Assembly Instructions 1/2

Control / General Part



for the Robot System HORST



For installation, operating and maintenance personnel
Always keep with the product!

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fruitcore robotics GmbH
Macairestr. 3
78467 Constance

Phone: (+)49 (0)7531 / 945 99-20
E-Mail: info@fruitcore.de
Internet: www.fruitcore-robotics.com

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Contents

1 Introduction 5
1.1 Principle 5
1.2 Liability 5
1.3 Warranty 5
1.4 Standards, directives and conformity 5
1.5 Signs, Symbols & Warnings 6
2 Security 7
2.1 Intended use 7
2.2 Non-intended use 7
2.2.1 Foreseeable misuse 7
2.3 Operator obligations 7
2.3.1 Risk assessment by the operator 7
2.3.2 Operating personnel 8
2.4 Working area, danger zone and protected area 8
2.5 Security functions 9
2.6 Residual risks 9
3 Transportation 9
4 Description of the robot system 10
4.1 Scope of delivery 10
4.2 Assemblies 10
4.2.1 Robot arm 10
4.2.2 Control 10
4.2.3 Panel with safety device (enabling switch and emergency stop button) 11
5 Installation and electrical installation 13
5.1 Set up control 13
5.2 Electrical installation 13
5.3 Electrical warnings 13
5.4 Robot connection 14
5.5 Mains connection 14
5.6 Control I/O 15
5.6.1 Overview of all interfaces 16
5.6.2 Safety-related inputs/outputs 17
5.6.3 Test signals A/B 21
5.6.4 General digital inputs 21
5.6.5 General digital outputs 22
5.6.6 +24 V power supply 23
5.6.7 Common features of all digital interfaces 24
5.6.8 Wiring examples for safety-related inputs/outputs 25
5.6.9 Wiring examples for general digital inputs/outputs 28
5.7 Tool I/O 29
5.8 Computer interfaces 30
5.8.1 PROFINET (optional) 30
5.8.2 Ethernet 30
5.8.3 USB 30
6 Commissioning and recommissioning 31
6.1 Switching on the robot system 32

6.2 Initialize robot ... 32
7 Operation ... 34
7.1 Safety instructions for operation ... 34
7.2 Operating modes ... 34
7.2.1 External operating mode selector switch ... 34
7.2.2 Teach mode ... 35
7.2.3 Automatic mode ... 35
7.3 Shutdown after end of operation ... 36
8 Emergency and troubleshooting ... 37
8.1 Behaviour in an emergency ... 37
8.1.1 Emergency operation - moving the robot without drive power ... 37
8.1.2 Emergency operation - moving the robot by freewheeling ... 39
8.2 Troubleshooting ... 39
8.2.1 Remote access for servicing ... 40
8.2.2 Error examples ... 41
9 Cleaning and maintenance ... 42
9.1 Cleaning ... 42
9.2 Maintenance and repair ... 42
10 Storage ... 44
11 Dismantling and disposal ... 44
11.1 Dismantling ... 44
11.2 Waste disposal ... 44
12 Appendix ... 45
12.1 Technical Data ... 45
12.2 Plug overview ... 46
12.3 Terminal assignment ... 46
12.4 Functional diagrams of electrical interfaces ... 48
12.4.1 Control I/O ... 48
12.4.2 Tool I/O ... 49
12.5 Spare parts & accessories ... 49
12.6 WIFI-Stick ... 49
12.7 Information on the enclosed USB surf stick ... 49
13 Glossary ... 50

Abbreviations

DI/DO	Digital In/Digital Out
I/O	Input/output
EIA	Emergency In A
ENA	Enable input A
ESD	Electrostatic Discharge
HI / LO	High (logical 1) / Low (logical 0)
HORST	Highly Optimized Robotic Systems Technology
OSSD	Output Switching Signal Device
PL	Performance level
SI/SO	Safety In/Out
SIM	Subscriber Identity Module
PLC	Programmable logic controller
SR	Safety relay
SSI	Safety Stop In
T1/T2	Teach mode 1/2
TCP	Tool center point

1 Introduction

1.1 Principle

The documentation for the HORST robot system consists of the following documents:

1) Assembly instructions
   a) General part (this document),
   b) Robot-specific part,
2) Documentation of the horstOS application software (https://www.fruitcore-robotics.com/de/wissen)
3) Optional accessories

This part of the assembly instructions, together with the robot-specific part, forms the assembly instructions for the robot system HORST. This document contains the majority of information, such as information on intended use, electrical installation and commissioning. Both parts together contain all the important information required to operate the robot system safely, properly and economically.

▶ Read both parts of this manual carefully and completely before putting the robot system into operation. Handle them with care and keep them at the robot's place of use. An illegible or missing manual must be replaced immediately.

1.2 Liability

The operating responsibility lies with the operator of the products. They must ensure that the operating personnel can and do act in accordance with these instructions. The responsibilities for operating the products must be clearly defined and adhered to so that no unclear responsibilities arise in terms of safety.
Accidents that could have been prevented by observing these instructions or generally applicable accident prevention and safety regulations cannot be attributed to the manufacturer: The manufacturer is not liable for damage caused by improper use or by modifications or conversions.

1.3 Warranty

Unless otherwise agreed in the purchase contract, we grant the statutory warranty period for the robot system and spare parts, starting on the day of delivery. In addition, the warranty provisions contained in the General Terms and Conditions of fruitcore robotics GmbH or in the individual purchase contract shall apply.

1.4 Standards, directives and conformity

The HORST robot system is considered to be a partly completed machinery within the meaning of the EC Machinery Directive 2006/42/EC and is supplied 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 partly completed machinery may not be put into service until it has been incorporated into a machine or assembled with other parts to form a machine that complies with the provisions of the EC Machinery Directive and for which an EC Declaration of Conformity in accordance with Annex II A has been issued.
The robot system also complies with the provisions of the EMC Directive (2014/30/EU) and the RoHS Directive (2011/65/EU).
The following standards were applied during the development of the robot system:

- DIN EN ISO 10218-1:2012
  Industrial robots - Safety requirements - Part 1: Robots
- DIN EN ISO 12100:2010
  General principles for design - Risk assessment and risk reduction
- DIN EN ISO 13849-1:2015 and 13849-2:2012
  Safety-related parts of control systems - Part 1: General principles for design & Part 2: Validation

– DIN EN ISO 13850:2015
  Emergency stop design guidelines
– DIN EN ISO 14118:2017
  Avoidance of unexpected start-up
– DIN EN 60204-1/A1:2019
  Electrical equipment of machines - General requirements
– DIN EN 60529
  Degrees of protection by enclosure

1.5 Signs, Symbols & Warnings

Enumerations

Simple enumerations are marked with "-".

Instructions for action

▶ Instructions for action are marked with " ".▶

⇒ Intermediate results and final results of the action are marked with " "⇒

It is essential to observe these instructions and pass the safety instructions on to other users.



DANGER!
This warns of an imminent danger that could lead to serious injury or death.

▶ After naming the hazard, instructions for action are listed which serve to avoid or eliminate the hazard.



WARNING!
This warns of a potentially imminent danger that could lead to serious injury or death.

▶ After naming the hazard, instructions for action are listed which serve to avoid or eliminate the hazard.



CAUTION!
This warns of a potentially dangerous situation that could lead to personal injury.

▶ After naming the hazard, instructions for action are listed which serve to avoid or eliminate the hazard.



ELECTRICAL VOLTAGE!
There is a warning about electrical voltage.

▶ After naming the hazard, instructions for action are listed which serve to avoid or eliminate the hazard.



CAUTION!
Risk of robot damage or damage to property!

▶ After naming the hazard, instructions are given on how to avoid or eliminate the hazard. There is no risk of injury.



Wear protective clothing!
This symbol reminds you to wear protective clothing (safety shoes, safety goggles, ...)



Danger of environmental damage!
This symbol indicates instructions which, if ignored, pose a danger to the environment. There is no risk of injury.



This symbol indicates information that enables the robot system to be used more effectively and economically.

2 Security

WARNING!
Incorrect operation or handling of the system can lead to serious personal injury.

- ▶ Read this manual in its entirety and observe the instructions and safety notes contained therein as well as the health and safety regulations and safety provisions of the legislator, supervisory authorities and professional associations.

2.1 Intended use

The HORST robot system is used to implement industrial robot applications as well as robotics applications in the field of education. The robot system is able to carry out movements independently after being programmed by the operator. As a rule, tools such as grippers are attached to the robot arm, which can be controlled by the robot system.

2.2 Non-intended use

Any use that deviates from or goes beyond the intended use (2.1) is deemed to be unauthorized misuse.

In the event of foreseeable misuse or improper handling of the robot system, the manufacturer's declaration of incorporation and thus the operating license automatically expire.

2.2.1 Foreseeable misuse

The integrator of the partly completed machinery is responsible for determining the reasonably foreseeable misapplications in a risk assessment and taking suitable measures to reduce these to an acceptable level.

2.3 Operator obligations

2.3.1 Risk assessment by the operator

DANGER!
Attachments, workpieces or combining the robot system with other machines can increase hazards or create new hazards.

- ▶ To ensure safety, the HORST robot system must be installed in accordance with the guidelines of the DIN EN ISO 12100 and DIN EN ISO 10218-2 standards.
- ▶ After installing the robot system or integrating it into a system, carry out a risk assessment for the entire system.

Additional protective devices must be installed to prevent hazards. Particular attention must be paid to the risks listed below:

– Crush, impact and cut 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 due to sharp edges:
  - of the robot
  - of the tool
  - of workpieces

– Tipping or falling of the robot during operation
  - of transportation
  - the assembly
  - during operation (due to inadequate fastening)
– 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 hazards when assemblies come into contact with liquids.
– Risk of falling due to cables lying around
– Danger due to incorrect integration into the control system of an overall installation.
– Danger due to insufficient integration into the higher-level emergency stop circuit.

2.3.2 Operating personnel

All persons who are assigned to work on the robot system are obliged to read this manual before starting work and to follow the instructions and safety information.



DANGER!
Possible personal injury due to untrained operating personnel

▶ The operating personnel must be trained in the work and the dangers of the robot system. Persons who have not been trained for this are not permitted to operate the robot system.



DANGER!
Possible personal injury due to operation by persons undergoing training

▶ Persons who are to be trained, are being trained or are undergoing training may only operate the robot system if supervision by a trained person with technical or electrotechnical training (teaching staff) is ensured.

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

– Operating the robot system in automatic mode
– Setting the system parameters (teach mode T1 and T2)

Instructed personnel with technical and electrotechnical training in addition to the:

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

2.4 Working area, danger zone and protected area

The **working area** is a defined 3D space within the reach of the robot, for specific dimensions see manual of the robot (Part 2). Attached tools, measuring devices and workpieces change the reach and therefore the working range of the robot. The **danger zone** includes the working area and the stopping distance of the robot. No persons may be within the danger zone while the robot is in operation. The **stopping distance** results from the reaction distance and braking distance of the robot.
The **protected area** is located outside the danger zone. People are allowed to stay in this area during all operating modes.



DANGER!
The automatic movement of the robot within the danger zone can cause sudden hazards.

▶ The robot may only be used within active, suitable protective devices. These must stop the robot movements within the danger zone.

2.5 Security functions

The robot controller has several types of safety functions that transfer the robot to a safe state. The safe state is achieved by braking all drive axes to a standstill. The two basic safety functions, emergency stop and safety stop, are described below:

Emergency stop

Bringing the robot to a safe state if an emergency occurs. This safety function is available in all operating modes. It has priority over all safety functions. It is triggered by the emergency stop button or by external safety controls. External emergency stop devices are connected to the emergency stop inputs of the control cabinet, hereinafter referred to as Control.
This safety function may only be used in emergency situations. The emergency stop must not be used for process-related stops.

Safety stop

Bringing the robot to a safe state for process-related safety-relevant situations. This safety function is to be used for process-related stops during which the operating personnel must be able to enter the danger zone.
The purpose of both types of safety functions is to bring about the safe state of the robot.
The safe state is characterized by the following properties:
Emergency stop: A category 1 stop is triggered. The robot is actively decelerated to a standstill, the brakes are applied and then the power to the drives is switched off.
Safety stop: A category 2 stop is triggered. The robot is actively braked to a standstill. The drive energy is not switched off. The safe standstill is monitored.

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

2.6 Residual risks

DANGER!
Danger due to human error or malfunctions

- When integrated into an overall system, the robot system must be integrated into the emergency stop circuit of the higher-level system.

ELECTRICAL VOLTAGE!
Possible personal injury due to electrical voltage

- Disconnect the robot from the power supply before carrying out any work on the electrical equipment.
- The electrical equipment of the robot system must be checked regularly. Defects such as loose connections or damaged cables must be rectified immediately.

3 Transportation

ATTENTION!
The robot system must be in its original packaging for transportation.

- The robot arm and in particular the Control system may only be transported in an upright position. Pallets are best suited for transportation.
- Follow the instructions in the second, robot-specific part of this manual when transporting the robot arm.

4 Description of the robot system

4.1 Scope of delivery

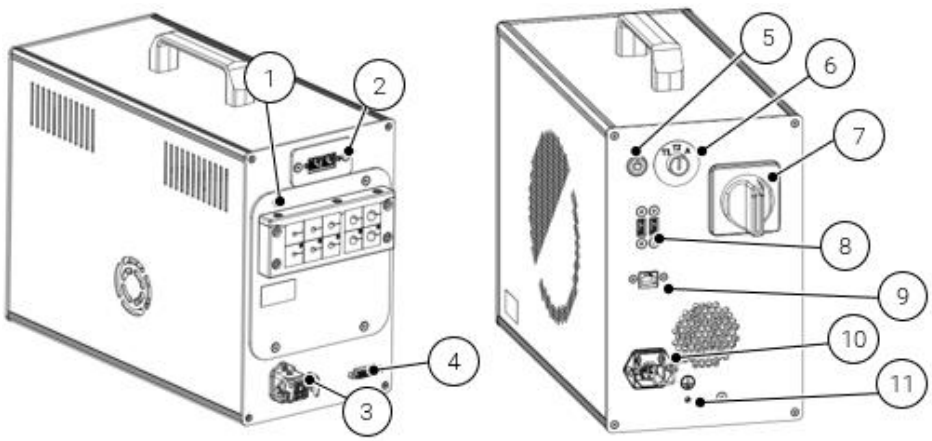
– Robot arm
– Control (switch cabinet) incl. tensioning strap for fixing
– Panel (portable control panel) incl. holder
– Connection cable (robot - control) 3 m
– Mains cable (1.8 m)
– DVI cable (5 m)
– Assembly set (4x DIN 912 M8x20 bolt, DIN 985 nut, DIN 125 washer)
– WIFI-Stick

4.2 Assemblies

4.2.1 Robot arm

See part 2 of the installation instructions.

4.2.2 Control



Control is the robot's control system. The main controller (horstIO) is installed in this control cabinet. Numerous interfaces also enable communication and control of other machines and external sensors and actuators.

Fig. 1: Control (front left, back right)

1 - Cable bushing for inputs / outputs
2 - Profinet connection (modular plug RJ45)
3 - Robot connection
4 - Panel connection
5 - PC ON/OFF button
6 - Operating mode selector switch
7 - Main switch
8 - Connection 2x USB 3.1 interface
9 - Ethernet connection (RJ45)
10 - Mains connection
11 - Externally accessible earthing connection

Technical Data Control	
Dimensions (LxWxH)	313 x 174 x 446 mm
Weight	9 kg
Protection class	IP20

4.2.3 Panel with safety device (enabling switch and emergency stop button)

4.2.3.1 Panel V1

1 - Connection to the Control
2 - Emergency stop button

The panel is a portable operating panel equipped with a touchscreen. It is connected to Control via a DVI cable. The DVI cable is supplied with a length of 5 m as standard.

