MyCo Robot Series

Comau Cobot
Electrical Manual



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Instruction Handbook

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SUMMARY

Introduction **3**
How to Use this Manual 3
Safety Advice for Users 3
Comau Service Center 4
Contact Details 4
Modification History **5**
1. Safety Matters **6**
Warning Signs 7
Safety 8
Introduction 8
Safety Precautions 8
Overview 8
Instructions for Use 9
For installation Operations 9
Operational and Thermal Aspects 10
Usage 10
Application Environment 11
Personnel Security 11
Responsibilities and Norms 12
Hazard Identification 13
Intended Use 13
Dealing with Emergencies 14
Emergency Stop 14
Recovery from Emergency 15
Emergency Movement of Forced Joints 15
Robotic Body Overpowering Safety Protection 15
Braking Distance and Braking Time 15
Handling and Precautions 16
Other Potential Risks 16
Repair and Maintenance Instructions 16
2. Mechanical Installation **18**
Unpacking 19
Installation Environment Requirements 19
Installation Space 20
Connection Cables 20
Description of External Interfaces and Connections 21

Control unit I/O Overview 23
Common Specification for All Digital I/O 24
Safety I/O 24
Default Security Configuration 24
Connecting the Emergency Stop Button 25
Communication with Other Machines or PLC 26
Share emergency stop with other machines 26
Non-auto reversible protection stop 27
Protective stop with reset button for automatic recovery 27
Building Generic Digital I/O 27
General Analogue I/O 29
Use of Analogue Outputs 29
Use of Analogue Input 30
Remote On/Off Control 30
Safety Barriers 31
Description of the IO Interface at the End of the Robot 31
Internal power supply specifications: 32
Digital output (Type: PNP) 32
Digital input (PNP) 33
Analogue input 33
2.11.5 33
3. Teach Pendant 35
The Start-up Process 36
4. Glossary 37

Introduction

This chapter contains:

– How to Use this Manual
– Safety Advice for Users
– Comau Service Center
– Contact Details

How to Use this Manual

This manual is intended for operators of the Comau S.p.A. range of robots who have some electrical and programming knowledge. The manual will guide the operator in the use of the Comau S.p.A. in the following areas.

– Safety matters: The operator should remember all safety instructions.

– Mechanical installation: The operator is guided through the installation of the robot.

– Electrical interface: Comau S.p.A.'s open interface is introduced to facilitate secondary development.

  - Software control: The operator is guided through the installation and operation of the software.

  - Safety configuration: The basic safety settings are described.

In this manual, all electrical interfaces of the robot arm and control unit are described. These interfaces are divided into five categories, each with a different purpose and properties: 1. control unit I/O; 2. tool I/O; 3. Ethernet; 4. power connection; 5. robot connection. The term "I/O" refers to the digital and analogue control signals to and from the interface.

Safety Advice for Users

There is a potential risk during operation in collaborative mode. It is the integrator's or user's responsibility to acknowledge the manufacturer's warnings, evaluate the risks associated with their specific application (as example: specific mechanical tools, grippers, etc.), and take all necessary precautions to avoid potential hazards. This includes configuring the robot's speed and sensitivity thresholds appropriately to ensure safe collaborative behavior.

The manufacturer disclaims all responsibility for any injury, accident, or damage to persons or property caused by improper use of the robot.

Comau Service Center

In case of need it is possible to contact the Comau Service Centre at the following addresses:

Sector	Address	Service provided
Service	https://www.comau.com/en/contact-us/after-sales/	Assistance in troubleshooting and software options request
		To require spare parts
		To require repair activities

Contact Details

Address: Via Rivalta, 30, 10095 Grugliasco (TO), Italy

Website: https://www.comau.com/

Modification History

Date	Edition of the Handbook	Contents
2025-08	00/2025.08	First release of the handbook

Safety Matters

This chapter contains the following topics:

- Warning Signs
- Safety
- Responsibilities and Norms
- Intended Use
- Dealing with Emergencies
- Braking Distance and Braking Time
- Handling and Precautions
- Other Potential Risks
- Repair and Maintenance Instructions

1.1 Warning Signs

The following different levels of safety markings will appear in this manual.



Danger: Failure to follow instructions can result in death or serious injury.



Warning: Failure to follow instructions can result in injury to persons or serious damage to the equipment.



Caution: Failure to follow the instructions may result in damage to the appliance.

1.2 Safety

1.2.1 Introduction

This chapter describes the safety principles and regulations that should be observed when operating a robot or the system of robot. This manual must be read carefully by the integrator and the user, with the warning signs being highlighted and strictly observed. Due to the complex and dangerous nature of robotic systems, users need to be fully aware of the risks involved in operating them and to comply with and enforce the specifications and requirements in this manual. Users and integrator need to be fully aware of the safety aspects and comply with ISO 10218, the safety standard for industrial robots.

Comau S.p.A. robots are equipped with a wide range of built-in safety functions as well as safety I/O, digital and analogue control signals to and from the electrical interface for connection to other machines and additional protection devices.



Note:

- The use and configuration of safety features and interfaces must follow the risk assessment procedures for each robot application.
- If the robot detects a fault or violation in the safety system (e.g. a wire in the emergency stop circuit is cut or a safety limit violation occurs) the robot will immediately cut off the power and stop.
- Stopping time should be considered as part of the application risk assessment.



Danger:

- The use of safety configuration parameters that differ from those identified in the risk assessment can result in hazards that cannot reasonably be eliminated or risks that cannot be adequately mitigated.
- The connection of the tool and jaws is ensured to be correct to avoid danger in the event of a power interruption.
- The end-effector is not protected by the safety system of Comau S.p.A., Ltd. The end-effector and/or the function of the connection cable are not monitored.

1.3 Safety Precautions

1.3.1 Overview

This manual contains safety measures to protect the user and to prevent damage to the machine. The user needs to read all the relevant descriptions in the manual

and be fully familiar with the safety matters. In this manual, we have tried to describe as many situations as possible. However, as there are so many possibilities, it is not possible to document all the situations that cannot or should not be done.

1.3.2 Instructions for Use

The following basic information needs to be understood and followed when starting up a robot or the system of robot for the first time, and other safety-related information is described elsewhere in the manual. However, it is not possible to be exhaustive and, in practice, specific issues need to be addressed.

1.3.3 For installation Operations



- Always install the robot and all electrical equipment in accordance with the requirements and specifications in these instructions.
- Initial testing and inspection of the robot and its protection system is required before the robot is used for the first time and before it is put into production.
- Before starting up the system and equipment for the first time, the equipment and system must be checked for integrity, safety of operation and any damage detected. Compliance with national or regional safety regulations is to be observed during this test and all safety functions must be tested.
- The user must check and ensure that all safety parameters and user programs are correct and that all safety functions are working correctly. A person qualified to operate the robot is required to check each safety function. The robot must only be started after a thorough and careful safety test has been carried out and the safety level has been reached.
- Specialist personnel are required to install and commission the robot in accordance with the installation standards.
- Once the robot has been installed and built, a full risk assessment will be carried out again and documentation will be kept.
- The security parameters are set and changed by authorized personnel, and passwords or isolation measures are used to prevent unauthorized personnel from changing or setting the security parameters. After the security factor has been modified, the relevant security functions need to be analyzed.



- In the event of an accident or abnormal operation, the robot can be stopped by pressing the emergency stop switch.
- Comau S.p.A. Robots' joint module is fitted with brakes to maintain the robot's stance during power failures.
- Comau S.p.A. Robots have a collision detection function. When the robot is energized by an external force that exceeds the normal range of forces set by the user for safety, the robot will automatically stop to prevent the robot or the operator from being injured in a collision. This feature is specifically designed by

Comau S.p.A. Robots for the safety of human-robot collaboration, but it requires the system of robot to be within normal operating limits and to use the Comau S.p.A. range of control units. If the user develops his/her own control unit, the robot will not have these functions. The user is responsible for the consequences of this hazard.

