

# Ned User Manual



## Ned

---

### Robot

Ned is a 6-axis collaborative robot arm designed for Education and Research.



Ned is designed to reproduce all the movements required in the most advanced uses in industry 4.0, with a **precision of 0.5mm** and a **repeatability of 0.5mm**.

Ned's **aluminum structure** makes it exemplary robust, allowing it to accomplish with fluidity the movements required for your robotics projects.

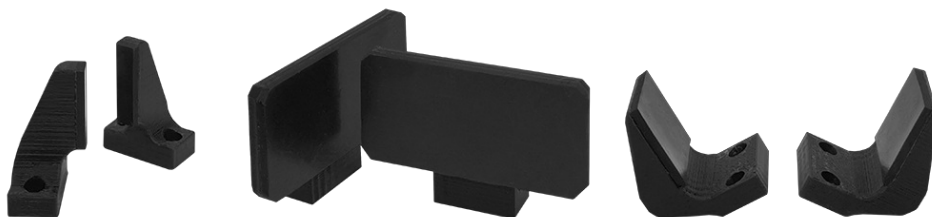
This **cobot** takes advantage of the capacities of the **Raspberry Pi 4**, with a 64-bit ARM V8 high performance processor, 2GB of RAM and an improved connectivity.

Ned is a **collaborative robot based on Ubuntu 18.04 and ROS** (Robot Operating System) Melodic, an open-source solution created for robotics. Through ROS, **Ned has multiple libraries** allowing you to conceive many programs, from the most simple to the most complex ones, responding then, in a flexible way, to your needs.

## Ned tools technical specifications

Mounting a tool on Ned is made easy with our brand new **EasyConnect system**. Simply plug your tool, connect its cable, and it is ready to use.

Ned's package includes a **Custom Gripper**. Its standard jaws can manipulate small objects, and you can 3D print your own custom jaws or buy our [set of jaws](index.html#overview-standard-jaws) (index.html#overview-standard-jaws) that contains the precision jaws, the flat ones and the XL ones.

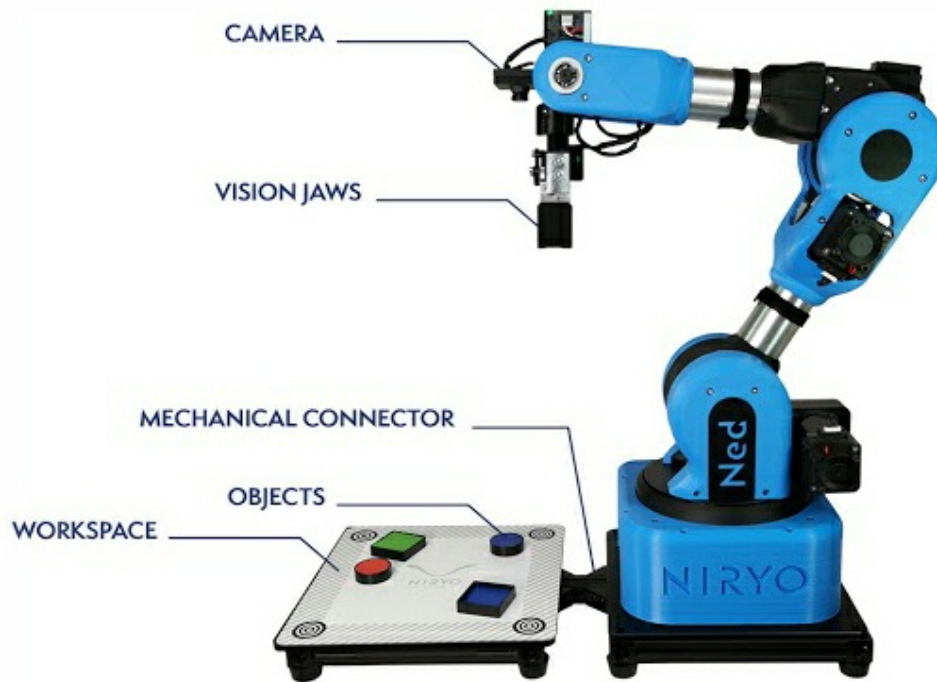


Ned can also be used with:

- The [Large Gripper](#) (index.html#large-gripper) which has the ability to grab larger objects while keeping the ability to close entirely;
- The [Adaptive Gripper](#) (index.html#adaptive-gripper) which allow Ned to grab non-standard objects with complex shapes (eg. an egg);
- The [Vacuum Pump](#) (index.html#vacuum-pump) to grab objects with plane and non-porous surfaces;
- The [Electromagnet](#) (index.html#electromagnet) that is useful to manipulate metallic objects, from one to many (eg. screws, bolts...).

**Ned's Ecosystem is designed to let you reproduce advanced use cases of industry 4.0.**

## Vision Set



**The Vision Set gives Ned the ability to see its environment and detect the objects to interact with based on their characteristics** (shape and/or color). This set includes :

- A camera that is mountable on Ned's wrist to give it a dynamic field of view depending on Ned's position;
- A workspace which is designed around a specific repositionnable material;
- Supports for the workspace and the robot, to build a rigid environment for the vision;
- 6 objects (3 rounds, 3 squares) of different colors to use our built-in recognition system based on colors and shapes. The squares are designed to be able to act as containers for the circles. Easily create an industry 4.0 pick & pack application with no particular knowledge of programming;
- Vision jaws for the Custom Gripper, that are specifically designed for the provided objects;
- A calibration tip to set your workspace up.

## Conveyor Belt

**The Conveyor Belt is the key add-on to prototype industry 4.0 production lines.**



The **Standard version** includes the Conveyor Belt, its control box for autonomous use, and an IR sensor to detect the presence of an object on it.



The **Education version** adds the following components:

- A mountable workspace to use vision functions directly on the Conveyor Belt;
- A slope that can help to create complex or multi-robot processes;
- An end-stop to stop the objects when they reach the end of the Conveyor Belt;
- The 6 objects of the Vision Set to extend the quantity of objects you can use on your production line;
- The Vision jaws to manipulate them.

**With Ned's ecosystem, you have the optimal solution to discover, learn and test industry 4.0 processes.**

## Overview of this manual

---

This manual contains instructions for:

- Safety Information about Ned;
- Mechanical and electrical installation of the robot;
- Software of the robot;
- Maintenance and troubleshooting.

This manual should be read before:

- Installation and electrical connections;
- First usage of the robot;
- Maintenance and repair.

## Safety notice

### Warning

You must read, understand, and follow all safety information in this manual.

It is important that the safety instruction on this manual and the electrical and the mechanical instructions are followed. The robot specifications should be respected to avoid all damage to the machine or to the user.

## Additional content

You can find additional content by clicking on the link [here](https://docs.niryo.com/) (https://docs.niryo.com/).

## Installation and commissioning

---

This section specifies the procedures to follow during unpacking and transportation.

### What the box contains

When you order Ned, you receive a box with the following items:

- 1x Ned Robot
- 1x Custom Gripper
- 1x Power cable
- 1x Universal travel plug adapter
- 1x SD card reader
- 1x Allen Key set

### Unpacking

1. Inspect Ned's packaging to make sure nothing is damaged;
2. Remove the packaging and check for any transport damage or loss;
3. Put Ned in a dedicated operating environment;
4. Make sure Ned is stable.