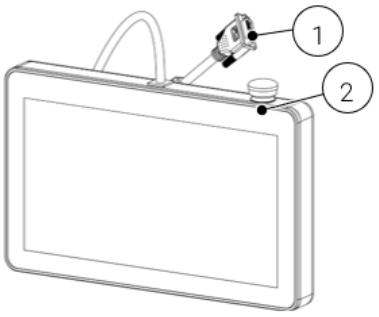


Fig. 2: Panel

When integrated into a complete system, the robot system must be integrated into the emergency stop circuit of the higher-level system. Follow the instructions in the section 5.6.2.

3 - 2x USB 2.0 ports
4 - Enabling switch

The enabling switch and two USB 2.0 interfaces are located on the back, which can be used to connect additional input devices (keyboard, mouse). The panel's USB interfaces are only intended for connecting input devices; please use the Control USB interface for storage media.

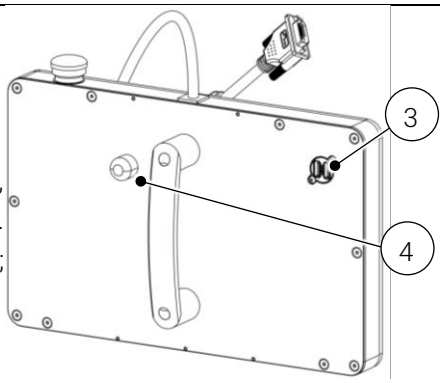


Fig. 3: Panel (rear)

To move the robot in teach mode, the enabling switch must always be held in the centre position. When pressed or released, the robot stops.

WARNING!

- Never connect a normal monitor to the DVI cable! As the cable assignment does not comply with the standard, this can damage the end device or Control!
- Never plug or unplug the panel during operation! To do this, switch off the Control.
- The USB interfaces on the panel are only intended for input devices. Use the Control interfaces for storage media.

The bracket (1) of the panel is used for table installation (2).

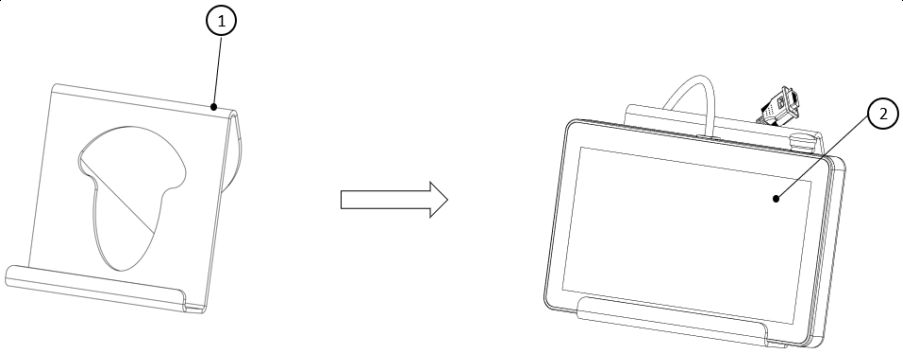


Fig. 4: Panel V1 bracket

Use the panel holder, e.g. in teaching mode, to avoid holding the panel by hand for long periods.

4.2.3.2 Panel V2 (available from September 2024)

1 - Emergency stop button
2 - 2x USB 2.0 connection

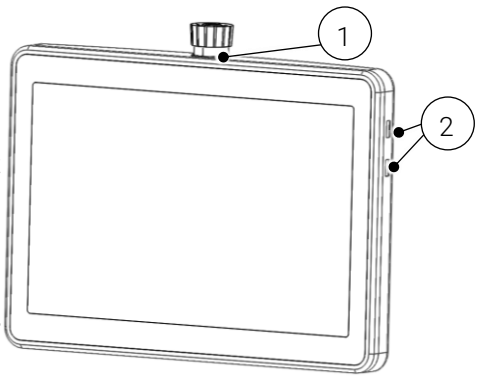


Fig. 5: Panel (V2)

The panel is a portable operating panel equipped with a touchscreen. It is connected to Control via a DVI cable. The DVI cable is supplied with a length of 5 m as standard.
There are two USB 2.0 ports on the side for connecting a mouse and keyboard, for example, but not for storage media - please use the USB ports on the Control for this.

When integrated into a complete system, the robot system must be integrated into the emergency stop circuit of the higher-level system. Follow the instructions in the section 5.6.2.

4 - Rotating handle (lockable)
5 - Enabling switch
6 - Connection to the Control

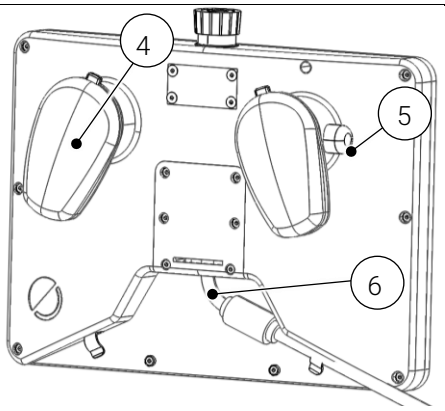


Fig. 6: Panel (V2) rear side

There are two rotating and lockable handles on the back, which can be adjusted by pressing the small button on the top.
The enabling switches are also located on the handles, making the panel suitable for both left-handed and right-handed users.

To move the robot in teach mode, the enabling switch must always be held in the centre position. When pressed or released, the robot stops.

WARNING!

- Never connect a normal monitor to the DVI cable! As the cable assignment does not comply with the standard, this can damage the end device or Control!
- Never plug or unplug the panel during operation! To do this, switch off the Control.
- The USB interfaces on the panel are only intended for input devices. Use the Control interfaces for storage media.

The handles on the back of the panel place it at a comfortable angle on the table, eliminating the need for a table stand.
For mounting on a robot cell, the adjacent bracket is part of the scope of delivery.

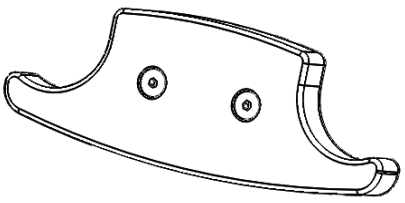


Fig. 7: Panel bracket (V2)

5 Installation and electrical installation

The robot system may only be operated in dry, level indoor areas with a solid surface.

5.1 Set up control

▶ Place Control in such a way that:

– the connection cable can be laid up to the robot,
– it is protected against damage and falling,
– there is a free space of 100 mm on all sides (ventilation slots must be free),
– access to the switches and connections is only guaranteed from outside the protected area.



ELECTRICAL VOLTAGE!
Possible personal injury due to electrical voltage



▶ Ensure that the cables and Control do not come into contact with liquids.
▶ Control must not be used in dusty or damp environments that exceed protection class IP20. Conductive dust must be avoided in particular.



The length of the supplied cables can be found in the technical data.

5.2 Electrical installation

This chapter describes the electrical installation of the robot system, i.e. the connection of the robot to the control cabinet (Control) and the connection of other devices and systems.
There are several electrical interfaces:

– Robot connection: Connection of the robot to Control
– Mains connection: Connection to the mains
– Control I/O: Connection of external devices and systems to Control
– Tool I/O: Connection of tools to the robot arm
– Computer interfaces

The safety instructions and warnings in the following chapter apply to all electrical interfaces.

5.3 Electrical warnings



ELECTRICAL VOLTAGE!
Possible personal injury due to electrical voltage



▶ Work on the electrical equipment may only be carried out by appropriately trained specialist personnel in accordance with electrotechnical regulations.
▶ Only use the mains cable supplied to connect to the mains supply. Damaged cables must not be used.
▶ Ensure that the power supply is disconnected during work on the robot and that it cannot be switched on unintentionally.



DANGER!
Danger due to incorrectly connected emergency stop AND safety stop devices

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

WARNING!
Improper earthing can lead to EMC problems.

- When earthing the robot system, ensure that appropriate protective and functional measures are taken in accordance with DIN VDE 0100 and EMC Directive 2014/30/EU.
- Ensure that the robot system is properly earthed. This means that there must be a common electrical connection to earth for all elements belonging to the system.

WARNING!
Risk of tripping

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

WARNING!
Unexpected robot movements

- Do not connect the power supply until you are sure that the installation is complete and correct.

ATTENTION!

- Only use the original cables supplied with the robot system. Do not use the robot for applications where the cables are exposed to bending.

DANGER!
Danger due to incorrectly connected emergency stop AND safety stop devices

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

5.4 Robot connection

- Connect the robot to Control using the connection cable.

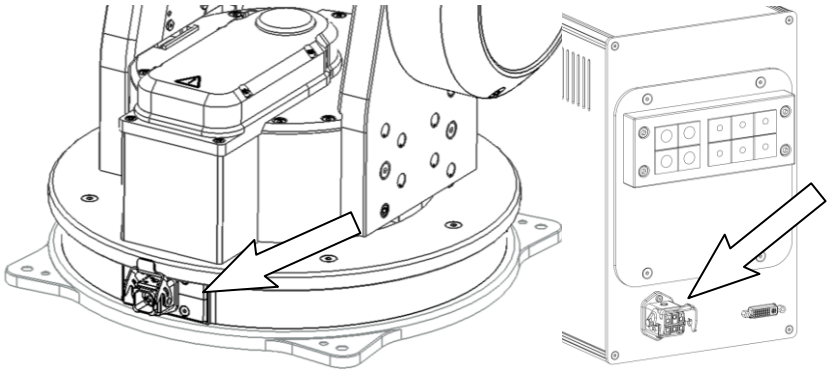


Fig. 8: Robot (example H1500) and control connections

ATTENTION!

- The robot connection cable must be plugged into Control before the power supply is switched on. It may only be plugged in or removed in a de-energized state
- The robot connection must never be disconnected during operation.
- The cable must not be extended or opened.

5.5 Mains connection

The mains connection to Control is a standard IEC C14 appliance inlet plug (IEC-60320) with integrated pull-out fuse. The mains cable supplied has an earthing contact plug at one end and an IEC C13 appliance coupler with a specially shaped housing at the other end. This, in conjunction with the safety catch, ensures a secure connection to the mains supply. **Therefore, always use the mains cable supplied**.

The power supply must have a main fuse, a residual current circuit breaker and an earthing connection (PE protective conductor).
Control is equipped with a mains input filter and a 6.3 A fuse.

▶ Connect Control to the mains using the mains cable supplied. Lay the mains cable so that it is secured against damage.

Parameters	min.	max.
Input voltage	90 VAC	260 VAC
Input frequency	47 Hz	63 Hz
Power consumption		6,0 A
Typical power consumption*		
H600		250 W
H1000 /H1000 G2		350 W/ 500 W
H1500 G2		500 W

*Measurement conditions: all axes moved simultaneously, speed 100 %, load 0 kg, measurement period 2 h

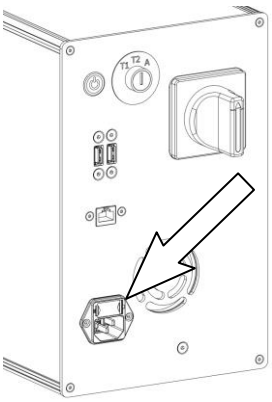


Fig. 9: Power connection

ELECTRICAL VOLTAGE!

▶ Ensure that all cables are connected correctly before Control is supplied with power. Always use the original power cable supplied.
▶ Ensure that the robot is earthed (connection of the mains plug to the PE protective earth conductor).
▶ A suitable circuit breaker and a suitable RCD (residual current device) must be installed.

5.6 Control I/O

This chapter describes how to connect devices to Control. The connections can be divided into four categories:

– Safety-relevant inputs/outputs
– General digital inputs/outputs
– Power supply +24 V
– Extension interface

The inputs and outputs for this are located on the bus mainboard (horstIO) installed in Control, which is accessible after removing the cable gland on Control. A tabular overview of the connectors and their terminal assignment can be found in the appendix / .12.212.3

▶ Loosen the four external M4 countersunk screws.
▶ Remove the cover of the cable gland (1).
▶ The horstIO connections are now accessible.
▶ If necessary, connect peripherals to the interfaces.
▶ Reattach the cover of the cable gland (1).

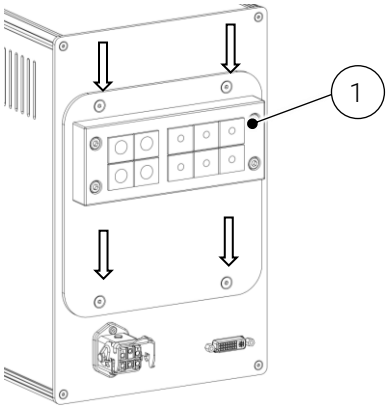


Fig. 10: Control cable entry

The connections are designed as plug-in screw terminal connectors. The supplied screw terminal connectors of type Amphenol Anytek TJ0831530000G (alternatively Phoenix Contact MC 1.5/ 8-ST-3.81) or push-in terminals such Phoenix Contact FK-MCP1.5/8ST-3.8 can be used as connectors.
The basic connector strip is of the type Amphenol Anytek OQ0832500000G.

5.6.1 Overview of all interfaces

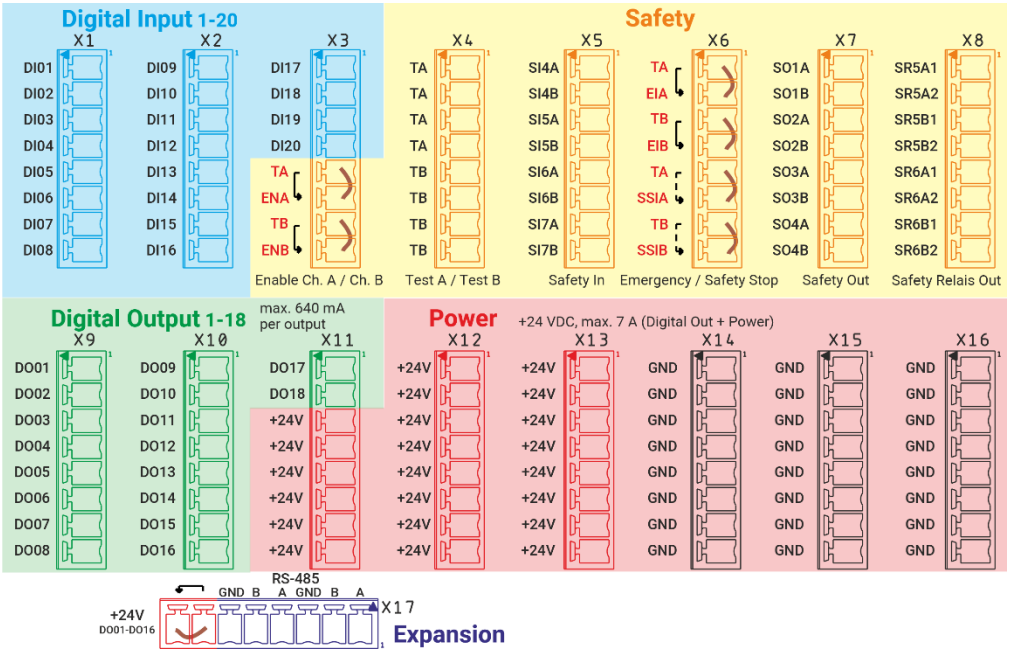


Fig. 11: horstIO interfaces

Blue area, terminals X1 to X3 - up to 28 general digital inputs:

– 20 digital inputs

– A further 8 digital inputs if the 4 configurable safety-related inputs are configured as normal inputs (terminal X5)

Orange area, terminal X6 - 7 safety-related inputs - each 2-channel:

– 3 dedicated inputs (red font)

- Emergency stop input - connection of potential-free contacts only
- Safety stop input
- Enabling switch internal

– 4 configurable inputs (external emergency stop, acknowledgement signals, etc.)