1.3.4 Operational and Thermal Aspects



- The robot body and control unit generate heat during operation. Do not operate or touch the robot while it is in operation or when it has just stopped working.
- Turn off the power and wait one hour before the machine cools down.
- Do not put your fingers into the hot area of the control unit.

1.3.5 Usage



- Ensure that the robot's arms and tools are correctly and securely fitted in place.
- Ensure that the robot's arms have enough space to move freely.
- If the robot is damaged, please do not use it and contact the technical support of Comau S.p.A.
- Do not connect safety devices to normal I/O interfaces, only use safety I/O interfaces.
- Ensure that the correct installation settings are made (e.g. mounting angle of the robot body, weight in TCP, TCP tool coordinates, safety configuration). Save the installation file and load it into the program.
- Tools and obstacles must not have sharp corners or twisted points. Ensure that the heads and faces of all people are out of reach of the robot.
- Pay attention to the motion of the robot when using the Teach Pendant. Any impact will release a large amount of kinetic energy, which is much higher than at high speeds and high payloads.
- Connecting different pieces of machinery may aggravate hazards or create new ones. Always carry out a thorough risk assessment of the entire installation. When different safety and emergency stop performance levels are required, always select the highest performance level. Always read and understand the manuals for all equipment used in the installation.
- Do not modify the robot. Changes to the robot may cause unpredictable hazards for integrator. The robot is authorized to be rebuilt in accordance with the latest version of all relevant service manuals. If the robot is altered or modified in any way, Comau S.p.A., Ltd. declines all responsibility.

1.3.6 Application Environment



- When the robot is connected to or working with machinery that can cause damage to the robot, it is strongly recommended that all functions of the robot and the robot program are checked separately. It is recommended to use temporary way points outside the working space of other machines to check the robot program.
- Comau S.p.A. is not responsible for damage to the robot or injury to persons caused by errors in the script or improper operation of the robot.
- Do not expose the robot to permanent magnetic fields at all times. Strong magnetic fields can damage the robot

1.3.7 Personnel Security

When operating the system of robot, the safety of the operator must be ensured first and foremost. The following are general precautions to be taken to ensure the safety of the operator.



Each operator using the system of robot should receive training through a training course organized by Comau S.p.A., Ltd Users are required to ensure that they are fully qualified to operate the robot in accordance with safe and standard operating procedures. For more information on training, please contact us at https://www.comau.com/.

- Do not wear loose clothing or jewellery when using the system of robot. When operating the robot, ensure that long hair is tied back behind the head.
- When the machine is in operation, even if the robot appears to have stopped, it may be in a state of imminent motion because it is waiting for a start signal. Even in such a state, the robot should be considered as being in motion.
- Lines should be drawn on the floor to mark the robot's range of motion so that the operator understands the range of motion of the robot including the gripping tools (manipulators, tools, etc.).
- Ensure that safety measures (e.g. guardrails, ropes, or protective screens) are in place near the robot's operating area to protect the operator and the surrounding population. Locks should be installed as necessary so that no one other than the operator can access the robot's power source.
- When using the operating panel and Teach Pendant, it is important to remove gloves before working as gloves may cause operational errors.
- In emergency and unusual situations, such as when a person is caught in or surrounded by the robot, force the joint to move by pushing or pulling on the robot arm with force (at least 500 N). Manual movement of the robot arm without electric drive is limited to emergency situations and may damage the joint.

1.4 Responsibilities and Norms

Comau S.p.A. Robots can form complete machines with other equipment and are not complete in their own right. Therefore, the information in this manual does not cover how to design, install and operate a complete robot comprehensively, and it does not cover all the possibilities that have an impact on the safety of the peripheral equipment of this complete system. The safety of a complete robot installation depends on how the robot is integrated. The integrator is required to carry out a risk assessment of the design and installation of the complete system in accordance with the laws, regulations and safety codes and standards of the country in which it is located. The risk assessment is one of the most important tasks that the integrator must complete and the following criteria can be used to implement the risk assessment process.

- ISO 12100:2010 Safety of machinery - General principles of design - Risk assessment and risk reduction.
- ISO 10218-1:2011 Robotics - Safety requirements - Part 1: Industrial robots
- ISO 10218-2:2011 Robotics - Safety requirements - Part 2: Industrial robot applications and robot cells.
- RIA TR R15.306-2014 Technical report on industrial robots and robotic systems - Safety requirements, task-based risk assessment methods.
- ANSI B11.0-2010 Safety of machinery; general requirements and risk assessment.

Integrator of Comau S.p.A. robots are required to perform, but not limited to, the following responsibilities.



- Comprehensive risk assessment of complete robotic systems;
- Confirmation of accurate design and installation of the entire system;
- Providing training to users and staff.
- Creating a complete and systematic code of practice, with clear instructions on how to use it; establish appropriate security measures.
- Use appropriate methods to eliminate hazards or minimize all hazards to an acceptable level at the time of final installation;
- Communicate the residual risk to the end user.

Marking the robot with the integrator logo and contact information; archiving the relevant technical documentation.

For a guide to the applicable standards and laws, please visit the website at https://www.comau.com/

All safety information contained in this manual should not be considered as a guarantee by Comau S.p.A.

Comau S.p.A. is committed to continuously improving the reliability and

performance of its products and therefore reserves the right to upgrade its products without prior notice.

1.4.1 Hazard Identification

The risk assessment should consider all potential contact between the operator and the robot during normal use as well as foreseeable mishandling. The operator's neck, face and head should not be exposed to contact. The use of the robot without the use of peripheral safety guards requires a risk assessment to be carried out first to determine whether the hazards involved would constitute an unacceptable risk, for example:



- The use of sharp end-effector or tool connectors may be dangerous.
- The handling of toxic or otherwise hazardous substances may be hazardous.
- The risk of the operator's fingers being caught in the base or joints of the robot.
- The risk of collision by robots.
- The danger of the robot or the tools attached to the end not being secured properly.
- Hazards caused by impacts between the robot payload and solid surfaces.

Integrator must measure such hazards and their associated risk levels through a risk assessment, and identify and implement measures to reduce the risk to an acceptable level. Please note that there may be other significant hazards associated with specific robotic equipment.

The risks associated with the collaborative operation of the Comau S.p.A. range of robots are reduced to as low a level as reasonably practicable by combining the inherent safety design measures applied to Comau S.p.A. robots with the safety specifications or risk assessments implemented by integrator and end users. This document allows any residual risks to be communicated to the integrator and end user prior to the installation of the robot. If the integrators' risk assessment determines that there are hazards in their particular application that may pose an unacceptable risk to the user, the integrator must take appropriate risk reduction measures to eliminate or minimize these hazards until the risk is reduced to an acceptable level. It is not safe to use it until appropriate risk reduction measures (if required) have been taken.

If the robot is installed non-cooperatively (e.g. when dangerous tools are used), the risk assessment may infer that integrator need to be programmed with additional safety equipment (e.g. safe start devices) to ensure the safety of people and equipment

1.5 Intended Use

The following statements of use are made when Comau S.p.A. robots are used only as general industrial equipment, e.g. to operate or hold tools, equipment, process or deliver parts or products. The Comau S.p.A. robots are only

permitted to be used under specified environmental conditions. For specific information on the operating environment and operating conditions, please refer to the Appendix section.

Comau S.p.A. robots have special safety level features that allow them to be operated collaboratively, i.e. without peripheral safety guards. However, this is only possible if the risk has been assessed as non-hazardous. This means that anticipated or accidental contact between the worker and the Comau S.p.A. robot or its end-effector or components does not pose an unacceptable risk, nor does anticipated or accidental contact with other objects (tools, equipment, surfaces, etc.) in the work area, provided that no safety guards or field sensing devices are used.

