

KINOVA

TOGETHER IN ROBOTICS



MEET GEN2

Remote robot manipulation system

USER GUIDE

Contents

Copyright notice.....	1
About this document.....	2
Symbols and definitions.....	3
Technical specifications.....	4
Acronyms and abbreviations.....	6
Warranty.....	8
Safety and warnings.....	9
Disclaimer.....	12
What's in the box?.....	13
Overview of the Remote robotic manipulation system.....	14
Overview of the Robot manipulator system.....	17
Robot.....	18
Robot external connectors.....	18
Robot support.....	19
Gripper adapter module.....	21
Camera module overview.....	22
Light sources overview.....	23
Laser overview.....	23
Robotiq gripper.....	23
Video adapter.....	24
Robot to video adapter cable.....	25

Communication system overview.....	26
Communication system modes of operation.....	27
Single Adapter mode.....	27
Paired Adapter mode.....	28
Components.....	29
Xbox One gamepad.....	30
Communication Adapter.....	30
Communications network interfaces.....	34
Default network interface settings.....	35
Command Line Interface Shell (CLI).....	36
Using the Command Line Interface (CLI).....	37
 Setting up the robot manipulator system.....	 53
Mounting the robot support.....	53
Installing the robot on the robot support.....	55
Installing the video adapter.....	56
 Setting up the Communication system.....	 58
Mounting a communication adapter.....	58
Installing the Operator Adapter (OA).....	59
Installing the Remote Adapter (RA).....	60
Establishing a communication link.....	60
 Controlling the gripper and gripper adapter using Xbox gamepad.....	 62
Gripper and gripper adapter control modes.....	62
Camera reference control mode.....	64
Robot base reference control mode.....	65
Go to position control mode.....	66
LED/laser control mode.....	67
 Robot manipulator system configuration.....	 69
Adjusting the laser angle.....	69
Viewing the video adapter output.....	69
Setting up a robot protection zone.....	70
 Communication system configuration.....	 73

Opening a secure shell session between a PC and a communication adapter.....	73
Set a communication adapter to Single Adapter mode.....	77
Pairing a new communication adapter for wired communication.....	78
Configuring Remote Adapter for paired wired communication.....	79
Configuring Operator Adapter for paired wired communication.....	79
Pairing a new communication adapter for Z9-PC radio communication.....	80
Configuring Remote Adapter for paired Z9-PC radio communication.....	80
Configuring Operator Adapter for paired Z9-PC radio communication.....	83
Maintenance of the Robot manipulator system.....	85
Robot manipulator system maintenance and cleaning.....	85
Updating robot firmware.....	85
Maintenance of the Communication system.....	89
Communication system maintenance and cleaning.....	89
Updating communication adapter firmware.....	90
Troubleshooting.....	92
Using the CLI Diagnostic menu.....	92
Communication Adapter status LED indications.....	92
Operator adapter robot status audible warning.....	94
Robotiq gripper status LED.....	95
Markings and labels.....	96
Normal use definition.....	97
Electromagnetic interference from RF sources.....	98
Disposal considerations.....	100
Contacting support.....	101

Copyright notice



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

About this document

This document contains information on the installation and operation of the Kinova® Remote robotic manipulation system.

⚠ Read all instructions before using this product.

⚠ Read all warnings on the product and in this guide.

⚠ Follow all instructions.

This document contains information regarding product setup and operation. It is intended for:

- Kinova product end users
- Field service, customer support and sales employees of authorized Kinova distributors

Symbols and definitions

 Important information regarding product safety

 DC power supply

 Gamepad connector

 Robot connector

 Network connector

 Video out

 Compliance with WEEE2 directive

 Compliance with ROHS3 directive

Technical specifications

The Gen2 Remote robot manipulation system is a system in which a robot can be controlled remotely.

Table 1: Robot Specifications

Specifications	Values
Robot	
Robot reach	98.4 cm
Robot maximum payload (without gripper adapter and gripper)	2.4 kg (mid range continuous)
	2.1 kg (full-reach peak, temporary)
Robot maximum payload (with gripper adapter and gripper)	700 g
Robot total mass (without gripper adapter and gripper)	5.5 kg
Maximum robot linear speed	20 cm/s
Robot joint range (software limitation)	± 27.7 turns
Robot internal communication cables	20-pin flat flex cable
Robot materials	Carbon fiber (links), Aluminum (actuators)
Robot power supply voltage	18 to 29 VDC
Average robot power	25 W (15 W standby)
Peak robot power	100 W
Gripper and Gripper adapter	
Laser frequency and power	Class IIIa, 650 nm, < 3 mW
LED light sources	2 x visible spectrum (9000 °K color temperature) 2 x infrared, 860 nm
Gripper opening	85 mm
Gripper finger speed	20 to 150 mm/s
Gripping force	20 to 235 N

Specifications	Values
Gripper adapter and gripper materials	• Gripper adapter - carbon fiber • Gripper - chassis and fingers - aluminum; finger tips - silicon
Communication adapter	
Communication adapter communication protocols	• Wired - Ethernet • Radio (option)
Communication adapter radio frequencies	902 to 928 MHz
Communication adapter range - radio link	up to 300 m line of sight
Communication adapter range - wired Ethernet	100 m (without repeater)
Communication adapter power requirements	11 VDC to 29 VDC
Indicators	4 RGB LED indicators, 5-color: • blue • green • yellow • red • white
Video adapter	
Video adapter output format	• PAL or NTSC • composite out (RCA) • 4:3 aspect ratio
Environmental limits	
Operating temperature	-10 °C to 40 °C

Acronyms and abbreviations

CLI

Command Line Interface

CLISH

Command Line Interface Shell

DC

Direct current

ESD

Electrostatic Discharge

IR

Infrared

LED

Light-emitting diode

NTSC

National Television System Committee

PAL

Phase Alternating Line

PC

Personal Computer

p/n

part number

qty

quantity

RCA

Radio Corporation of America

RF

Radio-Frequency

ROHS3

Restriction of Hazardous Substances Directive 2015/863/EU

SSH

Secure Shell

USB

Universal Serial Bus

WEEE2

Waste Electrical & Electronic Equipment Directive 2012/19/EU

Warranty

Subject to the terms of this clause, Kinova warrants to End User that the Products are free of defects in materials and workmanship that materially affect their performance for a period of two (2) years from the date Kinova ships the Products to the End User ("Delivery Date").

Kinova agrees to repair or replace (at Kinova's option) all Products which fail to conform to the relevant warranty provided that:

1. notification of the defect is received by Kinova within the warranty period specified above;
2. allegedly defective Products are returned to Kinova, (at the End User's expense, with Kinova's prior authorization) within thirty (30) days of the defect becoming apparent;
3. the Products have not been altered, modified or subject to misuse, incorrect installation, maintenance, neglect, accident or damage caused by excessive current or used with incompatible parts;
4. the End User is not in default under any of its obligations under this Agreement;
5. replacement Products must have the benefit of the applicable warranty for the remainder of the applicable warranty period.

If Kinova diligently repairs or replaces the Products in accordance with this section, it will be deemed to have no further liability for a breach of the relevant warranty.

Allegedly defective Products returned to Kinova in accordance with this contract will, if found by Kinova on examination not to be defective, be returned to the End User. Kinova may charge a fee for examination and testing.

The warranty cannot be assigned or transferred and is to the sole benefit of the End User.

Where the Products have been manufactured and supplied to Kinova by a third party, any warranty granted to Kinova in respect of the Products may be passed on to the End User.

Kinova is entitled in its absolute discretion to refund the price of the defective Products in the event that such price has already been paid.

Safety and warnings

Follow basic safety guidelines when working with Gen2 Remote robot manipulation system to avoid injury to the user or damage of the equipment.

General warnings

⚠ The system is designed to allow trained users to manipulate potentially hazardous materials at a distance using a remotely controlled robot. Do not attempt to use the system for this purpose unless you are properly trained and certified for such work.

⚠ Before manipulating potentially hazardous materials with the robot, ensure that the operator station is at a safe distance from the robot station, and that a proper safety perimeter has been established.

⚠ Remote manipulation of hazardous materials with the robot, while intended to be safe for the human operator, is inherently hazardous to the robot, gripper adapter, gripper, communication adapter, and video adapter and may result in damage to the equipment. The robot, gripper adapter, gripper, and communication adapter are **not** expressly designed to withstand explosive over- pressure and under-pressure, fire and extreme heat, corrosive materials, high-energy ionizing radiation, high voltages, or other sorts of extraordinary mechanical, chemical, electrical, or radiological stresses.

⚠ If the robot is exposed to extreme mechanical, chemical, electrical or radiological stresses, take the exposed parts of the system offline to perform a comprehensive damage assessment. In case of damage to the equipment, contact Kinova for advice and assistance on servicing; do not use the robot again until an assessment of damage and any needed servicing are complete.

⚠ Ensure that proper sterilization and decontamination procedures are undertaken for the system components after suspected, or confirmed exposure to, contamination by chemical, neurological, biological, or radiological agents, with observance of all standard procedures and safety clothing when handling contaminated equipment.

⚠ If components of the system become contaminated and damaged beyond the point of repair, ensure that all required local regulations for hazardous waste disposal are observed, with a certified specialized disposal agent or authority.

Robot warnings

⚠ Do not attempt to lift objects that are clearly above the maximum specified payload of the robot or larger than the gripper opening.

⚠ When lifting weight near the maximum load and reach, if the operator adapter emits a beeping noise and LED number four on the operator adapter displays solid yellow, there is a warning condition on the robot. This indicates the robot is approaching a fault condition. Put down the object in the gripper, bring the robot back to the home-retract position and wait until the warning goes away before continuing to use the robot.

⚠ Shutting down the power to the robot while holding an object in the gripper causes the object to fall. During planned shutdown, put down any objects in the gripper before shutting down the robot.

⚠ It is not recommended to operate the robot under heavy rain or snow.

⚠ When the power is turned off, the robot falls down slowly. This may cause damage to the robot or the gripper, depending on its position at the time of disconnection. It is recommended to support its wrist if possible before turning the power off.

⚠ Do not immerse any part of the robot under **water** or snow.

⚠ Operating the robot without a protection zone in place puts the robot in danger of colliding with objects in the surrounding area.

⚠ For a setup with the robot mounted on a mobile platform, do not move the platform while the robot is in a full reach position. Vibration of the platform, particularly in rough terrain, could cause damage to the robot if the robot is in full reach. Place the robot in a retracted position before moving the platform.

Gripper adapter warnings

⚠ To avoid the possibility of serious damage to eyesight, do not look directly at the gripper adapter laser beam.

Gripper

⚠ Read the documentation from Robotiq for the gripper and observe all recommended safety precautions listed therein.

Video adapter warnings

⚠ Do not open the chassis of the video adapter. The adapter is only to be opened by Kinova trained and certified service professionals.

⚠ Ensure that the ground connector of the video adapter is connected to ground.

Communication System warnings

⚠ Ensure that the ground connector of each communication adapter used is connected to ground.

⚠ Do not open the chassis of the communication adapter. The adapters are only to be opened by Kinova-trained and certified service professionals.

⚠ The USB controller connector on communication adapters is only designed to connect to an Xbox One controller or a USB key. It is not intended for connecting any other type of USB device; doing so may cause damage to the device.

⚠ The system stops when communication is lost between communication adapters.

Disclaimer

Kinova® and Kinova's logo are trademarks of Kinova inc., herein referred to as Kinova. All other brand and product names are trademarks or registered trademarks of their respective owners.

The mention of a product name does not necessarily imply an endorsement by Kinova. This manual is furnished under a lease agreement and may only be copied or used in accordance with the terms of such lease agreement. Except as permitted by the lease agreement, no part of this publication may be reproduced, stored in any retrieval system, or transmitted, in any form or by any means, electronic, mechanical, recording, or otherwise, without prior written consent of Kinova.

The content of this manual is furnished for informational use only and is subject to change without notice. It should not be construed as a commitment by Kinova. Kinova assumes no responsibility or liability for any errors or inaccuracies that may appear in this document.

Changes are periodically made to the information herein and will be incorporated into new editions of this publication. Kinova may make improvements and changes to the products and software programs described in this publication at any time.

Any questions or comments concerning this document, the information it contains or the product it describes may be sent to support@kinova.ca.

Kinova would like to thank you for your contribution, while retaining the right to use or distribute whatever information you supply in any way they believe appropriate (without incurring any obligations to you).

What's in the box?

The Remote Robotic Manipulation System comes in a box with several items.

- Kinova® Gen2 Ultra lightweight robot (p/n KR846) with Gripper adapter module (KR11703-01 or KR11703-02) and Robotiq gripper (p/n 000460)
- 4-pin ROHS power cable (p/n EH 01M8 0003) - qty 1
- robot base adapter (p/n KR11704)
- video adapter (p/n KR11716)
- monitor RCA-RCA video cable (p/n 008177)
- robot to video adapter cable (p/n KR11995)
- communication adapter - qty 1
 - with radio and antenna (p/n KR11708-02) or
 - without radio or antenna (p/n KR11708-01)
- communication adapters - qty 2
 - with radio and antenna (p/n KR11708-02) or
 - without radio or antenna (p/n KR11708-01)
 - DTM300PW240D2 Gen3 power supply (p/n 008080) - qty 1
 - IEC320-C13 18 AWG power cord, 3 Cond PLG-RCPT 6.5' (p/n 006306) - qty 1
 - communication box to power supply harness (p/n KR32569HAR) - qty 1
- Xbox One gamepad and cable (p/n 008054)
- power cable (p/n KR6109) - qty 1
- Ethernet cable (p/n 008052) - qty 2 or 3

Overview of the Remote robotic manipulation system

The Gen2 Remote robot manipulation system is an integrated system designed to support various applications requiring remote manipulation using a robotic arm.

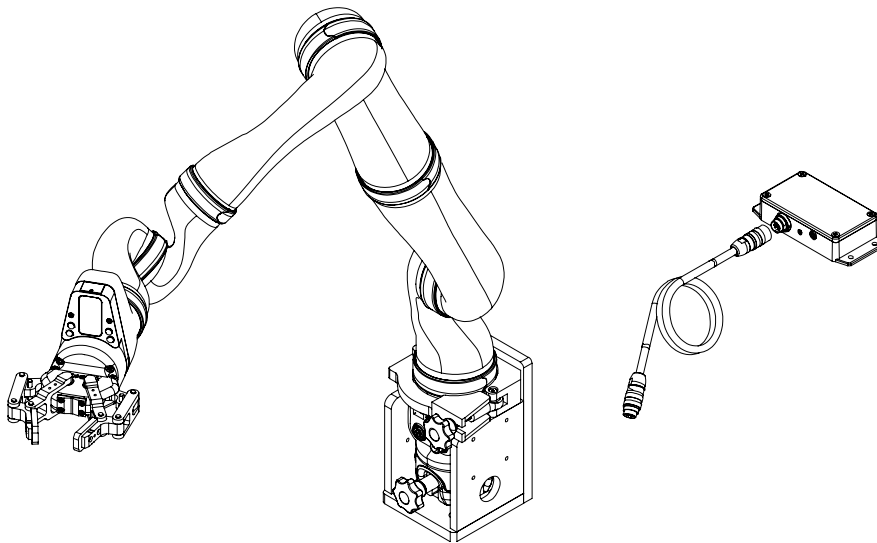
The system allows video-guided remote robotic manipulation of materials, including potentially hazardous materials, in a safe and effective manner.

System components

The Gen2 Remote robot manipulation system is made up of two sub-systems:

- Robot manipulator system
- Communication system

Robot manipulator system



Communication system

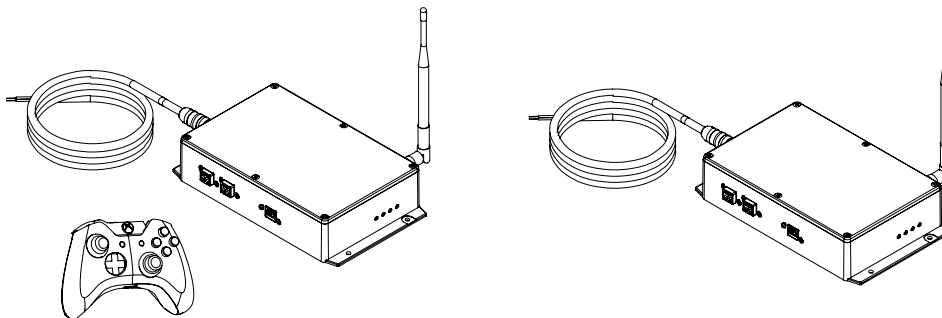


Figure 1: Remote robotic manipulation system components

High-level systems description

The robot manipulator system includes many parts that are integrated with the robot.

- Video camera
- Positioning guidance laser
- Visible and infrared light sources
- Two-finger gripper

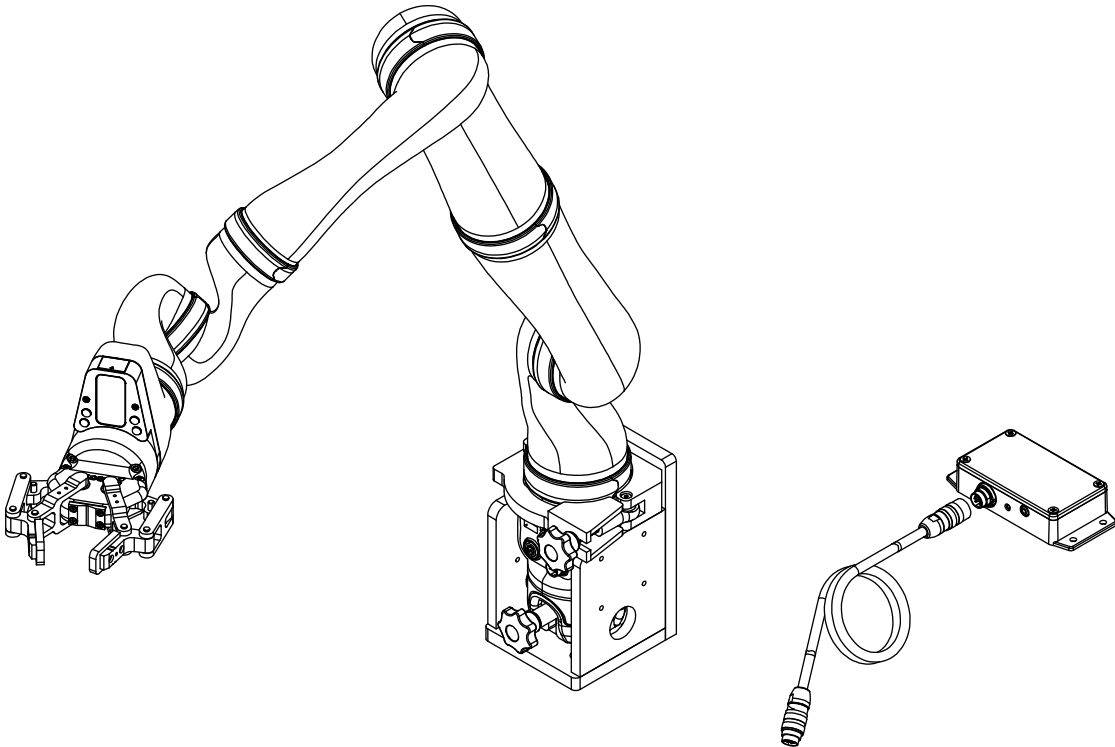


Figure 2: Robot manipulator system components

The robot manipulator system allows a user to use the robot and integrated peripherals to indirectly view and manipulate potentially hazardous materials while operating the system from a safe distance.

The communication system provides the communications link that allows the operator to remotely control the arm from a safe distance. An off-the-shelf Xbox One gamepad allows control of:

- Robot movement
- Opening and closing of gripper
- Positioning guidance laser (on/off)
- White light source for illumination (four intensity levels)

- IR light source for illumination (four intensity levels)

Control commands are transmitted from the remote operator communication adapter to the robotic arm communication adapter by means of the built-in radio communications link (line-of-sight distance up to 300 m), twisted pair Ethernet cabling (distance up to 100 m), or by means of another communication system.

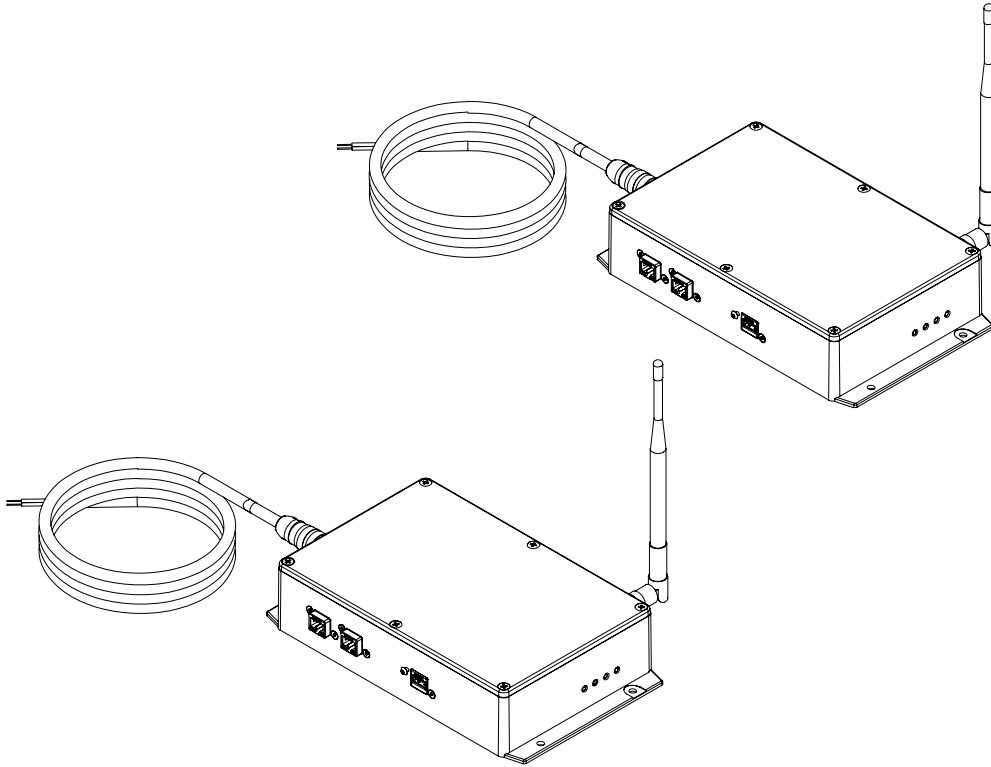


Figure 3: Communication system components

Users have the option of having the video signal from the integrated camera transmitted back to the user via their own third-party communications link to provide visual telepresence feedback to the operator.



Note: A video transmission link system is NOT a standard part of the Gen2 Remote robot manipulation system. The analog video signal available from the security robot system can be transmitted using a third-party solution. Choosing and configuring such a video transmission system is the responsibility of the user.

Overview of the Robot manipulator system

The robot manipulator sub-system consists of several smaller parts.

- Robot
- Robot support
- Gripper adapter
- Gripper
- Video adapter and robot to video adapter cable

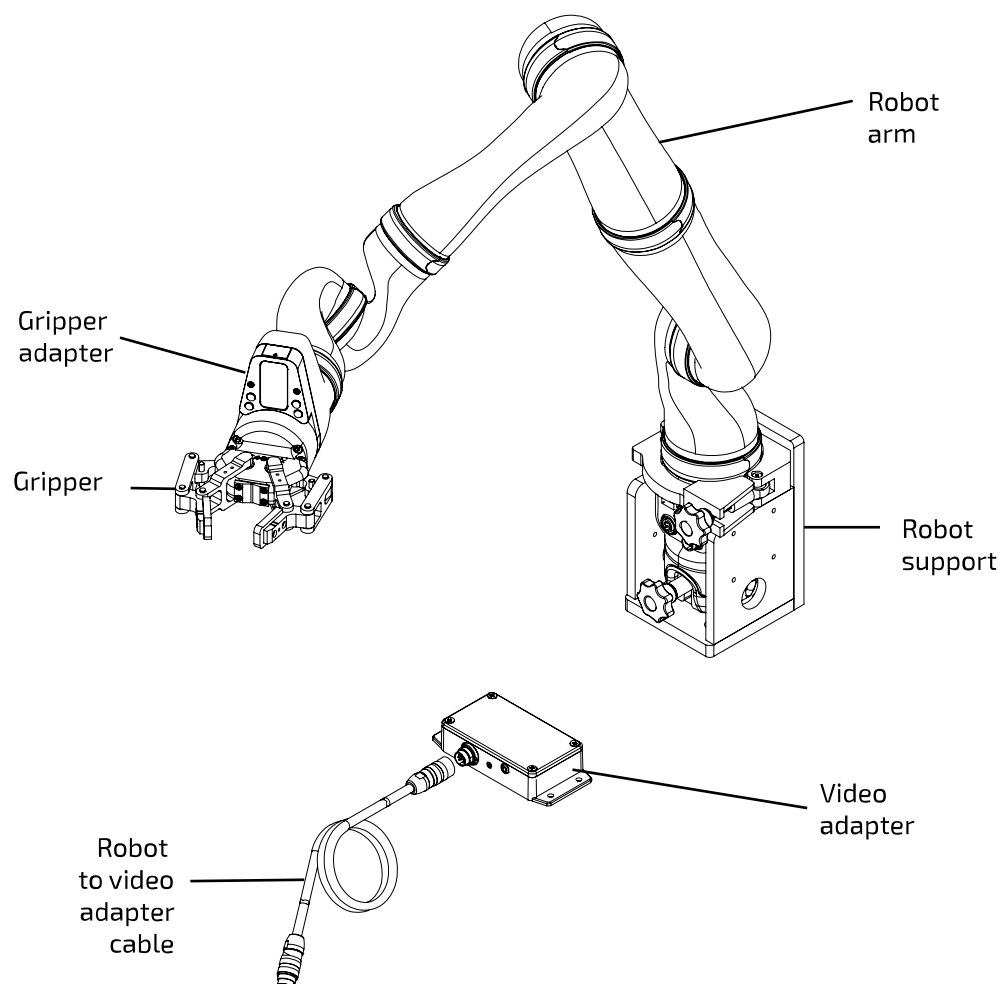


Figure 4: Robot manipulator system components

Robot

The robot manipulator system includes a specially modified Kinova® Gen2 Ultra lightweight robot.

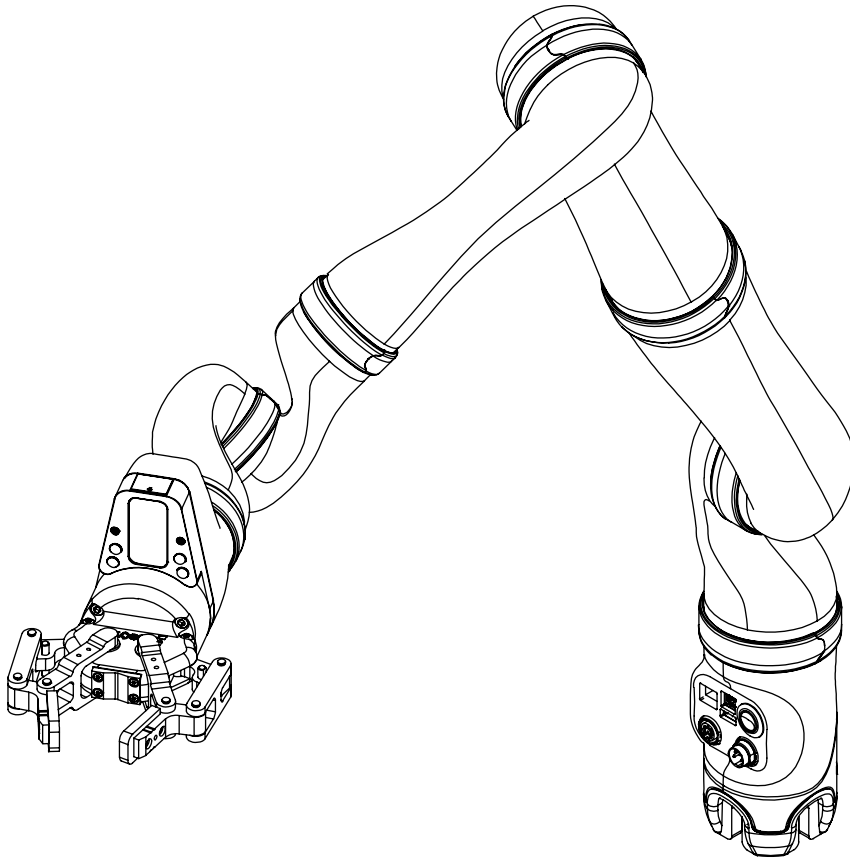


Figure 5: Gen2 Ultra lightweight robot with Gripper adapter and Robotiq gripper

The robot is a 7 DoF (degrees-of-freedom) robot with a spherical wrist.