Orange area, terminal X7 & X8 - 6 safety-related outputs, each 2-channel:

– 4 configurable outputs, push-pull (terminal X7)

– 2 configurable potential-free outputs (terminal X8, two relay contacts each)

Test signal generation TA/TB - OSSD signal for safety-relevant inputs

Green area - up to 30 general outputs:

– 18 digital outputs, push-pull / high-side (terminal X9, X10, X11)

– A further 8 digital push-pull outputs if the 4 configurable safety-related outputs are configured as normal outputs (terminal X7)

– Another 4 relay contacts, from the configurable potential-free safety-related outputs, configured as normal outputs (terminal X8)

Red area - common GND and +24 V terminals

Purple area: RS-485 interface for future expansions

External bridge for +24 V: can be routed via safety relays to switch off the digital outputs 1-16 in a safety-relevant manner.

An external enabling switch can be connected via the ENA/ENB and TA/TB terminals, but deactivates the internal enabling switch on the panel.

5.6.2 Safety-related inputs/outputs

Control is equipped with several safe inputs and outputs. Safe I/Os have a redundant design with two independent lines. This means that a fault or failure of one line does not result in the 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-relevant functions in the horstOS software, but it is also possible to use them 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 safety-related protective equipment of all kinds (e.. safety laser scanners). The functional difference is explained in the following table:

	Emergency stop input	Safety stop input
Active in the following operating modes	T1, T2, automatic	Automatic
Robot movement stops	Yes	
Power supply drives	Off	on
Program execution	paused	
Acknowledgement	manually on the panel	
Further operation after acknowledgement	Program continues to run at the interrupted point	
requires re-initialization	no	
Stop category (IEC 60204)	1	2
Performance level (ISO 13849-1)	PL d	



DANGER!
Danger due to incorrectly connected emergency stop devices

- ▶ Never connect safety signals to a PLC that does not correspond to at least the corresponding protection level. The safety functions can then be overridden, which can result in serious injury 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 DIs or safety stop inputs.



- ▶ Safety-related I/Os always have two channels. Always keep the two channels separate so that a fault does not lead to the loss of the safety function.
- ▶ The safety functions must be checked before commissioning and at regular intervals.

Crosswire detection (OSSD)

Cross-circuit detection (OSSD) can be switched on for the safety-relevant inputs. When OSSD is activated, the output is periodically switched off and the input is read back. If the result does not match, an error is triggered. This allows short circuits and cross circuits to be monitored.
When using the OSSD function, the internal OSSD signals must be used. If external OSSD signals are connected, the function must be deactivated in horstOS and the input filter activated. The adjustable time of the filter must be selected so that the test pulse is ignored (filter time > test pulse).

5.6.2.1 Emergency stop and safety stop I/O

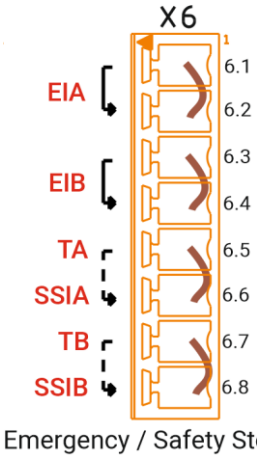


Fig. 12 : Connection Emergency stop / Safety stop

The inputs for emergency stop (EIA, EIB) and safety stop (SSIA, SSIB) are dedicated inputs (Safety In 1 & 2) for each control and can therefore not be configured. They are redundant with performance level "d" with category 3 according to EN ISO 13849-1 and also comply with the electrical specifications of the general digital inputs, see5.6.7.1 . The signals are located on terminal block X6.

The emergency stop signal (Emergency In) is connected to terminals X6.1 and X6.3. These are fed by the test signal TA/TB for the purpose of cross-circuit detection and are routed to this terminal via the emergency stop on the panel. On delivery, these are connected to the safe emergency stop inputs X6.2 and X6.4 via a jumper. An external emergency stop button can be connected in series to the emergency stop on the panel between X6.1/X6.2 and X6.3/X6.4.

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

It is possible to configure an input filter for the emergency stop and safety stop input in horstOS in the *Safety I/O* menu. The maximum time that can be set is 50 ms. See 5.6.7.2.

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

If the robot is operated independently, jumpers must be inserted in the terminals for emergency stop, safety stop and enabling switch, see Fig. 12 . These are inserted as standard on delivery.

When integrated into an overall system, the robot system must be integrated into the emergency stop circuit of the higher-level system.

When using OSSD, the signal is tested cyclically. These test pulses must not lead to all downstream control elements being switched off! Pay attention to this when selecting the devices to be connected.

5.6.2.2 Enabling switch I/O

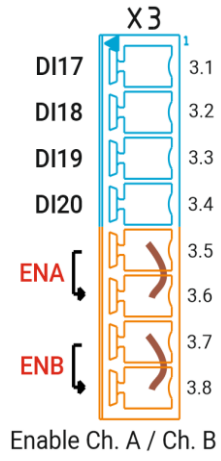


Fig. 13: Enabling switch connection

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 either. The enabling switch of the panel is connected to the controller at terminals X3.5 and X3.7 with the safe inputs at X3.6 and X3.8.

The signals on X3.5 and X3.7 are the enabling switch signals from the panel, which are fed by the test signals TA / TB (cross-circuit detection).

Instead of the internal enabling switch on the panel, an external enabling switch can be connected between TA/TB (X4) and X3.6 / X3.8. **In the as-delivered state, one jumper is inserted here. These jumpers must be removed when connecting an external enabling switch!**

It is possible to configure a filter for the enabling switch input in horstOS, see 5.6.7.2.

5.6.2.3 Configurable safe inputs

A new risk assessment must be carried out every time the safety configuration is changed!

There are 4 additional, configurable safe inputs SI4 to SI7 (Safety In) available on terminal block X5. These are also redundant with performance level "d" with category 3 in accordance with EN ISO 13849-1. They comply with the same electrical specifications as the general digital inputs. They can be used both as safety-related inputs with various configurable functions or as normal inputs.
There are two channels A and B per safe input.
These inputs can be operated with safe OSSD outputs (for cross-circuit detection, with configured input filter), with internal test signals TA / TB or completely without cross-circuit detection with 24 V signals.
The configuration for this is set in horstOS in the safety configuration and transmitted to the safety controllers. A filter can also be configured for the configurable safe inputs, see 5.6.7.2

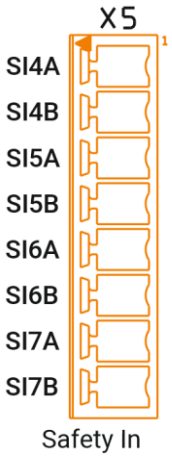


Fig. 14: SI connection

The following functions can be configured for the safe inputs (see):5.6.7.2

Function	Stop category	Description	Areas of application
None	-		SI is not queried.
Emergency stop	1	Signals internal emergency stop. Emergency stop output is set.	Internal emergency stop for additional emergency stop buttons.
External Emergency stop	1	External system signals emergency stop. Emergency stop output is not set.	Emergency stop of external machines, robot goes into emergency stop, but does not transmit a fault externally
Safety stop	2	Safety devices that are not active in teach mode with the enabling switch can be connected here. This allows the cell to be entered during teaching. Only active in automatic mode.	Safety gate circuit (light curtain, safety scanner, safety gates).
Self-releasing safety stop	2	Like safety stop, but automatic reset and restart of the robot after restoration of the safe state.	Safety devices if automatic restart is not critical (e.g. it is not possible to stay in a secured area).
Enabling switch	2	Safe stop if the enabling switch is pressed or not pressed. Only active in operating mode T1 and T2.	Integration of additional external approval device, queried in T1/T2.
Reduced Speed	0	Checking the reduced speed. Note: This function can be initiated via a DI. If the robot moves faster than the reduced speed, a category 0 stop is triggered.	Reduced speed monitoring (e.g. for safety scanners with several protected zones).
Two digital inputs	-	SI is configured as two general Dis.	Use as DI e.g. for sensors instead of as a safety function

The following also applies here: The system is always in a safe state with "Low" signals (0 V, logic 0), e.g. robot is at a low signal at the external emergency stop input.

5.6.2.4 Safe outputs

There are 6 configurable, safe outputs available. These are also designed redundantly with performance level "d" with category 3 (EN ISO 13849-1), whereby the outputs SR5 and SR6 (Safety Relay Out) are each implemented as potential-free contacts using forcibly guided relays. These outputs can be used, for , to inform other machines of the status of the robot.

The relay contacts can be loaded with 5 A and 24 V and are led out at terminal block X8. The safe outputs SO1-4 (Safety Out) on terminal block X7 correspond to the electrical specification of the digital outputs but are not coupled to the total current limit (see5.6.6). These are always configured as push-pull outputs.

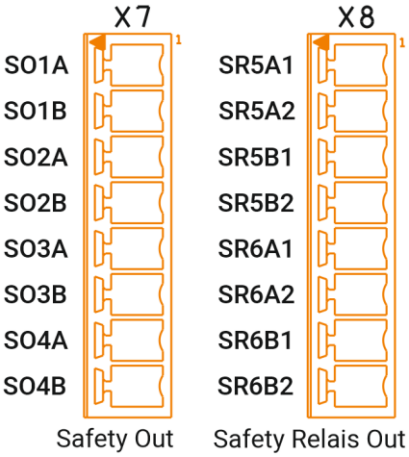


Fig. 15: Connection of safety outputs

Each of these outputs can be used with or without an OSSD function (time-shifted 400 µs low pulse) or as a general DO. Two normal DIs can be configured as additional read-back inputs for each SO. This enables safe switching of an external positively driven contactor/relay with read-back of the auxiliary contact states. An inverted or non-inverted signal can be used here. If a non-valid read-back signal is detected, a category 1 stop is triggered.

The following functions can be configured for the safe outputs (see): 5.6.7.2.

Function	Description
None	
Emergency stop	"LO": Robot is in emergency stop (internal emergency stop or triggered by error).
Robot stopped	"HI": no axis moves.
Reduced Speed	"HI": Robot is limited to a speed of 250 mm/s.
Teach mode	"HI": Robot is in teach mode.
Power release	As release for external machines in the cell "HI": Robot driving clearance has been granted. "LO": Standstill monitoring is active. There is an error status (in T1/T2 the enabling switch is not actuated, emergency stop/safety stop/error).
Enabling switch	"HI": Enabling switch actuated (centre position). "LO": Enabling switch not pressed or pressed through.
Forwarding Safety stop	output can be used to forward the safe operator protection to other devices (within the same safety zone). The maximum delay of the safety stop signal (from the safety stop input to its output at the safe output) is 10 ms. If an additional low-pass filter is configured in horstOS, the filter value is added to this delay.
2 DOs	Safe output is configured as two general digital outputs.

5.6.3 Test signals A/B

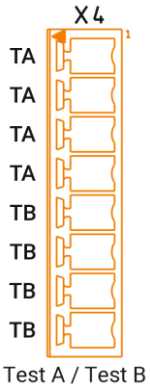


Fig. 16: Test signal connection

The internally generated OSSD signals, hereinafter referred to as test signals A and B, are output at terminal block X4. These can be used to supply external safety devices with two-channel, safe signals and feed them back to the control system. The parameters of the test signal are shown 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 µs, not configurable
Load capacity	max. 50 µF

5.6.4 General digital inputs

20 DIs (Digital In) are at terminal blocks X1, X2 and X3. DI01-20 are +24 V input channels and comply with IEC 61131-2 types 1 and 3.
If the *Configurable safe inputs* are configured as general DIs, 8 additional inputs are available. An additional filter can also be configured here via horstOS. The maximum possible duration for the general DIs is 32767 ms.
The following functions can be configured for the general DIs (see):5.6.7.2

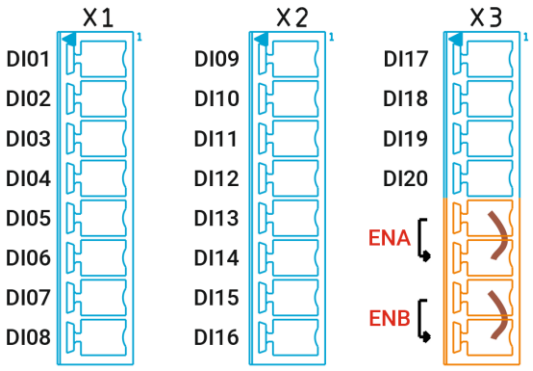


Fig. 17: Connection of general digital inputs

Function	Description
Not assigned	-
Start program	Starts a program from external, edge LO - HI
Pause program	Pauses a running program, edge LO - HI
Continue program	Continues a paused program, edge LO - HI
Program pause/resume	Pauses running program (edge LO-HI) or continues it (edge HI-LO)
Acknowledge internal error	Acknowledges an internal error, edge LO - HI
Acknowledge emergency stop	Acknowledges an internal emergency stop, edge LO - HI
Acknowledge safety stop	Acknowledges a safety stop, edge LO - HI
Acknowledge internal error / emergency stop / safety stop	Acknowledges all errors and emergency stop / safety stop, edge LO - HI
Reduced speed	Activates driving at reduced speed (not safety-relevant from the warning range of the laser scanner), edge LO - HI

5.6.5 General digital outputs

18 general DOs (Digital Out) are available at terminal blocks X9, X10 and X11. The outputs DO01-18 are +24 V output channels and can be configured as push-pull (switching against the positive supply voltage and against ground) or high-side switches (switching only against the positive supply voltage) via horstOS.
If the safe outputs (chapter0) are configured as general DOs, up to 12 additional outputs are available, 4 of which are potential-free.

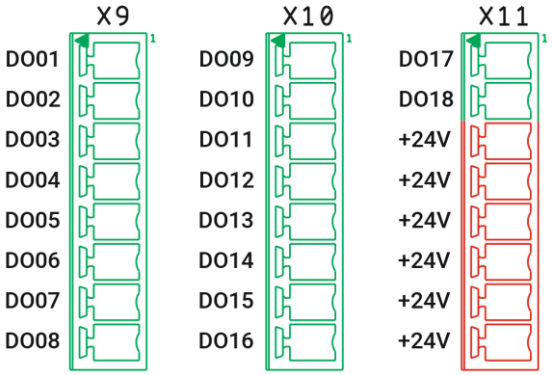


Fig. 18: Connection of general digital outputs

Each output can drive at least 640 mA when the signal is high (+24 V) and draw 440 mA when the signal is low (0 V). A total current limit of 7 A applies to DOs 01-16 and the +24 V outputs together. For more information, see the chapter5.6.6 . Resistive, capacitive and inductive loads can be switched. They are short-circuit-proof and protected against ESD and voltage peaks when switching inductive loads. **Always use a free-wheeling diode for inductive loads.**
The following functions can be configured for the general DOs (see):5.6.7.2

Function	Description
Not assigned	-
Emergency stop button	Exact image of the emergency stop button signal, for diagnostics (ORDERing with several emergency stop buttons). In larger systems, the actuated emergency stop button can be identified more easily. ATTENTION: several emergency stop inputs may be present. If ONE of the inputs is active, this output is also active.
Error	HI, if there is at least one unconfirmed error.
Program running	HI, when program is running.
Program paused	HI, when program is paused.
Program in the Playback mode	HI when the playback mode is active (you can see the menu for starting/stopping the program on the right)
Drives switched on	HI, when motors are energized.
Ready to drive	HI: Drives are switched on and drive enable is present. There is no error status.