### Operating conditions

Parameters	Value
Minimum Ambient Temperature	+5°C
Maximum Ambient Temperature	+45°C

## Shipping and transport position

This figure shows Ned in its shipping position, which is a recommended transport position to avoid Ned's damages.





## Safety instructions

### Safety signals and symbols

This section specifies all dangers that can arise when doing the work described in the User Manual. Each danger consists of:

- A caption specifying the danger level (DANGER, WARNING, or CAUTION) and the type of danger;
- A brief description of the danger;
- Instruction about how to eliminate danger.

Designation	Description
DANGER	Warns that an accident will occur if the instructions are not followed, resulting in an injury.
WARNING	Warns that an accident will occur if the instructions are not followed, resulting in a possible injury or product damage.
CAUTION	Warns of possible product damage.
NOTE	Describes an important fact or condition.
TIP	Describes additional information or an easy way to use the function.

Icon	Designation	Description
	ELECTROSTATIC DISCHARGE	Warns of a possible electrostatic discharge that may damage the robot.
	ELECTRICAL SHOCK	Warns of an electrical hazard.

## Safety Overview

This section includes information on general safety risks to be considered when performing installation and service work on Ned.

These safety instructions must be read and followed by any person who deals with Ned.

## Spare parts and special equipment

The installation and the use of external components is possible (such as Arduino, external sensors, devices). But the user must respect the electrical specifications and connections mentioned in the User Manual.

Niryo is not liable for damages or injuries caused by unauthorized modifications to the robot system or the misuse of the robot.

## Complete robot

### ⚠ Danger

1. Before installing, using, or programming Ned, read the product specifications and Manual;
2. Make sure to install Ned and all electrical equipment according to the specifications and the warnings from chapters [Installation and commissioning](#) ([index.html#installation-and-commissioning](#)) and [Technical specifications](#) ([index.html#technical-specifications](#));
3. Children are not allowed to operate Ned without adult supervision to prevent any possible injury or improper misuse of Ned;
4. Make sure that changing robot software will not cause hazards, damages to the Ned's system or injuries.

### ⚠ Warning

1. Motors and gearboxes are hot after running Ned for a long time. Avoid touching especially with a higher environment temperature;
2. Removing parts may result in the collapse of Ned. Take the necessary measures to ensure that Ned does not collapse as parts are removed;
3. Make sure to remove the power cable during assembly, wiring, or repair. Doing so will help to prevent equipment damage or accidental short-circuit;
4. The cable packages may be sensitive to mechanical damage;
5. Before using Ned, make sure to firmly fix it on a stable surface to avoid collapse or the fall of Ned;
6. Do not use Ned outside;
7. Do not put Ned in a humid environment or near water;
8. Do not install or operate Ned in dangerous environments (e.g., in the presence a strong magnetic field, dangerous gases, fire or flammables) to avoid dangers which may occur due to external conditions during operation;
9. Respect the technical specifications to avoid damaging the motors. Stepper motors and servo motors may be damaged if excessive force is used;
10. Make sure external change on the motors parameters or the robot software does not cause damage to Ned.
11. Do not open Ned base when the power cable is connected. Do not touch the electronic board, they may be hot.



Niryo is not liable for damages or injuries caused by unauthorized modifications to the robot system or the misuse of the robot.

#### ⓘ Caution

1. Do not turn off Ned during a sequence or a motion unless absolutely necessary, this may reduce Ned operating age;
2. Try to install Ned arm on a stable surface with enough space to avoid any shock or vibration.

## Voltage related risks, robot

A danger of high voltage is associated with the robot in:

- The power supply of the motors (11.1V, 8V);
- Ned's grippers are powered by 8V. A risk of short circuit and sparks exists. Be sure to make the installations with the power disconnected.

## Safety actions

- Fire extinguishing

#### ⓘ Note

Use a CARBON DIOXIDE (CO<sub>2</sub>) extinguisher in the event of a fire in Ned's system.

- Manually stopping or overriding the arm: if needed, Ned arm can be stopped manually. This is possible since Ned arm is light, the arm force is limited, and the drivetrain power is limited.

To prevent unnecessary damage and wear of Ned arm, it is recommended to use the normal stopping functions of Ned (by the software or the top button).

#### ⓘ Note

Ned is not equipped with brakes since its weight and design do not require a holding brake.

## Technical specifications

This section describes the technical specifications of Ned.





Parameters	Value
Weight	6,5 kg
Payload	300 g
Reach	440 mm
Degree of freedom	6 rotating joints
Joints range	$-170^{\circ} \leq \text{Joint 1} \leq 170^{\circ}$ $-120^{\circ} \leq \text{Joint 2} \leq 35^{\circ}$ $-77^{\circ} \leq \text{Joint 3} \leq 90^{\circ}$ $-120^{\circ} \leq \text{Joint 4} \leq 120^{\circ}$ $-100^{\circ} \leq \text{Joint 5} \leq 55^{\circ}$ $-145^{\circ} \leq \text{Joint 6} \leq 145^{\circ}$
Joints range	$-2,97 \text{ rad} \leq \text{Joint 1} \leq 2,97 \text{ rad}$ $-2,09 \text{ rad} \leq \text{Joint 2} \leq 0,61 \text{ rad}$ $-1,34 \text{ rad} \leq \text{Joint 3} \leq 1,57 \text{ rad}$ $-2,09 \text{ rad} \leq \text{Joint 4} \leq 2,09 \text{ rad}$ $-1,75 \text{ rad} \leq \text{Joint 5} \leq 0,96 \text{ rad}$ $-2,53 \text{ rad} \leq \text{Joint 6} \leq -2,53 \text{ rad}$
Joints speed limit	$\text{Joint 1} \leq 150^{\circ}/\text{s}$ $\text{Joint 2} \leq 115^{\circ}/\text{s}$ $\text{Joint 3} \leq 140^{\circ}/\text{s}$ $\text{Joint 4} \leq 180^{\circ}/\text{s}$ $\text{Joint 5} \leq 180^{\circ}/\text{s}$ $\text{Joint 6} \leq 180^{\circ}/\text{s}$
Joints speed limit	$\text{Joint 1} \leq 2.6 \text{ rad/s}$ $\text{Joint 2} \leq 2.0 \text{ rad/s}$ $\text{Joint 3} \leq 2.5 \text{ rad/s}$ $\text{Joint 4} \leq 3.14 \text{ rad/s}$ $\text{Joint 5} \leq 3.14 \text{ rad/s}$ $\text{Joint 6} \leq 3.14 \text{ rad/s}$
TCP max speed	1144 mm/s
Repeatability	0.5 mm

Parameters	Value
Footprint	200x200 mm
Mounting	Table
I/O power supply	5V for digital GPIO 12V for Switches output
I/O ports	Digital inputs/outputs 5V: 6 Digital outputs 12V: 2
I/O interface	2 x USB2.0 2 x USB3.0 1 x ETHERNET GIGABIT
Communication	Modbus TCP (master) TCP/IP CAN (slave, compatible with NiryoStepper motors)
Materials	Aluminum Plastic PLA
Temperature	5 - 45°C
Power supply	DC 11.1V - 6A
Programming Environment	Niryo Studio PyNiryo C++ Python ROS

