

JACOSOFT - User guide



ABOUT THIS DOCUMENT

This document was written for the 3.2.9.0 version of Jacosoft.



Read all instructions before using this product.



Keep these instructions for future reference.

This document contains information regarding the use of Jacosoft, a program devoted to facilitate the configuration and maintenance of Kinova robotic arms. This document is intended for:

- Kinova robotic arm users: JACO arms and MICO arms
- Field service, customer support and sales employees of authorized distributor of Kinova robotic arms.

Symbols, definitions and acronyms



Important information regarding the safety of Kinova's products and their operator.



Tip on the maintenance, operation and manipulation of Kinova's products.

General Information

Jacosoft is a software programming tool that can edit, read, write and store the robotic arm configuration parameters and help troubleshoot problems with the robotic arm.

This document contains detailed information on the use of Jacosoft. Detailed information on related subjects may be found in the following documents.

- | | |
|-----------------|--------------------------------|
| ✓ DG 5JSE 0002: | Jacosoft Installation Guide |
| ✓ DG 5DRE 0001: | USB Driver Installation Guide |
| ✓ DG 2JAE 0001: | JACO User Guide |
| ✓ DG 2JAE 0002: | JACO Maintenance Guide |
| ✓ DG 2MIE 0001: | MICO User Guide |
| ✓ DG 4UIE 0001: | Universal Interface User Guide |

Jacosoft can only be used if the following criteria are met:

- The Kinova robotic arm is powered;
- The Kinova robotic arm is connected to a computer with the USB cable provided by Kinova;
- The Jacosoft software was correctly installed on the computer;
- The adequate driver was correctly installed on the computer.

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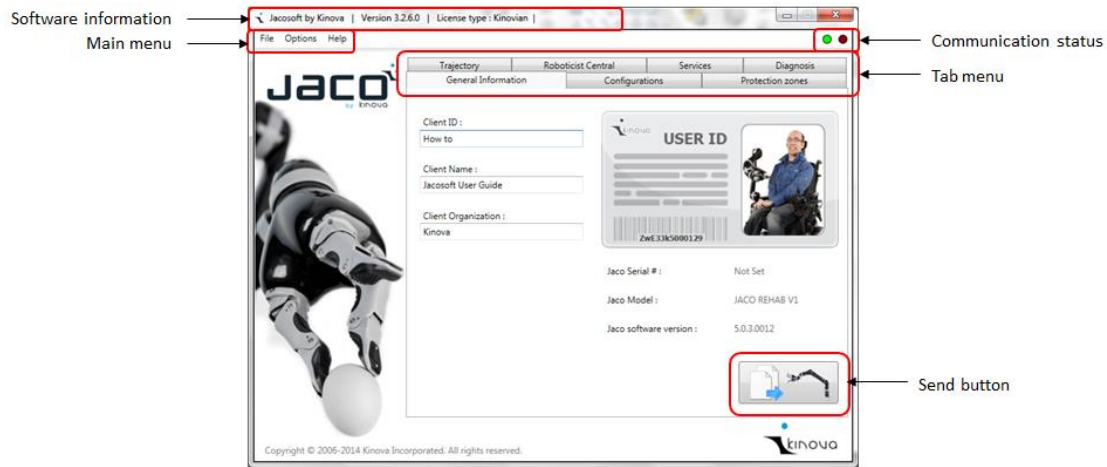
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SOFTWARE OVERVIEW



When the Kinova robotic arm is powered, there may be a delay before the communication with the software is established.



Anytime you change the information, you must press on the **SEND** button. If you change tab without saving the information, it will be lost.

Licence and access

The access to the different tabs is defined by the licence type. The following figure presents the tab to which each licence gives access.

	RESEARCH	REHAB	USER	SERVICE
General Information	✓	✓		✓
Configurations	✓	✓		✓
Protection zones	✓	✓		✓
Trajectory	✓			
Diagnosis	✓	✓	✓	✓
Service ¹				✓
Robotist Central	✓			

¹ The service tab is only used internally and the tab won't be described in this document.

MAIN MENU

File

The **File/Profile** menu will allow you to proceed with the following actions:

- Load : Import a previously « saved » configuration;
- Save : Save a configuration in a hidden folder and give a name to that configuration;
- Import : Import a previously « exported » configuration;
- Export : Save a configuration in a specified folder.



You must “Save” a profile in order to give it a name before exporting it. You cannot “Export” a profile and name it.

Options

The **Options/Control** menu will allow you to proceed with the following actions:

- Set Angular Control : Control each joint of the robotic arm independently.
- Set Cartesian Control : Control the end effector of the robotic arm through the established kinematics.

The **Options/Advance/Restore Factory Default** will allow resetting the default configurations (factory parameters) to the Kinova robotic arm.



The default configurations will reset the protection zones.



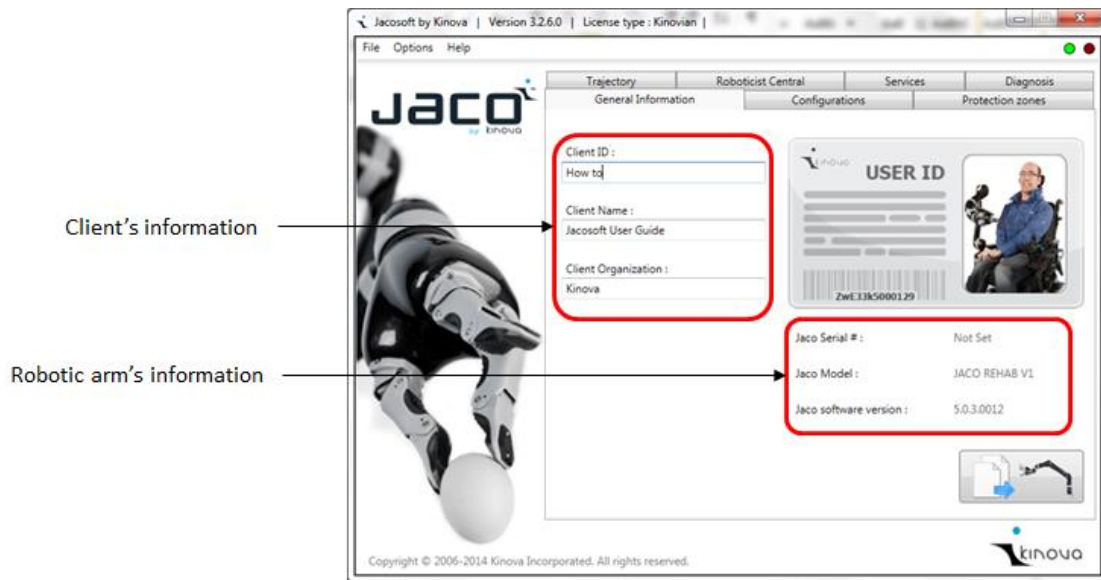
The robotic arm is right handed in its default configuration.



The mapping will also be reset to its default configuration.

GENERAL INFORMATION TAB

The following figure shows the General Information tab:



In the General information tab, you may enter the following information on the robotic arm user:

- Client ID : the client/user's identification;
- Client Name : the client/user's name;
- Client Organisation : the client/user's organization.

In this tab, you will also find important information concerning the robotic arm:

- Serial # : Robotic arm's serial number;
- Model : Robotic arm's model version;
- Software Version : Robotic arm's software version (DSP).



You may not modify that information as it is permanent and necessary to the robotic arm's identification.



Don't forget to save your information by pressing on the **SEND** button. If you change tab before pressing the **SEND** button, the newly change data will be lost.

CONFIGURATIONS TAB

The Configurations tab contains two sub tabs which will be explained in the following sections:

- Positioning tab;
- Control tab (including Mapping info).

Configurations/Positioning tab

The following figure shows the Configurations/Positioning tab.



The Positioning tab allows you to configure the following parameters:

- Laterality : the robotic arm laterality (left- or right-handedness);
- Retracted angle : the retracted angle of the RETRACT position² of the robotic arm (Retract Positioning (simple mode));
- Retracted trajectory : the HOME position, the RETRACT position and the trajectory between those positions (Retract Positioning (advance mode)).
- Related option

² The RETRACT position refers to the position occupied by the robotic arm when it is not in use. The RETRACT position allows minimizing the physical volume occupied by the robotic arm and its electrical consumption.