The robot receives power from an external power supply.

Movement of the robot is controllable in Cartesian (control of translation and rotation of gripper) mode. The movements of the robot are controlled using a gamepad supplied as part of the Kinova® Communication system.

Robot external connectors

The base connector panel has connectors for the robot.

- Ethernet (for control and configuration)
- joystick, controls, video out, expansion

- USB-B (for firmware update using Kinova® Software development kit)
- power

The following figure shows the external connectors.

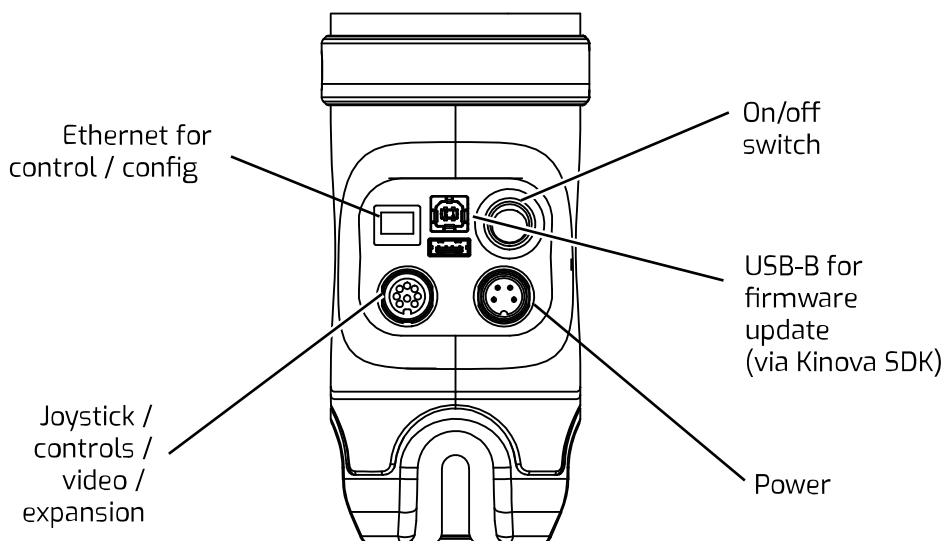


Figure 6: Robot external connectors

Robot support

The robot support holds the robot securely in place. It is fixed to a flat surface, and the robot base is mounted onto a mounting post on the adapter. The robot base is then secured using three locking knobs and a collar mechanism.

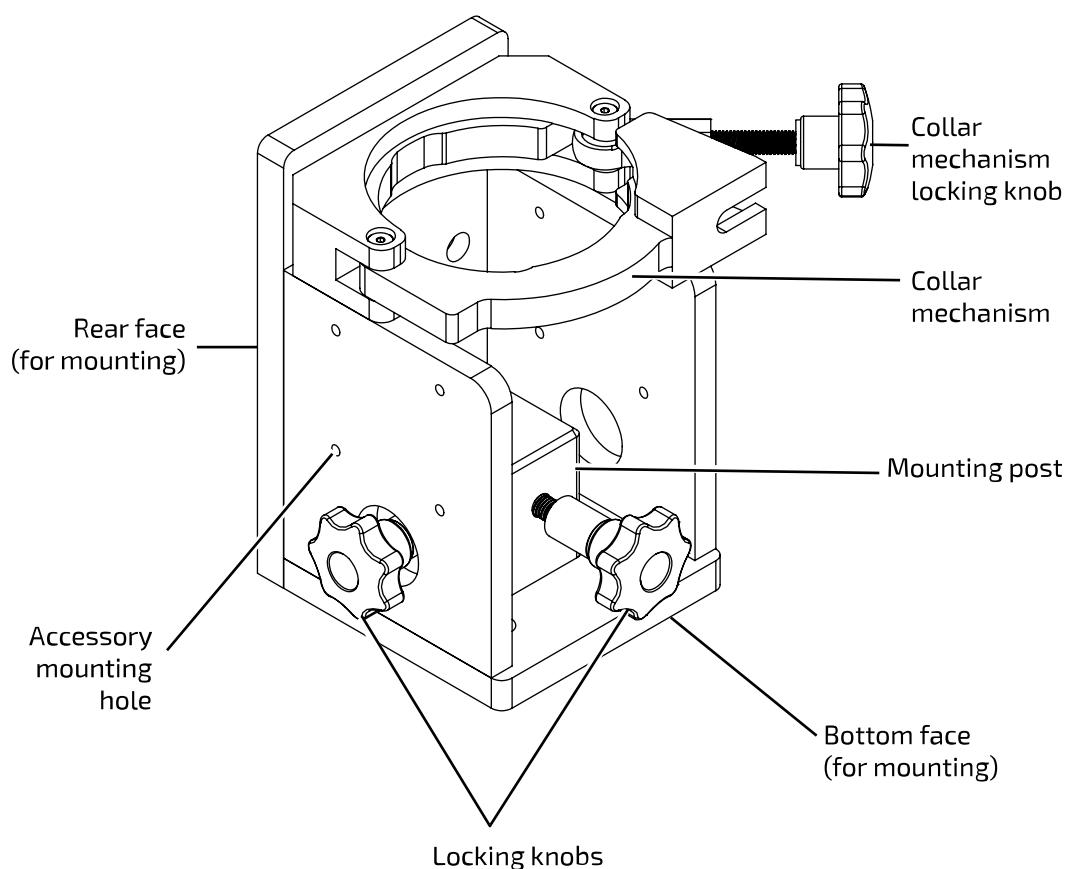


Figure 7: Robot support components

Holes in the two mounting faces (bottom and rear) allow for robust mounting in either the vertical or horizontal plane to a fixed or movable platform.

The side faces of the arm support each have four holes allowing for mounting of accessories as needed.

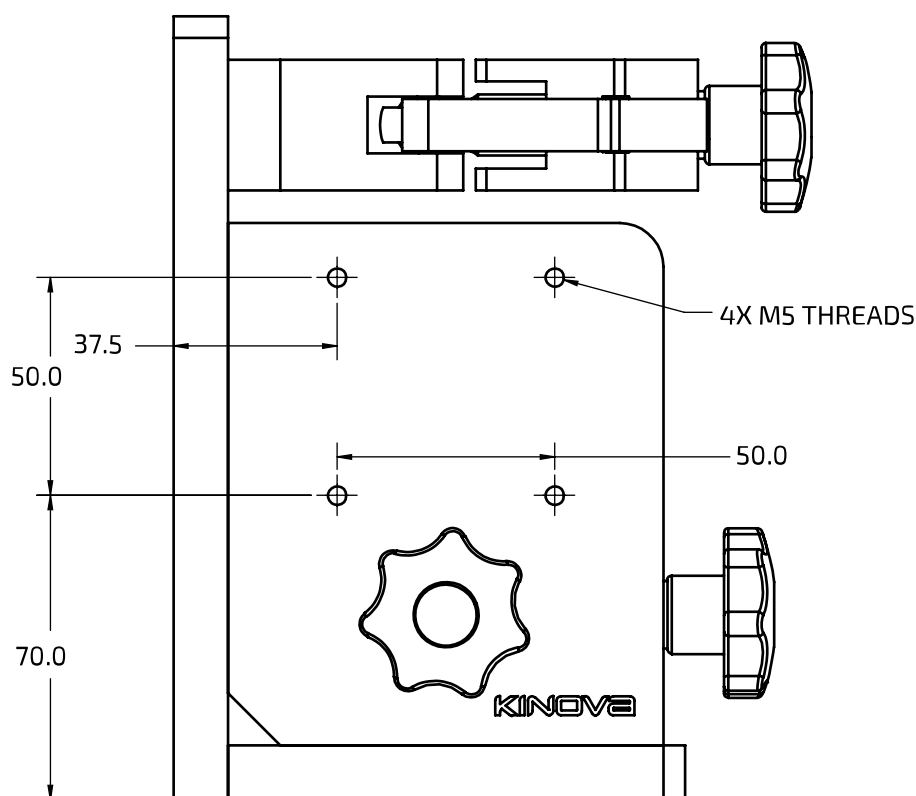


Figure 8: Side mounting holes for accessories (all dimensions in mm)

Gripper adapter module

The gripper adapter module enables the integration of a 2-finger 85 mm Robotiq gripper onto a Gen2 Ultra lightweight robot. The gripper adapter is located between the end of the robot and the gripper.

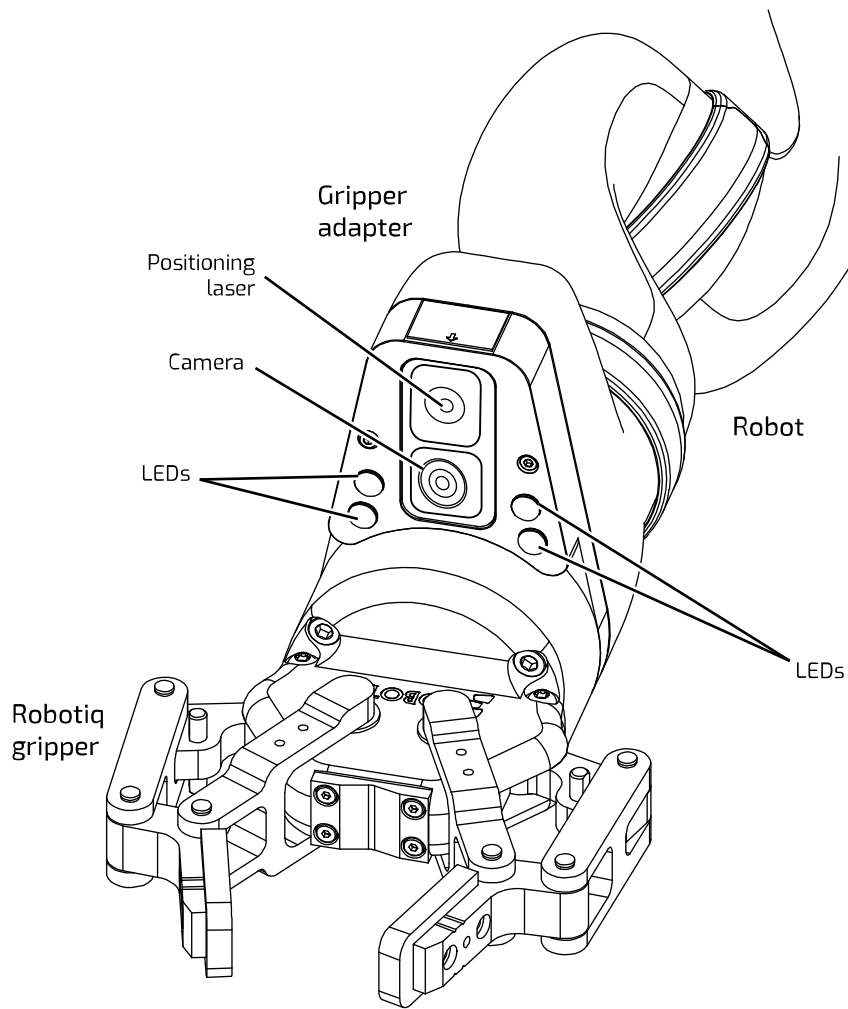


Figure 9: Gripper adapter module

The gripper adapter module includes integrated devices.

- Video camera
- Positioning laser
- Four illumination LEDs (two white-light, two infrared)

The gripper adapter and its devices receive power and control signals from the robot. The gripper adapter also transmits power and control signals to the attached gripper.

Camera module overview

The camera module features PAL or NTSC composite video output (using video adapter), as well as a wide field of view that is greater than 100°.

Light sources overview

The gripper adapter module includes four LED light sources for illumination purposes. At night or in other low-light situations, they make it easier to visualize objects when using the video camera.

There are four sources of illumination:

- two visible-spectrum LEDs (cool white light, 9000 K color temperature)
- two IR LEDs (infrared spectrum, 860 nm wavelength)

The light sources can be controlled using the gamepad in the Kinova[®] Communication system. Using the gamepad, the IR and white light LED intensities can be adjusted in four steps from off to full intensity.

Laser overview

The integrated tilting laser provides guidance for any gripper-held tool.

The tilting laser improves user depth perception and targeting, improving overall gripper manipulation. Its range extends from the tip of the gripper to 50 cm in front of it. At the tool tip, the laser beam diameter is less than 2.5 mm.

The laser angle can be adjusted mechanically on the back of the gripper adapter module using a 2.5 mm hex key, and ranges from horizontal (with respect to the gripper fingers) to approximately 30° below the horizontal.

The laser can be switched on using the gamepad of the Kinova[®] Communication system.

Robotiq gripper

The gripper adapter provides a means to connect a Robotiq 85 mm 2-finger gripper to a Gen2 Ultra lightweight robot.

The gripper is integrated mechanically and electronically with the robot via the gripper adapter.

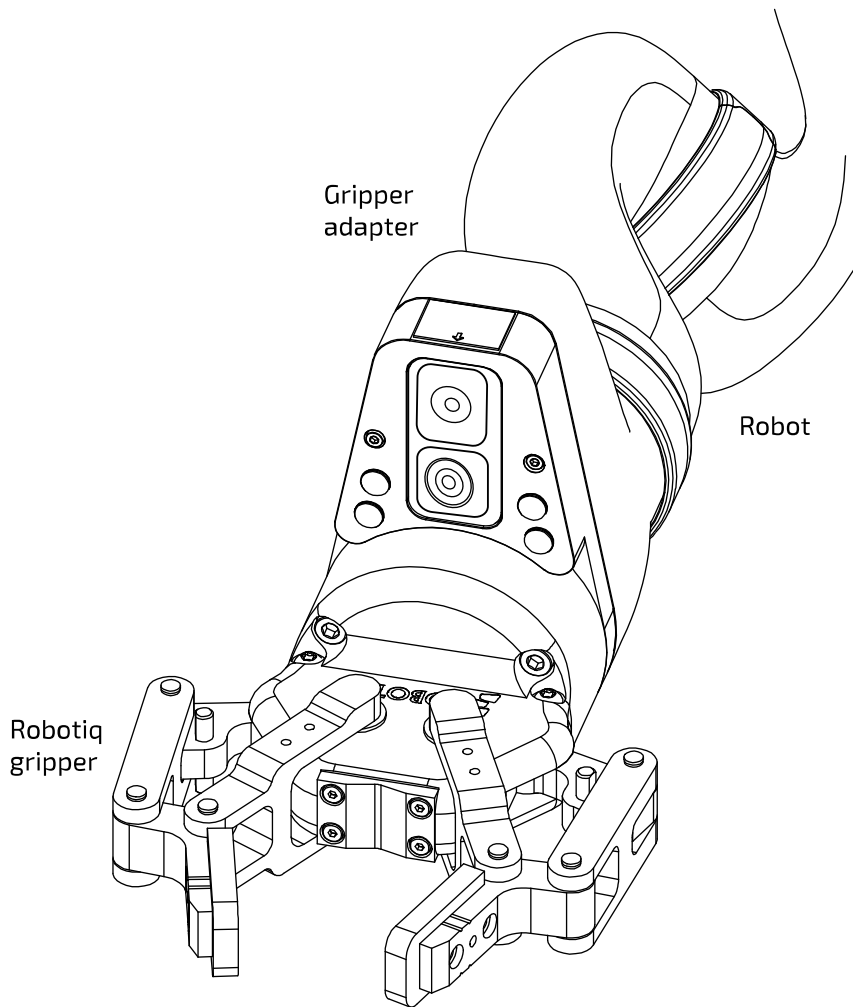


Figure 10: Robotiq 2-finger 85 mm gripper

When combined with the Communication system, the two gripper fingers can be controlled along with the robot and devices on the gripper adapter using a single controller device and adapter. This allows for grasping of objects (gripper opening has a width of 85 mm).

Video adapter

The video adapter converts the camera's differential video signals into a single-ended PAL or NTSC composite video signal.

The signal is output on the RCA connector on the side of the video adapter. It is mounted close to the robot support and is powered via a second cable connected to the expansion port of the robot base.

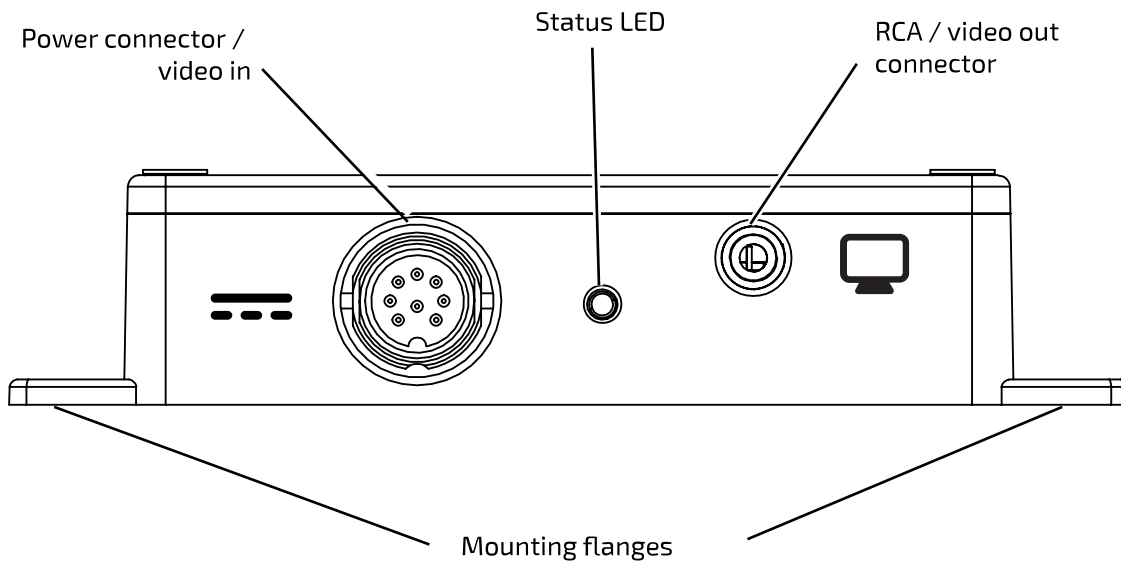


Figure 11: Video adapter

Robot to video adapter cable

The robot to video adapter cable conveys the differential video signal and the power to the video adapter.

The cable connects the joystick, or expansion, connector of the robot to the power connector of the video adapter, and provides the differential video signal, as well as the power to the video adapter.

The video stream is accessible from the video adapter via the RCA composite video output.

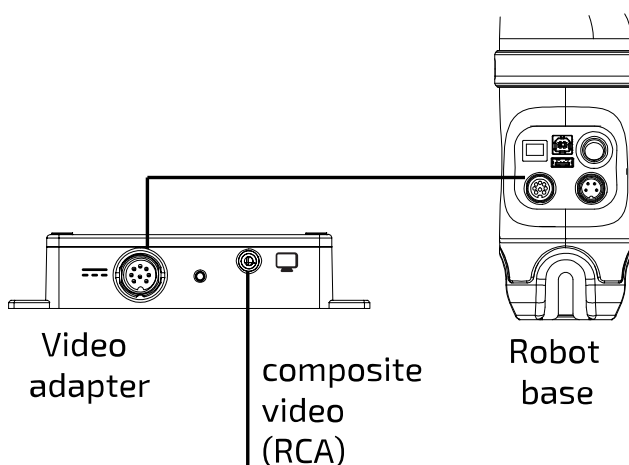


Figure 12: Robot to video adapter connection

Communication system overview

The Kinova® Communication system has several components and different modes of operation.

The communication system allows the teleoperation of a robot manipulator using a gamepad by transmitting control signals from an operator station to the remote robot over an adapter-mediated communication network.

The Communication system consists of the some components.

- Two communication adapters and cables
- Xbox One gamepad and cable (micro USB to USB type A)
- USB type A hub to connect the gamepad to the communication adapter

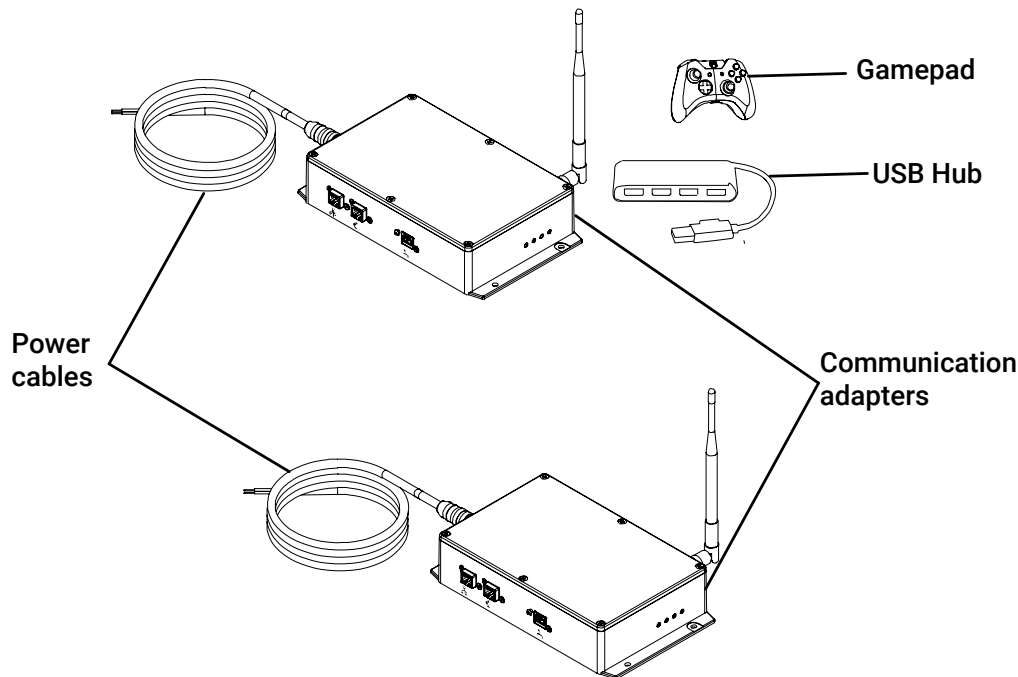


Figure 13: Communication System components

The communication adapters each have identical hardware and firmware, but are configurable for different modes of use using a command line interface (CLI) tool. They are available in one of two models.

- Built-in radio and antenna
- No radio

Communication system modes of operation

The system can be operated in one of two modes: Single adapter mode; Paired adapter mode.

Single Adapter mode

In Single Adapter mode, only one of the communication adapters is used. The Xbox gamepad is connected to a USB hub; the USB hub and the robot are both connected to the same adapter.

There are two options here for connecting the single adapter to the robot.

- Directly via an Ethernet cable (recommended approach for best results)
- Indirectly via a small, dedicated local network



Note: It is NOT recommended to run this through a large corporate or organizational network.



Note: If controlling the robot over a local network, the system integrator needs to make sure that the network has low latency and high bandwidth to ensure effective and reliable control.

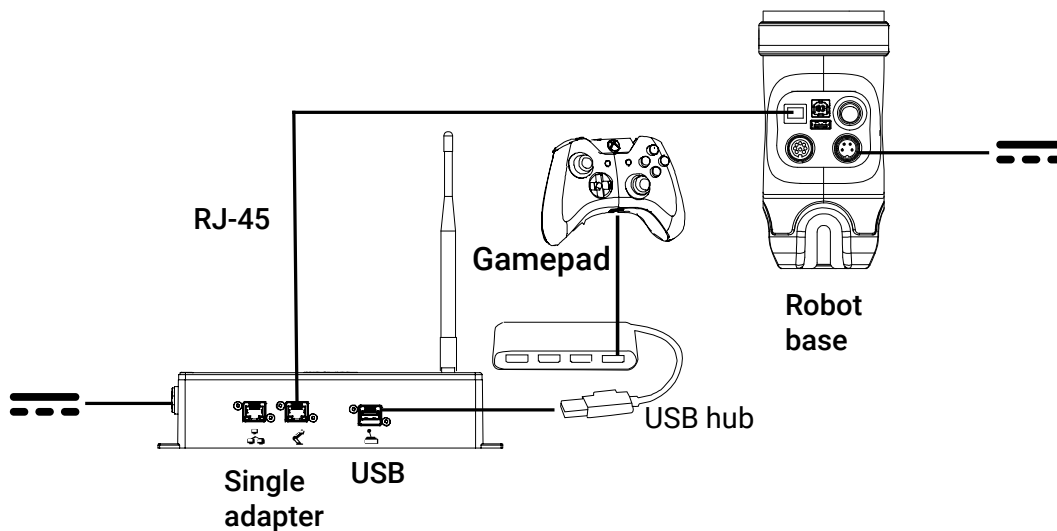


Figure 14: Single Adapter mode (direct connection to robot)

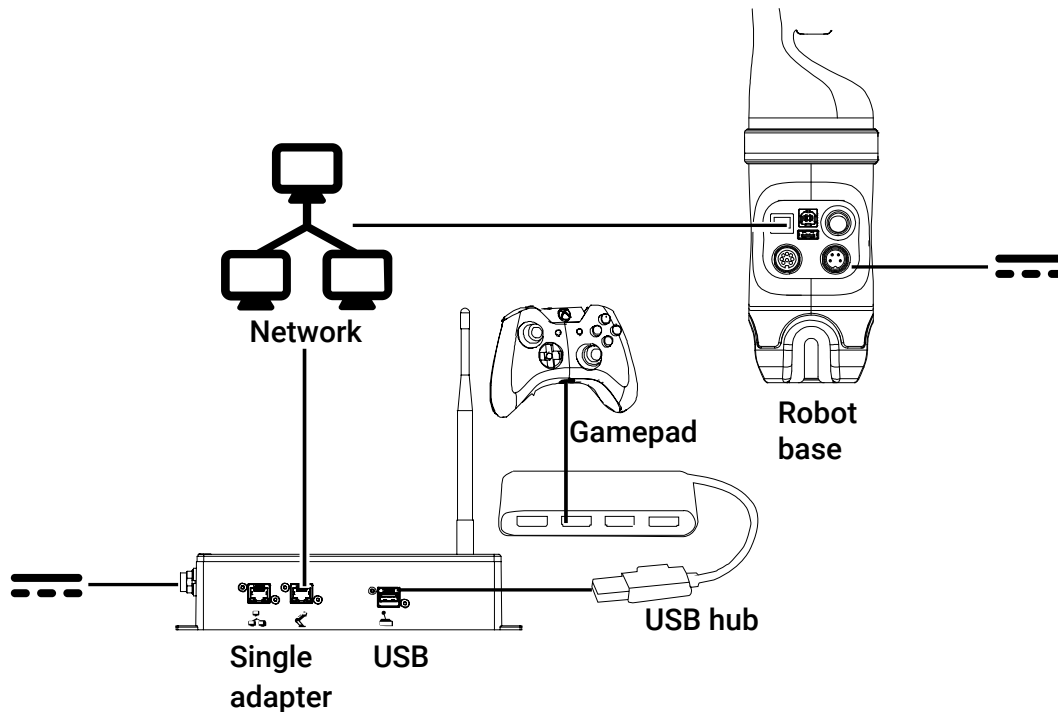


Figure 15: Single Adapter mode (connection via simple local area network)

Paired Adapter mode

In Paired Adapter mode, both adapters are used. They are each configured with different software settings, and are paired with each other for communications.

One adapter is configured as an Operator Adapter, while the other is configured as a Remote Adapter. The two adapters are located at two separate stations.

The Operator Adapter (OA) is installed at an operator station. A wired Xbox One gamepad is connected to a USB hub that is connected to the station to allow operation of a remote robot and any effector devices.