## Tools technical specifications

### Tools Overview

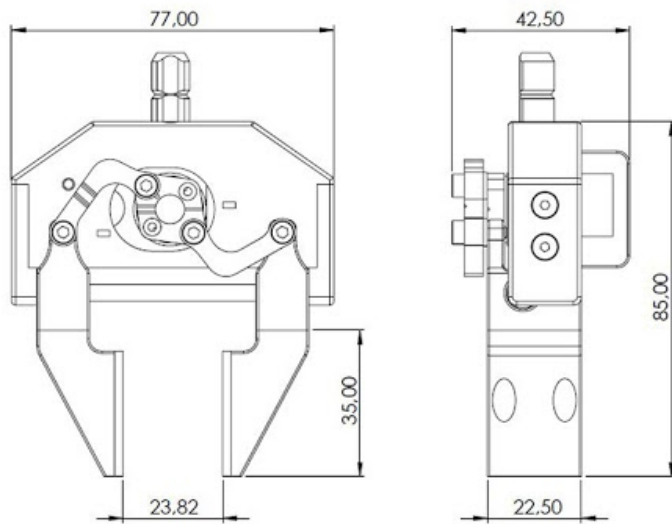
Ned is compatible with 5 different sorts of tools:

- 3 x Grippers
- 1 x Electromagnet
- 1 x Vacuum Pump

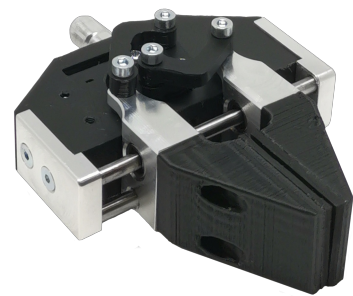
### Specifications

#### Custom Gripper

##### Overview - Standard Jaws

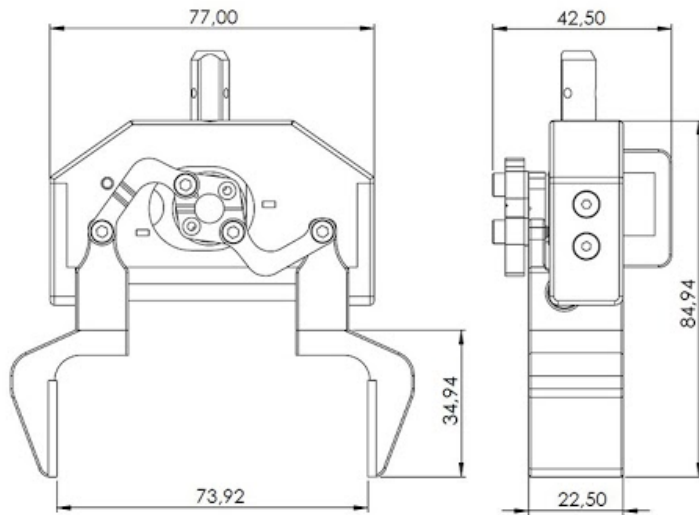


(\_images/GRIPPER\_STANDARD\_SCHEMA\_1.jpg)

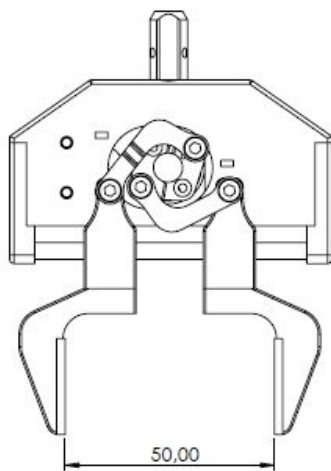


(\_images/GRIPPER\_MORS\_STANDARD.png)

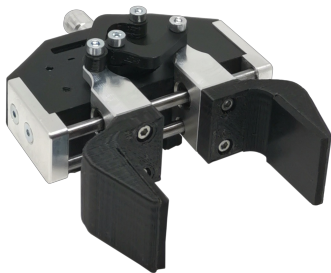
## Overview - XL Jaws



(\_images/GRIPPER\_XL\_SCHEMA\_1.jpg)

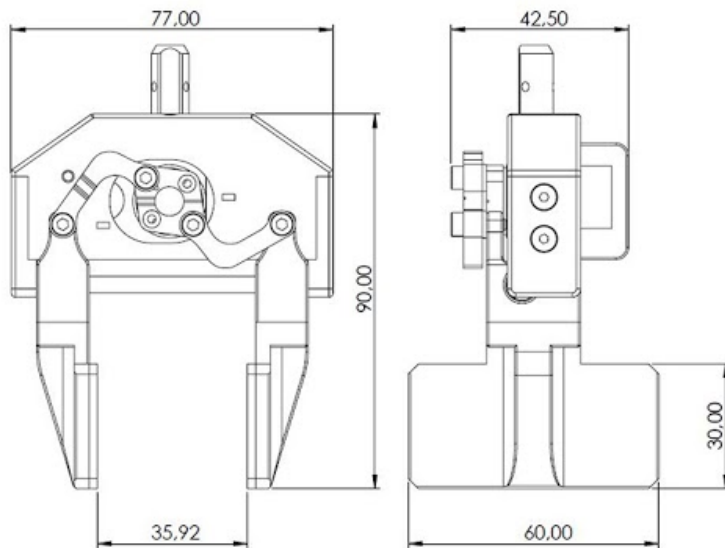


(\_images/GRIPPER\_XL\_SCHEMA\_2.jpg)

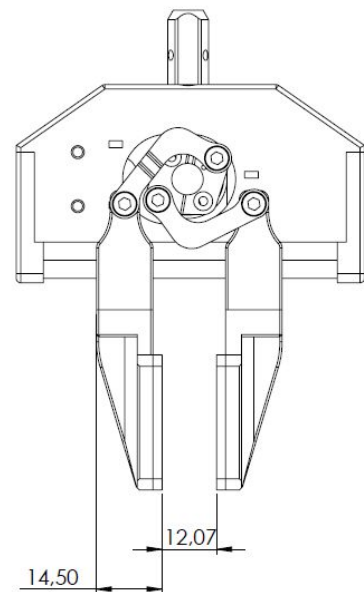


(\_images/GRIPPER\_MORS\_XL.png)

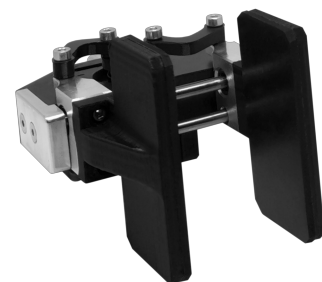
## Overview - Flat Jaws



(\_images/GRIPPER\_FLAT\_SCHEMA\_1.jpg)

