Robot System HORST600

Assembly Instructions

For installation, operating, and maintenance personnel

Always keep with the product!

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fruitcore robotics GmbH
Macairestr. 3
78467 Konstanz, Germany

Telephone: (+)49 (0)7531 / 945 99-20
Email: info@fruitcore.de
Website: www.fruitcore-robotics.com

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fruitcore robotics

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Abbreviations

AI	*Assembly Instructions*
DI/DO	*Digital In/ Digital Out*
I/O	*Input-/Output*
EIA	*Emergency In A*
ENA	*Enable Input A*
ESD	*Electrostatic Discharge*
HI	*High, logical 1*
HORST	*Highly Optimized Robotic Systems Technology*
LO	*Low, logical 0*
OSSD	*Output Switching Signal Device*
PL	*Performance Level*
PNP	*Plug and Play*
SI	*Safety In*
SIM	*Subscriber Identity Module*
SO	*Safety Out*
SR	*Safety Relais*
SSI	*Safety Stop In*
T1/T2	*Teach mode 1/2*
TCP	*Tool Center Point*

1 Introduction

1.1 Principle

The assembly instructions (AI) contain important information on how to operate the robot system in a safe, proper, and economically efficient way. Adherence to these AI helps to avoid hazards, reduce repair costs and downtime, and to increase the reliability and service life of the robot system. The operator is obligated to add instructions arising from existing national or company regulations on accident prevention and environmental protection to the AI.

Read the AI carefully and completely before commissioning the robot system. Treat the AI with care and keep it at the site of operation. Illegible or missing AI must be replaced immediately. For the efficient and safe control, programming and operation of the robot, please also read the detailed description of the user software.

1.2 General Information

The AI include a detailed description of the robot system and guidelines for transport and installation as well as comprehensive instructions for operating the robot system, tips for fault rectification, and information on maintenance.

The robot system delivered may include options that deviate from the text and images shown in these AI. This is due to the individual adaptation and further development of the robot system on the basis of the requests and orders of customers. These deviations do not constitute a basis for any claims.

The robot system must be used only for the permissible purposes listed in the AI. The manufacturer assumes no liability for the improper or unauthorized use of the robot system, operating errors, user errors or improper or insufficient maintenance.

1.3 Operating Responsibility and Liability

Operating responsibility lies with the operator of the robot system. The operations manager and all operators are obligated to act according to these AI.

The safety and accident prevention regulations of the following institutions must be observed:

- The country's laws
- The trade associations
- The responsible commercial liability insurance company.

The operations manager, the operating personnel, or – if the former cannot be held responsible due to a lack of training or basic knowledge – their supervisory staff will be charged with accidents resulting from the failure to observe these AI, safety and accident prevention regulations, or a lack of care.

1.3.1 Legal Disclaimer

We expressly stipulate that the manufacturer shall not be liable for damage caused by incorrect or negligent operation or maintenance, or improper use. This also applies to modifications and additions to as well as conversions of the robot system that may impair its safety. The manufacturer's liability shall expire in these cases.

1.4 Warranty

Unless otherwise agreed upon in the purchase contract, we will grant the legally prescribed warranty period for the robot system and spare parts. The warranty provisions specified in the general terms and conditions of fruitcore robotics, or the individual purchase contract apply in addition.

1.5 Organizational Measures

The responsibilities for the operation of the robot system must be clearly defined and adhered to, so that no unclear competencies arise from the point of view of safety. The operator must appoint a person responsible for operation, see section 2.4.2.

In addition, the operator must observe and instruct generally applicable, legal and other binding regulations for accident prevention and environmental protection.

1.6 Standards, Directives and Conformity

The robot system is considered partly completed machinery in accordance with the EC Machinery Directive. The robot system must be commissioned only under the following conditions:

- All safety functions and protection devices required for final machinery as defined by the EC Machinery Directive have been added to the robot system or
- The robot system is integrated in a system. or
- The robot system forms a system together with other machinery. This system or machinery must correspond to the provisions of the EC Machinery Directive. A CE declaration of conformity must be present. The operator is solely responsible for ensuring this.

Declaration of Conformity

The operator must prepare a declaration of conformity in accordance with the EC Machinery Directive for the entire machinery; this constitutes the basis for a corresponding CE marking.

Declaration of Incorporation

The robot system is delivered as partly completed machinery with a declaration of incorporation in accordance with Annex II B of the Machinery Directive 2006/42/EC.

The declaration of incorporation declares that the commissioning of the partly completed machinery remains impermissible until the partly completed machinery is installed in a piece of machinery or assembled together with other parts into a piece of machinery that corresponds to the provisions of the EC Machinery Directive, and the EC declaration of conformity in accordance with Annex II A is present.

This includes in particular that corresponding protective measures according to the risk assessment performed by the operator are taken and that these are to be verified and validated. To this end, the robot system offers a defined scope of safety functions. Emergency stop and safety stop I/Os are prepared in accordance with EN ISO 10218-1.

The operator must ensure the correct function of external protection devices.

The following standards and regulations were applied during the development of the robot system.

- EU Directive 2006/42/EC
  Machinery Directive
- EU-Directive 2014/30/EU
  EMC Directive
- EU-Directive 2011/65/EU
  RoHS Directive

- DIN EN ISO 10218-1:2012
  Robots and robotic devices – Safety requirements – Part 1: Robots
- DIN EN ISO 12100:2010
  Safety of Machinery – General principles of design – Risk assessment and risk reduction
- DIN EN ISO 13849-1:2015
  Safety of Machinery – Safety-related parts of control systems –
  Part 1: General principles of design
- DIN EN ISO 13849-2:2012
  Safety of Machinery – Safety-related parts of control systems – Part 2: Validation
- DIN EN ISO 13850:2015
  Safety of Machinery – Emergency stop principles of design
- DIN EN ISO 14118:2017
  Safety of Machinery – Prevention of unexpected start-up
- DIN EN 60204-1/A1:2019
  Safety of Machinery – Electrical equipment of machines – Part 1: General requirements
- DIN EN 60529
  Degrees of protection provided by enclosures

1.7 Signs, symbols

Lists

- Simple lists are marked with "–".

Instructions for action

All instructions for action for a procedure are listed in chronological order.

▶ Instructions are marked with "▶".

⇒ Intermediate results and end results of the action are marked with "⇒".

Notes

This symbol stands for information that allows a more effective and economically efficient use of the robot system.

1.7.1 Safety and Warning Signs

The following safety signs mark all actions that present a danger to life and limb of the operator or others around the operator. Make sure to observe these signs and act particularly caution in these cases. Also pass on the safety signs to other users.

DANGER!
The sign with the addition DANGER refers to an immediate danger. The danger will lead to serious injury or death of persons.

▶ The description of the danger is followed by instructions for action that serve to avoid or remove the danger.

WARNING!
The sign with the addition WARNING refers to possible danger. The danger can lead to serious injury or death of a person.

▶ The description of the danger is followed by instructions for action that serve to avoid or remove the danger.

CAUTION!
The sign with the addition CAUTION refers to a potentially hazardous situation. The danger can lead to injury of persons.

- ▶ The description of the danger is followed by instructions for action that serve to avoid or remove the danger.

ELECTRICAL VOLTAGE!

This sign is a warning for electricity.

It is posted for all work and operating procedures that are to be observed precisely in order to prevent danger to persons and the system by electricity.

ATTENTION! Danger of damage to robot or property.

This sign indicates information that, if disregarded, presents a danger to the robot system, individual modules, or the operating environment. There is no risk of injury.

Wear protective clothing.

Wear your personal protective equipment:

Safety shoes, protective helmet, safety goggles, and work gloves.

Danger of environmental damage.

This sign indicates information that, if disregarded, presents a danger to the environment. There is no risk of injury.

2 Safety

2.1 General Safety Information

WARNING!
Incorrect operation or handling of the robot system can lead to severe personal injuries.

- ▶ Persons who work with the robot system must be familiar with the safety information of these AI and act according to them.
- ▶ Make sure to observe the occupational safety regulations specified by the law, the regulatory agencies, and the professional associations. And observe the currently valid safety regulations and information.

2.2 Proper Use

The HORST robot system is used to implement industrial robot applications and robotics applications in the area of education. After being programmed by the operator, the robot system is able to execute movements independently. Add-on parts such as grippers or testing instruments can be attached to the robot. These can be controlled by the robot system.

The robot system must be operated only in dry, level interior spaces on a firm surface. The robot must be used only within suitable protection devices.

Note:

- The robot system must be used as intended and only in accordance with the AI and enclosed documents. All information and safety instructions of the AI must be observed. Any use that differs from or extends beyond this is considered improper and is expressly prohibited.
- All protection devices must be functional to use the robot system properly.

- Changes or conversions of the robot system must not be made without the manufacturer's approval
- In addition, the operator must observe and provide instruction on generally applicable legal and other binding regulations on accident prevention and environmental protection.

DANGER!
The robot system must not be used in rooms with a potentially explosive atmosphere.

2.3 Improper Use

Any use that is not described in subsection 2.2 or goes beyond it is considered improper use.

2.3.1 Foreseeable Misuse

The robot system is not intended for hazardous applications. Any use or application that deviates from the intended use is considered as impermissible misuse.

In the case of foreseeable misuse or improper handling of the robot system, the manufacturer's declaration of incorporation expires, and thus the operating permit also expires automatically.

Examples of foreseeable misuse include the following:

- Cutting and welding of workpieces
- Coating/painting if explosion protection is needed
- Use in contact with any kind of liquids (except lubricants intended for the robot system)
- Use in potentially explosive atmospheres
- Use in medical and life-critical applications
- Use prior to the implementation of a risk assessment of the entire application
- Use with applications with insufficient response times of the safety functions
- Use as a climbing aid
- Operation outside of the permissible operating parameters
- Use of the robot system by personnel who have not received the mandatory instructions
- Operation of the robot system outside of the specified technical limits
- Use of components that have not been approved by the manufacturer
- Repairs to components performed by unauthorized personnel
- Manipulation of power settings
- Attachment of accessories or add-on parts that are not approved for use by the manufacturer
- Removal or manipulation of protection devices, e.g. covers or speed restrictions
- Use of unsuitable aids, e.g. tools or lifting gear
- Operation of the robot system with defects
- Implementation of maintenance activities without shutting down the robot system before

These forms of misuse by operating personnel or third parties are strictly prohibited:

- The load capacity of the robot must not be exceeded.
- Sensors must not be covered, masked off, or otherwise disabled. The configuration of sensors must not be changed under any circumstances.
- The enabling switch and other actuating elements must not be bypassed, manipulated or disabled.
- Work must be performed only in the operating mode which is appropriate for the respective situation.
- The robot must be used only within suitable protection.

2.4 Operator's Duties

2.4.1 Risk Assessment by the Operator

DANGER!
Add-on parts, workpieces, or combining the robot system with other pieces of machinery can increase dangers or create new dangers.

- ▶ In order to ensure safety, robot system HORST must be installed in accordance with the guidelines specified in the standards DIN EN ISO 12100 and DIN EN ISO 10218-2.
- ▶ After you have assembled the robot system or integrated it in a system, perform a risk assessment for the entire system.

The risks listed below in particular must be observed:

- Crushing, impact, and cutting injuries:
  - Between the axes of the robot
  - Between the robot and the mounting surface
  - Between the linkage of the robot
- Crushing and cutting injuries:
  - Between the robot/tool and other objects
  - Between the robot/tool and solid surfaces
- Impact injuries caused by the robot
- Crushing and cutting injuries caused by sharp edges:
  - Of the robot
  - Of the tool
  - Of workpieces
- Tilting or falling of the robot.
  - During transport
  - During assembly
  - During operation (due to insufficient attachment)
- Tools/workpieces being flung around or falling down (due to incorrect assembly, design, programming, or interruption of the energy supply to the robot or end effector)
- Electrical danger in case of contact between modules and liquids.
- Danger of falling due to lines lying around.
- Danger due to incorrect integration in the control system of an overall system.
- Danger due to incorrect integration in the superordinate emergency stop circuit.

2.4.2 Operations Manager

DANGER!
Possible personal injuries caused by unsafe condition of the system

- ▶ The operator of the robot system is obligated to designate an operations manager at the installation location.
- ▶ The operations manager is obligated to operate the robot system only in safe condition.

In addition, the operations manager is obligated:

- to only let persons work on the robot system who are familiar with the fundamental regulations on occupational safety and accident prevention and who have been trained in handling the robot system by fruitcore robotics or by personnel authorized by fruitcore robotics.
- to only let persons who have read and understood the AI to work on the robot system
- to clearly determine the responsibility of the personnel for e.g. operating, repairing, and maintaining.
- to supervise the safety-conscious behavior of the personnel.
- to encourage the transport and operating personnel to wear protective clothing.
- to provide the personnel with the necessary safety equipment.

The operations manager must conduct checks as to the safety-conscious and danger-conscious behavior of the operating and maintenance personnel.

2.5 Operating Personnel

2.5.1 Obligation of the Operating Personnel

Before taking up work, all persons commissioned with working on the robot system undertake:

- to observe the fundamental regulations on occupational safety and accident prevention
- to read the AI and follow the instructions and safety information
- to check the robot system in terms of safety and proper function before starting work
- to contact the operations manager in the case of questions

2.5.2 Training of the Operating Personnel

DANGER!
Possible personal injuries caused by untrained operating personnel

▶ The operating personnel must be trained on the work with and dangers of the robot system by fruitcore robotics or authorized personnel commissioned by fruitcore robotics. Persons who have not received this training are not permitted to operate the robot system.

DANGER!
Possible personal injuries caused by the operation of persons undergoing training

▶ Persons to be trained or taught as well as apprentices are only permitted to operate the robot system if supervision by a trained person with technical or electrotechnical training (teaching personnel) is ensured.

The operating personnel must be at least 18 years old and physically and mentally fit to operate the robot.

Instructed personnel with technical training may be used for the following activities:

- Operating the robot system in automatic mode
- Adjusting the system parameters (teaching modes T1 and T2)

Instructed personnel with technical and electrotechnical training may also be used for:

- Assembly and commissioning of the robot system
- Troubleshooting and fault rectification
- Inspection, maintenance, and repair

2.6 Working Area, Danger Zone, and Safe Area

The **working area** is a defined 3D space within the range of the robot. When tools, measuring devices, and workpieces are attached, the range of the robot and therefore its working area change.

The **stopping distance** is calculated on the basis of the reaction and braking distance of the robot.

The **danger zone** includes the working area and stopping distance of the robot. Persons must not be in the danger zone while the robot is in operation.

DANGER!
Due to the robot's automatic movement, sudden dangers must be expected within the danger zone. Moving modules may cause personal injury or property damage.

- ▶ The robot system must be operated only in technically perfect condition.
- ▶ The robot must be used only within suitable, active protection devices. The protection devices must stop the robot's movement within the danger zone.

The **safe area** is located outside the danger zone. Persons may be in this area during all operating modes.

2.7 Safety Functions

The robot control is equipped with two different types of safety functions, both of which bring the robot into a safe condition. A safe state is achieved by braking all of the robot's drive axles.

Emergency Stop

Bringing about a safe condition of the robot in the event of an emergency situation. This safety function is available in all operating modes. It takes precedence over all safety functions. It is triggered by the emergency stop button or external safety controls. External emergency stop devices are connected to the emergency stop inputs of the switch cabinet, hereinafter referred to as Control.
This safety function must be used in emergency situations exclusively in order to bring the robot into a safe condition. The emergency stop must not be used for process-related stops.

Safety Stop

Bringing about a safe condition of the robot for process-related and safety-critical situations. This safety function is to be used for process-related stops during which operating personnel must be able to intervene in the danger zone.

The purpose of both types of safety functions is to bring about a safe condition of the robot.

The safe condition is marked by the following properties:

- **Emergency stop**: A category 1 stop is triggered. The robot is braked actively until it comes to a standstill; the brakes are applied, and the energy of the drives is then switched off.
- **Safety stop**: A category 2 stop is triggered. The robot is actively braked until it comes to a standstill. The drive power is not switched off. The safe standstill is monitored.

The robot control has other safety functions. These are described in the subsections on the configurable safety functions from page 25.

The safety-related performance of the control system corresponds to PL "d" with structure category 3 according to DIN EN ISO 13849-1:2015. It is defined by the risk assessment of the robot system or DIN EN ISO 10218-1:2012.

2.8 Residual Danger

The robot system is built according to the current state of the art and in line with the recognized safety rules. Nevertheless, danger to the user or third parties or impairments of the system and other material assets may arise in the course of use.

DANGER!
Danger resulting from human error or malfunctions

- When integrated in a complete system, the robot system must be integrated in the emergency stop circuit of the higher-level system.

RISK OF BURNS!
The robot generates heat during operation.

- The robot must not be touched during or immediately after operation.
- After switching off the robot, wait until it has cooled down or wear heat protection gloves.

ELECTRICAL VOLTAGE!
Possible personal injuries caused by applied electricity

- Work on the electrical equipment must be performed only by specialist personnel with appropriate training and in accordance with the electrotechnical rules.
- Make sure that Control or the cables do not come into direct contact with liquids.
- Prior to performing any work on the electrical equipment, disconnect the robot system from the power grid.
- In the event of malfunctions of the electrical equipment of the robot system, switch off the robot system immediately and rectify the malfunction.
- The electrical equipment of the robot system must be checked regularly. Defects such as loose connections or damaged cables must be rectified immediately.

3 Transport

CAUTION!
Risk of injury due to overloading or the robot falling

- The robot must be lifted exclusively at the swivel arm by at least two persons in order to prevent overloading or the robot from falling. If possible, the robot must be transported securely attached to a suitable mobile stand.
- You must prevent the robot from tilting. The robot must be lifted carefully and simultaneously by two people.

ATTENTION!
Risk of damage to the robot

- Only hold the robot by the swivel arm.
- Do not move the robot axes with force.

When delivered, the robot is in transport position (see figure below).

1 Robot
2 Swivel arm (hold at the arrow)

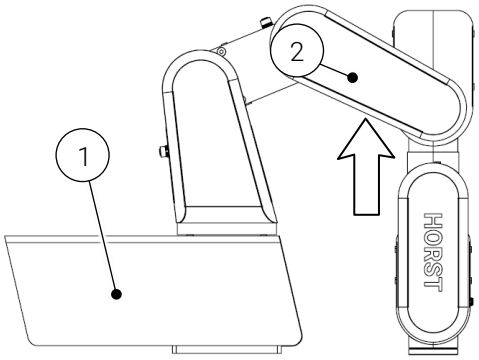


Fig. 3-1: Transport position

To transport the robot system again after use, follow the steps below:

- Before disconnecting the robot system from the power supply, start the “Shipping position” program in horstFX and leave it to run in full. This brings the robot to the correct position for shipping/transport.
- Alternatively, use the *Free Movement* software control to bring the robot to the transport position, as shown in the illustration above.
- Disassemble the robot system from the mounting surface (see 5.2.1)
- Securely package the robot, Panel, and Control.
- During further transport, the robot system must be secured against toppling over and falling down.

ATTENTION!
For transport, the robot system must be in the original packaging from fruitcore robotics. The robot system, especially the control have to be transported upright. Paletts are suitable for this purpose

4 Description of the Robot System

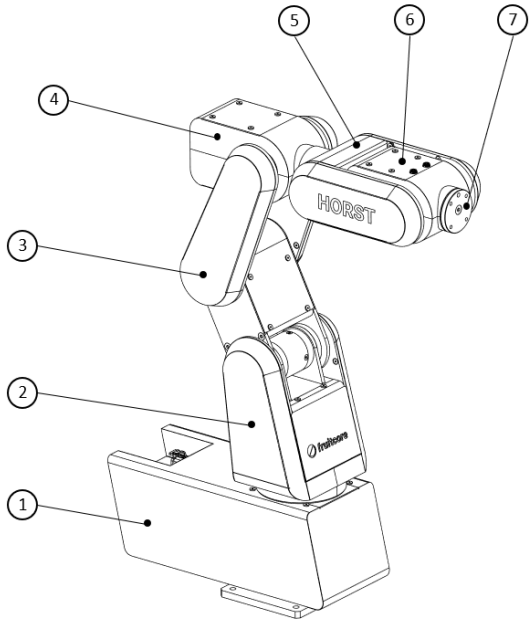
4.1 Scope of Delivery

The robot system is delivered with:

- Control (switch cabinet)
- Panel with mount for control panel
- Connection cable (robot – Control), 3 m
- Power cable (1.8 m)
- DVI cable (5 m)
- 4 mounting screws (DIN 7984 M8x20)
- Assembly Instructions
- USB-Surfstick incl. SIM card

4.2 Modules

4.2.1 Robot



1 Base – fixed part with floor flange
2 Base – moving part
3 Swivel arm
4 Support arm 1
5 Support arm 2
6 Support arm 3
7 Tool flange

Fig. 4-1: Robot HORST 600

Robot axes

The movements are realized via the rotation around 6 robot axes.