The Remote Adapter (RA) is located in the vicinity of the robot manipulator and connects to the robot.

Signals are transmitted between the two locations via one of two types of communications link.

- Radio-based or
- Wired Ethernet

Communication adapters with radio and antenna allow for both forms of signal transmission.

The model without radio allows for only wired Ethernet transmission; wiring with the KR23459HAR harness is the same as that for the radio link.

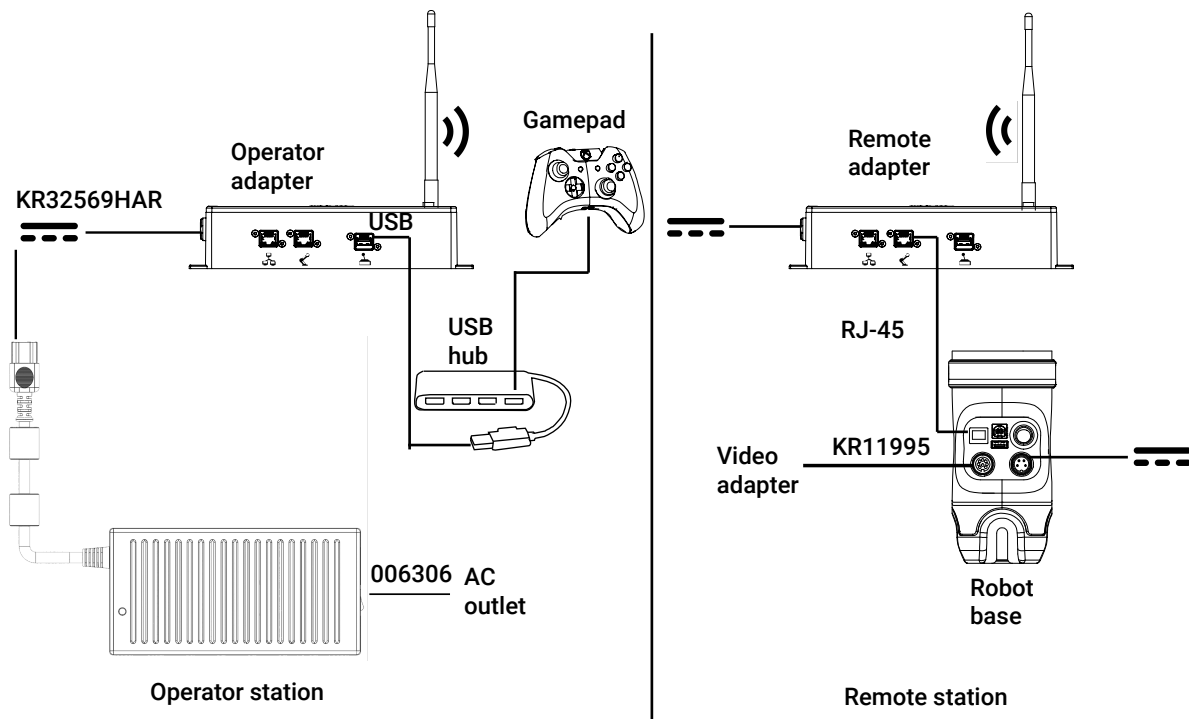


Figure 16: Paired Adapter mode (with radio link)

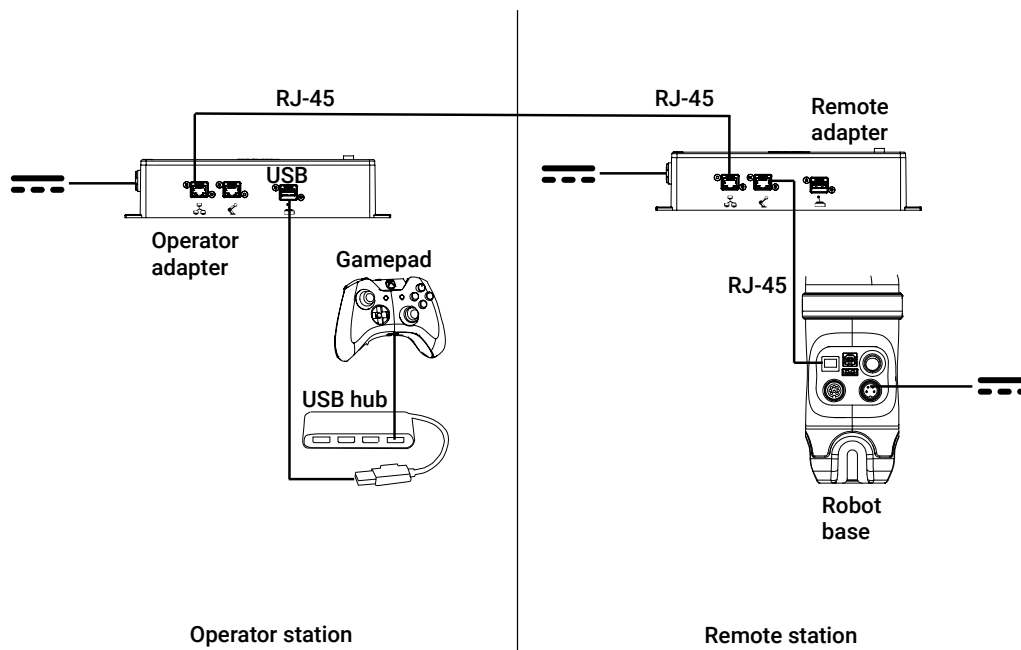


Figure 17: Paired Adapter mode (with wired Ethernet link)

Components

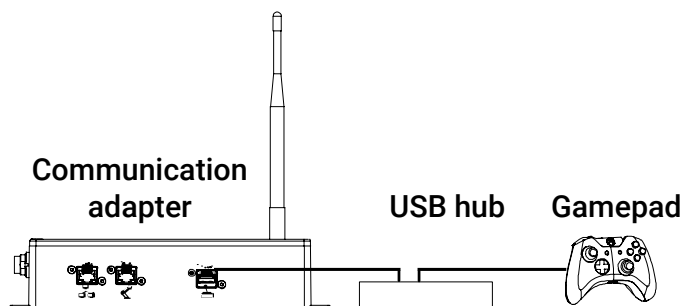
The components are the Xbox One gamepad and the Communication system.

Xbox One gamepad

The Xbox controller is intended to be used to control the robot using a combination of button press and control stick movements.

There are different control mappings available allowing control in different modes. Depending on the selected control mode, movement of the robot is accomplished by commanding x, y, and z translation and orientation.

The gamepad is used to control a robot through a communication adapter. The gamepad is connected to a USB hub that is connected to the communication adapter via a USB cable.



Communication Adapter

The Communication Adapters are housed in flanged enclosures.

Communication Adapters come in two models, one with built-in radio and antenna, and one without.

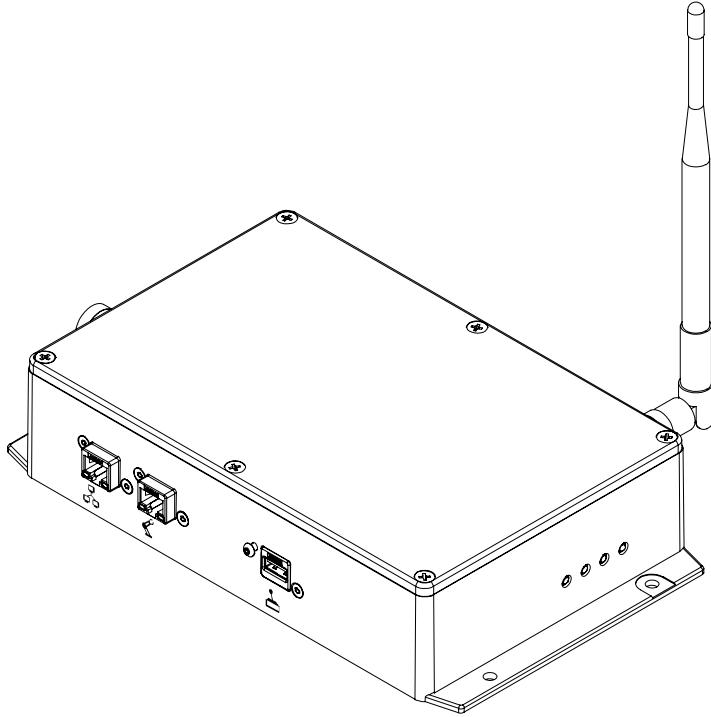


Figure 18: Communication Adapter (radio model p/n KR COM R001)

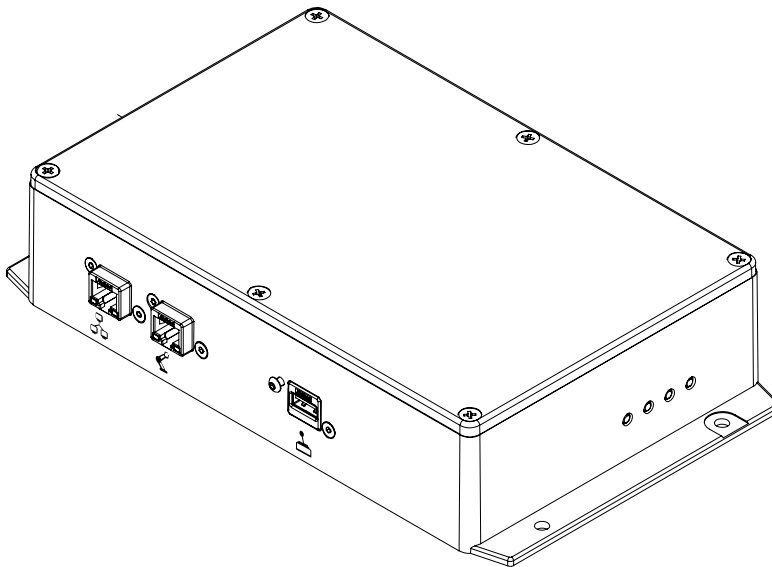


Figure 19: Communication Adapter (non-radio model p/n KR COM N001)

The communication adapters have several features.

- Network RJ-45 connector (Ethernet) for wired connection to another communication adapter or to an external Ethernet network (used for configuration and update purposes)

- Robot RJ-45 connector (Ethernet) to enable connection to a Gen2 Ultra lightweight robot
- USB connector to enable connection to the Xbox One gamepad
- Internal radio and antenna (radio model only)
- Status LEDs (qty 4)
- Mounting flanges

Each communication adapter has a grounding connection on the right hand mounting flange, beside the rear mounting hole closest to the antenna.



Note: This grounding connection needs to be connected to ground.

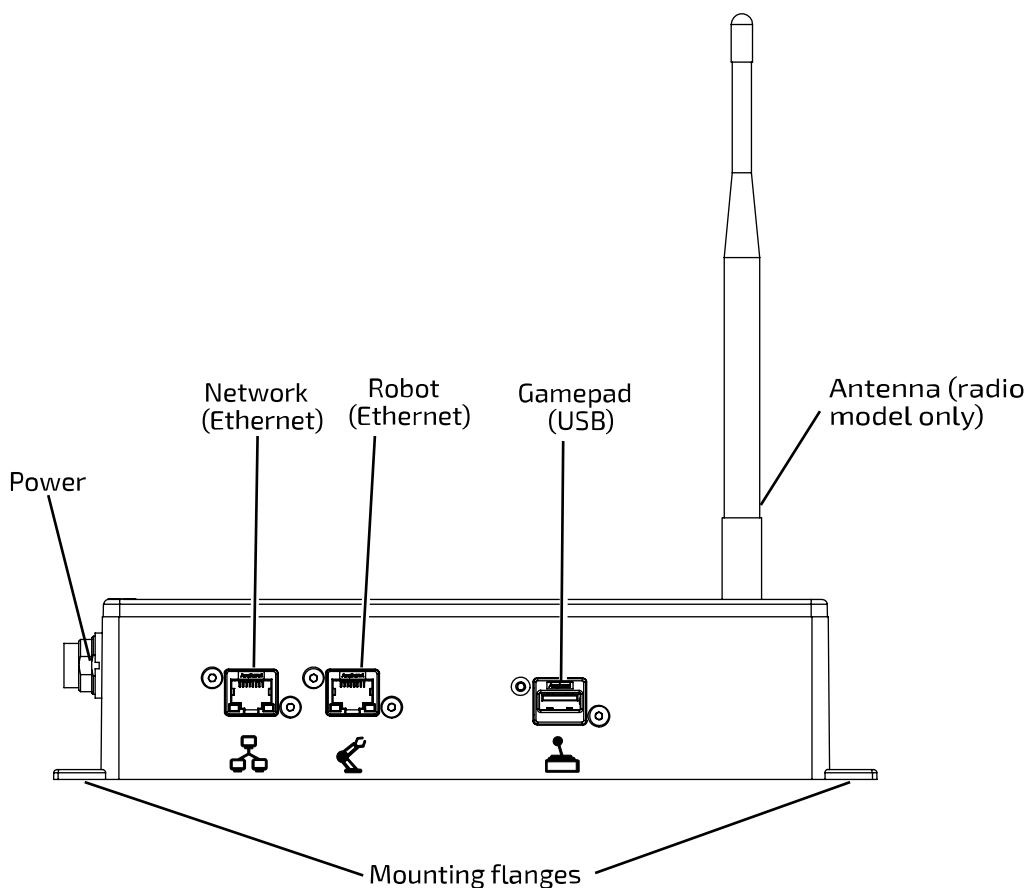


Figure 20: Communication Adapter connectors and antenna

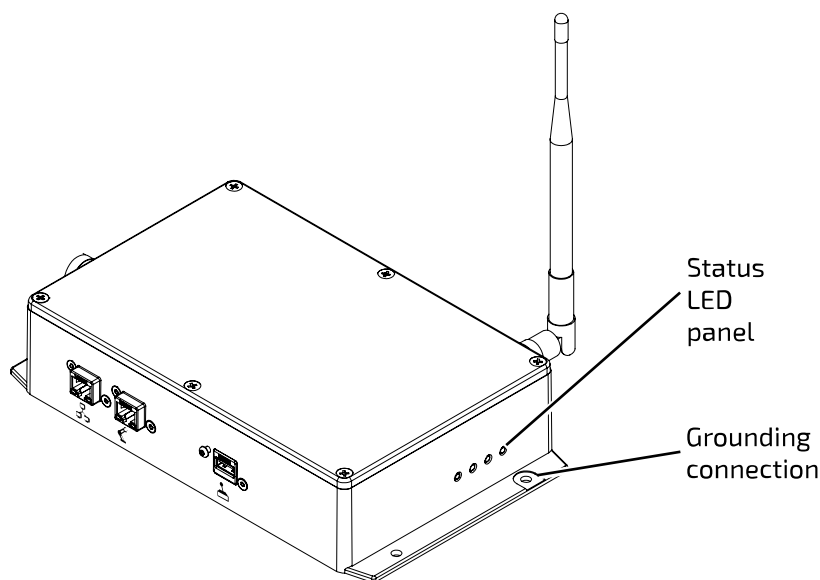


Figure 21: Communication Adapter status LEDs and grounding connection

Operator Adapter (OA)

A communication adapter can be software-configured as an Operator Adapter (OA).

An OA provides a connection point for a controller, as well as a wired (Ethernet) or wireless (radio) connection to a Remote Adapter (RA). The OA facilitates remote control of a robot using an Xbox One controller.

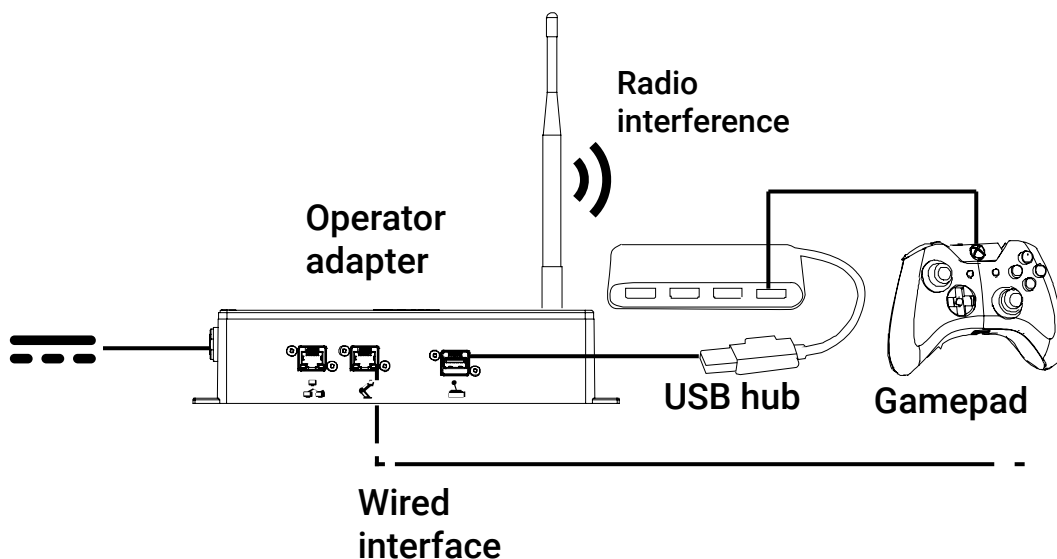


Figure 22: Operator Adapter

Remote Adapter (RA)

A communication adapter can be software-configured as a Remote Adapter (RA).

An RA provides an Ethernet (RJ-45) connector for connection to a Gen2 Ultra lightweight robot, as well as a wired (Ethernet) or wireless (radio) connection to an Operator Adapter (OA). The RA is a receiver for remote control commands sent from an Xbox One gamepad connected to a OA.

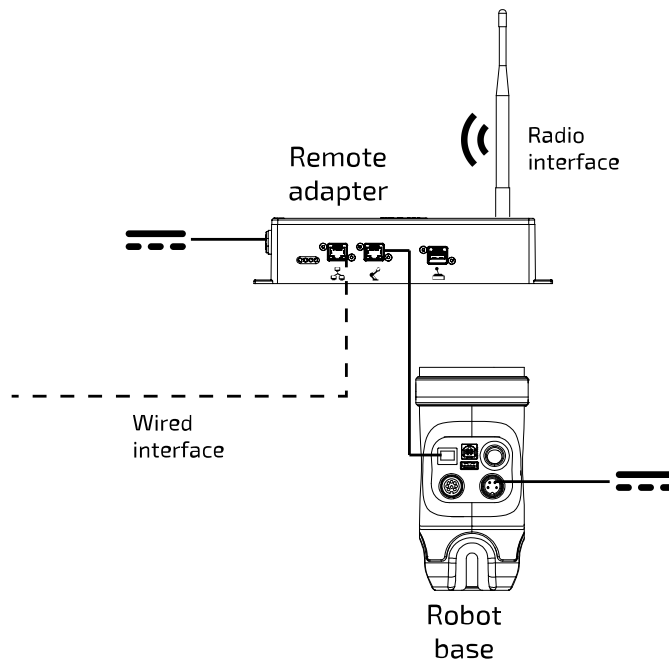


Figure 23: Remote Adapter

Communications network interfaces

The communication adapters communicate with each other and with the robot via a network.

Each communication adapter has three network interfaces, two for communications between the adapters, and one for communicating with the robot.

- Communications between the adapters
 - Wired network interface
 - Radio interface (for radio model of adapter)
- Communications between a communication adapter and the robot
 - Robot interface

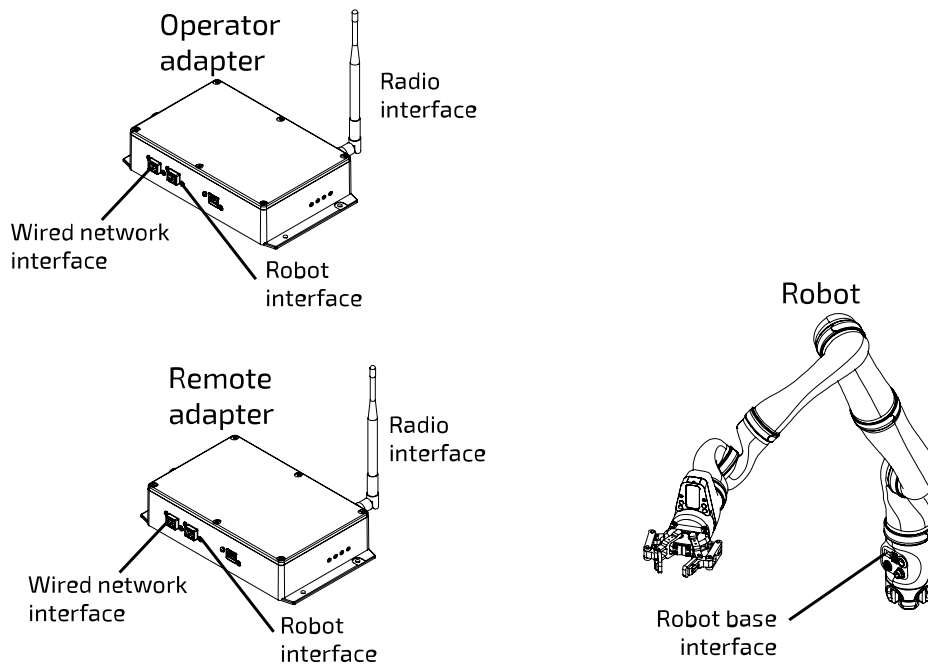


Figure 24: Network interfaces

Each of these interfaces requires IP settings (IP address, subnet mask, and gateway) to be configured. These settings can be configured manually using the command line interface (CLI).

Alternatively, if the communication adapters are connected to a local network with a DHCP server, the communication adapter interfaces can be configured, via the CLI, as DHCP clients, receiving their IP settings from the DHCP server.



Note: When configuring a communication adapter as a DHCP client, ensure that a DHCP server is connected. If the power is cycled while the adapter is set as a DHCP client, and there is no DHCP server connected, the adapters cannot receive IP addresses.

To enable communication between the two communication adapters, it is also necessary to configure, on each communication adapter, the IP address and port for the network interfaces of the other communication adapter.

When the communication adapters are purchased as a pair, the adapters arrive with the IP settings preconfigured. If you later need to replace one of the adapters, configuration may need to be performed using the CLI to ensure that the new adapter has properly configured IP settings so that the two adapters are paired to communicate with each other.

Default network interface settings

When the communication system is purchased with two paired communication adapters, the adapters are factory-configured to specific static IP settings.

Network interfaces default settings

A replacement unit usually is configured by Kinova with default IP settings for the role it is to take on, unless otherwise requested.

Communication Adapter IP settings can be configured, if desired, in the field, using the communication adapter command line interface (CLI).



Note: The robot base IP address is not configurable using the communication adapter CLI tool. It is only configurable using the Kinova Development Center application. It is strongly recommended to leave the robot IP address in its default setting and configure the communication adapter robot interfaces to be compatible with this default IP address for the robot base.

Table 2: Operator Adapter network interface default IP addresses (static)

Interface	IP address	Subnet mask
Robot interface	192.168.100.100	255.255.255.0
Wired network interface	172.16.0.10	255.255.255.0
Radio interface (for radio model of adapter)	192.168.111.10	255.255.255.0

Table 3: Remote Adapter network interface default IP addresses (static)

Interface	IP address	Subnet mask
Robot interface	192.168.100.100	255.255.255.0
Wired network interface	172.16.0.11	255.255.255.0
Radio interface (for radio model of adapter)	192.168.111.11	255.255.255.0

Table 4: Robot base interface defaults IP addresses (static)

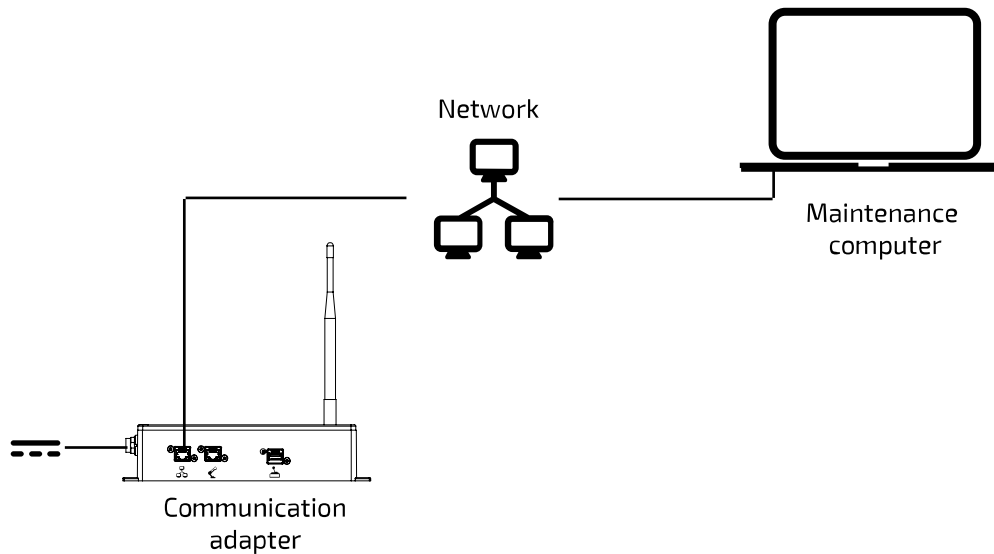
Interface	IP address	Subnet mask
Robot base	192.168.100.10	255.255.255.0

Command Line Interface Shell (CLI)

The Command Line Interface Shell (CLI) is a user-friendly command line interface (CLI) for the communication adapters, and is accessed when a user connects to the communication adapter

from a maintenance computer via the network port and establishes an ssh session with the adapter.

Figure 25: Communication Adapter configuration setup



The CLI is used for a range of configuration, setup, and maintenance tasks.

- Configuring the mode of operation and role of a communication adapter
- Setting up a robot protection zone
- Accessing diagnostic logs

Using the Command Line Interface (CLI)

The CLI provides a convivial command line user interface for configuring the communication adapters.

The CLI is built on the [CLISH framework](#).

Features

The command line interface has several features.

- Contextual menus display only the options available in the current context
- Context-sensitive help is available at all times by typing '?'
- Command auto-completion includes parameter validation
- Command line history can be recalled using the up arrow key and edited to more quickly re-enter commands

Establishing a secure shell connection to the communication adapter

This interface is accessible when a user makes a ssh (secure shell) connection to the communication adapter from a PC, either using a direct wired Ethernet connection or remotely over a local network. If you are using a Mac or Linux/Ubuntu machine, simply use the ssh utility from the command line terminal with the IP address of the communication adapter to which you are connecting.

If using Windows, you must use a Windows-based ssh (secure shell) client, such as PuTTY, or another terminal emulator with ssh support.

Interface structure

The CLI command options are organized in a tree structure. At the top level are several broad categories of actions which then branch down into more specific options, depending on the previous choice. Until the full command is executed, you can go back a level using `<backspace>` repeatedly. Each branch ends with an action being performed after `<Enter>`.

Top-level commands

At the top level, there are five options.