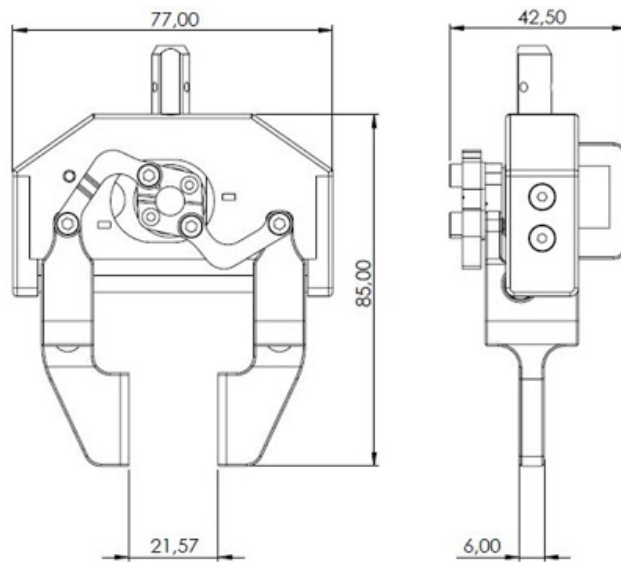


(\_images/GRIPPER\_FLAT\_SCHEMA\_2.jpg)



(\_images/GRIPPER\_MORS\_FLAT.png)

## Overview - Precision Jaws

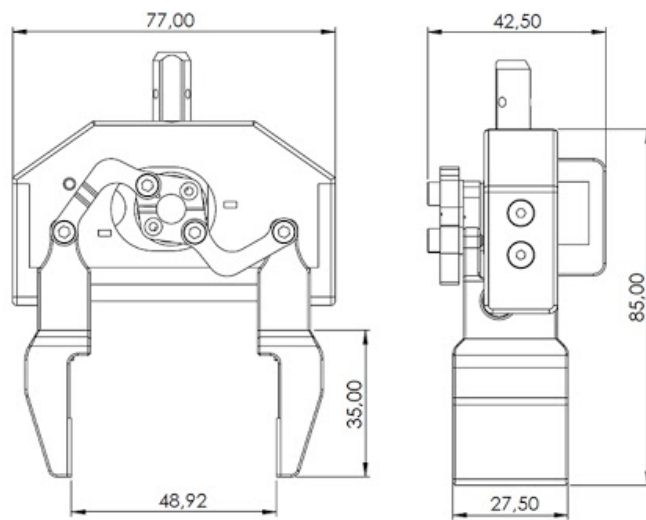


(\_images/GRIPPER\_PRECISION\_SCHEMA\_1.jpg)

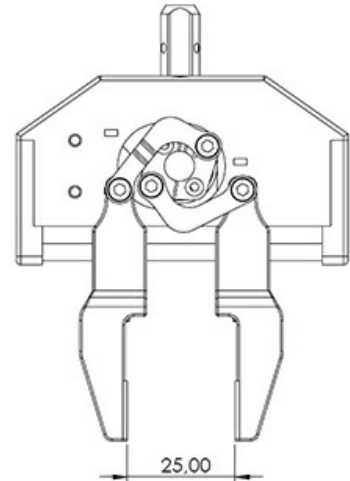


(\_images/GRIPPER\_MORS\_PRECISION.png)

## Overview - Vision Jaws



(\_images/GRIPPER\_VISION\_SCHEMA\_1.jpg)



(\_images/GRIPPER\_VISION\_SCHEMA\_2.jpg)



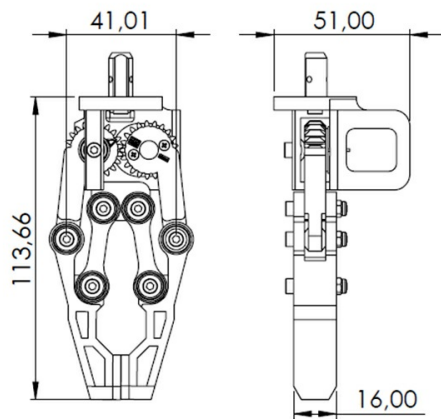
(\_images/GRIPPER\_MORS\_VISION.png)

### Custom Gripper's technical specifications

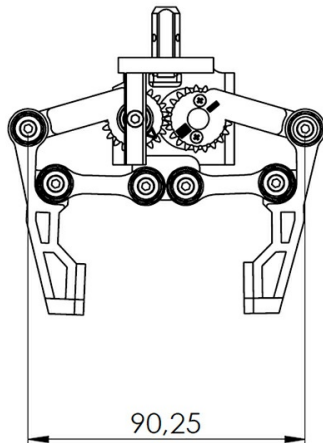
Parameter	Description
Max operating width	Standard Jaws: 23.82 mm XL Jaws: 73.92 mm Flat Jaws: 35.92 mm Precision Jaws: 21.57 mm Vision Jaws: 48.92 mm
Picking distance from end effector base	Standard Jaws: 85 mm XL Jaws: 85 mm Flat Jaws: 90 mm Precision Jaws: 85 mm Vision Jaws: 85 mm
Motor	XL320 Servo Motor
Weight	Standard Jaws: 109 g XL Jaws: 107 g Flat Jaws: 123 g Precision Jaws: 101 g Vision Jaws: 107 g
Power Supply	7.6 V
Operating temperature	5-45°C

### Large Gripper





(\_images/GRIPPER\_LARGE\_SCHEMA\_1.jpg)



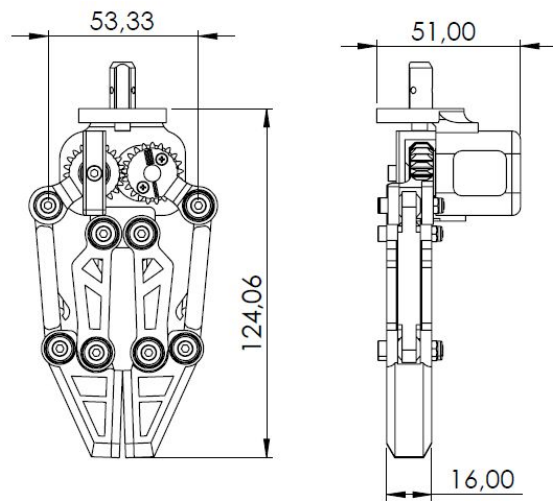
(\_images/GRIPPER\_LARGE\_SCHEMA\_2.jpg)



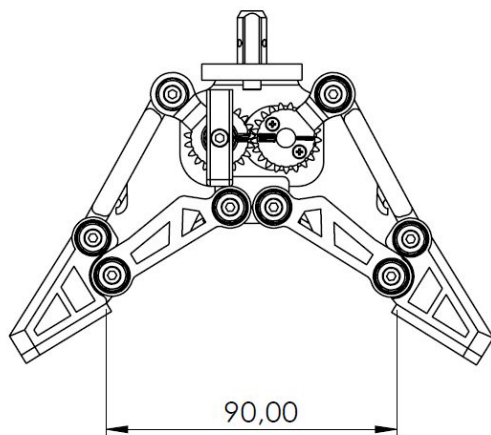
(\_images/GRIPPER\_LARGE.png)

Parameter	Description
Max operating width	60 mm
Picking distance from end effector base	80 mm
Motor	XL320 Servo Motor
Weight	90 g
Power Supply	7.6 V
Operating temperature	5-45°C