Safe shutdown of the general DOs

The digital outputs DO01-16 are fed from the +24V power supply via a bridge at X17.7/X17.8. In the as-delivered state, a bridge is inserted for this purpose.

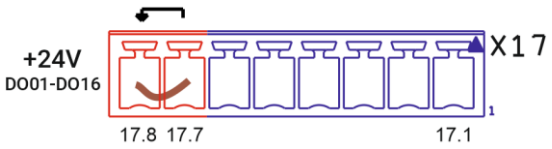


Fig. 19: Bridge for power supply DO01-16

If this bridge and the associated earth connection to the connected actuators are routed via a safety relay pair, these can be switched off in a safety-relevant manner (see wiring example5.6.9). This means that these normal DOs can be used for safety-relevant functions if the actuators connected to them are in a safe state when there is no voltage.

5.6.6 +24 V power supply

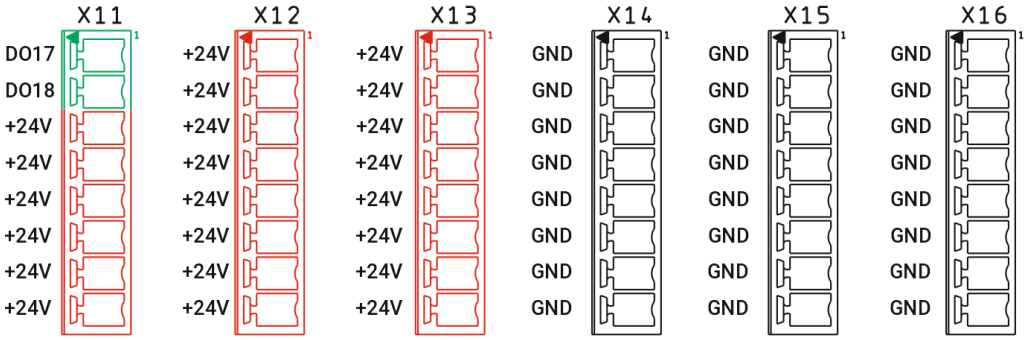


Fig. 20: Power supply +24 V

22 +24 V connections and 24 earth connections are available for the power supply of external devices. All +24 V connections and the general digital outputs DO01-16 together can be loaded up to a maximum of 7 A. If the total current is exceeded for a short time, the consumption is limited to this 7 A; if it is exceeded continuously (e.. due to a short circuit), the +24 V power supply is switched off. The safety-related outputs and the digital outputs DO17-18 are not affected by this. If the power supply is switched off, an attempt is made to switch it back on after approx. 500 ms; if this is not successful, a new attempt is made every 500 ms.
To ensure safe start-up, the maximum load at all +24V outputs must not exceed a value of 400 µF/48 Ω.
An external +24 V power supply can also be connected to terminal X17.8 (seeFig. 21). It is therefore possible to operate the general DO01-16 with an external power supply if the earth connection of the external voltage source is connected to the Control earth. The permissible values for an external power supply are given in the following table:

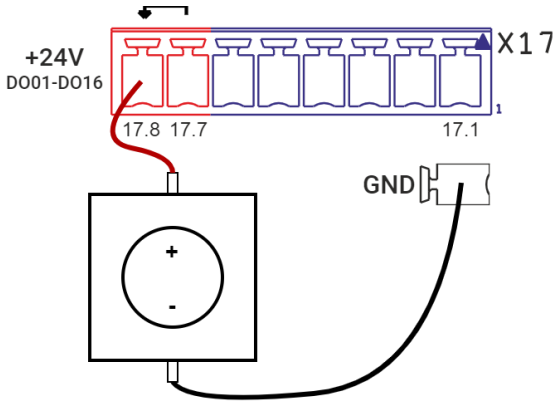


Fig. 21 : Feeding in external power supply

Power supply	min.	type.	max.	Unit
internal: Voltage	23,5	24	24,5	V
internal: current	0	-	7	A
external: Voltage	15	24	30	V
external: electricity	0	-	10	A

5.6.7 Common features of all digital interfaces

5.6.7.1 Electrical parameters

The specifications described in this chapter apply to all digital interfaces (safety-relevant and general). Functional diagrams of the interfaces can be found in the appendix (12.4).

Parameters	min.	typ.	max.	Description
Inputs				
Tension	-3 V	24 V	36 V	Input voltage
Switching threshold $_{HIGH - LO}$	6,0 V	7,5 V		logical high - low
Switching threshold $_{LO - HIGH}$		8,5 V	10	logical low - high
Power consumption		2,4 mA	2,6 mA	Input voltage 18 - 30 V
Input resistance	3			
ESD resistance		+/- 15 kV		Human Body Model
IEC 61131-2				1 & 3
Outputs				
Function				PNP (high-side) / push-pull, semiconductor
Tension	23,0* V	24 V	24,5 V	Output voltage
Current $_{HI_PP}$	0,64 A		0,85 A	per output, logic high, push-pull
Current $_{LOW_PP}$	0,44 A		0,65 A	per output, logic low, push-pull
Electricity $_{HI_HS}$	0,64 A		0,85 A	per output, logic high, high-side
Internal resistance $_{HIGH}$		110 mΩ	230 mΩ	
Internal resistance $_{LO}$		1 Ω	2,5 Ω	
Leakage current		100 µA	180 µA	
ESD resistance		+/- 8 kV		Contact us

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

5.6.7.2 Software setting options for digital interfaces

In the horstOS software, the inputs and outputs can also be configured in the *Configuration inputs/outputs* menu under *Settings & info*.

Assignment of functions

Functions can be assigned in horstOS for the general digital I/Os and the configurable safe I/Os (*Function assignment* setting). Examples are start program, acknowledge error or run at reduced speed. For the inputs, this means that the assigned function is executed when there is a valid signal at the corresponding input. For the outputs, this 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 I/Os, as they are permanently linked to the functions. No functions can be assigned to the exclusively safe inputs emergency stop, safety stop and enabling switch (Safety In 1-3).

Filter

A low-pass filter can be configured for all digital inputs, safety-relevant and general. Only when a signal is present for a minimum duration is it recognized as valid (e.g. for bouncing buttons). The time value can be set in the horstOS software under the *low-pass filter* setting.
Possible values here are between

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

DANGER!

The use of a low-pass filter extends the stopping time by the set value and can therefore lead to unexpected collisions with people or other objects and machines.

▶ Always adjust the safety distances to the corresponding stopping distances.

ATTENTION!

Risk of robot damage or property damage due to collision!

5.6.8 Wiring examples for safety-related inputs/outputs

In this section you will find examples of the wiring of the digital interfaces of Control. Further examples can be found at https://www.fruitcore-robotics.com/de/wissen.

5.6.8.1 Standard security configuration

On delivery, the control unit is configured to operate the robot alone. This means that no other customer-specific, safety-relevant devices are connected to the control unit. For this purpose, jumpers are inserted in connectors X3 and X6 for the mandatory emergency stop, safety stop and enabling switch functions, see adjacent figure.

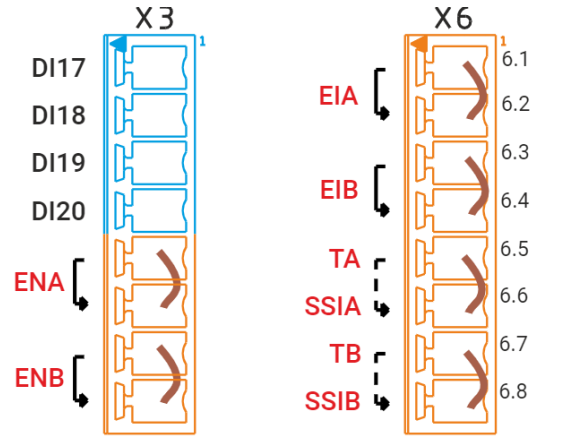


Fig.22 : Standard configuration

5.6.8.2 Additional emergency stop button

One or more additional emergency stop buttons are to be used, which act on the robot's emergency stop. The adjacent figures illustrate the connection of additional two-channel emergency stop buttons, which are connected in series to the button on the panel.

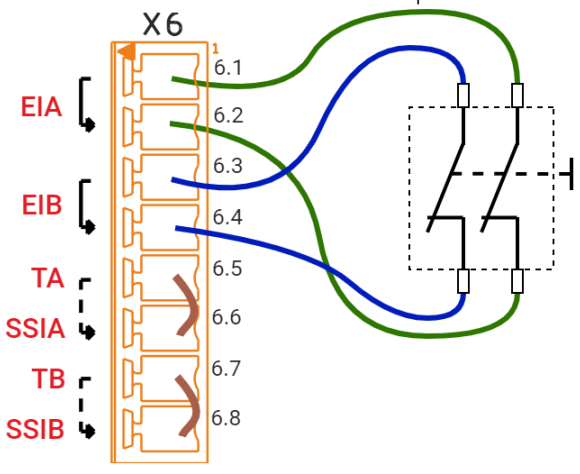


Fig.23 : Connection of external emergency stop button

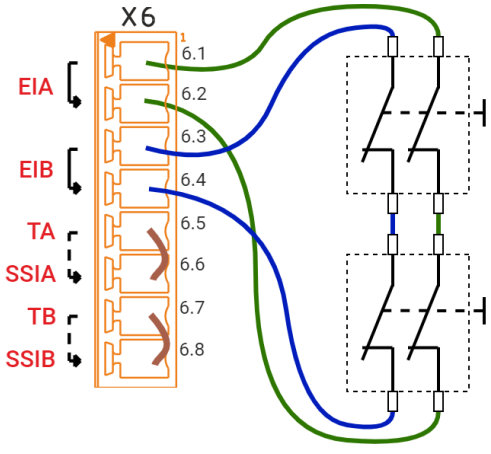


Fig.24 : Connection of several external emergency stop buttons

5.6.8.3 Safety relay

A safety relay is to be controlled safely and a contactor monitoring system is to be set up. The two inputs of the relay are connected to channels A and B of e.. Safety Out 1. A contactor monitoring function can be implemented by routing a +24 V signal via the feedback current path to a general digital input.

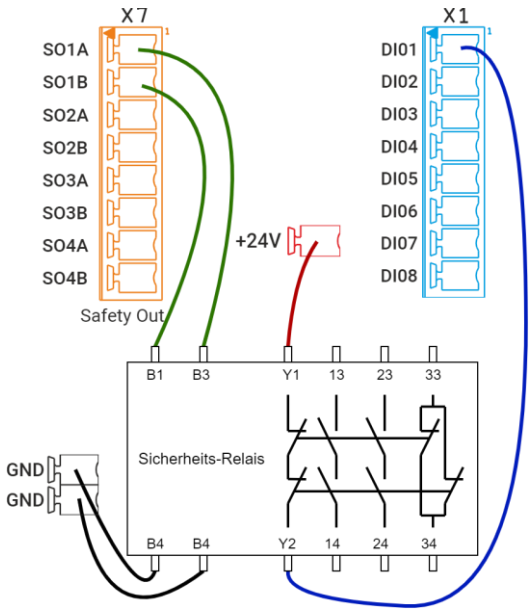


Fig.25 : Connection of a safety relay

5.6.8.4 Safety stop

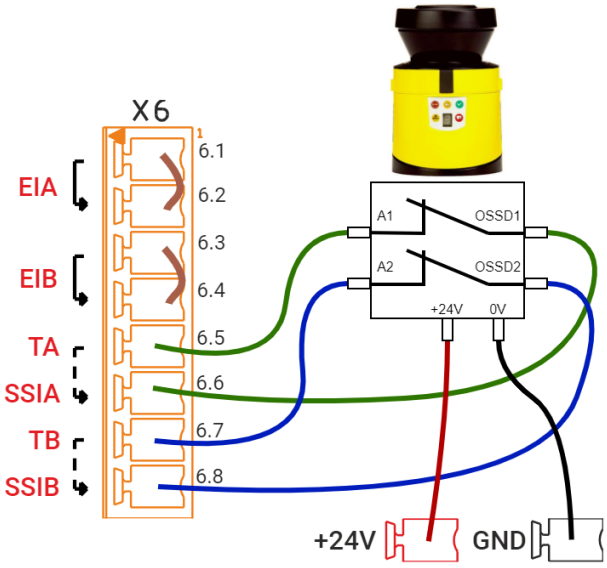


Fig.26 : Safety stop: Laser scanner internal test signal

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 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 controller.

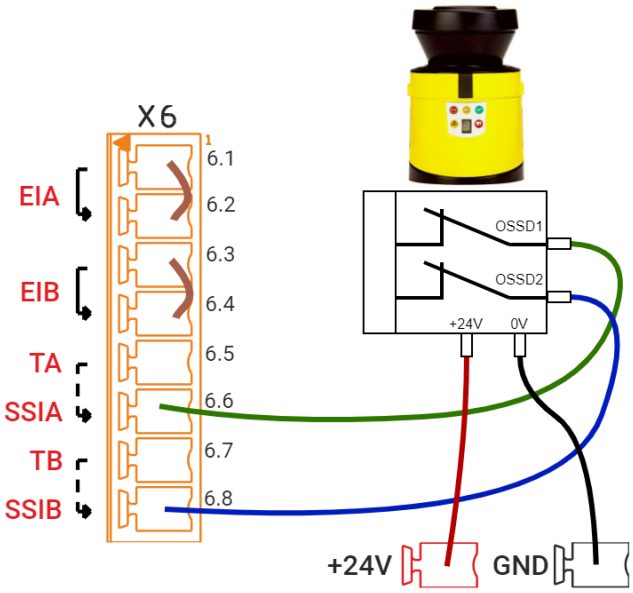


Fig.27 : Safety stop: Laser scanner external signal

Some laser scanners are designed to use their own OSSD signal. In this case, only their outputs need to be routed to the safety stop input of the main controller. In this configuration, the cross-circuit detection must be switched off in horstOS and the filter time must be set longer than the test pulse of the safety device (see *Safety-related inputs/outputs*

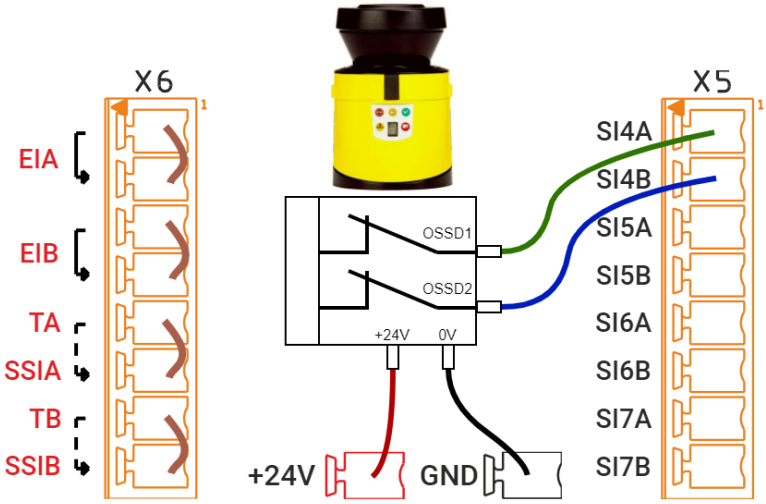


Fig.28 : Self-releasing safety stop

In both cases, the safety stop must be acknowledged manually after leaving the area. The example opposite shows the connection option for a safety stop with automatic continuation. The laser scanner is connected to a configurable safe input and the *self-releasing safety stop* function is assigned to this input.

5.6.8.5 Connect emergency stop of several devices

In a system, the robot is to be integrated into the emergency stop circuit of the other devices so that in an emergency it is not necessary to decide which emergency stop button has to be pressed. The figure opposite shows an example of the connection of two HORST robot systems. For this purpose, a configurable safe output is connected to a configurable safe input.