Don't forget to save your information by pressing on the **SEND** button. If you change tab before pressing the **SEND** button, the newly changed data will be lost.

LATERALITY

The robotic arm laterality is defined by the position of the arm in reference to its user. The following choices are available:

- Left handed : this option should be selected if the robotic arm is installed to the user's left side of body;
- Right handed : this option should be selected if the robotic arm is installed to the user's right side of body;

The default configuration of the robotic arm is right-handed.

When the Kinova robotic arm is bought as left-handed, the angle of the thumb is modified in order to optimise the grip of the end effector. In this case, the option: **FINGERS #2 AND #3 INVERTED** must be selected. If this is not selected, the thumb will not be closing with the adequate other finger³.

RETRACTED ANGLE - RETRACT POSITIONING (SIMPLE MODE)

The retracted angle will define the position in which the robotic arm will lie when piloted in its RETRACT position. The HOME position is not configurable with this option.

The retracted angle may be selected by pressing either one of the arrows located under the angle choices. The robotic arm figure should move accordingly to your selection.

You may save the information by pressing the **SEND** button and try the RETRACT position by accessing the HOME/RETRACT function (see the robotic arm user guide).



The RETRACT position configuration may interfere with the protection zones. If the arm won't move from the RETRACT position after its configuration, you must reconfigure it.

RETRACTED TRAJECTORY - RETRACT POSITIONING (ADVANCE MODE)



To configure a retracted trajectory (advance retract), the **ENABLE** box must be activated.

³ This option has no effect if configuring a MICO robotic arm.

The configuration of the RETRACT position with the advance mode will allow defining a sequence of positions (retracted trajectory) that will be reached by the robotic arm when moving from its HOME to its RETRACT position.

To configure an advance retracted trajectory, please go through the following steps:

1. Activate the **ENABLE** box.
2. Bring the robotic arm in its desired RETRACT position with the controller.
3. Press on the **ADD** button.
4. Repeat steps #2 and #3 for all the positions you wish to integrate in the retracted trajectory.
5. Save the information with the **SEND** button.



The RETRACT position is the first position to be added when configuring a retracted trajectory.

If some positions need to be moved up or down in the defined trajectory, you may select the position by clicking on it, and move it accordingly with the arrows located at the top of the trajectory box.



The RETRACT position configuration may interfere with the protection zones. If the arm won't move from the RETRACT position after its configuration, please reconfigure it.

To configure a retracted trajectory, you will need to move the robotic arm with the controller. You may choose to control the arm using Cartesian or Angular mode by selecting the desired option.

- Angular : Control each joint of the robotic arm independently.
- Cartesian : Control the end effector of the robotic arm through the established kinematics.



Angular control will disable all the security elements inherent to the control of the Kinova robotic arm.



Angular control should only be used by experimented technicians only.

DEFINING A GOOD HOME POSITION

The HOME position, also known as READY TO USE position, must be chosen with care (i.e. the HOME position must be far from any singularities that are often found when the actuators of the robotic arm's wrist are aligned).

Thus, when adding the HOME position in the context of an RETRACT TRAJECTORY (ADVANCE MODE), note that any HOME position accessed through the Cartesian control mode will not be problematic, while a HOME position accessed through the Angular control mode must be verified.

To verify a HOME position accessed and saved through the Angular control mode, from this position, you must switch to a Cartesian control mode and move the robotic arm through the control interface (joystick or wheelchair drive control). If the robotic arm moves, the previously saved HOME position is adequate. If Jacosoft automatically switch back to Angular control mode, the previously saved HOME position is not acceptable and must be changed.

To ease the search for a good HOME position, it is suggested to start from the default HOME position and move the robotic arm using the Cartesian control mode. A position located in front of the default HOME position has more chance to be accepted than one located in the back.

RELATED OPTION

Activating the **DELETE PRE-PROGRAMMED POSITIONS AT RETRACT** box will automatically delete all pre-programmed positions each time the robotic arm is brought to its RETRACT position.

Configurations/Control tab

The following figure shows the Configurations/Control tab.



In the Control tab, you may configure the following parameters:

- Joystick's sensitivity : the sensitivity of Kinova's joystick only
- Robotic arm speed : the maximal linear speed of the robotic arm's movements (speed is allowed between 4 and 20 cm/s)
- Drinking mode : the drinking mode parameters
- Spasm filter : the acceleration of the robotic arm's movement's slope and delay. The spasm filter modifies the response of the robotic arm to the control signal by increasing gradually its velocity. Depending on the spasm level of the filter, the velocity will increase more or less rapidly. The spasm filter has no effect on the stopping movements of the robotic arm. This filter enables to reject involuntary input to the control interface.

The spasm filter reduces or eliminates involuntary commands sent to the robot. This allows to be more precise, especially if the control is not proportional. When the user sends a command to move, the velocity will gradually increase. When the user wants to stop (by releasing the stick) the robot will stop immediately. The spasm filter can be activated with Jacosoft. There are five levels:

0 – The spasm filter is not activated

1 – Very low filter

2 – Low filter

3 – Medium filter

4 – High filter

It is also possible to configure the functionalities “Decrease spasm level” and “Increase spasm level” on a button or a stick.

- Mapping Info : all of the controller's settings



Don't forget to save your information by pressing on the **SEND** button. If you change tab before pressing the **SEND** button, the newly change data will be lost.

SENSITIVITY

The sensitivity parameter allows you to increase/decrease Kinova's joystick sensitivity in relation to the robotic arm's movements. The sensitivity is adjusted by moving the pointer towards the right (increase sensitivity) or the left (decrease sensitivity).

- If the sensitivity is minimal (100%), the controller responds with great proportionality.

- If the sensitivity is maximal (1000%), the controller responds with no proportionality.



The SENSITIVITY parameter is only effective for the Kinova joystick.

ROBOTIC ARM SPEED

The speed parameter is related to the linear displacement of the robotic arm's end effector and is defined in centimeters per second (cm/s).

The maximum speed is adjusted by entering a number going from 4 to 20, 20 being the maximum speed permitted by the Kinova robotic arm. For this setting, please follow the following advices:

- Increment the speed with the user's experiment with the robotic arm;
- For a non-experimented user, set a maximal speed of 4 to 7 cm/s;
- For an experimented user who's control lack of dexterity or proportionality, set a maximal speed of 10 to 15 cm/s;
- Only use a maximal speed of 20 cm/s with users who have experience, a proportional and dexterous control over the robotic arm.

DRINKING MODE

The drinking mode shifts in height (**Height of the glass**) and in distance (**Radius of the glass**) the center of rotation of the wrist⁴. It compensate when the user drinks directly from a glass or a bottle.

- Height of the glass : refers to the height of the bottle/glass neck in reference to the robotic arm end effector.
- Radius of the glass : refers to the glass/bottle radius.



The DRINKING MODE parameters must be set for a precise glass or bottle. Once those parameters are set, the user should always use the same glass and grip it from the same place (height).