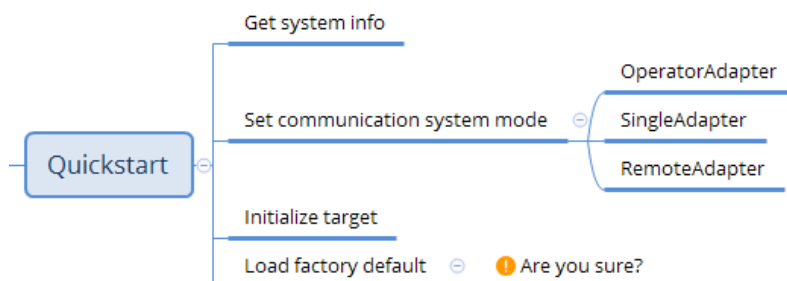
1. [Quickstart](#) - basic setup to get started without detailed configuration
2. [Configuration](#) - setting the communication transmission mode and basic robot configuration
3. [Diagnostic](#) - access to diagnostic logs and status information
4. [Advanced](#) - advanced configuration of IP addresses and other network settings; security credentials for the radio link (for adapters with radio option)
5. Reboot - reboots the connected communication adapter

Quickstart menu options

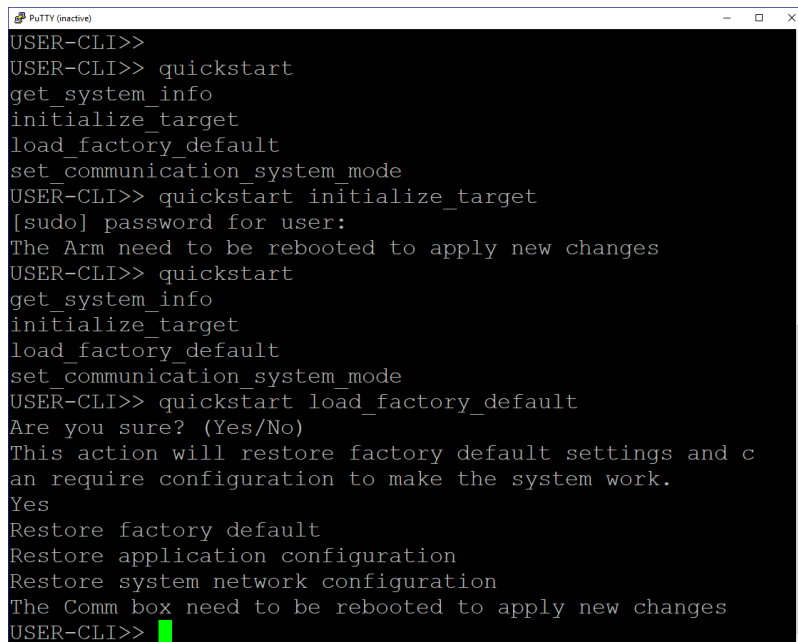
The `Quickstart` menu offers a way to quickly get information about the system and configure communication adapters to basic default settings.

The `Quickstart` menu is the ideal option for those who want to get started quickly without having to perform a lot of complicated configurations.

The `quickstart` menu has four options.



- `get_system_info` - displays various information about the system.
 - hardware information
 - power on self-test (POST) results
 - log settings
 - controller settings
 - network configurations
 - communications data snapshot
- `initialize_target` - re-initializes the robot. The robot needs to be rebooted to apply the change.
- `load_factory_default` - rolls the communication adapter back to the initial configuration when it was sent from the factory. You will be prompted for confirmation that this is what you want to do.



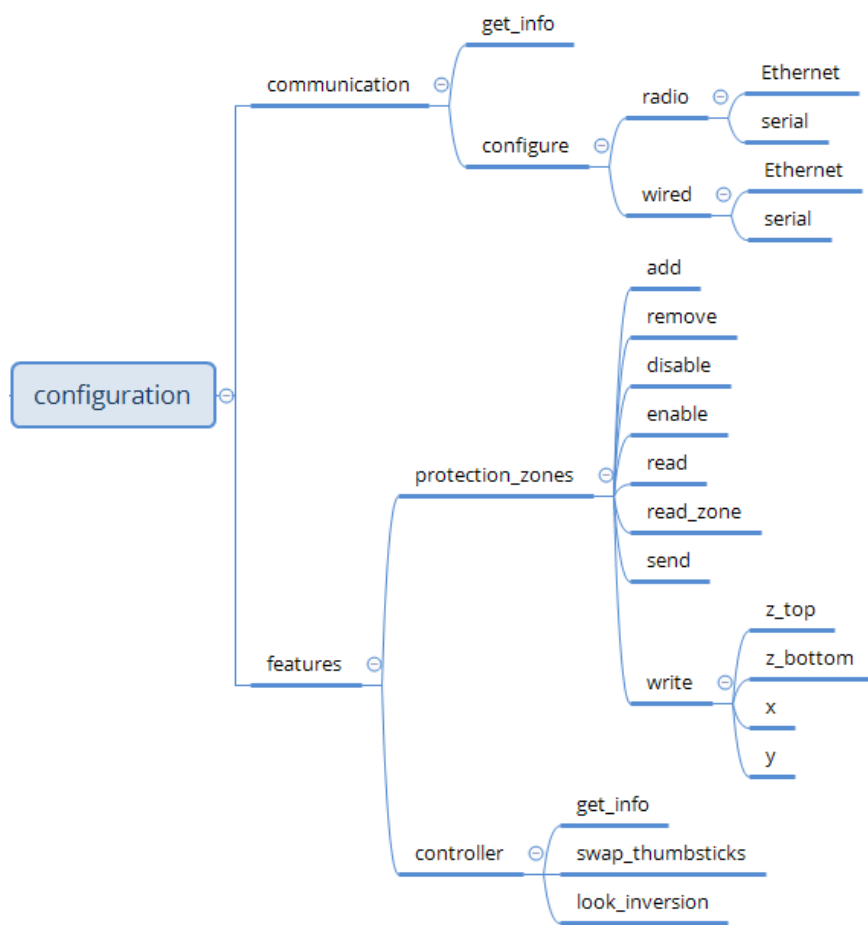
```
USER-CLI>>
USER-CLI>> quickstart
get_system_info
initialize_target
load_factory_default
set_communication_system_mode
USER-CLI>> quickstart initialize_target
[sudo] password for user:
The Arm need to be rebooted to apply new changes
USER-CLI>> quickstart
get_system_info
initialize_target
load_factory_default
set_communication_system_mode
USER-CLI>> quickstart load_factory_default
Are you sure? (Yes/No)
This action will restore factory default settings and c
an require configuration to make the system work.
Yes
Restore factory default
Restore application configuration
Restore system network configuration
The Comm box need to be rebooted to apply new changes
USER-CLI>>
```

- `set_communication_system_mode` - takes you to the next menu, where you can choose what mode to set for the communication adapter:
 - `OperatorAdapter`
 - `RemoteAdapter`
 - `SingleAdapter`

Configuration menu options

The configuration menu offers configuration of the communication channel to be used, as well as basic robot control modalities.

The configuration menu offers two options.



- communication
 - `get_info` - view the status of the communication system
 - `configure` - set the communication channel to use
 - `radio` - radio interface (for communication adapter with radio option)
 - `wired` - wired interface (Ethernet)

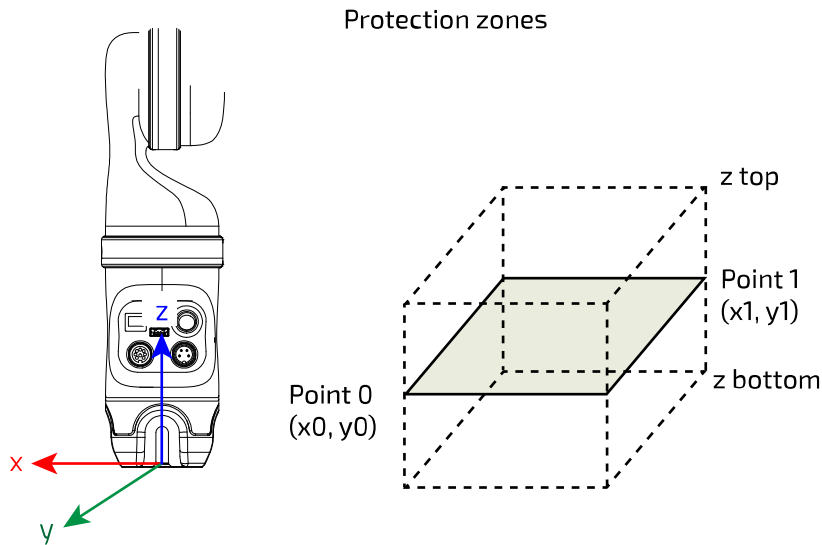
For each channel option, you have the choice of serial or Ethernet.



Note: Use the Ethernet option only. The serial option has no effect.

- **features** - configure different features of the robot
 - **controller** - configure settings for the gamepad
 - **get_info** - display current configurations for the gamepad
 - **look_inversion** - flip the y-axis for the pitch up and down control on the thumbstick, for the gripper orientation control response
 - **swap_thumbsticks** - swap the control mappings of the left and right thumbsticks
 - **protection_zones** - a protection zone defines a box-shaped zone surrounding the robot where the gripper must not enter. This is used for obstacle avoidance. Protection zones are labeled with a non-negative integer zone ID; they are defined in terms of two points in the x-y plane representing two opposing corners of a rectangle, and the z values for the top and

bottom of the protection zone. Protection zones are defined in terms of the reference frame of the robot base, as shown below.



Protection zones can be enabled or disabled. There are a number of menu options for configuring protection zones.

- `add` - create a new protection zone. Specify a zone ID that is not in use



Note: Attempting to add a zone ID that already exists returns an error.

- `remove` - remove an existing protection zone. Specify a zone ID that is currently in use



Note: Attempting to remove a zone ID that does not exist returns an error.

- `disable` - disable a given protection zone. Specify a zone ID that is currently in use



Note: Attempting to disable a zone ID that is already disabled or does not exist returns an error.

- `enable` - enable an existing protection zone. Specify a zone ID that exists but is not in use.



Note: Attempting to disable a zone ID that does not exist returns an error.

- `read` - displays information on all protection zones.



```

USER-CLI>> configuration feature protection_zones r
read      read_zone remove
USER-CLI>> configuration feature protection_zones read
[sudo] password for user:
Zone 0
    Enable = False
    Point 0
        x value = 0.30
        y value = -0.02
    Point 1
        x value = 0.31
        y value = -0.95
    zBottom = 0.0
    zTop = 0.50
Zone 1
    Enable = False
    Point 0
        x value = -0.30
        y value = -0.02
    Point 1
        x value = -0.30
        y value = -0.95
    zBottom = 0.01
    zTop = 0.5
USER-CLI>>

```

- `read_zone` - given a specified zone ID, displays the information about the protection zone

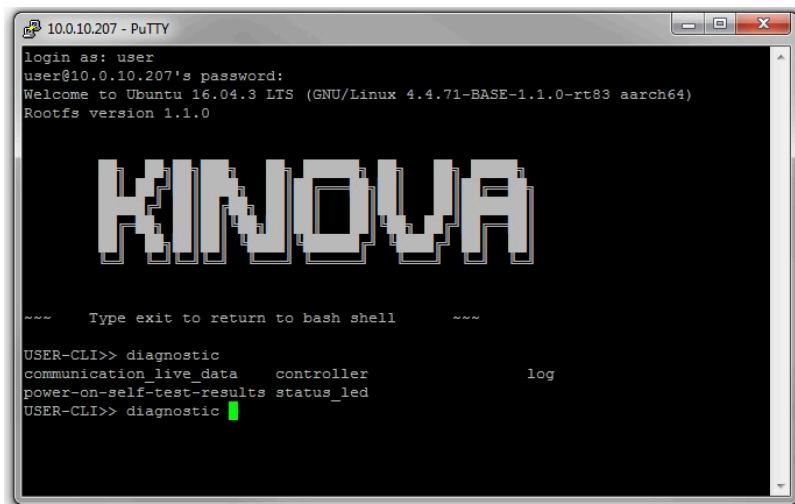


Note: Attempting to read a zone whose zone ID is not defined returns an error.

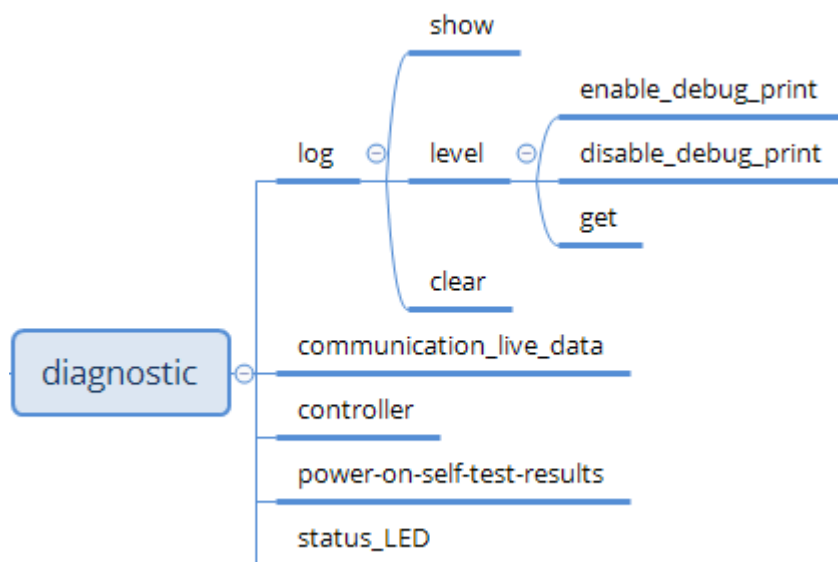
- `send` - sends all defined and enabled protection zones to the robot
- `write` - edits any of the coordinates of previously created protection zones. The zone ID - and in the case of x and y values, point number - need to be specified, along with the value of the coordinate, in meters.
 - `x` - defines the x value of the specified zone ID and point number. For example: `configuration feature protection_zone write x 3 0 0.3` modifies zone 3, changing the x value of point 0 to 0.3 meters
 - `y` - defines the y value of the specified zone ID and point number. For example, `configuration feature protection_zone write y 2 1 0.5` modifies zone 2, changing the y value of point 1 to 0.5 meters
 - `z_top` - defines the `z_top` value of the specified zone ID. For example, `configuration feature protection_zone write z_top 2 0.6` modifies zone 2, changing the value for `z_top` to 0.6 meters
 - `z_bottom` - defines the `z_bottom` value of the specified zone ID. For example, `configuration feature protection_zone write z_bottom 2 0.2` modifies zone 2, changing the value for `z_bottom` to 0.2 meters

Diagnostic menu options

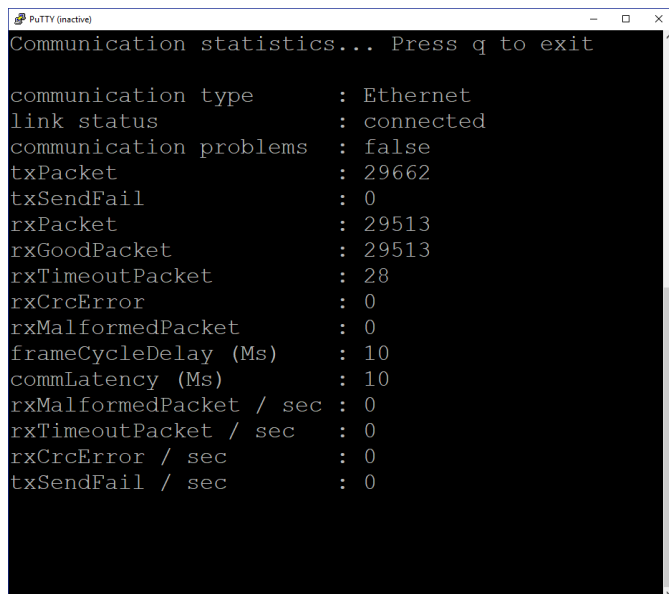
The `diagnostic` menu offers access to useful diagnostic information about the performance of the communication system, and can be a useful starting point for system troubleshooting.



The `diagnostic` menu includes five options.



- `communication_live_data` - real-time view of low-level statistics

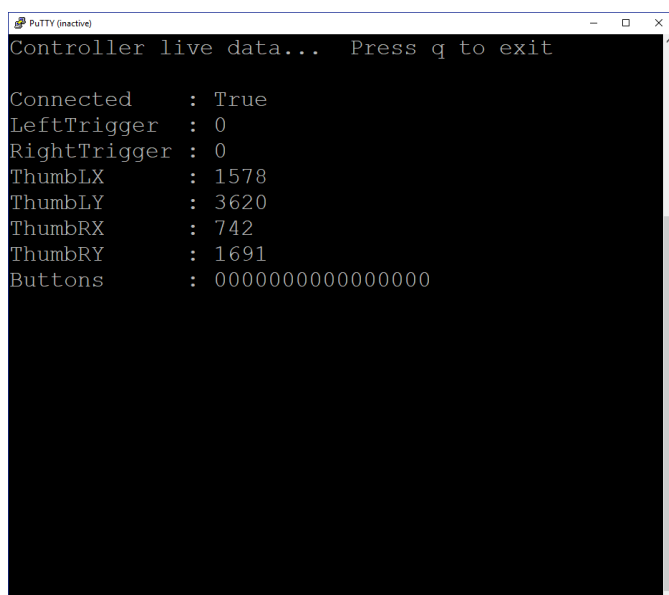


A screenshot of a PuTTY terminal window titled "PuTTY (inactive)". The window displays the text "Communication statistics... Press q to exit" at the top. Below this, a list of communication statistics is shown in a key-value format. The statistics include: communication type (Ethernet), link status (connected), communication problems (false), txPacket (29662), txSendFail (0), rxPacket (29513), rxGoodPacket (29513), rxTimeoutPacket (28), rxCrcError (0), rxMalformedPacket (0), frameCycleDelay (Ms) (10), commLatency (Ms) (10), rxMalformedPacket / sec (0), rxTimeoutPacket / sec (0), rxCrcError / sec (0), and txSendFail / sec (0).

```
PuTTY (inactive)
Communication statistics... Press q to exit

communication type      : Ethernet
link status             : connected
communication problems  : false
txPacket                : 29662
txSendFail              : 0
rxPacket                : 29513
rxGoodPacket            : 29513
rxTimeoutPacket         : 28
rxCrcError              : 0
rxMalformedPacket       : 0
frameCycleDelay (Ms)    : 10
commLatency (Ms)        : 10
rxMalformedPacket / sec : 0
rxTimeoutPacket / sec   : 0
rxCrcError / sec        : 0
txSendFail / sec        : 0
```

- `controller` - real-time view of controller data, including connectivity status and control inputs

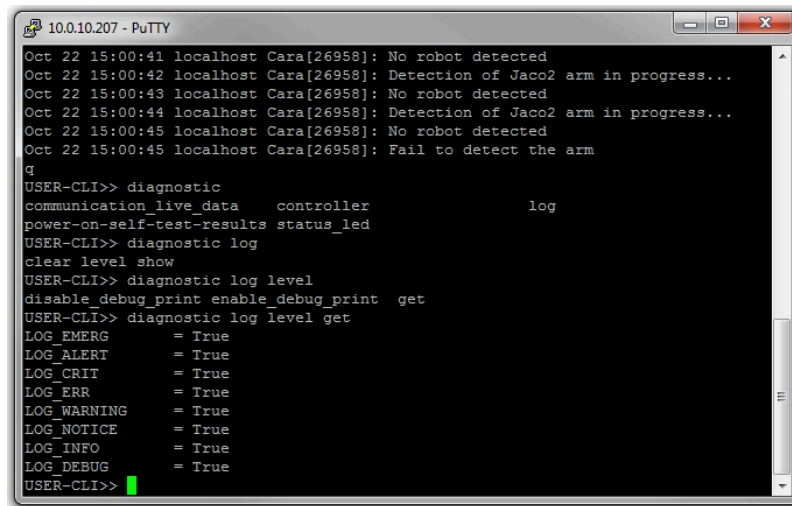


A screenshot of a PuTTY terminal window titled "PuTTY (inactive)". The window displays the text "Controller live data... Press q to exit" at the top. Below this, a list of controller data is shown in a key-value format. The data includes: Connected (True), LeftTrigger (0), RightTrigger (0), ThumbLX (1578), ThumbLY (3620), ThumbRX (742), ThumbRY (1691), and Buttons (0000000000000000).

```
PuTTY (inactive)
Controller live data... Press q to exit

Connected      : True
LeftTrigger    : 0
RightTrigger   : 0
ThumbLX        : 1578
ThumbLY        : 3620
ThumbRX        : 742
ThumbRY        : 1691
Buttons        : 0000000000000000
```

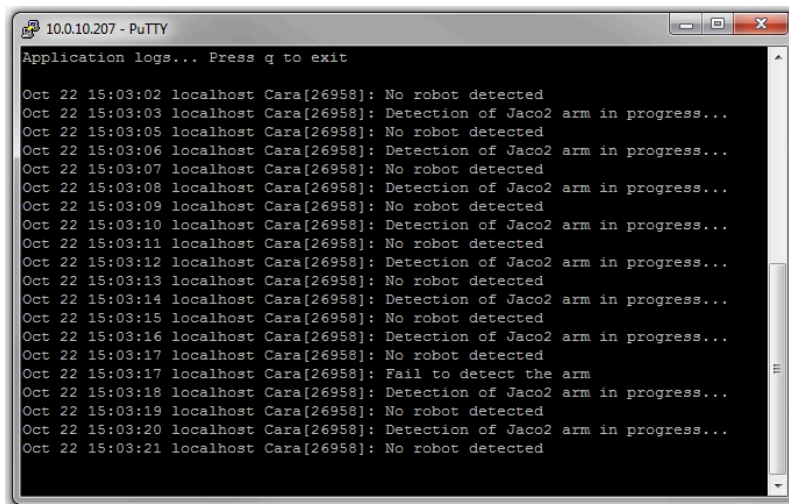
- log - access to logs
 - clear_logs - clears the currently saved logs
 - level - view and modify logging settings
 - disable_debug_print - disable logging of debugging data
 - enable_debug_print - enable logging of debugging data
 - get - displays current settings for types of logs that are recorded



```

10.0.10.207 - PuTTY
Oct 22 15:00:41 localhost Cara[26958]: No robot detected
Oct 22 15:00:42 localhost Cara[26958]: Detection of Jaco2 arm in progress...
Oct 22 15:00:43 localhost Cara[26958]: No robot detected
Oct 22 15:00:44 localhost Cara[26958]: Detection of Jaco2 arm in progress...
Oct 22 15:00:45 localhost Cara[26958]: No robot detected
Oct 22 15:00:45 localhost Cara[26958]: Fail to detect the arm
q
USER-CLI>> diagnostic
communication live_data      controller          log
power-on-self-test-results status_led
USER-CLI>> diagnostic log
clear level show
USER-CLI>> diagnostic log level
disable_debug_print enable_debug_print get
USER-CLI>> diagnostic log level get
LOG_EMERG      = True
LOG_ALERT      = True
LOG_CRIT       = True
LOG_ERR        = True
LOG_WARNING    = True
LOG_NOTICE     = True
LOG_INFO       = True
LOG_DEBUG      = True
USER-CLI>>
  
```

- show - display currently saved logs. You have the option to include a positive integer command line argument to specify that you only want to see a certain number of lines. For example, show 50 shows the first 50 lines of the log.

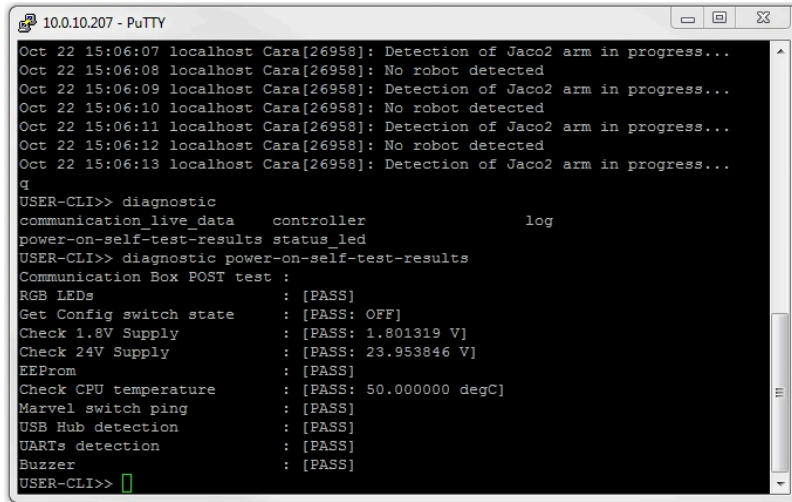


```

10.0.10.207 - PuTTY
Application logs... Press q to exit

Oct 22 15:03:02 localhost Cara[26958]: No robot detected
Oct 22 15:03:03 localhost Cara[26958]: Detection of Jaco2 arm in progress...
Oct 22 15:03:05 localhost Cara[26958]: No robot detected
Oct 22 15:03:06 localhost Cara[26958]: Detection of Jaco2 arm in progress...
Oct 22 15:03:07 localhost Cara[26958]: No robot detected
Oct 22 15:03:08 localhost Cara[26958]: Detection of Jaco2 arm in progress...
Oct 22 15:03:09 localhost Cara[26958]: No robot detected
Oct 22 15:03:10 localhost Cara[26958]: Detection of Jaco2 arm in progress...
Oct 22 15:03:11 localhost Cara[26958]: No robot detected
Oct 22 15:03:12 localhost Cara[26958]: Detection of Jaco2 arm in progress...
Oct 22 15:03:13 localhost Cara[26958]: No robot detected
Oct 22 15:03:14 localhost Cara[26958]: Detection of Jaco2 arm in progress...
Oct 22 15:03:15 localhost Cara[26958]: No robot detected
Oct 22 15:03:16 localhost Cara[26958]: Detection of Jaco2 arm in progress...
Oct 22 15:03:17 localhost Cara[26958]: No robot detected
Oct 22 15:03:17 localhost Cara[26958]: Fail to detect the arm
Oct 22 15:03:18 localhost Cara[26958]: Detection of Jaco2 arm in progress...
Oct 22 15:03:19 localhost Cara[26958]: No robot detected
Oct 22 15:03:20 localhost Cara[26958]: Detection of Jaco2 arm in progress...
Oct 22 15:03:21 localhost Cara[26958]: No robot detected
  
```

- `power-on-self-test` - displays results of power-on-self-tests (POST)

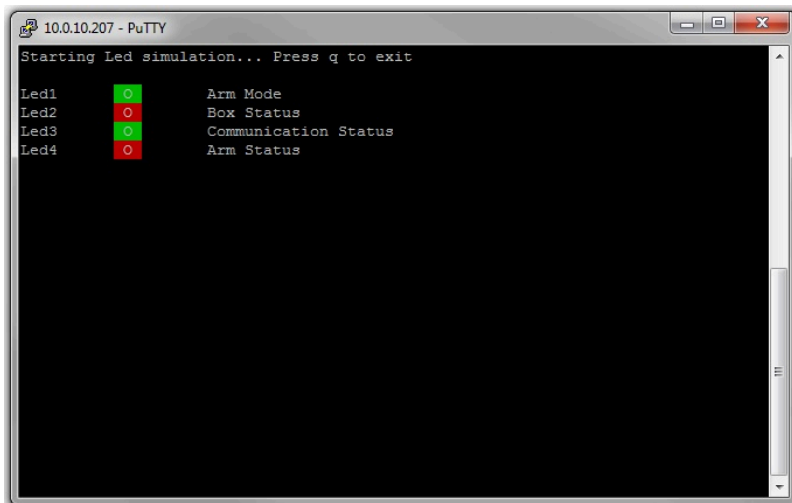


```

10.0.10.207 - PuTTY
Oct 22 15:06:07 localhost Cara[26958]: Detection of Jaco2 arm in progress...
Oct 22 15:06:08 localhost Cara[26958]: No robot detected
Oct 22 15:06:09 localhost Cara[26958]: Detection of Jaco2 arm in progress...
Oct 22 15:06:10 localhost Cara[26958]: No robot detected
Oct 22 15:06:11 localhost Cara[26958]: Detection of Jaco2 arm in progress...
Oct 22 15:06:12 localhost Cara[26958]: No robot detected
Oct 22 15:06:13 localhost Cara[26958]: Detection of Jaco2 arm in progress...
q
USER-CLI>> diagnostic
communication live data      controller      log
power-on-self-test-results  status_led
USER-CLI>> diagnostic power-on-self-test-results
Communication Box POST test :
RGB LEDs                    : [PASS]
Get Config switch state    : [PASS: OFF]
Check 1.8V Supply          : [PASS: 1.801319 V]
Check 24V Supply           : [PASS: 23.953846 V]
EEProm                     : [PASS]
Check CPU temperature       : [PASS: 50.000000 degC]
Marvel switch ping         : [PASS]
USB Hub detection          : [PASS]
UARTs detection            : [PASS]
Buzzer                     : [PASS]
USER-CLI>>

```

- `status_LED` - displays a real-time simulation of the status LEDs displayed on the adapter



```

10.0.10.207 - PuTTY
Starting Led simulation... Press q to exit

Led1    ON    Arm Mode
Led2    OFF   Box Status
Led3    ON    Communication Status
Led4    OFF   Arm Status

```

Advanced menu options

The `advanced` menu offers low level detailed configuration for the communication system.

Low-level configuration allows for advanced customizations, including network interface IP settings for connecting to a local area network.