Robot control units and robots are restricted to general industrial use and may not be used in applications contrary to their intended use. Prohibited uses include, but are not limited to, the following.



- For use in hazardous environments such as flammable and explosive atmospheres.
- A device for moving or handling people or other animals.
- For devices such as medical equipment involving human life.
- For installations that have a significant impact on social and public nature.
- For use in vibration-sensitive environments such as vehicles and ships.
- For use as a climbing tool.

1.6 Dealing with Emergencies

1.6.1 Emergency Stop



Pressing the emergency stop button will stop all robot movements. The emergency stop cannot be used as a risk reduction measure, but can be used as a secondary protection device.

If multiple emergency stop buttons are to be connected, a risk assessment of the robot application must be included. The emergency stop button meets the requirements of IEC 60947-5-5.

The Comau S.p.A. robots are equipped with an emergency stop button on the control unit and on the Teach Pendant, which must be pressed in the event of a dangerous situation or emergency. The control unit is equipped with an external emergency stop button port, which can be used by integrator or users as appropriate.

Tools or equipment connected to the end point that pose a potential threat must be integrated into the system's emergency stop circuit and failure to comply with this warning may result in death, serious personal injury or substantial property damage.

1.6.2 Recovery from Emergency



All push-button emergency stop devices have a "locking" function. This "lock" must be opened in order to end the emergency stop of the device. The "lock" can be opened by turning the emergency stop button.

Resuming from an emergency stop is a simple but very important step that should only be carried out once the danger to the system of robot has been completely removed.

1.6.3 Emergency Movement of Forced Joints



On rare occasions, it may be necessary to move one or more robot joints in an emergency situation where the robot's power supply has failed or is not wanted, this can be done by forcing the robot joints to move by.

Forced reverse drive: push or pull the robot arm with force (at least 500N) to force the joints to move.

Forced manual movement of the robot arm is limited to emergency situations and may damage the joints.

1.6.4 Robotic Body Overpowering Safety Protection



The robot body is protected by an over force safety function. When the robot body is powered up and stationary, the robot body will passively move in the direction of the collision force if an operator or other object accidentally touches the robot body and the collision force exceeds the safety threshold. This function ensures that in the event of a collision between an operator or other object and the robot body, damage to the operator, other objects and the robot body is reduced.

This function reduces the risk of collision damage and is subject to risk assessment for other uses. Safety emergency handling.

1.7 Braking Distance and Braking Time

Braking distance and braking time for category 1 stop

When the robot triggers a category 1 stop in the following configuration, the braking distance and braking time are measured in the following table.



- Extension: 100% (robot is fully extended horizontally at maximum arm length).
- Speed: 100% (general speed of the robot is set to 100% and the movement is performed at a joint speed of 150°/s).
- Payload: The maximum payload handled by the robot connected to TCP.
- Braking distance (rad) Braking time (ms)

1 axis (J1)	0.637	320
2 axis (J2)	0.637	250
3 axis (J3)	0.637	174

1.8 Handling and Precautions

When lifting the robot, the moving parts should be positioned in such a way that they do not cause unintended movements during lifting and transport, which can be harmful.



When packing for transport, the robot should be packed in accordance with packaging standards and marked with the required markings on the outside of the box. When transporting the robot, it is important that it is stable and that it is held in place. The control unit should be lifted using the handles. When moving the robot from its packaging material to the installation position, hold the robot until all the bolts in the robot base have been tightened.

After fixing the robot, power up the robot and use the robot dragging and teaching function to adjust the robot's attitude to the right position. After transport, keep the robot in its original packaging. Store the packaging material in a dry place in case you need to repack and move the robot in the future.

1.9 Other Potential Risks



Please note that there may be other significant hazards associated with specific robotic equipment.

- The fingers are pinned between the large and small arms.
- Sharp edges and points on tools or tool connectors pierce the skin.
- Sharp edges and pointy points on obstacles near the robot's trajectory pierce the skin.
- Injured by a robot collision.
- Sprains or fractures caused by impact between the robot's payload and a solid surface.
- Consequences due to loose bolts used to secure robot arms or tools.
- Objects fall off the tool, e.g. due to inappropriate clamping or power failure.
- Operating errors due to different emergency stop buttons on different machines.

1.10 Repair and Maintenance Instructions

- Please read the Comau S.p.A. electrical control unit interface instructions before installing the electrical control unit.

- Place the electrical control unit as far away from the noise source as possible. Too close to the noise source may lead to misalignment or malfunction.
- Do not apply excessive force to the connector and do not bend the cable excessively. Failure to do so may result in poor contact or disconnection.
- Please ensure that the equipment is well earthed.
- After connecting the cable please use the accessory nylon clips to secure the cable.
- Do not disassemble the electrical control unit yourself, as this may lead to electrical leakage and electric shock.
- The electrical control unit is equipped with fans at both ends, so do not block them when installing and keep them well ventilated.

All safety instructions in this manual must be strictly observed during maintenance work.



Note:



Dangers:

Remove the main input cable from the bottom of the electrical control unit to ensure it is completely disconnected. Disconnect any other energy sources connected to the robot arm or the electrical control unit. Take the necessary precautions to prevent others from reconnecting the system energy during maintenance.

- ·Please check the earth connection before switching the system back on.
- ·Please observe ESD regulations when dismantling the robot arm or electrical control unit.
- ·Avoid splitting the power supply in the electrical control unit. The electrical control unit can retain high voltage (up to 600V) for several hours after it has been switched off.
- ·Avoid water or dust entering the robot arm or the electrical control unit.
- · After maintenance and repair, checks must be carried out to ensure the required level of safety for the service. In doing so, valid national or local safety laws and regulations must be observed. At the same time, all safety functions should be tested to ensure that they are in order.

Mechanical Installation

This chapter contains the following topics:

– Unpacking
– Installation Environment Requirements
– Installation Space
– Connection Cables
– Description of External Interfaces and Connections
– control unit I/O Overview
– Common Specification for All Digital I/O
– Building Generic Digital I/O
– General Analogue I/O
– Safety Barriers
– Description of the IO Interface at the End of the Robot

2.1 Unpacking

Step 1

Open the carton and check that the contents are as listed in the packing list. If there are any missing or extra items, please contact your local sales office promptly.

Step 2

Remove the robot and check that it is complete and free from any obvious defects such as scratches. If you find any cosmetic quality problems, please contact your local sales office.

Step 3

Handling of the robot to the designated installation station.



Warning:

- Avoid violent opening and removal of the robot to prevent scratches on the surface of the robot or shocks and impacts to the robot.
- Please open the robot in a dry and clean environment.
- When taking the robot out of the box, please take care to protect the exterior of the robot from bumps and scratches. The robot needs to be protected from collisions during packing and transport.
- This can cause scratches on the surface of the robot or damage to the internal structure. It is recommended to use the robot's original wooden box or foam to wrap the robot's surface during transport.
- When lifting the robot, ensure that the lifting equipment can support the weight of the robot's components to prevent falls that could result in surface scratches, internal structural damage and injury to personnel. When handling the robot manually, the robot's base should be dragged by hand and handled by two or more people.
- When using other tools for handling the robot, ensure that the robot is secured to the handling tool to prevent it from tipping over.

2.2 Installation Environment Requirements

The robot should be installed indoors and meet the following requirements.

- Room temperature 0-50°C (to prevent excessive temperature changes).
- Relative humidity 10-80% (no condensation).
- Avoid direct sunlight.
- Avoid dust, fumes, salt, metal powders and water.
- Avoid shocks and vibrations.