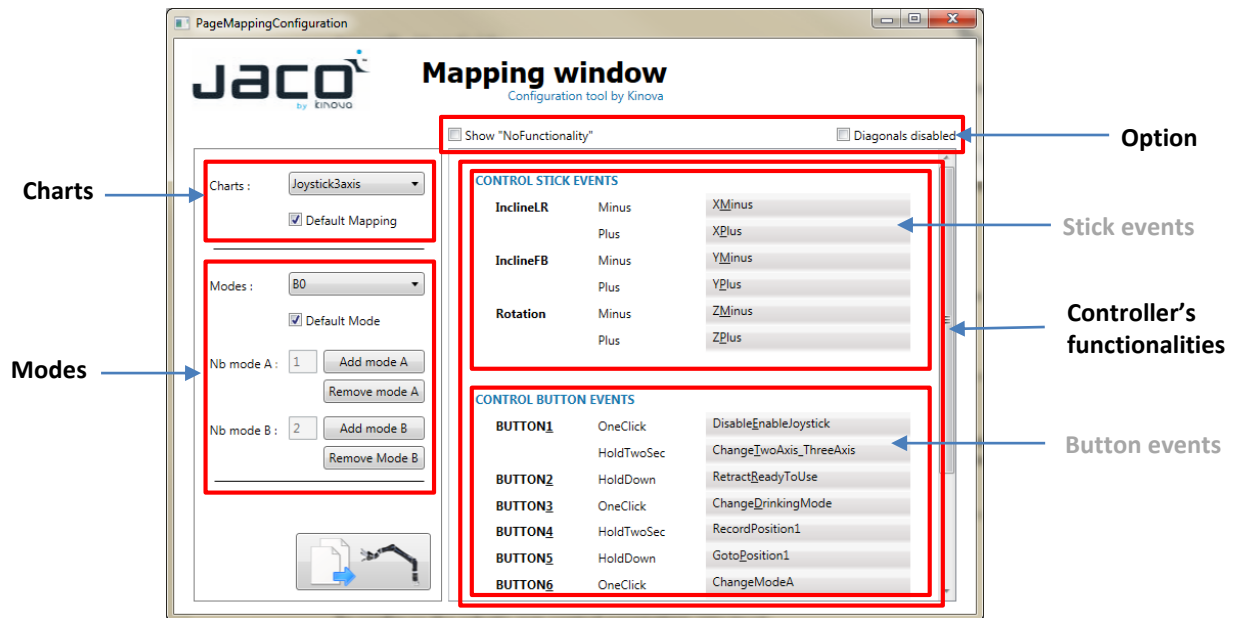
Configurations/Control/Mapping Info window

In the Mapping info window, you may configure many aspect of the controller used to operate the robotic arm. The action of mapping a control may seem complicated at first but is fairly

⁴ Please refer to the robotic arm user guide for detailed information on the drinking mode.

simple once the method is learned. Appendix 1 presents a step-by-step example for configuration of the mapping.

The Mapping info tab may be accessed by the **MAPPING INFO** button located on the right side of the window. After pressing on **MAPPING INFO** button, the following window should appear:



To configure the robotic arm control parameters, you must:

1. Choose the interface that is used in the **Charts** menu;
2. Define the quantity of control **Modes** that will be used and classify them under the available mode lists (List A and List B);
3. For each control mode, you must define the functionalities associated with the controller events (**Stick events**) and controller push buttons (**Buttons events**);
4. For each control mode, you must also define the adequate **Options**.



Don't forget to save your information by pressing on the **SEND** button. If you change tab before pressing the **SEND** button, the newly change data will be lost.

CHARTS

The charts menu will allow you to define the controller for which the control must be configured. The following list of interface is available:

- Joystick 3-Axis : refers to Kinova's joystick, used in 3-Axis operation mode.
- Joystick 2-Axis : refers to Kinova's joystick, used in 2-Axis operation mode.
- API Interface⁵ : refers to the programming interface of the robotic arm.
- Easy Rider Interface : refers to a multiple control system available on some wheelchairs and distributed by HMC.
- Universal Interface : refers to the electronic box distributed by Kinova and used to control the robotic arm through the wheelchair controller (See the Universal Interface User Guide).

The **Default mapping** option is used to indicate that the interface (Charts) chosen will be the one accessible at the robotic arm start-up. Only one Chart may be chosen for **Default Mapping**.

MODES

All the functions (basic and advanced functionalities) that must be accessible by the user must be configured and classified into two independent lists (**List A** and **List B**). For each list, you may enable and configure a maximum of 6 different control **Modes**. Therefore, a maximum of 12 control modes may be used to operate the robotic arm. The following figure shows the location of the two lists.

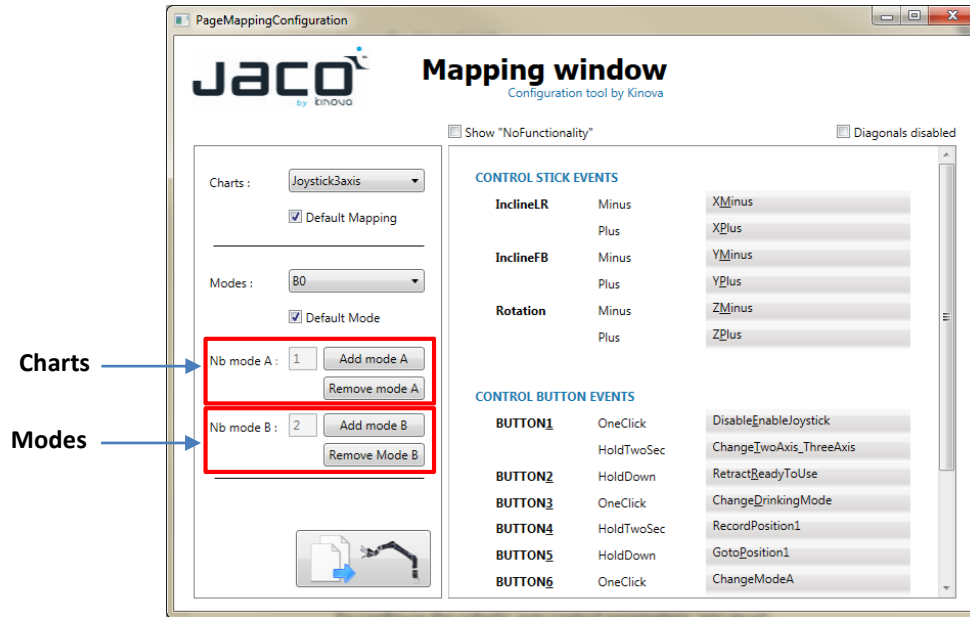
The **Add mode A** and **Remove mode A** buttons are used to, respectively, add and remove operation modes in List A while the **Add mode B** and **Remove mode B** buttons are used to, respectively, add and remove operation modes in List B.

The **Default Mode** option is used to indicate that the control mode chosen will be the one accessible at Kinova robotic arm's start-up. Only one Mode may be chosen for **Default Mode**.



The **Retract_ReadyToUse** function must be available in the **Default Mode**.

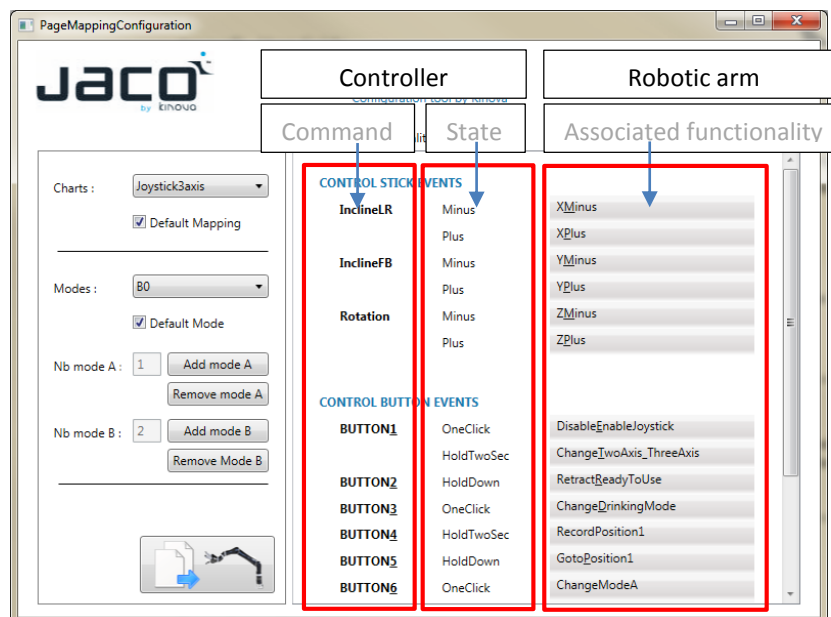
⁵ The "API Interface" chart is not available to the rehabilitation market.



