KINOVA



TOGETHER IN ROBOTICS

MEET LINK 6

USER GUIDE

Contents

Copyright notice **1**

Disclaimers **2**

Link 6 overview **3**
- Intended use 4
- Unintended uses 5
- Warranty 6
- EU Declaration of Incorporation 7
- FCC Declaration of Conformity 9
- Applicable firmware 11

Technical specifications **12**
- Schematics and dimensions 15
  - Effective workspace 17

Components **19**
- Base 19
  - Specifications and dimensions of the base of the arm 20
- Actuators 20
- Wrist interface overview 21
  - Force torque sensor 24
  - Mechanical interface 24
  - Electrical interface 24
  - Wrist interface compatibility 29
- Controller overview 29
  - Controller mounting interface 33
  - Controller electrical and communications interface 35
  - Industrial I/O panel overview 37
- Teach pendant overview 51

Safety **53**
- Precautions 53

Safety directives and warnings....54
Risk assessment....57
Safety equipment....58
Assessments before using the robot....59
Stop categories....59
Emergency stop....60
Move the arm without power....61
Safety functions....62
List of safety functions....62
Stopping times and distances....67
Diagnostic coverage....69
Safety modes....69
State timelines of safety functions....70
SF01 Emergency stop timeline....71
SF02 Protective stop timeline....72
SF03 Joint position monitoring timeline....73
SF04 Joint speed monitoring timeline....75
SF05 Monitored stop timeline....76
SF06 Protection zone monitoring timeline....77
SF07 TCP and Elbow speed monitoring timeline....79
Robot safety protections and limits....80
Joint limits....81
TCP limits....82
Elbow limits....83
Protection zones....84
Tool sphere....86
Zones pane....86
Zone shapes....90
Exporting or importing all protection zones into one file....92
Visualization pane....94
Safety I/Os....95
Safety inputs....96
Safety outputs....99
State timelines of safety outputs....101
Installing the drive power indicator....103
Safety checksums....104
Parameters that are the basis for the safety checksum....105
Arm calibration....106

Exporting calibration files....108
Importing arm calibration files....108
Preventing an unrecoverable fault....110
Recovering from an unrecoverable fault....110

Modes of operation of Link 6....112
Complete start-up sequence....113
State: Off....113
State: Controller initialization....114
State: Controller idle....115
State: Arm initialization....116
State: Arm maintenance....118
State: Monitored stop....118
State: Fault....119
Operating modes....121
Mode: Manual Jog....121
Mode: Hand Guiding....124
Mode: Hold-to-Run....126
Mode: Automatic....127
Recovery mode....128
Robot lights and what they mean: a reference....129

Hardware installation....133
Inside the Link 6 boxes....133
Unpacking the arm....134
Considerations before installing the arm....135
Base force reactions....136
Installing the arm directly to a surface....138
Installing the arm on a third-party adapter plate....140
Unpacking the controller....141
Considerations before installing the controller....141
Installing the controller on a flat surface....143
Installing the controller vertically....144
Connecting the arm to the controller....146
Installing the teach pendant mount....146
Connecting the teach pendant to the controller....148
Connecting power to the controller....149
Connecting a computer to the controller....150

Connecting a network to the controller....150

Initial software setup....151
Supported client devices....151
Logging in....152
Repositioning the arm to use it for the first time....154
Kortex Web App layout....155
Menu pages....156
Open Source software packages....159
Indicators, user profile, and power....159
Robot control panel....162
System information....164
Robot networking and communication....166
User management....167
Adding a user....170
Editing a user....172
Deleting a user....175
Elevating permissions....177
Remote access....178
Kinova® Kortex™ GitHub repository....180
Plugins....180
Getting the plugins for the robot....181
Installing plugins....183
Uninstalling plugins....185
Updating plugins....187
Overview of working with plugins....190
Configuring tools....191
Adding tools....194
Other actions that can be taken on tools....196
Configurations for the robot settings....197
Configuring the controller for robot controls....198
Configurations of the arm for robot controls....199
Configuring the gravity vector of the arm....200
Configuring the payload....201
Configuring the calibration parameters of the arm....203
Configuring collision detection on the arm....204
Configuring energy limitations on the arm....206
Configuring the force torque....207

Maintenance mode..... 209
Logs..... 211
Exporting logs..... 212
Generated events..... 212
Configuration files..... 213
Backing up the current configuration and setup..... 214
Common errors when backing up configuration files..... 215
Loading configuration files..... 216
Upgrading software from a teach pendant..... 217
Upgrading software from a computer..... 220
Consequences of downgrading from v3.2 to v3.1..... 223
Restoring factory defaults..... 224
Contact force reduction..... 225
Collision detection..... 226
Energy limitation..... 229

Visual programming..... 232
Overview of the Programs page..... 232
Overview of the Program page..... 233
Arm Speed Factor..... 236
Exporting a program from the teach pendant..... 237
Exporting a program from a computer..... 240
Importing a program from the teach pendant..... 241
Importing a program from a computer..... 245
Migrating and updating programs..... 246
Variables..... 249
Examples of JSON statements..... 254
Adding a variable global to all programs from the Variables page..... 255
Variable Management page..... 258
Adding a variable global to all programs from the Variable Manager page..... 262
Adding a variable global only to a specific program..... 267
Selecting a variable..... 272
Deleting a variable that is being used in a program..... 275
Core tiles..... 276
Common core parameters in the Tile Configuration pane..... 278
Basic: Set tile parameters..... 279
Basic: Wait tile parameters..... 280
Basic: Condition tile parameters..... 280

Basic: Loop tile parameters....282
Basic: Message tile parameters....285
Basic: Exit tile parameters....287
Robot: Change Active Tool List parameters....288
Robot: Change Payload tile parameters....290
Robot: Edit Tool Parameters action....292
Robot: Matrix tile parameters....294
Robot: Tool Path parameters....298
Tool Path waypoints....299
Path Configuration parameters....310
Custom Frame parameters....312
Robot: Waypoints tile parameters....313
Waypoint parameters....313
Constraint parameters....321
Custom Frame parameters....325
Debug tools for waypoints....326
Industrial I/O: tiles....329
Industrial I/O: Read Input tile parameters....329
Industrial I/O: Set Output tile parameters....331
Industrial I/O: Wait for Input tile parameters....333
Program creation....334
Creating a program....335
Hand Guiding panel....336
Jog Cartesian panel....337
Translation and rotation from the Jog Cartesian panel....337
Additional settings....338
Jog Angular panel....340
Additional settings....340
Debug panel overview....341
Debugging a program....343
Program is ready to use....344
Running a program in Automatic mode....344
Running a program in Hold-to-Run mode....345

Diagnostics....346
Built-in self tests....346
Status of safety functions....347
Status of the controller....348

Firmware update....351
Incompatible firmware version....351
Joint detection error....352
Joint fault....352
No kinematics support....352
Maximum ambient temperature reached....353
Maximum core temperature reached....353
Maximum Joint Motor Housing temperature reached....354
Maximum Joint Core temperature reached....354
Network error....355
Self-collision detected....355
Status of the Safety Control Unit....356
Emergency stop button signals disagreement....359
Safety input signals disagreement....360
Status of the actuators....360
Remedy for MCU internal diagnostics....364
Core temperature too high....364
Core temperature too low....365
Motor housing temperature too high....365
Motor housing temperature too low....365
Status of the wrist....366
Robot monitoring....368
Overview pane of the Monitoring page....369
Detailed pane of the Monitoring page....370
Event notifications....372
Filtering events....375

Plugins....379
Arm plugin....379
Industrial I/O Plugin....380
Controller digital outputs on the Industrial I/O plugin page....381
Controller digital inputs on the Industrial I/O plugin page....382
Controller analog I/O on the Industrial I/O plugin page....383
Wrist analog I/O on the Industrial I/O plugin page....384
Wrist digital I/O on the Industrial I/O plugin page....385
USB device access from plugins....387

Accessories....388

Wall mount kit....388
External emergency stop station....390
Installing an external emergency stop station....390
External 3-position enabling device....391
Installing the external 3-position enabling device....392

Maintenance....393
Consumables....393
Preventive maintenance....394
Daily maintenance....394
Weekly maintenance....395
Quarterly maintenance....395
Yearly maintenance....395
Unscheduled maintenance....396
Fastener maintenance....397

Servicing....398

Disposal....399

Troubleshooting....400
Issues related to hardware....400
Why does the controller have no power?....400
Why is the arm not powering on?....400
Why is the robot moving in joint Hand Guiding mode by itself?....401
Why is the snapshot button not working?....401
Why is my tool not working?....402
Emergency stop....402
Why is the wrist enabling device not enabling Hand Guiding mode?....403
Why is the controller hot?....403
Why did my robot collide with the tool installed on its end effector?....403
Why is my tool, connected to the M8 connector, not responding?....404
Why does the robot repeatedly report errors related tot he M8 Analog I/O channels?....404
Why does my robot refuse to move in a particular direction?....405
Why is my teach pendant only displaying a console?....405
Why are my digital outputs not operating at 24 V?....405
Issues related to safety elements....406

Why can I not edit any safety configurations?....406
Why is the external safety device not working?....406
Why is the robot stuck in Reduced mode?....407
Why is there a fault for exceeding speed limits when I am operating in Hand Guiding mode?....407
Issues related to modes of operation....407
Why is Manual mode disabled?....407
Why can the robot not exit Recovery mode?....408
Why is my robot not moving even if it is in an operating mode where it should be possible?....409
Issues related to plugins....409
Why can I not configure Industrial I/Os?....409
Issues related to programs and programming....409
Why can I not select a variable in the Select Variable page?....410
Why are tiles missing in the visual programming interface?....410
Why can I not find a program in the list of programs?....411
Why do some of the tiles of an imported program show a question mark?....411
Why are the Industrial I/O tiles not loading?....412
Why is my program running, but not making progress?....412
Why is my robot extremely slow?....412
Issues related to Kortex Web App....413
Why is the robot not going to the programmed position?....413
Why is the remote computer not connecting to Kortex Web App?....414
Why is Kortex Web App not responding on my remote computer?....415
Why is there a pop-up requesting visual confirmation of the robot pose after the robot reboots?....415
Why do the +/- buttons on the wrist not work with my tool?....416

Glossary....417
A....417
B....418
C....418
D....419
E....420
F....421
G....421
H....422
I....422

J.....423
K.....423
L.....424
M.....424
N.....425
O.....426
P.....426
R.....428
S.....430
T.....431
U.....432
W.....432

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Link 6 overview

The Link 6 is an *arm* with six *degrees of freedom (DoF)*, a powerful *controller*, and a *teach pendant*. It works under the Kortex software framework and *Kortex Web App*. Access Kortex Web App from the teach pendant or from a web browser on a remote computer.

Each axis is a joint and the part of the arm between each link is a joint. The robot parts from base to wrist are referred to as the arm. The arm has seven mechanical parts. The remaining parts of the robot are the controller and the teach pendant.



1	Teach pendant
2	Wrist
3	Forearm
4	Elbow
5	Arm
6	Shoulder
7	Base
8	Controller

Figure 1: Link 6

The arm can be manipulated with one hand. The wrist has a set of buttons on it that are used for toggling between *Cartesian* and Joint Hand Guiding, waypoint capturing, moving the arm, and *end effector* actions. With these buttons on the wrist, it is easy to teach the robot the movements it needs to memorize.

Because of the modular design of the robot, a variety of optional interfaces are available to connect as end effectors. Each of these optional interfaces has no visible cables.

Kinova offers a variety of optional parts.

- The Kinova Wall mount kit attaches the controller to walls.
- The Vision module enables 2D and 3D vision-related applications.
- The Robotiq Adapter attaches directly to the wrist and is compatible with multiple tools by Robotiq.
- The flange attaches to the OnRobot ISO adapter.
- Additional *Emergency stops* connect to the controller.
- One or more *enabling devices* connect to the controller.

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The wrist has a force torque sensor built into it. With the force torque sensor, hand guiding Link 6 is smooth.

The wrist has an interface to which an end effector can be installed. The end effector may be a gripper, polishing disk, nail gun, screwdriver, tool changer, and so on. It is the only part of the robot that is in direct contact with the piece being manipulated.

The controller can be considered the brain of the robot. Install the controller in an accessible location on the table, wall, or in a cabinet—wherever it makes it easy to power on or off the robot. Some installations of the controller require the optional Kinova wall mount kit.

Related topics
Components on page 19

Accessories on page 388

Intended use

Link 6 is intended for typical industrial applications to manipulate objects and tools in a non-explosive environment.

To ensure safe operation for all intended uses, perform a risk assessment and mitigate all the risks to a safe, acceptable level. Use the robot in industrial applications only and within the stated specifications.

There are many different types of industrial applications in which Link 6 can be used.

- Material handling
- Small parts assembly
- Machine tending
- Packaging
- Palletizing
- Bin picking
- Screw driving

Important: The list of industrial applications is not exhaustive.

When deciding how you can use the robot, keep in mind that the arm, controller, and teach pendant of Link 6 is designed to have an ingress protection rating of 54 (IP54). The first number indicates the level of protection from objects, such as dust; the second number indicates the level of protection from water. Therefore, an IP rating of 54 indicates two things about Link 6.

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- The robot is designed to have limited protection against dust and other small objects. It is limited because some small particles may still enter the robot. However, the robot can still operate with some particles in it.
- The robot is designed to be protected from splashes of water from all directions.

Related topics
Safety on page 53

Unintended uses

Link 6 is not intended to work in certain applications because it can damage the *robot system*, or lead to serious injury to, or death of, the user.

Kinova is not responsible for any damage caused to the robot system when the robot is not used as intended.

There are many different types of industrial applications in which Link 6 cannot be used.

- Flammable environments
- Radioactive environments
- Liquid environments, including water
- Outdoor climate conditions
- Medical applications
- Life critical applications

There also are a number of uses that can damage the robot and cause injury or death.

- Using the robot without first performing a risk assessment
- Climbing on the robot while it is in its box or on the robot when it is not in its box
- Standing on the controller
- Placing liquids, such as cups of coffee or tea, directly on the controller

DANGER: Do not use the robot in conditions that do not conform with the ingress protection rating of IP54.

Important: The lists of unintended uses is not exhaustive. There are many more unintended uses that are not cited.

Important: Link 6 does not support Power and Force Limiting (PFL) collaborative mode as described by ISO TS 15066.

Notice: Kinova assumes no liability of any kind if safety measures are not followed. Please read all the information concerning this product before using it.

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Warranty

 Refer to the *Term and Conditions* on the Kinova website: https://www.kinovarobotics.com/legal/terms-and-conditions.

 Refer to sales conditions for the defined life of service of the device.

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EU Declaration of Incorporation

Link 6 is a Partly Completed Machine. The declaration is a self-declared assessment, produced and signed by a manufacturer of a product, to assert that the product meets all of the requirements of the applicable directives.

Machinery Directive 2006/42/EC Article 1 states:

> […] the manufacturer of a partly completed machinery shall, before placing it on the market, ensure that a declaration of incorporation described in Annex ll, part 1, Section B has been drawn up.

The Declaration of Incorporation declares which essential requirements of the Directive is applied and fulfilled.

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DoI-C61000-003 R01

EU DECLARATION OF INCORPORATION

In accordance with ISO/IEC 17050-1:2004

Manufacturer : Kinova Robotics
4333 Boulevard de la Grande-Allée,
Boisbriand, QC J7H 1M7, Canada
Telephone: +1 514-277-3777

Description and identification of the partially completed machine(s):

Product and function: Robot (Multi-axis manipulator)
Models: KINOVA® Link 6 Robot KR C61 0003

KINOVA® Link 6 Robot KR C61 0003 shall only be put into service upon being integrated into a final complete machine (robot system, cell or application), which conforms with the provisions of the Machinery Directive and other applicable Directives.

When this incomplete machine is integrated and becomes a complete machine, the integrator is responsible for determining that the completed machine fulfils all applicable directives and updating the relevant harmonized standards, other standards, and documents.

It is declared that the above products, for what is supplied, fulfil the following directives as detailed below:

• Machinery Directive 2006/42/EC	The following clauses are applied and fulfilled: 1.1.2, 1.1.3, 1.1.5, 1.2.1, 1.2.3, 1.2.4.1, 1.2.4.2, 1.2.4.3, 1.2.4.4, 1.2.6, 1.3.1, 1.3.2, 1.3.4, 1.3.9, 1.5.1, 1.5.2, 1.5.4, 1.5.5, 1.5.6, 1.5.7, 1.5.8, 1.5.10, 1.5.11, 1.5.16, 1.6.1, 1.6.3, 1.7.1.1, 1.7.1.2, 2.2.1, 4.1.2.6, 4.2.1, 4.3.3, ANNEX B
• 2014/30/EU - EMC	Electromagnetic Compatibility
• 2014-35-EU - LVD	Low Voltage Directory
• 2011/65/EU - RoHS	Restriction Of Hazardous Substances *(in electrical and electronic equipment)*
• 2002/96/EC – WEEE	Waste Electronic and Electrical Equipment

The following supportive standards were used during the development of the partly completed machinery:

• IEC 60204-1:2016 + A1:2021	Safety of machinery - Electrical equipment of machines Part 1: General requirements
• ISO 10218-1:2011	Robots and robotic devices - Safety requirements for industrial robots – Part 1
• ISO 12100:2010	Safety of machinery - General principles for design - Risk assessment and risk reduction
• IEC 61000-6-1:2016	Electromagnetic compatibility (EMC) - Part 6-1: Generic standards - Immunity standard for residential, commercial and light-industrial environments
• IEC 61000-6-2:2016	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments
• IEC 61000-6-3:2020	Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for equipment in residential environments
• IEC 61000-6-4:2018	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments
• ISO 13849-1:2015	Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design
• ISO 13849-2	Safety of machinery - Safety-related parts of control systems - Part 2: Validation
• IEC 60529:2004	Degrees of Protection Provided by Enclosures (IP Code)
• IEC 61131-2:2017 (for I/O only)	Industrial-process measurement and control - Programmable controllers - Part 2: Equipment requirements and tests
• ISO 13850:2015	Safety of machinery — Emergency stop function — Principles for design
• ISO 14118:2017	Safety of machinery — Prevention of unexpected start-up

The manufacturer or its authorised representative will undertake to transmit, in response to a reasoned request by the national authorities, relevant information on the partly completed machinery.

The Technical Construction File is kept and maintained at the corporate headquarters of Kinova Robotics located at 4333 Boulevard de la Grande-Allée, Boisbriand, QC J7H 1M7, Canada.

Electronically signed by: Keven Frechette
Reason: I have reviewed and I approve the content of this document.
Date: Nov 21, 2023 09:12 EST

Keven Fréchette
Manager, Quality Assurance

Boisbriand, Canada

Date: 2023-11-21

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FCC Declaration of Conformity

The declaration is a self-declared assessment, produced and signed by a manufacturer of a product, to assert that the product meets all of the requirements of the applicable directives.

FCC Regulatory Disclosures: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help

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FCC-C61000-003 R01

FCC SUPPLIER'S DECLARATION OF CONFORMITY

Manufacturer Address :	Responsible Party – U.S. Contact Information
Kinova Robotics	Americas Compliance Consulting LLC dba iCertifi
4333 Boulevard de la Grande-Allée	1001 SW Disk Drive, Ste 250
Boisbriand, QC J7H 1M7, Canada	Bend, Oregon 97702 USA
Telephone: +1 514-277-3777	Email: FCC_sDoC@icertifi.com

Description and identification of the devices

Product and function: Robot (Multi-axis manipulator)

Models: KINOVA® Link 6 Robot KR C61 0003

These devices comply with Part 15 of the FCC Rules and Regulations for Information Technology:

Regulation: FCC 47 CFR Part 15.

Operation is subject to the following two conditions:

(1) these devices may not cause harmful interference, and
(2) these devices must accept any interference received, including interference that may cause undesired operation.

We, the responsible party iCertifi, declare that the product identified above conform to the applicable FCC rules and regulations. The method of testing was in accordance with the appropriate measurement standards, and all necessary steps have been taken to ensure that all production units of these devices will continue to comply with the Federal Communications Commission's requirements.

FC

Electronically signed by: Keven Frechette
Reason: I have reviewed and I approve the content of this document.
Date: Jan 17, 2024 11:31 EST

Keven Fréchette
Manager, Quality Assurance

Boisbriand Canada, January 17th 2024

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Applicable firmware

The current version of the user guide reflects a specific version of the firmware used in Link 6.

Whenever there is a change in the firmware, there usually is a change in the user guide. Always make sure the guide is matching the installed firmware.

If you are using an earlier firmware or software version, some of the features discussed in the document may not apply to your installation. To upgrade firmware and software, download the packages from the product technical resource page on the Kinova website and install them from **Maintenance** > **System Upgrade** in Kortex Web App.

Table 1: Firmware associated with user guide r4.2

Software	Version
Link 6 software update package	3.3.0

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Technical specifications

Link 6 is a modern, robust, robot capable of collaborative applications for all industries that want to benefit from automation.

Table 2: General

Degrees of freedom (DoF)	6
Continuous payload (full range, at 200 mm from wrist)	6.0 kg
Maximum half-dextrous reach	1000 mm
Maximum robot reach	1149 mm
Maximum Cartesian translation speed	2.0 m/s
Repeatability in accordance with ISO 9283 specification	up to 0.1 mm
Ingress protection rating (arm and controller)	IP54
Controller enclosure rating	NEMA Type 5
Ambient operating temperature	0 °C to 40 °C
Permissible altitude	1000 m or less above sea level
Maximum storage humidity (non-condensing)	95% at 30 °C
Maximum operating humidity (non-condensing)	95% at 20 °C
	50% at 40 °C
Arm weight (without cable)	21.45 kg
Arm materials	Aluminum, ABS plastic
Installation orientation of the arm	All
Acoustic noise level	70 dBA
Robot base footprint diameter	149 mm
Lifetime	35000 hrs

Table 3: Electrical

Input power supply voltage and frequency	110-240 V *AC*
	1 phase, 50-60 Hz
Peak Power rating	1400 W
Peak current rating	12.7A at 110 V AC

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	5.8A at 240 V AC
Recommended overcurrent protection device rating	15 A at 110 V AC
	7.5 A at 240 V AC
Short-circuit current rating	5 kA when protected by T class fuses with a maximum rating of 15 A
Distribution system type	*TT* or *TN* in accordance with *IEC* 60204-1
Steady state voltage	0.9-1.1 of nominal voltage, continuously
Frequency	0.99-1.01 of nominal frequency continuously; 0.98-1.02 short time
Harmonics	Not exceeding 12% of total *RMS*
Voltage interruption	Interrupted or at zero voltage for not more than 3 ms at any random time in the supply cycle with more than 1 s between successive interruptions
Voltage dips	Not exceeding 20% of the *RMS* voltage of the supply for more than one cycle with more than 1s between successive dips

Warning: Always use the *alternating current (AC)* cord provided by Kinova. Always refer to the table of Electrical specifications for the correct current rating. Failure to adhere to the recommended specifications can compromise the integrity of the system.

Attention: If the machine is powered from a *transformer neutral system (TN)* system, it is recommended to use a Class T fuse overcurrent protection device .

Attention: If the machine is powered from a *earthing electrode system (TT)* system, always use a Class T fuse overcurrent protection device with a device rating of 30 mA Type B *residual current device (RCD)*.

Table 4: Integrated force torque sensor

Range force/torque Fx, Fy, Fz, Tx, Ty, Tz	200 N / 20 N·m
Repeatability force Fx, Fy, Fz	0.5 N at 25 N and 4 N at 200 N

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Repeatability torque Tx, Ty, Tz	0.05 N·m at 2.5 N·m and 0.4 N·m at 20 N·m

Table 5: Actuators

Joint 1, 2, 3 range	± 357°
Joint 1, 2, 3 velocity	200 °/s
Joint 4, 5, 6 range	± 357°
Joint 4, 5, 6 velocity	320 °/s
Actuators sensors	Redundant position, current, voltage and estimated torque

Table 6: Interfaces

Controller interfaces	USB 3.0, Ethernet
Controller I/O	Digital: 16 inputs (8 redundant safe), 16 outputs (8 redundant safe)
	General purpose analog: 4 programmable input/output
	General purpose digital: 8 inputs, 8 outputs
Wrist I/O	Digital: 8 programmable input/output
	Analog: 2 programmable input/output
	Modbus RTU
	24 V supply @ 5 A
Wrist - Mechanical	Flange ISO 9409-1-50-4-M6

Table 7: Controller

Controller dimensions (with covers, feet, and protrusions)	454 mm x 208 mm x 395 mm
Controller weight	16.15 kg
Processor	Intel® Core™ i7 processor[1]
Memory	*RAM*: 8 GB DDR4
	Storage: 128 GB SSD

[1] Intel, the Intel logo, and Intel Core are trademarks of Intel Corporation or its subsidiaries.

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Table 8: Teach pendant

General	12.1”, touch capacitive, IP54
Weight (with 1 m cable)	1.80 kg

Table 9: Safety

Standards considered	Developed in accordance with UL1740, as well as ISO 10218-1:2011, IEC 60204-1:2016, and EU directives
Safety functions	Developed in accordance with ISO 12100:2010 and 13849-1:2015 Category 3 *PL d*

Table 10: Main accessories (optional parts)

Tool adapters with mounting hardware	Robotiq
Notice: Third-party adapters are compatible and available from the EOAT device manufacturers.	0.2 kg
E-stop button	0.2 kg

Related topics
Accessories on page 388

Schematics and dimensions

The dimensions of the *arm* and the *controller* are important for integration purposes. The arm must be placed such that it can perform the desired task safely.

Remember: Add the height of the *end effector* and its required workspace to Link 6, as well as the height of the surface on which the base is installed, for an accurate assessment of the amount of space required to install a robot.

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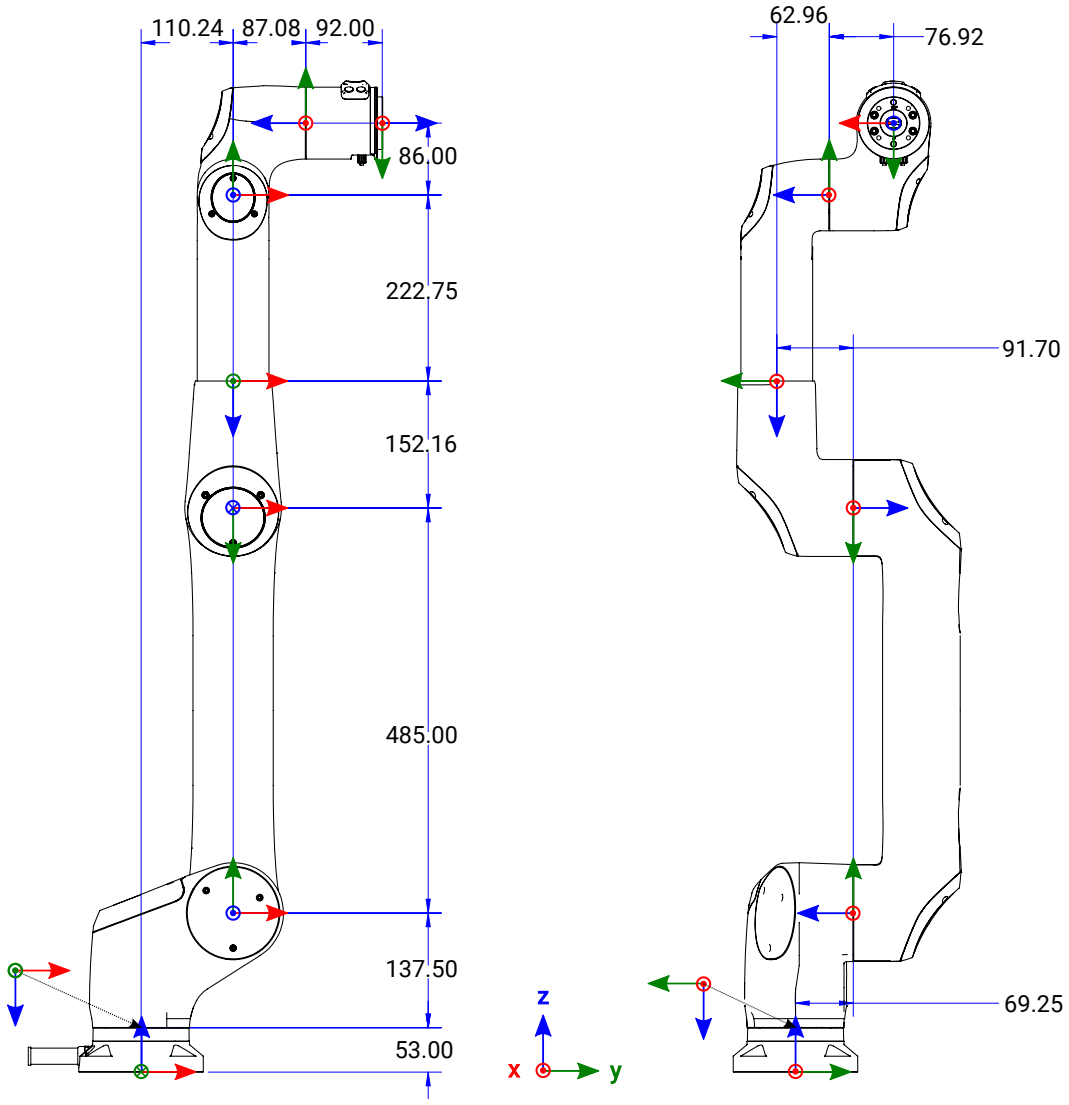


Figure 2: Arm dimensions in millimeters

The controller is a box that sits on a table, wall, or in a cabinet near the arm.

Note: To install the controller in a cabinet or on a wall, use the Kinova wall mount. The wall mount is an optional accessory.

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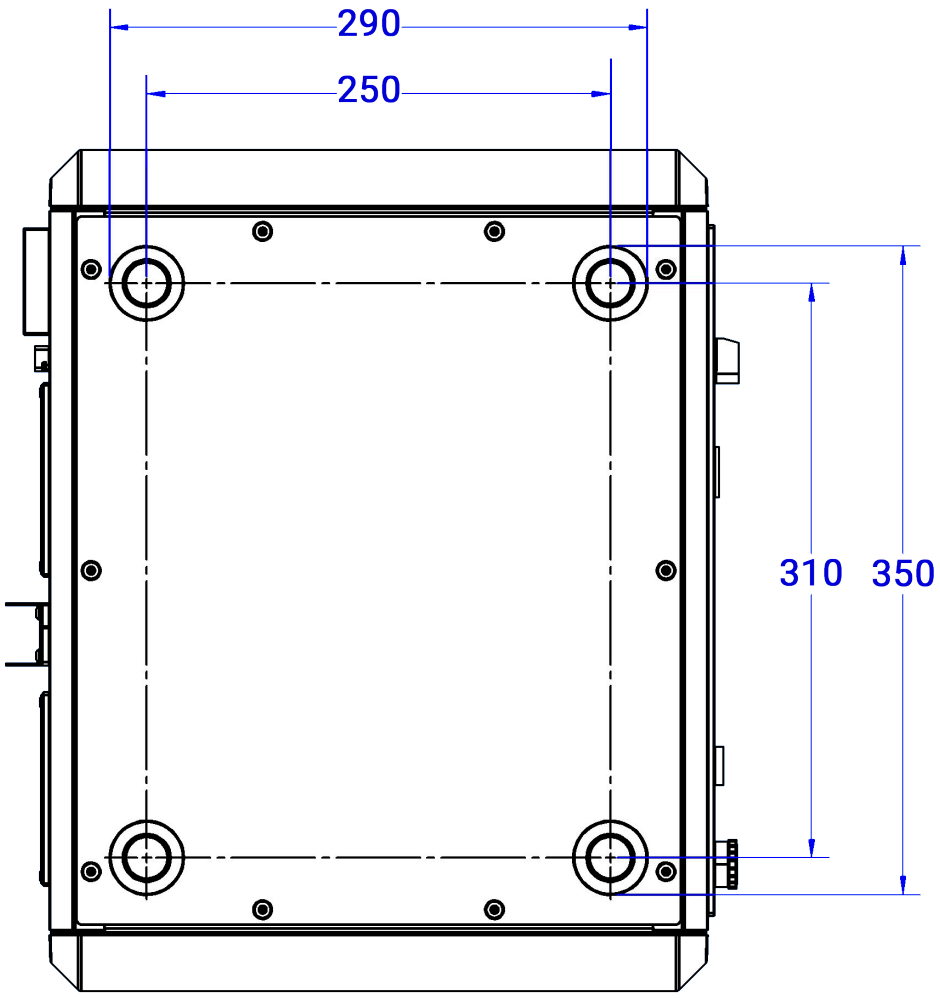


Figure 3: Controller dimensions in millimeters: Bottom view

Related topics

Safety directives and warnings on page 54

Move the arm without power on page 61

Joint limits on page 81

Wall mount kit on page 388

Effective workspace

Link 6 requires enough space to work optimally without interference from other equipment and people when it is being integrated. The workspace can be limited when the robot is used in a restricted environment by using protection zones in the *Kortex Web App*.

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The robot uses a three-dimensional (3D) oval space. Take the capsule-shaped aspect of the recommended reach and maximum working area into account when integrating the robot so that the arm is used for optimal performance.

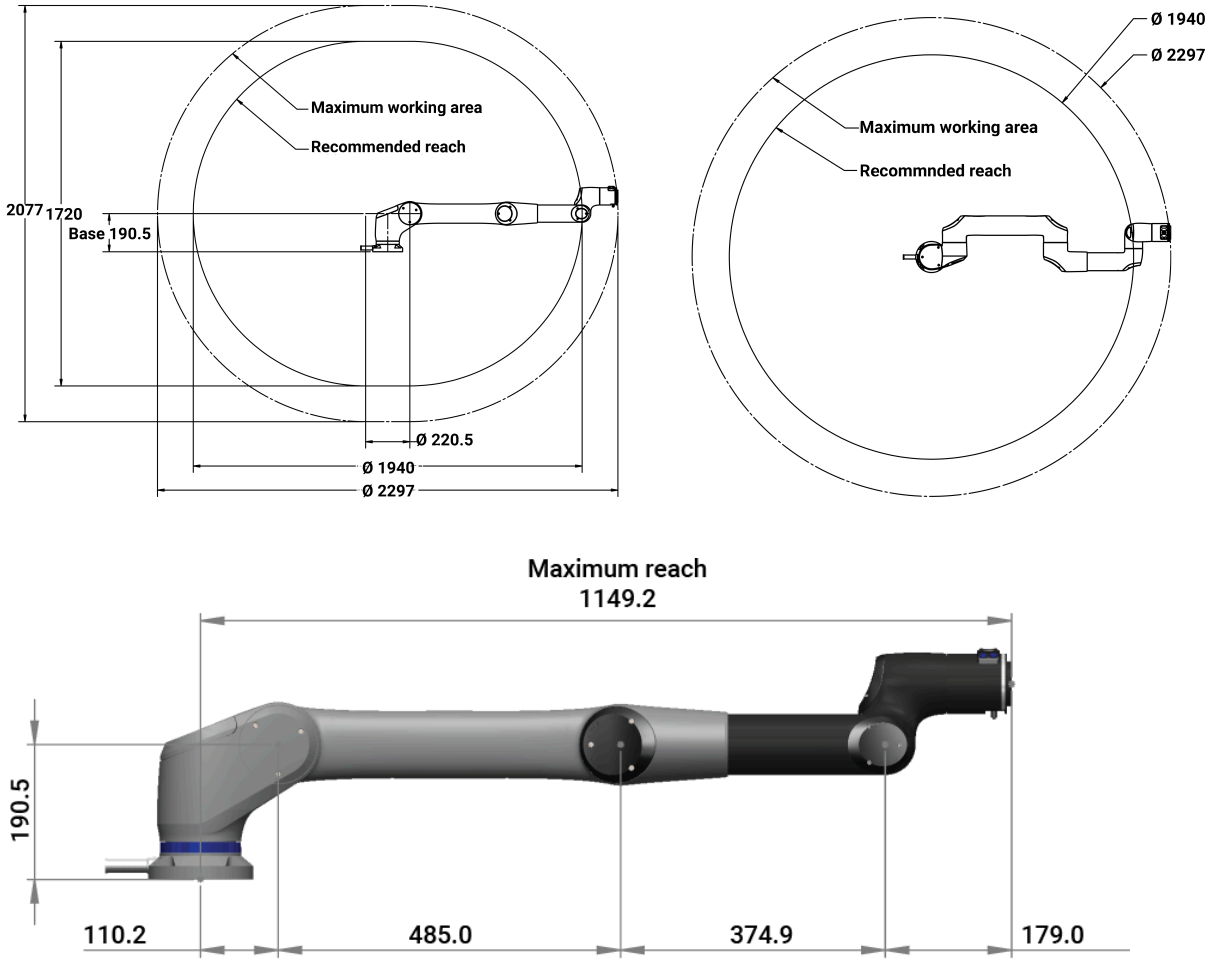


Figure 4: Recommended reach and maximum working area, vertical and horizontal

Related topics

Protection zones on page 84

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Components

Each component of Link 6 can be considered as a modular parts; each component has its specific role to play in the overall functionality.

Several components integrate with each other to define Link 6.

- *Base*
- *Actuators*
- *Wrist*
- *Controller*
- *Teach pendant*
- *Industrial I/O panel*
- *Wrist I/O*

Related topics

Link 6 overview on page 3

Base

The *base* is mainly a mounting interface for the *arm*. I

The base has a cable that is used to connect with the *controller*. The minimum *bending radius* of the cable is 70 mm.

CAUTION: Never disconnect the cable between the controller and the arm when the controller is switched on.



Figure 5: The base component

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Specifications and dimensions of the base of the arm

The *base* of the *arm* is designed to take into account the most common base sizes with similar arm capacities in industries, which facilitates swapping robotic arms.

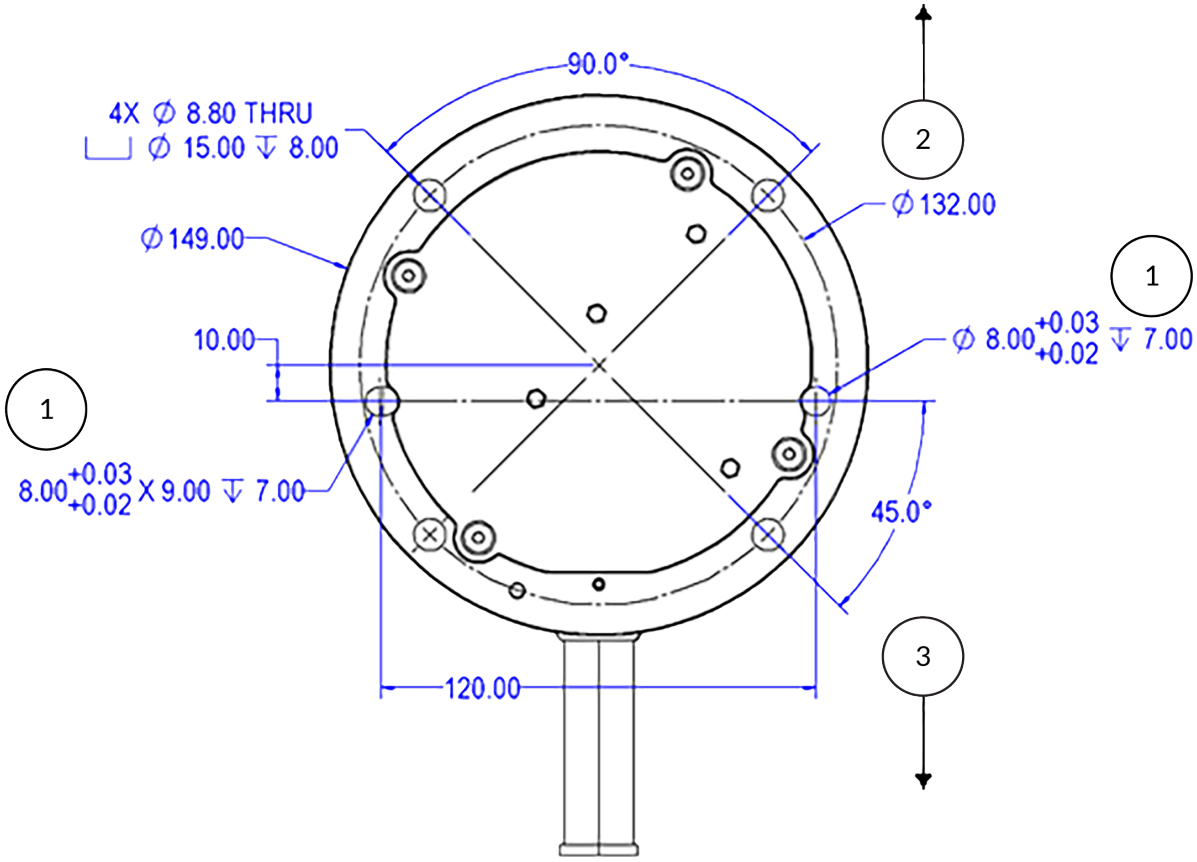


Figure 6: Top view of base dimensions in millimeters

1	Dowel hole feature for optional dowel pins
2	Front
3	Back

Related topics

Installing the arm directly to a surface on page 138

Installing the arm on a third-party adapter plate on page 140

Actuators

Link 6 has six *actuators*. The actuators come in two sizes. Three are large; three are small.

The Size 110 actuators have more load capacity than the Size 80 actuators. The Size 110 actuators are in the first three joints, when counting joints from the *base* upward. The Size 80

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actuators have more speed capacity than the Size 110 actuators. All actuators include dual *microcontrollers* and various sensors to satisfy the Safety architecture category 3, *performance level D* monitoring architecture.

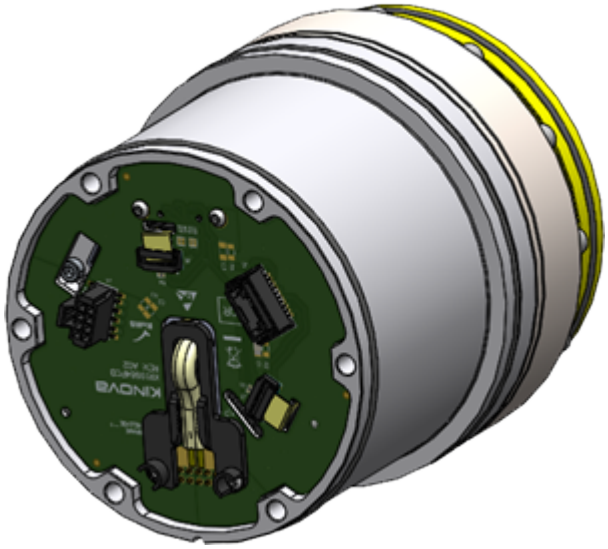


Figure 7: Size 110 actuator

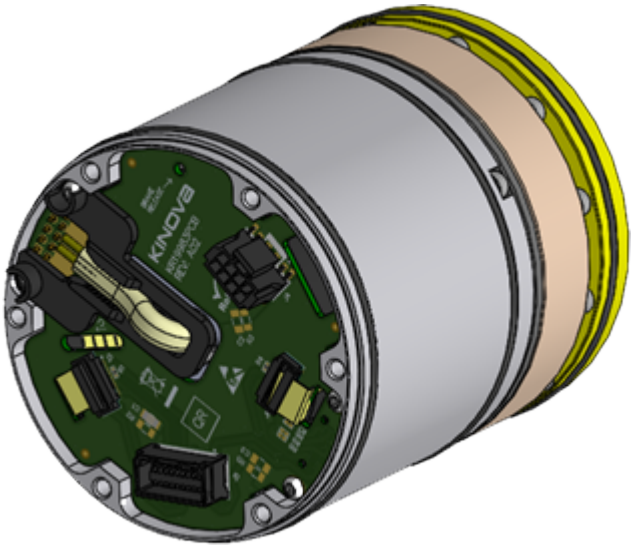


Figure 8: Size 80 actuator

Each actuator also has a mechanical brake that is activated from the *firmware* or when the power is removed from the arm.

Wrist interface overview

The *wrist* is a modular component to which a variety of *end effectors* can be attached.

The wrist has buttons for the user to control the robot manually, buttons for the user to interact with *Kortex Web App*, and LED status indicators on the *wrist ring* to indicate the current state of the robot. The wrist also has a built-in force torque sensor. The sensor is used in different applications, such as *Cartesian* Hand Guiding. The sensor ensures the correct amount of force and torque is used with the tool.

The wrist interface is made of eight main parts, one of which is not visible.

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Figure 9: Top of wrist

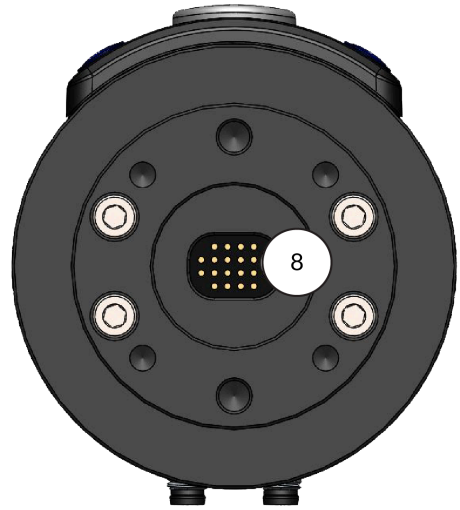
hidden	Built-in force torque sensor
2	Buttons
3	*Wrist ring*
4	*Flange* interface ISO 9409-1-50-4-M6
5	0° and 180° dowel pin positions



Figure 10: Bottom of wrist, M8 connectors

6	Connector A M8, 8 pin male connector 2 analog *I/O* and 4 digital I/O 24 V
7	Connector B M8, 8 pin male connector 1 *RS-485* for *Modbus RTU* and 4 digital I/O 24 V

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8	Central pogo pin connector RS-485 for Modbus RTU 24 V power

Figure 11: Pogo pin connector

Use the buttons on the top of the wrist to control the arm manually.



1	Hand Guiding mode Toggle button	Press to toggle between *Cartesian* and *angular* Hand Guiding modes.
2	Waypoint capture (Snapshot button)	Press to capture a snapshot of the current location of the arm when you are editing a waypoint block during visual programming.
3	*Wrist enabling device*	Press and hold while moving the arm to teach it the trajectory.
4	*End effector* actions	Press + and - as a way of using the actions of the end effectors as defined by the plugin of the end effector. For example, + can close grippers and - can open grippers.

Figure 12: Buttons on the wrist

Related topics

Modes of operation of Link 6 on page 112

Robot lights and what they mean: a reference on page 129

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Force torque sensor

The force torque sensor detects the force and torque applied to the *end effector*.

The six-axis force torque sensor is used in Hand Guiding mode to provide smooth and effortless experience.

Important: Applying forces above 1000 N and torques above 100 N·m can permanently damaged the sensor.

Mechanical interface

The *wrist* is designed to connect to many different types of *end effectors*. Its interface complies to ISO 9409-1-50-4-M6.

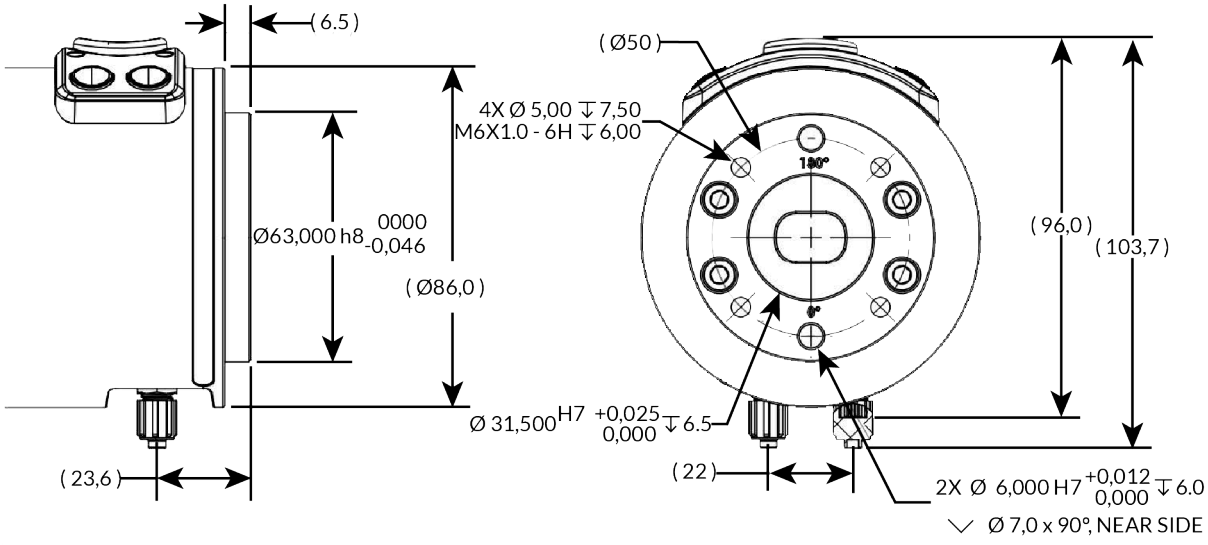


Figure 13: Mechanical interface of the wrist

Electrical interface

The *wrist* can connect electrically with *end effectors* through any combination of M8 8-pin connectors or all central pogo pins. Each of these methods is considered an interface.

Important: Accessories that connect to the wrist may or may not use the central connection of pogo pins. When the accessory does not use the central connection, keep the cap on the central pins to avoid potential damage to the pads on the *printed circuit board (PCB)*.

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Figure 14: Central connector on wrist with cap on and with cap off

M8 connectors

Each of the two M8 connectors have eight pins. The *I/O* associated with the connectors are designed to comply with IEC 61131-2.

Connector A has two analog I/Os and four digital I/Os. Connector B has a Modbus *remote terminal unit (RTU)* with an RS-485 interface and four digital I/Os. The digital I/Os of connector A and of connector B can be configured independently.

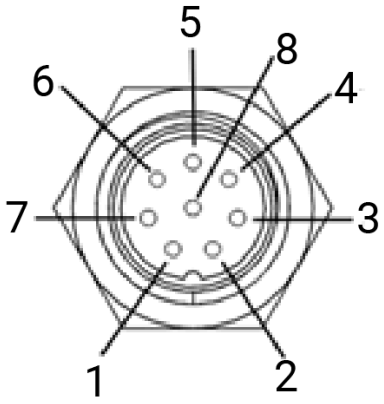


Figure 15: M8 connectors when facing the connector

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Table 11: M8 Connectors

	Connector A		Connector B	
Pin #	**Label**	**Purpose**	**Label**	**Purpose**
1	AOI_1	Analog In/Out	RS_485_P	RS-485 D+ (B)
2	AOI_2	Analog In/Out	RS_485_N	RS-485 D- (A)
3	DIGITAL_IO1	Digital In/Out	DIGITAL_IO5	Digital In/Out
4	DIGITAL_IO2	Digital In/Out	DIGITAL_IO6	Digital In/Out
5	+24v	Power	+24v	Power
6	DIGITAL_IO3	Digital In/Out	DIGITIAL_IO7	Digital In/Out
7	DIGITAL_IO4	Digital In/Out	DIGITIAL_IO8	Digital In/Out
8	GND	Ground	GND	Ground

Remember: Always leave the caps on the M8 connectors when they are not being used.

Pogo pins

In the center of the front of the flange is an interface for pogo pins. 24 V *DC* power and *RS-485* are the signals available through the pogo pins. The pin assignments are outlined in the pogo pin distribution table and figure.

Table 12: Pogo pin distribution

Pin Number	1	2	3	4	5	6
1						
2		Ground	BI_DC+	BI_DC-	Ground	
3	485_P	BI_DA-	24 V	24 V	BI_DB+	485_N
4	485_N	BI_DA+	24 V	24 V	BI_DB-	485_P
5		Ground	BI_DD-	BI_DD+	Ground	
6						

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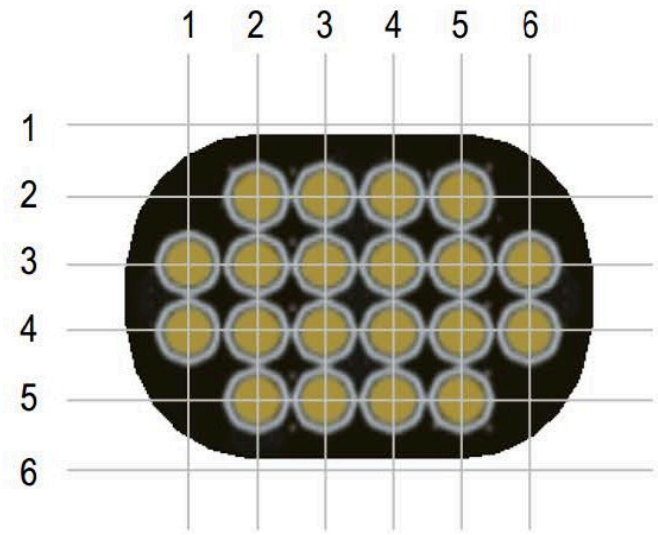


Figure 16: Pogo pin distribution that is facing the connector with the M8 connectors that are facing downwards

Analog inputs and outputs

Each analog I/O can be configured in four different ways.

Table 13: Analog interface configuration

Parameter	Min	Type	Max	Unit	Notes
Voltage	0		10	V	For input and output voltage mode, designed in accordance with IEC 61131-2
Current	4		20	mA	For input and output current mode, designed in accordance with IEC 61131-2
			25	mA	For output voltage mode
Resolution		1		mA	For current output mode. For higher resolution, refer to
		3		uA	For current input mode
		0.1		V	For voltage output mode. For higher resolution, refer to
		0.15		mV	For voltage input mode

Available power in the wrist

The wrist can handle a maximum of 5 A among all M8 connectors plus central pogo pin. If one M8 connector is using 1 A, there is only 4 A left for the other interfaces.

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Table 14: Power limitations

Electrical interface	Maximum continuous current
M8 24 V pin	1.4 A
Single pogo pin in center	2 A
All pins	5 A

Related topics

Wrist analog I/O on the Industrial I/O plugin page on page 384

General-purpose inputs and outputs for the wrist

Each digital I/O can be configured in three different ways: Digital Input, Digital Output High-Side, Digital Output Push-Pull.

Table 15: Digital outputs for the wrist

Digital outputs	Min	Typical	Max	Unit	Note
Rated current	0		500	mA	High state (*high-side* and *push-pull* configurations)
	0		100	mA	Low state (push-pull configuration only)
Voltage drop		0.95		V	At maximum current
Leakage current		0.06	0.12	mA	In low state of high-side configuration
Type		0.5			IEC 61131-2, *Positive logic*, and current sourcing when configured as high-side

Table 16: Digital inputs for the wrist

Digital inputs	Min	Typical	Max	Unit	Note
Low state voltage	0	0	5	V DC	OFF region
High state voltage	11	24	30	V DC	ON Region
Current	2	2.3	2.6	mA	
Type		1 and 3			IEC 61131-2, Positive logic, current sinking

Related topics

General-purpose digital inputs on page 41

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General-purpose digital outputs on page 42

Analog inputs on page 44

Analog outputs on page 45

Wrist digital I/O on the Industrial I/O plugin page on page 385

Wrist RS-485 interface

RS-485 on the wrist is used only for Modbus *RTU* when it is exposed through EIA/TIA-485-A, commonly referred to as RS-485.

Important: Modbus *remote terminal unit (RTU)* is the only supported communication protocol for the Wrist *RS-485* interface.

Table 17: RS-485 pins on the wrist

Label	Purpose
RS_485_P	RS-485 D+ (B)
RS_485_N	RS-485 D- (A)
GND	RS-485 SC (G)

Table 18: RS-485 power inputs

RS-485	Min	Typical	Max	Unit
Input voltage at A/B terminal	-7	5	12	V
Current			2	A

Wrist interface compatibility

The *wrist* must be compatible with the *end effector*, and other peripherals, attached to it.

Link 6 is compatible with a variety of end effectors.

- Kinova accessories
  - Robotiq adapter interfaces both mechanically and electrically with Robotiq products. It has central pogo pins, which means no cables are required when attaching Robotiq products.
- ISO flange, which follows the standard ISO 9409-1-50-4-M6, interfaces with end effectors.

Controller overview

The *controller* powers the *arm*. It stores all safety and non-safety parameters, the *firmware*, the trajectories, arm calibration, and so on.

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Typically, the controller is connected to the *teach pendant* or an external computer that runs *Kortex Web App*. The controller sends commands to *actuators* that translate the commands into movements in the joints of the arm.

The controller can be placed on a table or mounted on a wall.

The front of the controller has switches, buttons, and *I/O* ports.

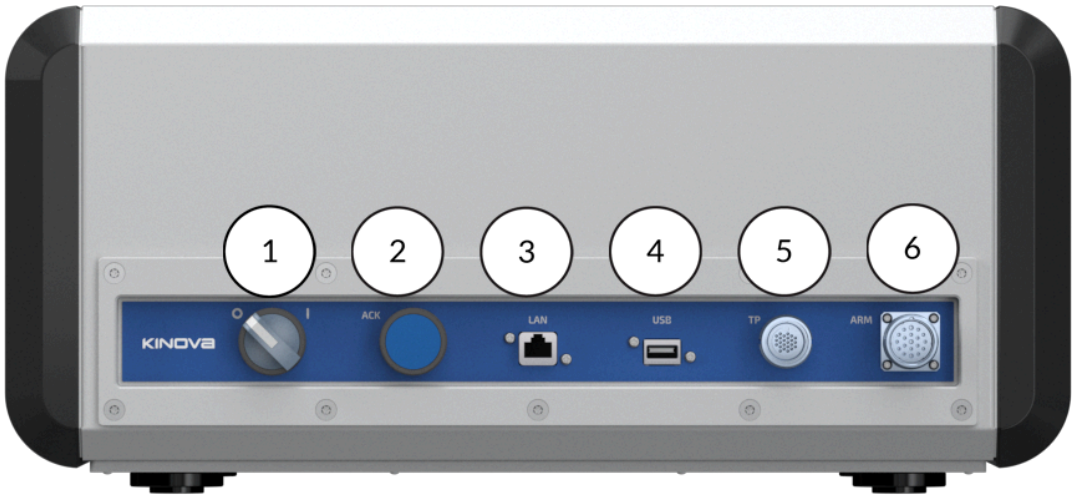


Figure 17: Front of controller

1 Power knob

A light illuminates behind the power knob when electrical power is coming through the controller. The light acts as a visual cue of the state the robot is currently in.

2 ACK button

A light illuminates in the center of the button and acts as a visual cue of the state the robot is currently in and what action must be taken.

The button can be configured in **Systems** > **Robot** in Kortex Web App such that it is mandatory to be pressed when operating in Automatic mode.

3 Ethernet connector

Use the Ethernet connector in the front of the controller to connect to a laptop or computer.

Note: Alternatively, use the Ethernet connector on the back of the controller.

4 *USB* port

Use the port to insert a *USB*.

Use the port to insert a *USB storage device* that contains data that must be pushed onto the controller, such as a new software unit package, or to store files that must be retrieved from the controller, such as an exported program.

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5 TP connector

Plug the teach pendant into the connector marked TP to connect to the controller.

6 ARM connector

Plug the arm into the connector marked ARM to connect it to the controller.

It also has a panel on the side to access *I/O* wiring. Inside the panel, there is a map of the location of each type of input and output.



Figure 18: Location of input and output connectors, which on the side panel

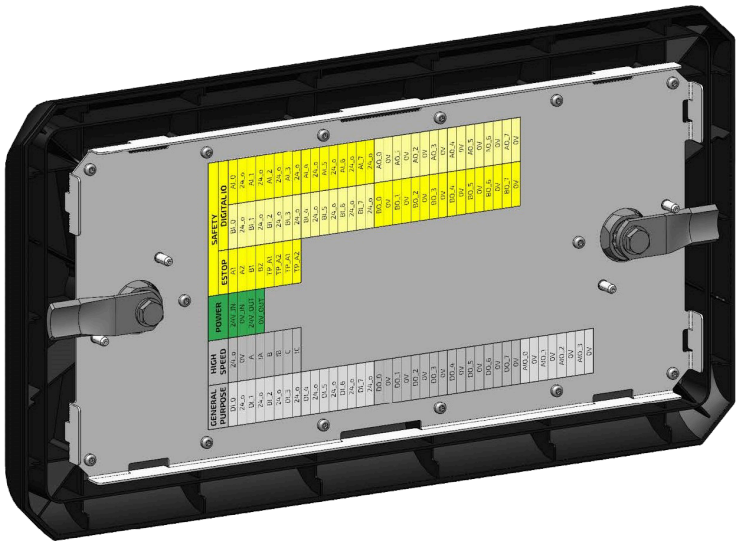


Figure 19: Map of input and output connectors is on the inside of the side panel

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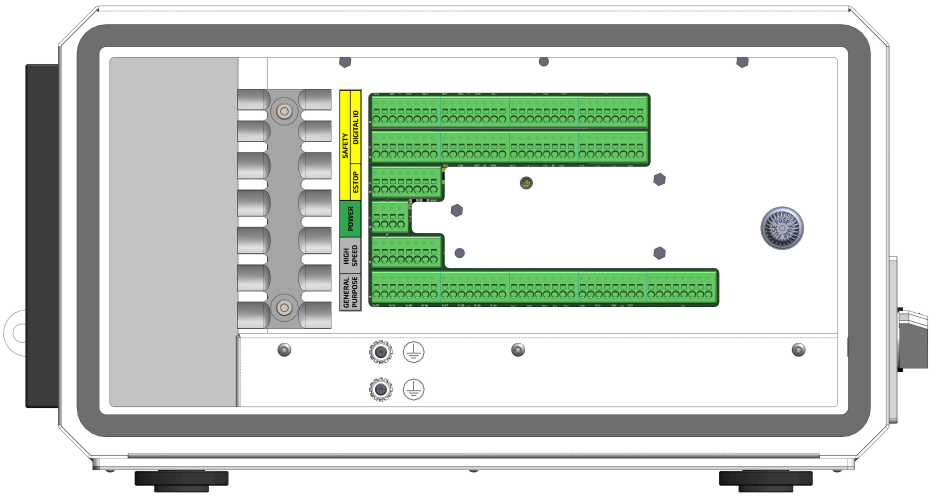


Figure 20: Input and output connectors are on the controller behind the side panel

The controller connects to an AC power supply from its back.

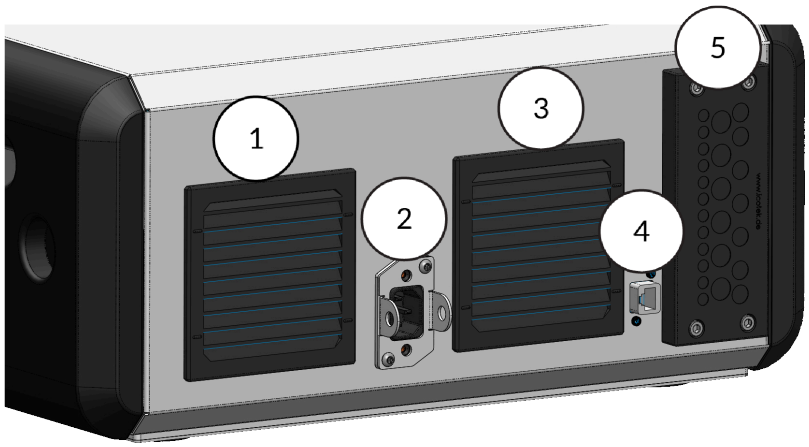


Figure 21: Back of controller

1 Fan-powered air exhaust

2 Electrical input for *AC* power

Unplug the *AC* power cord from the controller and use the brackets around the input to lock access to the power input whenever you perform maintenance on the robot.

3 Fanless air intake

4 *RJ45* Ethernet connector

Use the Ethernet connector at the back of the controller to connect to the network.

Note: Alternatively, use the Ethernet connector on the front of the controller.

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5 Entry plate for I/O connectors

Puncture holes in the entry plate for the wires that need to connect to the controller. The entry plate protects the wires from dust and liquids.

CAUTION: Never disconnect any cable from the controller when it is switched on.

Controller mounting interface

The *controller* must be mounted at least 60 cm from the floor or on a wall. For a wall installation, use the optional Wall mount kit.

An appropriate location to install the controller satisfies certain conditions.

- The underside of the installation surface is accessible.
- There is enough space to hold the controller.
- There is ample space around the controller for the airflow and access.



Figure 22: Controller feet location

The controller is designed and tested to operate in a Pollution Degree 2 environment, in accordance with UL1740.

Warning: Using the device in a higher Pollution Degree environment may pose a risk of electric shock or fire hazard. A Pollution Degree 2 environment is one in which non-conductive pollution is present, but may occasionally occur due to condensation.

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Related topics

Considerations before installing the controller on page 141

Installing the controller on a flat surface on page 143

Installing the controller vertically on page 144

Surface mount of controller

Dimensions of the *controller*, along with the location of its mounting points, is important to know before the controller is installed.

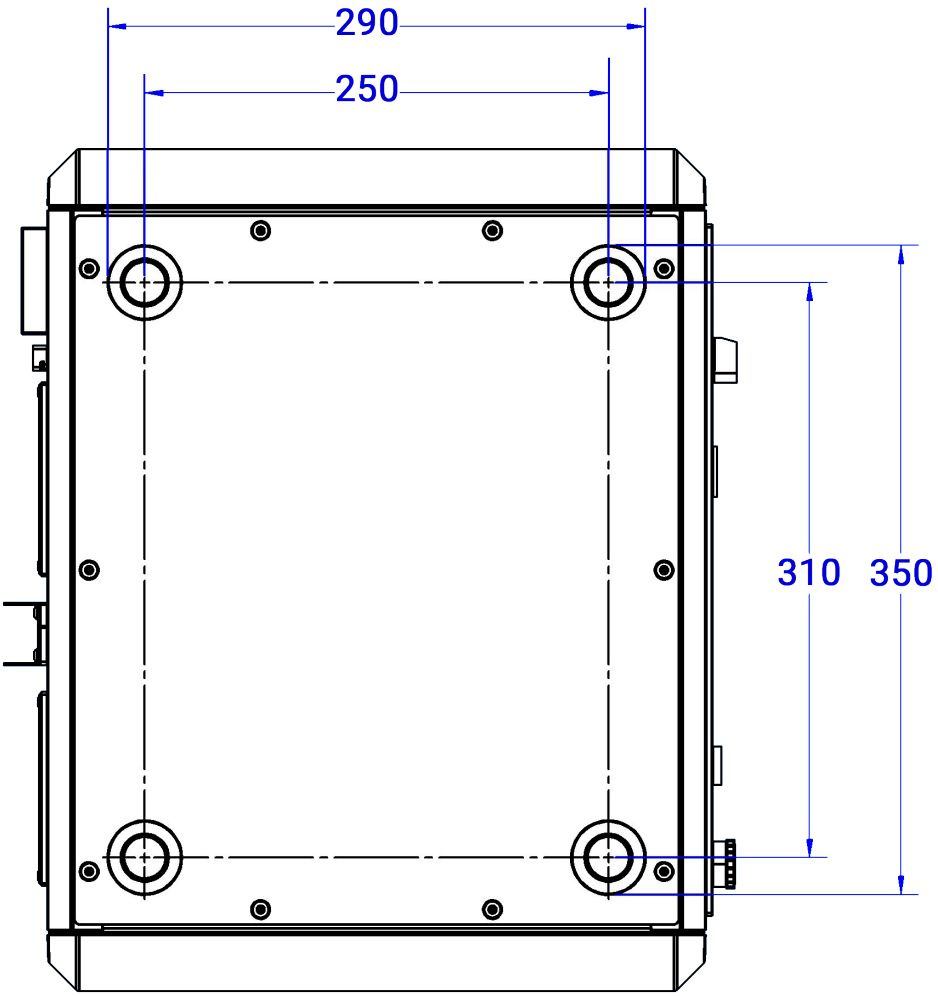


Figure 23: Mounting point measurements in millimeters

Related topics

Installing the controller on a flat surface on page 143

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Controller electrical and communications interface

There is an access panel on the *controller* with a mapping of all the inputs and outputs listed directly on the back.

The access panel is on the side of the controller. It is held closed by two *camlocks*. Lock and unlock directions are indicated on the front of the side panel. A bent lip on the door aids in guiding the door on and off the rest of the box.



Figure 24: Controller I/O side panel

1 Camlocks; Use 8 mm hex key to unlock and lock

On the inside of the panel is a mapping of the location of each input and output. See Figure 19: Map of input and output connectors is on the inside of the side panel on page 31.

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GENERAL PURPOSE	HIGH SPEED	POWER	SAFETY		
			ESTOP	DIGITAL IO	
DI_0	24_o	24V_IN	A1	BI_0	AI_0
24_o	0V	0V_IN	A2	24_o	24_o
DI_1	A	24V_OUT	B1	BI_1	AI_1
24_o	!A	0V_OUT	B2	24_o	24_o
DI_2	B		TP_A1	BI_2	AI_2
24_o	!B		TP_A2	24_o	24_o
DI_3	C		TP_B1	BI_3	AI_3
24_o	!C		TP_B2	24_o	24_o
DI_4				BI_4	AI_4
24_o				24_o	24_o
DI_5				BI_5	AI_5
24_o				24_o	24_o
DI_6				BI_6	AI_6
24_o				24_o	24_o
DI_7				BI_7	AI_7
24_o				24_o	24_o
DO_0				BO_0	AO_0
0V				0V	0V
DO_1				BO_1	AO_1
0V				0V	0V
DO_2				BO_2	AO_2
0V				0V	0V
DO_3				BO_3	AO_3
0V				0V	0V
DO_4				BO_4	AO_4
0V				0V	0V
DO_5				BO_5	AO_5
0V				0V	0V
DO_6				BO_6	AO_6
0V				0V	0V
DO_7				BO_7	AO_7
0V				0V	0V
AIO_0					
0V					
AIO_1					
0V					
AIO_2					
0V					
AIO_3					
0V					

Figure 25: Inputs and outputs map on the back of the panel

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I/O connections are connected to the controller through the side panel. The *protective earth* mount points and fuse are also inside the side panel of the controller.

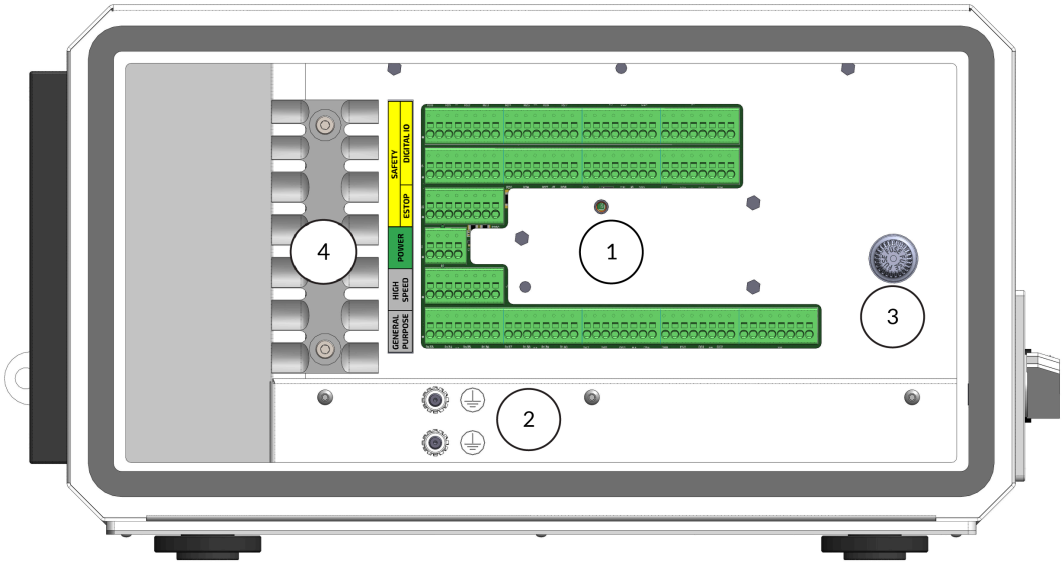


Figure 26: Inside the side panel of the controller

1	*I/Os* From top to bottom, they are Safety Digital I/O, Safety Digital I/O, Safety ESTOP, Power, High Speed, and General Purpose
2	Protective earth stud
3	Fuse holder with a fuse held in it
4	Strain relief mounting plate, used to tie-wrap and secure cables; ensures not too much strain is applied to the terminal

Related topics

Controller digital outputs on the Industrial I/O plugin page on page 381

Controller digital inputs on the Industrial I/O plugin page on page 382

Industrial I/O panel overview

The *controller* provides general-purpose electrical inputs and outputs from the Industrial *I/O* panel. It also provides safety-related electrical inputs and outputs from the Industrial I/O panel.

Note: Unless otherwise specified, all voltages and currents are *direct current (DC)*.

The *input/output (I/O)* panel is made of two parts.

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The safety *I/O*s are always powered by the internal power supply. The safety *I/O*s are divided into two banks, bank A and bank B, for redundancy. Each bank consists of eight (8) digital inputs and eight (8) digital outputs. The safety *I/O*s also contain the connections for an Emergency stop button.

The general-purpose *I/O*s are powered by 24 V IN and 0 V IN terminals. The terminals can receive their power from 24 V OUT and 0 V OUT terminals, or from an external power supply. The general-purpose I/Os contains eight (8) digital inputs, eight (8) digital outputs, four (4) analog I/Os, and provisions for high-speed encoder inputs.

The *industrial I/O panel* is designed to comply with specific standards.

- Safety I/O are designed in accordance with EMC Immunity requirements IEC 61326-3-1.
- Safety digital inputs and general-purpose digital inputs are designed in accordance with IEC 61131-2 Type 1 and Type 3.
- Safety digital outputs and general-purpose digital outputs are designed in accordance with IEC 61131-2 Type 0,5.
- General-purpose I/O are designed in accordance with EMC Immunity requirements IEC 61131-2 Section 7.

Positive logic, which is current sinking input and current sourcing output, is supported on the panel. *Negative logic* is not supported on the panel.

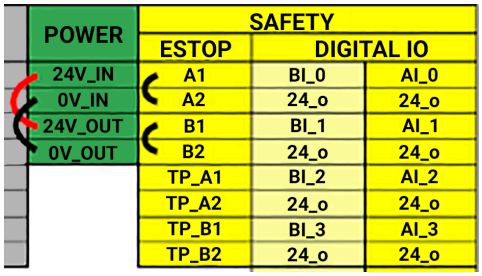


Figure 27: Default factory setting with internal supply used and external E-stop bypassed

Table 19: Industrial I/O terminals

Mechanical	Min	Typical	Max	Unit
Conductor size (*UL*/*cUL*)	16		24	*American Wire Gauge (AWG)*
Conductor size (*International Electrotechnical Commission (IEC)*)	0.2		1.5	mm^2
Stripping Length	8		10	mm

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Mechanical	Min	Typical	Max	Unit
Terminal pitch		3.5		mm
Ferrule		*Deutsches Institut für Normung (DIN)* 46228-4		

Important: When connecting devices to the I/O panel, keep the general-purpose and safety devices wires separate so that the installation-required isolation level is maintained.

Related topics

Installing the external 3-position enabling device on page 392

Industrial I/O power supply

Negative connections, labeled as 0V, are only for power and signaling. *protective earth (PE)* provides a low impedance path to ensure proper functioning in case of faults.

Be careful to connect power to the supplies correctly. When connected incorrectly, you can have undesirable side effects, such as reverse polarity and improper voltage levels. Link 6 is designed such that the 24V_IN and 0V_IN terminals are protected against reverse polarity.

Important: Use only *DC* signals.

Important: Do not exceed 28 V under any conditions.

Table 20: Internal power

Internal 24 V power supply	Min	Typical	Max	Unit
Voltage	23.5	24	24.5	V
Current (total)			2	A

Table 21: External power

External 24 V input requirements	Min	Typical	Max	Unit	Note
Voltage	20	24	28	V	

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External 24 V input requirements	Min	Typical	Max	Unit	Note
Current (total)			5	A	Fused internally at 10 A. The external power supply should be fused to a lesser value. It is recommended to fuse it at 5 A with an opening time that is less than 5 seconds.

The terminal connections belong to the POWER terminal group.

Table 22: Power terminal connections

Label	Purpose
24V_IN	24 V input to supply the general purpose *I/O*s.
0V_IN	0 V input to supply the general purpose *I/O*s.
24V_OUT	24 V output of the internal *I/O* power supply. Use only to jump with the terminal 24V_IN. If an external power supply is used to connect on the 24V_IN terminal, leave the terminal unconnected.
0V_OUT	0V output of the internal *I/O* power supply. Use only to jump with the terminal 0V_IN. If an external power supply is used to connect on the 0V_IN terminal, leave the terminal unconnected.

There are specific times when you can use the external power supply for general purpose *I/O*s.

- The total output current of the I/O panel exceeds 2 A.
- The general purpose *I/O*s must be supplied from the same power supply as the rest of the industry floor.
- The general purpose I/Os are tied to an external reference point, with up to 2000 V electrical isolation from the rest of the controller.

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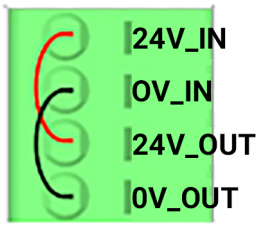


Figure 28: Internal power supply terminal connections

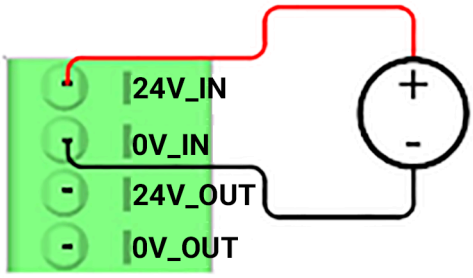


Figure 29: External power supply terminal connections

Related topics

Industrial I/O Plugin on page 380

General-purpose digital inputs

There are no common points between channels. Each input has its own associated 24 V wetting port.

The panel may not work properly when there is a miswired condition coming from any other location on the panel; this type of miswired condition does not lead to any permanent damage.

Important: The panel may be damaged if the miswiring comes from an external device.

Important: Miswiring issues does not apply to the 24 V power supply output.

There are isolation potentials between a channel and other circuits, including earth, as well as between channels under normal operation.

There is no hardware state indicator for general-purpose digital inputs.

Remove the power before connecting or disconnecting any input signals.

There is an additional external load when interconnecting inputs and outputs.

Table 23: Digital inputs

Digital inputs	Min	Typical	Max	Unit	Note
Low state voltage	0	0	5	V DC	OFF region
High state voltage	11	24	30	V DC	ON region
Current	2.0	2.3	2.6	mA	
Type		1 and 3			IEC 61131-2, *Positive logic*, current sinking

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Digital inputs	Min	Typical	Max	Unit	Note
Voltage drop			10.4	V DC	On 24 V wetting port

Each wetting port is designed to provide the power needed for a single input point. Do not use it as a generic power source.

The terminal connections belong to the GENERAL PURPOSE terminal group.

Table 24: Digital input terminal connections

Label	Purpose
DI_n (n=[0-7]	Terminal points for digital input
24_o	Wetting port for each digital input Each input has its own wetting port.

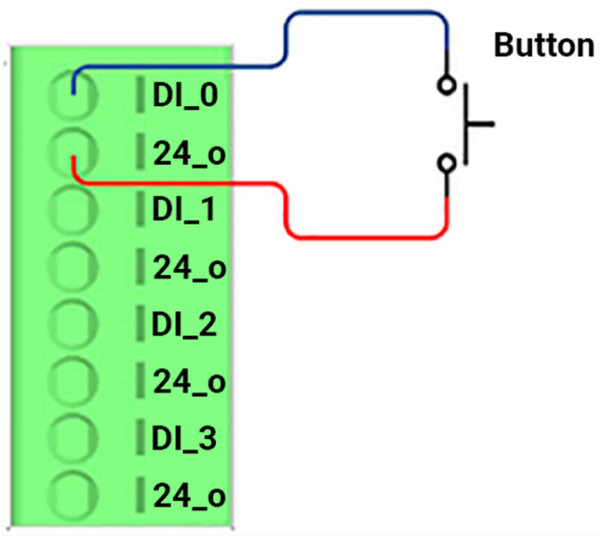


Figure 30: Digital input terminal connections

During the power up sequence, no inputs are read.

During the power down sequence, no inputs are read.

Related topics

Controller digital inputs on the Industrial I/O plugin page on page 382

General-purpose digital outputs

All 0 V ports are common, although each output has its own 0 V terminal.

All the digital outputs are short-circuit protected. An incorrect terminal connection does not lead to any permanent damage.

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There are isolation potentials between a channel and other circuits, including earth, as well as between channels under normal operation.

When using an internal power supply, the general-purpose channels are not isolated from the safety channels.

There is no visual indicator of the digital output state.

The digital outputs on the controller can be configured as *high side* (IEC 61131-2 TYPE 0,5) or push pull. A *push* is a source current. The *pull* is a sink current. The flow of electricity in the Pull is blocked; the outputs are unable to have the current sink into the digital output. The internal circuitry can switch between states quickly when the outputs are in push-pull mode even if the current sink is blocked from the external circuitry.

The high-side configuration is the default configuration on the digital outputs.

Table 25: Digital outputs

Digital outputs	Min	Typical	Max	Unit	Note
Rated current	0		500	mA	High state (high-side and push-pull configurations)
Voltage drop		0.55		V	At maximum current
Leakage current		0.08		mA	High side configuration
Type		0,5			IEC 61131-2, *Positive logic*, and current sourcing when configured as high-side

Each output can drain up to a maximum of 500 mA. If many outputs are connected and are high, the maximum current available from the internal power supply could be exceeded; an external power supply must be used.

The terminal connections belong to the GENERAL PURPOSE terminal group.

Table 26: Digital output terminal connections

Label	Purpose
DO_n (n=[0-7])	Terminal points for digital output
0V	0 V input to supply the digital I/Os

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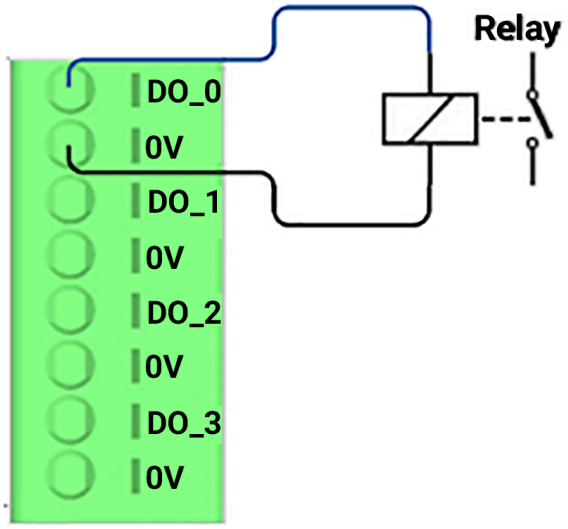


Figure 31: Digital output terminal connections

During the power up sequence, all outputs are in the low state.

During the power down sequence, all outputs shut down to the low state. The output from the *emergency stop (E-stop)* enters a low state; it generates and *E-stop* event on all external devices connected to this terminal.

Related topics

Controller digital outputs on the Industrial I/O plugin page on page 381

Analog inputs

There are four (4) analog inputs.

Analog input types are current and voltage. The input impedance in the signal range is in the on or off state; the state is specified by the manufacturer.

Table 27: Analog inputs in current mode

Analog inputs	Min	Typical	Max	Unit	Note
Current	4		20	mA	
Voltage		24		V	
Resolution		16		Bits	

Table 28: Analog inputs in voltage mode

Analog inputs	Min	Typical	Max	Unit	Note
Voltage	0		10	V	

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Analog inputs	Min	Typical	Max	Unit	Note
Current				mA	
Resolution		16		Bits	

The terminal connections belong to the GENERAL PURPOSE terminal group.

Table 29: Analog input general purpose terminal connections

Label	Purpose
AI_n (n=[0-7]	Terminal points for analog input.
0V	0 V input to supply the analog I/Os.

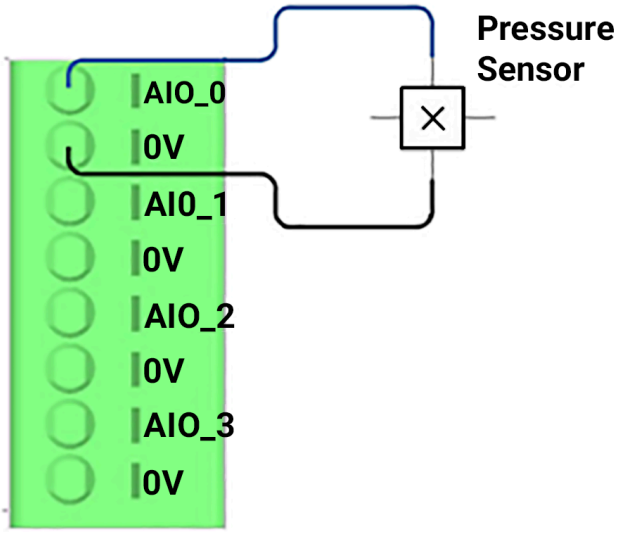


Figure 32: Analog terminal connections

During the power up sequence, no inputs are read.

During the power down sequence, no inputs are read.

Analog outputs

There are four (4) analog outputs.

Analog output types are current and voltage. The output impedance in the signal range is in the on or off state; the state is specified by the manufacturer.

The analog output has a maximum error at 25 °C ± % of full scale, with a temperature coefficient ± % of full scale/K. The maximum error over the full temperature range is ± % of the full scale.

The digital resolution is measured in number of bits.

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The data format returned from the application program is in binary, *Binary Coded Decimal (BCD)*, and so on. The value of the data is in the *Least Significant Bit (LSB)*.

Table 30: Analog outputs in current mode

Analog outputs	Min	Typical	Max	Unit	Note
Current	0		10	mA	
Resistance			760	ohm	
Resolution		13		Bits	

Table 31: Analog outputs in voltage mode

Analog outputs	Min	Typical	Max	Unit	Note
Voltage	0		10	V	
Current			29	mA	
Resolution		13		Bits	

The terminal connections belong to the GENERAL PURPOSE terminal group.

Table 32: Analog output general purpose terminal connections

Label	Purpose
AO_n (n=[0-7]	Terminal points for analog output.
0 V	0 V input to supply the analog I/Os.

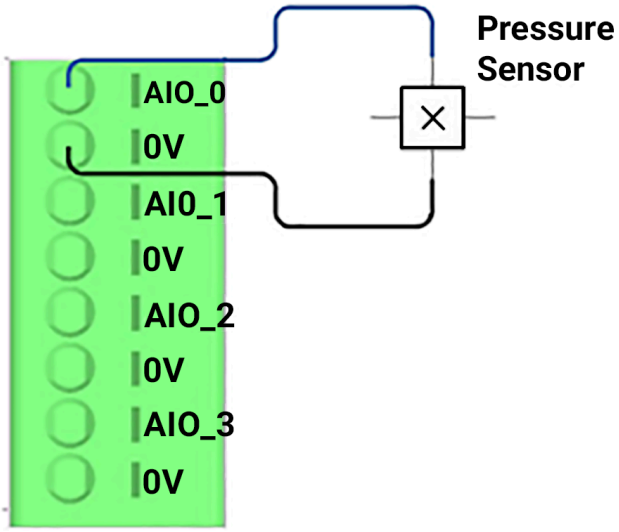


Figure 33: Analog terminal connections

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During the power up sequence, all outputs are in the low state.

During the power down sequence, all outputs shut down to the low state. The output from the *E-stop* enters a low state; it generates and *E-stop* event on all external devices connected to this terminal.

Emergency stop inputs

Emergency stop devices must comply with ISO 13850:2015.

Link 6 requires an emergency stop device with two (2) *Normally Closed (NC)* redundant contacts.

The terminal connections belong to the SAFETY - ESTOP terminal group.

Table 33: Emergency stop terminal connections

Label	Purpose
AI	24 V wetting port
A2	Channel A - digital input
B1	24 V output
B2	Channel B - digital input

A typical installation involves a teach pendant that is connected on the front panel. The emergency stop is an integrated part of the teach pendant. The only thing to do is to install a jumper wire on A1, A2, B1, and B2.



Figure 34: Terminal connections with jumper wire on A1, A2, B1, and B2 when the teach pendant is connected

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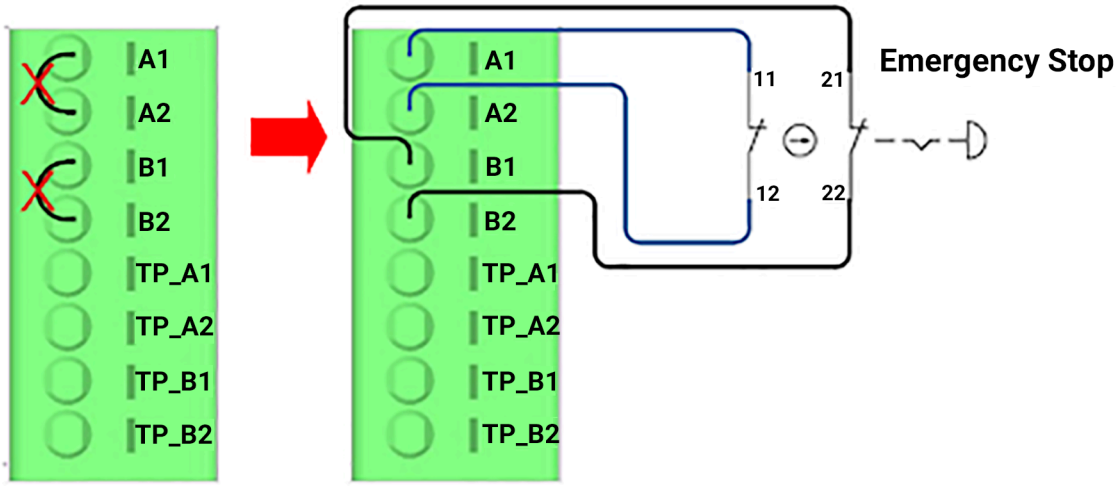


Figure 35: Terminal connections with external emergency stop connected

Teach pendant bypass inputs

There are only two ways to bypass teach pendant inputs. All other configurations prevent the robot arm from receiving power.

Important: Make sure the teach pendant is not installed when you bypass teach pendant inputs.

Important: When the teach pendant is bypassed, make sure there is an *external emergency stop button* installed on the **Emergency Stop** inputs.

If a teach pendant is connected on the front panel, leave TP_A1, TP_B1, and TP_B2 open. Remove any jumper wires that are installed.

If a teach pendant is not connected on the front panel, connect TP_A1 to TP_A1 and TP_B1 to TP_B2.

The terminal connections belong to the SAFETY - ESTOP terminal group.

Table 34: Teach pendant bypass inputs terminal connections

Label	Purpose
TP_A1	24V wetting port
TP_A2	
TP_B1	24V wetting port
TP_B2	

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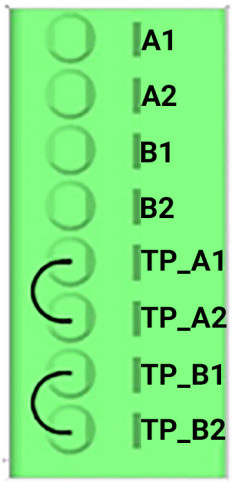


Figure 36: Teach pendant bypass inputs terminal connections

Safety-rated digital inputs

Safety-rated digital inputs are used for safety devices that have redundant signals.

Connect Bank A to one of the contacts of the safety device and connect Bank B to the redundant, secondary contact of the same safety device. For example, A0 and B0 can be connected to an enabling device.

All safety-rated inputs are expected to be *NC* when both redundant contacts are in a safe state. For example, an enabling device is expected to be closed when it is in the disabled position. A fault is triggered when there is a disagreement between the status of the tied redundant signals.

The terminal connections belong to the SAFETY - DIGITAL IO terminal group.

Table 35: Safety-rated digital inputs terminal connections

Label	Purpose
AI_n (n=[0-7])	Safety rated Bank A digital inputs
BI_n (n=[0-7])	Safety rated Bank B digital inputs
24_o	24 V wetting port for safety rated Bank A and safety rated Bank B digital inputs

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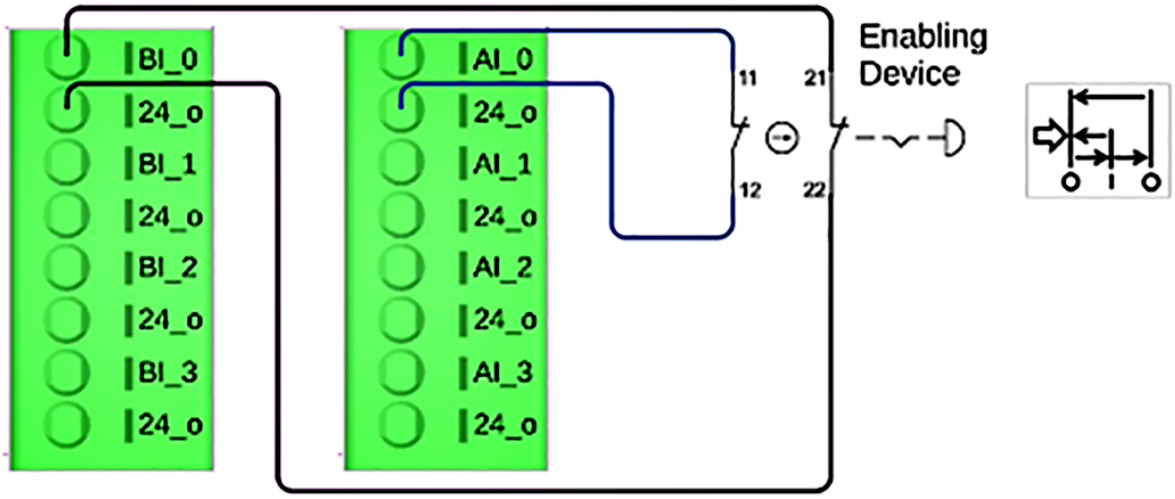


Figure 37: Safety-rated digital inputs terminal connections

Safety-rated digital outputs

A *programmable logic controller (PLC)* controller can initiaste actions that the digital outputs can perform.

Total current drain from all safety-rated digital outputs is 2A. If many outputs are connected and high, the maximum current available from the internal safety power supply can be exceeded.

Typical: 2A/16 max par channel

Max: 2A total

The terminal connections belong to the SAFETY - DIGITAL IO terminal group.

The digital outputs on the controller can be configured as *high side* (IEC 61131-2 TYPE 0,5) or push pull. A *push* is a source current. The *pull* is a sink current. The flow of electricity in the Pull is blocked; the outputs are unable to have the current sink into the digital output. The internal circuitry can switch between states quickly when the outputs are in push-pull mode even if the current sink is blocked from the external circuitry.

The high-side configuration is the default configuration on the digital outputs.

Table 36: Safety-rated digital outputs terminal connections

Label	Purpose
AO_n (n=[0-7])	Safety rated Bank A digital Outputs
BO_n (n=[0-7])	Safety rated Bank B digital Outputs
0V	0 V return path

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High-speed inputs

The terminal connections belong to the HIGH SPEED terminal group.

Important: Reserved for future use

Teach pendant overview

The *teach pendant* is a hand-held device used by *integrators* to configure and program the motions of a robot and by *operators* to select a program to run.

A cable connects the teach pendant to the *controller*.

The teach pendant is a touchscreen device with three buttons.

- *Emergency stop*
- Power
- *Pendant enabling device*



Figure 38: Teach pendant front

1 *E-stop* button

Use the E-stop button to stop the robot in emergency situations.

2 Power button

Use the power button to turn on the teach pendant and access Kortex Web App.



Figure 39: Teach pendant back

3 *Pendant enabling device*

Press and hold the teach pendant enabling device in the middle position when you are using the Jog interface to manually move the robot or when you are running a program in Hold to Run mode.

4 Mounting interface

Align the mounting interface with the mounting hooks and slide the pendant on the mount.

5 Strap holding interface

Slide your hand underneath the strap such that your thumb rests on top of the strap.

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Warning: Store all disconnected teach pendants in a safe location out of sight to prevent confusion between active and inactive emergency stops.

CAUTION: Never disconnect the cable from the teach pendant when the controller is switched on.

Related topics

Installing the teach pendant mount on page 146

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Safety

Link 6 is a powerful robot that can perform heavy duty industrial tasks. Read and understand all safety considerations before installing and using the robot.

Safety includes general warnings about the robot, risk assessments, what to do in an emergency, how to work the robot when it loses power, and so on.

It also includes all safety functions of Link 6.

Important: All topics that discuss safety refer specifically to Link 6 and do not apply to the robot system or interactions with other systems or devices.

Related topics

Installing the arm directly to a surface on page 138

Installing the arm on a third-party adapter plate on page 140

Precautions

Always observe precautions to avoid serious injury to users, damage to other equipment, and damage to Link 6.

Read all safety information available in this guide, as well as diagnostic, maintenance, servicing, support, and troubleshooting topics, to perform a proper risk assessment and to know how to train users.

Use the robot as it is intended to be used.

Perform a risk assessment not only on Link 6, but on the entire *robot system*. Make sure in the risk assessment that the international safety standard for robotic systems, ISO 10218-1/-2, is respected, as well as all territory-specific standards for your area when applicable.

Perform a *Lockout Tagout (LOTO)* procedure so that no cable can be connected to the robot when it is under maintenance or any other situation where the power needs to be removed; it prevents the robot from being switched on accidentally.

Dispose of the robot in accordance with the laws and regulations of the territory in which the robot is installed.

Related topics

Intended use on page 4

Risk assessment on page 57

Maintenance on page 393

Servicing on page 398

Disposal on page 399

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Safety directives and warnings

Follow basic safety guidelines when working with Link 6 to avoid injury to the user or damage of the equipment.

Familiarize yourself with what must be done to avoid the various dangers, warning, and cautions when working with the robot, Link 6.

Directives specific to the integrator

The *integrator* is responsible for the safe use of Link 6; the integrator must follow certain directives.

Important: Link 6 does not support Power and Force Limiting (PFL) collaborative mode as described by ISO TS 15066. Keep this in mind during analysis and assessment phases.

- Perform a hazard analysis for the robot and the robot cell.