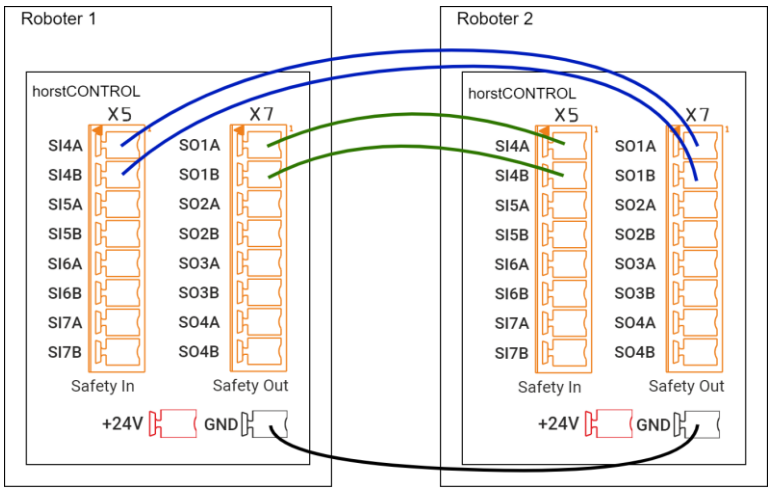


Fig.29 the emergency stop of several devices with each other

5.6.8.6 Connection to a higher-level safety PLC

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

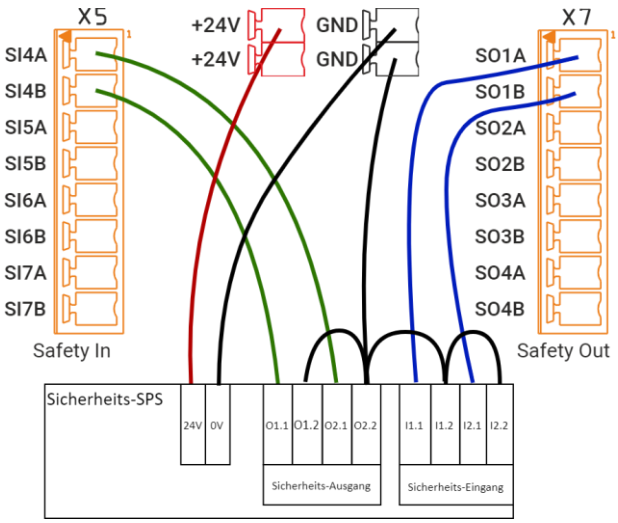


Fig.30 : Higher-level PLC

5.6.8.7 Safe shutdown of the digital outputs

The general DOs 1-16 should be switched off for safety reasons. For this purpose, the bridge between X17.7 & X17.8 is removed and routed together with the earth connection via the potential-free, safe output SR5. If the safety output SR5/SR6 is assigned the power enable configuration (see0), the relay is opened in the event of a fault and the outputs can be safely switched off. A load connected to DO01, as in this example, is thus safely switched off. Please note that in this case, all other loads connected to the general DOs 1-16 are also switched off

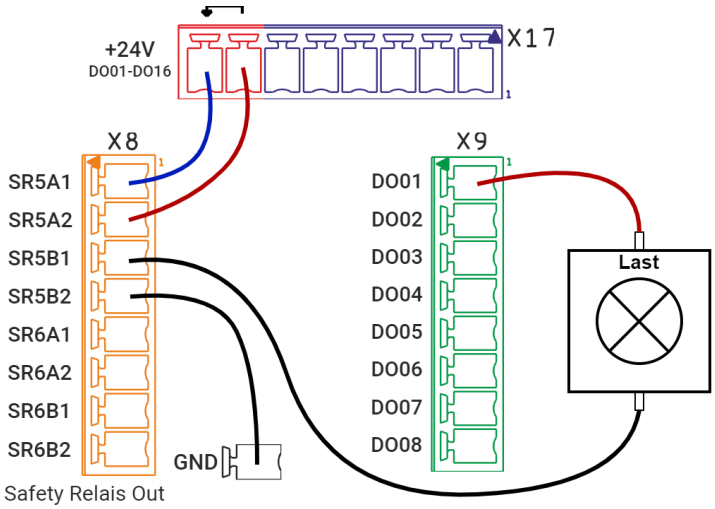


Fig.31 : Safe disconnection of the +24 V supply and DOs

Always use a freewheeling diode for inductive loads.

5.6.9 Wiring examples for general digital inputs/outputs

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

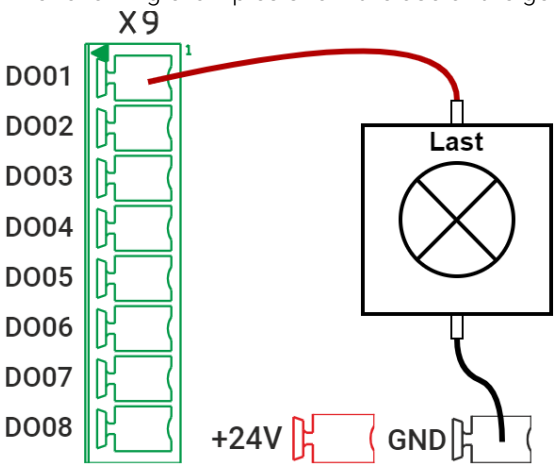


Fig. 32: Consumer at the output

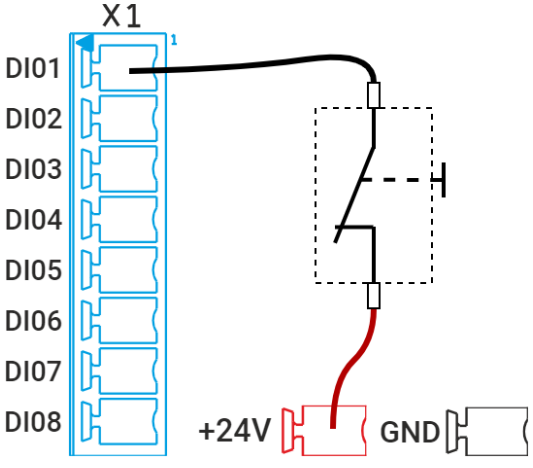


Fig. 33: Button on the digital output

An inductive proximity switch configured as a PNP normally closed contact is to be connected to a digital input.

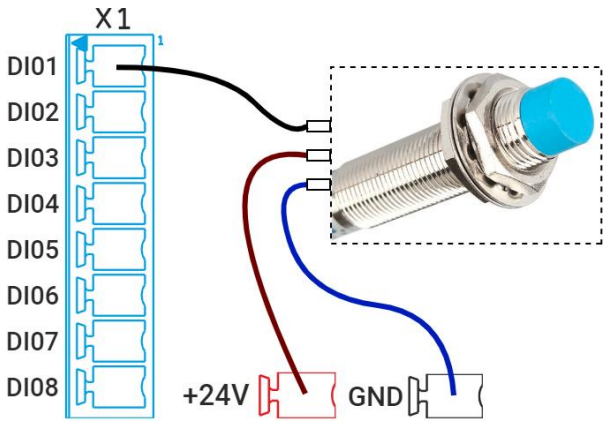


Fig.34 : Inductive sensor at the digital output

5.7 Tool I/O

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

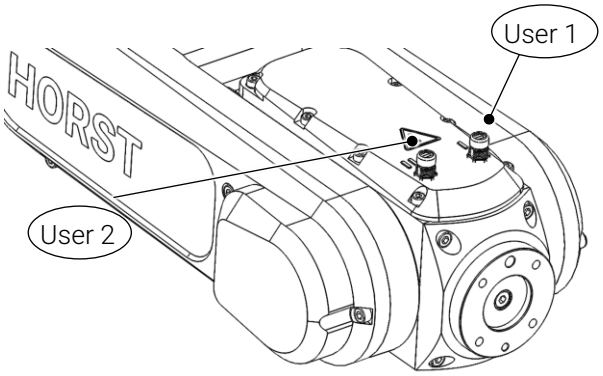


Fig. 35: Electrical connections for tools

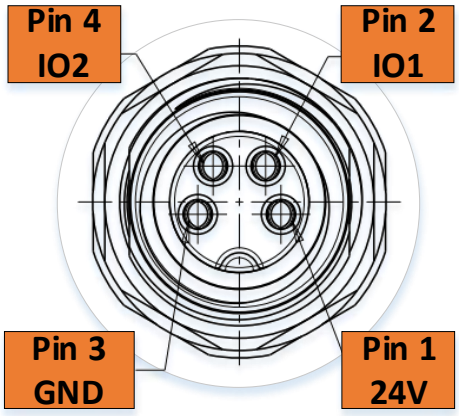


Fig. 36: Slot assignment tool I/O

The interfaces are designed as four-pin, A-coded M8 sockets (TE Connectivity T4071017041-001). A plug connector with the following properties must be used as the counterpart:
M8 male, 4-pin, angled, A-coded.
The tool I/Os can be configured as inputs or outputs in horstOS (menu *Configuration Inputs/Outputs→ Special I/O*). By default, the two I/Os of interface User 1 are configured as outputs and the two of interface User 2 as inputs.
Configured as outputs, these act as push-pull switches and can be loaded with max. 600 mA each when switched to the positive supply voltage and max. 200 mA each when switched to ground. The maximum current carrying capacity of all tool I/Os on support arm 3, i.e. the four possible DOs and the +24 V power supply together, is 2.5 A.
Configured as inputs, these are IEC61131-2 type 3-compliant. A functional diagram of this interface can be found in the appendix.

The following table shows the tool I/O parameters.

Parameters	min.	type.	max.	Unit	Description
Inputs					
Tension	-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
Power consumption		2,3	2,6	mA	
IEC 61131-2				Type	3
Outputs					
Function				Type	Push-pull, semiconductor
Tension		24		V	Output voltage
Current $_{HI_PP}$	0		0,6	A	per output, logically high
Current $_{LO_PP}$	0		0,2	A	per output, logic low
Internal resistance $_{HI}$		120	240	mΩ	Logically high
Leakage current	-150		150	µA	
Total electricity			2,5	A	all 4 digital outputs and +24 V
ESD resistance		+/-7		kV	Contact us

5.8 Computer interfaces

A computer is installed in Control, the accessible interfaces of which are described in this section.

5.8.1 PROFINET (optional)

Control has an optional PROFINET communication interface (PROFINET IO, conformity class C), which can be used to exchange data between a PLC and the robot. PROFINET (Process Field Network) is a real-time-capable industrial Ethernet protocol that is used as a standard protocol in automation. The robot can be controlled and monitored by the PLC using PROFINET communication. HORST assumes the role of the client (slave) and is controlled by the PLC (server or master). This allows HORST to be easily integrated into an existing production line and communicate with various peripheral devices. In addition to executing specific commands, freely writable memory areas are available in which Int, float and Boolean data types can be exchanged.
The connection is made via an RJ45 modular plug and a category 5 (CAT5) network cable on the front of the Control (see 4.2.2)

5.8.2 Ethernet

With the Ethernet interface, remote access or remote control of the robot is optionally possible, as is program synchronization. It is also used to transmit telemetry data to horstCOSMOS. The following is required to access horstCOSMOS:

– Connected network cable
– Connection to https://horstcosmos.com on port 443
– TLS 1.2 and TLS 1.3 must not be blocked by the firewall

The RJ45 modular plug for the Ethernet connection is located on the back of Control. The transmission speed of the connection is a minimum of 10 and a maximum of 1000 Mb/s.

5.8.3 USB

A total of 4 USB interfaces are available for connecting additional input devices and data carriers, 2 USB 3.1 at the rear of Control and 2 USB 2.0 at the rear of the panel. **The USB interfaces on the panel are only intended for input devices; the interfaces on Control must be used for data carriers.**

6 Commissioning and recommissioning



ELECTRICAL VOLTAGE!

Possible personal injury and damage to property due to electrical voltage

- ▶ Work on the electrical equipment may only be carried out by appropriately trained specialist personnel in accordance with electrotechnical regulations.
- ▶ Ensure that the power supply is disconnected during work on the robot and that it cannot be switched on unintentionally.
- ▶ Only use the cables supplied to connect to the mains supply. Damaged cables must not be used.
- ▶ The panel may only be disconnected from or connected to Control when it is de-energized.



DANGER!

Danger due to missing protective and safety devices and defective/damaged assemblies or accessories

- ▶ Only operate the robot system with functional protective and safety devices.



CAUTION!

Damage due to condensation

- ▶ Never switch the robot on immediately if it has been moved from a cold to a warm environment. The resulting condensation could damage the electronics. We recommend allowing the system to adjust to the ambient temperature overnight.



DANGER!

Danger due to incorrect commissioning

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

Before commissioning:

- ▶ Ensure that the robot is earthed (connection of the mains plug to PE protective earth). A suitable RCD (residual current device) must be installed.
- ▶ Before switching on the power supply, make sure that the connecting cable between the control unit and the robot and the mains cable are connected to the power supply.
- ▶ Ensure that there is sufficient space so that the robot arm can move freely. There must be no obstacles or persons in the working area. Note that attachments and workpieces change the reach of the robot and therefore the danger zone.
- ▶ Make sure that the robot and any attachments are properly secured.
- ▶ If the robot is combined with other machines in a system, ensure that these cannot cause any hazards when the protective device is inactive (teach mode) or that measures have been taken to control their hazards (enable switch required for activation).
- ▶ If the robot, control or mechanical interface or any parts of the protective device are damaged, the robot must not be used.
- ▶ Safety devices (emergency stop, safety stop) may only be connected to safety-relevant interfaces and must be designed redundantly.
- ▶ Ensure that the safety measures are set up and configured in accordance with the risk assessment. The safety devices must stop the robot movements within the danger zone. Check that they are functioning properly.
- ▶ Check the emergency stop and safety stop functions.
- ▶ Do not enter the danger zone of the robot during operation and do not touch it.

6.1 Switching on the robot system

▶ Turn the main switch on the Control to ON.

⇒ The software (horstOS) starts on the panel.

⇒ If a user role was logged in during the last use, which does not have the authorization to remain logged in after a restart, the pop-up window for switching appears.

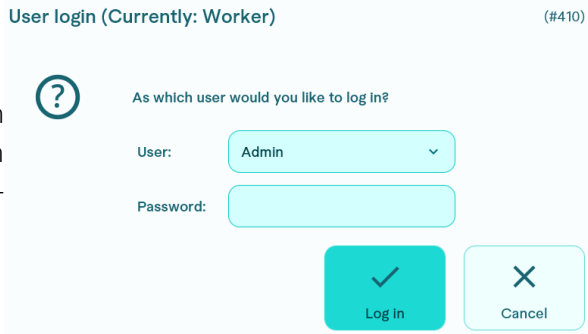


Fig. 37: Change user role

▶ Select Connect to robot in the main menu.

▶ Wait until "Connection to robot successfully established" appears on the display.

CAUTION!
Danger due to incorrect authorization management!

▶ To prevent unauthorized or undetected changes to security-relevant settings, for example, a password should be defined for all user roles. This ensures that people only perform functions in accordance with their qualifications.

6.2 Initialize robot

WARNING!
Risk of impact and crushing due to robot movements

The safety stop function is deactivated during initialization.

▶ In initialization mode, cordon off the area around the robot and secure it against access by unauthorized persons. No persons may be in the danger zone of the robot.

Initialization must be carried out each time the robot system is switched on if the power supply has been interrupted. During initialization, you should check the function of the enabling switch by deliberately releasing and pressing it occasionally.

▶ Select the Manual button.

⇒ The Automatic initialization menu appears.

The axes can be moved manually here if automatic initialization is not possible.