CONTROLLER'S FUNCTIONALITIES

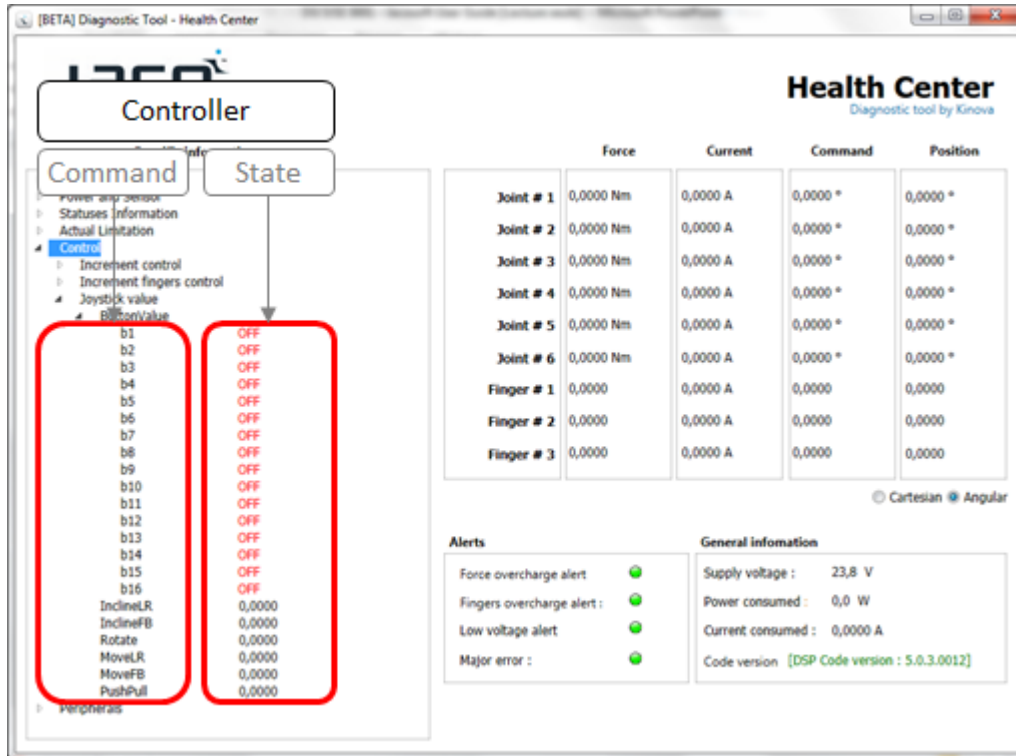
The configuration of the controller's functionalities is divided into three categories:

- The controller's command
- The controller's state
- The robotic arm's associated functionality



CONTROLLER COMMAND AND STATE

To define your controller's associated **Commands** and **States**, please refer to the Health Center (Diagnosis tab) under the Control/Joystick Value menu as shown in the following figure. The known **Commands** and **States** associated with Kinova's joystick and Universal Interface are respectively defined in Appendix 2 and 3.



The 6 following states can be associated to each buttons:

- OneClick : Push and release the button.
- HoldOneSec : Push on the button for a whole second.
- HoldTwoSec : Push on the button for two seconds.
- HoldThreeSec : Push on the button for three seconds.
- HoldFourSec : Push on the button for four seconds.
- HoldDown : Push on the button until the desired position is reached or when the functionality has ended.



If the "HoldDown" state is configured for a button, only a "OneClick" may be additionally configured for this button.



If the “HoldXSec” state is configured for a button, only a “OneClick” may be additionally configured for this button.

ROBOTIC ARM FUNCTIONALITY

The following functionality may be configured on either the **stick** or the **buttons events**.

- No functionality and state. : No function is associated with the controller command

Basic configurations

- Retract_ReadyToUse : Reach the HOME or the RETRACT position.
- ChangeModeA⁶ : Toggle between the modes of List A.
- ChangeModeB⁷ : Toggle between the modes of list B.

Those functionalities may be associated with the values read in the Health Center under Control/Increment Control.

Motion

- X_Plus : Left translation of the end effector.
- X_Minus : Right translation of the end effector.
- Y_Plus : Back translation of the end effector.
- Y_Minus : Front translation of the end effector.
- Z_Plus : Upward translation of the end effector.
- Z_Minus : Downward translation of the end effector.
- Xtheta_Plus : Movement of the wrist - Left lateral orientation of the end effector
- Xtheta_Minus : Movement of the wrist – Right lateral orientation of the end effector
- Ytheta_Plus : Movement of the wrist – Top vertical orientation of the end effector
- Ytheta_Minus : Movement of the wrist – Bottom vertical orientation of the end effector
- Ztheta_Plus : Rotation of the wrist on itself

⁶ ChangeModeA was listed as ChangeMode_Left in Jacosoft’s older versions.

⁷ ChangeModeB was listed as ChangeMode_Right in Jacosoft’s older versions.

- Ztheta_Minus : Rotation of the wrist on itself.
- OpenHandTwoFingers : Move Finger #1 and the “index” outward.
- CloseHandTwoFingers : Move Finger #1 and the “index” inward.
- OpenHandThreeFingers : Move three fingers outward.
- CloseHandThreeFingers : Move three fingers inward.

Go To

The **Go To** category includes a basic **Go To** (predefined position) and an **Advance Go To** (predefined trajectory).

In the **basic Go To** (predefined position), the user needs to record a position and reach it when needed. Each predefined position needs 2 different functions: Record and GoTo. Up to 5 predefined positions may be recorded.

- Goto_PositionX⁸ : Go to the previously recorded predefined position X.
- RecordPositionX : Record the predefined position X.

In the **advance Go To** (predefined trajectory), the user needs to record a minimum of 1 position (or point) in space. This sequence of points defines the predefined trajectory that will be followed (round trip) by the robotic arm when needed. An additional point may be added at all time and there is a limit of 20 points that may be included into a trajectory. The points will be followed in the order they have been added. When the user first activates the functionality, the recorded position nearest to the actual location will be reached first. Each time the user reactivates the functionality afterwards, the trajectory will toggle between normal trajectory and reverse trajectory (similarly to the ready-retract). Up to 5 trajectories may be recorded.



The opening/closing position of the fingers when a position is recorded is not important as the fingers will stay in the opening/closing position in which they are when the GOTO function is activated, and will stay there through all the predefined trajectory..

- AdvanceGOTO_X : Move the robotic arm in the sequence recorded with the AdvanceGOTO_Add_X function.
- AdvanceGOTO_Clear_X : Delete all the points of the AdvanceGOTO_X
- AdvanceGOTO_Add_X : Used to add a position to an AdvanceGOTO_X.

⁸ Up to 5 positions may be recorded and used. Only use this function with “HoldDown”.

The **Automatic Orientation** placed the robotic arm's end effector in a position defined by the axis.

- **AutomaticOrientationXPlus** : Directs the opening of the end effectors towards the left and aligns the axis that comes out of the end effector on the X axis.
- **AutomaticOrientationXMinus** : Directs the opening of the end effectors towards the right and aligns the axis that comes out of the end effector on the X axis.
- **AutomaticOrientationYPlus** : Directs the opening of the end effectors towards the front and aligns the axis that comes out of the end effector on the Y axis.
- **AutomaticOrientationYMinus** : Directs the opening of the end effectors towards the back and aligns the axis that comes out of the end effector on the Z axis.
- **AutomaticOrientationZPlus** : Directs the opening of the end effectors towards the ceiling and aligns the axis that comes out of the end effector on the Z axis.
- **AutomaticOrientationZMinus** : Directs the opening of the end effectors towards the floor and aligns the axis that comes out of the end effector on the Z axis.

Configuration

- **Disable_EnableJoystick** : Enable or disable the controller.

The robotic arm minimal **speed** is 4 cm/s. The robotic arm maximal speed is defined in the Configurations/Control tab.

- **DecreaseSpeed** : Decrease the robotic arm speed to its minimum value with an increment of 5 cm/s.
- **IncreaseSpeed** : Increase the robotic arm speed to its maximum permitted value with an increment of 5 cm/s.

The **spasm filter** induces a delay (acceleration slope) between the moment the control signal is received and when the function is activated. The spasm filter is only valid for the robotic arm basic movements.

- **IncreaseSpasmLevel** : Increase the effect of the spasm filter.
- **DecreaseSpasmLevel** : Decrease the effect of the spasm filter.

Some **additional functions** may be configured to the control mapping.

- **Change_DrinkingMode** : Enable or disable the drinking mode.

- **Change_TwoAxis_ThreeAxis⁹** : Toggle between the 2- or 3-Axis operation modes.



Please note that Jacosoft was designed to configure the totality of the control parameters. However, your Kinova robotic arm's version may not support those functionalities. If the configuration you are trying to save won't work, please contact Kinova for technical support.