## Adaptive Gripper



(\_images/GRIPPER\_ADAPTATIVE\_SCHEMA\_1.jpg)



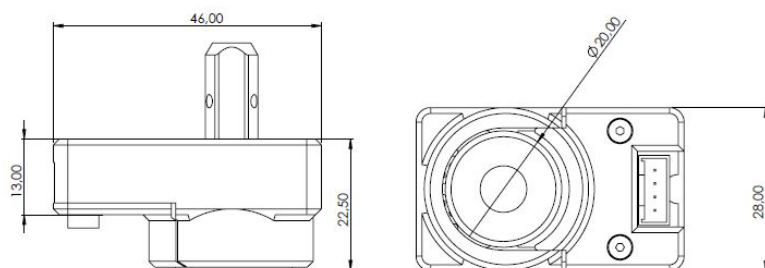
(\_images/GRIPPER\_ADAPTATIVE\_SCHEMA\_2.jpg)



(\_images/GRIPPER\_ADAPTATIF.png)

Parameter	Description
Max operating width	90 mm
Picking distance from end effector base	85 mm
Motor	XL320 Servo Motor
Weight	110 g
Power Supply	7.6 V
Operating temperature	5-45°C

## Electromagnet



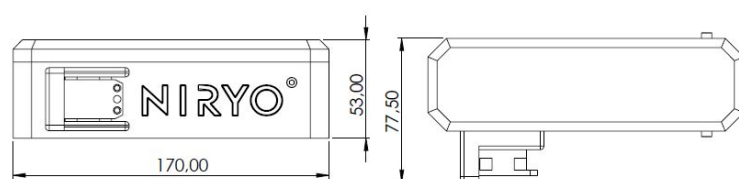
(\_images/GRIPPER\_ELECTROMAGNET\_SCHEMA\_1.jpg)



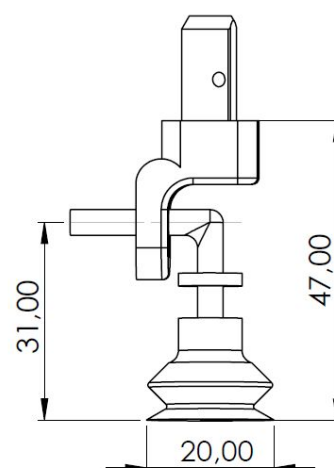
(\_images/AIMANT.png)

Parameter	Description
Max operating width	20 mm
Picking surface	20 mm
Picking distance from end effector base	22.5 mm
Control interface	Digital output
Weight	42 g
Power Supply	5 V
Operating temperature	5-45°C

## Vacuum Pump



(\_images/GRIPPER\_VACUUM\_PUMP\_SCHEMA\_1.jpg)



(\_images/GRIPPER\_VACUUM\_PUMP\_SCHEMA\_2.jpg)



(\_images/POMPE.png)

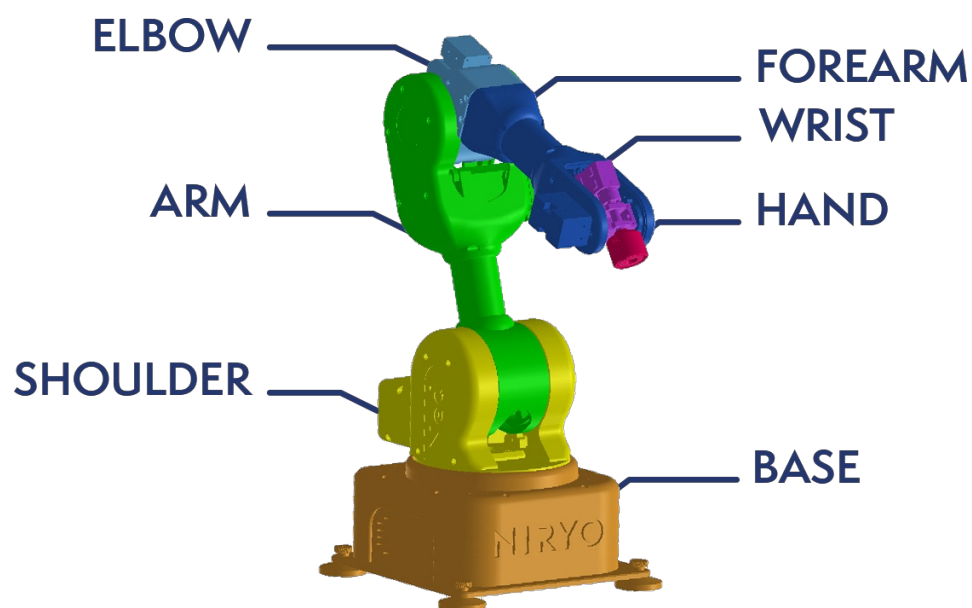
Parameter	Description
Vacuum Pump control	Integrated XL320 servo motor
Weight	10 g
Total weight	170 g
Payload	300 g
Power Supply	7.6 V
Operating temperature	5-45°C
Vacuum Tube dimension	20 mm
Picking distance from end effector base	47 mm