You can find the values for the ranges of movement in the Annex

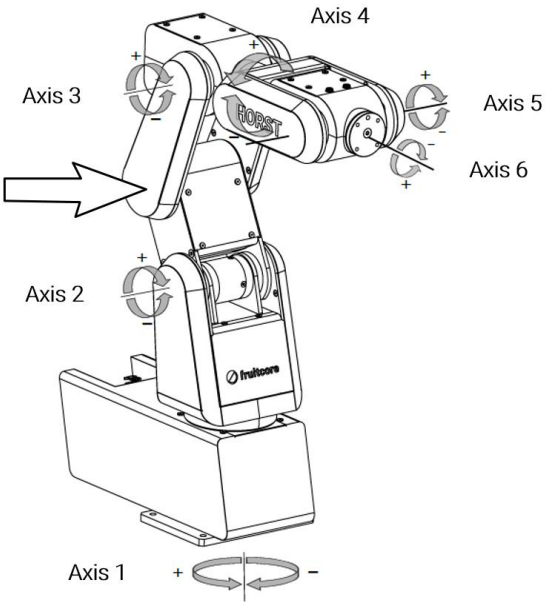


Fig. 4-2: Robot axes

4.2.2 Panel (operating panel)

1 Touch display (user interface)

2 Connection to Control

3 Emergency stop button

The Panel features a portable operating panel equipped with a touchscreen display. It is connected to Control by a DVI cable. As standard, a 5 m long DVI cable is supplied.

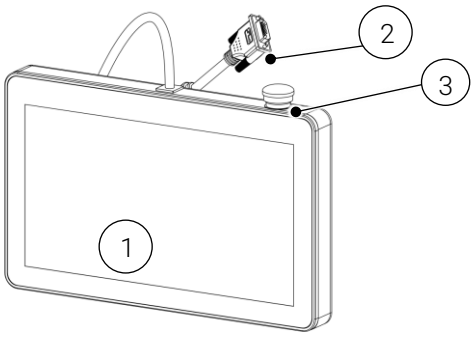


Fig. 4-3: Operating panel

4 2x USB 2.0 ports

5 Enabling switch

The enabling switch and two USB 2.0 ports for connecting additional input devices (keyboard, mouse) are located on the rear. The USB ports of the Panel are intended only for connecting input devices. Use the USB port on Control to connect storage media.

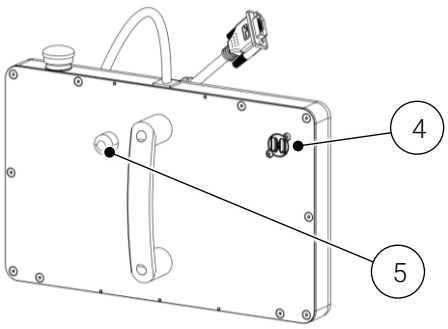


Fig. 4-4: Rear side of Panel

In order for the robot to perform movements in teaching mode, the enabling switch must always be kept in the center position.

WARNING!

- Never connect a standard monitor to the DVI cable! As the wiring does not correspond to the standard, this could damage the end device or Control!
- Never plug in or unplug the Panel during operation! Switch Control off first.
- The USB ports on the Panel are only provided for input devices. For storage media, use the interfaces of Control

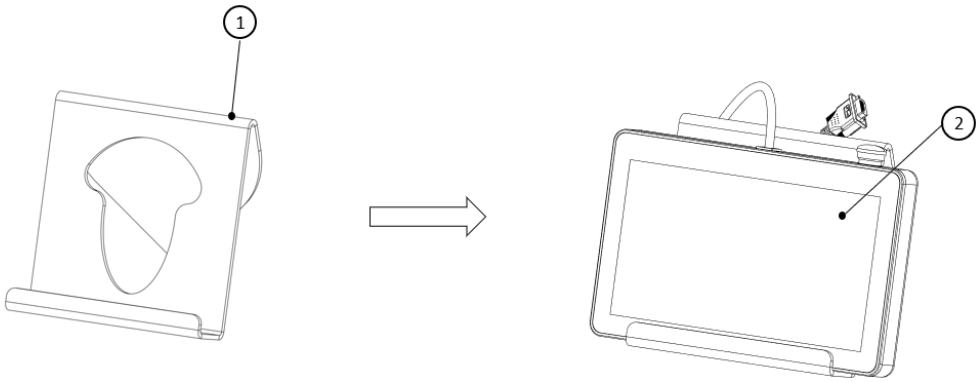


Fig. 4-5: Mount for Panel

The mount (1) for the Panel is used for desktop installation (2).

Use the mount for the Panel e.g. in teaching mode, to prevent having to hold the Panel by hand for a long time.

4.2.3 Control (switch cabinet)

Control is the robot's control system. The main control (horstIO) is installed in this switch cabinet. Countless interfaces also enable communication with and control of other machines and external sensors and actuators. The front side of Control is shown on the left, the rear side on the right shows.

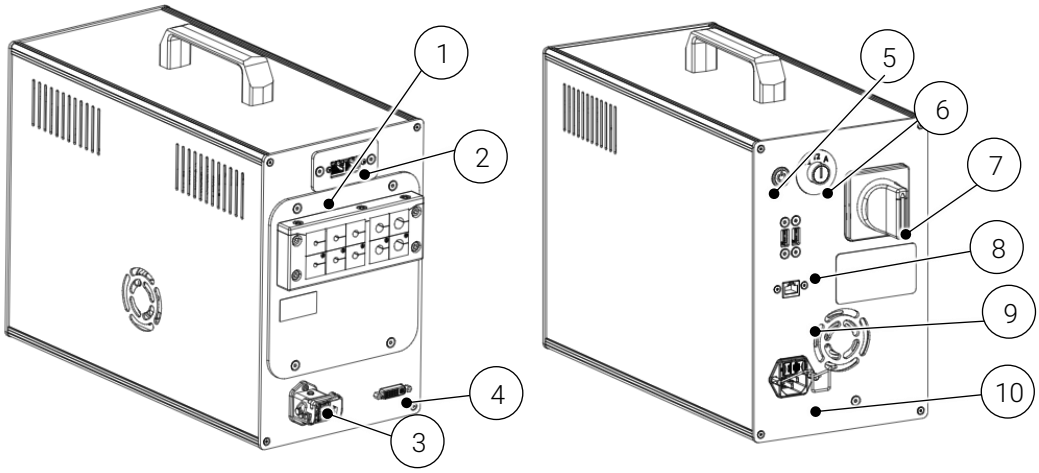


Fig. 4-6: Control switch cabinet

1 Cable duct for inputs/outputs (interfaces)
2 PROFINET connection (modular plug RJ45) (optional)
3 Robot connection
4 Panel connection
5 PC ON/OFF button
6 Operating modes selector switch
7 Main switch

8 2x USB 3.1 ports
9 Ethernet port (modular plug RJ45)
10 Power connection

4.3 Protection Devices

4.3.1 Enabling Switch

The enabling switch is executed in three stages. The center position is “active”.

1 Enabling switch

The enabling switch is on the rear side of the Panel.

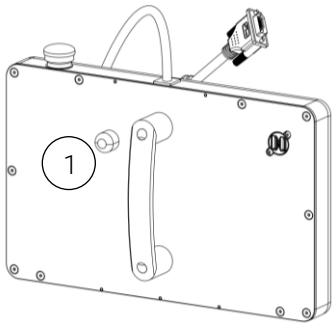


Fig. 4-7: Rear side of Panel

4.3.2 Emergency stop button

When integrated in a complete system, the robot system must be integrated in the emergency stop circuit of the higher-level system.

Observe the information on this in subsection *Safety-critical Inputs/Outputs*.

1 Emergency stop button

The emergency stop button is on the top right-hand side of the Panel.

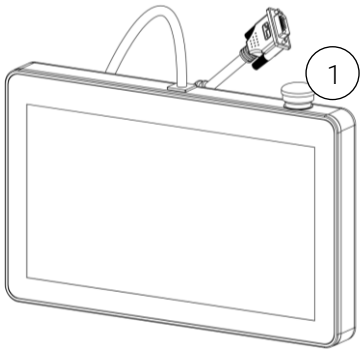


Fig. 4-8: Emergency stop button

4.4 Add-on Parts & Tools (Option)

Add-on parts can be additional mechanical attachments, such as flange plates (e.g. for mounting pneumatic accessories) or tools such as grippers. To mount tools on the mechanical interface, a standard tool flange is installed in accordance with DIN EN ISO 9409-1 (for dimensions, see 5.3). To mount add-on parts, mounting points for flange plates are provided on the robot arm, see Annex *Optional Accessories*.

DANGER!
Add-on parts an increase hazards or create new hazards.

▶ After assembling add-on parts, perform a risk assessment for the entire system. Additional safety precautions may be required based on this.

5 Assembly

5.1 Working Area of the Robot

The following figures display the size and shape of the working area.

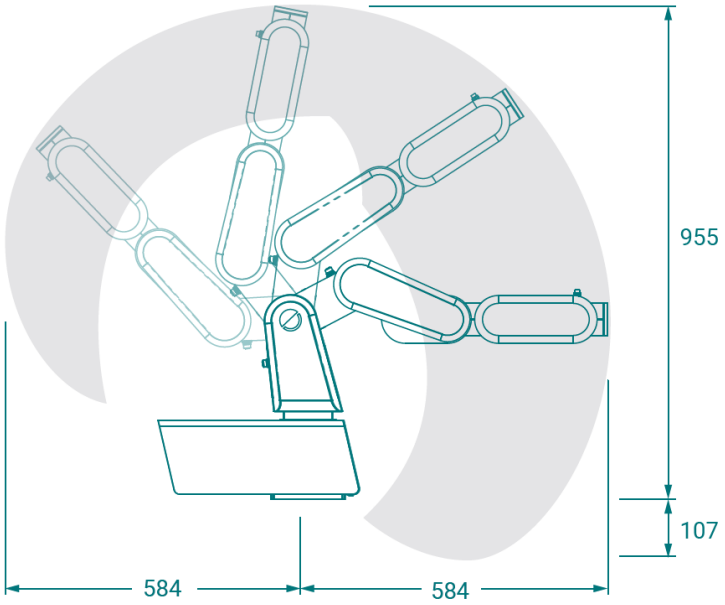


Fig. 5-1: Side view of working area

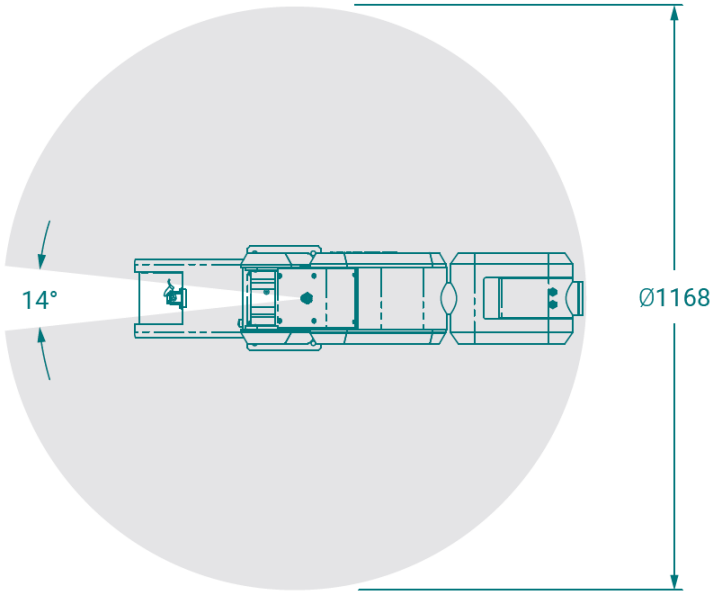


Fig. 5-2: Top view of working area

5.2 Assembly of the Robot

DANGER!
Danger due to incorrect assembly and commissioning

- ▶ Assembly and commissioning must be performed only by persons with technical and electrotechnical training who were also authorized by fruitcore robotics.

CAUTION!
Risk of injury due to the robot falling

- ▶ Secure the robot against tilting until it is attached to the mounting surface.

ATTENTION!
Risk of damage to the robot.

- ▶ Do not lift the robot by the swivel or support arm.
- ▶ Do not move the robot axes with force.

For the specifications regarding the condition of the mounting surface, see the following subsection.

Note before setting up:

- ▶ Check the modules for damage. Do not mount/use damaged parts.
- ▶ Ensure that there is sufficient room for the robot arm to move freely. There must be no obstacles in the working area.
- ▶ If the robot is combined with other machinery in a system, make sure that the other machinery cannot damage the robot.
- ▶ Ensure that suitable protection devices are installed. The protection devices must stop the robot's movement within the danger zone.
- ▶ Protection devices (emergency stop, safety stop) must be connected only to safety-critical interfaces and must be designed to be redundant.

5.2.1 Mounting Surface

The robot must be mounted on a suitable, level, firm, dry, vibration-free, and non-moving surface with mounting screws. The mounting surface should be made of steel or aluminium or possess comparable strength values. The maximum permissible inclination of the mounting surface is +/- 3°. The robot is not designed for movement on a linear axis or a moving platform. Permissible acceleration torques must be requested from the manufacturer, fruitcore robotics. **Ceiling-mounting of the robot is possible, but not on a wall.**

The load-bearing capacity of the mounting surface must be at least two times the weight of the robot and five times the maximum tilting moment of the robot (320 Nm).

5.2.2 Assembling the Robot

5.2.2.1 Base plate

- ▶ Prepare the mounting surface according to the drilling pattern (see Fig. 5-3).
- ▶ Lift the robot by the swivel arm and position it on the mounting surface.
- ▶ Secure the robot against tipping until it has been fixed on the mounting surface
- ▶ Attach the robot with the 4 mounting screws supplied (DIN 7984, M8x20) with 20 Nm.

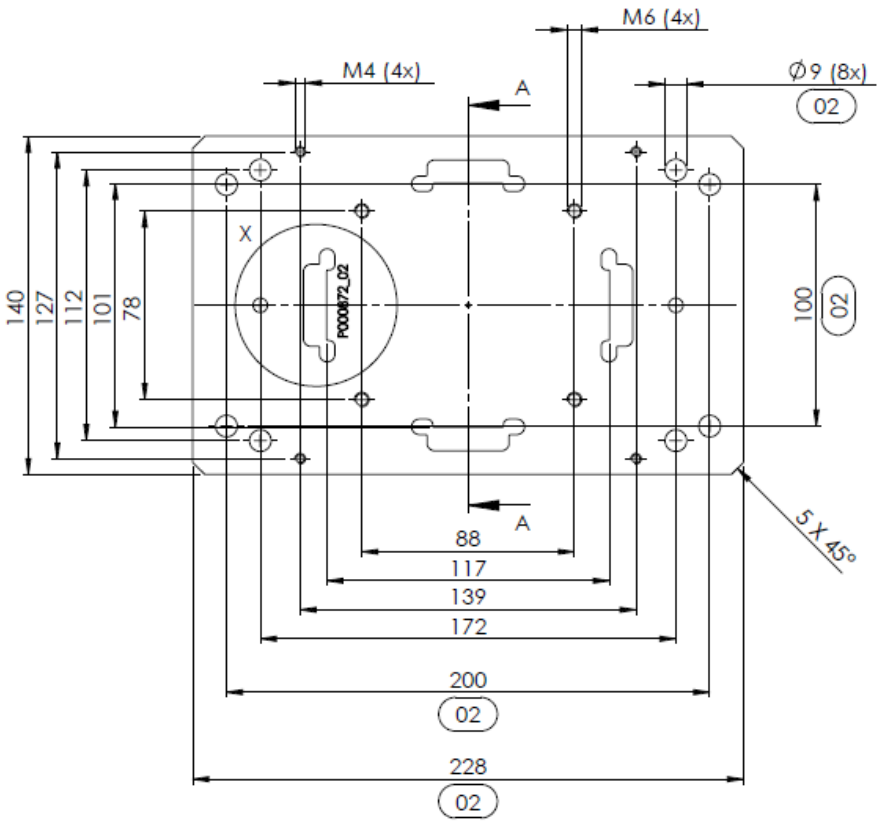


Fig. 5-3: Base plate – Mounting and positioning holes

5.2.3 Restricting the Movement Space

ATTENTION!
Risk of damage to the robot.

- ▶ Ensure that the movement space is limited by the software and never drive into the mechanical end stops of the robot.

If the robot is intended for operating mode “Manual with high speed (T2)”, the integrator must provide a limited space to reduce the size of the danger zone. The movement space must also be limited by the software.

- ▶ The stop bolt (1) is at the rear of the base
- ▶ Undo the screws (2) of the cover
- ▶ Remove the cover (3)
- ▶ Bring the robot into position
- ▶ so that the thread of the desired
- ▶ stop position is accessible from above
- ▶ Mount the screw (4)
- ▶ DIN 912 M8x12 / Steel 8.8, galvanized
- ▶ (not included in scope of delivery)
- ▶ at the desired position
- ▶ Secure the cover again

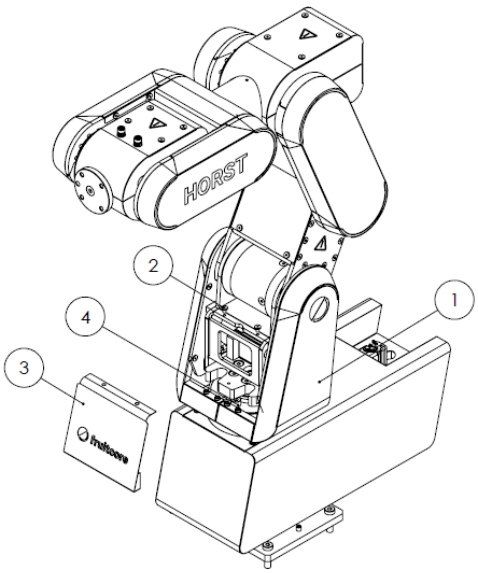


Fig. 5-4: Mechanical axis limitation for axis 1

5.3 Assembling Add-on Parts

Add-on parts such as grippers or testing instruments can be attached to the robot.

ATTENTION!

- ▶ Do not attach anything to the cables of the robot.
- ▶ Make sure, the robot's cables and external lines are not touched when the robot is moving.

WARNING!
Change of the danger zone due to add-on parts

- ▶ Note that the range of the robot and thus the danger zone change with add-on parts.

WARNING!
Danger due to the add-on parts and workpieces being ejected during operation

- ▶ Before commissioning, ensure that the add-on part is securely attached.
- ▶ Avoid eccentric loads to prevent upswing.
- ▶ Adhere to the holding forces adapted to the process parameters.

The robot is equipped with an interface for add-on parts. It has four holes with an M6 thread for attaching the add-on parts.

For accurate assembly, the Ø6 hole can be used with a pin.

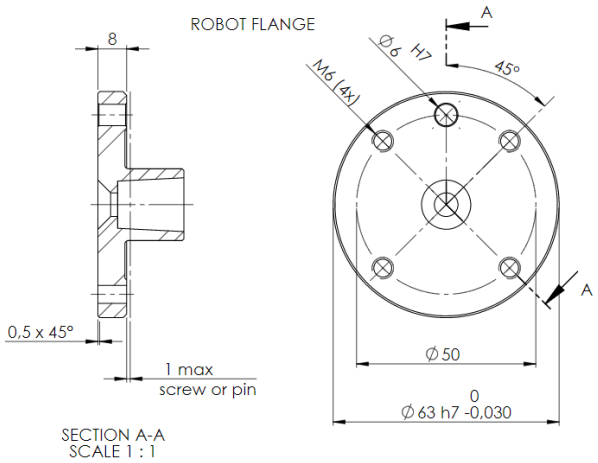


Fig. 5-5: Tool flange drawing

Refer to the Annex for information on optional add-on parts from fruitcore robotics.