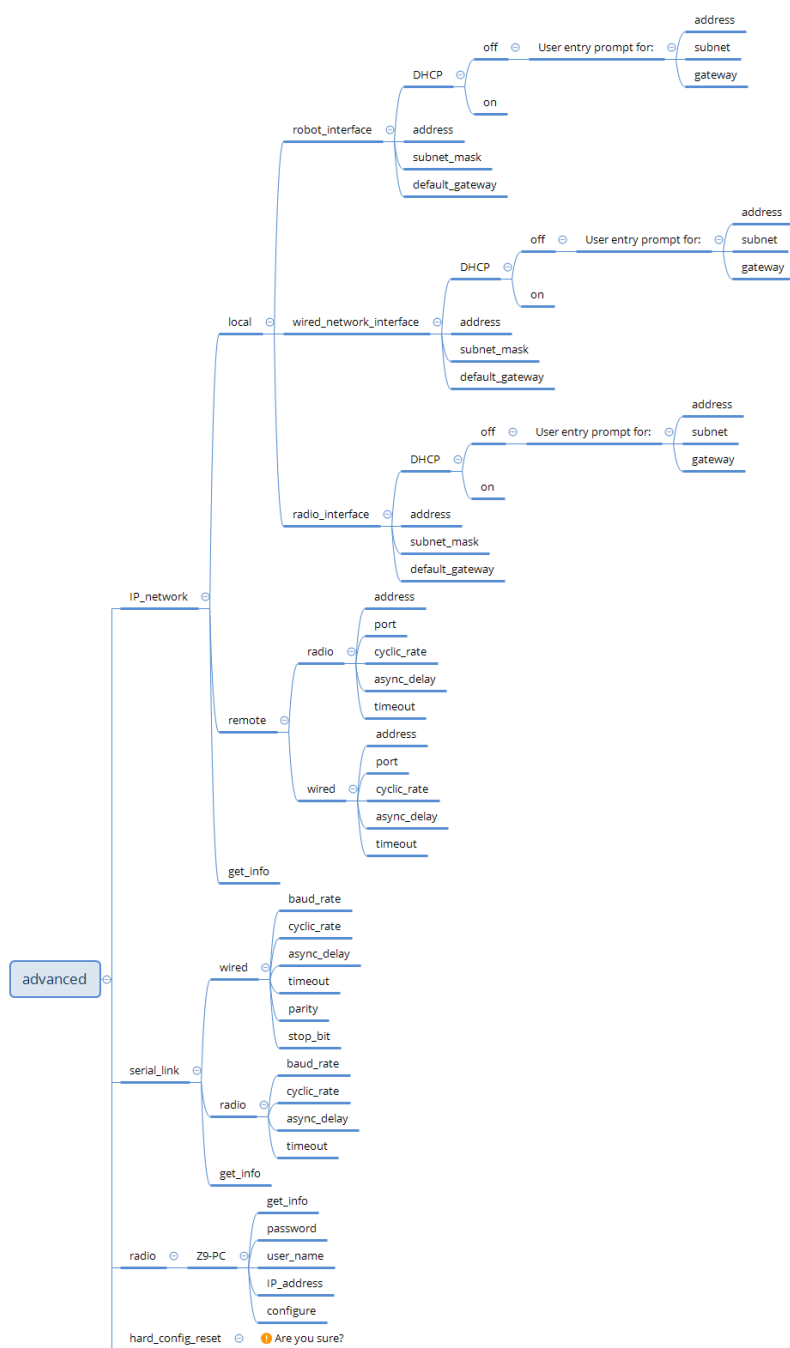


Note: The `advanced` menu is for advanced users only, and should only be modified with care. Incorrect settings may result in malfunctions or unpredictable behavior.



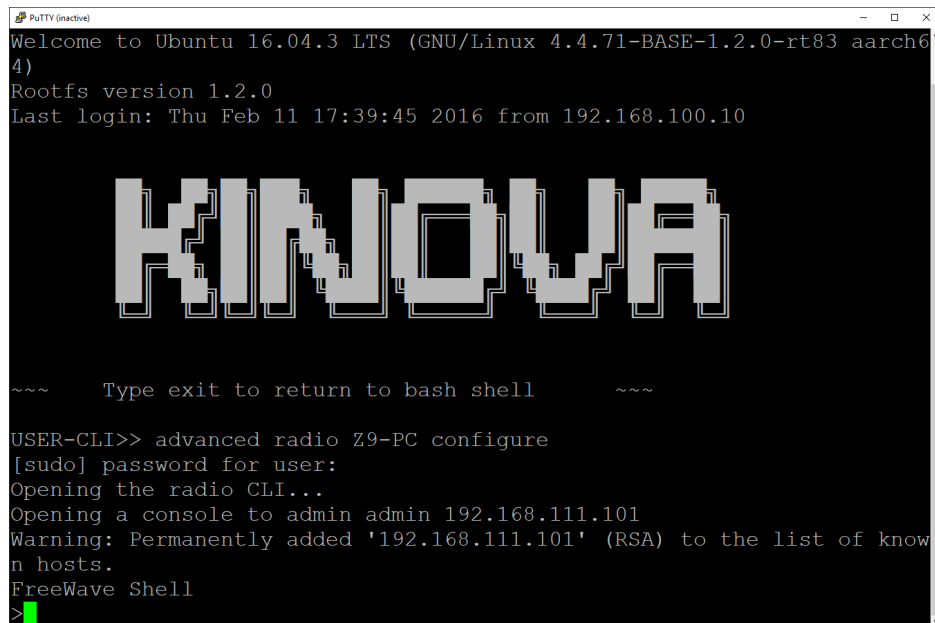
Note: The `load_factory_default` option in the `quickstart` menu is used to return to factory defaults in the event of problems caused by modifying advanced configuration settings.

The advanced menu offers four options.



- **IP network** - configure IP addresses and other network communication settings for the adapter
- serial_link (n/a)

- **radio** - view radio settings, and set the internal IP address and credentials for the radio
 - **Z9-PC**
 - **get_info** - get information about the radio settings
 - **password** - set password for the radio
 - **username** - set username for the radio
 - **IP_address** - identify internal IP address used for the radio (setting the IP address in the radio itself is done in the radio CLI, accessible via `advanced radio configure`)
 - **configure** - opens Z9-PC radio manufacturer (FreeWave) CLI shell



```

Putty (inactive)
Welcome to Ubuntu 16.04.3 LTS (GNU/Linux 4.4.71-BASE-1.2.0-rt83 aarch64)
Rootfs version 1.2.0
Last login: Thu Feb 11 17:39:45 2016 from 192.168.100.10

  KINOVA