  Important: Hazard analysis is a mandatory activity to have a complete risk assessment as described by ISO 10218-2:2011.
- Perform a risk assessment based on the system, the environment, and the user before installing Link 6.
- Include any and all external equipment, objects, and any other parts of the complete robot system added by the integrator in the risk assessment.
- Include specific precautions with respect to earthquakes when the robot is installed in an earthquake zone.
- Design the robot cell so that it is optimally ergonomic.
- Make sure the robot cell has restricted space when the robot is foreseen to be used in Manual mode at high speed.
- Install the *arm* and the *controller* such that they are easily accessible for maintenance purposes.
- Install the arm and the controller such that they do not impede on the ergonomics of the entire robotic environment.

Danger

DANGER: A danger is an impending hazardous situation that can result in serious injury or even death, or can severely damage property. Avoid impending hazardous situations that are associated with dangers.

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Keep objects and hands out of *pinch point* zones. Pinch points directly on the robot are located at the shoulder, elbow, and wrist.



1	shoulder
2	elbow
3	wrist

Do not switch on the robot before the base is fixed sturdily.
Disconnect the power supply and perform *LOTO* procedures when maintenance tasks must be performed.
Stop the robot immediately when a part of the robot begins to vibrate. Contact support at support@kinova.ca
Stop the robot immediately when a joint on arm suddenly becomes loose. Contact support at support@kinova.ca
Stop the robot immediately when the arm suddenly loosens from the base. Secure the arm tightly to the surface.
Operate the robot manually only when no one is inside the safeguarded zone.
Keep the robot cell void of people, especially when the robot is operating at high speeds.
Make sure nobody is in the robot cell when operating the robot at high speed.

Warnings

Warning: A warning is a potentially hazardous situation that can cause minor to moderate injury to workers, might result in serious injury or even death, and can damage the property significantly. Avoid potentially hazardous situations that are associated with warnings.

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The personnel working with Link 6 should always be trained.

Note: Training requirements are determined by the integrator's *risk analysis*.

Either warm or cool the environment before storing the robot.
Do not store the robot in an environment that is below -40 °C.
Do not store the robot in an environment that is above +65 °C.
Ensure the system undergoes a proper warm-up period before starting regular operations to mitigate issues with the robot. **Important:** Increased mechanical resistance may arise when the robot is used in environments with temperatures approaching 0 °C. Resistance may also arise when the robot is left inactive for extended periods in temperatures below 0 °C, such as overnight or during extended breaks. Increases in mechanical resistance may trigger system alarms or warnings related to motion or collision detection.
Do not power the robot in an environment that is below 0 °C; the robot may malfunction.
Do not power the robot in an environment that is above 40 °C; the robot may malfunction.
Do not use the robot in an environment that is below 0 °C; the robot may malfunction.
Do not use the robot in an environment that is above 40 °C; the robot may malfunction.
Do not touch the robot if the temperature of the environment is above 40 °C. The robot may be hot to the touch.
Do not use the robot when there are external signs of significant damage on the arm, controller, or the teach pendant.
Do not use the robot when the I/O panel is open or damaged.
Do not open the controller panel when the controller is in a wet environment.
Do not open the controller IO panel when the controller is in an *EMI*-sensitive environment.
Do not use the robot near flames or sources of heat.
Do not use the robot to take objects under water.
Do not use the robot in heavy rain.
Do not use the robot in an explosive environment.
Always perform a *LOTO* procedure on the controller during maintenance. Follow *LOTO* procedures and adhere to safety guidelines. Failure to adhering to safety guidelines may result in accidents and serious injury.

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Include any and all external equipment, objects, and any other parts of the complete robot system added by the integrator in the risk assessment.
Include specific precautions with respect to earthquakes when the robot is installed in an earthquake zone

Cautions

CAUTION: A caution is a hazardous situation that may cause minor to moderate injury to workers and can damage the property. Avoid hazardous situations that are associated with cautions.

Do not touch the robot when the surface of the robot or the controller become hot.
Remove objects blocking the enclosure fans. Obstructed fans can lead to loss of functionality in internal components and can cause the controller to become hot to the touch. If there are no objects blocking the enclosure fans and the controller becomes hot to the touch, the fans may be clogged by dust or debris. Perform basic maintenance and fan cleaning.
Backdrive the robot only in case of emergency.
Always perform a status check after backdriving the actuators.
Do not make any changes to the robot that may alter the compliance status of the robot. Unapproved changes to the robot may lead to the loss of authorization to use the robot.

Related topics

Intended use on page 4

Unintended uses on page 5

Weekly maintenance on page 395

Installing the arm directly to a surface on page 138

Installing the arm on a third-party adapter plate on page 140

Move the arm without power on page 61

Risk assessment

Before installing Link 6, determine all potential risks in using the robot according to applicable standards ISO 10218, ISO 12100 for robot and machine safety.

There are several different steps in determining all potential risks.

Hazard identification	Identify all hazard and risk factors that can potentially cause harm

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Risk analysis	Analyze and evaluate the risk associated with each hazard.
Risk control	Eliminate, or reduce the risk to an acceptable level, each potential hazard.

Take into account the entire *robot system* and its environment when performing a risk assessment, not just Link 6. It is impossible to cite every potential hazard because of the myriad applications into which Link 6 can be integrated. The potential hazards listed is not exhaustive.

Examples of what to take into account when performing a risk assessment:

- Other robots used in the robot system
- Anticipated tasks of the robot system
- Anticipated workpieces
- Anticipated tools
- Anticipated uses
- Anticipated tasks
- Anticipated environments
- Types of applications, whether *collaborative* or *non-collaborative*

  Note: For more details, please refer to ISO 10218 and ISO TS 15066 for additional guidance.
- Robot parameters including, but not limited to, speeds and trajectories
- Safety function parameters including, but not limited to, restricted areas and speed limited by areas
- Protective measures including, but not limited to, interlocks, presence detection, fencing, and guards
- User training

Perform all risk assessments in compliance with the applicable standards of the territory where the robot is installed.

Important: Make sure the risk assessment is accessible to all users of the robot.

Safety equipment

Applicable standards and the results of the *risk analysis* determine the requirements for safety equipment.

The equipment includes items that protect users against injury and death. Some equipment is mandatory.

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Examples of mandatory equipment:

- One or more emergency stops
  The exact number of required emergency stop buttons is determined by the layout of the system and the application of the robot.
- One *enabling device*

Some equipment may be useful, depending on the environment, standards, and risk analysis.

Examples of optional, yet useful, equipment:

- Fencing
- Dividers
- One or more light curtains to detect when something is entering the working area of the robot
- One or more scanners to detect when something is entering the working area of the robot

Assessments before using the robot

Every time before using Link 6, perform system checks to prevent potential damage to the robot, the robot system, and the user that could lead to a dangerous situation.

Make sure the risk assessment is available to all users.

Make sure all users receive training regarding safety concerns.

Verify that all tasks that are intended to be performed with the robot, including installation, programming, maintenance, and decommissioning, are listed in the risk assessment and that the risk assessment has been performed.

Related topics
Preventive maintenance on page 394

Stop categories

The different categories of stopping the motion of the arm safely when an emergency arises is designed to reduce existing hazards. The stop categories are aligned with IEC 60204-1.

Table 37: Stop categories

Stop category	Description
0	Removes electrical power from the arm immediately.
1	Initiated by pressing the *E-stop* button.

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Stop category	Description
	Initiated by faults detected by the *Safety Control Unit (SCU)*.
	Stops the movement of the arm and, when the arm has stopped moving, removes electrical power from the robot.
2	Brings the arm to a Monitored Stop.
	Power remains available to the arm.

Related topics

List of safety functions on page 62

State: Monitored stop on page 118

Operating modes on page 121

Emergency stop

An emergency is an unexpected situation that can lead to injury, or can damage the robot system or the objects it manipulates. An *E-stop* stops arm motion quickly in case of an emergency.

When an emergency arises during the operation of Link 6 or any other part of the *robot system*, press the *E-stop* button. Pressing the *E-stop* button triggers a stop category 1, which stops the movement of the arm before removing power from the arm.

Whenever the *E-stop* is pressed, the light behind the ACK button on the controller and the light around the wrist wring switches off. Re-arm the *E-stop* button and reset the robot in *Kortex Web App*. After recovering from the stop, inspect the area for any obstructions that can interfere with the operation of the robot. Also, inspect the robot to ensure it has not been damaged.

If there is no damage and the emergency situation has been handled, restart the robot using Kortex Web App.

Note: An *E-stop* button is on the *teach pendant*. An *E-stop* may also be connected to the controller. When Link 6 is being used in Hand Guiding mode, make sure the *E-stop* is within reach.

Related topics

State: Fault on page 119

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Move the arm without power

In specific situations, it may become necessary to move the arm when it lacks power, especially to ensure the safety of individuals within the workspace of the arm. The procedure is known as backdriving.

When the arm is without power, the brakes of each are engaged.

Important: Moving the arm without power demands a substantial amount of force.

Move the arm to a safe even without power by *backdriving* the brakes manually in each joint. Moving the arm without power requires a substantial amount of force.

Backdriving limits

Each joint in the robot arm is engineered to rotate within a range of +357° and -357°. However, it is vital to understand that the safe backdriving range should be limited to joint limits. Attempting to exceed this backdriving range can result in damage to the internal wiring of the robot.

Emergency procedure for moving the robot

In case of emergencies, such as a person being trapped by the robot, it is imperative to take immediate action. Push the robot arm out of the way with the appropriate force. The brake mechanism operates on a friction system. When subjected to a sufficient force, the joints of the robot move. The force required varies depending on factors such as the position of the robot, the *payload*, and the desired stop position.

Always perform a status check after backdriving the robot.

Warnings and cautions

Warning: Exceeding a backdriving range of +/- 90° may lead to damage to the robot and its internal cables, with the risk of exceeding mechanical joint limits. Damage can occur even with movements less than this limit, depending on the position of the arm. Only backdrive the robot the necessary amount to remove the impediment.

Warning: The robot may need to be reprogrammed after backdriving the actuators.

CAUTION: Manually backdriving the actuators may result in damage to the brakes.

CAUTION: Backdrive the robot only in emergency situations.

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Status check after backdriving

After backdriving the actuators, it is critical to perform a status check to ensure the proper functioning and alignment of the robot. After the status check, if any additional pop-up messages or unexpected behaviors occur, promptly contact our support team at support@kinova.ca for further assistance.

Related topics
Why is there a pop-up requesting visual confirmation of the robot pose after the robot reboots? on page 415
Safety directives and warnings on page 54

Safety functions

Link 6 has built-in tools designed to help the *integrator* to reduce risk when performing the risk analysis.

The tools are also known as safety functions. Safety functions rely on the hardware, firmware, the *SCU*, electronics, sensors, and other elements of the robot.

List of safety functions

Safety functions are built into Link 6 to minimize hazards in the robot system.

Table 38: List of safety functions

Number	Name	Triggers stop category	Level of performance
SF01	*Emergency stop*	SC1	ISO 13849-1:2015 Category 3 PL d
SF02	*Protective stop*	SC2	ISO 13849-1:2015 Category 3 PL d
SF03	*Joint position*	SC2	ISO 13849-1:2015 Category 3 PL d
SF04	*Joint speed*	SC2	ISO 13849-1:2015 Category 3 PL d
SF05	*Monitored stop*	SC0	ISO 13849-1:2015 Category 3 PL d
SF06	*Protection zone*	SC2	ISO 13849-1:2015 Category 3 PL d

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Number	Name	Triggers stop category	Level of performance
SF07	*Tool Center Point (TCP)* & *Elbow* speed	SC2	ISO 13849-1:2015 Category 3 PL d

Related topics

Stop categories on page 59

Safety modes on page 69

Robot safety protections and limits on page 80

Protection zones on page 84

Status of safety functions on page 347

SF01 Emergency stop

What does SF01 monitor?

SF01 monitors external emergency signals from the Safety I/Os to the robot. It initiates a *stop category* 1, which stops the movement of the robot before removing power from the arm.

Cause of the trigger

- The *E-stop* button is pressed on the *teach pendant*.
- A signal is detected on the input reserved for emergency stops.

Remedy

1. Make sure that it is safe to resume operation of the robot.
2. Tap **CLEAR FAULT** in the Robot control panel to remove the signal.
3. Reset the E-stop button by turning the button.
4. Switch the arm on.

Related topics

State: Fault on page 119

List of safety functions on page 62

Status of safety functions on page 347

SF02 Protective stop

What does SF02 monitor?

SF02 monitors *protective stop* signals connected as a Safety Input on the I/O panel. Protective stops interrupt the robot motion, but it does not remove power from the arm. It is a *stop category* 2.

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Cause of the trigger #1

Internal processes of the *main processing unit* (*Main Processing Unit (MPU)*) are avoiding a category 0 stop before safety thresholds are exceeded.

Remedy for trigger #1

Tap > **VIEW ALL** to identify the cause of the protective stop. Fix the cause of the stop.

Cause of the trigger #2

External devices assigned as protective stops on the **Safety I/Os** page.

Remedy for trigger #2

Ensure the signal of the specific I/O channel is off by sending a Protective Stop Reset signal. For example, switch off the light curtain signal, close a door linked with this specific signal, and so on.

Related topics

Safety I/Os on page 95

List of safety functions on page 62

Status of safety functions on page 347

SF03 Joint position monitoring

What does SF03 monitor?

SF03 monitors the positions of each joint and compares the positions with the limits set in the **Position Limits** page in Kortex Web App.

Tip: Access the **Position Limits** page by tapping **Safety** > **Joint Limits**.

Cause of the trigger

Certain trajectories may inadvertently make a single joint rotate constantly in the same direction without unwrapping. It is most common with the last joint. The unidirectional rotation may also happen when operating in Automatic and Recovery modes. It results in a *stop category* 2 protective stop.

Remedy

1. Clear the associated fault.
2. Identify which joint is nearing its position limit.
3. Move that joint in the position opposite to its limit.

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4. Launch the **Jog Angular** panel and check the current joint positions.
5. Adjust the trajectory that caused the fault so that the joint unwraps before it reaches the limit.

Related topics

Joint limits on page 81
Operating modes on page 121
Mode: Manual Jog on page 121
List of safety functions on page 62
Status of safety functions on page 347

SF04 Joint speed monitoring

What does SF04 monitor?

SF04 monitors the speed of each joint and compares the speeds with the limits set in the **Speed Limits** page in Kortex Web App.

Tip: Access the **Position Limits** page by tapping **Safety** > **Joint Limits** > **Speed Limits**.

Cause of the trigger

- Unforeseen environmental forces could cause parts of the robot to exceed the speed planned for its trajectory. The unforeseen forces, such as a collision with a wall, may cause the *actuators* to *backdrive*.
- It can also be caused when the robot is in Monitored Stop when an external force is applied to it.

It results in a *stop category* 2 protective stop.

Remedy

Resume the trajectory. Link 6 has built-in functions to saturate its speed limits automatically.

If the error is triggered consistently, consider modifying the trajectory.

Related topics

Joint limits on page 81
Elbow limits on page 83
Operating modes on page 121
Mode: Manual Jog on page 121
List of safety functions on page 62
Status of safety functions on page 347

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SF05 Monitored stop

What does SF05 monitor?

SF05, or *Monitored stop*, monitors the velocity of each joint and makes sure the velocity is zero when the robot is not moving. It makes sure the arm remains in a standstill position.

Cause of the trigger

Motion in the *actuators* is detected and results in a stop category 0. For example, when the arm is vibrating a lot, the arm stops moving.

Remedy

1. Remove the external source of motion.
2. Add damping elements to each source of vibration that is in contact with the robot.

Related topics

List of safety functions on page 62

Status of safety functions on page 347

SF06 Protection zone monitoring

What does SF06 monitor?

SF06 monitors the robot to make sure no part of the robot, including the user-defined tool sphere, comes in contact with any of the user-defined *protection zones* that are enabled.

Cause of the trigger

The robot touches an enabled protection zone when operating in Manual or running a program. It results in a *stop category* 2.

Remedy

1. Power the robot.
2. Clear the fault.
3. Use Recovery mode to leave the protection zone.
4. Reconfigure protection zones if necessary and safe from **Safety** > **Protection Zones** in *Kortex Web App*.
5. Disable protection zones if necessary and safe from **SafetyProtection Zones** in Kortex Web App.

Related topics

Operating modes on page 121

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Protection zones on page 84
List of safety functions on page 62
Status of safety functions on page 347

SF07 TCP and elbow speed monitoring

What does SF07 monitor?

SF07 monitors the *Cartesian* speeds of the *TCP* and the *elbow*, which is the third joint, so that the speeds do not exceed the values set in the **TCP & Elbow Limits** page in Kortex Web App.

Tip: Access the **TCP & Elbow Limits** page by tapping **Safety** > **TCP & Elbow Limits**.

Cause of the trigger

- A large force is exerted on the robot during Hand Guiding mode, causing the speed of the *TCP* or elbow to increase.
- Joint commands, especially on the first joint, reach large angular speeds.

It results in a *stop category* 2.

Remedy

- Apply constraints on local motion to limit the joint speeds and to keep the joint speeds within safe values.
- Modify the trajectory to include more waypoints such that the end effector and the elbow cannot reach high velocities.

Related topics

Mode: Hand Guiding on page 124
TCP limits on page 82
Elbow limits on page 83
List of safety functions on page 62
Status of safety functions on page 347

Stopping times and distances

The stopping time, measured in milliseconds, and distance, measured in degrees, are detailed for the first three joints of the *arm*. It follows ISO 10218-1:2011.

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Table 39: Stopping time and distance in accordance with ISO 10218-1:2011

Percentage of maximum payload (%)	Extension (%)	Speed (%)	First joint (Base)		Second joint (Shoulder)		Third joint (Elbow)	
			Stop time (ms)	Stop distance (°)	Stop time (ms)	Stop distance (°)	Stop time (ms)	Stop distance (°)
33%	33%	33%	290.13	7.76	238.42	6.87	532.08	8.50
		66%	331.05	19.02	611.09	20.11	756.18	30.78
		100%	409.52	38.57	591.21	40.43	705.37	41.67
	66%	33%	205.13	6.20	582.20	7.79	786.88	8.43
		66%	320.01	18.35	568.73	19.44	718.73	21.26
		100%	324.87	32.39	553.50	39.02	681.18	35.97
	100%	33%	343.08	4.80	333.61	6.26	704.49	8.95
		66%	182.39	9.12	440.58	12.00	601.87	22.07
		100%	262.86	17.04	677.68	22.66	717.89	41.58
66%	33%	33%	197.77	7.39	506.05	16.22	499.89	8.45
		66%	286.76	20.12	648.17	19.14	709.07	28.28
		100%	476.89	39.13	726.71	41.24	632.92	41.79
	66%	33%	267.15	6.06	430.09	10.97	588.40	8.41
		66%	254.99	16.61	501.77	23.12	604.31	21.10
		100%	331.13	32.28	525.56	36.19	608.16	33.33
	100%	33%	136.35	3.96	482.65	6.25	794.85	8.10
		66%	178.68	8.85	467.53	13.46	694.57	21.52
		100%	272.87	17.40	651.80	24.57	761.62	41.16
100%	33%	33%	198.08	7.54	997.89	7.06	649.97	8.54
		66%	286.74	19.16	614.52	20.16	671.20	28.75
		100%	478.41	40.18	541.15	40.65	589.54	41.46
	66%	33%	162.72	6.27	506.89	11.63	668.56	8.68
		66%	275.33	16.77	484.38	21.69	726.22	22.62

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Percentage of maximum payload (%)	Extension (%)	Speed (%)	First joint (Base)		Second joint (Shoulder)		Third joint (Elbow)	
			Stop time (ms)	Stop distance (°)	Stop time (ms)	Stop distance (°)	Stop time (ms)	Stop distance (°)
		100%	323.83	32.35	699.15	37.72	649.07	31.39
	100%	33%	174.20	5.94	390.97	6.59	698.42	9.25
		66%	180.34	9.05	463.63	14.23	742.03	23.35
		100%	344.00	37.41	509.47	23.16	892.70	42.64

Diagnostic coverage

Link 6 continually monitors itself and all diagnostics are displayed in *Kortex Web App*.

All safety functions are monitored. The state of each part that makes the *arm* work are also monitored. Problems encountered, with respect to safety functions of the arm, are displayed on the **Status** pages. The problems must be resolved before the robot can move again.

General and detailed information about the *base*, *actuators*, *end effector*, and *flange* positions are displayed on the **Monitoring** pages.

Related topics

Diagnostics on page 346

Status of safety functions on page 347

Safety modes

Configure speeds both as normal or reduced to define safe operation of the robot.

Normal *safety mode* determines the maximum speeds at which the robot can move in *Cartesian* and *angular* directions.

Reduced safety mode also determines the maximum speeds at which the robot can move in Cartesian and Angular directions. However, the maximum speeds in reduced mode are lower than those of the normal safety mode.

Reduced mode can be triggered by safety inputs. For instance, when the robot is learning its trajectories through Hand Guiding, the speed is dictated by the reduced mode to prevent injury.

Remember: It is the responsibility of the *integrator* to set all normal and reduced speeds with respect to the risk assessment. Also, all reduced speeds must be configured to be less than the corresponding normal speed.

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Reduced mode can be selected from *Kortex Web App*.

Related topics

Mode: Manual Jog on page 121

Mode: Hand Guiding on page 124

Mode: Hold-to-Run on page 126

List of safety functions on page 62

Robot safety protections and limits on page 80

State timelines of safety functions

Each safety function enters one of two states during operations.

A change in the state of the arm during different modes of operation dictate the state of each of the safety functions.

Table 40: Existing states and modes of operation

Safety function states	• active • inactive
Arm states	• Initialization • Idle • Maintenance • Brake Release • Operational • Fault power off • Recovery • Fault power on
Operating modes	• Manual Jog • Hand Guiding • Hold to Run • Automatic • Monitored Stop • Recovery

Related topics

State timelines of safety outputs on page 101

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SF01 Emergency stop timeline

The triggers for and the recovery from the Emergency stop function changes the state of the function.

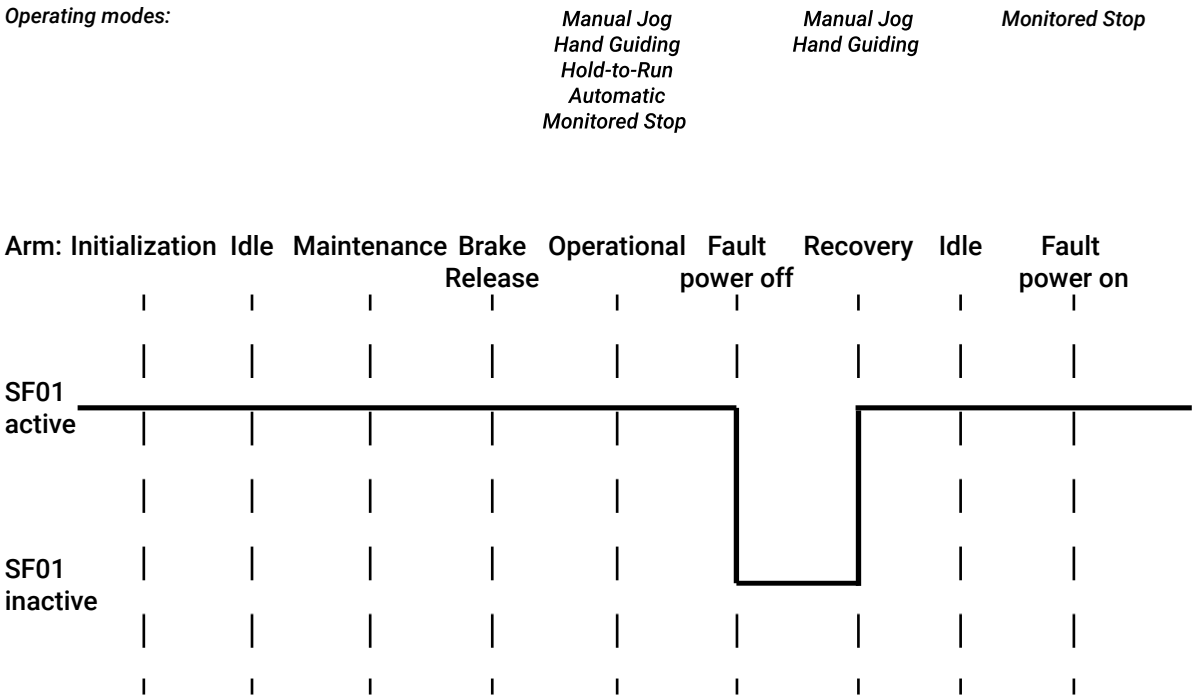
Equally important in knowing the timeline of a safety function is knowing where to find the current safety function status. For the status of SF01 Emergency stop function, there are a few places in Kortex Web App.

- **Diagnostics** > **Status** > **Safety Functions**
- **Diagnostics** > **Status** > **SCU** > **Emergency stop button signals disagreement**
- **Diagnostics** > **Status** > **SCU** > **Teach pendant emergency stop button signals disagreement**

Table 41: SF01 trigger and action timeline

Monitor frequency of trigger	0.01 s
Trigger	• One of two channels of the Emergency stop safety input sends the signal to the controller . • The *E-stop* button on the teach pendant is pressed.
Trigger results	• Stop category 1 is deployed. • The arm is in Fault power off.
Reset	• Release E-stop button attached to the controller. • Release E-stop button on the teach pendant. • Clear the fault from Kortex Web App .
Reset result	• State of robot is Idle. • No power is feeding the arm.
Failsafe	Not applicable

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Note: SF01 is inactive when the arm is in the state Fault power off only when it is initiated by stop category 0 or stop category 1 only.

Figure 40: Timeline for SF01 before and after being triggered

SF02 Protective stop timeline

The triggers for and the recovery from the Protective stop function changes the state of the function.

Equally important in knowing the timeline of a safety function is knowing where to find the current safety function status. For the status of SF02 Protective stop function, there is one place to look in Kortex Web App: **Diagnostics** > **Status** > **Safety Functions**.

Table 42: SF02 trigger and action timeline

Monitor frequency of trigger	0.01 s
Trigger	One of two channels of the Protective stop safety input sends the signal to the controller .
Trigger results	• *Stop category* 2 is deployed. **Remember:** The operating mode is Monitored Stop. • The operating mode cannot be changed. • The arm is Operational.

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Reset conditions - Automatic	The function resets automatically when all the channels of the safety input that are configured for Protective Stop with Automatic Reset signals the controller.
Reset conditions - Manual	All conditions must be met. • All the channels of the safety input that are configured for Protective Stop with Manual Reset. • All the channels of the safety input that are configured for Protective Stop Reset signals the controller.
Reset result	The program resumes operation.
Failsafe	SF02 can experience processing errors. In this case, stop category 0 is deployed.

Operating modes: *Hold-to-Run Manual Jog Automatic Hand Guiding Monitored Stop*

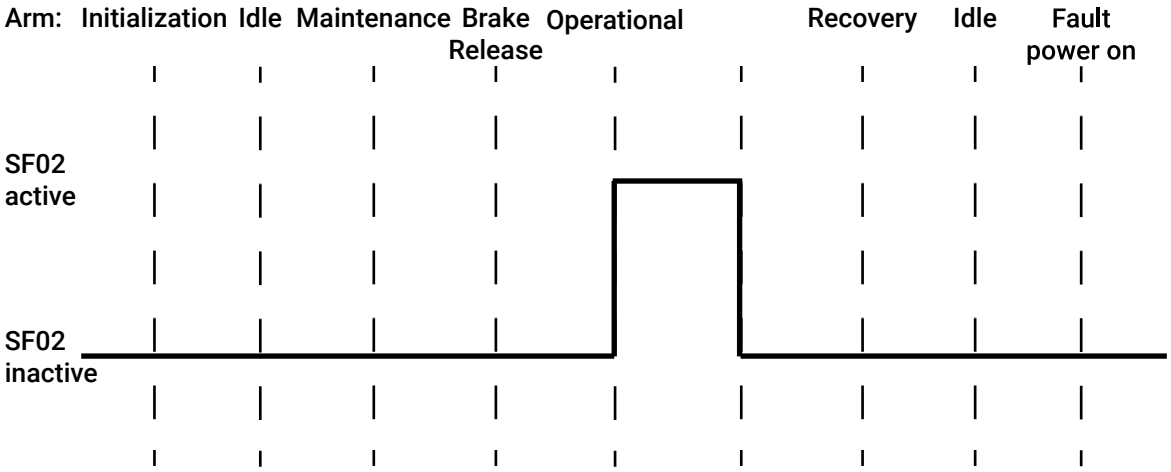


Figure 41: Timeline for SF02 before and after being triggered

SF03 Joint position monitoring timeline

Each safety function enters one of two states during operations; it depends on the current state of the arm and the current mode of operation.

Equally important in knowing the timeline of a safety function is knowing where to find the current safety function status. For the status of SF03 Joint position monitoring function, there are a few places in Kortex Web App.

- **Diagnostics** > **Status** > **Safety Functions**

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- **Diagnostics** > **Safety I/Os** > **Joint Limits** > **Position Limits**

Table 43: SF03 trigger and action timeline

Monitor frequency of trigger	0.01 s
Trigger	One of the joint positions is outside the configured limit.
Trigger results	• Stop category 2 is deployed. • The arm is in the state Fault power on.
Reset conditions	All conditions must be met. • Each joint position is within operational limits. • The arm is Operational and is in the operating mode Monitored Stop.
Reset	Tap **CLEAR FAULT**.
Reset result	Normal conditions lead to two results. • The operating mode is Monitored Stop. • The arm does not move. Abnormal conditions lead to two results. • The arm is in Recovery. • The position of at least one joint is between the recovery and the operational limit.
Failsafe	SF03 can experience processing errors. In this case, stop category 0 is deployed.

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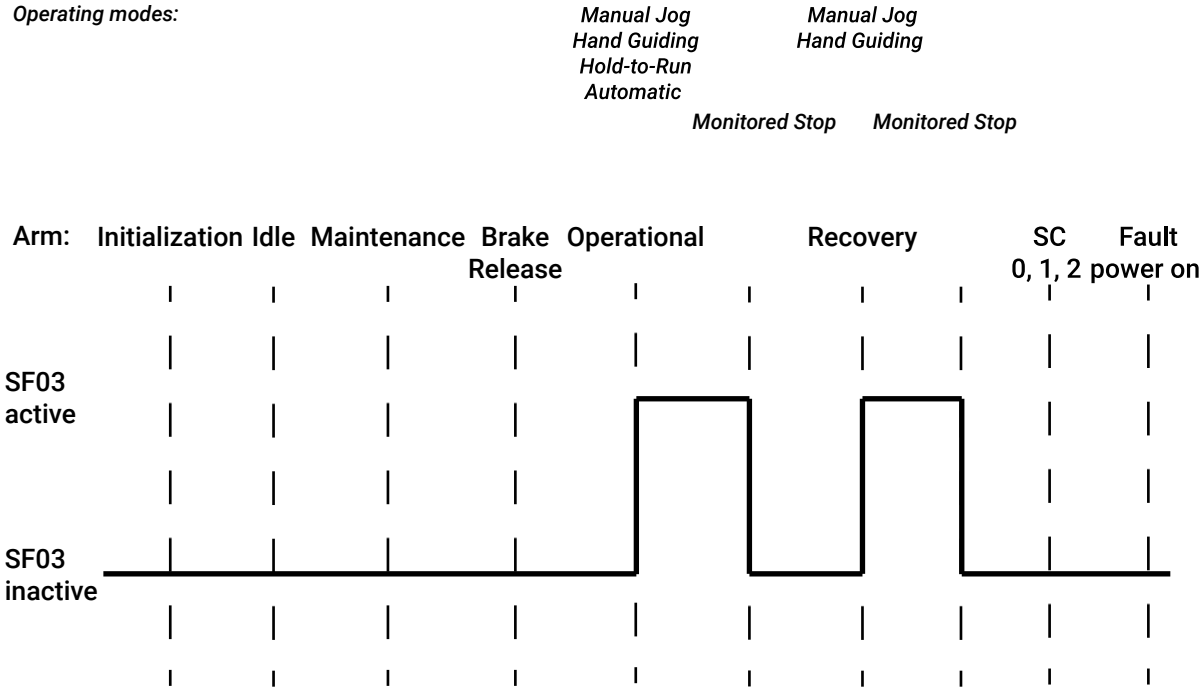


Figure 42: Timeline for SF03 before and after being triggered

SF04 Joint speed monitoring timeline

Each safety function enters one of two states during operations; it depends on the current state of the arm and the current mode of operation.

Equally important in knowing the timeline of a safety function is knowing where to find the current safety function status. For the status of SF04 Joint speed monitoring function, there are a few places in Kortex Web App.

- **Diagnostics** > **Status** > **Safety Functions**
- **Diagnostics** > **Safety** > **Joint Limits** > **Speed Limits**

Table 44: SF04 trigger and action timeline

Monitor frequency of trigger	0.01 s
Trigger	The speed of at least one joint is faster than its configured limit.
Trigger results	• Stop category 2 is deployed. • The operating mode is Monitored Stop. • The arm is in the state Fault power on.
Reset conditions	The speed of the joints are corrected to be within operational limits.
Reset	Tap **CLEAR FAULT**.

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Reset result	Normal conditions lead to two results. • The operating mode is Monitored Stop. • The arm does not move.
Failsafe	SF04 can experience processing errors. In this case, stop category 0 is deployed.

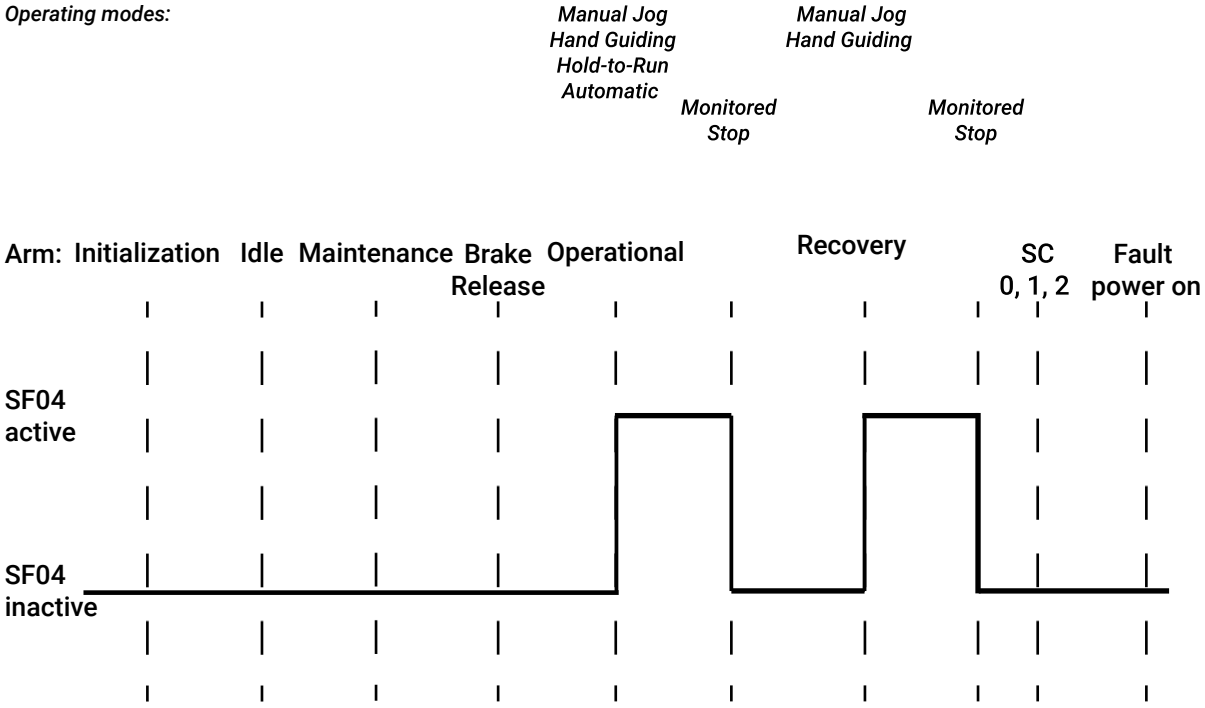


Figure 43: Timeline for SF04 before and after being triggered

Related topics

State timeline for the safety output Normal Speed Mode

SF05 Monitored stop timeline

Each safety function enters one of two states during operations; it depends on the current state of the arm and the current mode of operation.

Equally important in knowing the timeline of a safety function is knowing where to find the current safety function status. For the status of SF05 Monitored stop function, there is one place to look in Kortex Web App: **Diagnostics** > **Status** > **Safety Functions**.

Table 45: SF05 trigger and action timeline

Monitor frequency of trigger	0.01 s

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Trigger	• The arm is in the process of stopping and has taken more than 1000 ms to stop. • The difference between the actual position of at least one joint and its position when the robot entered the stop state is more than 0.5°.
Trigger results	• Stop category 0 is deployed. • The arm is in the state Fault power off.
Reset	Tap **CLEAR FAULT**.
Reset result	The operating mode is Monitored Stop.
Failsafe	When SF05 does not receive joint positions for more than 60 ms, stop category 0 is deployed.

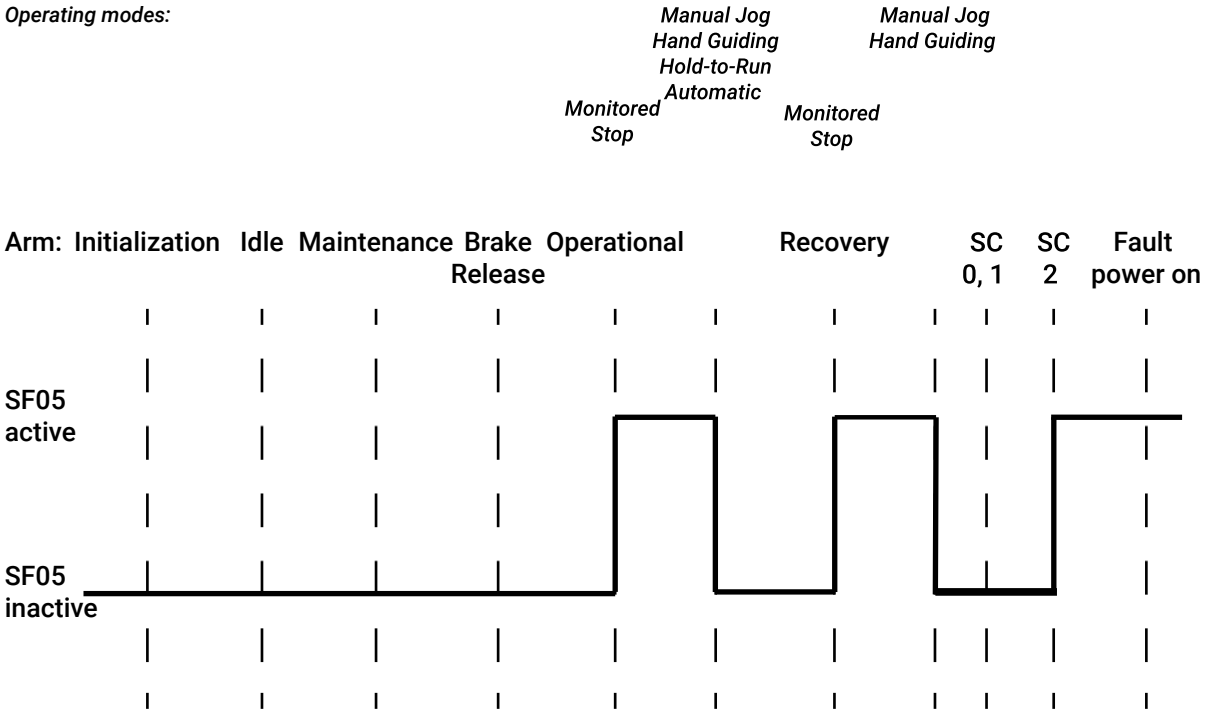


Figure 44: Timeline for SF05 before and after being triggered

SF06 Protection zone monitoring timeline

Each safety function enters one of two states during operations; it depends on the current state of the arm and the current mode of operation.

Equally important in knowing the timeline of a safety function is knowing where to find the current safety function status. For the status of SF05 Monitored stop0 function, there is one place to look in Kortex Web App: **Diagnostics** > **Status** > **Safety Functions**.

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Table 46: SF06 trigger and action timeline

Monitor frequency of trigger	0.01 s
Trigger	• Any part of the flange enters at least one protection zone. • Any part of the tool enters at least one protection zone. • Any *checkpoint* enters at least one protection zone.
Trigger results	• Stop category 2 is deployed. • The arm is in the state Fault power on.
Reset conditions	All conditions must be met. • Tool sphere is outside all configured protection zones. • All *checkpoints* are outside all configured protection zones.
Reset	Tap **CLEAR FAULT**.
Reset result	• The operating mode is Monitored Stop. • The arm does not move.
Failsafe	SF06 can experience processing errors. In this case, stop category 0 is deployed.
Operating modes:	*Manual Jog* *Hand Guiding* *Hold-to-Run* *Automatic* *Monitored Stop* *Manual Jog* *Hand Guiding* *Monitored Stop*

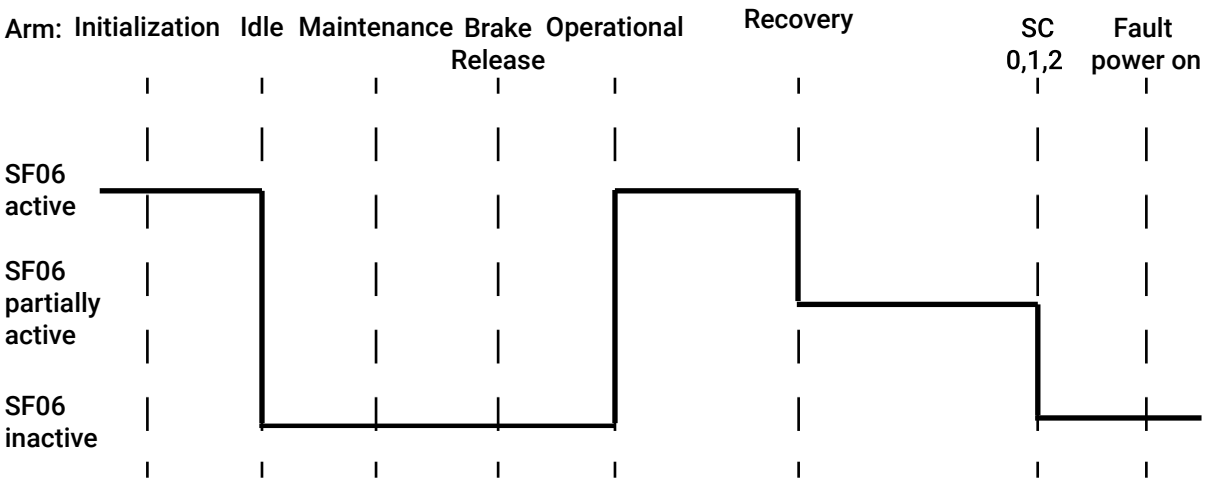


Figure 45: Timeline for SF06 before and after being triggered

Related topics

State timeline for the safety output Normal Speed Mode

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SF07 TCP and Elbow speed monitoring timeline

Each safety function enters one of two states during operations; it depends on the current state of the arm and the current mode of operation.

Equally important in knowing the timeline of a safety function is knowing where to find the current safety function status. For the status of SF07 TCP and Elbow speed monitoring function, there are a few places in Kortex Web App.

- **Diagnostics** > **Status** > **Safety Functions**
- **Safety** > **TCP & Elbow Limits** > **TCP Limits**
- **Safety** > **TCP & Elbow Limits** > **Elbow Limits**

Table 47: SF07 trigger and action timeline

Monitor frequency of trigger	0.01 s
Trigger	At least one trigger is needed. • TCP translation speed is higher than the configured limit. • TCP rotation speed is higher than the configured limit. • Elbow translation speed is higher than the configured limit.
Trigger results	• Stop category 2 is deployed. • The operating mode becomes Monitored Stop. • The arm is in the state Fault power on.
Reset conditions	• The TCP translation speed is corrected to be lower than the configured limit. • The TCP rotation speed is corrected to be lower than the configured limit. • The Elbow translation speed is corrected to be lower than the configured limit.
Reset	Tap **CLEAR FAULT**.
Reset result	• The operating mode is Monitored Stop. • The arm does not move.
Failsafe	SF07 can experience processing errors. In this case, stop category 0 is deployed.

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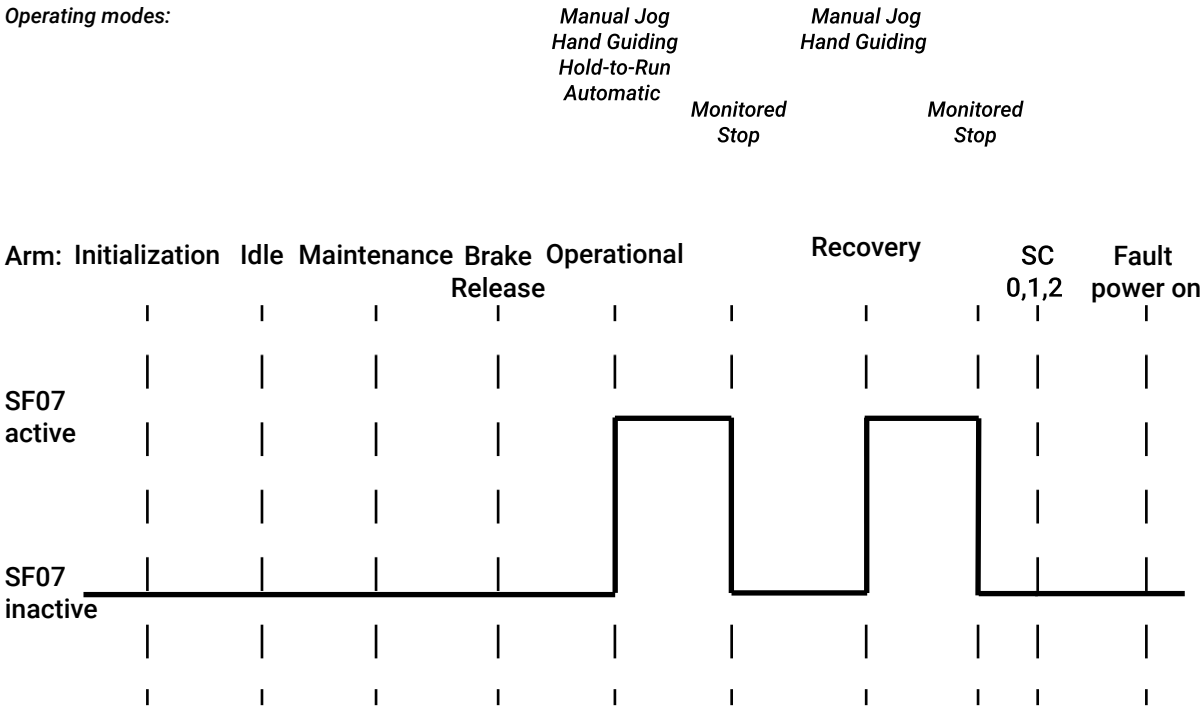


Figure 46: Timeline for SF07 before and after being triggered

Related topics

State timeline for the safety output Normal Speed Mode

Robot safety protections and limits

To make sure the robot operates safely in its working environment, configure joint limits, *TCP* and *elbow* limits, *protection zones*, and safety I/Os.

All tasks related to configuring the robot with respect to safety are performed by the *integrator*.

Important: Safety parameters can be modified only when there is no power in the arm.

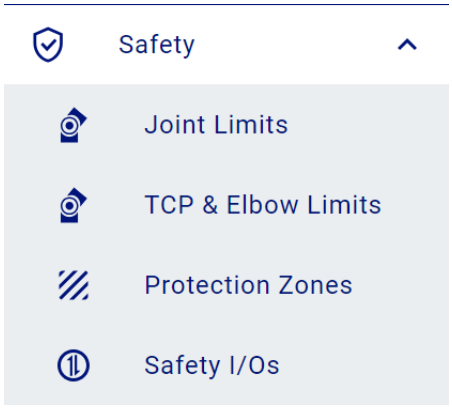


Figure 47: Accessing the safety pages

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The *controller* prevents movement, speed, and force outside of the configured limits. The configured limits are monitored by certain safety functions.

- *Emergency stop*
- *Protective stop*
- *Joint position*
- *Joint speed*
- *Protection zone*
- *TCP* and elbow speed

Related topics

List of safety functions on page 62

Safety modes on page 69

Joint limits

Each joint can be configured with specific minimum and maximum *angular* positions. Additionally, the speed of each joint can be configured in both normal and reduced safety modes.

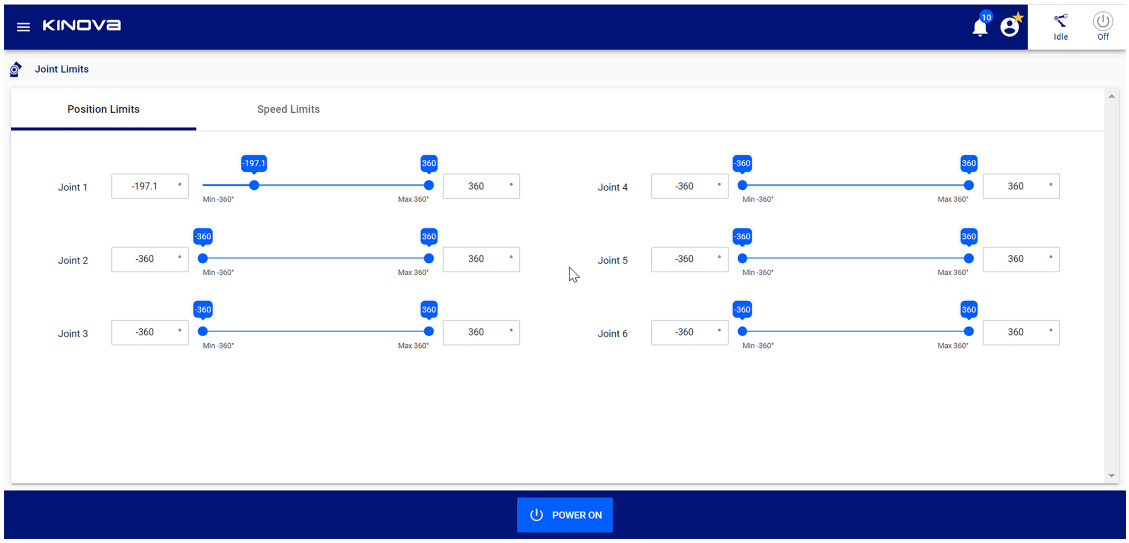


Figure 48: Position Limits page of Joint Limits page

When configuring the speed limits of the joints, select either **Normal** or **Reduced** from the **Safety Mode** menu. The limits apply to the safety mode that is selected.

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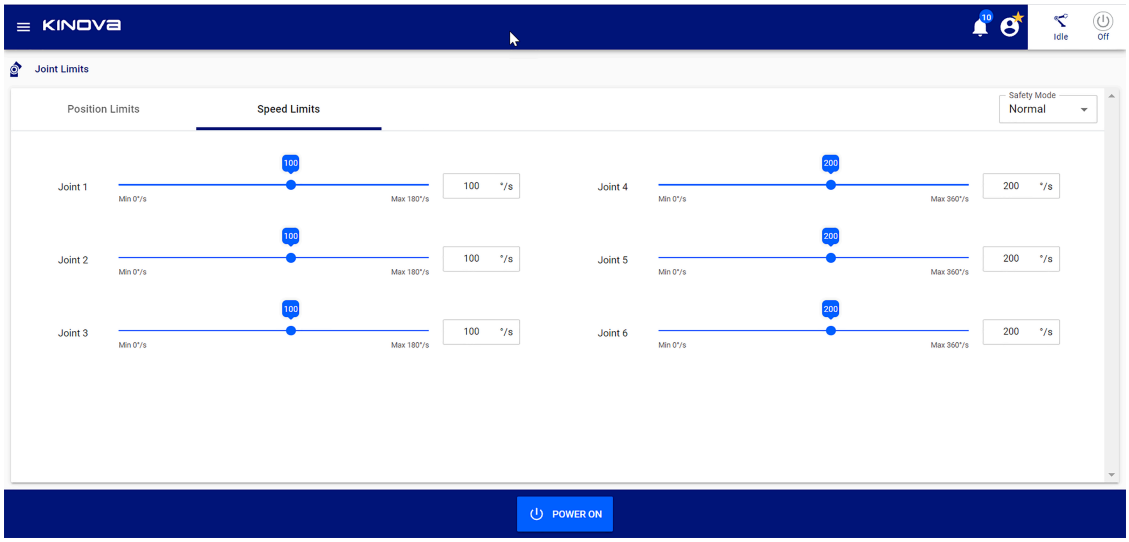


Figure 49: Speed Limits page of Joint Limits page

Table 48: Ranges of speed limits for joints

Safety mode	Joint size	Joint number	Speed range
Normal	Size 110	1 to 3	15 °/s to 200 °/s
	Size 80	4 to 6	30 °/s to 320 °/s
Reduced	Size 110	1 to 3	15 °/s to 80 °/s
	Size 80	4 to 6	30 °/s to 160 °/s

TCP limits

The speed of the position and rotation of the *TCP* being used must be configured.

The configured *TCP* speeds in the reduced safety mode must be less than the configured *TCP* speeds in the corresponding normal safety mode.

Important: There must be no power in the arm when the robot safeties are being configured.

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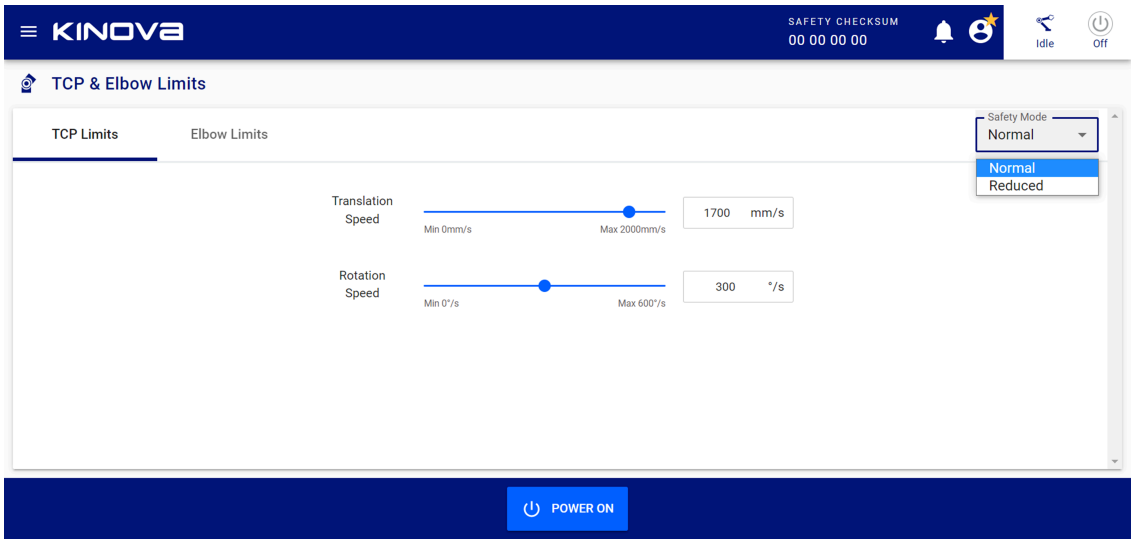


Figure 50: TCP limits

Table 49: TCP configuration speed limits

TCP limit	Safety mode	Description
Note: The range represents the limits, or thresholds, that trigger faults. They are not in any way desired velocities.		
Translation Speed	**Normal**	Use the slider to configure the normal translation speed. Range: 0 mm/s to 2000 mm/s Default: 1700 mm/s
	Reduced	Use the slider to configure the reduced translation speed. Range: 50 mm/s to 250 mm/s Default: 250 mm/s
Rotation Speed	**Normal**	Use the slider to configure the normal rotation speed. Range:: 0 °/s to 600 °/s Default: 300 °/s
	Reduced	Use the slider to configure the reduced rotation speed. Range: 0 °/s to 150 °/s Default: 150 °/s

Elbow limits

The speed of the *elbow* must be configured.

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Important: There must be no power in the arm when the robot safeties are being configured.

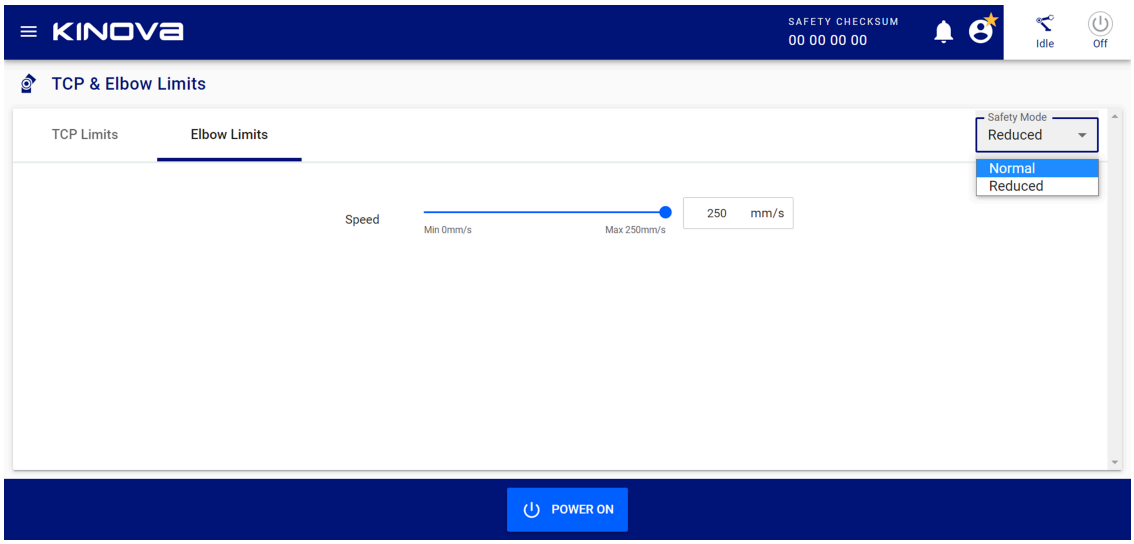


Figure 51: Elbow speed limits

Table 50: Elbow configuration speed limits

Elbow limit	Safety mode	Description
Speed	**Normal**	Use the slider to configure the normal speed. Range: 50 mm/s to 2000 mm/s Default: 1700 mm/s
	Reduced	Use the slider to configure the reduced speed. Range: 50 mm/s to 250 mm/s Default: 250 mm/s

Protection zones

Prevent or limit where the robot can move by creating *protection zones*.

The zones are three-dimensional geometric volumes intended to limit the possibility of the robot running into users or objects near it. Protection zones define such things as walls, tables, and objects. Up to eight zones, excluding the tool zone, can be active simultaneously.

Important: The zone defined for the tool is the only zone that cannot be disabled. However, like the other zones, it can be modified. The tool zone must exist so that the robot takes the size of the end effector into account.

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Important: There must be no power in the arm when the zones are being defined.

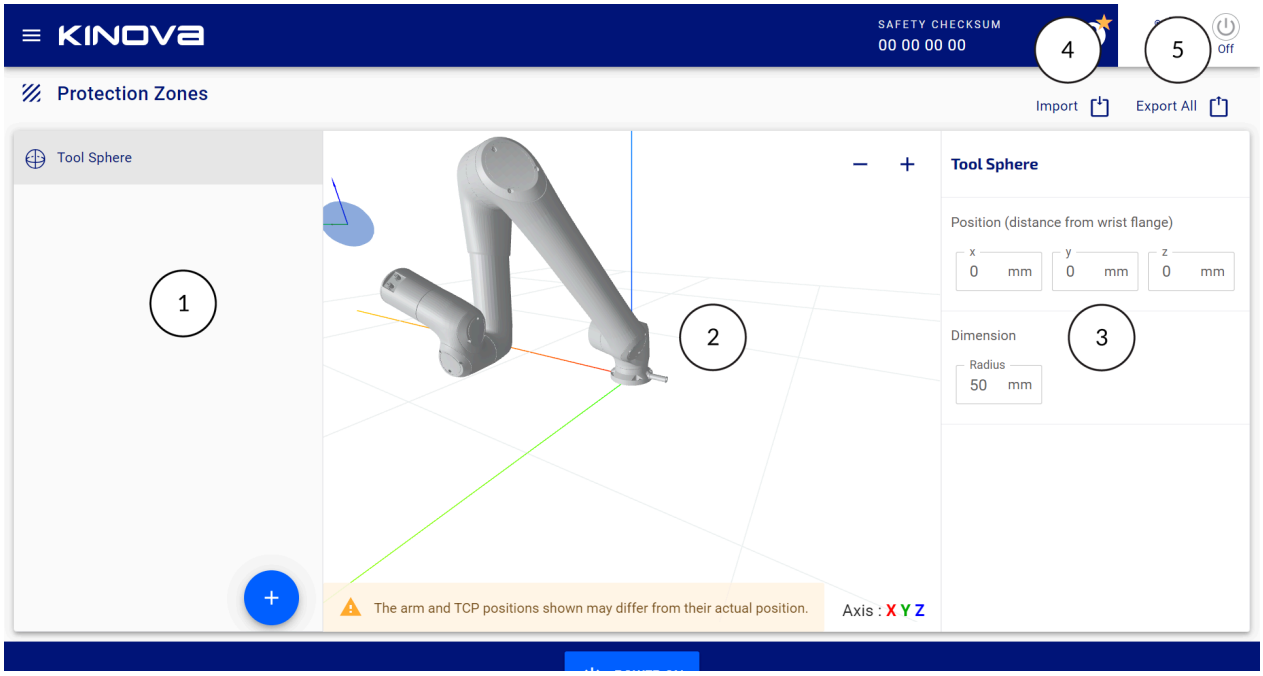


Figure 52: The Protection Zones page

1 Zones pane

2 Visualization pane

3 Zones configuration pane

4 **Import**

Important: Import is available on the teach pendant only when a *USB storage device* is connected in the USB port on the controller. It is available from a web browser when there is no USB storage device.

5 **Export All**

Important: Export is available on the teach pendant only when a *USB storage device* is connected in the USB port on the controller. It is available from a web browser when there is no USB storage device.

When you first access the **Protection Zones** page, only the **Zones** and **Visualization** panes are visible. Tap on any of the zones in the Zones pane to view its corresponding configuration pane.

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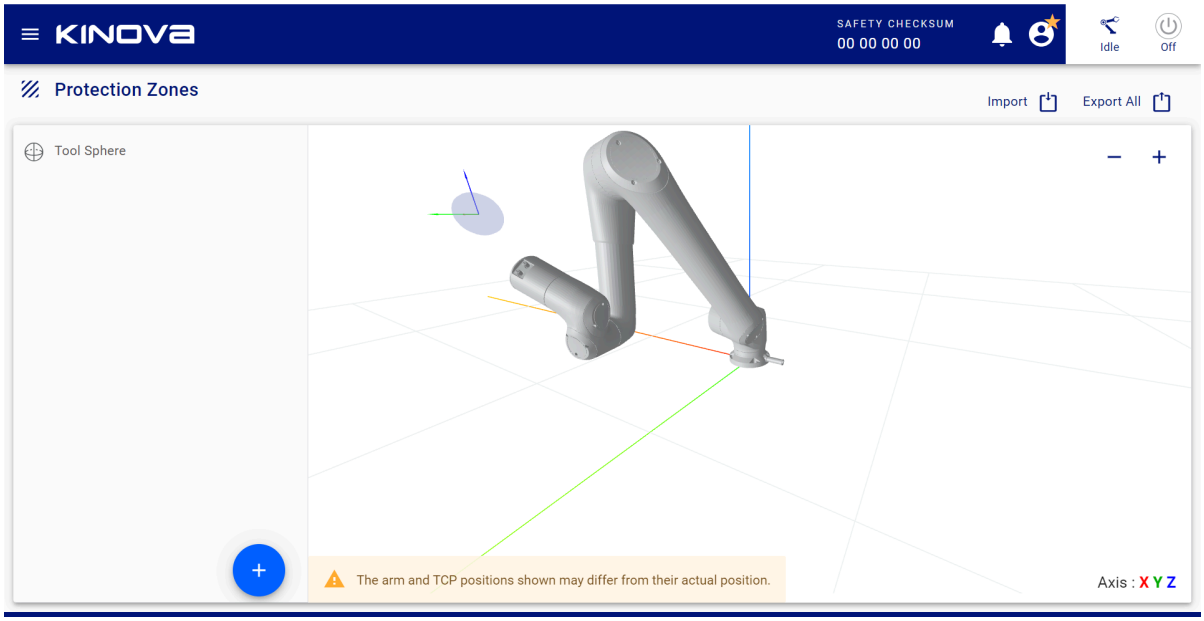


Figure 53: Initial launch of Protection Zones page

Related topics

Effective workspace on page 17

List of safety functions on page 62

Tool sphere

The tool sphere, displayed in the **Protection Zones** page, is a *protection zone* for the *end effector* on the *arm*. The tool sphere is the only protection zone that moves with the arm.

The end effector and the arm must never collide with each other. Therefore, the tool sphere is always displayed in the **Protection Zones** page. It can never be deleted and it can never be deactivated. However, the zone of the tool sphere can be modified.

Important: Always define the tool sphere with respect to the flange.

Important: Always make sure the tool sphere size and offset reflect reality.

Zones pane

Create, rename, duplicate, and delete zones from the **Zones pane**. Export individual protection zones as XML or JSON from a web browser.

The zone for the *end effector* is always present; in the pane, it is listed as the **Tool Sphere**.

Important: The zone defined for the tool is the only zone that cannot be deleted. It must exist so that the robot takes the shape and offset of the end effector into account.

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Protection zones that are already defined are listed in the **Protection Zones** pane.

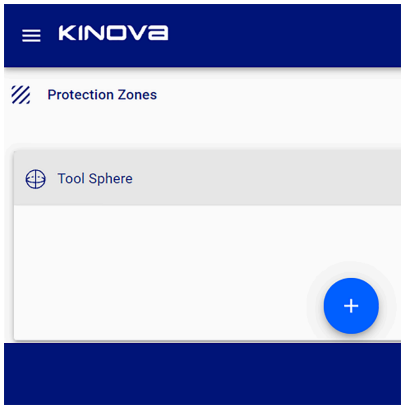


Figure 54: Example when no zones, except for the tool, are listed in the Zones pane

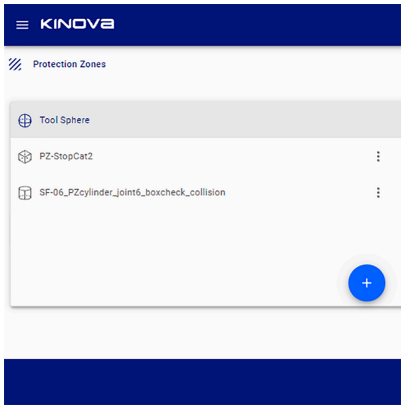
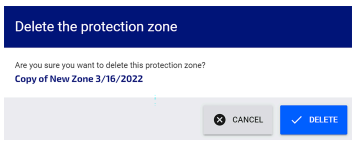


Figure 55: Example of multiple zones listed in the Zones pane

Table 51: Actions that can be performed on each protection zone from the *kebab* (⋮) menu

Selected zone actions	Description
Duplicate	Create a new zone that is a duplicate of the selected protection zone. **Tip:** When the maximum number of zones are created, a message is displayed on the page indicating that no more zones can be added. Also, the option to duplicate from the menu is not selectable.
Delete	Delete the selected zone. A confirmation dialog launches. Tap **Delete** to delete the zone. 

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Selected zone actions	Description
Export XML	Export the currently saved configuration of the selected zone as an XML file. **Important:** Export is available on the teach pendant only when a *USB storage device* is connected in the USB port on the controller. It is available from a web browser when there is no USB storage device.
Export JSON	Export the currently save configuration of the selected zone as a JSON file. **Important:** Export is available on the teach pendant only when a *USB storage device* is connected in the USB port on the controller. It is available from a web browser when there is no USB storage device.

Adding a protection zone

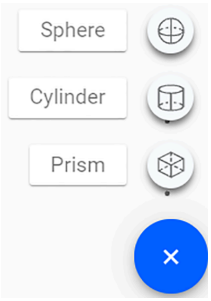
Protection zones are areas where the robot cannot enter.

About this task

Create one protection zone for each object or area that the robot must avoid. Up to eight zones can be created. All eight zones can be active and monitored by the robot at one time. Zones can be left inactive.

Procedure

1. Tap the hamburger menu ( ) to expand the menu.
2. Tap **Safety** > **Protection Zones**.
3. Tap + in the Zones pane of the **Protection Zones** page.
   A menu of zone shapes launches.



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4. Tap one of the three shapes.
   The new zone with its shape is highlighted in the Visualization pane.

   The default values of the zone is launched in the Configuration pane.

   The default name of the protection zone is "New Zone MM/DD/YYYY", where MM is the numerical month, DD is the numerical day, and YYYY is the numerical year.
5. Enter the desired values in the Configuration pane.
6. Tap **Activate Zone** to make the zone active.

Manipulating existing safety zones

Deleting, duplicating, and renaming zones are all ways of manipulating existing zones.

About this task

The entire operation is performed within the Zones pane.

Procedure

1. Tap the hamburger menu (☰) to expand the menu.
2. Tap **Safety** > **Protection Zones**.
3. Tap the zone in the list that needs to be manipulated.

   A single tap selects the zone.
4. Tap the associated *kebab* (⋮) menu.
   A menu for the selected zone launches.
5. Tap the action needed for that zone.

   - Tap **Delete** to delete a zone.
   - Tap **Duplicate** to duplicate a zone. Modify the zone properties after duplicating it.

     Note: A duplicated protection zone always uses the default zone name "New Zone MM/DD/YYYY", where MM is the numerical month, DD is the numerical day, and YYYY is the numerical year.
   - Tap **Export JSON** to export the zone to a JSON file.

     Important: Export is available on the teach pendant only when a *USB storage device* is connected in the USB port on the controller. It is available from a web browser when there is no USB storage device.
   - Tap **Export XML** to export the zone to an XML file.

     Important: Export is available on the teach pendant only when a *USB storage device* is connected in the USB port on the controller. It is available from a web browser when there is no USB storage device.

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Zone shapes

Each zone is created using a specific shape.

There are three shapes that are available. Some properties are shared among all shape.

Table 52: Properties common to all zone shapes that can be added

Properties	Description
Name	When the shape is first created, its name is automatically set to the current date appended to the string "New Zone".
	Change the name to something meaningful.
Activate Zone	By default, the zone is active.
	Deactivate the zone when the environment around the robot is going to change. For example, when a single arm is used in multiple setups, it is convenient to be able to activate the desired zone for the current environment.

Some properties are specific to the shape. The properties of the zones must be defined or configured. Configure the zones in the **Configuration pane**.

Tip: To enter values, tap in the text box of the property that needs changing and use the slider. The value changes in the currently selected text box.

Table 53: Properties specific to the tool sphere zone

Properties	Description
Position (distance from base)	Distance is measured from the x,y,z coordinates of the wrist flange and is measured in millimeters.
	Default coordinates: (0,0,0)
Dimension	The dimension of the **Radius** of the sphere measured in millimeters.
	Default radial size: 200 mm

Table 54: Properties specific to the sphere zone

Properties	Description
Position (distance from base)	Distance is measured from the x,y,z coordinates of the base and is measured in millimeters.
	Default coordinates: (0,0,0)

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Properties	Description
Dimension	Enter the dimension of the sphere as a radius.
	The **Radius** is measured in millimeters.
	Default radial size: 200 mm

Table 55: Properties specific to the cylinder zone 

Properties	Description
Position (distance from base)	Distance is measured from the x,y,z coordinates of the base and is measured in millimeters.
	Default coordinates: (0,0,0)
Orientation - Euler	Enter the orientation of the cylinder using the extrinsic ZYX Euler angle convention.
	Orientation is measured in degrees.
Dimension	Enter the height (z) and radius of the cylinder.
	Height and **Radius** are measured in millimeters.
	Default height: 300 mm
	Default radial size: 200 mm

Table 56: Properties specific to the prism zone 

Properties	Description
Position (distance from base)	Distance is measured from the x,y,z coordinates of the base and is measured in millimeters.
	Default coordinates: (0,0,0)
Orientation - Euler	Enter the orientation of the prism using the extrinsic ZYX Euler angle convention.
	Orientation is measured in degrees.
Dimension	Enter the length (x), width (y), and height (z) of the prism.
	Length, **Width**, and **Height** are measured in millimeters.
	Default length: 250 mm
	Default width: 250 mm

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Properties	Description
	Default height: 250 mm

Euler angle convention used

Euler angles are used to represent the orientation of an object, such as a robot tool. The convention used is Tait-Bryan, extrinsic ZYX.

There are three ways to rotate from the reference coordinate from (x,y,z) to the considered rigid body.

1. Rotation about fixed x axis of an angle rx (γ).
2. Rotation about fixed y axis of an angle ry (β).
3. Rotation about fixed z axis of an angle rz (α).

With this angle convention, we can define the associated rotation matrix.

$$R = Z(\alpha)Y(\beta)X(\gamma)$$

Exporting or importing all protection zones into one file

All protection zones can be exported into one XML or JSON file after they are defined. All protection zones can be imported at once.

About this task

Exporting protection zones is a fast way to integrate the robot, especially when multiple robots are in the working environment. Define protection zones for one of the robots, import the file for the next robot, and modify the values for it. Again, these new protection zones can be exported.

Important: Export is available on the teach pendant only when a *USB storage device* is connected in the USB port on the controller. It is available from a web browser when there is no USB storage device.

Important: Import is available on the teach pendant only when a *USB storage device* is connected in the USB port on the controller. It is available from a web browser when there is no USB storage device.

Important: The exported and imported protection zones do not include the zone definition for the tool.

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Figure 56: Location of Protection zone Export All button

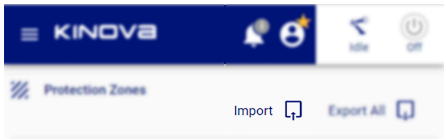


Figure 57: Location of Protection zone Import button

Procedure

Export all protection zones to one file.

1. Tap **Export All** > **Export JSON** or **Export All** > **Export XML** to export all the protection zones to a JSON or XML file.
   All protection zones are saved in the zone definition file.

Import all zone from one file

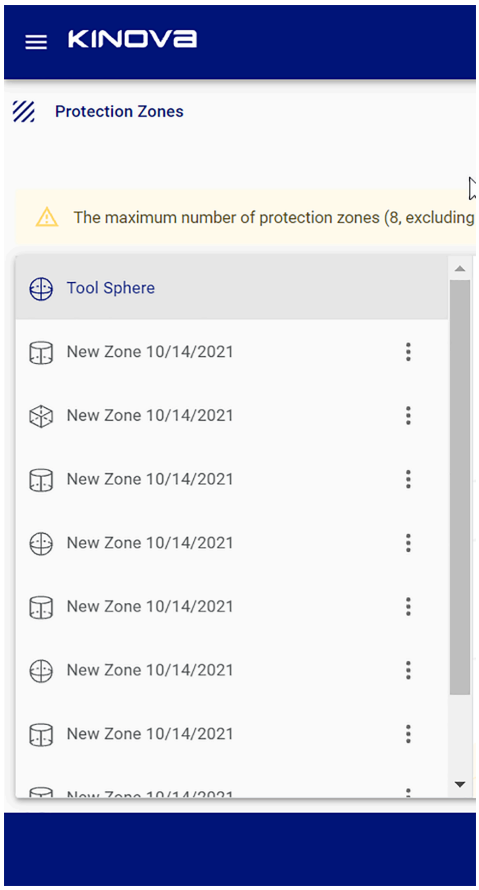
2. Tap **Import**.
3. Browse to the location where the protection zone XML or JSON files are stored.
4. Select the desired file.

Results

The **Zones pane** populates with all the protection zones defined in the file.

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Example:



Visualization pane

A visualization of the defined protection zones, as well as the arm of Link 6 in its current position, is in the **Visualization pane**. The view helps to determine the protection zones in a 3-dimensional space with respect to the robot.

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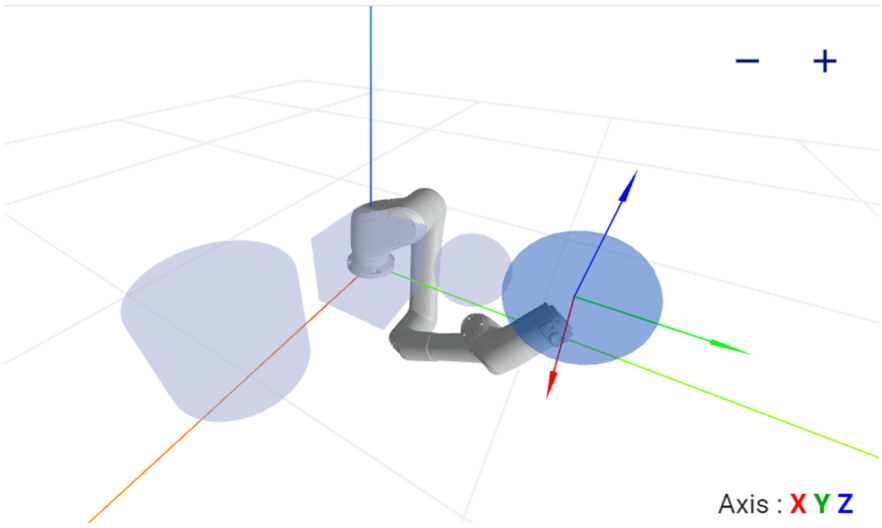


Figure 58: Visualization pane with tool sphere, robot, and other protection zones

Zoom in, zoom out, and view the zones from different angles.

Safety I/Os

Each safety input and output can be assigned to one or more of the eight channels.

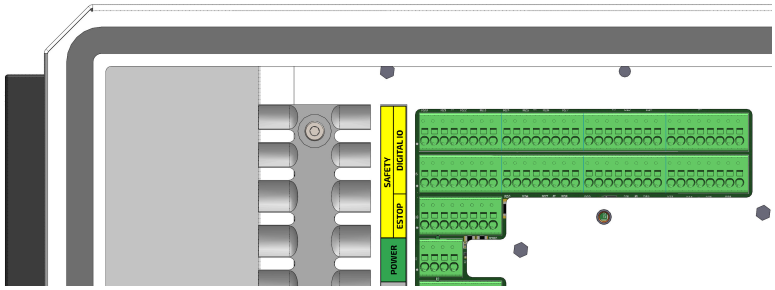


Figure 59: Location of connectors for the Safety I/O equipment

When the *physical equipment* is connected to the *controller* through the safety digital input and output terminals, it can then be assigned a specific behavior on the corresponding channel in Kortex Web App. The channels are numbered 0 through 7.

Important: Make sure the arm is in the Idle *state* before you configure safety inputs and outputs. The arm is in the Idle state when the arm is switched off, but the controller is switched on.

Each input safety function is connected to two electrical inputs. When a safety function is triggered, the state changes on both electrical inputs simultaneously.

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Likewise, each output safety function is connected to two electrical outputs. When a safety function is triggered, the state changes on both electrical outputs simultaneously.

A discrepancy in states between the two channels implies there is an electrical system fault or there is a device fault.

Safety inputs

Inputs are connected to one of eight channels. A channel is assigned an input function through *Kortex Web App*. When a channel is assigned to an input function, that input function is no longer available on the other channels.

Access the **Safety I/Os** page by tapping **Safety** > **Safety I/Os**. The default pane is **Inputs**.

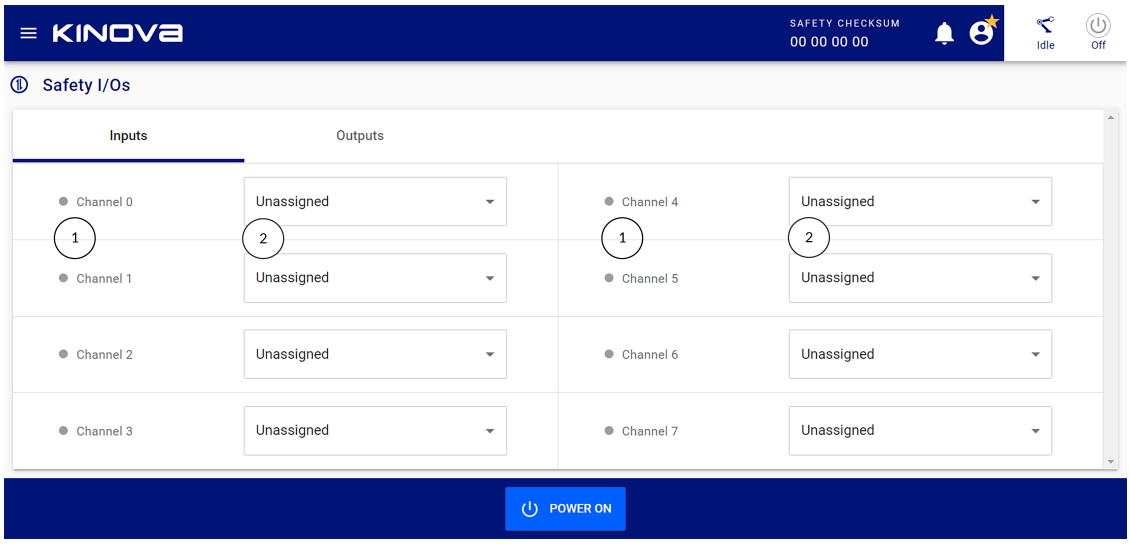


Figure 60: Safety inputs pane

1	Input channel	2	Safety behavior; function

The safety input behavior drop-down has several choices. Each safety input is assigned a specific safety behavior. The different conditions are listed in the safety input drop-down.

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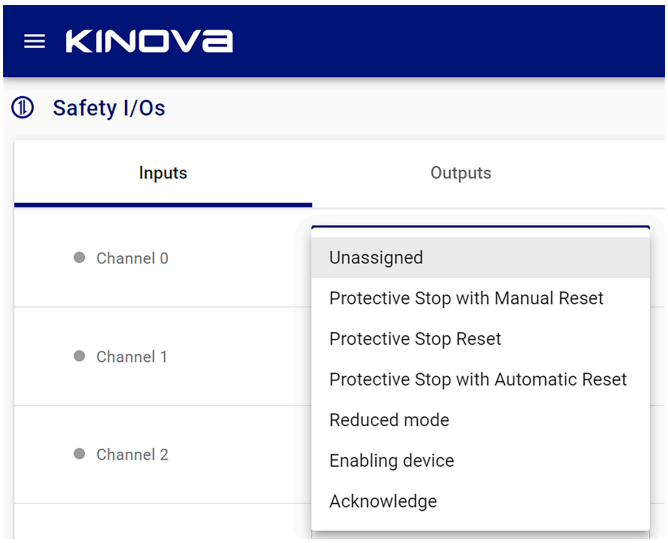


Figure 61: Input functions

All safety digital inputs are *normally closed*. The behavior of *NC* changes depending on what configuration is assigned to the channel.

Table 57: Safety input conditions available for each channel

Safety input function name	Description
Unassigned	Channel behavior is not altered for the connected equipment.
Protective Stop with Manual Reset	The robot automatically comes to a *stop category* 2. When the input safety function is triggered, the program automatically pauses running. After the signal is released, the user must reset the robot before it can resume operations. The robot must be in one of two operating modes. • Automatic mode • Hold to Run mode
Protective Stop Reset	The robot is in *Monitored stop* mode when the *protective stop* is activated. Use the reset input to resume operation. The program resumes where it left off provided the program paused because of a **Protective Stop with Automatic Reset** and provided no fault has occurred. If an electrical system fault or a device fault occurs, the robot comes to a category 0 stop with no chance of resuming from the original paused location of the program.

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Safety input function name	Description
Protective Stop with Automatic Reset	The robot pauses its task automatically and comes to a stop category 2. After the signal is released, the robot resumes operation immediately. After the fault is cleared or the intrusion is gone, the robot resumes operations. The robot must be in one of two operating modes. • Automatic mode • Hold to Run mode
Reduced Mode	The reduced speed limits are enforced in all operating modes as long as the signal is active. If the robot is moving at a speed higher than the reduced speed limit when reduced mode is triggered, the robot slows down and complies with the reduced speed. The robot continues to operate at reduced speeds when the signal is released. When there is an electrical system or device fault, the robot comes to a category 0 stop.
Enabling device	Connect an external *enabling device* to the controller and assign the corresponding channel the enabling device behavior. When one enabling device is pressed, regardless of where it is, the robot can be moved manually. **CAUTION:** It is possible that more than one enabling device is connected. However, only one enabling device should be used at a time. When there is an electrical system or device fault, the robot comes to a category 0 stop.
Acknowledge Automatic Mode	The channel overrides the ACK button on the controller when Acknowledge Automatic Mode is not set on the **Controller** pane of the **Robot** page. When the robot is operating in Automatic mode, the acknowledge safety input overrides the need to press the ACK button on the controller; the **Acknowledge Automatic Mode** dialog never launches at the start of running a program in Automatic mode.

Input signals are compatible with devices that implement *OSSD* behavior. The pulsed *Output Signal Switching Device (OSSD)* signals are filtered with the period is less than 3 ms.

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Safety outputs

Outputs are connected to one of eight channels. A channel is assigned an output function through *Kortex Web App*. When a channel is assigned to an output function, that output function is still available on the other channels.

Access safety outputs by tapping **Safety** > **Safety I/Os** > **Outputs**.

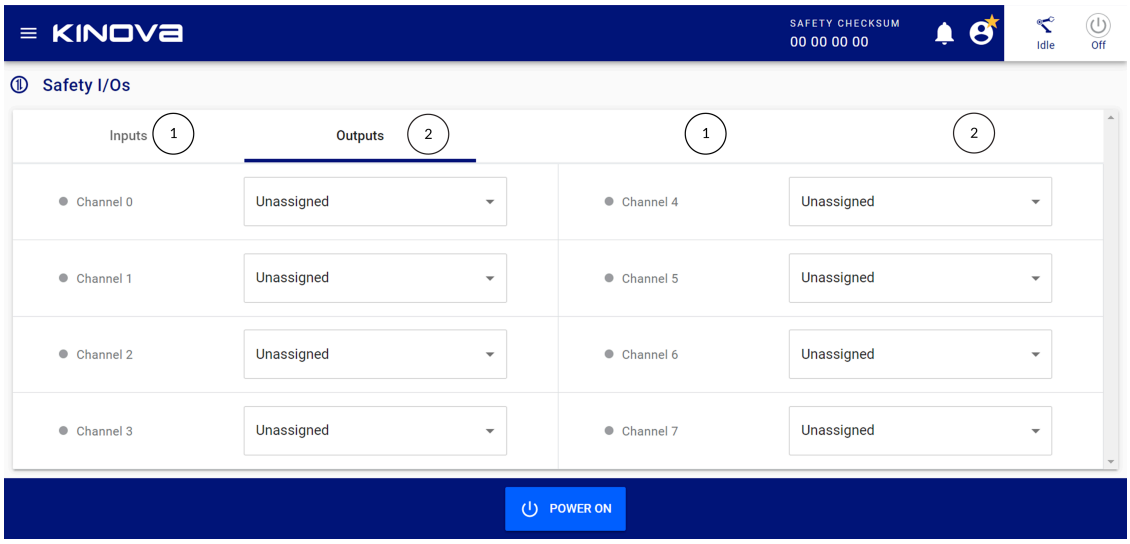


Figure 62: Safety outputs pane

1 Output channel 2 Safety behavior; function

Each safety output monitors a specific condition. The different conditions are listed in the safety output menu. Connect Safety Output channels to external Safety monitoring devices, such as a PLC, to obtain live feedback from Link 6.

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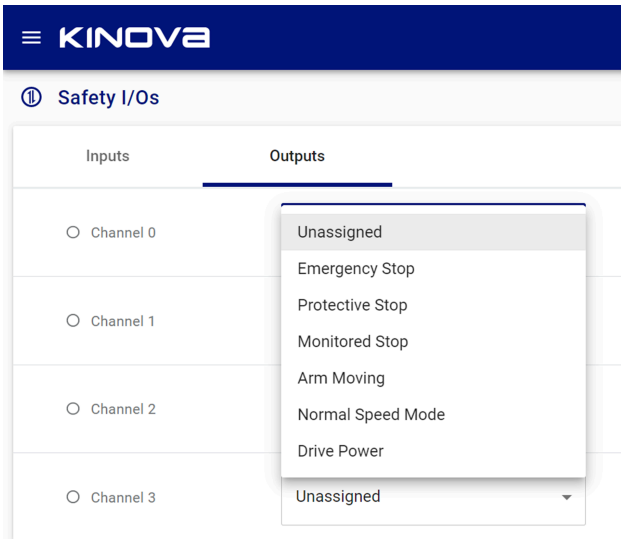


Figure 63: Output functions

Table 58: Output safety conditions available for each channel

Safety output function name	Description
Unassigned	No output function is assigned for the connected equipment. **Important:** When a factory reset is performed, any channel assigned to a safety output channel becomes unassigned. The output channels need to be reassigned.
Emergency Stop	The output condition is set only when it is triggered by pressing an *E-stop* button; the safety function remains active even when the robot arm is switched off. After the *E-stop* button is released and the fault is cleared, the safety function is inactive.
Protective Stop	The output condition is set when the robot is currently in a Protective Stop.
Monitored Stop	The channel signals the robot is waiting for user input; it makes sure there is no movement in any joint of the arm. The output condition is set only when the robot in the Monitored Stop operating mode.
Arm Moving	The channel signals the robot that the arm is currently moving, as is the case when the robot is in Hand Guiding, Manual Jog, Hold to Run, or Automatic mode.

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Safety output function name	Description
Normal Speed Mode	The channel signal is raised when the robot is operating using the **Normal Speed Safety Mode** limits. It is triggered whenever the Normal Speed Mode is set and the Reduced Mode Safety function is not set.
Drive Power	The channel signal is raised when the actuator drives receive power.

Safety outputs set redundant hardware channels. For example, when the safety output function Emergency stop is assigned to channel 3, it actually is assigned to both AO_3 and BO_3. By using redundant hardware channels, load capacity, and the speed of switching between supplying and absorbing electricity is maximized.

Important: Although you can configure the channels to use the safety output functions, you cannot configure the hardware channels independently. For example, you cannot configure AO_3 and BO_3 to do different things.

Transitioning between giving and taking current is performed within 20 ms of triggering an output function. Any discrepancy between the channels during transitions does not exceed 5 ms.

Related topics
Installing the drive power indicator on page 103

State timelines of safety outputs

The majority of the state timelines of safety outputs are described through the different safety functions. However, there are two safety outputs that are not described by the safety functions.

Each safety output enters one of two states during operations.

A change in the state of the arm during different modes of operation dictate the state of each of the safety outputs. However, the Normal Speed Mode safety output may also depend on the selected Safety Mode.

Table 59: Safety output states that are described as safety function

Safety output state	Corresponding safety function
Unassigned	n/a
Emergency Stop	SF01 Emergency Stop
Protective Stop	SF02 Protective Stop
Monitored Stop	SF05 Monitored Stop

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Safety output state	Corresponding safety function
Arm Moving	n/a
Normal Speed Mode	n/a

Note: The safety output state **Unassigned** indicates that no safety output is assigned to the channel.

Related topics

SF01 Emergency stop timeline on page 71

SF02 Protective stop timeline on page 72

SF05 Monitored stop timeline on page 76

State timelines of safety functions on page 70

State timeline for the safety output Arm Moving

Each safety output enters one of two states during operations; it depends on the current state of the arm and the current mode of operation.

Equally important in knowing the timeline of a safety output is knowing where to find the current safety output status. To know the status of the safety output **Arm Moving**, look at what is highlighted in the Robot control panel or the robot status button in the robot status area. The current operating mode reflects the current status of Arm Moving.



Figure 64: Robot control panel



Figure 65: Robot status button

Table 60: Arm Moving timeline

Monitor frequency of trigger	0.02 s

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Trigger off	The robot must be in one of the arm states to exit the Arm Moving state. • Initialization • Idle • Maintenance • Brake Release • Fault power off • Fault power on Alternatively, the robot must be in the operating mode Monitored Stop.
Trigger on	The arm must be operational and the robot must be in one of the operating modes to enter the Arm Moving state. • Automatic • Hand Guiding • Hold to Run • Manual Jog

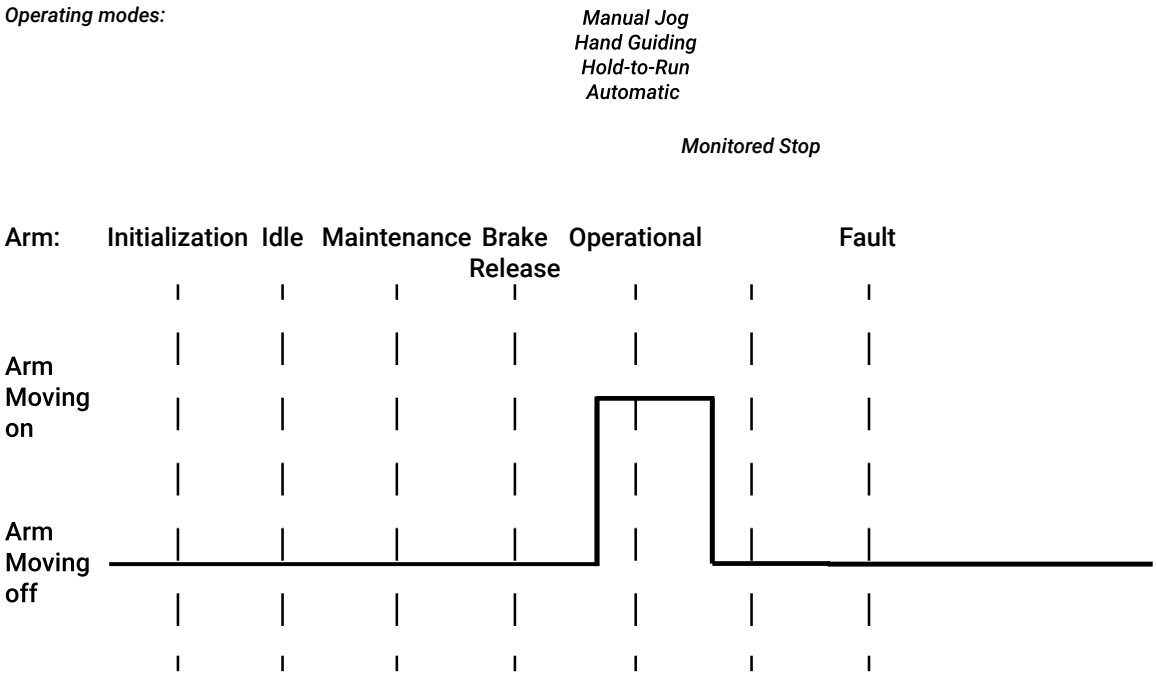


Figure 66: Timeline for the safety output Arm Moving

Installing the drive power indicator

The drive power indicator is a light that indicates that the drive power in the actuator is on.

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About this task

The drive power indicator connects through the Industrial I/O panel on the *controller*. To conform to UL1740 requirements, the indicator must illuminate yellow or amber.

Procedure

1. Choose either a yellow or amber light to conform to UL1740 requirements.
2. Connect the indicator to the controller through the Industrial I/O panel on the *controller*.

   Tip: Pay attention to which green slot is used physically to connect the indicator. You have to use the same numbered channel in Kortex Web App.
3. Tap **Safety**.
4. Tap **Drive Power** from the list of outputs to the channel on which the indicator is physically connected to on the controller.

Results

The indicator illuminates when the drive power is on.

Related topics

Safety outputs on page 99

Safety checksums

The *administrator* needs a quick way to look at the *robot* and walk away with peace of mind knowing the safety configurations he put in place are working as expected.

The safety checksum is a human readable hexadecimal value displayed beside the Notification iconon Kortex Web App. It is the value calculated from the *SCU* and the *MPU*, using *cyclic redundancy check (CRC)*, on all safety parameters.

Whenever the robot is switched on, the *MPU* safety parameter checksum is compared with the *SCU* safety parameter checksum. When a safety parameter is changed, a new checksum is calculated by the *MPU* and compared against the *SCU* checksum.

The operator and administrator must look at the safety checksum and know whether someone has modified any of the safety configurations; it helps to prevent unwanted changes in the safety configuration. They can know from a glance whether any safety configurations are failing. They can write configuration build instructions for their environment and list the checksum for other administrators to know the valid safety checksum.

If the safety parameter checksums do not match, the robot enters a fault state in which the administrator must manually correct all safety parameter values. This task is not time-consuming

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provided there is a configuration build instruction available that includes the valid safety checksum value.

Parameters that are the basis for the safety checksum

The calculation of the safety checksum is based on the configuration of the safety functions, the state of each of the safety functions, and calibration files.

Table 61: Checksum parameters

Safety parameter	Description
Configuration of safety inputs	Binding between safety input channels and the configured function **Example:** Channel 1 is assigned to the function **Enabling device**.
Configuration of safety outputs	Binding between safety output channels and the configured function **Example:** Channel 4 is assigned to the function **Monitored stop**
SF03	Safety joint position limit monitoring for joints 1 to 6
SF04	Safety joint speed monitoring for reduced speed limits for joints 1 to 6 Safety joint speed monitoring for normal speed limits for joints 1 to 6
SF06	Protection zone monitoring • Position of all configured protection zones • Shape type (sphere, cylinder, rectangular prism) • Dimensions of all configured protection zones • Orientation of all cylindrical and prismatic protection zones • Activation status: enabled or disabled Tool Sphere • Position (X,Y,Z) • Dimension

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Safety parameter	Description
SF07	Safety TCP monitoring • Translation speed normal speed mode limit • Orientation speed normal speed mode limit • Translation speed reduced speed mode limit • Orientation speed reduced speed mode limit Safety Elbow monitoring • Translation speed normal speed mode limit • Translation speed reduced speed mode limit

Arm calibration

Microscopic assembly defects are compensated by the firmware of the robot when the arm is calibrated.

The calibration package contains the default calibration file associated with the serial number found on the arm, and its checksum.

The calibration file contains a few vital pieces of information.