▶ To do this, press and hold the enabling switch in the middle position.

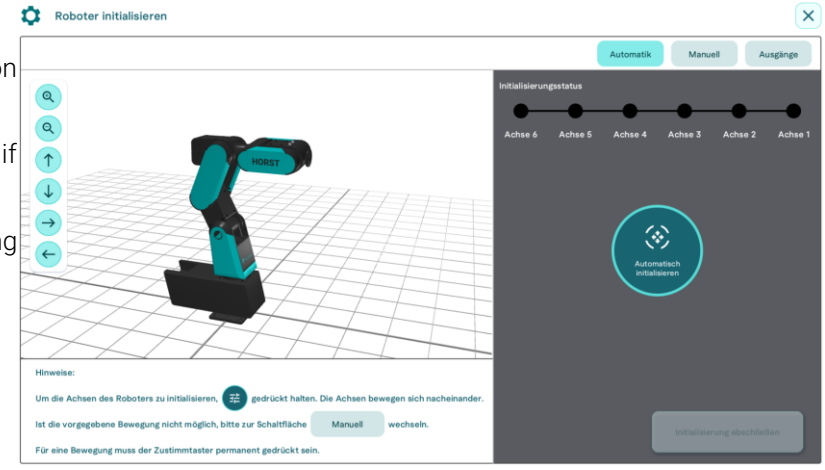


*Fig. 38: **Automatic initialization** menu*

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

▶ Press and hold the Auto Init button and keep the enabling switch pressed in the middle position.

⇒ Automatic initialization of the axes is performed.

⇒ If the initialization was successful, all six points (initialization status) of the axes are displayed in turquoise.

To perform initialization, the axes (starting with axis 6) must perform 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!

Observe the robot to avoid collisions.

▶ Select the Manual button.

⇒ The Automatic initialization menu appears.

The axes can be moved manually here if automatic initialization is not possible.

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

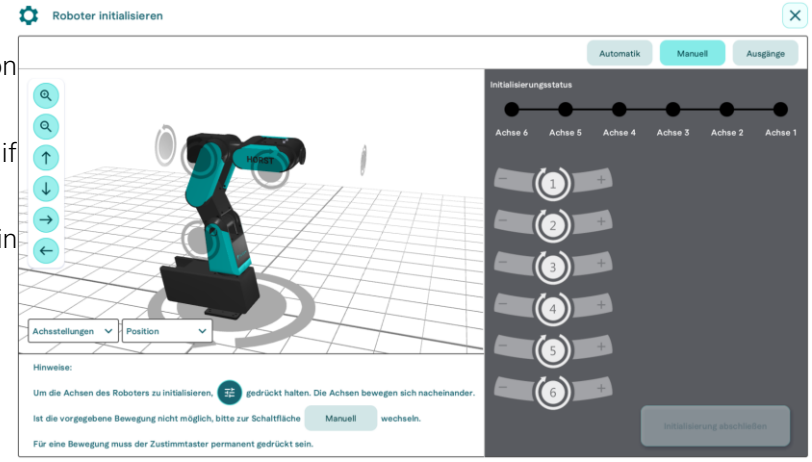


*Fig. 39: **Manual initialization** menu*

The axes can be moved manually here if automatic initialization is not possible.

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

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

⇒ If the initialization was successful, the dot (initialization status) of the respective axis is displayed in turquoise.

A gripper may need to be opened in order to carry out the initialization. In this case, use the **Outputs** button to switch to the **Initialize robot - Outputs** menu.

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

▶ Switch the desired output using the corresponding toggle button.

▶ The automatic/manual initialization of the axes was successful if all six points (initialization status) of the axes are displayed in turquoise.

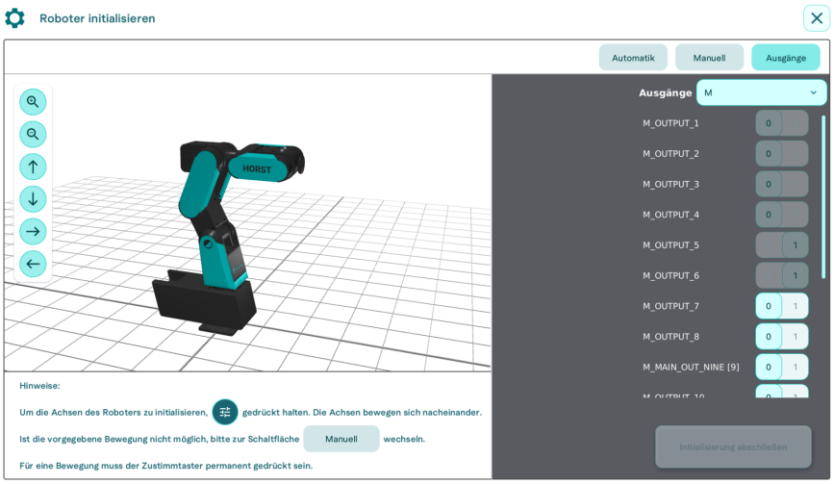


*Fig. 40: **Initialize robot** menu **- Outputs***

⇒ The **Complete initialization** button is activated and can be confirmed.

7 Operation

Information on operating the horstOS software can be found in the fruitcore knowledge base.
Before programming waypoints, make sure that the system has reached operating temperature. Thermal expansion in the robot system can lead to position deviations.

▶ Switch on the robot system at least 30 minutes before programming.

7.1 Safety instructions for operation

DANGER!
Possible personal injury due to incorrect commissioning

▶ Ensure that all commissioning requirements are met and that all instructions have been followed.
▶ Within a permanently installed protective device, the mounting surface of the robot must be stationary.
▶ Do not expose the robot system to permanent magnetic fields. Very strong magnetic fields can damage the robot system.
▶ Do not enter the danger zone of the robot during operation and do not touch the robot.
▶ Only operate the robot system if it is undamaged. The robot system must be checked at least once per working day/shift for externally visible damage and defects. Any changes or damage must be reported immediately to the person or department responsible.
    ⇒ In the event of malfunctions, shut down the robot system immediately and secure it against restarting, including by third parties. Report any malfunctions immediately to the person responsible for operation and rectify them or have them rectified if necessary.
▶ Never modify the robot system. Fruitcore robotics excludes any liability if the product has been modified.
▶ Check the emergency stop and safety stop functions daily.
▶ Only perform switch-on and switch-off operations in accordance with this manual.
▶ Make sure that only the connected panel is in the vicinity of the robot to avoid confusion with inactive emergency stop buttons.

7.2 Operating modes

The robot can be operated in 3 operating modes:

– Teaching T1 (manual operation with reduced speed)
– Teaching T2 (manual operation at high speed)
– Automatic mode

The operating modes are changed using the operating mode selector switch on Control, which is designed as an operating mode selector switch.

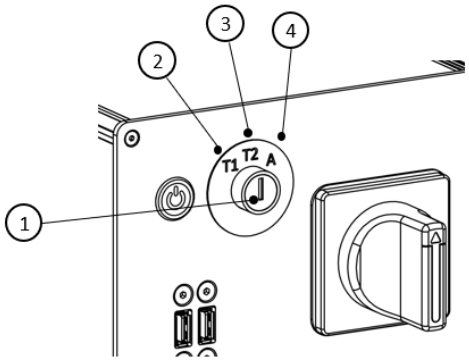


Fig. 41: Operating mode selector switch

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

7.2.1 External operating mode selector switch

A Molex MicroFit socket of type 43640-0300 is provided on Control for connecting an external operating mode selector switch. The matching mating connector is, for example, MOLEX 43645-0300. If an external operating mode selector switch is connected, the internally installed selector switch must remain in position T2.

The following **truth table** shows which combination of voltages must be applied to the contacts in order to set the respective operating mode. **(0 = 0 V or open, 1 = 24 V)**

Operating mode	DI_ROBOT_MODE_1	DI_ROBOT_MODE_2
A	0	1
T1	1	0
T2	0	0

7.2.2 Teach mode

WARNING!
Risk of impact and crushing due to robot movements. The safety stop function is deactivated during teaching.

- ▶ In teach mode, cordon off the area around the robot and secure it against access by unauthorized persons. No persons may be in the danger zone of the robot.
- ▶ Secure the panel and control against operation by unauthorized persons in teach mode.

The robot can only be moved manually in two-handed mode. To move the robot, the enabling switch must always be held down in the middle position in operating modes T1 and T2. In addition, the desired control element on the display must be held down. As soon as one of the two conditions is no longer met, the robot brakes to a standstill.

- ▶ Switch on the robot system (see section 6.1).

Changing the operating mode causes the robot to stop. A warning message appears on the display. To continue, the message must be confirmed. In the meantime, the enabling switch must be released.

Teach mode can be carried out in two operating modes: T1 or T2.

T1 - Programming mode

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

T2 - Program verification operation

The TCP speed is not limited. The robot can only be moved with an enabling switch.

- ▶ Set the operating mode selector switch on the Control to T1 or T2. Remove the key to prevent unauthorized persons from switching over.
  - ⇒ Confirm the change of operating mode (the enabling switch must be released).
  - ⇒ Create, edit or execute a program.

7.2.3 Automatic mode

In automatic mode, programs are executed automatically. The robot moves without an enabling switch and the safety stop input is active.

Danger!
Risk of impact and crushing due to robot movements

- ▶ Make sure that nobody is inside the protected area.
- ▶ Ensure that suitable protective devices are installed and active. Check that the protective devices are functioning properly.

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

- ▶ Before starting automatic operation, it must be ensured that the program to be executed has been correctly programmed and tested.

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

- ▶ Do not make any changes to the program in automatic mode.
- ▶ Make sure that no unauthorized persons have access to the panel.

▶ Set the operating mode selector switch on Control to automatic. Remove the key to prevent unauthorized persons from switching over.

Changing the operating mode causes the robot to stop. A warning message appears on the display. To continue, the message must be confirmed. In the meantime, the enabling switch must be released.

▶ Create, edit or execute a program.

7.3 Shutdown after end of operation

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

⇒ The robot brakes immediately.

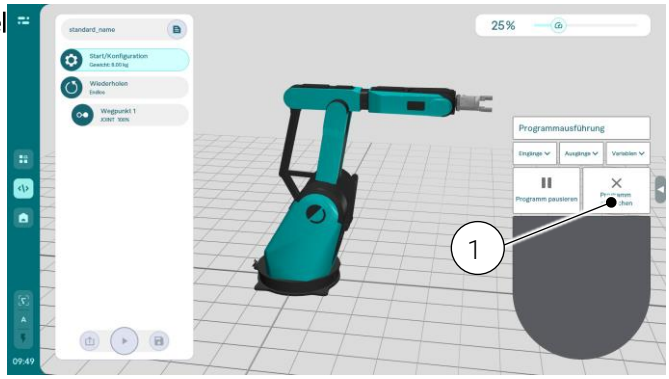


Fig. 42: Cancel program execution

▶ Check that the robot is in a safe position (e.g. no more workpiece in the gripper).
▶ If necessary, bring the robot into a safe position by moving it manually.

ATTENTION!
Before switching off the robot system, a proper shutdown of the computer integrated in Control for the software (horstOS) must be ensured.

▶ Navigate to the main menu. Tap the Exit horstOS button there. A pop-up window appears with two selection options. Select the Shut down system option here and then confirm with the OK button.

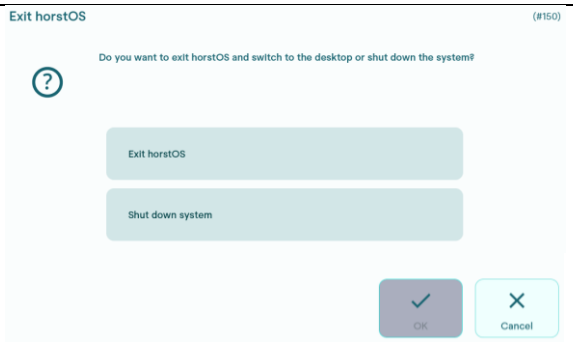


Fig. 43: Shutting down the computer

▶ Alternatively, you can also shut down the computer integrated in Control for the software (horstOS) as follows:
▶ Press the PC ON/OFF button (see4.2.2) on Control. A pop-up window appears. In this pop-up window, tap the Shut Down button (1) to shut down the computer.
▶ Switch the main switch on the Control to OFF.
▶ Secure the main switch with a lock.

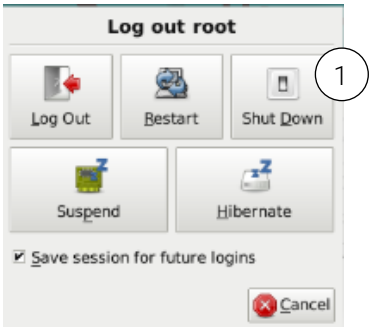


Fig. 44: Alternative shutdown

8 Emergency and troubleshooting

8.1 Behaviour in an emergency

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

When integrated into a complete system, the robot system must be integrated into the emergency stop circuit of the higher-level system. Follow the instructions at5.6.2

Emergency stop: Stop category 1

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

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

▶ Eliminate the hazardous situation.

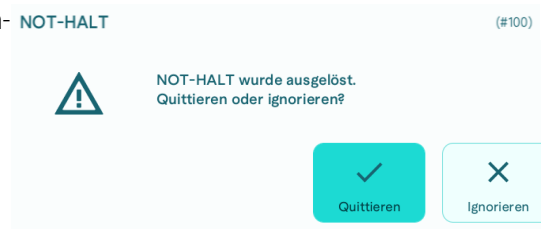


Fig. 45: EMERGENCY STOP message

Resetting the emergency stop

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

▶ Unlock the emergency stop button by pulling it out.

⇒ The Acknowledge button is activated.

▶ Acknowledge the warning message on the display.

⇒ If the emergency stop has been reset, the program will only continue to run as soon as it is resumed manually.

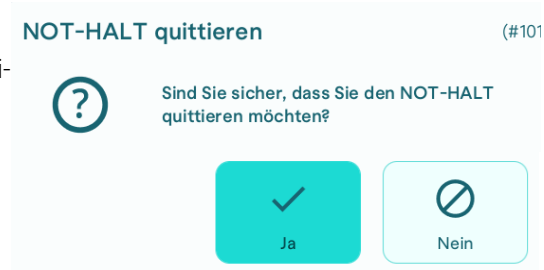


Fig. 46: EMERGENCY STOP - Confirm acknowledgement

8.1.1 Emergency operation - moving the robot without drive power

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

DANGER!
By acting hastily in emergency situations

▶ Before the procedure, be aware of whether and which axle(s) must be moved in which direction in order to solve the existing emergency situation.

▶ Make sure that no part of your body can get between the robot's moving axes.

WARNING!
Risk of impact and crushing due to robot movements. The release of residual stresses or gravity can lead to unintentional robot movements.

▶ Secure the robot arm against unintentional movement.

WARNING!
Risk of impact and crushing due to unexpected robot movements

- ▶ If necessary, remove workpieces from the gripper.
- ▶ Disconnect the robot system from the power supply.
- ▶ Disconnect any mounted, compressed air-operated tools from the compressed air supply.

DANGER!
Defective and damaged components and assemblies / incorrect assembly

The robot system must not be restarted after loosening the tensioning sets. Incorrect assembly can cause the belts to break.

- ▶ Contact fruitcore robotics.

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

WARNING!
Danger due to damaged assemblies as a result of emergency operation

If the robot arm was moved manually in an emergency, components of the robot system may have been damaged. This may result in uncontrolled start-up.

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

If the robot cannot be moved with force, it is possible to loosen the tensioning set of the belt so that the arm can move freely.

DANGER!
Risk of impact, crushing and shearing due to the robot arm falling down. The robot arm collapses when the clamping set is released.