~~~   Type exit to return to bash shell   ~~~

USER-CLI>> advanced radio Z9-PC configure
[sudo] password for user:
Opening the radio CLI...
Opening a console to admin admin 192.168.111.101
Warning: Permanently added '192.168.111.101' (RSA) to the list of known hosts.
FreeWave Shell
>
  
```

- **hard_config_reset** - this resets the communication adapter to preproduction (not configured) settings. You are prompted to confirm before proceeding.



Note: This option provides more than a simple factory reset rollback, and needs to be followed up with manual reconfiguration of the communication adapter. Ensure that you understand the consequences before using this option, which should only be used as a last resort if a factory reset does not work.

IP network menu

The `IP_network` menu is for configuring IP network settings for the nodes on the communication network.

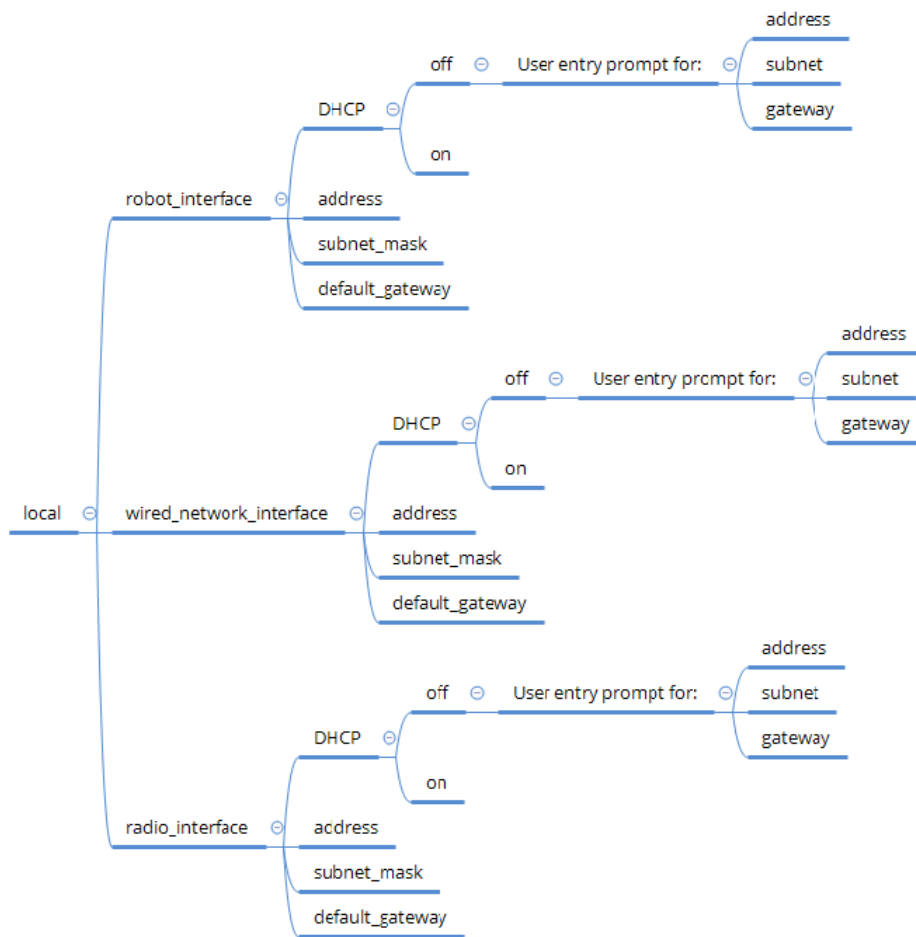
The menu offers three options.

- **Local** - configures the IP settings for the network interfaces of the communication adapter to which you are connected

- **Remote** - specifies the IP address and port settings of the other communication adapter, so that communications can be established using the available interfaces
- `get_info` - returns information about the IP settings of the communication adapter, as well as its MAC address.

Local adapter IP configuration menu

Use the `local` menu for the CLI application to configure IP settings for the communication adapter to which you are connected.



The `local` menu allows you to choose one of the (up to) three available network interfaces to configure

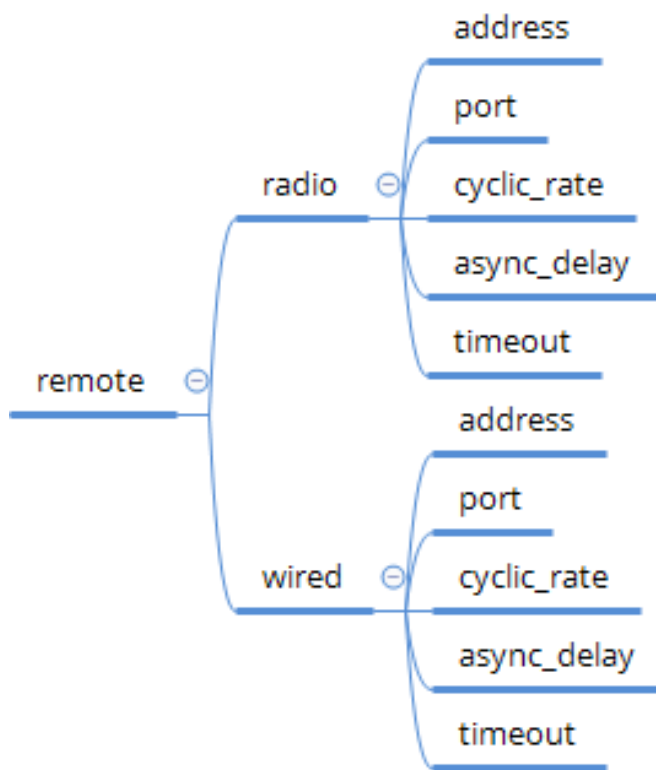
- `robot_interface`
- `wired_network_interface`
- `radio_interface` (radio model only)

Choosing any of the three available interfaces leads to a further menu tree. Each interface allows the same configuration options.

- DHCP `off` - Use static IP settings. Static IP assignment is the default. Selecting this option prompts user to set IP parameters one by one.
- DHCP `on` - if connecting to a local area network with DHCP server. Allows the DHCP server to assign an IP address automatically to the adapter when connected. This option is made available for the flexibility of end users, but it is not generally recommended to connect to a local area network. Contact Kinova support if this is an option that your organization is interested in exploring.
- `address` - set the IP address individually
- `subnet_mask` - set the subnet mask individually
- `default_gateway` - set the default gateway individually

Remote Adapter IP configuration menu

The `remote` adapter IP configuration menu for the CLI application is used for entering the IP address and port for the second communication adapter, so that the first can locate and communicate with the second.



The remote adapter menu lets you identify the settings used on either of the communication interfaces (wired or radio) on the other communication adapter.

- radio (available for radio model of adapter only)
 - address
 - port
 - cyclic_rate
 - async_delay
 - timeout
- wired_network_interface
 - address
 - port
 - cyclic_rate
 - async_delay
 - timeout



Note: To perform this configuration, you will need to first connect to the other communication adapter and obtain the IP address and port using **quickstart > get_system_info**.

Setting up the robot manipulator system

Before using the Gen2 Remote robot manipulation system, it must be installed in a specific order.

About this task

Setting up the robot manipulator system involves three procedures that must be performed in sequence.

Procedure

1. [Mount the robot support.](#)
2. [Install the robot on the robot support.](#)
3. [Install the video adapter.](#)

Mounting the robot support

The robot support is the first part of the system that must be installed.

Before you begin

The robot support can be mounted with 4 M6 socket head cap screws (SHCS) to a flat surface through pre-drilled holes on the bottom or rear face of the robot support. You must analyze your particular setup to determine which of the two plates to use for mounting - rear or bottom.



Note: There are holes for M5 screws on the left and right faces of the arm support. These holes are meant for mounting accessories onto the side of the arm support as needed, and are not for mounting the arm base itself onto a surface.

About this task

The robot support provides for a secure mechanical mounting of the robotic arm in the area it will be used. A flat surface (horizontal or vertical) is required to install the robot support. The robot support can be installed on either a fixed or mobile platform.

Procedure

1. On the mounting surface drill four holes based on the hole patterns of the robot support (thread tapping is optional).

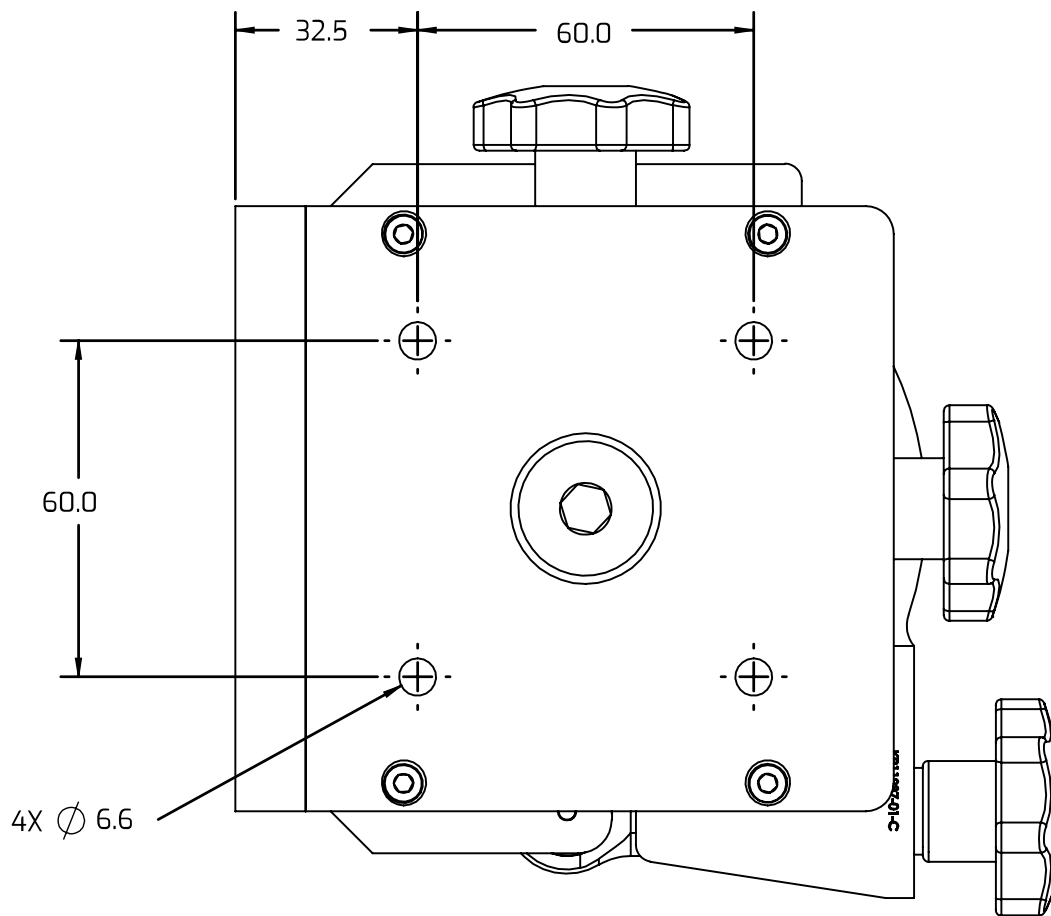


Figure 26: Bottom face hole pattern (all dimensions in mm)

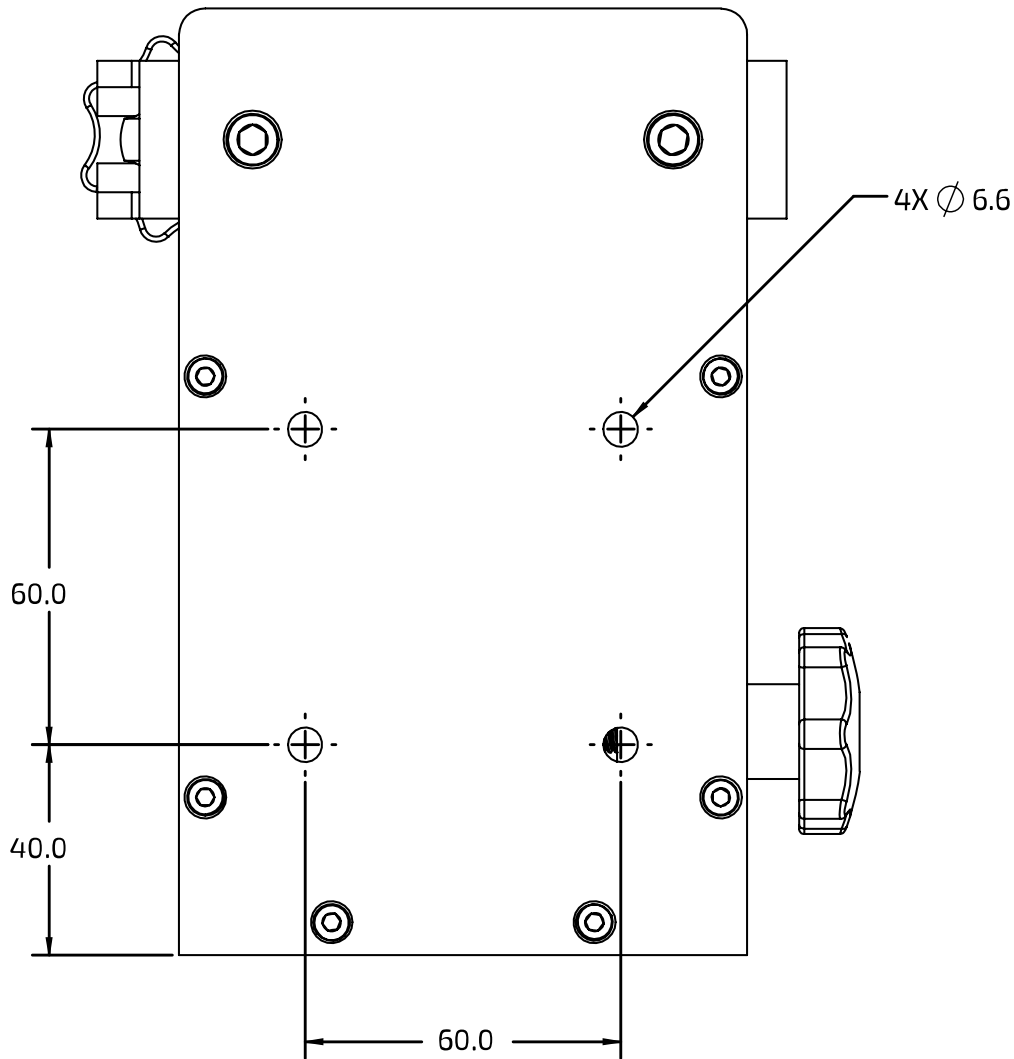


Figure 27: Rear face hole pattern (all dimensions in mm)

2. Attach the chosen mounting face of the robot support to the mounting surface using four M6 SCHS screws (and nuts, if required). The screws are to go from the inside of the support, through the face into the mounting surface. Torque until the support is firmly secured.

Installing the robot on the robot support

The robot is the second part of the system to be installed.

Before you begin

The robot support must already be mounted on the mounting surface.

About this task

Procedure

1. Lower the base of the robot over the robot support mounting post.
2. Tighten the two mounting post locking knobs (one on front, one on either of the sides) by turning them clockwise to secure the robot.
3. Swing the collar mechanism closed and slide the collar mechanism locking knob into the corresponding slot in the collar mechanism.
4. Turn the locking knob counter-clockwise by hand until the collar mechanism is securely closed.



Note: Do not over-tighten the locking knob.

5. Connect the robot to battery power by connecting one end of the provided power cable to the power connector of the robot and the other to the battery power supply.

Installing the video adapter

The video adapter the last part to be installed.

Before you begin

You must analyze your particular setup to determine the most convenient location to mount the video adapter. The mounting location needs to be close to that of the arm support to allow for a video cable connection to the robotic arm mounted in the arm support.



Note: The video adapter must be installed with the connectors facing down (+/-) 15° to protect against water ingress.

About this task

The video adapter can be mounted with four M5 screws to a flat surface through pre-drilled holes on the mounting flanges of the adapter.

Procedure

1. Drill four holes in a flat mounting surface using the mounting hole pattern of the video adapter mounting flanges as a guide.

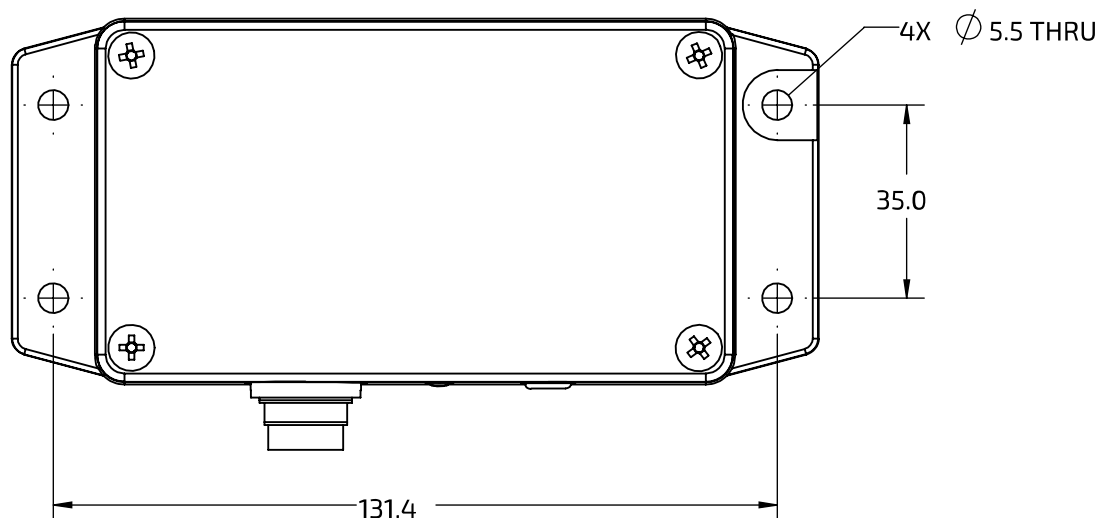


Figure 28: Video adapter flange mounting holes (measurements in mm)

2. Secure the video adapter to the surface using four M5 screws (and nuts, if applicable).
3. One of the mounting holes has an exposed grounding connection. Connect this to ground.
4. Connect the video cable from the robotic arm base to the power/video in connector of the video adapter.
5. Connect the video out RCA connector to your video monitor.

Setting up the Communication system

The Communication system must be set up by installing the two adapters and establishing a communication link.

About this task

Setting up the communication system consists of three steps that must be performed in sequence.

Procedure

1. [Installing the Operator Adapter](#)
2. [Installing the Remote Adapter](#)
3. [Establishing a communication link](#)

Mounting a communication adapter

The Communication Adapter must be installed on a flat surface.

About this task

The Communication Adapters come with mounting flanges for mounting with screws to a stable surface.



Note: When not in use, the USB connectors on the Communication Adapters (gamepad connectors) must be plugged with the provided plug when not in use. This is to guard against water ingress in the connectors.

Procedure

1. At the desired mounting location, mark, drill four M5 holes into a flat, horizontal mounting surface according to the hole pattern of the Communication Adapter flanges.

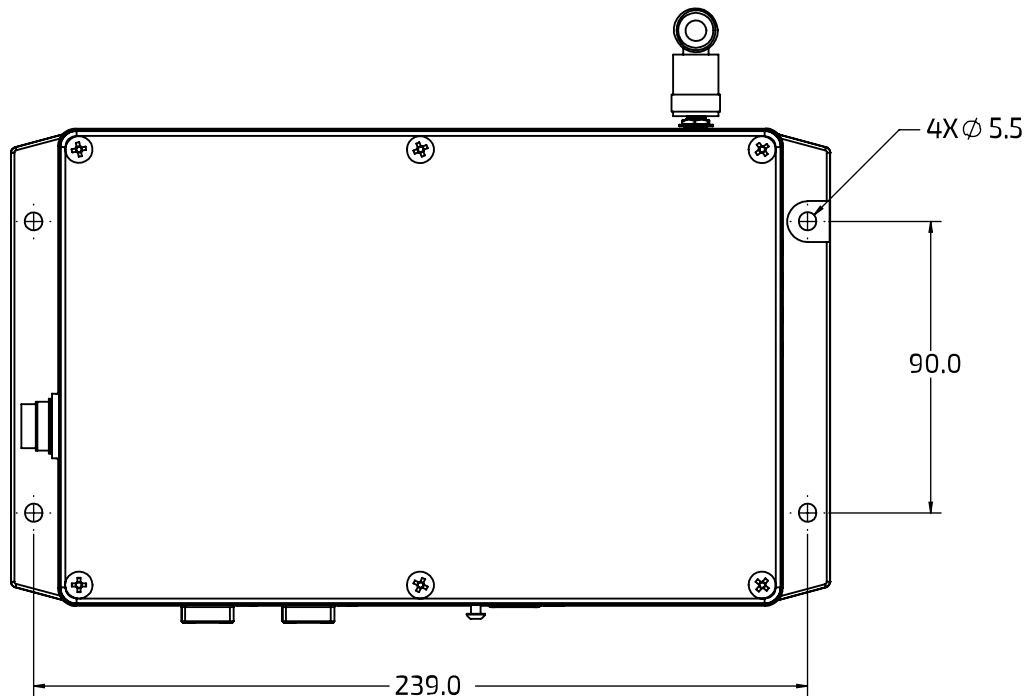


Figure 29: Communication Adapter mounting holes (all measurements in mm)

2. Place the Communication Adapter flat on the surface with the mounting holes on the Communication Adapter aligned with the four holes drilled in the surface.
3. Using four M5 screws, fix the Communication Adapter enclosure to the surface.
4. One of the mounting holes has an exposed grounding connection. Connect this to ground.
5. Connect the cables.

Installing the Operator Adapter (OA)

The Operator Adapter must be installed and then connected.

Before you begin

You must choose a location, whether fixed or mobile, to set up the operator station from which the user can control the remote robot. A local battery power supply for the operator adapter is also required.

About this task

Mounting the Operator Adapter uses the same general steps as mounting any Communication Adapter.

Procedure

1. [Mount the Operator Adapter](#) on a flat surface (this step is optional).
2. Connect the OA power connector to one end of the supplied power cable.
3. Connect the leads on the other end of the power cable to the battery terminals, respecting the indicated polarity.
4. Connect the micro USB end of the supplied USB cable to the Xbox connector.
5. Connect the Type-A end of the supplied USB cable to the OA USB connector.

Installing the Remote Adapter (RA)

The Remote Adapter must be installed and then connected.

Before you begin

You must choose a location, whether fixed or mobile, for the remote station where the robotic arm is installed. You also need a local battery power supply for both the remote adapter and the robotic arm.

About this task

Mounting the Remote Adapter uses the same general steps as mounting any Communication Adapter.

Procedure

1. [Mount the Remote Adapter](#) on a flat surface (this step is optional).
2. Connect the RA power connector to the supplied power cable.
3. Connect the leads on the other end of the supplied power cable to the battery terminals, respecting the indicated polarity.
4. Connect one end of the supplied RJ-45 cable to the RA Robot Network RJ-45 connector.
5. Connect the other end of the supplied RJ-45 cable to the RJ-45 connector on the base connector panel of the robotic arm.

Establishing a communication link

for the Gen2 Remote robot manipulation system to work, a communication link must be established between the robot and the adapters.

The communication adapters, when equipped with radio and antenna, allow for two forms of communication:

- radio link, wireless (up to 300 m line-of-sight)

- Ethernet link, wired (up to 100 m without repeater)

For communication adapters without the optional radio and antenna, only the wired link is available.

General steps

1. Ensure that the robot and both communication adapters are connected to electrical power.
2. Ensure that the remote adapter robot connector is connected to the robot RJ-45 connector.
3. Ensure that the Xbox gamepad is connected to the operator adapter USB connector.

Establishing a wired link

To establish a wired communication link:

1. Connect one end of an RJ-45 (Ethernet) cable to the operator adapter network connector.
2. Connect the other end of the same RJ-45 cable to the remote adapter network connector.

Establishing a radio communication link

Following the general steps listed above.

In addition, ensure that there is an unobstructed line-of-sight between the operator adapter antenna and the remote adapter antenna.

Testing the communication link

To test the communication link, operate the controller to confirm that the robot and its end effector are responding. It may be helpful to have another person to help perform this test.

Controlling the gripper and gripper adapter using Xbox gamepad

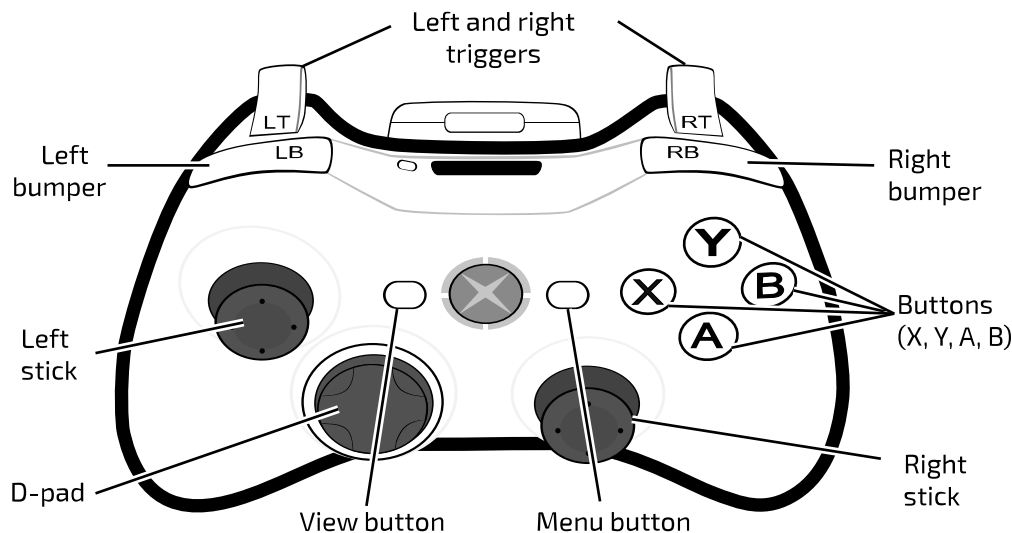
The gripper and gripper adapter are operated using an Xbox One gamepad.

There are several actions that can be taken related to the gripper and gripper adapter. These actions are mapped to the controls.

- Selection of the control mode
- Movement of the gripper - in Cartesian mode: translation and orientation
- Opening and closing the gripper
- Turning the positioning guidance laser on and off
- Turning the white and infrared LED illumination sources on and off

Gamepad controls

The gamepad offers several controls.



Gripper and gripper adapter control modes

The gamepad has changeable control modes for the gripper and gripper adapter.

There are four control modes available for controlling the gripper and gripper adapter using the communication system gamepad.

1. Camera reference mode - translate and change the orientation of the gripper from the perspective of a Cartesian coordinate system attached to the gripper adapter camera. Also, open and close the gripper fingers. This control mode is useful when controlling the system with visual feedback from the video camera.

2. Robot base reference mode - translate and change orientation of the gripper in Cartesian coordinates from the point of view of a user standing behind the robot looking forward. Also, to open and close the gripper fingers.
3. Go-to position - Save a position or command the gripper to move to a defined position.
4. Laser control mode - Control the intensity level for white and IR LEDs and toggle the laser.

Changing control mode

In all control modes, the A, B, X, and Y buttons on the gamepad are set aside for the purpose of selecting and changing the control mode.

Table 5: Mode Select control mapping

Control	Mode		
buttons	A	mode select	Go-to position mode
	B		LED/laser mode
	X		Camera reference mode (Cartesian)
	Y		Base reference mode (Cartesian)

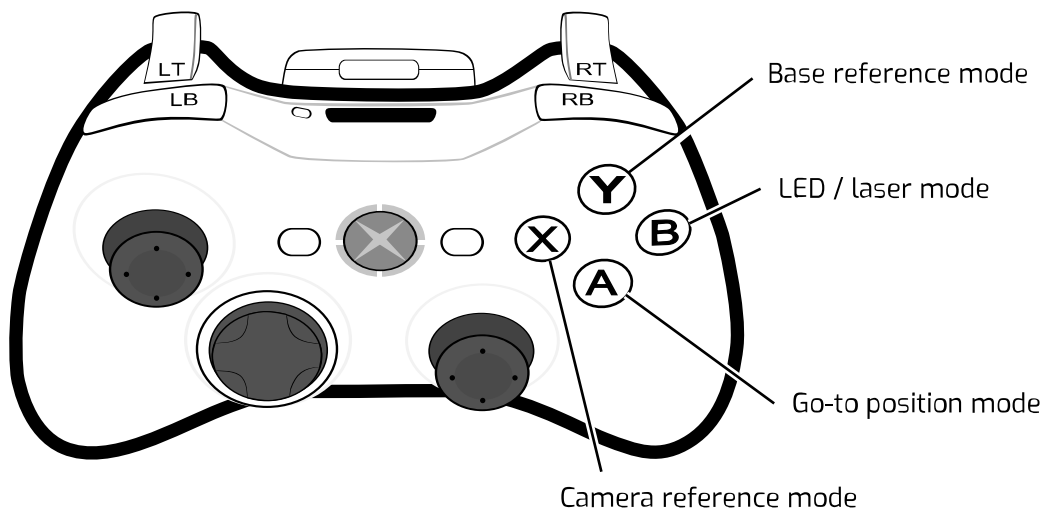


Figure 30: Mode Select controls

Camera reference control mode

Camera reference control mode controls the motion of the gripper in Cartesian coordinates with respect to the perspective of the view from the gripper adapter camera.

The camera reference control mode controls translation of the gripper in three dimensions and rotation on three axes. Activate the camera reference control mode by pressing the X button.

Table 6: Camera reference control mode mapping

Control		Action	
triggers	left/right	backward/forward	translate gripper
left stick	left/right	left/right	
	down/up	down up	
right stick	left/right	yaw left/right	rotate gripper
	down/up	pitch down/up	
bumpers	left/right	roll left/right	
D-pad	left/right	open/close	gripper fingers
	up/down	increase/decrease	gripper speed
buttons	Menu (held)	robot arm + gripper initialize	home/retract robot and open gripper
	View (held)	robot arm home/retract	home/retract robot without opening gripper

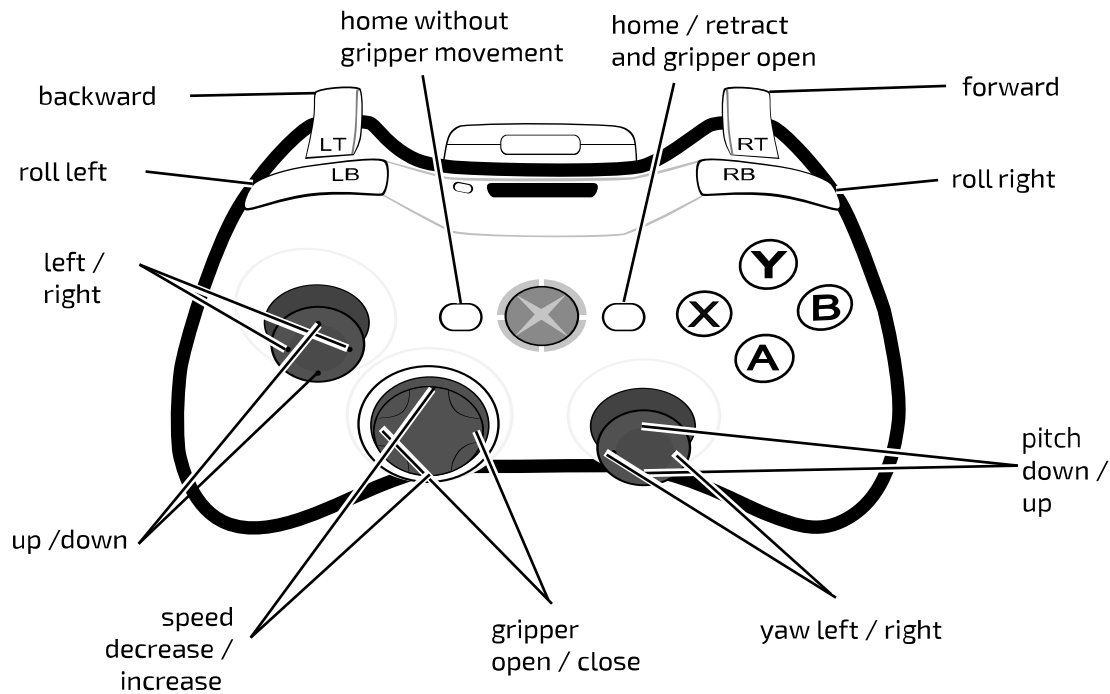


Figure 31: Camera reference controls diagram

Robot base reference control mode

Robot base reference control mode controls the motion of the gripper in Cartesian coordinates with respect to the perspective of the view from the back of the robot base, looking forward.

Activate the robot reference control mode by pressing the Y button.

Table 7: Robot base reference control mode mapping

Control		Action	
triggers	left/right	down/up	move gripper
left stick	left/right	left/right	
	down/up	backward/forward	
right stick	left/right	yaw left/right	rotate gripper
	down/up	pitch down/up	
bumpers	left/right	roll left/right	
D-pad	left/right	open/close	gripper fingers
	up/down	increase/decrease	gripper speed

Control		Action	
buttons	Menu (held)	robot arm + gripper initialize	home/retract robot and open gripper
	View (held)	robot arm home/retract	home/retract robot without opening gripper

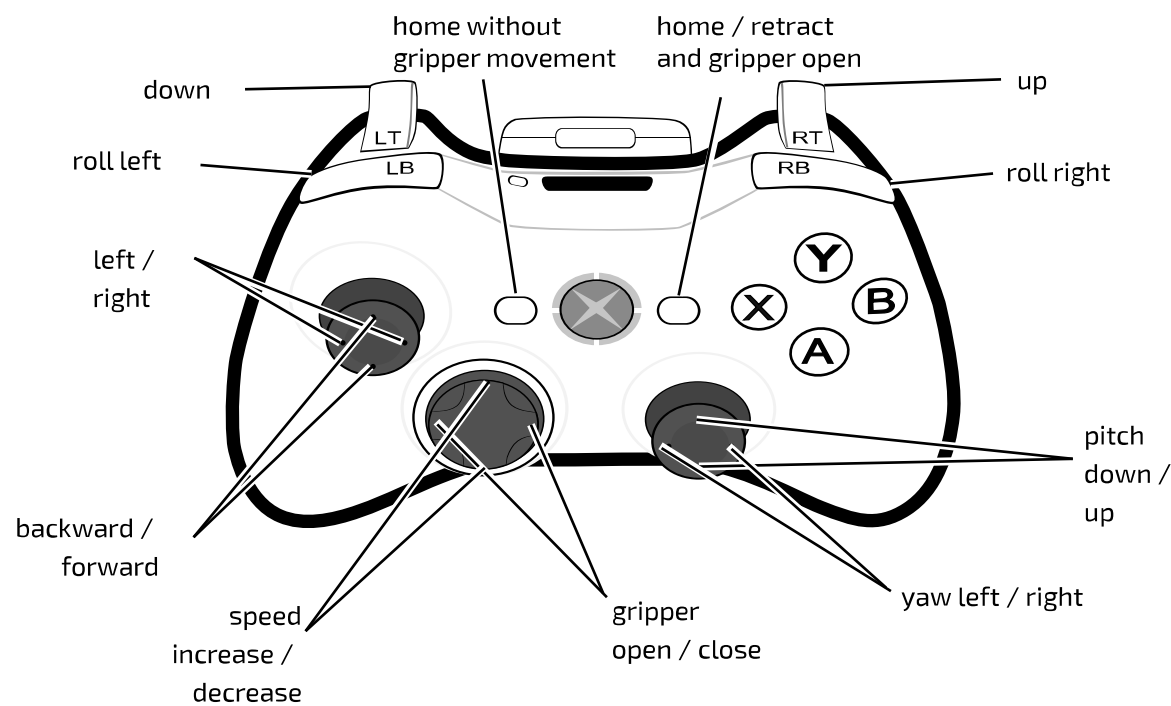


Figure 32: Robot base reference controls diagram

Go to position control mode

The Go to position control mode saves a position or command the gripper to go to a saved position.

Activate the go to position control mode by pressing the A button.

Table 8: Go to position control mode mapping

Control		Action	
left stick	Hold down one second	save position 1	
right stick	Hold down one second	save position 2	
bumpers	left/right	saved position 1/saved position 2	go to position

Control		Action
button	Menu (held)	go to shipping case pose (for ease of putting the robot back in the shipping case for transport)

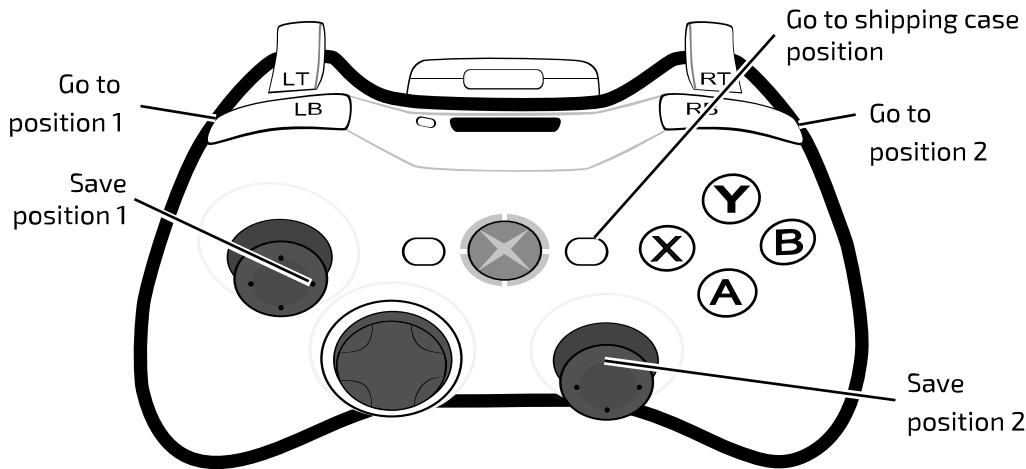


Figure 33: Go to position controls diagram

LED/laser control mode

The LED/laser control mode controls the positioning laser and the LEDs for illumination.

Activate LED/laser control mode by pressing the B button.

Table 9: LED/laser control mode mapping

Control		Action	
bumper	left	cycle white LED intensity	0 1 2 3 4
bumper	right	cycle IR LED intensity	0 1 2 3 4
button	Menu	toggle laser	on/off

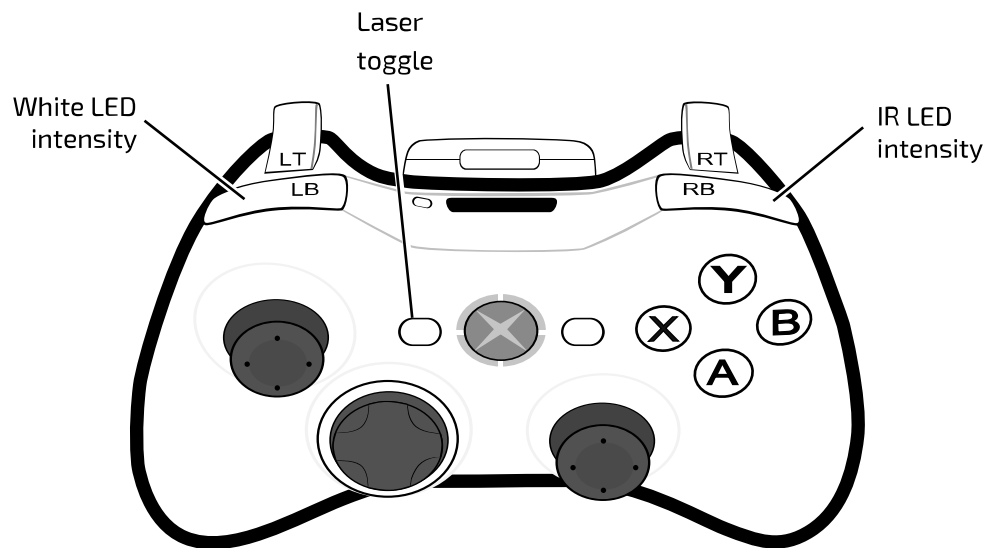


Figure 34: LED/laser controls diagram

Robot manipulator system configuration

The Gen2 Remote robot manipulation system must be configured before use.

There are three basic steps in configuring the Gen2 Remote robot manipulation system.

- Adjust the angle of the laser.
- View the test video link.
- Set the protection zone.

Adjusting the laser angle

The tilt angle of the laser on the gripper adapter can be adjusted between 0° (horizontal position) and 30° degrees downward.

The tilt angle can be adjusted with a 2.5 mm hex key by turning a screw on the back of the gripper adapter.

Turning the screw clockwise moves the screw inward and tilts the laser beam downward.

Turning the screw counterclockwise moves the screw outward and raise the laser beam upward.



Note: While the screw stops at the forward limit of the laser in the clockwise direction, there is no limit in the counterclockwise direction. Be careful not to turn the screw too far counterclockwise, or the screw will come out all the way.

Viewing the video adapter output

It is important to view the output of the video adapter to ensure the system works as expected.

Before you begin

You must have a monitor or television with an RCA composite input.

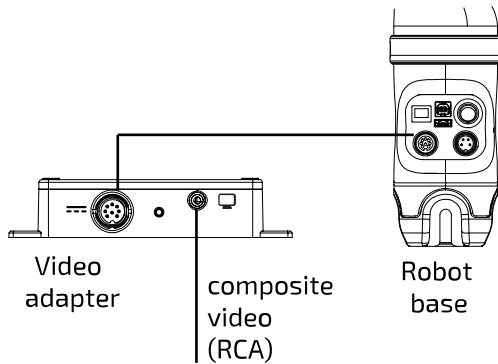
About this task

The gripper adapter camera produces an analog video signal. This video signal is accessible at the video adapter.

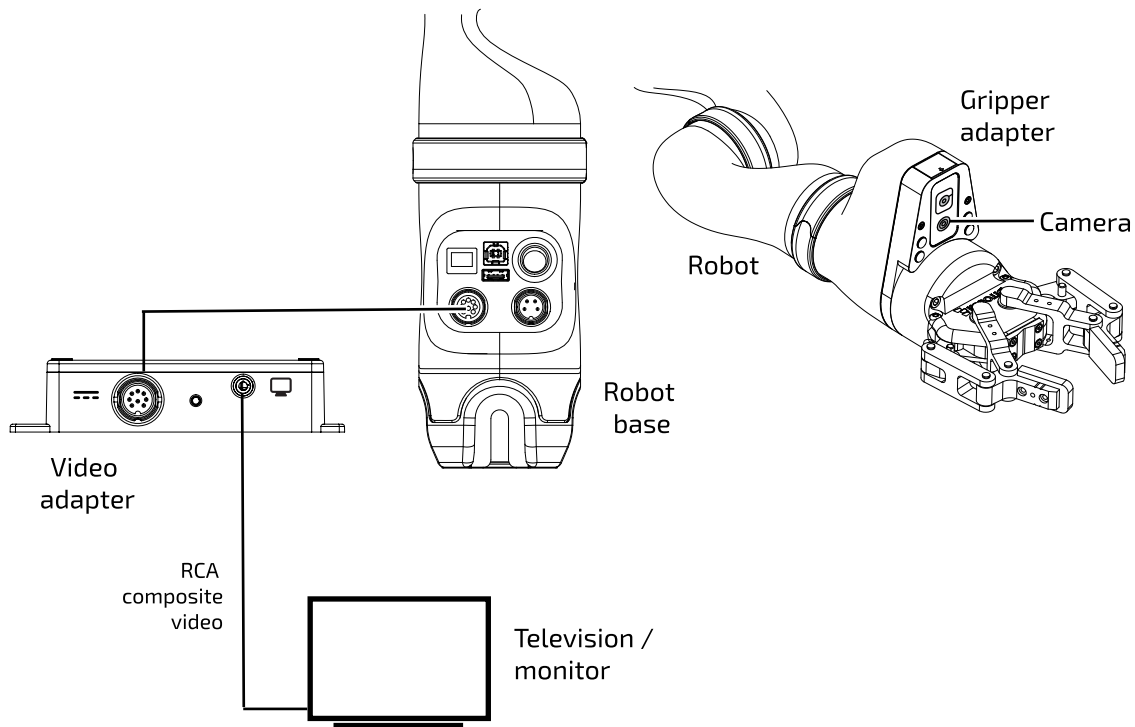
Procedure

1. Power on the security arm system using the power switch on the base of the robotic arm.

2. Connect one end of a RCA composite video cable to the RCA out connector on the video adapter.



3. Connect the other end of the RCA composite video cable to the RCA composite input of the monitor/television.



4. Power on the monitor or the television and select the RCA composite video input for display.

Results

You should be able to view the video from the gripper adapter camera on the screen.

Setting up a robot protection zone

Set up a protection zone for the robot to avoid collisions, using the Communication System Command Line Interface (CLI).

Before you begin

Open a ssh session with the communications adapter that is connected to the robot (remote adapter).

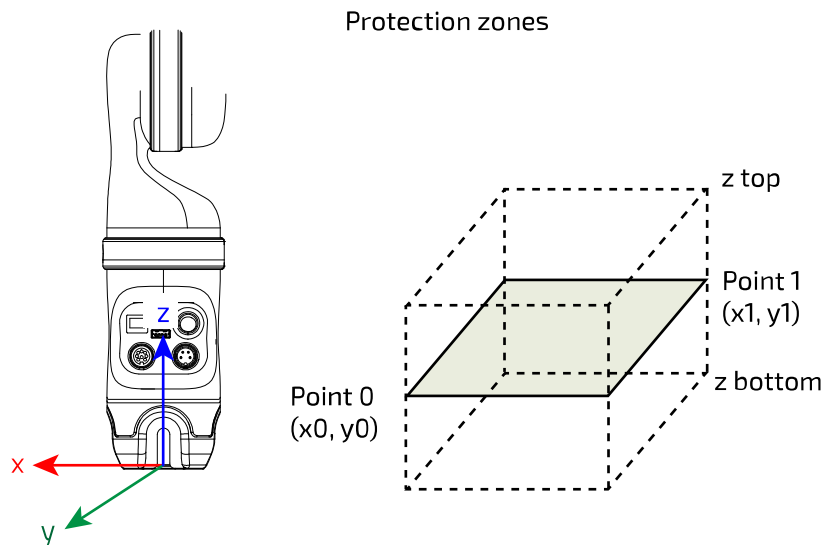
About this task

Using the CLI, it is possible to set up a protection zone for the robot via the communication adapter connected to the robot. A protection zone is a box-shaped region around the robotic arm which the gripper is prevented from entering.



Note: Protection zones can only be successfully configured from the remote adapter (the adapter connected to the robot). If you connect to the operator adapter and perform the procedure, the CLI does display any errors, but the protection zone DOES NOT take effect on the robot.

Configuring a protection zone involves setting two points, point 0 and point 1, to define the diagonal limits of the horizontal rectangular cross-section, as well as the bottom and top z limits of the zone.



Procedure

1. **Create a new zone:** Type `configuration features protection_zone add 3` and hit enter to create a new protection zone with zone ID 3.

2. Configure the zone dimensions:

- a) **Configure point 0** (for example, to (0.30, 0.40)) - **x value:** configuration features protection_zone write x 3 0 0.30, **y value:** configuration features protection_zone write y 3 0 0.40
- b) **Configure point 1** (for example, to (0.60, 0.80)) - **x value:** configuration features protection_zone write x 3 1 0.60, **y value:** configuration features protection_zone write y 3 1 0.80
- c) **Configure z_bottom** (for example, to 0.20) - configuration features protection_zone write z_bottom 3 0.20
- d) **Configure z_top** (for example, to 0.60) - configuration features protection_zone write z_top 3 0.60

3. Enable the protection zone: Type configuration features protection_zone enable 3.

4. Send to the robot: Type configuration features protection_zone send.

Results

The protection zone is now configured and enabled on the robot.

Communication system configuration

The communication system when sold as two paired communication adapters is configured to work out of the box using default settings without any configuration involved.

However, when buying a single communication adapter, some configuration is required, with the specifics depending on the intended use:

- to configure a new communication adapter as a Single Adapter
- to integrate a replacement communication adapter in the case of a malfunctioning unit; some configuration is required to "pair" the new communication adapter to the existing communication adapter
 - pairing for wired communications
 - pairing for radio communications

Communication adapters can be configured using the CLI tool. This tool can be accessed from a PC via a ssh connection to the adapter over wired Ethernet connection.

The following materials are intended to guide you through the three basic configuration scenarios above, with the assumption that you are reasonably familiar with command line interfaces and basics of network configuration.

If you have more complex configuration needs or require more specific guidance, please contact Kinova support at support@kinova.ca.

Opening a secure shell session between a PC and a communication adapter

Configure your PC Ethernet adapter and open a secure shell to the communication adapter using PuTTY running under Windows 10.

About this task

For any tasks which involve the use of the Command Line Interface (CLI), the Ethernet adapter on your computer must first be configured for use with the communication adapter, and a secure shell (ssh) connection established.

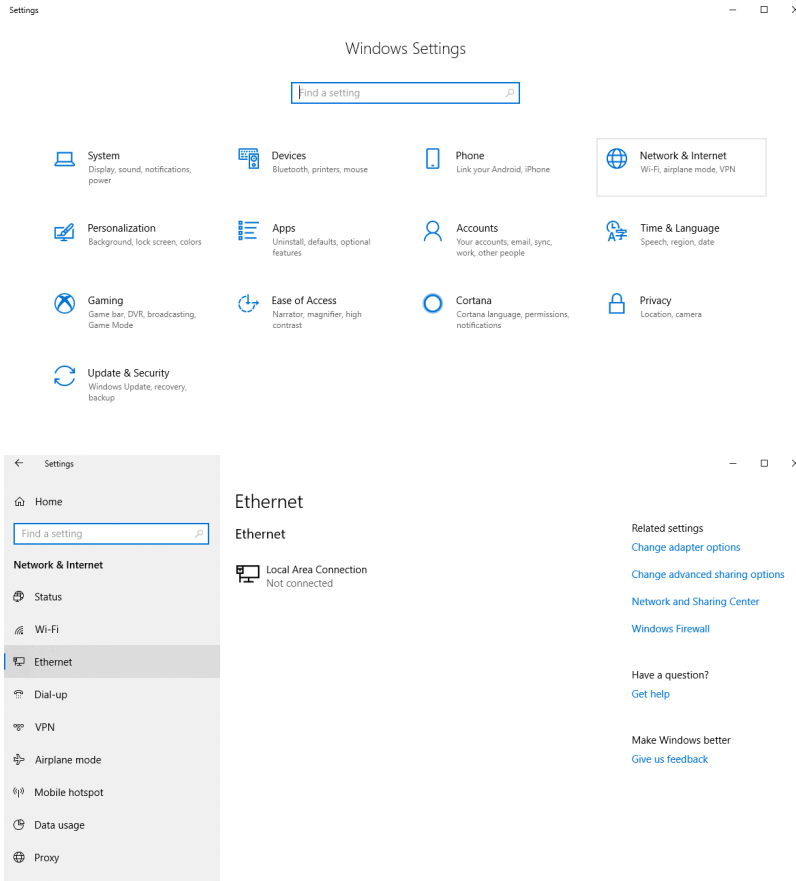


Note: Neither the PC, nor the communication adapter must be connected to a corporate network

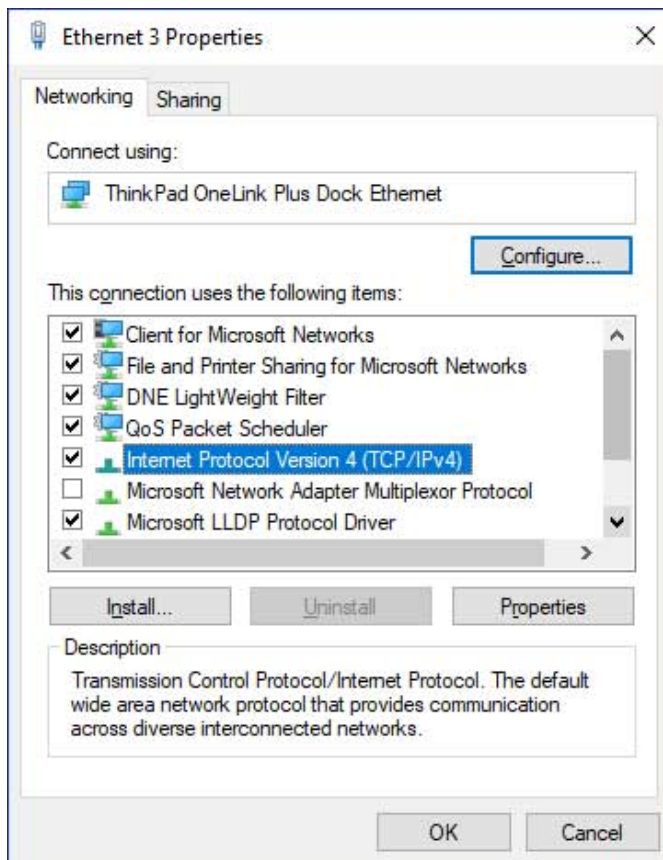
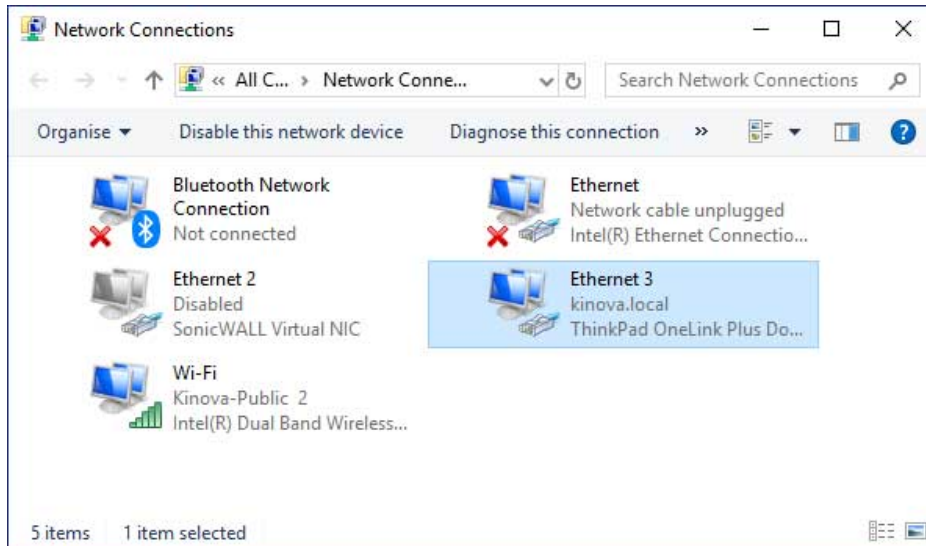
Procedure

1. Connect the Ethernet port of a PC or laptop to the robot network connector  on the communication adapter you want to configure, using a standard RJ-45 (Ethernet) cable.

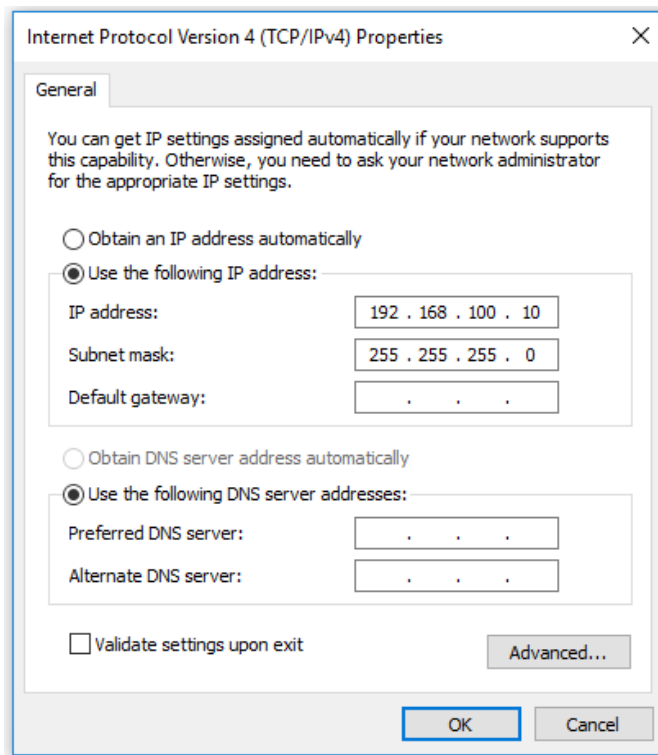
2. Power on the adapter to be configured (and remove power to any other adapter on the same network)
3. In Windows 10 Settings, click **Network & Internet**, then **Ethernet**, followed by **Change adapter options**.



4. Right-click the Ethernet interface to be configured, and select Properties to open the Local Area Connection Properties window. Select Internet Protocol Version 4 (TCP/IPv4), ensuring that the corresponding checkbox is ticked:

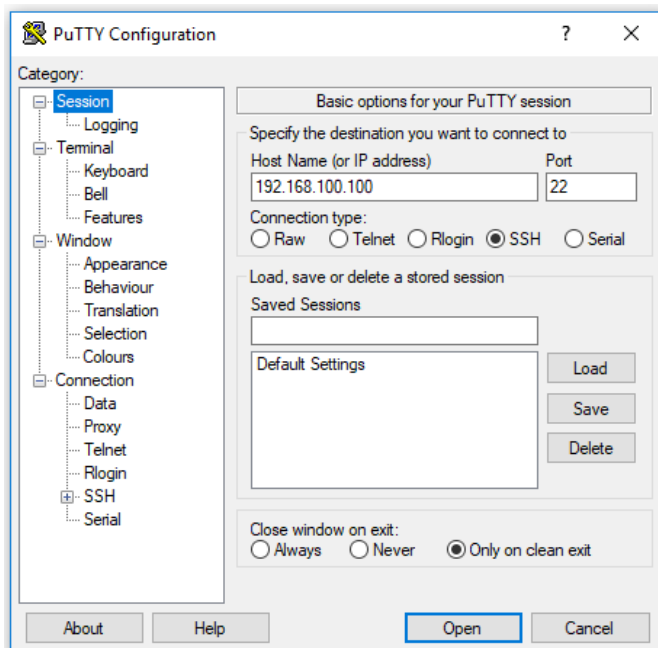


- Click **Properties**, choose to use a static address, and enter a compatible IP address (192.168.100.10) and address mask (255.255.255.0) as indicated below. When you are finished, click **OK**.

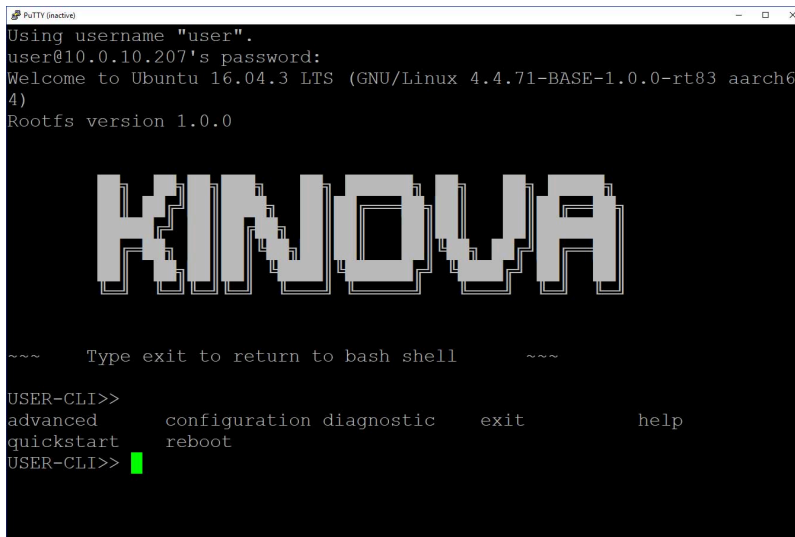


- Using a terminal emulator that supports SSH, open a secure shell session. Use [PuTTY](#).
- Launch PuTTY.

The PuTTY Configuration dialog launches.



8. Click the **SSH** radio button under the **Session** tab and set the IP address to that of the robot interface of the communication adapter: 192.168.100.100
9. Click **Connection > Data**, set the Auto-login username to `user`.
10. Return to the **Session** tab, select **Default Settings** and click **Save**.
11. Click **Open** and enter the password at the prompt (default is `user`).
12. The `USER-CLI>>` prompt indicates that the CLI script is running and ready to accept commands. Type `<TAB>` to display the available commands.