- Calibration date
- Serial number of the arm
- Geometric calibration parameters
- Elasto-static calibration parameters

Access the status of the arm at **Systems** > **Robot** > **Arm** > **Calibration**.

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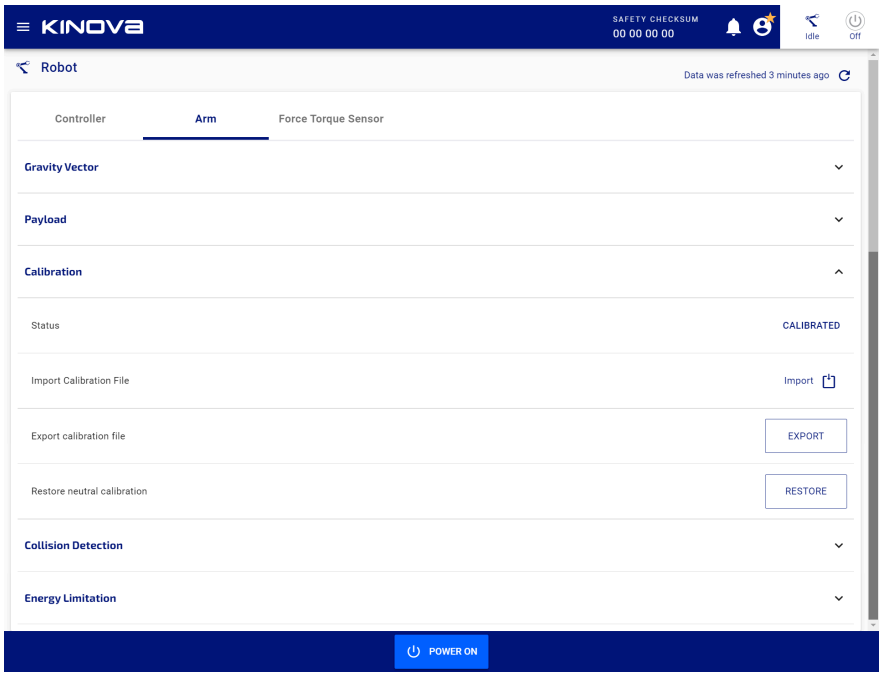


Figure 67: Arm calibration status

The arm calibration can be in one of three states.

Table 62: Arm calibration states

State	Description
Not Calibrated	The controller is switched on and validation of the calibration file is not yet started. The neutral calibration package is used because the validation of the selected calibration package fails.
Waiting Arm Power On	The controller is switched on and validation of the stored calibration file is successful. If the serial number does not match the serial number in the calibration file, the arm cannot power on. **Tip:** To recover from this situation, restore the neutral calibration file and reboot the controller.
Calibrated	The controller and the arm are switched on, the calibration file is valid, and the serial number of the arm matches what is in the calibration file.

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Exporting calibration files

When you first switch on your Link 6, save the default arm calibration package. Use the exported arm calibration package to communicate with Kinova support if anything goes wrong when you first start your robot.

About this task

If you have multiple Link 6 units, you may want tot save a backup calibration package for each unit. Each backup calibration package can be re-uploaded on controllers if you end up inadvertently matching an *arm* with a controller that is not its original *controller*.

The default arm calibration file is also known as the neutral arm calibration file. It can be used to back up the default calibration for a specific arm.

Important: Only an *administrator* can export calibration files.

Procedure

Procedure

1. Insert a *USB storage device* into the controller.
2. Tap **Systems** > **Robot** > **Arm** > **Calibration**.
3. Tap **EXPORT** in the **Export calibration file** pane.
   A **Select mount to export** dialog launches with the name of the USB storage device.
4. Tap **EXPORT**.

Note: Tap **CANCEL** when you do not want to export the current calibration package.

Results

The current arm calibration is saved as a zip file on the USB storage device.

What to do next

Remember to remove the USB storage device from the controller and store the USB storage device in a safe place.

Importing arm calibration files

You may want to calibrate the arm with the default neutral file, the last saved file, or a completely different calibration file.

Before you begin

Kinova keeps archives of the calibration package of each unit. The calibration package contains the data obtained during calibration in our factory. If you misplace the calibration file of your arm,

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contact support@kinova.ca to provide you with the original calibration package that matches your *arm*.

About this task

All imported calibration packages are verified before storing it in the controller.

Important: Calibration packages can be imported only when the controller is idle and the arm is switched off.

Important: Only an *administrator* can import calibration files.

Procedure

Procedure

1. Insert a *USB storage device* into the controller.
2. Tap **Systems** > **Robot** > **Arm** > **Calibration**.
3. Tap **Import** in the **Import calibration file** pane.
   A dialog launches with a list of all arm calibration packages on the USB storage device.
4. Tap the name of the calibration package that you want to import.
5. Tap **PROCEED**.

Note: Tap **CANCEL** when you do not want to export the current calibration package.

Results

The selected arm calibration is saved in the controller.

Note: If, for any reason, the imported calibration file cannot validate, the neutral calibration file is installed and the arm is listed as being Not Calibrated.

What to do next

Verify whether the arm calibration package imported successfully.

- Tap **Systems** > **Robot** > **Arm** > **Calibration**.
  - Success: the arm is listed as **Calibrated**
  - Failure: the arm is listed as **Not Calibrated**
- **Diagnostics** > **Status** > **Controller** and check the status of **Serial number mismatch between arm and calibration file**.
  - Success: the status icon is green with a check mark
  - Failure: the status icon is red

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Note: When the arm is listed as **Not Calibrated** and the status is green, the neutral arm calibration package is running. All movements are less accurate.

Preventing an unrecoverable fault

If you exchange a controller or arm, the robot may enter a fault state.

About this task

The calibration file stored on the *controller* is associated with the serial number of the arm. A change in parts means a change in serial number association. A change in serial number means the calibration file cannot function on the new parts and the system enters a fault state.

Unrecoverable faults due to exchanges of parts are preventable.

Procedure

1. Make sure you have a copy of the current configuration file for the old arm and old controller.

   If you cannot find the calibration file for the robot before exchanging parts, export the calibration file.

   Tip: If you put the old arm back in place, you already have its specific calibration ready to go.
2. Switch off the arm and the controller of Link 6.
3. Exchange the arm or controller.
4. Switch on the controller and keep the arm switched off.
5. Import the correct calibration file by tapping **Systems** > **Robot** > **Controller** > **Import** and selecting the correct file.
6. Switch on the arm.

Results

The robot is operational.

Related topics

Configurations of the arm for robot controls on page 199

Importing arm calibration files on page 108

Exporting calibration files on page 108

Recovering from an unrecoverable fault on page 110

Recovering from an unrecoverable fault

If you exchange a controller or arm, and the calibration file is associated with the old controller or arm, you can still recover from the fault.

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About this task

It is assumed that the steps in preventing the fault from occurring were accidentally omitted when the parts were exchanged.

It is assumed Link 6 is running.

Procedure

1. Switch off the arm.
2. Switch off the controller.
3. Switch on the controller.
4. Import the correct calibration file by tapping **Systems** > **Robot** > **Controller** > **Import** and selecting the correct file.
5. Switch on the arm.

Results

The robot is operational.

Related topics

Configurations of the arm for robot controls on page 199

Exporting calibration files on page 108

Preventing an unrecoverable fault on page 110

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Modes of operation of Link 6

The robot enters different *states* and *modes* during operation. The states often have a visual component for the user to recognize. The modes, which is how the user interacts with the robot, have a visual component for the user to recognize.

The basic modes of operation require user intervention.

- Startup
- Operation
- Recovery

Within each of the basic modes are internal modes and states.

There are three places to look for cues to determine what state the robot is in.

- *Controller*
- *Wrist*
- *Kortex Web App*

Location of lights to watch on the controller and the wrist

Communication between the robot and the user is achieved by lights found on the controller and around the *wrist ring*.

Table 63: Controller and arm when Link 6 is off



1	Power knob	3	*Wrist ring*
2	ACK button		

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Convention for the representation of the states

In an attempt to help visualize what is happening, the graphics follow a convention for flashing lights. In every case, the number of lines represent the number of flashes of light for each second.

- A single line coming out the sides of what is supposed to be the lit portion of equipment indicates one flash for each second. The color of the lines represents the color of the lights.

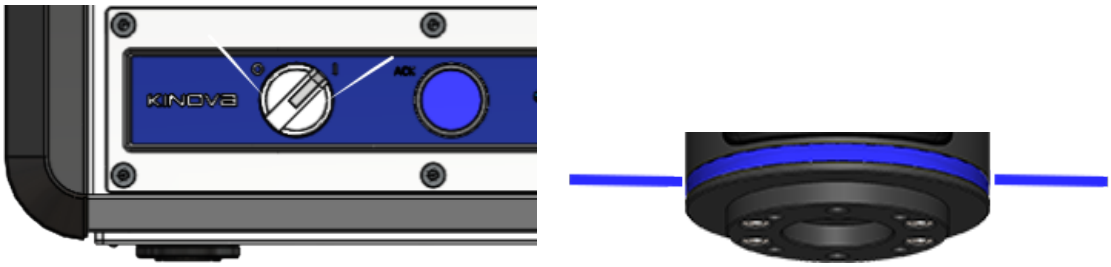


Figure 68: Example of equipment flashing once per second

- Two lines coming out the sides of what is supposed to be the lit portion of equipment indicates two flashes for each second. The color of the lines represents the color of the lights.

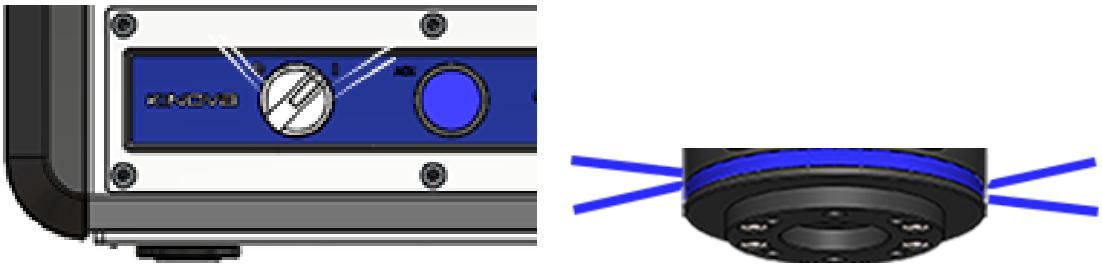


Figure 69: Example of equipment flashing twice per second

There also is a table that explains what each portion of a graphic is attempting to represent.

Complete start-up sequence

It is a two-part process to start up Link 6: first turn on the *controller* and then the *arm*. This two-part process means the robot goes through six different *states*.

Off — Controller initialization — Controller idle — Arm initialization — Arm maintenance — *Monitored stop*

State: Off

Link 6 is not energized when the power button on the *controller* is switched off.

When Link 6 is off, all lights are extinguished.

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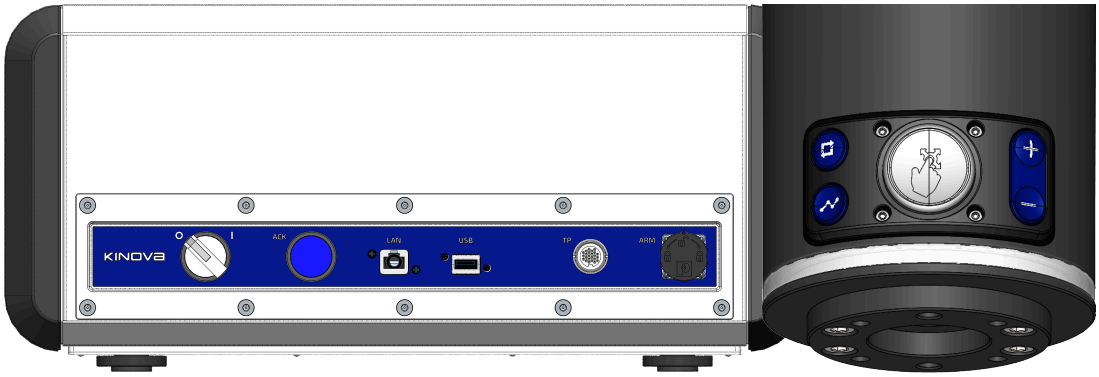


Figure 70: Controller when it is off

Figure 71: Wrist ring when it is off

Important: If there is a light on the controller power knob, turn off Link 6 by turning the power knob to the off position.

Controller lights	Wrist ring	Description
Power knob points to the O, or off, position.	No light illuminates from the wrist.	Arm does not receive power.
No light illuminates on the controller power knob.		
ACK button on the controller does not illuminate.		

The startup workflow begins with switching on the controller and switching on the arm.

State: Controller initialization

When the knob on the *controller* is turned to the I, or on, position the controller is in its initialization state.

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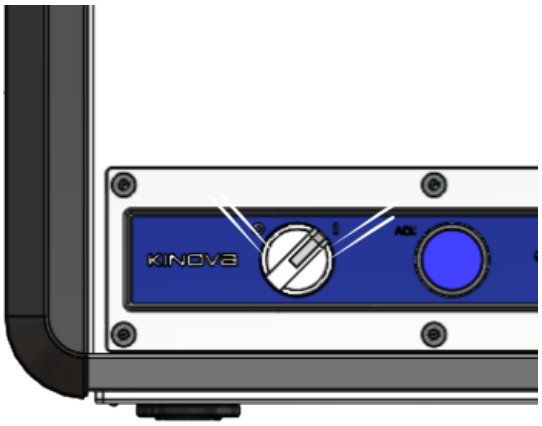


Figure 72: Visual cues for controller initialization

Controller lights	Wrist ring	Description
Power knob points to the I, or on, position.	No light illuminates from the wrist.	Controller receives power.
Power knob on the controller flashes white twice (2) each second.		Processors in controller *boot*.
ACK button on the controller does not illuminate.		Application software for the *I/O* boards and teach pendant, if installed, start.
		Calibration, configuration, and safety checks are validated.

When the light behind the power button is a steady white, the initialization of the controller is complete. The controller enters a new state: Idle.

State: Controller idle

When Link 6 is idle, there is power in the *controller*, but not in the *arm*.

You can recognize the Idle state by looking at the power button on the controller; its light is a steady white.

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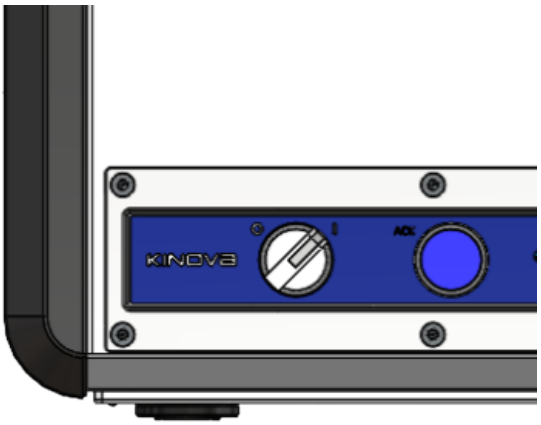


Figure 73: Controller when it is idle

Controller lights	Wrist ring	Description
Power knob on controller illuminates white steadily.	No light illuminates from the wrist.	Controller is fully operational and idle.
ACK button on the controller does not illuminate.		Arm is not on.

State: Arm initialization

After switching on the *arm* from *Kortex Web App*, the arm enters an initialization process, much like the *controller*.

Arm initialization is recognized by looking at the white light of the power knob on the controller and at the light around the wrist.

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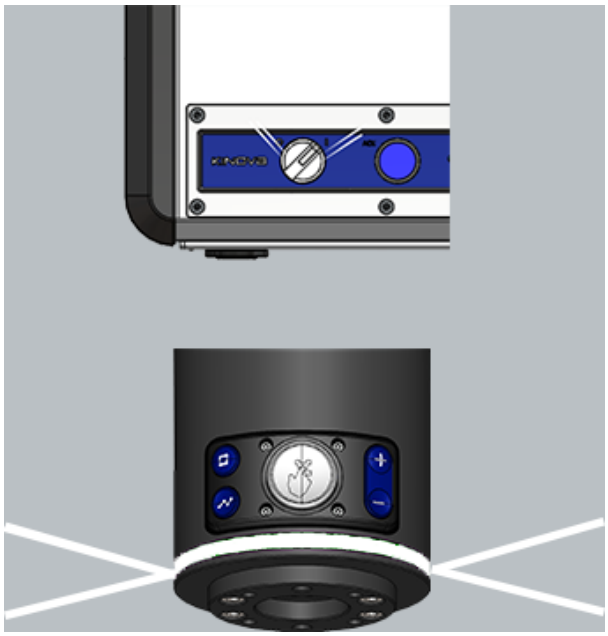


Figure 74: Visual cues of arm initialization

Controller lights	Wrist ring	Description
Power knob on the controller flashes white twice (2) each second.	Wrist ring flashes white once (1) each second.	Arm is receiving power.
		Arm is *booting* up the *actuators* and is checking the *firmware* and software are compatible with the arm.
Power knob on the controller flashes white twice (2) each second.		Kortex Web App displays the state as **Initialized**.

Important: The wrist ring flashes white when the arm is switched on to ensure the functionality of all components of the wrist ring light. White uses all components of the wrist ring lights; it can be used to validate the functionality of the hardware, in accordance with IEC60204. If the wrist ring is not white, report the situation immediately to support@kinova.ca.

If the hardware needs a firmware update, the arm enters the Arm maintenance state and returns to the Arm initialization state after maintenance is complete. Firmware updates take approximately 5 minutes.

After the arm is initialized and the firmware is up-to-date, the brakes in the actuators release.

The brakes in each actuator for each joint are released one at a time in a specific sequence. The sequential release keeps the robot steady when it is powering up.

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State: Arm maintenance

Maintenance only happens when the *firmware* must be updated.

After the firmware is updated, the robot restarts the Arm initialization process to make sure there are no other issues.

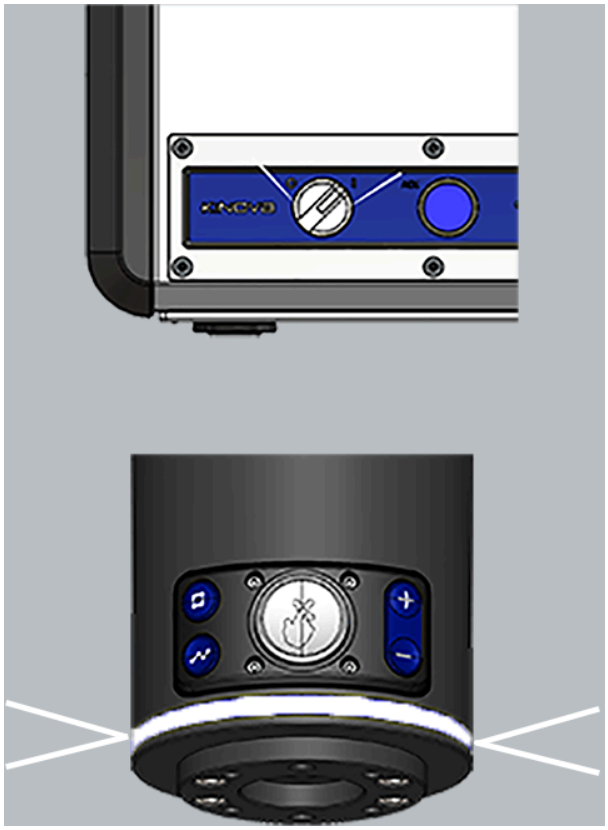


Figure 75: Visual cues of arm maintenance in progress

Controller lights	Wrist ring	Description
Power knob on the controller flashes white once (1) each second.	Wrist ring flashes white twice (2) each second.	*Microcontrollers* on the *actuators* receive firmware updates.
ACK button on the controller does not illuminate.		*Kortex Web App* displays the state as **Initialized**.

After firmware is updated, the Arm initialization state restarts.

State: Monitored stop

Link 6 is ready to be used and is in a standstill position; it is waiting for user input.

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Figure 76: Visual cues of robot in *Monitored stop*

Controller lights	Wrist ring	Description
Power knob on controller illuminates white steadily.	Wrist ring illuminates blue steadily.	Mechanical brakes in the *arm* are released.
ACK button on the controller does not illuminate.		The arm is fully operational and is waiting for commands.

Related topics

Stop categories on page 59

State: Fault

Link 6 can stop unexpectedly or may need to stop suddenly.

There are a few main ways the robot can stop suddenly.

- The *arm* exceeds the configured safety limits for position; a *protective stop* has been issued to the arm.
- Someone presses the *emergency stop* button.
- A fault is detected. Faults are failures in internal, built-in tests and safety functions.

The *SCU* is responsible for triggering a *stop category* 0 fault; no power is in the arm.

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The *Microcontroller Unit (MCU)* is responsible for triggering the fault; the *wrist ring* illuminates red.



Figure 77: Visual cue of fault without power



Figure 78: Visual cue of fault with power

Controller lights	Wrist ring	Description
Power knob on the controller flashes white four (4) times each second.	No light illuminates from the wrist.	An internal fault occurred.
ACK button on the controller does not illuminate.		There is no power in the arm.
Power knob on the controller flashes white four (4) times each second.	Wrist ring flashes red twice (2) each second.	An internal fault occurred.
ACK button on the controller does not illuminate.		There is power in the arm.

Related topics

Recovery mode on page 128

Why can the robot not exit Recovery mode? on page 408

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Operating modes

When the *controller* and *arm* are on, Link 6 is in the Monitored Stop state and can be used in any of the modes of operation available to it.

Each mode of operation is a way in interacting with the robot to make it move.

- Manual Jog
- Hand Guiding
- Hold to Run
- Automatic

Related topics
Stop categories on page 59

Mode: Manual Jog

Use the mode Manual Jog to move the *arm* with *Kortex Web App*. There are two jog interfaces: *Cartesian* control and joint, or *angular*, control.

There are a few requirements before you start moving the arm.

- Make sure no one is inside the safeguarded space.
- Use the *teach pendant enabling device*. If the *pendant* is not available, use an external *enabling device* connected to the *controller*. The enabling device must be pressed down and held in its center position.
- There must be a request for movement coming from Kortex Web App.

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Figure 79: Jog Cartesian icon and control panel

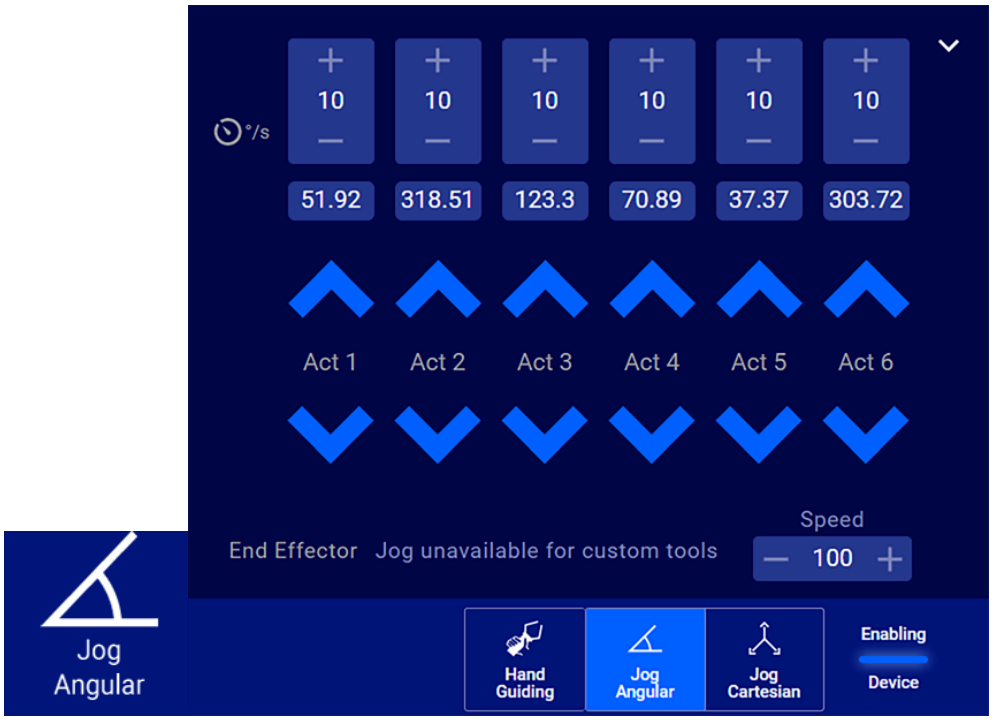


Figure 80: Jog angular icon and control panel

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1 Enabling device



2

Figure 81: Location of enabling device on the teach pendant

When the robot is in the mode Manual Jog, there is a steady, white light behind the power knob on the controller and a steady, blue light on the wrist.



Figure 82: Visual cues of Manual mode

Controller lights	Wrist ring	Description
Power knob on controller illuminates white steadily.	Wrist ring illuminates white steadily.	Move the arm in any direction with Kortex Web App while holding the pendant enabling device in the pressed position.
ACK button on the controller does not illuminate.		

When the robot is in Manual mode, Link 6 operates strictly in Reduced safety speeds to reduce the possibility of injury.

Exit Manual jog mode by releasing the enabling device. Link 6 returns to the *Monitored stop* state.

DANGER: Do not attempt to stop or prevent the robot from moving by holding the robot; it can result in serious injury.

2 Disclaimer: the color of the hardware in the image may differ from your installation

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Related topics

Safety modes on page 69

Jog Angular panel on page 340

Jog Cartesian panel on page 337

Mode: Hand Guiding

Use Hand Guiding mode to move the arm to a specific location manually.

While keeping the *wrist enabling device* pressed in the middle position, move the *arm* up or down, left or right, forward or backwards, as well as rotate the arm or the wrist around any of the joints.

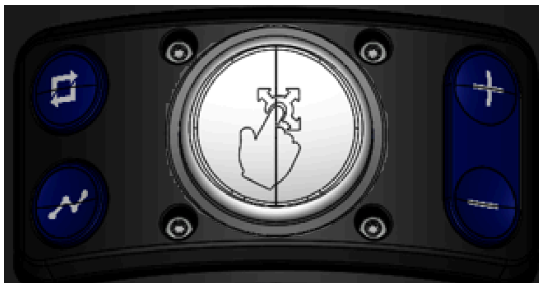


Figure 83: Center button on the wrist is the wrist enabling device button

The arm stops moving when the wrist enabling device is not pressed or when it is pressed completely.

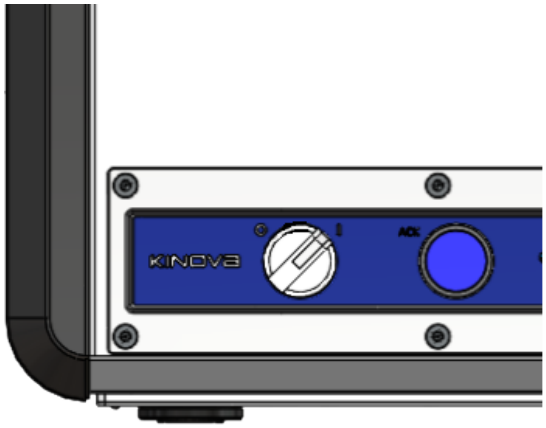




Figure 84: Visual cues of the Hand Guiding mode

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Controller lights	Wrist ring	Description
Power knob on controller illuminates white steadily.	Wrist ring illuminates white steadily.	Move the arm in any direction while holding the wrist enabling device button in the pressed position.
ACK button on the controller does not illuminate.		

Within the Hand Guiding mode are two different Guidance modes.

- *Cartesian*

  Warning: Cartesian Hand Guiding uses sensors situated internally to the wrist. To avoid unintentional movement, it is recommended to manipulate the arm from the wrist only during Cartesian Hand Guiding.

- *Angular*

Enable Hand Guiding mode by pressing the *wrist enabling device*. Press the Hand Guiding mode Toggle button to enable one of the two Hand Guiding modes.



Figure 85: Location of Hand Guiding mode Toggle on the wrist

When the arm is in Hand Guiding mode, Link 6 operates strictly in Reduced safety speeds to reduce the possibility of injury.

DANGER: The only time you can stop or prevent a arm from moving is when you are operating in Hand Guiding mode.

DANGER: The only time you can stop or prevent a arm from moving is when you are operating in Hand Guiding mode.

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DANGER: Make sure no one is inside the safeguarded zone.

Related topics

Safety modes on page 69

Hand Guiding panel on page 336

Mode: Hold-to-Run

Hold-to-Run is a special mode available only to users with *admin* privileges.

The Hold to Run mode is used to develop and verify a programmed sequence works as expected before the program is release to other users.

Hold to Run is also used for troubleshooting a situation with the robot. Slow down arm movement during this mode to ease observing the actual actions in the programmed sequence.

To be able to move the *arm*, an *enabling device* must be pressed.

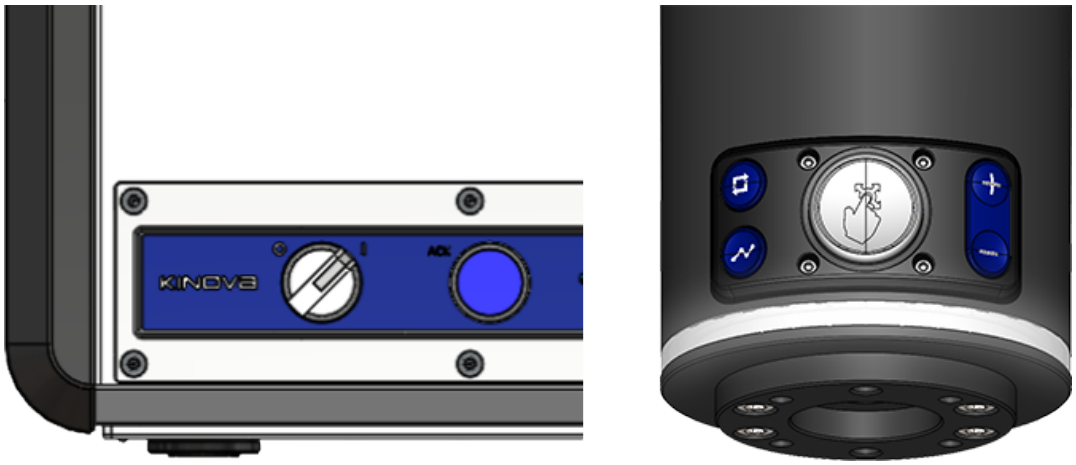


Figure 86: Visual cues of the mode Hold to Run when there is no issue

Controller lights	Wrist ring	Description
Power knob on controller illuminates white steadily.	Wrist ring illuminates white steadily.	The selected program is ready to be verified.
ACK button on the controller does not illuminate.		

When the robot is in Hold to Run mode, Link 6 can operate in either Reduced or Normal safety speeds. By default, the robot operates in Reduced safety speeds to reduce the possibility of injury.

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DANGER: Do not attempt to use the wrist buttons when a program is running and the robot is in Hold to Run mode; it can result in serious injury.

DANGER: Do not attempt to stop or prevent the robot from moving by holding the robot; it can result in serious injury.

Related topics

User management on page 167

Running a program in Automatic mode on page 344

Safety modes on page 69

Running a program in Hold-to-Run mode on page 345

Mode: Automatic

Known as the normal mode of operation, it is used to play a *program sequence* that has been validated.

When the arm is in Automatic mode, Link 6 can operate at either **Reduced** or **Normal** safety speed. By default, the arm operates at Normal safety speeds.

One of the first things the arm does when Automatic mode is selected is to activate all safeties, even those that are suspended due to an event or user interaction.

Note: Automatic mode is intended for the *operator*.

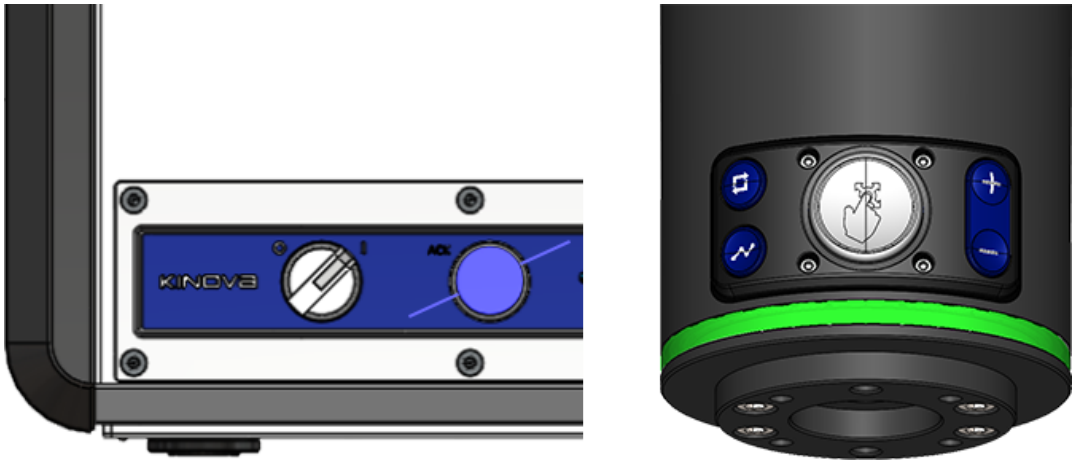


Figure 87: Visual cues for the Automatic mode

Controller lights	Wrist ring	Description
Power knob on controller illuminates white steadily.	Wrist ring illuminates green steadily.	The selected program is ready to be run.

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Controller lights	Wrist ring	Description
ACK button on the controller flashes blue once (1) each second.		

When the arm is in Automatic mode and the *E-stop* is pressed, the arm stops automatically and no power feeds the arm.

When the arm is in Automatic mode and the arm enters a protective stop, the arm stops. However, once the issue is corrected and the ACK button is pressed, the arm can resume the program.

DANGER: When the arm is operating in Automatic mode, never attempt to control the arm by grabbing the arm or touching the controls on the wrist. Attempting to control the arm when it is moving in Automatic mode can result in injury.

Tip: Control the arm safely when it is not moving.

DANGER: Do not attempt to stop or prevent the arm from moving by holding the arm; it can result in serious injury.

Related topics

Safety modes on page 69

Running a program in Automatic mode on page 344

Recovery mode

Some faults stop the arm and leave it in a state that triggers the same fault after the fault has been cleared. These are the faults that require a recovery strategy for the arm.

There are several ways a fault can be cleared and leave the arm in a fault state. One example is a arm enters a *protection zone* and stops. The fault is cleared using *Kortex Web App*, but the *arm* is still within the protection zone.

There is only one way to get out of recovery mode. Move the arm to a safe position using either Hand Guiding or Manual Jog. All position-related safeties are ignored during recovery. All joint speed safety limits are limited to a maximum speed of 30 °/s.

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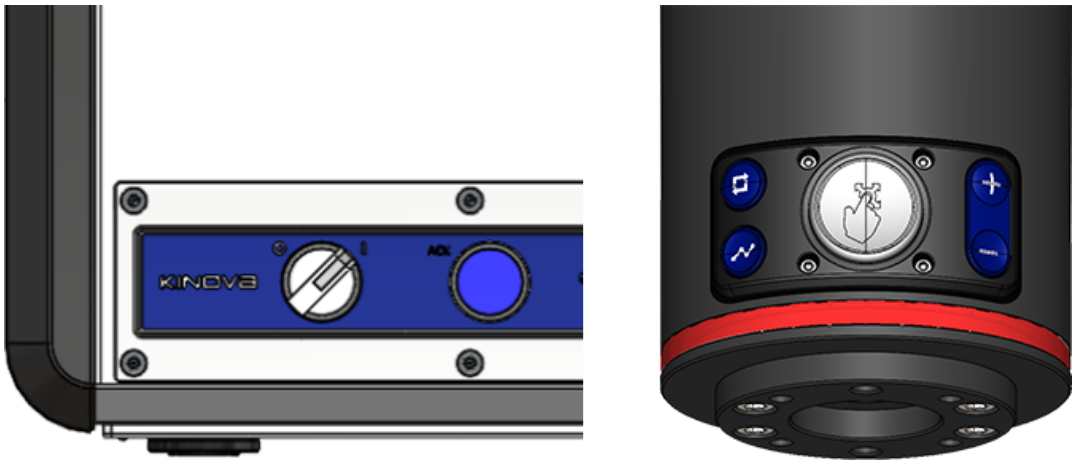


Figure 88: Visual cues of arm in Recovery

Controller lights	Wrist ring	Description
Power knob on controller illuminates white steadily.	Wrist ring illuminates yellow steadily.	The arm requires user intervention that involves using *Kortex Web App* and the *wrist enabling device*.
ACK button on the controller does not illuminate.		

Related topics

State: Fault on page 119

Why can the robot not exit Recovery mode? on page 408

Robot lights and what they mean: a reference

You can tell which mode or state the robot is currently in by looking at the lights on the *controller* and on the *wrist ring* on the *arm*.

Table 64: What the lights on the controller and the wrist ring on the arm mean

Description	Meaning
Power knob points to the O, or off, position.	Controller is off.
ACK button on the controller does not illuminate.	
Power knob on the controller flashes white twice (2) each second.	Arm is powering on.
	Processors in controller *boot*.

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Description	Meaning
ACK button on the controller does not illuminate.	Application software for the I/O boards and *teach pendant*, if installed, start.
	Calibration, configuration, and safety checks are validated.
Power knob on controller illuminates white steadily.	Controller is fully operational and idle.
ACK button on the controller does not illuminate.	Arm is not on.
Power knob on the controller flashes white twice (2) each second.	Arm is powering on.
Power knob on the controller flashes white twice (2) each second.	
ACK button on the controller does not illuminate.	Controller checks whether the *firmware* in the arm matches the firmware in the software unit in the controller.
Wrist ring illuminates white steadily.	*Kortex Web App* displays the state first as **Initialized** and then as **Brakes Released** during this stage unless a firmware updates is required. If firmware updates are required, Kortex Web App displays first **Initialized**, then **Maintenance**, and then **Brakes Released**.
Power knob on the controller flashes white once (1) each second.	Firmware updates. **Important:** Firmware in the arm updates right after powering on the arm only when an update occurs in the software unit in the controller.
ACK button on the controller does not illuminate.	
Power knob on the controller flashes white twice (2) each second.	Kortex Web App displays the state as **MAINTENANCE MODE**.
Power knob on controller illuminates white steadily.	The arm is fully operational and is in *Monitored stop*.
ACK button on the controller does not illuminate.	Kortex Web App displays the state first as **Brakes Released** and then as **Operational**.
Wrist ring illuminates blue steadily.	
Power knob on controller illuminates white steadily.	Link 6 is operating in Hold to Run mode or is waiting for confirmation to operate in Automatic mode.
ACK button on the controller flashes blue once (1) each second.	

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Description	Meaning
Wrist ring illuminates white steadily.	
Power knob on controller illuminates white steadily.	The robot is operating either in Hold to Run mode or in Automatic mode.
ACK button on the controller flashes blue once (1) each second.	The program is running and the *enabling device* has not been pressed for over five (5) minutes.
Wrist ring illuminates green steadily.	It is also possible that the configured speed is greater than the reduced mode speed.
Power knob on controller illuminates white steadily.	The robot is operating in Manual Jog mode.
ACK button on the controller does not illuminate.	Move the arm in any direction with Kortex Web App and with the enabling device pressed in the middle position.
Wrist ring illuminates white steadily.	
Power knob on controller illuminates white steadily.	The robot is operating in Hand Guiding mode.
ACK button on the controller does not illuminate.	Move the arm in any direction while holding the wrist enabling device button in the middle position.
Wrist ring illuminates white steadily.	
Power knob on controller illuminates white steadily.	The robot is waiting for confirmation to proceed operations in Automatic mode.
ACK button on the controller flashes blue once (1) each second.	
Power knob on controller illuminates white steadily.	The robot is in Recovery mode.
Wrist ring illuminates red steadily.	The arm of the Link 6 is outside the area in which it is allowed to be in, such as within a *protection zone*, or one or more of the joints is outside its safety limits.
Wrist ring illuminates red steadily.	
Power knob on controller illuminates white steadily.	The robot is recovering from an emergency stop caused by pressing the *E-stop* button.
ACK button on the controller illuminates blue steadily.	
No light illuminates from the wrist.	

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Description	Meaning
Power knob on the controller flashes white four (4) times each second.	An internal fault occurred.
ACK button on the controller does not illuminate.	There is no power in the arm.
No light illuminates from the wrist.	
Wrist ring flashes white four (4) times each second.	An internal fault occurred.
ACK button on the controller does not illuminate.	There is power in the arm.
Wrist ring illuminates red steadily.	The joint or zone limit is reached.

Related topics

Indicators, user profile, and power on page 159

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Hardware installation

Link 6 requires installation in the working environment.

Installation involves placing the *arm* where it is going to be performing tasks, placing the *controller* within the constraints of the length of the cable to the arm in an accessible location, and making sure the robot is installed according to safety guidelines.

Before unpacking, the *integrator* should already know the size of the robot from the technical specifications, have performed a risk assessment, and be familiar with the safety considerations.

Important: Always place the boxes so that the arrows on the boxes point up to avoid possible damage to the equipment.

Related topics

Safety directives and warnings on page 54

Inside the Link 6 boxes

Link 6 comes in two cardboard boxes. Both boxes are heavy. It is advisable to have two people carry each box.

The smaller box contains the *controller*, a box with the accessories, and a box with the *teach pendant*. The box with accessories contains the power cord for the controller, as well as all optional accessories bought with Link 6.

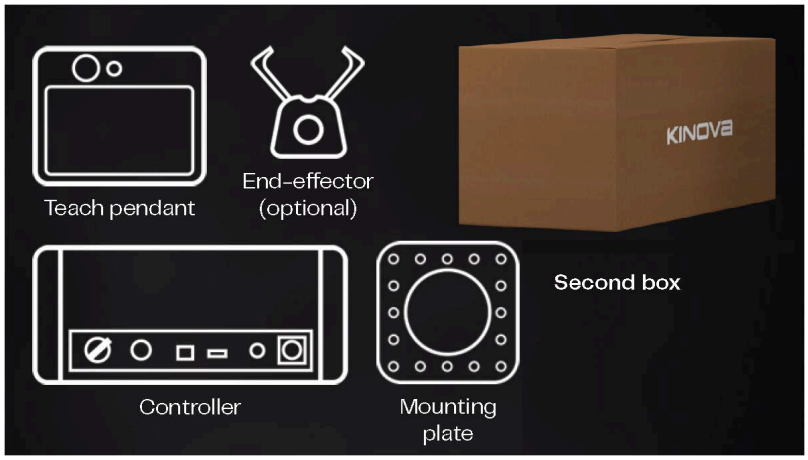


Figure 89: Box with controller, mounting plate, accessories box, and *teach pendant* box

The larger box contains the *arm*, along with its cable attached to the *base* of the arm.

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Figure 90: Box with arm and attached cable

Related topics

Accessories on page 388

Components on page 19

Unpacking the arm

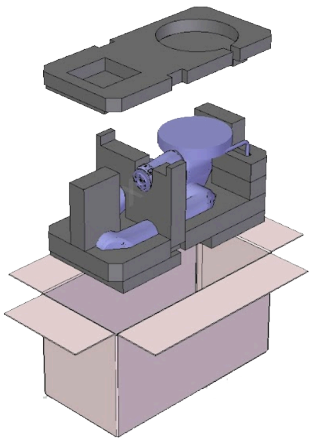
The box containing the *arm* is the larger of the two Link 6 boxes.

About this task

It is recommended to unpack the contents of the arm box at the installation site for the arm.

Procedure

1. Make sure the arrows on the box are pointing upward.
2. Open the larger box.
3. Lift the layer of foam off and set it aside.



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4. Remove the arm from the box.

Considerations before installing the arm

The *arm* is heavy and large. It is advisable for two people to be involved in unpacking and installing the arm.

Make sure the box that contains the arm is near the area where the arm is to be installed. Have all the tools and screws necessary for installing the arm easily accessible at the mounting location.

Wherever the arm is installed, there is a set of guidelines that should be followed.

- **DANGER:** Do not switch on the robot before the base is fixed sturdily.
- Make sure all the tools and screws necessary to install the arm are easily accessible at the mounting location.
- Make sure the surface on which the arm is to be mounted is flat within 0.1 mm.
- Make sure the surface on which the arm is to be mounted is stiff enough so that it does not degrade the task to be performed by the robot.

  DANGER: When the mounting surface where the arm is not sufficiently sturdy, the arm could become a hazard to people and equipment around it.
- Make sure you know which installation approach is required: directly on a surface or on a mounting plate.
- Have a minimum of two (2) people for safe installation for any orientation installation that is not on a flat, horizontal surface.
- Make sure to adjust the gravity vector for any orientation installation that is not on a flat, horizontal surface.
- Use the mounting dowel holes when your installation requires the robot to be repositioned accurately at the same place.

  DANGER: The arm could be unstable until is fixed securely.

The arm must be kept within specific temperatures ranges during storage and use.

Table 65: Safe temperatures for the arm

Action	Minimum temperature	Maximum temperature
Storage	-40 °C	65 °C
Powering up	0 °C	40 °C
Operating	-20 °C	40 °C

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Related topics

Safety directives and warnings on page 54

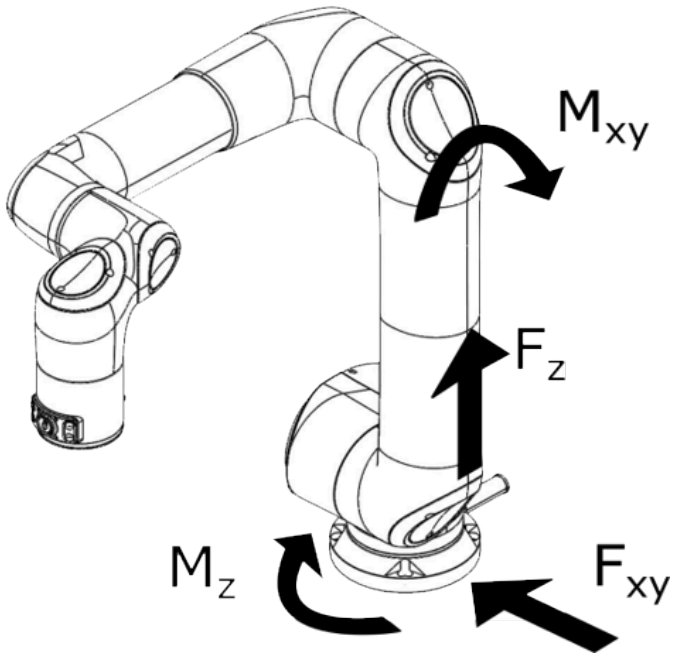
Configurations for the robot settings on page 197

Base force reactions on page 136

Base force reactions

The *base* feels the forces whenever any part of the *arm* moves.

The calculation includes the forces and moments created from the weight of the robot and its dynamic properties. The calculation does not include any of the equipment fitted on the robot.



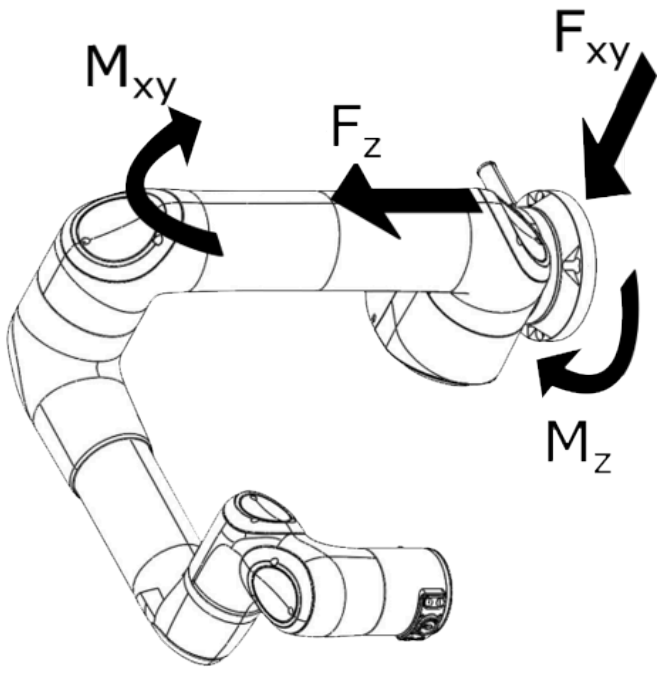
F_{xy}	Force in any direction along the XY plane
F_z	Force along the Z plane
M_{xy}	Moment that acts on the robot base along the XY plane
M_z	Moment that acts on the robot base along the Z plane

Figure 91: Floor-mounted safety forces

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Table 66: Safety factor applied on load cases when the base is mounted on the floor

Load case details	Vertical Moment Mx N·m Max	Min	Vertical Force Fz N Max	Min	Horizontal Moment Mz N·m Max	Min	Horizontal Force Fxy Max	Min
At rest	352	-352	-602	-602	0	0	0	0
At maximum speed No acceleration	210	210	57	-1262	0	0	899	-899
At maximum servoing acceleration Maximum speed	529	-529	188	-1003	500	-500	773	-773
At maximum braking torque Emergency stop maximum speed	634	-634	334	-1421	600	-600	896	-896



F_{xy}	Force in any direction along the XY plane
F_z	Force along the Z plane
M_{xy}	Moment that acts on the robot base along the XY plane

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M_z	Moment that acts on the robot base along the Z plane

Figure 92: Wall-mounted safety forces

Table 67: Safety factor applied on load cases when the base is mounted on the wall

Load case details	Vertical Moment Mx N·m Max	Min	Vertical Force Fz N Max	Min	Horizontal Moment Mz N·m Max	Min	Horizontal Force Fxy Max	Min
At rest	352	-352	0	0	0	0	-602	-602
At maximum speed No acceleration	210	210	659	-659	0	0	297	-1502
At maximum servoing acceleration Maximum speed	529	-529	802	-802	500	-500	80	-1285
At maximum braking torque Emergency stop maximum speed	634	-634	937	-937	600	-600	-105	-1421

Related topics

Considerations before installing the arm on page 135

Installing the arm directly to a surface

One way to install the *arm* is directly to a surface, without a mounting plate.

Before you begin

Personnel

- **Number of Workers:** 2 when the orientation installation is not on a flat, horizontal surface

Supplies

- 4 x M8 socket head cap screws, grade 12.9 steel

Note: Torque: 20 N·m

Note: An equivalent imperial 5/16 in screw with equal or better mechanical properties and underhead contact patch can be used.

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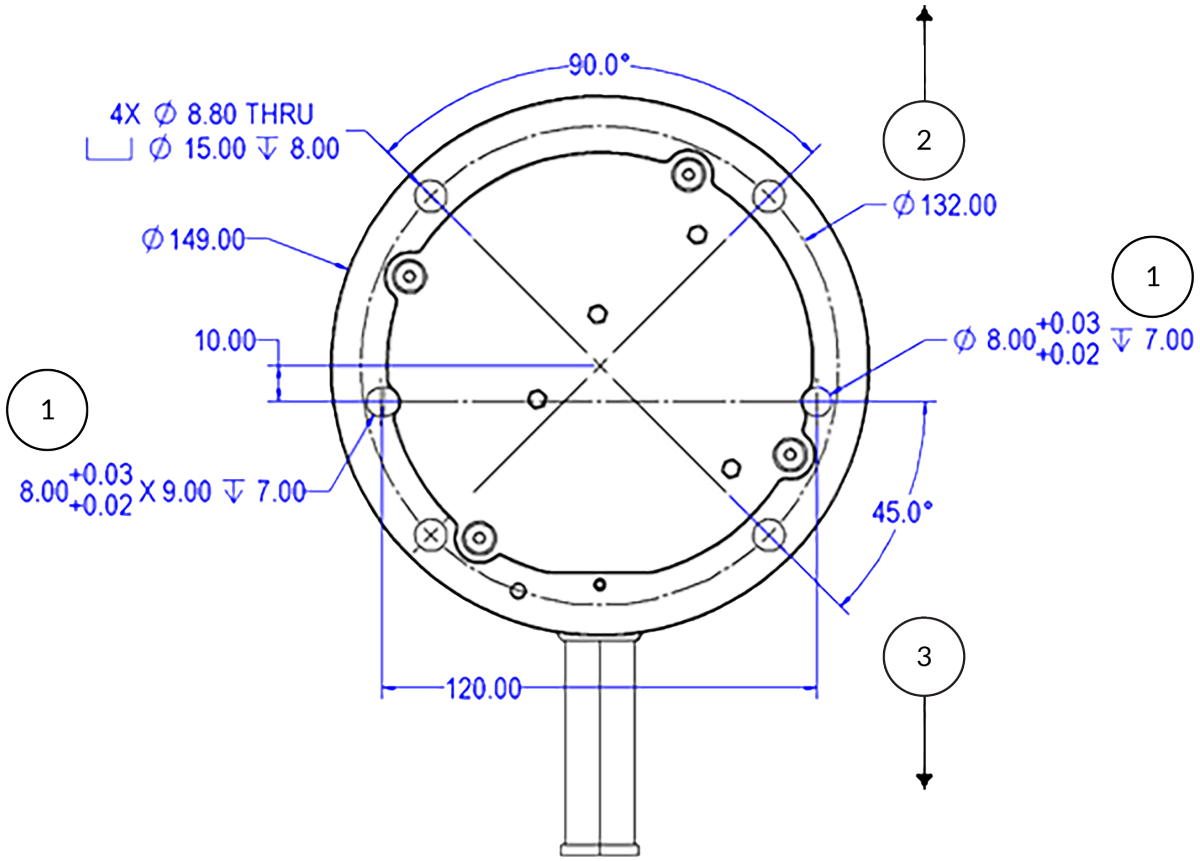
- 2 x 8 mm dowels

About this task

The arm is in a flat packaging pose to minimize the amount of space it takes in its packaging. This packaging pose also eases installation.

Procedure

1. Define the location and prepare the surface according to the mounting pattern drawing.

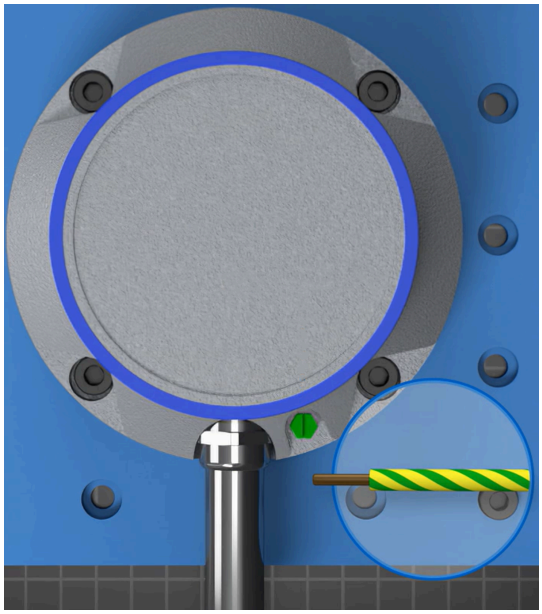


1 - Dowel hole feature for optional dowel pins; 2 - Front; 3 - Back

2. Place the arm on the surface with the holes of the *base* lining up with the holes of the surface.
3. Secure the base with 5 mm hex key according to the hardware requirement.

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4. Secure the green ground cable to the *protective earth* at the back of the base using the green screw.



5. Remove the protective covering from the arm.

Related topics

Base force reactions on page 136

Considerations before installing the arm on page 135

Specifications and dimensions of the base of the arm on page 20

Safety on page 53

Safety directives and warnings on page 54

Installing the arm on a third-party adapter plate

One way to install the *arm* is to install it on a mounting plate.

About this task

Follow the installation procedure outlined in the third-party documentation.

Related topics

Specifications and dimensions of the base of the arm on page 20

Safety on page 53

Safety directives and warnings on page 54

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Unpacking the controller

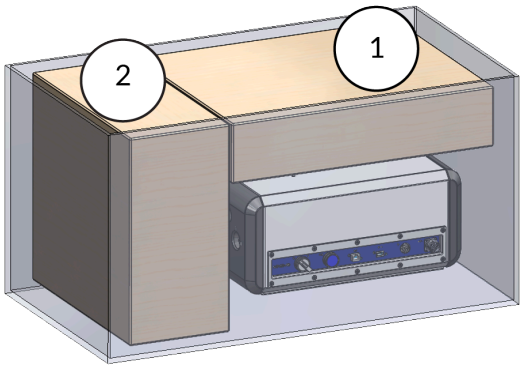
The box containing the *controller* is the smaller box, but it contains all the accessories bought with Link 6, as well as the power cord for the controller.

About this task

Unpack on a stable surface clear of other objects to make unpacking easier. It is recommended to unpack the contents of the controller box near the installation site for the controller.

Procedure

1. Make sure the arrows on the box are pointing upward.
2. Open the smaller box.
   Two cardboard boxes become accessible.



1 Accessories box

2 *Teach pendant* box

3. Remove the accessories and teach pendant boxes and place them on a stable surface.
4. Open the boxes and make sure everything you bought is there.
5. Remove the items from their foam wrapping one at a time and set them aside in a safe place.
6. Take out the Quick start guide and place it in an accessible location.
7. Remove the controller from the box and place it on a table.

Considerations before installing the controller

The controller must be installed on a stable surface. The surface must be able to support the weight of the controller without becoming deformed or unstable.

There are several ways in which the *controller* can be installed.

- Placed on a stable surface, such as a table.
- Secured to a stable surface, such as a table.
- Secured to a wall.
- Secured it in a stable, well-ventilated cabinet, either on a shelf or on the wall of the cabinet.

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Note: When the controller must be secured to a wall or to the inside wall of a cabinet, it is recommended to use the optional Kinova Wall mount kit.

Restriction: Place the IO access panel facing down when installing the controller on a vertical surface, whether with or without the Kinova Wall mount kit.

Wherever the controller is installed, there is a set of guidelines that must be obeyed.

- Do not put anything on top of the controller.
- Make sure the controller is at least 60 cm from the ground to ensure proper operation and user safety.
- Make sure the controller has ample space around it.
- Make sure the controller is not in a position where it can be bumped.
- Make sure the controller is installed less than the attaching cable length away from the arm; the cable that connects the arm to the controller has a finite length and the route the cable must take must be taken into account.
- Make sure there is at least a 50 cm gap in the back where the fans are installed when installing horizontally.
- Make sure there is at least a 50 cm gap on the side where the fans are installed when installing vertically.
- Make sure 10 cm on the side from a wall to maintain proper air flow around the controller.
- Make sure the I/O panel and the controls on the front of the controller are easy to access.
- Make sure the LED on the power knob and on the ACK button are visible.



Figure 93: Linear perspective of the controller and its airflow requirements

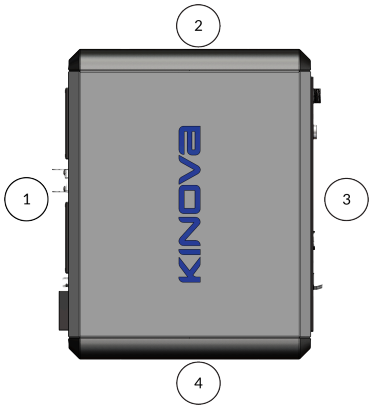


Figure 94: Top view of the controller and its airflow requirements

1	Minimum 50 cm from the wall for fan airflow
2	Minimum 10 cm from the wall

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3	Easy access to connectors, switches, and LED status
4	Easy access to I/O panel

If there is no access to the underside of the installation surface and there is no need to fix it, leave the controller on its four rubber feet. However, if there is a need to fix it and it cannot be fixed to the installation surface, use the optional Kinova Wall mount kit.

The controller must be kept within specific temperatures ranges during storage and use.

Table 68: Safe temperatures for the controller

Action	Minimum temperature	Maximum temperature
Storage	-40 °C	65 °C
Powering up	0 °C	40 °C
Operating	-20 °C	40 °C

Related topics

Controller mounting interface on page 33
Installing the controller on a flat surface on page 143
Installing the controller vertically on page 144
Maximum ambient temperature reached on page 353
Maximum core temperature reached on page 353

Installing the controller on a flat surface

The *controller* must never be in a position where it can slip or fall.

Before you begin

Personnel

- **Number of Workers:** 1

Supplies

- 4 x M6-1.0-6h screws, closed end nut inserts

Note: Maximum thread engagement depth: 6 mm

Note: Torque: 7-9 N·m

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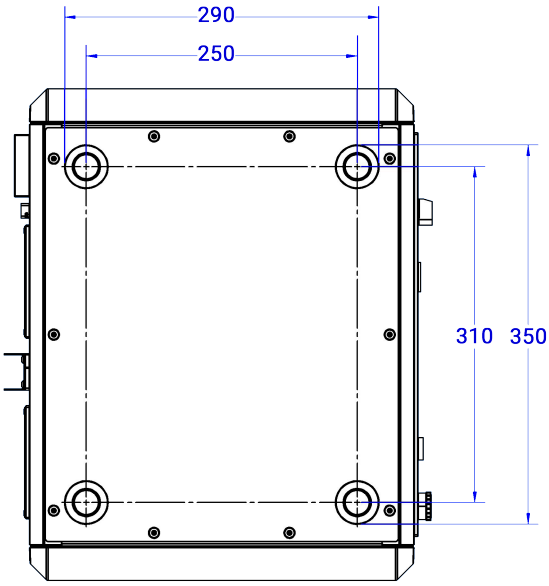


Figure 95: Mounting points of the controller, measured in millimeters

About this task

Verify the technical specifications of the controller to ensure there is maximum airflow around the controller, as well as enough space to hold the controller without putting it in a position in which it can be bumped.

The controller does come with anti-slip feet. Therefore, it is possible that placing it on a suitable flat surface suffices.

Alternatively, the controller can be secured to a flat surface.

Procedure

1. Align the foot mounts on the controller with the holes in the stable surface.
2. Place each of the M6 screws from under the surface into the foot mount location on the controller.
3. Tighten each screw until the controller cannot move.

Related topics

Considerations before installing the controller on page 141

Controller mounting interface on page 33

Surface mount of controller on page 34

Installing the controller vertically

The Kinova Wall mount kit is designed to fit perfectly with the Link 6 *controller*.

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Before you begin

Personnel:

- **Number of Workers:** 1

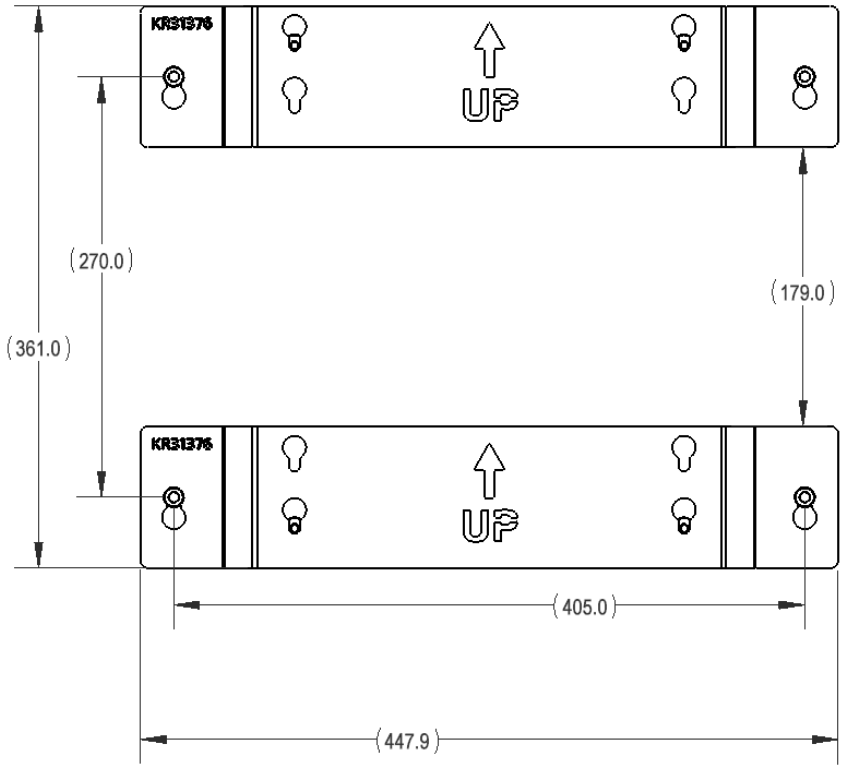
Supplies

- 1 x Kinova Wall mount kit, which contains 2 brackets
- 4 x Socket head: M8 x 1.25 mm thread, 14 mm long zinc-plated screw
- 4 x Flanged hex head: M6 x 1.00 mm thread, 10 mm long black phosphate screw

About this task

A minimum flat area required to install the Wall mount is 361x448 mm.

The position of the Wall mount kit screws are at 270x405 mm.



Fix the controller to the Wall mount kit. Fix the controller with Wall mount kit assembly to the vertical surface.

Warning: The controller must have the IO access panel facing down.

Procedure

1. Unscrew the anti-slip, rubber feet on the controller to remove them.

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2. Fix the controller to the Wall mount kit with the M6 screws.

   The fastening screws must be torqued to 8 N·m.

3. Fix the Wall mount and controller to the vertical surface using the M8 screws such that the I/O panel is on the side opposite to the UP arrow on the mount.

   The IO panel faces down.

   The fastening screws must be torqued to 10 N·m.

Related topics

Considerations before installing the controller on page 141

Controller mounting interface on page 33

Wall mount kit on page 388

Connecting the arm to the controller

The *arm* receives commands from the *controller* through a cable.

Procedure

1. Take the cable that comes out of the *base* of the arm.
2. Connect the end of the cable into the connector marked ARM on the controller.



3. Screw the cable in place.

Installing the teach pendant mount

The *teach pendant* comes with a flat display mounting interface (FDMI™) that can be attached to a wall or other vertical surface. When the teach pendant is not in use, store it between 60 cm and 190 cm from the ground for easy access.

Before you begin

Personnel

- **Number of Workers:** 1

Supplies

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For the *MIS-D* installation

- 4 x MIS-D compatible screws (M4 with 0.7 mm thread)
- Washers

For the 90 x 45 mm

- 4 x M8 screws

About this task

The teach pendant mount is compatible with VESA MIS-D, 75, and is compatible with the VESA Flat Display Mounting Interface (FDMI™) Standard. It has a 75 x 75 mm screw mounting pattern.

It also has a 90 x 45 mm pattern, which is not FDMI compatible. However, that pattern can be used to anchor the mount with M8 screws. The 90 x 45 mm alternative approach is excellent for such installations as 45 mm extrusion systems.

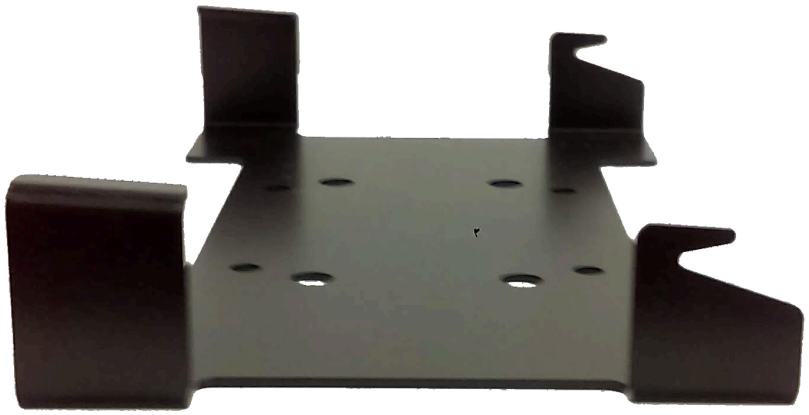


Figure 96: Teach pendant mount

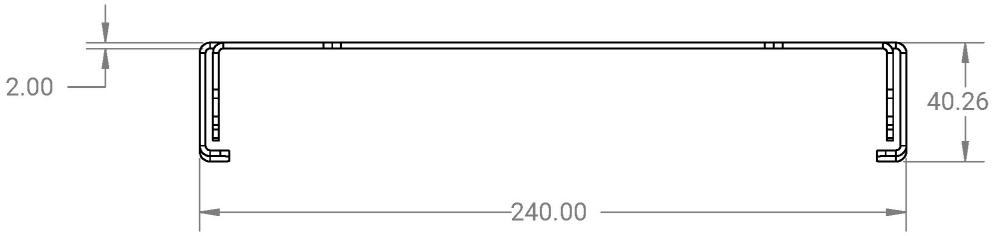


Figure 97: Specifications of the top view of the teach pendant mount

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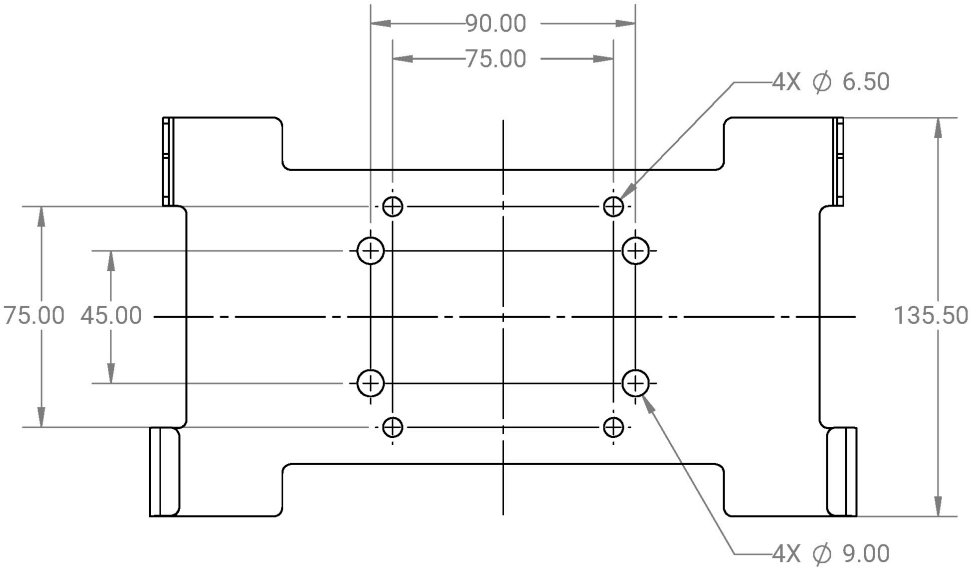


Figure 98: Specification of the front view of the teach pendant mount

Procedure

1. Choose whether you are installing using the FDMI standard or the 90 x 45 mm pattern; this determines which equipment and tools you need for installation.
2. Use the specifications in the figures to secure the teach pendant mount to the surface.

Related topics
Teach pendant overview on page 51

Connecting the teach pendant to the controller

The *controller* sends and receives commands from *Kortex Web App* on the *teach pendant*.

About this task

A cable is attached permanently to the teach pendant.

Procedure

1. Take the cable that comes out of the teach pendant.

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2. Connect the end of the cable into the connector marked TP on the controller.



3. Screw the cable in place.

Connecting power to the controller

The *controller* requires power to power the rest of the robot.

Before you begin

The *AC* power line must be protected with a 15 A circuit breaker, or equivalent overcurrent protective device, at 120 V AC, and with a 7.5 A circuit breaker, or equivalent overcurrent protective device at 240 V AC.

The controller must be switched off.

About this task

The *arm* must be connected to the controller before the initial start-up of the controller.

Procedure

1. Plug one end the *AC* cord into the back of the controller.



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2. Plug the other end of the *AC* cord into an electric socket.



Connecting a computer to the controller

Kortex Web App may be run on a computer, but it works only if the computer is connected to the *controller*.

Before you begin

You need to have an Ethernet CAT5 cable.

About this task

You can use a computer to program Link 6, particularly when you want to program the robot with minimal downtime.

Procedure

1. Connect one end of the cable to the Ethernet port on the front or back of the controller.
2. Connect the other end of the cable to the computer.

Connecting a network to the controller

There are times when you need a permanent set-up in which the *controller* connects directly to a network.

Before you begin

You need to have an Ethernet CAT5 cable.

About this task

You can use a computer to program Link 6, particularly when you want to program the robot with minimal downtime.

Procedure

1. Connect one end of the cable to the Ethernet port on the front or the back of the controller.
2. Connect the other end of the cable to the network switch.

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Initial software setup

Before you can start using Link 6, you have to configure the robot using *Kortex Web App*.

Kortex Web App is a Web-based *GUI* used for configuring, controlling, and monitoring the robot.

Supported client devices

Kortex Web App runs on the *teach pendant* that is connected to the *controller* with a cable. It also runs on a web browser on the computer that is connected to the controller over a wired Ethernet.

Kortex Web App is a responsive web application. It is designed to adapt itself to various aspect ratios and resolutions so that it can run on multiple platforms.

There are two types of users who use the teach pendant.

- The integrator can use the teach pendant when they configure or program the robot.
- The operator can use the teach pendant to run a validated program, provided they use it within an area defined by the integrator. The area should be outside of the *robot cell*.



Figure 99: Kortex Web App on a teach pendant

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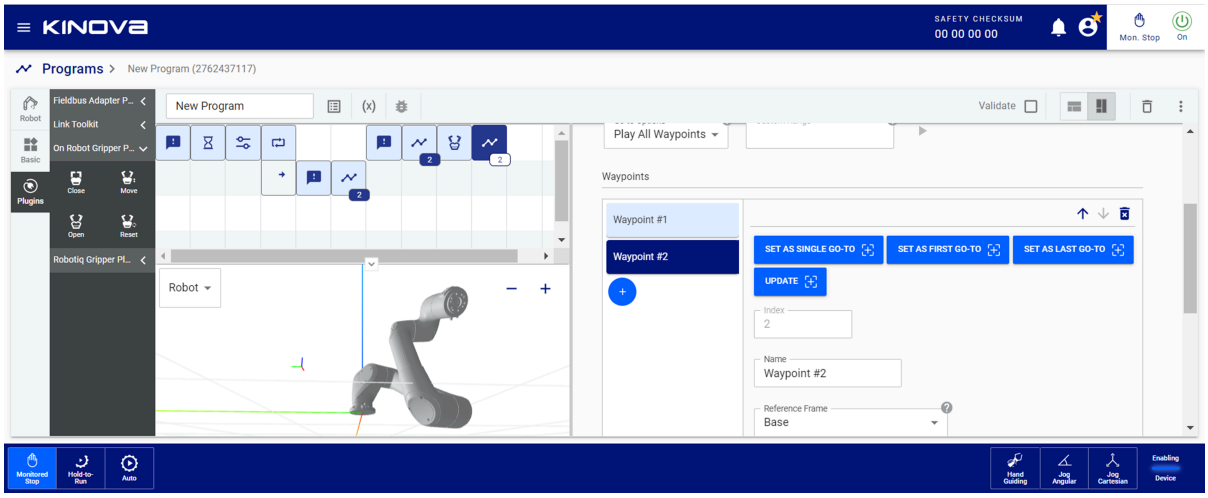


Figure 100: Kortex Web App in a web browser

Logging in

The first step in using Link 6 is to log into *Kortex Web App*. You can use either a computer or a *teach pendant*.

Before you begin

When you use Kortex Web App in a web browser, make sure the *controller* and the computer are connected with an Ethernet cable so that there is an established network connection.

When you use Kortex Web App in a teach pendant, make sure it is connected to the controller. There is no need to establish a network connection in this case.

Link 6 may still be in its package position. It also is possible that it is in its home position.

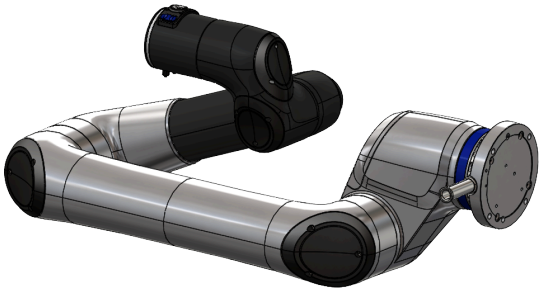


Figure 101: Link 6 in its package position

About this task

Kortex Web App is a Web-based *Graphical User Interface (GUI)* used for configuring, controlling, and monitoring the robot.

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Procedure

1. Switch on the controller.

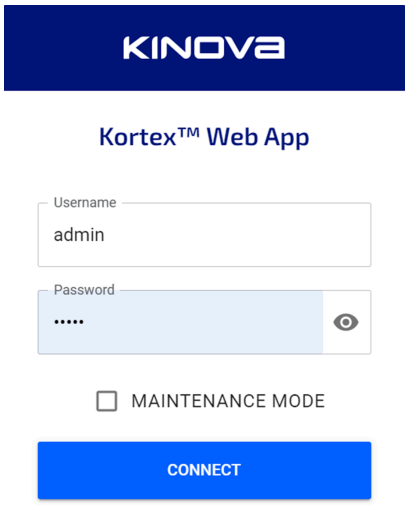


The power knob flashes a white light while the controller initializes the software and *firmware*. When the controller is ready to be used, the power knob illuminates a steady white light.

The teach pendant switches on automatically if it is connected to the controller.

Kortex Web App launches automatically. It uses the default IP address `192.168.1.10` if it is connected to an external device using an Ethernet cable.

Kortex Web App launches its login dialog.



2. Enter the user name and password of the admin user.

Username is `admin`.
Password is `admin`.

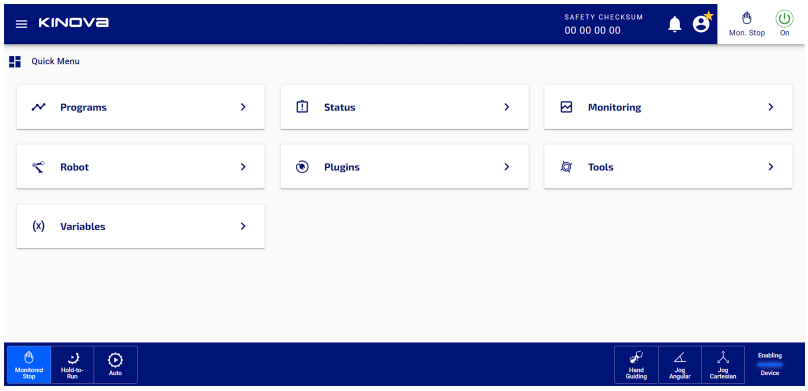
Important: Change the admin password when this is the first log in.

Important: Usernames and passwords are case sensitive.

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3. Tap **CONNECT**.

   The **Home** page of Kortex Web App launches. The **Home** page displays the Quick Menu.



Repositioning the arm to use it for the first time

After the arm is installed, it probably will not be in an optimal position for starting to use the robot.

About this task

The robot must be on and the *admin user* must be logged on. The robot is in its factory settings, which means there are no programs yet. Use *Kortex Web App* in close proximity to the robot *arm* to make it easier to reposition the arm for the first time.

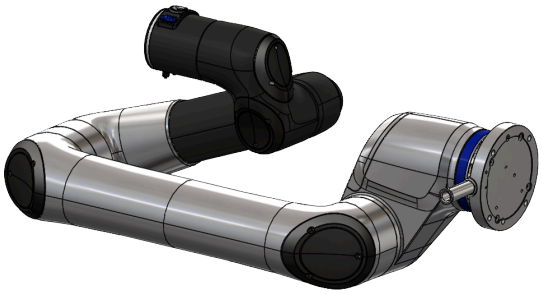


Figure 102: Link 6 in its package position

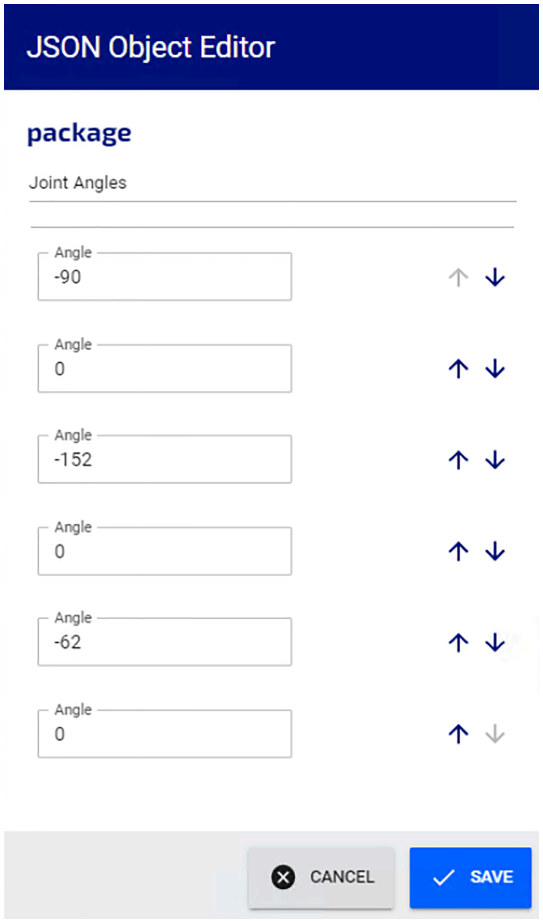
Table 69: Angles of each joint, from joint 1 to joint 6, of the packaging pose

Joint	Packaging pose angle
1	-90°
2	0°
3	-152°
4	0°
5	-62°

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Joint	Packaging pose angle
6	0°

Figure 103: Angles of each joint in the Packaging pose



Procedure

1. Press and hold the *wrist enabling device* on the arm.
2. Use joint, or *angular*, Hand Guiding mode to move the robot out of its packaging pose and into a stable starting pose.

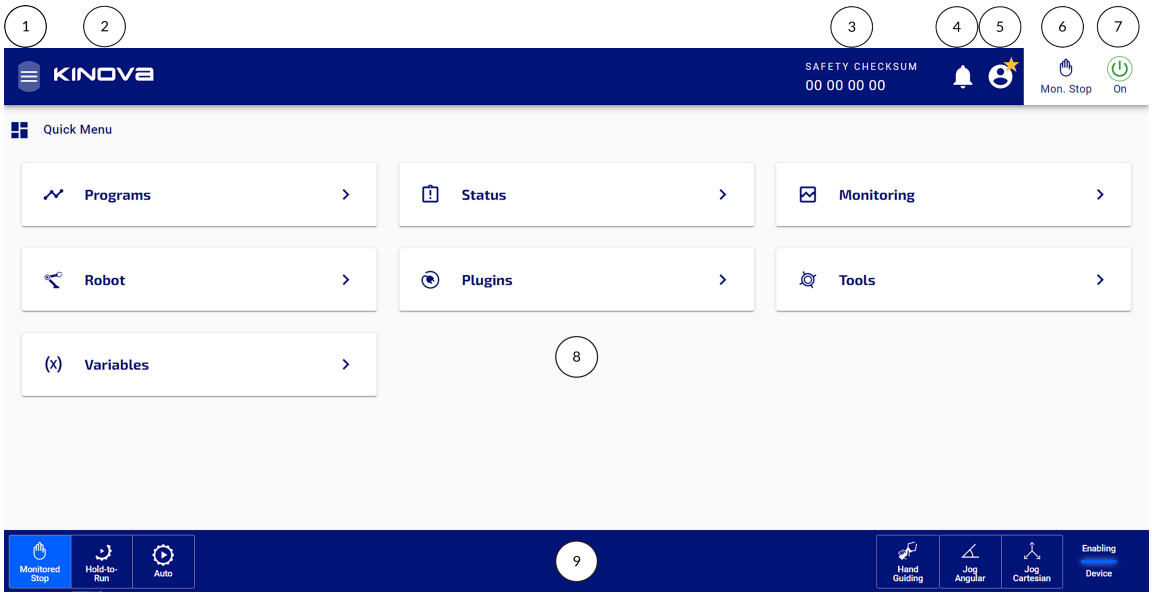
   Alternative: Press and hold the teach pendant enabling device, and use **Jog Angular**.

3. Release the wrist enabling device.
   The arm is now in the correct position to begin programming.

Kortex Web App layout

Kortex Web App has several areas.

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Header

1 **Hamburger** menu to access pages

2 Kinova logo to access the **Quick Menu** page

3 SAFETY CHECKSUM

4 Notification indicator

5 User profile

6 Mode indicator

7 On power button

Important: Tapping the power button switches the arm on or off.

Footer

8 **Main information panel**

9 **Robot control panel**

Menu pages

Access the different *Kortex Web App* functionalities from the Hamburger menu or the Quick Menu.

When you tap on the Kinova logo in Kortex Web App, Quick Menu page launches. Access the most frequently used pages from the Quick Menu. Tapping on any of the items in the Main information panel brings you to the selected function.

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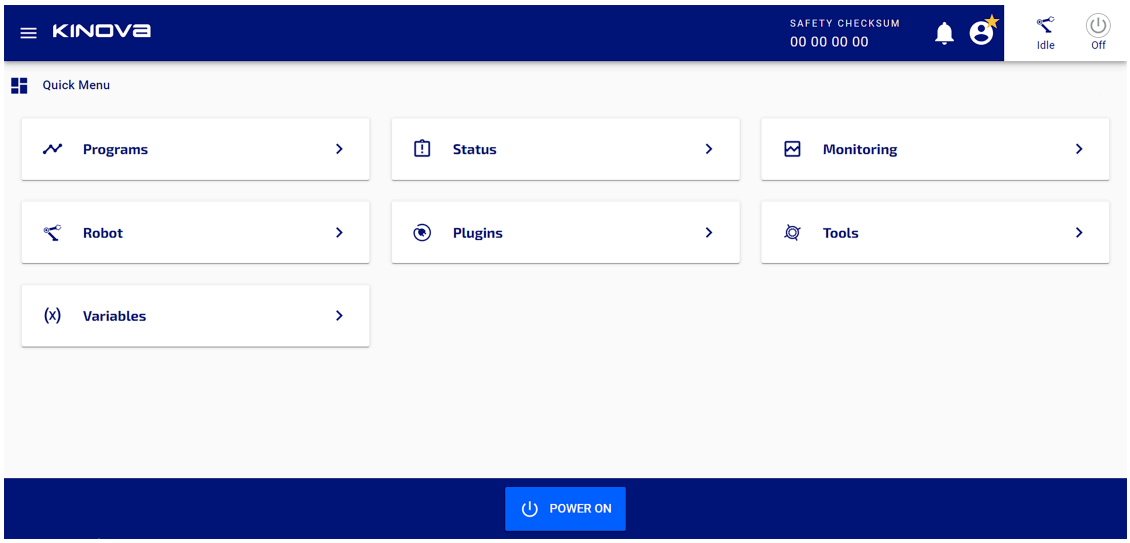


Figure 104: Quick menu page

Alternatively, you can tap on the **Hamburger** icon (☰) to display the full menu. The different functions are organized into logical groups.

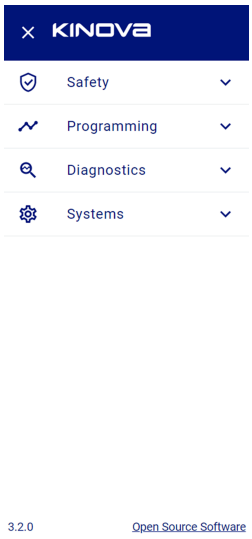


Figure 105: Full menu from the Hamburger icon

The main menu is made of four main options, each of which is subdivided further.

Access all safety-related actions of the robot from the **Safety** menu.

- **Joint Limits**: Define the maximum position of each joint from -357° to +357°, as well as the maximum speeds at which the joints move in reduced safety mode and normal safety mode.
- **TCP & Elbow Limits**: Define the maximum translation and rotation speeds of the *TCP* and the elbow.
- **Protection Zones**: Define the zones where the robot must not enter.

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- **Safety I/Os**: Define the behavior of the equipment connected to the safety I/Os on the controller on the corresponding input and output channels.

Access everything you need to create a program from the **Programming** menu.

- **Variables**: Define variables, along with their scopes, for modifying plugins and creating programs.
- **Programs**: Create, modify, and select programs, using actions defined by plugins and variables in the system.

Access monitoring and status information from the **Diagnostics** menu.

- **Status**: View the status of the main parts of the robot
  - **Safety Functions**
  - **Controller**
  - **SCU**
  - **Actuators**
  - **Wrist**
- **Monitoring**: View the live feedback from every sensor reading and the values derived form them.

    Example: The position of the *TCP*.

From the **Systems** menu, you can access information about the system in general, as well as perform general purpose tasks, such as upgrading the system and adding new users.

- **Information**: View information specific to Link 6 as a product, its controller, and its arm.
- **Robot**: Configure parameters for the robot.
- **Tools**: View, modify, and add tools to reflect what is installed on the robot.
- **Plugins**: View, modify, and add *plugins* to use with the robot.
- **Networks**: View and modify the existing network communication system.
- **Remote Access**: Select which external sources can communicate with the robot.
- **Users**: View, modify, and add users who can use the robot. All users are listed on this page.
- **Maintenance**: Export logs of information related to the functionality of the robot, as well as save and load system configurations.

At the bottom of the menu, there are two pieces of information.

- The firmware version of Link 6
- A link to the **Open Source Software** that are used to build Link 6 software

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Open Source software packages

Link 6 is built using some Open Source software components. The licenses are listed on this **Open Source Software** page.

Access the **Open Source Software** page by tapping **Hamburger** > **Open Source Software**.

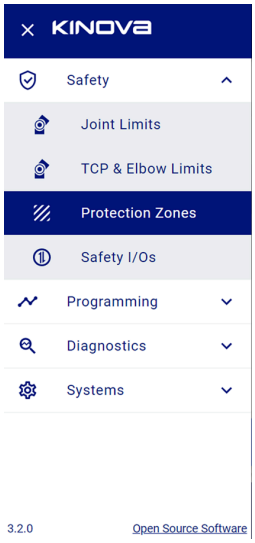


Figure 106: Accessing the Open Source Software page

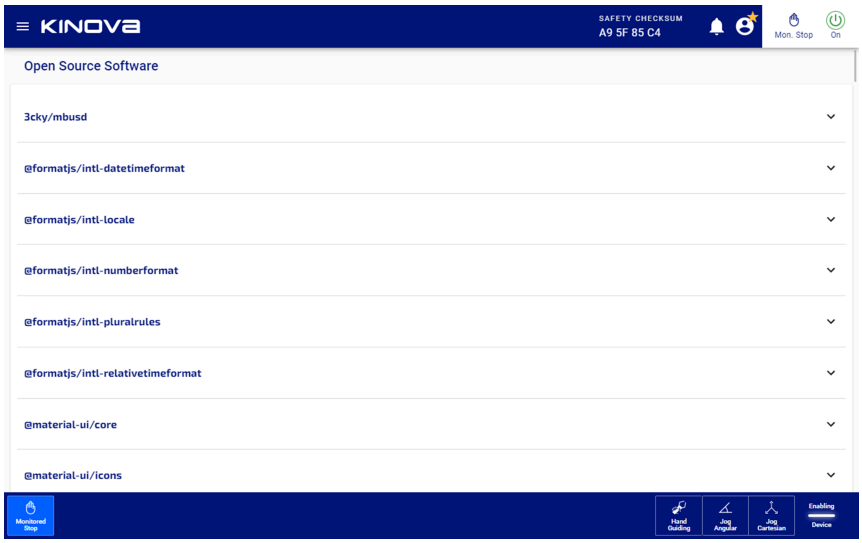


Figure 107: Open Source Software page

Tap on any of the packages listed to view its corresponding license.

Indicators, user profile, and power

Sometimes, you need a quick way to access notifications, your profile, the current mode of the robot, and a way to power on or off the *arm* of Link 6.

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In the same header as the Hamburger and the Kinova logo are four more icons.



Figure 108: Indicators, modes, and arm power status



The Safety checksum icon is a unique number that represents the current configuration of several safety elements derived from the *MPU* and the *SCU*.

- SF03 Safety position limits
- SF04 Safety joint speed monitoring reduced and normal speed limits for all joints
- SF-06 Protection zone positions, shape type, dimensions, orientations, and activation status
- Safety inputs and outputs
- Safety TCP orientation speed monitoring normal and reduced speed mode limits
- Safety TCP translation speed monitoring reduced speed mode limits
- Safety elbow translation speed monitoring normal and reduced speed mode limits

The administrator is responsible for writing down the checksum when they are satisfied with the safety configuration. Any change in the value displayed in the Safety checksum icon indicates a change in the safety configuration.



Tap the Notification icon to launch the **Events** page.



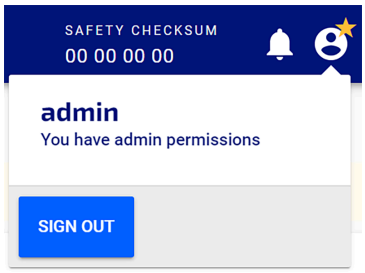
The admin user is logged into Kortex Web App.



An *operator* is logged into *Kortex Web App*.

Tap the User profile icon to launch the **User profile** .

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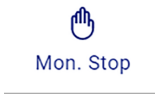


The **User profile** displays the role and permissions of the currently logged-in user. It is from this panel that you can sign out.

The Robot status icon displays the current mode that Link 6 currently is in.



Idle: the controller is on and the arm is off.



Monitored Stop: the arm is switched on and is waiting to be used.



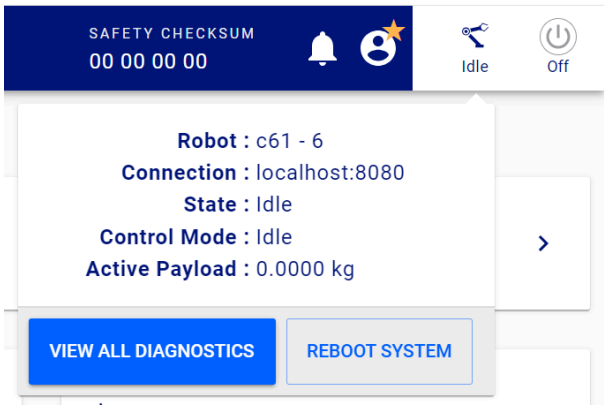
Hold to Run: arm is moved by hand or by a program under supervision for testing purposes.



Automatic: the arm is controlled entirely by a program.



Maintenance mode: Administrator is performing maintenance on the robot.



Tap the Robot status icon to launch a summary of the diagnostics of the robot.
Tap **VIEW ALL DIAGNOSTICS** to view information on the **Status** page.
Tap **REBOOT SYSTEM** to *reboot* the robot.



The Arm Power Off icon indicates the arm of Link 6 is off. The icon is gray.

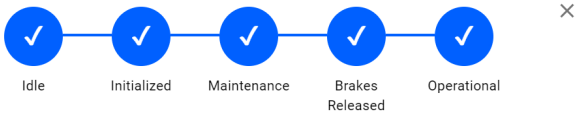
Tap to switch the arm on.

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The Arm Power On icon indicates the arm of Link 6 is on. The icon is green. The states above the Robot control panel indicate the arm is operational.

Tap to switch the arm off.



When the arm is switched on, the state of the arm shows that it is on and is operational.

The Robot status icon changes to Monitored Stop.

Related topics

Event notifications on page 372

Robot lights and what they mean: a reference on page 129

User management on page 167

Robot control panel

The Robot control panel is a status panel when operating the *arm* manually and is another way to change the operating mode of the arm.

The current operating mode is displayed on the left of the panel. Tap it to access the other available operating modes.



Figure 109: Example of the Robot control panel



Figure 110: Example of the Robot control panel in Manual Jog mode

The current mode is a lighter blue than the rest of the Robot control panel.

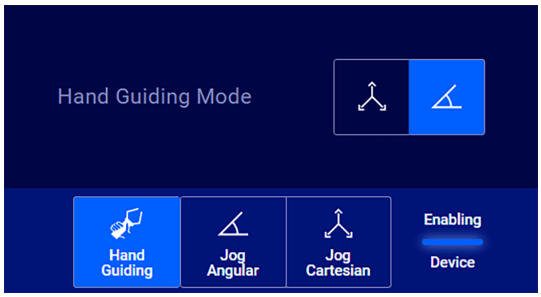
At the opposite end of the Robot control panel are the manual control modes, as well as the *enabling device* status.



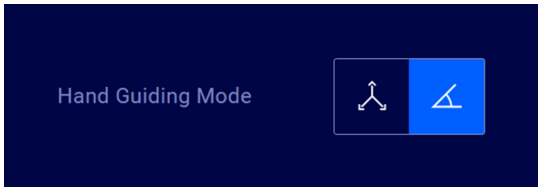
Figure 111: Virtual controls and mode toggles with enabling device off and then on

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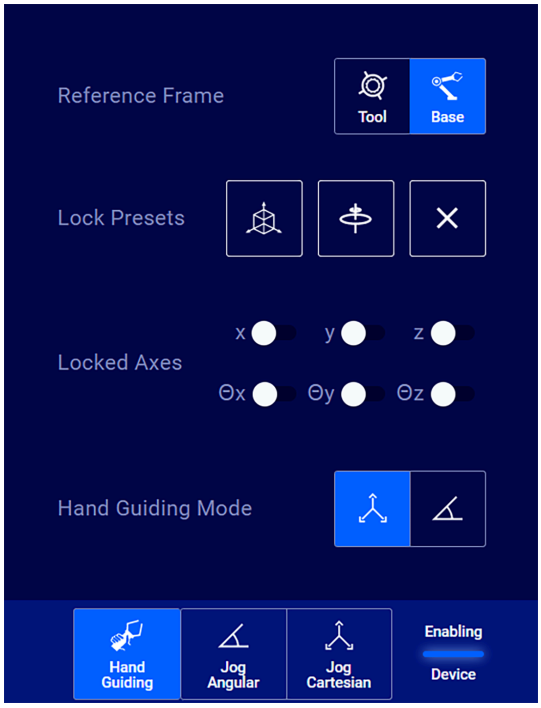
Tapping any one of these three buttons launches a window with controls. The controls are available only when the enabling device is held in the middle position.