- ▶ Secure the robot arm against this.

- ▶ Remove the covers (1) of the belt drives on both sides using a suitable screwdriver.
- ▶ Attention: This action voids the warranty and the robot system may only be restarted after consultation with fruitcore robotics.

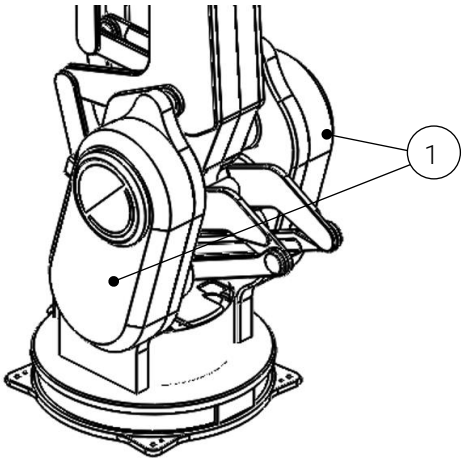


Fig. 47: Belt drive cover

(2) - Strap
(3) - Clamping set

- ▶ Loosen the clamping set (3) at the four clamping screws or the hexagon nut. (If the clamping set does not loosen automatically, this can be achieved by applying pressure or light blows to the loosened screws).

  ⇒ The robot arm can now be moved manually.

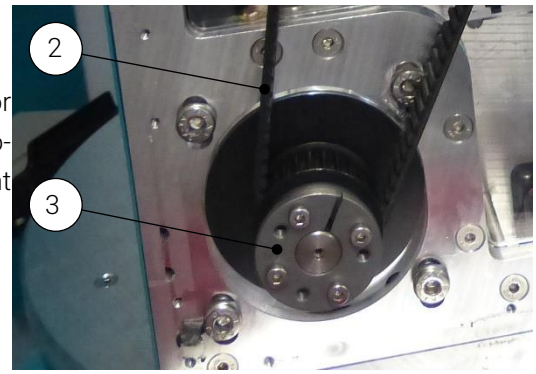
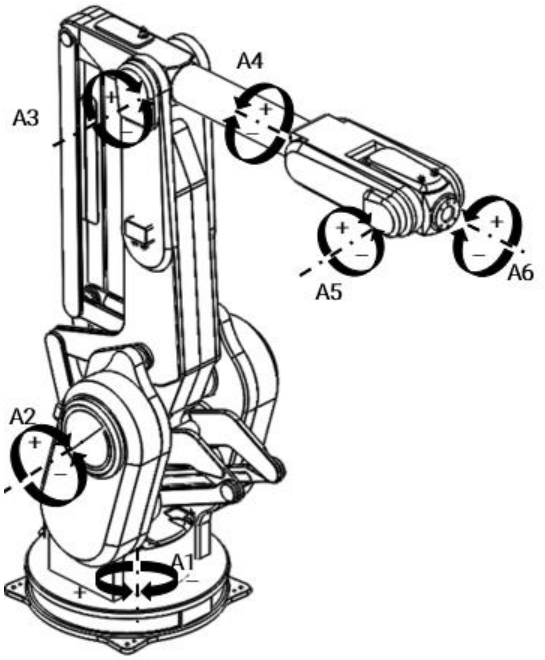


Fig. 48: Clamping set (Fig. similar)

8.1.2 Emergency operation - moving the robot by freewheeling

DANGER!
By acting hastily in emergency situations

- ▶ Before the procedure, be aware of whether and which axis(es) must be moved in which direction in order to solve or improve the existing emergency situation.
- ▶ Please refer to the adjacent illustration.
- ▶ Move the robot in Free Driving mode in small steps until the emergency situation is resolved.



8.2 Troubleshooting

DANGER!
Danger due to incorrect troubleshooting

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

If faults occur in the robot system, corresponding error messages (system errors) are displayed on the panel.

- ▶ Follow the instructions on the panel to rectify the cause of the error.
- ▶ Acknowledge the error message on the display when all causes of the error have been eliminated.
- ▶ Create a service ticket at *https://horstcosmos.com/service* if you cannot rectify the cause of the error yourself.

In the event of software problems, switch off the robot system as described in section and switch it on again as described in section6.1 .

If step losses occur due to overloading or blocking of the robot arm, the parking brakes are automatically activated. After 250 step losses or "overloads", safe operation of the brakes can no longer be guaranteed. Please contact fruitcore robotics.

The number of overloads is logged in the settings and information under Robot system data in horstOS (see adjacent figure).

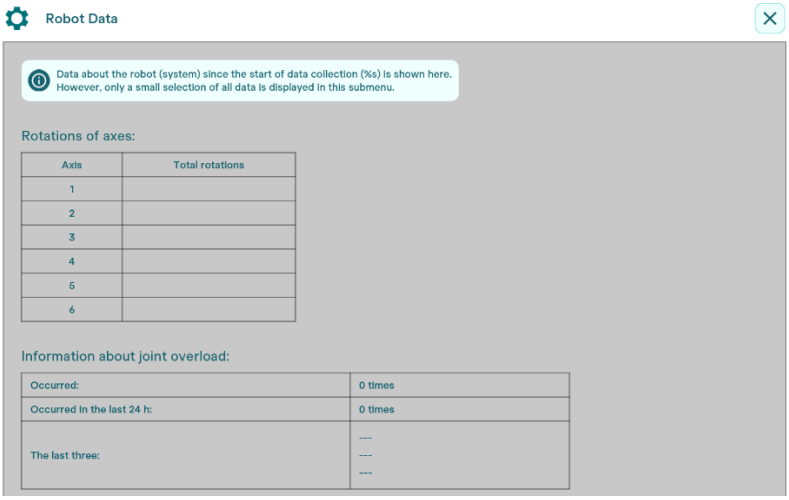


Fig. 49: Overloading the robot

DANGER!
Danger due to incorrect maintenance and brake failure

- ▶ Regularly check the load changes of the brakes via *Settings & info > Robot data > Robot system data*
- ▶ After the permissible load cycles of the parking brake have expired, contact fruitcore robotics service to have the brakes checked professionally.

8.2.1 Remote access for servicing

DANGER!
Danger due to incorrect troubleshooting

- ▶ Always follow the instructions of the service personnel and only enter the robot's movement area when instructed to do so.
- ▶ If a dangerous situation arises during remote access, press the emergency stop button! All movements are stopped and the connection to TeamViewer is terminated.

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

Connection setup

TeamViewer can be started in horstOS via *Settings & info > Service & remote access*.
The TeamViewer window opens so that the ID and password can be passed on to the service staff. The password is regenerated for each session.
Once the connection has been established, local control is automatically deactivated. A red border with red lettering "Remote access active" on the panel indicates that remote access is currently activated.

The following security measures are active during remote access:

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

8.2.2 Error examples

Error	Index	Description	Cause	Solution
ROBOT_JOINT_ OVERLOAD	Joint	Load on axle too high	Specified weight is not correct	Check weight Observe maximum load
			Collision	Check program
BUS_DRIVER_ DISCONNECT	Joint	Motor driver does not respond	Defective bus cable	Replace bus cable
			Defective motor driver	contact fruitcore robotics
BUS_ENCODER_ DISCONNECT	Joint	Encoder does not respond	Defective bus cable	Replace bus cable
			Defective encoder	contact fruitcore robotics
CROSS_COMP_ SAFETY_INPUT-3	Safety Input	States of the safety channels A & B (KL1 & KL2) differ	Enabling switch not pressed properly in the centre position	Check the control panel; Correct actuation of the enabling switch
CROSS_COMP_ SAFETY_INPUT-4 to 7			Channel A & B different→ Faulty connection, cable break or similar.	Check wiring; check cables for damage
POWER_24V_IO_ NOT_GOOD	-	Short circuit in the IO circuit	Short circuit from 24 V to GND	Check wiring; check cables for damage
SAFETY_REDUCED_ VELOCITY_EXCEEDED	-	Speed limit has been exceeded (reduced speed)	Speed of 250mm/s was exceeded	Check the configuration settings of the security scanner and horstOS
SAFETY_ STANDSTILL_ VIOLATION	-	Robot has moved during standstill monitoring	Robot was moved although no movement was to be executed	Checking the function of the brakes
SAFETY_IO_OSSD_ FAILED_INPUT	Safety Input	An OSSD pulse on a safety input on a safety input could not be read back	Cross circuit or short circuit on OSSD cable	Check wiring; check cables for damage
SAFETY_IO_OSSD_ FAILED_OUTPUT	Safety Output	OSSD pulse on a safety output could not be read back	Cross circuit or short circuit on OSSD cable	Check wiring; check cables for damage
SAFETY_IO_ READBACK_CH_A	Safety Output	Read-back failed for a safety output, channel A/B	Short circuit to 0, unexpected value is present at the safety outputs (0 instead of 1 or vice versa), channel A or B	Check wiring; check cables for damage
SAFETY_IO_ READBACK_CH_B				
SAFETY_IO_ EXT_READBACK_A	Safety Output	External read-back failed for a safety output, channel A or B	Read-back channel is activated in horstOS, signal faulty, channel A or B	Check wiring; check cables for damage
SAFETY_IO_ EXT_READBACK_B				
BUS_DRIVER_DISCONNECT2-6 BUS_ENCODER-DISCONNECT 2-6 USER-IO_ DISCONNECT	Joint	If these errors occur together and cannot be acknowledged	Short circuit on 48V line, Short circuit on slip ring Short circuit on BUS subscriber	Check left micro fuse on robot base (only applies to H600) Contact fruitcore robotics
BUS_DRIVER_DISCONNECT_1 BUS_ENCODER_DISCONNECT_1	Joint	Encoder and motor driver do not respond	Short circuit on 48V line, Short circuit on slip ring Short circuit on BUS subscriber	Check right micro fuse on robot base (only applies to H600) Contact fruitcore robotics

9 Cleaning and maintenance



RISK OF CRUSHING, IMPACT AND CUTTING!

Possible personal injury due to collapse of the robot arm due to belt breaking.

If the power supply to the robot system is stopped, the motor brake of the respective robot axis takes effect. Due to the elasticity of the belt drives, they can still move slightly. Manual intervention can therefore lead to injuries even when the system is at rest.

If a belt breaks unexpectedly, the robot arm can collapse.

- ▶ During maintenance work, the robot arm must be adequately secured against collapsing. Do not stand under the robot arm.
- ▶ Do not reach into the linkage or between the axes of the robot system at any time.



DANGER OF PARTS BEING EJECTED!

Possible personal injury due to unexpected ejection or dropping of parts

- ▶ Ensure that tools or components are securely attached to the robot.
- ▶ If necessary, remove workpieces from the gripper before cleaning and maintenance.

9.1 Cleaning

The components become dirty depending on the ambient conditions of the robot system:

⇒ fruitcore robotics recommends weekly cleaning.



Wear protective clothing!

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



CAUTION!

Danger of machine damage

- ▶ Do NOT clean the control and panel with compressed air.
- ▶ Do not use any aggressive, flammable or abrasive liquids/cleaning agents.
- ▶ Prevent liquids from entering the system.
- ▶ Remove dust, shavings and other particles with a vacuum cleaner or a clean cleaning cloth, NOT with compressed air.



Environmental protection!

- ▶ Dispose of the waste and used cleaning cloths in an environmentally friendly manner.

9.2 Maintenance and repair



DANGER!

Danger due to incorrect maintenance and repair

- ▶ Maintenance may only be carried out by persons with technical and electrotechnical training.
- ▶ Repairs to the robot system may only be carried out by fruitcore robotics.



DANGER!

Danger due to electric shock

- ▶ Connection and work on the electronics may only be carried out by qualified electricians.

WARNING!
Risk of impact and crushing due to unexpected robot movements

- ▶ Disconnect the robot system from the power supply and the compressed air supply before carrying out cleaning and maintenance work.
- ▶ Put up warning signs and cordon off the danger zone and secure it, panel and control against access by unauthorized persons.
- ▶ If necessary, remove workpieces from the gripper before cleaning and maintenance.

WARNING!
Danger due to missing protective devices and defective / damaged assemblies or accessories

- ▶ After completing the work, reinstall all protective devices. Check all assemblies and accessories and carry out a test run with the entire system to check that it is working correctly.

Refer to this manual and, if applicable, the accompanying documentation for the maintenance work on the robot system. Always adhere to the prescribed maintenance and inspection intervals.
Spare parts must comply with the technical requirements specified by fruitcore robotics. This is always guaranteed for original spare parts.

- ▶ If there is a service contract with fruitcore robotics, care must be taken to ensure that the robot system data is continuously transferred to horstCOSMOS.

⇒ If there is no service contract, all maintenance work must be ordered independently from fruitcore robotics. If the following deadlines are not met, safe and error-free operation cannot be guaranteed and liability for any events arising in this connection shall lapse.

The robot system is designed for a service life of 50,000 hours, which corresponds to a service life of 10 years with an annual operating time of 5,000 hours.
If the maximum permissible number of braking operations during movements is not exceeded (see section 8.2), the service life of the brakes is equal to that of the entire system.

Task	Interval
Check the entire robot system (robot arm + control) for external damage	weekly
The emergency stop function must be function-tested	weekly
Check all accessible screws for tightness and retighten if necessary	monthly
Function test of the safety inputs/outputs	monthly
Check the ventilation filters for dirt and vacuum if necessary	monthly
Function test of all terminals	Half-yearly

10 Storage

If the robot system is stored for later use or taken out of service, it must be protected with suitable packaging. The robot system must be stored in a dry, frost-free place, protected from precipitation and strong temperature fluctuations.

- ▶ Shut down the robot and dismantle it like described in the manuals.
- ▶ Pack robots, controls and panels securely.

11 Dismantling and disposal

11.1 Dismantling

- ▶ Move the robot to the transport position, see second part (robot part) of this manual.
- ▶ Shut down the robot as described in the section 7.3 .
- ▶ Dismantle or secure attachments if necessary.
- ▶ Disconnect and remove electrical and pneumatic lines from the power supply if necessary.
- ▶ Disconnect the connection cable between the robot and the Control.
- ▶ Dismantle the robot.

11.2 Waste disposal



Danger of environmental damage!

All parts of the robot system must be disposed of in such a way as to prevent damage to health and the environment.

- ▶ Dispose of all parts of the machine in such a way as to prevent damage to health and the environment. Pay attention to the materials used. Old devices can also be registered for return to fruitcore robotics via a request to service@fruitcore.de in accordance with the Electrical and Electronic Equipment Act.