```
Putty (inactive)
Using username "user".
user@10.0.10.207's password:
Welcome to Ubuntu 16.04.3 LTS (GNU/Linux 4.4.71-BASE-1.0.0-rt83 aarch64)
Rootfs version 1.0.0

  KINOVA

~~~  Type exit to return to bash shell  ~~~

USER-CLI>>
advanced      configuration diagnostic  exit           help
quickstart    reboot
USER-CLI>>
```

What to do next

Once connected to the CLI, you can perform various configurations on the communication adapter.

Set a communication adapter to Single Adapter mode

When there is only one Communication Adapter, it must be set to Single Adapter mode.

Before you begin

[Open a secure shell connection](#) between your computer and the Communication Adapter.

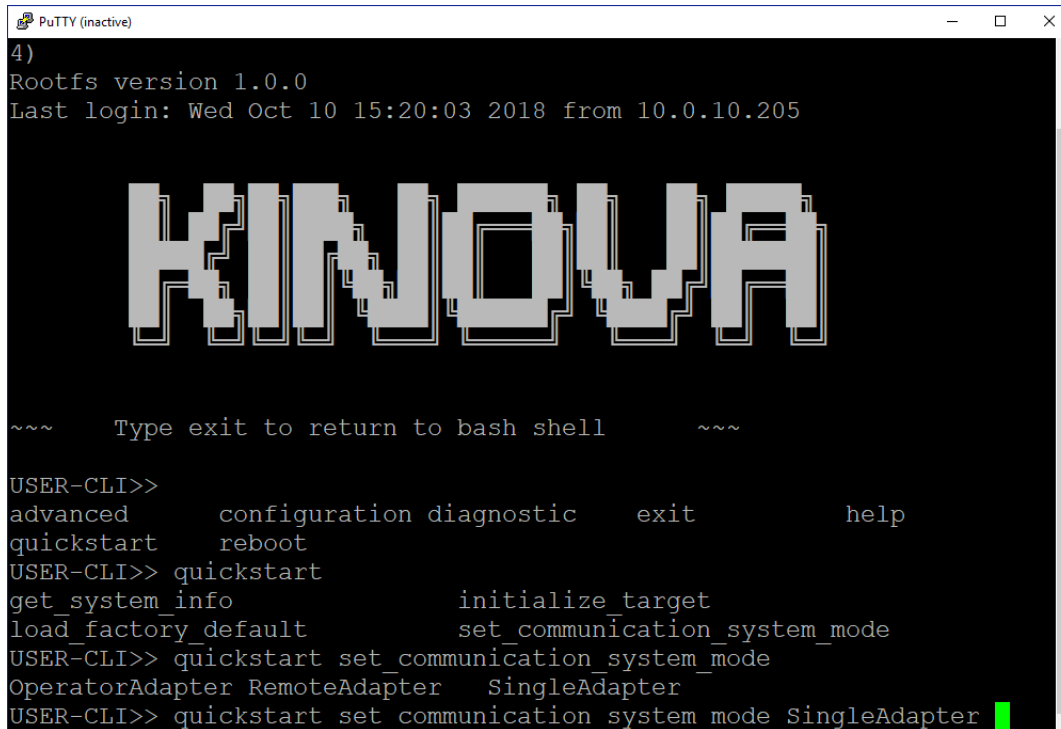
About this task

Communication adapters are configurable, and can be used either as a pair for remote teleoperation over a distance, or as a Single Adapter in Single Adapter mode. In Single Adapter mode the operator controls the robot with a single communication adapter. To use the Communication Adapter in Single Adapter mode, it is necessary to configure it as a Single Adapter. This is done using the Command Line Interface Shell (CLI).

Procedure

1. In the CLI, select `quickstart` to go to the Quickstart menu.

2. Select `set_communication_system_mode` from the Quickstart menu.
3. Type `SingleAdapter` followed by `<Enter>`.



```
PuTTY (inactive)
4)
Rootfs version 1.0.0
Last login: Wed Oct 10 15:20:03 2018 from 10.0.10.205

  K I N O V A