Modes available in Hand Guiding mode

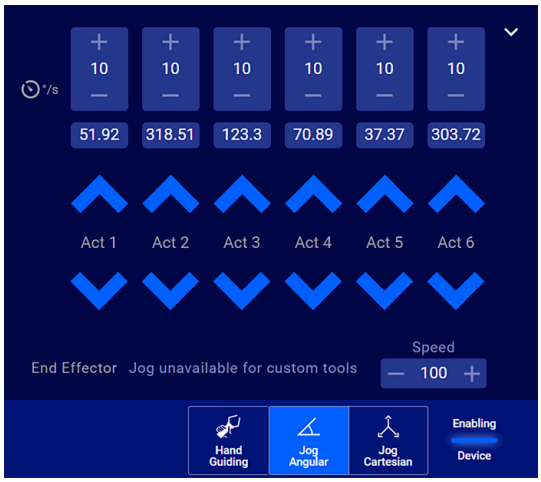


Virtual controls in *angular* Hand Guiding mode



Virtual controls in *Cartesian* Hand Guiding mode

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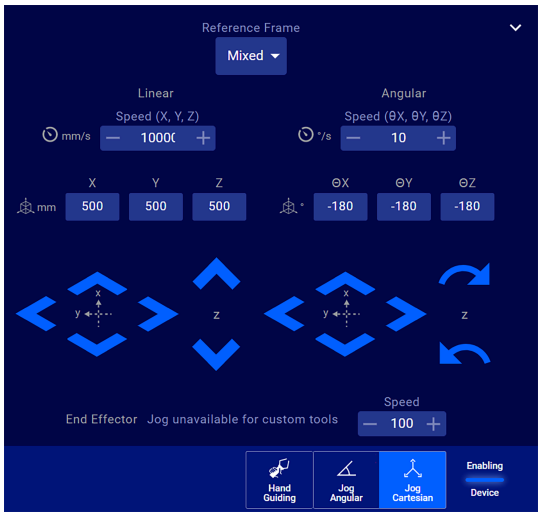


Virtual controls in *angular* Manual Jog mode

Tip: The controls are available only when the enabling device is held in the center position.

Tip: Tap the up arrow ( ) in the corner to expand the view of the controls.

Tip: Tap the down arrow ( ) in the corner to collapse the view of the controls.



Virtual controls in *Cartesian* Manual Jog mode

Tip: The controls are available only when the enabling device Is held in the center position.

Tip: Tap the up arrow ( ) in the corner to expand the view of the controls.

Tip: Tap the down arrow ( ) in the corner to collapse the view of the controls.

Note: When you tap Hand Guiding in the Robot control panel, the current mode is automatically Monitored Stop.

Note: When you tap Jog Angular or Jog Cartesian in the Robot control panel, the current mode is automatically Manual.

Related topics

Additional settings on page 340

System information

Whenever you need to know anything related to the product and the versions associated with it, such as upgrade eligibility or gathering specific information for Support, check the **Information** page.

Tap **Systems** > **Information** to access the **Information** page.

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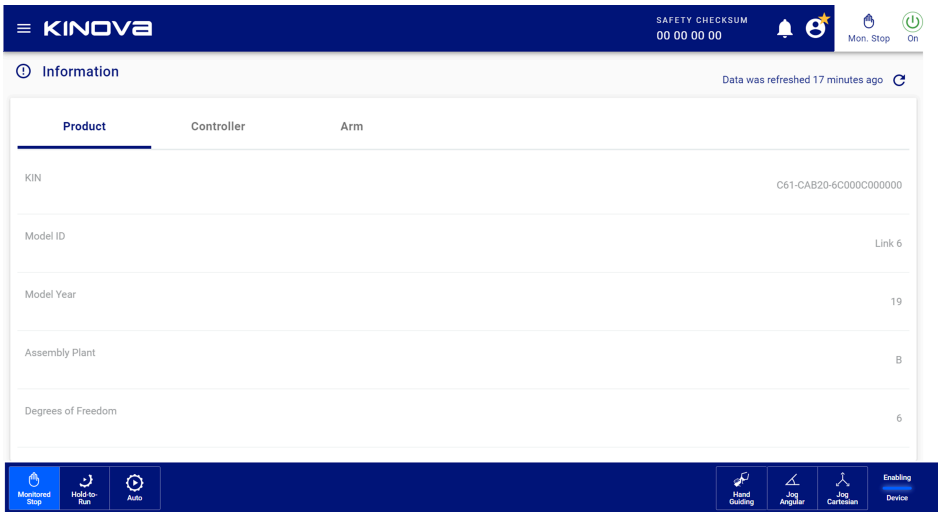


Figure 112: Information page when first launched

Tap on **Controller**, **Product**, or **Arm** to access the associated system information.

Table 70: Information available on each system pane

System part	Associated information
Controller	Serial Number
	Part Number
	Part Number Revision
	Main Processing Unit **(MPU)**
	MAC Address
	Safety Control Unit **(SCU)**
	MAC Address
	Bootloader Version
Product	*KIN*
	Model ID
	Model Year
	Assembly Plant
	Degrees of Freedom
Arm	**Actuator 1** through **Actuator 6**
	Bootloader Version

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System part	Associated information
	Device Type
	MAC Address
	Part Number
	Part Number Revision
	Serial Number
	Actuator Safety 1 through **Actuator 6**
	Bootloader Version
	MAC Address

Robot networking and communication

The Link 6 controller can be connected to an IPv4 network to access the robot from a remote location.

All local networking and communication configurations are accessed by tapping **Systems** > **Networks**.

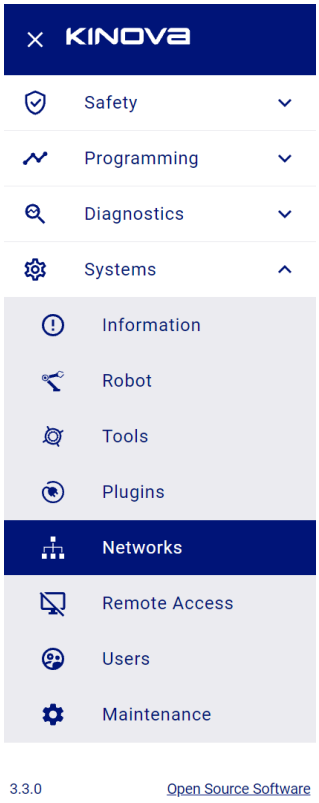


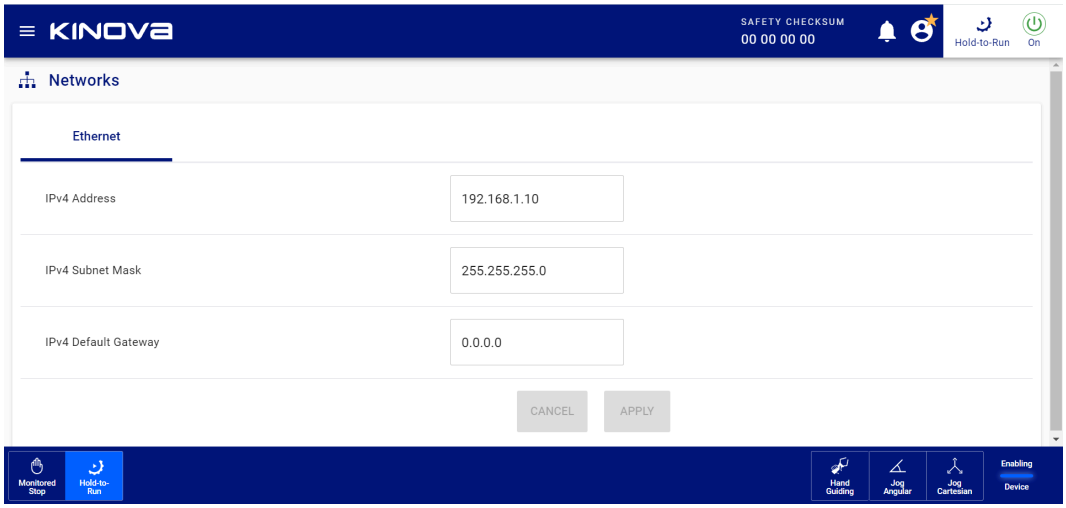
Figure 113: Accessing robot networking and communication configurations

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The factory settings of the Controller Ethernet port IPv4 network can be modified in the **Network** page by entering the appropriate values.

Table 71: Default IPv4 network values

Field	Default value
IPv4 Address	192.168.1.10
IPv4 Subnet Mask	255.255.255.0
IPv4 Default Gateway	0.0.0.0



When you change the values on the **Network** page, tap **APPLY** for the values to take effect.

Tip: Kortex Web App can be accessed from a web browser on a computer by entering the IPv4 address of the Link 6 controller in the address bar of the web browser.

Trouble: If accessing the robot through the IPv4 address does not work, verify the computer Ethernet port configuration and the robot Ethernet configuration; the two IP addresses must be on the same subnet.

Trouble: If accessing the robot through the IPv4 address does not work when the default Link 6 configuration is used, make sure the IP address of the computer is `192.168.1.XX`, where `XX` represents a unique number from 1 to 255, excluding `192.168.1.10`.

User management

There are two different types of users: *admin* users, and *operators*. Each of these user types are associated with *roles*, which determine what they can and cannot do in an application. It is common to refer to a user by the role they have.

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The Administrator role carries more permissions than the Operator role. For instance, an admin is able to create users, but an operator cannot. However, both are able to run a validated program.

When there is a star beside the User profile icon, the user is an admin user. When there is no star, the user is an operator user.

Table 72: Access to pages depending on role

Admin user	Operator user
Login	**Login**
Quick Menu, Home page • **Programs** • **Status** • **Monitoring** • **Robot** • **Plugins** • **Tools** • **(x) Variables**	**Quick Menu**, Home page • **Programs** • **Status** • **Monitoring**
Safety • **Joint Limits** • **TCP & Elbow Limits** • **Protection Zones** • **Safety I/Os**	**Safety** • **Joint Limits** • **TCP & Elbow Limits** • **Protection Zones** • **Safety I/Os**
Configure	View only
Programming • **(x) Variables** • **Programs**	**Programs** • **Programs**
Create, debug, validate for use, run program	Select and run validated program

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Admin user ( )

Diagnostics

- **Status**: View only
- **Monitoring**:
  - View only.
  - Download snapshot of current data if a USB storage device is inserted in the USB port of the controller .
- **Events**

  Tip: Access the **Events** page by tapping on the Notification bell icon.

  - Search for an event.
  - Filter for specific events by type and by date range.
  - Control what is displayed on the **Events** page.
  - Select an event and delete it.

view only

Systems

- **Information**: View only
- **Robot**: Configure
- **Tools**: Add and configure
- **Plugins**: Install and configure
- **Networks**: Configure
- **Remote Access**: Enable and disable Modbus protocol and Kortex *Application Programming Interface (API)* communication
- **Users**: Manage users
- **Maintenance**: Perform basic software maintenance of the robot, such as saving configurations of the robot, restoring older configurations of the robot, and upgrading the software and firmware

Operator user ( )

Diagnostics

- **Status**: View only
- **Monitoring**:
  - View only.
  - Download snapshot of current data if a USB storage device is inserted in the USB port of the controller.
- **Events**

  Tip: Access the **Events** page by tapping on the Notification bell icon.

  - Search for an event.
  - Filter for specific events by type and by date range.
  - Control what is displayed on the **Events** page.
  - Select an event and delete it.

view only

Systems

- **Information**: View only
- **Maintenance**: Perform basic software maintenance of the robot, such as exporting current data and saving current configurations of the robot

All user management tasks are accessed by tapping **Systems** > **Users**.

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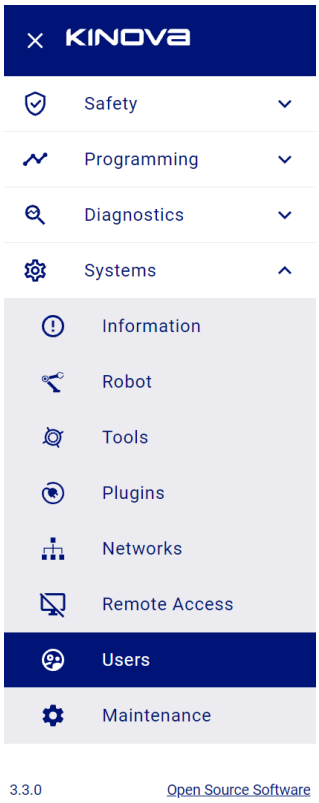


Figure 114: Accessing user management operations

Related topics

Kinova® Kortex™ GitHub repository on page 180

Indicators, user profile, and power on page 159

Adding a user

New *operators* can be added to the system.

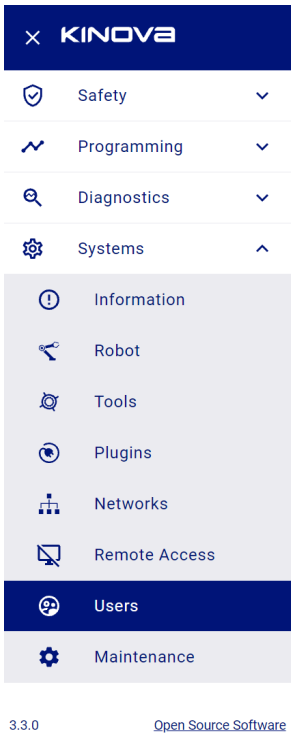
About this task

The *admin* user adds users to the system. All users added to the system are operators.

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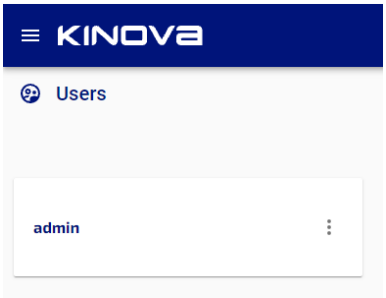
Procedure

1. Tap **Systems** > **Users**.



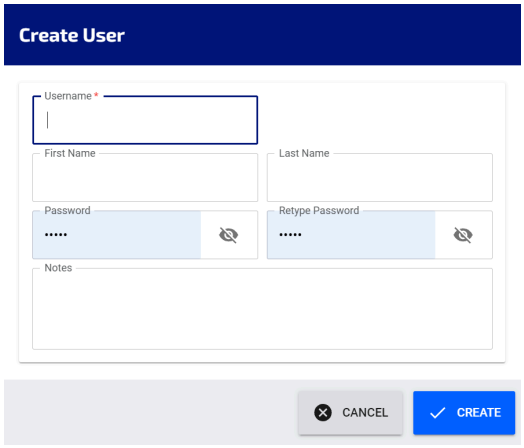
All users are displayed on the **Users** page.

Important: The first time the **Users** page is accessed, one user is already listed. That is the Administrator user account used to log into Web App.



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2. Tap ⊕ in the bottom right corner to add more users.
   The **Create user** dialog launches.



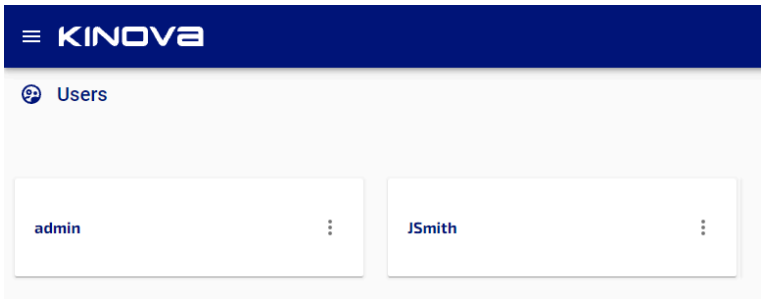
3. Enter information in the fields.
   - **Username**
   - **First Name**
   - **Last Name**
   - **Password**
   - **Retype Password**
   - **Notes**

   Important: The username and password are case sensitive.

4. Tap **CREATE**.

Results

A user is added to the list of current users.



Editing a user

When a user is created in the system, it is possible that the user's name was misspelled, a different username must be used, or the password must be updated. In all these cases, the admin must edit the user information.

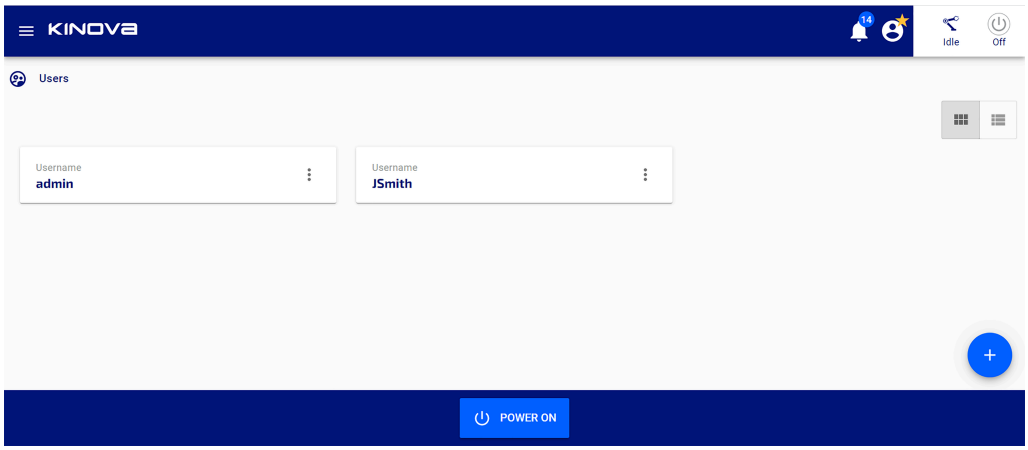
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About this task

The *admin* edits users in the system.

Procedure

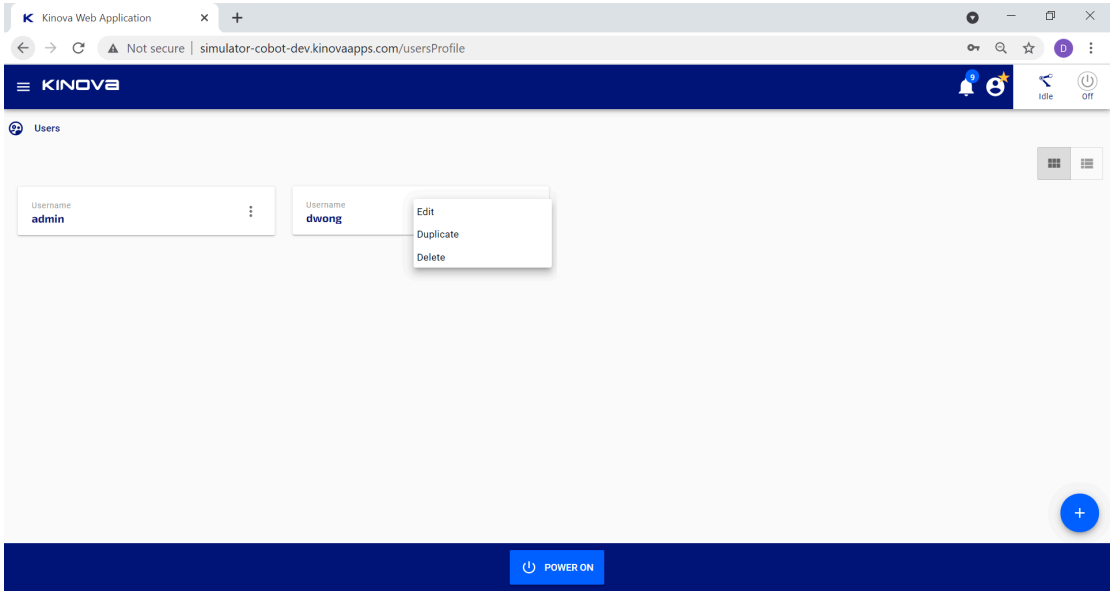
1. Tap **Systems** > **Users**.
   All users are displayed on the **Users** page.



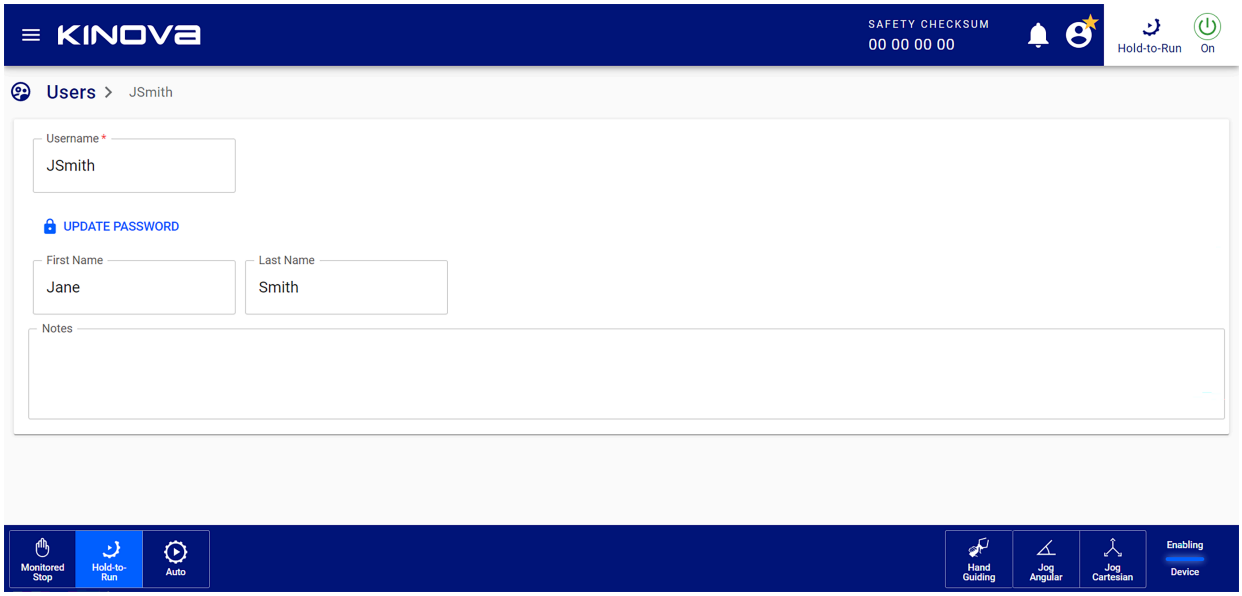
2. Tap on a name of the user.
3. Tap the *kebab menu* (⋮).

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4. Tap **Edit**.



The **Edit User Profile** page is displayed.

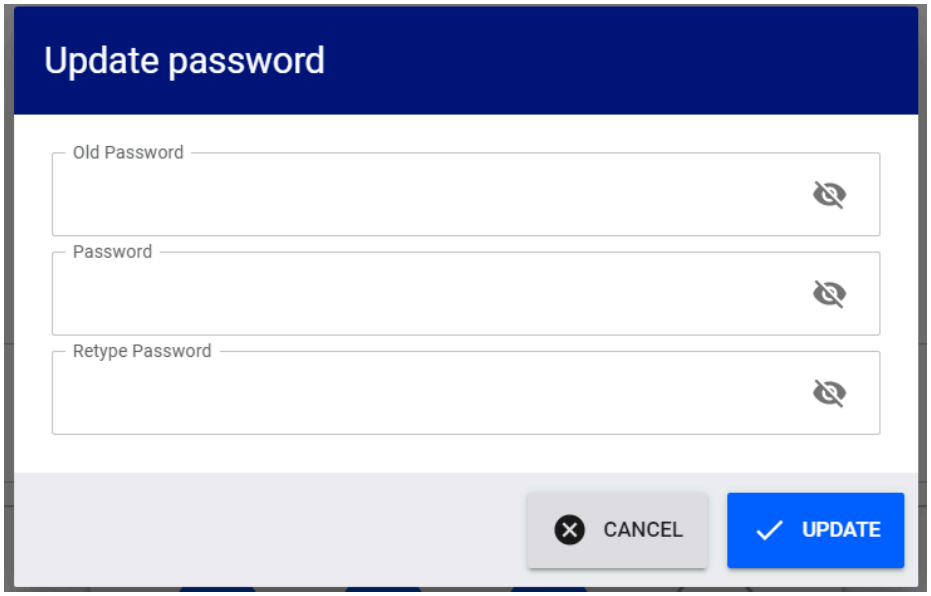


5. Update the information.

- **Username**
- **First Name**
- **Last Name**
- **Notes**

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6. Tap **UPDATE PASSWORD** to change the user's password.
   The **Update password** dialog launches.



7. Enter the **Old Password**, new **Password**, and **Retype Password**.
8. Tap **UPDATE**.

Results

All edited information is saved automatically.

Deleting a user

Sometimes a user must be removed from the system.

About this task

The *admin* removes users from the system.

Procedure

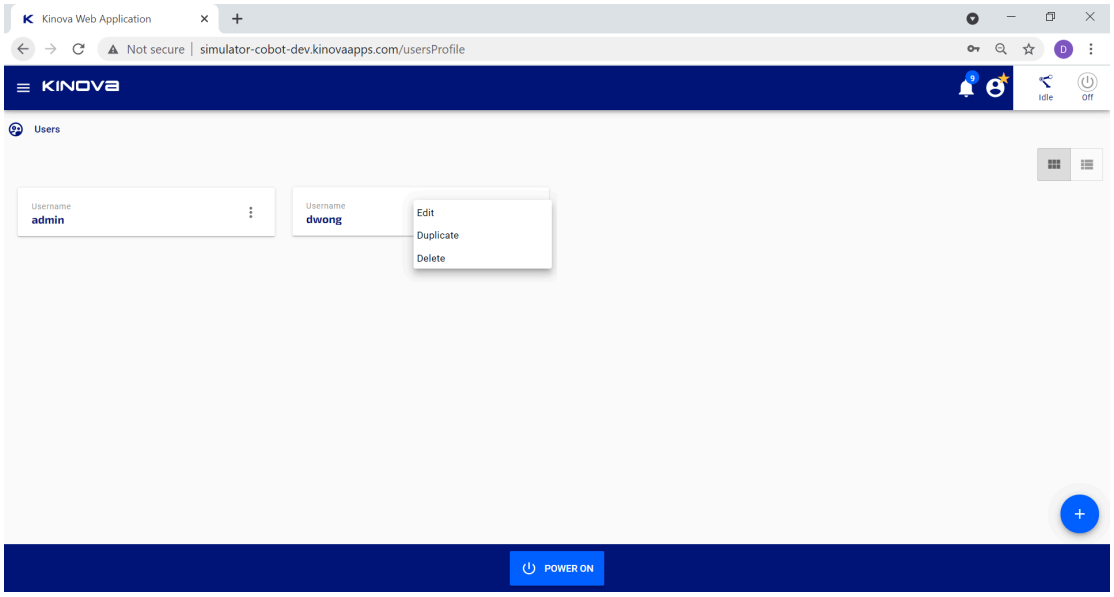
1. Tap **Systems** > **Users**
   All users are displayed on the **Users** page.

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2. Tap the *kebab menu* of the user to be deleted.

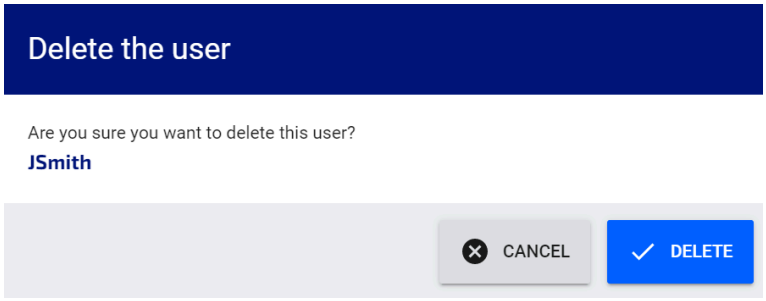
   Note: Administrator accounts cannot be modified or deleted. The content of the kebab menu is not selectable.

   A contextual menu launches, one of the choices being to delete the user.



3. Tap **Delete**.

   A **Delete the user** confirmation dialog launches.

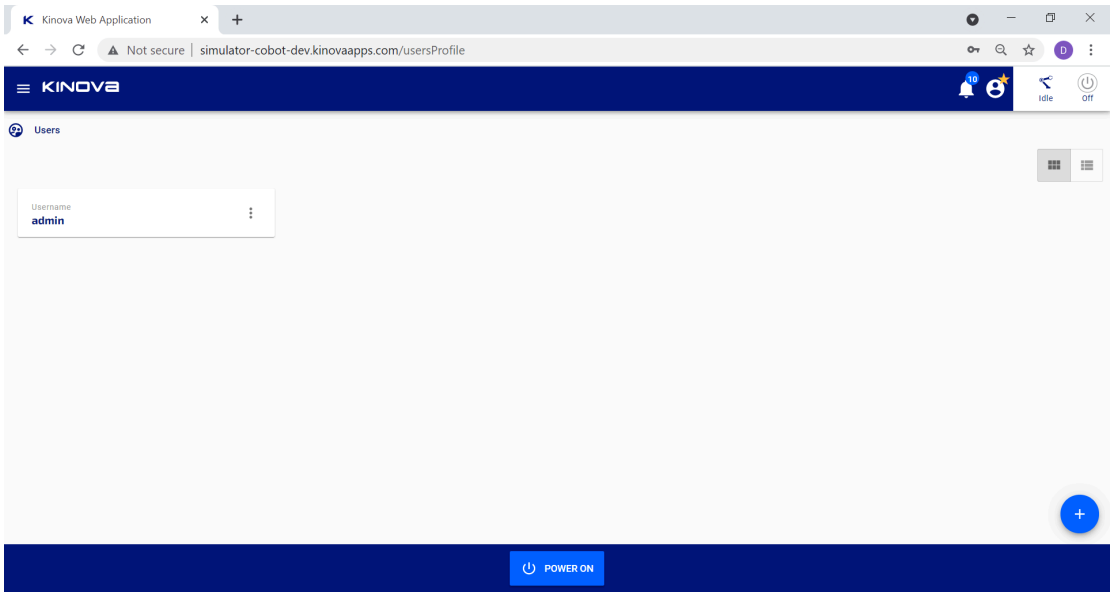


4. Tap **Delete** to delete the selected user.

Results

The selected user is deleted from the system.

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Elevating permissions

The *role* of a user may need to change from *operator* to *admin user*.

Before you begin

Log in *Kortex Web App* as an operator.

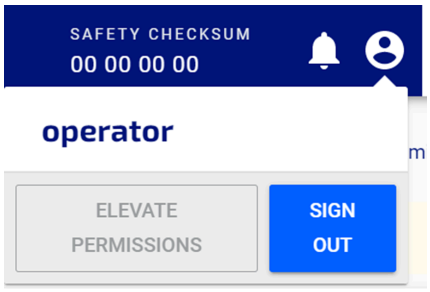
About this task

An operator can elevate their permissions to the administrator level only when the operator knows the admin password.

Procedure

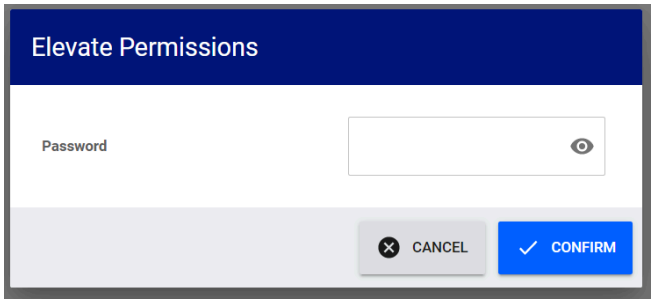
1. Tap **User Profile** .

   A **User profile** launches.

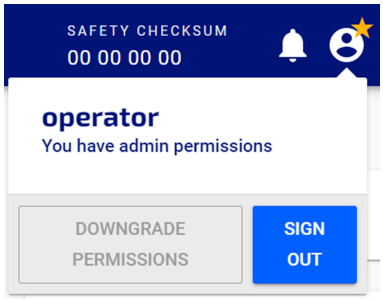


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2. Tap **ELEVATE PERMISSIONS**.
   The **Elevate Permissions** dialog launches.



3. Enter the admin user `password`.
4. Tap **CONFIRM** to elevate permissions.
   The current user can now do the same tasks as an admin user.



Tip: A quick way to make sure the current user is an admin user or an operator is to look at the **User Profile** icon.

- An administrator user has steady star on the **User Profile** icon. An administrator user cannot downgrade their permissions.
- An operator with elevated permissions has a flashing star on the **User Profile** icon. An operator with elevated permissions can downgrade their permission level.
- An operator with operator level permissions has no star on the **User Profile**. An operator can elevate their permissions if they know the admin password.

Remote access

You do not have to use Kortex Web App to communicate with Link 6. You can access it remotely.

All remote communication configurations are accessed by tapping **Systems** > **Remote Access**.

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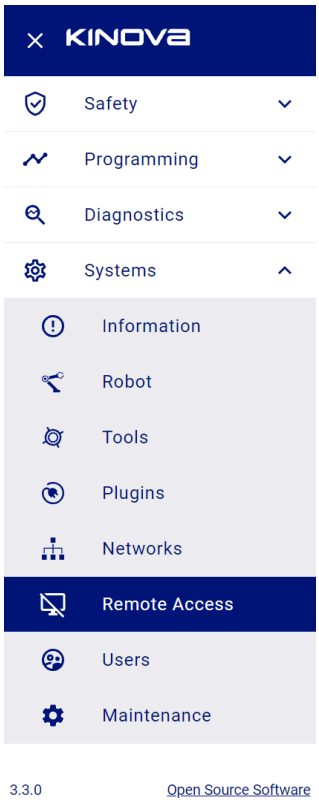


Figure 115: Accessing remote access configurations

A warning is displayed directly on the **Remote Access** page that states that active sessions may close when the communication is enabled or disabled.

The only communication systems that can be enabled or disabled directly with the arm are the Modbus TCP port protocol and the Kortex *API*. The enabled state of the protocol and the *API* are maintained, or persist, so that they are always there after *booting* and *rebooting*.

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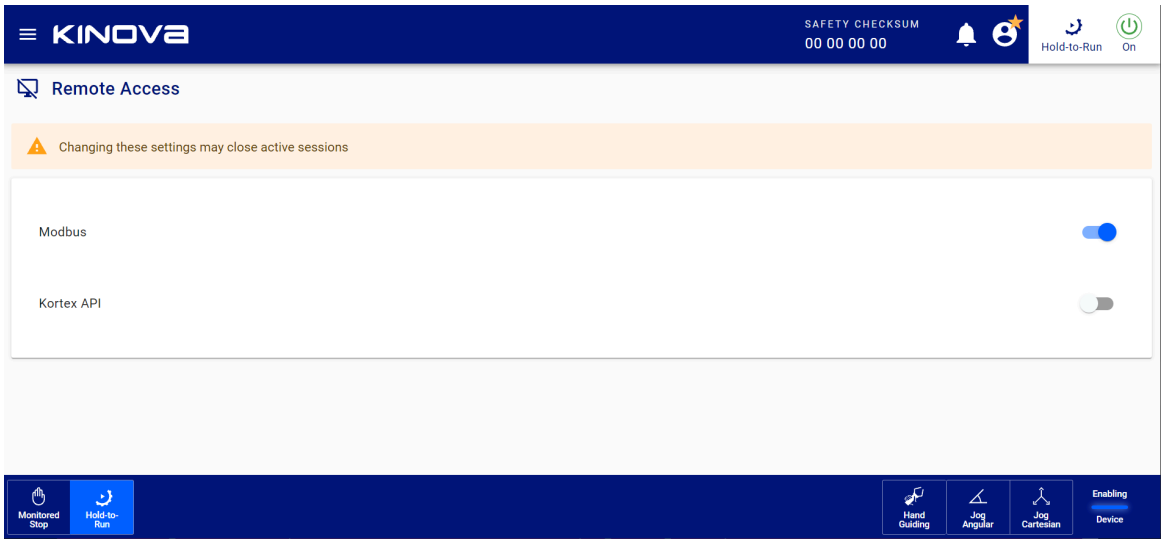


Figure 116: Remote Access page

Important: When **Kortex API** is enabled, you can use the software interface to program the interactions of your system with Link 6. The correct set of permissions is required to work with the Kortex *API*.

Related topics

Kinova® Kortex™ GitHub repository on page 180

Kinova® Kortex™ GitHub repository

For more detailed information about developing applications using the API, visit the Kinova® Kortex™ GitHub repository at https://github.com/Kinovarobotics/Kinova-Kortex3-Link6.

The repository offers access to a number of resources for developers.

- Setup instructions and release notes
- Detailed *API* documentation in Python
- Code examples
- JSON program examples

Plugins

In addition to the pre-installed *plugins*, the *administrator* can extend the functionality of the robot through additional plugins to the *Kortex Web App*.

Pre-installed plugins are related directly to Link 6 and cannot be uninstalled.

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Arm plugin	The plugin handles all actions needed to control the *arm*. The configuration and settings of the arm are not visible because they are not modifiable.
Industrial I/O plugin	The plugin handles all general *I/O* between the *controller* and on the *wrist*. That is, the plugin exchanges information using pure electrical signals through cables connected to some other piece of equipment.

All installed plugins start to run when the controller is switched on. However, they can be stopped so the settings can be modified or deactivated.

Related topics
Plugins on page 379

Getting the plugins for the robot

Upload and installation must be done from the teach pendant and a *USB storage device* connected to the controller or from Kortex Web App running on a computer that has access to the files.

Before you begin

All plugins have dependencies on different aspects of the robot.

Make sure to verify all dependencies before installing the plugin.

Table 73: Plugin dependencies and expected issues when dependencies not met

Dependency	What to expect when dependencies are not met
Hardware resources • *random access memory (RAM)* • Storage • *central processing unit (CPU)* core • Video camera stream, if applicable • *graphics processing unit (GPU)*, if applicable	Installation failure

About this task

The plugin installation file is named `<plugin_name_><version>.kp`, where <version> is the version of the plugin. Contact Kinova to get the appropriate plugin file if you are unsure which files you need.

A computer or *USB storage device* is needed to upload and install the plugin installation file.

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Note: Plugins are updated from time to time. Always make sure you have the latest plugin for your installation.

Important: If the plugin is not compatible with the currently running version of Link 6, an error dialog launches.

Procedure

1. Plug the USB storage device on the computer.
2. Download the plugin installation file `<plugin_name_><version>.kp`.
3. Save the plugin installation file in the root directory of the USB storage device.
4. Eject the USB storage device after the transfer of the plugin installation file is complete.
5. Plug the USB storage device on the *controller*.

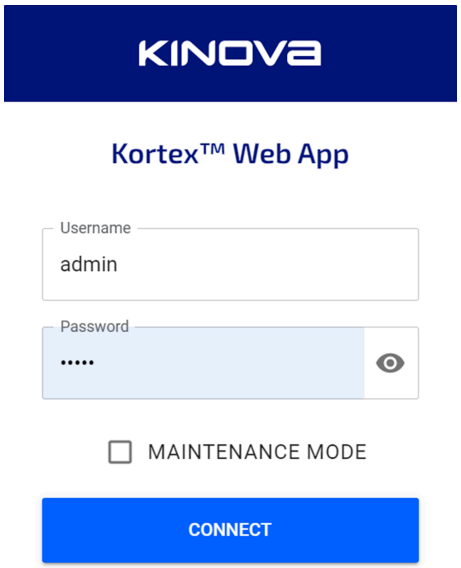


6. Switch on the *teach pendant*.

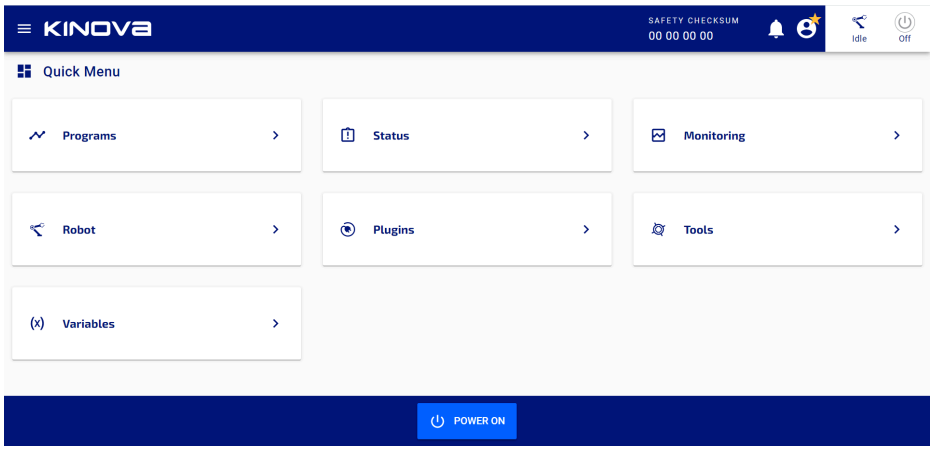


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7. Enter the administrator credentials.



8. Tap **CONNECT**.



9. Tap **POWER ON**.
   The arm is switched on.

What to do next

Install the required plugins from the **Plugins** page in *Kortex Web App*.

Installing plugins

Some *end effectors* and *robot system* require special plugins that need to be installed before they can be use as intended. Other plugins may operate in a standalone fashion to add new features to your robot.

Before you begin

The arm must be switched off before plugins are installed.

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The plugin must not be installed.

About this task

Plugin files have a `.kp` extension.

All installed plugins are accessed by tapping **Systems** > **Plugins**.

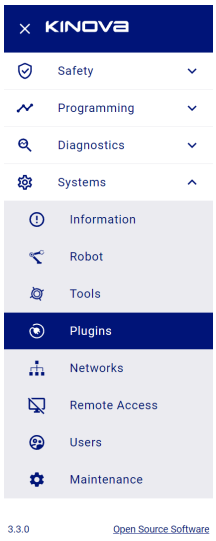
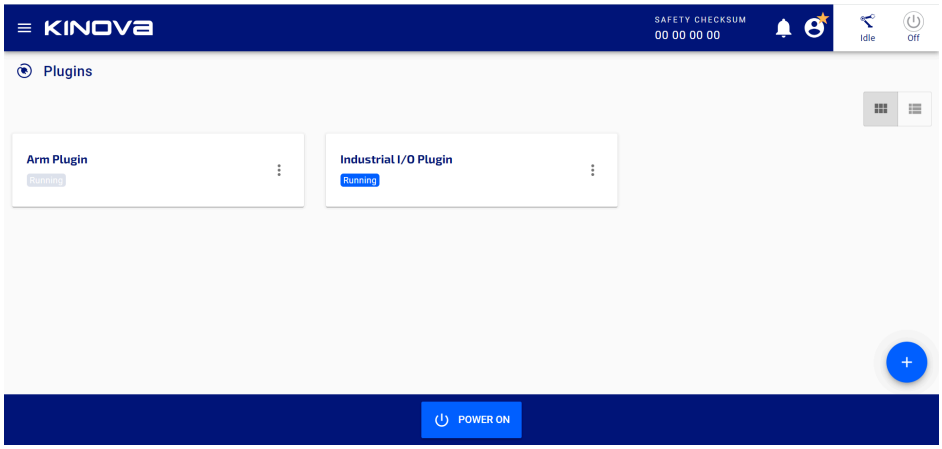


Figure 117: Accessing the plugins

Procedure

1. Tap **Systems** > **Plugins**.
   The **Plugins** page launches.



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2. Tap **+**
   A **Plugin Installation** dialog launches.



3. Tap **SELECT FILE**.
   A window launches.
4. Browse and select the file with .kp extension.
5. Tap **Open**.
   The **Plugin Installation** dialog shows the name of the selected file.



6. Tap **INSTALL**.
   The plugin is listed on the **Plugins** page and is running.
7. Tap **CLOSE** to close the **Plugin Installation** dialog.

Related topics
Uninstalling plugins on page 185

Uninstalling plugins

It is recommended to uninstall the existing end-effector plugin before installing the new plugin because there may be conflicts in their structures.

Before you begin

The arm must be turned off before plugins are uninstalled.

About this task

All installed plugins are accessed by tapping **Systems** > **Plugins**.

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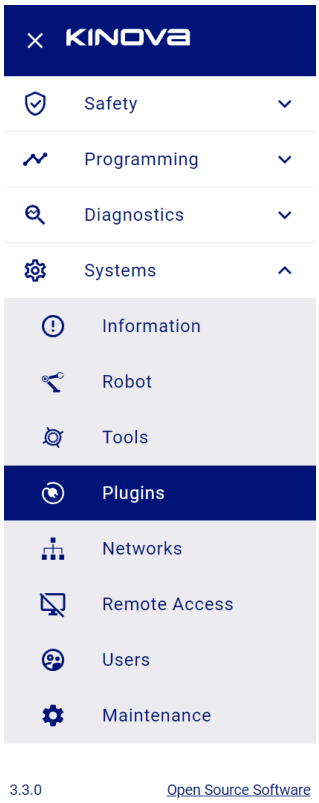
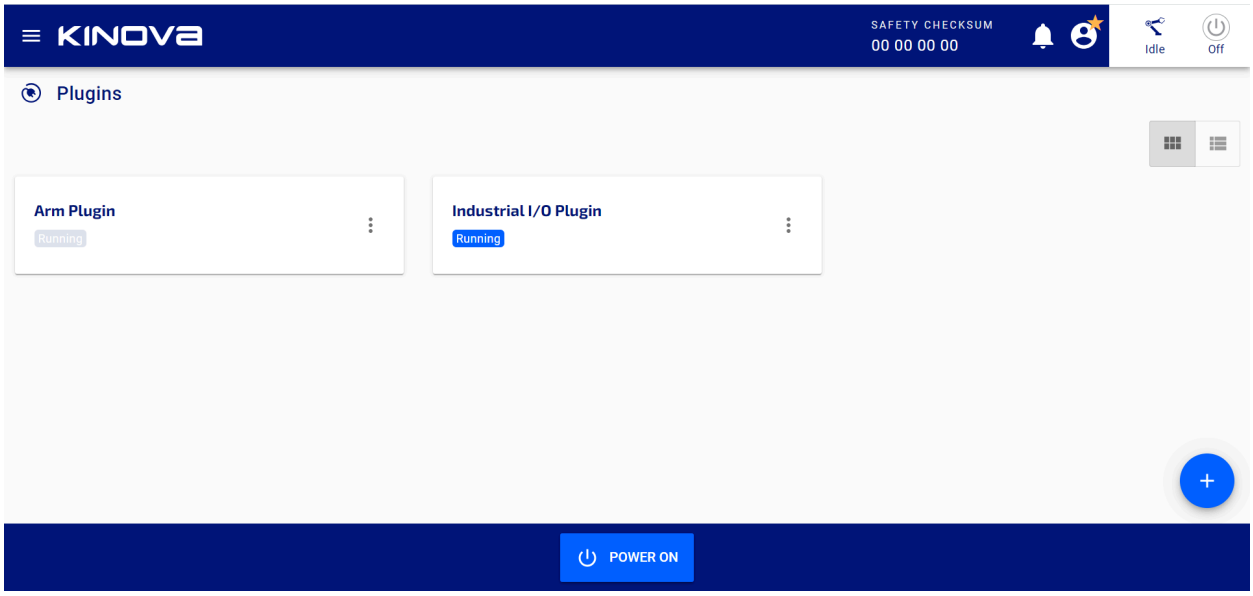


Figure 118: Accessing the plugins

Procedure

1. Tap **Systems** > **Plugins**.
   The **Plugins** page launches.



2. Tap the plugin that you plan on uninstalling.
   The **Configurations** page of the plugin launches.

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3. Switch off **Active**.
   The plugin stops running.
4. Tap **Plugins** to return to the main **Plugins** page.
5. Tap ⋮ > **Delete**.

Results

The plugin is uninstalled and is not on the **Plugins** page.

Any tools associated with the uninstalled plugin are automatically removed from the **Active** and **Inactive (drag & drop)** panes of the **Tools** page.

Related topics

Installing plugins on page 183

Updating plugins

Integrate improvements to the plugins by updating them.

Before you begin

Download the latest version of the plugin. Contact Kinova to get the appropriate plugin file if you are unsure which files you need.

About this task

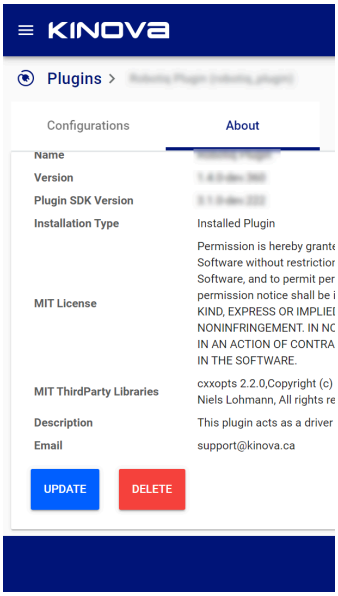
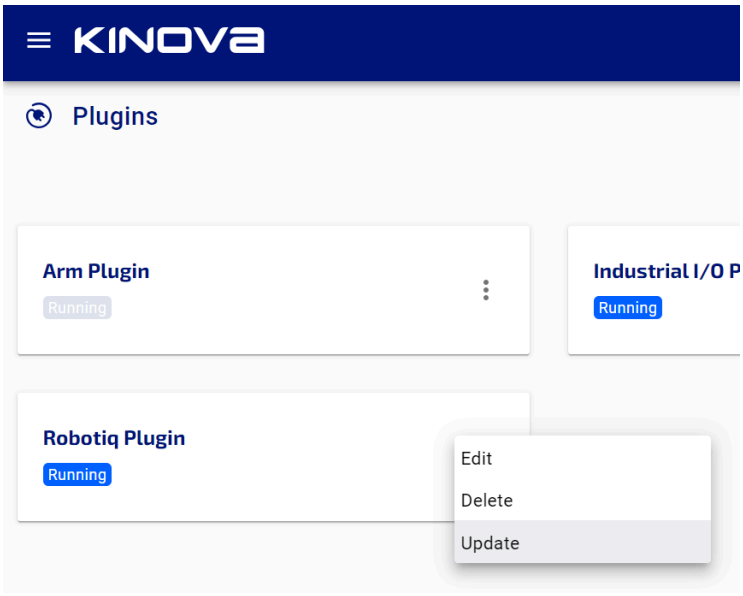
Use a computer or a *teach pendant*. Update plugins directly from the **Plugins** page or from the **About** page of the plugin.

Procedure

1. Get the latest version of the plugin.
2. Tap **Systems** > **Plugins**.
3. Tap the plugin that you want to update.

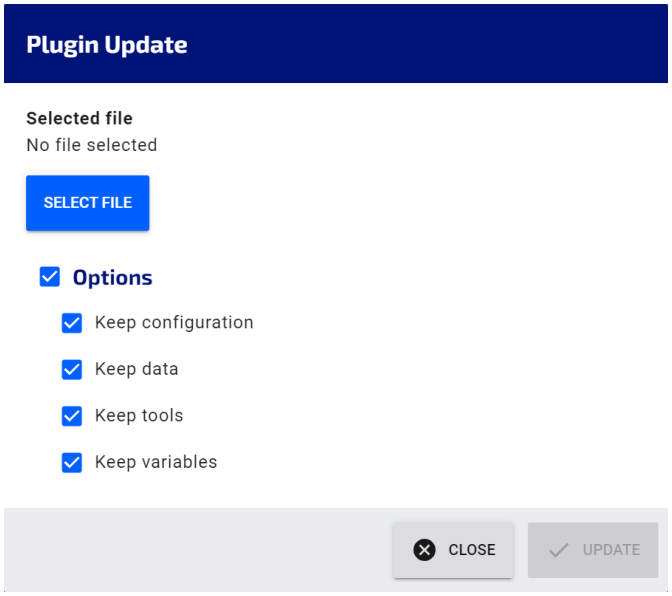
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4. Access the update dialog in one of two ways.

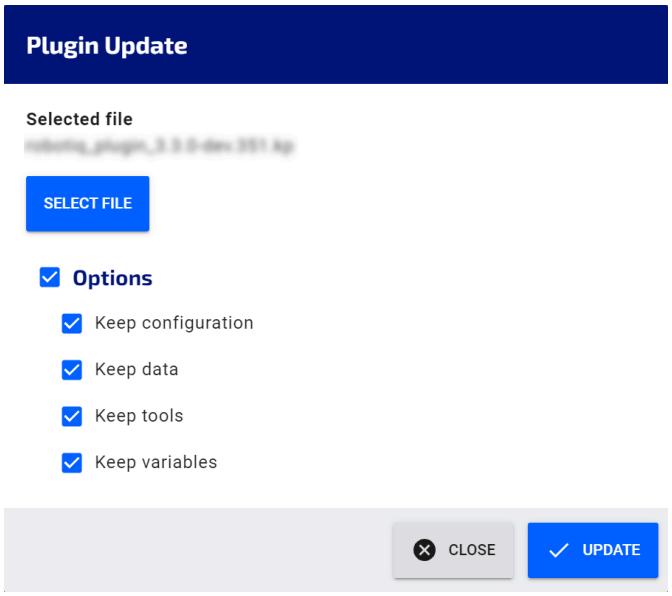
Option	Description
Update from the About page of the plugin	**a.** Tap **About**. The **About** page launches. 
Update from the Plugins page	**a.** Navigate to the **Plugins** page. **b.** Tap the *kebab menu* (⋮) of the plugin that you want to update. 

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5. Tap **Update**.
   The **Plugin Update** dialog launches.



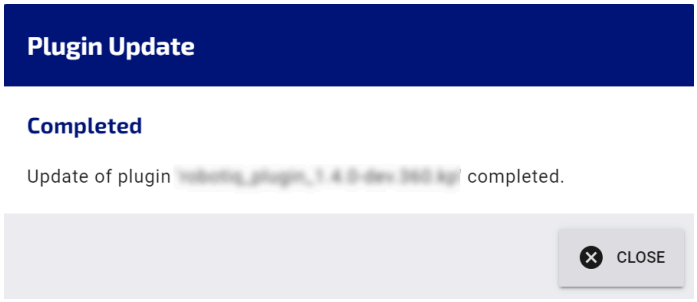
6. Tap **SELECT FILE**.
7. Select the plugin file.
   The name of the file is displayed as the **Selected file**.



8. Tap **Options**.
   By default, all data is selected. Deselect any information you want to ignore. Data that can be saved include the configuration, data, tools, and variables.
9. Select the type of data you want to keep from the current plugin.

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10. Tap **UPDATE**.
    The **Plugin Update** indicates that the plugin is updated.



11. Tap **CLOSE**.
    The **Plugin Update** dialog closes.

Overview of working with plugins

Tapping a plugin from the **Plugins** page launches the page of that plugin.



Figure 119: Example of a plugin page of a plugin that is stopped

1 Tap **Plugins** to return to the list of plugins.

2 Name of the selected plugin with the name of the *namespace* associated with the selected plugin in parentheses.

3 Tap **Configurations** to view and modify the current configurations of the selected plugin.

Important: Tap **Stop** (Stop) before you attempt to modify the current configurations.

Important: Tap **Start** (Start) after you modify the configurations. The plugin runs with the latest configuration values.

When there are no modifiable configurations in the plugin, a message is displayed.

```
This plugin does not expose any configuration.
```


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4 Tap **About** to view important information about the selected plugin.

- Name
- Version
- Plugin SDK Version
- Installation Type
- Licenses
- Libraries
- Description
- Email

5 Toggle **Active** to deactivate plugins that need to be installed but are not being used. When the toggle is white, it is off.

Tap **Active** to activate a deactivated plugin. When the toggle is blue, it is on.

6 The current operating state of the plugin.

Tap **Stop** (Stop ■) to stop the plugin from running. The button changes to **Start** (Start ▶).

Tap **Start** to restart the plugin after modifying its settings. The button changes to **Stop**.

Configuring tools

All tools need to be configured before they are used.

About this task

All tool configuration tasks are accessed by tapping **Systems** > **Tools**.

Tip: Before you can edit the active tools, the robot arm must be switched off or the robot must be in Monitored Stop mode.

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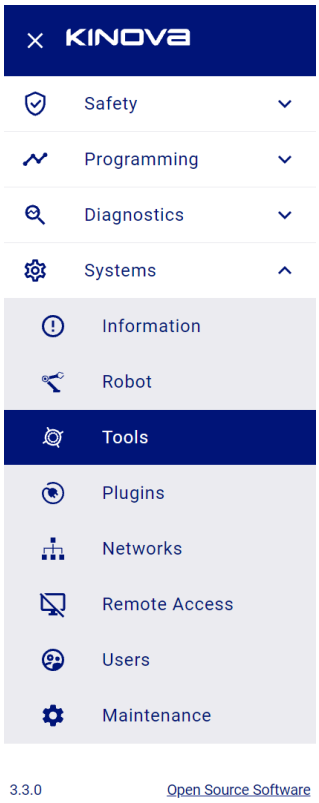
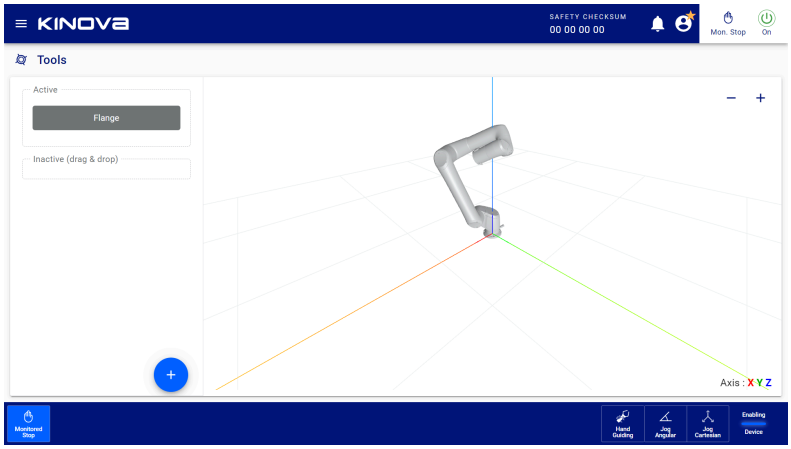


Figure 120: Accessing tool configuration operations

Procedure

1. Tap **Systems** > **Tools**.
   The **Tools** page launches.



   The tools are listed on the left side in two groupings: **Active** and **Inactive (drag & drop)**. The *flange* is always listed in the **Active** tools list because all tools are attached to it.

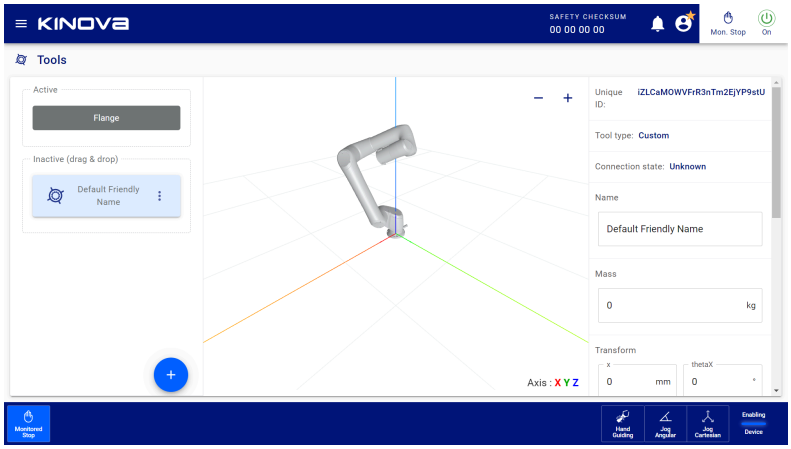
   The center is a 3D view of the arm that can be moved around to help you visualize the tool reference frame. Tap **+** or **-** to zoom in or out. Hold and move the view around to have different viewpoints of the robot.

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2. Select a tool in the **Active** or the **Inactive (drag & drop)** pane.

   Tip: Kinova accessories and tools supported by plugins that are installed are available in the **Inactive (drag & drop)** pane.

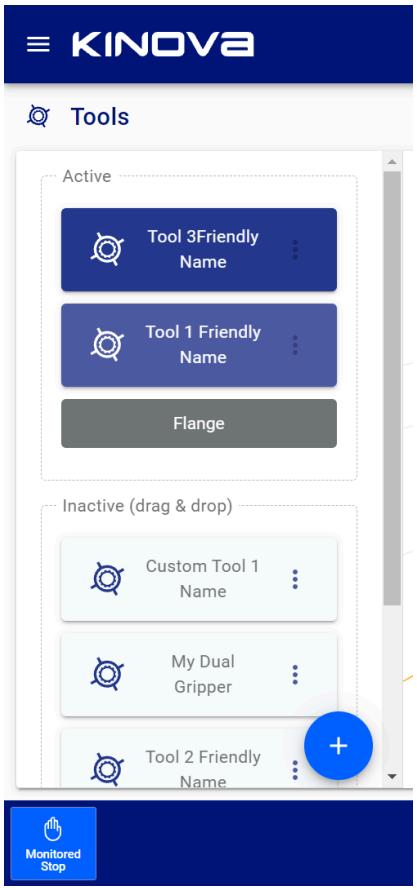
   The properties of the selected tool are displayed on the right.



3. Modify the values in the **Properties** panel.

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4. Drag and drop each tool in the order they are assembled onto the flange of the *wrist*.
   A flange is already on the wrist. When you physically add a tool, if the next one is Tool 1 Friendly Name, drag that tool to be above Flange. If the next tool is Tool 3 Friendly Name, drag that above Tool 1 Friendly Name.



Adding tools

Custom tools do not come with their own *plugins*. The tool can still be added and defined so that the robot can take it into consideration when following position commands.

Before you begin

Know the mass, transformation, center of mass, and inertia matrix of your tool.

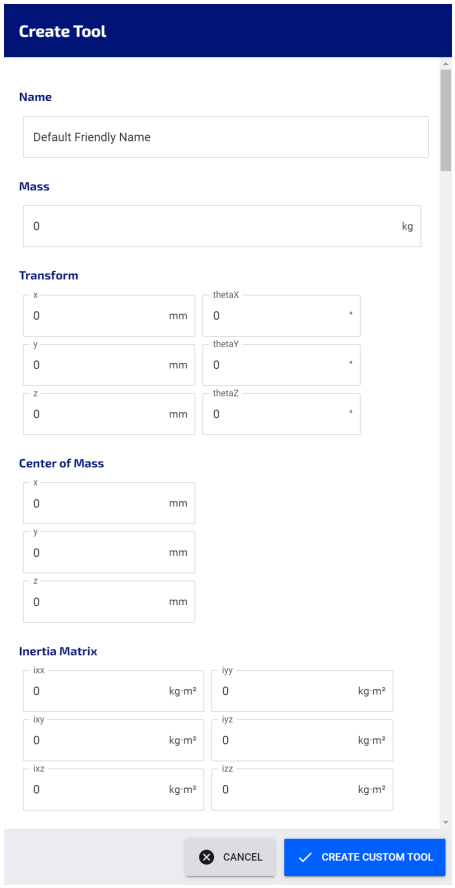
About this task

The properties of the custom tool affect the *TCP* of the entire robot.

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Procedure

1. Tap ⊕.
   The **Create Tool** dialog launches.



2. Enter the information about the tool.
   - **Name**
   - **Mass** in kg
   - **Transform: x, y, z** in mm
   - **Transform**: **thetaX**, **thetaY**, **thetaZ**
   - **Center of Mass: x, y, z** in mm
   - **Inertia Matrix: ixx, ixy, ixz, iyy, iyz, izz** in $kg \cdot m^2$

3. **DANGER:** Make sure the **Mass** and **Center of Mass** input for the payload correspond to the physical mass and center of mass of the payload installed on the robot.
   If the physical mass and physical center of mass of the payload does not match what is entered in the Create Tool form, it could lead to erratic behavior of the robot when it is used in Hand Guiding mode.

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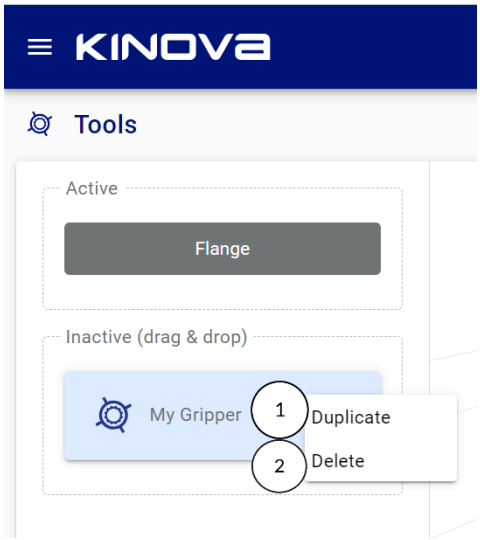
Always validate the mass and center of mass that is entered in Create Tool against the physical inertial parameters.

Tap **CREATE CUSTOM TOOL**.

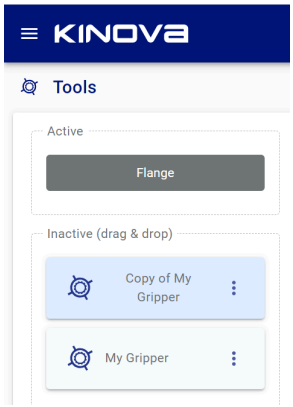
The new tool is added to the list of available tools.

Other actions that can be taken on tools

There are three actions you can perform on available custom tools.



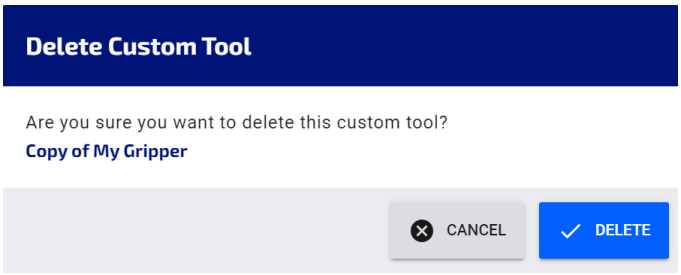
1 **Duplicate** The tool is duplicated as "Copy of" followed by the name of the copied tool.



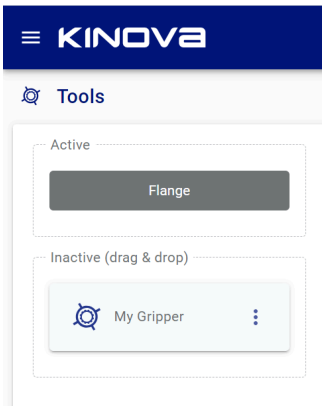
Important: If the name of the tool is more than 17 characters, the tool is not duplicated.

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2 **Delete** A confirmation dialog launches.



Tap **Delete** and the selected tool is no longer available.



Configurations for the robot settings

Some of the robot settings in the controller, the arm, and the force torque sensor in the wrist are configurable.

All configurations specific to the robot are accessed by tapping **Systems** > **Robot**.

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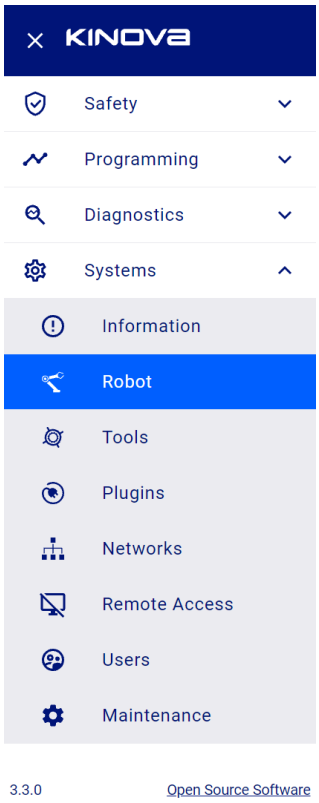


Figure 121: Accessing the robot settings

Configuring the controller for robot controls

The **Robot Controller** page displays the configurations that can be changed for the controller.

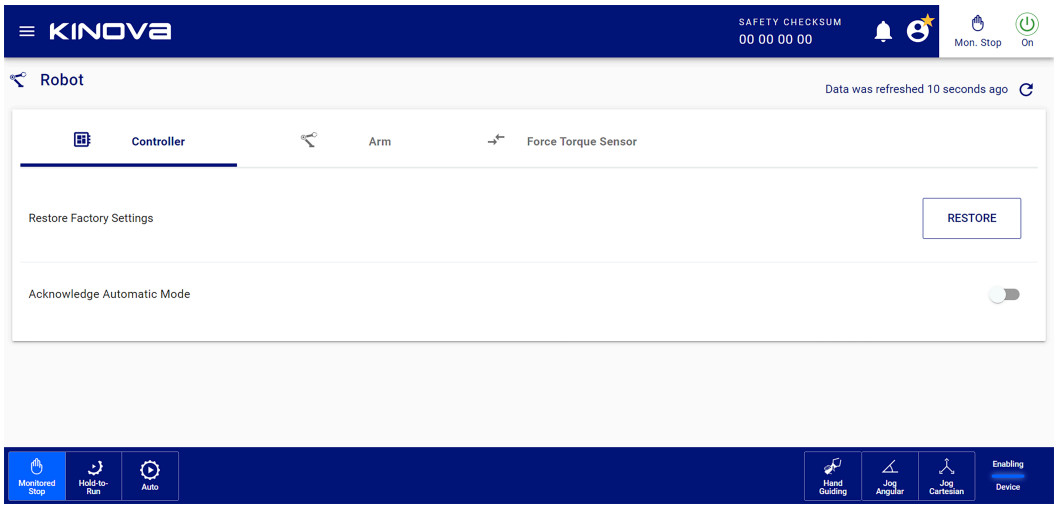
About this task

All controller configurations for the robot must be performed when the robot is in Monitored Stop.

The only changes that can be made to the robot with respect to the controller involve using the settings from the factory, as well as using or overriding the Acknowledge button on the controller.

Access the **Controller** page by tapping **Systems** > **Robot**. The **Controller** page is the default page.

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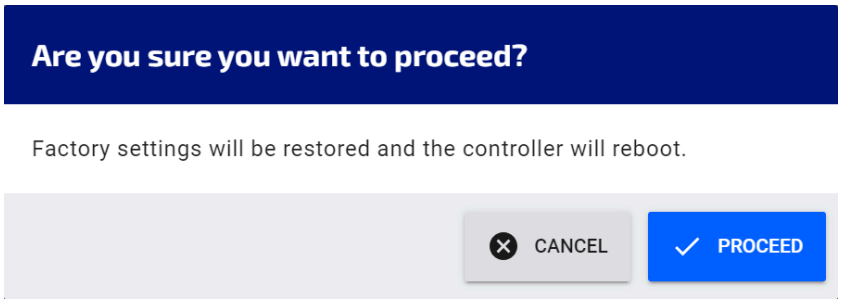


Procedure

1. Tap **RESTORE** in the **Restore Factory Settings** pane to reinstate factory settings in the *base*.

   Remember: When you restore factory settings, all configurations, *plugins*, and programs are deleted.

   A confirmation dialog launches, reminding you the controller reboots after resetting the robot to factory settings.



2. Tap the **Acknowledge Automatic Mode** slider to enable or disable the use the ACK button on the controller to confirm running a program in Automatic mode.

   Note: By default, the **Acknowledge Automatic Mode** is enabled.

Related topics

Restoring factory defaults on page 224

Configurations of the arm for robot controls

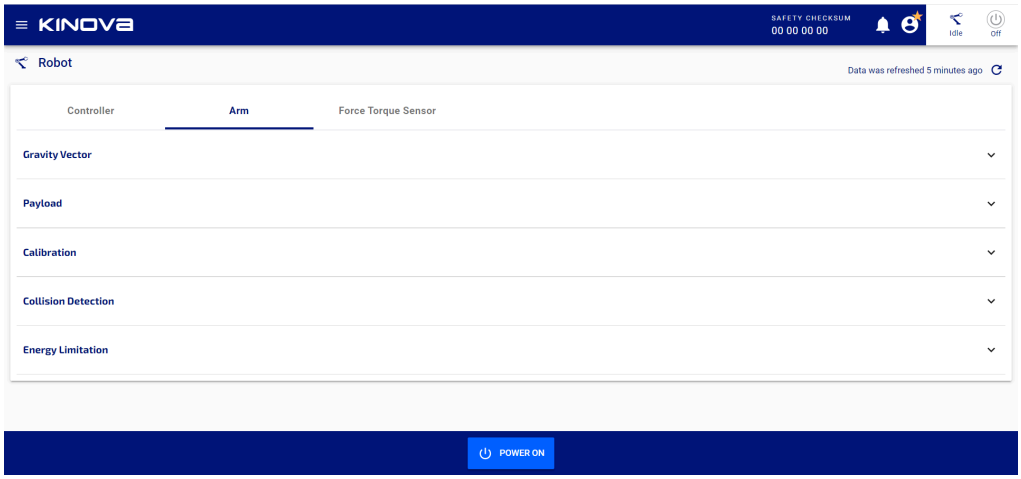
The **Robot Arm** page displays the configurations that can be changed for the arm.

All *arm* configurations for the robot must be performed when the robot is in Monitored Stop.

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The only changes that can be made to the robot with respect to the arm involve its *gravity vector*, *payload*, calibration, collision detection, and energy limitation.

Access the **Arm** page by tapping **Systems** > **Robot** > **Arm**.



Configuring the gravity vector of the arm

The gravity vector must be defined accurately so that the robot can compensate for torque on the actuators. When the robot is unboxed, the robot is oriented sideways.

About this task

The *controller* expects the arm to be oriented up with gravity pointing down. When the arm is installed on a table, the gravity vector must be configured as (x = 0 m/s^2, y = 0 m/s^2, z = -9.81 m/s^2).

Important: Gravity is acceleration towards Earth. An arm that is installed on a table has a directional gravity that is represented by a minus (-) sign because of the gravitational pull on the wrist towards Earth. An arm that is installed directly on the ceiling as a directional gravity that is represented by a positive (+) sign because the wrist is already facing Earth.

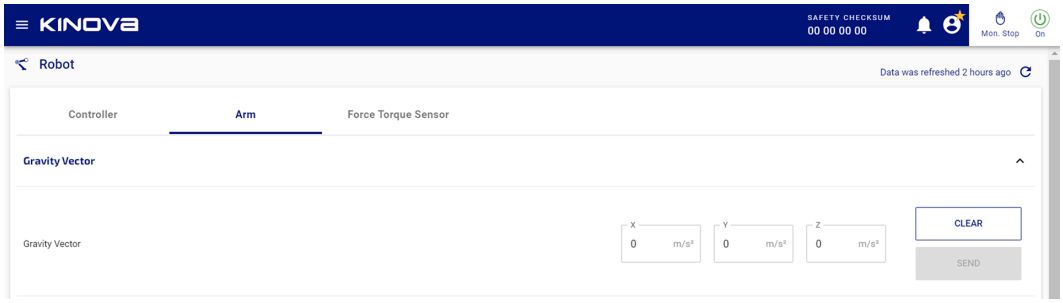
Important: It is the responsibility of the *integrator* and the risk analysis that was performed to make sure the gravity vector is configured correctly.

Access the **Arm** page by tapping **Systems** > **Robot** > **Arm**.

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Procedure

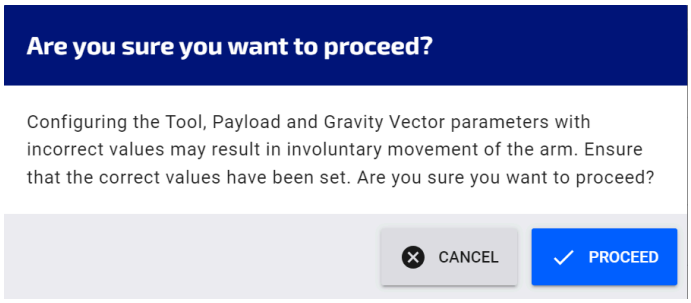
1. Tap **Gravity Vector** to access configurable parameters of the gravity vector of the arm.
   The **Gravity Vector** pane launches.



2. Enter values for x, y, and z in m/s^2, expressed in the Base reference system.

   Important: The gravity vector is not normalized and is not scaled. Make sure to keep the standard acceleration of gravity at 9.81 m/s^2; any other value affects the feeling of the robot when operating in Hand Guiding mode.

3. Tap **SEND**.
   A confirmation dialog launches when errors are suspected.



4. Tap **PROCEED** to apply the gravity vector values to the controller or tap **CANCEL** to cancel the operation.
5. Tap **CLEAR** to erase the values entered that have not been sent.

Related topics

Configurations of the arm for robot controls on page 199

Configuring the payload

The mass and center of the object being picked affect the positioning and speed of the robot.

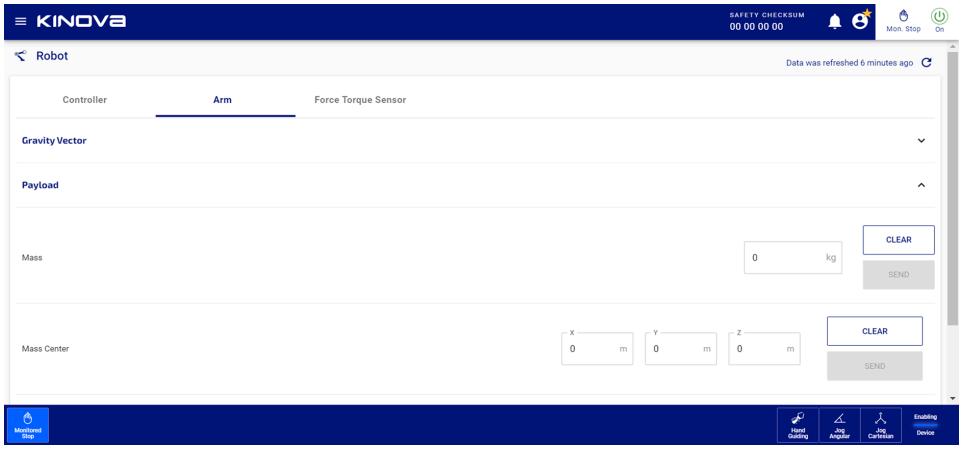
About this task

Access the **Arm** page by tapping **Systems** > **Robot** > **Arm**.

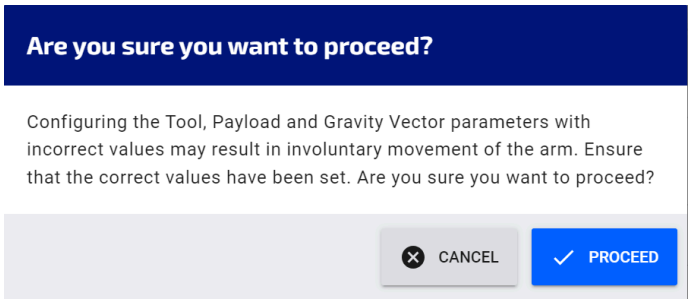
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Procedure

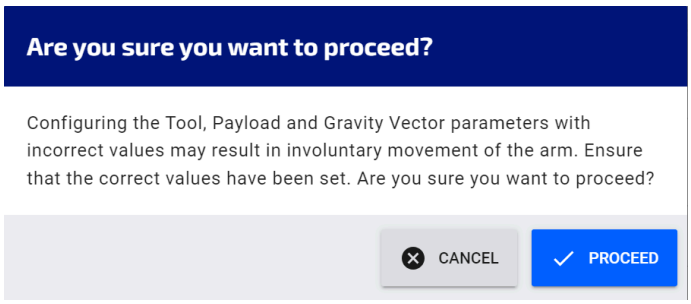
1. Tap **Payload** to access configurable parameters of the payload.
   The **Payload** pane launches.



2. Enter the `Mass` in kg of the object being picked.
3. Tap **SEND**.
   A confirmation dialog launches.



4. Tap **PROCEED** to apply the mass of the object that is to be picked to the controller or tap **CANCEL** to cancel the values entered.
5. Tap **CLEAR** to erase the values from the page.
6. Enter the `Mass Center` in meters of the object being picked.
7. Tap **SEND**.
   A confirmation dialog launches.



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8. Tap **PROCEED** to apply the mass of the object that is to be picked to the controller or tap **CANCEL** to cancel the values entered.
9. Tap **CLEAR** to erase the values from the page.

Related topics

Configurations of the arm for robot controls on page 199

Configuring the calibration parameters of the arm

Calibrating the arm leads to increased accuracy in the movement.

About this task

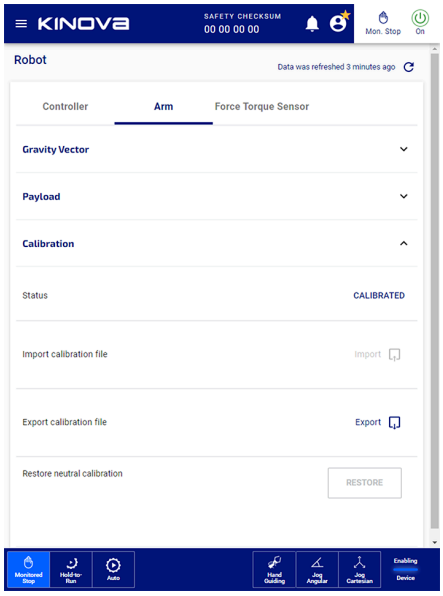
Calibration files contain the date and time of the calibration file, the serial number of the arm, and parametric values. There must be an active calibration file for the robot to operate.

Access the **Arm** page by tapping **Systems** > **Robot** > **Arm**.

Procedure

1. Tap **Calibration** to access configurable parameters.

   The **Calibration** pane launches.



2. Look at **Status** for the current calibration status of the arm.

   The status of the calibration indicates whether there are issues before you start using the robot.

   - **Calibrated**
   - **Not Calibrated**
   - **Waiting Arm Power On**

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3. Tap **Import** from the **Import calibration file** pane to import a calibration file when the controller is replaced.

   Calibration files can be imported only when the robot is idling with the arm switched off. The arm is recalibrated with the content of the file only after a reboot of the robot.

   Tip: The arm must not be switched on to import a calibration file.

4. Tap **EXPORT** from the **Export calibration file** pane to export the current calibration file before changing the controller.
5. Tap **RESTORE** in the **Restore neutral calibration** pane.

   Neutral calibration implies the arm is not calibrated.

   Tip: The arm must not be switched on to restore the calibration.

Related topics

Configurations of the arm for robot controls on page 199

Configuring collision detection on the arm

Configuring the parameters for collision detection leads to safer operations.

About this task

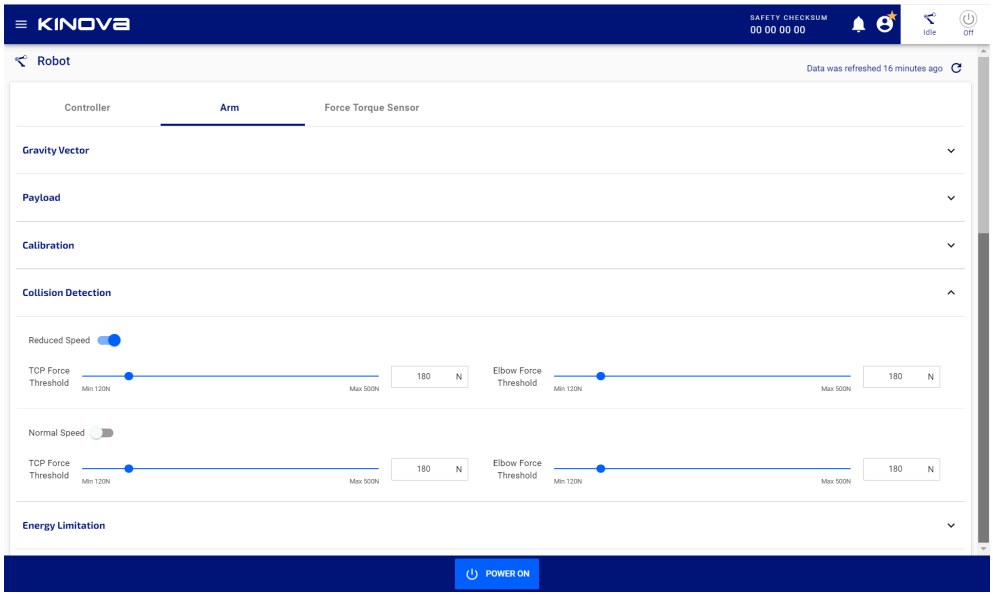
Access the **Arm** page by tapping **Systems** > **Robot** > **Arm**.

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Procedure

1. Tap **Collision Detection** to access configurable parameters for detecting collisions with the arm.

   The **Collision Detection** pane launches.



2. Tap the **Reduced Speed** slider to enable or disable reduced speeds in collision detection.
3. Drag the **TCP Force Threshold** slider to set an amount of force to be used as the amount of external force on the TCP that is needed for a collision to be detected when **Reduced Speed** is enabled.

   The range of the force on the TCP is from 120 N to 500 N.
4. Drag the **Elbow Force Threshold** slider to set an amount of force to be used as the amount of external force on the elbow that is needed for a collision to be detected when **Reduced Speed** is enabled.

   The range of the force on the elbow is from 120 N to 500 N.
5. Tap the **Normal Speed** slider to enable or disable normal speeds in collision detection.
6. Drag the **TCP Force Threshold** slider to set an amount of force to be used as the amount of external force on the TCP that is needed for a collision to be detected when **Normal Speed** is enabled.

   The range of the force on the TCP is from 120 N to 500 N.
7. Drag the **Elbow Force Threshold** slider to set an amount of force to be used as the amount of external force on the elbow that is needed for a collision to be detected when **Normal Speed** is enabled.

   The range of the force on the elbow is from 120 N to 500 N.

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Related topics

Configurations of the arm for robot controls on page 199

Configuring energy limitations on the arm

Configuring the parameters for energy limitations leads to safer operations.

About this task

Access the **Arm** page by tapping **Systems** > **Robot** > **Arm**.

Procedure

1. Tap **Energy Limitation** to access configurable parameters for energy limitations for the arm. The **Energy Limitation** pane launches.



2. Tap the **Reduced Speed** slider to enable or disable reduced speeds in energy limitations.
3. Drag the **TCP Energy Limit** slider to set an amount of force to be used as the amount of external force on the TCP that is needed for a collision to be detected when **Reduced Speed** is enabled.

   Energy limitation of the TCP ranges from 0.005 J N to 50 J.
4. Drag the **Elbow Energy Limit** slider to set an amount of force to be used as the amount of external force on the elbow that is needed for a collision to be detected when **Reduced Speed** is enabled.

   Energy limitation on the elbow ranges from 0.005 J to 50 J.
5. Tap the **Normal Speed** slider to enable or disable normal speeds in collision detection.

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6. Drag the **TCP Energy Limit** slider to set an amount of force to be used as the amount of external force on the TCP that is needed for a collision to be detected when **Normal Speed** is enabled.

   Energy limitation of the TCP ranges from 0.005 J N to 50 J.

7. Drag the **Elbow Energy Limit** slider to set an amount of force to be used as the amount of external force on the elbow that is needed for a collision to be detected when **Normal Speed** is enabled.

   Energy limitation on the elbow ranges from 0.005 J to 50 J.

Related topics

Configurations of the arm for robot controls on page 199

Configuring the force torque

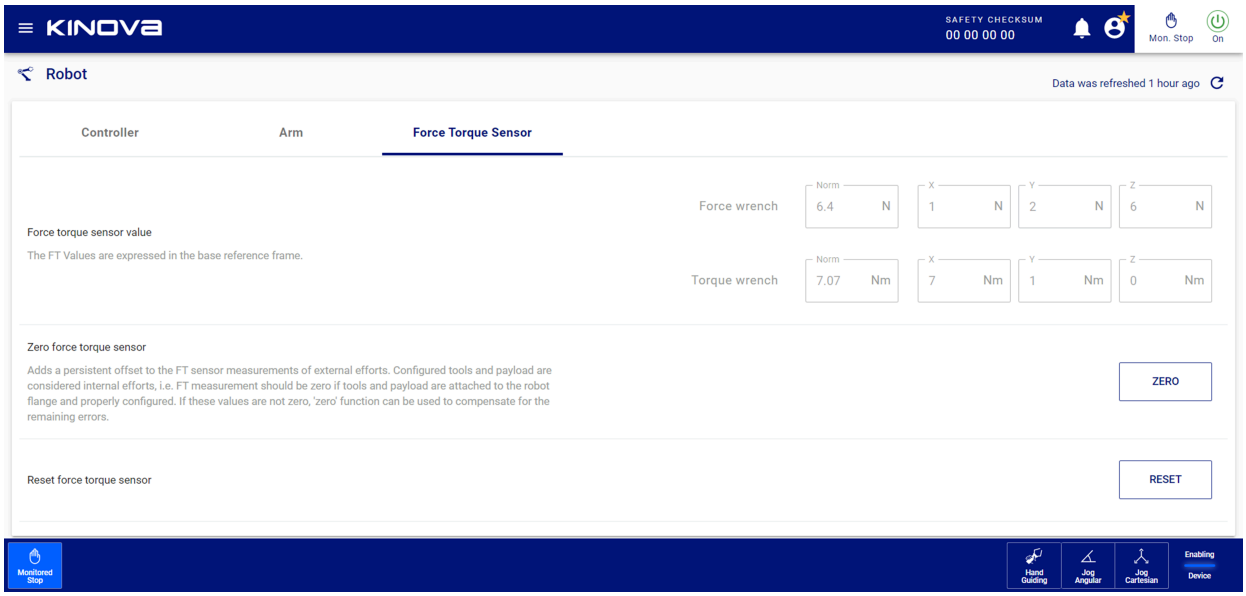
The **Robot Force Torque Sensor** page displays the configurations that can be changed for the force torque sensor in the wrist.

About this task

All configurations for the force torque sensor on the robot must be performed when the robot is in Monitored Stop.

Force is measured with respect to the base of the robot.

Access the **Force Torque Sensor** page by tapping **Systems** > **Robot** > **Force Torque Sensor**.



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Procedure

1. Look at the force and torque values in the **Force Torque Sensor** pane.

   The values are relative to the reference frame at the tool mounting flange of the robot. It displays the current **Force wrench**, measured in N, and **Torque wrench**, measured in N·m, of the robot.

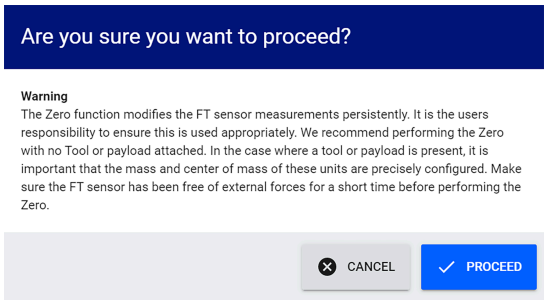
Performing a Zero function

2. Tap **ZERO** in the **Zero force torque sensor** pane.

   A zero function is necessary when the values listed in **Force wrench** are not 0 N or the values listed in **Torque wrench** are not 0 N·m when no external forces are applied. Shock and temperature can cause non-zero values.

   A confirmation dialog that recommends two situations for the robot to be in before proceeding with the Zero function.

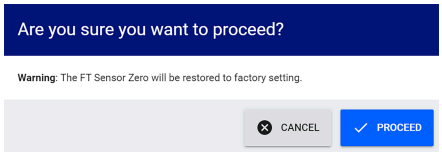
   - No tool or payload should be attached to the robot.
   - If a tool or payload is already attached to the robot, make sure the correct values for the mass and center of mass are entered accurately.



3. Tap **PROCEED** to zero the force torque sensor or tap **CANCEL** to cancel the Zero operation.

Resetting

4. Tap **RESET** in the **Reset force torque sensor** to restore the default offsets of the force torque sensor.
   A confirmation dialog launches with the warning that the force torque sensor is going to be set to its factory settings.



5. Tap **PROCEED** to return to factory settings of the force torque or **CANCEL** to cancel the reset operation.

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Maintenance mode

Kinova recommends backing up the Link 6 firmware operations and data from the internal processes on a regular basis to make troubleshooting issues easier.

Performing software maintenance is made of two actions.

- Back up the software configuration of your Link 6 system.
- Save system log files that contain vital information when the system suddenly stops working the way it should.

Select **MAINTENANCE MODE** on the login dialog or tap **Systems** > **Maintenance** to perform maintenance when Link 6 is operating or when the arm is off.

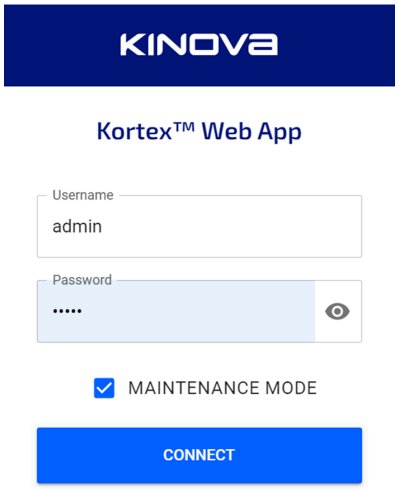


Figure 122: Login dialog

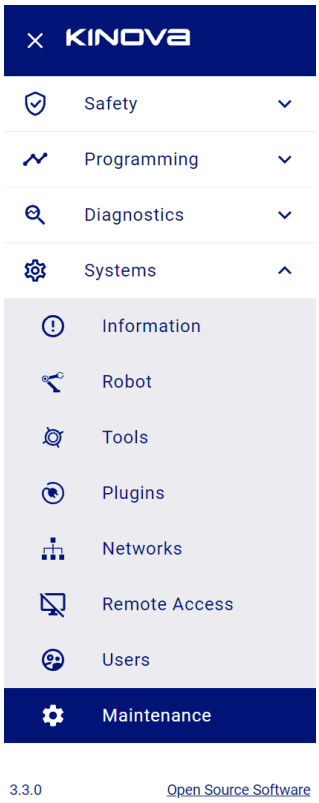


Figure 123: Accessing maintenance tasks

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Figure 124: Maintenance page

The header of the **Maintenance** page has a slightly different look when it is accessed from the login dialog with **MAINTENANCE MODE** selected.



Figure 125: Kortex Web App header in Maintenance mode



Figure 126: Regular Kortex Web App header

The footer of the **Maintenance** page also has a slightly different look when it is accessed from the login dialog with **MAINTENANCE MODE** selected. The Robot control panel is not present.

The **Maintenance** page has functionality differences that depend whether you are an administrator or an operator. The difference is that the administrator is the only user who can **LOAD** different configurations.

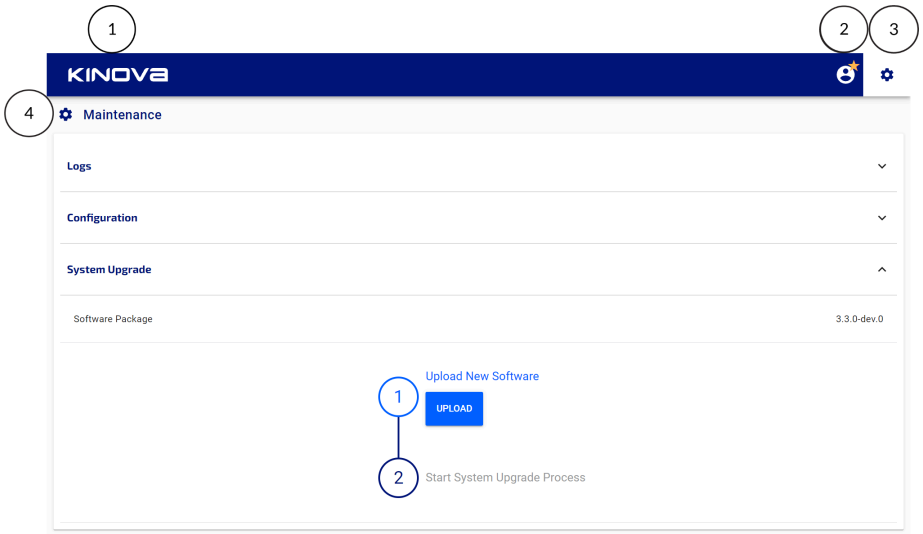


Figure 127: Maintenance page when log in with Maintenance Mode

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1	The Kinova logo keeps the user on the **Maintenance** page.
2	The User profile icon is available so that you can log out.
3	The Mode indicator shows the user is in Maintenance mode.
4	The text indicates the name of the page.

The **Maintenance** page is divided into three panes.

- **Logs**
- **Configuration**
- **System Upgrade**

Logs

Collecting logs on a regular basis helps to troubleshoot issues with the Kinova support team.

Log files are `.ZIP` files that contain vital information about the robot. The log files are saved automatically with the file name `logs_[YYYY]_[MM]_[DD]_-_[hh]_[mm]_[ss]Z.zip`.

YYYY	four-digit year **Example:** 2023
MM	month, from 1 to 12
DD	day, from 1 to 31
hh	hour of the day, from 00 to 23
mm	minutes, from 00 to 59
ss	seconds, from 00 to 59
Z	timestamp is within the UTC time zone indicator

Log files do not exceed 1.5 GB. The exported log include logs from the current system *boot*.

The log also includes information about resource usage, the total amount of time the robot has been operating, memory statistics, version of the *SWU* that is currently installed, system and software interrupts, network adapter statistics, disk space statistics, mount points of the system, a snapshot of the database, a snapshot of the dump files generated by the controller.

All log files are password protected.

When a request to export the logs is made, no other request to export can be performed until the previous export is completed.

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Exporting logs

The Kinova support team may ask you to export logs to help troubleshoot an issue while using Link 6.

Before you begin

Make sure you have a *USB storage device* connected to the *controller* when you are exporting logs from the teach pendant. When you are using a computer instead, the log file exports to a location on your computer.

About this task

Log files are protected with passwords.

Tip: Logs cannot be exported when the robot is operating.

Procedure

1. Deactivate the enabling device when the current operating mode is Hold to Run or Manual Jog.
2. Set the operating mode to **Monitored Stop**.
3. Access the **Maintenance** page by performing one of two actions.
   - Log into Kortex Web App in Maintenance mode.
   - Tap **Systems** > **Maintenance**.
4. Tap **Logs**.
   The **Logs** pane expands.
5. Tap **EXPORT**.
   A file with all the system information is saved automatically to the *USB* when the teach pendant is used.

   A file with all the system information is saved in the download section of the web browser when a computer is used.

Generated events

Events are generated for many operations.

Each event is structured with the same format.

Table 74: Structure of generated events

Event heading	Description
Issue	What generated the event

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Event heading	Description
Title	The title given to the issue
Severity	One of four levels of severity • CRITICAL • ERROR • INFO • WARNING
Timestamp	The time when the event is generated
Code	The error code associated with what generated the event
Explanation	An explanation of the problem if there is one
Suggestion	Zero or more suggestions on how to proceed

Configuration files

Backup configuration files protect you by saving the amount of time needed to return to known working configurations of a system that may have been altered for a minor change in a previous task.

Configuration files explicitly list information about how the robot is set up.

Table 75: Information saved in configuration files

Configurations	
Safety functions and their limits	Safety I/Os
Protection zones	State of acknowledge automatic mode
Gravity vector	Payload
Remote access	Collision detection
Energy limitations	Programs (names, properties, actions)
Persistent variables	Users and their encrypted passwords
Tool configurations	Plugin configurations
Plugin binary files	Plugin docker volumes
Other information	
Date and time of the backup file	Factory KIN

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Serial number of the controller	Serial number of the arm **Tip:** The arm must be switched on to have its serial number saved.
Version of the *SWU*	List of all plugins that are installed
Version of each plugin that is installed	Checksum

Configuration files are `.ZIP` files that contain vital information about the robot. The configuration files are saved automatically with the file name `Link_Configuration_[XXXXX]_[YYYY]_[MM]_[DD][Thh]_[mm]_[ss][Z]<_#>.zip`.