## Mechanical interface

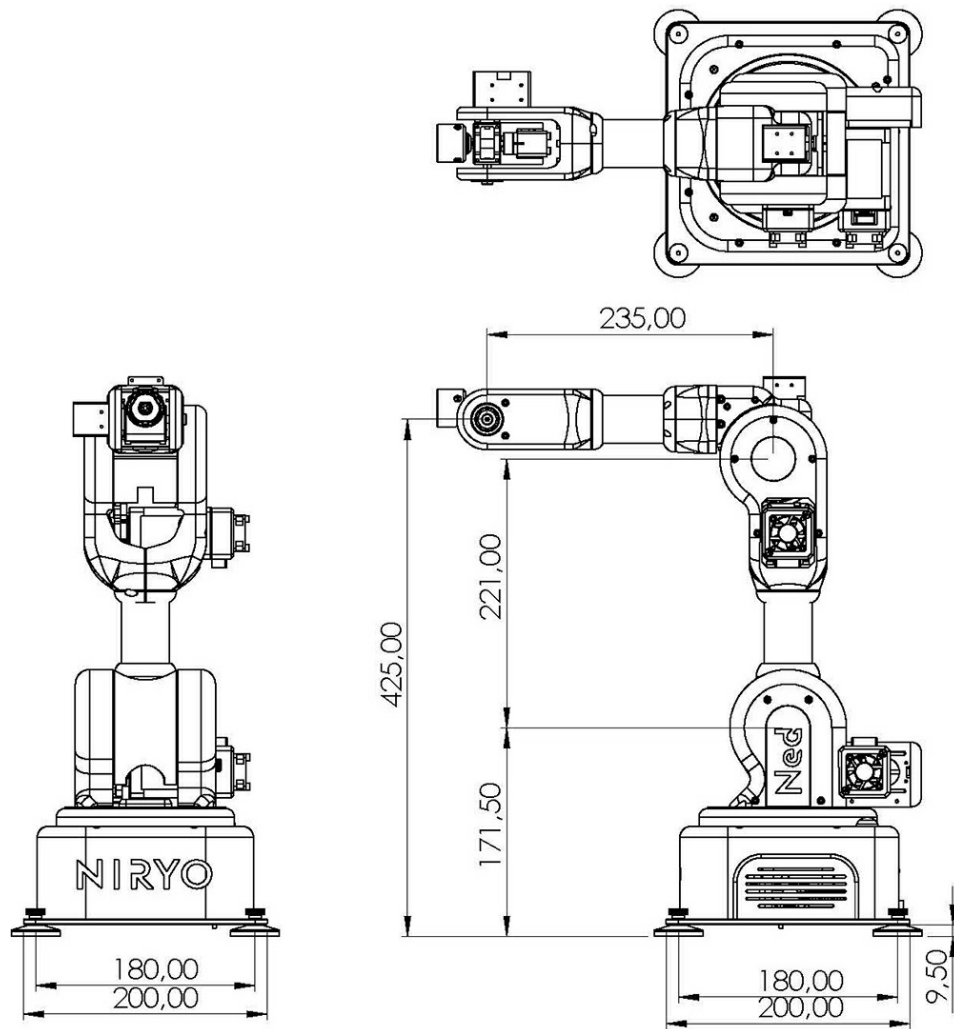
### Mechanical Overview

This chapter introduces the mechanical and the electrical interfaces of Ned.

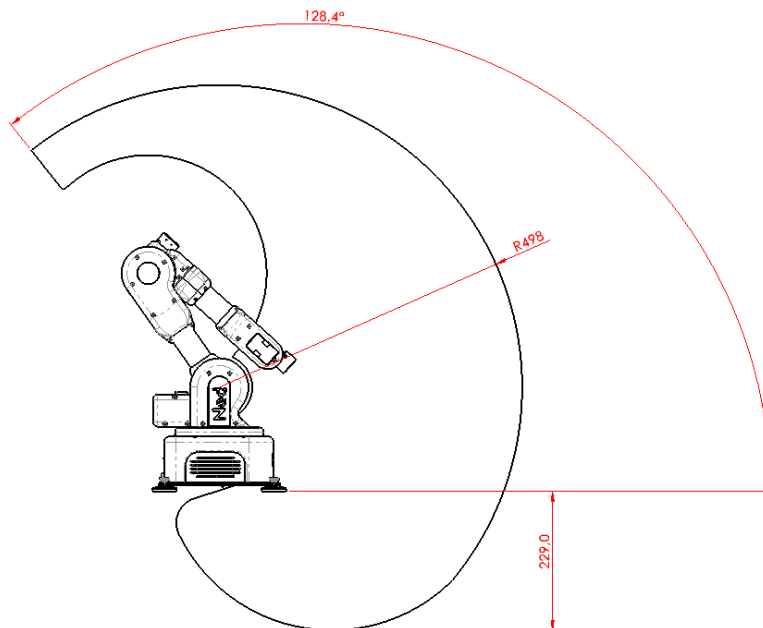
Ned is a 6-axis collaborative robotic arm. It consists mainly of six robot joints of aluminum with plastic covers. Ned consists of 7 parts :

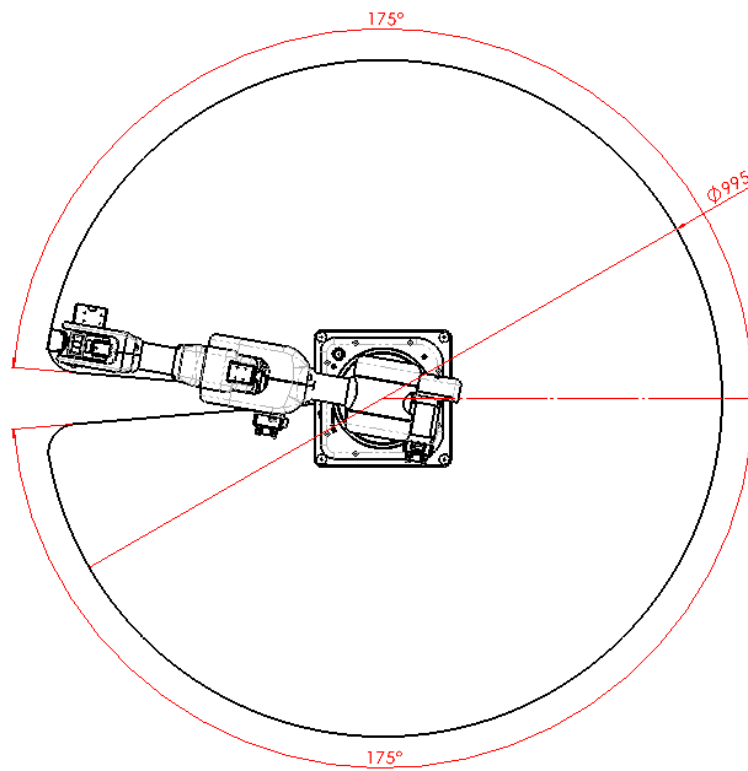


### Three-view of the robot



## Robot workspace





## Tool mounting

Each tool has the same mechanical connector interface. This option allows a quick-change option of the tool and good stability. See the picture below.



## Vision Set mounting

To mount the Vision Set, all you need to do is attach the camera to Ned's wrist, set up and fix your workspace to Ned's structure to have a stable environment and put the vision jaws on the Custom Gripper.



## Robot calibration

Ned is delivered without a mechanical calibration. Ned can not execute any motion properly without auto-calibration because of a mismatch between the origin of each motor and its corresponding origin stored in the controller.

### Note

Make sure to process the calibration in order to align the origins of every joint.

### Hint

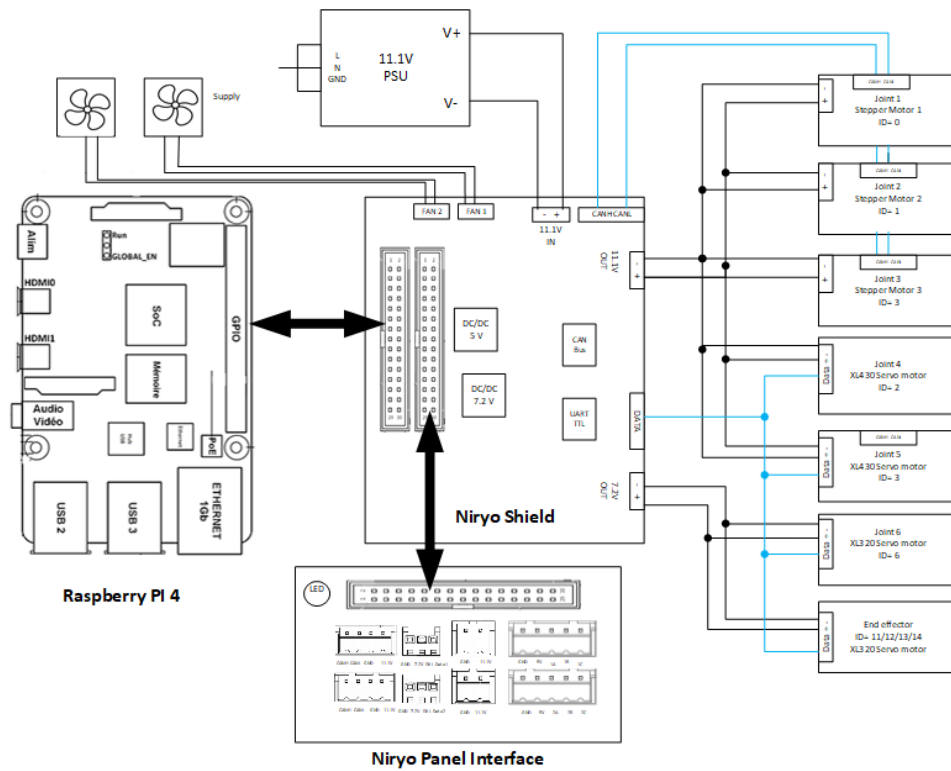
Check [Niryo Studio Manual](https://docs.niryo.com/product/niryo-studio/index.html) (<https://docs.niryo.com/product/niryo-studio/index.html>) to get more information about Ned's calibration.