~~~   Type exit to return to bash shell   ~~~

USER-CLI>>
advanced      configuration diagnostic  exit          help
quickstart    reboot
USER-CLI>> quickstart
get_system info          initialize target
load_factory default     set_communication_system_mode
USER-CLI>> quickstart set_communication_system_mode
OperatorAdapter RemoteAdapter  SingleAdapter
USER-CLI>> quickstart set_communication_system_mode SingleAdapter █
```

4. Reboot the communication adapter for the changes to take effect.

Results

The communication adapter mode is now set to Single Adapter.

What to do next

You can now connect the robot and the Xbox gamepad to the Single Adapter and operate the robot using the gamepad.

Pairing a new communication adapter for wired communication

When there are two Communication Adapters, they must be paired. Wired communication is one of the ways they can be paired.

About this task

This procedure configures the two communication adapters to communicate with each other over wired communications. In general, this requires configuration on each of the communication adapters, remote and operator adapter. The complete pairing procedure performs the configurations on each adapter to put the wired communication configurations to

the same default settings Kinova uses when configuring a pair of adapters before sending to a customer.



Note: If you are confident that the existing communication adapter has been kept in the same default static IP settings since it was first received, then no configurations are required on the existing adapter, only the new adapter. However, for the sake of completeness, the following sections will describe the full configuration of both adapters. To ensure a proper configuration, Kinova recommends to follow the complete procedure in general with both communication adapters.

Procedure

1. [Configuring the Remote Adapter for paired wired communication.](#)
2. [Configuring the Operator Adapter for paired wired communication.](#)

Configuring Remote Adapter for paired wired communication

Configure a remote adapter for paired wired communication.

Before you begin

[Open a secure shell connection](#) between your computer and the robot port of the Remote adapter.

Procedure

1. Change the controller type to be a Remote Adapter: CLI -> `quickstart`
`set_communication_system_mode RemoteAdapter`
2. Set the IP of the Wired interface: CLI -> `advanced ip_network local`
`wired_network_interface address` . Enter the following IP: 172.16.0.11
3. Set the Subnet Mask of the Wired interface: CLI -> `advanced ip_network local`
`wired_network_interface subnet_mask` Enter the following IP: 255.255.255.0
4. Set remote wired IP: CLI -> `advanced ip_network remote wired address 172.16.0.10`
5. Set wired Ethernet communication mode: CLI -> `configuration communication`
`configure wired ethernet`
6. Reboot the adapter: CLI -> `reboot`
7. Close the ssh window used for the Remote Adapter.

Configuring Operator Adapter for paired wired communication

Configure an Operator Adapter for paired wired communication.

Before you begin

[Open a secure shell connection](#) between your computer and the robot port of the Operator adapter.

Procedure

1. Change the controller type to be a Operator Adapter : CLI -> `quickstart`
`set_communication_system_mode OperatorAdapter`
2. Set the IP of the Wired interface: CLI -> `advanced ip_network local`
`wired_network_interface address` Enter the following IP: 172.16.0.10
3. Set the Subnet Mask of the Wired interface: CLI -> `advanced ip_network local`
`wired_network_interface subnet_mask` Enter the following IP: 255.255.255.0
4. Set remote wired IP: CLI -> `advanced ip_network remote wired address` 172.16.0.11
5. Set wired Ethernet communication mode: CLI -> `configuration communication`
`configure wired ethernet`
6. Reboot the adapter: CLI -> `reboot`
7. Close the ssh window used for the Operator Adapter.

Pairing a new communication adapter for Z9-PC radio communication

Pair a new communication adapter for Z9-PC radio communication.

About this task

Two communication adapters are configured to communicate with each other over radio communications. It requires configuration on each of the communication adapters, remote and operator adapter. The complete pairing procedure performs the configurations on each adapter to put the radio communication configurations to the same default settings Kinova uses when configuring a pair of adapters before sending to a customer.

Procedure

1. [Configuring the Remote Adapter for paired radio communication.](#)
2. [Configuring the Operator Adapter for paired radio communication.](#)

Configuring Remote Adapter for paired Z9-PC radio communication

Configure a Remote Adapter for paired Z9-PC radio communication.

Before you begin

Open a [secure shell connection](#) between your computer and the robot port of the Remote Adapter [192.168.100.100] and remove power from the Operator Adapter.

Procedure

1. Change the controller type to be a Remote Adapter: CLI-> `quickstart`
`set_communication_system_mode RemoteAdapter`
2. Set the IP of the Radio interface: CLI-> `advanced ip_network local`
`radio_network_interface address`. Enter the following IP: 192.168.111.11
3. Set the Subnet Mask of the Radio interface: CLI-> `advanced ip_network local`
`radio_network_interface subnet_mask`. Enter the following mask: 255.255.255.0
4. Reboot the communication adapter: CLI-> `reboot`
5. Connect by ssh to the Remote Adapter: 192.168.100.100
6. Open a shell on the radio: CLI-> `advanced radio z9-pc configure`
7. Reset the radio to factory default: RADIO-CLI-> `config.factoryDefaults 1`



Important: This command hangs or disconnect the current session, so close your ssh window.

8. Open a ssh shell to the Remote Adapter: [192.168.100.100]
9. Change the radio IP address to 192.168.111.100. CLI->`advanced radio z9-pc`
`ip_address 192.168.111.100`
10. Open a shell on the radio: CLI-> `advanced radio z9-pc configure`. You are prompted for a password. Use password user.
11. Change the IP address of the radio to 192.168.111.101 (The Remote Adapter Radio IP address must be different from the Operator Adapter radio IP address)
a) RADIO-CLI-> `network.ip_address=192.168.111.101`



Important: After this command, the shell may hang (the connection drop because the IP has changed).

- b) Close putty (or the SSH session), but DO NOT remove power to the Remote Adapter
12. Open a ssh shell to the Remote Adapter: [192.168.100.100]
13. Change the radio IP address to 192.168.111.101. CLI->`advanced radio z9-pc`
`ip_address 192.168.111.101`

14. Get the adapter serial number. You will need the serial number in the next step to create a NETWORK_ID to use for the radio configuration of both communication adapters.
 - a) CLI-> `quickstart get_system_info`
 - b) Copy the serial number shown by the field : `Serial Number (S/N)`
 - c) Remove any letters and special characters to keep only the digits. For example, WO123456-1 gives the number 1234561
15. Compute a NETWORK_ID for the pair of radios
 - a) On a calculator, in scientific mode (or any mode that has the modulo function)
 - b) Enter the serial number obtained from previous step, press `Mod` key and enter the modulo value: 65533
 - c) Copy this result value and save it in a file for later.This will be the NETWORK_ID in this procedure.
16. Generate a SHA-2 key (256-bit in hex format)
 - a) Go to this web site:
<http://www.allkeysgenerator.com/Random/Security-Encryption-Key-Generator.aspx>
 - b) Click `Generate a 256-bit key`
 - c) Select: `Hex` check box
 - d) Copy obtained key and save it for later.

 **Note:** This is the ENCRYPTION_KEY. Configuring both adapters with the same NETWORK_ID and ENCRYPTION_KEY allows for secure communications between the two radios.
17. Open a shell on the radio: CLI-> `advanced radio z9-pc configure`
18. Set radio data rate to 1M: RADIO-CLI-> `radioSettings.rfDataRate=RATE_1M`
19. Set radio in gateway mode: RADIO-CLI-> `radioSettings.radioMode=Gateway`
20. Enable hopping mode: RADIO-CLI-> `radioHoppingMode=Hopping_On`
21. Set a unique network ID for the pair of radios: RADIO-CLI->
`radioSettings.networkId=<PASTE_NETWORK_ID>`
22. Activate Encryption: RADIO-CLI-> `encryption.activeKey 1`
23. Set the encryption key to the ENCRYPTION_KEY obtained previously: RADIO-CLI->
`encryption.setKey=key1 <PASTE_ENCRYPTION_KEY>`
24. Save the configuration: RADIO-CLI-> `save`
25. Exit the radio shell (will exit the radio shell and go back to the adapter CLI): RADIO-CLI->
`exit`

26. Set the adapter communication type to radio Ethernet: CLI-> `configuration communication configure radio ethernet`
27. Reboot the adapter to apply all configurations: CLI-> `reboot`

What to do next

[Configure the operator adapter for paired Z9-PC radio communication.](#)

Configuring Operator Adapter for paired Z9-PC radio communication

Configure an Operator Adapter for paired wired communication.

Before you begin

Open a [secure shell connection](#) between your computer and the robot port of the Operator Adapter [192.168.100.100] and remove power from the Remote Adapter. The procedure for [configuring the remote adapter](#) needs to be carried out first. You must have a NETWORK_ID and ENCRYPTION_KEY created for the Remote Adapter configuration to securely pair the radios.

Procedure

1. Change the controller type to be a Operator Adapter: CLI-> `quickstart set_communication_system_mode OperatorAdapter`
2. Set the IP of the Radio interface: CLI-> `advanced ip_network local radio_network_interface address`. Enter the following IP: 192.168.111.10
3. Set the Subnet Mask of the Radio interface: CLI-> `advanced ip_network local radio_network_interface subnet_mask`. Enter the following mask: 255.255.255.0
4. Reboot the adapter: CLI-> `reboot`
5. Connect by ssh to the Remote Adapter: 192.168.100.100
6. Open a shell on the radio: CLI-> `advanced radio z9-pc configure`
7. Reset the radio to factory default configurations: RADIO-CLI-> `config.factoryDefaults 1`.



Important: This command hangs or disconnects the current session, so close your ssh window.

8. Connect by ssh to the Operator Adapter: [192.168.100.100]
9. Change the radio IP address to 192.168.111.100. CLI-> `advanced radio z9-pc ip_address 192.168.111.100`
10. Open a shell on the radio: CLI-> `advanced radio z9-pc configure`
11. Set radio data rate to 1M: RADIO-CLI-> `radioSettings.rfDataRate=RATE_1M`

- 12. Set radio in endpoint mode:** RADIO-CLI-> `radioSettings.radioMode=Endpoint`
- 13. Enable hopping mode.** RADIO-CLI-> `radioHoppingMode=Hopping_On`
- 14. Set a unique network ID for the pair of radios, using the network ID created earlier:** RADIO-CLI-> `radioSettings.networkId=<PASTE_NETWORK_ID>`
- 15. Activate Encryption:** RADIO-CLI-> `encryption.activeKey 1`
- 16. Set the encryption key:** RADIO-CLI-> `encryption.setKey=key1<br><PASTE_ENCRYPTION_KEY>`
- 17. Save the configuration:** RADIO-CLI-> `save`
- 18. Exit the radio shell (will exit the radio shell and go back to the communication adapter CLI):**
RADIO-CLI-> `exit`
- 19. Set the adapter communication type to radio Ethernet:** CLI-> `configuration<br>communication configure radio ethernet`
- 20. Reboot the adapter to apply all configurations:** CLI-> `reboot`

Maintenance of the Robot manipulator system

Basic cleaning and maintenance of the physical parts of the system, as well as applying updates to the firmware, is necessary to keep the system working as expected.

Robot manipulator system maintenance and cleaning

Basic cleaning and occasional maintenance is needed to keep the system in working order.

Cleaning instructions

Only the external surfaces of the robot, gripper adapter, gripper, and video adapter may be cleaned. This is done using a damp cloth and mild detergent. The following describes the steps for cleaning the product:

- Prepare a water and soap solution using about 2 ml of dish soap for 100 ml of water
- Immerse a clean cotton cloth in the solution
- Remove the cloth and wring out thoroughly
- Gently rub the external surface to be cleaned

⚠ Do not wash more than three times per day.

⚠ The product is not intended to be sterile. No sterilization process should be used on the product.

⚠ Do not rub the external surfaces with abrasive materials.

Scheduled maintenance

This product requires no scheduled field servicing and components are not field serviceable.

Unscheduled maintenance

⚠ Refer all servicing to qualified service personnel. Servicing is required when the apparatus has been damaged in any way, for example if the power-supply cord or plug is damaged, if the product does not operate normally or if it has been dropped.

⚠ The product has no user-serviceable parts. Do not open.

Damaged or malfunctioning gripper adapters are field replaceable, and replacement units can be ordered from Kinova.

Updating robot firmware

Update the robot firmware by using the Kinova[®] Development center application.

Before you begin

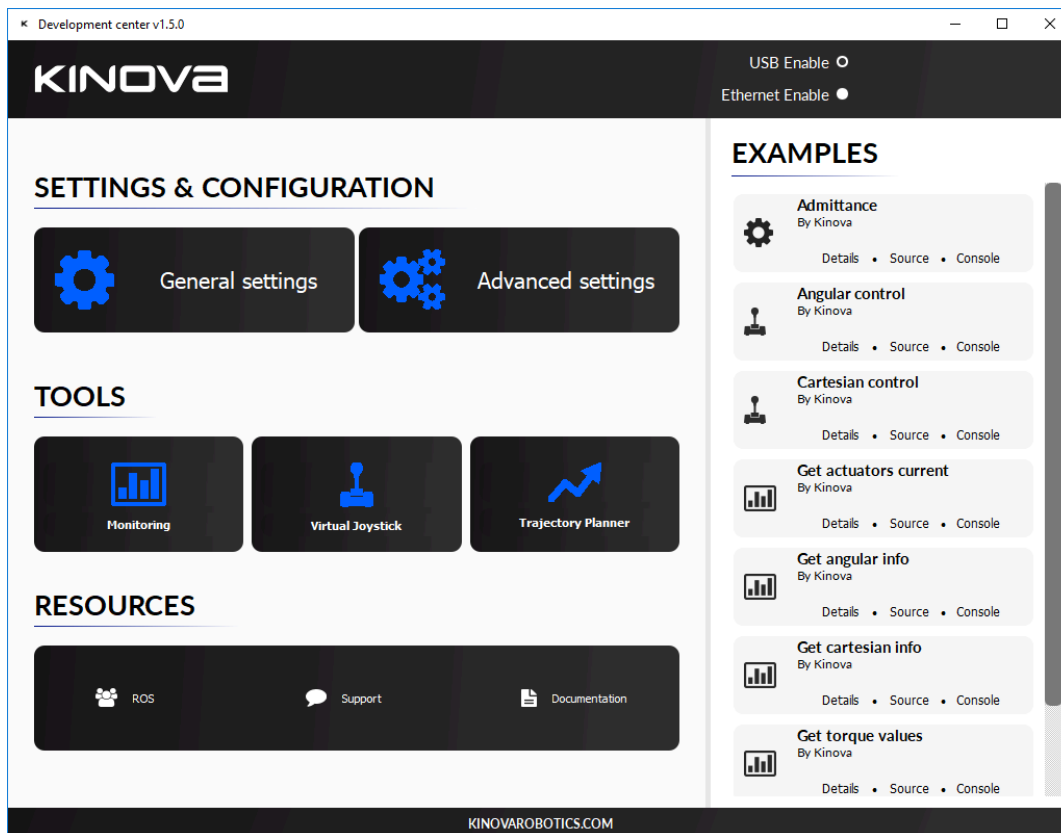
You must have a laptop computer with the Kinova Software development kit installed and Kinova USB drivers have been installed. You must have previously downloaded the new .hex firmware file. You must also have a USB type A to USB type B cable.

About this task

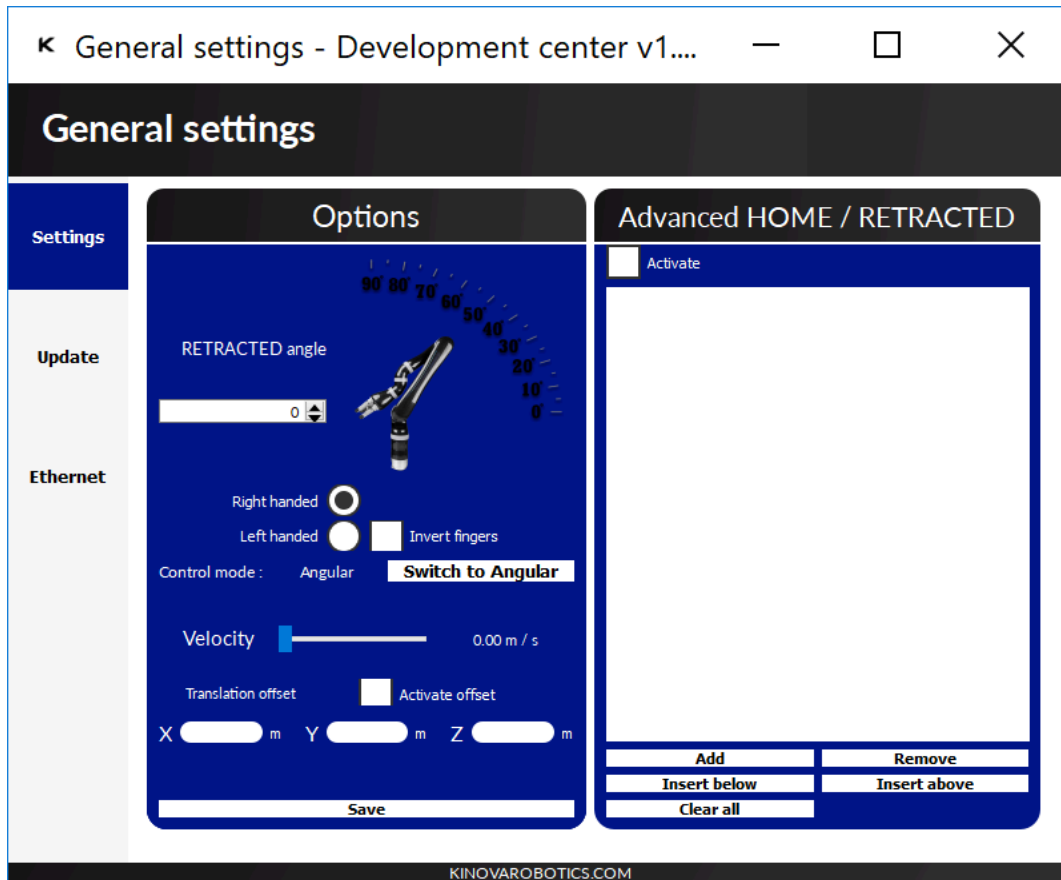
From time to time you may want to update the robot firmware.

Procedure

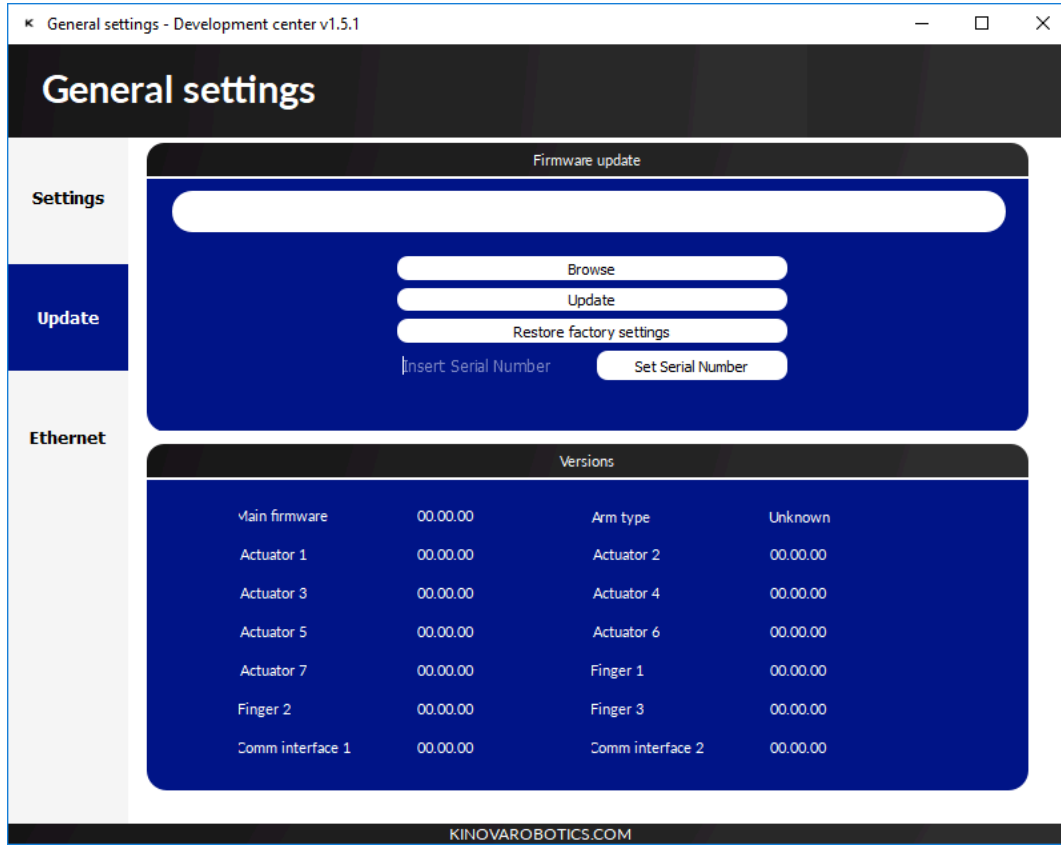
1. Locate the USB type B connector on the connector panel of the robot base. Take your USB cable, and connect the USB type B end to the arm controller.
2. Connect the other end of the cable to a USB type A port on the laptop.
3. Flip the power switch to on if the robot is not powered on.
4. Open the Development center software on the laptop.



5. Click the **General Settings** button to launch the **Configuration** window.



6. Click the **Update** button to open the **Firmware update** tab.



7. Click the **Browse** button to launch a **File Explorer** window and find the new .hex firmware file. Select the file and click **Open** to proceed.
8. Click update. The firmware will be installed on the robot.

⚠ Do not unplug the USB cable while the firmware update process is in progress. You could corrupt the firmware of the robot and render it unusable. Such damage is not covered by warranty.

9. Turn the robot power off and then back on to reboot the robot.

Results

The firmware is now updated on the robot.

Maintenance of the Communication system

Basic cleaning and maintenance of the physical parts of the system, as well as applying updates to the firmware, is necessary to keep the system working as expected.

Communication system maintenance and cleaning

Basic cleaning and occasional maintenance is needed to keep the system in working order.

Cleaning instructions

Only the external surfaces of the communication adapters may be cleaned. This is done using a damp cloth and mild detergent. The following describes the steps for cleaning the product:

- Prepare a water and soap solution using about 2 ml of dish soap for 100 ml of water
- Immerse a clean cotton cloth in the solution
- Remove the cloth and wring out thoroughly
- Gently wipe the external surface to be cleaned

⚠ Do not wash more than three times per day.

⚠ Do not immerse any part of the product under water or snow.

⚠ The product is not intended to be sterile. No sterilization process should be used on the product.

⚠ Do not rub the external surfaces with abrasive materials.

Scheduled maintenance

This product requires no scheduled field servicing - components are not field serviceable.

Unscheduled maintenance

⚠ Refer all servicing to qualified service personnel. Servicing is required when the apparatus has been damaged in any way, for example if the power-supply cord or plug is damaged, if the product does not operate normally or if it has been dropped.

⚠ The product has no user-serviceable parts. Do not open.

Damaged or malfunctioning communication adapters are field replaceable, and replacement units can be ordered from Kinova. Replacement of a communication adapter requires configuration to pair with the existing adapter.

Updating communication adapter firmware

Update the firmware on the Communication Adapters when updates are available.

Before you begin

Your computer must be connected via a network connection to the communication adapter to be updated. You must have already downloaded a .swu firmware update package.

About this task

From time to time, it may be necessary to update the firmware on the Communication Adapters. Field technicians are not able to update the underlying operating system of the adapters, but can update the high level firmware. While connected to the communication adapter over a network connection, you can access a basic web interface for firmware updates by entering the IP address in a web browser with port 8080.

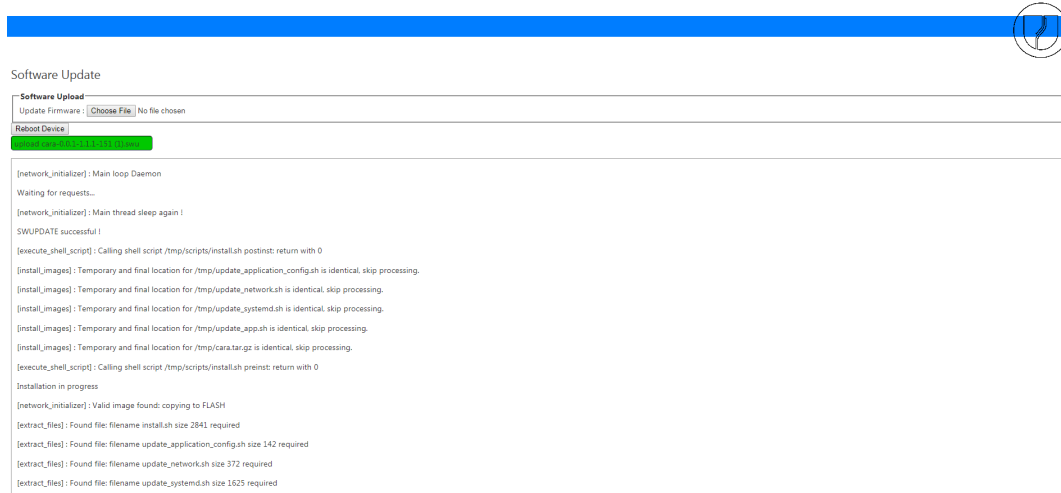
Procedure

1. Open a web browser and enter the IP address with port 8080 specified, in the browser address bar. For example, if the IP address is 172.16.0.10, enter 172.16.0.10:8080. This will take you to the web interface.



2. Click the **Choose File** button. This opens up a **File Explorer** window to browse for the .swu for the new firmware.

3. Once you have found the file, select it. The update proceeds immediately, and the messages in the window indicate progress.



4. When the firmware finishes updating, the communication adapter reboots automatically so that the changes can take effect.

Results

The firmware is now be up to date.

Troubleshooting

When the system does not operate in the expected manner, steps can be taken to solve the issue before contacting Kinova.

Using the CLI Diagnostic menu

Use of the CLI diagnostic menu to troubleshoot issues.

The Diagnostic menu in CLI can be accessed by typing `d` and then `<TAB>` at the top level menu in the application.

The Diagnostic menu offers several pages of information that can be of use in tracking down the source of issues.

Communication live data gives a real-time of low-level communication statistics related to packets sent and received. Low-level communication issues can cause performance issues for the system and will show up here.

Controller gives real-time status on the gamepad connectivity as well as the control inputs that are detected. Comparing to actual control inputs can show if there are any issues with the controller.

Log allows you to read logs recorded by the communication adapter.

Power on self test shows the results of several tests for the communication adapter, highlighting possible hardware issues with the communication adapter.

Status LED shows a real-time simulation of what is displayed on the status LEDs of the communication adapter to which you are connected. If you are connected to the adapter over a network, this can be handy for remote viewing of the status LEDs, which give information on robot control mode, communication adapter status, communication status, and robot status.

Communication Adapter status LED indications

The LED status indicators on the RA and OA have specific meanings.

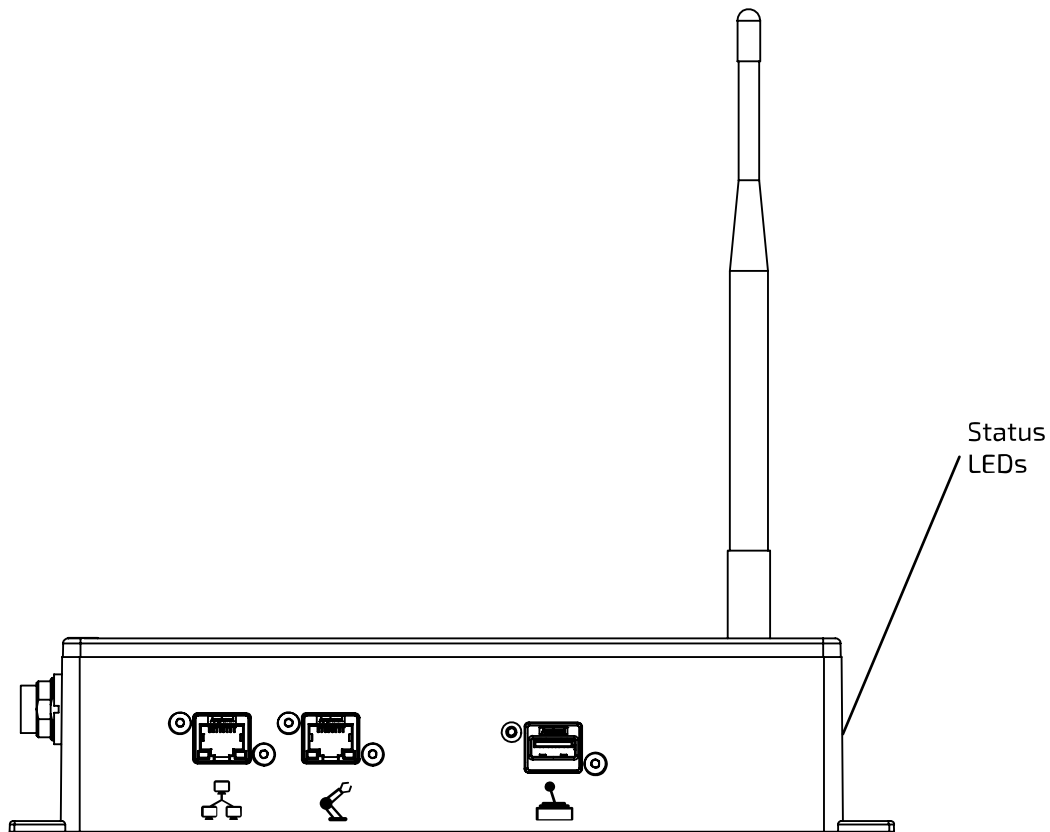
Overview

Each communication adapter has four status LEDs on the side of the device. These LEDs provide visual status information.

- Robot mode
- Communication adapter status
- Communication status

- Robot status

This information is useful for troubleshooting purposes.



Each communication adapter has four LED indicators, each of which can display six possible colors.

- Violet
- Blue
- Green
- Yellow
- Red
- White

In addition, each color can be continuous or blinking.

LED status information

Table 10: Communication Adapter LED status interpretation

LED	Category	Color/State		Description
1	Robot control mode	violet	solid	booting up
		blue	solid	go-to position mode
			blinking	robot controlled in LED/laser control mode
		green	solid	robot controlled in gripper reference Cartesian control mode
			blinking	robot controlled in base reference Cartesian control mode
2	Communication Adapter status	blue	blinking	adapter ready and configured as Operator Adapter
		green	blinking	adapter ready and configured as Remote Adapter
		white	blinking	adapter ready and configured as Single Adapter
		red	blinking	gamepad error (not present or fault)
		off		adapter not ready
3	Communication status	green	solid	communication OK
		yellow	solid	communication error/latency
		red	blinking	major communication problem
4	Robot status	green	solid	robot ready - the robot is good to go
		yellow	solid	torque/temperature/voltage warning - payload torque applied to the robot is too high, temperature of one of the robot actuators is too high, or the input voltage to the robot is too low or too high. Lower the robot arm and release the weight as soon as possible to avoid possible damage to the robot.
		red	solid	major robot fault detected - robot can not be used until the fault is cleared.
			blinking	robot not detected

Operator adapter robot status audible warning

The Operator Adapter has an audible robot status warning.

When the robot status enters a warning state due to status approaching fault limits, a beeping sound is emitted by the Operator Adapter. This audible warning accompanies the solid yellow indication on LED #4 of the Operator Adapter. This serves as a back up indicator to alert the operator to a robot warning state.

Robotiq gripper status LED

The LED on the Robotiq gripper illuminates in different colors for different reasons.

Overview

The Robotiq gripper has status LEDs, one on the top of the gripper and one on the bottom.

The top LED is covered by the gripper adapter, however the bottom LED is visible.

The LED can display in two colors.

- Red
- Blue

These colors can display as off, solid, or blinking.

LEDs information

Table 11: Status LED interpretation

Color/state	Description
Solid blue and red	booting up
Solid blue	powered on with no errors (communication is active)
Solid red	minor fault
Blinking red/blue	major fault

Markings and labels

The system components have markings and labels affixed on them.

Please note that these labels may slightly differ from the ones accompanying your device depending of your country. The figure depicts the information about labels on robot base, and on other components of the system.

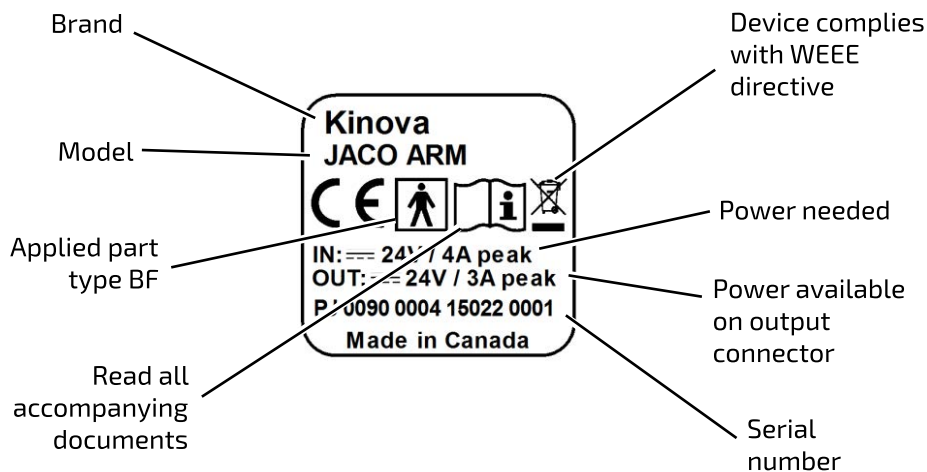


Figure 35: Robot labeling

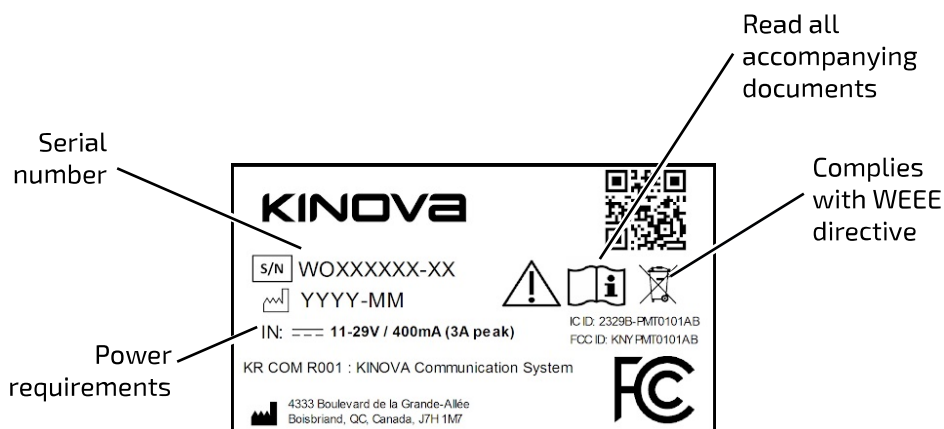


Figure 36: Other labeling

Normal use definition

Use the robot within the confines of what is determined to be normal.

The definition of a normal use of the robot with gripper and gripper adapter includes lifting, pushing, pulling or manipulating graspable objects with mass up to a maximum load:

- **Continuous manipulation** 0.7 kg from minimum to middle reach

The robot is designed to be able to hold objects, but in some positions and loads near the maximum reach and maximum loads, the manipulator can overheat. Before overheating becomes dangerous for either the user or the arm, the robot status LED on the communication adapter is solid yellow. This is a warning. If this warning indication appears, put down any object in the gripper as soon as possible, bring back the robot to the HOME or RETRACTED positions and wait until the warning goes away before continuing to use the arm.



Note: During normal operation, the joints undergo heating. They are normally covered with plastic rings which protect the user from any injury that may occur from touching hot metal parts directly.

⚠ For a setup with the robot mounted on a mobile platform, do not move the platform while the robot is in a full reach position. Vibration of the platform, particularly in rough terrain, could cause damage to the robot if the robot is in full reach. Always place the robot in a retracted position before moving the platform.

Electromagnetic interference from RF sources

The Security Arm has EMI considerations.

Even though the product complies with all relevant standards, your arm may still be susceptible to EMI (electromagnetic interference) from RF sources such as radio and TV transmitters, amateur radio (ham), two-way radios, and cellular phones to name just a few. The interference (from RF sources) may cause the product to stop moving for a period of up to 10 seconds. In this case, the device re-initializes and you are able to continue to use it. In extremely rare cases, it can permanently damage the control system.

The intensity of the interference is measured in volts per meter (V/m). The product can resist EMI up to a certain intensity level, which is called the 'immunity level'. The higher the immunity level, the greater the protection. The current technology is capable of achieving at least a 20 V/m immunity level, which would provide effective protection from the more common sources of radiated EMI.

There are a number of sources of relatively intense electromagnetic fields in the environment. Some of these sources are obvious and easy to avoid. Others are not so apparent and exposure is unavoidable. However, we believe that by following the guidelines and warnings listed below, the risk of EMI is minimized.

The sources of radiated EMI can be broadly classified into three types:

1. Gripper-held portable transceivers (For example, transmitters-receivers with the antenna mounted directly on the transmitting unit, including CB [citizens band], walkie-talkie, security, fire/police transceivers, cellular phones, and other personal communication devices). Some cellular phones and similar devices transmit signals while they are switched on, even if they are not actively being used.
2. Medium-range mobile transceivers, such as those used in police cars, fire trucks, ambulances and taxis. These usually have the antenna mounted on the outside of the vehicle.
3. Long-range transmitters and transceivers, such as commercial broadcast transmitters (radio and TV broadcast antenna towers) and amateur (ham) radios. Other types of gripper-held devices, such as cordless phones, laptop computers, AM/FM radios, TV sets, CD players, cassette players, and small appliances, such as electric shavers and hair dryers are unlikely to cause EMI problems.

Because EM energy rapidly becomes more intense as one moves closer to the transmitting antenna (source), the EM fields from gripper-held radio wave sources (transceivers) are of special concern. It is possible to unintentionally bring high levels of EM energy very close to the control system while using these sorts of devices. Therefore, the warnings listed below are recommended to reduce the effects of possible interference with the control system.

- ⚠ Do not operate a gripper-held transceiver (transmitter-receivers), such as CB (citizens band), or switch on personal communication devices, such as cellular phones, while the device is turned on.
- ⚠ Be aware of nearby transmitters, such as radio or TV stations, and try to avoid coming close to them.
- ⚠ Be aware that introducing accessories or components in proximity to the device may make it more susceptible to EMI.
- ⚠ Report all incidents of unintended shutdown to your local distributor, and take note of the nearby sources of EMI.

Disposal considerations

 The product contains parts that are deemed to be hazardous waste at the end of the useful product life. For further information on recycling, contact your local recycling authority or Kinova distributor. In any case, always dispose of product via a recognized agent.

Additional procedures are required if the equipment has been contaminated with hazardous agents, including chemical, neurological, biological, and radiological agents. Follow all decontamination and hazardous waste disposal regulations of your jurisdiction.

Contacting support

If you need help or have any questions about this product, this guide or the information detailed within, please contact Kinova by phone at 1 (514) 277-3777, or by email at support@kinova.ca.

We value your comments!

To help us assist you more effectively with problem reports, please have the following information ready when contacting Kinova or distributor support:

- Date and time the problem occurred
- Environment where the problem occurred
- Actions performed immediately before the problem occurred
- Product serial number (this will allow the support agent to access the information regarding your product, such as software version, part revisions and characteristics, etc.).

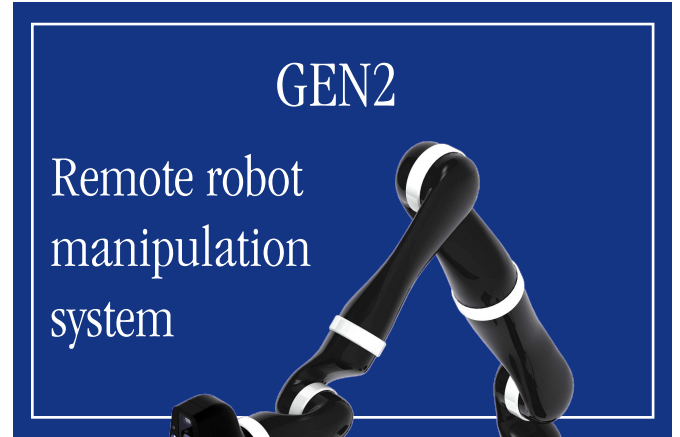
If the product needs to be returned to Kinova, ensure the product is packaged in its original case for transportation.

For technical support issues or more information about product end of life, contact Kinova inc. at **Address:** Kinova inc., 4333 boulevard de la Grande-Allée, Boisbriand, QC, Canada, J7H 1M7.

Telephone: 1-855-6-Kinova. **email:** support@kinova.ca.

German customers can contact our German office at **Address:** Kinova Europe GmbH, 91555 Feuchtwangen, Germany. **Telephone:** +0800 5466822, **email:** support@kinovarobotics.de.

TOGETHER IN ROBOTICS



GEN2
Remote robot
manipulation
system



EN-UG-011-r4.1-202406

PROUDLY MADE IN
📍 QUEBEC, CANADA

KINOVA

kinovarobotics.com | info@kinovarobotics.com | +1 (855) 654-6682

© Kinova inc 2023. All rights reserved.

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