XXXXX	Controller serial number
YYYY	Four-digit year the file is created **Example:** 2023
MM	Month the file is created, from 1 to 12
DD	Day the file is created, from 1 to 31
Thh	Hour the file is created, from 00 to 23
mm	Minutes the file is created, from 00 to 59
ss	Seconds the file is created, from 00 to 59
Z	Timestamp is within the UTC time zone indicator
_#	Optional sequential number added when the name of the configuration backup file matches another configuration file that already exists on the *USB* **Examples:** `Link_Configuration_XXXXX_YYYY-MM-DDThh-mm-ssZ.zip`, `Link_Configuration_XXXXX_YYYY-MM-DDThh-mm-ssZ_1.zip`, `Link_Configuration_XXXXX_YYYY-MM-DDThh-mm-ssZ_2.zip`

Backing up the current configuration and setup

When you have determined the best configuration needed for Link 6 to operate a task, save the configuration.

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Before you begin

Make sure to connect a *USB storage device* to the controller before backing up your configuration.

About this task

Operators and Administrators can create the backup configuration files.

Remember: Only one backup configuration file can be created at a time.

Procedure

1. Access the **Maintenance** page by performing one of two actions.
   - Log into Kortex Web App in Maintenance mode.
   - Tap **Systems** > **Maintenance**.
2. Tap **Configuration**.
   The **Configuration** expands.
3. Tap **SAVE**.

Option	Description
To computer	File is saved automatically to the remote computer
To teach pendant	File is saved to the root of the USB storage device on the controller.

Common errors when backing up configuration files

There may be times when error messages are displayed when backing up configuration files. When there is an error, the configuration files are not saved.

Issue	Error message
There is a request from the teach pendant to save a configuration file, but there is no *USB storage device* in the *controller*.	`No USB storage device detected on the controller Front Panel USB port.`
There is a *USB storage device* inserted in the port on the controller, but the USB storage device has less than 2 GB of space left on it.	`Not enough space in "<pathname>" to save the configuration backup file.` **Note:** `<pathname>` is the path where the backup configuration file is to be saved.

Issue:	
Error code	9000
Severity	Error

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Title	Logs Export Error
Explanation	The specified USB storage device is not mounted.
Suggestion	Try the following actions to resolve the issue: a. Make sure the USB storage device is correctly plugged in the controller. b. Unplug/plug the USB storage device. c. Reboot the system. d. Contact Kinova Support.

Issue: The USB storage device has less than 2 GB of free space available for the log file.

Error code	9001
Severity	Error
Title	Logs Export Error
Explanation	The specified USB storage device has insufficient space to save the logs. The USB storage device needs at least 2 GB of available space.
Suggestion	Try the following actions to resolve the issue: a. Remove USB storage device and free space. b. Use a USB storage device with sufficient available space.

Issue: A log is in the process of being exported and there is another request to export a log.

Error code	9004
Severity	Error
Title	Logs Export Error
Explanation	A request to export logs is already being processed. A single request can be processed at a time.
Suggestion	Try the following actions to resolve the issue: a. Retry later. b. Reboot the system.

Loading configuration files

Load configuration files when you need to recover from a change or when you want to use a specific configuration for a specific task.

About this task

For safety reasons, only the *administrator* can load configuration files; the correct file must be restored to the robot given the tasks the robot needs to perform.

Note: Only one backup configuration file can be restored at a time.

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Important: The arm must be switched off.

Important: Notify the user that the network address can be changed with the new configuration.

Procedure

1. Access the **Maintenance** page by performing one of two actions.
   - Log into Kortex Web App in Maintenance mode.
   - Tap **Systems** > **Maintenance**.
2. Tap **Configuration**.
   The **Configuration** expands.
3. Tap **LOAD**.
   The **File Upload** dialog launches with the message `The system will automatically reboot at the end of the configuration restoration.`
4. Select the configuration file to restore.

Option	Description
From computer	Tap **SELECT FILE** to select a configuration file that is accessible from the remote computer.
From teach pendant	Select the file from the list on the **File Upload** dialog.

Results

Success: The system reboots. The login dialog displays the message `The configuration was restored successfully.`

Partial success: The system reboots. The login dialog displays a list of parameters and plugins that could not be restored after the message `The configuration was partially restored. The following parameters/plugins were not restored:`

Failure: The system cancels the restoring of a configuration file when the current configurations of the network, force torque sensor offset, and arm calibration cannot be maintained. All the parameters that caused the cancellation are listed on Kortex Web App.

Upgrading software from a teach pendant

There are continuous improvements made to Link 6. Make sure that your operations take advantage of these improvements by upgrading the software driving the robot.

About this task

Only the *admin* can update the software.

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All software upgrades are accessed by tapping **Systems** > **Maintenance** > **System Upgrade**.

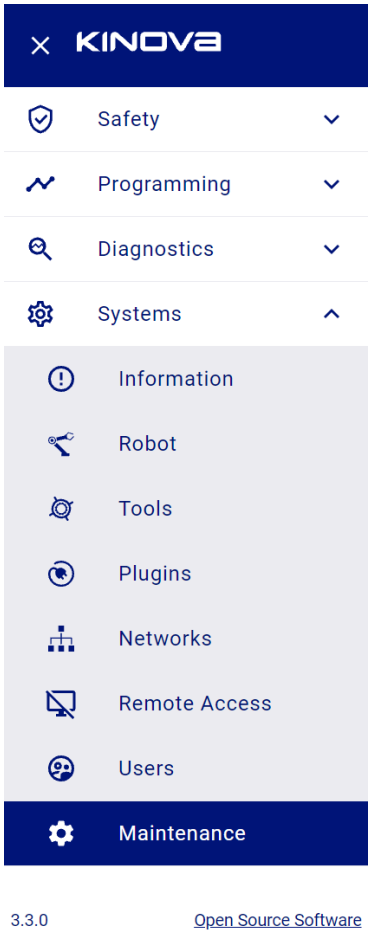


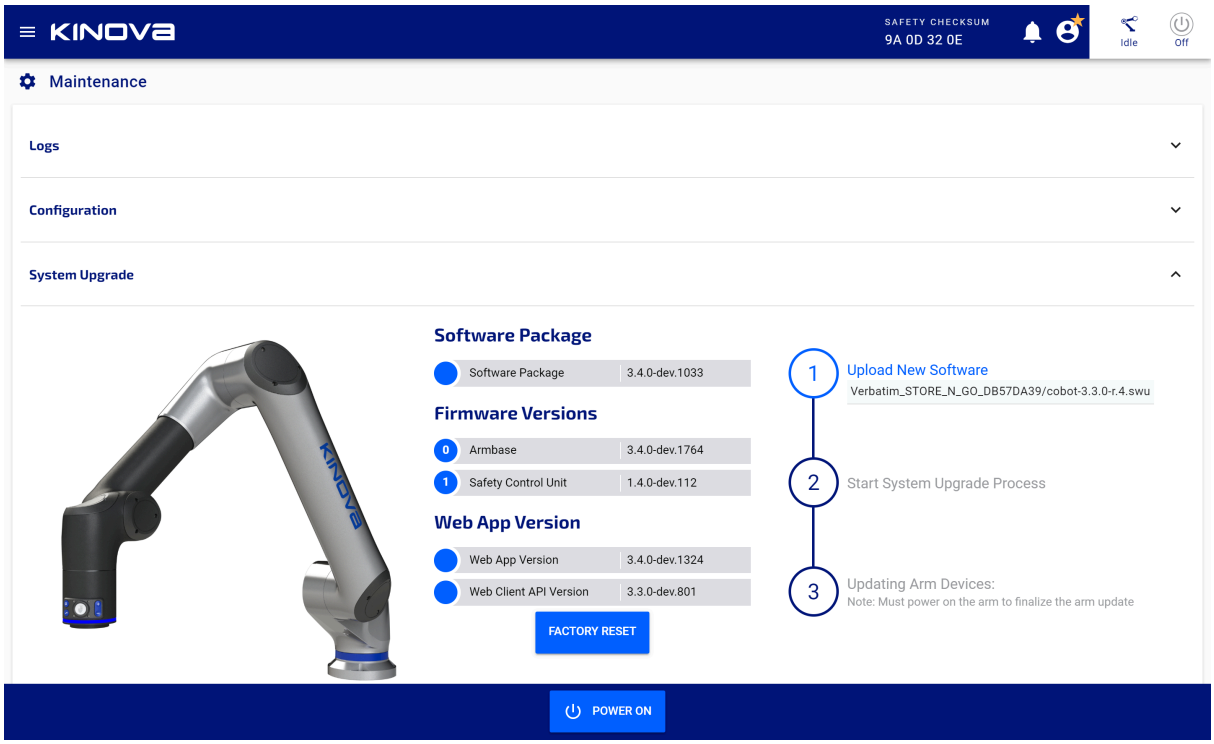
Figure 128: Accessing the software upgrade operation

Procedure

1. Download the new software package from a computer onto a *USB storage device*.
2. Place the USB storage device in the USB port on the controller.
3. Switch off the arm.

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4. Tap **Systems** > **Maintenance** > **System Upgrade**.
   The **System Upgrade** pane launches. It shows the current version of Kortex Web App, Web Client *API*, *firmware* bundle, and firmware versions, as well as the names of all available firmware.

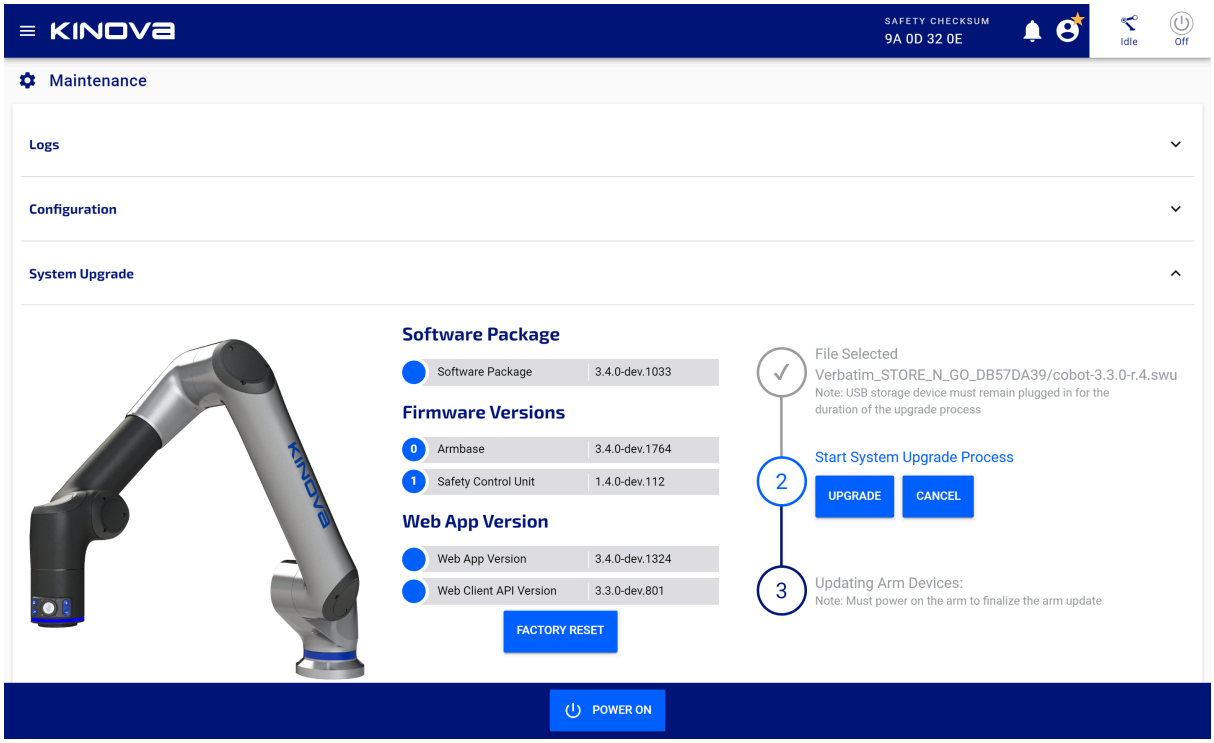


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5. Tap the desired version of software.

   The system file that is used to upgrade the system have the extension `.swu`.

   The timeline moves from **Upload New Software** to **Start System Upgrade Process**.



6. Tap **UPGRADE**.

   The controller upgrades take a little bit of time. After the controller is upgraded, it reboots.

   Each *actuator* receives its upgrade after the arm is switched on automatically by the controller. The upgrade of the actuators takes more time than the upgrade of the controller. There are six (6) actuators and each actuator receives firmware updates when there are changes.

Results

The robot reboots with the upgraded firmware and software.

Upgrading software from a computer

There are continuous improvements made to Link 6. Make sure that your operations take advantage of these improvements by upgrading the software driving the robot.

About this task

Only the *admin* can update the software.

The administrator needs to know where to find the new software, whether that it is on the local drive, a network drive, or *USB storage device*.

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All software upgrades are accessed by tapping **Systems** > **Maintenance** > **System Upgrade**.

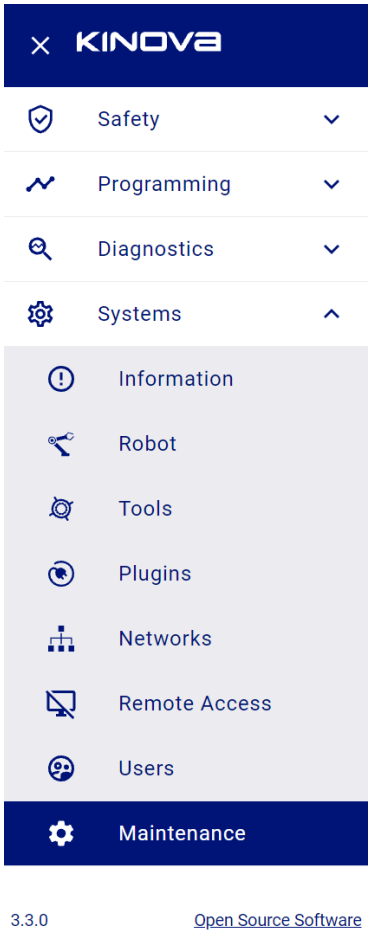


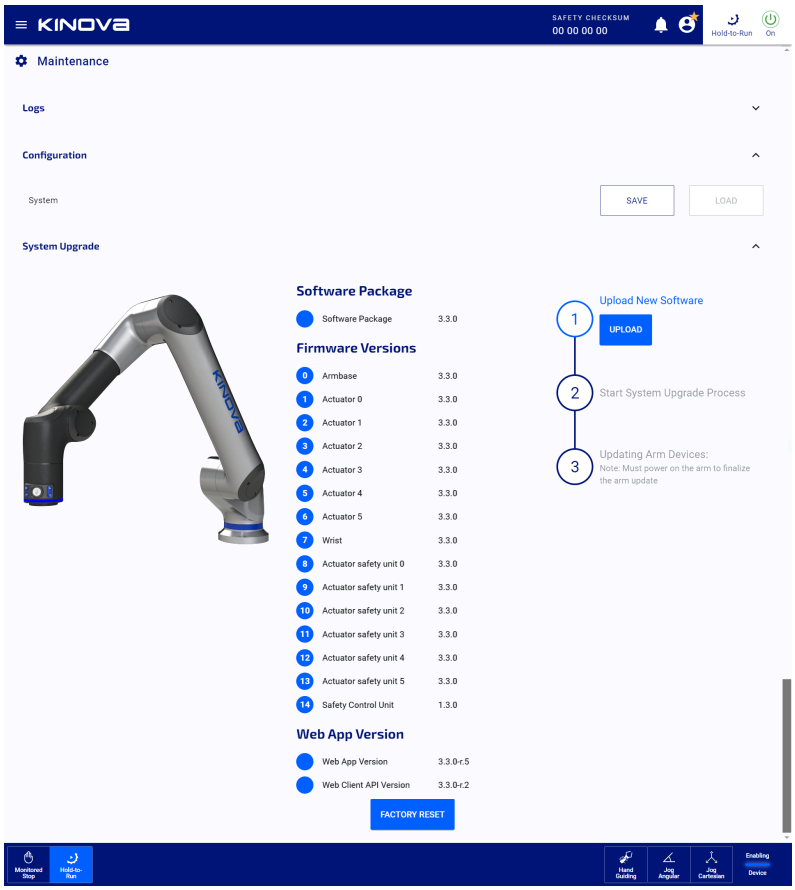
Figure 129: Accessing the software upgrade operation

Procedure

1. Download the new software package from a computer onto a USB storage device.
2. Switch off the arm.

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3. Tap **Systems** > **Maintenance** > **System Upgrade**.
   The **System Upgrade** pane launches. It shows the current version of Kortex Web App, Web Client API, *firmware* bundle, and firmware versions.



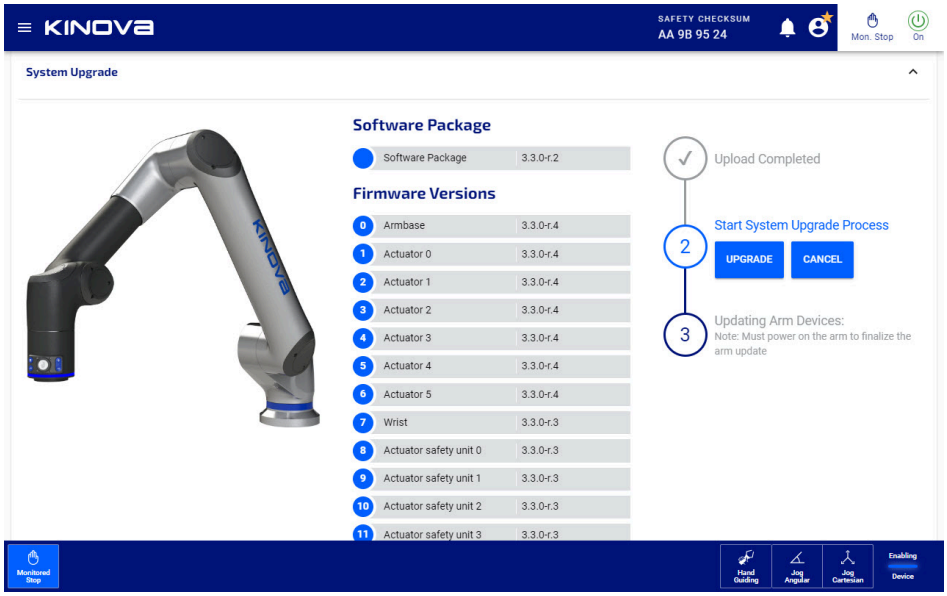
4. Tap **UPLOAD**.

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5. Select the desired version of software.

   The system file that is used to upgrade the system have the extension `.swu`.

   The timeline moves from **Upload New Software** to **Start System Upgrade Process**.



6. Tap **UPGRADE**.

   The controller upgrades take a little bit of time. After the controller is upgraded, it reboots.

   Each *actuator* receives its upgrade after the arm is switched on automatically by the controller. The upgrade of the actuators takes more time than the upgrade of the controller. There are six (6) actuators and each actuator receives firmware updates when there are changes.

Results

The robot reboots with the upgraded firmware and software.

Consequences of downgrading from v3.2 to v3.1

It is entirely possible that you may want to work with an older version of Link 6. Reverting to an older version comes with restrictions.

Version 3.2 is not backwards compatible with version 3.1.

Any configurations done using version 3.2 are lost with a downgrade to 3.1. If you do want to downgrade to 3.1, take note of the current configuration of your system, downgrade to 3.1.x, and perform a factory reset. Re-enter the configuration of your system by referring to your notes.

Note: Many plugin or plugin versions may not compatible with v3.1.

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Restoring factory defaults

An efficient way to revert the system to its default configuration is to restore the factory settings.

About this task

Only the *admin user* can restore the software.

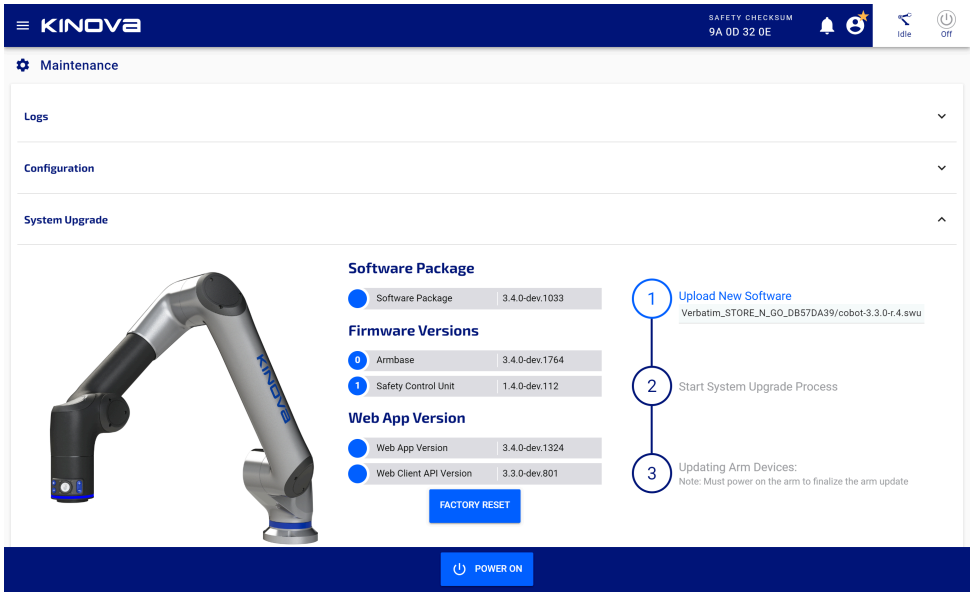
CAUTION: When you restore factory defaults, you lose all your configurations, settings, and programs. You also lose all the user profiles.

Procedure

Restoring factory settings from the Maintenance page

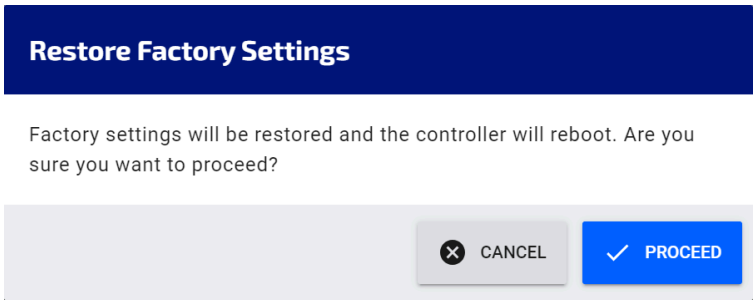
Tip: Factory settings can also be restored from the **Robot** page.

1. Tap **Off** in the On section of *Kortex Web App* to turn off the *arm*.
2. Tap **Systems** > **Maintenance** > **System Upgrade**.
   The **System Upgrade** pane launches.



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3. Tap **FACTORY RESET**.
   A confirmation dialog launches, reminding you the controller reboots after resetting the robot to factory settings.



Results

All settings and configurations revert to the factory settings. All programs, *plugins*, and users, except for the admin user account, are deleted. All safety I/Os revert to their default values. The username and password of the admin user reverts to the `admin` and `admin`, respectively.

Related topics
Configuring the controller for robot controls on page 198

Contact force reduction

It may be important to minimize the contact force in case of an unexpected collision of the arm with its environment, especially with a human operator.

To reduce the contact force of a collision, configure **Collision Detection** and **Energy Limitation** parameters.

Expect higher collision forces under certain conditions; the performance of contact force reduction changes over the workspace of the robot.

- Higher collision forces can be expected because of the physical properties of the manipulator.
- Higher collision forces can be expected when there is a collision with an arm that is nearly fully extended in the radial direction because it takes longer to detect this type of collision. Use protection zones and limit the range of the joints to avoid motion of the TCP in areas where the arm is nearly fully extended.
- Reduced performance can be expected when the *end effector*, or tool, moves closer to the base.

Tip: Have the robot pick up objects as close as possible to the object's center of mass to avoid in-hand movement of the object when it is lifted.

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Collision detection

Link 6 has a feature in which collisions between the *arm*, and at least one object or person, can be detected. When a collision is detected, the robot transitions to Monitored Stop.

When the *arm* is switched off or the robot is in Monitored Stop, configure thresholds for the amount of force detected before stopping the robot. Collision detection is triggered when the force values exceed the thresholds and the system is set in fault. After the fault is cleared, the robot resumes operation from where it was during its program.

Important: Although the thresholds triggers a fault, the thresholds do not prevent the robot from applying more force than the defined threshold.

Smaller thresholds decrease the amount of force felt for a collision to be detected. Larger thresholds increases the amount of force felt for a collision to be detected.

The performance of contact force reduction changes over the workspace of the robot. Expect higher collision forces under specific conditions.

- Higher collision forces can be expected when the physical properties of the manipulator, such as speed, payload, and acceleration, are operating at or near their maximum limits.
- Greater chances of collision forces can be expected when the settings programmed for the robot do not accurately match the real-world conditions and constraints.
- Higher collision forces can be expected when there is a collision with an arm that is nearly fully extended because it takes longer to detect this type of collision.
- Reduced performance can be expected when the *end effector*, or tool, moves closer to the base.

Important: It is crucial to monitor these parameters closely and ensure that the programmed settings of the robot align with the actual operating environment and task requirements. Use **Energy Limitation** to complement **Collision Detection** parameters to limit the speed of the manipulator.

A collision that is detected can be a false positive.

- The posture of the arm is close to a singularity.
- A payload is added and it is not configured correctly.
- The gravity vector is not defined correctly.
- Force threshold configuration values are smaller than the configuration values used in factory setting in Reduced speed mode.
- Force threshold configuration values are reduced, but the energy limits are not reduced.
- Energy limitation functionality is disabled.
- High acceleration constraints in waypoints.

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There are many other ways for a false positive collision detection to occur.

Access the **Arm** by tapping **Systems** > **Robot** > **Arm**.

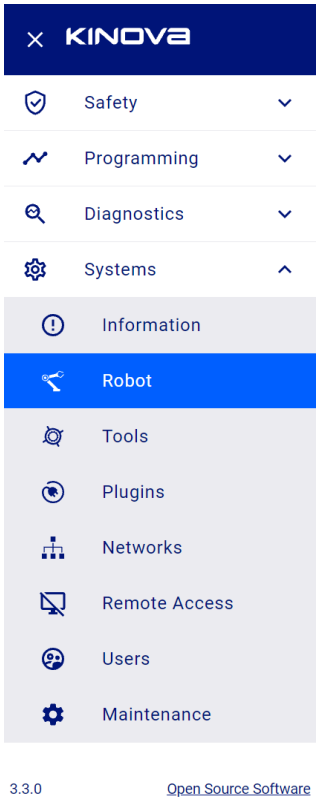


Figure 130: Accessing the Robot page

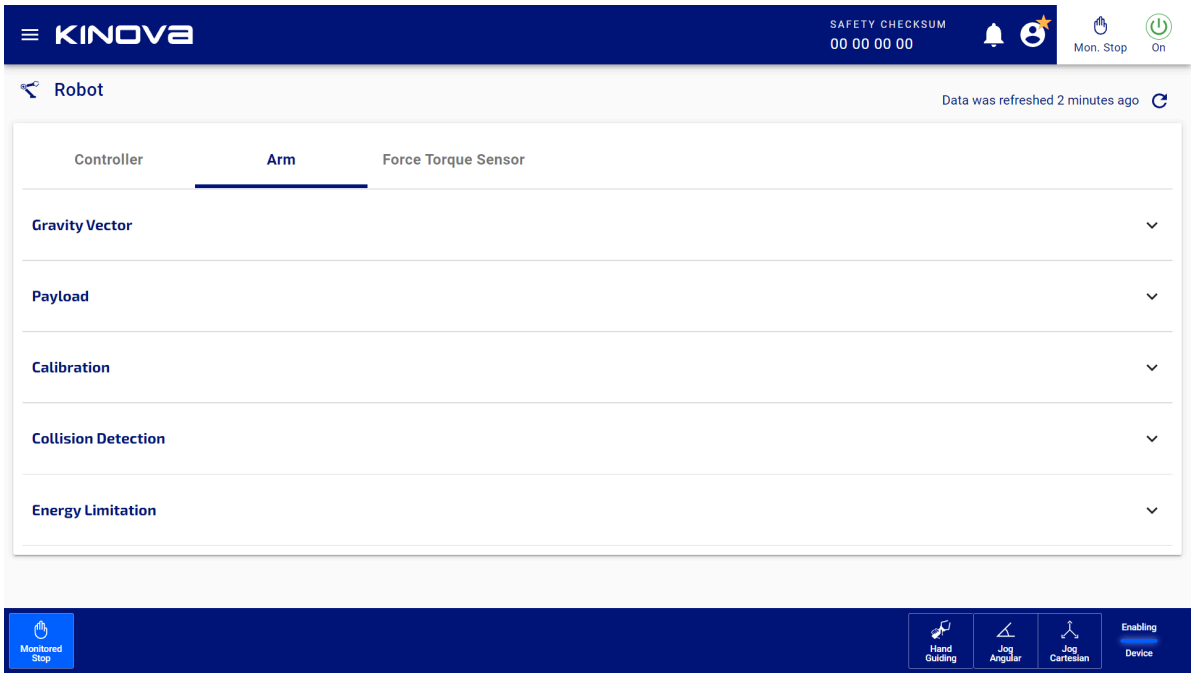


Figure 131: The Arm page

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Tap **Collision Detection** to launch the **Collision Detection** pane.



Figure 132: Collision Detection pane on the Robot Arm page

Configure thresholds for collision detection in both reduced and normal speeds.

Table 76: Parameters to configure collision detection

Configuration	Description
Reduced Speed	Tap to switch between activating and deactivating collision detection at reduced speeds. Default setting: on
TCP Force Threshold	Use the slider to set the threshold. Range: 120 N to 500 N Default setting: 180 N
Elbow Force Threshold	Use the slider to set the threshold. Range: 120 N to 500 N Default setting: 180 N
Normal Speed	Tap to switch between activating and deactivating collision detection at normal speeds. Default setting: on
TCP Force Threshold	Use the slider to set the threshold. Range: 120 N to 500 N Default setting: 180 N
Elbow Force Threshold	Use the slider to set the threshold. Range: 120 N to 500 N Default setting: 180 N

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Energy limitation

The effective kinetic energy at the TCP and elbow is limited by limiting the speed of the TCP or the elbow, respectively. Limiting the kinetic energy reduces the energy that can be transferred in a collision, which reduces the contact force.

The kinetic energy is proportional to the square of the velocity. For example, the kinetic energy of a mass is defined as

$$\text{kinetic energy} = \frac{1}{2} * m * v^2$$

where
m = mass
v = velocity

Link 6 considers the payload, as well as the robot components, when evaluating the kinetic energy.

Smaller limits of energy means the robot may travel slower along a trajectory. Larger limits of energy means the robot may travel faster along a trajectory.

When the *arm* is switched off or the robot is in Monitored Stop, configure the limits of energy that can be used to control the maximum speed of the *TCP* or *elbow* in real time.

Access the **Arm** by tapping **Systems** > **Robot** > **Arm**.

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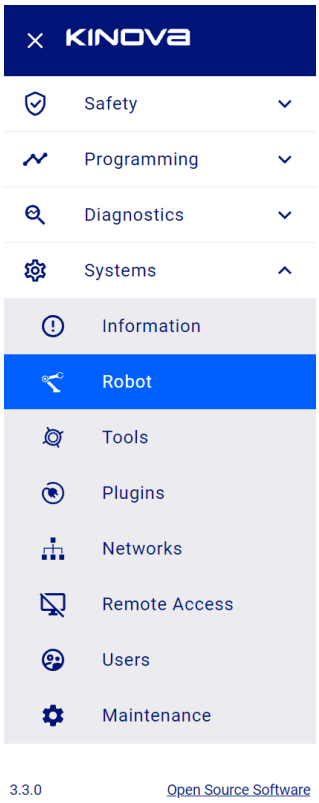


Figure 133: Accessing the Robot page

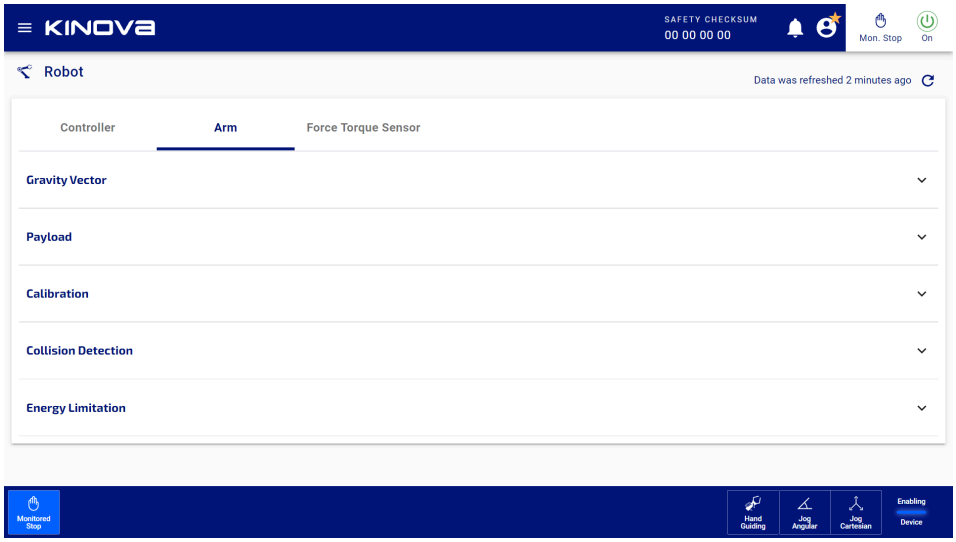


Figure 134: The Arm page

Tap **Energy Limitation** to launch the **Energy Limitation** pane.

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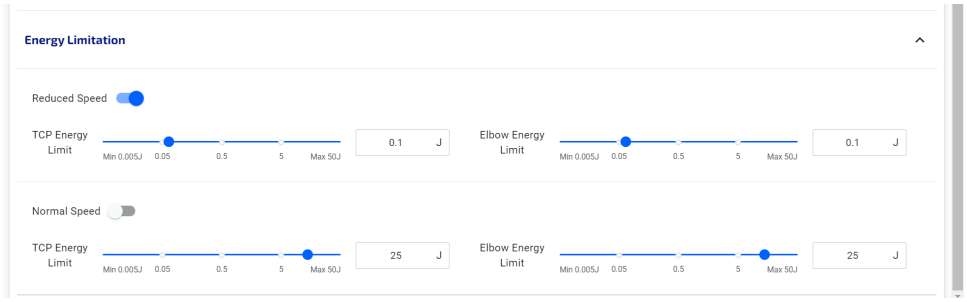


Figure 135: Energy Limitation pane on the Robot Arm page

Configure the energy limits for both reduced and normal speeds.

Table 77: Parameters to configure energy limitation

Configuration	Description
Reduced Speed	Tap to switch between activating and deactivating energy limitation at reduced speeds. Default setting: on
TCP Energy Limit	Use the slider to set the limit. Range: 0.005 to 50 J Default setting: 0.1 J
Elbow Energy Limit	Use the slider to set the limit. Range: 0.005 to 50 J Default setting: 0.1 J
Normal Speed	Tap to switch between activating and deactivating energy limitation at normal speeds. Default setting: off
TCP Energy Limit	Use the slider to set the threshold. Range: 0.005 to 50 J Default setting: 25 J
Elbow Energy Limit	Use the slider to set the threshold. Range: 0.005 to 50 J Default setting: 25 J

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Visual programming

To create programs for your Link 6, use the intuitive and easy-to-use *GUI*, Kortex Web App, and its tile-based, code-free visual programming interface.

By using the tiles, you can teach the robot its tasks, manipulate variables, and interact with external devices.

The result is accurate trajectories with reduced downtime for the robot.

From the **Programs** page, you can see which programs are validated and which ones are not validated. You can also perform tasks on programs.

- **Edit**
- **Duplicate**
- **Delete**
- **Export JSON**

Overview of the Programs page

The **Programs** page is where programs are created and listed.

Tap **Programming** > **Programs** to access and create programs.

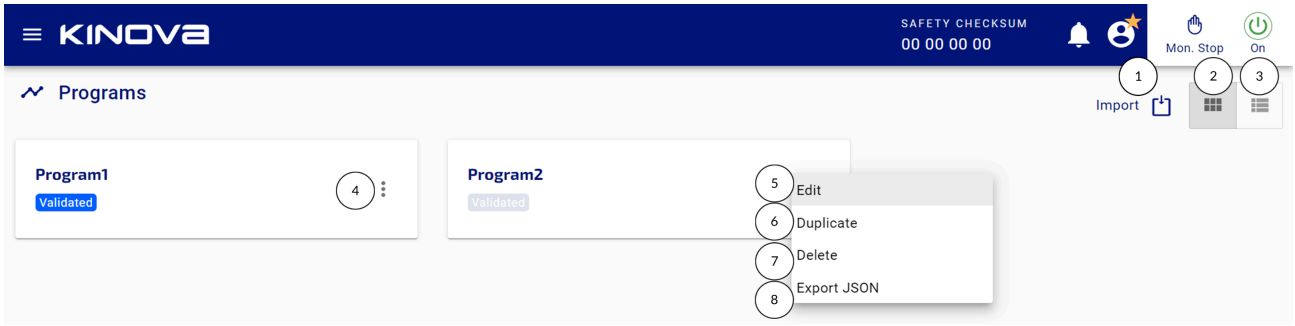


Figure 136: Parts of the Programs page

1 Tap **Import** to import a program from a USB storage device.

Tip: Programs are in JSON files.

2 Tap the card view icon ( ) to view the programs in a tiled fashion.

3 Tap to list view icon ( ) to view the programs in a list.

4 Tap the *kebab menu* ( ) to access the contextual menu of actions that can be used on the program.

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5 Tap **Edit** to edit any part of the program, including its name.

Result: The **Program** page launches.

6 Tap **Duplicate** to make a copy of a program.

Result: The **Program** page launches with the program name set to "Copy of [name of program] (MM/DD/YYYY).

7 Tap **Delete** to delete the program.

Result: A **Delete Program** confirmation dialog launches where you have the choice to **CANCEL** the deletion of the program or to proceed to **DELETE** the program.

Important: When a program is deleted, it does not appear on the **Programs** page. The only way to get the program back is if the program is exported before it is deleted.

8 Tap **Export JSON** to export the program to a JSON file.

Tip: The name of the JSON file is the same as the name of the program.

Overview of the Program page

The **Program** page is where programs are created and debugged.

Tap **Programming** > **Programs** to access the visual programming interface. Tap **+** or an existing program to access the **Program** page.

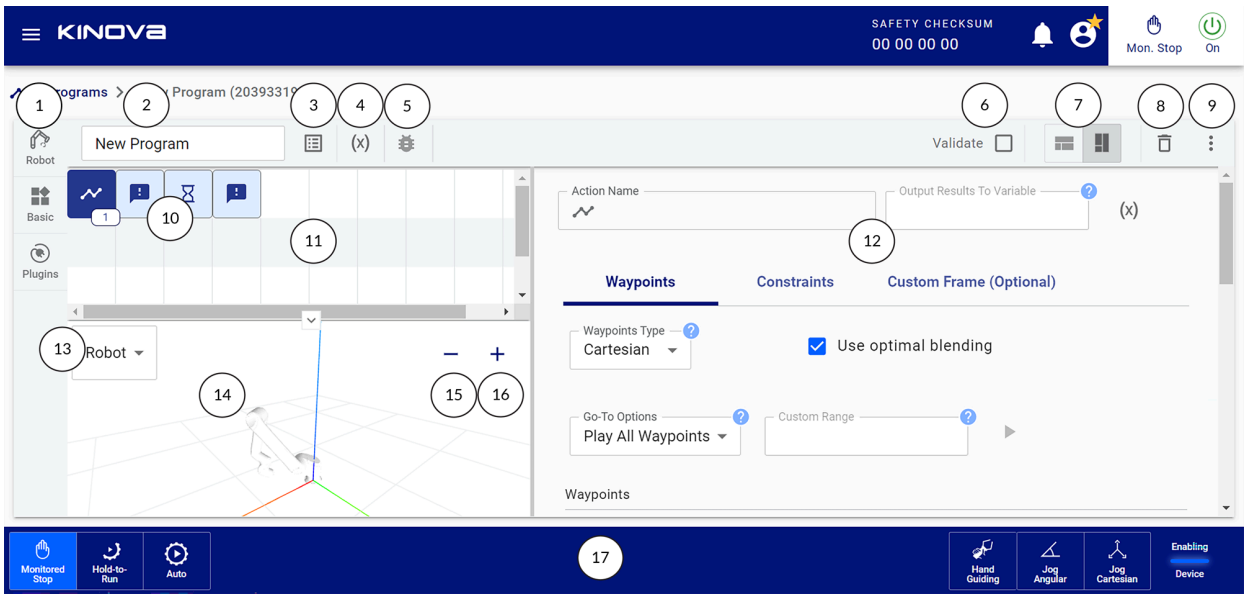


Figure 137: Parts of the Program page

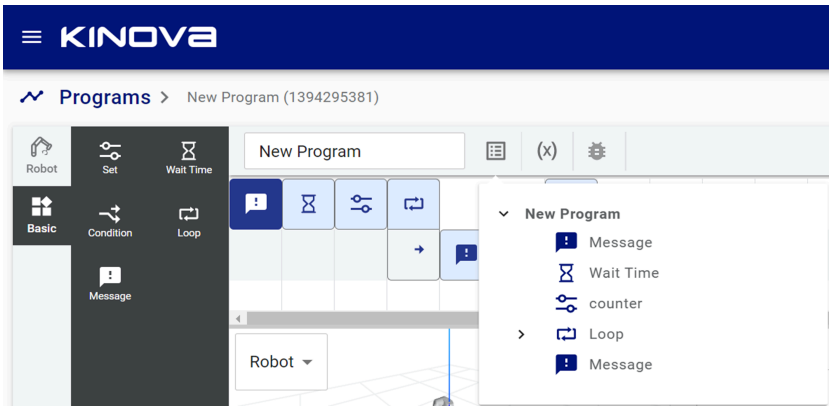
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1 Tap any icon in the column to expand and collapse the **Action** menu.

2 Enter a `meaningful name` for the program.

Tip: Program names can have a maximum of 80 characters.

3 Tap the **Tree layout** ( ) to view the tiles of the program in tree layout.



4 Tap **Variable Manager (X)** to launch the **Variable Manager** page and define variables within the scope of the program, as well as within the scope of persistent variables.

5 Tap **Debugger** to select the debugger tool and gather information about the program and its events while it runs. Tap **Debugger** to exit the debugger.

Tip: The **Debugger** button acts as a toggle button. When it is a dark blue, it is on. When it is gray, it is off.

6 Tap **Validate** to release the program to the operator.

7 Tap one of the two **Layout** buttons.

is the default layout where then entire **Tile configuration** pane is to the right of the **Sequence editor**; the layout is known as horizontal layout.

has the **Sequence editor** across the top half of the **Program** page; the layout is known as vertical layout.

8 Tap **Delete** to delete the currently selected tile.

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9 Tap the *kebab menu* (⋮) to access additional tasks that can be performed on the program in the **Sequence editor**.

- **Duplicate**

  Result: The **Program** page changes its name to "Copy of [name of program] (MM/DD/YYYY) and contains the same program as the original program.

- **Delete**

  Result: A **Delete Program** confirmation dialog launches where you have the choice to **CANCEL** the deletion of the program or to proceed to **DELETE** the program.

  Important: When a program is deleted, it does not appear on the **Programs** page. The only way to get the program back is if the program is exported before it is deleted.

- **Export JSON**

  Tip: The name of the JSON file is the same as the name of the program.

10 Drag available **Tiles** from the **Action** menu into the **Sequence editor** to create a program.

11 The **Sequence editor** is a drag-and-drop timeline editor of tiles that are performed by the program when it runs.

12 Tap on any tile in the program to populate the **Tile configuration** pane with the fields to create the correct parameters for the tile.

13 Select the visualization object.

Note: Without the Vision plugin installed, only visualization object that is available is the robot.
With the Vision plugin installed, additional visualization objects are available.

14 The **Visualization** displays the robot in its current position.

15 Zoom out of the **Visualization**.

16 Zoom in the **Visualization**.

17 Use the icons in the **Robot control panel** to change modes of operation and to manipulate the playing of a program.

When *Kortex Web App* is operating in Hold to Run mode and in Automatic mode, the Robot control panel displays two more parts.

- Program play area
- Program speed control

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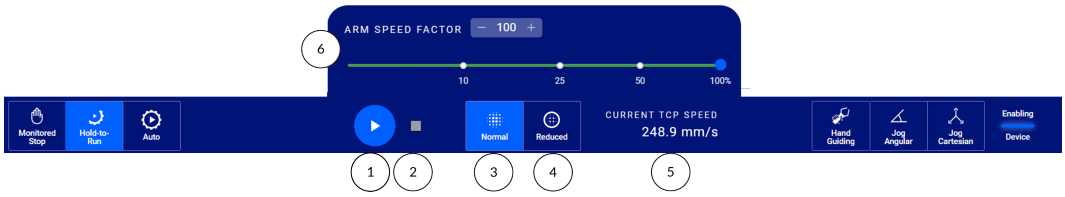


Figure 138: The parts of the Robot control panel

Program play area

1 Tap to play the program.

2 Tap to stop the program.

Program speed control

3 Tap to run the program at normal speed.

Important: It is recommended to run at reduced speed at least once before running at normal speeds when you are operating in Hold to Run; injury is possible.

4 Tap to run the program at reduced speed.

Important: It is recommended to run at the reduced speed when you are operating in Hold to Run.

5 The current translation speed set for the *TCP*.

6 Slide the **ARM SPEED FACTOR** slider, or tap **+** or **-** to change the speed of the arm in relation to the speed of the configured trajectory speed.

Arm Speed Factor

While operating in Hold to Run, you can see whether the arm is traveling within the defined speed limits.

Safety modes ensure the robot moves within a specific range of speeds. Normal and reduced speeds also ensure the robot does not move faster than what is deemed safe for the tasks it is performing. However, it is possible that, for any given trajectory, the robot must be slowed down even further to remain safe.

Use the arm speed factor to reduce the speed of the arm by a percentage to ensure safe operation of the robot.

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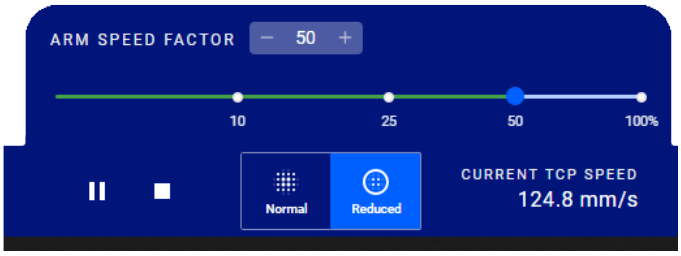


Figure 139: Arm speed is at 50% of the configured trajectory speed limits

A section of the scale in green indicates the ratio of the actual speed to the configured trajectory speed.

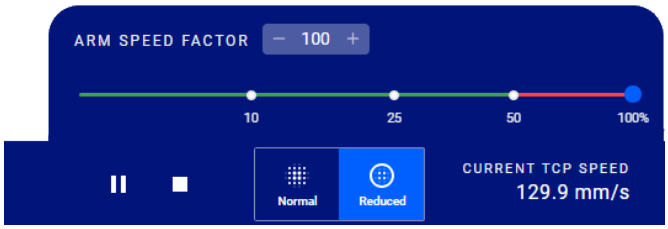


Figure 140: Arm speed is lower than the configured trajectory speed limits

A section of the scale in red indicates the percentage of the arm speed in relation to the trajectory speed is not met.

> **Example:** Suppose the slider is at 100% and the trajectory speed is configured to be 500 mm/s. If the TCP is moves at 250 mm/s either because of energy limitations or it is the speed limit of the TCP, the scale is green up to the 50% mark. After the 50% mark, the slider is red.

The **ARM SPEED FACTOR** is used in **Normal** and **Reduced** speeds. Transitioning from **Normal** to **Reduced** speed has no impact on the **ARM SPEED FACTOR**. However, transitioning from **Reduced** to **Normal** sets the **ARM SPEED FACTOR** to 5%.

Exporting a program from the teach pendant

Save programs to port the programs to different robots. Use a USB storage device when working from a teach pendant.

Before you begin

- Make sure you are an administrator.
- Make sure you have a *USB storage device* available.

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About this task

Programs are exported individually from a teach pendant that is connected to a controller.

Export the program from either the **Programs** page or from the program itself.

All actions, global variables, and persistent variables are exported with the program.

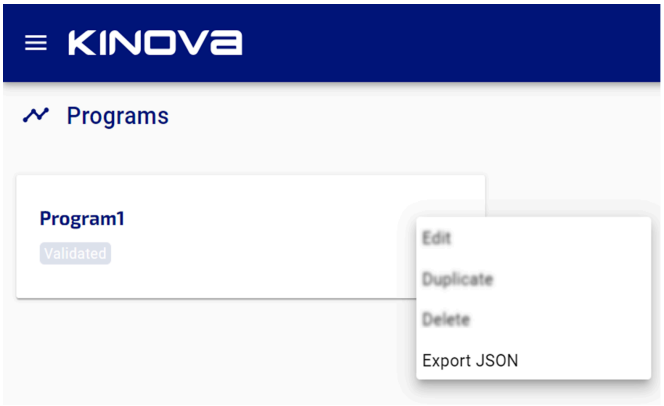


Figure 141: Export from the Programs page

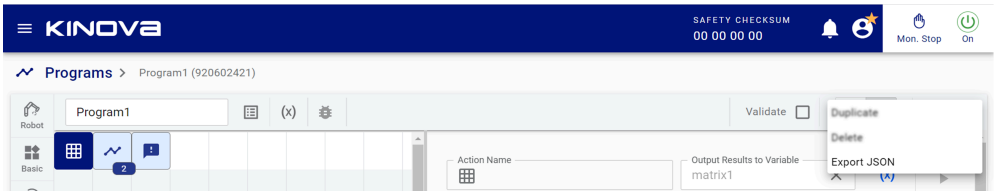


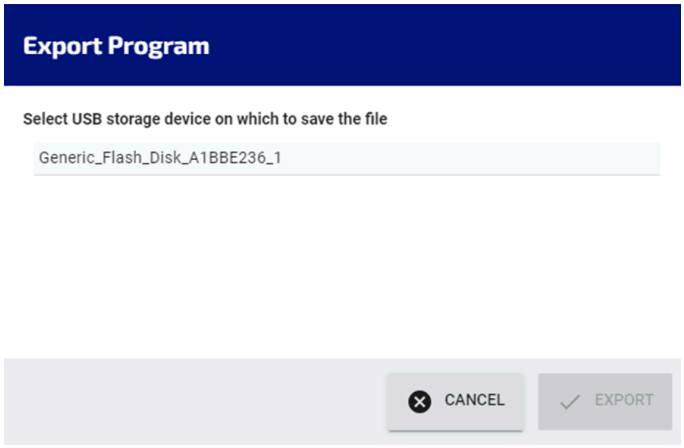
Figure 142: Export from the Program page

Procedure

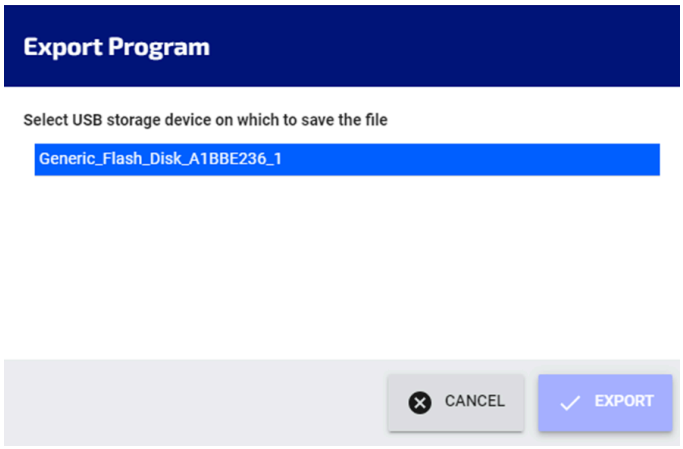
1. Plug a USB storage device into the controller.
2. Tap the *kebab menu*(⋮) on either the program on the **Programs** page or on the **Program** page.

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3. Tap **Export JSON**.
   The **Export Program** dialog launches with all the USB storage devices the controller detects.



4. Select the USB storage device.



5. Tap **EXPORT**.
   The program saves directly to the selected USB storage device using the name of the program as the name of the JSON file.

Results

Important: When you export a program that has the same name as another program in the USB storage device, `(#)` is added in the file name.

Example: `Program1.json` already exists. The export of another Program1 is saved as `Program1(1).json`. A subsequent export of Program1 is saved as `Program1(2).json`.

Related topics

Variables on page 249

Variable Management page on page 258

Importing a program from the teach pendant on page 241

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Exporting a program from a computer

Save programs to port the programs to different robots. Use a computer to save the program.

Before you begin

Make sure you are an administrator.

About this task

Programs are exported individually from a computer that is connected to the system with Kortex Web App.

Export the program from either the **Programs** page or from the program itself.

All actions, global variables, and persistent variables are exported with the program.

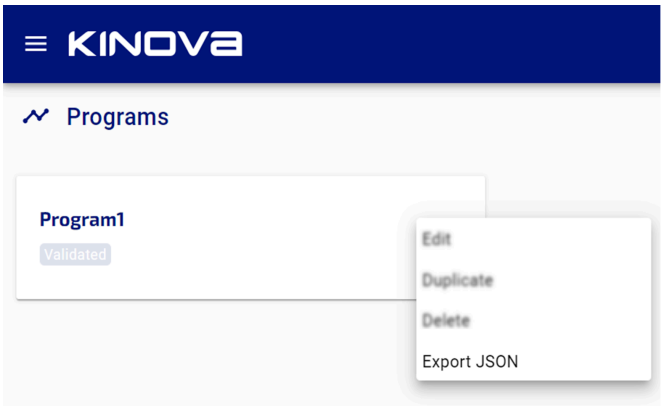


Figure 143: Export from the Programs page

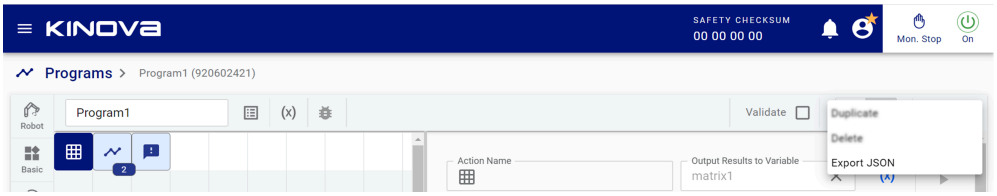


Figure 144: Export from the Program page

Procedure

1. Tap the *kebab menu*(⋮) on either the program on the **Programs** page or on the **Program** page.
2. Tap **Export JSON**.
   The program saves automatically to the computer or directly to the selected location on the computer, depending on the browser settings. It uses the name of the program as the name of the JSON file.

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Results

Important: When you export a program that has the same name as another program on the computer, `(#)` is added in the file name.

Example: `Program1.json` already exists. The export of another Program1 is saved as `Program1(1).json`. A subsequent export of Program1 is saved as `Program1(2).json`.

Importing a program from the teach pendant

Import a ready-made program to a robot instead of rewriting the program. Import from a USB storage device when working from a teach pendant.

About this task

- Make sure you are an administrator.
- Make sure you have the USB storage device with the programs available.

Programs are imported individually from a teach pendant that is connected to a controller that has a USB storage device connected to it.

Different situations can arise when you import a program that has persistent variables.

- A new persistent variable is in the list of global variables on the **Variables** page.
- An error message launches after the program is imported, indicating that there already exists a persistent variable with the same name, but with different properties.

```
The imported program contains at least one global persistent variable
 that differs from the current existing variables defined in the robot
 environment. Check the actual robot configuration to ensure that the
 variable's properties are correct.
```

- An error message is on the **Tile configuration** pane, indicating the currently selected action in the program contains one or more errors.
- A persistent variable cannot be selected from the **Select Variable** page because the variable is defined incorrectly.

Some older programs do not include the persistent variables that they use. When you import these kind of programs, an error message launches after the program is imported, indicating that variables need to be created and verified.

```
The imported program uses persistent variables that are not defined in the
 imported program file. Validate or create each persistent variable needed
 by the imported program in the current robot configuration.
```


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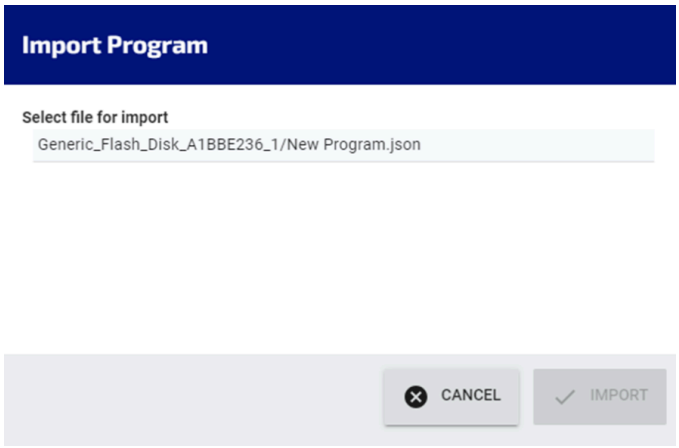
Repeat the procedure for each program you want to import.



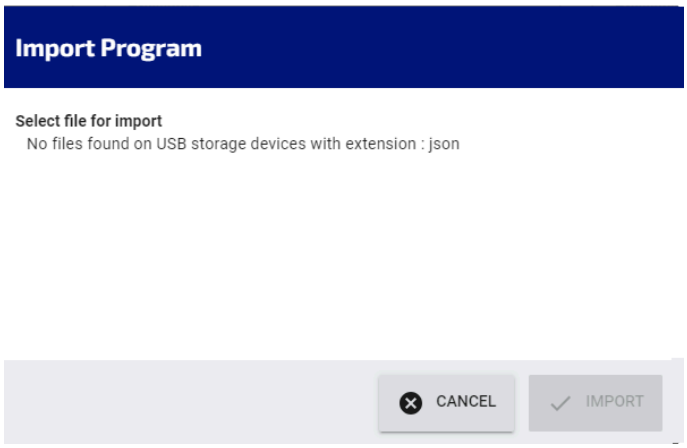
Figure 145: Import from the Programs page

Procedure

1. Plug a *USB storage device* into the controller.
2. Tap **Programming** > **Programs** or **Quick Menu** > **Programs** to access the **Programs** page.
3. Tap **Import** ( ).
   The **Import Program** dialog launches with all the programs that are available to import.



   If no JSON files are stored on the selected USB storage device, the **Import Program** dialog displays a message.



4. Select a program.

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5. Tap **IMPORT**.
   The program is added to the programs currently on the **Programs** page; its validation status is gray.



Important: It is possible to import a program that has the same name as a program that already exists in the **Programs** page.



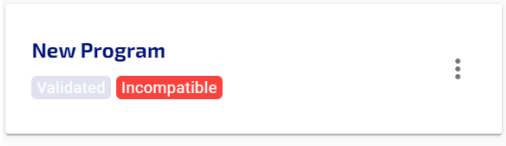
You can edit the name of the imported program to differentiate the program. If you do edit the name, when you export the program, it exports with the new program name.

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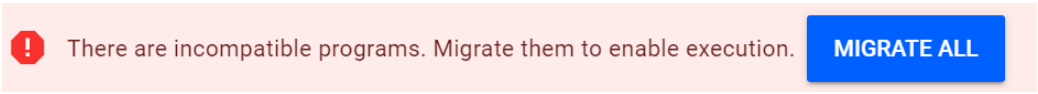
6. Test the program and tap **Validate** when the program is working as expected.
   The re-validated program is listed on the **Programs** page with its validation status marked active.



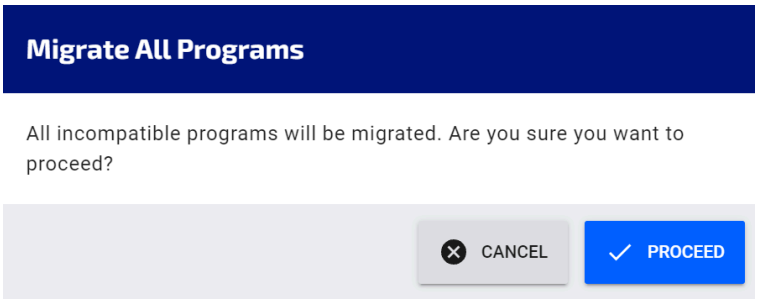
It is possible that the imported program is old. When that happens, the imported program shows it is incompatible.



An error message is also displayed.



A confirmation dialog launches to make sure you want to proceed with migrating all incompatible programs.



Tap **CANCEL** or **PROCEED**. Another message dialog launches when all programs are migrated.



Related topics

Variables on page 249

Variable Management page on page 258

Exporting a program from the teach pendant on page 237

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Importing a program from a computer

Import a ready-made program to a robot instead of rewriting the program. Import from a computer running Kortex Web App.

About this task

Make sure you are an administrator.

Programs are imported individually from a computer that is connected to the system with Kortex Web App.

Different situations can arise when you import a program that has persistent variables.

- A new persistent variable is in the list of global variables on the **Variables** page.
- An error message launches after the program is imported, indicating that there already exists a persistent variable with the same name, but with different properties.

```
The imported program contains at least one global persistent variable
 that differs from the current existing variables defined in the robot
 environment. Check the actual robot configuration to ensure that the
 variable's properties are correct.
```

- An error message is on the **Tile configuration** pane, indicating the currently selected action in the program contains one or more errors.
- A persistent variable cannot be selected from the **Select Variable** page because the variable is defined incorrectly.

Some older programs do not include the persistent variables that they use. When you import these kind of programs, an error message launches after the program is imported, indicating that variables need to be created and verified.

```
The imported program uses persistent variables that are not defined in the
 imported program file. Validate or create each persistent variable needed
 by the imported program in the current robot configuration.
```

Repeat the procedure for each program you want to import.



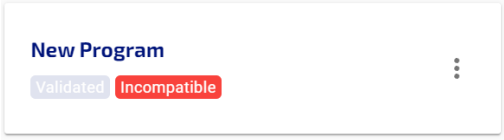
Figure 146: Import from the Programs page

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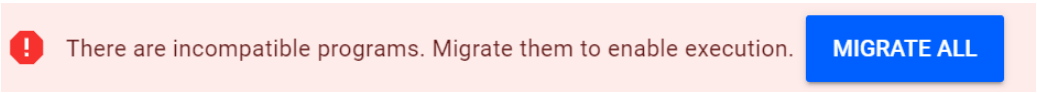
Procedure

1. Tap **Programming** > **Programs** or **Quick Menu** > **Programs** to access the **Programs** page.
2. Tap **Import** ( ).
   The program imports automatically from the computer or directly from the selected location on the computer, depending on the browser settings.

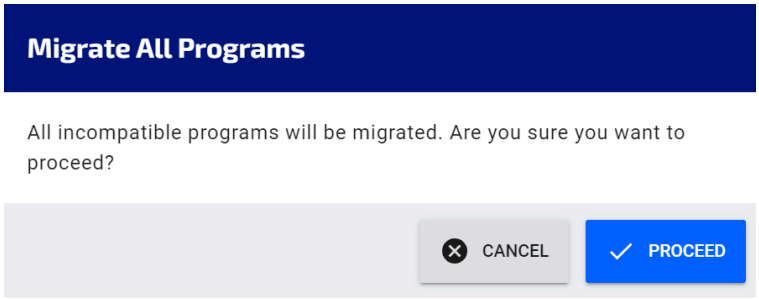
   It is possible that the imported program is old. When that happens, the imported program shows it is incompatible.



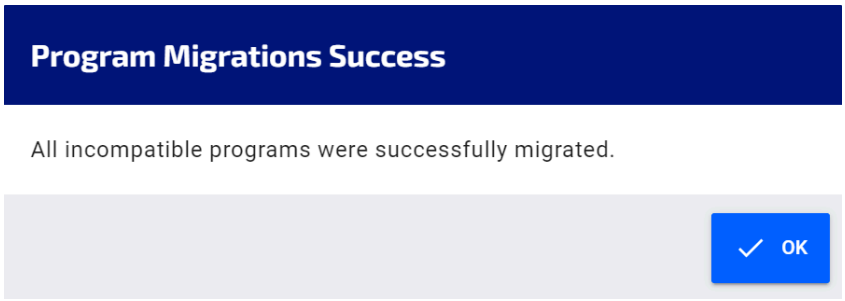
   An error message is also displayed.



   A confirmation dialog launches to make sure you want to proceed with migrating all incompatible programs.



   Tap **CANCEL** or **PROCEED**. Another message dialog launches when all programs are migrated.



Migrating and updating programs

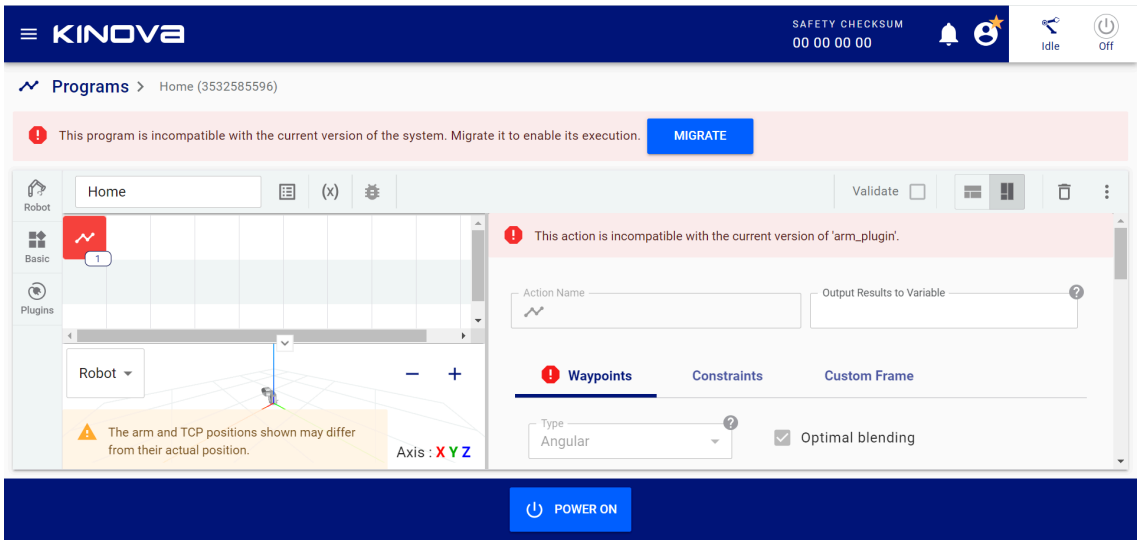
Programs created in older versions of Kortex Web App can be imported and used.

About this task

Migrating older programs updates the programs so that they can be used right away.

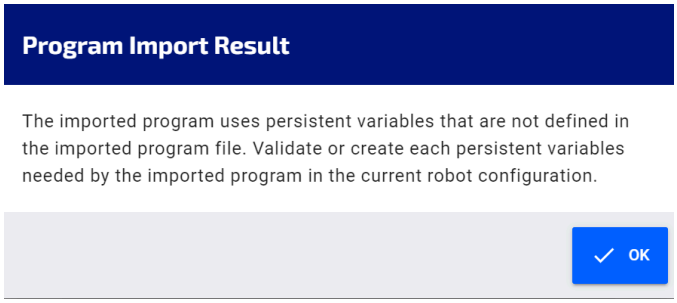
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Programs that are incompatible with the current version launch with error messages and an option to migrate all incompatible programs so that they end up compatible.



Procedure

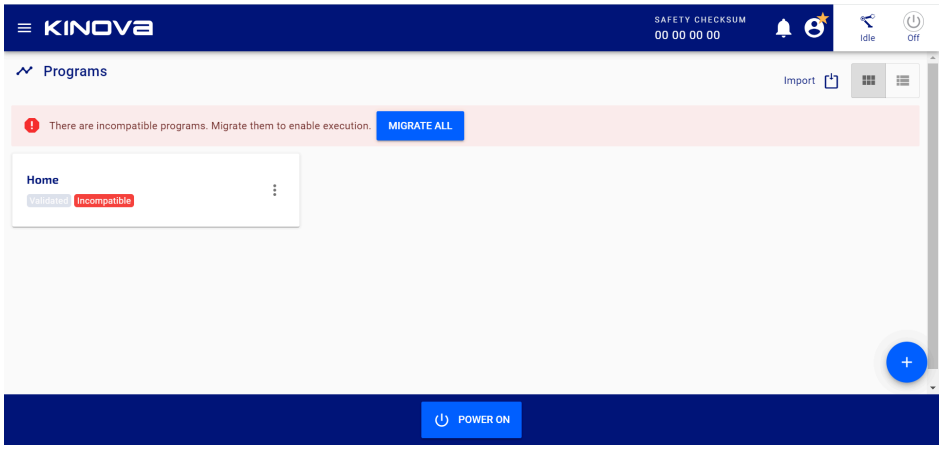
1. Tap **Programs**.
   The **Programs** page launches.
2. Tap **Import** and select the program to import.
   The selected program can be selected from the **Programs** page.
3. Select the incompatible program.
   The **Program Import Result** dialog launches, stating additional actions needed to make the program work properly.



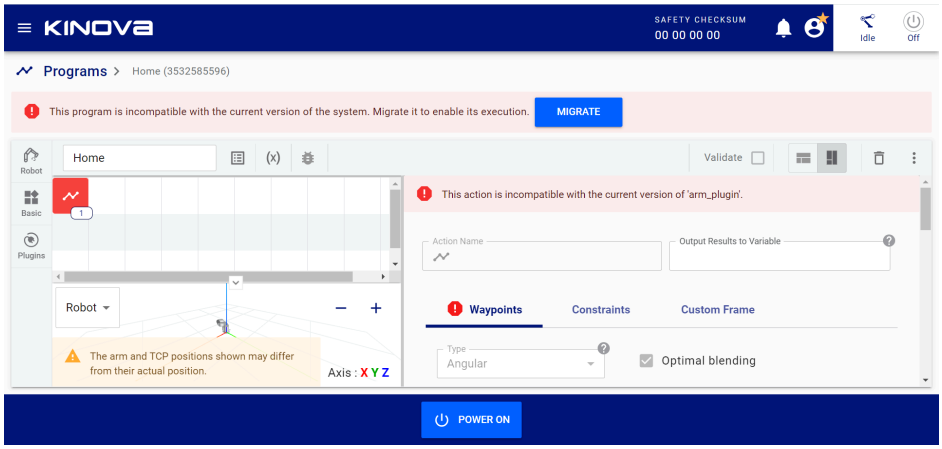
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4. Tap **OK**.

   The dialog closes and it is clear that the program is incompatible with Kortex Web App.



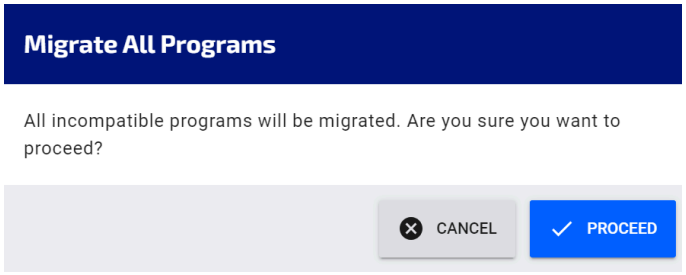
   Launch the program as it is shows more details as to where the incompatibilities exist.



5. Tap **MIGRATE**.

Option	Description
From within program	Only the program that is launched is migrated to be compatible with the currently running version of Kortex Web App. The **Migrate Program** confirmation dialog launches. **Migrate Program** Program 'Home' will be migrated. Are you sure you want to proceed? CANCEL PROCEED

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Option	Description
From the Programs page	All incompatible programs on the **Programs** page are migrated to be compatible with the currently running version of Kortex Web App. The **Migrate All Programs** confirmation dialog launches. 

6. Tap **PROCEED**.
   The **Program Migrations Success** confirmation dialog launches.



Results

Launching any of the migrated programs shows the program is compatible with the currently running version of Kortex Web App.

Variables

Define variables for the all programs and for specific *plugins* with a global *namespace*. Variables in the program affect how the robot functions.

To access the **Variables** page, tap **Programming** > **Variables**.

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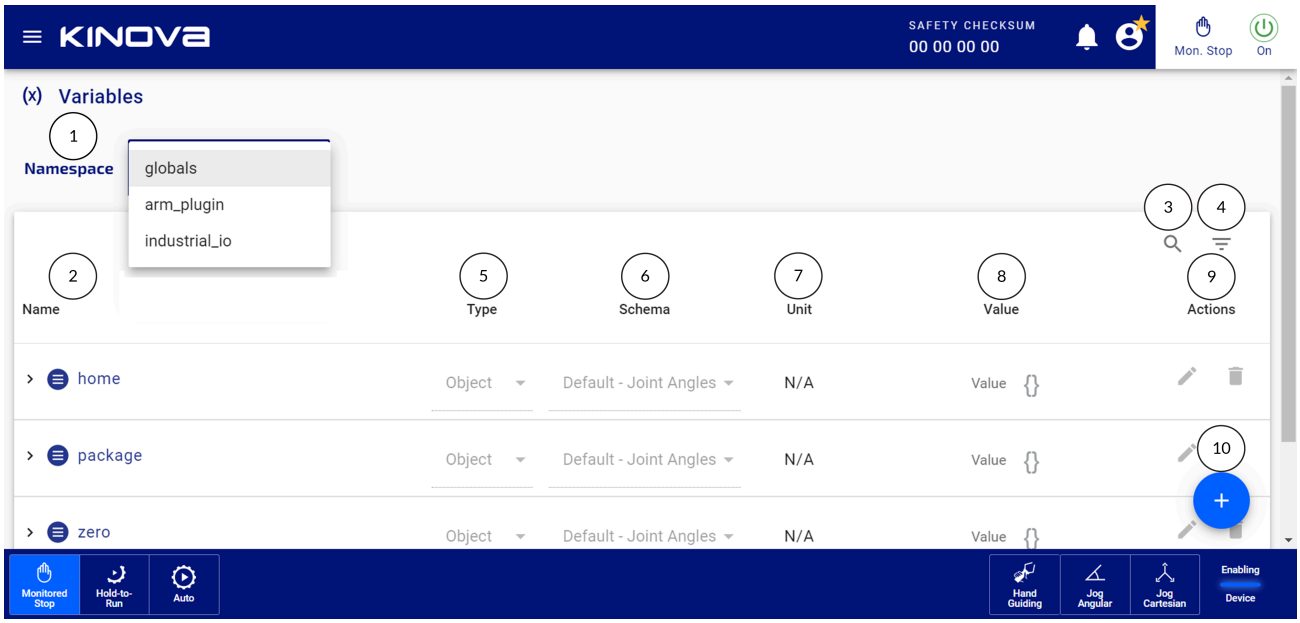


Figure 147: The Variables page

1 **Namespace** helps define the scope of the variable. Variables defined from this page are defined for all programs.
There are default namespaces.

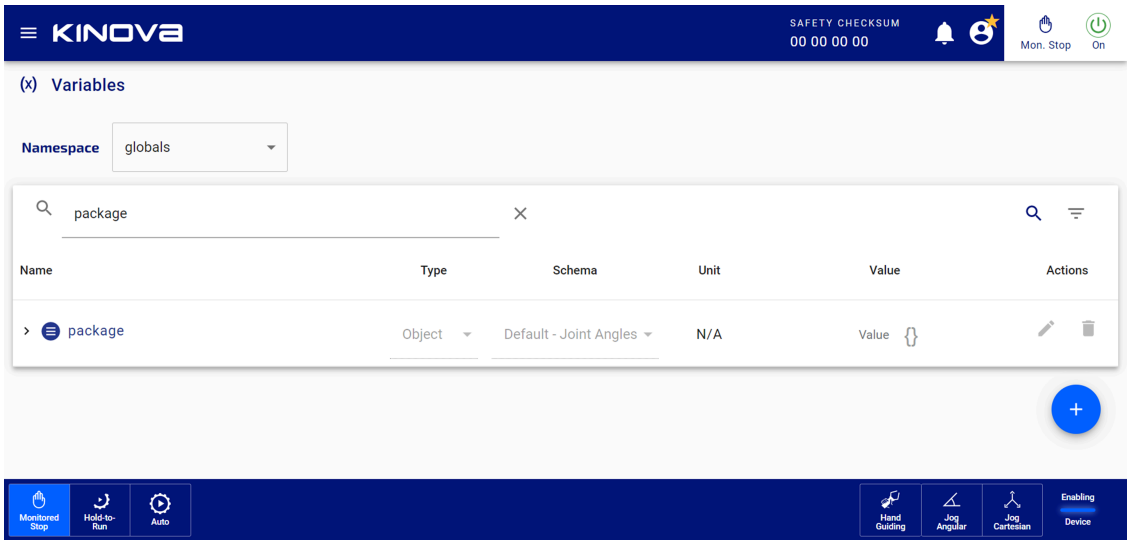
- **globals** are global variables that are global for all programs. They include the pre-made global variables *home*, *package*, and *zero*.
- **arm_plugin** are global variables that are global for all programs and are directly related to the arm.
- **industrial_io** are global variables that are global for all programs and are directly related to the industrial I/Os of the robot.

In addition to the default namespaces, each plugin that is installed on Link 6 has their namespace available in the same list.

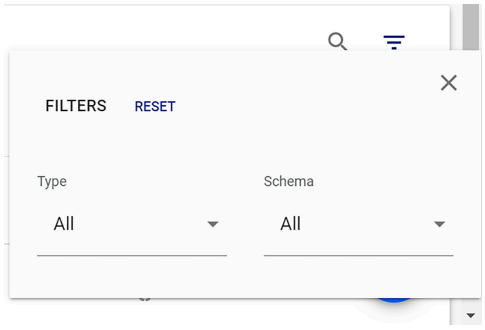
2 Name of the variable that is defined in the currently selected namespace.

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3 Tap to search variable names, types, or schemas. The result is displayed on the page. For example, search *package* results in the page displaying all global variables named `package` if it exists as a global variable in the currently selected global namespace.



4 Tap the filter icon (⚲) to filter the list of variables by Type and by Schema on the **Variables** page.



Select a filter type from the **Type** menu.

- **All**: Boolean, Number, Object, and String
- **Boolean**: True, False
- **Number**: Integer, float
- **Object**: Complex structure
- **String**: Text

Select a Schema type from the **Schema** menu list when the **Type** is **Object**. The menu lists all schemas that are available.

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5 Define the type of the user-defined variable by selecting a type from the **Type** menu.

- **String**: Text
- **Boolean**: True, False
- **Number**: Integer, float
- **Object**: Complex structure

Tip: You must create a variable to define a type.

6 Define the schema of the user-defined variable of type **Object** by selecting a schema from the **Schema** menu.

- **Unspecified**: custom structure
- **Default - Pose**: Cartesian transformation
- **Default - Joint Angles**: List of angles, one for each joint
- **Default - Payload**
- **Arm Plugin - Matrix - Output**: List of poses
- **Arm Plugin - Tool Path - Output**: List of poses
- **Arm Plugin - Waypoints - Output**: Cartesian and angular position of the waypoint
- **Industrial I/O Plugin - Read Input - Output**: Read input and its corresponding defined output

Remember: There are four types of read input.

- Controller digital: **DI_0** to **DI_7**
- Controller analog: **AIO_0** to **AIO_3**
- Wrist digital: **WRIST_DIGITAL_IO1** to **WRIST_DIGITAL_IO8**
- Wrist analog: **WRIST_AOI_1** and **WRIST_AOI_2**

Note: Read Input Output is used in conjunction with the Industrial I/O plugin.

Tip: You must create a variable to define a type.

Each plugin that is installed has its own set of schemas that you can use for new variables.

7 Define the value associated with the variable. Tap the {} icon to invoke the **JSON Object Editor** dialog and change the key-pair values as necessary.

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8 When the modifiable global variable is of type **Number**, select the unit to be associated with the variable.

- unspecified
- s
- mm
- kg
- mm/s
- mm/s^2
- °/s
- $°/s^2$
- N
- °
- mA
- V
- °C
- N·m
- kg/m^2
- kPa

Note: Units are used in context of selecting a number to validate its compatibility with the selected field.

9 There are at most two actions that can be taken for each modifiable global namespace variable.

- **Edit** (✎)
- **Delete** (🗑)

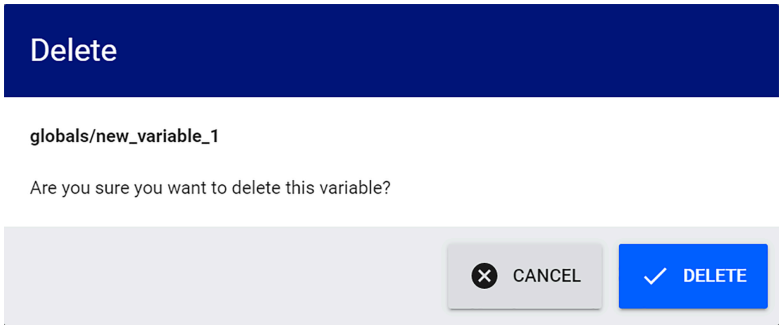
Tap the edit icon (✎) to modify the name of the user-defined global variable.

Note: The user-defined global variables that come with Link 6, *home*, *package*, and *zero*, cannot be edited.

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Tap the delete icon ( ) to delete the user-defined global variable.

Note: The global variables that come with Link 6, *home*, *package*, and *zero*, cannot be deleted.



Restriction: Do not delete any variable defined as a global variable from the **Persistent Variables** of the **Variable Manager** and **Select Variable** pages unless you know for a fact that the variable in question is not used in any program used by the robot.

10 Tap to create a variable in the currently selected namespace.

Global variables created on the **Variables** page are accessible in the **Persistent Variables** pane of the **Variable Manager** page, as well as on the **Persistent Variables** of the **Select Variable** page of the currently selected program.

Related topics

Variable Management page on page 258

Industrial I/O Plugin on page 380

Examples of JSON statements

JavaScript Object Notation (JSON) is a key-value format for representing structured data. It is text-based, which makes it readable. JSOM is used to define values for variables.

Defining strings

Use double quotation marks around strings.

Example:

```
{"name":"John"}
{"age":30}
{"sale":true}
```

```
meaningful_variable_name = {
"employee":{"name":"John", "age":30, "city":"Montreal"}
```


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```
}
```

Access the value John by writing `${meaningful_variable_name.employee.name}`

Define a variable named *var* as an array of values.