RELATION BETWEEN CONTROLLER STATE AND POSSIBLE ASSOCIATE FUNCTIONS

Some of the robotic arm associated functionalities may only be mapped using a specific controller state. The following figure shows these relations.

	ONE CLICK	HOLD X SECONDS	HOLD DOWN
Basic configurations	ChangeModeA ChangeModeB	ChangeModeA ChangeModeB	Retract_Ready to use
Motion			X_Plus, X_Minus Y_Plus, Y_Minus Z_Plus, Z_Minus Xteta_Plus, Xteta_Minus Yteta_Plus, Yteta_Minus Zteta_Plus, Zteta_Minus OpenHandTwoFingers, CloseHandTwoFingers OpenHandThreeFingers, CloseHandThreeFingers
Go To	RecordPositionX AdvanceGOTO_Add_X AdvanceGOTO_Clear_X	RecordPositionX AdvanceGOTO_Add_X AdvanceGOTO_Clear_X	Goto_PositionX AdvanceGOTO_X AutomaticOrientation - XPlus, XMinus, YPlus, YMinus, ZPlus, ZMinus
Configurations	Disable_EnableJoystick DecreaseSpeed IncreaseSpeed IncreaseSpasmLevel	Disable_EnableJoystick DecreaseSpeed IncreaseSpeed IncreaseSpasmLevel	

⁹ Only available with the Kinova joystick.

	DecreaseSpasmLevel Change_DrinkingMode Change_TwoAxis_Three Axis.	DecreaseSpasmLevel Change_DrinkingMode Change_TwoAxis_Three Axis	
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DIAGONALS

To disable the diagonal movements of the controller, select the Diagonals Disabled option.



Diagonals should be disabled for finger movements.

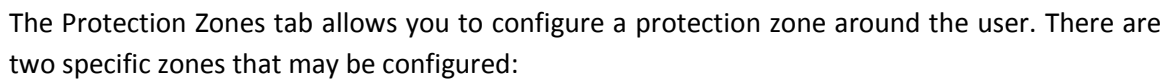


Diagonals should be disabled when 2 movements that can't be controlled simultaneously are joined in the same operation mode.

NO FUNCTIONALITY

To show the totality of the configurable commands, check the Show "No Functionality" box.

The following figure shows the Protection Zones tab.



-
- A diagram of a blue wheelchair. A light blue rectangular box is superimposed over the upper part of the wheelchair, specifically covering the seat and the upper back area. To the right of the box, there are two horizontal light blue bars. The top bar is labeled 'No go zone' and has a light blue arrow pointing to the top edge of the box. The bottom bar is labeled 'Slow zone' and has a light blue arrow pointing to the bottom edge of the box.



The protection zone represents a compromise between the user's mobility and the possibility of the Kinova robotic arm to access the area near his/her head. Once the protection zone is set, it should be validated thoroughly by the user to make sure it suits his/her daily needs.



Don't forget to save your information by pressing on the **SEND** button. If you change tab before pressing the **SEND** button, the newly change data will be lost.

No Go Zone

No parts of the robotic arm¹⁰ are allowed to enter the No Go Zone. To configure the No Go Zone, you must follow the following directives:

1. Bring the Kinova robotic arm's fingertip near the user's mouth.



The "Mouth Position" should always be reached by a qualified technician using Kinova's joystick.

2. Press on the **GET ACTUAL POSITION** button to determine the No Go Zone front limit.



To set a No Go Zone that begins at the user's face, you may open the fingers to their maximum opening range and surround the user's mouth with the hand before pressing the **GET ACTUAL POSITION** button.

3. Measure the distance of elements 1, 2, 3 et 4 :

- Element #1 refers to the user's head diameter in cm.
- Element #2 refers to the user's face height in cm.
- Element #3 refers to the distance between the user's chin and hips in cm.
- Element #4 refers to the user's shoulders in cm.



The No Go Zone is extremely important for the user's safety. The user should never use the robotic arm unsupervised if this zone is not configured.

Slow Zone

The Slow Zone refers to a virtual border located around the No Go Zone. The robotic arm will slow its movements when entering the Slow Zone and will stop at the No Go Zone. To configure the Slow Zone, you must:

¹⁰ The robotic arm protection is based on the position of the actuators (joints).

1. Define the Slow Zone thickness by moving the cursor towards the right to increase or the left to decrease the thickness.



The Slow Zone thickness will be displayed in cm.

2. Define the Slow Zone speed by moving the cursor towards the right to increase or the left to decrease the robotic arm speed in the Slow Zone.



The Slow Zone speed will be displayed according to a % referring to the fraction of the maximum speed configured in the Control tab.¹¹.

Options

DELETE ALL ZONES

The **DELETE ALL ZONES** button allows you to erase all the information saved in the robotic arm concerning the protection zones.

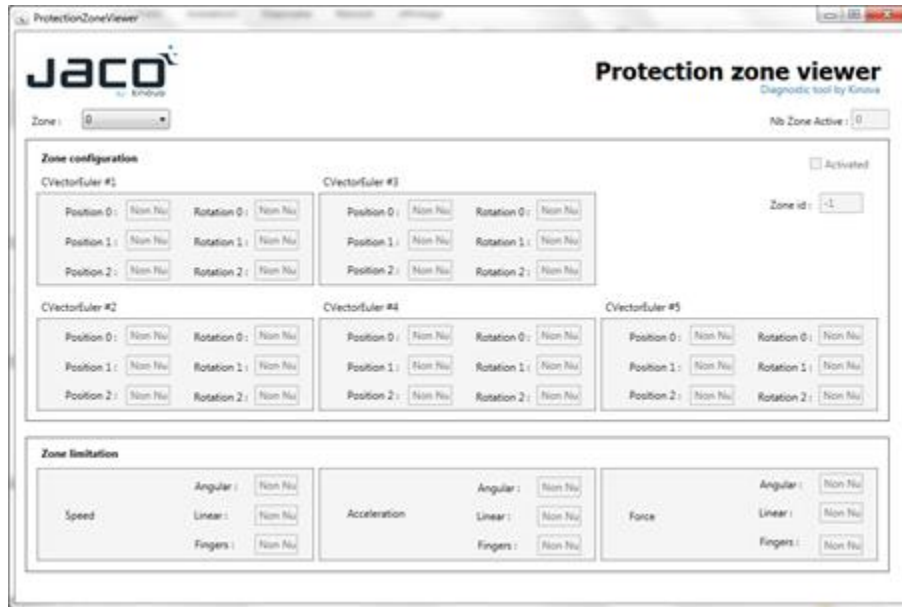


The protection zones must be deleted before being modified.

SHOW VIEWER

The **SHOW VIEWER** button allows you to display the following window. This window shows the data saved concerning the protection zones.

¹¹ For example: 100% refers to the normal speed of the robotic arm (Permitted max speed). If you choose 26%, the robotic arm will move at 26% of the Permitted Max Speed when entering the Slow Zone.