## Electrical interface

### Electrical interface Overview

Electrical architecture:





## Electrical warnings and cautions

### ⚠ Danger

- Make sure that all the equipment and the wires are kept dry. If water enters the equipment, disconnect the power;
- Carefully follow the safety instructions of the next section to avoid damaging your robot.

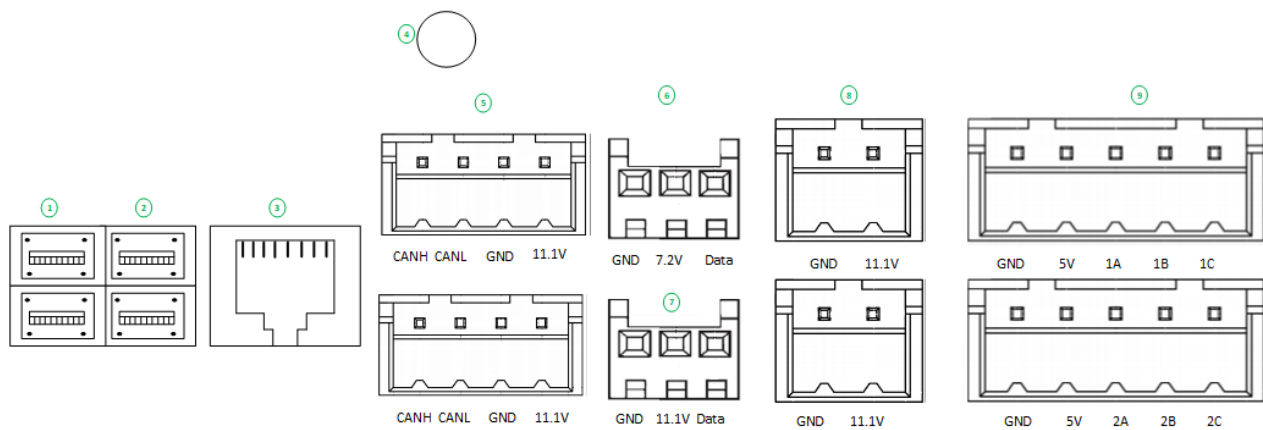
### ⚠ Warning

Do not unplug or power off the robot during use, you may damage the Raspberry Pi 4 inside the robot, or the micro SD card inside the Raspberry Pi 4

## Panel connectors

### Panel connectors Overview





1	2 x USB port 2.0
2	2 x USB port 3.0
3	Ethernet port
4	Panel LED
5	2 x NiryoStepper connector
6	XL320 connector
7	XL430 connector (not used)
8	2 x SW : 12 V digital output
9	2 x GPIO panel
10	Top button

## Power supply

Ned is powered with AC/DC adapter with 11.1V output

Parameters	value
Frequency	50/60 Hz
Input	AC 100-240 V , 1.5 A
Output	11.1 V – 6 A

### ⚠ Warning

- When Ned is turned on, do not disconnect the power supply of Ned. You may damage the Raspberry Pi 4 inside Ned, or the micro-SD card.
- If you modify the original power supply of the robot, you should respect the same specifications.
- Before plugging the power connector and powering on Ned, first make sure that:
  - Ned is on a flat and stable surface;
  - The power switch is turned off (position 0);
  - Ned has enough space to move without hitting something or someone.

## Power Switch

The power switch turns Ned on and off. It enables the power supply.

Always switch it off after shutting down Ned and turn it on to power on Ned.

### ⚠ Warning

Before plugging or unplugging the power supply, make sure to turn off the switch.  
Do not keep the switch on after shutting down Ned, otherwise, the power will be present on the motors and on the shield

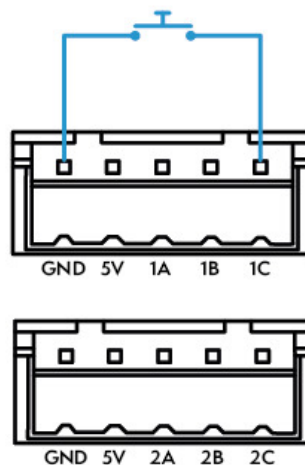
## Digital inputs/outputs

- Ned has 6 inputs/outputs that can be configured either as digital input or digital output with Niryo Studio (see [How to program the digital I/O on the Software Manual](https://docs.niryo.com/product/niryo-studio/index.html) (<https://docs.niryo.com/product/niryo-studio/index.html>)).

Terminal	Parameters	Min	Max	Unit
<b>Digital Input</b>				
[1A-2A-1B-2B-1C-2B]	Voltage	0	5	V
<b>Digital output</b>				
[1A-2A-1B-2B-1C-2B]	Voltage	0	5	V

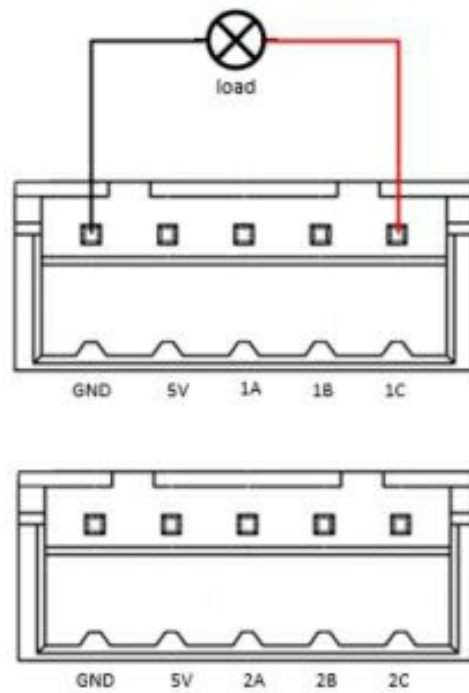
- Digital input connection:

This illustration below shows how to connect a button to a digital input.