For information on optional add-on parts from third-party manufacturers, refer to their product documentation.

Optional accessory flange plates can be mounted for add-on parts that are to be attached to the robot arm (e.g. pneumatic valves) (see Annex).

ATTENTION!

Note when routing pneumatic valves and lines:

- ▶ During attachment, the risk of collision with other modules must be taken into consideration.
- ▶ The lines must not be crushed or torn off by the robot's movements, and they must be secured against detaching (possibly with cable ties or the like).

5.3.1 Pneumatic Connection of Add-on Parts

ATTENTION!

Cables laid on the robot arm must be secured against loosening.

The pneumatic connection values of the add-on parts can be found in the manufacturer documentation.

- ▶ After securely mounting all pneumatic components (e.g. gripper), connect the compressed air supply.

5.4 Setting Up Control

- ▶ Position Control in compliance with the following:
  - The connection cable can be routed to the robot.
  - It is protected against damaged and falling down.
  - There is 100 mm of free space on all sides (the ventilation slots must be free).
  - Accessibility of the switches and connections only from outside the protected area is ensured.

ELECTRICAL VOLTAGE!

Possible personal injuries caused by applied electricity

- ▶ Make sure that the cables and Control do not come into direct contact with liquids.
- ▶ Control must not be used in dusty or humid environments that exceed protection classification IP20. Conductive dust in particular must be avoided.

Refer to the technical data for the length of the included cables.

6 Electrical Installation

This section describes the electrical installation of the robot system, i.e. the connection of the robot to the switch cabinet (Control) as well as the connection of other devices and systems.

There are several electrical interfaces:

- Robot connection: Connection of the robot to Control (switch cabinet)
- Power connection: Connection to the power supply
- Control I/O: Connection of external devices and systems to the switch cabinet
- Tool I/O: Connection of tools to the robot arm
- Computer interfaces

The safety and warning notes in the following section apply to all electrical interfaces.

6.1 Electrical System Warning Notes

ELECTRICAL VOLTAGE!

Possible personal injuries caused by applied electricity

- ▶ Work on the electrical equipment must be performed only by specialist personnel with appropriate training and in accordance with the electrotechnical rules.
- ▶ Only use the included power cable. Do not use damaged cables.
- ▶ Make sure that the power supply is switched off while working on the robot and that it cannot be switched on again by accident.

DANGER!

Danger due to incorrectly connected emergency stop and safety stop devices

- ▶ Only use the interface for emergency stop I/O to connect external emergency stop devices. Do not connect any emergency stop devices to normal I/O or to the safety stop I/O.
- ▶ Only use the interface for safety stop I/O to connect external safety stop devices. Do not connect any safety stop devices to normal I/O or to the emergency stop I/O.

WARNING!

EMC problems may occur due to incorrect grounding.

- ▶ When grounding the robot system, ensure corresponding protective and functional measures as per DIN VDE 0100 and EMC Directive 2014/30/EU.
- ▶ Ensure that the robot system is properly grounded. I.e. there must be a shared electrical connection between all elements belonging to the system and ground.

WARNING!

Trip hazard

- ▶ Ensure that cables and hoses for media and power supply are properly laid and secured.

WARNING!

Unexpected movements of the robot

- ▶ Only connect the power supply when the assembly has been fully completed and is correct.

ATTENTION!

Only use the original cables supplied with the robot system. Do not use the robot for applications that expose the cables to bending.

6.2 Robot Connection

- ▶ Connect the robot to Control using the connection cable.

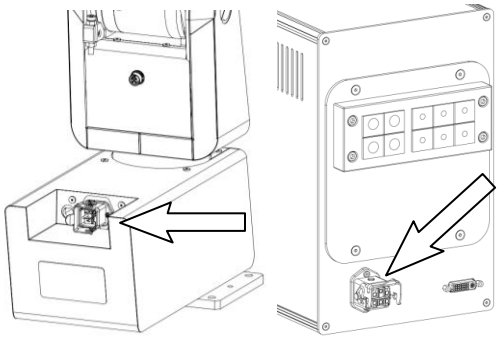


Fig. 6-1: Connection of the robot and the control unit

ATTENTION!

The robot connection cable must be plugged into Control before the power is switched on. **It must only be plugged in or disconnected in a deenergized state.**

The robot must never be disconnected during operation.

The cable must not be extended or opened.

6.3 Power Connection

The Control power connection is a standard IEC C14 male socket (IEC-60320) with integrated pull-out protection. The supplied power cable has a safety plug at one end and an IEC C13 cold-device coupling with specially molded housing at the other end. This, together with the pull-out protection, ensures reliable connection to the power supply. Therefore, always used the power cable supplied.

The power supply must have:

- Main fuse
- Circuit breaker
- Ground connection (PE protective conductor)

Control is equipped with a power entry filter and a 6.3 A fuse.

▶ Connect Control to the power supply with the supplied power cable. Lay the power cable such that it is protected against damage.

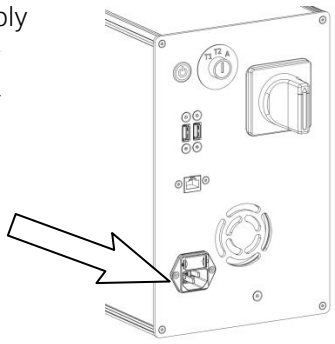


Fig. 6-2: Power connection to Control

Parameter	min.	typ.	max.	Unit	measuring conditions
Input voltage	90	-	260	VAC	Control PCC, Robot H600, all axes moved at the same time, speed 100%, load capacity 0 kg, measuring period 2 hours
Input frequency	47	-	63	Hz	
Current consumption			4.4	A	
Rated power draw (1)		210		W	

Table 6-1: Mains connection characteristic values

ELECTRICAL VOLTAGE!

▶ Ensure that all cables are connected correctly before supplying Control with power. Always use the original power cable supplied.

▶ Make sure that the robot is grounded (power plug connected to PE protective conductor).

▶ A suitable circuit breaker and a suitable RCD (residual current operated device) must be installed.

6.4 Control I/O

This section describes how to connect devices to Control.

The connections can be split into four categories:

- Safety-critical inputs/outputs
- General digital outputs
- +24 V power supply
- Add-on interface

The inputs and outputs for this are located on the horstIO – the main control installed in Control – which is accessible on Control after removal of the cable duct. You can find a table overview of the connectors and their terminal assignments in the Annex 13.7/13.8 from page 57.

- ▶ Undo the four external M4 countersunk head screws.
- ▶ Remove the cable duct cover (1).
- ▶ The horstIO connections are now accessible.
- ▶ If relevant, connect peripherals to the interfaces.
- ▶ Secure the cable duct cover again.

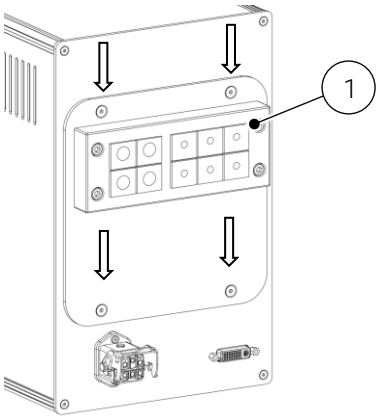


Fig. 6-3: Control cable duct

The connections are designed as pluggable screw terminal connectors. The supplied screw terminal connectors of type Amphenol Anytek TJ0831530000G (alternatively Phoenix Contact MC 1.5/ 8-ST-3.81) or even Push-In terminals, such as Phoenix Contact FK-MCP1.5/8ST-3.8 can be used as connectors.

The connector base strip is of type Amphenol Anytek OQ0832500000G.

6.4.1 Overview of All Interfaces

The following graphic shows the layout of the interfaces available on the horstIO.

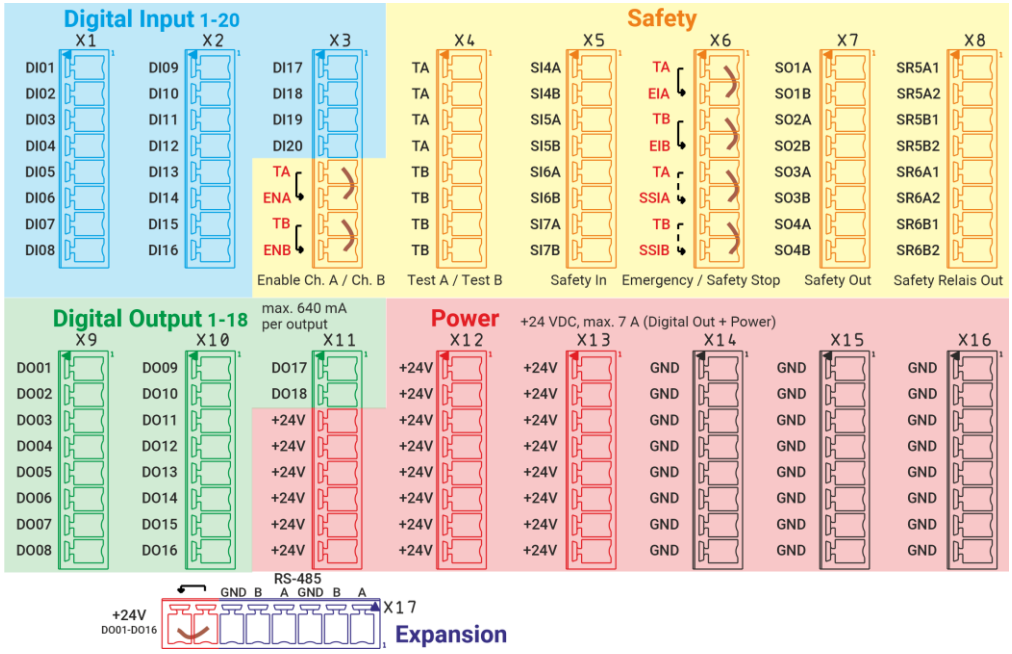


Fig. 6-4: horstIO interfaces

- 7 safety-critical inputs – 2-channels each (orange area)

    - 3 dedicated inputs (orange area with red font)
        - Emergency stop input – connection of potential-free contacts only
        - Safety stop input
        - Internal enabling switch
    - 4 configurable outputs (external emergency stop, acknowledgement signals, etc.)
- 6 safety-critical outputs, 2-channels each (orange area, black font)
    - 4 configurable outputs, push-pull
    - 2 configurable, potential-free outputs (two relay contacts each)
- Test signal generation TA/TB: OSSD signal for safety-critical inputs
- Up to 28 general digital inputs (blue area)
    - 20 digital inputs
    - A further 8 digital inputs, if the 4 configurable, safety-critical inputs are configured as normal inputs
- Up to 30 general outputs (green area)
    - 18 digital outputs, Push-Pull / High-Side
    - A further 8 digital outputs, push-pull, if the 4 configurable, safety-critical outputs are configured as normal outputs
    - A further 4 relay contacts, from the configurable, potential-free, safety-critical outputs, configured as normal outputs
- Shared GND and +24 V terminals (red area)
- RS-485 interface for future extensions (purple area)
- External bridge for +24 V: can be routed via the safety relay for safety-critical switch off of digital outputs 1-16.
- An external enabling switch can be connected via terminals ENA/ENB and TA/TB, but deactivates the internal enabling switch on the Panel.

6.4.2 Safety-critical Inputs/Outputs

Control is equipped with several safe inputs and outputs. Safe I/Os are established redundantly through two independent lines. An incident or failure of a line therefore does not result in the complete loss of the safety function.

Some of the safe I/Os are configurable to enable extended connectivity and functionality with devices and systems. They can be assigned safety-critical functions in the horstFX software, but they can also be used as normal digital I/Os.

The emergency stop and safety stop inputs as well as the enabling switch input are exclusively safe inputs. The emergency stop input is only intended for the connection of emergency stop devices. The safety stop inputs apply to all kinds of safety-critical protection devices. The functional difference is explained in the following table:

	Emergency stop input	**Safety stop input**
Active	In all operating modes (T1, T2, Automatic)	Only in automatic mode
Robot movement stops	Yes	Yes
Energization of drives	Off	On
Program execution	Paused	Paused
Acknowledgement	Manually at the Panel	Manually at the Panel

Further operation after acknowledgement	Program continues running at interrupted position	Program continues running at interrupted position
Requires reinitialization	No *	No *
Stop category (IEC 60204)	1	2
Power level (ISO 13849-1)	PL d	PL d

** Only if the power supply has been interrupted must the robot must be reinitialized.*

Table 6-2: Functional difference between emergency stop and safety stop

DANGER!
Danger due to incorrectly connected emergency stop devices

- Never connect safety signals to a PLC that does not meet at least the corresponding protection level. This could cause the safety functions to be overridden, which could result in serious injuries or death.
- Only use the safe inputs for emergency stop to connect additional emergency stop devices. Do not connect any emergency stop devices to general digital inputs or safety stop inputs.
- Safety-critical I/Os always have two channels. The two channels must be kept separate to prevent a fault from causing loss of the safety function.
- The safety functions must be tested before commissioning and at regular intervals.

Output Signal Switching Device (OSSD)

For safety-critical inputs, an output signal switching device (OSSD) can be activated. With an output signal switching device activated, the output is periodically switched off and the input read back. If the results do not match, an error is triggered. This means short circuits and cross-circuits can be monitored.

When using the OSSD function, the internal OSSD signals must be used. When external OSSD signals are connected, the function must be deactivated in horstFX and the input filter activated. The configurable time of the filter must be selected such that the test impulse is ignored (filter time > test impulse).

6.4.2.1 Emergency Stop and Safety Stop I/O

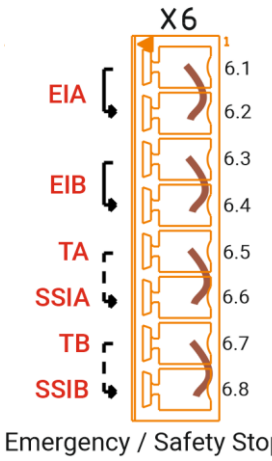


Fig. 6-5: Emergency stop/ safety stop connection

The inputs for emergency stop (EIA, EIB) and safety stop (SSIA, SSIB) are available, dedicated inputs on every Control (Safety In 1&2) and therefore cannot be configured. They are redundant with performance level "d", category 3, as per EN ISO 13849-1 and also meet the electrical specifications of the general digital inputs, see *Electrical Parameters*, page 30. The signals are at terminal block X6.

The signal for emergency stop an (Emergency In) is at terminal X6.1 and X6.3. These are fed in from test signal TA / TB for the output signal switching device and are routed to this terminal via the emergency stop on the Panel.

In the delivery state, bridges connect these to the safe emergency stop inputs X6.2 and X6.4. An external emergency stop button can be series-connected to the emergency stop on the Panel between X6.1/X6.2 and X6.3/X6.4.

X6.6 and X6.8 are the respective inputs for a safety stop (Safety Stop In). At these connections, either potential-free contacts and the internal cross-circuit detection via signals TA / TB can be used, or an external safe output (e.g. safety laser scanner) can be connected.

For the emergency stop and safety stop input, it is possible to configure an input filter in horstFX in the *Safety I/O* menu. The maximum configurable time is 50 ms. See 6.4.7.2.

The system is always in a safe state with "low" signals (0 V, logical 0), e.g. robot has a low signal at the external emergency stop input.

If the robot has to be operated independently, bridges must be inserted in the terminals for emergency stop, safety stop and enabling switch, see Fig. 6-5. These are inserted as standard in the delivery state.

When integrated in a complete system, the robot system must be integrated in the emergency stop circuit of the higher-level system.

When using an output signal switching device (OSSD), the signal is tested cyclically. These test pulses must not cause a shut-down of all downstream control elements. Please keep this in mind when selecting the devices to be connected.

6.4.2.2 Enabling Switch I/O

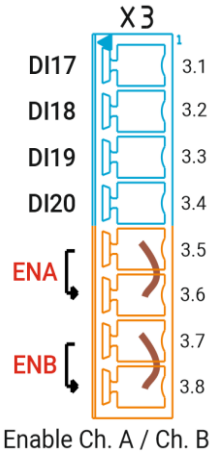


Fig. 6-6: Enabling switch connection

The Enable input (ENA, ENB) is another dedicated input (Safety In 3), which is intended exclusively for a three-stage enabling device (enabling switch) and therefore cannot be configured. The enabling switch of the Panel is connected to the safe inputs at terminals X3.5 and X3.7 in the lower half of terminal block X3, and to the control system at terminals X3.6 and X3.8.

The signals at X3.5 and X3.7 are the enabling switch signals from the Panel, which are fed from the test signals TA/TB (OSSD).

Instead of the internal enabling switch on the Panel, an external enabling switch can be connected between TA/TB (X4) and X3.6 / X3.8. **One bridge each is inserted here in the delivery state. These bridges must be removed when connecting an external enabling switch!**

For the enabling switch input, it is possible to configure a filter in horstFX, see 6.4.7.2.

6.4.2.3 Configurable Safe Inputs

There are 4 further, configurable safe inputs SI4 to SI7 (Safety In) on terminal block X5. These are also designed redundantly with Performance Level “d”, Category 3, in accordance with EN ISO 13849-1. They meet the same electrical specifications as the general digital inputs. They can be used both as safety-critical inputs with different, configurable functions, or as normal inputs.

In each case, two channels A and B are available for each safe input.

These inputs can be operated with safe OSSD outputs (for cross-circuit recognition, with configured input filter), with internal test signals TA / TB or entirely without cross-circuit recognition with 24 V signals.

The configuration for this is set up in the safety configuration in horstFX and sent to the safety controller. A filter can also be configured for the configurable safe inputs, see 6.4.7.

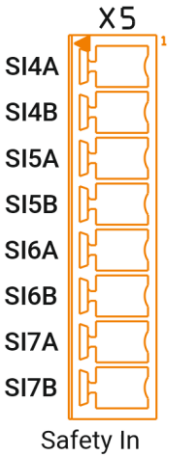


Fig. 6-7: Connection of safe inputs

Each time the safety configuration is changed, a new risk assessment must be carried out!

The following functions can be configured for the safe inputs, see 6.4.7.2:

Function	Stop cat.	Description	Field of application
None	-		Safety-input is not read.
Emergency stop	1	Signals an internal emergency stop Emergency stop output is set.	Internal emergency stop for additional emergency stop buttons.
External emergency stop	1	External system signal emergency stop. Emergency stop output is not set.	Emergency stop of external machines, robot goes into emergency stop, but does not give a fault to external
Safety Stop	2	Protection devices that are not active in teaching mode with an enabling switch can be connected here. This means the cell can be entered during teaching. Only active in automatic mode.	Safety gate circuit (light curtain, safety scanner, safety gates).
Safety stop self-triggering	2	Like the safety stop, but automatic reset and restart of the robot after recovery of the safe state.	Safety devices if automatic restart is not critical (e.g. staying in secured area not possible).
Enabling switch	2	Safe stop, if enabling switch is pushed through or is not pressed. Only active in teach modes.	Integration of additional external consent facility, queried in T1/T2.
Reduced speed	0	Checks the reduced speed. Note: This function can be initiated via a digital input. If the robot moves faster than the reduced speed, category 0 stop is triggered.	Monitoring reduced speed (e.g. for safety scanners with multiple protective areas).
Two digital inputs	-	Safe input is configured as two general digital inputs.	Use as digital input (e.g. for sensors instead of safety function)

Table 6-3: Configurable functions for safe inputs

Here too the following applies: The system is always in a safe state with "low" signals (0 V, logical 0), e.g. robot has a low signal at the external emergency stop input.

6.4.2.4 Safe Outputs

There are 6 configurable, safe outputs. These are also designed redundantly with Performance Level “d”, Category 3, in accordance with EN ISO 13849-1, although outputs SR5 and SR6 (Safety Relay Out) are each implemented as potential-free contacts by means of positively controlled relays. With these outputs, it is possible to tell other machines what state the robot is in. The relay contacts can be loaded with 5 A and 24 V and are brought out at terminal block X8. The safe outputs SO1 to SO4 (Safety Out) at terminal block X7 correspond to the electrical specification of the digital outputs but are not coupled with the total current limit (see 6.4.6). These are always configured as Push-Pull outputs.

Each of these outputs can be used without OSSD function (chronologically offset 400 µs Low Impulse) or al a general digital output.

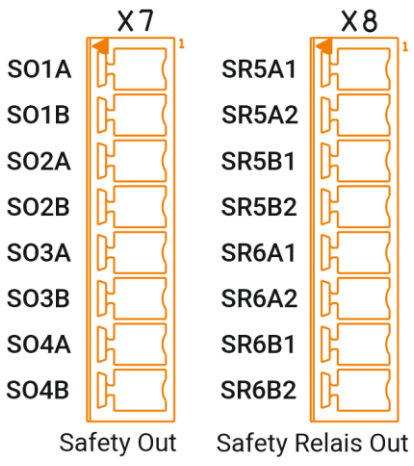


Fig. 6-8: Connection of safe outputs

For each safe output, two normal digital inputs can be configured as additional read-back inputs. This enables safe switching of an external, positively controlled contactor or relay with read-back of the auxiliary contact states. An inverted or non-inverted signal can be used here. If an invalid read-back signal is detected, a Category 1 stop is triggered.

The following functions can be configured for the safe outputs, see 6.4.7.2:

Function	Description
None	
Emergency stop	"LO": The robot is in emergency stop (internal emergency stop or triggered by an error).
Robot stopped	"HI": No axis is moving.
Reduced speed	"HI": The robot is limited to a speed of 250 mm/s.
Teaching mode	"HI": The robot is in teaching mode.
Robot allowed to move	As release for external machines in the cell "HI": Robot travel release is issued. "LO": Standstill monitoring is active. An error status is present (in T1/T2, the enabling switch is not actuated, emergency stop/safety stop/error).
Enabling switch	"HI": Enabling switch actuated (center position). "LO": Enabling switch not actuated or pressed.
Forwarding Safety Stop input	Output can be used to forward the guaranteed operator protection to other devices (within the same protection area). The maximum delay of the safety stop signal – from safety stop input until output at the corresponding pin – amounts to 10 ms. When setting an additional low-pass filter in horstFX this filter value will be added to the delay.
Two digital outputs	Safe output is configured as two general digital outputs.

Table 6-4: Configurable functions for safe outputs

6.4.3 Test Signals A/B

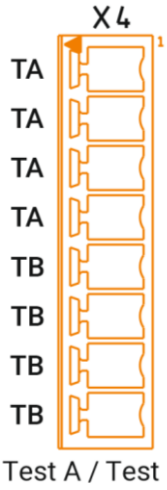


Figure 6-9: Test signal connection

The internally generated OSSD signals, hereinafter referred to as test signals A and B, are issued at terminal block X4. These can be used to supply external protection devices with two-channel, safe signals and return these to the control system. The parameters of the test signal are specified in the following table:

Table 6-5: Test signal characteristic values

Type	Push-Pull
Output voltage	23.5 – 24.5 V
Test pulse period	100 ms, not configurable
Test pulse duration	400 µs, not configurable
Load capacity	max. 50 µF

6.4.4 General Digital Inputs

There are 20 general digital inputs available at terminal blocks X1, X2 and X3. Inputs DI01-DI20 (Digital In) are +24V input channels and correspond to IEC 61131-2 Type 1 and 3.

If the *Configurable Safe Inputs* are configured as general digital inputs, 8 further inputs are available.

An additional filter can also be configured here via horstFX. The maximum possible duration for the general digital inputs is 32767 ms.

The following functions can be configured for the general digital inputs, see 6.4.7.2:

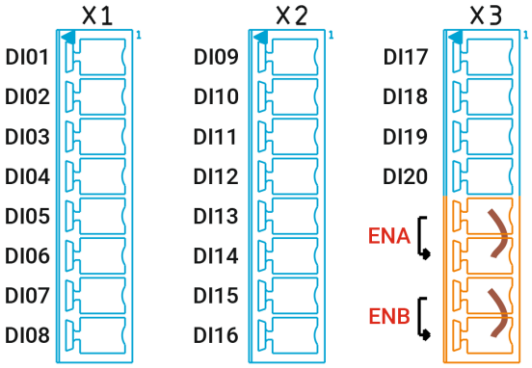


Fig. 6-10: Connection of general digital inputs

Function	Description
Not assigned	-
Start program	Starts a program from outside, flank LO – HI
Pause program	Pauses a running program, flank LO – HI
Continue program	Continues a paused program, flank LO – HI
Pause/continue program	Pauses a running program (flank LO – HI) or continues it (flank HI – LO)
Acknowledge internal error	Acknowledges an internal error, flank LO – HI
Acknowledge emergency stop	Acknowledges an internal emergency stop, flank LO – HI
Acknowledge safety stop	Acknowledges a safety stop, flank LO – HI
Acknowledge internal error/emergency stop/safety stop	Acknowledges all errors and emergency stops/safety stop, flank LO – HI
Reduced speed	Activates driving with reduced speed (not safety-critical from the laser scanner's warning area), flank LO – HI

Table 6-6: Configurable functions for general digital inputs

6.4.5 General Digital Outputs

There are 18 general digital outputs available at terminal blocks X9, X10 and X11. Outputs DO01 to DO18 (Digital Out) are +24V output channels and can be configured as Push-Pull (switch to positive supply voltage and to ground) or High-Side switches (switch only to the positive supply voltage) via horstFX. If the *Safe Outputs* are configured as general outputs, up to 12 further outputs are available, of which 4 are potential-free. Each output can source at least 640 mA if the signal is high (+24 V) and sink 440 mA if the signal is low (0 V). For the 16 digital outputs DO01-DO16 and the +24V-outputs together a total current amount of 7 A applies.

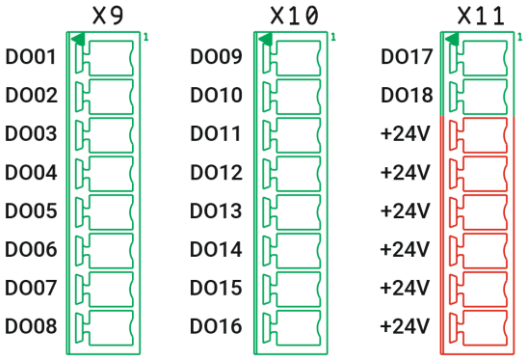


Fig. 6-11: Connecting general digital outputs

Further information about this in chapter 6.4.6. Ohmic, capacitive and inductive loads can be switched. They are short-circuit-proof and protected against ESD as well as voltage peaks when switching inductive loads. **Always use a free-wheeling diode for inductive loads.**

The following functions can be configured for the general digital outputs, see 6.4.7.2

Function	Description
Not assigned	-
Emergency stop button	Exact image of the emergency stop button signal, for diagnostics (OR function with several emergency stop buttons). For larger systems, the actuated emergency stop button is easier to identify. ATTENTION: There may be several emergency stop inputs. If ONE of the inputs is active, it is also the output.
Error	HI if there is at least one unconfirmed error.
Program running	HI if the program is running.
Program paused	HI if the program is paused.
Program in playback mode	HI if playback mode is active (you can see the menu to start/stop the program on the right-hand side)
Drives switched on	HI if the motors are energized.
Ready	HI: Drives are switched on and travel release is available. No error status is present.

Table 6-7: Configurable functions for general digital outputs

Safe Shut-down of the General Digital Outputs

Digital outputs DO01 to DO16 are supplied by the +24V power supply via a bridge at X17.7/X17.8. One bridge each is inserted here in the delivery state. If this bridge and the associated ground connection are routed to the connected actuators via a safety relay pair, these can be switched off in a safety-critical manner (see wiring example 6.4.8.7).

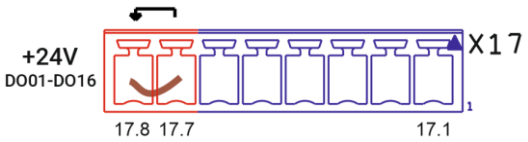


Fig. 6-12: Bridge for power supply DO01-16

Thus, these normal digital outputs can be used for safety-critical functions, if the connected actuators are in a safe state when deenergized.

6.4.6 +24 V Power Supply

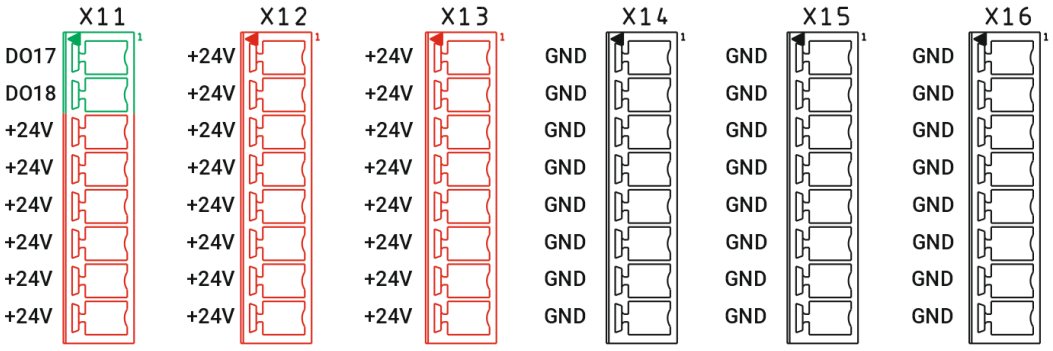


Fig. 6-13: +24 V power supply

For the power supply to external devices, 22 +24V connections and 24 ground connections are available. All +24V connections **and** the general digital outputs DO01-DO16 **together** can be loaded up to a maximum of **7A**. If the total current is briefly exceeded, the drain is limited to this 7 A, and if it is exceeded for a longer period of time (e.g. due to short circuit) the +24V power supply is switched off. The safety-critical outputs as well as the

digital outputs DO17-DO18 are not affected by this. In the event of a deactivation, the power supply attempts to switch back on again after about 500 ms. If unsuccessful, a new attempt will be started every 500 ms.

To ensure safe start-up, the maximum load on all +24V outputs must not exceed a value of 400 µF/48 Ω.

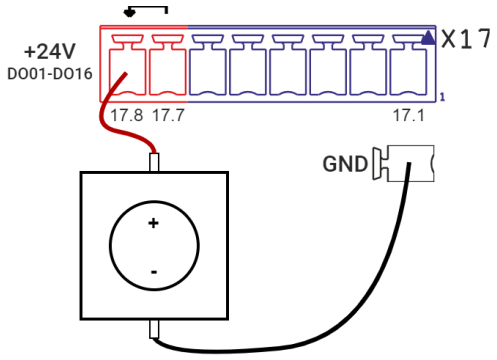


Fig. 6-14: Feed of an external power supply

Likewise, an external +24 V power supply can be placed at terminal X17.8 (see adjacent figure). It is therefore possible to operate the general digital outputs DO01-16 with an external power supply if the ground connection of the external power source is connected to the ground of Control. The permissible values for an external power supply are specified in the table below:

Table 6-8: Characteristic values of the +24 V power supply

Power supply	min.	typ.	max.	Unit
Internal: Voltage	23.5	24	24.5	V
Internal: Current	0	-	7	A
External: Voltage	15	24	30	V
External: Current	0	-	10	A

6.4.7 Common Features of All Digital Interfaces

6.4.7.1 Electrical Parameters

The specifications described in this section apply to all digital interfaces (safety-critical and general). The functional wiring diagrams for the interfaces can be found in the Annex (13.9).

Parameter	min.	typ.	max.	Unit	Description
Inputs					
Voltage	-3	24	36	V	Input voltage
Switching threshold $_{HIGH-LO}$	6.0	7.5		V	Logical high–low
Switching threshold $_{LO-HIGH}$		8.5	10	V	Logical low–high
Current consumption		2.4	2.6	mA	Input voltage 18 – 30 V
Input resistance	3			kΩ	
ESD strength		+/- 15		kV	Human Body Model
IEC 61131-2				Type	1 & 3
Outputs					
Function				Type	PNP (High-Side) or Push-Pull, semi-conductor
Voltage	23.0*	24	24.5	V	Output voltage
Current $_{HI\_PP}$	0.64		0.85	A	Per output, logically high, Push-Pull
Current $_{LOW\_PP}$	0.44		0.65	A	Per output, logically low, Push-Pull
Current $_{HI\_HS}$	0.64		0.85	A	Per output, logically high, High-Side
Internal resistance $_{HIGH}$		110	230	mΩ	
Internal resistance $_{LO}$		1	2.5	Ω	

Leakage current	100	180	µA	
ESD strength	+/- 8		kV	Contact

Table 6-9: Characteristic values of digital I/O horstIO

* at full load push-pull logically low, otherwise 23.9 V.

6.4.7.2 Software Configuration Options for Digital Interfaces

In the horstFX software, the inputs and outputs can also be configured in the *Configuration of Inputs/Outputs* menu under *Settings & Info*.

Assignment of Functions

In horstFX, functions can be assigned to the general digital I/Os and the configurable safe I/Os (*Function assignment* setting). Examples include starting the program, acknowledging errors or moving at reduced speed. For the inputs, this means that the assigned function is executed if there is a valid signal at the corresponding input. For the outputs, it means that the assigned function is executed when the corresponding output is switched. The I/Os configured in this way are then no longer available as normal digital inputs/outputs, as they have a fixed link with the functions. The exclusively safe inputs (emergency stop, safety stop and enabling switch) (Safety In 1-3) cannot be assigned functions.

Filters

For all digital inputs – safety-critical and general – a low-pass filter can be configured. Only if a signal is present for a minimum period of time is it recognized as valid (e.g. for bouncing switches). The time value can be set in the horstFX software under the *Low-pass filter* setting.

Possible values are between

- 1 and 50 ms for all safety-critical inputs (dedicated and configurable).
- 1 and 50 ms for all safe inputs configured as general digital inputs
- 1 and 32767 ms for all general digital inputs.

DANGER!

A low-pass filter increases the stopping distance and can therefor result in unexpected collisions with people or other objects and machines.

▶ Always adjust safety distances to the corresponding stopping distances.

ATTENTION!

Danger of damage to robot or property.

A collision can cause significant damage to the robot system or any surrounding objects.

6.4.8 Wiring Examples of Safety-critical Inputs/Outputs

This subsection provides examples of the wiring of digital interfaces on Control. Other examples can be found on horstCOSMOS.

6.4.8.1 Standard Safety Configuration

In the delivery state, the control system is configured for sole operation of the robot. This means that no further customized, safety-critical devices are connected to the control system. For the mandatory functions

- Emergency stop
- Safety stop
- Enabling switch

bridges are plugged into connectors X3 and X6 for this purpose, see adjacent figure.

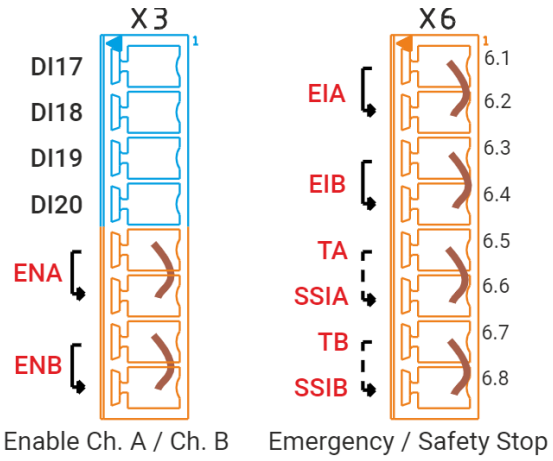


Fig. 6-15: Standard safety configuration

6.4.8.2 Additional Emergency Stop Buttons

One or more additional emergency stop buttons should be used, which cause the robot to stop in an emergency. The adjacent figures clarify the connection of further two-channel emergency stop buttons, which are series-connected to the button on the Panel.

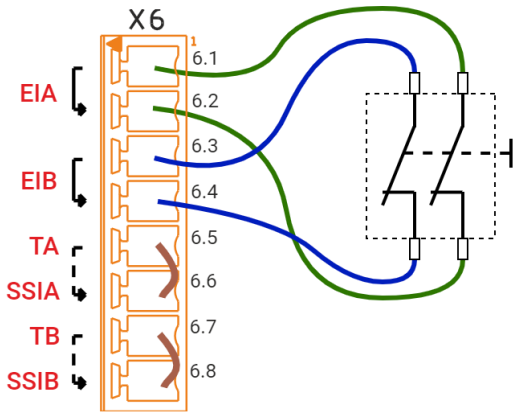


Fig. 6-16:

Connection of external emergency stop buttons

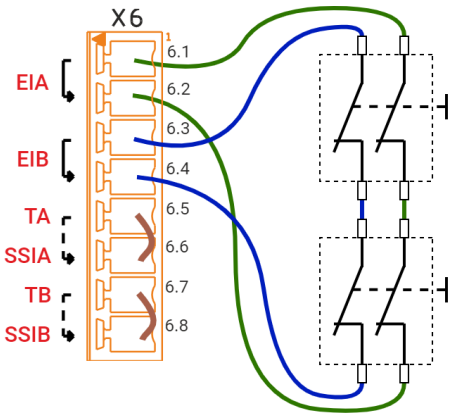


Fig. 6-17:

Connection of several external emergency stop buttons

6.4.8.3 Safety Relay

A safety relay should be safely actuated and contactor monitoring should be set up. The two inputs of the relay are connected to channel A and channel B of e.g. Safety Out 1. Contactor monitoring can be achieved by routing a +24 V signal via the feedback current path to a general digital input.

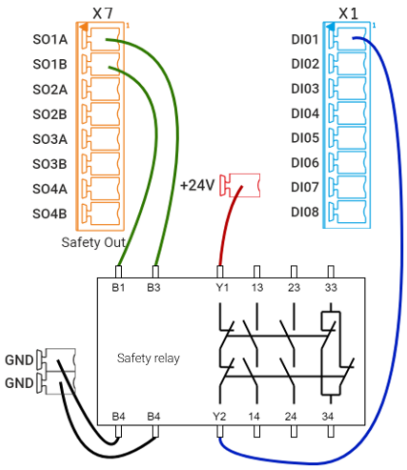


Fig. 6-18: Connection of a safety relay

6.4.8.4 Safety Stop

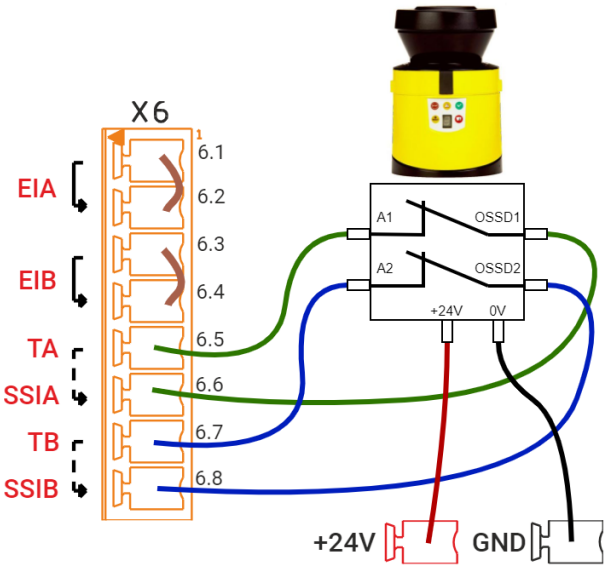


Fig. 6-19: Safety stop: Laser Scanner with Internal Test Signal

The robot should be stopped safely as soon as the protected area of a safety laser scanner is entered. The first example shows the connection of a laser scanner when using the internal test signal. This is routed to the control inputs of the laser scanner; its outputs are, in turn, routed to the safety stop input of the main control.

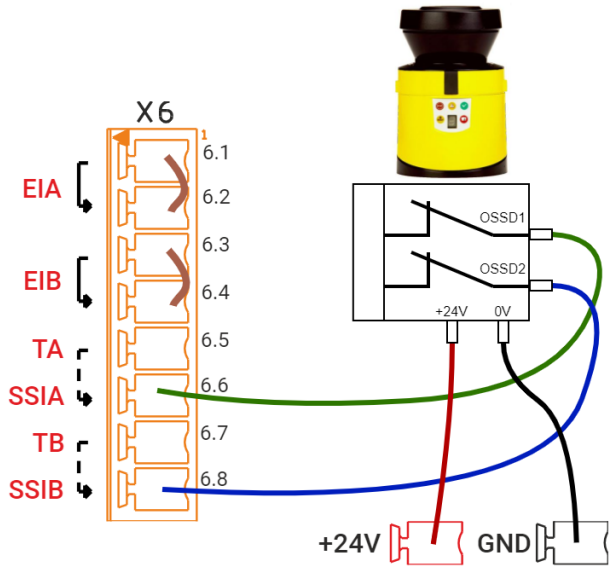


Fig. 6-20: Safety stop: Laser Scanner with External Test Signal

Some laser scanners are intended for the use of a separate OSSD signal. In this case, only their outputs must be routed to the safety stop input of the main control. In this configuration, the cross-circuit recognition must be deactivated in horstFX and the filter time set greater than the test impulse of the protection device (see *6.4.2*).

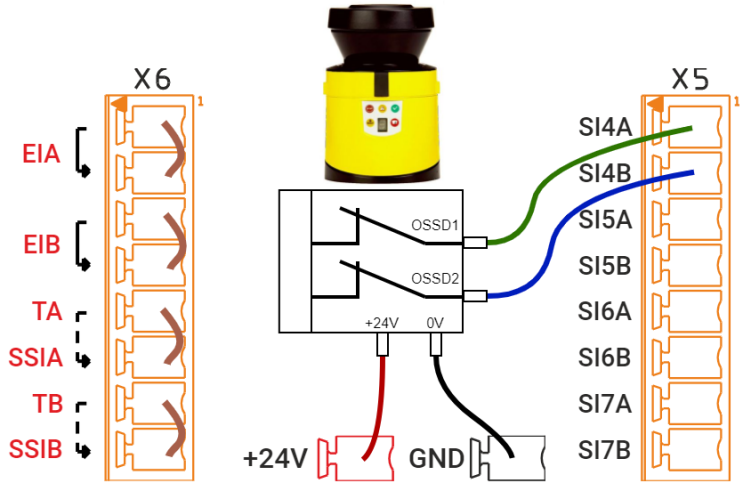


Fig. 6-21: Self-triggering safety stop

In both cases, the safety stop must be acknowledged manually after exiting the area. The adjacent example shows the options for connecting a safety stop with automatic continuation. Here, the laser scanner is connected to a configurable safe input and this input is assigned the *Self-triggering safety stop* function.

6.4.8.5 Connecting Emergency Stop for Several Devices

In a system, the robot should be integrated in the emergency stop circuit of the other devices so that there is no need, in an emergency, to decide which emergency stop button must be pressed. The adjacent figure shows an example of the connection between two HORST robot systems. In each case, a configurable safe output is connected to a configurable safe input

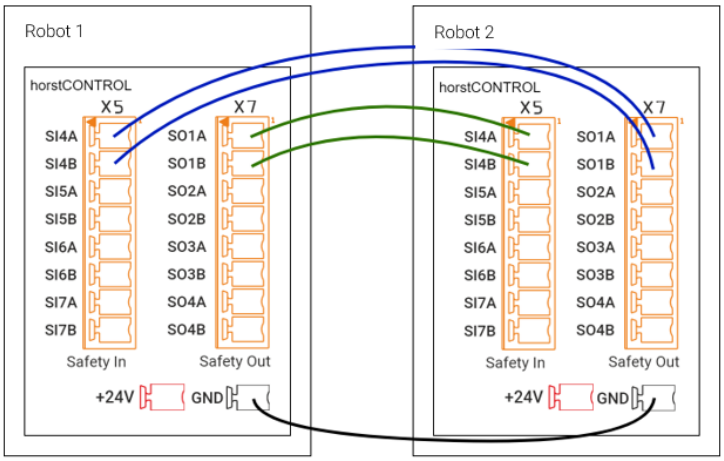


Fig. 6-22: Connecting emergency stop for several devices with each other

6.4.8.6 Connection to a Superordinate Safety PLC

The robot should be integrated in a system in which a safety PLC controls and monitors the safety functions. A configurable safe output is connected to a 2-channel input of the safety PLC here, and a configurable safe input is connected to a 2-channel output of the PLC.

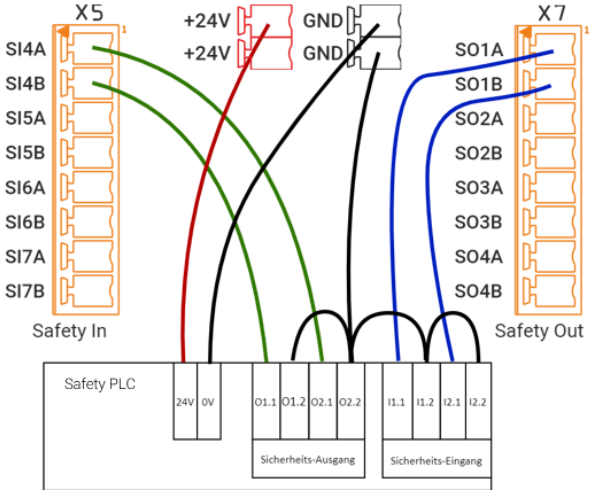


Fig. 6-23: Superordinate safety PLC

6.4.8.7 Safe Deactivation of the Digital Outputs

General digital outputs DO01-16 should be deactivated in a safety-critical manner. To this end, the bridge between X17.7 and X17.8 is removed and routed via the potential-free, safe output SR5 together with the ground connection. If the SR5/SR6 safety output is set to 'robot allowed to move' (see 6.4.2.4), the relay is opened in the error status and the outputs can be switched off safely. A consumer connected to DO01 as shown in this example is therefore safely deactivated. Note that in this case all other consumers connected to the general digital outputs DO01-16 are also deactivated. **Always use a free-wheeling diode for inductive loads.**

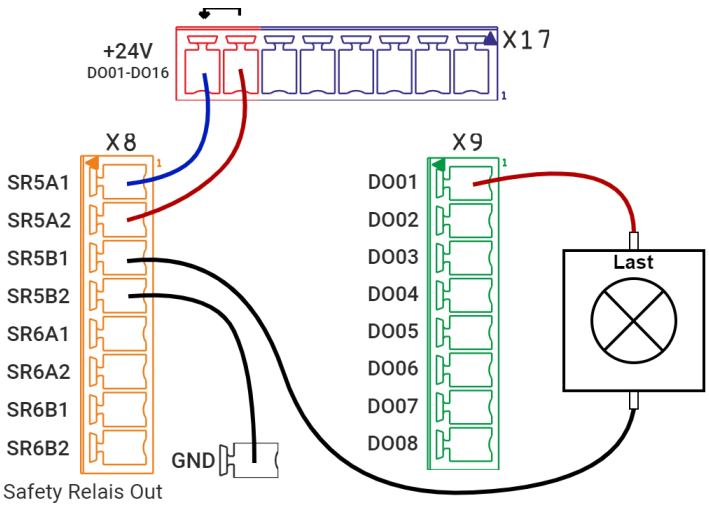


Fig. 6-24: Safe deactivation of the +24 V supply and the digital outputs

6.4.9 Wiring Examples of Digital Inputs/Outputs

The following examples show the use of the general digital inputs and outputs.

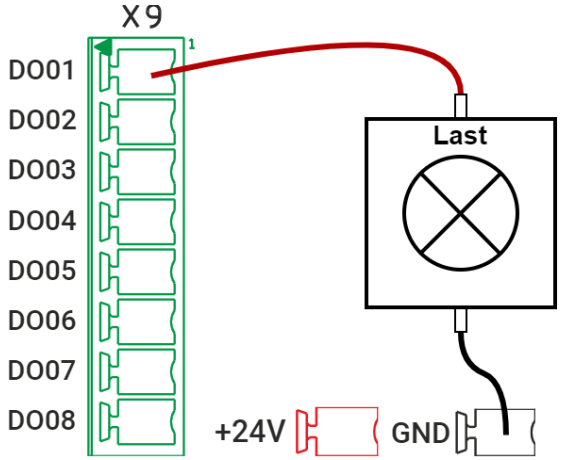


Fig. 6-25: Consumer at the digital output

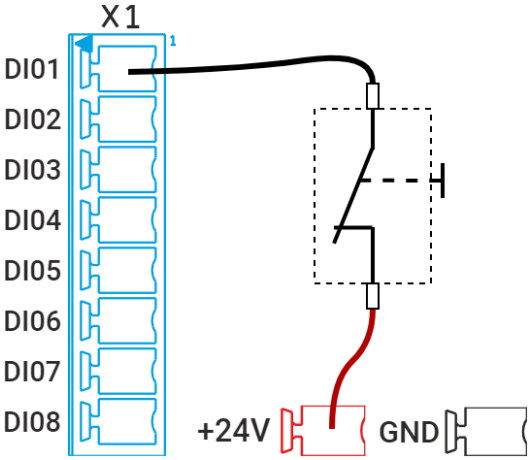


Fig. 6-26: Button at the digital input

An inductive proximity switch in the configuration as a PNP normally closed contact should be connected to a digital input.

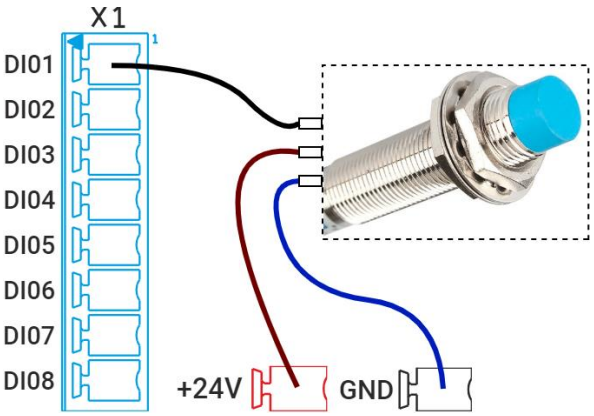


Fig. 6-27: Inductive sensor at digital input

6.5 Tool I/O

On support arm 3 of the robot, there are two interfaces (User 1, User 2), which supply current and control signals for grippers and sensors that can be mounted at the tool interface of the support arm 3. Each of these interfaces has two digital inputs/outputs as well as a +24 V power supply.

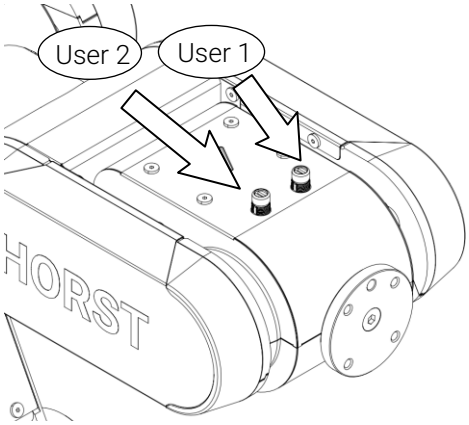


Fig. 6-28: Electrical connections for tools

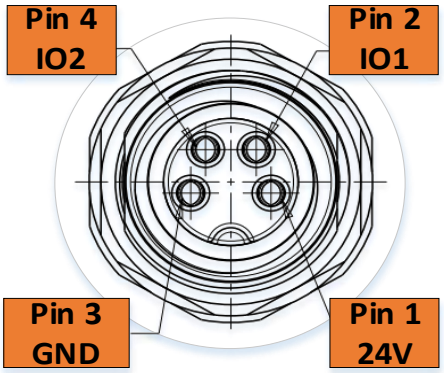


Fig. 6-29: Tool I/O pin assignment

The interfaces are designed as 4-pin, A-coded M8 sockets (TE Connectivity T4071017041-001). As a counter-piece, a plug connector with the following properties must be used:

M8 male, 4-ping, angled, A-coded.

The tool I/Os can be configured in horstFX as inputs or outputs (*Configuration of inputs/outputs* → *Special I/O* menu). As standard, the two I/Os of the User 1 interface are configured as outputs and the two I/Os of the User 2 interface are configured as inputs.

Configured as outputs, these act as Push-Pull switches and can be loaded with a maximum of 600 mA each, if connected to the positive power supply, and a maximum of 200 mA each, if switched to ground. The maximum current-carrying capacity of all tool I/Os on support arm 3, i.e. the four possible digital outputs and the +24 V power supply together, is 2.5 A. Configured as inputs, these are compliant with IEC 61131-2 Type 3. A functional diagram of this interface is provided in the Annex. The parameters of the tool I/O are specified in the table on the next page.

Parameter	min.	typ.	max.	Unit	Description
Inputs					
Voltage	-1.5	24	24.3	V	Input voltage
Switching threshold$_{HI-LO}$	5.5		6.8	V	Logical high–low
Switching threshold$_{LO-HI}$	6.7		8	V	Logical low–high
Current consumption		2.3	2.6	mA	
IEC 61131-2				Type	3
Outputs					
Function				Type	Push-Pull, semiconductor
Voltage		24		V	Output voltage
Current $_{HI\_PP}$	0		0.6	A	Per output, logically high
Current $_{LO\_PP}$	0		0.2	A	Per output, logically low
Internal resistance $_{HI}$		120	240	mΩ	Logically high
Leakage current	-150		150	µA	
Total current			2.5	A	All 4 digital outputs and +24 V
ESD strength		+/-7		kV	Contact

Table 6-10: Characteristic values of tool inputs/outputs

6.6 Computer Interfaces

In Control there is an integrated computer whose accessible interfaces are described in this subsection.

6.6.1 PROFINET (optional)

Control has an optional PROFINET communication interface (PROFINET IO, conformity class C), through which it is possible to exchange data between a PLC and the robot. PROFINET (Process Field Network) is a real-time capable industrial Ethernet protocol, which is used as the standard protocol in automation. Using PROFINET communication, the robot can be controlled and monitored from the PLC. HORST takes on the role of the client (Slave) and is controlled by the PLC (server or Master). As a result, HORST is easy to integrate in an existing production line and can communicate with different peripheral equipment. In addition to executing specific commands, there are also freely describable storage areas in which Int, Float and Boolean data types can be exchanged.

The connection is made via a RJ45 modular connector and a category 5 network cable (CAT5) on the front of Control, see subsection *Control (switch cabinet)*.

6.6.2 Ethernet

The Ethernet interface enables optional remote access and remote control of the robot. This is also used for connection to horstCOSMOS, which enables e.g. program synchronization and the transmission of telemetry data and error messages. For access to horstCOSMOS, the following are required:

- connected network cable
- connection to https://horstcosmos.com at port 443
- TLS 1.2 and TLS 1.3 must not be blocked by the firewall

The RJ45 modular connector to the Ethernet port is on the rear side of Control. The characteristic values for the connection are as follows:

	min.	typ.	max.	Unit
Transmission speed	10	-	1000	Mb/s

6.6.3 USB

To connect further input devices and data carriers, there are a total of four USB ports: two USB 3.1 ports on the rear side of Control, and two USB 2.0 ports on the rear side of the Panel. The USB ports on the Panel are only provided for input devices only. For data carriers, use the ports on Control.

7 Commissioning

ELECTRICAL VOLTAGE!

Possible personal injuries caused by applied electricity

- ▶ Work on the electrical equipment must be performed only by specialist personnel with appropriate training and in accordance with the electrotechnical rules.
- ▶ Make sure that the power supply is switched off while working on the robot and that it cannot be switched on again by accident.
- ▶ Use only the included cables to connect to the power grid. Do not use damaged cables.

DANGER!

Danger due to missing protection devices and safety equipment as well as defective/damaged modules or accessories.

- ▶ Only commission the robot system with functional protection devices and safety equipment as well as functional modules or accessories.

WARNING!

Danger of impact and crushing due to robot movement

- ▶ Close off the installation area and protect it against access by unauthorized persons.
- ▶ Secure the Panel and Control against operation by unauthorized persons.

CAUTION!

Damage due to the water condensation

Never switch the robot on immediately if it has been brought from a cold into a warm environment. The condensate that forms in these conditions could damage the electronics. We recommend leaving the system overnight to adjust to the ambient temperature.

DANGER!
Danger resulting from incorrect commissioning

- ▶ Commissioning must be performed only by persons with technical and electrotechnical training who were also authorized by fruitcore robotics.

Before commissioning:

- ▶ Make sure that any transport equipment or transport securing devices have been removed.
- ▶ Make sure that the robot and any add-on parts are screwed on properly and safely.
- ▶ Ensure that there is sufficient room for the robot arm to move freely. No obstacles or persons are allowed in the working area.
- ▶ Note that the range of the robot and thus the danger zone change with add-on parts and workpieces.
- ▶ If the robot is combined with other machinery in a system, make sure that the other machinery cannot damage the robot.
- ▶ Make sure that the safety measures according to the risk assessment have been put in place and configured to ensure that the commissioning personnel, operators, and bystanders are protected.
- ▶ Familiarize yourself with the work environment of the robot system prior to commissioning.
- ▶ Ensure that suitable protection devices were installed. The protection devices must stop the robot's movement within the danger zone. Check the protection devices for proper function.
- ▶ In case of damage to the robot, Control, or mechanical interface, as well as all parts of the protection device, the robot must not be used.
- ▶ Protection devices (emergency stop, safety stop) must be connected only to safety-critical interfaces and must be designed to be redundant.
- ▶ Only operate the robot system in undamaged condition.
- ▶ Check the emergency stop and safety stop functions daily.
- ▶ Do not enter the danger zone of the robot during operation, and do not touch the robot.
- ▶ Make sure that the robot is grounded (power plug connected to PE protective conductor). A suitable RCD (residual current operated device) must be installed.
- ▶ Before the power supply is switched on, it must be ensured that the connection cable is connected between the Control and the robot, and the power cable is connected to the power supply.

7.1 Switching on the Robot System

- ▶ Switch the main switch on the Control to ON.
  - ⇒ The software (horstFX) starts up on the Panel.
  - ⇒ The main menu appears on the display.

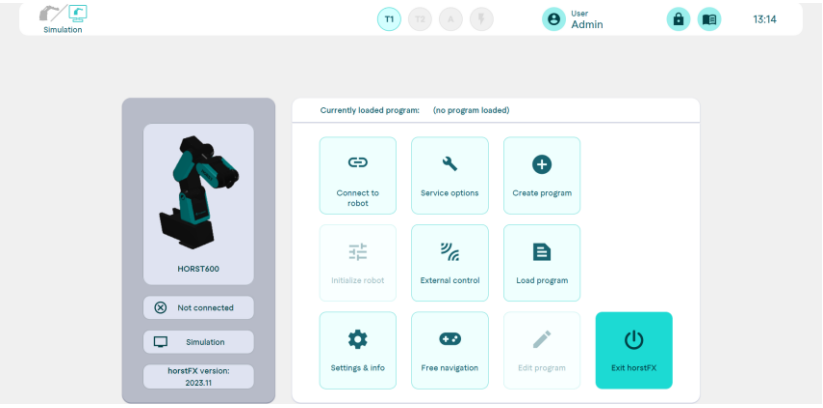


Fig. 7-1: Main menu

⇒ If a user role that is not authorized to remain logged in after a restart was logged in when the software (horstFX) was last used, the pop-up window for switching the user role appears.

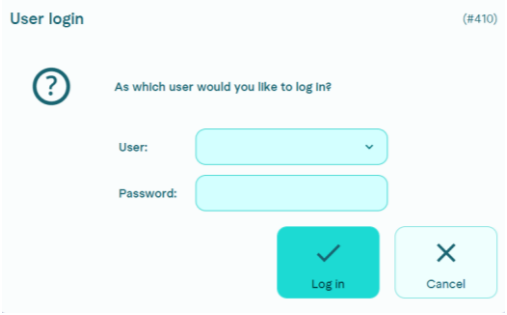


Fig. 7-2: Switching user roles

▶ In the main menu, select connect to robot.

▶ Wait until the display shows "connection with robot established successfully."

In the next step, the robot must be initialized.

7.2 Initializing the Robot

WARNING!
Danger of impact and crushing due to robot movement

The safety stop function is deactivated during the initialization.

▶ During initialization operation, close off the area around the robot and protect it against access by unauthorized persons. There must be no persons in the danger zone of the robot.

The initialization must be performed whenever the robot system is switched on after the power supply was interrupted.

During the initialization, you should check the enabling switch for proper function by deliberately letting it go and pressing it down every so often.

▶ In the main menu, select initialize robot.

⇒ The automatic initialization menu appears.

The menu at the top right displays the initialization status of the six axes of the robot. Axes that have not yet been initialized are shown as black dots. After the initialisation, the colour changes to turquoise.

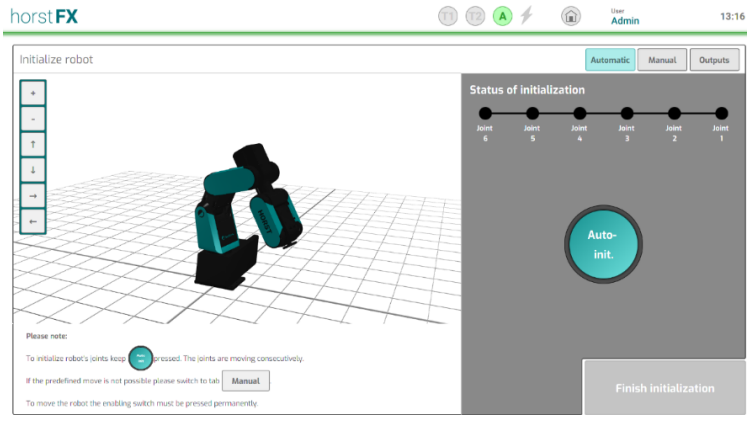


Fig. 7-3: Automatic initialization menu

▶ Press and hold the enabling switch in the centre position.

▶ Press and hold the Auto Init button.

⇒ The automatic initialization of the axes is performed.

⇒ If the initialization was successful, all six dots (initialization status) for the axes will be turquoise.

To perform the initialization, the axes (starting with axis 6) must carry out a movement one after the other. If this is not possible, the axes must be moved manually. In this case, switch to the manual initialization menu.

ATTENTION!

Keep an eye on the robot to prevent collisions.

Select the **manual** button.

⇒ The manual initialization menu appears.

This allows the axes to be moved manually in the case that automatic initialization is not possible.

Press and hold the enabling switch in the middle position.

Select the axes one after the other and move them slightly until successful initialization is displayed.

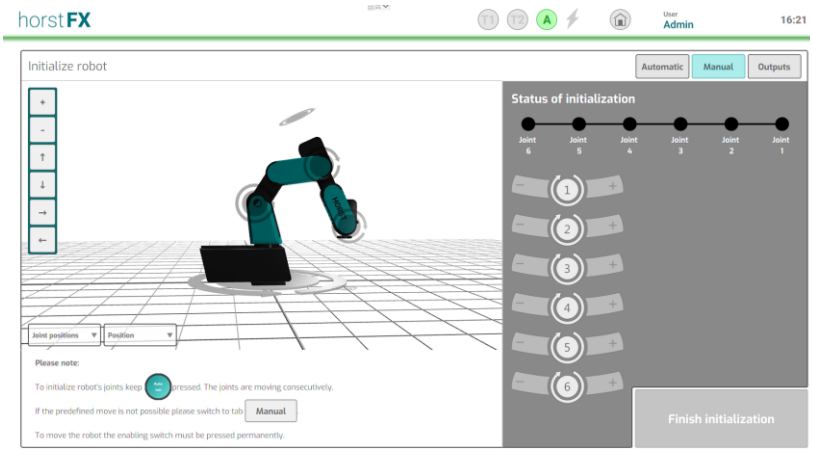


Fig. 7-4: Manual initialisation menu

⇒ A turquoise dot (initialization status) of the respective axis shows if initializing was successful.

It may be necessary to open a gripper to perform the initialization. In this case, switch to the **initialize robot – outputs** menu via the **outputs** button.

Outputs can be switched manually here. For example, a gripper can be opened before the initialization drive is continued.

▶ Switch the desired output via the corresponding changeover button.

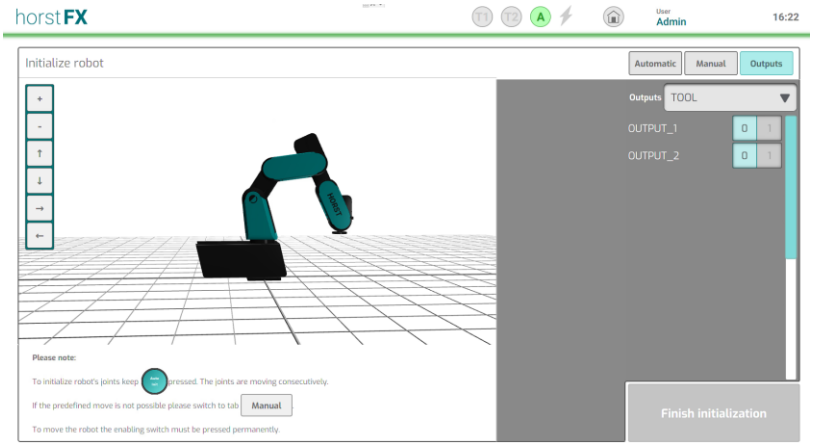


*Fig. 7-5: **Initialize robot – outputs menu***

The automatic/manual initialization of the axes was successful if all six dots (initialization status) for the axes are shown in turquoise.

8 Operation

8.1 Safety Information on Operation

DANGER!
Possible personal injuries caused by careless handling of the system.

- ▶ Make sure that the robot arm and the tool are screwed on properly and safely.
- ▶ Ensure that there is sufficient room for the robot arm to move freely. There must be no obstacles in the working area. Note that the range of the robot and thus the danger zone change with add-on parts and workpieces.
- ▶ If the robot is combined with other machinery in a system, make sure that the other machinery cannot damage the robot.
- ▶ Do not expose the robot system to permanent magnetic fields. Very strong magnetic fields can damage the robot system.
- ▶ Ensure that suitable protection devices were installed. The protection devices must stop the robot's movement within the danger zone. Check the protection devices for proper function.
- ▶ Do not enter the danger zone of the robot during operation, and do not touch the robot.
- ▶ Only operate the robot system in undamaged condition. Never modify the robot system. fruitcore robotics excludes any liability if the product has been modified.
- ▶ Check the emergency stop and safety stop functions.
- ▶ The robot system must be checked for externally visible damage and defects at least once per day/shift. Changes or damage that have occurred must be reported to the person or office responsible immediately.
  - ⇒ In the event of malfunctions, switch off the robot system immediately and secure it against restarting, including by third parties. Report malfunctions immediately to the operations manager and rectify or have them rectified immediately.
- ▶ Only perform switch on and switch off processes in accordance with the AI.
- ▶ It is only permissible to disconnect the Panel from or connect it to Control when it is disconnected from the power supply.

Ensure that only the connected Panel is in the vicinity of the robot to avoid confusions with inactive emergency stop buttons.

8.2 Operating Modes

The robot can be operated in three operating modes. Change the operating modes using the operating mode selector switch on Control, which is designed as a key switch.

- Teaching mode T1
  (manual operation, reduced speed)
- Teaching mode T2
  (manual operation, high speed)
- Automatic mode

1 Operating modes selector switch
2 Position for operating mode T1
3 Position for operating mode T2
4 Position for automatic mode

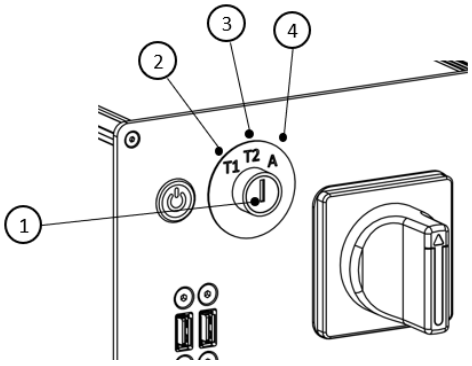


Fig. 8-1: Operating modes selector switch

8.2.1 Teaching mode

WARNING!
Danger of impact and crushing due to robot movement
The safety stop function is deactivated in teaching mode.

- ▶ While the robot is in teaching mode, close off the area around the robot, and protect it against access by unauthorized persons. There must be no persons in the danger zone of the robot.
- ▶ While the robot is in teaching mode, secure the Panel and Control against operation by unauthorized persons.
- ▶ After teaching is completed, remove the key from the operating mode selector switch to prevent unauthorized switching of the operating mode.

The robot can only be moved manually in two-handed operation. To move the robot, the enabling switch must always be kept pressed in the center position in operating modes T1 and T2. In addition, the desired control element must be kept pressed on the display. As soon as one of the two conditions is no longer fulfilled, the robot will brake to a standstill.

▶ Switch on the robot system (see subsection 0).

Switching to a different operating mode causes the robot to stop. A warning message appears on the display. The message must be confirmed in order to proceed. The enabling switch must be released during this time.

There are two teaching modes: T1 or T2.

T1 – programming mode

The speed of the TCP is limited to 250 mm/s. The robot can be moved only with the enabling switch.

Before programming waypoints, ensure that the system has reached operating temperature. Thermal expansion in the robot system can result in position deviations.

- ▶ Switch the robot system on at least 60 minutes before the programming process.

T2 – program verification mode

The speed of the TCP can exceed 250 mm/s. The robot can be moved only with the enabling switch.

▶ Switch the operating modes selector switch on Control to T1 or T2. Pull out the key to prevent unauthorized persons from changing the operating mode.

⇒ To confirm the change of operating mode; the enabling switch must be released to do this.

⇒ Create, edit, or execute a program.

8.2.2 Automatic Mode

Programs are executed automatically in automatic mode. The robot acts without the enabling switch and the safety functions are active.

DANGER!
Danger of impact and crushing due to robot movement

- ▶ Ensure that there are no persons within the protected area.
- ▶ Ensure that suitable protection devices are installed and are active.
- ▶ Check the protection devices for proper function.

ATTENTION!
Danger of damage due to incorrect or missing configurations in the software.

- ▶ Ensure that the program to be executed has been programmed and tested correctly before staring automatic mode.

ATTENTION!
Risk of collision due to program changes during automatic mode.

- ▶ Do not make any changes to the program during automatic mode.
- ▶ Ensure that no unauthorized persons have access to the Panel.

▶ Switch on the robot system (see subsection 0).

Switching to a different operating mode causes the robot to stop. A warning message appears on the display. The message must be confirmed in order to proceed. The enabling switch must be released during this time.

▶ Switch the operating modes selector switch on Control to **automatic**. Pull out the key to prevent unauthorized persons from changing the operating mode.

▶ To confirm the change of operating mode; the enabling switch must be released to do this.

▶ Create, edit, or execute a program.

8.3 Shutdown after End of Operation

At the end of operation, the robot system must be shut down.

▶ To cancel a running program, tap the **cancel program** button (1).

⇒ The robot is braked immediately.

Fig. 8-2: Cancel program execution

▶ Check whether the robot is in a safe position (e.g. there is no workpiece in the gripper).
If necessary, move the robot to a safe position manually via the free movement.

ATTENTION!

- ▶ Before the robot system is switched off, it must be ensured that the computer for the software (horstFX) that is integrated in Control is shut down properly.

▶ Navigate to the main menu. Tap on the Exit horstFX button there. A pop-up window with two options appears. Select the option shut down system (1) and then confirm with the OK button (2).

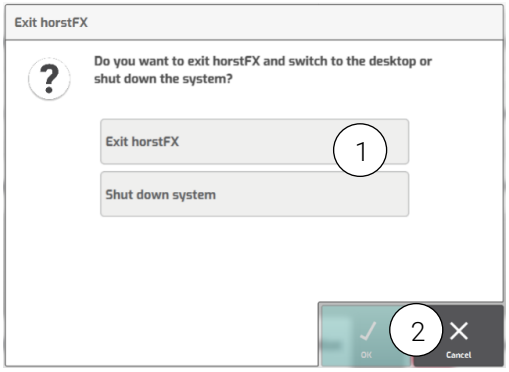


Fig. 8-3: Shutting down the computer (horstFX)

Alternatively, you can also shut down the computer for the software (horstFX) that is integrated in the Control as follows:

▶ Press the PC ON/OFF button of the Control. A pop-up window appears. In this pop-up window, press the Shut Down button (1) to shut down the computer for the software (horstFX)

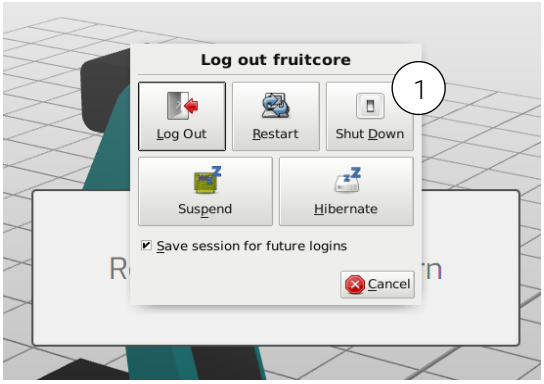


Fig. 8-3: Shutting down – alternative

▶ Switch the main switch on the Control to ON.

▶ Secure the main switch with a lock.

9 Emergency and Troubleshooting

9.1 Behaviour in an emergency

In an emergency, the robot system must be stopped by the emergency stop button.

When integrated into a complete system, the robot system must be integrated into the emergency stop circuit of the higher-level system. Observe the notes in the section *Safety-relevant inputs/outputs*.

Emergency stop: Stop category 1

Stopping is achieved by active braking, as the energy supply to the drive elements is initially maintained. Only after a stop is made is the energy supply disconnected and the brakes are applied. This is a controlled stop in which the robot does not leave its programmed path.

▶ The pop-up window appears in the display with the warning message that the emergency stop has been triggered.

▶ Eliminate the hazardous situation.

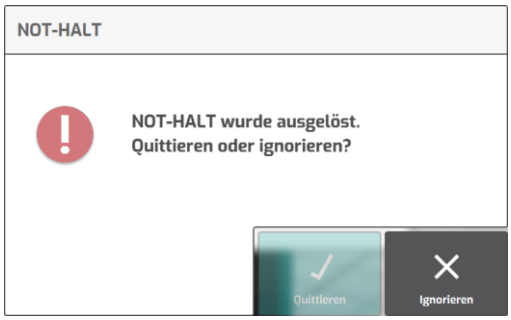


Fig. 9-1: Emergency stop warning message

Resetting the emergency stop

▶ Before resetting, check whether the danger has been eliminated.

▶ Unlock the emergency stop button by pulling it out.

⇒ The Acknowledge button is activated.

▶ Acknowledge the warning message on the display.

⇒ If the emergency stop has been reset, the program will not continue until it is resumed manually.

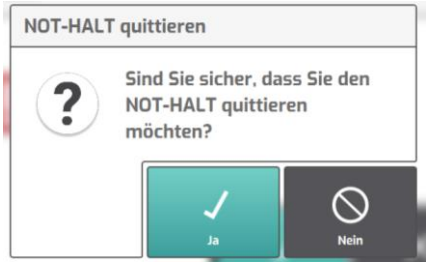


Fig. 9-2: Emergency stop - confirm

9.1.1 Emergency operation - moving the robot without drive energy

The robot's axes may only be moved without drive energy in emergencies, e.g. to free persons. The personnel carrying out the operation must have basic technical training and observe the following warnings and instructions. Specialist fruitcore personnel must be called in to recommission the system.

DANGER!

By acting hastily in emergency situations

- ▶ Before intervening, make yourself aware of whether and which axle(s) must be moved in which direction in order to solve or improve the existing emergency situation
- ▶ Make sure that no part of the body can get between the moving axes of the robot.

WARNING!

Risk of impact and crushing due to movements of the robot.

Unintentional movements of the robot can occur due to the release of internal stresses or gravity.

- ▶ Secure the robot arm against unintentional movements.
- ▶ Remove workpieces from the gripper if necessary.
- ▶ Disconnect the robot system from the mains.
- ▶ If necessary, disconnect mounted, compressed air-driven tools from the air supply.

DANGER!

Defective and damaged components and assemblies / faulty assembly

After loosening the clamping sets, do not restart the robot system. Incorrect assembly can cause the belts to break.

- ▶ Contact fruitcore robotics.

- ▶ Now move the robot arm in the desired direction with a strong movement.
- ▶ Then secure the robot again against unintentional movement.
- ▶ Attention: The warranty expires with this action and the robot system may only be restarted after consultation with fruitcore robotics.

WARNING!

Danger from damaged assemblies due to emergency operation

If the robot arm was moved manually in an emergency, assemblies of the robot system may have been damaged. Uncontrolled start-up may be the result.

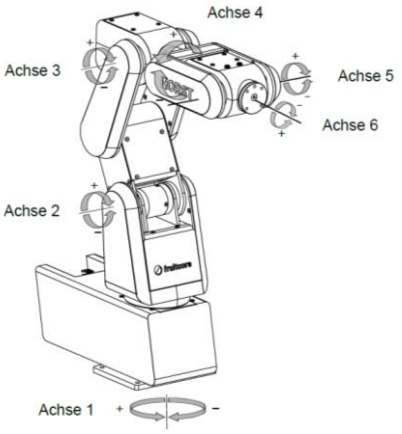
- ▶ Have the robot system checked by fruitcore robotics customer service before putting it back into operation.

9.1.2 Emergency operation - moving the robot by free movement

DANGER!

By acting hastily in emergency situations

- ▶ Before intervening, make yourself aware of whether and which axis(es) must be moved in which direction in order to solve or improve the existing emergency situation.
- ▶ Use the adjacent illustration as a guide.
- ▶ Move the robot in small steps in free driving mode until the emergency situation is solved.



9.2 Troubleshooting

DANGER!

Danger due to incorrect troubleshooting

- ▶ Troubleshooting may only be carried out by persons with technical and electrotechnical training.

If faults arise on the robot system, corresponding fault messages (system faults) are shown on the Panel.

- ▶ Follow the instructions on the Panel to rectify the cause of the fault.
- ▶ Confirm the fault message on the display once all causes of the fault have been removed.
- ▶ Create a service ticket at https://horstcosmos.com/service if you cannot eliminate the causes of the error yourself.

In the case of software problems, switch off the robot system as described in subsection 8.3 ,and switch it on again as described in subsection 0.

If step losses occur due to overload or blocking of the robot arm, the brakes are automatically activated. After 250 step losses or brake activations, safe functioning of the brakes can no longer be guaranteed. Contact fruitcore robotics for this purpose.

The number of overloads is logged in the settings and info, robot system data in HorstFX.

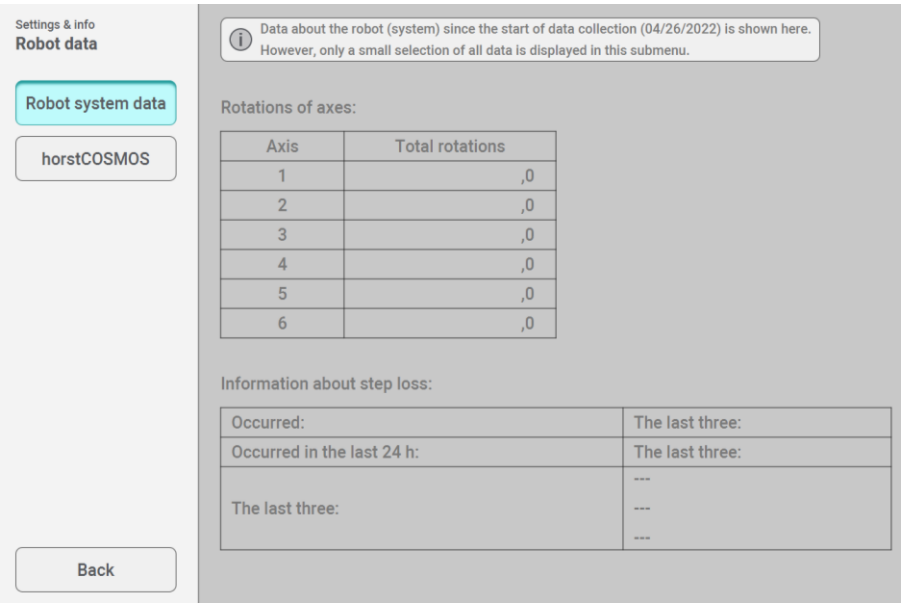


Figure 9-1: Overloads of the robot

DANGER!
Danger due to incorrect fault rectification and brake failure

- ▶ Regularly check the load changes of the brakes in *Settings & Info > Robot data > Robot system data*
- ▶ After the permissible load changes of the brake have expired, contact the service department of fruitcore robotics to have the brakes inspected professionally.

9.2.1 Remote access in case of service

DANGER!
Danger due to negligent remote access

- ▶ Always follow the instructions of the service personnel and only enter the movement range of the robot when instructed to do so.
- ▶ If a hazardous situation arises during remote access, press the emergency stop button! All movements will be stopped and the connection to TeamViewer will be cut.

If you contact the fruitcore robotics service department for live support, it is possible to control the affected robot remotely using TeamViewer in order to solve the problem at hand.

Establishing a connection

TeamViewer can be started in HorstFX via *Settings & info > Service & remote access*.

The TeamViewer window opens and the ID and password can be passed on to the service personnel. The password is regenerated for each session.

Once the connection is established, the local control is automatically deactivated. A red border with red writing "*Remote access active*" signals on the panel that remote access is currently activated.

During remote access, the following safety measures are active:

- – Only one side can control the robot, locally or remotely. The input of the other is blocked. In case of emergency, the emergency stop can always be pressed locally to stop remote access and bring the robot to stop category 1.
- – The high speed manual mode (T2) is blocked. Automatic mode is possible when there is no person in the protected area and all safety devices are active.
- – No safety configurations and parameters related to robot movement limitation can be stored.

9.2.2 Example Errors

Error	Index	Description	Cause	Troubleshooting
ROBOT_JOINT_ OVERLOAD	Joint	Load on axis too high	submitted weight is not correct	Check weight be aware of maximum
			collision	Check program
BUS_DRIVER_ DISCONNECT	Joint	Motor driver does not respond	Bus cables defect	Change bus cables
			Motor driver defect	Contact fruitcore robotics
BUS_ENCODER_ DISCONNECT	Joint	Encoder does not respond	Bus cables defect	Change bus cables

Error	Index	Description	Cause	Troubleshooting
			Encoder defect	Contact fruitcore robotics
CROSS_COMP_ SAFETY_INPUT-3	Safety Input	Safety channels A & B (KL1 & KL2) differ	Enabling switch is not pressed correctly	Check panel; press enabling switch correctly
CROSS_COMP_ SAFETY_INPUT-4 to 7			channel A & B differ → wrong connection, broken cable	Check wiring; check cable if damaged
POWER_24V_IO_ NOT_GOOD	-	Short circuit in IO-circuit	Short circuit of 24V and GND	Check wiring; check cable if damaged
SAFETY_REDUCED_ VELOCITY_EXCEEDED	-	Limit of reduced speed was exceeded	Faster than speed of 250mm/s	Check configuration settings of laser scanner and HorstFX
SAFETY_ STANDSTILL_ VIOLATION	-	Robot moved during standstill monitoring	Robot moved despite no movement was initiated	Check brakes
SAFETY_IO_OSSD_ FAILED_INPUT	Safety Input	OSSD-signal on Safety Input could not be read back	Cross connection or short circuit on OSSD-cable	Check wiring; check cable if damaged
SAFETY_IO_OSSD_ FAILED_OUTPUT	Safety Output	OSSD-signal on Safety Output could not be read back	Cross connection or short circuit on OSSD-cable	Check wiring; check cable if damaged
SAFETY_IO_ READBACK_CH_A	Safety Output	Safety Output readback failed, channel A/B	short circuit to 0; unexpected value at Safety-outputs (0 instead of 1 and vice versa), channel A or B	Check wiring; check cable if damaged
SAFETY_IO_ READBACK_CH_B				
SAFETY_IO_ EXT_READBACK_A	Safety Output	External readback failed on Safety Output, channel A or B	Readback channel is active in horstFX, signal wrong, channel A or B	Check wiring; check cable if damaged
SAFETY_IO_ EXT_READBACK_B				
BUS_DRIVER_DIS-CONNECT2 to 6 BUS_ENCODER-DIS-CONNECT 2 to 6 USER-IO_ DISCONNECT	Joint	If these errors occur together and cannot be acknowledged	Short circuit on 48V cable Short circuit on slip ring Short circuit on BUS sharing unit	Check left micro fuse on robot base (only H600) contact fruitcore robotics
BUS_DRIVER_DIS-CONNECT_1 BUS_ENCODER_DIS-CONNECT_1	Joint	Encoder and motor driver do not respond	Short circuit on 48V cable Short circuit on slip ring Short circuit on BUS sharing unit	Check right micro fuse on robot base (only H600) contact fruitcore robotics

10 Cleaning and Maintenance

DANGER!
Danger resulting from incorrect maintenance

- ▶ Maintenance must be performed only by persons with technical and electrotechnical training who were also authorized by fruitcore robotics.

DANGER!
Danger of electric shock

- ▶ The connection and any work on the electrical equipment must be performed by electrotechnical specialist personnel only.

WARNING!
Danger of impact and crushing due to unexpected robot movement

- ▶ Remove any workpieces from the gripper prior to cleaning or maintenance.
- ▶ Prior to carrying out cleaning or maintenance work, disconnect the robot system from the power grid and disconnect any mounted tools that are operated with compressed air from its supply.
- ▶ Close off the danger zone and protect it against access by unauthorized persons.
- ▶ Set up warning signs to prevent the system from being started up while work is being performed. Secure the Panel and Control against operation by unauthorized persons.

Refer to the AI and any the accompanying documentation for information on maintaining the robot system.

Maintenance and inspection intervals stipulated in the AI, including the replacement of wear and spare parts, must be observed.

Spare parts must correspond to the technical requirements specified by fruitcore robotics. This is always guaranteed with original spare parts.

DANGER!
Danger resulting from incorrect maintenance

- ▶ Maintenance must be performed only by persons with technical and electrotechnical training who were also authorized by fruitcore robotics.

WARNING!
Danger due to missing protection devices as well as defective/damaged modules or accessories.

- ▶ Assemble all protection devices after completing work. Check all modules and accessories.
- ▶ Perform a test run of the entire system, and check it for proper functioning.

WARNING!
The robot arm must not be moved by applying external force.

Modules of the robot system may be damaged if the robot arm was moved manually in an emergency. This may result in an uncontrolled start-up.

- ▶ Have the robot system checked by the customer service of fruitcore robotics before recommissioning.

DANGER OF CRUSHING, IMPACT AND CUTTING!

Possible personal injuries due to the robot arm collapsing during maintenance work

If a belt tears unexpectedly, the robot arm may collapse.

- ▶ During maintenance work, the robot arm must be sufficiently secured against collapsing.
- ▶ Do not stand under the robot arm.
- ▶ Never insert your hand into the linkage, the four-bar linkages, or between the axes of the robot system.

DANGER OF EJECTION OF PARTS!

Possible personal injuries due to unexpected ejection or dropping of parts during maintenance

- ▶ Ensure that tools or components are attached securely to the robot.
- ▶ Only move workpieces if they are gripped safely.
- ▶ Only perform commissioning, maintenance, and cleaning when there is no workpiece in the gripper, if possible.
- ▶ The operator must perform a risk assessment for the entire system. If there is a danger of ejection, protection devices that provide protection against ejected parts must be used.

10.1 Cleaning

Depending on the ambient conditions of the robot system, the components become dirty. Clean the robot regularly. Frequency of cleaning depends on the degree of soiling. fruitcore robotics recommends cleaning the robot once a week.

The robot does not have to be disassembled for cleaning.

Wear protective clothing.

- ▶ Wear safety goggles, protective gloves, and a dust mask while cleaning.

ATTENTION!

Danger of machine damage

- ▶ Do not use compressed air to clean Control and Panel.
- ▶ Do not use aggressive, flammable, or abrasive liquids/cleaning agents.
- ▶ Avoid the ingress of liquids into parts of the system.
- ▶ Use a vacuum cleaner to remove dust, chips, and other particles from the robot.
- ▶ Use a clean cloth to clean Control and Panel.

Environmental protection!

- ▶ Dispose of the waste and used cleaning cloths in an environmentally responsible way.

10.2 Maintenance and Repair

Repairs to the robot system may only be carried out by fruitcore robotics. If a service contract exists with fruitcore robotics, it must be ensured that the robot system data is continuously transferred to horstCOSMOS. If there is no service contract, all maintenance work must be ordered independently from fruitcore robotics. If the following deadlines are missed, safe and fault-free operation cannot be guaranteed and liability for any events arising in this connection will lapse.

The robot system is designed for a service life of 50,000 h, which corresponds to a service life of 10 years with an annual operating time of 5,000 h.

If the maximum permissible number of braking operations during movements is not exceeded (see section 9), the service life of the brakes is equal to that of the entire system.

- Contact fruitcore robotics as soon as
  - 15,000 operating hours have been reached to have the toothed belts inspected.
  - 30,000 operating hours have been reached to have the gears inspected.
- Check the robot system weekly for external damage.
- The emergency stop function must be functionally checked weekly.
- All accessible screws must be checked monthly for tightness and tightened if necessary.
- The BUS cables must be checked monthly for damage. The correct fit of their screw connections must also be checked.
- The safety inputs/outputs on the control unit must be functionally checked monthly if they are used.
- The ventilation filters must be checked monthly for dirt and vacuumed with a hoover if they are dirty.
- All terminals must be checked for function every six months.

11 Storage

If the robot system is stored away for use at a later time or decommissioned, it must be protected with suitable packaging.

The robot system must be stored in a dry, frost-protected place that is not exposed to rainfall or heavy temperature fluctuations.

- Shut the robot down and disassemble it (see subsections 8.3 and 12.1).
- Securely package the robot, Panel, and Control.

12 Disassembly and Disposal

12.1 Disassembly

- Disassemble or secure any add-on parts.
- Move the robot to transport position (see subsection *Transport*).
- Shut the robot down (see subsection Shutdown after End of Operation).
- Disconnect any electrical and pneumatic lines from the power supply.
- Disconnect the connection cable between the robot and Control.
- Disassemble the robot.

12.2 Disposal

Danger of environmental damage.

All parts of the robot system must be disposed of in such a way that any damage to health or the environment can be ruled out.

- Shut the robot down (see subsection Shutdown after End of Operation) and disassemble it.
- Dispose of all parts of the robot system in such a way that any damage to health or the environment can be ruled out. Note the materials used.

Materials Used

Material	Unit
Copper	Cables
Steel, aluminum	Modules of the robot
Plastic, rubber, PVC	Drive belts, cabels
Electronics	Control, Panel, power electronics, mainboard, motor driver, fan, rotary pulse generator

13 Annex

13.1 Technical Data

Robot	
Dimensions (L x W x H)	602 mm x 200 mm x 450 mm
Robot weight	Approx. 30 kg
Nominal load according to VDI 2861-2	2 kg The nominal load characterizes in terms of amount the load that an industrial robot can handle as the vectorial sum of tool load and payload without restriction of the kinematic and geometric parameters specified for the axes. Measured at nominal distance Rn from the tool flange: 76.5 mm (eccentricity e: 38.3 mm; offset Z: 66.3 mm) See Nominal load13.2
Permissible load capacity	Max. 3 kg (after consultation with fruitcore robotics) The permissible load capacity is reduced depending on the position of the center of gravity of the load.
Maximum range	584 mm (without attachment)
Position repeatability	+/- 0.05 mm
Number of axes	6
Protection classification	IP54
Noise emission	< 70 dB(A)
Installation area (L x W)	382 mm x 200 mm

Axis	**Range of movement**	**Speed (at load of 3 -0 kg)**
1	+/- 173°	240 - 370 °/s
2	+115° / -64°	90 - 140 °/s
3	+41° / -176°	190 - 340 °/s
4	+/- 172°	620 - 1080 °/s
5	+/- 142°	580 - 940 °/s
6	+/- 300 °	660 - 1080 °/s
TCP Vmax		~ 3,5 - 4,4 m/s

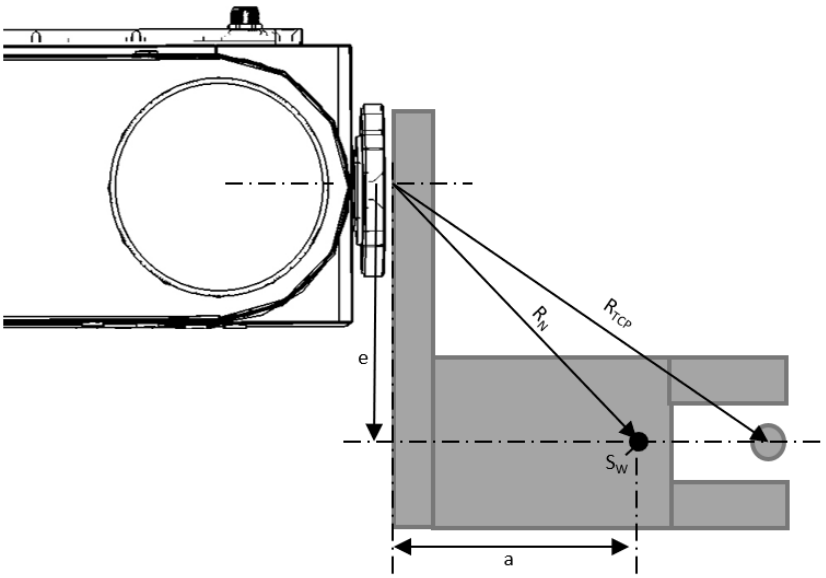
Panel	
Dimensions (L x W x H)	340 x 245 x 85 mm
Weight	2.4 kg
Display	13.3-inch touchscreen (Full HD monitor: 1920 x 1080)
Software	horstFX (graphical user interface)
Mount	Fixture for mounting on the wall, table, or cell

Control	
Dimensions (L x W x H)	460 x 315 x 175 mm
Weight	9 kg
Protection classification	IP20
Wiring of HORST	Cable between robot and Control: 3.0 m
Wiring of the Panel	DVI-D 24+1, 5.0 m
Power cable	5 m, CEE 7/4 / IEC-60320 C13, with pull-out protection
Power supply	115/230 VAC, 50 – 60 Hz, max 4.4 A (at 230 V)
Rated power draw	typ. 210 W (H600)
Protection	6.3 A (2x)
Communication	TCP/IP 100 Mbit Ethernet (web interface / http)
Safety-critical interfaces	Emergency stop, safety stop, enabling switch +4 safe inputs, +6 safe outputs (2 relays)
I/O connections on Control	20 inputs, +8 configurable 18 outputs, +8 configurable, +4 relay contacts
I/O connections for attachments on support arm	2x 2 inputs/outputs

Ambient conditions	
Ambient temperature	0 – 40 °C
Relative humidity	10 % – 75 % Control must not be used in dusty or humid environments exceeding IP54. Conductive dust in particular must be avoided.
Height above sea level	Up to 1,000 m above sea level without power reduction

13.2 Nominal load

var.	value



R_n	76.5 mm
e	38.25 mm
a	66.3 mm
R_{TCP}	114.75 mm

13.3 Stopping Distances and Stopping Times

The stopping distance is the distance covered by the TCP after the stop signal is triggered and until a complete standstill is reached.

DANGER!

A speed upgrade or load change can result in longer braking distances and unexpected collisions with people or other objects and machines. The same applies for a low-pass filter.

▶ Always adjust safety distances to the corresponding stopping distances.

ATTENTION!

Danger of damage to robot or property.

The stopping time is the time that passes from the stop signal being triggered until the robot reaches a complete standstill. The stopping distances and times have been determined for the three main axes 1, 2 and 3.

The table shows the stopping distances and stopping times when triggered by an emergency stop signal at speed 100 %.

	Average stopping distance		stopping time	
	Load 0 kg	Load 3 kg	reduced	100%
Axis 1	106.3°	63.9°	0.35 s	0.55 s
Axis 2	32.7°	14°	0.35 s	0.55 s
Axis 3	94.1°	44.8°	0.35 s	0.55 s

Table 13-1: Stopping distances and times

The braking time is a correcting variable defined by the control system. The stopping distance is therefore independent of the respective applied load or the load of the robot arm. The influence of speed on the stopping distance can be seen in the figure below.

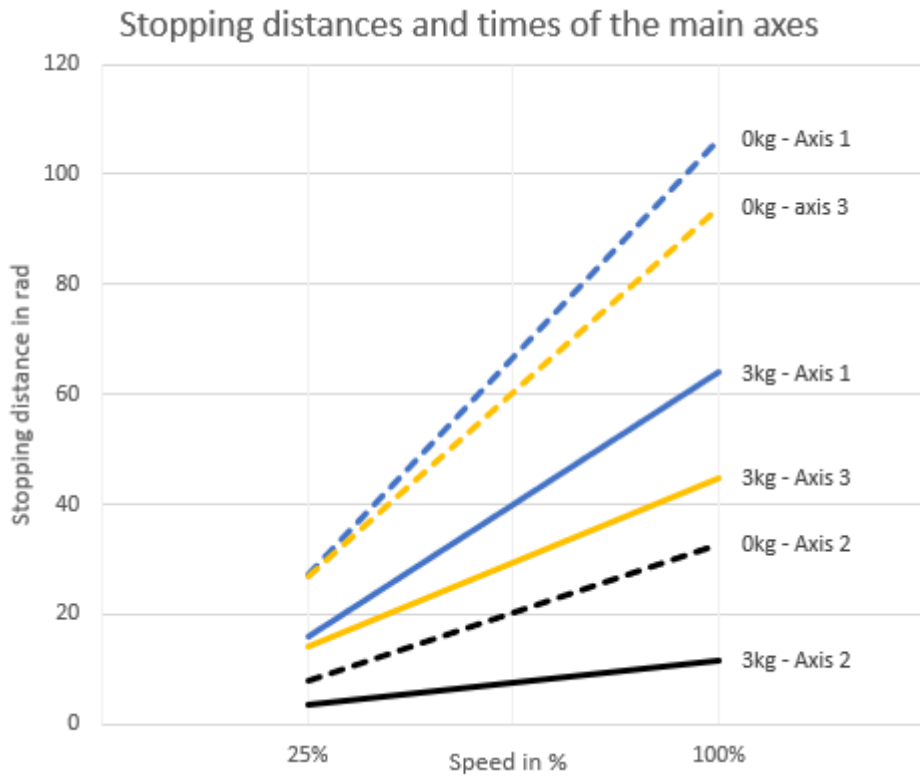


Fig. 13-1: Stopping distances of the main axes in degrees (°) with 5 kg

The stopping distances and stopping times shown have been determined by trial and are intended as guide values. The actual stopping distances and stopping times may differ depending on operating mode, use case, and number of braking processes. It is therefore recommended that stopping distances and stopping times be determined under real conditions in the respective use case and the values checked at least once a year.

13.4 Optional Accessories

The following accessories can be purchased from fruitcore robotics.

Order number	Component	Comment
On request	**Tool flange**	
On request	**Accessory flange plate**	
On request	**Mobile Robot Base**	
On request	**Safety laser scanner (270°)**	Monitoring of the danger zone
On request	**Mechanical stop, axis 2**	Free of charge
On request	**Mechanical stop, axis 3**	Free of charge
On request	**Extended Cable between Control and robot**	6m / 10m

Table 13-2: Optional accessories

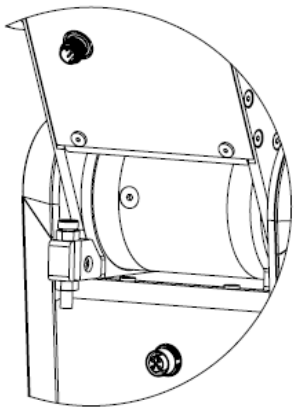


Fig. 13-2: Mechanical stop, axis 2

Handling of Mechanical Stop, Axis 2:

1. Set the stop in the software
2. Loosen 1x cover screw
3. Assemble the stop assembly, tightening torque 2 Nm
4. Attach the stop screw to the stop with approx. 1 mm gap

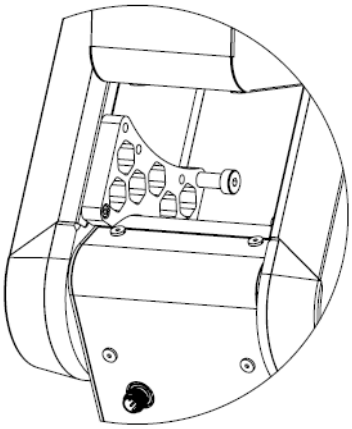


Fig. 13-3: Mechanical stop, axis 3

Handling of Mechanical Stop, Axis 3:

1. In the software, set the stop to 10° or 20°
2. Loosen 2x cover screw
3. Assemble the stop assembly, tightening torque 2 Nm

Position the stop screw in accordance with the configured stop

Attaching External Energy Chains

Attachments that are to be mounted on the robot arm (e.g. pneumatic valves) can be mounted at the same points where the panel sheets are attached. Alternatively, cable or hose holders can be bonded to the robot at the points provided for this purpose.

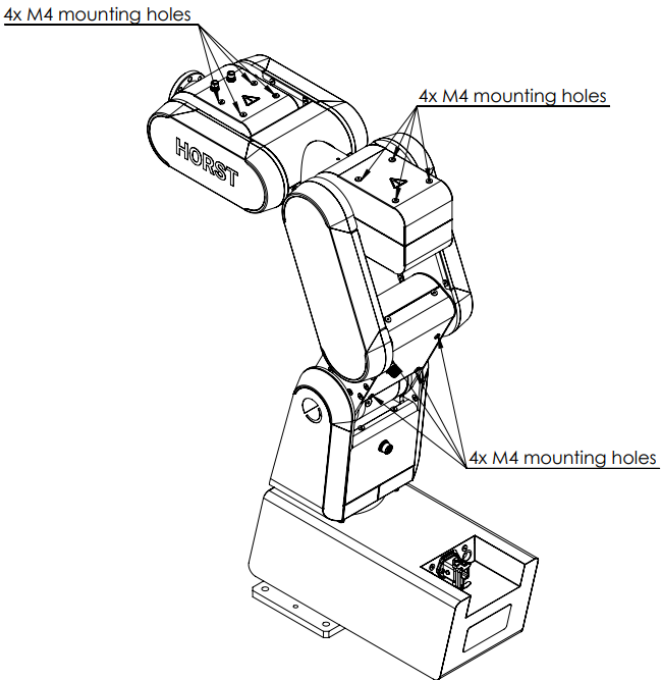


Fig. 13-5: Attaching external energy chains

13.5 Spare Parts

Order number	Component	Comment
On request	**Support arm 1**	

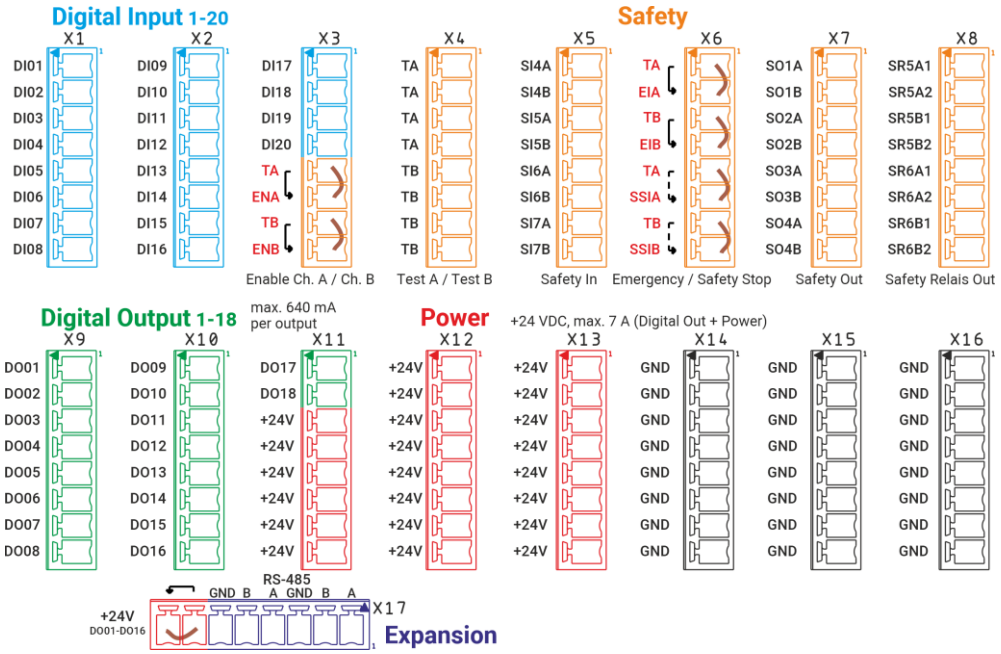
On request	**Support arm 2**
On request	**Support arm 3**
On request	**Control**
On request	**Panel**
On request	**Cable between Control and robot**
On request	**Cardboard for packaging**

Table 13-3: Spare Parts

13.6 Type Plates

The robot's type plate is located on the base of the rear side of the robot. Control's type plate is located on its rear side. Panel's type plate is located on its rear side.

13.7 Overview of Connectors



CONNECTOR	DESCRIPTION
X1	Digital inputs 1-8
X2	Digital inputs 9-16
X3	Digital inputs 17-20, Enable (enabling switch)
X4	Test signals A / B
X5	Safe inputs 4-7
X6	Emergency stop/safety stop
X7	Safe outputs 1-4
X8	Safe outputs 5-6 (pot.free)
X9	Digital outputs 1-8
X10	Digital outputs 9-16

X11	Digital outputs 17-18, +24 V
X12	+24 V
X13	+24 V
X14	Ground
X15	Ground
X16	Ground
X17	RS-485, bridge +24 V

Table 13-4: Digital I/O Control connectors

13.8 Terminal Assignment

Terminal	Assignment	I/O	Safe	Description.
X1.1 … X1.8	DI01 … DI08	I	✗	General digital inputs 1-8
X2.1 … X2.8	DI09 … DI16	I	✗	General digital inputs 9-16
X3.1 … X3.4	DI17 … DI18	I	✗	General digital inputs 17-20
X3.5	ENA	A	✓	Test signal for enabling switch, channel A
X3.6	ENA	I	✓	Enabling switch input (SI3A), channel A Standard: Bridge to X3.5
X3.7	ENB	A	✓	Test signal for enabling switch, channel B
X3.8	ENB	I	✓	Enabling switch input (SI3B), channel B Standard: Bridge to X3.7
X4.1 … X4.4	TA	A	✓	Test signal A
X4.5 … X4.8	TB	A	✓	Test signal B
X5.1	SI4A	I	🔧	Configurable, safe input 4, Channel A
X5.2	SI4B	I	🔧	Configurable, safe input 4, Channel B
X5.3	SI5A	I	🔧	Configurable, safe input 5, Channel A
X5.4	SI5B	I	🔧	Configurable, safe input 5, Channel B
X5.5	SI6A	I	🔧	Configurable, safe input 6, Channel A
X5.6	SI6B	I	🔧	Configurable, safe input 7, Channel B
X5.7	SI7A	I	🔧	Configurable, safe input 8, Channel A
X5.8	SI7B	I	🔧	Configurable, safe input 8, Channel B
X6.1	EIA out	A	✓	Test signal for emergency stop, channel A
X6.2	EIA in	I	✓	Emergency stop input (SI1A), channel A Standard: Bridge to X6.1
X6.3	EIB out	A	✓	Test signal for emergency stop, channel B

X6.4	EIB in	I	✓	Emergency stop input (SI1B), channel B Standard: Bridge to X6.3
X6.5	TA	A	✓	Test signal for safety stop, channel A
X6.6	SSIA	I	✓	Safety stop input (SI2A), channel A Standard: Bridge to X6.5
X6.7	TB	A	✓	Test signal for safety stop, channel B
X6.8	SSIB	I	✓	Safety stop input (SI2B), channel B Standard: Bridge to X6.7
X7.1	SO1A	A	🔧	Configurable, safe output 1, Channel A
X7.2	SO1B	A	🔧	Configurable, safe output 1, Channel B
Terminal	Assignment	I/O	Safe	Description
X7.3	SO2A	A	🔧	Configurable, safe output 2, Channel A
X7.4	SO2B	A	🔧	Configurable, safe output 2, Channel B
X7.5	SO3A	A	🔧	Configurable, safe output 3, Channel A
X7.6	SO3B	A	🔧	Configurable, safe output 3, Channel B
X7.7	SO4A	A	🔧	Configurable, safe output 4, Channel A
X7.8	SO4B	A	🔧	Configurable, secure output 4, Channel B
X8.1	SR5A1	A	🔧	Conf. safe output 5, potential-free contact A1
X8.2	SR5A2	A	🔧	Conf. safe output 5, potential-free contact A2
X8.3	SR5B1	A	🔧	Conf. safe output 5, potential-free contact B1
X8.4	SR5B2	A	🔧	Conf. safe output 5, potential-free contact B2
X8.5	SR6A1	A	🔧	Conf. safe output 6, potential-free contact A1
X8.6	SR6A2	A	🔧	Conf. safe output 6, potential-free contact A2
X8.7	SR6B1	A	🔧	Conf. safe output 6, potential-free contact B1
X8.8	SR6B2	A	🔧	Conf. safe output 6, potential-free contact B2
X9.1 … X9.8	DO01 … DO08	A	✗	General digital outputs 1-8
X10.1 … X10.8	DO09 … DO16	A	✗	General digital outputs 9-16
X11.1 … X11.2	DO17 … DO18	A	✗	General digital outputs 17-18
X11.3 … X11.8	+24V	A	✗	Power supply +24 V
X12.1 … X12.8	+24V	A	✗	Power supply +24 V
X13.1 … X13.8	+24V	A	✗	Power supply +24 V
X14.1 … X14.8	GND	A	✗	Ground
X15.1 … X15.8	GND	A	✗	Ground
X16.1 … X16.8	GND	A	✗	Ground

X17.1	RS485_A	I/O	✗	RS-485 add-on port #1, Signal A
X17.2	RS485_B	I/O	✗	RS-485 add-on port #1, Signal B
X17.3	GND	A	✗	Ground
X17.4	RS485_A	I/O	✗	RS-485 add-on port #2, Signal A
X17.5	RS485_B	I/O	✗	RS-485 add-on port #2, Signal B
X17.6	GND	A	✗	Ground
X17.7	+24V_out	A	✗	Output power supply DO01-16
X17.8	+24V_in	I	✗	Input power supply DO01-16 Standard: Bridge to X17.7

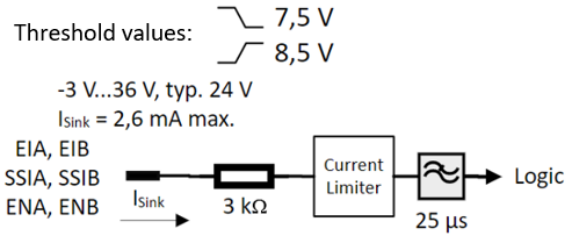
Table 13-5: Terminal assignment of digital I/O Control

Legend: ✓ Safe I/O Unsafe ✗ I/O Configurable I/O 🔧

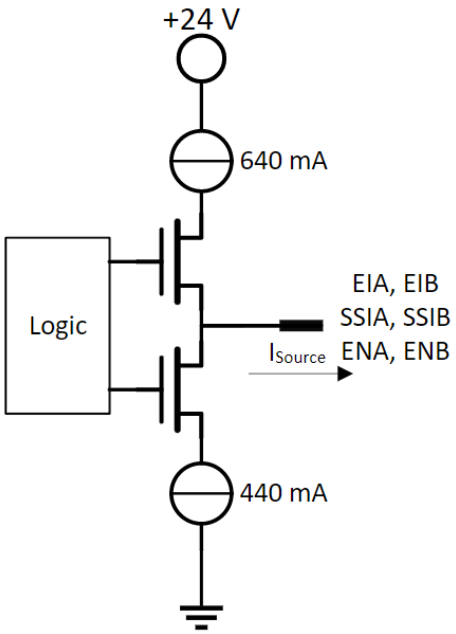
13.9 Functional Wiring Diagrams of the Electrical Interfaces

13.9.1 Control I/O

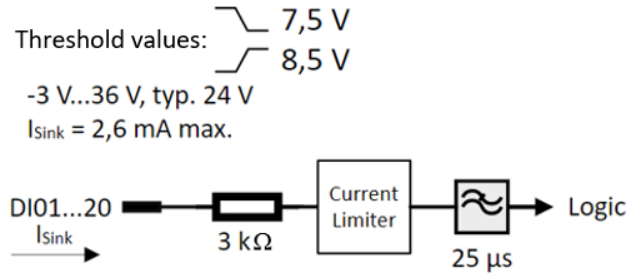
Safe input



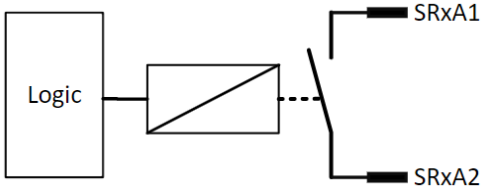
Safe output



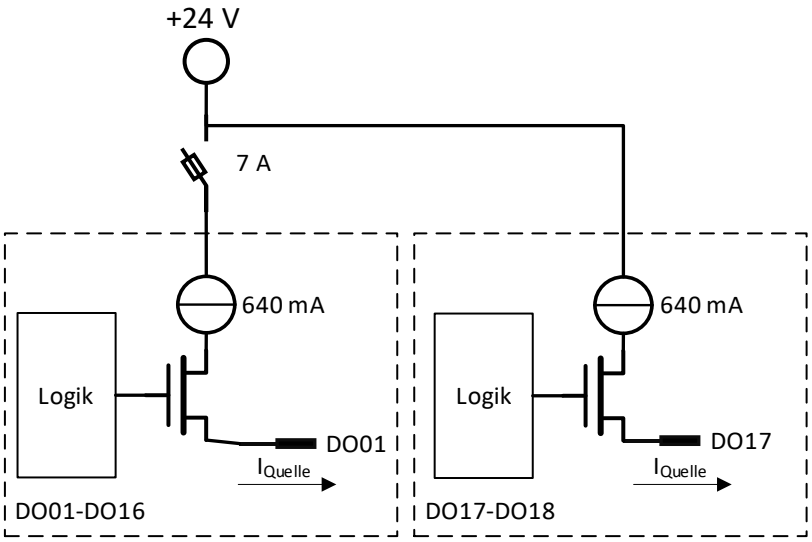
General digital input



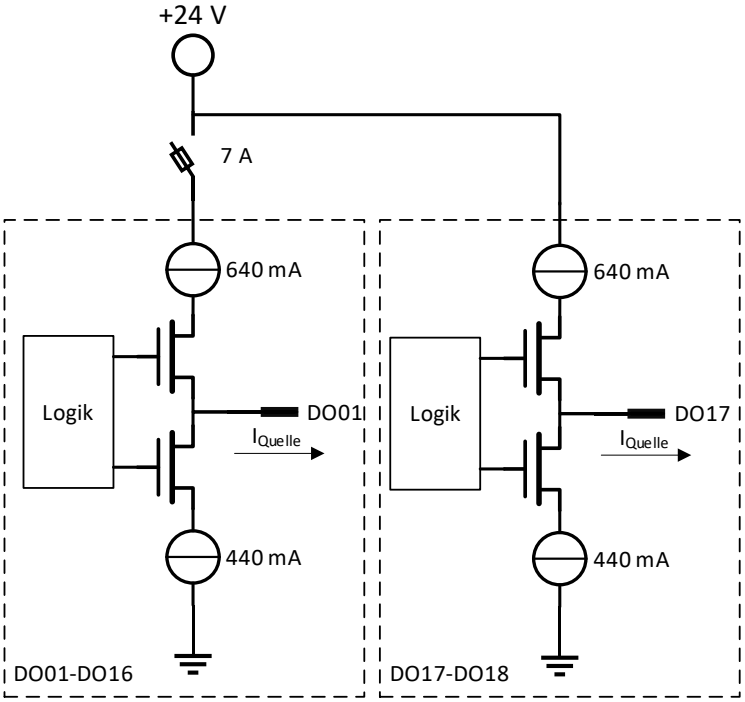
Potential-free output



General digital output (High-Side)

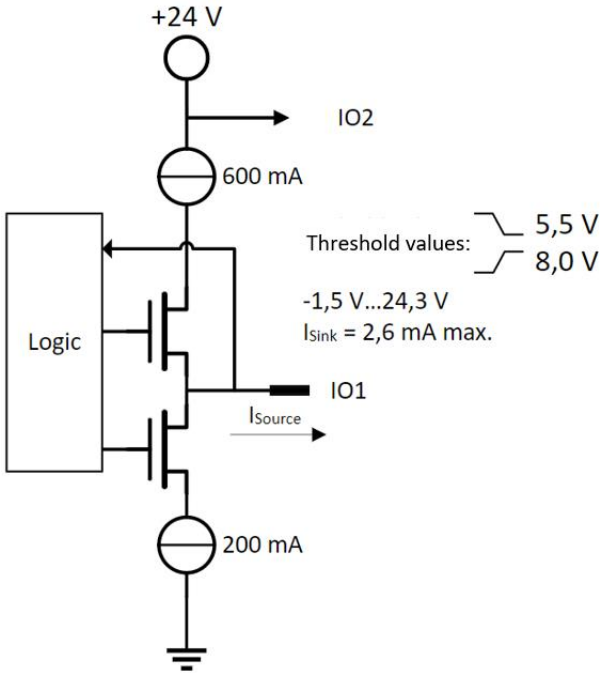


General digital output (Push-Pull)



13.9.2 Tool I/O

Digital input/output



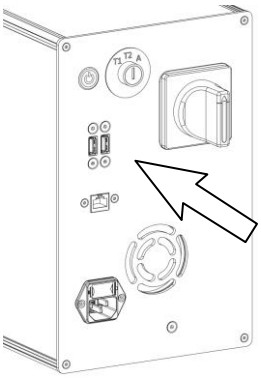
13.10 USB surfstick/Modem Stick

The enclosed USB surfstick enables you to go online with the robot system without having to integrate it into your company network. In this way, system and process data can be regularly transmitted to the horstCOS-MOS IIoT platform and viewed there. In addition, our service technicians can directly access their robot system via TeamViewer in case of service.
The use of the USB surfstick does not cause any additional costs for you. It is up to you whether you want to use the USB surfstick permanently, only in case of service or not at all. The operation of the robot system is also possible without using the USB surfstick.

Installation

The USB surfstick is pre-configured and already equipped with a SIM card. Therefore, it can be put into operation within a few minutes.

▶ Plug the USB surfstick into one of the two free USB ports on the back of Control.

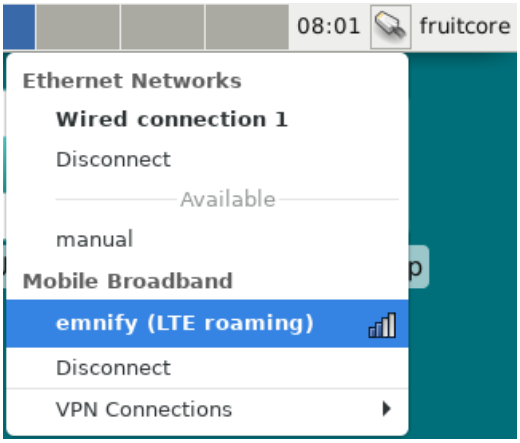


After plugging in, it flashes red. The connection establishment starts automatically, indicated by a faster red flashing. If the connection has been established successfully, the USB surfstick flashes blue once per second.

About three minutes after switching on Control, the USB surf stick is available and connected to the Internet

Connection problems

To ensure the best possible connection, the USB surfstick should not be covered or obstructed. The strength of the mobile network in general may be severely reduced in the application environment.
If the USB surfstick does not connect automatically, press Connect. If problems occur, plug the stick in and unplug it again.



14 Glossary

Stop category 0

Stopping is achieved by an immediate interruption in the power supply to the drive components. This uncontrolled stopping can cause the robot to deviate from its programmed track. For more information on this, see EN ISO 13850 or DIN EN 60204-1.

Stop category 1

Stopping is achieved through active braking, as the energy supply to the drive components is initially maintained. Only after a successful stop is the power supply disconnected. This is a controlled stop, during which the robot does not exit is programmed track. For more information on this, see EN ISO 13850 or DIN EN 60204-1.

Stop category 2

Stopping is achieved through active braking (controlled stopping), and after the stop, the energy supply to the drive components is maintained. The safe control system monitors the stop. For more information on this, see DIN EN 60204-1.

Performance Level

The Performance Level (PL) describes the capacity of safety-related parts of a control system to execute safety-critical functions under predictable conditions. The required Performance Level is also used to achieve the required risk minimization for individual safety functions. Therefore, the Performance Level of safety-critical parts of a control system must be at least as high as the required Performance Level. The Performance Level “d” is the second highest reliability classification. For more information on this, see DIN EN 13849-1.