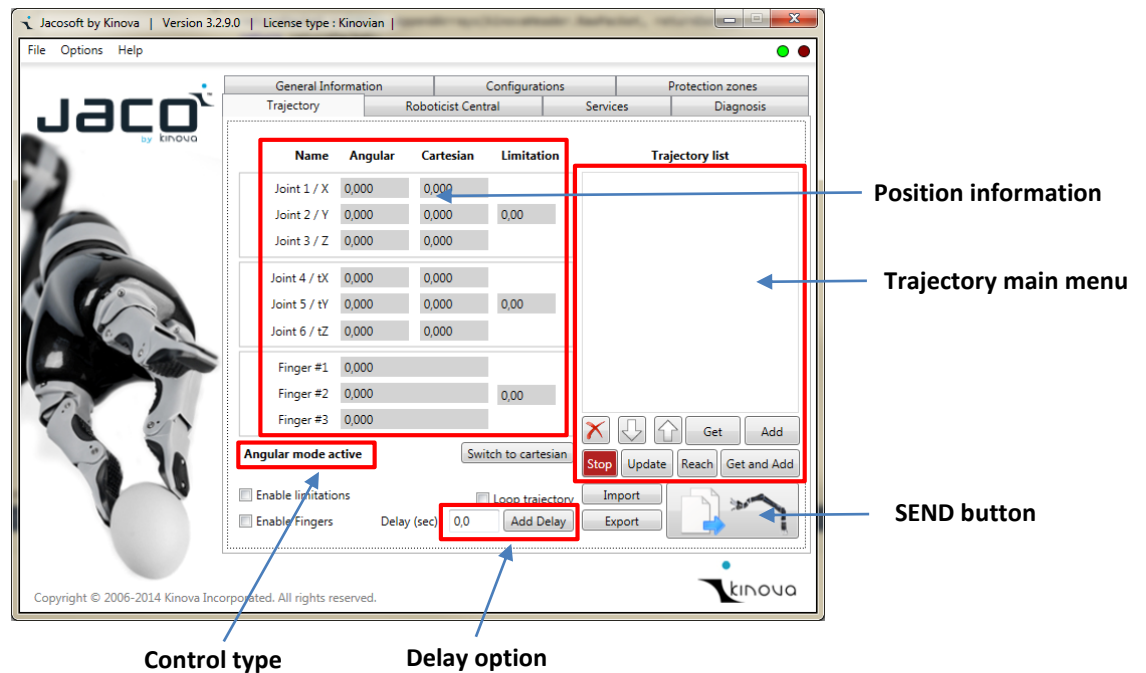


TRAJECTORY TAB



The Trajectory tab is only available with the Research licence.

The Trajectory tab allows you to configure, save and load a specific trajectory. The following figure shows the Trajectory tab.



A trajectory may be constituted of the following elements:

- Position (either reached by Cartesian or Angular control) with or without a Speed limitation;
- Delay (in seconds);

Positions

There is 2 way to add a position to the trajectory. The first one is:

1. Reach a position with the robotic arm.
2. Click on the **GET** button located at the bottom of the MAIN TRAJECTORY MENU.

3. If you wish to add a speed limitation (see SPEED OPTION) when reaching this position, activate the Enable limitation box and put a limitation value in the limitation box of the POSITION INFORMATION section.
4. If you wish to add this position, click on the **ADD** button.

The second one is:

1. Reach a position with the robotic arm.
2. Click *on* the **GET AND ADD** button located at the bottom of the MAIN TRAJECTORY MENU.

Delays

To **add a delay** to a trajectory, you must:

1. Enter a number (delay in seconds) under the Delay box (see DELAY OPTION).
2. Click on the **ADD DELAY** button.

Trajectory

At any time, you may move an item in the trajectory up or down the list by selecting this item and using the appropriate arrows.

At any time, you can select a point from the trajectory, modify its position information and click on the UPDATE button to modify the selected point.

You may also delete the item by selecting this item and clicking on the  button

You may also reach the item by selecting this item and clicking on the **REACH POSITION** button.

You may also loop the trajectory by activating the LOOP TRAJECTORY box. Once the Loop Trajectory box is selected, a **STOP LOOP** button will appear to allow you to stop the trajectory at any time.

To start the trajectory, you must click on the **SEND** button.

You may also either **SAVE** the newly configured trajectory or **LOAD** a previously saved one by using, respectively, the **IMPORT** and **EXPORT** buttons.

To erase a trajectory, you must select every event independently and erase them independently.

ROBOTICIST CENTRAL



The Trajectory tab is only available with the Research licence.

The following figure shows the Roboticist Central tab.



The Roboticist Central tab allows you to perform the following actions in addition to the activation/de-activation of different control options.

- Set zero torque sensor
- Set PID filter
- Set PID
- Set zero position
- Set actuator address
- Reference frame
- Force control
- Current limitation

Set zero torque sensor

This function allows you to reset the torque sensor zero of one or all the actuators.

To reset a unique torque sensor, you must select the SET ZERO TORQUE SENSOR FUNCTION in the function menu, enter the address of the sensor to reset and click on the **SEND COMMAND** button.

To reset all the torque sensors, you must select the SET ZERO TORQUE SENSOR FUNCTION in the function menu and click on the **SEND TO ALL** button.

Set PID filter

This function allows you to modify the filter of the PID filter of one or all the actuators.

To modify a PID filter to one or all the actuators, you must select the SET PID FILTER in the function menu and enter the following information:

- Address : the address of the actuator you wish to modify the PID filter. If you wish to modify all the actuators, no information is needed in this box
- Command : Low pass filter on the command, this is the cut-off frequency (RAD/s). The suggested range is [0, 1000].
- Derivative : Low pass filter on the error derivative, this is the cut-off frequency (RAD/s). The suggested range is [0, 1000].
- Error : Low pass filter on the error, this is the cut-off frequency (RAD/s). The suggested range is [0, 1000].

For the modification of a precise PID filter, click on the **SEND COMMAND** button. For the modification n of all PID filters, click on the **SEND TO ALL** button.

Set PID

This function allows you to modify the PID parameters on one or all the actuators.

To set and modify the PID parameters on one or all the actuators, you must select the SET PID in the function menu and enter the following information:

- Address : the address of the actuator you wish to modify the PID filter. If you wish to modify all the actuators, no information is needed in this box.
- P : The proportional part of the controller. The suggested range is [0, 2].
- I : The integral part of the controller.
- D : The derivative part of the Controller. The suggested range is [0, 0.1].

For the modification of a precise PID, click on the **SEND COMMAND** button. For the modification n of all PID, click on the **SEND TO ALL** button.

Set zero position

This function allows you to reset the position of one or all the actuators.

To reset the position of one or all actuators, you must place the, or all of, the actuators in a precise position (see following figure).

Then, you must select the SET ZERO POSITION in the function menu. Enter the address of the actuator (sensor) to reset one actuator and click on the **SEND COMMAND** button.

Set zero torque sensor

To reset all the torque sensors, you must select the SET ZERO TORQUE SENSOR FUNCTION in the function menu and click on the **SEND TO ALL** button.

Set actuator address

This function allows you to modify the name of a specific address.

To modify an address, you must select the SET ACTUATOR ADDRESS in the function menu and enter the following information:

- Address : the address of the actuator you wish to modify.
- New address : the new name you wish to give to the previously defined address.

Then, click on the **SEND COMMAND** button.

Options

REFERENCE FRAME

The REFERENCE FRAME option allows you to choose the reference frame for the movement of the hand between the following options:

- Fixed frame : the hand moves in space following the given command and without performing and rotation. The opening of the fingers direction doesn't change. This is the "classic" robot motion in which when the robot moves in translation, the orientation of the end effector remains constant.
- Actuator 1 frame : the hand moves in space and the opening of the fingers direction change follows the movement of actuator 1. This is the "default" robot motion in which the orientation of the end effector changes in translation movements to perform a more "human like" motion.

FORCE CONTROL

The FORCE CONTROL option allows to you activate or deactivate the force control of the robotic arm.



This option is only available with a robotic arm equipped with torque sensors.

CURRENT LIMITATION

The CURRENT LIMITATION option allows to you activate or deactivate the current limitation security feature of the robotic arm.

DIAGNOSIS TAB

The Diagnosis tab gives access to a powerful diagnostic tool dedicated to help a Kinova representative assist you with any technical issue occurring with the robotic arm. In the Diagnosis tab, you will find:

- **Firmware information** : display the firmware version of the robotic arm's basic components;
- **Update** : actualize the internal programs (DSP version) of the robotic arm.
- **Health Center** : display more information on the robotic arm.

The following figure presents the Diagnosis tab.



Firmware information

This section allows you to see if every motor (fingers) and actuators (rotating joints) are recognised by the robotic arm and see their actual firmware version.