```
{"n":[0,1,2,3,4,5]}
```

The result of `${var.n[0]}` is 0 and of `${var.n[3]}` is 3.

Defining iterators

When you define a variable as an iterator, it must be defined as type Number. The first index is always 0. `${var.n[${i}]}` outputs the value of each iteration over the array.

Adding a variable global to all programs from the Variables page

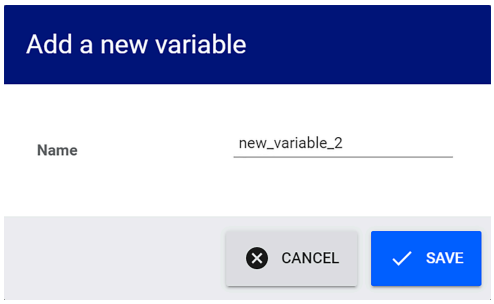
Variables can be created either for all programs a robot uses or for only a specific program. Variables created for all programs are made from the **Variables** page.

About this task

Variables that belong to the global namespace are accessible as **Persistent Variables** in the **Select Variable** and **Variable Manager** pages. Variables defined here are available to all programs.

Procedure

1. Tap **Programming** > **Variables**.
   The **Variables** page launches.
2. Select the appropriate *namespace* for the variable that is about to be created.
3. Tap ⊕.
   The **Create Variable** dialog launches.



4. Enter a meaningful name for the global variable.
   Underscores are allowed. Spaces and dashes are not allowed in the name.

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5. Tap **SAVE**.
   The new variable is displayed on the **Variables** page. The variable can also be seen on the **Select Variable** and **Variable Manager** pages.
6. Select one **Type** for the variable.

Option	Description
String	A word, phrase, or sentence
Boolean	**false** or **true**
Number	Integer or floating point number
Object	A **Schema** • **Unspecified** • **Default - Pose** • **Default - Joint Angles** • **Default - Payload** • **Arm Plugin - Matrix - Output** • **Arm Plugin - Tool Path - Output** • **Arm Plugin - Waypoints - Output** • **Industrial I/O Plugin - Read Input - Output**

   Note: The schemas that are listed are the default schemas. When additional plugins are installed, their associated schema are available from the **Object** menu.

7. (Only when the variable is of **Type Number**). Enter a number in the **Value** box and associate a **Unit** of measurement from the menu.

   Important: When you leave the **Unit** as **unspecified**, the variable has no unit associated with it.

8. (Only when the variable is of **Type Object**.) Tap the **Schema** for the type of object that variable represents.

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9. (Only when the variable is of **Type Object**.) Tap the **Value** icon ({}) and enter the values in the **JSON Object Editor** and tap **SAVE**.

   The information entered can then be available in entities of various tiles.



Figure 148: Editor for object type Unspecified

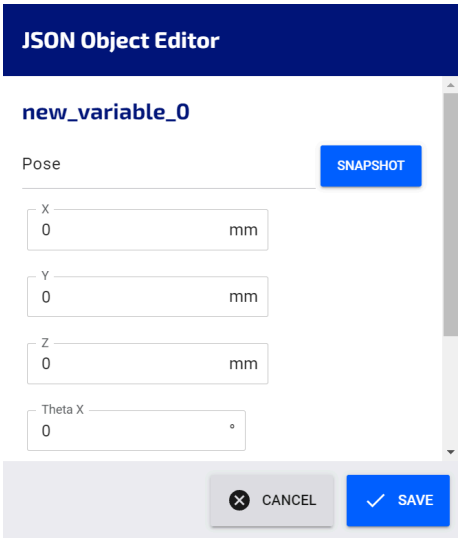


Figure 149: Editor for object type Default - Pose

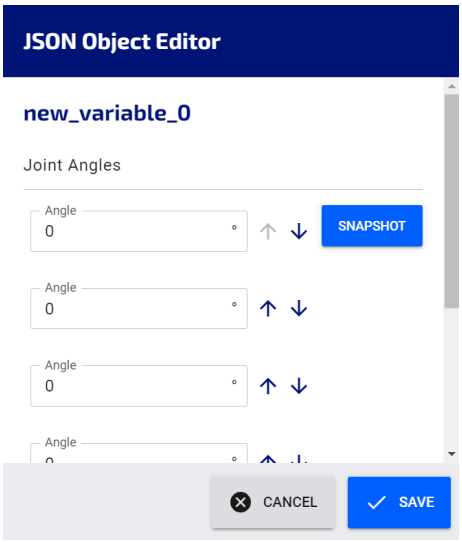


Figure 150: Editor for object type Default - Joint Angles

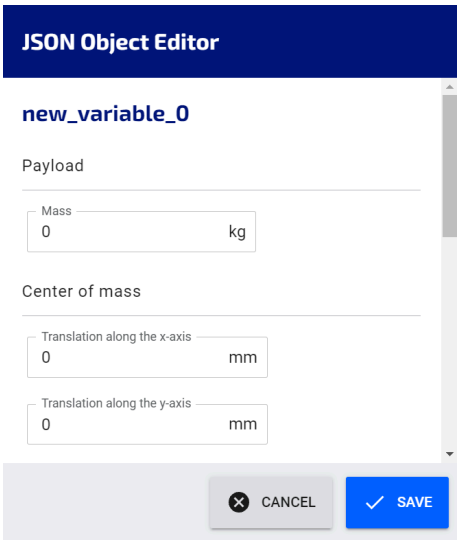


Figure 151: Editor object type Default - Payload

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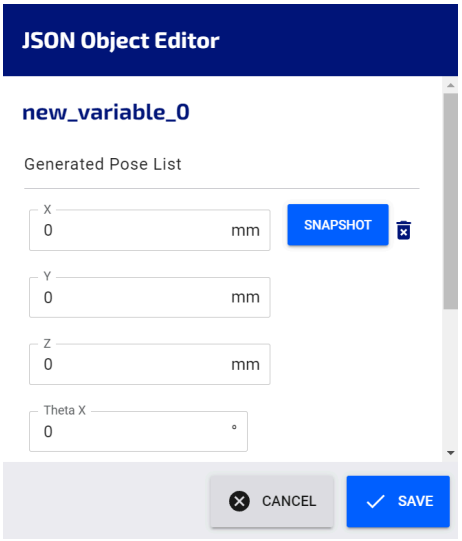


Figure 152: Editor object type Arm Plugin - Matrix - Output

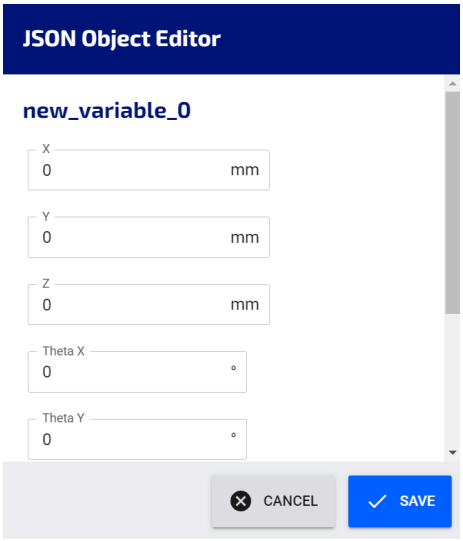


Figure 153: Editor object type Arm Plugin - Tool Path - Output

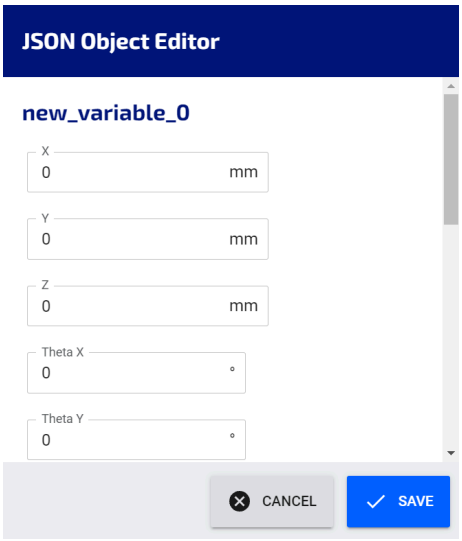


Figure 154: Editor object type Arm Plugin - Waypoints - Output when first invoked

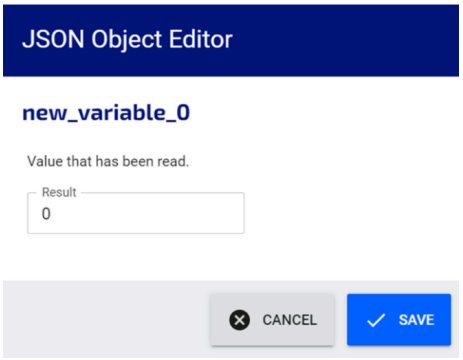


Figure 155: Editor object type Industrial I/O Plugin - Read Input - Output

Related topics

Examples of JSON statements on page 254

Variable Management page

Variables in the program, either as specific to a program or as global to all programs, makes it easy to exchange and reuse information in the programs.

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To access the **Variable Manager** page, select a program from the **Programs** page and tap the (x) near the name of the program.

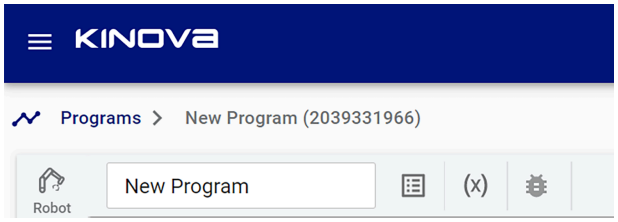


Figure 156: Variable Manager (x) button location on the Program page

The **Variable Manager** page launches. All the variables that currently are defined for the current program are under the **Program Variables**. All the variables that are currently defined globally for all programs are in the **Persistent Variables**.

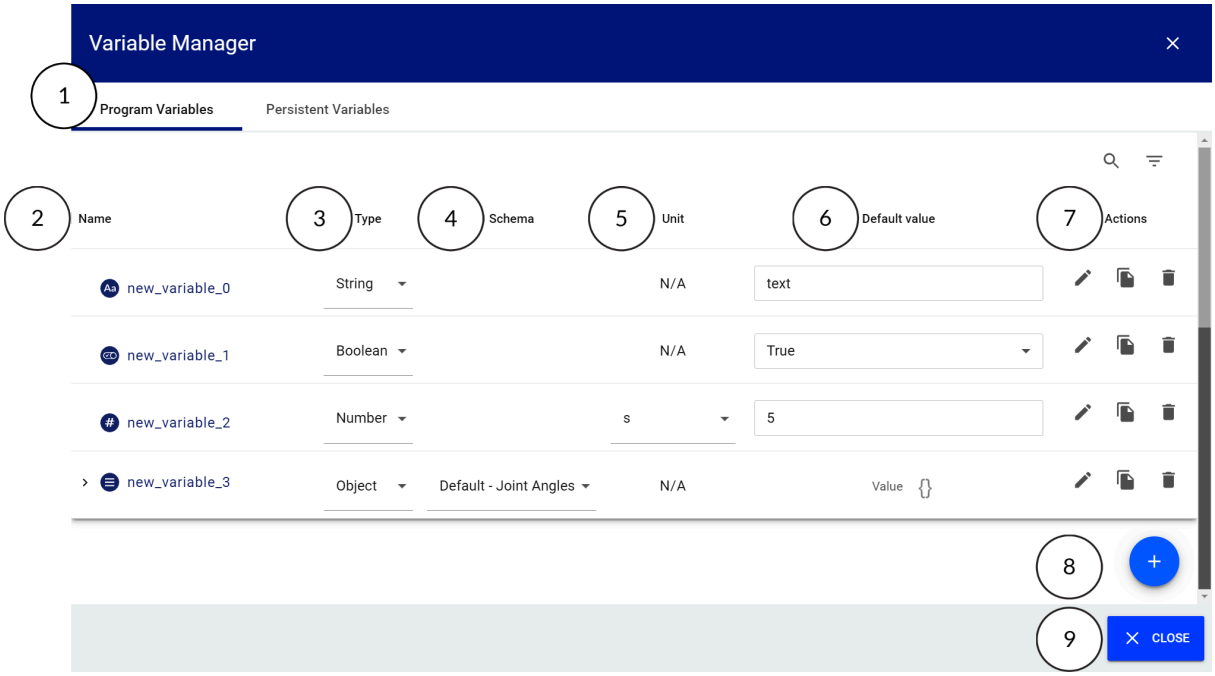


Figure 157: The Variable Manager page

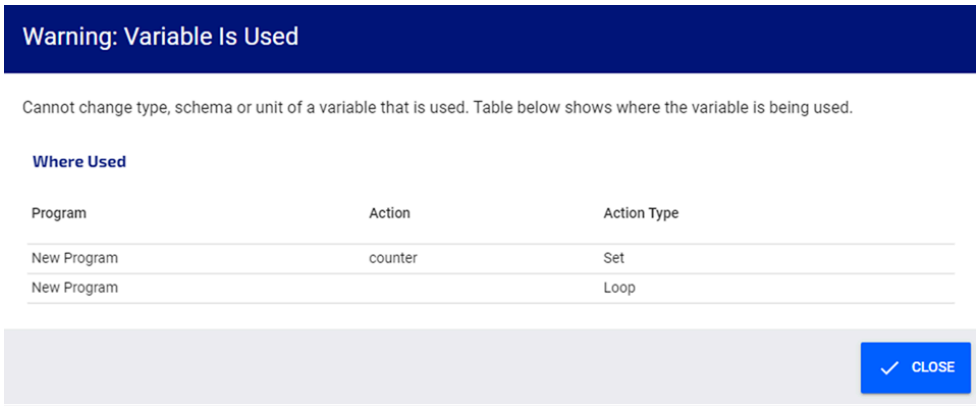
1 Work with the variables that are defined only for the currently selected program by making sure **Program Variables** is selected.

2 Name of variable.

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3 The **Type** of the variable is displayed. Tap it to change the type.

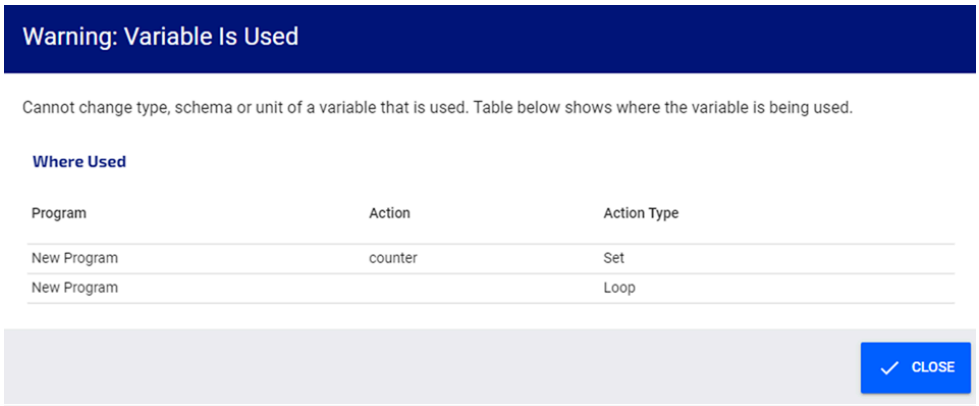
Note: You cannot change the type of the variable when the variable is being used in a program. If you attempt to change the type, a warning dialog launches.



Tap **CLOSE** to close the dialog. Nothing changes on the **Variable Manager** page.

4 The **Schema** of the variable is available only for **Object** types. Tap it to change the **Schema**.

Note: You cannot change the type of the variable when the variable is being used in a program. If you attempt to change the type, a warning dialog launches.



Tap **CLOSE** to close the dialog. Nothing changes on the **Variable Manager** page.

5 The **Unit** of the variable is available only for **Type Number**. Tap to change the unit, especially when the **Unit** is listed as **Unspecified**.

6 The default value of the variable is displayed. Enter a different default value for the variable.

7 **Edit** (), **Duplicate** (), and **Delete** () are **Actions** that you can take on the variables.

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Tap to edit the name of the variable. The **Edit variable** dialog launches and shows where the variable is already in use.

Important: When you change the name of a variable that is already in use, select **Rename all references** to ensure the name of the variable is updated in all programs that use it.

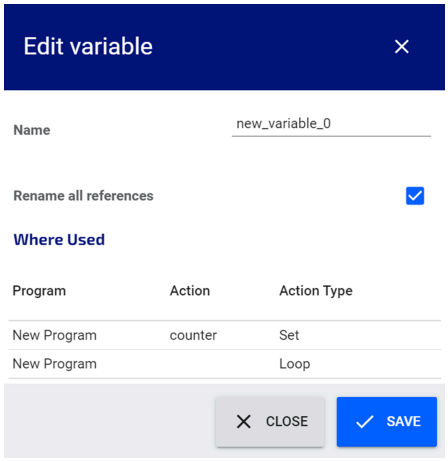


Figure 158: Edit variable dialog when the variable is in use

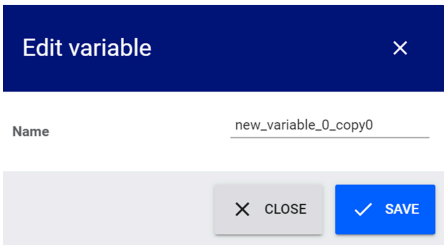


Figure 159: Edit variable dialog when the variable is not in use

Tap to duplicate the current variable. The duplicated variable has appends to the name of the copied variable the string "_copy" and the number of times the same variable has been copied.

Example: Suppose the variable name is *new_variable_0*. The first time it is duplicated, the new variable is named *new_variable_0_copy0*. The second time it is duplicated, the new variable is named *new_variable_0_copy1*.

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Tap to delete the variable.
When the variable is being used, a **Delete** warning or confirmation dialog launches.

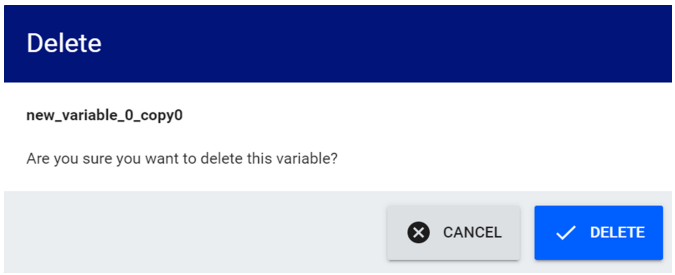


Figure 160: Delete confirmation dialog

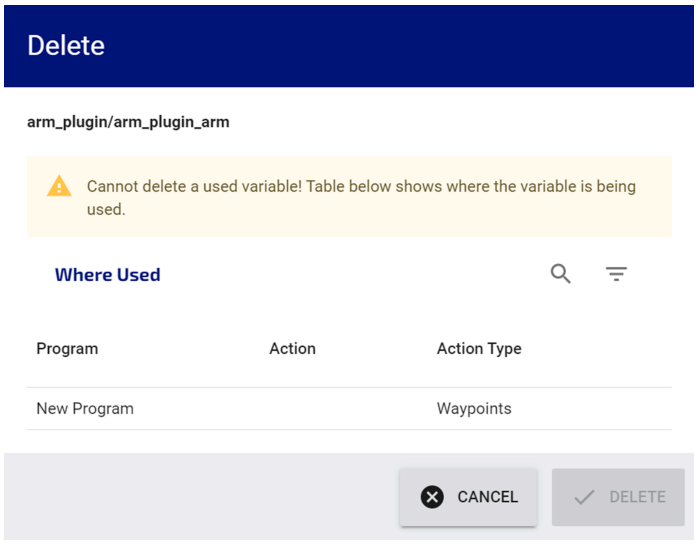


Figure 161: Delete warning dialog

8 Tap to create a variable for the program.
The **Create Variable** dialog launches. Enter a meaningful name for the new variable.

9 Tap **CLOSE** to close the **Variable Manager** page and return to the **Programs** page.

Related topics
Variables on page 249
Industrial I/O Plugin on page 380

Adding a variable global to all programs from the Variable Manager page

Variables can be created either for all programs a robot uses or for only a specific program.
Variables created for all programs can also be made from the **Variable Manager** page.

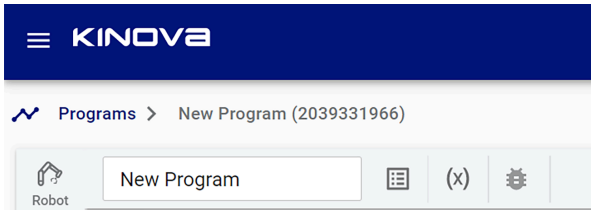
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About this task

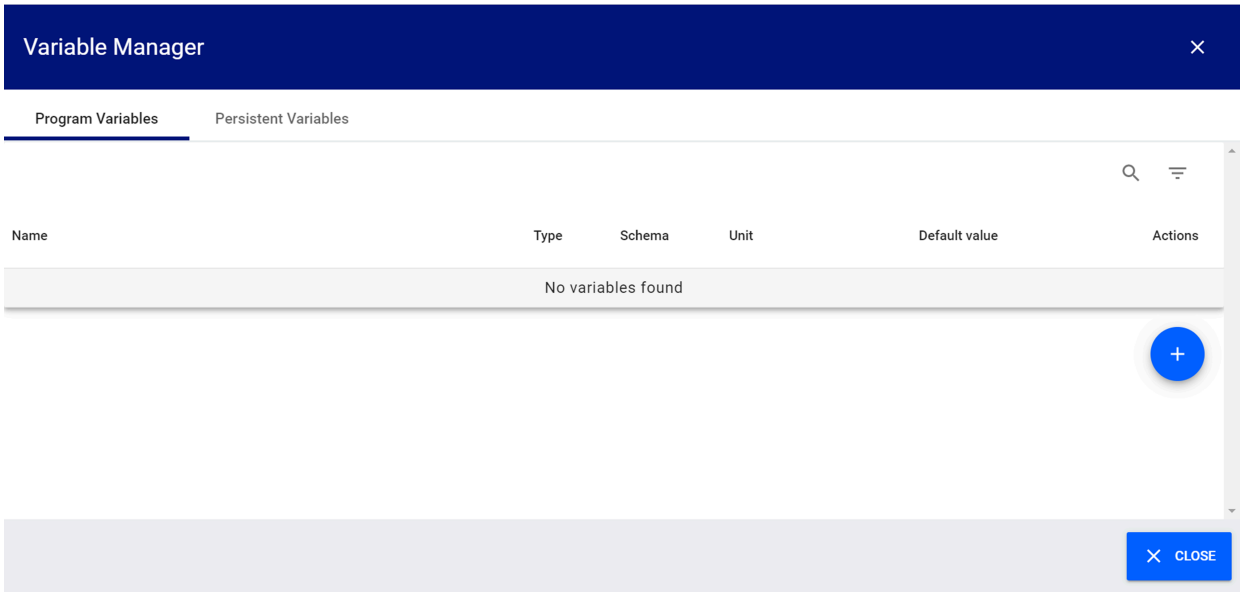
Variables that belong to the global *namespace* are accessible as **Persistent Variables** in the **Select Variable** and **Variable Manager** pages. Variables defined here are available to all programs.

Procedure

1. Select a program from the **Programs** page.
2. Tap **Variable Manager** (x).

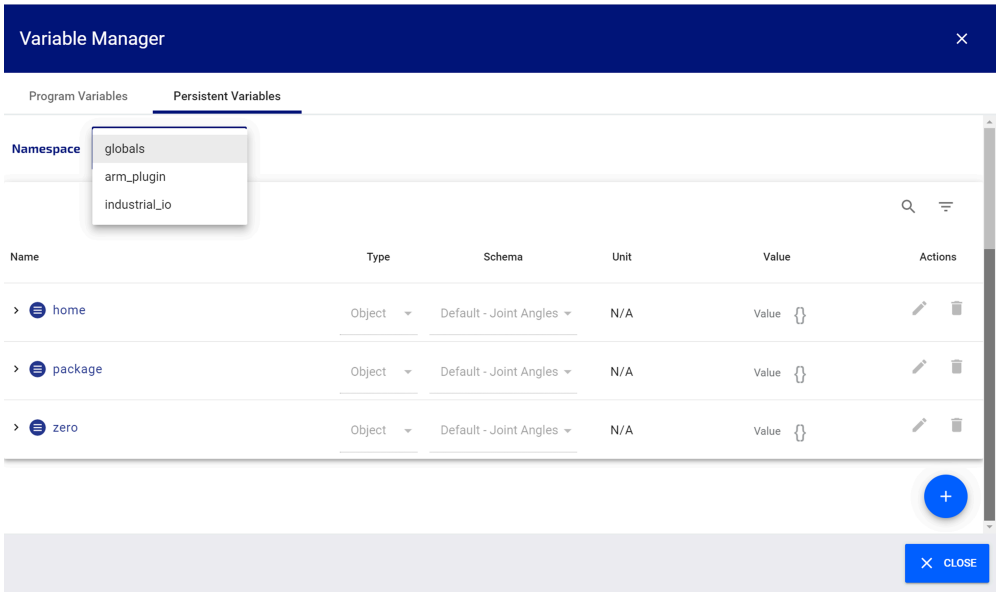


The **Variable Manager** page launches.

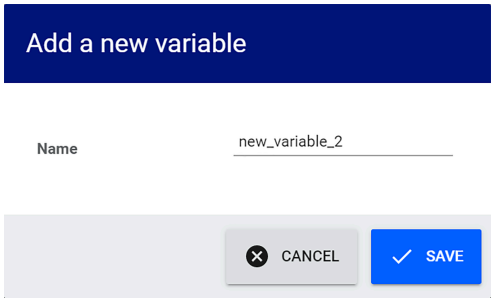


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3. Tap the **Persistent Variables**.



4. Select the appropriate **Namespace** for the variable that is about to be created.
5. Tap ⊕.
   The **Create Variable** dialog launches.



6. Enter a meaningful name for the global variable.
   Underscores are allowed. Spaces and dashes are not allowed in the name.
7. Tap **SAVE**.
   The new variable is displayed on the **Variable Manager** page. The variable can also be seen on the **Select Variable** and **Variables** pages.
8. Select one **Type** for the variable.

Option	Description
String	A word, phrase, or sentence
Boolean	**false** or **true**
Number	Integer or floating point number
Object	A **Schema**

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Option	Description
	• **Unspecified** • **Default - Pose** • **Default - Joint Angles** • **Default - Payload** • **Arm Plugin - Matrix - Output** • **Arm Plugin - Tool Path - Output** • **Arm Plugin - Waypoints - Output** • **Industrial I/O Plugin - Read Input - Output**

Note: The schemas that are listed are the default schemas. When additional plugins are installed, their associated schema are available from the **Object** menu.

9. (Only when the variable is of **Type Number**.) Enter a number in the **Value** box and associate a **Unit** of measurement from the menu.

Important: When you leave the **Unit** as **Unspecified**, the variable has no unit associated with it.

10. (Only when the variable is of **Type Object**.) Tap the **Schema** for the type of object that variable represents.
11. Tap the **Value** icon ({}) to enter the values in the **JSON Object Editor** and tap **SAVE**.

The information entered can then be available in entities of various tiles.



Figure 162: Editor for object type Unspecified

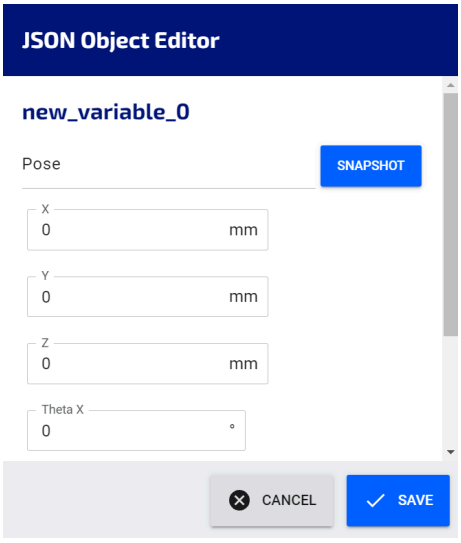


Figure 163: Editor for object type Default - Pose

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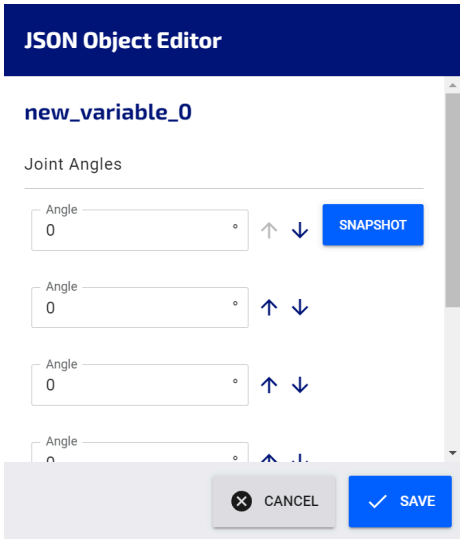


Figure 164: Editor for object type Default - Joint Angles

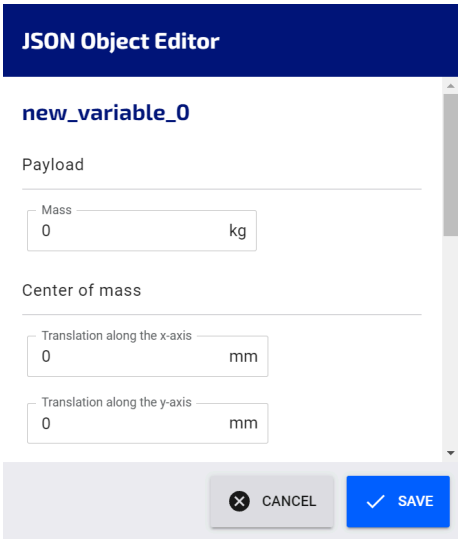


Figure 165: Editor object type Default - Payload

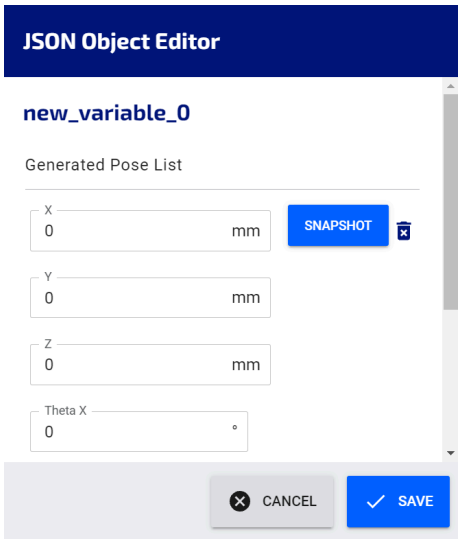


Figure 166: Editor object type Arm Plugin - Matrix - Output

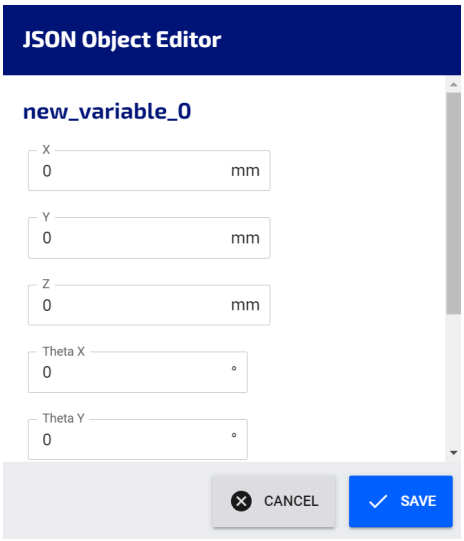


Figure 167: Editor object type Arm Plugin - Tool Path - Output

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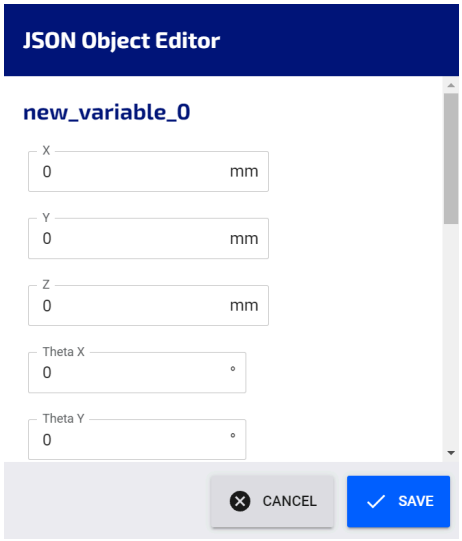


Figure 168: Editor object type Arm Plugin - Waypoints - Output when first invoked

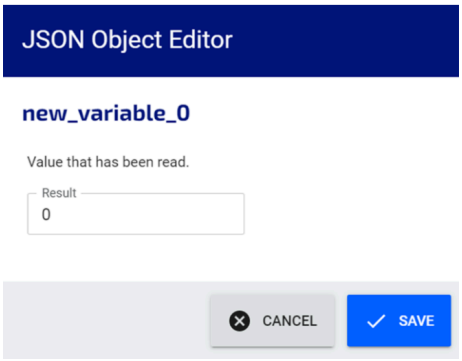


Figure 169: Editor object type Industrial I/O Plugin - Read Input - Output

Adding a variable global only to a specific program

A program can benefit from global variables that are specific only to that program. Variables that are global only within a program are created from the **Variable Manager** page.

About this task

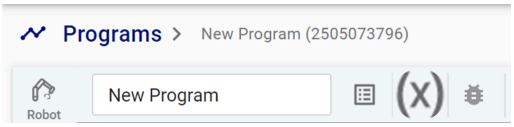
Variables that are added to the program namespace are available as **Program Variables** on the **Variable Manager** and **Select Variable** pages.

Procedure

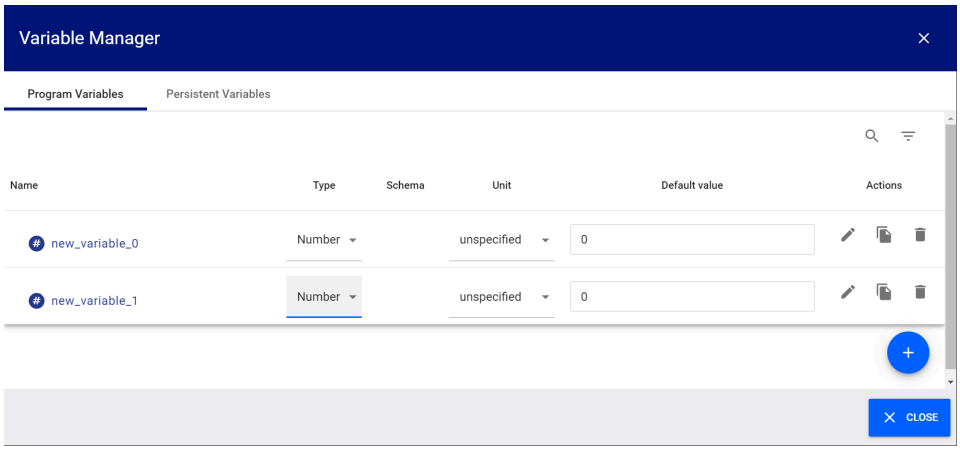
1. Tap **Programming** > **Programs** and select a program.
   The **Program** page launches.

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2. Tap **(X)** in the banner beside the name of the program.



The **Variable Manager** page launches.



3. Tap **Program Variables**.

4. Tap ⊕.

The **Create Variable** dialog launches.

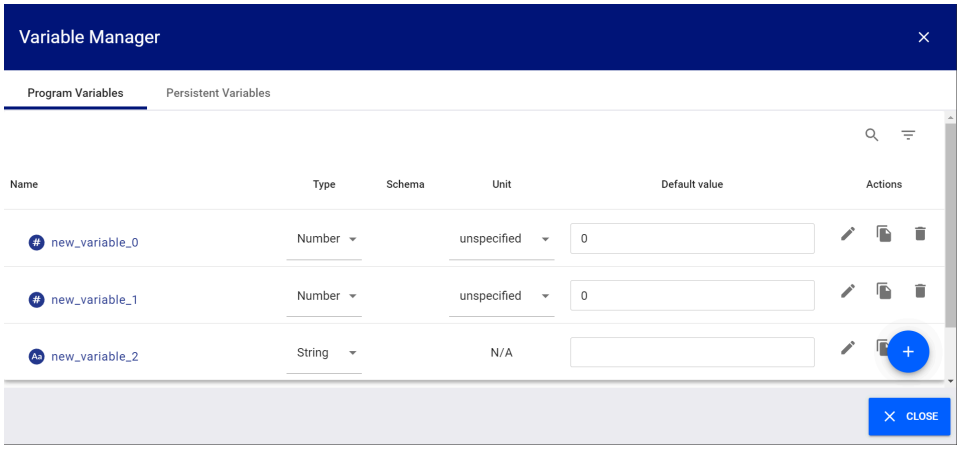


5. Enter a meaningful name for the variable.

Underscores are allowed. Spaces and dashes are not allowed in the name.

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6. Tap **SAVE**.
   The new variable is displayed on the **Program Variables** of the **Variable Manager** page.



7. Select a **Type** for the variable.

Option	Description
String	A word, phrase, or sentence
Boolean	**false** or **true**
Number	Enter an integer or floating point number. Select a **Unit** for the number.
Object	A **Schema** • **Unspecified** • **Default - Pose** • **Default - Joint Angles** • **Default - Payload** • **Arm Plugin - Matrix - Output** • **Arm Plugin - Tool Path - Output** • **Arm Plugin - Waypoints - Output** • **Industrial I/O Plugin - Read Input - Output**

   Note: The schemas that are listed are the default schemas.

8. (Only when the variable is of **Type Object**.) Tap the **Schema** for the type of object that variable represents.

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9. (Only when the variable is of **Type Object**.) Tap the **Value** icon ({}) next and enter the values in the **JSON Object Editor** and tap **SAVE**.

   The variable is available in entities of various tiles.



Figure 170: Editor for object type Unspecified

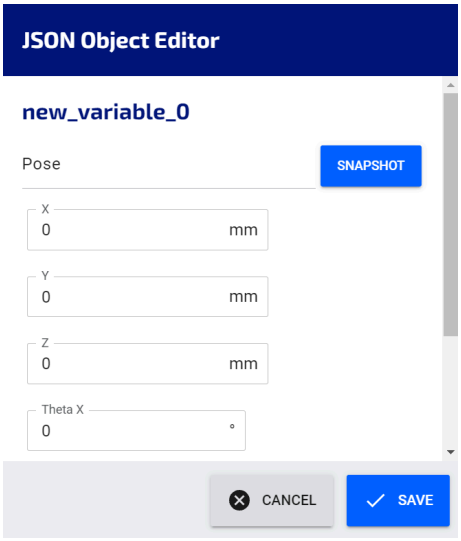


Figure 171: Editor for object type Default - Pose

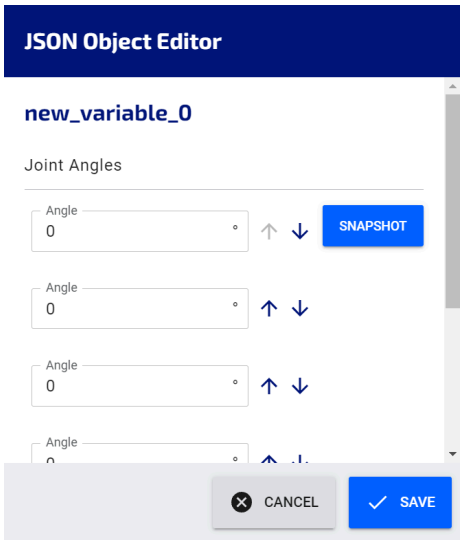


Figure 172: Editor for object type Default - Joint Angles

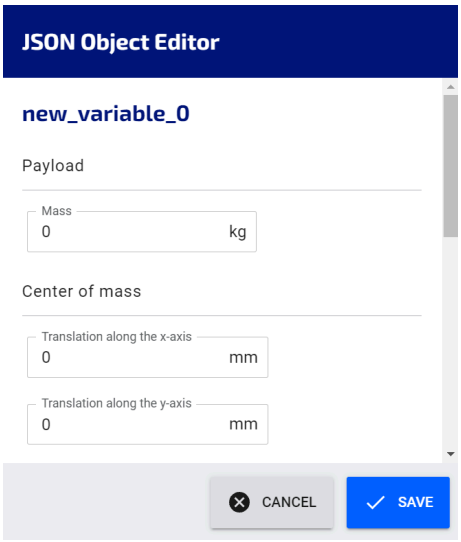


Figure 173: Editor object type Default - Payload

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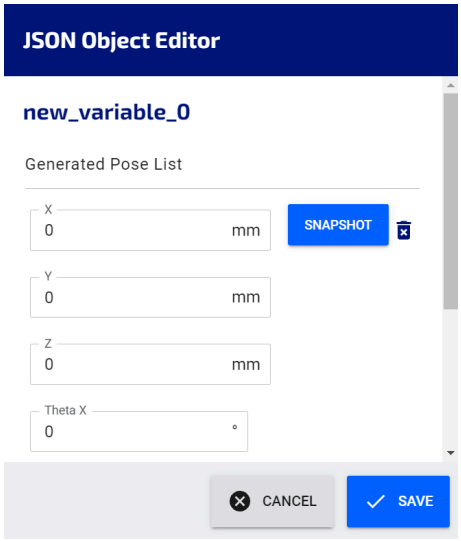


Figure 174: Editor object type Arm Plugin - Matrix - Output

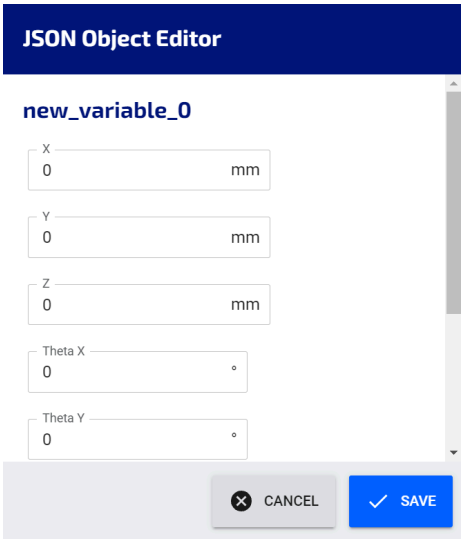


Figure 175: Editor object type Arm Plugin - Tool Path - Output

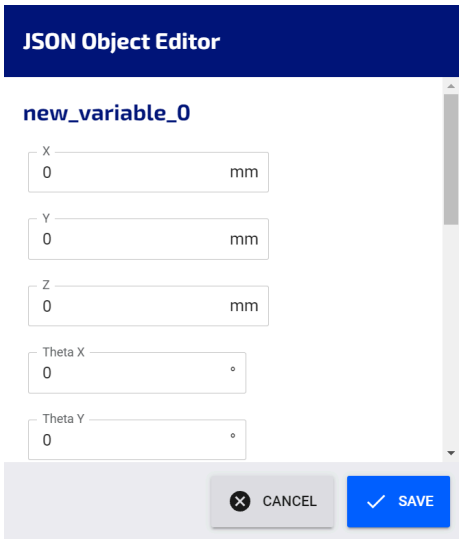


Figure 176: Editor object type Arm Plugin - Waypoints - Output when first invoked

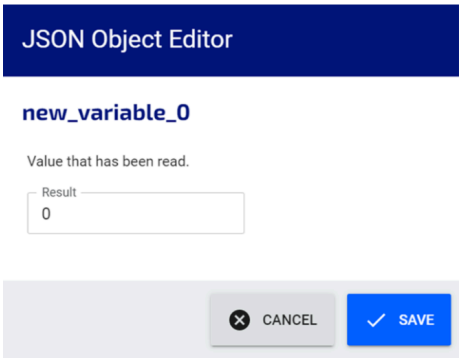


Figure 177: Editor object type Industrial I/O Plugin - Read Input - Output

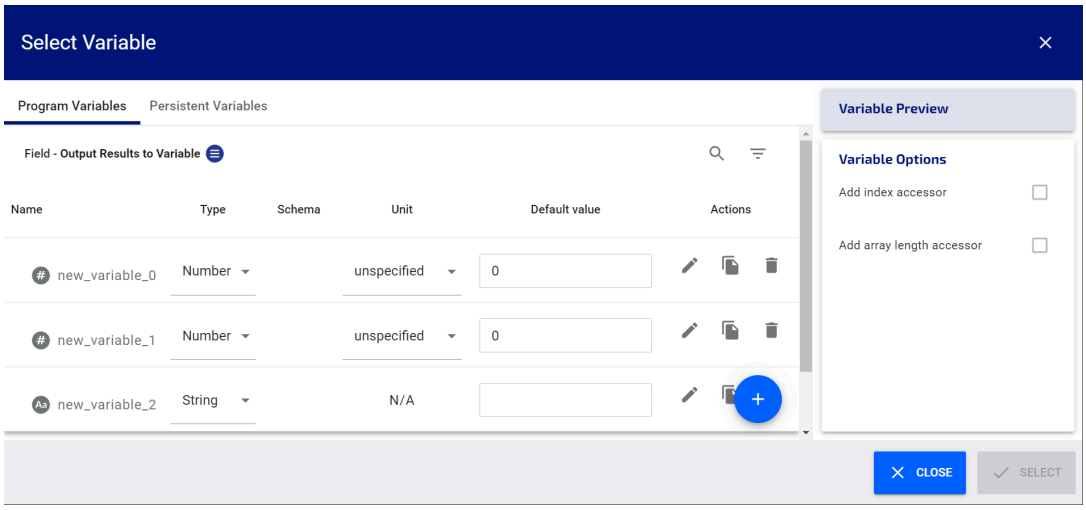
10. Tap **CLOSE**.
    The **Select Variable** page closes and the **Program** page is displayed.

Tip: You can also create variables in context from the **Select Variable** page.

11. Tap a tile in the **Sequence editor** pane.

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12. Tap **(X)** beside **Output Results to Variable**.
    The **Select Variable** page launches with the name of the field to which the variable is to be associated.



Selecting a variable

Sometimes you need to select a variable that is already defined and use it in a program.

About this task

It assumes that all program variables and global variables are already defined.

Procedure

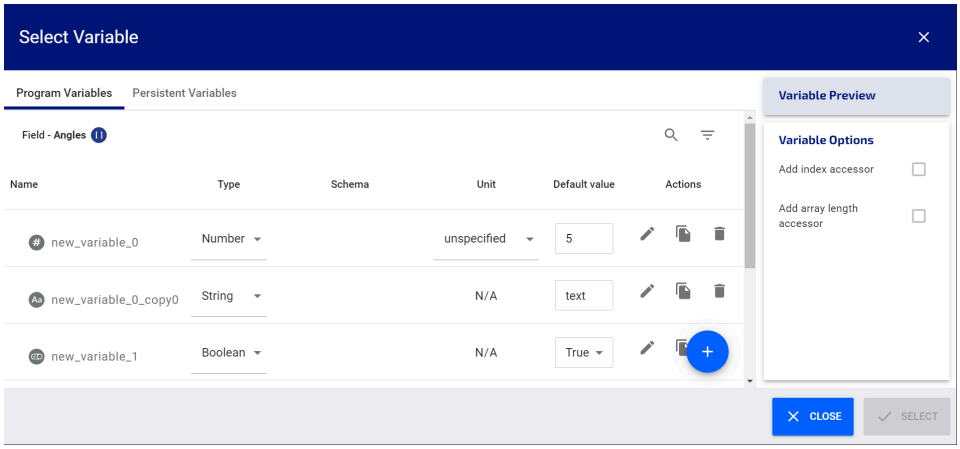
1. Drag and drop an action tile in the **Sequence editor**.
2. Tap **(X)** beside any field in the **Tile configuration** pane.

Note: The **(X)** that launches the **Select Variable** page is displayed in different locations in the **Tile configuration**, depending on which tile is selected in the program.

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The selectable variables are filtered, based on the type, schema, and units associated with the field.

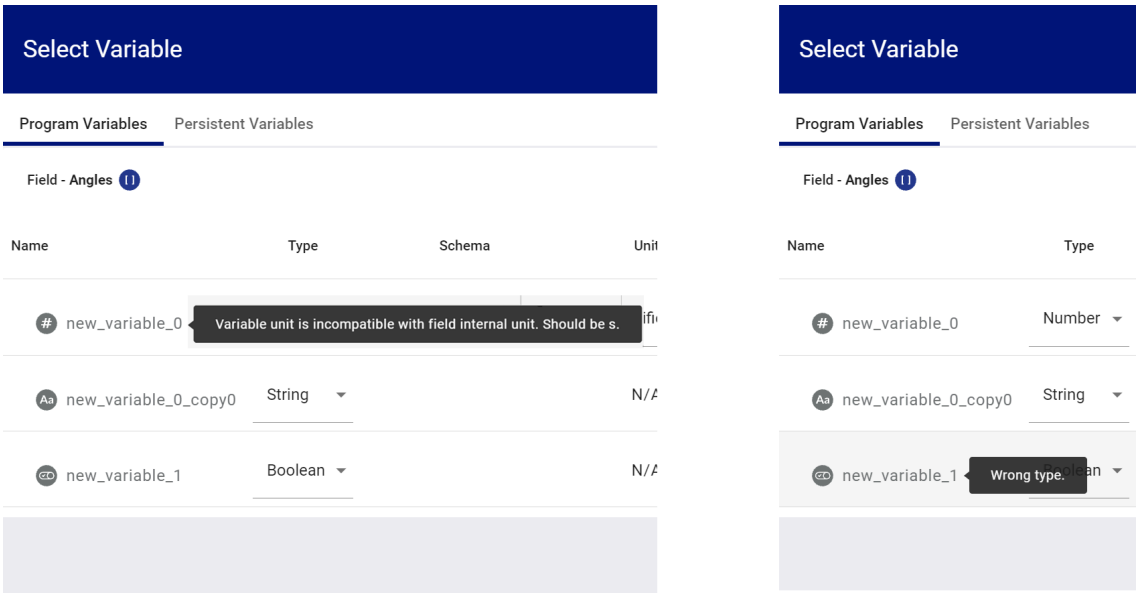
The **Select Variable** page launches.



3. Tap the variable that you want.

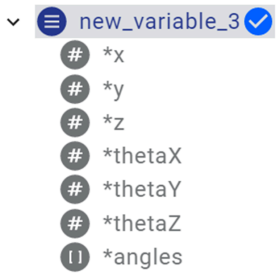
Note: You can select from **Program Variables** or **Persistent Variables**. If the variable you select is not of the same type as the field, a tip displays an error message.

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Note: If the variable that you need is not defined as a variable global to the program and is not defined as a persistent variable, you can create the variable by tapping ⊕ and creating the desired variable.

The name of the variable is highlighted and a check mark displays beside the name.

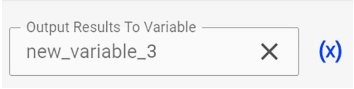


Tapping on the small arrow beside the variable name reveals the content of that variable if it is a complex variable.

4. Tap **SELECT**.
   The **Select Variable** page closes.

   The name of the selected variable displays in the **Output Results to Variable** text box.

   Remember: The name of the selected variable is in the text box where the **Select Variable** is invoked.



Tip: Clear any text field that is filled with a selected variable or selected variable element by tapping the X in the text field.

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Deleting a variable that is being used in a program

When you duplicate a program to speed up program creation, you may find that some variables are not needed for your new program. You need to delete the variable, but only from the program.

About this task

Variables that are used in programs are on the **Program Variables** of the **Variable Manager** page. When you attempt to delete a program variable that is used by the program from the **Variable Manager** page, a **Delete** warning dialog launches.

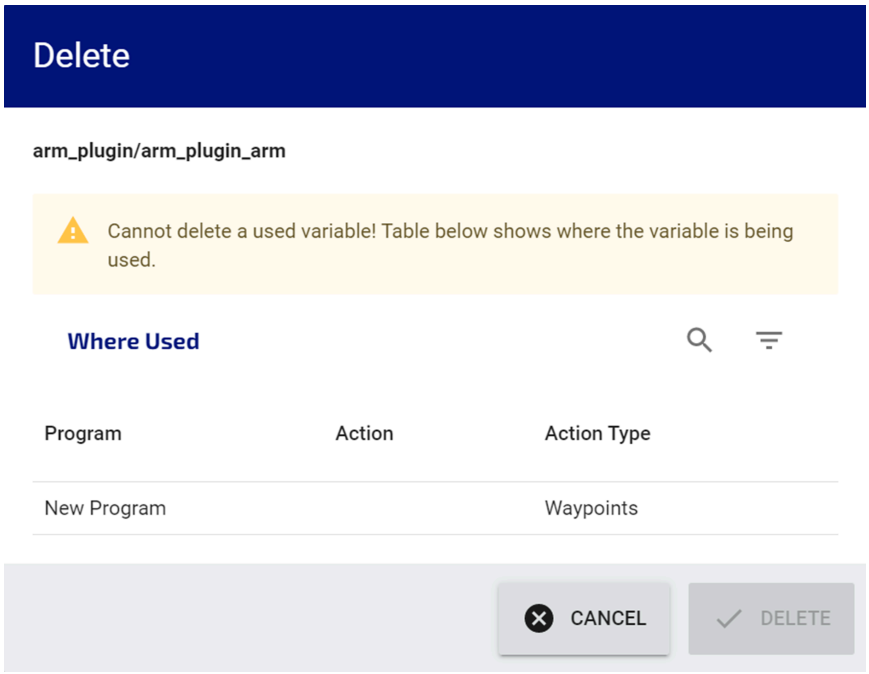


Figure 178: Delete program variable warning dialog

From the **Delete** warning dialog, you can see which program is using the variable and which action type is using it.

Restriction: Do not delete any variable defined as a global variable from the **Persistent Variables** of the **Variable Manager** and **Select Variable** pages unless you know for a fact that the variable in question is not used in any program used by the robot.

Procedure

1. Take note of all the places the variable is used in the program.
2. Tap **CLOSE** on the **Delete** warning dialog.
3. Tap **CLOSE** on the **Variable Manager** page.
4. Tap on the tile corresponding to the location of the variable.

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5. Tap the **X** beside each instance of the variable in the **Tile configuration** pane.
   The field clears.
6. Repeat steps 4 and 5 for each place the variable is being used.
7. Launch the **Variable Manager** page .
8. Select the variable and tap .
   The **Delete** confirmation dialog launches.
9. Tap **Delete**.

Results

The variable is no longer available.

Core tiles

The **Programs** page has two sets of core tiles that are used to drag and drop into the **Sequence editor** to create programs: **Robot** and **Basic**.

Although there is also a **Plugins** tile, and there may be other tiles, none of them are considered to be core tiles.

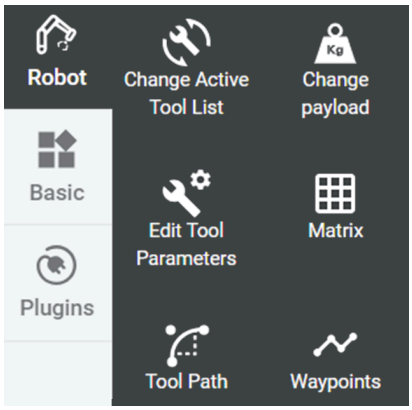


Figure 179: Robot action tiles

Table 78: Robot action tiles

Tile	Tile name	Description
	**Change Active Tool List**	Change the tools, and their order, that are available when the program is still running.
	**Change Payload**	Define a new payload when the program is still running.
	**Edit Tool Parameters**	Change the parametric values of the currently selected tool when the program is still running.

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Tile	Tile name	Description
	**Matrix**	Define a matrix of positions.
	**Tool Path**	Define a complex trajectory with specific constraints.
	**Waypoints**	Create a list of waypoints in the program.  **Remember:** Each list must be all *angular* or all *Cartesian*.

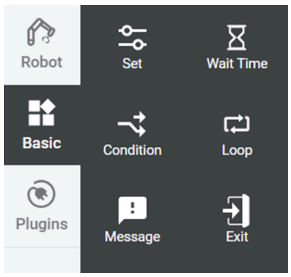


Figure 180: Basic action tiles

Table 79: Basic action tiles

Tile	Tile name	Description
	**Set**	Set the value of a variable. If there is a default value, **Set** overrides the default value.
	**Wait Time**	Introduce a period of time to wait before proceeding to the next step in the program.
	**Condition**	Create a condition in the program.
	**Loop**	Create a loop in the program.
	**Message**	Create a message in the program.  **Note:** Runtime values of variables can be printed in messages by using the syntax `${variable_name}` .
	**Exit**	Exit the program.

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Important: Aside from the core tiles, each installed *plugin* may have its own set of tiles. These additional tiles are displayed in the same area, but under **Plugins**, as the core actions to ease programming.
Each core tile has its own set of parameters that must be defined in the **Tile configuration** pane.

Common core parameters in the Tile Configuration pane

The **Tile configuration** changes dynamically, depending on which tile is dragged into the **Sequence editor**.

The content of the **Tile configuration** changes dynamically with the selected tile. However, there are a few parameters that remain the same for all tiles.



Figure 181: Common parameters in the Tile Configuration pane

Table 80: Entities common to all core tiles

Item	Description
Action Name	Enter a meaningful name for the currently selected tile.
Output Results to Variable	Output results of a variable that is selected for the currently selected tile. **Note:** Not all tiles have any information for this field.
(X)	Tap to launch the **Select Variable** page. Select and modify, or create a variable. **Note:** Not all tiles can select a variable. It is used for the Industrial I/O tiles.
	Play the selected tile when you are in Hold to Run mode. It launches **Variables use by action**, where you can modify values, if necessary, before playing by tapping **PLAY**. **Important:** **Play ( )** does not work with the **Condition** and the **Loop** actions.

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Basic: Set tile parameters

The **Set** tile is a core basic tile. When you drag it into an available tile in the **Sequence editor**, the **Tile configuration** changes dynamically to expose the entities of **Set** that can be configured.

Use **Set** when you need to set the value of one or more variables.

Tip: Whenever you see **(X)** beside an exposed entity, tap it to launch the **Select Variable** page and store the value you entered in a variable.

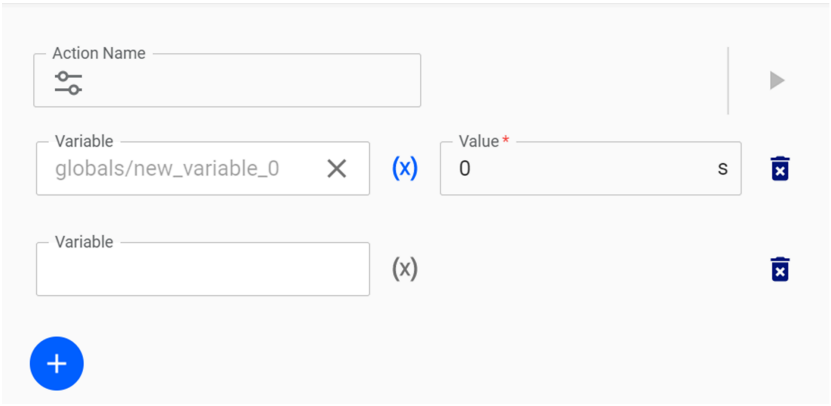


Figure 182: Tile configuration when Set is the current tile

Table 81: Core basic Set entities

Item	Description
Action Name	Select an action from the list that launches when you tap it or enter a meaningful action name for the selected tile.
Variable	Select a variable from the list. **Note:** Tapping **(X)** beside the text field launches the **Select Variable** window where you can select an existing variable, in which case you are assigning the variable a value, or you can create a variable.
Value	Enter the value of the variable.
	Tap to delete the variable from the list.
	Tap to add another variable.

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Basic: Wait tile parameters

The **Wait Time** tile is a core basic tile. When you drag it into an available tile in the **Sequence editor**, the **Tile configuration** changes dynamically to expose the entities of **Wait Time** that can be configured.

Use **Wait Time** when you need to introduce a specified amount of time for the robot to wait before proceeding in the program.

Remember: Whenever you see **(X)** beside an exposed entity, tap it to launch the **Select Variable** page and select the amount of time to wait.

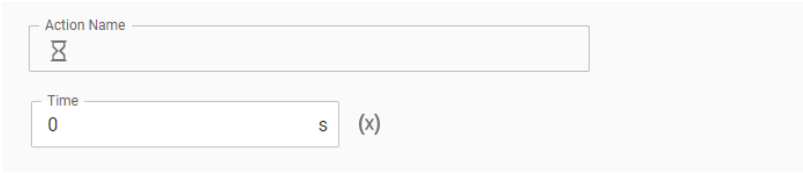


Figure 183: The Tile configuration when Wait Time is the current tile

Table 82: Core basic Wait Time entities

Item	Description
Time	Enter either an integer or a floating point value. Time is measured in seconds.

Basic: Condition tile parameters

The **Condition** tile is a core basic tile. When you drag it into an available tile in the **Sequence editor**, the **Tile configuration** changes dynamically to expose the entities of **Condition** that can be configured.

Use **Condition** when you need to introduce one or more conditions in the program before proceeding in the program.

Tip: Whenever you see **(X)** beside an exposed entity, tap it to launch the **Select Variable** page and select the variable to use in the condition.

When the **Condition** tile is dragged into the **Sequence editor**, it expands.

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Figure 184: The Condition tile expands in the Sequence editor

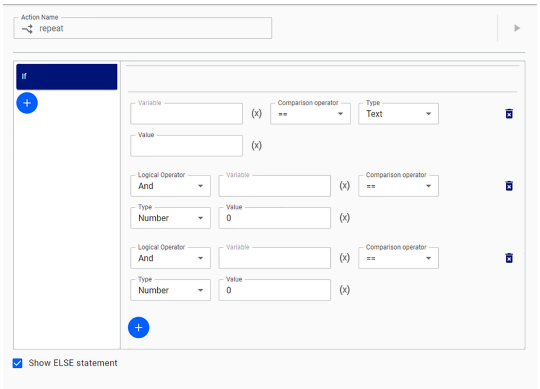


Figure 185: The Tile configuration when Condition is the current tile

A condition starts with **If** and requires variables and values to set the condition.

Table 83: Core basic Condition entities

Item	Description
Variable	Tap to launch the **Select Variable** window where you can select or create a variable to use in the condition.
Comparison operator	Select from the drop-down. • **==** • **>** • **>=** • **<** • **<=**
Type	Select from the drop-down. • **Boolean**: **true**, **false** • **Number**: integer or floating point • **Text**: string of letters
Value	Enter or select the value associated with the selected type.

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Item	Description
	Tap to introduce an alternative condition as an **Else if** statement. The **Else if** also requires a **Variable**, **Comparison operator**, **Type**, **Value** for the selected Type. When **Else if** is selected, another tile is displayed in the **Sequence editor**. 
Show ELSE statement	Select to show the program going through the else condition. The tile in the **Sequence editor** expands. 

Basic: Loop tile parameters

The **Loop** tile is a core basic tile. When you drag it into an available tile in the **Sequence editor**, the **Tile configuration** changes dynamically to expose the entities of **Loop** that can be configured.

Use **Loop** when you need actions to repeat a certain number of times.

Tip: Whenever you see **(X)** beside an exposed entity, tap it to launch the **Select Variable** page and store the value you entered in a variable.

When the **Loop** tile is dragged into the **Sequence editor**, it expands.



Figure 186: The Loop tile expanded in the Sequence editor

The parameters of the **Loop** tile are divided into the global aspects of an action an the specific conditions of the variable, known as the **Looping Conditions**.

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Table 84: Core basic Loop entities

Item	Description
Action Name	Select an action from the list that launches when you tap it or enter a meaningful action name for the selected tile.
Do at least once	Select if you need to perform the actions in the loop at least once.
Iterator	Tap to select or create a variable that increments automatically by 1 on each repetition of the actions in the loop. • The variable used as an iterator must be of type `integer`. • The variable is used for iterating, or counting, over a loop. • The value of the iterator can be modified during run-time; its modified value is taken into consideration. • The default value is used when the iterator has no value defined. **Example:** When the iterator variable has a default of 0 and has not be used yet, the iterator uses `0` as the first number. When the iterator has a default value of 5 and has not be used yet, the iterator starts counting from 5.
Maximum iterations	Enter the maximum number of times the actions within the loop are needed. **Warning:** When **Maximum iterations** is set to 0, the actions in the loop repeat as long as the **Looping Conditions** are true. **Note:** The default maximum number of iterations is 1.
Looping Conditions	

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Item	Description
Variable	Tap to launch the **Select Variable** window where you can select or create a variable to use for the loop. **Tip:** The variable used in the **Looping Conditions** pane can be any variable, including the **Iterator**. The value and the variable that are being compared must be of the same type.
Comparison operator.	Select from the drop-down. • **==**: equals • **>**: greater than • **>=**: greater than or equal • **<**: less than • **<=**: less than or equal • **!=**: not equal
Value	Enter the value associated with the selected type. Alternatively, tap **(X)** to select a variable as the value. The value entered, or the variable selected, must be of the same type as the **Variable** in the **Looping Conditions** pane.
Logical Operator	Select from the drop-down. • **and** • **or** You need the logical operator to combine two or more conditions for the loop to continue.
+	Tap to add more conditions.

Examples of maximum iterations

Example 1: The default value of the iterator variable is 0. The maximum number of iterations is 1. The loop is performed one time; the value of the iterator is 0.

Example 2: The default value of the iterator variable is 1. The maximum number of iterations is 1. The loop is performed one time; the value of the iterator is 1.

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Example 3: The default value of the iterator variable is 5. The maximum number of iterations is 1. The loop is performed one time; the value of the iterator is 5.

Example 4: The default value of the iterator variable is 0. The maximum number of iterations is 5. The loop is performed five times; the value of the iterator is 4.

Example 5: The default value of the iterator variable is 1. The maximum number of iterations is 5. The loop is performed five times; the value of the iterator is 5.

Basic: Message tile parameters

The **Message** tile is a core basic tile. When you drag it into an available tile in the **Sequence editor**, the **Tile configuration** changes dynamically to expose the entities of **Message** that can be configured.

Use **Message** when you want to display a message with important information while the program is running.

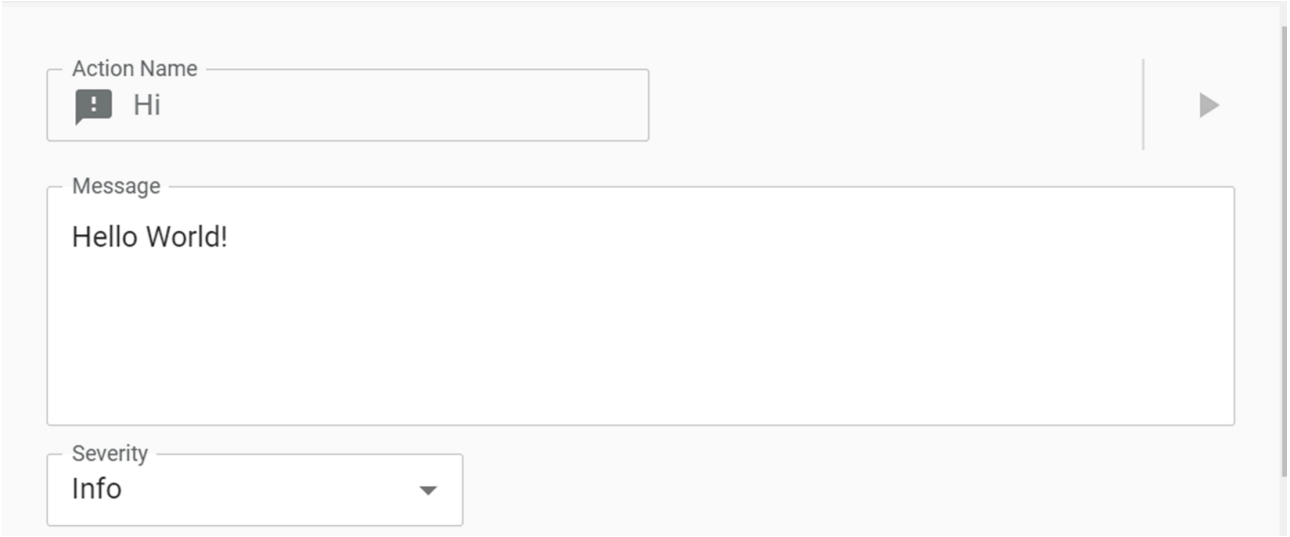


Figure 187: The Tile configuration pane when Message is the current tile

Messages are primarily string based; however, you can display the values of variables as pop-ups in Kortex Web App.

In addition to displaying text in pop-ups, each message generates an *event*. To read over a series of **Message** action output, tap **Notifications** ( )to launch the **Events** page and filter for the message-generated events.

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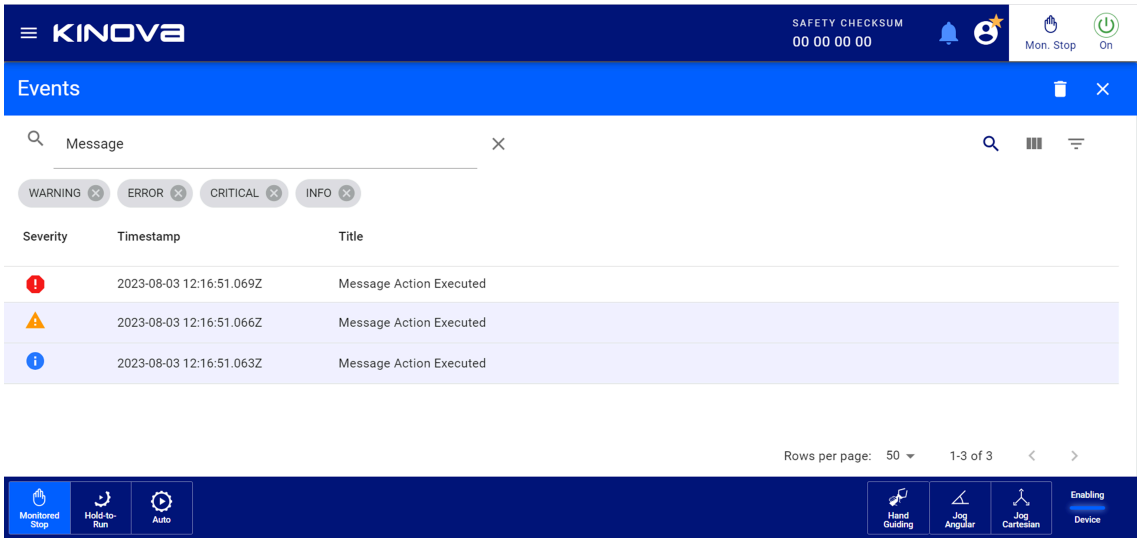


Figure 188: Events filtered for the Message action

Tip: Use the **Message** action to output vital information just before using the **Exit** action to help understand why the program has stopped.

Table 85: Core basic Message entities

Item	Description
Message	Enter a message. Messages can display run-time values of variables. To display the values of variables in a message, follow the coding rules. Property specification — Properties of variables are accessed by using dot (.) notation. **Example:** `pose.x` Array indices — Access specific elements in an array by using square brackets []. **Example:** `pose.angles[0]` Namespaces — When a variable is located within a specific namespace, prefix it with a forward slash /. **Example:** `globals/variable1`

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Item	Description
Severity	Select the level of severity for the message. • **Error** • **Info** • **Warning**

Related topics

Basic: Exit tile parameters on page 287

Basic: Exit tile parameters

The **Exit** tile is a core basic tile. When you drag it into an available tile in the **Sequence editor**, the **Tile configuration** changes dynamically to expose the entities of **Exit** that can be configured.

Use the **Exit** () action to exit a program and either enter Monitored Stop operating mode or stay in the current operating mode.

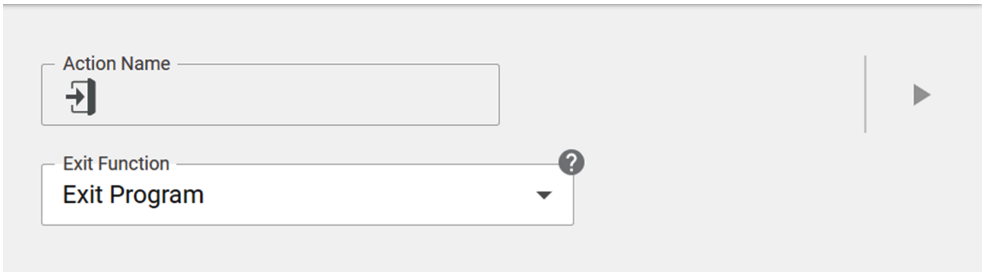


Figure 189: The Tile configuration when Exit is the current tile



Figure 190: Exit functions that are available

Examples of when to use the action:

- The state of a digital input is incompatible with the application.
- Part presence sensor unexpectedly detects a part.
- If the value of read inputs is high, but the expected value is low, abort the program.

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Tip: Use the **Message** action to output vital information just before using the **Exit** action to make troubleshooting easier.

Table 86: Core basic Exit entities

Item	Description
Exit Function	Select the type of exit you need at that point in the program. • **Abort Program** • **Exit Program**
Abort Program	Select **Abort Program** to exit a program such that the program stops and the operating mode switches to Monitored Stop, which creates a safe environment where the robot cannot move.
Exit Program	Select **Exit Program** to exit a program gracefully, such that the system recognizes the program comes to a successful end. The operating mode stays in the operating mode of the robot before **Exit Program** is invoked; the program can be restarted without changing operating modes.

Related topics
Basic: Message tile parameters on page 285

Robot: Change Active Tool List parameters

The **Change Active Tool List** action is used when mechanical tool changers change the end effector. For example, some tasks may require a change between vacuum and finger gripper, or between sanders of different coarseness.

Whenever the end effector changes, the robot must be able to adjust the position of the *TCP*, as well as its inertial model, to ensure the trajectories and safety functions work properly. The **Change Active Tool List** action signals the robot of the change.

Use the **Change Active Tool List** action in a program when another tool configuration needs to be used while the program is running. The action is a blocking action; no other action can be running when the action is active.

The tool listed in the **Change Active Tool List** action must be configured on the **Tools** page. It must exist in either the **Inactive (drag & drop)** or **Active** pane.

Important: When the name of a tool is modified from the **Tools** page, the **Change Active Tool List** actions associated with the tool that had a name change becomes invalid. After

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changing the name of the tool, select the tool with its new name in the **Tile configuration** pane.

After the action runs, the list of tools listed in the **Active** list on the **Tools** page changes to match with the tool listed in the **Change Active Tool List** tile. The order of the tools on the **Tools** reflects the order defined in the **Change Active Tool List** action. The active tool list becomes permanent.

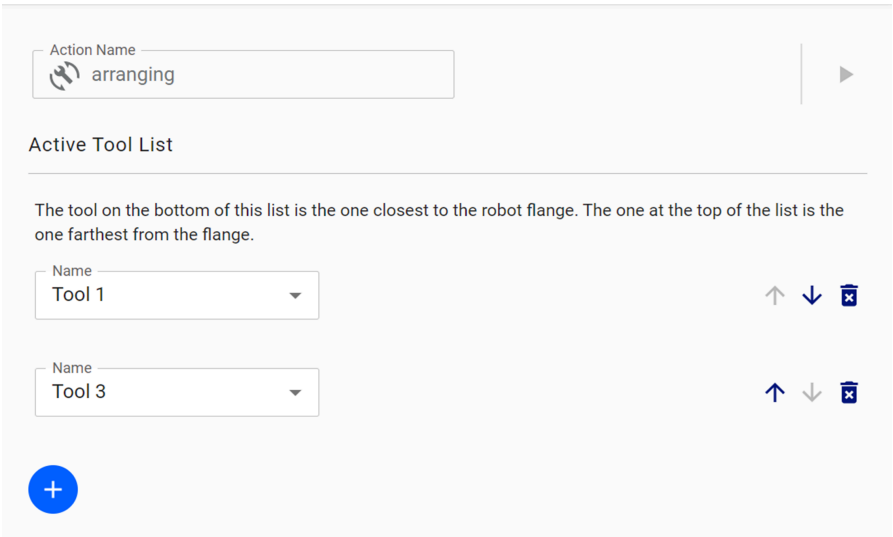


Figure 191: Entities of the Change Active Tool List tile on the Parameter sub-pane in the Tile configuration

Important: When the tool requested in the **Change Active Tool List** action is not available on the **Tools** page, the error message displayed is `Error with value provided.`

Important: When a tool is selected more than once in the **Change Active Tool List** action, the error message displayed is `The tool has already been specified.`

The order of the tools in the list represents the order in which the tools are attached to the flange. The tool that is selected at the top of the list is farthest from the flange. The tool that is selected at the bottom of the list is closest to the flange.

The system automatically performs TCP calculations after the active tool is changed in the program to ensure safe continuity in the program.

Table 87: Core robot Change Active Tool List entities

Item	Description
Name	Select the name of the tool.
↑	Move the tool up in the list, farther from the flange.
↓	Move the tool down in the list, close to the flange.

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Item	Description
	Delete the tool from the list.
	Add a tool to the list.

After the **Change Active Tool List** action runs, the tools move between the **Inactive (drag & drop)** pane and the **Active** pane in the **Tools** page to reflect the tool order.

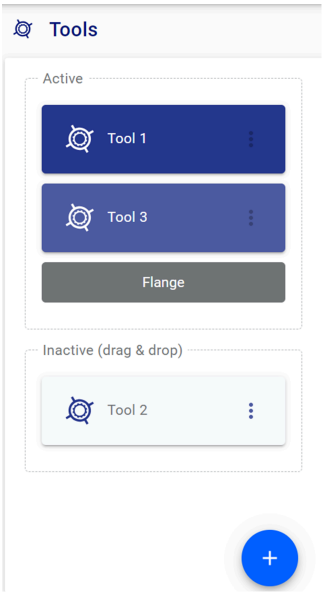


Figure 192: Tools page after the Change Active Tool List action

Related topics
Configuring tools on page 191

Robot: Change Payload tile parameters

The **Change Payload** tile is a core robot tile. When you drag it into an available tile in the **Sequence editor**, the **Tile configuration** changes dynamically to expose the entities of the payload that can be configured.

The **Change Payload** tile is used to configure payloads while a program is running. No other action can run while the **Change Payload** is running. If the program is stopped at the time the **Change Payload** tile is active, the **Change Payload** action remains active. One or more **Change Payload** actions can be dragged into the **Sequence editor** to create a program.

The parameters of a payload are grouped into three parts.

- **Payload**
- **Center of Mass**

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- **Inertia Matrix**

The parameters are modifiable when the robot is in one of three states.

- The arm is switched off.
- The arm is switched on and is in Monitored Stop mode.
- The arm is switched on and is in Hold to Run mode.

Tip: Whenever you see **(X)** beside an exposed entity, tap it to launch the **Select Variable** page and store the value you entered in a variable.

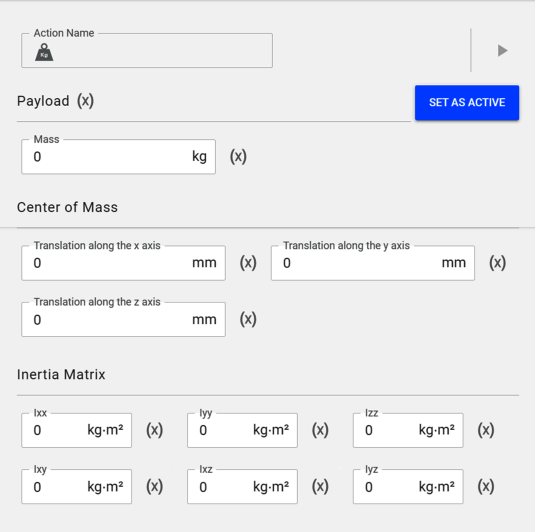


Figure 193: Entities of the Change Payload tile on the Parameter sub-pane in the Tile configuration

Table 88: Core robot Change Payload entities

Item	Description
Payload	
SET AS ACTIVE	Tap to set the payload configuration defined in the parameter configuration pane as active. The currently active payload is displayed in the **Payload** pane on **Systems** > **Robot** > **Arm**.
Mass	Enter the mass of the new payload. Valid range for mass: 0.0000 to 9.0000 kg
Center of Mass	
Translation along the x axis	Enter the translation along the x axis with respect to the flange. Valid range: -1000 to 1000 mm

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Item	Description
Translation along the y axis	Enter the translation along the y axis with respect to the flange. Valid range: -1000 to 1000 mm
Translation along the z axis	Enter the translation along the z axis with respect to the flange. Valid range: -1000 to 1000 mm
Inertia Matrix	
Ixx	Enter the moment of inertia with respect to the x axis of the flange. Valid range: 0 to 1 $kg \cdot m^2$
Iyy	Enter the moment of inertia with respect to the y axis of the flange. Valid range: 0 to 1 $kg \cdot m^2$
Izz	Enter the moment of inertia with respect to the z axis of the flange. Valid range: 0 to 1 $kg \cdot m^2$
Ixy	Enter the product of inertia Ixy. Valid range: -1 to 1 $kg \cdot m^2$
Ixz	Enter the product of inertia Ixz. Valid range: -1 to 1 $kg \cdot m^2$
Iyz	Enter the product of inertia Iyz. Valid range: -1 to 1 $kg \cdot m^2$

Robot: Edit Tool Parameters action

Tool parameters that are changed by the **Edit Tool Parameters** action are permanent from the time the action is performed; the parametric values persist across programs.

A specific program may require one or more active tools to be in a different pose than it normally would be in at that point in the program.

Always keep in mind the moment of inertia, the mass, and the center of mass of the tool.

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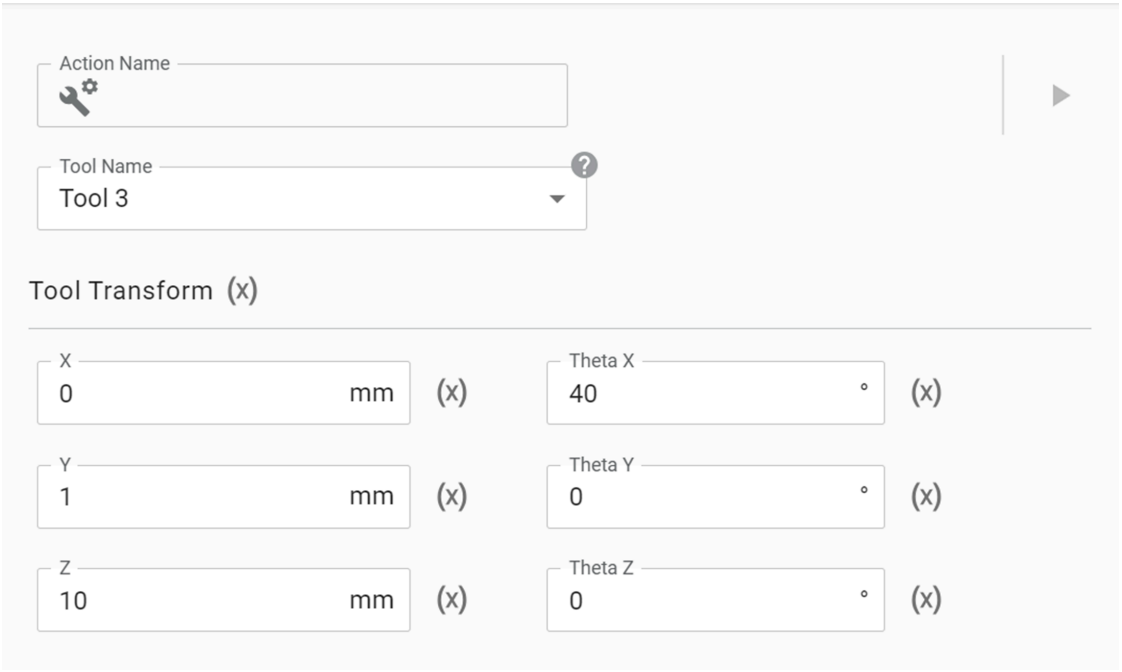


Table 89: Core robot Edit Tool Parameters entities

Item	Description
Tool Name	Select the name of the tool that needs to have its pose altered while the program is running.
Tool Transform	Enter the change in the pose by changing the values in **X**, **Y**, **Z**, **Theta X**, **Theta Y**, and **Theta Z** as needed.

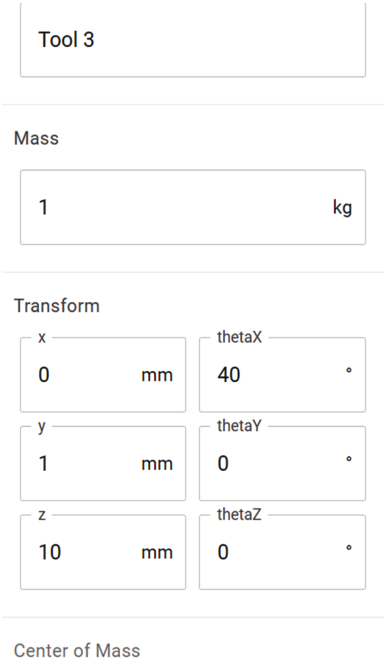
Use variables to create a completely new transform or to create part of a new transform for the tool by tapping **(X)**, which launches the **Select Variable** page. Select the variable that matches the field.

Remember: If the variable does not yet exist, create it from the **Select Variable** page by tapping the add button (+).

Variable parameter	Variable type	Variable Unit	Variable Schema
Tool Transform	**Object**	n/a	**Default - Pose**
X, **Y**, **Z**	**Number**	mm	n/a
Theta X, **Theta Y**, **Theta Z**	**Number**	°	n/a

After the **Edit Tool Parameters** action runs, the new **Transform** values are displayed on the **Tools** page when you select the edited tool.

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Related topics

Selecting a variable on page 272

Variable Management page on page 258

Configuring tools on page 191

Robot: Matrix tile parameters

The **Matrix** tile is a core robot tile. When you drag it into an available tile in the **Sequence editor**, the **Tile configuration** changes dynamically to expose the entities of the matrix that can be configured.

The **Matrix** tile is used to define a large number of Cartesian poses that are spaced evenly on a 3D grid. Only a few parameters must be entered. Store the list of poses in a variable so that it can be used in a program.

Important: The tile does not make the robot move; it only performs the computations needed to make the robot move during runtime.

The parameters of the matrix are grouped into three parts. Each part is a sub-pane in the **Tile configuration**. Each sub-pane is accessible by tapping on its name.

- **Parameters**
- **Coordinates**

Tip: Tap **(X)** beside an exposed entity to launch the **Select Variable** page and replace the value in the entity with the content of the variable.

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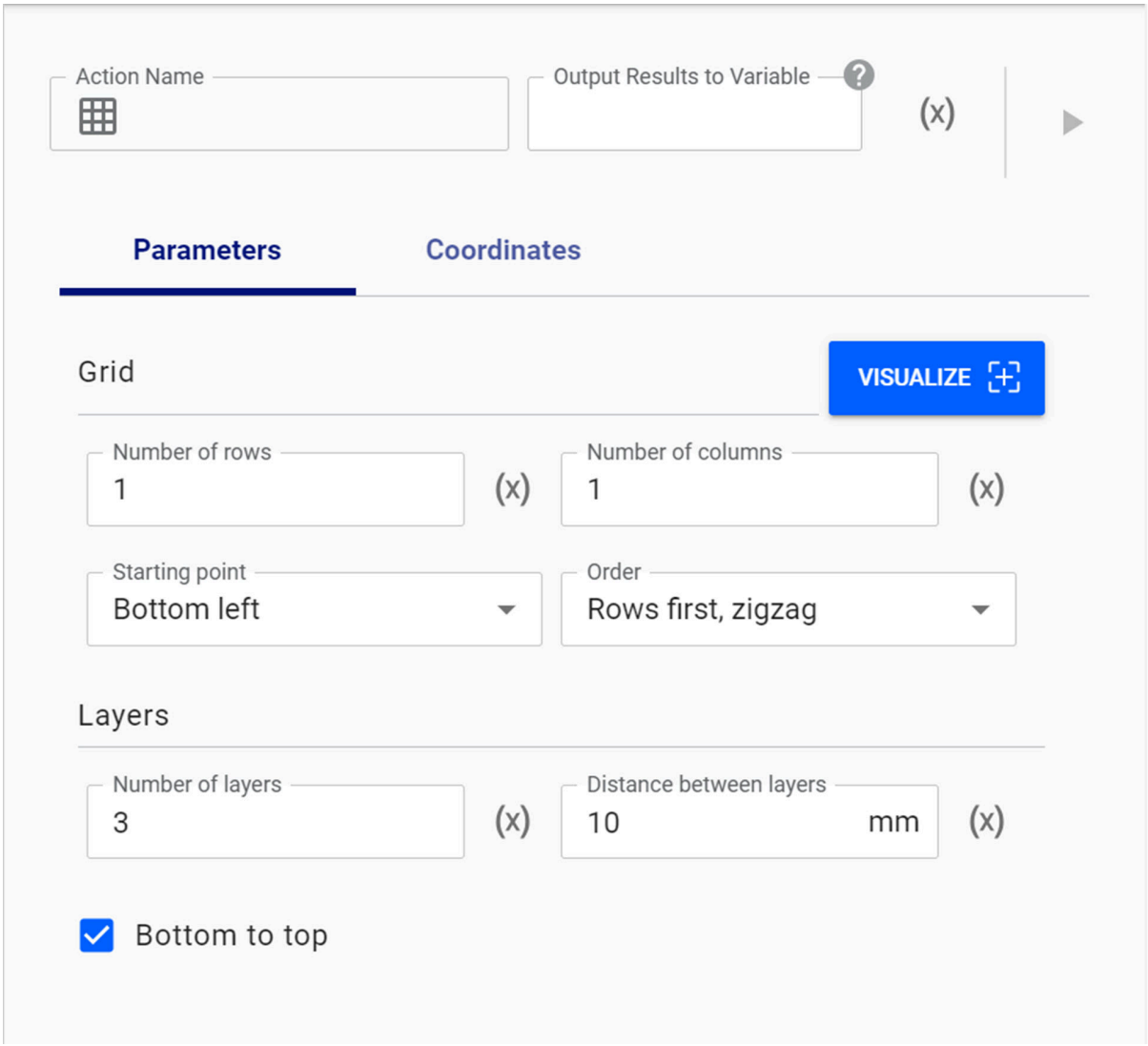


Figure 194: Entities of the Matrix tile on the Parameter sub-pane in the Tile configuration

Table 90: Core robot Matrix entities on the Parameters sub-pane

Item	Description
Grid	
VISUALIZE	Tap to compute the positions of the matrix and display the positions in the 3D rendering of the robot in the **Visualization**.
Number of rows	Enter the number of rows in the matrix.
Number of columns	Enter the number of columns in the matrix.

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Item	Description
Starting point	Select from the drop-down. • **Bottom left** • **Bottom right** • **Top left** • **Top right**
Order	Select from the drop-down. • **Rows first, zigzag** • **Rows first, back and forth** • **Columns first, zigzag** • **Columns first, back and forth** • **Randomized**
Layers	
Number of layers	Enter the number of layers in the matrix.
Distance between layers	Tap in the text field or tap **(X)** to select, or create, a variable that defines the distance between layers.
Bottom to top?	Select to run the matrix from the bottom layer to the top layer. Deselect to play from the top layer to the bottom.

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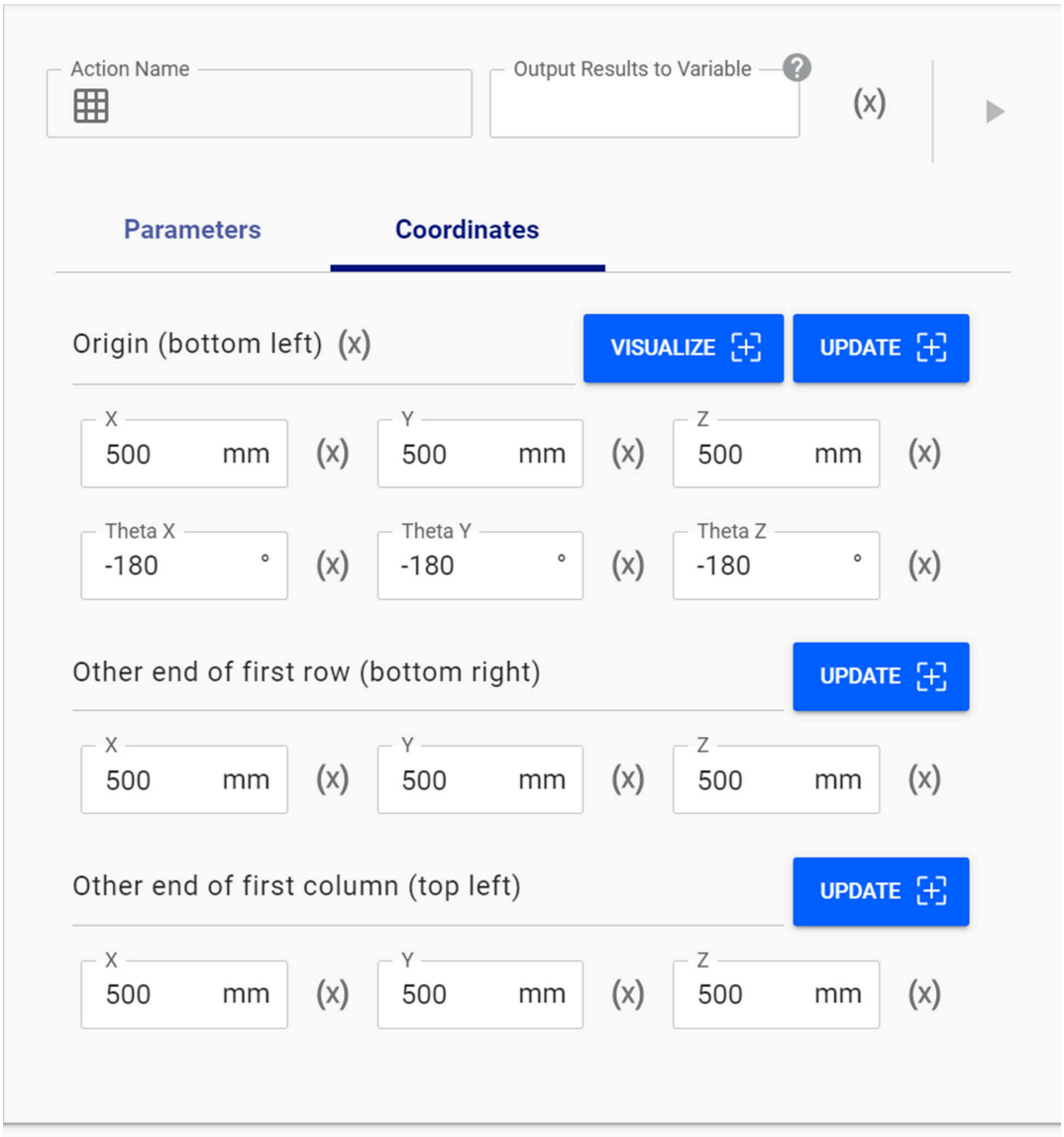


Figure 195: Entities of the Matrix tile on the Coordinates sub-pane in the Tile configuration

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Table 91: Core robot Matrix entities on the Coordinates sub-pane

Item	Description
Origin (bottom left)	The origin is the selected **Starting point** on the **Parameters** sub-pane. Tap **VISUALIZE** to display the computed positions of the matrix in the **Visualization**. Tap **UPDATE** when you want to overwrite the values in the origin parameter fields with the current pose of the robot. Tap the **X**, **Y**, **Z**, **Theta X**, **Theta Y**, **Theta Z** text boxes, or the **(X)** beside them, to select or create a variable that has the associated values. **Note:** You can also use the snapshot button on the wrist of the robot to set the origin.
Other end of first row (bottom right)	Enter values for **X**, **Y**, and **Z**. Tap **UPDATE** when you want to overwrite the values in the parameter fields of the other end of the first row with the current pose of the robot. **Note:** You can also use the snapshot button on the wrist of the robot to set the end of the first row.
Other end of first column (top left)	Enter values for **X**, **Y**, and **Z**. Tap **UPDATE** when you want to overwrite the values in the parameter fields of the other end of the first column with the current pose of the robot. **Note:** You can also use the snapshot button on the wrist of the robot to set the end of the first column.

Robot: Tool Path parameters

The **Tool Path** tile is a core robot tile. When you drag it into an available tile in the **Sequence editor**, the **Tile configuration** changes dynamically to expose the entities of the Tool Path that can be configured.

Use the **Tool Path** action to move the robot along complex paths under specific constraints. The **Tool Path** action can control processes, such as in welding where the robot must maintain a constant speed and must stay exactly on the trajectory.

The parameters of **Tool Path** are grouped into three parts. Each part is a sub-pane in the **Tile configuration**. Each sub-pane is accessible by tapping on its name.

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- **Waypoints**
- **Path Configuration**
- **Custom Frame**

Tip: Whenever you see **(X)** beside an exposed entity, tap it to launch the **Select Variable** page and select a variable to use for the exposed entity.

Tool Path waypoints

Each **Tool Path** tile in a program must define one or more waypoints for the robot to move continuously.

The **Tool Path** tile holds a configurable list of waypoints the robot uses to move to complete a task. The **Tool Path** action aims to reach and maintain the defined speed throughout the task.

Important: The arm must be switched on to add waypoints in the tool path. The arm can be off when you edit waypoints.

Some of the parameters are the same regardless of the type of waypoint; others are specific to the type of waypoint.

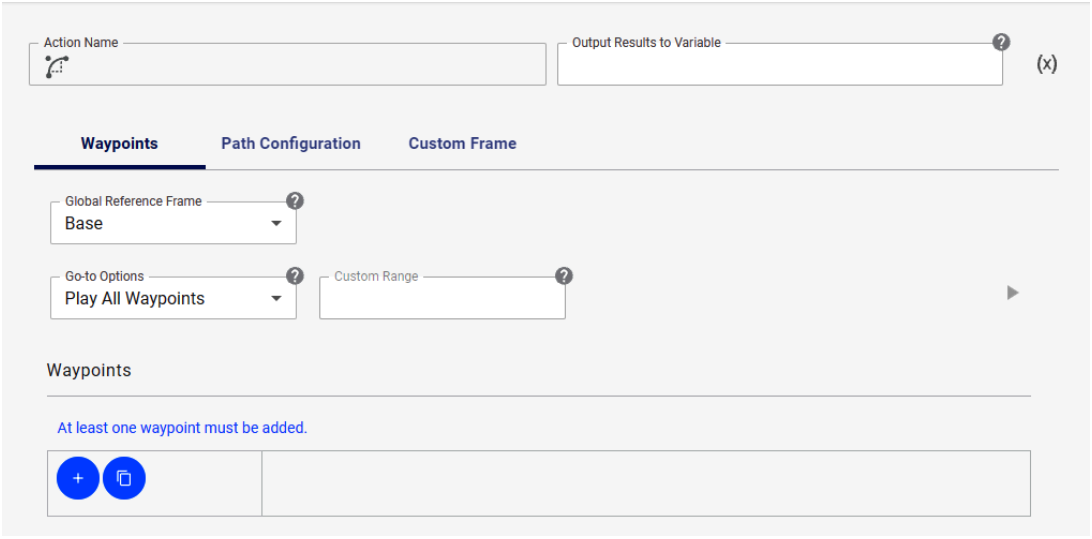


Figure 196: Parameters common to all types of tool path waypoints

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Table 92: Parameters common to all types of waypoints

Item	Description
Global Reference Frame	Select a frame of reference. The waypoint pose converts automatically with respect to the frame of reference. • **Base** • **Custom**
Go-to Options	**Play All Waypoints** Play all waypoints listed in the **Waypoints** pane. **Play Custom Range** Play only the waypoints within the range defined in **Custom Range**.
Custom Range	Enter the start and end waypoints. For example, if 6 waypoints are defined in a tile and you want to investigate only from waypoint #2 and want to end at waypoint #5, you would enter the range as 2-5. **Note:** The **Custom Range** field can be used only when **Play Custom Range** is selected from **Go-to Options**.
	Tap **Play** ( ) from the **Waypoints** sub-pane to check the Cartesian poses and orientation of the arm at each of the locations in the **Custom Range** list. **Tip:** Available only in Hold to Run mode when you are testing the waypoints for the program you are creating.
Waypoints pane	
	Tap **+** in the **Waypoints** sub-pane to add a waypoint to the list of waypoints for the currently selected waypoint tile. The waypoint is added to the list of waypoints. The default waypoint name is Waypoint #1, Waypoint #2, Waypoint #3, and so on. **Tip:** Give the waypoint a meaningful name by changing the text in the **Name** text field. Parameters for the new waypoint launches in the **Waypoints** sub-pane. The parameters that are displayed depend on what is selected from **Waypoint type**: **Straight line** or **Arc point**.
	Tap to copy the currently selected waypoint.

When a waypoint is added, the **Waypoints** pane expands.

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Figure 197: Entities of the Waypoints pane

1 Enter the index of the currently selected waypoint in the waypoints list and view the total number of waypoints in the list.

2 Tap the arrows to move the selected waypoint up or down the waypoints list.

3 Tap to delete the currently selected waypoint.

4 Select any waypoint in the waypoint list to define its parameters.

5 Waypoint debugging tools.

SET AS FIRST GO-TO

Tap to select the waypoint as the first point in a waypoint list to move towards.

SET AS SINGLE GO-TO

Tap to select the waypoint as a single point to move towards.

SET AS LAST GO-TO

Tap to select the waypoint as the last waypoint in the waypoint list to move towards

When the last go-to waypoint is not set explicitly, the range ends with the index of the last waypoint in the list. When the last go-to waypoint is set explicitly, the range ends with the index of the waypoint selected as the last go-to.

6 Change the **Name** of the currently selected waypoint to a more meaningful name, if desired. The default names are "Waypoint #" with the next available number appended to it. For example, "Waypoint #1", "Waypoint #2", "Waypoint #3", and so on.

7 Select the **Waypoint type**.

- **Straight line**
- **Arc point**

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Configure the parameters according to the currently selected **Waypoint type**: **Straight line** or **Arc point**.

The parameters of each **Straight line** and **Arc point** waypoint can be defined by the use of variables.

Speed and acceleration can be controlled for each waypoint, whether **Straight line** or **Arc point**. When waypoint-specific speeds are defined, velocity is maintained during the blend. When waypoint-specific accelerations are defined, no acceleration along the path occurs during the blend.

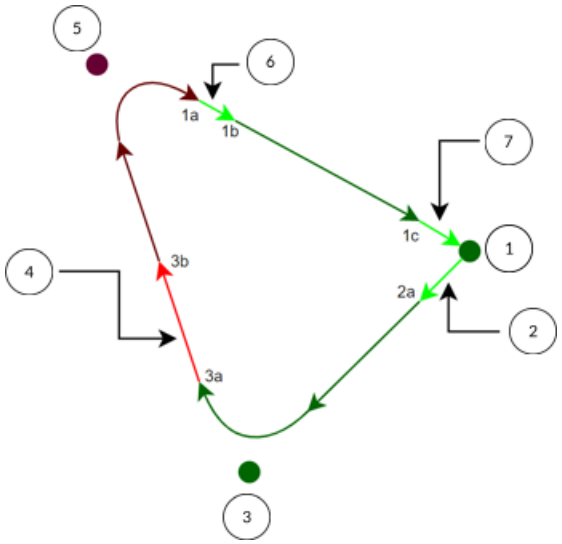


Figure 198: Waypoint-specific speeds and blending

1 Waypoint 1
No blending
v = 100 mm/s
a = 1 m/s^2

2 Acceleration of waypoint 2 to reach the speed of waypoint 2

3 Waypoint 2
Blending
v = 100 mm/s
a = 1 m/s^2

4 Acceleration of waypoint 3 to reach the speed of waypoint 3

5 Waypoint 3
Blending
v = 50 mm/s
a = 0.25 m/s^2

6 Acceleration of waypoint 1 to reach the speed of waypoint 1

7 Acceleration of waypoint 1 to stop

The speed and acceleration of each **Straight line** and **Arc point** waypoint can be can be reset to their default values. Default speeds and accelerations are the globally configured values.

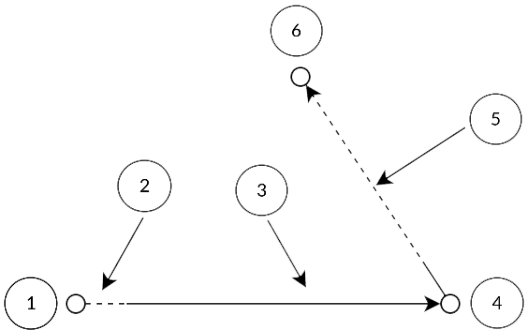
Straight line waypoints

A **Straight line** waypoint creates a straight line segment from the previous waypoint to the **Straight line** waypoint.

Important: The first and last waypoints in the **Tool Path** action waypoint list must be **Straight line** waypoints.

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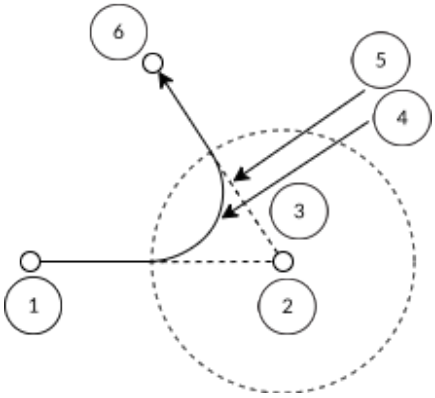
When the arm approaches a straight line waypoint without blending, the arm moves along the trajectory in a straight line and stops momentarily before proceeding to the next waypoint.



1 Previous waypoint
2 Possible arc radius or blending from previous waypoint
3 Straight line segment
4 Straight line waypoint
5 Next segment (defined by next waypoint)
6 Next waypoint

Figure 199: Tool Path action Straight line waypoint definition

There is the option to use *blending* on the waypoints. Blending is optional. It helps to keep the arm moving along its trajectory in a straight line towards the intermediate point; the arm does not stop at that point, but continues moving towards the next waypoint. **Fine Positioning** blending maintains a constant velocity in the trajectory in the corners. **Radius** blending controls how close to the intermediate point the arm needs to be to the waypoint.



1 Previous waypoint
2 Straight line waypoint with blending
3 Radius
4 Path with blending
5 Path without blending
6 Next waypoint

Figure 200: Tool Path action Straight line with and without blending waypoint definition

Straight line parameters

A **Straight line** waypoint creates a straight line segment from the previous waypoint to the **Straight line** waypoint.

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When you select **Straight line** as the waypoint type, the associated waypoint and path configuration parameters are displayed.

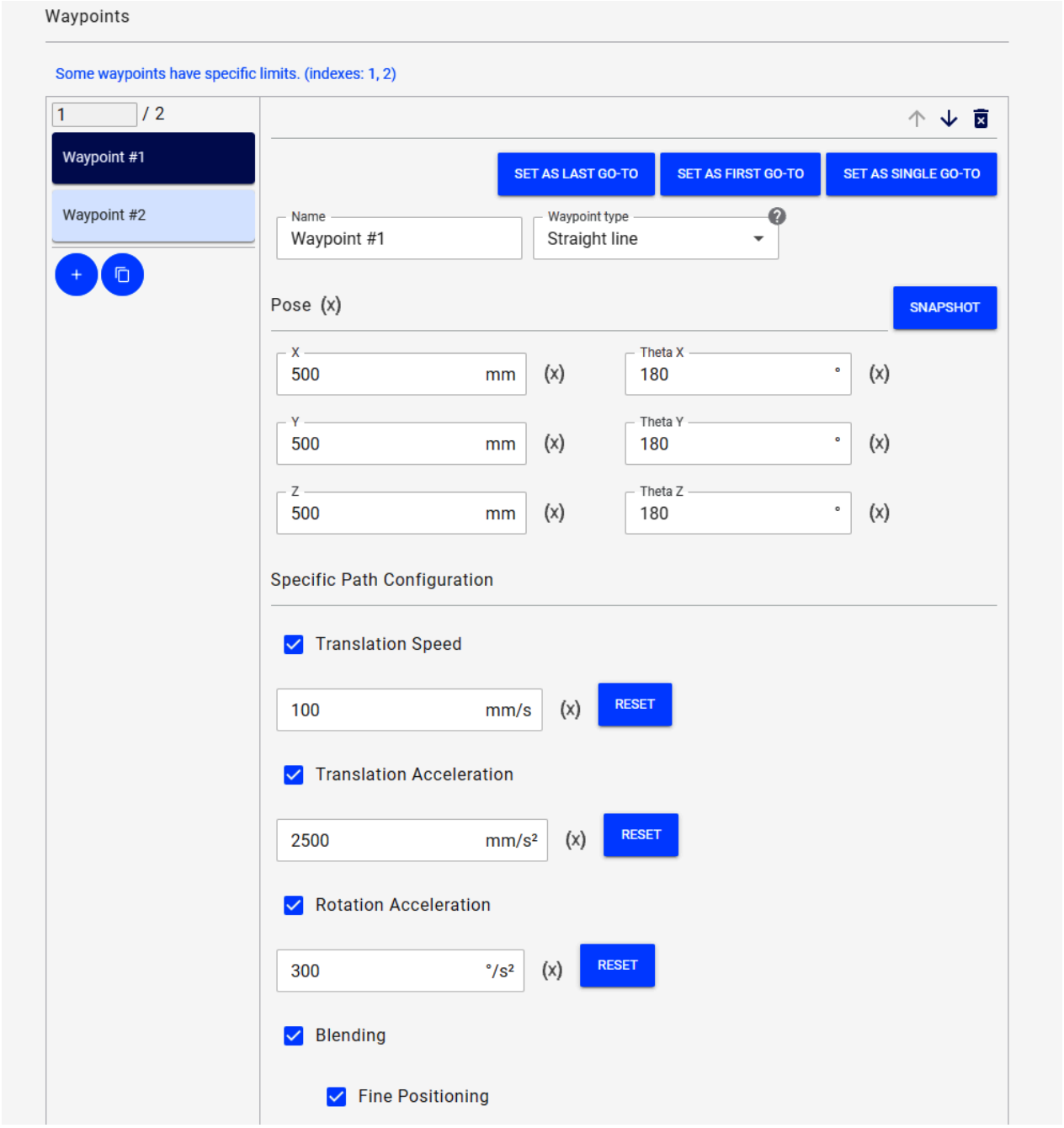


Figure 201: Parameters of the Straight line waypoints

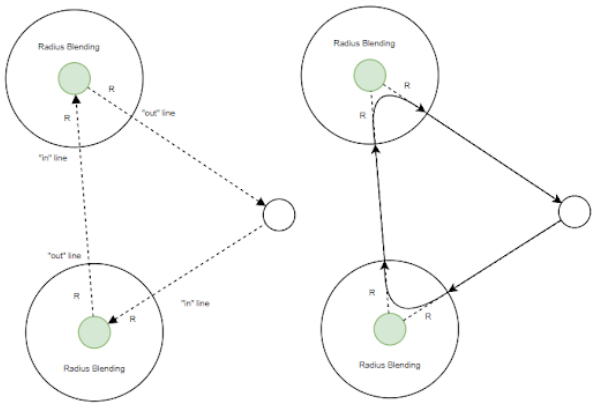
Table 93: Parameters of Straight line waypoints

Item	Description
Pose pane	

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Item	Description
Pose	Pose is expressed in Cartesian and angular coordinates. Move the robot into position and use the **SNAPSHOT** button to fill in the current pose of the robot, taking into account the currently selected **Global Reference Frame**.
X, **Y**, **Z**	The current Cartesian position of the waypoint selected in the list is displayed. Change the values if you know your values are more accurate than what is currently listed. Measurements are in millimeters.
Theta X, **Theta Y**, **Theta Z**	The current angular position of the waypoint selected in the list. Change the values if you know your values are more accurate than what is currently listed. Measurements are in degrees.
Specific Path Configuration pane	
RESET	Tap to revert to the default value of the parameter.
Translation Speed	Select to enter the translation speed in a text box. Default: 100 mm/s Minimum: 0.01 mm/s Maximum: 2,000 mm/s  **Remember:** The robot moves at the defined speed on its approach to the current waypoint.
Translation Acceleration	Select to enter the translation acceleration in the text box for the *TCP* moving towards the selected waypoint. Default: 2,500 mm/s^2 Minimum: 10 mm/s^2 Maximum: 12,000 mm/s^2  **Remember:** The robot starts to accelerate from the previous waypoint towards the current waypoint.
Rotation Acceleration	Select to enter the orientation acceleration for the *TCP* moving towards the selected waypoint. Default: 300 $°/s^2$ Minimum: 1 $°/s^2$ Maximum: 1,500 $°/s^2$  **Remember:** The robot starts to accelerate its rotation from the previous waypoint while it moves towards the current waypoint.

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Item	Description
Blending	Select when the robot needs to move continuously. Enter a radius to use as the maximum amount of distance that can be used when approaching the waypoint; this is radius blending. Default: 20 mm Minimum: 0.1 mm Maximum: 500 mm 
Fine Positioning	Select when the waypoint is the first or the last waypoint in the **Tool Path** action and the position of the waypoint must be exact. **Note:** The robot stops momentarily when it reaches the waypoint.
Radius	Enter a radius to use as the maximum amount of distance that can be used when approaching the waypoint.

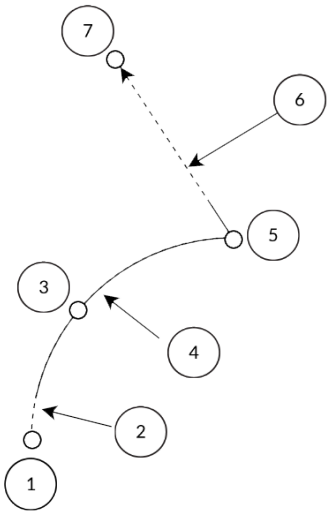
Arc point waypoints

An **Arc point** waypoint creates a curved segment to the waypoint.

Use **Arc point** to define the midpoint of an arc.

When the arm approaches an arc point waypoint without blending, the arm moves along the trajectory in an arc and stops momentarily at the waypoint before proceeding to the next waypoint.

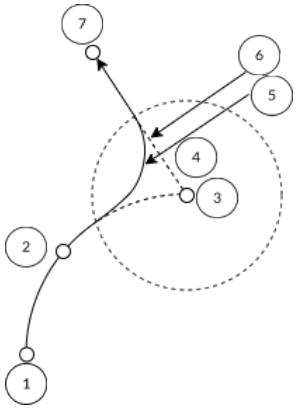
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1 Previous waypoint
2 Possible blending from previous waypoint
3 Via point
4 Arc point segment
5 Arc point waypoint
6 Next segment,which is defined by the next waypoint
7 Next waypoint

Figure 202: Tool Path action Arc point waypoint definition

There is the option to use *blending* on the waypoints. Blending is optional. It helps to keep the arm moving along its trajectory in an arc towards the intermediate point; the arm does not stop at that point, but continues moving towards the next waypoint. **Fine Positioning** blending maintains a constant velocity in the trajectory in the curved trajectory. **Radius** blending controls how close to the intermediate point the arm needs to be to the waypoint.



1 Previous waypoint
2 Via point
3 Arc point waypoint with blending
4 Radius
5 Path with blending
6 Path without blending
7 Next waypoint

Figure 203: Tool Path action arc with and without blending waypoint definition

Arc point parameters

An **Arc point** waypoint creates a curved segment to the waypoint.

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When you select **Arc point** as the waypoint type, the associated waypoint and path configuration parameters are displayed.

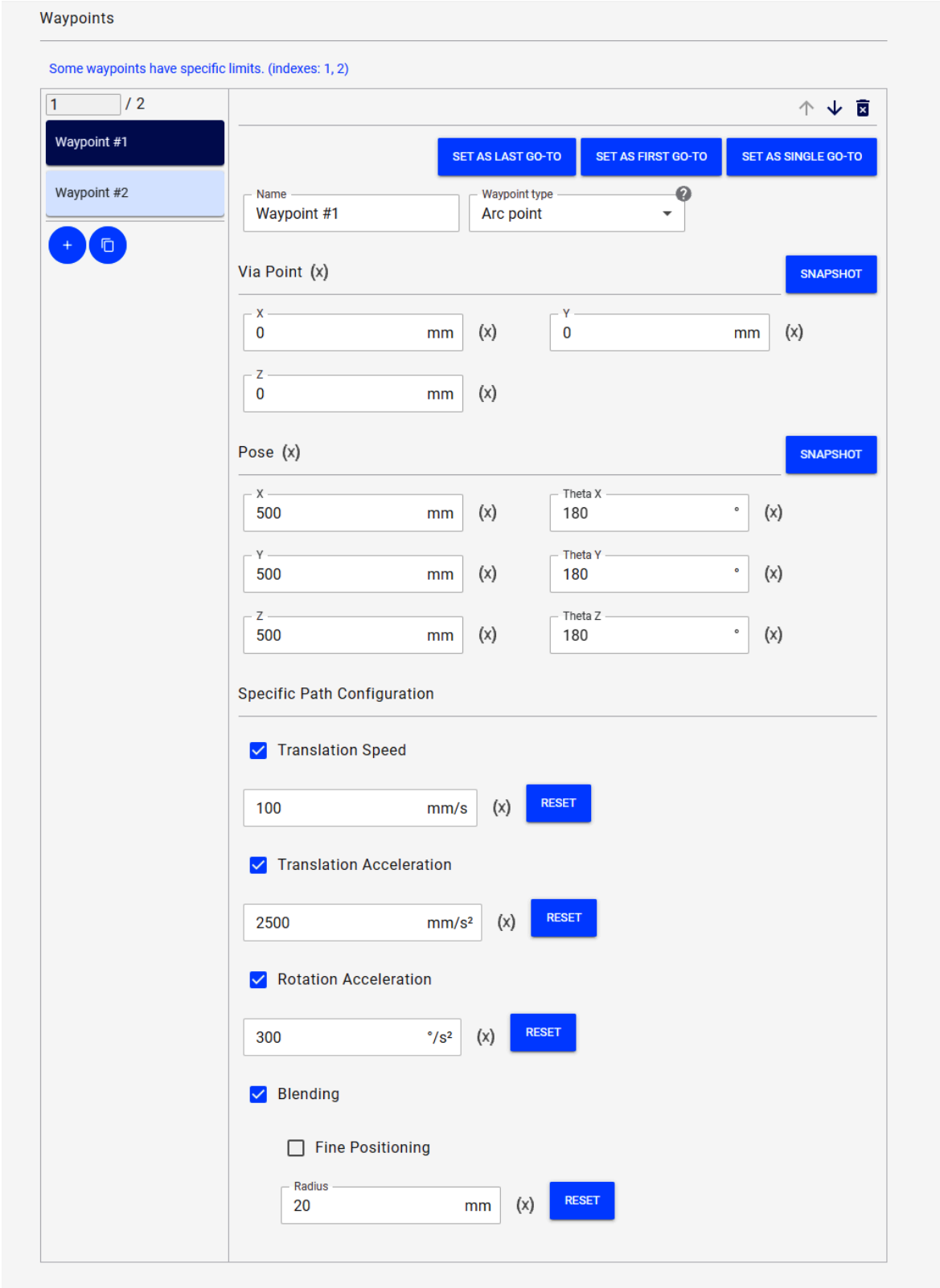


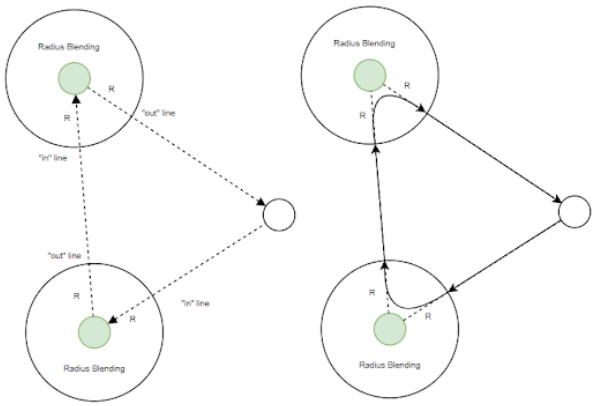
Figure 204: Parameters of the Arc point waypoints

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Table 94: Parameters of Arc point waypoints

Item	Description
Via Point pane	
XYZ	Cartesian position, defined in the same reference frame as its pose, of the intermediary point along the path of the circle. Define the intermediary point by tapping **(X)** to use a variable, or by moving the arm into position and tapping **SNAPSHOT** to get the coordinates.
Pose pane	
Pose	Pose is expressed in Cartesian and angular coordinates. Move the robot into position and use the **SNAPSHOT** button to fill in the current pose of the robot, taking into account the currently selected **Global Reference Frame**.
X, **Y**, **Z**	The current Cartesian position of the waypoint selected in the list is displayed. Change the values if you know your values are more accurate than what is currently listed. Measurements are in millimeters.
Theta X, **Theta Y**, **Theta Z**	The current angular position of the waypoint selected in the list. Change the values if you know your values are more accurate than what is currently listed. Measurements are in degrees.
Specific Path Configuration pane	
RESET	Tap to revert to the default value of the parameter.
Translation Speed	Select to enter the translation speed in a text box. Default: 100 mm/s Minimum: 0.01 mm/s Maximum: 2,000 mm/s **Remember:** The robot moves at the defined speed on its approach to the current waypoint.
Translation Acceleration	Select to enter the translation acceleration in the text box for the *TCP* moving towards the selected waypoint. Default: 2,500 mm/s^2 Minimum: 10 mm/s^2 Maximum: 12,000 mm/s^2 **Remember:** The robot starts to accelerate from the previous waypoint towards the current waypoint.

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Item	Description
Rotation Acceleration	Select to enter the orientation acceleration for the *TCP* moving towards the selected waypoint. Default: 300 °/s^2 Minimum: 1 °/s^2 Maximum: 1,500 °/s^2 **Remember:** The robot starts to accelerate its rotation from the previous waypoint while it moves towards the current waypoint.
Blending	Select when the robot needs to move continuously. Enter a radius to use as the maximum amount of distance that can be used when approaching the waypoint; this is radius blending. Default: 20 mm Minimum: 0.1 mm Maximum: 500 mm 
Fine Positioning	Select when the position of the waypoint must be exact. **Note:** The robot stops momentarily when it reaches the waypoint.
Radius	Enter a radius to use as the maximum amount of distance that can be used when approaching the waypoint.

Path Configuration parameters

Each **Tool Path** tile can have its own set of global speed and acceleration limits.

The global speed and acceleration limits do not apply to the waypoints that have waypoint-specific speed and acceleration limits defined on the **Waypoints** pane.

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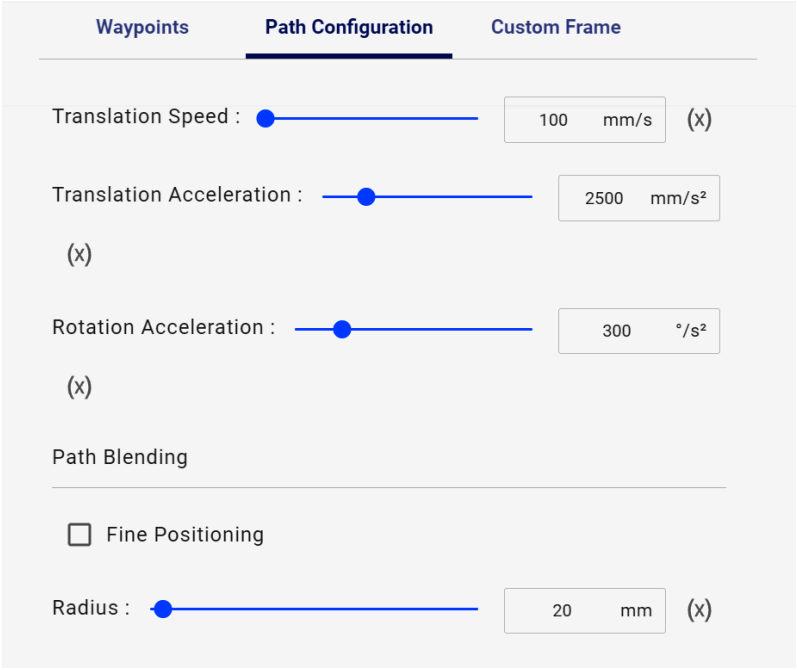


Figure 205: Path Configuration parameters

Table 95: Global parameters for the path

Item	Description
Translation Speed	Drag the slider to enter the global translation speed for the path. Default: 100 mm/s Minimum: 1 mm/s Maximum: 2,000 mm/s
Translation Acceleration	Drag the slider to enter the global translation acceleration for the path. Default: 300 mm/s^2 Minimum: 1 mm/s^2 Maximum: 12,000 mm/s^2
Rotation Acceleration	Drag the slider to enter the global rotation acceleration for the path. Default: 300 $°/s^2$ Minimum: 1 $°/s^2$ Maximum: 1,500 $°/s^2$
Path Blending pane	
Fine Positioning	Select when the position of the waypoint must be exact. **Note:** The robot stops momentarily when it reaches the waypoint.

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Item	Description
Radius	Enter a radius to use as the maximum amount of distance that can be used when approaching the waypoint. Default: 20 mm Minimum: 0.1 mm Maximum: 500 mm

Custom Frame parameters

For all waypoints in a **Tool Path** action, you can define a global point of reference in the **Custom Frame** pane.

The global frame defined must use the base frame of reference.

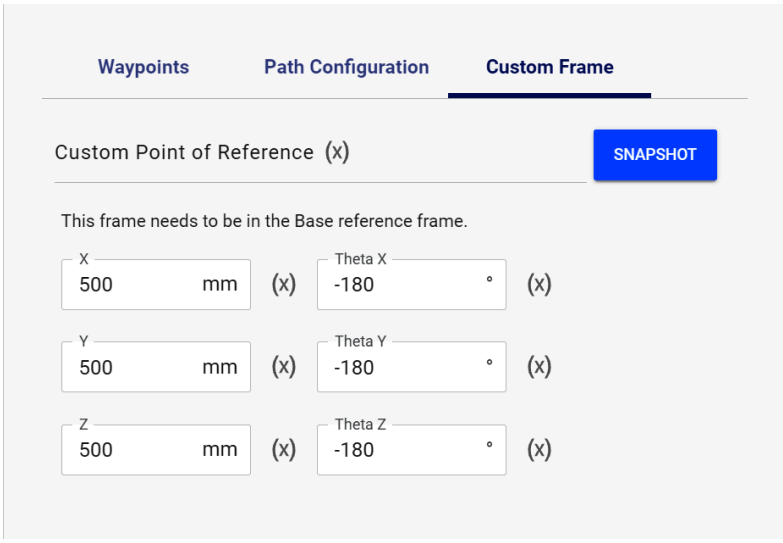


Figure 206: Custom Frame parameters

Table 96: Global parameters for the custom frame

Item	Description
Custom Point of Reference pane	
(X)	Tap to select a variable with Schema defined as **Default - Pose** to fill in the current pose as the custom frame with respect to the base.
SNAPSHOT	Move the arm into position and tap **SNAPSHOT** to fill in the current pose as the custom frame with respect to the base.
X, **Y**, **Z**	Enter the current Cartesian position of the arm as the custom point of reference. Measurements are in millimeters.

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Item	Description
Theta X, **Theta Y**, **Theta Z**	The current TCP orientation of the arm as the custom point of reference. Measurements are in degrees.

Robot: Waypoints tile parameters

The **Waypoints** tile is a core robot tile. When you drag it into an available tile in the **Sequence editor**, the **Tile configuration** changes dynamically to expose the entities of the waypoints that can be configured.

Use the **Waypoints** action for tasks that involve carrying parts and other tools. The **Waypoints** action ensures that the constraints on the robot are never exceeded.

The parameters of the list of waypoints are grouped into three parts. Each part is a sub-pane in the **Tile configuration**. Each sub-pane is accessible by tapping on its name.

- **Waypoints**
- **Constraints**
- **Custom Frame**

Tip: Whenever you see **(X)** beside an exposed entity, tap it to launch the **Select Variable** page and select a variable to use for the exposed entity.

Waypoint parameters

Each **Waypoints** tile in a program must define one or more waypoints for the robot to move.

The **Waypoints** tile holds a configurable list of waypoints the robot uses to move to complete a task.

Important: The arm must be switched on before you can define waypoints for the robot.

Tip: Configure the waypoints in the waypoint list when you are in Monitored Stop mode or Hold to Run mode. Select the mode from the Robot control panel.

Some of the parameters are the same regardless of the type of waypoint; others are specific to the type of waypoint.

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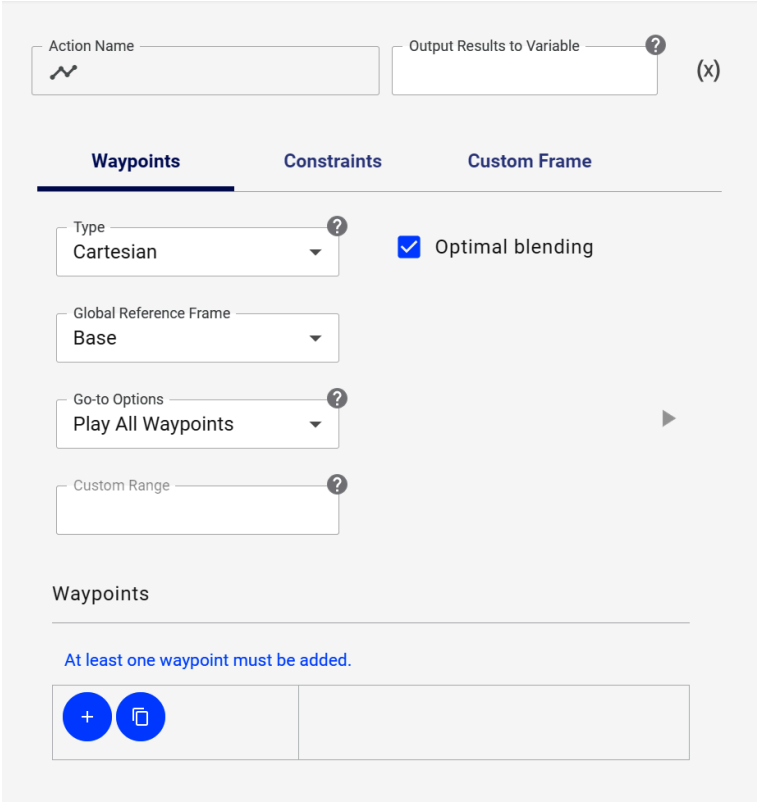


Figure 207: Global waypoint parameters

Table 97: Global waypoint parameters

Item	Description
Type	Select **Cartesian** to move the *TCP* with Cartesian coordinates, using inverse kinematics. Select **Angular** to move the robot arm joint directly, which using forward kinematics.
Optimal blending	When selected, the robot takes a time-optimal path from one end of the trajectory to another without actually reaching the intermediary points.
Global Reference Frame	Select a frame of reference. The waypoint pose converts automatically with respect to the frame of reference. • **Base** • **Tool** • **Custom** **Important:** Available only for Cartesian coordinates.

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Item	Description
Go-to Options	**Play All Waypoints** Play all waypoints listed in the **Waypoints** pane. **Play Custom Range** Play only the waypoints within the range defined in **Custom Range**.
Custom Range	Enter the start and end waypoints. For example, if 6 waypoints are defined in a tile and you want to investigate only from waypoint #2 and want to end at waypoint #5, you would enter the range as 2-5. **Note:** The **Custom Range** field can be used only when **Play Custom Range** is selected from **Go-to Options**.
Waypoints pane	
	Tap **+** in the **Waypoints** sub-pane to add a waypoint to the list of waypoints for the currently selected waypoint tile. The waypoint is added to the list of waypoints. The default waypoint name is Waypoint #1, Waypoint #2, Waypoint #3, and so on. **Tip:** Give the waypoint a meaningful name by changing the text in the **Name** text field. Parameters for the new waypoint launches in the **Waypoints** sub-pane. The parameters that are displayed depend on what is selected from **Type**.
	Tap to copy the currently selected waypoint.

When a waypoint is added, the **Waypoints** pane expands.

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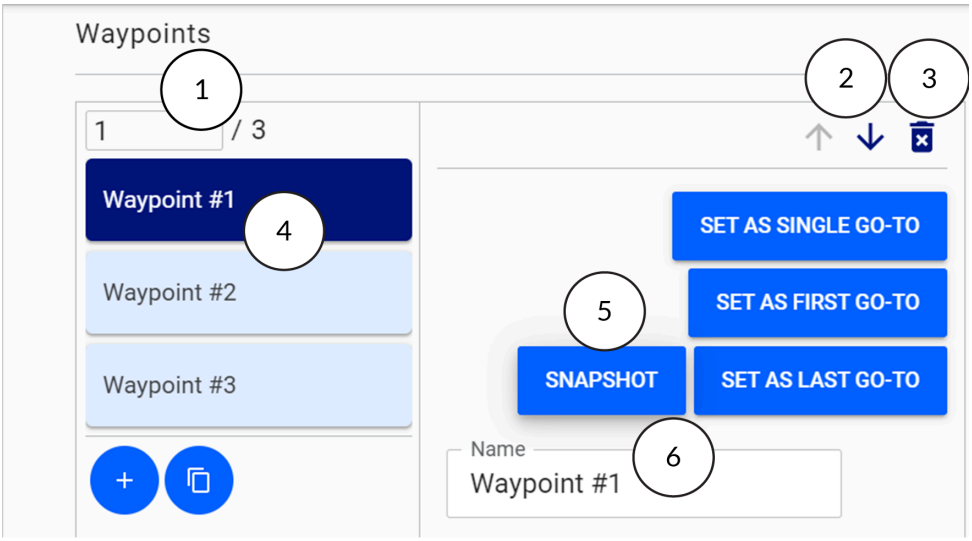


Figure 208: Entities of the Waypoints pane

1 Enter the index of the currently selected waypoint in the waypoints list and view the total number of waypoints in the list.
Alternatively, select a waypoint from the list to view its index.

2 Tap the arrows to move the selected waypoint up or down the waypoints list.

3 Tap to delete the currently selected waypoint.

4 Select any waypoint in the waypoint list to define its parameters.

5 Tap **SNAPSHOT** to have the system read the current Cartesian pose of the robot, taking into account the currently selected **Global Reference Frame**, and update the pose.

6 Change the **Name** of the currently selected waypoint to a more meaningful name, if desired.
The default names are "Waypoint #" with the next available number appended to it. For example, "Waypoint #1", "Waypoint #2", "Waypoint #3", and so on.

Configure the parameters according to the currently selected waypoint **Type**: **Cartesian** or **Angular**.

Cartesian waypoint parameters

When you select **Cartesian** as the waypoint type, the parameters related to Cartesian poses are displayed.

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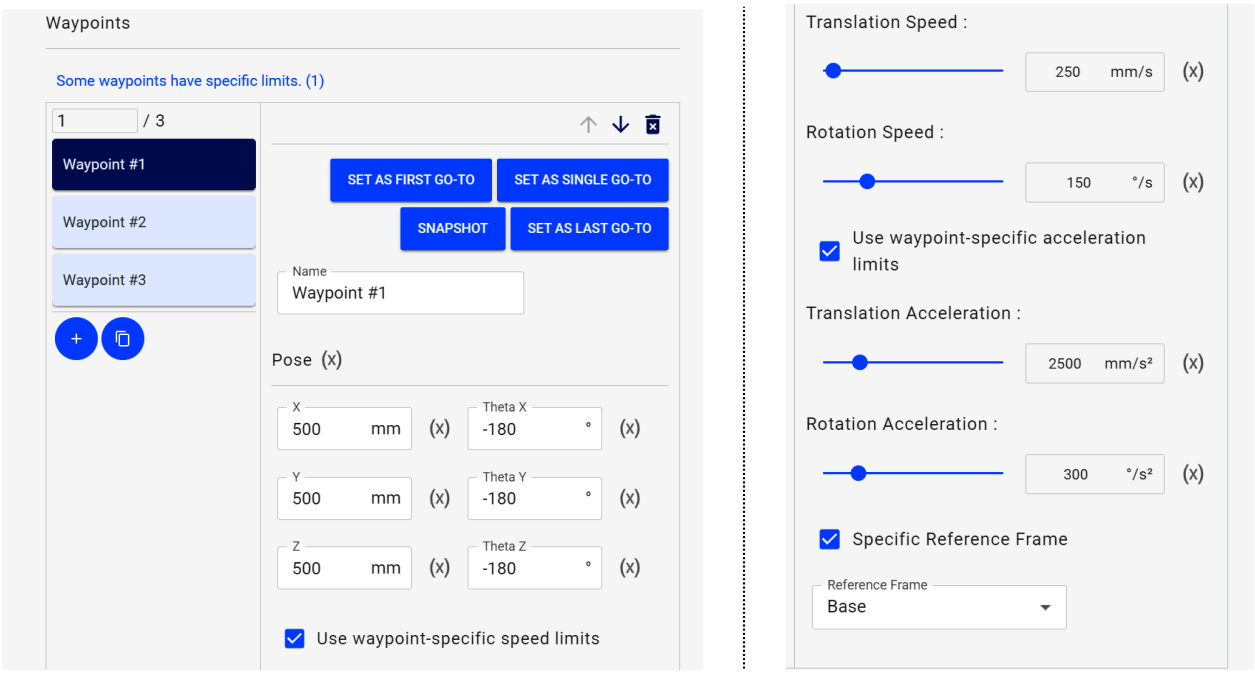


Figure 209: Parameters of Cartesian waypoints

The majority of the parameters of each waypoint can be defined by variables. The only parameter that cannot be fed by a variable is the **Specific Reference Frame** of a specific waypoint.

Table 98: Parameters of Cartesian waypoints

Item	Description
Pose	Pose is expressed in Cartesian coordinates. Move the robot into position and use the **SNAPSHOT** button to fill in the current pose of the robot, taking into account the currently selected **Global Reference Frame**.
X, **Y**, **Z**	The current Cartesian position of the waypoint selected in the list is displayed. Change the values if you know your values are more accurate than what is currently listed. Measurements are in millimeters.
Theta X, **Theta Y**, **Theta Z**	The current TCP orientation of the waypoint selected in the list. Change the values if you know your values are more accurate than what is currently listed. Measurements are in degrees.
Use waypoint-specific speed limits	Select when you want to set a specific speed limit on the robot when moving toward the selected waypoint instead of using the parametric values shared among all waypoints in the list. The pane expands to reveal **Translation Speed** and **Rotation Speed**.

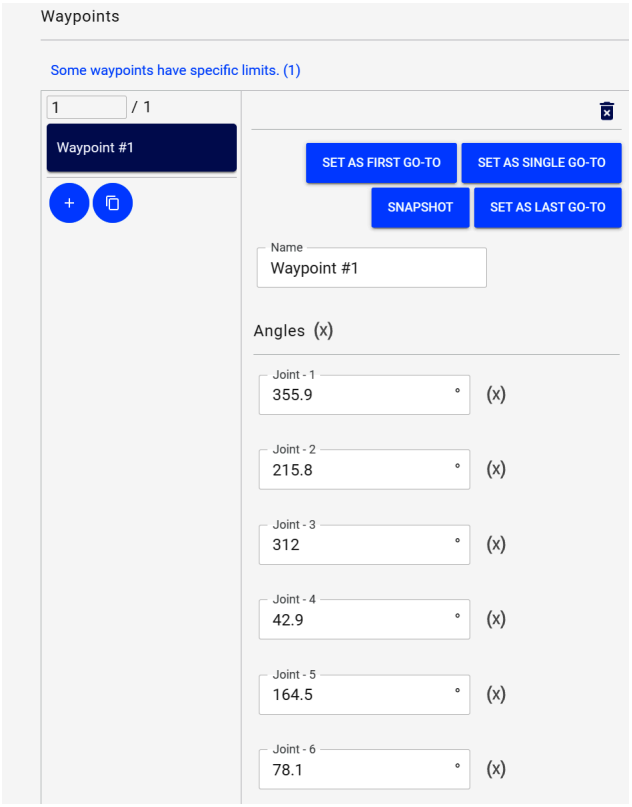
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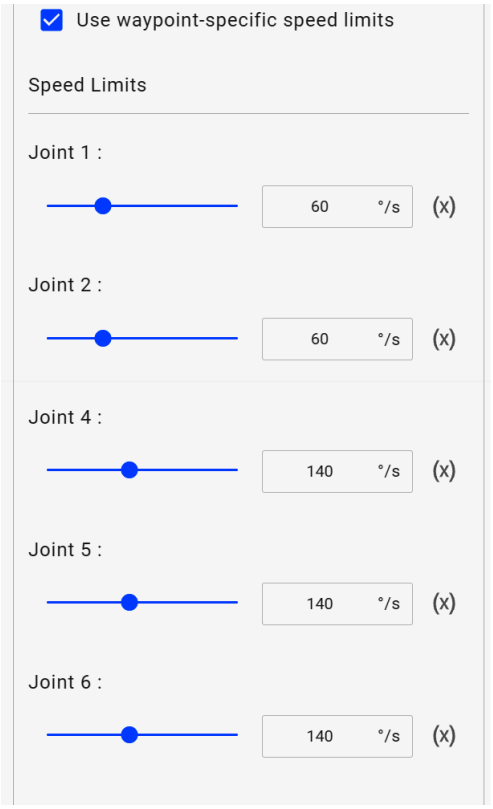
Item	Description
Translation Speed	Drag the slider to set the translation speed. Default: 250 mm/s Minimum: 10 mm/s Maximum: 2,000 mm/s
Rotation Speed	Drag the slider to set the rotation speed. Default: 150 °/s Minimum: 1 °/s Maximum: 600 °/s
Use waypoint-specific acceleration limits	Select when you want to use specific acceleration limits on the robot when moving toward the selected waypoint instead of using the parametric values shared among all waypoints in the list. The pane expands to reveal **Translation Acceleration** and **Rotation Acceleration**.
Translation Acceleration	Drag the slider to set the translation acceleration for the *TCP* moving towards the selected waypoint. Default: 2,500 mm/s^2 Minimum: 10 mm/s2 Maximum: 12,000 mm/s^2
Rotation Acceleration	Drag the slider to set the orientation acceleration for the *TCP* moving towards the selected waypoint. Default: 300 $°/s^2$ Minimum: 1 $°/s^2$ Maximum: 1,500 $°/s^2$
Specific Reference Frame	Select to define the **Reference Frame** for the current waypoint.
Reference Frame	Select a frame of reference for the currently selected waypoint. The waypoint pose converts automatically with respect to the frame of reference. • **Base** • **Tool** • **Custom**

Angular waypoint parameters

When you select **Angular** as the waypoint type, the parameters related to the angular configuration of the robot when moving toward that location are displayed.

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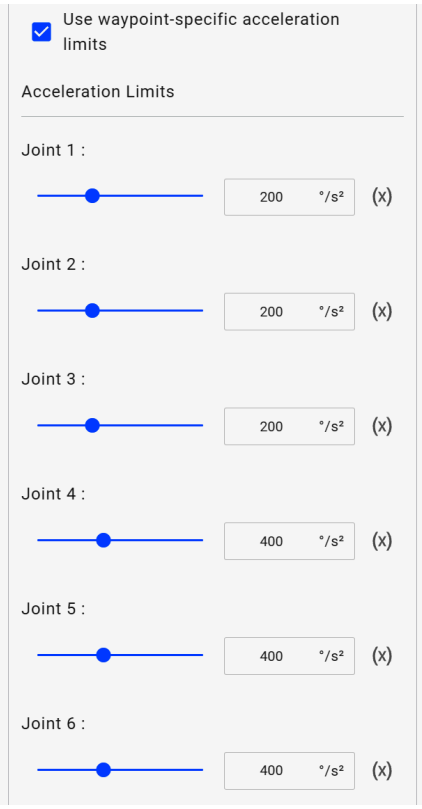


Figure 210: Parameters of angular waypoints

The parameters of each angular waypoint can be defined by using variables.

Table 99: Parameters of Angular waypoints

Item	Description
Angles	The robot angular configuration is expressed in degrees for each of the joints.
Joint 1, **Joint 2**,**Joint 3**, **Joint 4**, **Joint 5**, **Joint 6**	Enter the angular position of each joint moving toward the waypoint selected in the list. Change the values if you know your values are more accurate than what is currently listed. Minimum of each joint: -357° Maximum of each joint: +357°
Use waypoint-specific speed limits	Select when you want to set a specific speed limit on the robot when moving toward the selected waypoint instead of using the parametric values shared among all waypoints in the list. The **Speed Limits** sub-pane launches.
Speed Limits	

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Item	Description
Joint 1, **Joint 2**,**Joint 3**	Drag the slider to set the speed limit of the joint moving toward the currently selected waypoint. Minimum: 1 °/s Maximum: 200 °/s. **Important:** The desired speed cannot exceed the Safety Joint Speed Limit defined on **Safety** > **Joint Limits**.
Joint 4, **Joint 5**, **Joint 6**	Drag the slider to set the speed limit of the joint moving toward the currently selected waypoint. Minimum: 1 °/s Maximum: 320 °/s **Important:** The desired speed cannot exceed the Safety Joint Speed Limit defined on **Safety** > **Joint Limits**.
Use waypoint-specific acceleration limits	Select when you want to set a specific speed limit on the robot moving toward the selected waypoint instead of using the parametric values shared among all waypoints in the list. The **Acceleration Limits** sub-pane launches.
Acceleration Limits	
Joint 1, **Joint 2**,**Joint 3**	Drag the slider to set the acceleration limit of the joint toward the currently selected waypoint. Minimum: 1 $°/s^2$ Maximum: 600$°/s^2$
Joint 4, **Joint 5**, **Joint 6**	Drag the slider to set the acceleration limit of the joint toward the currently selected waypoint. Minimum: 1 $°/s^2$ Maximum: 1,000$°/s^2$

Constraint parameters

Each **Waypoints** tile can have its own set of global speed and acceleration limits.

The global speed and acceleration limits do not apply to the waypoints that have waypoint-specific speed and acceleration limits defined on the **Waypoints** pane.

The constraints available depend on the type of waypoint: Cartesian or angular.

The Cartesian and angular parameters of each waypoint can be defined with variables.

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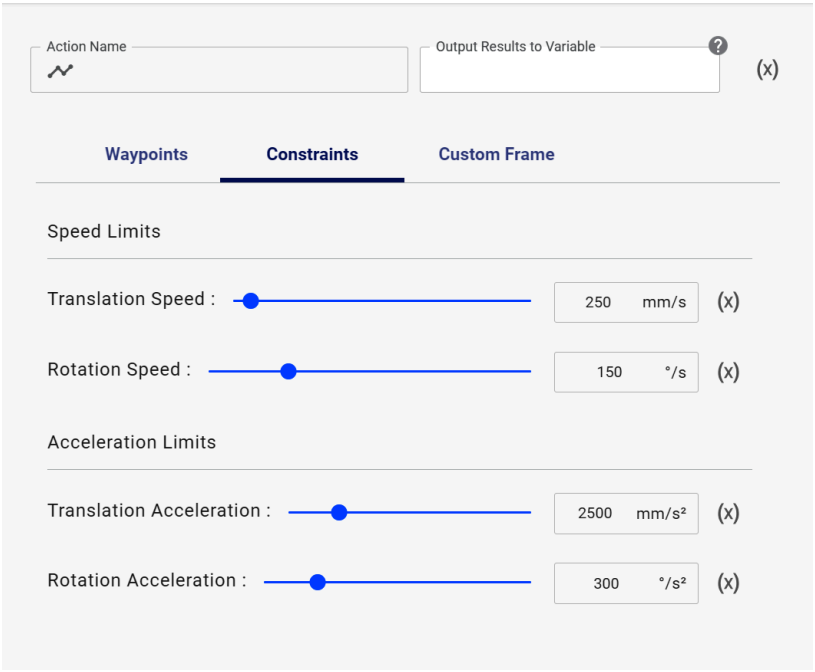


Figure 211: Constraints for Cartesian waypoints

Table 100: Constraints for Cartesian waypoints

Item	Description
Speed Limits	
Translation Speed	Drag the slider to set the translation speed. Default: 250 mm/s Minimum: 10 mm/s Maximum: 2,000 mm/s
Rotation Speed	Drag the slider to set the rotation speed. Default: 150 °/s Minimum: 1 °/s Maximum: 600 °/s
Acceleration Limits	
Translation Acceleration	Drag the slider to set the translation acceleration for the *TCP* moving towards the selected waypoint. Default: 2,500 mm/s^2 Minimum: 10 mm/s2 Maximum: 12,000 mm/s^2

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Item	Description
Rotation Speed	Drag the slider to set the rotation speed. Default: 300 °/s Minimum: 1 °/s Maximum: 1500 °/s

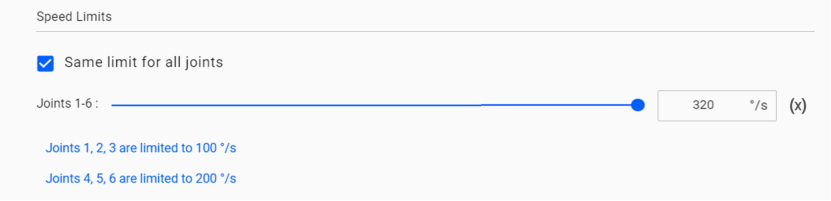
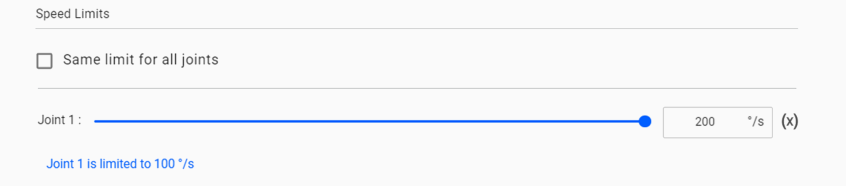


Figure 212: Constraints for angular waypoint

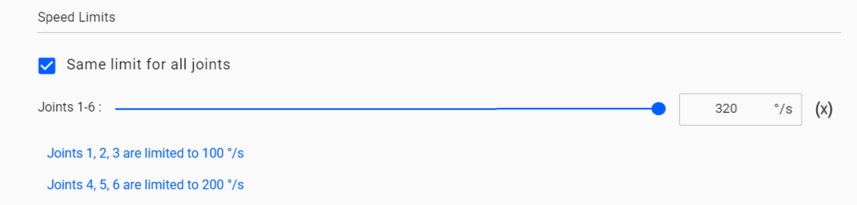
Table 101: Constraints for angular waypoints

Item	Description
Speed Limits sub-pane	
Same limit for all joints	Select when you want to constrain all six joints by the same speed.

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Item	Description
Joints 1-6	Drag the slider to set the speed for all joints moving toward the selected waypoint. **Tip:** A message launches when the speed you select exceeds the safety speed defined on **Safety** > **Joint Limits** > **Speed Limits** for one or more joints.  **Remember:** Safety speed limits override all other speed limits. Minimum: 1 °/s Maximum: 320 °/s
Same limit for all joints	Deselect when you want to constrain one or more specific joints by a specific speed. **Tip:** A message launches under each joint where the speed you select exceeds the safety speed defined on **Safety** > **Joint Limits** > **Speed Limits**. 
Joint 1, **Joint 2**, **Joint 3**	Drag the slider to set the speed for the specific joint moving toward the selected waypoint. **Remember:** Safety speed limits override all other speed limits. Minimum: 1 °/s Maximum: 200 °/s

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Item	Description
Joint 4, **Joint 5**, **Joint 6**	Drag the slider to set the desired speed for the specific joint at the selected waypoint. **Tip:** A message launches when the speed you select exceeds the safety speed defined on **Safety** > **Joint Limits** > **Speed Limits** for the specified joint.  **Remember:** Safety speed limits override all other speed limits. Minimum: 1 °/s Maximum: 320 °/s
Acceleration Limits sub-pane	
Same limit for all joints	Select when you want to constrain all six joints by the same acceleration.
Joints 1-6	Drag the slider to set the speed for all joints moving toward the selected waypoint. Minimum: 1 °/s Maximum: 1,000 °/s
Same limit for all joints	Deselect when you want to constrain one or more specific joints by a specific acceleration.
Joint 1, **Joint 2**, **Joint 3**	Drag the slider to set the speed for the specific joint moving toward the selected waypoint. Minimum: 1 °/s Maximum: 600 °/s
Joint 4, **Joint 5**, **Joint 6**	Drag the slider to set the speed for the specific joint moving toward the selected waypoint. Minimum: 1 °/s Maximum: 1,000 °/s

Custom Frame parameters

In certain scenarios, it is easier to program waypoints in relation to a specific pose.

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The specific pose can be used as a frame of reference for any waypoint in the list. The frame of reference for the custom frame definition must be **Base**.

Tip: The only debugging tool available for a custom frame is **SNAPSHOT**. Tap **SNAPSHOT** to have the system read the current Cartesian pose of the robot, taking into account the **Base** reference frame, and update the pose.

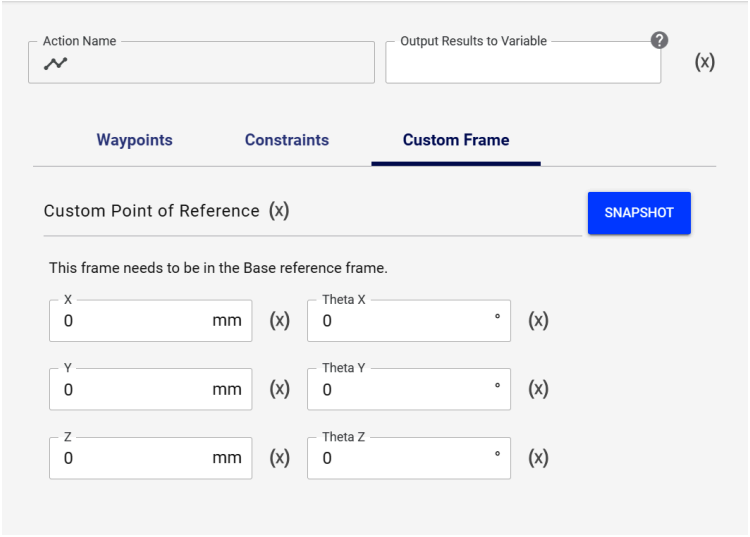


Figure 213: Custom Frame parameters

Debug tools for waypoints

To simplify creating the perfect waypoints in a program, a few debug tools are available.

Any settings made on individual waypoints with the debug tools are not valid during an actual run of the full program.

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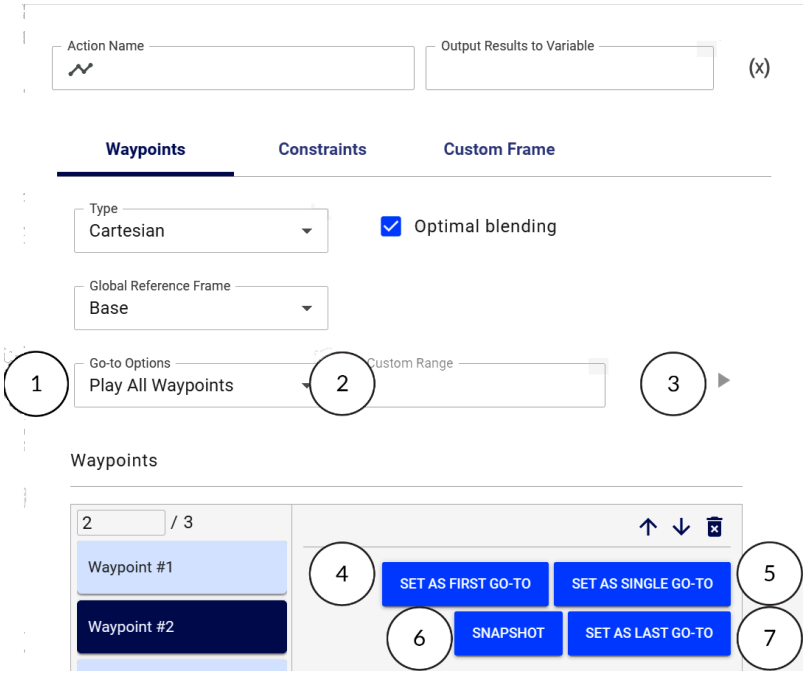


Figure 214: Tools for debugging waypoints

1 **Go-to Options** **Play All Waypoints**

Play all waypoints listed in the **Waypoints** pane.

Play Custom Range

Play only the waypoints within the range defined in **Custom Range**.

2 **Custom Range** Enter the start and end waypoints.
For example, if 6 waypoints are defined in a tile and you want to investigate only from waypoint #2 and want to end at waypoint #5, you would enter the range as 2-5.

Note: The **Custom Range** field can be used only when **Play Custom Range** is selected from **Go-to Options**.

3 Tap **Play** ( ) from the **Waypoints** sub-pane to check the Cartesian poses and orientation of the arm at each of the locations in the **Custom Range** list.

Tip: Available only in Hold to Run mode when you are testing the waypoints for the program you are creating.

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4	**SET AS FIRST GO-TO**	Tap to set the correct indices in the **Go-to Options**. Click **Play** (▶) near the **Go-to Options** to make the arm move. **Go-to Options** changes automatically to **Play Custom Range**. **Custom Range** displays the index of the waypoint selected as the first waypoint to which the arm automatically moves. When the first go-to waypoint is not set explicitly, Custom Range begins with the first index of waypoints in the list. When the first go-to waypoint is set explicitly, the range begins with the index of the waypoint selected as the first go-to. The index of the waypoint defined as the first go-to must be smaller than the index of any waypoint that is defined as the last go-to. ⚠ **Warning:** Tapping **Play** (▶) in the Program play area runs the entire program, disregarding the **Go-to Options**.
5	**SET AS SINGLE GO-TO**	Tap to set the correct indices in the **Go-to Options**. Click **Play** (▶) near the **Go-to Options** to make the arm move. **Go-to Options** changes automatically to **Play Custom Range**. **Custom Range** displays the index of the waypoint in the list to which the arm automatically moves. ⚠ **Warning:** Tapping **Play** (▶) in the Program play area runs the entire program, disregarding the **Go-to Options**.
6	**SNAPSHOT**	Tap to overwrite the current values in the fields with the current position of the robot, taking into account the **Global Reference Frame**.

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7	**SET AS LAST GO-TO**	Tap to set the correct indices in the **Go-to Options**. Click **Play** (▶) near the **Go-to Options** to make the arm move. **Go-to Options** changes automatically to **Play Custom Range**. When the last go-to waypoint is not set explicitly, the range ends with the index of the last waypoint in the list. When the last go-to waypoint is set explicitly, the range ends with the index of the waypoint selected as the last go-to. **Custom Range** ends with the index of the waypoint selected as the last waypoint to which the arm automatically moves. The index of the waypoint defined as the last go-to must be larger than the index of any waypoint that is defined as the first go-to. **Note:** It is possible to have waypoints listed after the last go-to waypoint in the **Waypoints** list, but those waypoints do not end up in the range unless the range is altered to include the new last waypoint. **Warning:** Tapping **Play** (▶) in the Program play area runs the entire program, disregarding the **Go-to Options**.

Industrial I/O: tiles

The Industrial I/O plugin has a few tiles that can be used in programs.

Table 102: Tiles that belong to Industrial I/O

Tile	Tile name	Description
	**Read Input**	Reads a signal from an Industrial input channel and stores it in a variable for later use.
	**Set Output**	Sends a signal on a desired industrial output channel.
	**Wait for Input**	Pauses a program until a signal is received on a specific input channel or until a timeout is triggered.

Industrial I/O: Read Input tile parameters

The **Read Input** tile is an Industrial I/O tile. When you drag it into an available tile in the **Sequence editor**, the **Tile configuration** changes dynamically to expose the entities of **Read Input** that can be configured.

Use **Read Input** to configure the type of input that needs to be used at that point in the program.

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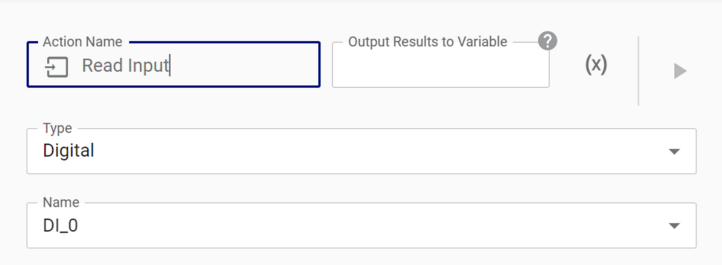


Figure 215: The Tile configuration when Read Input is the current tile

Table 103: Industrial I/O Read Input parameters

Item	Description
Type	Select one of the available read input types. • **Digital** • **Analog** • **Wrist Digital** • **Wrist Analog**
Name	Select the name of the available input of the chosen type as defined by the Industrial I/O plugin configuration. The content depends on the selected read input type.
Type	***Associated names***
Digital	• **DI_0** • **DI_1** • **DI_2** • **DI_3** • **DI_4** • **DI_5** • **DI_6** • **DI_7**
Analog	Select one of the user-defined names from the list of analog inputs. • **AIO_0** • **AIO_1** • **AIO_2** • **AIO_3**

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Item	Description
Wrist Digital	Select one of the user-defined names from the list of wrist digital inputs. • **WRIST_DIGITAL_IO1** • **WRIST_DIGITAL_IO2** • **WRIST_DIGITAL_IO3** • **WRIST_DIGITAL_IO4**
Wrist Analog	Select one of the user-defined names from the list of wrist analog inputs. • **WRIST_AOI_1** • **WRIST_AOI_2**

If the name of the pin that is selected is not configured to be an input, an error message displays directly in the **Tile configuration** pane.

Example:

```
This pin is not configured as input.
```

Industrial I/O: Set Output tile parameters

The **Set Output** tile is an Industrial I/O tile. When you drag it into an available tile in the **Sequence editor**, the **Tile configuration** changes dynamically to expose the entities of **Set Output** that can be configured.

Use **Set Output** to configure the type of input that needs to be used at that point in the program.

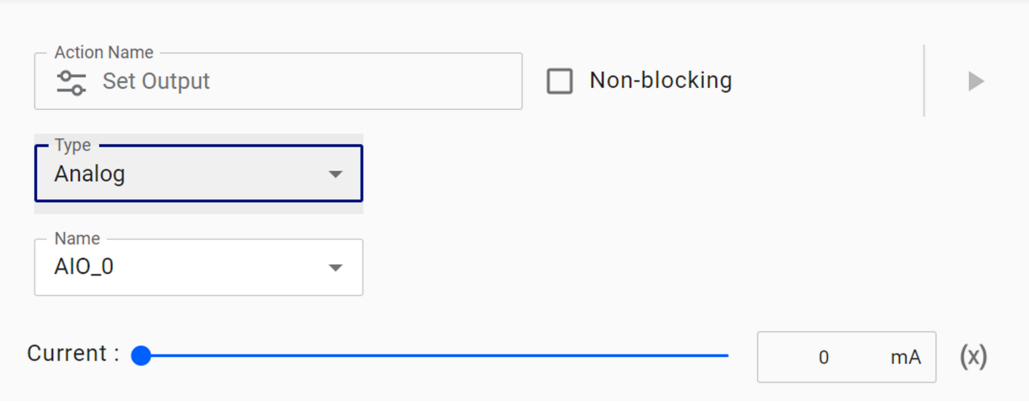


Figure 216: One example of the Tile configuration of the Set Output action

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Table 104: Industrial I/O Set Output parameters

Item	Description
Type	Select one of the available set output types. • **Digital** • **Analog** • **Wrist Digital** • **Wrist Analog**
Name	Select the name of the available pin of the selected type, as defined by the Industrial I/O plugin configuration. The content depends on the selected read input type.
Parameters for the output **Digital** and **Wrist Digital** output	
State	When the selected output channel is in the selected state, your program resumes. • **High** • **Low**
Parameters for the output **Analog** and **Wrist Analog** output	
Current	Use the slider to set the maximum current that the output can reach. Range: Range: 0 to 25 mA
Voltage	Use the slider to set the maximum voltage that the output can reach. Range: Range: 0 to 11 V

If the name of the pin that is selected is not configured to be an input, an error message displays directly in the **Tile configuration** pane.

Example:

```
This pin is not configured as output.
```

Related topics

Industrial I/O Plugin on page 380

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Industrial I/O: Wait for Input tile parameters

The **Wait for Input** tile is an Industrial I/O tile. When you drag it into an available tile in the **Sequence editor**, the **Tile configuration** changes dynamically to expose the entities of **Wait for Input** that can be configured.

Use **Wait for Input** to pause a program until the specified signal configuration is sent on an industrial input channel.

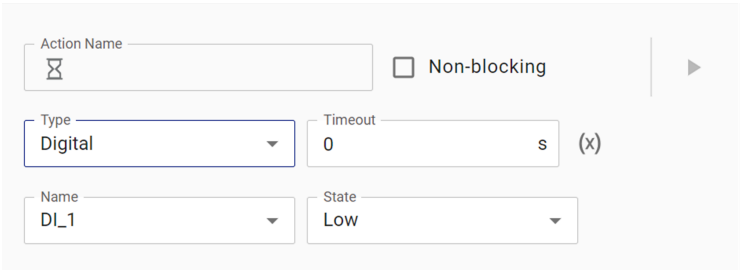


Figure 217: The Tile configuration when Wait for Input is the current tile and the Input Type is either Digital or Wrist Digital

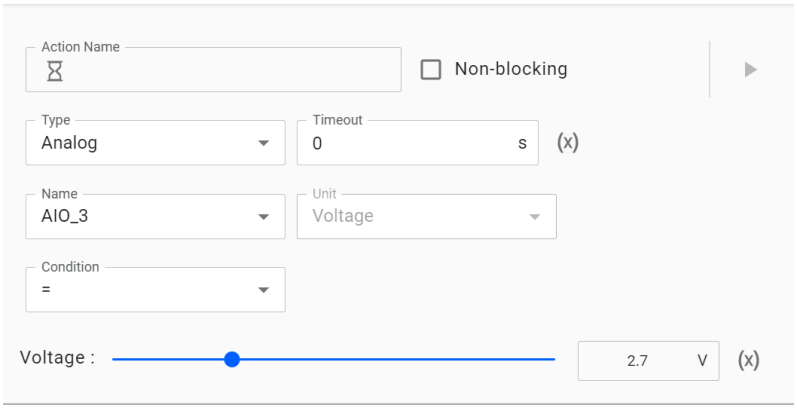


Figure 218: The Tile configuration when Wait for Input is the current tile and the Input Type is either Analog or Wrist Analog

Table 105: Industrial I/O Wait For Input parameters

Item	Description
Type	Select one of the available set output types. • **Digital** • **Analog** • **Wrist Digital** • **Wrist Analog**

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Item	Description
Timeout	Force the program to stop running if it must wait the number of seconds entered.
Name	Select the name of the available input of the chosen type as defined by the Industrial I/O plugin configuration. The content depends on the selected read input type.
Parameters specific to **Digital** and **Wrist Digital**	
State	When the selected input channel is in the selected state, your program resumes. • **High** • **Low**
Parameters specific to **Analog** and **Wrist Analog**	
Unit	Displays the unit that is configured for the pin. **Note:** The unit is defined on the **Industrial I/O Plugin** plugin **Configurations** pane.
Condition	When the input timeout meets the selected condition, the program resumes. • **==** • **>** • **>=** • **<** • **<=**
Current	Use the slider to set the maximum current that the output can reach. Range: Range: 0 to 25 mA
Voltage	Use the slider to set the maximum voltage that the output can reach. Range: Range: 0 to 10 V

Program creation

The *admin* is responsible for creating programs that can be run safely by *operators*.

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It is common practice to create a program using a combination of Hand Guiding, Manual Jog, and *Kortex Web App*. The combination used is a matter of preference. However, there are times when using Hand Guiding and Kortex Web App is the preferred approach, such as when the robot arm is approaching a surface.

After the program is debugged and is known to be working as expected, it must be validated. Tap **Validate**.



Figure 219: Validate button on the same line as the name of the program on the Program page

Validated programs on the **Programs** page have a green check mark.

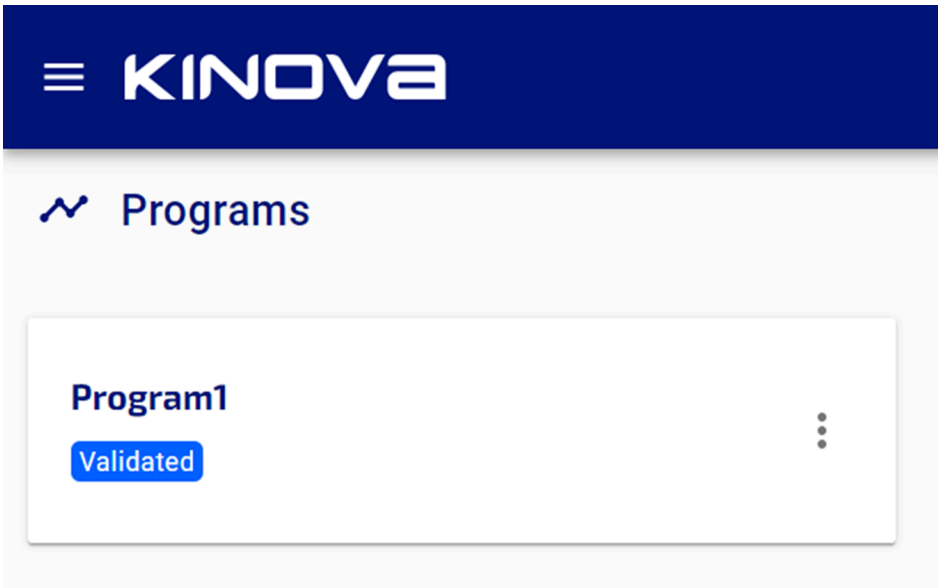


Figure 220: Example of a validated program

Only validated programs are available to operators.

Creating a program

Every program is unique to the work environment of the robot.

About this task

Teaching trajectories to the robot in a program can be made easier using Hand Guiding mode. Use the Cartesian Hand Guiding mode to leverage the force torque sensor for more sensitive and accurate motion. Use angular Hand Guiding to guide any joint.

Alternatively, use the Visual Programming interface.

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Procedure

1. Tap **Programming** > **Programs**.
2. Tap **Add** (+).
3. Drag and drop tiles from the **Action** menu to the **Sequence editor**.
4. Tap an action tile in the **Sequence editor** to configures the properties of the action.
5. Test the program.
6. Tap **Validate**.

Hand Guiding panel

Hand Guiding takes into account external forces and torque feedback from the environment of the robot.

When you press and hold the Wrist enabling device in the middle position, the **Hand Guiding** in the **Robot control panel** is selected and the **Enabling device** icon illuminates blue.



Figure 221: Hand Guiding button in the panel



Figure 222: Enabling Device icon

There are two types of motion in Hand Guiding mode.

- **Cartesian** ( ): The tool moves according to the force and torque applied on the wrist, as measured by the built-in force torque sensor.
- **Angular** ( ): The joints of the robot rotate according to the external torques applied at the joint.

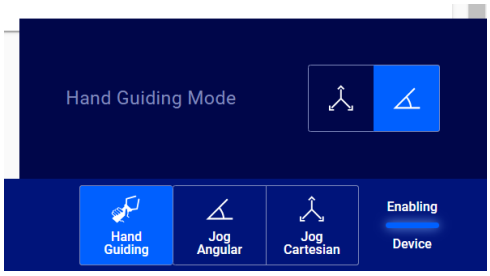


Figure 223: Hand Guiding panel

Related topics

Mode: Hand Guiding on page 124

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Jog Cartesian panel

To control the position and orientation of the *end effector* of the robot, use the **Jog Cartesian** panel in Kortex Web App.

Important: Jog Cartesian is accessible only when the *teach pendant enabling device* or an external *enabling device* is held in the middle position.

Tap **Jog Cartesian** in the **Robot control panel** to access the **Jog Cartesian** panel.



Figure 224: Jog Cartesian button in the panel

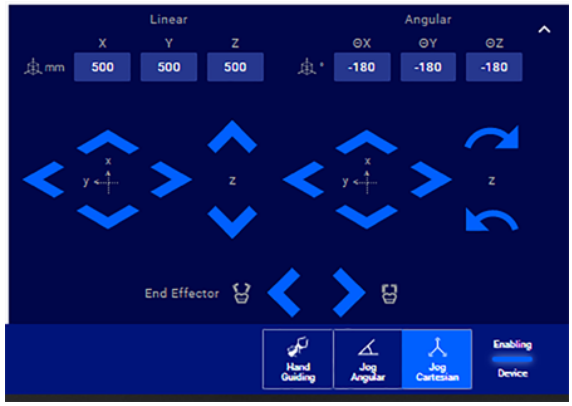


Figure 225: Jog Cartesian panel

Related topics
Mode: Manual Jog on page 121

Translation and rotation from the Jog Cartesian panel

Control linear and angular motion of the tool by using the **Jog Cartesian** panel.

There are two sets of virtual joysticks.

- The linear joystick applies a translational motion to the *TCP*.
- The angular joystick applies a rotational motion to the *TCP* with respect to the current position.



Figure 226: Controls for the Cartesian movement of the arm

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Each set of virtual joysticks features a 2-axis joystick for controlling the x and y axes, and a 1-axis joystick to control in the z-axis.

When you tap on the controls, the values are displayed for the current position (x, y, z) and orientation (θx, θy, θz) of the end effector.



Figure 227: Values of the position of the arm

Note: The orientation representation uses a z-y-x Tait-Bryan intrinsic convention.

Additional settings

Reference frames, linear speeds, and *angular* speeds are not modified as often as other *Cartesian* settings, but can be modified in the **Jog Cartesian** panel.

There is an up arrow in the upper right corner.

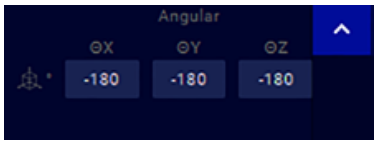


Figure 228: Jog Cartesian panel up arrow

Tapping it unveils additional settings available in Jog Cartesian mode.

- speed control
- reference frame selection

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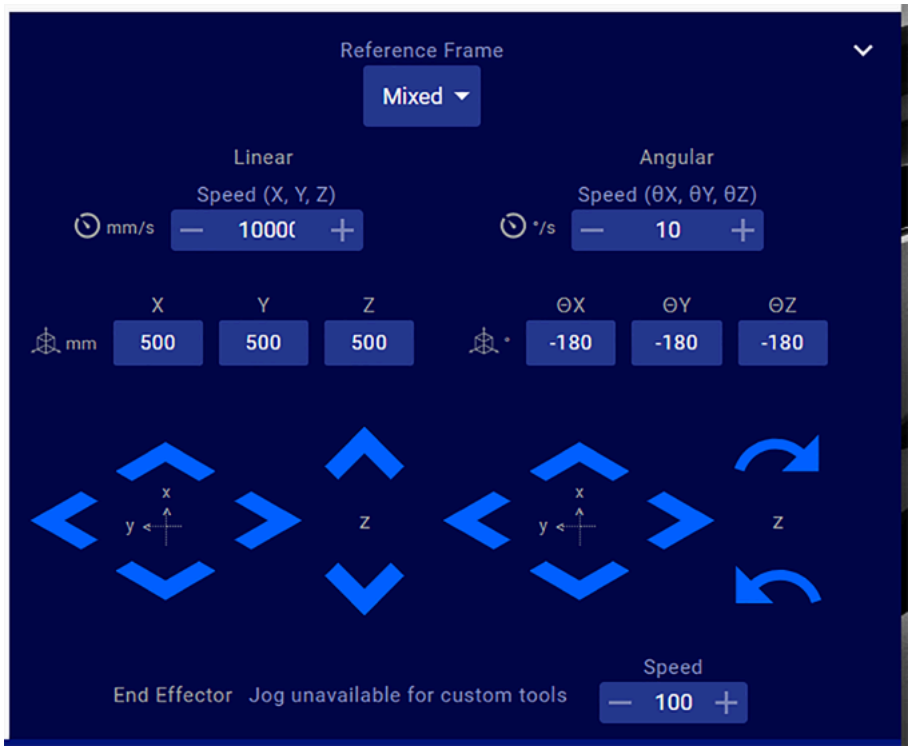


Figure 229: Additional settings in the Jog Cartesian panel

The linear speeds are measured in mm/s and the angular speeds in °/s. Configure the linear and angular speeds for the motion.

The Cartesian velocity of the *TCP* is specified in one of three reference frame conventions.

- **Mixed**: linear with the *base* being the frame of reference; angular with the tool being the frame of reference
- **Tool**: linear and angular with the base being the frame of reference
- **Base**: linear and angular with the base being the frame of reference

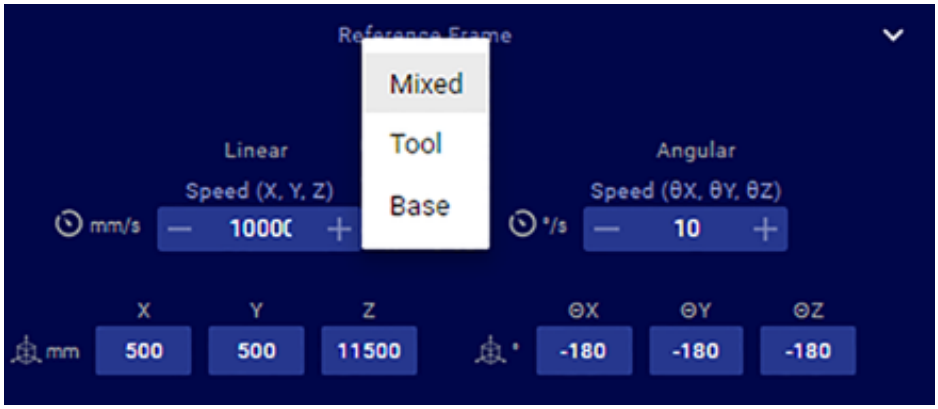


Figure 230: Available frames of reference in the Jog Cartesian panel

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Jog Angular panel

To control the joint by joint movement of the robot, use the **Jog Angular** panel in *Kortex Web App*.

With the **Jog Angular** panel, control the robot joint angles and the *end effector* using a mouse or *teach pendant*.

Tap **Jog Angular** in the Robot control panel to access the **Jog Angular** panel.



Figure 231: Jog Angular button in the panel



Figure 232: Jog Angular panel

The joint angles are controlled through angular velocity. Control the angle of each *actuator*, as well as end effectors. The robot *arm* responds to the virtual *angular* manipulation.

Note: For joints with joint rotation limits, the robot enforces software joint angle limits to prevent these joints from reaching the physical limits. When you control these joints, the software causes the arm joints to stop responding when the limits are reached.

Each angle is measured in degrees. The value displayed is restricted to minus or plus a full rotation; that is, -360° to +360°. However, the arm stops movement at ±357°.

Related topics
Mode: Manual Jog on page 121

Additional settings

Maximum speeds for actuators and fingers are not modified as often as other *angular* settings, but can be modified in the **Jog Angular** panel.

There is an up arrow in the upper right corner.

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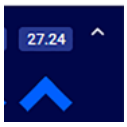


Figure 233: Jog Angular panel up arrow

Tapping it unveils additional settings available in Jog Angular mode.

- Maximum speed for each actuator
- Maximum speed for fingers when a gripper is installed

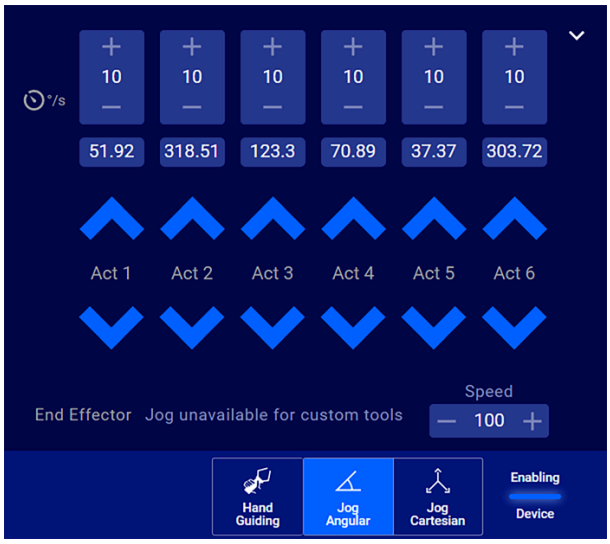


Figure 234: Additional settings in the Jog Angular panel

To control the angle of each *actuator*, use the virtual controls to apply a velocity in the given direction. Increase the angle by tapping the up arrow; decrease the angle by tapping the down arrow. The speed does not exceed the set limit. The angle continues to change as long as the arrows are being used.

Note: The desired joint speeds must be less than the default joint speeds.

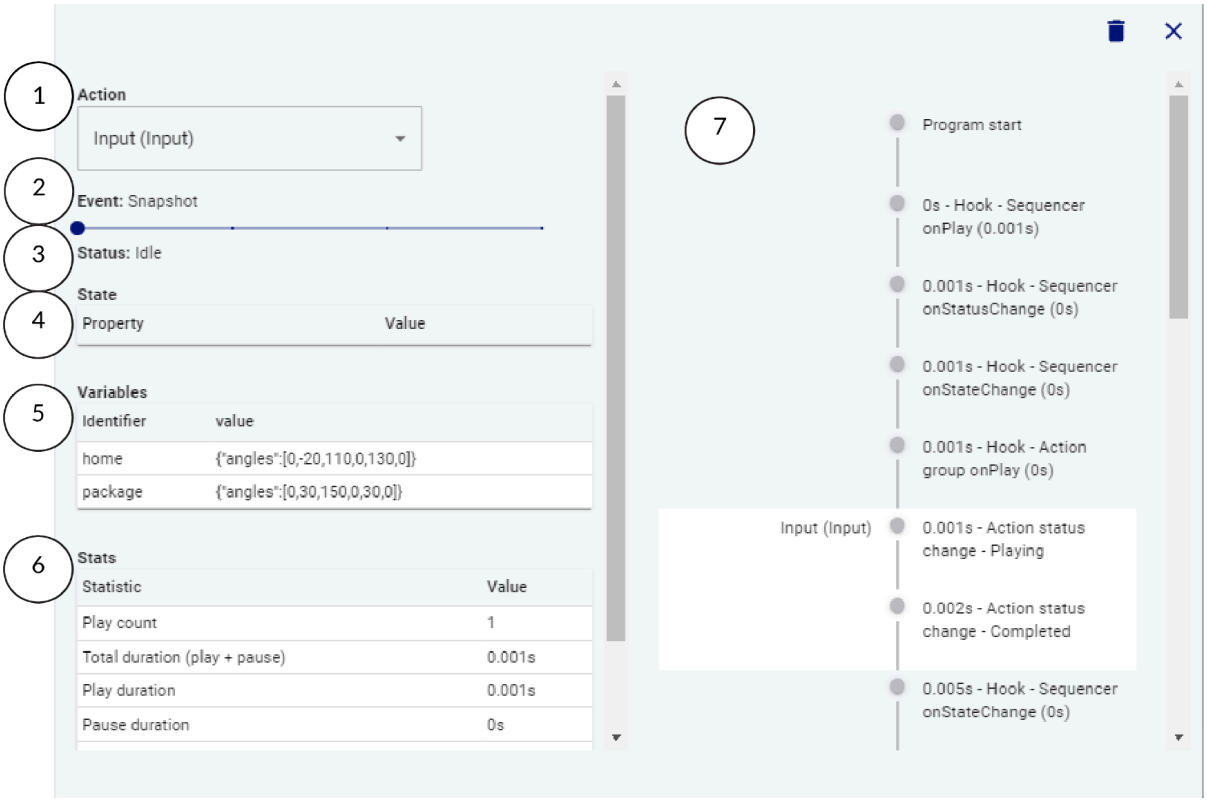
Related topics

Robot control panel on page 162

Debug panel overview

It is important to know whether the program is running optimally before it is released to the users. The **Debug** panel launches at the end of the run of a debugging session.

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1 Action — Select one of the actions in the drop-down to highlight them in the timeline.

Alternatively, tap on any of the events in the timeline to view the action in the drop-down list.

2 Event — Event is the action selected from which the debugger is to run.

3 Status — Status is the mode of operation the robot is in.

4 State — State lists the different property states and their values during the run of the program.

5 Variables — Variables are used by the program.

- Identifier is the name of the variable.
- Value is the value of the named variable.

6 Stats (Statistics) — Statistics are information about the program.

- Play count is the number of times the program is run.
- Total duration (play + pause) is the total of time the program runs, before pauses, before the program ends.
- Play duration is the amount of time the program plays before it ends.
- Pause duration is the amount of time the program is paused.
- Pause count is the number of times the program is paused.
- Failure count is the number of times the program fails.

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7	Timeline of events	The visual timeline of events that occur while the program runs. Tap on any of the events in the timeline to view information related to that event.

Debugging a program

Determine whether the program is running optimally by using the debugger and the play controls in the Robot control panel.

About this task

There must be a program in the **Program** page.

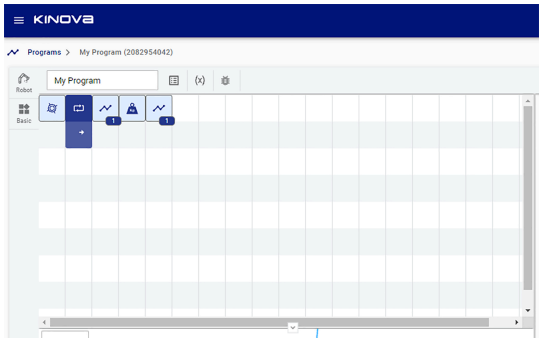
Procedure

1. Tap Hold to Run ( ).
2. Tap **Debug** ( ).

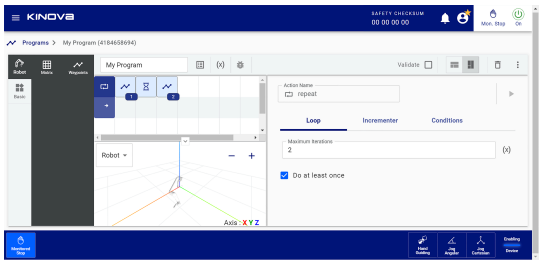


3. Tap a tile in the **Sequence editor** from where you want to start debugging.

Tip: It is easier to debug small portions of a program. However, remember to debug from the very beginning of the program as well to make sure the program runs smoothly between sections.



The **Tile configuration** populates with details about the selected action.



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Program is ready to use

The robot is ready to be used in its environment and to perform its tasks.

All users can run a program that is validated. There are different ways to run a program.

- Run the program in Automatic mode. This is the most common way of running a program for operators.
- (Admin users only) Run a program in Hold to Run mode.

Running a program in Automatic mode

Work in Automatic mode to run a program with little to no intervention.

Before you begin

The program is fully debugged and validated.

About this task

The robot must be on and operational. All users can run a validated program.

Important: To run in Automatic mode, you usually use the ACK button on the *controller* or an external ACK button, and **Acknowledge Automatic Mode** is enabled from **Systems** > **Robot**. **Acknowledge Automatic Mode** is enabled by default.
It is possible to avoid using the ACK button on the controller.

- Disable the **Acknowledge Automatic Mode** button on **Systems** > **Robot** > **Acknowledge Automatic Mode**.
- Assign **Acknowledgment** to one channel on **Safety I/Os** > **Inputs**.

Procedure

1. Tap **Programming** > **Programs**.
2. Tap the program to select a program to run.
3. Tap Automatic ( ).
4. Press the ACK button on the controller.
5. Tap in the **Robot control panel**
   (

).
   The program runs at the programmed speed.

   Note: At any time in Automatic mode, tap the **Program speed control** buttons to slow down the speed of the program and to resume its normal speed.

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Related topics

Mode: Automatic on page 127

Running a program in Hold-to-Run mode

Work in Hold to Run mode to run a program knowing that intervention may be required.

Before you begin

The enabling device must be pressed and held in the middle position to run the program.

About this task

The robot must be on and operational. When you run a program in Hold to Run mode, you may want to determine whether it needs further debugging or they may want to see how it works either at reduced or normal speeds.

Procedure

1. Tap **Programming** > **Programs**.
2. Tap the program to select a program to run.
3. Tap Hold to Run ( ).
4. Tap ▶ in the Robot control panel.

   Note: If the playing speed of the program is more than 250 mm/s, a warning dialog launches. Follow safety measures and confirm before proceeding.

   The program runs at the programmed speed.

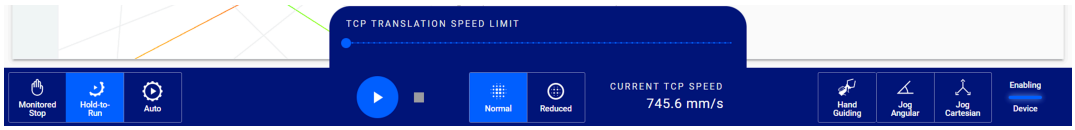
   Note: At any time in Hold to Run mode, tap the Program speed control buttons to slow down the speed of the program and to resume its normal speed.

5. Tap **Reduced** ( ) or **Normal** ( ) speed.



6. Tap ▶ in the Robot control panel.

   When you operate Hold to Run mode at **Normal** safety speeds, you can change the speed limit of the *TCP* translation speed while the program is running.



Related topics

Mode: Hold-to-Run on page 126

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Diagnostics

You can view potential issues in any part of the robot from the diagnostic pages.

The pages are found under the **Diagnostics** menu.

- **Status**: displays the results of all the built-in tests
- **Monitoring**: displays live information from the sensors about the robot, divided into four groups

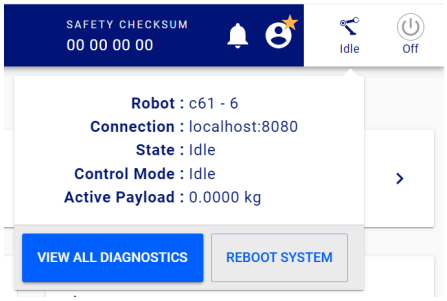
Faults identified by the diagnostics function, as well as normal operating events, generate messages that are displayed as notifications and can be found in the **Events** page. Access all events through Kortex Web App by tapping the **Notifications** icon ( ).

Built-in self tests

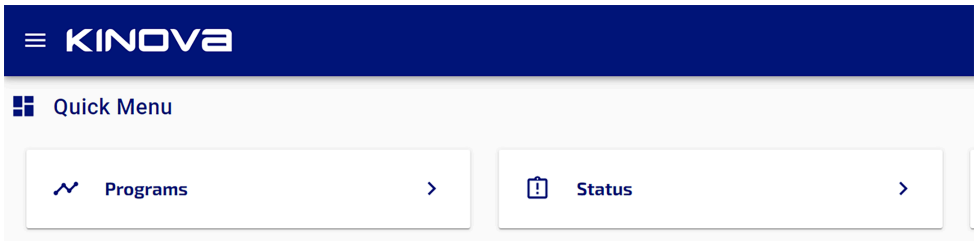
Kortex Web App displays self-test results, such as a robot component not functioning properly, on the **Status** page.

There are several ways to access the **Status** page.

- Tap the Robot status icon (Mon. Stop) and tap **VIEW ALL DIAGNOSTICS**.

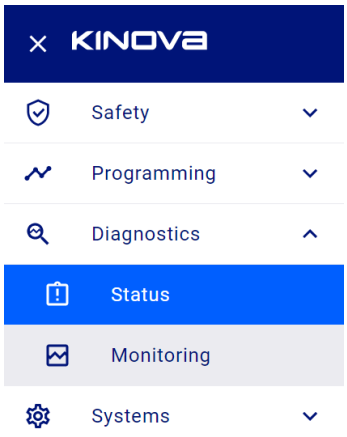


- Tap **Status** from Quick Menu.



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- Tap *hamburger menu* > **Diagnostics** > **Status**.



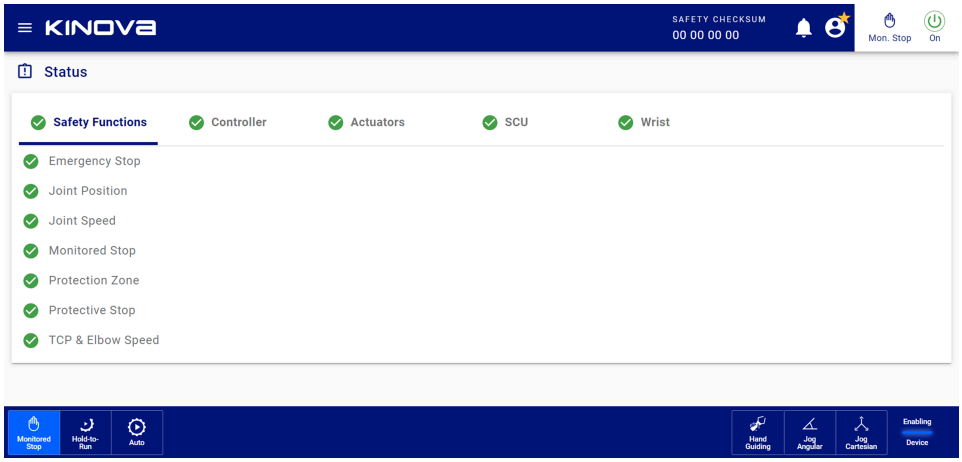


Figure 235: Status page

The page is divided into several panes.

- **Safety Functions**
- **Controller**
- **SCU**
- **Actuators**
- **Wrist**

Status of safety functions

The status of each of the safety functions, from SF1 to SF7, is listed on the **Safety Functions** pane.

Safety functions are monitored by the *SCU*. The state of each safety function is displayed.

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- A green circle with a check mark (✅) beside the name of the safety function indicates that safety function has no events.
- A red octagon (🛑) beside the name of the safety function indicates that safety function is triggered or activated.

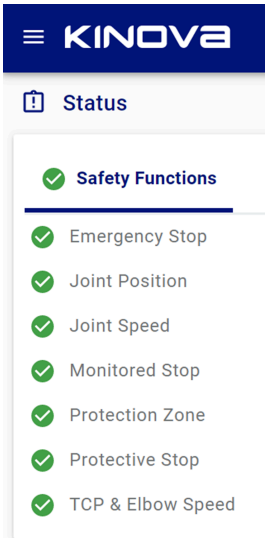


Figure 236: Status of safety functions

Related topics

List of safety functions on page 62

SF01 Emergency stop on page 63
SF02 Protective stop on page 63
SF03 Joint position monitoring on page 64
SF04 Joint speed monitoring on page 65
SF05 Monitored stop on page 66
SF06 Protection zone monitoring on page 66
SF07 TCP and elbow speed monitoring on page 67

Status of the controller

The status of each part of the *controller* is displayed on the **Controller** pane on the **Status** page.

The status of the controller summarizes the internal diagnostics of the controller.

On the **Controller** pane, you can search for different issues or view only what is failing.



Figure 237: Search and filter on the Controllerpane

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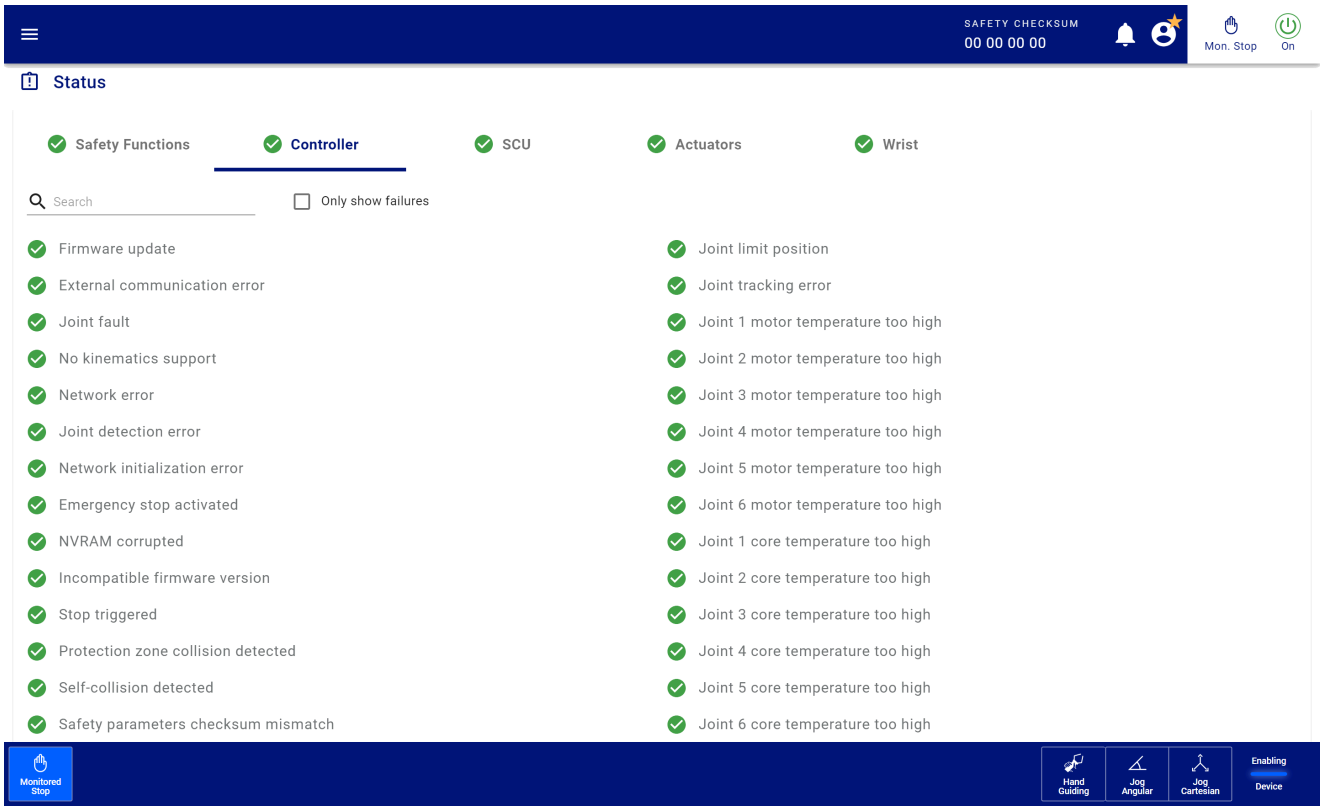


Figure 238: Status page of the controller

Each controller status displays one of its two status indicators, depending on the overall state of all its internal diagnostics.

- A green circle with a check mark (✅) beside the status indicates that all diagnostics for the controller are fine.
- A red octagon (🛑) beside the name of the controller diagnostic indicates that internal diagnostic has errors; more information may be available by tapping the Notifications icon (🔔).

The **Controller** pane displays all the status that are being monitored, including internal variables. Some of the internal variables cannot be accessed by users; the variables may be associated with hardware problems. Contact support at support@kinova.ca

Table 106: Listing of some of the controller status

Status	Not addressable by users	Addressable by users
Firmware update		x
External communication error		x
Joint fault		x

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Status	Not addressable by users	Addressable by users
No kinematics support	x	
Network error	x	
Joint detection error	x	
Network initialization error	x	
Emergency stop activated		x
NVRAM corrupted	x	
Incompatible firmware version		x
Stop triggered		x
Protection zone collision detected		x
Self-collision detected		x
Safety parameters checksum mismatch	x	
Hard stop command failed	x	
Singularity error detected		x
Joint limit position		x
Joint tracking error		x
Joint 1-6 motor temperature too high		x
Joint 1-6 core temperature too high		x
Serial number mismatch between arm and calibration file		x
Actuator model invalid	x	

When you are not able to intervene with a status, you can attempt to recover on your own before contacting support.

1. Take note of the exact error along with the conditions that seem to have triggered it.

   Tip: When a fault triggers, a message launches in Kortex Web App that provides information.

   - Name of the fault
   - Error code

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- Explanation of what can trigger the fault
- What can be done to fix the problem

2. Reboot the controller.
3. Re-install the *software update package (SWU)* if the error persists.
4. If the problem persists, contact support at support@kinova.ca.

Related topics
Protection zones on page 84

Firmware update

What does *Firmware update* monitor?

Firmware update failure monitors whether the latest *firmware* uploaded to the robot is installed properly.

Causes of the trigger

- Communication is faulty when the *SWU* package is uploaded to the robot.
- Firmware is corrupted during its initial download from kinovarobotics.com/resources.

Remedy

1. Download the latest version of the firmware by selecting **Product** > **Link 6** on kinovarobotics.com/resources.
2. Restart the firmware installation.

Incompatible firmware version

What does *Incompatible firmware version* monitor?

Incompatible firmware version monitors whether the *firmware* installed on the controller is compatible with the robot.

Cause of the trigger

A *SWU* package meant for another model of the robot may have been installed on the controller.

Remedy

1. Download the latest version of the firmware by selecting **Product** > **Link 6** on kinovarobotics.com/resources.
2. Restart the firmware installation.

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Joint detection error

What does *Joint detection error* monitor?

Joint detection error monitors whether the number of *actuators* detected by the *controller* is the same as its expected configuration.

Cause of the trigger

Communication packets may be lost between the internal devices of the robot.

Remedy

1. Take note of the exact error along with the conditions that seem to have triggered it.
2. Reboot the controller.
3. Re-install the *SWU* package if the problem persists.
4. If the problem persists, contact support at support@kinova.ca.

Joint fault

What does *Joint fault* monitor?

Joint fault monitors all actuators to determine whether any of them are currently in a fault state.

Cause of the trigger

There are multiple reasons for actuators being in fault.

Remedy

1. Tap **Actuators**.
2. Search `Joint`.
3. Identify the *actuator* in fault and its trigger.
4. Contact Kinova at support@kinova.ca.

Related topics

Status of the actuators on page 360

No kinematics support

What does *No kinematics support* monitor?

No kinematics support monitors whether the *controller* can find the kinematic information to control the *arm* properly.

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Cause of the trigger

The files that contain the information in the controller file system may be corrupted.

Remedy

1. Take note of the exact error along with the conditions that seem to have triggered it.
2. Reboot the controller.
3. Re-install the *SWU* package if the problem persists.
4. If the problem persists, contact support at support@kinova.ca.

Maximum ambient temperature reached

What does *Maximum SCU Board temperature* monitor?

Maximum SCU Board temperature reached monitors the temperature of the *SCU* board.

Cause of the trigger

- The room where the *controller* is installed may be too warm.
- There is not enough space behind the controller for its fan to disperse its internal heat properly; the temperature close to the controller is warmer than the actual temperature of the room.

Remedy

1. Make sure the controller has enough room to dissipate heat properly and that it operates under the recommended conditions.
2. Make sure the air filters on the controller are clean.
3. Make sure the fan is spinning freely.
4. Make sure the controller has enough room to dissipate heat properly.

Related topics

Considerations before installing the controller on page 141

Maximum core temperature reached

What does *Maximum core temperature reached* monitor?

Maximum core temperature reached monitors the temperature within the core of the *controller*. It must not exceed 75 °C.

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Cause of the trigger

The fan within the controller is not able to dissipate heat efficiently enough.

Remedy

1. Make sure the controller has enough room to dissipate heat properly and that it operates under the recommended conditions.
2. Make sure the air filters on the controller are clean.
3. Make sure the fan is spinning freely.
4. Make sure the controller has enough room to dissipate heat properly.

Related topics

Considerations before installing the controller on page 141

Maximum Joint Motor Housing temperature reached

What does *Joint Motor Housing temperature* monitor?

Joint Motor Housing temperature monitors the temperature of the housing of the *actuators*. The temperature must not exceed 73.0 °C.

Cause of the trigger

The monitored temperature threshold is over the temperature limit. The system triggers a preventive stop.

Remedy

1. Switch off the robot and let it cool down.
2. Reduce the speed of the robot.
3. Reduce the acceleration of the robot.
4. Contact Kinova Customer Support at support@kinova.ca.

Maximum Joint Core temperature reached

What does *Joint Core temperature* monitor?

Joint Core temperature monitors the temperature within the core of the *actuators*. The temperature must not exceed 88.0 °C.

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Cause of the trigger

The monitored temperature threshold is over the temperature limit. The system triggers a preventive stop.

Remedy

1. Switch off the robot and let it cool down.
2. Reduce the speed of the robot.
3. Reduce the acceleration of the robot.
4. Contact Kinova Customer Support at support@kinova.ca.

Network error

What does *Network error* monitor?

Network error monitors the communication between the controller and the arm components.

Cause of the trigger

Communication packets may be corrupted or lost between the internal devices of the robot.

Remedy

1. Take note of the exact error along with the conditions that seem to have triggered it.
2. Reboot the controller.
3. Re-install the *SWU* package if the problem persists.
4. If the problem persists, contact support at support@kinova.ca.

Remedy #2

1. Reboot the controller.
2. Re-install the *SWU* package if the problem persists.
3. Contact support at support@kinova.ca

Self-collision detected

What does *Self-collision detected* monitor?

Self-collision detected monitors whether non-consecutive robot links are at risk of entering in contact with each other.

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Cause

Manual control and trajectories can drive the robot in configurations where self-collisions can occur.

Remedy

1. Modify your trajectory accordingly when it is clear from observing the pose of the robot which links are at risk of entering in contact.
2. Validate the size of your Tool Sphere in the **Protection Zones** page.

Related topics
Protection zones on page 84

Status of the Safety Control Unit

The status of each low-level safety validation feature is displayed on the **SCU** pane of the **Status** page.

The *SCU* rarely enters warning or error states because there are watchers in the *MCU* that normally trigger their own faults before the *SCU* reaches its thresholds.

On the **SCU** pane, you can search for specific state strings, all errors, or all warnings.



Figure 239: Filter for specific status

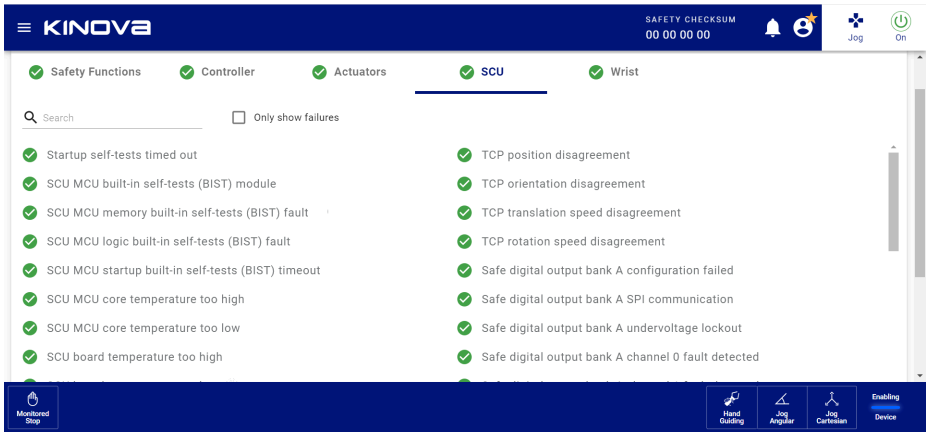


Figure 240: Status page of the *SCU*

Each status displays one of its two status indicators, depending on the overall state of all its internal diagnostics.

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- A green circle with a check mark (✅) beside the status indicates that all diagnostics for the *SCU* is fine.
- A red octagon (🛑) beside the name of the diagnostic indicates the diagnostic has failed; more information may be available by tapping the Notifications icon (🔔).

Table 107: Listing of *SCU* status

Status	Status
Startup self-tests timed out	TCP position disagreement
SCU MCU built-in self-tests (BIST) module	TCP orientation disagreement
SCU MCU memory built-in self-tests (BIST) fault	TCP translation speed disagreement
SCU MCU logic built-in self-tests (BIST) fault	TCP rotation speed disagreement
SCU MCU startup built-in self-tests (BIST) timeout	Safe digital output bank A configuration failed
SCU MCU core temperature too high	Safe digital output bank A SPI communication
SCU MCU core temperature too low	Safe digital output bank A undervoltage lockout
SCU board temperature too high	Safe digital output bank A channel 0 fault detected
SCU board temperature too low	Safe digital output bank A channel 1 fault detected
SBC SPI configuration failed	Safe digital output bank A channel 2 fault detected
SBC fault detected	Safe digital output bank A channel 3 fault detected
SBC debug mode active	Safe digital output bank A channel 4 fault detected
Clamp VIN overvoltage	Safe digital output bank A channel 5 fault detected
Clamp VIN undervoltage	Safe digital output bank A channel 6 fault detected
Clamp VOUT overvoltage	Safe digital output bank A channel 7 fault detected
Clamp VOUT undervoltage	Safe digital output bank B configuration failed
Clamp temperature too high	Safe digital output bank B SPI communication
Arm overcurrent	Safe digital output bank B undervoltage lockout
Emergency stop button signals disagreement	Safe digital output bank B channel 0 fault detected
Safety input 0 signals disagreement	Safe digital output bank B channel 1 fault detected
Safety input 1 signals disagreement	Safe digital output bank B channel 2 fault detected
Safety input 2 signals disagreement	Safe digital output bank B channel 3 fault detected
Safety input 3 signals disagreement	Safe digital output bank B channel 4 fault detected

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Status	Status
Safety input 4 signals disagreement	Safe digital output bank B channel 5 fault detected
Safety input 5 signals disagreement	Safe digital output bank B channel 6 fault detected
Safety input 6 signals disagreement	Safe digital output bank B channel 7 fault detected
Safety input 7 signals disagreement	FCCU reset occurred
Teach pendant emergency stop button signals disagreement	Software watchdog timer reset occurred
Teach pendant enabling button signals disagreement	SBC watchdog reset occurred
Safe communication failure MPU	Joint fault detected
Safe communication failure joint 1 main MCU	Joint 1 position disagreement
Safe communication failure joint 1 safety MCU	Joint 2 position disagreement
Safe communication failure joint 2 main MCU	Joint 3 position disagreement
Safe communication failure joint 2 safety MCU	Joint 4 position disagreement
Safe communication failure joint 3 main MCU	Joint 5 position disagreement
Safe communication failure joint 3 safety MCU	Joint 6 position disagreement
Safe communication failure joint 4 main MCU	Joint 1 speed disagreement
Safe communication failure joint 4 safety MCU	Joint 2 speed disagreement
Safe communication failure joint 5 main MCU	Joint 3 speed disagreement
Safe communication failure joint 5 safety MCU	Joint 4 speed disagreement
Safe communication failure joint 6 main MCU	Joint 5 speed disagreement
Safe communication failure joint 6 safety MCU	Joint 6 speed disagreement
Safe communication failure wrist main MCU	Joint 1 torque disagreement
Safe communication failure wrist safety MCU	Joint 2 torque disagreement
Safe digital input bank A configuration failed	Joint 3 torque disagreement
Safe digital input bank A SPI communication	Joint 4 torque disagreement
Safe digital input bank A fault detected	Joint 5 torque disagreement
Safe digital input bank B configuration failed	Joint 6 torque disagreement
Safe digital input bank B SPI communication	Arm power relay A stuck
Safe digital input bank B fault detected	Arm power relay B stuck

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Status	Status
Enabling devices vs. arm operating mode violation detected	Malfunction detected in Emergency Stop Delay Circuit A
Wrist enabling device vs. arm operating mode violation detected	Malfunction detected in Emergency Stop Delay Circuit B

You can attempt to recover on your own before contacting support.

1. Take note of the exact error along with the conditions that seem to have triggered it.

   Tip: When a fault triggers, a message launches in Kortex Web App that provides information.

   - Name of the fault
   - Error code
   - Explanation of what can trigger the fault
   - What can be done to fix the problem

2. Reboot the controller.
3. Re-install the *SWU* if the error persists.
4. If the problem persists, contact support at support@kinova.ca.

Emergency stop button signals disagreement

What does *Emergency stop button signals disagreement* monitor?

Emergency stop button signals disagreement monitors whether the signals coming from the emergency stop button are at the same level on the Emergency stop inputs on the *I/O* panel. The signals on the I/O panel are A1, A2, B1, and B2.

Cause

The emergency stop button may not be fully engaged or fully released.

Remedy

1. Make sure the button is either fully engaged or fully released, broken, or miswired.
2. Check the wiring of the e-stop button.
3. Take note of the exact error along with the conditions that seem to have triggered it.
4. Reboot the controller.
5. Re-install the *SWU* package if the problem persists.
6. If the problem persists, contact support at support@kinova.ca.

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Safety input signals disagreement

What does *Safety input signals disagreement* monitor?

Safety input signals disagreement monitors whether each of the safety I/O redundant signals are in alignment with the state of the robot.

Cause

The connections on the *I/O* panel or *distant device* may be loose.

Remedy

1. Make sure the connections on the I/O panel and distant device are secure.
2. Take note of the exact error along with the conditions that seem to have triggered it.
3. Reboot the controller.
4. Re-install the *SWU* package if the problem persists.
5. If the problem persists, contact support at support@kinova.ca.

Status of the actuators

The status of each *actuator* is displayed on the **Actuators** pane of the **Status** page.

The status of the actuators summarizes the internal diagnostics of the actuators.

On the **Actuators** pane, you can search for different issues or view only what is failing.



Figure 241: Search and filter on Actuators pane

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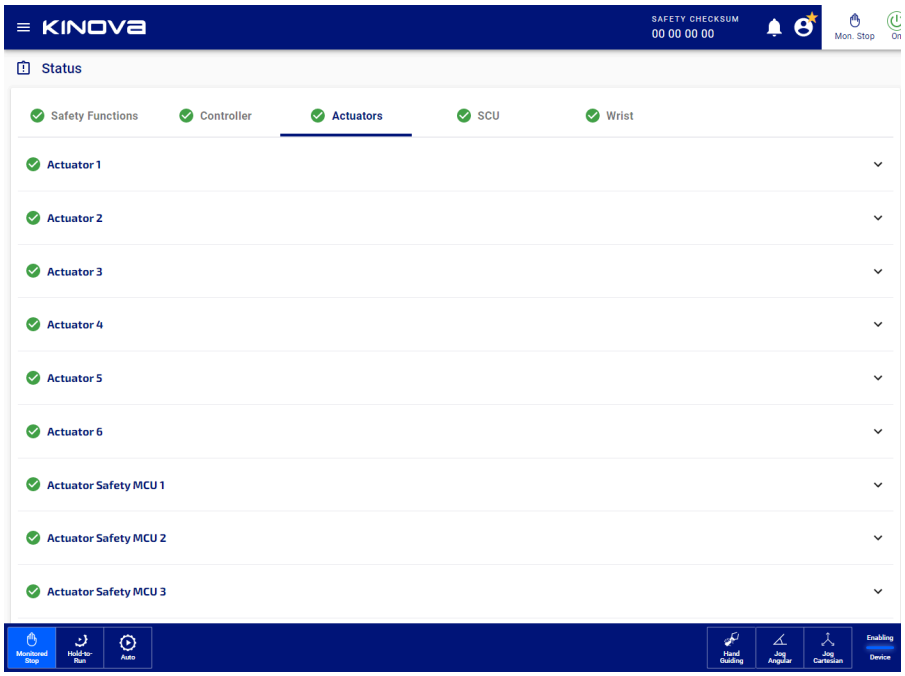


Figure 242: Status page of the actuators when all actuator status are good

Each actuator pane displays one of two status indicators, depending on the overall state of all its internal diagnostics.

- A green circle with a check mark (✅) beside the actuator indicates that all diagnostics for that actuator is fine.
- A red octagon (🛑) beside the actuator indicates that the diagnostic has failed. More information is available by expanding the pane and possible recovery steps may be available by tapping the Notifications icon (🔔).

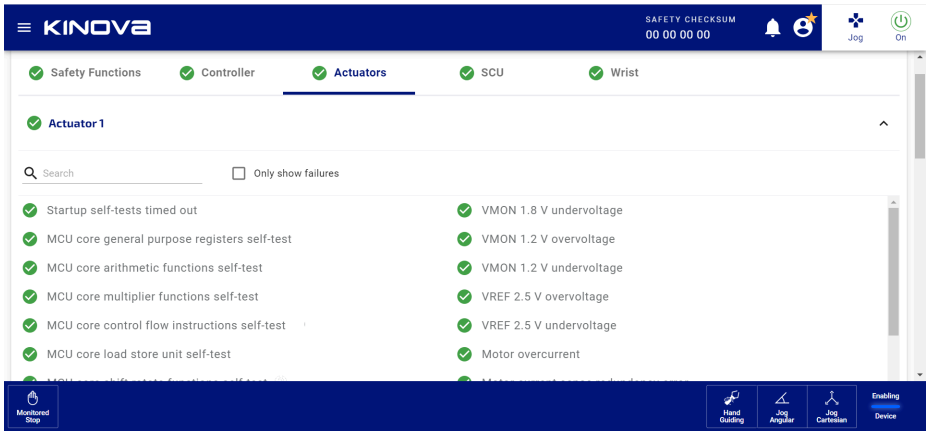


Figure 243: Status page of the actuators with an actuator pane expanded

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The **Actuators** pane displays all internal diagnostics of the actuators, including internal variables. Some of the internal variables cannot be accessed by users; the variables may be associated with hardware problems.

Each safety *MCU* actuator status is listed separately for each actuator.

Table 108: Listing of diagnostic status of each actuator

Status	Status
Startup self-test timed out	VMON 1.8 V undervoltage
MCU core general purpose registers self-test	VMON 1.2 V overvoltage
MCU core arithmetic functions self-test	VMON 1.2 V undervoltage
MCU core multiplier functions self-test	VREF 2.5 V overvoltage
MCU core control flow instructions self-test	VREF 2.5 V undervoltage
MCU core load store unit self-test	Motor overcurrent
MCU core shift rotate functions self-test	Motor current sense redundancy error
MCU core stack pointer self-test	Motor phases current unbalanced
MCU core pipeline functions self-test	Motor encoder configuration failed
MCU core FPU registers bank self-test	Motor encoder fault detected
MCU core FPU single precision functions self-test	Motor encoder error pin asserted
MCU core cache management logic self-test	Motor encoder SPI QEI position disagreement
MCU RAM self-test	Joint encoder configuration failed
Joint position following error	Joint encoder fault detected
Joint maximum velocity	Joint encoder diagnostic pin asserted
Joint position limit high	Joint encoder SPI QEI position disagreement
Joint position limit low	Encoders position disagreement
Joint maximum torque	Motor housing temp sensor I2C error
Motor driver configuration failed	Motor housing temperature too high
Motor driver fault pin asserted	Motor housing temperature too low
Motor driver VDS overcurrent	Core temperature too high
Motor driver gate driver fault	Core temperature too low
Motor driver PSU undervoltage lockout	EEPROM I2C error

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Status	Status
Motor driver gate driver undervoltage lockout	EEPROM corrupted
Motor driver thermal shutdown	FRAM I2C error
Motor driver sense amplifier overcurrent	FRAM corrupted
Brake driver fault pin asserted	XCOM safety MCU not detected
Brake not releasing	XCOM configuration failed
Brake circuit current out of range	XCOM SPI communication
Brake circuit unexpected voltage	Motor driver enable pin disagreement
Brake release motion out of range	Brake driver enable pin disagreement
VMON 48 V overvoltage	VMON 48V disagreement
VMON 48 V undervoltage	Motor housing temperature disagreement
VMON 5 V overvoltage	Joint position disagreement
VMON 5 V undervoltage	Motor position disagreement
VMON 3.3 V overvoltage	Joint velocity disagreement
VMON 3.3 V undervoltage	Motor velocity disagreement
VMON 2.8 V overvoltage	Motor current disagreement
VMON 2.8 V undervoltage	Safe communication
VMON 1.8 V overvoltage	Independent or window watchdog reset occurred

When you are not able to intervene with a status, attempt to recover on your own before contacting support.

1. Take note of the exact error along with the conditions that seem to have triggered it.

   Tip: When a fault triggers, a message launches in Kortex Web App that provides information.

   - Name of the fault
   - Error code
   - Explanation of what can trigger the fault
   - What can be done to fix the problem

2. Reboot the controller.
3. Re-install the *SWU* if the error persists.
4. If the problem persists, contact support at support@kinova.ca.

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Related topics

Joint fault on page 352

Remedy for MCU internal diagnostics

Many different errors of the status of the *actuators* can be caused by the status of the *MCU*.

About this task

Take the same remedial steps for each of the actuator status.

- Startup self-tests timed out
- *MCU* core general purpose registers self-test failure
- *MCU* core arithmetic functions self-test failure
- *MCU* core multiplier functions self-test failure
- *MCU* core control flow instructions self-test failure
- *MCU* core load store unit self-test failure
- *MCU* core stack pointer self-test failure
- *MCU* core pipeline functions self-test failure
- *MCU* core FPU registers bank self-test failure
- *MCU* core FPU single precision functions self-test failure

Procedure

1. Take note of the exact error along with the conditions that seem to have triggered it.
2. Reboot the *controller*.
3. Re-install the *SWU* if the error persists.
4. If the problem persists, contact support at support@kinova.ca.

Core temperature too high

What does *Core temperature too high* monitor?

Core temperature too high monitors whether the core temperature is below a specific temperature.

Cause of the trigger

Trajectories with sustained high torques generate heat at a faster pace than it is dissipated.

Remedy

Leave the robot at rest and let it cool down. If a continuous program is triggering this fault, consider modifying the trajectory to reduce the duration of high applied torques.

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Core temperature too low

What does *Core temperature too low* monitor?

Core temperature too low monitors whether the core temperature is above a specific temperature.

Cause of the trigger

Low internal temperature is a consequence of low ambient temperature.

Remedy

Make sure the robot is operating in the recommended ambient temperature.

Motor housing temperature too high

What does *Motor housing temperature too high* monitor?

Motor housing temperature too high monitors whether the temperature of the motor housing is below a specific temperature.

Cause of the trigger

Trajectories with sustained high torques generate heat at a faster pace than it is dissipated.

Remedy

Leave the robot at rest and let it cool down. If a continuous program is triggering this fault, consider modifying the trajectory to reduce the duration of high applied torques.

Motor housing temperature too low

What does *Motor housing temperature too low* monitor?

Motor housing temperature too low monitors whether the temperature of the motor housing is over a specific temperature.

Cause of the trigger

Low internal temperature is a consequence of low ambient temperature.

Remedy

Make sure the robot is operating in the recommended ambient temperature.

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Status of the wrist

The status of each part of the *wrist* is displayed on the **Wrist** pane on the **Status** page.

The status of the wrist summarizes the internal diagnostics of the wrist.

On the **Wrist** pane, you can search for different issues or view only what is failing.



Figure 244: Search and filter on

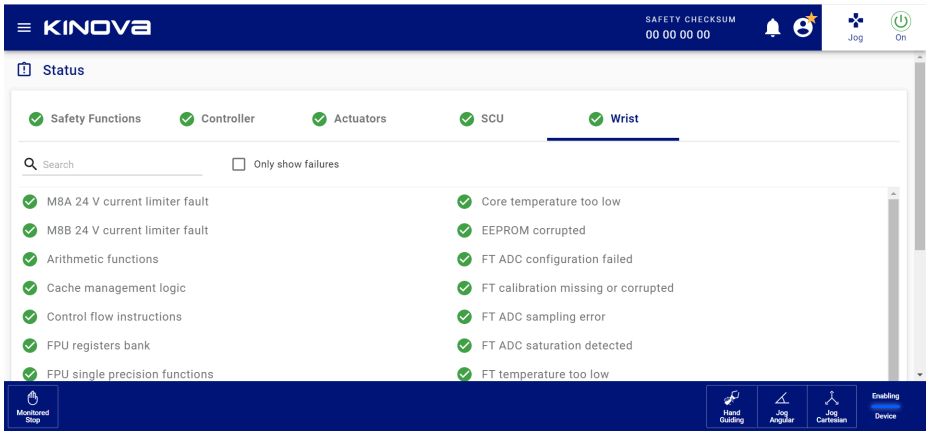


Figure 245: Status page of the wrist

Each wrist status displays one of its two status indicators, depending on the overall state of all its internal diagnostics.

- A green circle with a check mark (✅) beside the status indicates that all diagnostics for the wrist are fine.
- A red octagon (🛑) beside the name of the controller status indicates that status has errors; more information may be available by tapping the Notifications icon (🔔).

The **Wrist** pane displays all the status that are being monitored, including internal variables. Some of the internal variables cannot be accessed by users; the variables may be associated with hardware problems. Contact support at support@kinova.ca

Table 109: Listing of diagnostic status of the wrist

Status	Status
M8A 24 V current limiter fault	Core temperature too low
M8B 24 V current limiter fault	EEPROM corrupted

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Status	Status
Arithmetic functions	FT ADC configuration failed
Cache management logic	FT calibration missing or corrupted
Control flow instructions	FT ADC sampling error
FPU registers bank	FT ADC saturation detected
FPU single precision functions	FT temperature too low
General purpose registers	FT temperature too high
Load/store unit(s)	Watchdog reset occurred
Multiplier functions	M8A analog IO channel 1 fault detected
Pipeline functions	M8A analog IO channel 2 fault detected
Shift and rotate functions	M8A digital IO configuration failed
Stack pointer	M8A digital IO overcurrent
MCU RAM BIST fault	M8A digital IO SPI communication
Voltage 24 V	M8A digital IO supply error
Voltage 2V5	M8A digital IO thermal shutdown
Voltage 3V3	M8B analog IO channel 1 fault detected
Voltage monitoring 3V3 undervoltage	M8B analog IO channel 2 fault detected
Voltage monitoring 3V3 overvoltage	M8B digital IO configuration failed
Startup self tests timed out	M8B digital IO overcurrent
Voltage monitoring 10 V overvoltage	M8B digital IO SPI communication
Voltage monitoring 10 V undervoltage	M8B digital IO supply error
Voltage monitoring 10 V overvoltage	M8B digital IO thermal shutdown
Voltage monitoring 10 V undervoltage	Analog IO configuration
Voltage monitoring 48 V overvoltage	Analog IO fault detected
Voltage monitoring 48 V undervoltage	Safe communication
Core temperature too high	

When you are not able to intervene with a status, you can attempt to recover on your own before contacting support.

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1. Take note of the exact error along with the conditions that seem to have triggered it.

   Tip: When a fault triggers, a message launches in Kortex Web App that provides information.

   - Name of the fault
   - Error code
   - Explanation of what can trigger the fault
   - What can be done to fix the problem

2. Reboot the controller.
3. Re-install the *SWU* if the error persists.
4. If the problem persists, contact support at support@kinova.ca.

Robot monitoring

At any time, you can view current information about the *base*, *actuators*, *end effector* that is in use, and the flange pose.

The **Monitoring** pages display the live feedback from the sensors on the robot, as well as values computed from that feedback. Computed values include TCP position and velocity, among others.

To access the robot **Monitoring** page, tap ☰ > **Diagnostics** > **Monitoring**.

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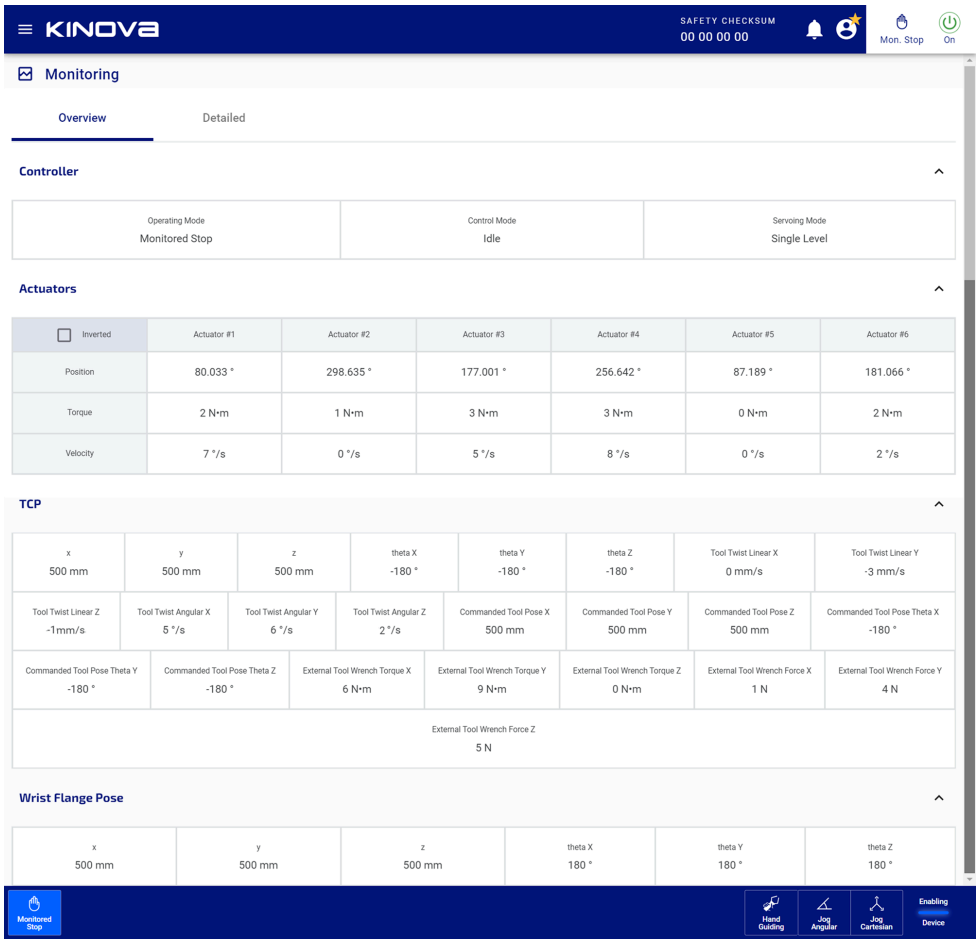


Figure 246: Overview pane of the Monitoring page

The page is divided into two panes.

- **Overview**
- **Detailed**

Select or deselect **Inverted** to interchange the top row with the first column of the Actuators table.

Overview pane of the Monitoring page

The **Overview** pane displays an overview of the position and state the robot is currently in.

The **Monitoring** page is subdivided into four main parts.

- **Controller**
- **Actuators**
- **TCP**
- **Wrist Flange Pose**

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Table 110: Content of the Overview pane

Part	Information displayed
Controller	Operating Mode
	Control Mode
	Servoing Mode
Actuators	The **Inverted** checkbox controls the layout of the **Actuators** table. Selecting or deselecting it, the top row and the first column interchange: the top row becomes the first column and the first column becomes the top row.
	Position of each actuator; measured in °
	Torque of each actuator; measured in N·m
	Velocity of each actuator; measured in °/s
TCP	x, y, and z; measured in mm
	theta X, theta Y, and theta Z; measured in °
	Tool Twist Linear X, Y, and Z; measured in m/s
	Tool Twist Angular X, Y, and Z; measured in °/s
	Commanded Tool Pose X, Y, and Z; measured in mm
	Commanded Tool Pose Theta X, Theta Y, and Theta Z; measured in °
	External Tool Wrench Torque X, Y, and Z; measured in N·m
	External Tool Wrench Force X, Y, and Z; measured in N
Wrist Flange Pose	x, y, and z; measured in mm
	theta X, theta Y, and theta Z; measured in °

Detailed pane of the Monitoring page

The **Detailed** pane displays more information about the controller and the *actuators*. The information about the *TCP* and the *flange* are the same as that in the **Overview** pane.

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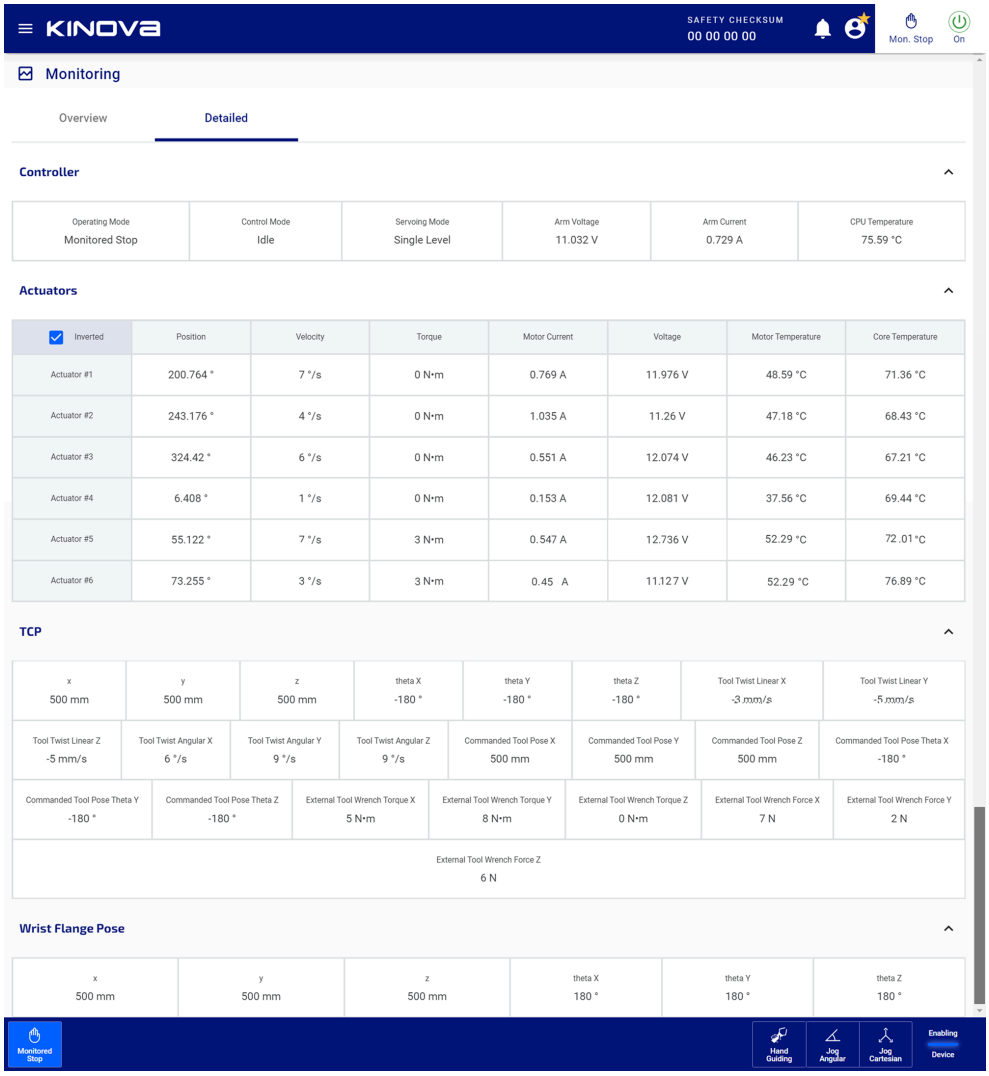


Figure 247: Detailed pane of the Monitoring page

Table 111: Content of the Detailed pane not in the Overview pane

Part	Information displayed
Controller	Arm Voltage
	Arm Current
	CPU Temperature
Actuators	Motor Current of each actuator; measured in A
	Voltage of each actuator; measured in V
	Motor Temperature; measured in °C
	Core Temperature; measured in °C

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Related topics

Overview pane of the Monitoring page on page 369

Event notifications

Robot actions and interactions with Kortex Web App may be added to a list of events that can be viewed on the **Events** page.

Access the list of saved *events* by tapping the notification bell.



Figure 248: Notification bell when not selected



Figure 249: Notification bell when selected



Figure 250: Notification bell when an informational event is triggered



Figure 251: Notification bell when an warning event is triggered

View events that have happened from the **Events** page.

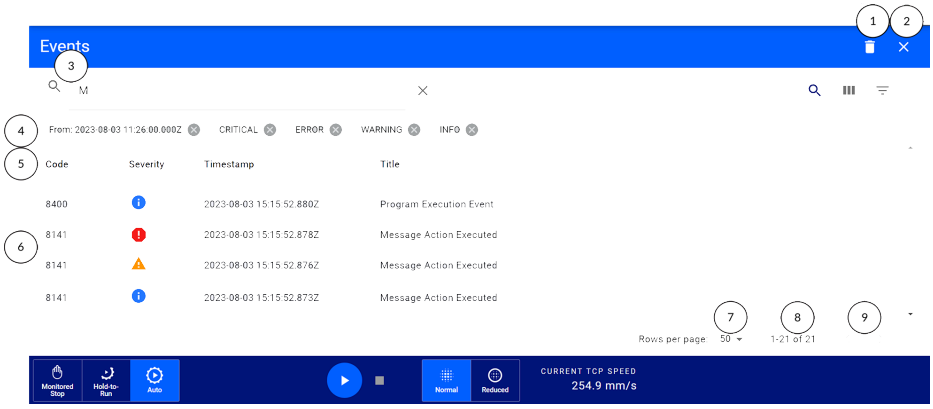


Figure 252: The Events page and its parts

1 **Delete** icon ( )
Tap to delete the events on the page.

2 **Close** icon (X)
Tap to close the page.

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3 Filtering tools

All filtering tools can be used independently or with each other.

Search bar

Enter one or more words that may be found in the title of the notification to view all similar notifications.

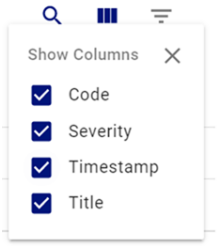
Tap **X** to remove the search.

Search icon (🔍)

Tap the icon to launch the **Search** bar.

Show Columns (▮▮▮)

Tap to launch the **Show Columns** pane.



Select one or more of the types of information you want to see.

- Code
- Severity
- Timestamp
- Title

Tap **X** to close the **Show Columns** pane.

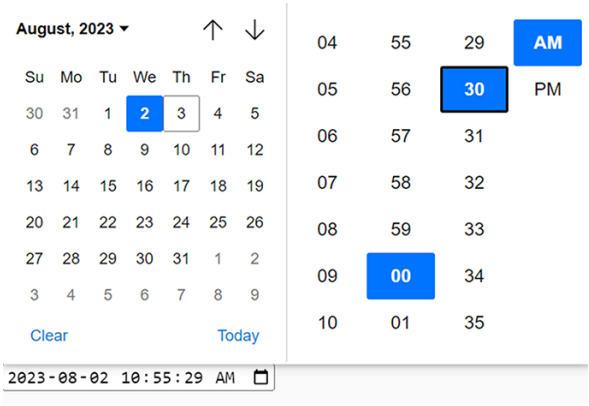
Filter icon (⏷)

Tap to launch the **Filter** pane.



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Enter start and end dates if you want to view notifications within a time range.



Select and deselect filters based on **Severity** of the notification.

- **CRITICAL**
- **ERROR**
- **INFO**
- **WARNING**

Tap **RESET** to clear the current filters.

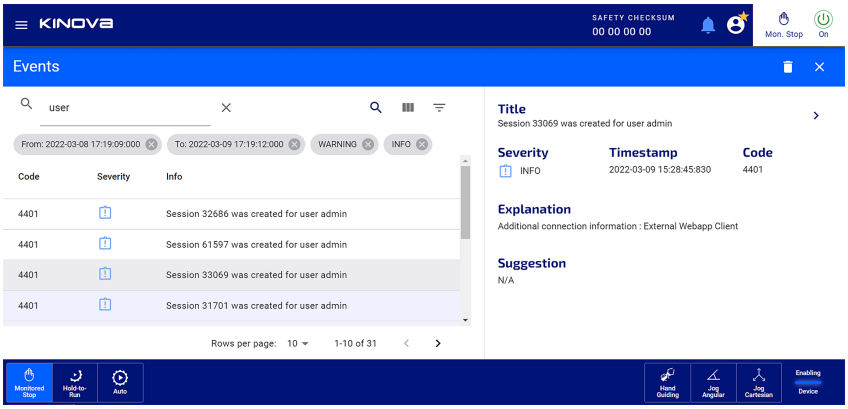
Tap **X** to close the **Filter** pane.

4 Active filters
The filters that have been selected using the filtering tools.
Tap **X** to close the filter that is not applicable.

5 Table column headers
The column headers indicate the type of information that is displayed.

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6 Information
A summary of each event that meets
the filtering criterion is displayed in the Details pane.



Title	Summary of the event
Severity	Level of severity of the event
Timestamp	Date and time the event took place
Code	Number associated with the event to make reporting easy
Explanation	Reason the event is triggered In the case of Message action events, the content of the Message action
Suggestion	Details what can be done to circumvent the event if applicable
	Tap **>** to close the **Details** pane.

7 Number of rows, or item entries, of information that is to be displayed on each page
Current options are **10**, **25**, **50**, **100**.

8 The range of item entries currently displayed, with respect to the number of item entries to be displayed on each page, and the total number of entries that meet the filtering criterion defined with the filtering tools.

9 Previous and Next arrows
Tap to navigate the
pages of events.

Filtering events

Many events take place while Link 6 is running. To sort through them all is eased with filtering.

About this task

Events are timestamped, have associated codes, and are grouped together by level of severity. Filtering on any combination of range of time, code, and level of severity helps to reduce the number of events you have to examine.

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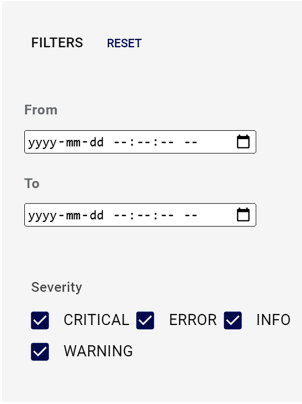
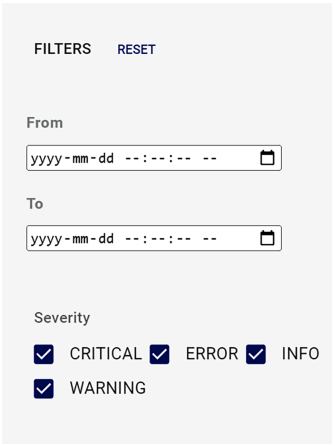


Figure 253: Filter panel

Procedure

1. Tap the filter icon ( ).
   The **Filter** panel launches.



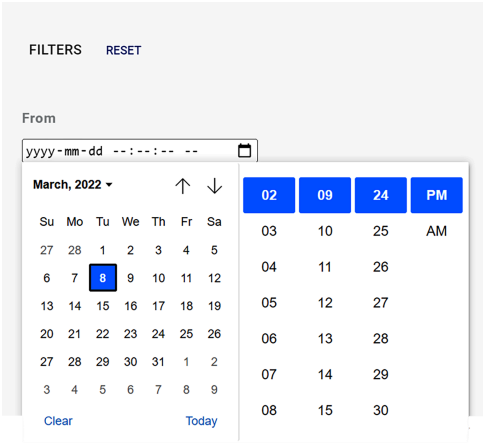
Clear all selections in the Filter panel.

2. Tap **RESET**.
   - The **From** and **To** dates clear and show only the date formats.
   - All **Severity** level checkboxes are deselected.

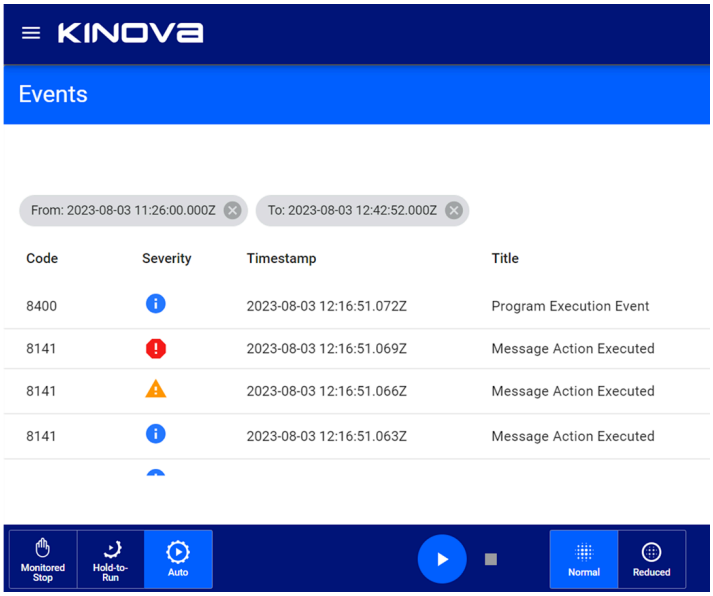
Define how you want to filter event data in the Filter panel.

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3. Enter **From** and **To** dates either by entering the date manually or by tapping the calendar when you want to look for an event within a certain time frame.



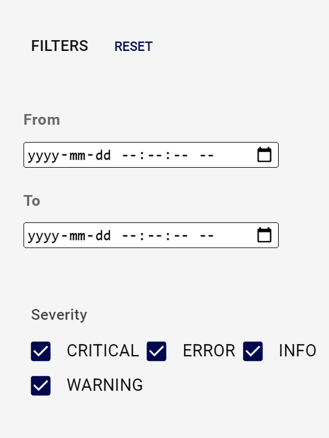
Note: When you enter a date range with no **Severity** level, all events that happen within the range are displayed.



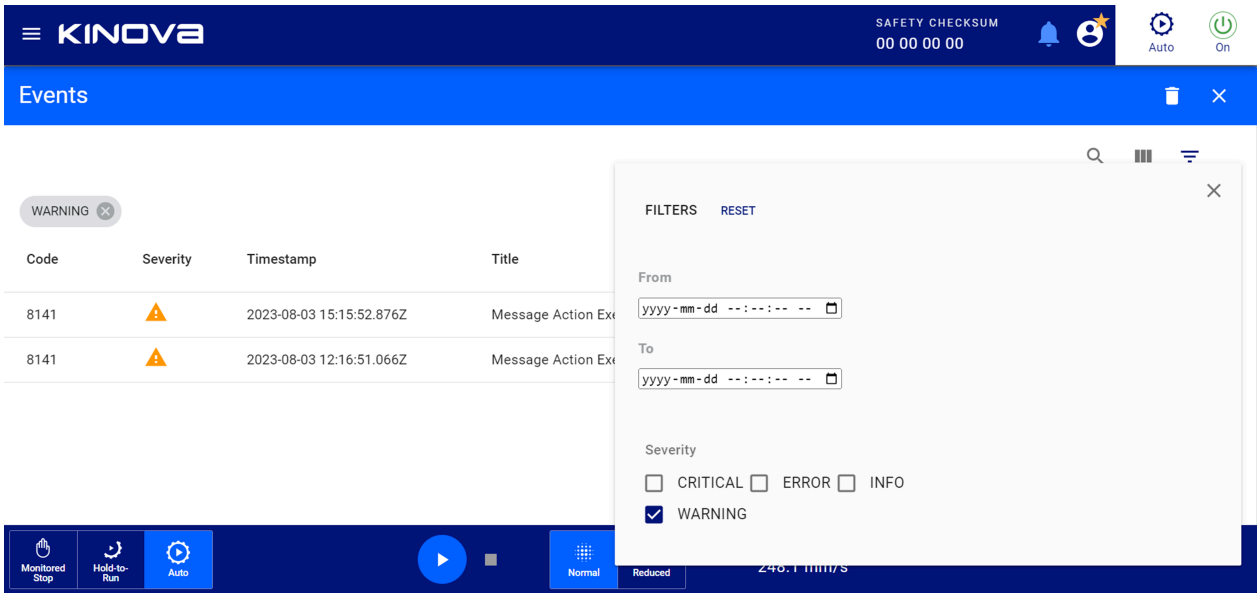
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4. Select 0 or more **Severity** levels you want to use for filtering.

   Selectable severity levels: **CRITICAL**, **ERROR**, **INFO**, **WARNING**.



   The events that are displayed have a severity level that matches what is selected in the filter. That is, if only **WARNING** is selected, only events with type **WARNING** are displayed.



   When no date range is entered and no severity level is selected, all events are displayed with respect to the columns selected in the **Show Columns** panel.

5. Tap X when you want to close the **Filter** panel.

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Plugins

Link 6 is designed modularly, which makes it easy to expand on its capabilities. The extensions are added on as *plugins*.

Link 6 comes with two pre-installed plugins and cannot be uninstalled.

Arm plugin	The plugin handles all actions needed to control the *arm*. The configuration and settings of the arm plugin are not visible because they are not modifiable.
Industrial I/O plugin	The plugin exchanges information using pure electrical signals through cables connected to some other piece of equipment between the *controller* and on the *wrist*.

Administrators can install new plugins to expand the capabilities of their robot. The plugins are on the Kinova website under Resources.

All installed plugins start to run when the controller is switched on. However, they can be stopped so the settings can be modified or deactivated.

Many plugins contain actions that the user can use when programming the robot with the visual programming interface in Kortex Web App. Each plugin may also contain parameters that can be modified in Kortex Web App from the corresponding plugin page. **Deactivate** the plugin before modifying the plugin parameters.

All plugins have two pages: **Configurations** and **About**.

Related topics

Visual programming on page 232

Installing plugins on page 183

Overview of working with plugins on page 190

Kinova® Kortex™ GitHub repository on page 180

Plugins on page 180

Arm plugin

Link 6 comes with the *arm plugin* pre-installed.

There are no configurable parameters for the arm plugin. The **Configurations** portion of the **Arm plugin** page merely states that it does not have any modifiable configurations.

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The **About** portion lists information specific to the arm, such as name, package name, version, type of installation, and a description of the plugin.

Industrial I/O Plugin

Link 6 comes with the Industrial I/O *plugin* pre-installed.

The Industrial I/O plugin has tiles in the visual programming interface in *Kortex Web App* to exchange information using pure electrical signals through cables connected to some other piece of equipment. The equipment is connected to the general purpose in the *controller*.

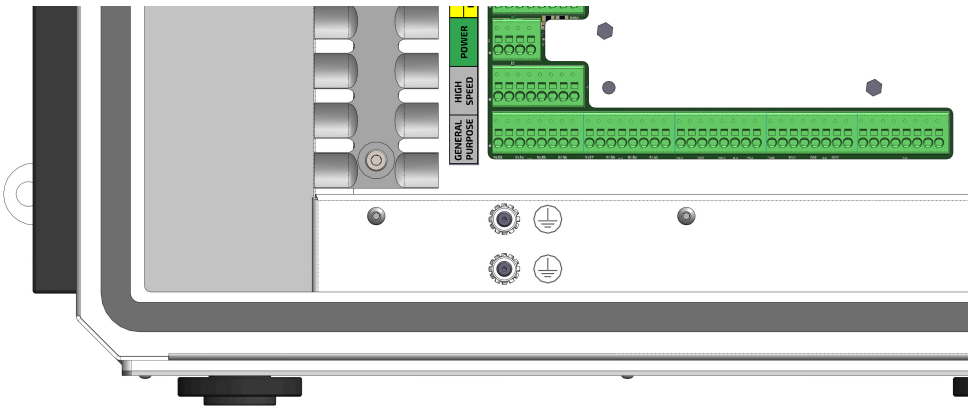


Figure 254: General purpose I/O connection on the controller

There are many configurable parameters for the Industrial I/O plugin. Access all parameters from **Systems** > **Plugins** > **Industrial I/O Plugin** > **Configurations**. The plugin has several pages of configurations, each page dedicated to one aspect of industrial I/Os.

- **Controller Digital Outputs**
- **Controller Digital Inputs**
- **Controller Analog**
- **Wrist Analog**
- **Wrist Digital**

Important: To configure any part of the Industrial I/O plugin, the Industrial I/O panel mus be energized through the 24_IN/0V_IN terminals.

Important: To configure any part of the Industrial I/O plugin, you must first tap **Stop** to stop running the plugin.

Related topics

Variables on page 249

Variable Management page on page 258

Industrial I/O power supply on page 39

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Controller digital outputs on the Industrial I/O plugin page

All digital outputs for the controller must be configured on the **Controller Digital Outputs** pane of the **Industrial I/O Plugin** plugin page.

Each digital output for the *controller* is defined independently from the other digital output for the controller.

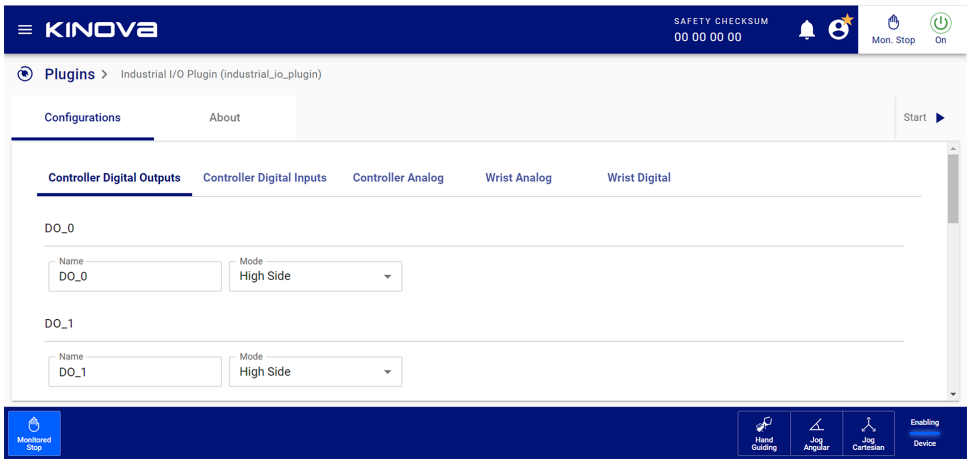


Figure 255: Controller Digital Outputs pane

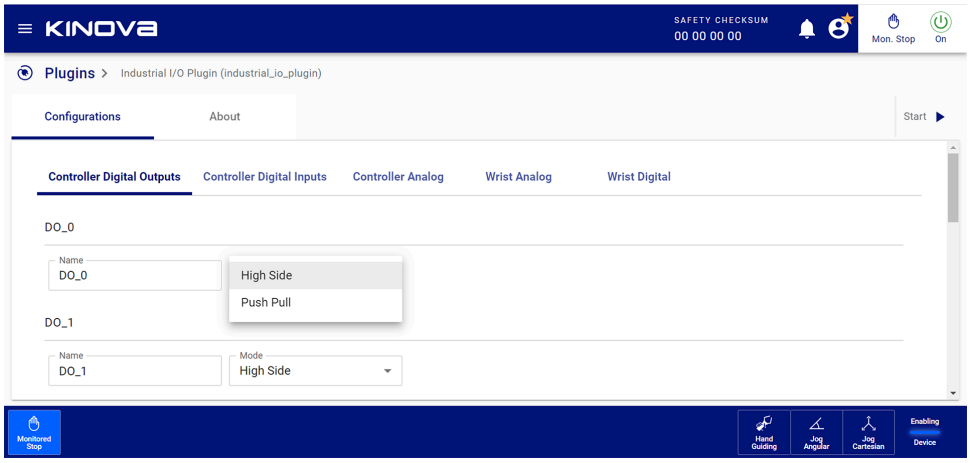


Figure 256: Controller Digital Outputs pane with Mode drop-down

Each digital I/O of the controller has its own smaller pane on the **Controller Digital Outputs** pane. Each one of **DO_0** to **DO_7** corresponds to each of the terminal connections on the controller.

Parameter	Description
Name	Enter a meaningful name for that specific digital output for the controller.
	The name is visible in the visual programming interface.

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Parameter	Description
Mode	Select a driver mode. • **High Side** • **Push Pull**

The digital outputs on the controller can be configured as *high side* (IEC 61131-2 TYPE 0,5) or push pull. A *push* is a source current. The *pull* is a sink current. The flow of electricity in the Pull is blocked; the outputs are unable to have the current sink into the digital output. The internal circuitry can switch between states quickly when the outputs are in push-pull mode even if the current sink is blocked from the external circuitry.

Related topics

Industrial I/O: Set Output tile parameters on page 331

General-purpose digital outputs on page 42

Controller electrical and communications interface on page 35

Controller digital inputs on the Industrial I/O plugin page

All digital inputs for the *controller* must be configured on the **Controller Digital Inputs** pane of the **Industrial I/O Plugin** plugin page.

Each digital input for the controller is defined independently from the other digital input for the controller.

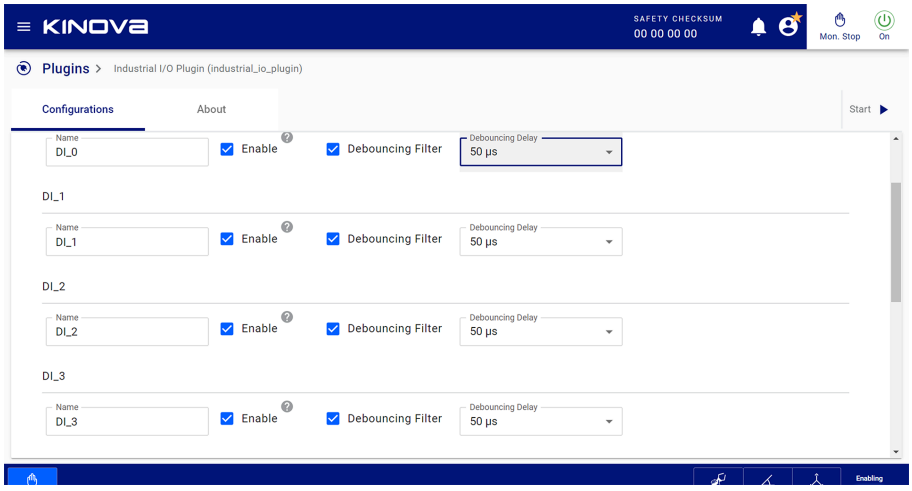


Figure 257: Controller Digital Inputs pane

Each one of **DI_0** to **DI_7** corresponds to each of the terminal connections on the controller.

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Parameter	Description
Name	Enter a meaningful name for that specific digital input for the controller. The name is visible in the visual programming interface.
Enable	Select when you want to enable the input.
Debouncing Filter	Select to apply *debouncing* delay to the input delay.
Debouncing Delay	Configure the debouncing delay in microseconds. Valid values are 50 µs, 100 µs, 400 µs, 800 µs, 1600 µs, 3200 µs, 12800 µs, and 20000 µs.

Related topics

Industrial I/O: Set Output tile parameters on page 331

General-purpose digital inputs on page 41

Controller electrical and communications interface on page 35

Controller analog I/O on the Industrial I/O plugin page

All analog *I/O* for the *controller* can be configured on the **Controller Analog** pane of the **Industrial I/O Plugin** plugin page.

Analog I/O has a voltage resolution of 0.1 V and a current resolution of 1 mA.

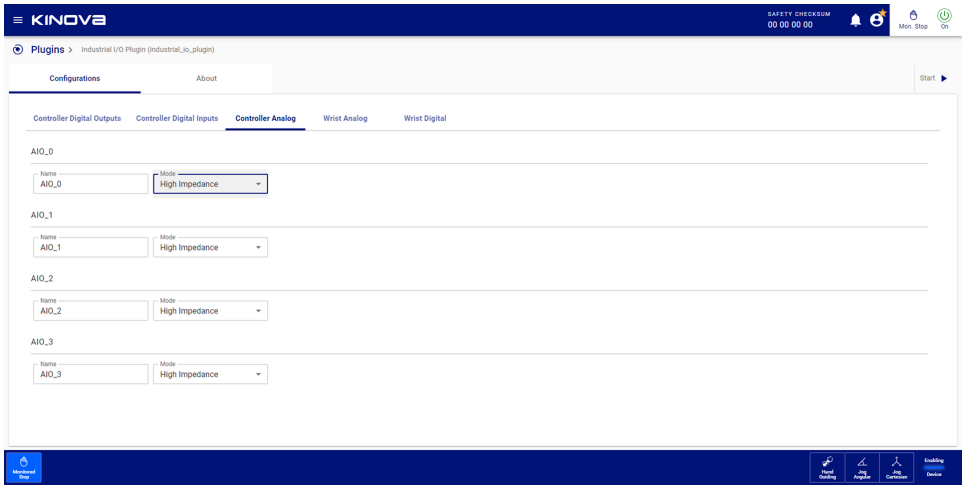


Figure 258: Controller Analog pane

Each one of **AIO_0** to **AIO_3** corresponds to each of the terminal connections on the controller.

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Table 112: Controller analog configurations

Parameter	Description
Mode	Select a driver mode. • **High Impedance** (disable) • **Voltage Output** • **Current Output** • **Voltage Input** • **Current Input**
Name	Enter a meaningful name for that specific analog input or output for the controller. The name is visible in the visual programming interface.

Related topics

Industrial I/O: Set Output tile parameters on page 331

Wrist analog I/O on the Industrial I/O plugin page

All analog *I/O* for the *wrist* can be configured on the **Wrist Analog** pane of the **Industrial I/O Plugin** plugin page.

Analog I/O has a voltage resolution of 0.1 V and a current resolution of 1 mA.

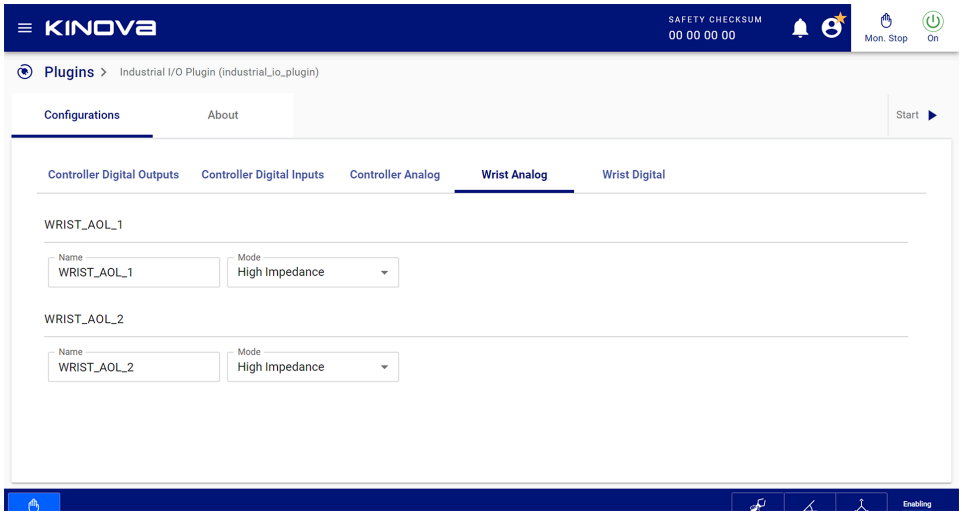


Figure 259: Wrist Analog pane

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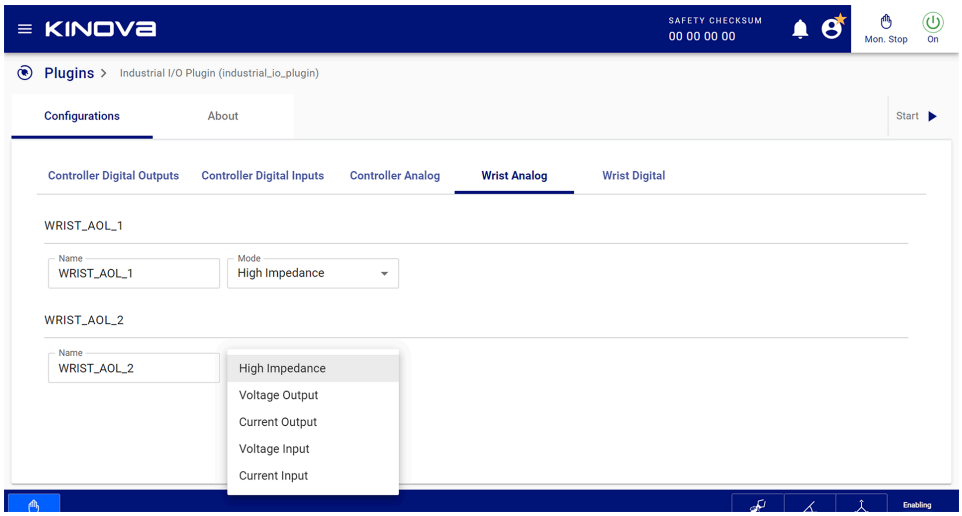


Figure 260: Wrist Analog pane with Mode drop-down

Each one of **WRIST_AOI_1** and **WRIST_AOI_2** corresponds to the two AIO_n signals on the M8-A connector on the wrist.

Table 113: Wrist analog configurations

Parameter	Description
Name	Enter a meaningful name for that specific analog input or output for the controller. The name is visible in the visual programming interface.
Mode	Select a mode. • **High Impedance** (disabled) • **Voltage Output** • **Current Output** • **Voltage Input** • **Current Input**

Related topics

Industrial I/O: Set Output tile parameters on page 331

Electrical interface on page 24

Wrist digital I/O on the Industrial I/O plugin page

All digital inputs and outputs for the *wrist* must be configured on the **Wrist Digital** pane of the **Industrial I/O Plugin** plugin page.

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Each digital input and output of the wrist is defined independently from the other digital input and output of the wrist.

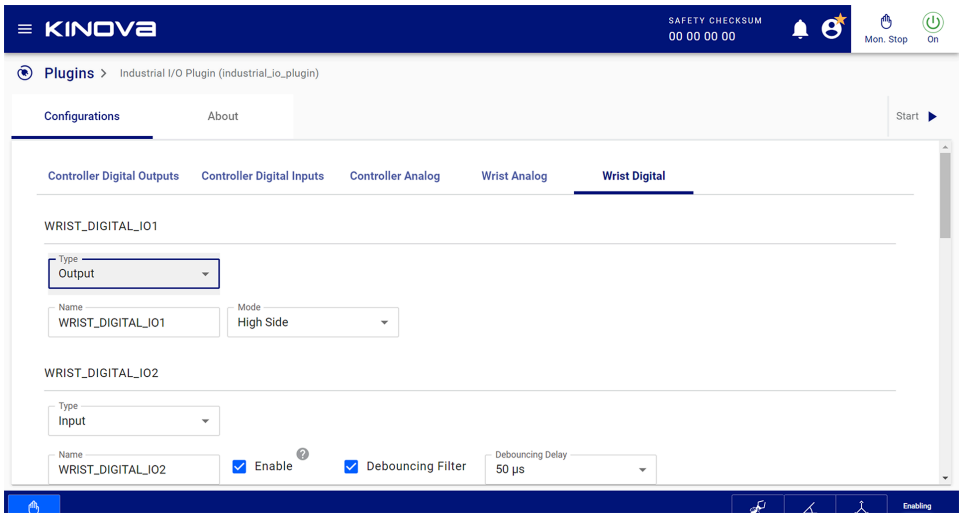


Figure 261: Wrist Digital pane when the pin is set an output

Each one of **WRIST_DIGITAL_IO1** to **WRIST_DIGITAL_IO8** corresponds to each of the eight pins on the M8 connector on the wrist.

Table 114: Wrist digital configurations

Parameter	Description
Type	Select either **Input** or **Output**.
Name	Enter a meaningful name for that specific analog input or output for the controller. The name is visible in the visual programming interface.
Parameters specific to **Input** pins	
Enable	Select when you want to enable the input.
Debouncing Filter	Select to apply *debouncing* delay to the input delay.
Debouncing Delay	Configure the debouncing delay in microseconds. Valid values are 50 µs, 100 µs, 400 µs, 800 µs, 1600 µs, 3200 µs, 12800 µs, and 20000 µs.
Parameters specific to **Output** pins	
Mode	Select one of two modes. • **High Side** • **Push Pull**

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The digital outputs on the wrist support the conventional push-pull configuration. A *push* is a source current. A *pull* is a sink current. The *high-side* configuration is designed in accordance with IEC 61131-2 TYPE 0,5.

Related topics

Industrial I/O: Set Output tile parameters on page 331

Wrist I/O

USB device access from plugins

Plugins can access USB devices, such as a *USB storage device* or camera, that are connected to the controller.

A *USB* can be inserted and left in the controller so that plugins can access the device while the plugin is running.

Important: When a USB device is connected to the controller while the plugin is already running, the plugin must be restarted so that it can access the USB device.

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Accessories

Accessories can enhance the Link 6 experience, either by keeping the work environment aesthetically pleasing or by increasing the functional capabilities of the robot.

Accessories range from mounts to adapters to vision systems that simplify complex tasks.

In addition to the accessories available from Kinova, there is a growing number of accessories that Link 6 can support.

Table 115: Partner accessories that are compatible with Link 6

Accessory	Plugin	Plugin version
OnRobot RG2 Gripper	OnRobot Plugin	2.0.1
Kinova Robotiq adapter	n/a	n/a
Robotiq 2F-85 Gripper	Robotiq Plugin	1.3.1
Robotiq 2F-140 Gripper	Robotiq Plugin	1.3.1
Robotiq Hand-E Gripper	Robotiq Plugin	1.3.1
Vision module	Vision Plugin	1.2.0

Related topics
Link 6 overview on page 3

Wall mount kit

Install the *controller* on a vertical structure, such as on a wall or in a well-ventilated cabinet by using the Kinova Wall mount kit.

For ease of installation, always install the controller to the Wall mount kit first and then install the assembly to the vertical surface. The Wall mount kit has pocket holes to facilitate installation. The space behind the Wall mount kit can be used to route cables.

Fix the Wall mount kit with the arrow facing up. Attach the controller to the Wall mount kit such that the Industrial I/O panel opens towards the ground; the panel facing the ground is optimal for cable, ingress, and thermal management.

The Wall mount kit is 36 mm away from the wall. Its size and its distance between mounting holes are shown in the figure.

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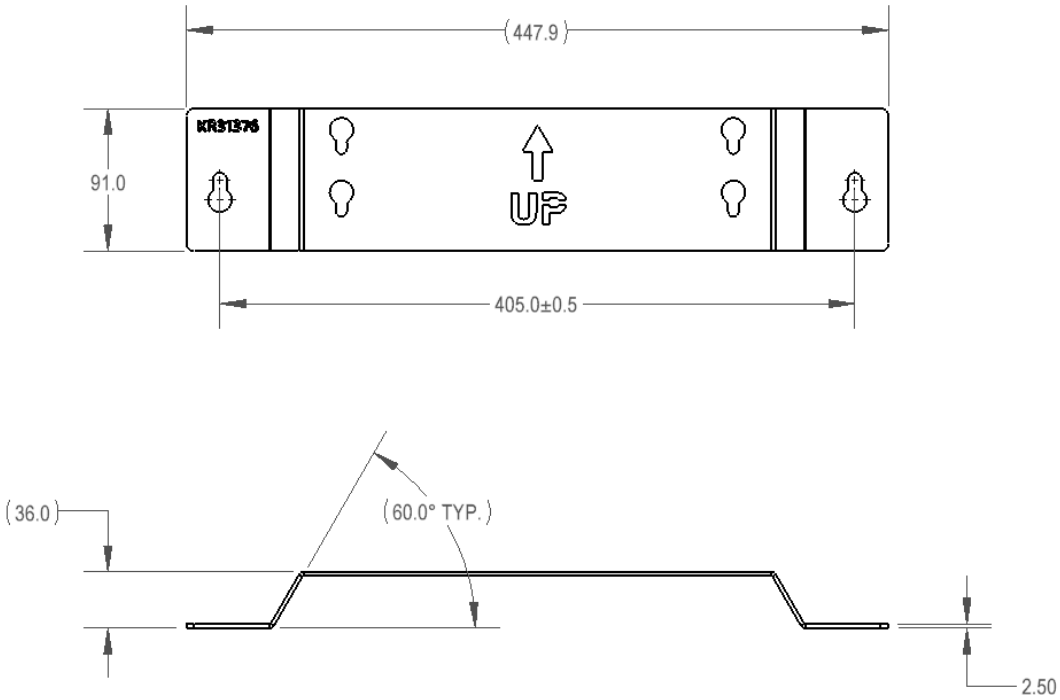


Figure 262: Dimensions of the Kinova Wall mount kit measured in millimeters



Figure 263: Controller with Kinova Wall mount kit

Related topics

Installing the controller directly on a wall

Installing the controller vertically on page 144

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External emergency stop station

The *E-stop* station is an optional component that provides *E-stop* functions in case the *teach pendant* is not used or additional *E-stop* locations are required. It is connected directly to the terminals in the *controller I/O*.

Photo: Rockwell Automation



Figure 264: Rockwell Automation 800F-1YMQ3

Related topics

Safety I/Os on page 95

Installing an external emergency stop station

Whenever you need to install an external *E-stop* station, be sure to read and follow all mounting instructions from the manufacturer.

Before you begin

Personnel:

- **Number of Workers:** 1

Supplies

- 1 x Emergency stop station
- 1 x Cable with a minimum of 4 wires
- Ferrule (optional)

Tools

- screw driver
- crimping tool

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About this task

View or download publications at rok.auto/literature .

Procedure

1. Make sure the *controller* is switched off.
2. Connect the *E-stop* to the controller. Use the wire order on the E-stop connector.

Terminal (Controller side)	Wire color	Pin (Device side)
A1	Black	2
A2	Red	1
B1	White	4
B2	Yellow	3

3. Connect the 4-pin connector to the Emergency stop station.

Related topics

Safety I/Os on page 95

External 3-position enabling device

The external 3-position *enabling device* is an optional component that provides enabling device functions in case the *teach pendant* is not used.

The 3-position enabling device is connected directly to the terminals in the *I/O* panel of the controller.

Photo: IDEC



Figure 265: IDEC HE1G-21SM

Related topics

Safety I/Os on page 95

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Installing the external 3-position enabling device

Whenever you need to install an external 3-position *enabling device*, be sure to read and follow all mounting instructions from the manufacturer.

Before you begin

Personnel:

- **Number of Workers:** 1

Supplies

- 1 x 3-position enabling device
- 1 x Cable with a minimum of 4 wires
- Ferrule (optional)

Tools

- screw driver
- crimping tool

About this task

View or download publications at www.ca.idec.com.

Procedure

1. Make sure the *controller* is switched off.
2. Follow the wiring instructions in Industrial I/O Safety I/O inputs.
   Wiring for use of Channel 0

Terminal (Controller side)	Wire color	Pin (Device side)
AI_x*	Black	2
24_o (Bank A)	Red	1
BI_x*	White	4
24_o (Bank B)	Yellow	3

   * where x is channel 0 to channel 7
3. Set the safety input channel to **Enabling Device**.

Related topics

Safety I/Os on page 95

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Maintenance

Preventive maintenance of Link 6 averts major issues that can arise, and keeps the robot and users safe.

There are three main things to do to give the robot a long and productive life.

- Clean the robot.
- Perform a visual inspection of the robot.
- Service the robot according to schedule.

To perform basic maintenance, always have a good supply of consumables.

Maintenance is made of preventive measures and maintaining fasteners.

Consumables

It is possible to reorder some of the parts of the Link 6.

Table 116: Consumable parts list

Part	Manufacturer	Part number	Order number	Quantity on hand	Note
Plastic dust protection cap - M23	Phoenix Contact	RC-Z2469	1611797	1	
Sealed cap for wrist Pogo pins	Kinova	KR21537		1	
Controller cable entry plate	Icotek	KEL-DPZ 24|25	50710	0	Replace if needed.
Controller cable entry plate plug kit	Icotek	ST-B	42801	0	Seal the controller after removing the cables.
Fuse 3AB/AG, Fast-Acting, 15 A	Generic			2	North America only
Fuse 5 mm x 20 mm, Fast-Acting, 15 A	Generic			2	EU only
Fan filter	Rübsamen & Herr	AM 115P		5	Quantity may vary, based on working environment.

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Preventive maintenance

Always perform preventive maintenance within the scheduled maintenance time frame whenever possible to avoid downtime of the robot. Preventive maintenance is made up of actions performed daily, weekly, quarterly, and yearly.

Different parts of Link 6 require maintenance checks on a daily, weekly, quarterly, or yearly schedule. Some preventive maintenance does not adhere to a specific schedule.

Note: Maintenance is performed by an administrator.

Daily maintenance

Always perform daily tasks daily before operating the robot to avoid downtime of the robot.

Table 117: Daily checks for preventive maintenance

Validation task	Corrective action
Check the cabling.	n/a
Check the emergency stop functions as expected.	Contact support at support@kinova.ca
Check all states of the 3-position enabling device function as expected if it is expected to be used.	Contact support at support@kinova.ca
Check all terminal connections are secured.	Redo connections.
Check the cables are in good condition with no rips, tears, or frays.	Contact support at support@kinova.ca
Check the robot joint caps are installed properly on the robot with no visible gaps and secure.	Contact support at support@kinova.ca
Check the tools and accessories are attached correctly and are not loose.	Secure the tools and accessories.
Check the joints are not loose.	Contact support at support@kinova.ca
Check the bolts on the base are tightened according to the specifications and the base does not move when the robot moves.	Secure the base of the arm.
Check the casing of the controller is closed, with no openings along the edges or elsewhere.	Contact support at support@kinova.ca
Check the Industrial I/O panel on the controller is closed.	Close the panels on the controller.

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Validation task	Corrective action
Check the end caps are on all electrical connectors that are not in use.	Place end caps on all exposed electrical connectors.
Check the environment is the same as usual, with no additional objects in the area.	Remove objects that normally are not in the environment.
Check the checksum has not changed since the last safety configuration.	Verify all safety configurations are correct and mark down the new checksum.

Weekly maintenance

Always perform weekly tasks weekly to avoid downtime of the robot.

Table 118: Weekly checks for preventive maintenance

Validation task	Corrective action
Check that the air filter in the controller is clean.	Replace the air filter.

Quarterly maintenance

Always perform quarterly tasks every three months to avoid downtime of the robot.

Table 119: Quarterly checks for preventive maintenance

Validation task	Corrective action
Check the main power is secured to the controller.	Reattach the latch.
Check all connected safety inputs and outputs are secured and functioning.	Contact support at support@kinova.ca
Check the cable and connector of the Teach pendant are in good shape.	Contact support at support@kinova.ca
Torque check the base fastener.	Retorque.
Torque check the wrist fastener and end effector tooling.	Retorque.
Make sure the actuator covers are not loose.	Retorque.
Check that the fan in the controller is rotating freely.	Contact support at support@kinova.ca

Yearly maintenance

Always perform yearly tasks every year to avoid downtime of the robot.

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Table 120: Yearly checks for preventive maintenance

Validation task	Corrective action
Check Protective earth grounding resistance is less than 0.1 Ω to the controller.	Replace the cable.
Check Protective earth grounding resistance is less than 0.1 Ω to the arm.	Replace the cable.

Unscheduled maintenance

Even by following a maintenance schedule, unexpected maintenance could be required.

Some of the unscheduled maintenance tasks are also scheduled maintenance tasks under certain circumstances. For instance, when there is a sudden power outage or when an accident happens with the robot, it is recommended to perform a visual inspection of the robot.

Table 121: Unscheduled maintenance tasks

Validation task	Corrective action
Cables are in good condition with no rips, tears, or frays.	Contact support at support@kinova.ca
Joint caps are on the robot. Also, make sure there are no visible gaps and that they are secured in place.	Contact support at support@kinova.ca
Tools and accessories are attached correctly and are not loose.	Secure the tools and accessories.
Joints are not loose.	Contact support at support@kinova.ca
Base is fixed correctly. In other words, the bolts on the base are tightened according to the specifications and the base dose not move when the robot moves.	Secure the base of the arm.
Casing of the controller is closed, with no openings along the edges or elsewhere.	Contact support at support@kinova.ca
Panel on the controller is closed.	Close the panels on the controller.
End caps are on all electrical connectors that are not in use.	Place end caps on all exposed electrical connectors.
Environment is the same as usual, with no additional objects in the area.	Remove objects that normally are not in the environment.

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Validation task	Corrective action
Fuse is functioning.	Replace the fuse.

Fastener maintenance

To keep Link 6 safe, the fasteners require regular maintenance.

Table 122: Fastener locations and maintenance

Robot part	Location	Quantity	Fastener type	Recommended torque	Maximum thread engagement
Base	Base to table	4	M8×1.25	20 N·m	
	Protective earth screw	1	M5×0.8		
Arm	Actuator covers - Size 80	3	M4×0.7 - 8	0.5 N·m	
	Actuator covers - Size 110	4	M4x0.7 - 8	0.5 N·m	
Wrist	End effector tooling	4	M6×1.0	7-9 N·m	6.0 mm
	Bracket for GigE adapter (2x side)	2	M4×0.7		5.0 mm
Controller	Cable pass-through plate	4	M5×0.8		
	Protective earth stud	1	M5×0.8		
	Optional Wall mount kit fasteners to controller	4	M6×1.0	10 N·m	
	Optional wall mount kit fasteners to wall	4	M8×1.25	14 N·m	
Teach pendant	Mounting bracket fasteners to wall	4			

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Servicing

Some routine maintenance and repair work must be performed by a Kinova expert.

Not servicing Link 6 in a timely manner voids the Kinova warranty.

Contact Kinova support to learn how to have the robot serviced.

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Disposal

The product contains parts that are deemed to be hazardous waste at the end of the life of the product.

After Link 6 has reached its life expectancy, you have two options.

- Continue using the device.
- Replace the robot and dispose of the old device appropriately.

If you wish to continue using Link 6 after its expected lifespan, Kinova highly recommends that you return the device temporarily to Kinova for routine servicing that includes inspection of the robot, as well as replacement and repair of any internal components that may be worn out.



If you wish to dispose of the robot, note that the robot contains materials that can be recycled. However, some of the materials are deemed hazardous. Specialized companies can dismantle the unit and sort out these materials. When you dispose of the unit, inform yourself about local regulations concerning waste management.

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Troubleshooting

Knowing how to correct and recover from robotic issues is important to keeping the Link 6 working.

When Link 6 encounters a problem, it usually triggers a fault. When a fault is triggered, the information on the **Status** page should be enough to come to a diagnostic. There may be cases in which some users view certain behaviors as undesirable; however, from the point of view of the robot, the supposed undesirable behavior is expected. There is no diagnostic information available for expected behavior.

There are many examples of expected robot behavior that some users may deem undesirable listed. If you believe you have an issue with Link 6, check to see if you can find a similar issue. If you cannot find an issue similar to yours, please write to us at support@kinova.ca.

Issues related to hardware

Examples of hardware-related issues that you may have deal with the controller, the arm, the buttons on the wrist, the tool, and external equipment.

Why does the controller have no power?

Condition

The power button on the controller is switched on, but there is no power in the controller.

Cause

The power cable may not be connected to the controller or to a power source.

Remedy

1. Connect the power cable to the controller.
2. Connect the other end of the power cable to the power source.

Why is the arm not powering on?

Condition

The controller is on, but the arm does not power on.

Cause

The cable attached to the arm of the robot is not connected to the controller.

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Remedy

Connect the arm cable to the controller.

Why is the robot moving in joint Hand Guiding mode by itself?

Condition

The robot is in Joint Hand Guiding mode and it is moving without the application of external forces.

Cause

The masses or centers of mass of the tool or payload is not correct.

Remedy

1. Make sure the mass of the tool entered in Kortex Web App matches that of the tool.
2. Make sure the center of mass of the tool entered in Kortex Web App matches that of the center of mass of the tool.
3. Make sure the mass of the payload entered in Kortex Web App matches that of the payload.
4. Make sure the center of mass of the payload entered in Kortex Web App matches that of the center of mass of the payload.

Why is the snapshot button not working?

Condition #1

When the waypoint capture, or snapshot, button is pressed, the waypoint does not appear in the program that is currently on the **Program** page.

Cause

The current context on the **Program** page is selecting a block that is not a waypoint block.

Remedy

1. Look at the **Sequence editor** to see which block is selected.
2. Select the waypoint capture block that represents where you currently are in the program.
3. Press the waypoint capture button.

Cause #2

The snapshot button is held for too long.

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Remedy for cause #2

Press the snapshot button quickly.

Why is my tool not working?

Condition

The tool connected to the robot is not working.

Cause

The plugin associated with the tool is not installed or is not activated.

Remedy

1. Tap **Systems** > **Plugins** to access the **Plugins** page.
2. Install the plugin associated with the tool if it is not already installed.
3. Activate the plugin associated with the tool.
4. Reset or initialize the plugin associated with the tool if the plugin requires this action.

Related topics
Installing plugins on page 183

Emergency stop

Condition

An emergency stop signal is sent to the robot.

Cause

There are two possible causes.

- The E-stop button on the teach pendant, or elsewhere in the system, is pressed.
- A signal is detected on the input reserved for emergency stops.

Remedy

1. Make sure nothing is interfering with the robot and that it is safe to proceed.
2. Remove the signal.

   Example: Release the E-stop button, such as the one on the teach pendant, by turning the button.
3. Clear the fault from Kortex Web App.
4. Make sure the jumper wire configuration matches the installation.

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Why is the wrist enabling device not enabling Hand Guiding mode?

Condition

The robot cannot be moved by hand. The wrist ring flashes green once each second.

Cause

The enabling device on the wrist is not pressed and held in its center position.

Remedy

Press the Wrist enabling device in the center position until the wrist ring illuminates a steady blue. Continue to hold the button in the center position while you move the arm.

Why is the controller hot?

Condition

The *controller* is hot or the diagnostics in *Kortex Web App* indicate the *SCU* or the *MCU* are overheating.

Cause

The temperature of the SCU core or MCU board is too high.

Remedy

1. Check the controller fans are spinning freely.
2. Check that neither the controller fans nor the fan filter are clogged.

Why did my robot collide with the tool installed on its end effector?

Condition

While the robot was moving, it collided with the tool installed on its *end effector*.

Cause

The tool sphere protection zone is not configured to contain the entire tool.

Remedy

1. Switch off the arm.

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2. Navigate to **Safety** > **Protection Zones**.
3. Configure the Tool Sphere protection zone so that it contains the entire volume of your tool.

Why is my tool, connected to the M8 connector, not responding?

Condition

A tool is connected to an M8 connector on the wrist, but the tool is not responding to commands received from a program.

Cause #1

The connection to the M8 connector is incorrect.

Remedy #1

Validate that the correct M8 connector is used and that the connector is not damaged.

Cause #2

The plugin of the tool is not running.

Remedy #2

Validate that the plugin of the tool is installed and running.

Why does the robot repeatedly report errors related tot he M8 Analog I/O channels?

Condition

Sometimes, the robot is in fault and reports a Joint Fault Detected (error code 201), M8 Analog IO Fault Detected (80033), and 8A Analog IO Channel 2 Fault Detected (80035).

Cause

The wrist analog I/O is configured in the **Industrial I/O Plugin** as a current output when a high impedance or nothing is connected to it.

Remedy

Connect a lower impedance load on the I/O or perform a factory reset by tapping **Maintenance** > > **System Upgrade** > **FACTORY RESET**.

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Why does my robot refuse to move in a particular direction?

Condition

While moving the robot in Manual Jog or Hand Guiding mode, the robot refuses to move in a certain direction; however, it does move in other directions.

Cause

One or multiple joints are reaching their position limits.

Remedy

Use Jog Angular mode to move the actuator back to its zero position.

Why is my teach pendant only displaying a console?

Condition

The teach pendant is connected and the controller is switched on, but only a console is displayed on the teach pendant.

Cause

The connector of the teach pendant is inserted incorrectly in the controller, which causes some of the pins to be misaligned.

Remedy

Disconnect and reconnect the teach pendant properly.

Why are my digital outputs not operating at 24 V?

Condition

Multiple elements are connected to consecutive digital outputs. Applying an output signal does not yield 24V.

Cause

The load on a terminal block, composed of 4 I/Os, is too high.

Remedy

Distribute the electrical load over more terminal blocks.

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Issues related to safety elements

Examples of safety-related issues that you may have deal with the safety configurations and safety I/O connections.

Why can I not edit any safety configurations?

Condition

None of the parameters on any of the **Safety** pages are modifiable.

Note: This condition only happens when the user is an *operator* and is not an *admin user*.

Cause

The user is an operator. Only admin users can modify safety configurations.

Remedy

1. Tap > **ELEVATE PERMISSIONS** and enter the admin password.
2. Contact an admin user to discuss which safeties may need to be modified.

Why is the external safety device not working?

Condition

The external device attached to the robot is not working. The robot is in a *stop category (SC)* 0, where there is no electrical power in the robot.

Cause

The device is not configured correctly on the safety I/O channel.

Remedy

Make sure the safety I/O channel associated with the external device is configured correctly.

Select the correct safety type from the safety type drop-down on the **Safety I/Os** page in *Kortex Web App* for the channel where the device is connected.

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Why is the robot stuck in Reduced mode?

Condition

The robot is moving at Reduced speed. All **Safety** pages indicate the robot should be moving at Normal speeds.

Cause

The robot is receiving a signal to operate at Reduced speed.

Remedy

Make sure no safety I/O channel is sending a signal to the robot to operate at Reduced speed.

Why is there a fault for exceeding speed limits when I am operating in Hand Guiding mode?

Condition

When operating in joint Hand Guiding mode, the robot triggers a fault for exceeding speed limits.

Cause

When the arm is driven in joint Hand Guiding mode near the outer edge of its workspace, small angular velocities can yield large *Cartesian* velocities on the *TCP* and trigger speed limit faults.

Remedy

Move the *TCP* closer to the arm when you move the first two joints of the robot in Hand Guiding mode.

Issues related to modes of operation

Examples of issues with modes of operation that you may have include modes being disabled and modes that seem stuck.

Why is Manual mode disabled?

Condition

The arrows of the virtual joystick of Jog Angular and Jog Cartesian in *Kortex Web App* are grayed out.

The *enabling device* in Kortex Web App illuminates white.

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Cause

The enabling device is not held in its center position.

Remedy

1. Make sure you are not pressing the enabling device all the way to the bottom.
2. Make sure you are pressing the enabling device in its middle position.

Why can the robot not exit Recovery mode?

Condition

The robot cannot exit Recovery mode. The wrist ring flashes yellow two times each second.

Remember: As long as the robot is in Recovery mode, all safety position-related limits are ignored and all joint speed safety limits are limited to a maximum speed of 30 °/s.

Cause

There are two situations where the robot remains in recovery mode.

- The initial cause of the fault is still in effect.
- After clearing the initial fault, another fault is triggered in the current configuration of the robot.

Remedy

- Make sure the robot is far from its position limits.
- Make sure the robot is outside of the enabled protection zones.

  1. Make sure the speed limit of each of the joints is set to 30 °/s.
  2. Tap **Safety** > **Protection Zones**.
  3. Move the robot to a safe position using either Hand Guiding or Manual Jog mode.
  4. Visualize the current pose of the robot relative to the protection zones.

Related topics

Protection zones on page 84

Recovery mode on page 128

State: Fault on page 119

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Why is my robot not moving even if it is in an operating mode where it should be possible?

Condition

When operating in Automatic, Hold to Run, or Manual mode, the robot does not perform any *Cartesian* command. A notification is displayed on the teach pendant, but the robot does not enter a fault state.

Cause

The robot is near a singularity.

Remedy

Use any angular control mode to move the robot away from the singularity.

Issues related to plugins

Examples of issues you may have with plugins deal with plugin installation, configuration, and activation.

Why can I not configure Industrial I/Os?

Condition

The fields on the **Configurations** page of the **Industrial I/O Plugin** page are not selectable.

Cause

The Industrial I/Os need to be switched on before they can be configured.

Remedy

Make sure the Industrial I/Os are receiving power.

Related topics

Industrial I/O Plugin on page 380

Industrial I/O panel overview on page 37

Issues related to programs and programming

Examples of issues related to programs and programming deal with variables, action blocks, and programs.

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Why can I not select a variable in the Select Variable page?

Condition

A variable in the **Select Variable** page is grayed out and cannot be selected.

Cause

The format of the desired variable does not match the format expected by the field.

Remedy

Make sure the variable you are trying to select has the same type, schema, and unit as the field you are trying to fill.

Why are tiles missing in the visual programming interface?

Condition

The tiles cannot be found anywhere under the **Actions** menu on the **Program** page.

Cause of the trigger #1

The plugin associated with the missing tiles is not installed or is not activated.

Remedy for trigger #1

1. Tap **Systems** > **Plugins** to see if the plugin associated with the missing actions is installed.

Situation	Action to take
Plugin is not installed	Install the plugin.

2. Tap the plugin to access its **Configurations** page.

Situation	Action to take
Run ▶ is displayed	Plugin is not active. Tap **Run** to activate the plugin.
Stop ■ is displayed	Plugin is active.

3. Return to the **Program** page of the program where the issue occurred.

   The plugin is displayed on the page with all its available actions.

Cause of the trigger #2

A fault occurs in the arm.

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Remedy for trigger #2

1. Restart the program.
2. Refresh the page.

Related topics
Installing plugins on page 183

Why can I not find a program in the list of programs?

Condition

A specific program is not found on the **Programs** page in Kortex Web App.

Note: This condition only happens when the user is an *operator* and is not an *admin user*.

Cause

The user is an operator and the admin user has not validated the program.

Remedy

The admin user must validate the program. After it is validated, the program appears in the list of programs for all users, including operators.

Why do some of the tiles of an imported program show a question mark?

Condition

A program is imported. One or more tiles on the **Program** page displays a question mark.

Cause

The imported program contains tiles from plugins that currently are not installed or activated on the controller.

1. Export the program.
2. Remove the program from Kortex Web App.
3. Install the missing plugins.
4. Activate the plugins.
5. Re-import the program.

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Why are the Industrial I/O tiles not loading?

Condition

When trying to run a program that uses tiles from the Industrial I/O plugin, the Industrial I/O tile configuration does not load properly.

Cause

There is a bug that happens occasionally when the Industrial I/Os on the controller are connected to power when controller is already switched on.

Remedy

Force the Industrial I/O plugin to reinitialize by dragging any Industrial I/O tile anywhere in the program. Optionally, delete the tile and after the plugin re-initializes, add it back to the program.

Why is my program running, but not making progress?

Condition

A running program does not make any progress, but it is not interrupted and there are no faults being triggered.

Cause

A `Wait` or `Wait for Input` tile is not configured correctly.

Remedy

Validate the configuration of the `Wait` or `Wait for Input` tile. Their duration parameters are in seconds.

Why is my robot extremely slow?

Condition

A program is running a waypoint trajectory at an abnormally low speed.

Cause #1

The safety limits of the robot are configured to enforce low velocities.

Remedy #1

Switch off the arm and increase the velocity limits provided the risk assessment is not impacted by the change.

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Cause #2

Constraints applied to the waypoint are forcing the robot to operate at lower speeds to make the trajectory feasible.

Remedy #2

1. Validate that the local speed and acceleration limits of each waypoint are correct.
2. Validate that the global waypoint trajectory speed and acceleration limits are correct.

Cause #3

When blending during the trajectory requires accelerations that are too fast, speed is automatically reduced so that it is feasible to travel the trajectory.

Remedy #3

Perform one or more of the actions to fix the situation.

- Increase the acceleration limits.
- Increase the size of the blending radius.
- Activate the **Optimal blending** solution for the tile.

Issues related to Kortex Web App

Examples of issues related to *Kortex Web App* include such things as software and configuring problems.

Why is the robot not going to the programmed position?

Condition

The robot is programmed to go to specific locations. The robot is not moving to the expected locations.

Cause of the trigger #1

The tool is not configured correctly.

Remedy for trigger #1

1. Tap **Systems** > **Tools** to access the **Tools** page.
2. Make sure the tool is added in the correct stacking position.
3. Make sure all configurable parameters of the tool have the correct values.

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Cause of the trigger #2

The robot is not calibrated.

Remedy for trigger #2

1. Tap **Systems** > **Robot** > **Arm**.
2. Expand the **Calibration** pane.
3. Verify that the calibration status is **Not Calibrated**.
4. Tap **Import** in the **Import calibration file** panel to upload the calibration file to the robot.

   Important: Contact support@kinova.ca if the administrator does not have a backup of the calibration file.
5. Verify that the calibration status is **Calibrated**

Related topics

Adding tools on page 194

Configuring tools on page 191

Configurations of the arm for robot controls on page 199

Why is the remote computer not connecting to Kortex Web App?

Condition

The controller is on, but *Kortex Web App* is not displayed on the remote computer.

Cause #1

The Ethernet cable is not connected to the remote computer or the controller.

Remedy #1

Make sure one end of the Ethernet cable is connected to the controller and that the other end is connected to the remote computer.

Cause #2

The netmask of the Ethernet interface on the remote computer does not match the IP address of the controller.

Remedy #2

Make sure the netmask of your Ethernet interface is appropriate for the range of the two or more devices that are communicating with the robot. The default IP address of the controller is `192.168.1.10`.

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Cause #3

A user is logged on with the teach pendant.

Remedy #3

Make the user who is using the teach pendant log out.

Why is Kortex Web App not responding on my remote computer?

Condition

Kortex Web App is running on a remote computer, but there is no response from interacting with the application. The application behaves as if it were frozen.

Cause

The remote computer has memory performance issues.

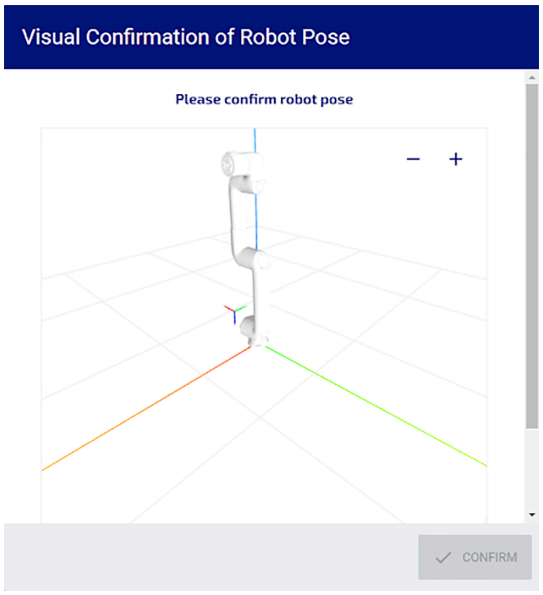
Remedy

Refresh the browser.

Why is there a pop-up requesting visual confirmation of the robot pose after the robot reboots?

Condition

A pop up appears after boot. It requests confirmation of pose of the robot.



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Cause

After the robot is transported or when the robot is *backdriven* while it is switched off, a mismatch occurs between the last known position in memory and the current position.

Remedy

If the position of robot matches the visual representation, tap **CONFIRM**.

If the position of robot does not match the visual representation, do not confirm a mismatched pose. Contact support at support@kinova.ca for investigation.

Related topics

Move the arm without power on page 61

Why do the +/- buttons on the wrist not work with my tool?

Condition

A plugin that is supposed to support controlling a tool with the end effector action (+/-) button on the wrist is running, but pressing the end effector action (+/-) button does not operate the tool.

Cause

The tool is not configured as active in the **Tools** page.

Remedy

1. Navigate to **Systems** > **Tools**.
2. Drag the desired tool from the **Inactive (drag & drop)** list to the top of the **Active** tool list.

Note: The tool must be listed in the **Inactive (drag & drop)** pane in the same order as it is installed on the wrist.

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Glossary

A

AC

type of electrical current

alternating current (AC)

actuator

a device that is responsible for arm motion

ACM

Auxiliary Control Module (ACM)

administrator

a person who configures and uses the robot

synonym: admin user, admin

angular

refers to the rotational capabilities of a joint

arm

the part of the robot from the base to the wrist and that moves

API

a software interface between the Kortex software and your own software

Application Programming Interface (API)

asynchronous

two or more operations not happening at the same time

AWG

a standardized wire gauge system; unit of measurement

American Wire Gauge (AWG)

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B

backdrive

to move the robot manually without using electrical power

base

the bottom-most part of the arm that is placed on a surface for installation; support section of the arm

BCD

a way to represent each decimal digit in its binary equivalent using no more than 4 binary digits

Binary Coded Decimal (BCD)

bending radius

the radius of the inner-most curvature when bending an object, such as a cable; an object with a smaller radius have higher flexibility to bend before potentially becoming damaged

blocking

the inability for a robotic program to proceed to its next step until the current, blocking, action is finished

boot

to switch on, or start

C

camlock

a type of fastener

Cartesian

linear movement along the x, y, and z coordinate lines

checkpoint

Cartesian coordinate (X,Y,Z) used to determine self-collision and protection zone violations

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collaborative

the ability for an integrated robot to work in a shared space, or in close proximity of people and other equipment, based on its integration

controller

the part of the robot from where the software operates

CPU

the portion of the computer that retrieves and performs instructions

central processing unit (CPU)

CRC

code that detects errors in changes to data

cyclic redundancy check (CRC)

cUL

tested to Canadian standards by Underwriters' Laboratories

D

DC

type of electrical current

direct current (DC)

debounce

the act of ensuring one and only one signal is used when opening or closing a contact in an electronic device

DIN

a German standardization organization that is part of the ISO standards body

Deutsches Institut für Normung (DIN)

synonym: German Institute for Standardization

distant device

device that drives the signal; the device can be a computer, a PLC, a switch, and so on.

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device used to alert the user to check the connections on the controller are fine

DoF

the number of variable directions needed to define the configuration of a robot, particularly for all the directions in which the motion can occur

degrees of freedom (*DoF*)

E

EFT

a series of quick, high frequency pulses often caused by electricity flowing through the circuitry

Electrical Fast Transient (EFT)

synonym: fast transient, burst, *EFT/B*

EFT/B

see *EFT*

elbow

the location of the 3rd actuator in the robot arm

EMI

unwanted electromagnetic interference generated by an external source

electromagnetic interference (EMI)

enabling device

a device used to send a signal to the robot that the user is going to move the robot either in Manual Jog mode or Hand Guiding mode.

synonym: pendant enabling device, wrist enabling device

end effector

device specifically designed for attachment to the flange of the wrist

ESD

the sudden flow of electricity between two objects that have different charges

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electrostatic discharge (ESD)

E-stop

manually actuated control device used to initiate an emergency stop function

emergency stop (E-stop)

event

an action that happens, and is recognized by the software or firmware

F

FCCU

Fault Collection and Control Unit (FCCU)

FDMI

Flat Display Mounting Interface™™ (FDMI)

firmware

in computers, it is low-level software that is programmed into read-only memory and is used directly by hardware

flange

a mechanical interface used for attaching another object

G

gravity vector

gravitational acceleration with direction and strength; measured in m/s^2 in each Cartesian direction (X, Y, Z)

GPU

originally created to enhance graphic rendering, it also has proven itself useful in many other applications, such as artificial intelligence

graphics processing unit (GPU)

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GUI

a way of interacting with a program of a computer that involves windows, dialogs, icons, and menus

Graphical User Interface (GUI)

synonym: *HMI*

H

hamburger menu

three vertical lines that, when tapped or clicked, expose a menu of actions or tasks from which the user can choose; usually used for main menus



hamburger, menu

main menu on page 424

hazard identification

the act of identifying all hazards that may cause harm

high side

refers to circuitry designed to switch the voltage supply

HMI

a way of interacting with a machine with such items as push buttons connected to a relay or a menu on a touch screen

human machine interface (HMI)

I

IEC

an organization that creates international standards for electrotechnology

International Electrotechnical Commission (IEC)

industrial I/O panel

a panel on the *controller* where the *integrator* connects external devices

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integrator

a person who incorporates the robot in a larger system or environment

I/O

refers to the information that is passed into or out of a computer

input/output (I/O)

IOM

Input/Output Modules (IOM)

ACM on page 417

J

joint

section of the manipulator system that allows one rotational degree of freedom

joint position

the rotational position of a joint, measured in °

joint speed

the velocity at which the joint rotates, measured in °/s

K

kebab menu

three vertical dots that, when tapped, expose a menu of actions or tasks from which the user can choose; usually used for contextual menus

synonym: contextual menu, menu options, options, menu

KIN

Kinova inventory number

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Kortex Web App

the *GUI* that runs on a web server on the *controller* and is accessed on the *teach pendant* or on an external computer

synonym: Web App

L

Link 6

a teach pendant, controller, arm, software, and firmware; when describing its functionality, it may include the third-party end effector as a part of it

synonym: *robot*

LOTO

safety procedure where power is removed from the machinery, one or more locks is placed on the power supplies, and a tag is added to the lock with the name or initials of the worker who locked out the machinery

Lockout Tagout (LOTO)

LSB

the right-most bit in a binary number

Least Significant Bit (LSB)

M

main menu

a menu, or list, of operations that can be performed; most often accessed in the banner of an software or from a *hamburger menu*

MAC

unique identifier that identifies a device on a network

Media Access Control (MAC)

MCU

a device used in the actuators to read sensors and report sensor information

Microcontroller Unit (MCU)

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microcontroller

in computers, a miniature computer integrated on a computer chip; often has firmware installed on it

MIS-D

a standard used for attaching devices with displays to mounts

field of view (MIS-D)

Modbus/TCP

communications protocol that uses a *TCP/IP* protocol over an Ethernet

Modbus *RTU*

communications serial protocol that uses an *RTU* protocol over an Ethernet

Modbus RTU (Modbus)

mode

a way of operating or using a system

Monitored stop

the robot is not moving, has power, and is actively monitoring that it is not doing anything

MPU

a device in the controller that manages external communication and inverse kinematics, sends commands to each actuator, and collects information from all other devices

Main Processing Unit (MPU)

N

namespace

a way in computer science of grouping together all objects that work together such that each object has a unique name

NC

electricity flows through a contact in its normal state

Normally Closed (NC)

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negative logic

the meanings of binary signal levels are interchanged such that high voltage is 0 and low voltage is 1; sourcing inputs and sinking outputs

synonym: NPN

non-blocking

the ability for a robotic program to proceed to its next step even when the current action is not finished

non-collaborative

the inability for the robot to work in a shared space, or in close proximity of people and other equipment; the need for the robot to be in an enclosed, self-contained area to operate safely

O

operator

a person who uses, but who does not configure, the robot

OSSD

a device that outputs a signal to shut down the machine; used as part of a safety system of a machine

Output Signal Switching Device (OSSD)

P

payload

the load the robot carries, excluding the tool attached to the flange

PCB

a structure that is made up of conductive and insulating layers

printed circuit board (PCB)

PE

a system that connects a power supply with the ground

protective earth (PE)

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synonym: ground

pendant

a device used to configure and control the movements of a robot

synonym: *teach pendant*

pendant enabling device

enabling device located on a teach pendant, usually as a button

enabling device on page 420

synonym: *enabling device*, *teach pendant enabling device*

physical equipment

equipment that connects to the *controller* through the Industrial I/O panel

pinch point

an area in which a body part can get in between a stationary part and a moving part of the machinery

PL d

Performance Level D

Performance Level d (PL d)

position

the definition of the location of an object location in 3D space, usually defined by a 3D *coordinate system* using X, Y, and Z coordinates

PLC

an industrial computer used in controlling manufacturing processes

programmable logic controller (PLC)

plugin

software that is added to an pre-existing base software so as to give the application additional capabilities

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positive logic

the meanings of binary signal levels are interchanged such that high voltage is 1 and low voltage is 0; sourcing outputs and sinking inputs

synonym: PNP

program sequence

an ordered list of actions that a program must perform to complete its task; the sequence can be started, paused, resumed, and stopped

synonym: program

protection zone

an area where the robot cannot enter

also known as *Safety zone*

protective stop

a stop in which the robot stops, but there still is power in the robot

synonym: SF02

pull

a sink current

push

a source current

R

RAM

the memory of the computer that stores data for the *CPU* to use

random access memory (RAM)

RCD

a safety devices that removes power from an object when there is a fault, protecting against accidental electrocution and fire

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residual current device (RCD)

reboot

to restart the computer

risk analysis

a study of the potential dangers in using something, often equipment

risk control

the plan to avoid or lessen the risk involved

RJ45

a jack with 8 pins

RMS

average of signal over time to minimize high peaks and low troughs in a signal

root mean square (RMS)

robot

teach pendant, controller, arm, software, and firmware; it may also include an end effector

robot cell

a set of one or more machines that work in conjunction with one or more programmable robots

robot system

an entire automated system consisting entirely of robots or automated equipment

role

a type of user with a specified set of tasks that they can do, frequently in the realm of software

RS-485

a standard that defines an electrical and physical interface used for communication between devices

synonym: TIA-485(-A), EIA-485

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RTU

an electronic device controlled by microprocessors that interfaces with other systems and is used to send and receive data

remote terminal unit (RTU)

S

safety mode

one of two speeds that are used when determining the maximum speed at which the robot can operate

Safety zone

see *protection zone*see

sinking

provide the electrical signal with a path to ground

SC2

stop category 2

synonym: *protective stop*

SCU

a processor in the controller that processes all safety functions

Safety Control Unit (SCU)

sourcing

provide the necessary voltage for a circuit

state

describes the overall condition of Link 6

stop category

a type of safety control function that stops arm movement

stop category (SC)

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SWU

a file format, used by Kinova, to package firmware updates

software update package (SWU)

synchronous

two or more operations happening at the same time

T

TCP

the position and orientation of the tool; tool center point

Tool Center Point (TCP)

TCP/IP

set of communication protocols used in computer networks and in the Internet

Transmission Control Protocol/Internet Protocol (TCP/IP)

TCP on page 431

teach pendant

a device used to configure and control the movements of a robot

synonym: pendant

teach pendant enabling device

enabling device located on a teach pendant, usually as a button

enabling device on page 420

synonym: *enabling device*, *pendant enabling device*

TN

an electrical system in which exposed conductive parts are connected directly to the neutral and not directly to earth

transformer neutral system (TN)

synonym: earthed neutral

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transform

the position and orientation of the object with respect to the base of the robot

TT

an electrical system in which one point of the power supply is connected directly to earth, as is any exposed conductive part

earthing electrode system (TT)

synonym: exposed conductive parts neutral

U

UL

Underwriters Laboratories Inc., an organization dedicated to testing and creating standards for electrical products

Underwriters Laboratories (UL)

USB

industry computer bus standard that makes it easier to transfer data between devices

Universal Serial Bus (USB)

USB storage device

a portable storage device that plugs into *USB* ports

USB

also known as thumb drive, flash drive, USB stick

W

wrist

the part found between the robot arm and the robot hand the part found at the end of the robot arm to which end effectors may be attached

wrist enabling device

enabling device located on the wrist of the robot, usually as a button

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enabling device on page 420

synonym: *enabling device*

wrist I/O

the electrical interface located on the *wrist* where external tools are connected

wrist ring

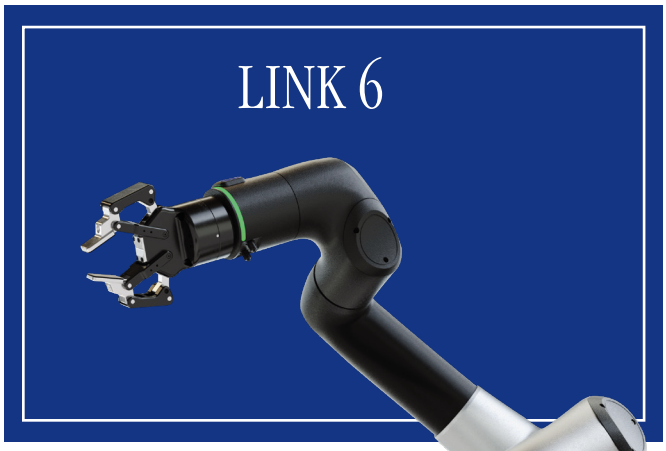
the LED ring found around the wrist

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TOGETHER IN ROBOTICS







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