Smart Jig when testing a newly vision-taught location. As such, although other locations may be taught before the jig nest itself is taught, ***the jig nest location must be tested and confirmed before any other locations may be tested.***

Before a newly vision-taught location may be tested, one of the following conditions must be met, depending on the type of location being tested:

- ***If testing the jig nest location,*** ensure that the Portrait and Landscape regrip locations have been confirmed. (See

"Confirming Regrip Locations" on page 35.)

- ***If testing any other location,*** ensure that the jig nest location has itself been tested and confirmed using this procedure.

Procedure: To test a newly vision-taught location, perform the following steps:

TIP *For more information about navigating in Momentum, see the Momentum User Guide.*

TIP *Depending on the device and the location(s) being tested, the images shown in this procedure may vary from what appears on screen.*

1. In Momentum, select the **Profile** button in the **Editors** section of the **View** ribbon. The Profile Editor appears in the Main Viewer and the Editor ribbon is displayed in the main toolbar.

TIP *If testing the jig nest location, select the Spinnaker while performing the following step.*

2. In the Profile Editor, select the icon for the device containing the nest location(s) that will be tested.

3. Select the **Test** button in the **Movers** section of the **Devices** ribbon. The Pick & Place Test Wizard appears.

4. In the wizard's Getting Started screen, begin the test process by selecting the **Next** button. The Select Test Nests screen appears.

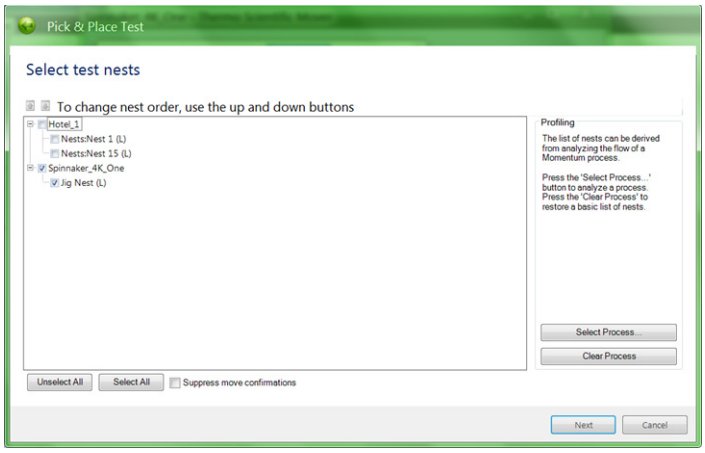

Figure 1: Testing Vision-Taught Locations (Select Test Nests)

5. Perform one of the following actions, depending on the location being tested:

    - ***If testing the jig nest location,*** expand the **[Spinnaker Name]** section, and then select the **Jig Nest** box. Ensure that this is the only location selected, and then select the **Next** button. The Select Start Nest screen appears.

TIP *If necessary, multiple locations associated with multiple devices may be tested during a single session, so long as the jig nest is not being tested.*

    - ***If testing any other location,*** select the checkbox(es) for the location(s) being tested, and then select the **Next** button. The Select Start Nest screen appears.

6. Perform one of the following actions, depending on the location being tested:

    - ***If testing the jig nest location,*** in the **Starting Nest** dropdown menu, select the Spinnaker regrip station (nest).

    - ***If testing any other location,*** in the **Starting Nest** dropdown menu, select the jig nest.

7. Determine whether the Smart Jig will be returned to its starting location after the test is completed by selecting or deselecting the **Return to Starting Nest** box, and then select the **Next** button. The Place the Jig screen appears.

8. Place the Smart Jig in the selected starting location, as instructed in the Place the Jig screen. Be sure to observe specific instructions regarding landscape versus portrait orientation and the direction which the target pattern must face.

9. After placing the Smart Jig, in the Place the Jig screen, select the **Next** button. The Spinnaker moves to the starting location, picks up the Smart Jig, and then transfers it to the location being tested. After placing the Smart Jig in the test location, the Spinnaker returns to the Safe location, and the Pick & Place Test screen appears.

10. Examine how the Smart Jig sits in the test location. Depending on how it has been placed, in the Pick & Place Test screen, perform one of the following actions:

TIP *If more than one location is being tested, the user will be prompted to evaluate the Smart Jig's positioning in each location before the next location is tested.*

    - If the Smart Jig was placed correctly, confirm that the location has been taught accurately by selecting **Yes**. The Test Complete screen appears. If the **Return to Starting Nest** box was selected, the Spinnaker returns the Smart Jig to the starting location, and then moves to the Safe location.

    - If the Smart Jig has not been placed correctly and is significantly misaligned in the test location (or is not in the test location at all), reteach the location by selecting **No - Reteach**. The Test Wizard closes and the Teach Wizard appears. (See "Using Momentum to Teach the Spinnaker" on page 27.)

    - If the Smart Jig has not been placed correctly, but is only slightly misaligned in the test location, return the Smart Jig to the starting location by hand, and then repeat the test by selecting **No - Retest**. The Spinnaker moves the Smart Jig to the test

location again and the Pick & Place Test screen reappears.

11. After the Smart Jig has been placed correctly, in the Test Complete screen, select the **Finish** button. The wizard closes and the test is complete.

If the jig nest was tested and the Smart Jig was returned to the regrip station after the test was completed, place it in the jig nest now. The jig nest is the permanent storage location for the Smart Jig, and will serve as the Smart Jig's starting location when other locations are tested.

Using Momentum to Heal Locations

Occasionally, the location of a nest in relation to the Spinnaker may change, such as when a device is moved or realigned during maintenance. This change may be slight, but could still be enough to prevent the Spinnaker from properly gripping or positioning containers within the nest.

When this occurs, Momentum's vision-teaching process may be used to evaluate the difference between the nest's known (taught) location and its new location, and to reteach the Spinnaker as needed.

This process, known as "healing," is an automated routine that is either scheduled or initiated by the user, and carried out by Momentum.

Understanding Healing

During a healing session, the Spinnaker moves the Smart Jig to the nest which is to be healed. The Spinnaker then uses its camera to take an image of the Smart Jig in the same manner as it would during a vision-teaching session. (See "Vision-Teaching New Locations" on page 27.)

Momentum then calculates the location of the Smart Jig in comparison to the Spinnaker's camera. If the resulting location data is different from the data for the nest's current known location, Momentum initiates a new vision-teaching session and the nest location is retaught.

The healing routine may be initiated manually or may be scheduled to start at a set time, such as during a period when the Spinnaker is in low demand. Additionally, a single routine may be used to heal a single nest or multiple nests in sequence.

Healing Locations

Procedure: To initiate a healing session, perform the following steps:

1. In Momentum, select the **Profile** button in the **Editors** section of the **View** ribbon. The Profile Editor appears in the Main Viewer and the Editor ribbon is displayed in the main toolbar.

2. In the Profile Editor, select the icon for the device containing the nest location(s) that will be healed.

3. Select the **Heal** button in the **Movers** section of the **Devices** ribbon. The Nest Healing window appears.

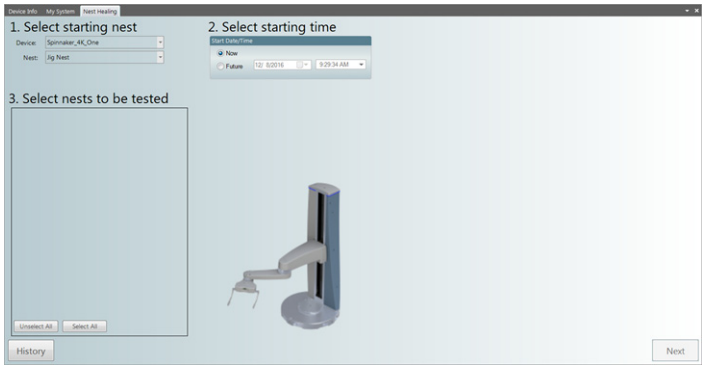

Figure 2: Nest Healing Window

4. Select the starting location for the Smart Jig. (In most cases, this will be the jig nest.)

5. Select the time when the healing session will start.

6. Select the checkbox for each nest location that will be healed during this session, and then select the **Next** button.

7. Set the Smart Jig in the selected starting location.

8. Ensure that there are no containers in the nest(s) that will be healed during this session, and then select the **Next** button. The Run Monitor appears.

9. When ready to start the healing session, select the **Run** button. The Spinnaker begins the healing routine and carries it out under Momentum's direction.

As the healing session is being carried out, the results for each nest location and the run's overall progress are displayed in the Run Monitor. To pause the session, select the **Pause** button. To end the session, select the **Stop** button.

After the healing session has been completed, the Smart Jig is returned to its starting location and a summary of the session's results is displayed.

Using MoverTeach to Teach the Spinnaker

Users working with non-Momentum systems cannot use vision-teaching, but can still teach the Spinnaker new locations manually using MoverTeach.

Understanding the Motion Database

All locations that have been taught to the Spinnaker are stored in the MoverFramework Motion Database.

Unlike with Momentum, which automates many of the tasks involved in recording and storing location data during a teaching session, teaching with MoverTeach requires the user to interact directly with the Motion Database.

Sections and Subsections

The database sorts information about locations first by device or function, and then by information type.

Database sections are defined by the device or overall function to which they relate. When the Spinnaker is first installed, the database includes two factory-taught sections, Regrip and STDloc.

Regrip The Regrip section contains information relating to the Spinnaker regrip station.

STDloc The STDloc (standard location) section contains information relating to general locations that are either related to the system as a whole or that are specific to the Spinnaker, such as its Safe location.

Device Sections Each time a new device is added to the system, the locational information related to that device is stored in a section named after that device. For more information about adding devices to MoverTeach, see the *MoverTeach User Guide*.

Information contained within each section is further divided into the following standard subsections:

Locations Specific points in space which the Spinnaker has been taught and to which it can move.

Extrapolations Rules used to determine one location by using another, taught location as a starting point. An extrapolation defines the distance and direction from the starting location, and the resulting point is stored as a new location. For example, the transit[0] location for a nest may be determined by extrapolating from that nest location.

Interpolations Rules used to determine one or more locations based in the space between two taught locations. For example, based on the locations of Nests One and Eight, an interpolation determines the locations of Nests Two through Seven.

Speeds Values that determine the Spinnaker's speed when it moves between locations.

Paths Path values define a safe route which the Spinnaker may use when moving between two locations.

Regions A region defines a set of locations which the Spinnaker may move safely between. For example, the safeRegion value in the STDloc section lists the Safe and Regrip locations as ones which the Spinnaker may move between safely, without risk of collision.

Location Types

There are four types of locations used to determine a safe path by which the Spinnaker approaches a device's nest.

Safe A location in the general area of the device. The Spinnaker moves to the device's Safe location before beginning its approach toward the nest.

Nest.safe A location in the general area of the nest. The Spinnaker moves from the device's Safe location to the nest.safe location as the first step in its approach toward the nest. If a device has multiple nests, each nest has its own nest.safe location.

Transit A transit location is a point to which the Spinnaker moves during its approach from the nest.safe location to the nest. The number of transit locations (if any) along this route depends on the type of device, its location within the system, and the number of nests it contains.

Nest The location where the Spinnaker places and retrieves a container.

The following diagram shows the approach path for a device with a single nest. Due to its configuration and location within the system, the

Spinnaker must move to two transit points as it approaches the nest.

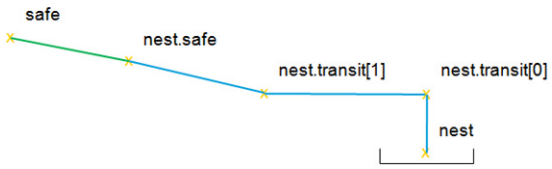

Figure 3: Approach Diagram (Single Nest With Multiple Transits)

The following diagram shows the approach path for a device with multiple nests, such as a random-access hotel. Due to its configuration and location within the system, the Spinnaker must move to only one transit location when approaching each nest.

Figure 4: Approach Diagram (Multiple Nests With Single Transits)

Requirements for Manual Teaching

To use MoverTeach to teach the Spinnaker new locations, the following conditions must be met:

- The Spinnaker has been installed, configured, and tested. (See the *Spinnaker Installation Guide*.)
- If teaching the location of a nest other than the jig nest, the device containing that nest has been added to MoverTeach's list of devices.
- The Spinnaker has been initialized and is ready for operation. (See "Initializing the Spinnaker" on page 9.)
- The Portrait and Landscape regrip locations have been confirmed. (See "Confirming Regrip Locations" on page 35.)

Confirming Regrip Locations

Although the Portrait and Landscape regrip locations are taught before the Spinnaker leaves the factory, the Spinnaker must be installed before these locations can be taught with enough precision to allow the Spinnaker to pick up a container placed in the regrip station.

As such, the Spinnaker may move to the Portrait and Landscape locations, but these locations must be retaught in order to confirm that the Spinnaker is positioned as needed to pick up a container.

Because the regrip station is often used as the starting location during teaching sessions, the regrip locations should be confirmed before any other locations are taught, including the jig nest.

Procedure: To confirm the regrip locations, perform the following steps:

TIP *For more information about the MoverTeach controls mentioned below, see "Moving the Spinnaker by Direct Command" on page 15.*

1. Place the Smart Jig in the regrip station's portrait orientation.

2. In MoverTeach's Motion Database field, expand the **Regrip** section and its **locations** subsection. Two locations, Landscape and Portrait, are available.

3. Move the Spinnaker to the Portrait regrip location by right-clicking the **portrait** location, and then selecting **SmartMoveTo**. The Spinnaker's arm moves so that the gripper is positioned in a portrait orientation above the regrip station.

TIP *If moving the Spinnaker by direct commands, use the Tool jog control type, as it is the best-suited for small, more precise movements. (See "Choosing a Jog Control Type" on page 19.)*

4. Adjust the Spinnaker's position as needed to align the gripper fingers with the dimples on the sides of the Smart Jig. The Spinnaker may be moved either by limping it (see "Limping the Spinnaker" on page 15) or by issuing direct move commands (see "Moving the Spinnaker by Direct Command" on page 15).

5. After positioning the Spinnaker, in MoverTeach, close the gripper fingers by selecting the **Close** button. If it does not appear that the teeth on the finger pads have aligned with the dimples on the Smart Jig, open the fingers, reposition the Spinnaker, and repeat this step until the teeth and dimples are aligned.

6. Right-click the **portrait** location, and then select **Teach Joint Location**. The Joint jog control coordinates for the Spinnaker's current location are saved to MoverTeach's temporary memory.

7. To test whether the Spinnaker has gripped the Smart Jig securely, move it to the Safe location by right-clicking **safe** in the **STDloc** section's **locations** subsection, and then selecting **SmartMoveTo**. If the Smart Jig falls while the Spinnaker is moving or if it does not appear secure, repeat the previous steps until successful.

8. After the Smart Jig has been moved to the Safe location successfully, return the Smart Jig to the regrip station by right-clicking the **portrait** location, and then selecting **SmartMoveTo**. The Spinnaker returns to the Portrait regrip location.

9. In MoverTeach, open the gripper fingers.

10. Return the Spinnaker to the Safe location.

11. Test the newly taught location by right-clicking the **portrait** location, and then selecting **Get Plate Into Gripper**. If the newly taught position is accurate, the Spinnaker moves to the Portrait regrip location, picks up the Smart Jig, and then moves it to the Safe location. If the Spinnaker fails to pick up the Smart Jig, or if it drops the Smart Jig after doing so, repeat the teaching procedure until successful.

12. After the Portrait regrip location has been tested successfully, transfer the new Portrait regrip location data from MoverTeach's temporary memory to the Motion Database by selecting **Save**

Motion Database in the **Motion DB** menu. The Portrait regrip location has been confirmed.

After confirming the Portrait regrip location, repeat these steps with the Landscape regrip location.

Teaching New Locations Manually

To teach a new location manually, perform the following procedures in the order in which they are provided.

TIP *For more information about the MoverTeach controls mentioned below, see "Moving the Spinnaker by Direct Command" on page 15.*

Preparing to Teach Manually

Before a new location can be taught manually, the Smart Jig must be held securely by the gripper fingers (known as "getting the jig").

In most cases, the following procedure will involve getting the Smart Jig from the regrip station. If the Portrait and Landscape regrip locations have not yet been confirmed, do so now before continuing. (See "Confirming Regrip Locations" on page 35.)

Procedure: To get the Smart Jig, perform the following steps:

1. Place the Smart Jig in the Spinnaker regrip station in either the portrait or landscape orientation, depending on the orientation of the nest location that will be taught.

2. In MoverTeach's Motion Database field, expand the **Regrip** section and its **locations** subsection. Two locations, Landscape and Portrait, are available.

3. Get the Smart Jig by right-clicking either the **landscape** or **portrait** location, as appropriate, and then selecting **Get Plate Into Gripper**. The Spinnaker moves to the selected regrip location, picks up the Smart Jig, and then moves it to the Safe location.

Teaching Manually

After the Smart Jig is held securely in the gripper fingers (see "Preparing to Teach Manually" on page 37), the Spinnaker is ready for manual teaching.

Procedure: To teach a new location manually, perform the following steps:

TIP *If moving the Spinnaker by direct command, consider using the Joint jog control type to move the Smart Jig into the general area of the nest, and then the more precise Cartesian and/or Tool types to position the Smart Jig in the nest. (See "Choosing a Jog Control Type" on page 19.)*

1. Move the Spinnaker so that the Smart Jig is positioned in the nest location that is being taught. The Spinnaker may be moved either by limping it (see "Limping the Spinnaker" on page 15) or by issuing direct move commands (see "Moving the Spinnaker by Direct Command" on page 15).

2. Ensure that the Smart Jig is positioned properly in the nest before continuing. When doing so, consider the following:

   - If the nest includes locators or other positioning aids, ensure that these are used to position the Smart Jig.

   - If the nest does not include locators or other positioning aids, ensure that the Smart Jig is centered in the nest.

- Gently tap the top of the Smart Jig to determine if it is sitting flush against the floor of the nest.

- Slide a piece of paper or a card between the sides of the Smart Jig and the sides or positioning aids of the nest. Check if there is equal space on all opposite sides of the Smart Jig.

- If the Spinnaker is limped, ensure that the Smart Jig sits level in the nest by gently tapping the top of the Spinnaker upper arm.

3. After confirming that the Smart Jig has been positioned properly, in MoverTeach, expand the **[Device Name]** section and its **locations** subsection.

4. In the **locations** subsection, right-click the location that is being taught, and then select either **Teach Joint Location** or **Teach Cartesian Location**, depending on the jog control type currently being used. The selected jog control coordinates for the Spinnaker's current location are saved to MoverTeach's temporary memory.

5. If there are other locations that are derived from the newly taught location, recalculate those locations by performing one of the following steps:

   - If the other location(s) derived from this location are all associated with the same device, recalculate them by right-clicking the **[Device Name]** section, and then selecting **Recalculate Derived Locations**. All derived locations associated with that device are recalculated based on the newly taught location.

   - If one or more locations that are derived from this location are associated with other devices (that is, if they are stored in a different section of the Motion Database than this location), update the entire Motion Database by selecting **Recalculate Derived Locations in All Sections** in the **Motion DB** menu. All derived locations in the Motion Database are recalculated based on the newly taught location.

6. Return the Spinnaker to the Safe location by right-clicking **safe** in the **STDloc** section's **locations** subsection, and then selecting **SmartMoveTo**. The Spinnaker moves the Smart Jig to the Safe location.

TIP *For alternative testing methods to those described in the following steps, see* *"Alternative Testing Methods" on page 39.*

7. To test the Spinnaker's ability to set the Smart Jig in the newly taught location, in the **[Device Name]** section's **locations** subsection, right-click the **[nest name]** location, and then select **Put Plate Into Nest**. If the newly taught position is accurate, the Spinnaker moves to the nest location, sets the Smart Jig securely in the nest, and then returns to the Safe location. If the Spinnaker fails to place the Smart Jig properly, repeat the teaching procedure until successful.

8. After the Spinnaker has successfully placed the Smart Jig securely in the nest location, return the Spinnaker to the Safe location if it is not already there.

9. To test the Spinnaker's ability to get the Smart Jig from the newly taught location, in the **[Device Name]** section's **locations** subsection, right-click the **[nest name]** location, and then select **Get Plate Into Gripper**. If the newly taught position is accurate, the Spinnaker moves to the nest

location, gets the Smart Jig, and then moves it to the Safe location. If the Spinnaker fails to pick up the Smart Jig or if it drops the Smart Jig after doing so, repeat the teaching procedure until successful.

10. After the newly taught location has been tested successfully, transfer the new location data from MoverTeach's temporary memory to the Motion Database by selecting **Save Motion Database** in the **Motion DB** menu. The new location has been confirmed.

Alternative Testing Methods

The teaching procedure described above uses the Put Plate Into Nest and Get Plate Into Gripper commands to test newly taught locations. These commands issue multiple movement commands at once to the Spinnaker and make it easy for users to test locations.

Depending on the amount of control and involvement that a user wants to have during testing, the alternative methods described below may be used instead of these commands.

Testing With Direct Commands

Users who want more direct control over the Spinnaker's actions while testing may do so by manually issuing the movement commands which Put Plate Into Nest and Get Plate Into Gripper issue as automated sequences.

Using this method, the user moves the Spinnaker to the nest and Safe locations using the related SmartMoveTo commands, and uses the gripper commands to open and close the gripper fingers. (See "Moving the Spinnaker by Direct Command" on page 15.)

Testing With a Script

Users who want to simplify the test process by automating it entirely may do so by writing a script.

Scripts can be written and executed using MoverTeach's Test Tool, which is accessed by selecting **Test Tool** in the **Mover Utility** menu.

Maintenance

This chapter explains how to clean the Spinnaker, and how to ensure that it remains in proper working order.

CAUTION! Only trained and authorized personnel may repair the Spinnaker. If it appears to be damaged, contact the Customer Support Group. (See “Contacting Customer Support” on page 2.)

Safety During Maintenance

When performing the maintenance tasks described below, ensure that the following safety information is observed:

WARNING! Failure to adhere to the following information may result in serious injury or death.

- Do not attempt to disassemble the Spinnaker power supply adapter or any other electrical components. Doing so may result in a lethal electric shock.
- Before cleaning the Spinnaker, ensure that it has been completely de-energized and disconnected from the power supply.

Scheduling Service

To ensure that the Spinnaker remains in proper working condition, it must undergo a maintenance inspection once per year.

This inspection may only be performed by a qualified Thermo Fisher Scientific technician.

For more information about maintenance inspections and other related services, contact the Customer Support Group. (See “Contacting Customer Support” on page 2.)

Cleaning the Spinnaker

Ensuring that the Spinnaker remains clean is a necessary part of its regular care and maintenance.

NOTICE Do not autoclave any part of the Spinnaker.

Cleaning Spills

The Spinnaker should be cleaned immediately following a spill due to a collision or other upset.

Procedure: To clean the Spinnaker after a spill has occurred, perform the following steps:

> ***TIP*** *For more information about the Spinnaker controls mentioned in the following procedure, see “Using the Control Puck” on page 13.*

CAUTION! The Spinnaker must be de-energized before it may be cleaned. Failure to do so may result in injury.

1. De-energize the Spinnaker motors by pressing the **Motor Off** button.
2. Remove all power to the Spinnaker by setting the **DC Power** switch to OFF.
3. Ensure that power has been removed from the Spinnaker by disconnecting the power cord from the power outlet.

4. If the Spinnaker is adjacent to any random-access hotels and/or sequential-access stacks, remove them and set them aside in a safe location before continuing.