- Digital output connection:

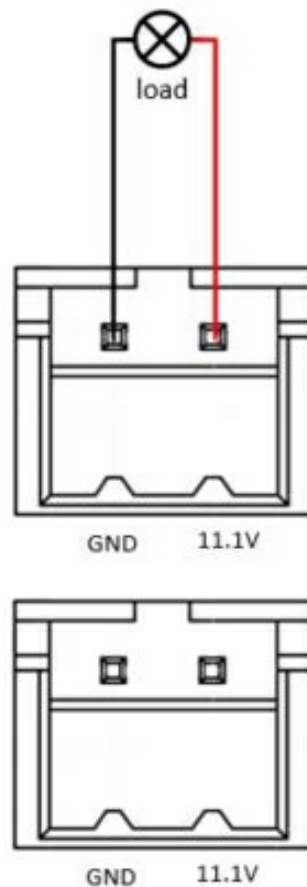
This example shows how to connect a load in order to be controlled from a digital output (see below).



### Switch connections

Terminal	Parameters	Min	Max	Unit
Digital Output				
SW1, SW2	Voltage	0	11.6	V
	Current	0	0.5	A

Below is an example of how to connect an external load to the switch output.



## Ethernet

An Ethernet connection is provided at the panel connector of Ned.

The Ethernet interface can be used for the following:

- Modbus TCP/IP;
- PyNiryo;
- Connect Ned to your local area network.

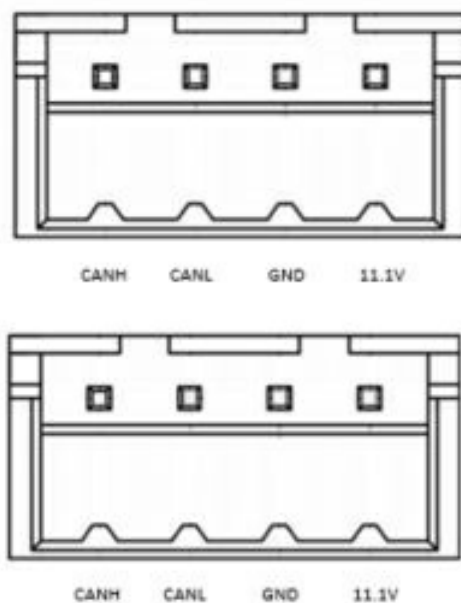
## USB Port

The USB can be used to connect the keyboard, mouse, or Vision Set.

Find more information about Vision Set on the [Vision Set Manual](https://docs.niryo.com/product/vision-set/index.html) (<https://docs.niryo.com/product/vision-set/index.html>).

## NiryoStepper connectors

NiryoStepper connectors interface can be used to drive a NiryoStepper motor. It is based on CAN Bus communication protocol.

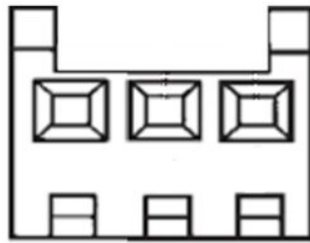


This interface can be used to drive Niryo's [Conveyor Belt](https://docs.niryo.com/product/conveyor-belt/index.html) (<https://docs.niryo.com/product/conveyor-belt/index.html>).

## DXL connection

### XL320 Connector

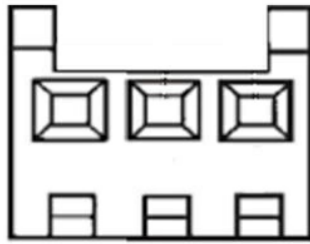
This connector can be used to connect Ned's Vacuum Pump tool.



GND 7.2V DXL-Data1

### XL430 Connector

Not used.



GND 7.2V DXL-Data2

### Panel LED

Ned's LED panel has several colors which represent different modes and error status. Refer to the following table:

Color / Blinking	Description	Troubleshooting
Solid blue	Hotspot mode, the robot has started and creates its own Wi-Fi network.	N/A
Solid green	Connected mode, the robot is fully started and connected to a Wi-Fi network.	N/A
Alternating between Green/Red	Motor error on connected mode	Check "HARDWARE STATUS" and logs to troubleshoot the error.
Alternating between Blue/Red	Motor error on hotspot mode.	Check "HARDWARE STATUS" and logs to troubleshoot the error.
Solid purple	Robot controller is shutting down	N/A
Alternating white – green	The robot is paused on connected mode	N/A
Alternating white – blue	The robot is paused on hotspot mode	N/A
Solid red	On start-up: the robot is booting; On power off: shutdown completed	N/A

### Top button

The top button of Ned has multiple functionalities depending on how long you press the button and the number of presses.

#### Note

All functionalities are available for use only after the robot has been fully started (LED is green or blue).

Press count / Delay	Function
<b>Program is executing</b>	
1 press - 0.1 and 3s	Pause the robot program with Learning Mode off.
2 press - 0.1 and 3s	Pause the robot program with Learning Mode on.
<b>Program is paused</b>	
1 press - 0.1 and 3s	Continue the program.
2 press - 0.1 and 3s	Stop the program.
<b>Program is set on autorun</b>	
1 press - 0.1 and 3s	Start an autorun program.
<b>Programming the robot with blockly</b>	
1 press - 0.1 and 3s	Add / save a freedrive joint position.

#### Note

When you pause the robot's program with the top button, you should either press the button to continue or press twice to stop it.

#### Hint

You can test your robot hardware for the first time without using any software tool, you can follow the steps below:

- Plug the power supply;
- Turn on the power switch button;
- Wait until the LED panel turns blue (if it is the first time you use Ned this should take 2 minutes);
- Press the top button: Ned will start by calibrating and then it will execute a pre-saved sequence.

## Tool wiring

### Custom Gripper, Large Gripper and Adaptive Gripper:

There is a cable on the tool end of Ned with 3 pins. This connector can drive Custom Gripper, Large Gripper and Adaptive Gripper.

#### Note

Make sure to respect color order when you are wiring your gripper.

#### Warning

Not respecting the wiring instructions may damage your gripper or Ned.

### Vacuum pump:

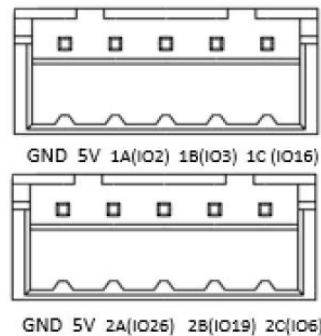
Plug the suction cup to Ned's hand and connect the motor wire to the [XL320 Connector](#) placed at the back



of Ned.

### Electromagnet:

Plug the electromagnet to Ned's hand and connect the cable on the GPIO1 or GPIO 2 connector on the panel connector.



#### Note

Information about programming and using the tool are available on the [Software Manual](https://docs.niryo.com/product/niryo-studio/index.html) (<https://docs.niryo.com/product/niryo-studio/index.html>)

## Advanced Programming

There are many other ways to develop on Ned.

For more information, please refer to the following links:

- [Niryo Studio](https://docs.niryo.com/product/niryo-studio/index.html) (<https://docs.niryo.com/product/niryo-studio/index.html>)
- [Python](https://docs.niryo.com/dev/pyniryo/index.html) (<https://docs.niryo.com/dev/pyniryo/index.html>)
- [ROS](https://docs.niryo.com/dev/ros/index.html) (<https://docs.niryo.com/dev/ros/index.html>)
- [Modbus](https://docs.niryo.com/dev/modbus/index.html) (<https://docs.niryo.com/dev/modbus/index.html>)

Suggest a modification

Download as PDF