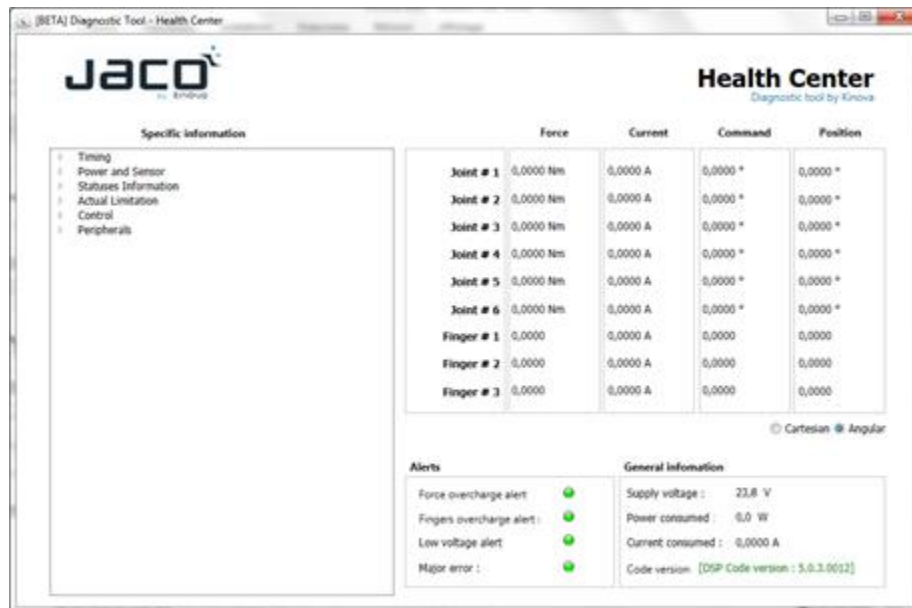
Update

This function allows you to reprogram your robotic arm using the adequate ".hex" file provided by Kinova. Note that once the arm has been reprogrammed, it will be automatically set to its default factory settings.

Health Center

The following window should appear after pressing on the **SHOW HEALTH CENTER** button.

The Health Center is a real time information center. The data may help to detect a technical problem with the robotic arm, define the actual temperature of each joint, determine the usage made of the robotic arm, and many more.



If any problem should occur with your robotic arm, please communicate with a Kinova representative who'll help you through this section.

SPECIFIC INFORMATION

On the left side of the window, you have access to a menu from which you may choose the element you would like to analyze. On the right side, you may see the information available for the chosen elements.

Timing

- Absolute

Not used anymore, it displays the “from startup” value

- From startup

Sum of the time (in seconds) that the robotic arm is powered. This sum is cumulated from the robotic arm startup.

- Control Time (startup)

Sum of the control signal input (joystick or wheelchair drive control movements, push on buttons, etc) recorded by the robotic arm. This sum is cumulated from the robotic arm startup.

- Control Time (absolute)

Not used anymore, it displays the “Control Time (startup)” value.

Power and Sensor

- Average power

Average power consumption (in Watt) of the robotic arm in real time.

- Acceleration sensor (X,Y,Z)

Acceleration (in gravitational force – G) measured by the accelerometers located in the arm.

Statuses Information

- Status

Not used anymore

- Control operator

The actual control operator, it can be one of the following:

- ExternalJoystick3Axis
- ExternalJoystick2Axis
- GUI
- ExpansionCardEasyRider
- UniversalAdapter
- GeneralInterface

- Control mode

A value only used with the default 3 axis joystick, it can be one of the following:

- Arm
- Wrist
- Hand

- Hand mode

This is the type of end effector that is currently used, it can be one of the following:

- ThreeFingers
- TwoFingers

- Connected joints quantity

Quantity of joint currently detected by the robotic arm.

- Position type

The actual type of position, it can be one of the following:

- PositionNoMovements
- CartesianPosition
- AngularPosition
- RetractedPosition
- PreDefinedPosition1
- PreDefinedPosition2
- PreDefinedPosition3
- PreDefinedPosition4
- PreDefinedPosition5
- CartesianSpeed
- AngularSpeed
- TimeDelay

- Error information (SPI, CAN)

Those values are mostly used as a diagnostic tool by Kinova.

- System status/Retract status

Present 6 options, defining the position of the robotic arm in space. Those options are: NoInit-to-ready (the arm has not been initialized yet, nor is it in its HOME position), Ready-to-Retract (the arm is between the HOME and the RETRACT position, moving towards the RETRACT position), Retract-to-Ready (the arm is between the HOME and the RETRACT position, moving towards the HOME position), Retract stdby (the arm is in its RETRACT position), Ready stdby (the arm is in its HOME position, it is ready to move), Normal stdby (the arm has been initialized and is in a position outside the HOME position, it is ready to move).

Actual Limitation

- Speed (linear, angular, fingers)

Those values represents speed (velocity) limitation on linear (translation), angular (orientation) and fingers movement. Currently, the fingers speed is not used.

- Force (linear, angular, fingers)

Those values represents the forces limitation. This feature is not used for the moment.

- Acceleration (linear, angular, fingers)

Those values are the current acceleration for the linear (translation), angular (orientation) and fingers movement.

Control

- Increment control
This represents the velocity command sent to the robotic arm for the last 10ms interval.
- Increment fingers control
This represents the fingers command sent to the robotic arm for the last 10ms interval.
- Joystick value
Those are the value received by the active controller.

Peripherals

- Peripherals connected
A list a connected peripheral.
- Peripheral device ID
The ID of each connected peripherals.

UPPER RIGHT WINDOWS

- Force
Force measured by respective sensors on each actuator. In a robotic arm without force sensors, this measure is estimated from the current value.
- Current
Those are the current (motor) measured by respective sensors on each actuator.
- Command
Those values are the command sent to each actuator. You can think of that as a target position or the desired position.
- Position
Those values are the position read by the encoder of each actuator. You can think of that as the real position.

ALERTS

There is 4 possible alert that can be triggered by the robotic arm. The first one is a force overcharge alert, this indicates that the robotic arm reach its maximum force. The second one is the fingers overcharge, this value indicates the one of the fingers is consuming too much current. The low voltage alert shows that the main supply line has been below 16 volts for more than 3 seconds. The major error warning is triggered when something really wrong is happening inside the robotic arm.

GENERAL INFORMATION

This section offers information about the current firmware version and the main supply line.

CONTACTING SUPPORT

If you need help or have any questions about this product, this guide or the information detailed in it, please contact a Kinova representative at:

- Support@KinovaRobotics.com.

We value your comments!



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APPENDIX 1: STEP-BY-STEP EXAMPLE FOR MAPPING CONFIGURATION

The following section describes a step-by-step approach to help configure the mapping of two fictive client cases. The information on the client's control method, mobility and needs have to be acquired before configuring the mapping.

For an adequate configuration of the mapping, there are 18 functions to assure, one of which (Change Mode) must be assured in every mode. For easiness of mapping schematics, the following abbreviations will be used:

FUNCTIONS	ABBREVIATIONS
X_Minus	X-
X_Plus	X+
Y_Minus	Y-
Y_Plus	Y+
Z_Minus	Z-
Z_Plus	Z+
Xteta_Minus	XO-
Xteta_Plus	XO+
Yteta_Minus	YO-
Yteta_Plus	YO+
Zteta_Minus	ZO-
Zteta_Plus	ZO+
Open Hand Three Fingers	OF3
Close Hand Three Fingers	CF3
Open Hand Two Fingers	OF2
Close Hand Two Fingers	CF2
Retract_ReadyToUse (HOME/RETRACT)	H/R
Change Mode	C.M.

Here are the main steps of the mapping configuration:

- 1) With the Kinova robotic arm Health Center, Control/Joystick Value and Button Value menu, find out which buttons and which joystick movements relate to which command and states;
- 2) Define how much modes will be needed;
- 3) Define in which list they will be placed;
- 4) Assign the functions in the modes in the most intuitive way possible;
- 5) Disable the diagonals when needed;
- 6) Place the Retract_ReadyToUse (H/R) function in default mode in order to be able to set the arm in its ready position at the Kinova robotic arm onset;
- 7) Decide the methods for switching between modes.

Case #1: 4 d.o.f. control interface, 1 external button possibility

CLIENT'S INFORMATION

- Client drives all his wheelchair functions through a 4 functions (4 d.o.f.) sip and puff device.
- Client has space and mobility for 1 additional push button only.

CHARTS USED

- Controlling a Kinova robotic arm through the wheelchair control interface may only be achieved through the Universal Interface.