5. Using an absorbent, lint-free cloth, gently soak up any spilled liquids on or around the Spinnaker. When doing so, avoid direct contact with any electrical components, such as the power connection on the Spinnaker base.

6. Replace any hotels and/or stacks that were removed earlier.

After the Spinnaker is clean and dry, operation may resume. (See “Energizing the Spinnaker” on page 9.)

Periodic Cleaning

Regardless of how often the Spinnaker is in operation, it should be cleaned at least once per month in order to remove any dust or debris that may eventually interfere with normal operation.

Procedure: To ensure that the Spinnaker is free of any dust or debris, perform the following steps:

TIP *For more information about the Spinnaker controls mentioned in the following procedure, see “Using the Control Puck” on page 13.*

CAUTION! The Spinnaker must be de-energized before it may be cleaned. Failure to do so may result in injury.

1. De-energize the Spinnaker motors by pressing the **Motor Off** button.

2. Remove all power to the Spinnaker by setting the **DC Power** switch to OFF.

3. Ensure that power has been removed from the Spinnaker by disconnecting the power cord from the power outlet.

4. Lightly dab a sponge or soft, lint-free cloth in a solution of water mixed with a mild detergent. (Alternatively, a mild isopropyl alcohol-based cleaning agent may also be used.) Ensure that the sponge or cloth is only damp (well-wrung and no longer dripping) before continuing.

5. Gently wipe the surface of the Spinnaker, removing any dust or debris which may have accumulated. When doing so, avoid direct contact with any electrical components, such as the power connection on the Spinnaker base.

6. If the Spinnaker is connected to a base plate that supports any random-access hotels and/or sequential-access stacks, remove the hotels and/or stacks and clean them separately using the same sponge or cloth and cleaning solution.

7. Before replacing the hotels and/or stacks, clean and dry the base plate.

8. After ensuring that the base plate is dry, replace any hotels and/or stacks removed earlier.

After the Spinnaker is clean and dry, operation may resume. (See “Energizing the Spinnaker” on page 9.)

Testing the Safety Controls

In order to ensure that the Spinnaker can be stopped quickly and easily, should the need arise, the controls used to do so (located on the Spinnaker control puck) must be tested regularly.

This test should be performed either once per month or each time the Spinnaker is power-cycled, whichever is more frequent.

TIP *For more information about the Spinnaker controls mentioned in the following procedure, see "Using the Control Puck" on page 13.*

Procedure: To test the Spinnaker's power controls, perform the following steps:

1. To turn on main power and energize the Spinnaker's internal control modules, set the control puck's **DC Power** switch to ON (•). The indicator lights at the top of the Spinnaker (4K models only) pulse white for a few seconds, and then glow green. Main power is now ON.

2. Ensure that the **Motor Off** button is not pressed in. If it is, turn it clockwise until it springs back out.

3. Energize the motors by pressing the **Motor On** button. The button glows green and the indicator lights (4K models only) as well as the light on the Spinnaker arm glow blue. The arm should now be under motor control.

4. To confirm that the motors are functional, attempt to gently move the arm by hand. If the arm resists being moved, the motors are functional.

5. De-energize the motors by pressing the **Motor Off** button. The **Motor On** button goes dark and the Spinnaker arm is no longer under motor control.

6. To confirm that the motors have been de-energized, attempt to gently move the arm by hand. If the arm moves without resistance, the motors have been successfully de-energized and the Motor Off button is functional.

7. Reset the **Motor Off** button by turning it until it springs back out.

8. De-energize the Spinnaker by setting the **DC Power** switch to OFF. The indicator lights go dark and the Spinnaker internal control modules are no longer energized.

Disposing of the Spinnaker

When disposing of the Spinnaker, ***European Union customers*** must adhere to all requirements as stated in the Waste Electrical and Electronic Equipment (WEEE) Directive 2002/96/EC.

Within the European Union, the Spinnaker may not be disposed of via municipal waste collection or a similar service.

For more information about how to properly dispose of the Spinnaker, contact your local vendor or the Thermo Scientific Customer Support Group. (See "Contacting Customer Support" on page 2.)

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