Materials used

Material	Unit
Copper	Cables
Steel, aluminium	Assemblies of the robot
Plastic, rubber, PVC	Toothed belt
Electronic waste	Control, panel, power electronics, main board, motor driver, fan, rotary encoder

12 Appendix

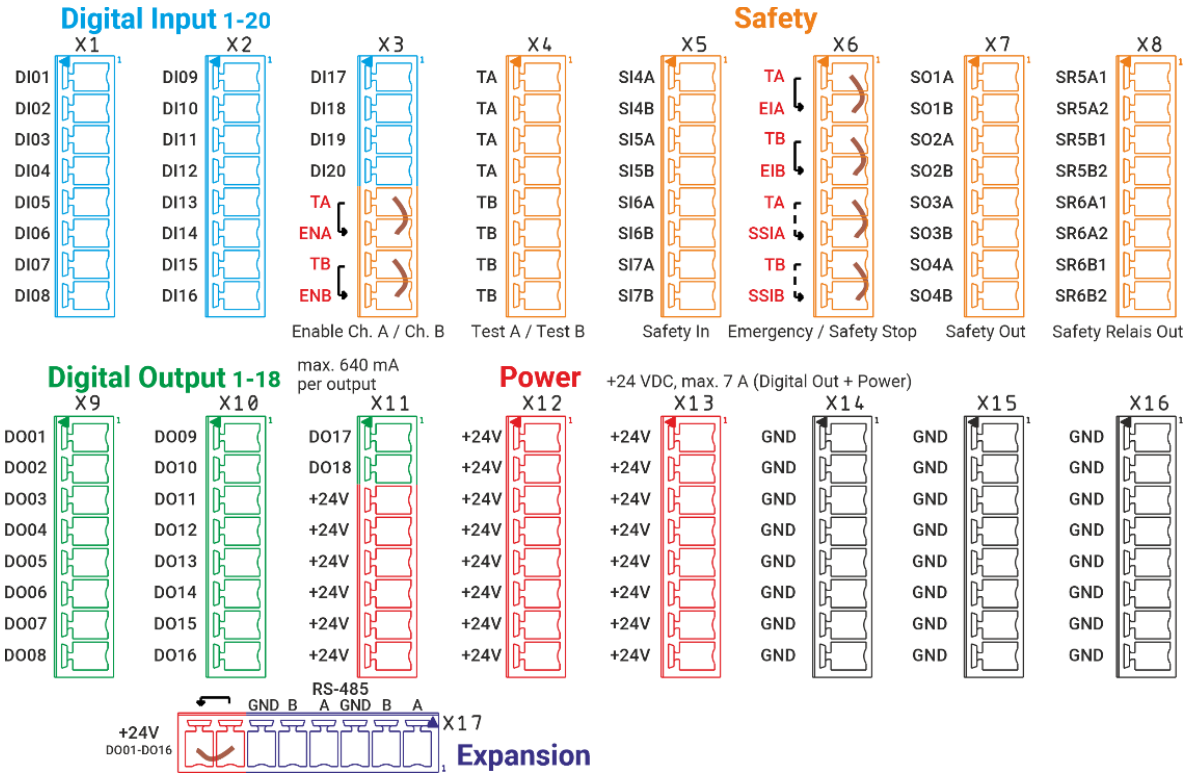
12.1 Technical Data

Control	
Dimensions (LxWxH)	460 x 315 x 175 mm
Weight	9 kg
Protection class	IP20
HORST cabling	Cable between robot and control 3.0 m
Wiring panel	DVI-D 24+1, 5.0 m
Mains cable	5 m, CEE 7/4 / IEC-60320 C13, with pull-off fuse
Power supply	115/230 VAC, 50 - 60 Hz, max. 6.0 A (at 230 V)
Power consumption	max. 1000 W
Protection	6.3 A (2x)
Communication	TCP/IP 100 Mbit Ethernet (web interface / http)
Security-relevant interfaces	Emergency stop, safety stop, enabling switch +4 safe inputs, +6 safe outputs (2 relays)
I/O connections on Control	20 inputs, +8 configurable 18 outputs, +8 configurable, +4 relay contacts
I/O connections for attachments on the support arm	2x 2 inputs/outputs

Control panel	Panel V1	Panel V2
Dimensions (LxWxH)	340 x 245 x 85 mm	330 x 255 x 95 mm
Weight	1.9 kg	1.9 kg
Protection class	IP20	IP54
13.3" touchscreen display resolution (pixels)	1920 x 1080 (HD)	2560 x 1600 (2K)
Device for wall, table or cell mounting	Yes	Yes

Ambient conditions	
Ambient temperature	5 - 40 °C
Relative humidity	10 % - 75 %
Operation in potentially explosive environments	prohibited
Height above sea level	up to 1000 m without power reduction

12.2 Plug overview



PLUG	DESCRIPTION	PLUG	DESCRIPTION
X1	Digital inputs 1-8	X10	Digital outputs 9-16
X2	Digital inputs 9-16	X11	Digital outputs 17-18, +24 V
X3	Digital inputs 17-20, Enable (enabling switch)	X12	+24 V
X4	Test signal A / B	X13	+24 V
X5	Safe inputs 4-7	X14	Mass
X6	Emergency stop / safety stop	X15	Mass
X7	Safe outputs 1-4	X16	Mass
X8	Safe outputs 5-6 (potential-free)	X17	RS-485, bridge +24 V
X9	Digital outputs 1-8		

12.3 Terminal assignment

Clamp	Occupancy	I/O	safe	Description.
X1.1 ... X1.8	DI01 ... DI08	E	✗	General digital inputs 1-8
X2.1 ... X2.8	DI09 ... DI16	E	✗	General digital inputs 9-16
X3.1 ... X3.4	DI17 ... DI18	E	✗	General digital inputs 17-20
X3.5	ENA	A	✓	Test signal f. Enabling switch, channel A
X3.6	ENA	E	✓	Enabling switch input (SI3A), channel A Standard: Bridge to X3.5
X3.7	ENB	A	✓	Test signal f. Enabling switch, channel B
X3.8	ENB	E	✓	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	E	🔧	Configurable safe input 4, channel A
X5.2	SI4B	E	🔧	Configurable safe input 4, channel B

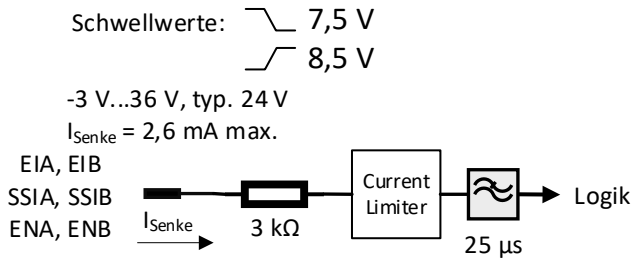
Clamp	Occupancy	I/O	safe	Description.
X5.3	SI5A	E		Configurable safe input 5, channel A
X5.4	SI5B	E		Configurable safe input 5, channel B
X5.5	SI6A	E		Configurable safe input 6, channel A
X5.6	SI6B	E		Configurable safe input 7, channel B
X5.7	SI7A	E		Configurable safe input 8, channel A
X5.8	SI7B	E		Configurable safe input 8, channel B
X6.1	EIA out	A		Test signal f. Emergency stop, channel A
X6.2	EIA in	E		Emergency stop input (SI1A), channel A Standard: Bridge to X6.1
X6.3	EIB out	A		Test signal f. Emergency stop, channel B
X6.4	EIB in	E		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	E		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	E		Safety stop input (SI2B), channel B Standard: Bridge to X6.7
X7.1	SO1A	A		Configurable safe output 1, channel A
X7.2	SO1B	A		Configurable safe output 1, channel B
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 safe output 4, channel B
X8.1	SR5A1	A		Config. safe output 5, potential-free contact A1
X8.2	SR5A2	A		Config. safe output 5, potential-free contact A2
X8.3	SR5B1	A		Config. safe output 5, potential-free contact B1
X8.4	SR5B2	A		Config. safe output 5, potential-free contact B2
X8.5	SR6A1	A		Config. safe output 6, potential-free contact A1
X8.6	SR6A2	A		Config. safe output 6, potential-free contact A2
X8.7	SR6B1	A		Config. safe output 6, potential-free contact B1
X8.8	SR6B2	A		Config. 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		Mass
X15.1 ... X15.8	GND	A		Mass
X16.1 ... X16.8	GND	A		Mass
X17.1	RS485_A	I/O		RS-485 extension port #1, signal A
X17.2	RS485_B	I/O		RS-485 extension port #1, signal B
X17.3	GND	A		Mass

Clamp	Occupancy	I/O	safe	Description.
X17.4	RS485_A	I/O		RS-485 extension port #2, signal A
X17.5	RS485_B	I/O		RS-485 extension port #2, signal B
X17.6	GND	A		Mass
X17.7	+24V_out	A		Power supply output DO01-16
X17.8	+24V_in	E		Input power supply DO01-16 Standard: Bridge to X17.7
Legend	Safe I/O	non-safe I/O		Configurable I/O

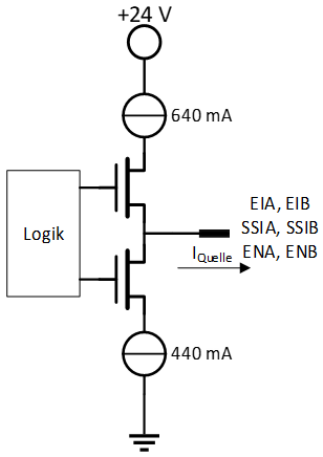
12.4 Functional diagrams of electrical interfaces

12.4.1 Control I/O

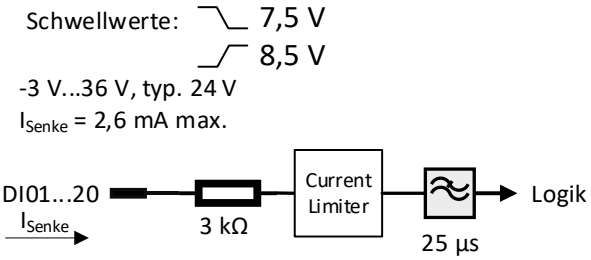
Safety Input



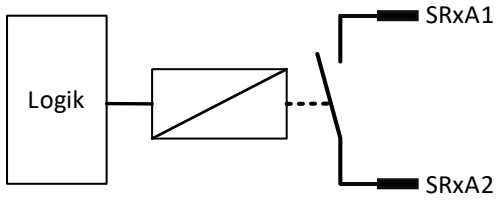
Safety Output



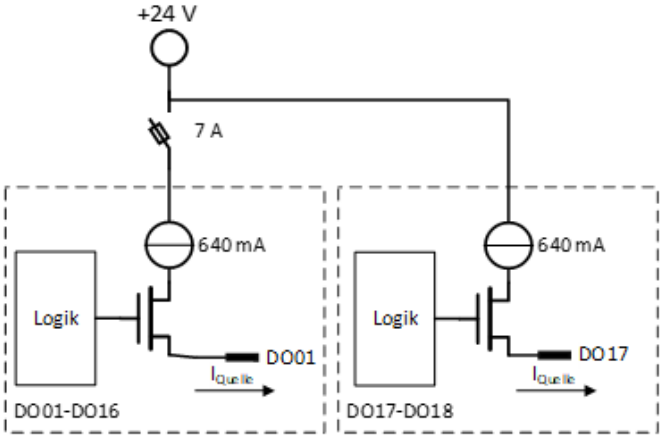
General digital input



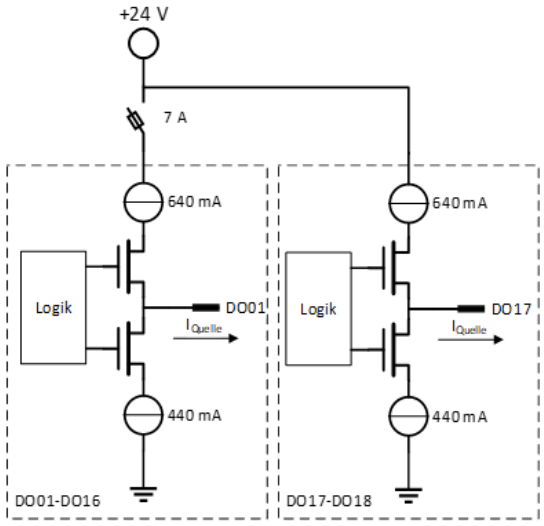
Floating output



General digital output (high-side)

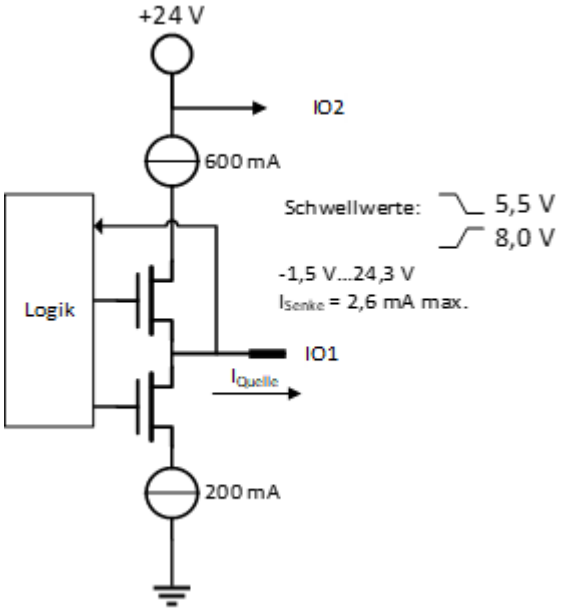


General digital output (push-pull)



12.4.2 Tool I/O

Digital input/output



12.5 Spare parts & accessories

Spare parts such as panels, cables or support arms can be ordered from fruitcore robotics on request. The following accessories can also be purchased from fruitcore robotics:

Component	Remark
Tool flange	
Accessory flange plate	
Mechanical stop Axis2	free of charge
Mechanical stop Axis3	free of charge
Extended cable robot - control (umbilical cord)	6m / 10m

12.6 WIFI-Stick

You can use the WIFI-Stick (TP-LINK TL-WN722N) to make your Control WIFI-compatible. This stick allows you to connect the robot to a wireless network. Configuration is carried out via the network settings in horstOS, where you can select the WIFI and enter the password.

12.7 Information on the enclosed USB surf stick

The enclosed USB surf stick allows you to go online with the robot system without having to integrate it into your company network. This means that system and process data can be regularly transferred to the IIoT platform horstCOSMOS and viewed there. In addition, fruitcore service technicians can access your robot system directly via TeamViewer when servicing is required.
The use of the USB surf stick does not incur any additional costs for you. It is up to you whether you want to use the USB surf stick permanently, only for servicing or not at all. The robot system can also be operated normally without using the USB surf stick.

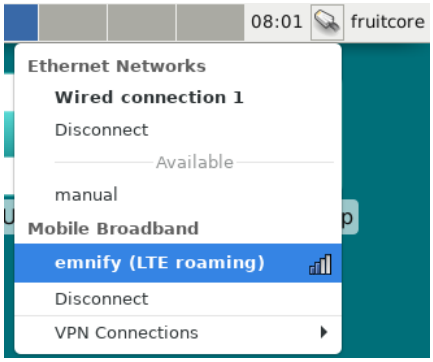
Installation



The USB surf stick is preconfigured and already equipped with a SIM card. It can therefore be put into operation within a few minutes.

- ▶ Insert the USB surf stick into one of the two free USB ports on the back of the Control.
- ▶ It flashes red when plugged in. The connection setup starts automatically, which is indicated by faster red flashing. Once the connection has been successfully established, the USB surf stick flashes blue once per second.
- ▶ About three minutes after switching on Control, the USB surf stick is available and connected to the Internet.

Connection problems



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

13 Glossary

Stop category 0

Stopping is achieved by immediately interrupting the energy supply to the drive elements. This uncontrolled stopping can cause the robot to deviate from its programmed path. Further information on this can be found in EN ISO 13850 or DIN EN 60204-1.

Stop category 1

Stopping is achieved by active braking, as the energy supply to the drive elements is initially maintained. The energy supply is only disconnected once the robot has stopped. This is a controlled stop in which the robot does not leave its programmed path. Further information on this can be found in EN ISO 13850 or DIN EN 60204-1.

Stop category 2

Stopping is achieved by active braking (controlled stopping), and the energy supply to the drive elements is maintained after the stop. The safe control system monitors the standstill. Further information on this can be found in DIN EN 60204-1.

Performance level

The Performance Level (PL) describes the ability of safety-related parts of a control system to perform safety-relevant functions under foreseeable conditions. On the other hand, the required performance level is used to achieve the necessary risk minimization for individual safety functions. Therefore, the performance level of safety-related parts of a control system must be at least as high as the required performance level. Performance level "d" is the second-highest reliability classification. Further information on this can be found in DIN EN ISO 13849-1.