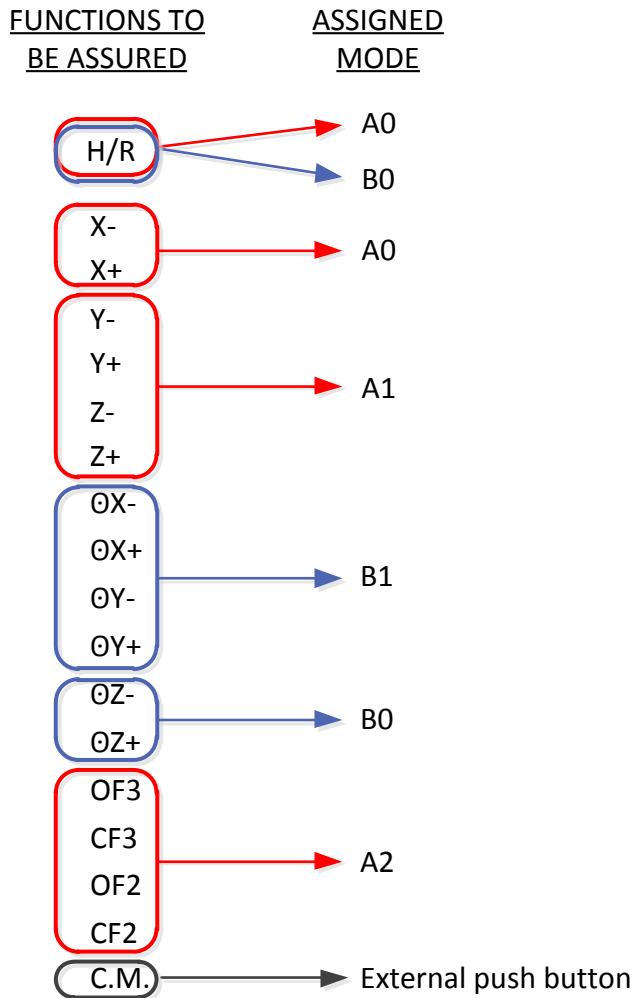
MAPPING CONFIGURATION NECESSITY

- 1) With the Kinova robotic arm Health Center, Control/Joystick Value and Button Value menu, find out which buttons and which joystick movements relate to which command and states.
- 2) Define how much modes will be needed
 - Change Mode (C.M.) assured by external push button;
 - 4 d.o.f. control interface;
 - 17 functions to assure.

➤ Equation used: $\frac{17 \text{ functions}}{4 \text{ d.o.f.}} > 4 \text{ modes} = 5 \text{ modes}.$
- 3) Define in which list the modes will be placed
 - There are 2 lists;
 - Each list may incorporate up to 6 modes;

- Separating the modes into 2 different lists will allow changing modes in a more intuitive way.
- 3 modes in list A
- 2 modes in list B

4) Assign the functions and movements in the modes



5) Disable the diagonals when needed

- Disable diagonals in following modes:
 - A0
 - A2
 - B0

- 6) Place the Retract_ReadyToUse (H/R) function in default mode in order to be able to set the arm in its ready position at the Kinova robotic arm onset.
 - Either B0 or A0 may be set as default mode.
- 7) Decide the methods for switching between modes
 - The external push button will be used to change between mode;
 - There are 2 lists;
 - HoldTwoSec will be used to access list A in all of the modes assigned in list B;
 - OneClick will be used to toggle into list A in all of the modes assigned in list A;
 - HoldTwoSec will be used to access list B in all of the modes assigned in list A;
 - OneClick will be used to toggle into list B in all of the modes assigned in list B.

Case #2: 3 way controller (cephalic joystick), no external button

CLIENT'S INFORMATION

- Client drives all his wheelchair functions through a 3 functions (3 d.o.f.) cephalic device.
- Client has neither space nor mobility for additional push button.

CHARTS USED

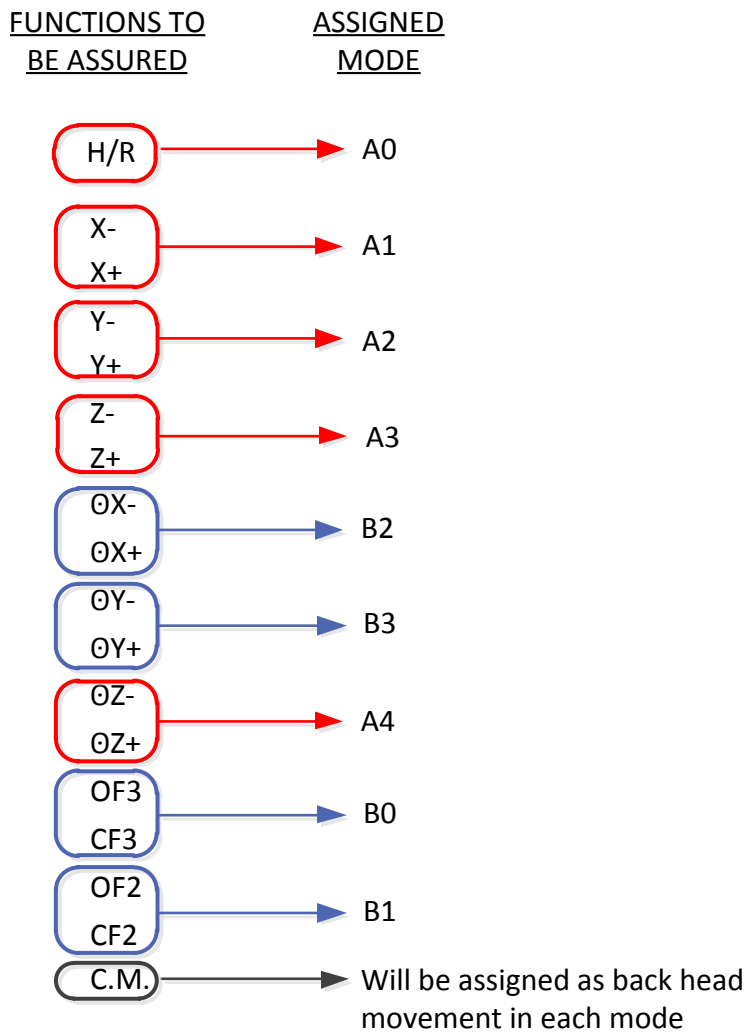
- Controlling a Kinova robotic arm through the wheelchair control interface may only be achieved through the Universal Interface.

MAPPING CONFIGURATION NECESSITY

- 1) With the Kinova robotic arm Health Center, Control/Joystick Value and Button Value menu, find out which buttons and which joystick movements relate to which command and states.
- 2) Define how much modes will be needed
 - 3 d.o.f. control interface minus 1 that will be used in each mode for Change Mode (C.M.)
→ 2 d.o.f.
 - 17 functions to assure.
 - Equation used: $\frac{17 \text{ functions}}{2 \text{ d.o.f.}} > 8 \text{ modes} = 9 \text{ modes}.$
- 3) Define in which list the will be placed
 - There are 2 lists;
 - Each list may incorporate up to 6 modes;

- Separating the modes into 2 different lists will allow changing modes in a more intuitive way.
- 5 modes in list A
- 4 modes in list B

4) Assign the functions and movements in the modes



5) Disable the diagonals when needed

- Disable diagonals in all the modes.

6) Place the Retract_ReadyToUse (H/R) function in default mode in order to be able to set the arm in its ready position at the Kinova robotic arm onset.

- A0 must be set as default mode.

7) Decide the methods for switching between modes

- Change Mode (C.M.) will be assigned to the back head movement in each mode.
- There are 2 lists;
- HoldOneSec will be used to access list A in all of the modes assigned in list B.
- OneClick will be used to toggle into list A in all of the modes assigned in list A.
- HoldOneSec will be used to access list B in all of the modes assigned in list A.
- OneClick will be used to toggle into list B in all of the modes assigned in list B.

APPENDIX 2: KINOVA'S JOYSTICK ASSOCIATED COMMAND AND STATES

The Kinova joystick associated Commands and States are defined in the following figure. If you are using another controller, please refer to the Health Center (Diagnosis tab) under the Control/Joystick Value menu to define the controller Commands and States.

COMMAND	STATES « PLUS »	STATES « MINUS »
InclineLR	Right inclination of the lever	Left inclination of the lever
InclineFB	Front inclination of the lever	Back inclination of the lever
Rotation	Clockwise rotation of the lever	Counter clockwise rotation of the lever
MoveLB	No functionality	
MoveFB	No functionality	
Push	No functionality	

The buttons **Command** and **States** associated to Kinova's joystick are defined in the following figure:

