

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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List of abbreviations

μs	<i>Microseconds</i>
HI	<i>High, Logical 1</i>
HORST	<i>Highly Optimized Robotic Systems Technology</i>
I/O	<i>Input/Output</i>
kV	<i>Kilovolt</i>
$\text{k}\Omega$	<i>Kilo ohm</i>
LO	<i>Low, Logical 0</i>
mA	<i>Milliampere</i>
ms	<i>milliseconds</i>
$\text{m}\Omega$	<i>Milli ohm</i>
OSSD	<i>Output Switching Signal Device</i>
TCP	<i>Tool Center Point</i>
Ω	<i>Ohm</i>

1 Introduction

1.1 Principle

The Assembly Instructions contain important information on how to operate the robot system in a safe, proper, and economically efficient way. Adherence to these Assembly Instructions 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 Assembly Instructions.

The Assembly Instructions must always be available at the site of operation of the robot system.



Read the Assembly Instructions carefully and completely before commissioning the robot system.

Treat the Assembly Instructions with care. Illegible or missing Assembly Instructions 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 in the Software horstFX user manual, which is always accessible on www.horstcosmos.com.

1.2 General Information

The Assembly Instructions 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 Assembly Instructions. This is due to the individual adaptation and further development of the robot system on the basis of the requests and orders of the individual customers. These deviations do not constitute a basis for claims of any kind.

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

Section 2 *Safety* of the Assembly Instructions contains instructions and associated information on the safe use of the robot system. The instructions specified in this section must always be observed.

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 Assembly Instructions.

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 Assembly Instructions, safety and accident prevention regulations, or a lack of care. Therefore, please take due care and caution.

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, starting on the day of delivery.

The warranty provisions specified in the general terms and conditions of fruitcore robotics GmbH or the individual purchase contract apply in addition.

1.5 Organizational Measures

The responsibilities when operating the robot system must be clearly defined and observed to ensure that no unclear responsibilities arise with regard to the aspect of safety (e.g. "Who switches off the robot?", "Who secures the robot against unauthorized use?", "Who controls the safety components?").

An operations manager must be appointed by the operator. The operations manager is obligated to allow the operating personnel time for work and safety instruction on the basis of these Assembly Instructions. Malfunctions must be reported to the operations manager immediately.

In addition, the operator must observe and provide instruction on generally applicable legal and other binding regulations on accident prevention and environmental protection.

1.6 Applied Standards and Regulations

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

- **EU Directive 2006/42/EC**
Machinery Directive
- **DIN EN ISO 10218-1**
Robots and robotic devices – Safety requirements – Part 1: Robots
- **DIN EN ISO 12100**
Safety of Machinery – General principles of design – Risk assessment and risk reduction
- **DIN EN ISO 13849-1**
Safety of Machinery – Safety-related parts of control systems –
Part 1: General principles of design
- **DIN EN ISO 13849-2**
Safety of Machinery – Safety-related parts of control systems – Part 2: Validation
- **DIN EN ISO 13850**
Safety of Machinery – Emergency stop principles of design
- **DIN EN ISO 14118**
Safety of Machinery – Prevention of unexpected start-up
- **DIN EN 60204-1/A1**
Safety of Machinery – Electrical equipment of machines – Part 1: General requirements
- **DIN EN 60529**
Degrees of protection provided by enclosures
- **ISO 9409-1**
Industrial robots– Mechanical interfaces – Part 1: Plates

1.7 Signs, symbols

The following symbols are used in the Assembly Instructions:

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 “⇒”.

Note



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

1.8 Marking of the 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 exercise particular 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.

The safety signs are often used in combination with a pictogram in the text to clarify the source of 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

The HORST robot system is a quality product manufactured in accordance with the recognized rules of technology. The robot system left the manufacturing plant in perfect condition in terms of safety.

The robot system is designed and built according to the current state of the art in safety technology. However, there is always a residual risk!

For your own safety, always observe the following:



WARNING!

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

- ▶ In order to avoid damage, these Assembly Instructions must be read, understood, and observed.
- ▶ Persons who work with the robot system must be familiar with the safety information of these Assembly Instructions and act according to them.
- ▶ Always observe the currently valid safety regulations and -information.
- ▶ Make sure to observe the occupational safety regulations specified by the law, the regulatory agencies, and the professional associations.

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 (e.g. separating protection device, light curtain, or safety laser scanner).

Note:

- The robot system must be used as intended and only in accordance with the Assembly Instructions (AI) and the enclosed documents. All information and safety instructions of the AI for the operating personnel must be observed. Any use that differs from or extends beyond this is considered improper and is expressly prohibited.
- In addition, the operator must observe and provide instruction on generally applicable legal and other binding regulations on accident prevention and environmental protection.
- All protection devices must be functional in order for the robot system to be used properly.
- Changes to or conversions of the robot system must not be made without the manufacturer's approval.



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 section 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, as a result of which the operating permit also expires automatically.

Examples of foreseeable misuse include the following:

- Cutting and welding of workpieces
- Coating/painting
- 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 appropriate instruction, training, or authorization
- 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 expressly 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 according to the instructions

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 or otherwise 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 devices (e.g. separating protection device, light curtain, or safety laser scanner).

2.4 Operator's Duties

2.4.1 EU Declaration of Conformity and Declaration of Incorporation



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:

1. 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:
2. The robot system is integrated in a system.
Or:
3. 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.

2.4.2 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.

To prevent dangers, additional protection devices (e.g. separating protection device, light curtain, or safety laser scanner) must be installed.

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.

2.4.3 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 perfect and 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 GmbH or by personnel authorized by fruitcore robotics GmbH.
- to only let persons who have read and understood the AI, and confirmed this with their signature, to work on the robot system (see Work and Safety Briefing).
- to clearly determine the responsibility of the personnel for operating, converting, 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 confirm this with their signature.
- to follow the instructions and safety information of the AI.
- to check the robot system in terms of safety and proper function before starting work.
- to contact the operations manager or fruitcore robotics GmbH in 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 GmbH or authorized personnel commissioned by fruitcore robotics GmbH.
- ▶ 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 trained on the work with and dangers of the robot system by fruitcore robotics GmbH or authorized personnel commissioned by fruitcore robotics GmbH.

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

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 the following activities:

- 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 distance 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 and with active safety equipment.
- ▶ The robot must be used only within suitable protection devices (e.g. separating protection device, light curtain, or safety laser scanner). 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.

The two fundamental emergency stop and safety stop safety functions are described below.

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 the horstCONTROL.

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 37.



The safety-related performance of the control system corresponds to PL "d" with structure category 3 according to DIN EN ISO 13849-1:2006. It is defined by the risk assessment of the robot system or DIN EN ISO 10218-1.

2.8 Safety Information for Assembly and 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 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 GmbH.



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 horstPANEL (operating panel) and horstCONTROL against operation by unauthorized persons.



CAUTION!

Risk of injury due to overloading or the robot falling

- ▶ The robot must be lifted by at least two persons in order to prevent overloading or the robot from falling.



CAUTION!

Damage due to the formation of condensate

Never switch the robot on immediately if it has been brought from a cold environment 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.

2.9 Safety Information on Operation

- ▶ 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.
- ▶ The mounting surface of the robot must be stationary within a firmly installed protection device.
- ▶ 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 (e.g. separating protection device, light curtain, or safety laser scanner) were installed. The protection devices must stop the robot's movement within the danger zone. Check the protection devices for proper function every day.
- ▶ 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 GmbH excludes any liability if the product has been modified.
- ▶ Check the emergency stop and safety stop functions daily.
- ▶ 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.



DANGER!

Possible personal injuries caused by careless handling of the system.

- ▶ Refrain from any unsafe method of working!
 - ⇒ 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 Assembly instructions.
- ▶ It is only permissible to disconnect the horstPANEL from or connect it to the horstCONTROL when it is disconnected from the power supply.
- ▶ Ensure that only the connected horstPANEL is in the vicinity of the robot to avoid confusions with inactive emergency stop buttons.

2.9.1 Emergency Situations



DANGER!

Due to the robot system'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 and with functional protection devices.
- ▶ The robot must be used only within suitable protection devices (e.g. separating protection device, light curtain, or safety laser scanner).

In the event of an emergency, the robot system must be stopped with the emergency stop button (see subsection *Emergency Stop Button*, page 24).



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*, page 35.

2.9.2 Emergency Operation – Moving the Robot without Drive Power

The axes of the robot must be moved without drive power only in emergencies, in particular for the purpose of freeing persons. The personnel performing the rescue operation must have undergone basic technical training and observe the following warnings and instructions. Specialist personnel from fruitcore robotics GmbH must be called for recommissioning the system.



WARNING!

Danger of impact and crushing due to robot movement

Unintended movement of the robot may occur due to the release of internal stress or gravity.

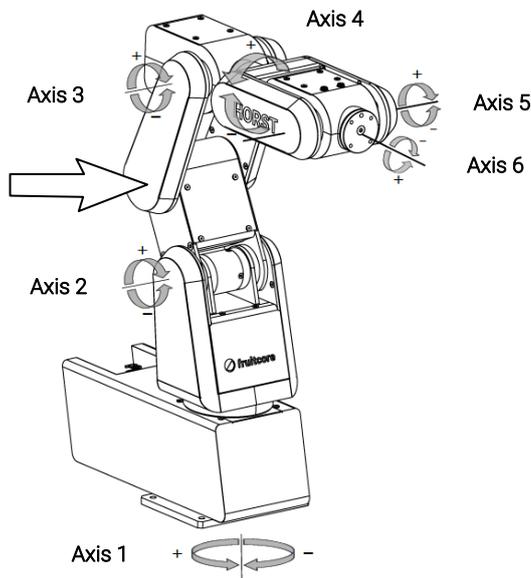
- ▶ Secure the robot arm against unintended movement.



WARNING!

Danger of impact and crushing due to unexpected robot movement

- ▶ Remove any workpieces from the gripper.
 - ▶ Disconnect the robot system from the power grid.
 - ▶ Disconnect any assembled tools that are operated with compressed air from the compressed air 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 horstPANEL and horstCONTROL against operation by unauthorized persons.
-
- ▶ Hold the robot arm by the swivel arm, exactly between axis 2 and axis 3 (see arrow in figure below). Ensure that no body parts can come between the moving axes of the robot.
 - ▶ Now move the robot arm with a powerful movement in the desired direction.



- ▶ Then secure the robot arm again against unintended movements.

Attention: The warranty expires when this action is performed and the robot system must only be started up again after consultation with fruitcore robotics GmbH.



DANGER!

Defective and damaged components and modules / faulty assembly

After manual movement of the robot arm, the robot system must not be started up again. This could result in significant personal injuries.

- ▶ Contact fruitcore robotics GmbH

2.10 Safety Information for Fault Rectification, Cleaning, and Maintenance Work



DANGER!

Danger resulting from incorrect fault rectification and maintenance

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



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 the compressed air 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 horstPANEL and horstCONTROL against operation by unauthorized persons.



WARNING!

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

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



Read the Assembly Instructions!

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

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



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

2.11 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.



WARNING!

Operation without protection devices presents a risk of injury

- ▶ The robot must be used only within suitable protection devices (e.g. separating protection device, light curtain, or safety laser scanner).
- ▶ All protection devices must always be completely assembled and functional. The protection devices must be removed only while maintenance work is being performed by the maintenance personnel.

Improper use of the robot system may result in the following dangers:



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 the horstCONTROL or the cables do not come into direct contact with liquids. This may result in electric shocks with a significant health risk or even death.
- ▶ 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.



DANGER OF CRUSHING, IMPACT AND CUTTING!

Possible personal injuries due to unexpected movement of the robot system during maintenance work

If the energy supply to the robot system is stopped, the engine brake of the respective robot axis is applied. Since the belt drives are elastic, they may still move slightly. As a result, manual intervention can lead to injuries even in idle mode.

- ▶ Never insert your hand into the area of motion or between the axes of the robot.



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 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 work

- ▶ Ensure that tools or components are attached securely to the robot.
- ▶ Only move workpieces if they are gripped safely.
- ▶ If possible, perform commissioning, maintenance, and cleaning work only when no workpiece is in the gripper.
- ▶ 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.

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)

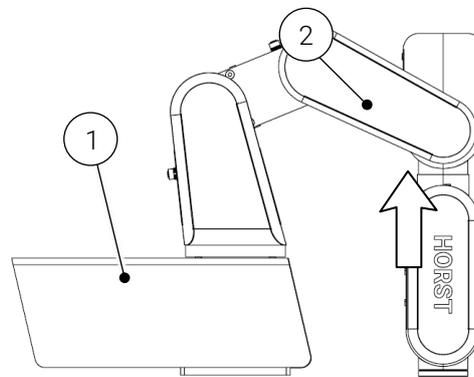


Fig. 3-1: Transport position

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 *Freies Fahren* (free movement) software control to bring the robot to the transport position, as shown in the illustration above (see the horstFX user manual, section “Free movement”)
- ▶ Disassemble the robot system from the mounting surface (see subsection *Disassembly*, page 69).
- ▶ Securely package the robot, horstPANEL, and horstCONTROL.

- ▶ 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 GmbH.

4 Description of the Robot System

In this section, we will describe the robot system and its components.

4.1 Scope of Delivery

The robot system is delivered with:

- HORST robot
- horstCONTROL (switch cabinet)
- horstPANEL (portable operating panel)
- Connection cable (robot – horstCONTROL), 3 m
- Power cable (1.8 m)
- DVI cable (5 m)
- 4 mounting screws (DIN 7984 M8x20)
- Mount for control panel
- Assembly Instructions
- Surfstick incl. SIM card (not included with the HORST600light)

4.2 Modules

In this subsection, the main modules of the robot system are presented. The most important components are listed and some are explained in more detail.

4.2.1 Robot

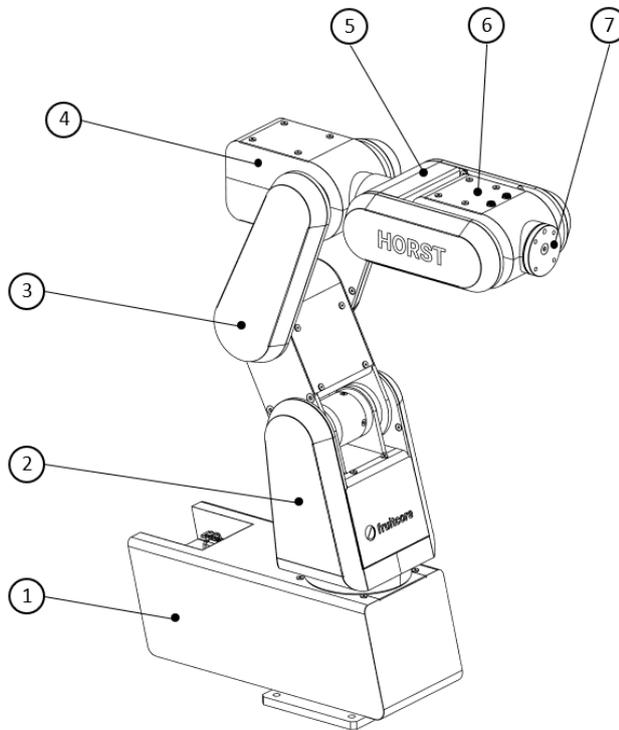


Fig. 4-1: Robot HORST 600

- 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

Robot axes

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

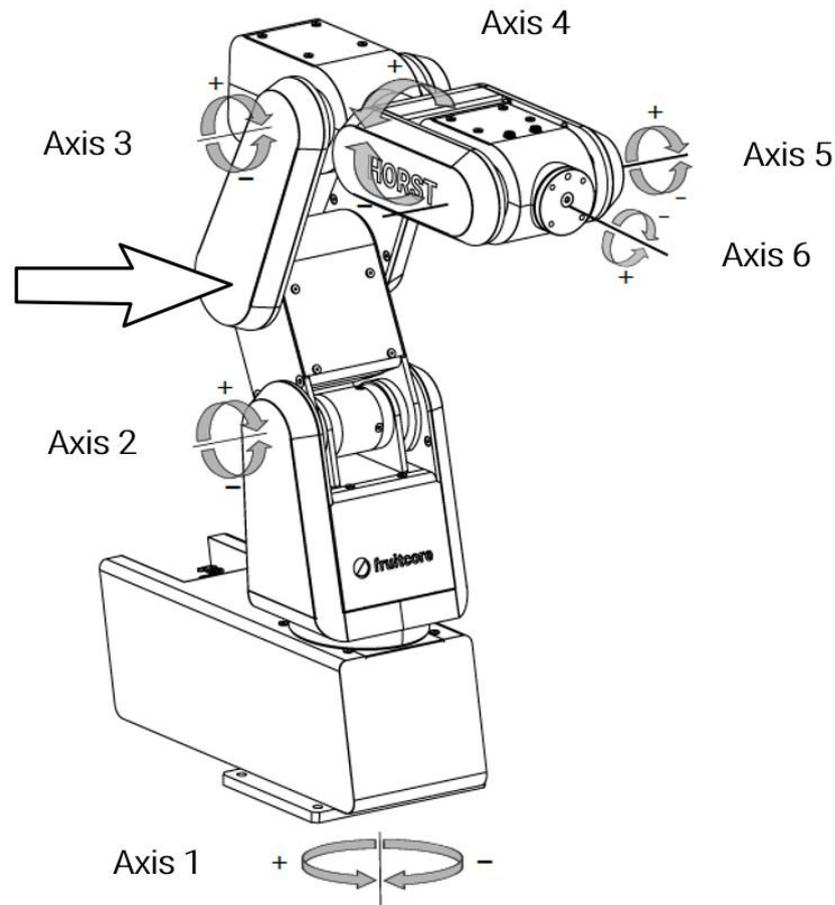


Fig. 4-2: Robot axes



You can find the values for the ranges of movement in the Annex *Technical Data*, page 70.

4.2.2 horstPANEL (operating panel)

- 1 Touch display (user interface)
- 2 Connection to horstCONTROL
- 3 Emergency stop button

The horstPANEL features a portable operating panel equipped with a touchscreen display. It is connected to the horstCONTROL by a DVI cable.

As standard, a 5 m long DVI cable is supplied. Up to 15 m are possible after consultation with fruitcore robotics GmbH.

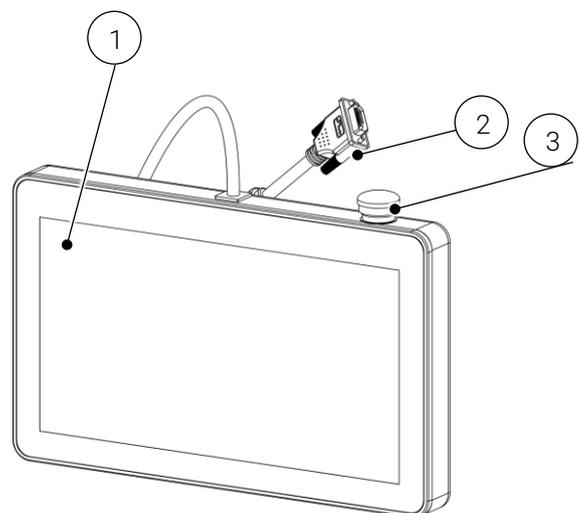


Fig. 4-3: horstPANEL operating panel

- 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 on the horstPANEL are intended only for connecting input devices. Use the USB port on the horstCONTROL to connect storage media.

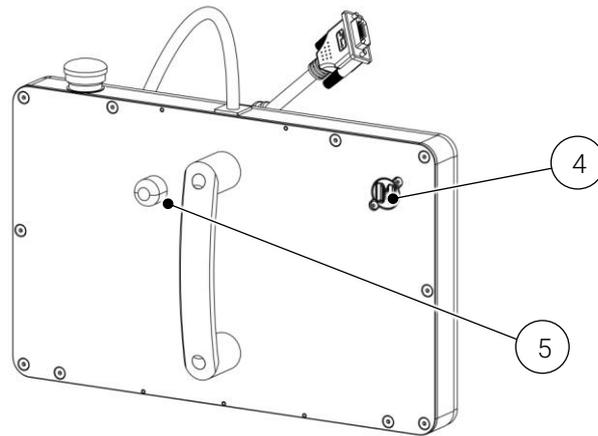


Fig. 4-4: Rear side of horstPANEL



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 the horstCONTROL!
- Never plug in or unplug the horstPANEL during operation! Switch the horstCONTROL off first.
- The USB ports on the horstPANEL are only provided for input devices. For storage media, use the interfaces of the horstCONTROL

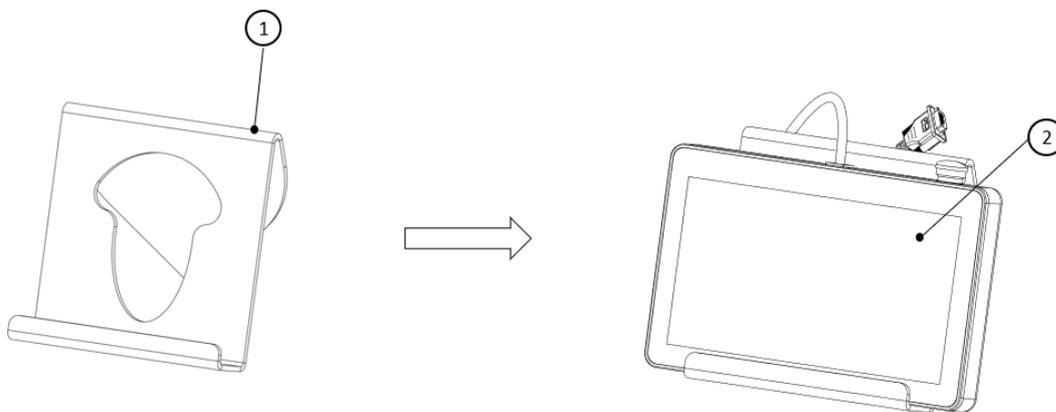


Fig. 4-5: Mount for horstPANEL

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



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

4.2.3 horstCONTROL (switch cabinet)

The horstCONTROL 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 left-hand image shows the front side of the horstCONTROL, and the right-hand image shows the rear side.

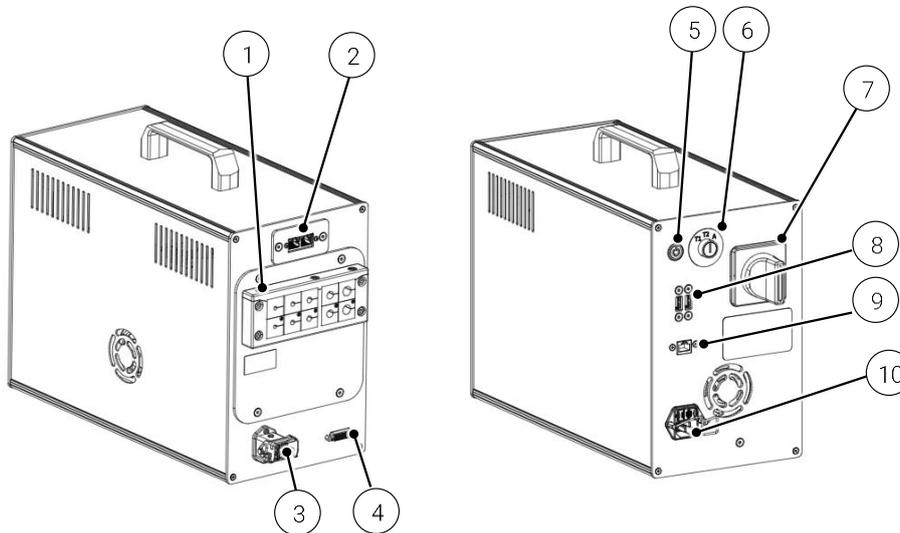


Fig. 4-6: horstCONTROL switch cabinet

- 1 Cable duct for inputs/outputs (interfaces)
- 2 PROFINET connection (modular plug RJ45) (optional)
- 3 Robot connection
- 4 horstPANEL connection
- 5 PC ON/OFF button
- 6 Operating modes selector switch
- 7 Main switch
- 8 Connection 2x USB 3.1 port
- 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 horstPANEL.

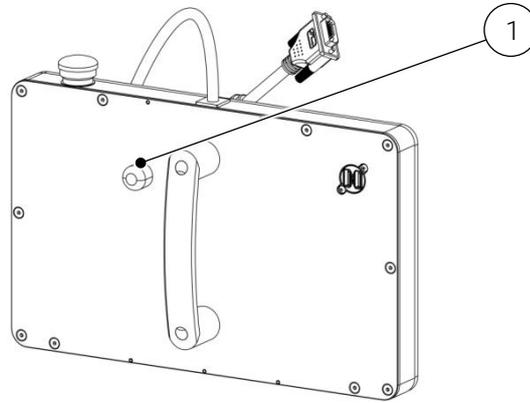


Fig. 4-7: Rear side of horstPANEL

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*, page 35.

- 1 Emergency Stop Button

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

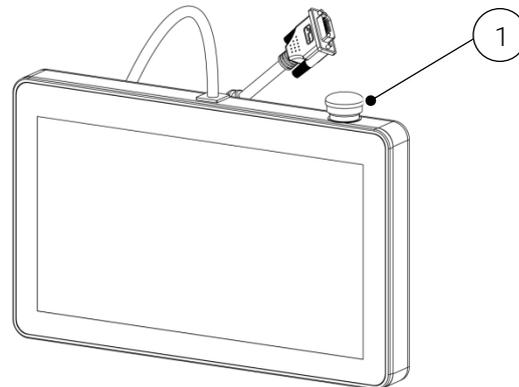


Fig. 4-8: Emergency stop button

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 *Assembling Add-on Parts*, page 28).

To mount add-on parts, mounting points for flange plates are provided on the robot arm, see Annex *Optional Accessories*, page 75.



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.

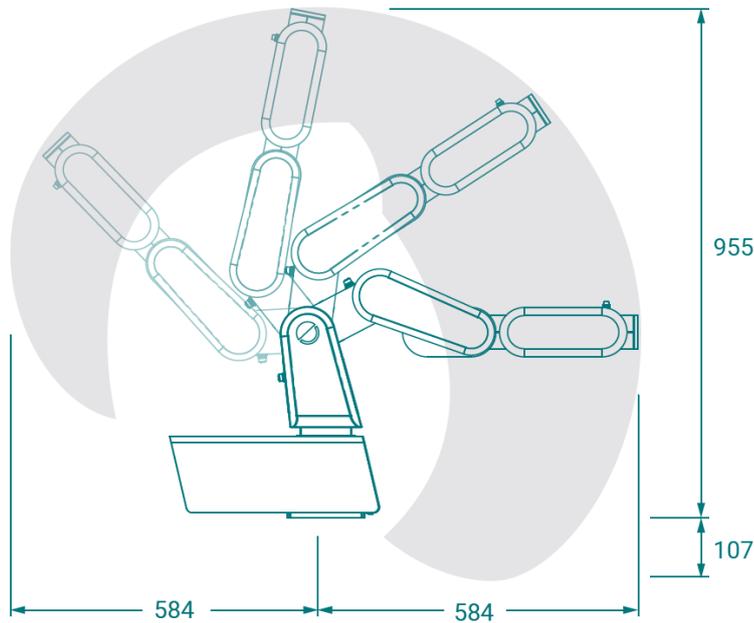


Fig. 5-1: Side view of working area

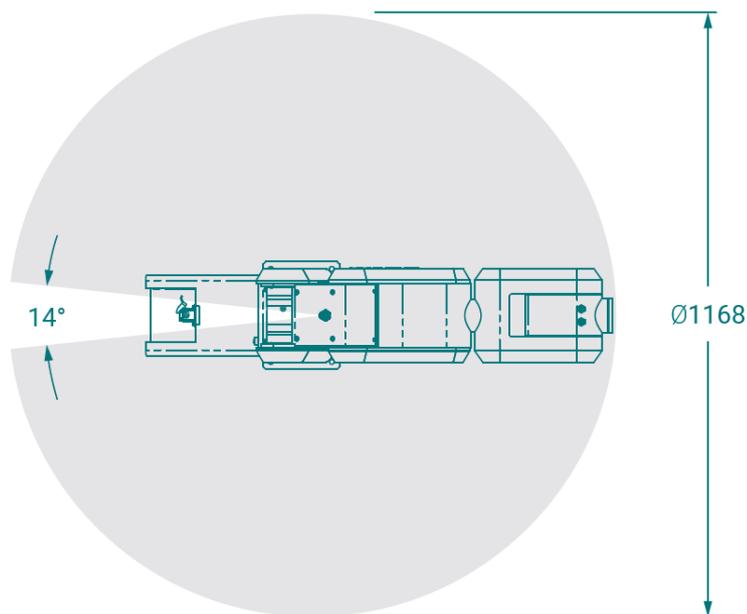


Fig. 5-2: Plan view of working area

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 GmbH.



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.

- ▶ Only lift the robot by the swivel 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 (e.g. separating protection device, light curtain, or safety laser scanner) 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 aluminum or possess comparable strength values.

The load-bearing capacity of the mounting surface must be at least five times the weight of the robot and nine times the maximum tilting moment of the robot with load capacity (320 Nm). The maximum load capacity is taken into account in these values.

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 GmbH. The robot must be assembled on a level surface with a maximum tilt of 5°. Wall or ceiling-mounting only on consultation with fruitcore robotics GmbH.



5.2.2 Assembling the Robot

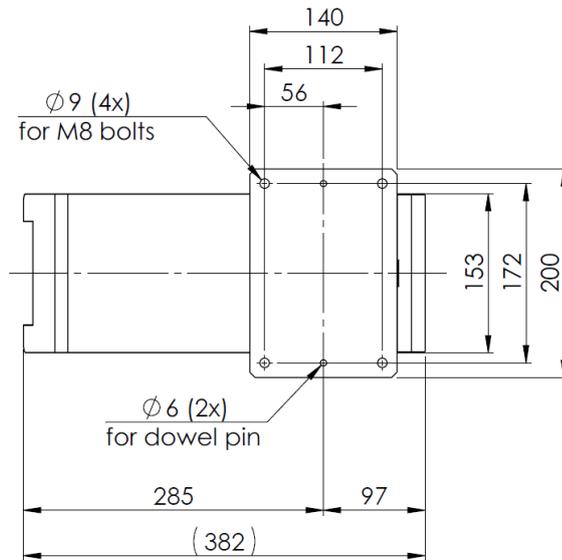


Fig. 5-3: Base plate – Mounting and positioning holes

- ▶ 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 prepared mounting surface.
- ▶ Secure the robot against tilting until it is attached to the mounting surface.
- ▶ Align the robot with pins via the positioning holes.
- ▶ Attach the robot with the 4 mounting screws supplied (DIN 7984, M8x20) with 20 Nm.

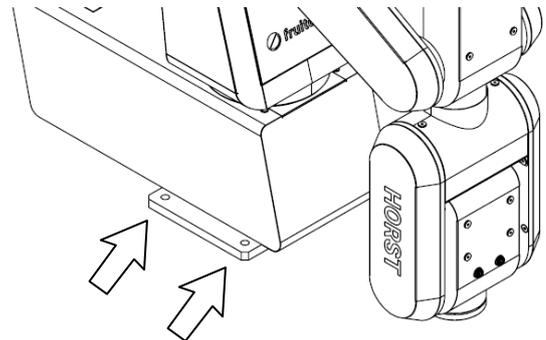


Fig. 5-4: Fastening the mounting screws

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**, see horstFX user manual, subsection *Axis restriction*)

- ▶ 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

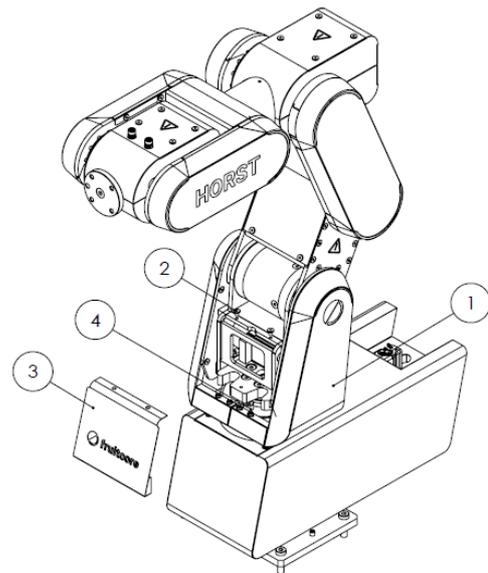


Fig. 5-5: Sketch of mechanical axis limitation for axis 1

5.3 Assembling Add-on Parts

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



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 $\varnothing 6$ hole can be used with a pin.

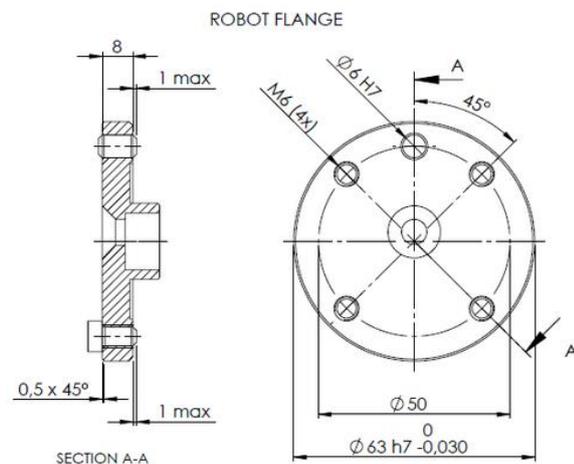


Fig. 5-6: Tool flange drawing



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



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



Add-on parts (e.g. pneumatic valves) can be fitted on the robot arm after consultation with fruitcore robotics GmbH.



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 can be found in the documentation from the manufacturer of the add-on parts.

- ▶ When all pneumatic components (gripper, cables, valves) are securely mounted, connect the compressed air supply.

5.4 Setting Up horstCONTROL

- ▶ Position the horstCONTROL 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 the horstCONTROL do not come into direct contact with liquids.
- ▶ The horstCONTROL 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 (horstCONTROL) as well as the connection of other devices and systems. There are several electrical interfaces:

- Robot connection: Connection of the robot to the horstCONTROL (switch cabinet)
- Power connection: Connection to the power supply
- horstCONTROL 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.
- ▶ Use only the included power cable to connect to the power grid. Do not use damaged cables.



ELECTRICAL VOLTAGE!

Possible personal injuries caused by applied electricity



- ▶ 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 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.



DANGER!

Danger due to incorrectly connected safety stop devices

- ▶ Only use the interface for safety stop I/O to connect external safety stop devices (e.g. safety laser scanners). 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 the 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 you are certain that 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 the horstCONTROL using the connection cable.

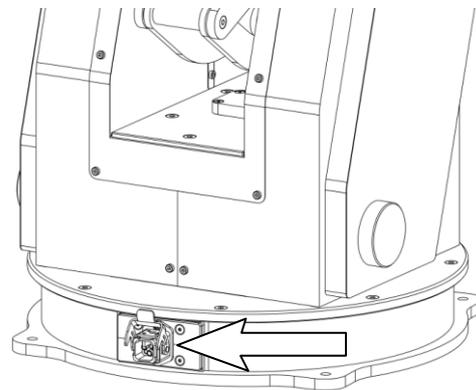


Fig. 6-1: Interface on the robot

- 1 Robot connection to horstCONTROL

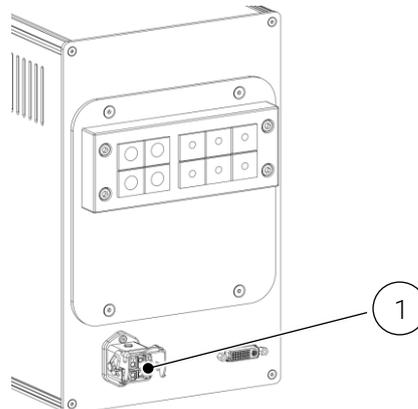


Fig. 6-2: Robot connection to horstCONTROL



ATTENTION!

The robot connection cable must be plugged into the horstCONTROL 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 horstCONTROL 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 use the power cable supplied.

The power supply must have:

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

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

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

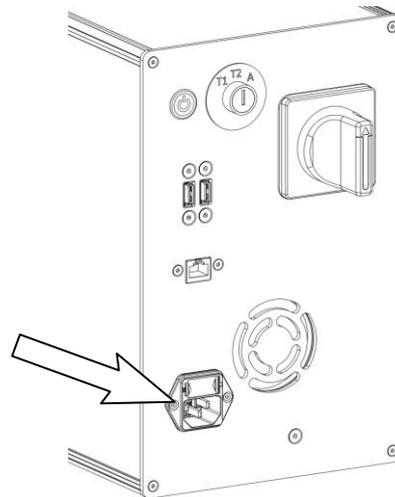


Fig. 6-3: Power connection to horstCONTROL

Parameter	min.	typ.	max.	Unit
Input voltage	90	-	260	VAC
Input frequency	47	-	63	Hz
Current consumption			4.4	A
Rated power draw ¹		210		W

Table 6-1: Mains connection characteristic values

1) Power draw measuring conditions: horstCONTROL PCA, Robot H600, all axes moved at the same time, speed 100%, load capacity 0 kg, measuring period 2 hours



ELECTRICAL VOLTAGE!

- ▶ Ensure that all cables are connected correctly before supplying the horstCONTROL 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 horstCONTROL I/O

This section describes how to connect devices to the horstCONTROL.

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 the horstCONTROL – which is accessible on the horstCONTROL after removal of the cable duct. You can find a table overview of the connectors and their terminal assignments in the Annex 13.7 from page 79.

- ▶ 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 (1) again.

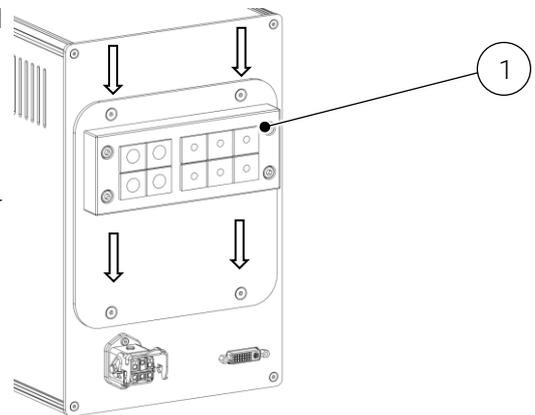


Fig. 6-4: horstCONTROL cable duct

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 horstI/O.

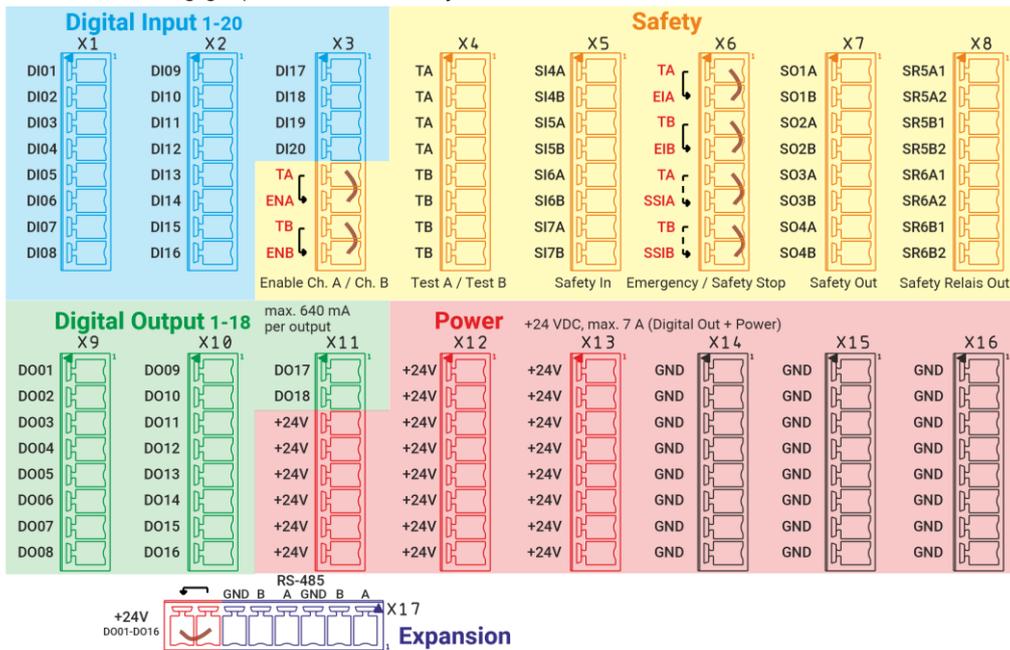


Fig. 6-5: horstI/O interfaces

- 7 safety-critical inputs – 2-channels each (orange area)
 - o 3 dedicated inputs (orange area with red font)
 - Emergency stop input – connection of potential-free contacts only
 - Safety stop input
 - Internal enabling switch
 - o 4 configurable outputs (external emergency stop, acknowledgement signals, etc.)
- 6 safety-critical outputs, 2-channels each (orange area, black font)
 - o 4 configurable outputs, push-pull
 - o 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)
 - o 20 digital inputs
 - o A further 8 digital inputs, if the 4 configurable, safety-critical inputs are configured as normal inputs
- Up to 30 general outputs (green area)
 - o 18 digital outputs, Push-Pull / High-Side
 - o A further 8 digital outputs, push-pull, if the 4 configurable, safety-critical outputs are configured as normal outputs
 - o 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 horstPANEL.

6.4.2 Safety-critical Inputs/Outputs

The horstCONTROL 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 (e.g. safety laser scanners). 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 horstPANEL	Manually at the horstPANEL
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 6-3: Functional difference between emergency stop and safety stop



DANGER!

Danger due to incorrectly connected emergency stop devices

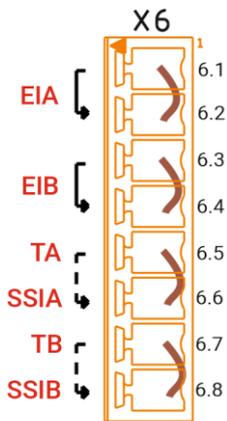
- ▶ Never connect safety signals to a PLC that does not meet at least the corresponding protection level. This could cause the safety functions to be overridden, which could result in serious injuries or death.
- ▶ Only use the safe inputs for emergency stop to connect additional emergency stop devices. 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



The inputs for emergency stop (EIA, EIB) and safety stop (SSIA, SSIB) are available, dedicated inputs on every horstCONTROL (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 43. 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 horstPANEL.

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 horstPANEL 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.

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

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 *Software Configuration Options for Digital Interfaces*, page 44.



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. 6-6. 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

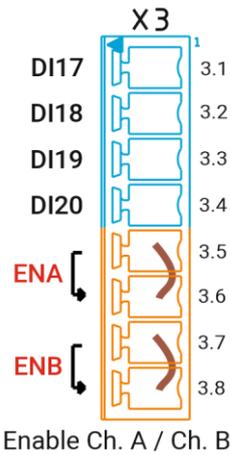


Fig. 6-7: Enabling switch connection

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 horstPANEL 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 horst-PANEL, which are fed from the test signals TA / TB (output signal switching device).

Instead of the internal enabling switch on the horstPANEL, 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 *Software Configuration Options for Digital Interfaces*, page 44.

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 *Software Configuration Options for Digital Interfaces*, page 44.

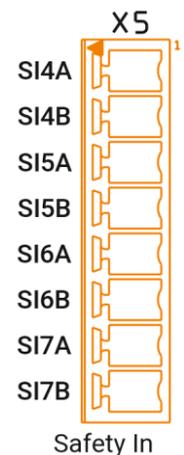


Fig. 6-8: Connection of safe inputs



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 *Software Configuration Options for Digital Interfaces*, page 44):

Function	Stop category	Description
None	-	
Emergency stop	1	Signals an internal emergency stop. Emergency stop output is set.
External emergency stop	1	External system signal emergency stop. Emergency stop output is not set.
Safety Stop	1	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 stop Self-triggering	2	Like the safety stop, but automatic reset and restart of the robot after recovery of the safe state.
Enabling switch	2	Safe stop, if enabling switch is pushed through or is not pressed.
Reduced speed	0	Checks the saved, reduced speeds. If the robot moves faster than the reduced speed, a Stop Category 0 is triggered.
Two digital inputs	-	Safe input is configured as two general digital inputs.

Table 6-4: 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 +24 V Power Supply, page 42). 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 as a general digital output.

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.

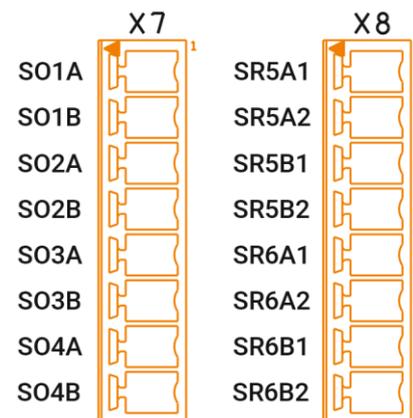


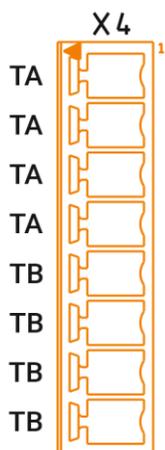
Fig. 6-9: Connection of safe outputs

The following functions can be configured for the safe outputs (see *Software Configuration Options for Digital Interfaces*, page 44):

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.
Standstill monitoring active	As release for external machines in the cell "HI": Robot travel release is issued. "LO": Standstill monitoring is active. There is a stop condition (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.
Safety stop	Output can be used to forward the guaranteed operator protection to other devices (within the same protection area).
Two digital outputs	Safe output is configured as two general digital outputs.

Table 6-5: Configurable functions for safe outputs

6.4.3 Test Signals A/B



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:

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

Table 6-6: Test signal characteristic values

Figure 6-10: Test signal connection

6.4.4 General Digital Inputs

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

If the *Configurable Safe Inputs*, page 37 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.

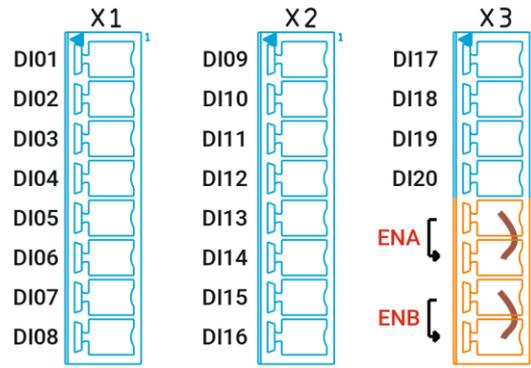


Fig. 6-11: Connection of general digital inputs

The following functions can be configured for the general digital inputs (see *Software Configuration Options for Digital Interfaces*, page 44):

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 6-7: 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 +24 V 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*, page 38 are configured as general outputs, up to 12 further outputs are available, of which 4 are potential-free.

Each output can drive at least 640 mA if the signal is high (+24 V), and 440 mA if the signal is low (0 V). The total current limit in section +24 V Power Supply, page 42 applies.

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.

The following functions can be configured for the general digital outputs (see *Software Configuration Options for Digital Interfaces*, page 44):

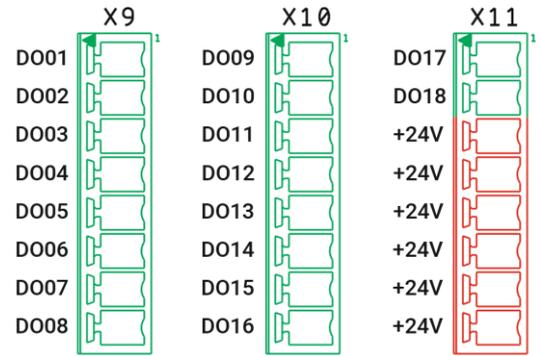


Fig. 6-12: Connecting general digital outputs

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. There is no stop condition.

Table 6-8: Configurable functions for general digital outputs

Safe Shut-down of the General Digital Outputs

Digital outputs DO01 to DO16 are supplied by the +24 V 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 *Safe Deactivation of the Digital Outputs*, page 47).

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

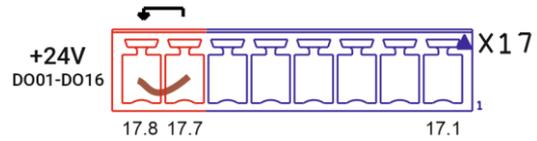


Fig. 6-13: Bridge for power supply DO01-16

6.4.6 +24 V Power Supply

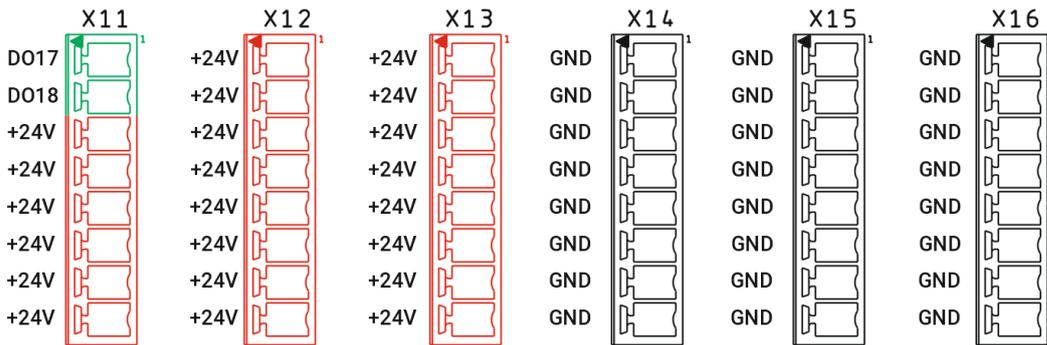


Fig. 6-14: +24 V power supply

For the power supply to external devices, 22 +24 V connections and 24 ground connections are available. All +24 V connections **and** the general digital outputs DO01-DO16 **together** can be loaded up to a maximum of **7 A**. 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 +24 V 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.

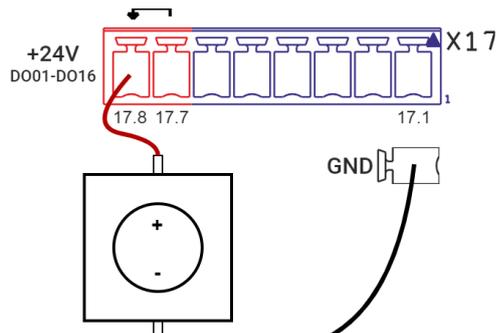


Fig. 6-15: Feed of an external power supply

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 the horstCONTROL. The permissible values for an external power supply are specified in the table below:

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

Table 6-9: Characteristic values of the +24 V power supply

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 (*Functional Wiring Diagrams* of the Electrical Interfaces, page 82).

Parameter	min.	typ.	max.	Unit	Description
<i>Inputs</i>					
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			k Ω	
ESD strength IEC 61131-2		+/- 15		kV Type	Human Body Model 1 & 3
<i>Outputs</i>					
Function				Type	PNP (High-Side) or Push-Pull, semi-conductor
Voltage	23.5	24	24.5	V	Output voltage
Current _{HLPP}	0	0.64	1.2	A	Per output, logically high, Push-Pull
Current _{LOW_PP}	0	0.44	0.81	A	Per output, logically low, Push-Pull
Current _{HLHS}	0	0.64	1.2	A	Per output, logically high, High-Side
Internal resistance HIGH		110	230	m Ω	
Internal resistance _{LO}		1	2.5	Ω	
Leakage current		100	180	μ A	
ESD strength		+/- 8		kV	Contact

Table 6-10: Characteristic values of digital I/O horstIO

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. More on this in the horstFX manual.

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.

6.4.8 Wiring Examples of Safety-critical Inputs/Outputs

This subsection provides examples of the wiring of digital interfaces on the horstCONTROL. 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.

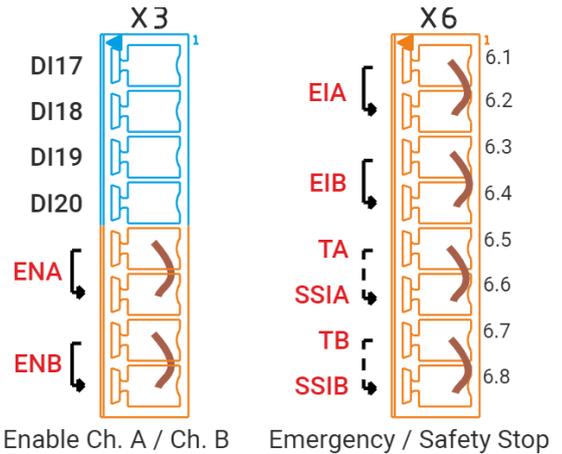


Fig. 6-16: Standard safety configuration

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 horstPANEL.

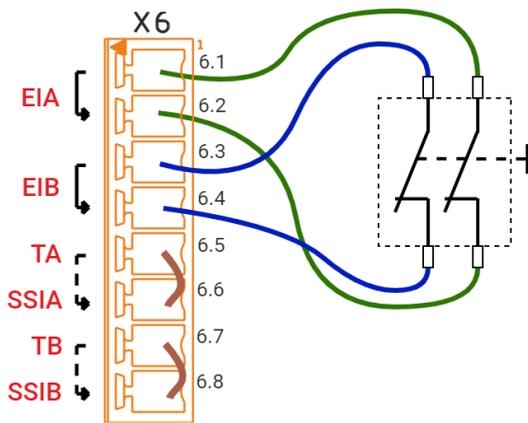


Fig. 6-17: Connection of external emergency stop button

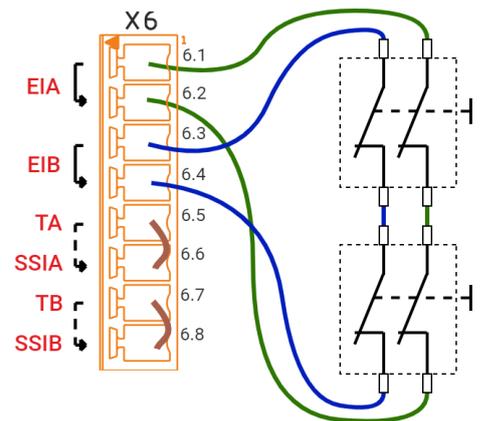


Fig. 6-18: Connection of several external emergency stop buttons

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.

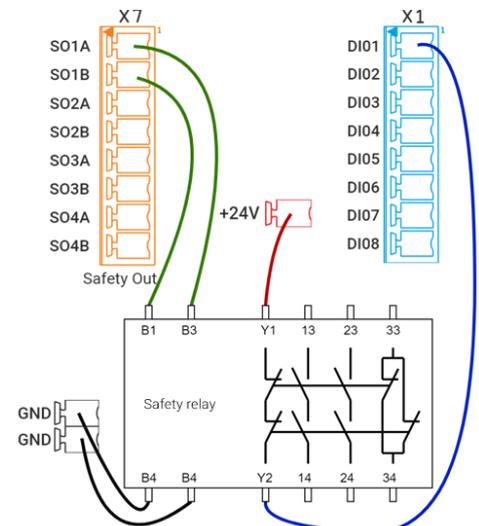


Fig. 6-19: Connection of a safety relay

6.4.8.4 Safety Stop

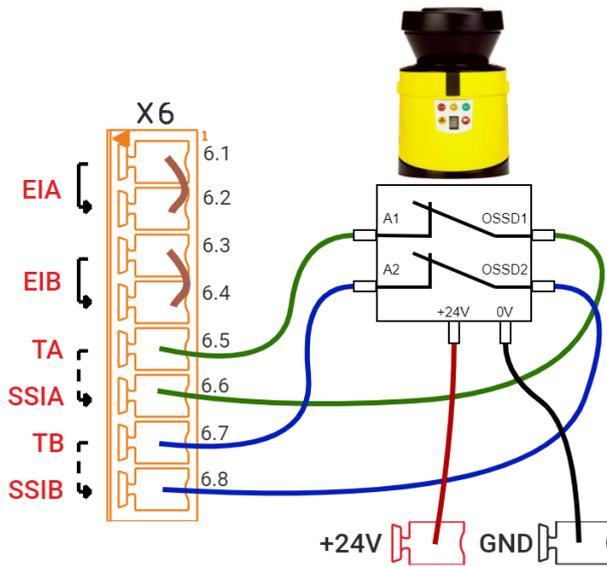


Fig. 6-20: Safety Stop Laser Scanner with Internal Test Signal

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.

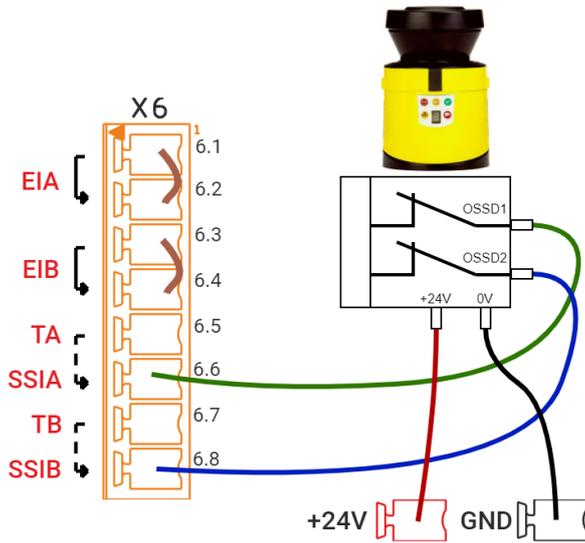


Fig. 6-21: Safety Stop Laser Scanner with External Test Signal

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 *Safety-critical Inputs/Outputs*, page 35).

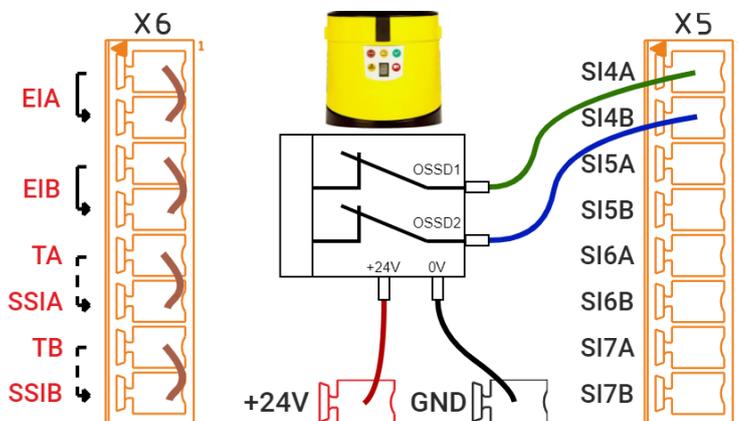


Fig. 6-22: Self-triggering safety stop

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.

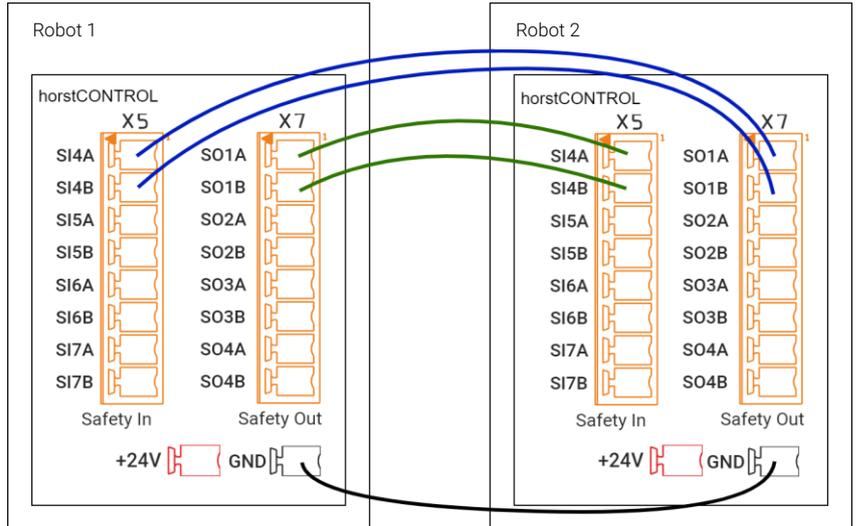


Fig. 6-23: Connecting emergency stop for several devices with each other

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.

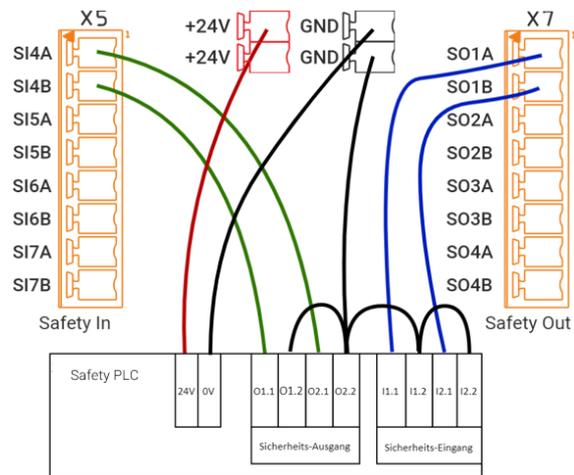


Fig. 6-24: Superordinate safety PLC

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. 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.

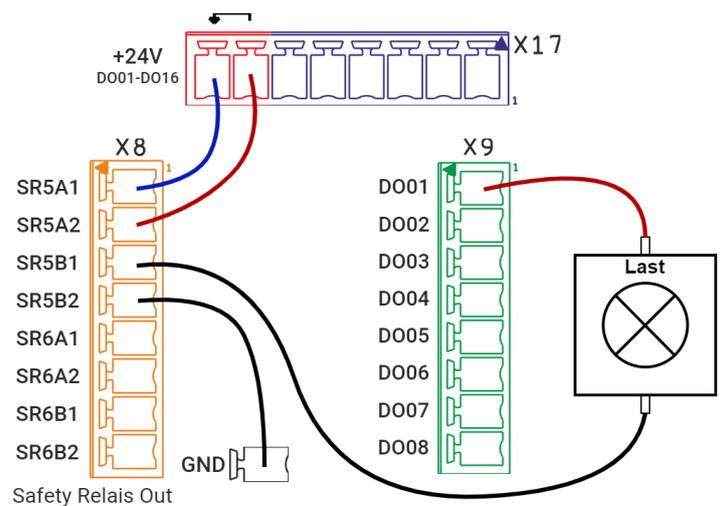


Fig. 6-25: Safe deactivation of the +24 V supply and the digital outputs

6.4.9 Wiring Examples of Digital Inputs/Outputs

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

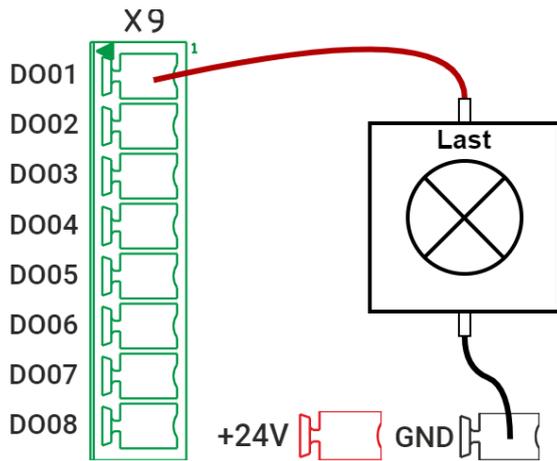


Fig. 6-26: Consumer at the digital output

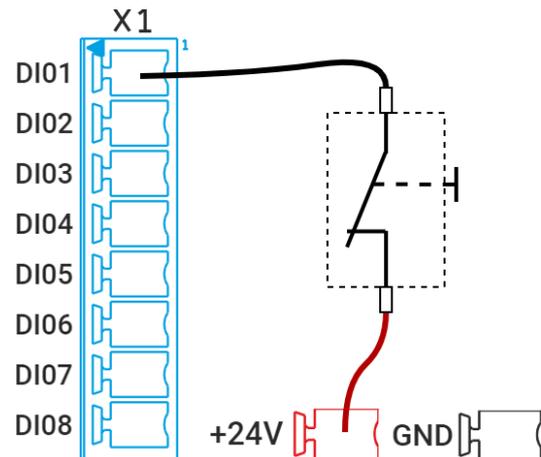


Fig. 6-27: Button at the digital input

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

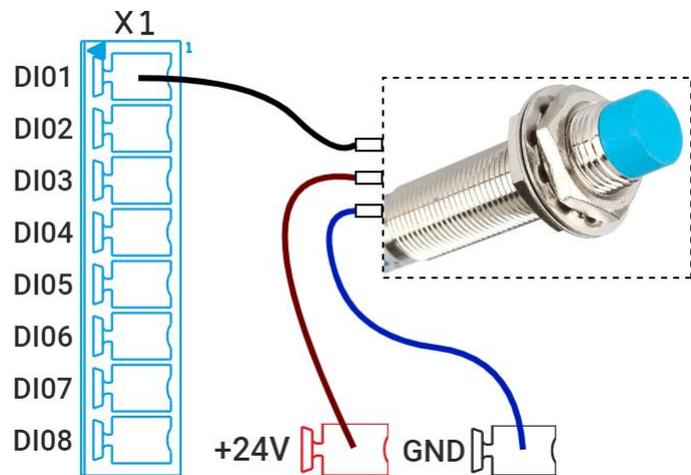


Fig. 6-28: Inductive sensor at digital input

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.

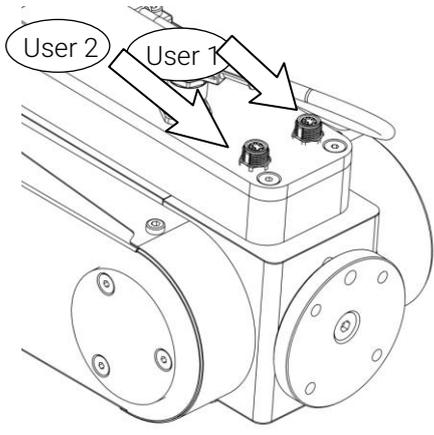


Fig. 6-29: Electrical connections for tools

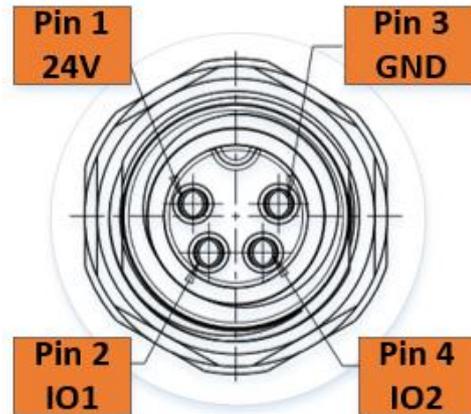


Fig. 6-30: Tool I/O slot assignment

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 IEC61131-2 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
<i>Inputs</i>					
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
<i>Outputs</i>					
Function				Type	Push-Pull, semiconductor
Voltage		24		V	Output voltage
Current _{HLPP}	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 the horstCONTROL there is an integrated computer whose accessible interfaces are described in this subsection.

6.6.1 PROFINET (optional)

The horstCONTROL 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 the horstCONTROL (see subsection *horstCONTROL (switch cabinet)*, page 23).

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 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 the horstCONTROL. 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 the horstCONTROL, and two USB 2.0 ports on the rear side of the horstPANEL. The USB ports on the horstPANEL are only provided for input devices only. For data carriers, use the ports on the horstCONTROL

7 Commissioning



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 GmbH.

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. There must be no obstacles or persons 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 (e.g. separating protection device, light curtain, or safety laser scanner) 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, horstCONTROL, 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 connecting cable is connected between the horstCONTROL 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 horstCONTROL to **ON**.
 - ⇒ The software (horstFX) starts up on the horstPANEL.
 - ⇒ The main menu appears on the display.

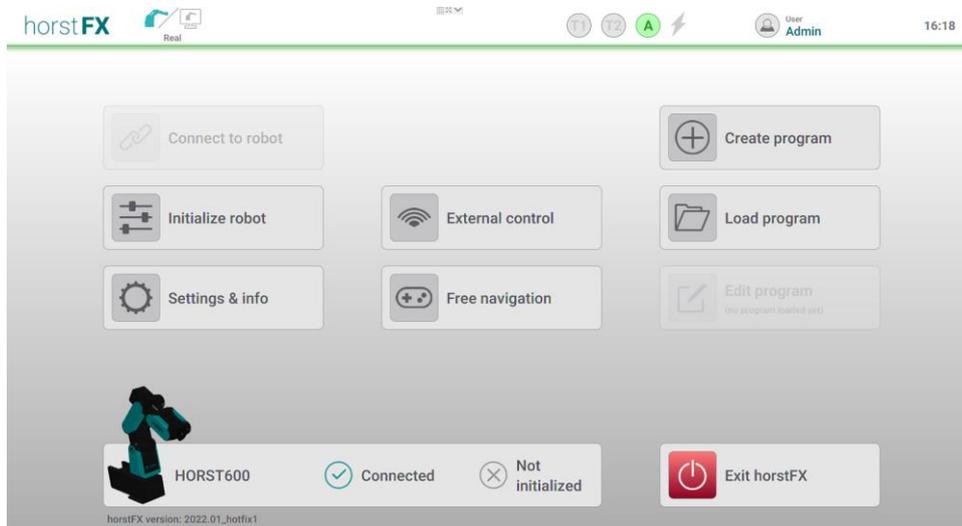


Fig. 7-1: Main menu

- ⇒ 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.

For information on the user roles, see the *User Roles* subsection of the *horstFX* software user manual.

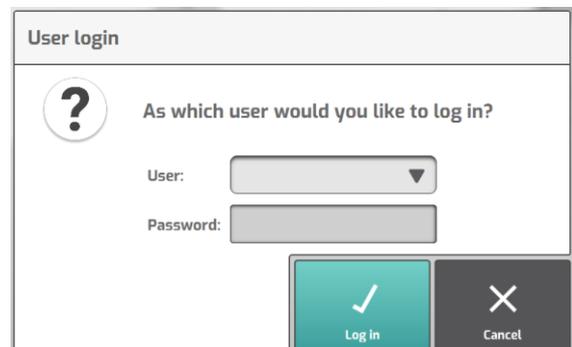


Fig. 7-2: Switching user roles

- ▶ In the main menu, select **connect to robot**.
- ▶ Wait until the display shows “connection with robot established successful.”

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.

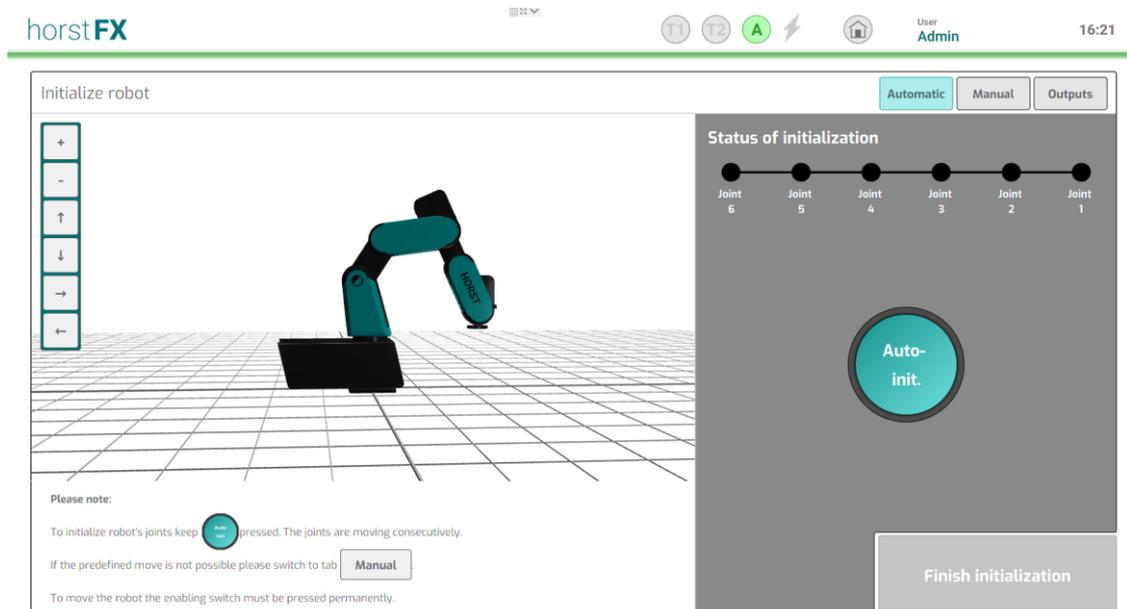


Fig. 7-3: *Automatic initialization menu*

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

- ▶ Press and hold the enabling switch in the center 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 are shown in 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 **Manuell** (manual) button. ⇒ The **manual initialization** menu appears.

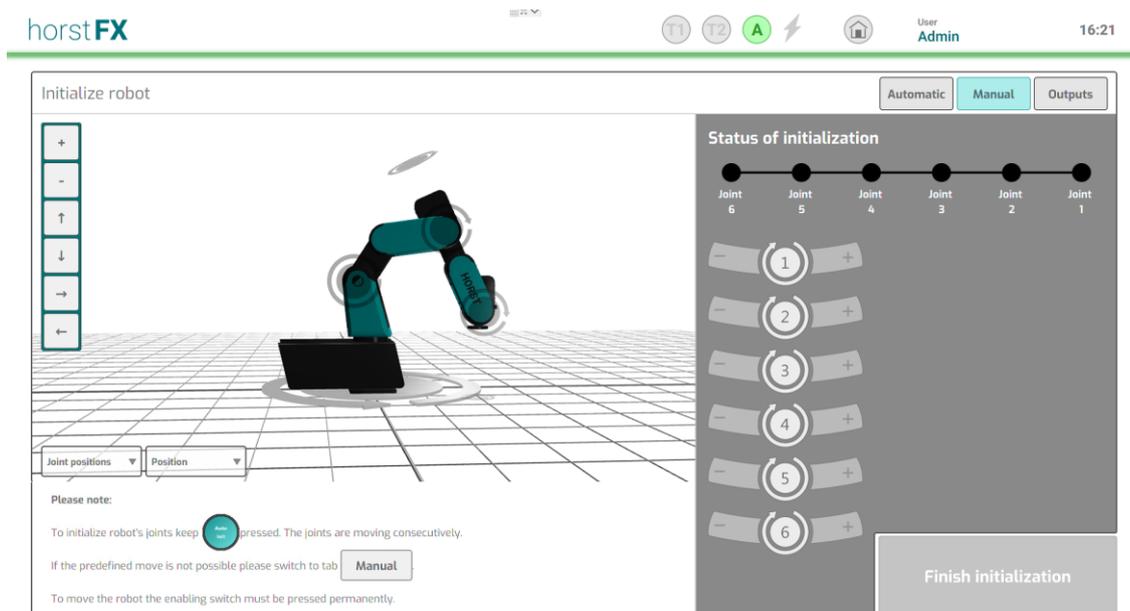


Fig. 7-4: *Manual initialization* menu

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 center position.
- ▶ Select the axes one after the other and move them slightly until successful initialization is displayed.
 - ⇒ If the initialization was successful, the dot (initialization status) for the respective axis is shown in turquoise.

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.

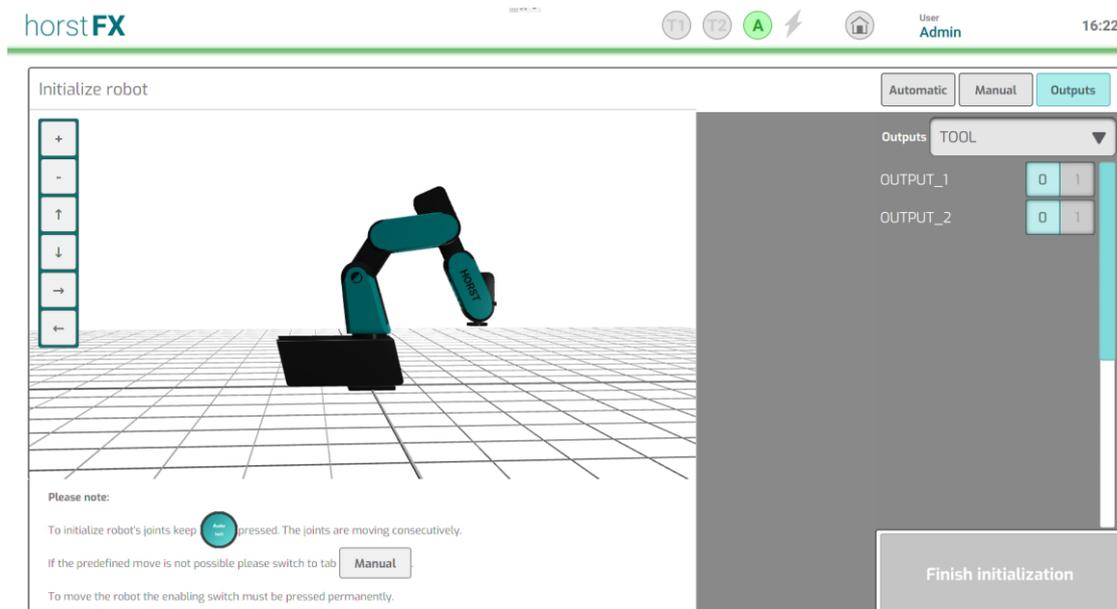


Fig. 7-5: Initialize robot – outputs menu

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.

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

- ⇒ The **complete initialization** button is activated.
- ▶ Press the complete initialization button. ⇒ The initialization of the robot is completed.
- ⇒ The main menu is shown again.
- ⇒ The robot is ready.

8 Operation



For information on how to operate the horstFX software, see the enclosed horstFX user manual or go to www.horstcosmos.com



WARNING!

Danger due to the failure of the emergency stop and safety stop functions

- ▶ Check the emergency stop and safety stop functions daily.

8.1 Behavior in an Emergency



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 horstPANEL and horstCONTROL against operation by unauthorized persons.



WARNING!

The robot arm may be moved by applying external force only in emergencies.

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 GmbH before recommissioning it.

- ▶ In an emergency, press the emergency stop button (1).
 - ⇒ All movements of the robot are braked until it comes to a standstill. The program is paused.

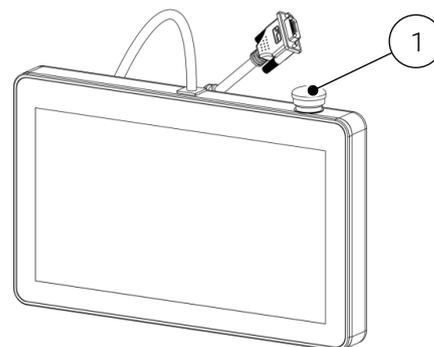


Fig. 8-1: horstPANEL

- ▶ Rectify the danger situation.
- ▶ A pop-up window with a warning message stating that an emergency stop was triggered appears on the display.

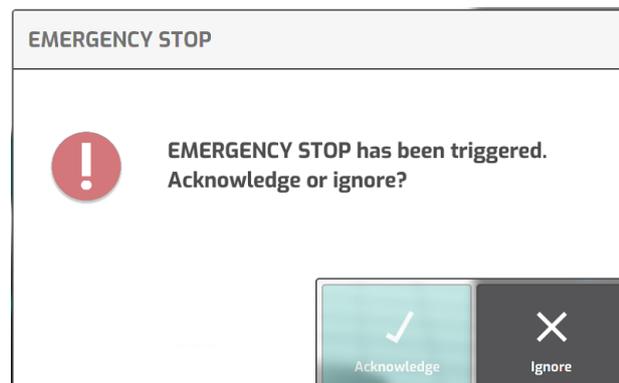


Fig. 8-2: Emergency stop warning message

Reset the emergency stop

- ▶ Check whether the danger has been rectified before resetting the emergency stop.
- ▶ Release the emergency stop button by pulling it out.
 - ⇒ The **confirm** button is activated.
- ▶ Confirm the warning message on the display.
 - ⇒ If the emergency stop was reset, the program only starts up again once it is continued manually.



Fig. 8-3: Emergency stop – confirmation

8.2 Operating Modes

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

The following operating modes are provided for:

- Teaching mode T1 (manual operation with reduced speed)
- Teaching mode T2 (manual operation at 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

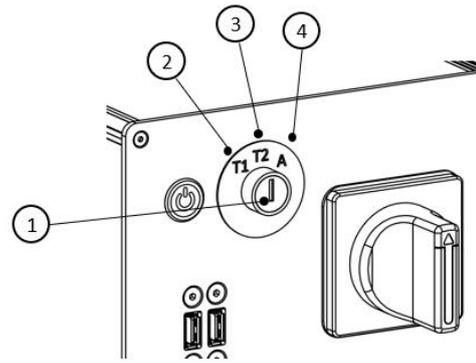


Fig. 8-4: Operating modes selector switch

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 horstPANEL and horstCONTROL 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.

- ▶ Switch on the robot system (see subsection 7.1, page 53).



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.

- ▶ If necessary, reinitialize the robot (see subsection 7.2, page 54).



If the power supply was interrupted previously, the robot must be reinitialized.



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 (tool center point) 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 and leave the motors to warm up in energized mode (e.g. “Free Movement”).

T2 – program verification mode

The speed of the TCP (tool center point) can exceed 250 mm/s. The robot can be moved only with the enabling switch.

- ▶ Switch the operating modes selector switch on the horstCONTROL to **T1** or **T2**. Pull out the key to prevent unauthorized persons from changing the operating mode.
 - ⇒ Confirm the change of operating mode.
 - ⇒ Create, edit, or execute a program (see user manual).

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 (e.g. separating protection device, light curtain, or safety laser scanner) are installed and are active.

Check the protection devices for proper function.

- ▶ Switch on the robot system (see subsection 7.1, page 53).



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 starting 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 horstPANEL.

- ▶ If necessary, reinitialize the robot (see subsection 7.2, page 54).



If the power supply was interrupted previously, the robot must be reinitialized.



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 the horstCONTROL to **automatic**. Pull out the key to prevent unauthorized persons from changing the operating mode.
- ▶ Confirm the change of operating mode; the enabling switch must be released to do this (see horstFX user manual).
- ▶ Create, edit, or execute a program (see horstFX user manual).

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.

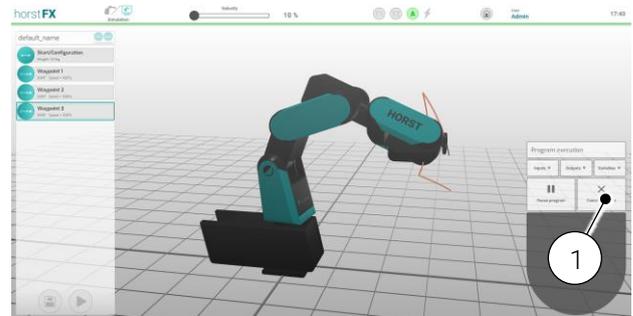


Fig. 8-5: Cancel program execution

- ▶ 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** menu (see *horstFX* user manual, section *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 the horstCONTROL 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).

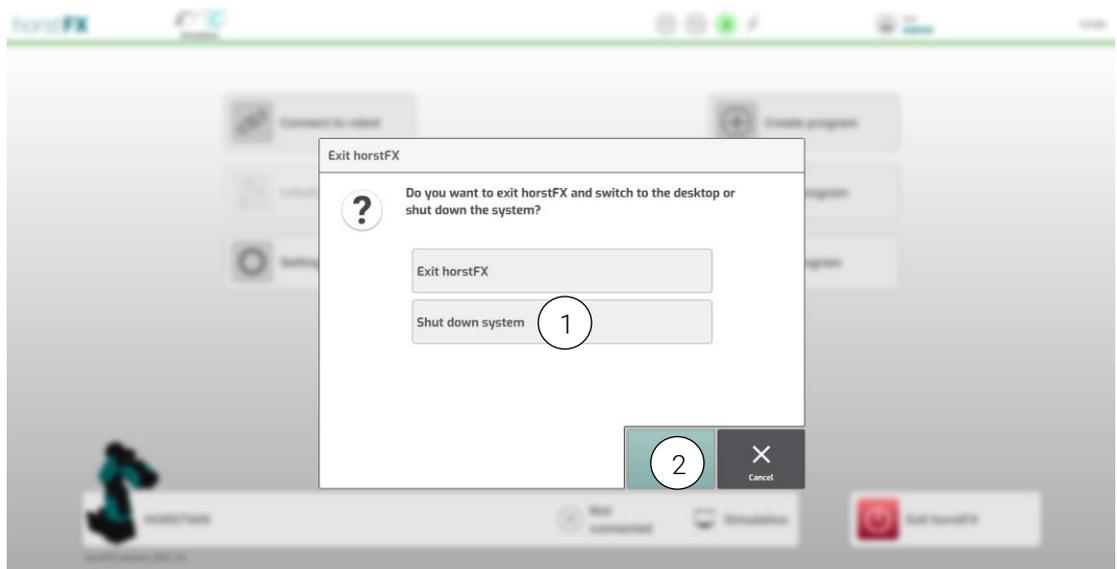


Fig. 8-6: Shutting down the computer for the software (horstFX)

- ▶ Alternatively, you can also shut down the computer for the software (horstFX) that is integrated in the horstCONTROL as follows:
- ▶ Press the PC ON/OFF button (see subsection *horstCONTROL (switch cabinet)*, page 23) on the horstCONTROL. 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).

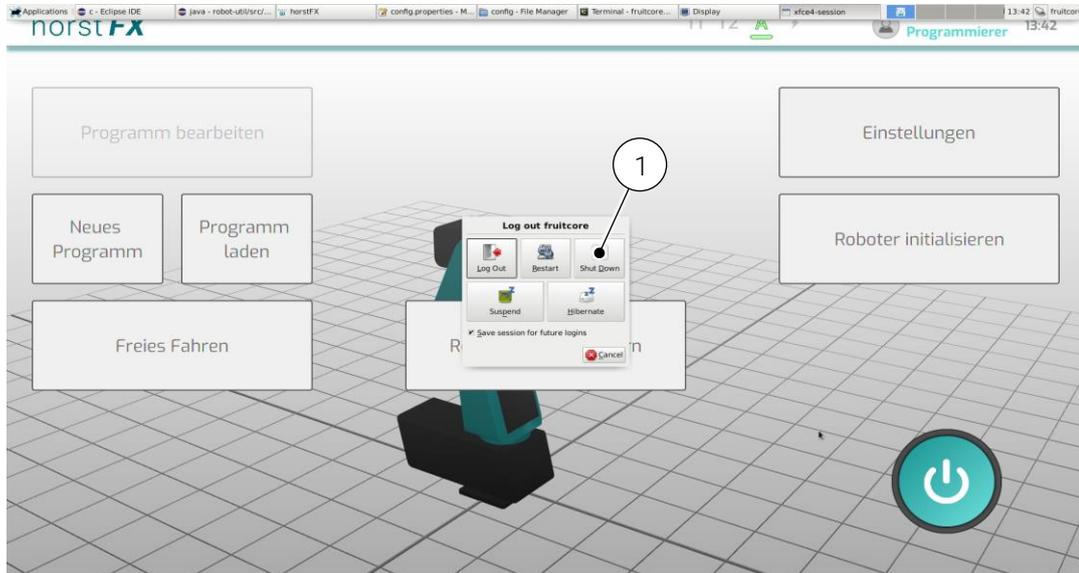


Fig. 8-7: Shutting down the computer for the software (horstFX)

- ▶ Switch the main switch on the horstCONTROL to **ON**.
- ▶ Secure the main switch with a lock.

9 Fault Rectification

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

- ▶ Follow the instructions on the horstPANEL to rectify the cause of the fault.
- ▶ Confirm the fault message on the display once all causes of the fault have been removed.
- ▶ Call the fruitcore robotics GmbH service if you cannot remove the causes of the fault yourself.



In the case of software problems, switch off the robot system as described in subsection 8.3, page 63 and switch it on again as described in subsection 7.1, page 53 .

If step losses occur due to overloading or blocking of the robot arm, the brakes are automatically activated. After 250 step losses or brake activations, the warranty of the brakes expires.



DANGER!

Danger due to faulty maintenance and brake failure

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

10 Cleaning and Maintenance



DANGER!

Danger of electric shock

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



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 GmbH.



WARNING!

Danger of impact and crushing due to unexpected robot movement

- ▶ Remove any workpieces from the gripper prior to cleaning or maintenance.
- ▶ Disconnect the robot system from the power grid and compressed-air supply prior to carrying out cleaning or maintenance work.
- ▶ Disconnect any installed tools that are operated with compressed air from the compressed air 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 horstPANEL and horstCONTROL against operation by unauthorized persons.



WARNING!

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

- ▶ Assemble all protection devices after completing the work. Check all modules and accessories.
- ▶ After completing the maintenance work, 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 GmbH before recommissioning it.



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

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 GmbH 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.

- ▶ Use a vacuum cleaner or compressed air to remove dust, chips, and other particles from the robot.
- ▶ Use a clean cloth to clean the horstCONTROL and horstPANEL.



ATTENTION!

Danger of machine damage

- ▶ Do not use compressed air to clean the horstCONTROL and horstPANEL.
- ▶ Do not use aggressive, flammable, or abrasive liquids/cleaning agents to clean the robot system.
- ▶ Avoid the ingress of liquids into parts of the system.



Environmental protection!

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

10.2 Maintenance and Repair

The operating personnel must check the robot system for external damage **every day**.

If there is a service contract with fruitcore robotics GmbH, care must be taken that the robot system data is continuously sent to horstCOSMOS, see the horstFX user manual.

The drive belts must be checked by the fruitcore robotics GmbH service **every year**.

Only fruitcore robotics GmbH may carry out repairs on the robot system.

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 Shutdown after End of Operation, page 63 and Disassembly, page 69).
- ▶ Securely package the robot, horstPANEL, and horstCONTROL.

12 Disassembly and Disposal

12.1 Disassembly

- ▶ Disassemble or secure any add-on parts.
- ▶ Move the robot to transport position (see subsection *Transport*, page 18).
- ▶ Shut the robot down (see subsection *Shutdown after End of Operation*, page 63).
- ▶ Disconnect and remove any electrical and pneumatic lines from the power supply.
- ▶ Disconnect the connection cable between the robot and the horstCONTROL.
- ▶ Disassemble the robot.
- ▶ Prepare the robot system for transport (see subsection *Transport*, page 18).

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*, page 63) and disassemble it.
- ▶ Dispose of all parts of the machine in such a way that any damage to health or the environment can be ruled out. Note the materials used.

Materials Used

The following materials were used predominantly to build the robot system:

Material	Unit
Copper	Cable
Steel, aluminum	Modules of the robot
Plastic, rubber, PVC	Drive belts
Electronic scrap	horstCONTROL, horstPANEL, <ul style="list-style-type: none"> • In the robot: Power electronics, mainboard, motor driver, fan, rotary pulse generator

Table 12-1: Materials used

13 Annex

The Annex includes:

- Technical Data
- Information on Stopping Distances and Stopping Times
- Information on Optional Accessories and Spare Parts
- Information on Type Plates
- Description of Connectors and Terminal Assignments
- Functional Wiring Diagram of the Electrical Interfaces

13.1 Technical Data

Robot	
Dimensions in as-delivered condition (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 R _n from the tool flange: 76.5 mm (eccentricity e: 38.3 mm; offset Z: 66.3 mm)
Permissible load capacity	Max. 3 kg (After consultation with fruitcore robotics GmbH) The permissible load capacity is reduced depending on the position of the center of gravity of the load.
Maximum range	584 mm (Note that the robot's range changes when tools, measuring devices, and workpieces are attached.)
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 data		H600 without <i>horstFX</i> performance	H600 fast with <i>horstFX</i> performance
Axis	Range of movement	Speed (independent of load)	Speed (load capacity of 0 kg)
1	+/- 173°	190°/s	370°/s
2	+115° / -64°	70°/s	140°/s
3	+41 / -176°	210°/s	420°/s
4	+/- 172°	610°/s	1220°/s
5	+/- 142°	470°/s	940°/s
6	+/- 300 °	640°/s	1280°/s
TCP Vmax		~ 1.4 m/s	~ 4.4 m/s
Axis		Acceleration (independent of load)	Acceleration (at a load capacity of 0 kg)
1		370°/s ²	740°/s ²
2		100°/s ²	200°/s ²
3		810°/s ²	1620°/s ²
4		4410°/s ²	8820°/s ²
5		3140°/s ²	6280°/s ²
6		2750°/s ²	5490°/s ²

horstPANEL	
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

horstCONTROL	
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 horstCONTROL: 3.0 m
Wiring of the horstPANEL	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)

horstCONTROL	
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 horstCONTROL	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	5 – 40 °C
Relative humidity	10 % – 75 % The horstCONTROL must not be used in dusty or humid environments that exceed protection classification 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 Stopping Distances and Stopping Times

The stopping distance is the distance covered by the TCP (Tool Center Point) after the stop signal is triggered and until a complete standstill is reached.



DANGER!

A speed update or load change can result in longer braking distances and 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.

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 stopping times have been determined for the three main axes Axis 1, Axis 2 and Axis 3.

The table shows the stopping distances and stopping times when triggered by an emergency stop signal at speed 100 % with *horstFX performance*. Without *horstFX performance* the stopping time is the same and the stopping distances are correspondingly shorter.

	Average stopping distance (°)		Average stopping time (s)	
	Load 0 kg	Load 3 kg	Load 0 kg	Load 3 kg
Axis 1	106.3	63.9	0.49	0.48
Axis 2	32.7	14	0.48	0.49
Axis 3	94.1	44.8	0.48	0.49

Table 13-1: Stopping distances and times with *horstFX performance*

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

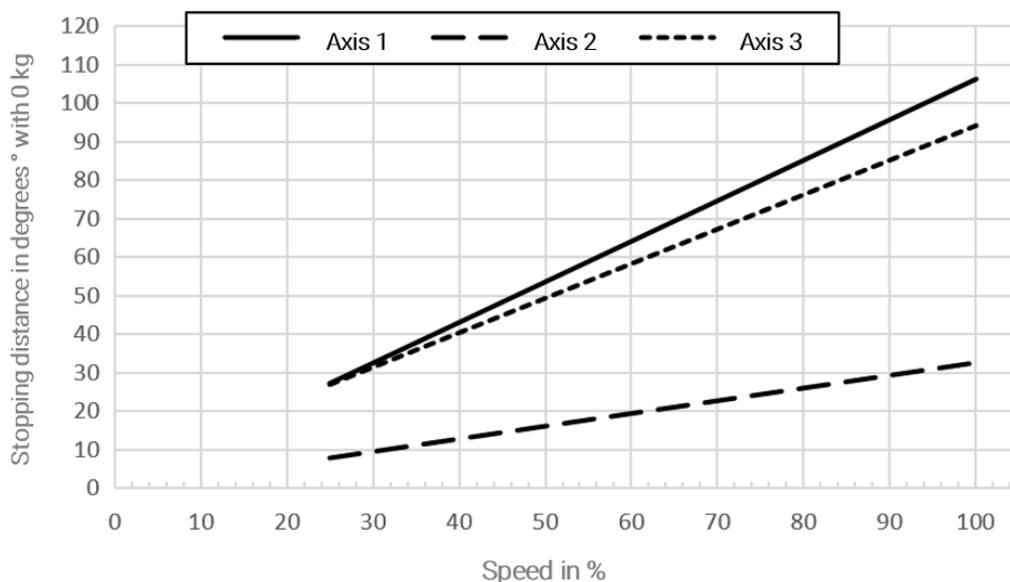


Fig. 13-1: Stopping distances of the main axes in degrees (°) with 0 kg

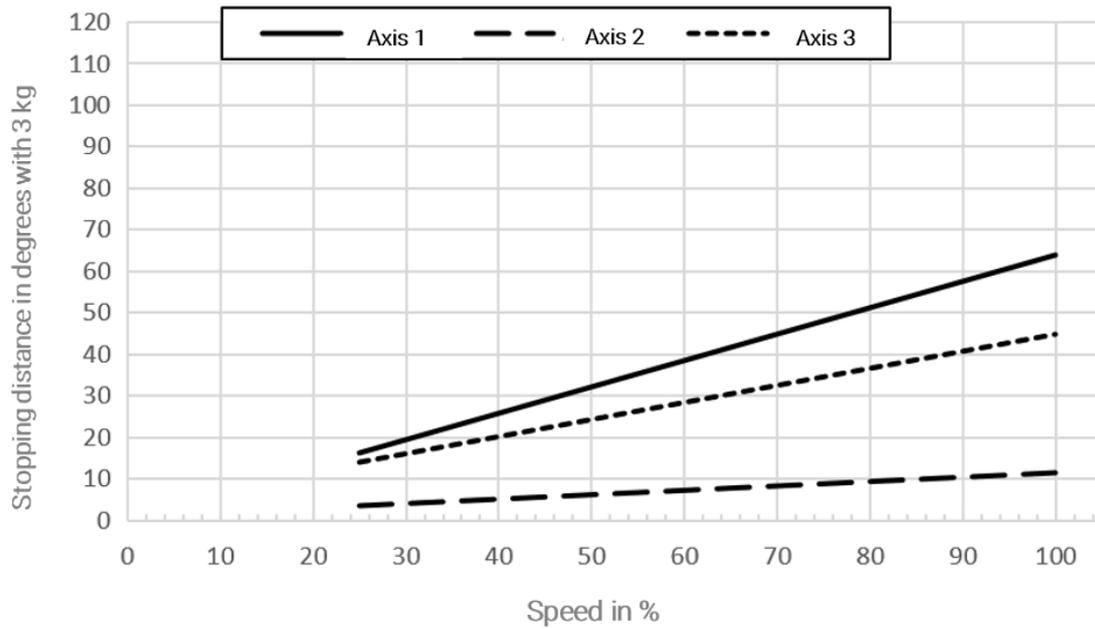


Fig. 13-2: Stopping distances of the main axes in degrees (°) with 3 kg



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.

13.3 Optional Accessories

The following accessories can be purchased from fruitcore robotics GmbH.

Order no.	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

Table 13-2: Optional accessories

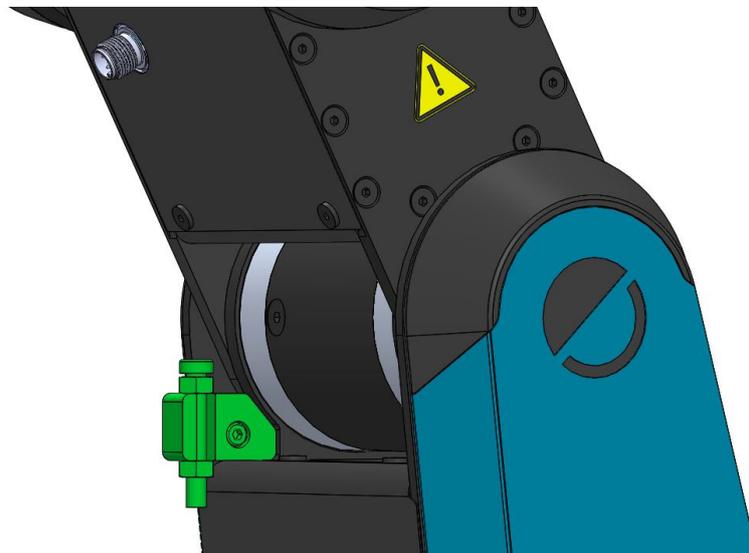


Fig. 13-3: Mechanical stop, axis 2

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

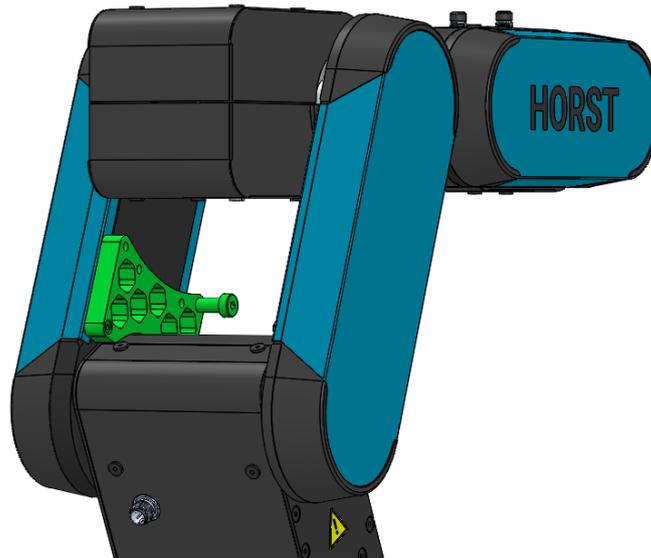


Fig. 13-4: Mechanical stop, axis 3

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
4. Position the stop screw in accordance with the configured stop

Attaching External Energy Chains

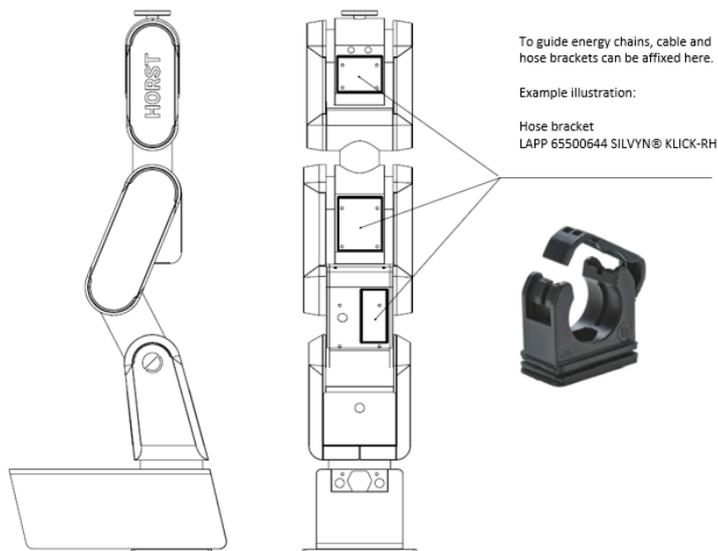


Fig. 13-5: Attaching external energy chains

13.4 Spare Parts

The following spare parts can be purchased from fruitcore robotics GmbH.

Order no.	Component	Comment
On request	Support arm 1	
On request	Support arm 2	
On request	Support arm 3	
On request	horstCONTROL	
On request	horstPANEL	
On request	Cable - horstCONTROL / Robot	
On request	Cardboard for packaging	

Table 13-3: Spare Parts

13.5 Type Plates

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

		fruitcore robotics GmbH Macairestrasse 3 78467 Konstanz	
Product/Model		HORST600	
Art. No.	PHB	Weight	29 kg
Serial No.	PHB000100	Nominal load	2 kg
Constr. year	2021	Range	584 mm
Made in Germany www.fruitcore-robotics.com			

Fig. 13-6: Robot type plate

The horstCONTROL type plate is located on its rear side.

		fruitcore robotics GmbH Macairestrasse 3 78467 Konstanz	
Product/Model		horstCONTROL	
Art. No.	PCA	Nominal voltage	230 V/50 Hz
Serial No.	PCA220001	Current (max.)	4,4 A
Constr. year	2021	Power (Typ.) H600/H900	250 W/350 W
Made in Germany www.fruitcore-robotics.com			

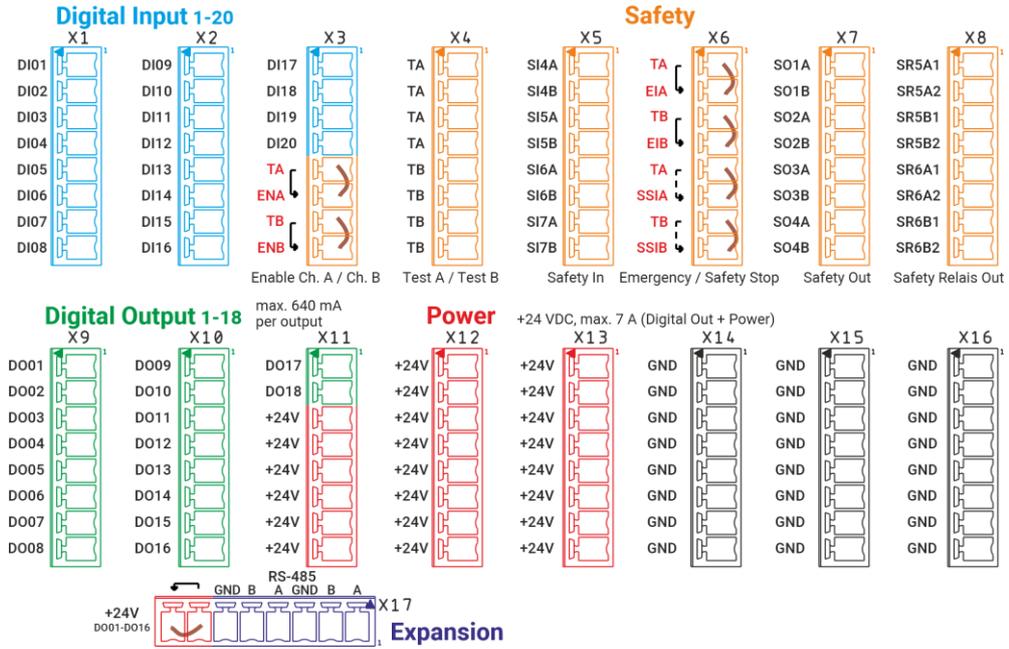
Fig. 13-7: horstCONTROL type plate

The horstPANEL type plate is located on its rear side.

		fruitcore robotics GmbH Macairestrasse 3 78467 Konstanz	
Product	horstPANEL	Art. No.	PPA
Serial No.	PPA000100	Construction year	2020
Made in Germany www.fruitcore-robotics.com			

Fig. 13-8: horstPANEL type plate

13.6 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 horstCONTROL connectors

13.7 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	S01A	A		Configurable, safe output 1, Channel A
X7.2	S01B	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

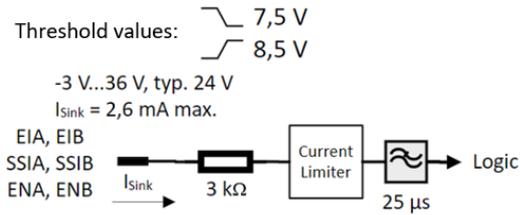
Table 13-5: Terminal assignment of digital I/O horstCONTROL

Legend:  Safe I/O  Unsafe I/O  I/O Configurable I/O 

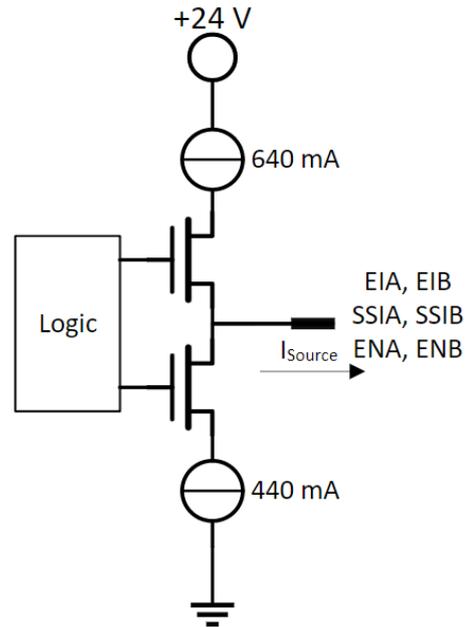
13.8 Functional Wiring Diagrams of the Electrical Interfaces

13.8.1 horstCONTROL I/O

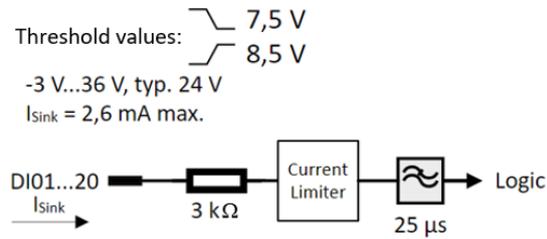
Safe input



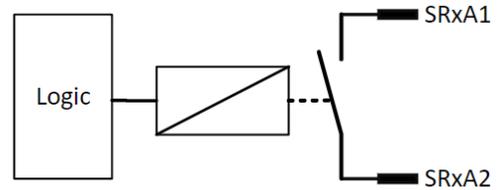
Safe Output



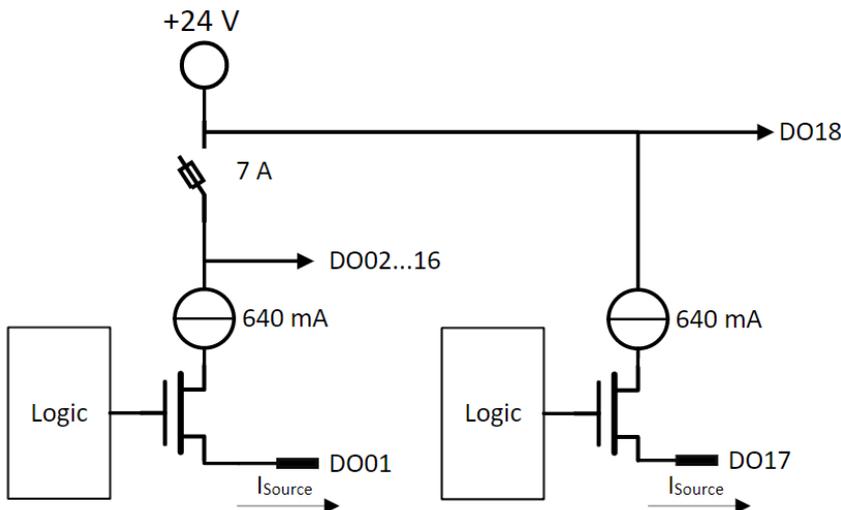
General digital input



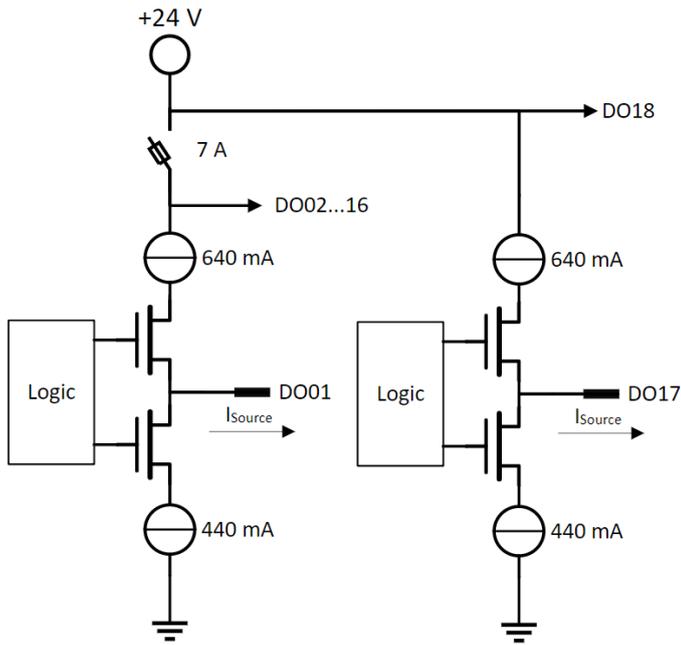
Potential-free output



General digital output (High-Side)

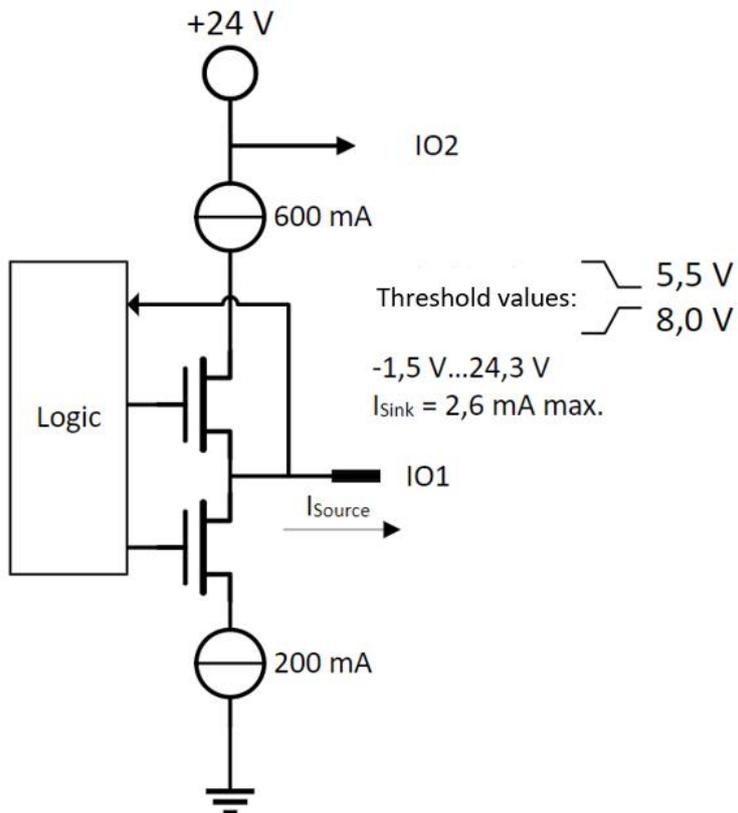


General digital output (Push-Pull)



13.8.2 Tool I/O

Digital input/output



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 its 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.