- Keep away from flammable, explosive and corrosive gas-solid liquids. Keep away from sources of electrical interference.
- The range of installation space for the robot is shown in the robot dimensions and in the specification sheet for the electrical control unit.

2.3 Installation Space

Please check the installation space with reference to the robot working area and the electrical control unit dimensions.

Warning:

- In addition to the space required for the installation of the robot and the electrical control unit, etc., please ensure the minimum space required for the following conditions: space for the installation and working of the robot end fixture; space for the robot teaching; space for the movement of the operator for installation, inspection and maintenance; space for the air circuit.
- The minimum bend radius of the robot's power cable is 90 mm. When installing the cable, make sure that you leave enough space for the power signal cable and other cables to prevent them from being bent excessively.
- Make sure that the safety distance is at least 100 mm greater than the maximum working space at the end of the robot with the fixture installed.

2.4 Connection Cables

The wire is the electrical control unit power cable, as shown in the diagram below, which is 5 meters long. For the robot to be powered up, the control unit must be connected to the power supply. This must be done by connecting the standard IEC C14 plug on the bottom of the control unit with the corresponding IEC C13 cable.

Caution:

- The power supply shall be equipped with at least the following accessories.
- Grounding.
- Mains fuses.
- Residual current circuit breakers.

It is recommended to install a power switch on all equipment in the robot application so that it can be locked and tagged during maintenance.

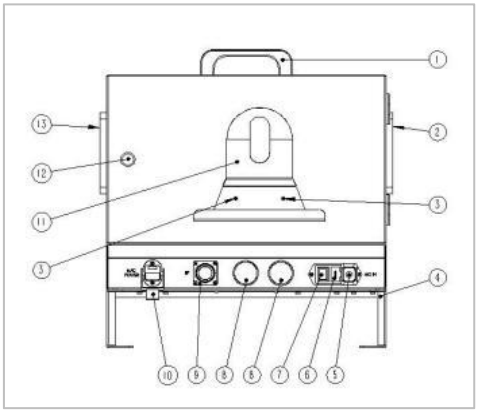


The cable is the one that connects the body to the control unit as shown in the diagram below. The cable is 5 meters long and is connected to the robot and the control unit. The straight connector is connected to the robot base socket, and the elbow connector is connected to the control unit socket.

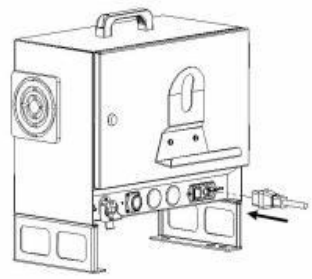
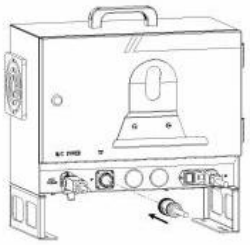
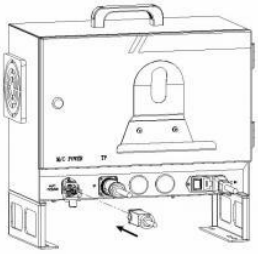
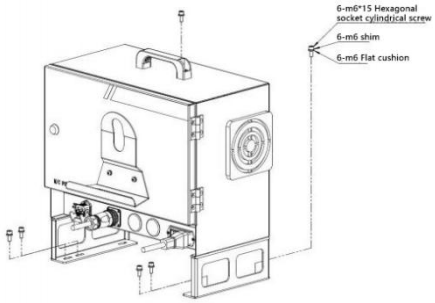
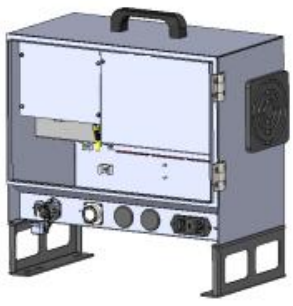


2.5 Description of External Interfaces and Connections

Front:



NO.	Name
1	Carrying handle
2	Exhaust port
3	Screws
4	Fixed stand
5	AC power socket
6	Fuse
7	control unit power switch
8	Protective ring
9	Teach Pendant's connectors
10	Connectors for robots
11	Teach Pendant's stand
12	Cabinet locking holes
13	Air inlet

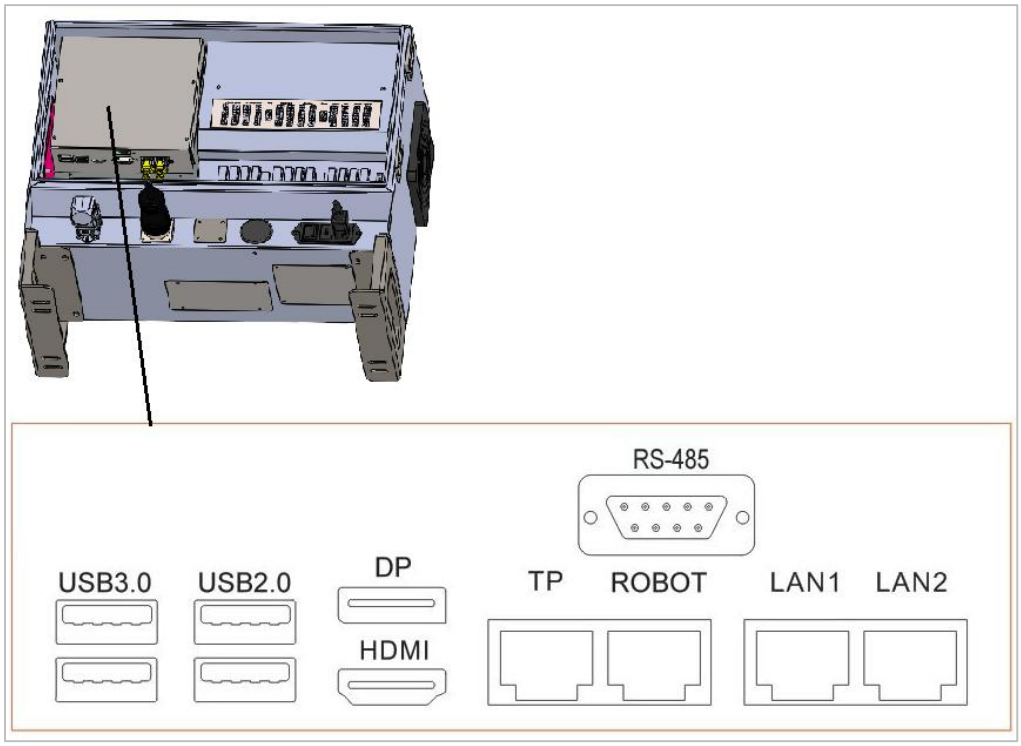
control unit connected to AC power	
control unit connection Teach Pendant	
control unit connected robots	
control unit's fixation	
The interior of the control unit as a whole.	

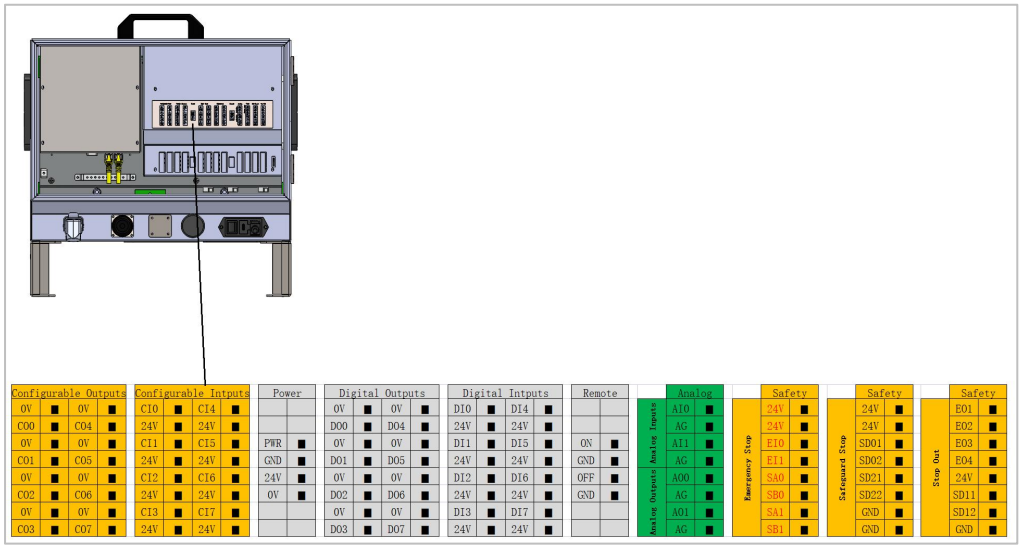
control unit internal interface

In the lower left-hand side of the electric box, there is a HDMI interface for external connections, a USB interface for external devices, an HMI interface for simultaneous display of the Teach Pendant, and two external Ethernet interfaces (for external devices).

These two Ethernet interfaces are suitable for the following.

- Modbus TCP, Ethernet TCP/IP





2.6 Control unit I/O Overview

The control unit provides a range of external interfaces to enable the control unit I/O to be connected to a variety of devices such as external relays, PLC, sensors, emergency stop devices etc.

The control unit panel I/O interface layout is as follows:

From left to right: configurable IO, power supply interface, general purpose IO, remote signal interface, analogue input/output interface, safety signal.

2.7 Common Specification for All Digital I/O

This section describes the electrical specification of the 24V digital I/O provided by the control unit.

2.7.1 Safety I/O

This section describes the dedicated safety inputs (red text font), which are used in accordance with the 24V digital I/O general specifications. The safety inputs include emergency stop and safety protection stop. The emergency stop input is only used for emergency stop devices. The safety stop input is used for all types of safety type protection devices. The following are the differences in function. The differences in function are as follows.

Terminal	Emergency stop	Safety protection stop
Robot stops moving	Yes	Yes
Run the program	Stop	Suspension
Robot power	Close	Open
Initialization	Manual	Automatic or manual
Frequency of use	Low	General
Needs to be reinitialized	Release the brake only	No
Shutdown category (IEC 60204)	1	2

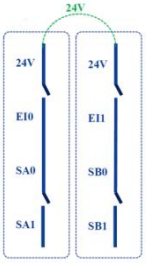


Dangers:

- Do not connect safety signals to non-safety PLC. Failure to observe this warning may result in injury or death due to failure of the safety function. Always separate the safety signals from the general I/O interface signals.
- All safety I/O are redundant (two independent channels). By keeping the two channels independent, it is ensured that the safety function is not lost if one of the channels fails.
- The robot must be checked for safety functions before use and must be tested regularly.

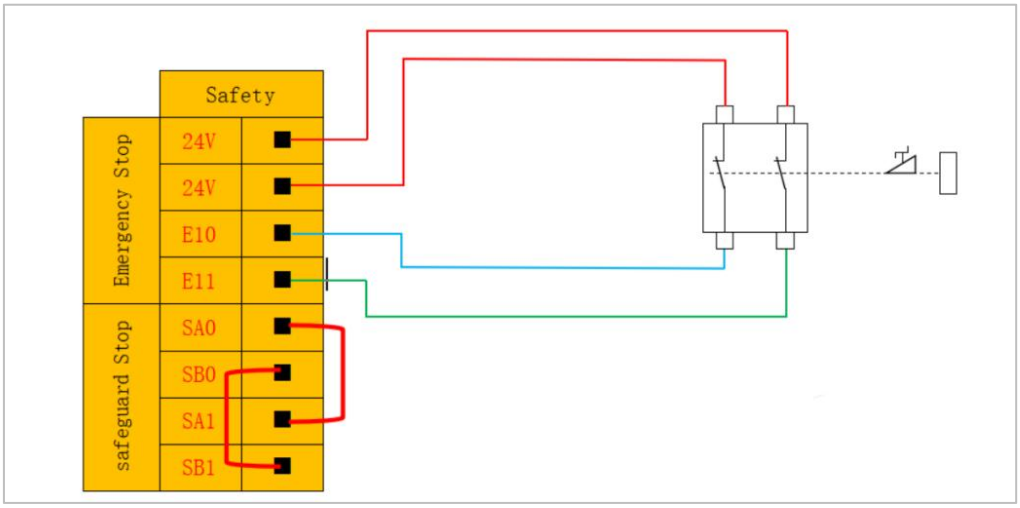
2.7.2 Default Security Configuration

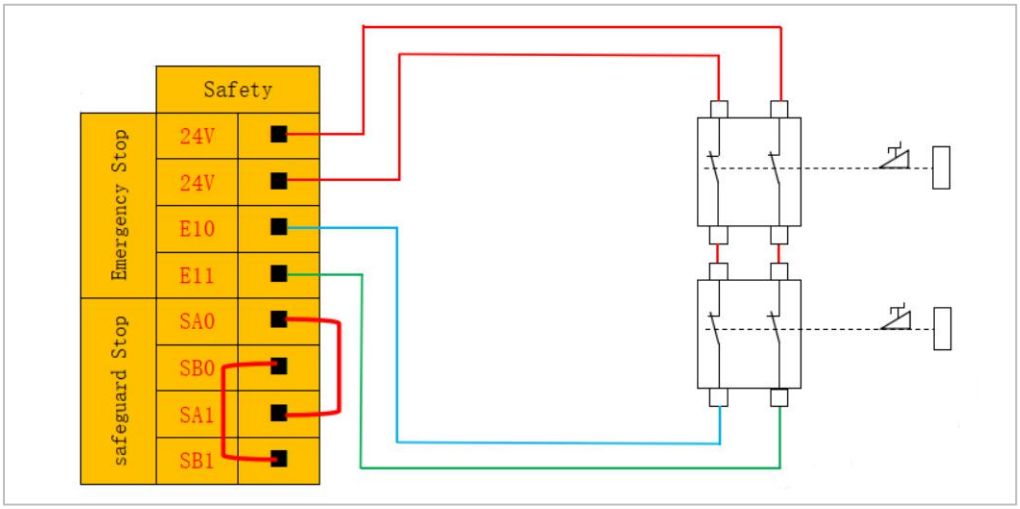
The robot is delivered in the default security configuration, with no other security devices connected, which is configured as follows by and under the integrator’s responsibility:



2.7.3 Connecting the Emergency Stop Button

The following diagram shows an external diagram for connecting one or more emergency stop buttons.



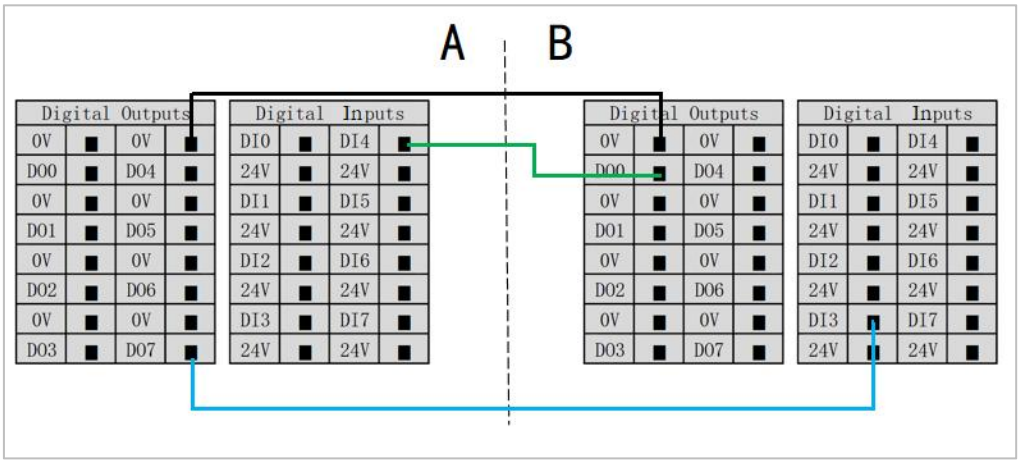


To activate the robot, the following sequence of operations is required:

- Turn up the emergency stop switch
- Reset the safety relay on the trainer and power up the body.
- Enabling
- Run track

2.7.4 Communication with Other Machines or PLC

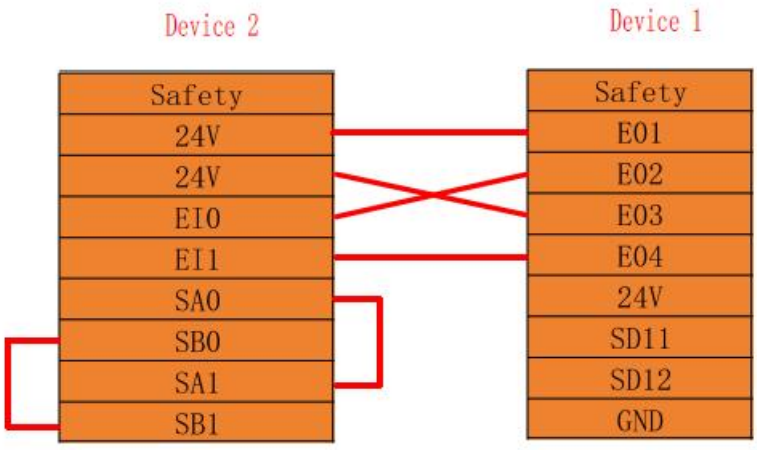
This example shows how a simple button can be connected to a digital input.



2.7.5 Share emergency stop with other machines

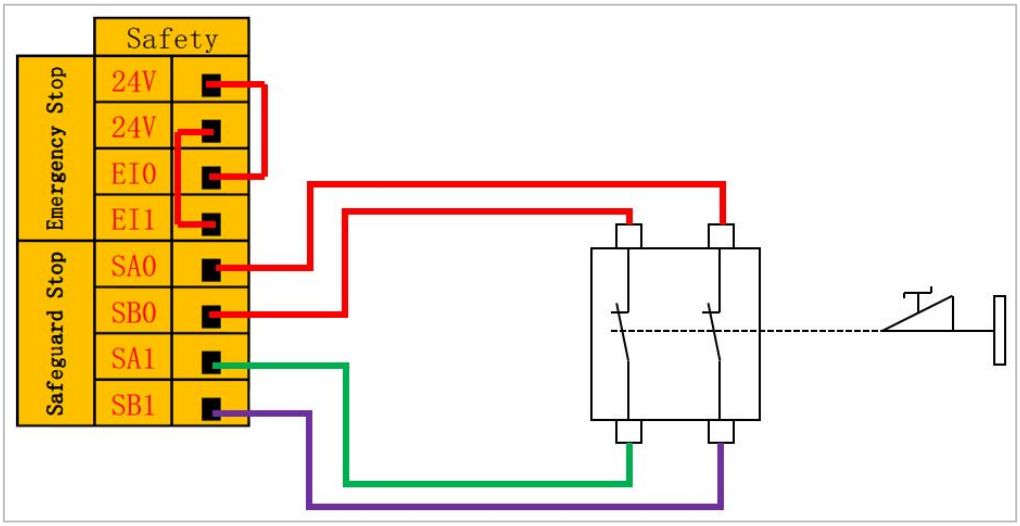
When robots are used in conjunction with other machines, it is often necessary to set up a common emergency stop circuit. By setting up a common circuit, the operator does not have to think about which emergency stop button to use. Both machines need to wait for each other to jump out of the emergency stop condition, so the standard emergency stop input cannot be used for sharing.

As shown in the figure below, Device 1, serving as an external emergency stop button, can control a single emergency stop for all interlocked machines. By connecting Device 1 as shown in the wiring diagram below to the emergency stop handling port of Device 2, it is possible to achieve the effect of both Device 1 and Device 2 triggering the emergency stop simultaneously. At the same time, this connection method can also be extended to Device 3, Device 4, and so on.



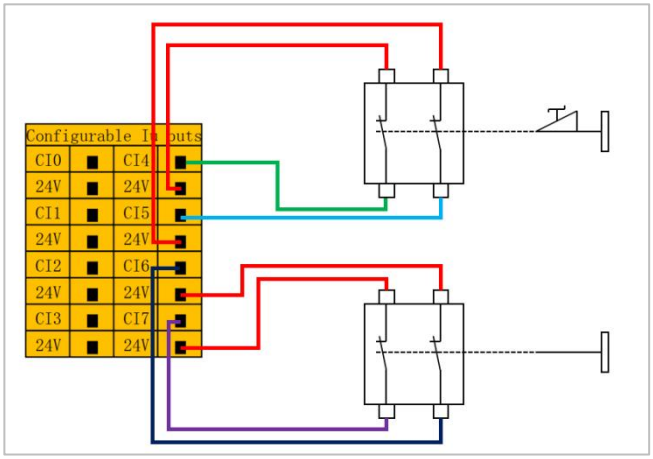
2.7.6 Non-auto reversible protection stop

This is used in the same way as the robot emergency stop to reactivate the robot's movement when the robot body is powered off in a category 1 guard stop (power down).



2.7.7 Protective stop with reset button for automatic recovery

Such stops are de-configured from the input of the configurable IO. If the guard interface is used to interact with the light curtain, it needs to be reset from outside the safety zone. The reset button must be a dual channel type button. In this example, the I/O for resetting the configuration are "CI6-CI7" and the configuration IO "CI4-CI5" are the guard input.



2.7.8 Safety light curtain

As shown in the figure, use two NPN-type sensors to connect 24 volts to SD01 and connect 24 volts to SD21. When the sensors are not triggered, ensure that the NPN sensor signal output terminals, SD01 and SD21, are at a 24-volt high level.

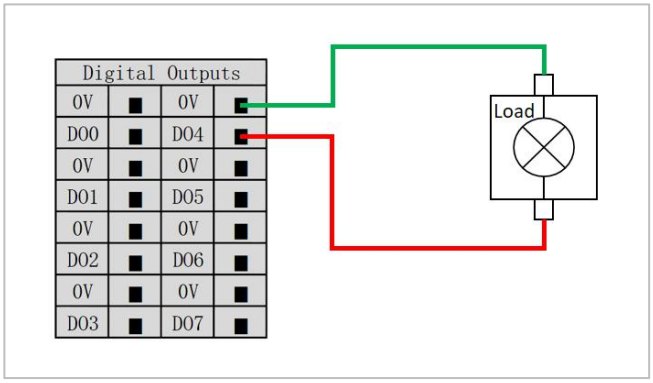
When the sensors are triggered, the high level on SD01 and SD21 is canceled, activating the safety light curtain function.



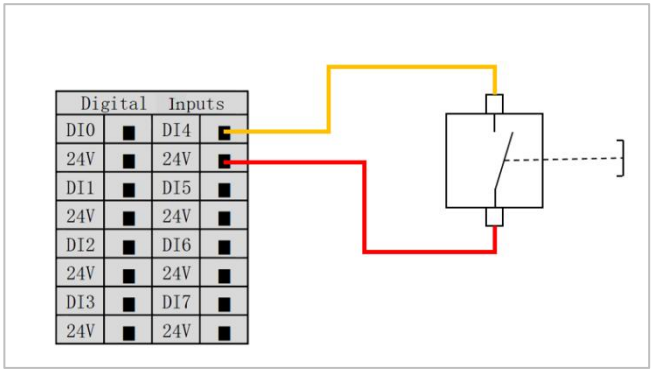
2.8 Building Generic Digital I/O

Universal digital I/O must follow the common configuration of digital I/O. Flexible I/O that are not used for safety functions can be used as general-purpose digital I/O.

Use of digital outputs:



Control of digital input using buttons:



2.9 General Analogue I/O

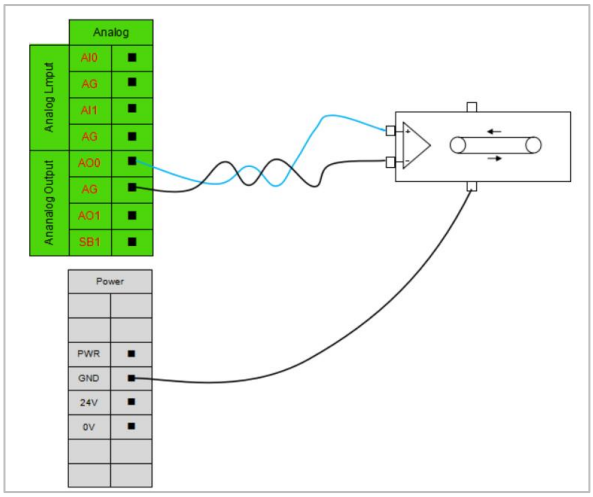
For setting or measuring the voltage (0-10V) or current (4-20mA) between devices. For high accuracy, the following rules should be followed when using them.

- Use the GND nearest to the I/O.
- The measuring device and the control unit use the same ground (GND) and the analogue I/O are not potentially isolated from the control unit.
- Use a shielded or twisted pair cable. Connect the shielded cable to "GND" on the universal I/O terminal.
- Current signals are insensitive to noise, so it is preferable to operate the device in current mode. The corresponding I/O configuration is as follows.

Voltage mode input					
AIx - AG	Voltage	0	-	10	V
AIx - AG	Resistor	-	12	-	Kohm
AIx - AG	Decomposition energy	-	12	-	Bit
Current mode output					
AOx - AG	Current	4	-	20	mA
AOx - AG	Voltage	0	-	10	V
AOx - AG	Decomposition energy	-	16	-	Bit
Voltage mode output					
AOx - AG	Voltage	0	-	10	V
AOx - AG	Current	0	-	20	mA
AOx - AG	Resistor	-	43	-	ohm
AOx - AG	Decomposition energy	-	16	-	Bit

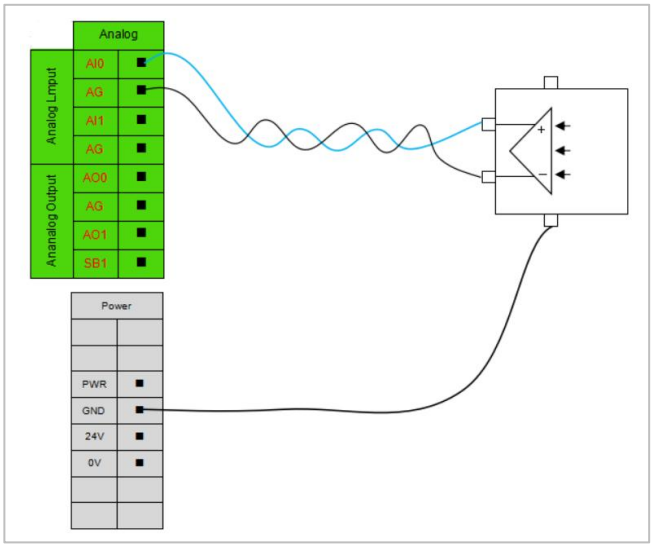
2.9.1 Use of Analogue Outputs

The following example shows how the analogue speed control input can be used to control the conveyor belt.



2.9.2 Use of Analogue Input

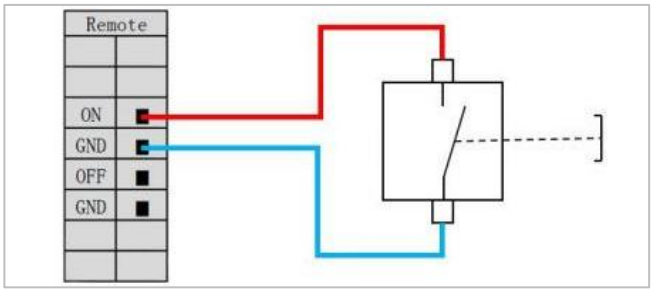
The analogue I/O interfaces are green terminated. These interfaces can be used to set or measure the voltage (0-10V) or current (4-20mA) to and from other devices. The following example shows how to connect an analogue sensor.



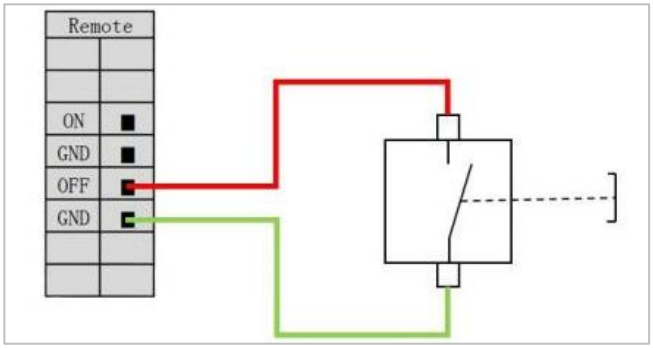
2.9.3 Remote On/Off Control

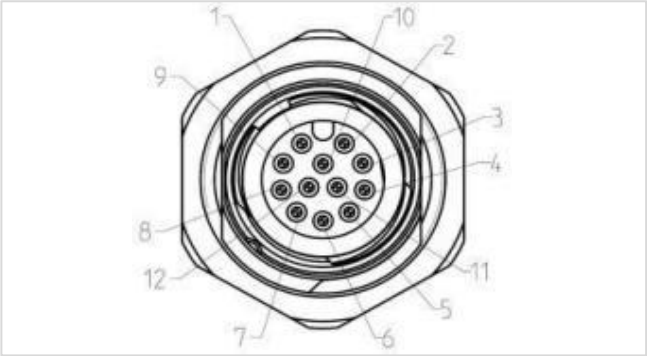
With Power IO, the control unit can be switched on and off without the Teach Pendant switch button. It is built in the following way:

Switch on:



Shutdown:





2.10 Safety Barriers

The user should carry out a risk assessment for the specific robot application to determine whether a safety barrier should be installed in the actual operating environment. If safety rails are required, the size of the safety rails should be carefully calculated.

Recommendation: Radius of the parapet space circle > arm length of the robot arm + length of the end fixture of the robot arm.

2.11 Description of the IO Interface at the End of the Robot

The tool IO external wiring harness is defined as follows.

Connector plugs			
PIN	**Definition**	**Thread colour**	**Signal description**
1	INPUT_0	Brown	Digital input 0
2	INPUT_1	Blue	Digital input 1
3	INPUT_2	White	Digital input 2
4	OUTPUT_0	Green	Digital output 0
5	OUTPUT_1	Powder	Digital output 1
6	OUTPUT_2	Yellow	Digital output 2
7	485_A	Black	485 Communication pin A
8	485_B	Grey	485 Communication pin B
9	AIO	Red	Analogue input 0
10	AI1	Purple	Analogue input 1
11	24V	Grey powder	Power supply (24V)
12	GND	Red and Blue	Ground (0V)

2.11.1 Internal power supply specifications:

Parameters	Minimum value	Typical values	Maximum value	Unit
24V supply voltage	22	24	26.4	V
24V supply current	0.005	1	1.5	A

If the current exceeds its limit, the software will protect and switch off the output and the internal control system will generate an error message which will be displayed in the robot log; the power output of both ports is the output of the same power supply.

2.11.2 Digital output (Type: PNP)

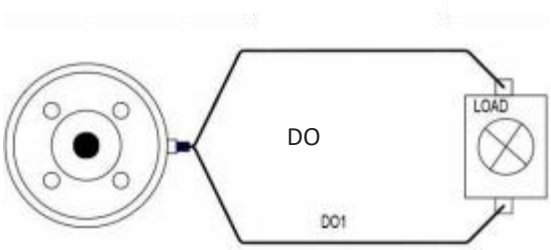
Digital output					
Terminal	Parameter	Minimum value	Typical value	Maximum value	Unit
DOx	Current	0	-	0.4	A
DOx	Voltage drop	0	-	0.5	V
DOx	Leakage current	0	-	0.5	MA
DOx	Function	-	PNP	-	Category
DOx	IEC 61131-2	-	0.4A	-	Category

The digital outputs are implemented in such a way that only current can be poured into GND (0V) and no pull current is applied. When the digital output is active, the corresponding connector is driven to GND, when the digital output is disabled, the corresponding connector is open (open collector/open drain).

Note: The digital outputs of the tool are not current limited and may be permanently damaged if the specified data is exceeded.

Example of Using a Digital Output

This example illustrates the use of the IO board's power supply for external devices, if the external system's own power supply is to be used, a common ground is required.

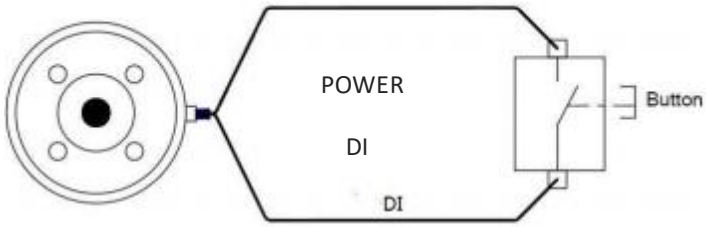


2.11.3 Digital input (PNP)

Digital input					
Terminal	Parameter	Minimum value	Typical value	Maximum value	Unit
DIx	Voltage	-3	-	30	V
DIx	OFF Zone	-3	-	5	V
DIx	ON Zone	11	-	30	V
DIx	Current (11-30V)	2	-	15	MA
DIx	Function	-	PNP	-	Category
DIx	IEC 61131-2	-	3	-	Category

The digital input are equipped with weak pull-down resistors. This means that the floating input always reads low.

Example of using a digital input:



The example above shows how to connect a simple button or switch. This example shows the use of the IO board's power supply to power an external device, if the external system is to be powered by its own power supply, a common ground is required.

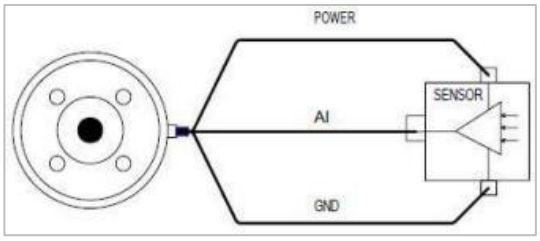
2.11.4 Analogue input

Parameters	Minimum value	Typical values	Maximum value	Unit
Input Voltage	0		10	V
Input resistance		15K		Ohms

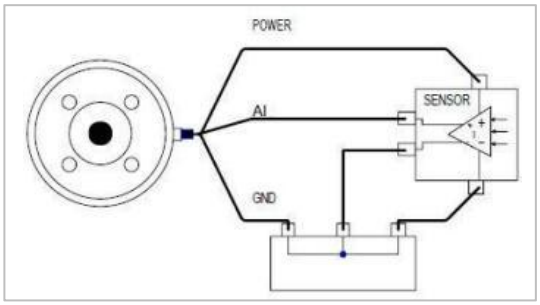
2.11.5

The analogue input to the tool is a non-differential input and any variation in the current at the common ground connector may cause an interfering signal at the analogue input, as there will be a voltage drop across the earth wire and inside the connector, which is important to recognize.

In order to clearly illustrate the simplicity of using analogue input, the following are some simple examples.



The diagram above shows the connection to the unit when the user output is also a single-ended analogue signal.

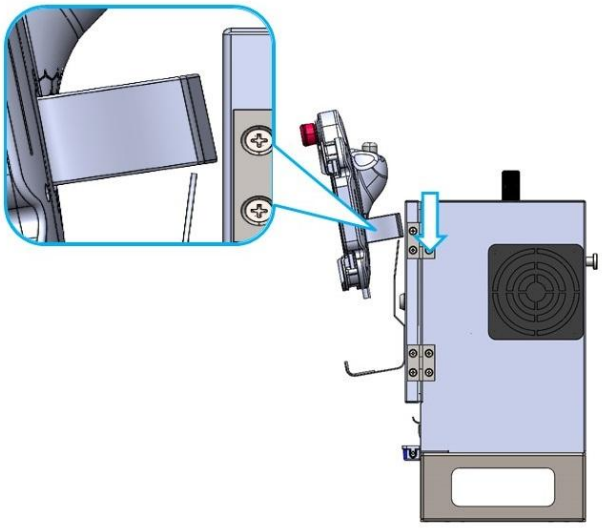


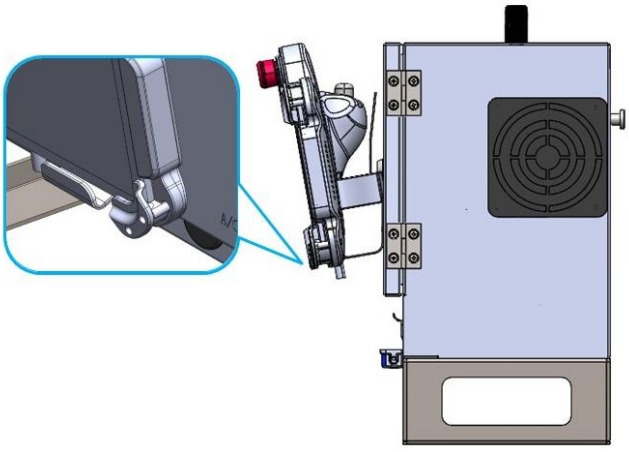
The diagram above shows the connection to the unit when the user output is an analogue signal with differential output. Simply connect the negative terminal of the output to GND (0V) using a terminal strip.

Teach Pendant

The figure below shows the Comau S.p.A. teach pendant, with the robot start button on the right, the emergency stop button on the left, and a three-position start switch on the back. The figure also shows the installation method.

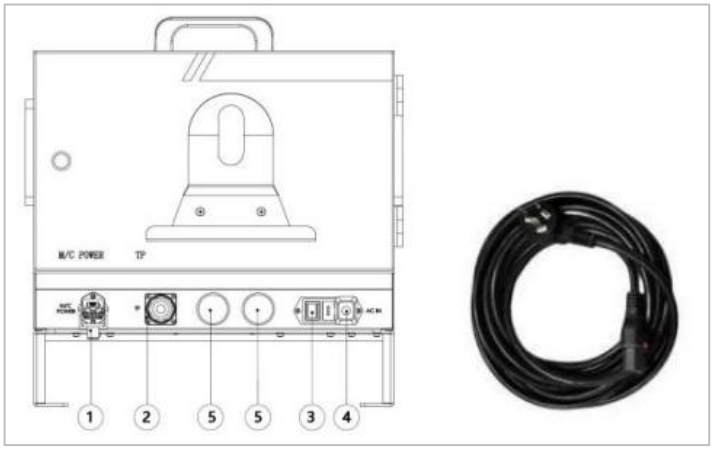






The Start-up Process

- Connection of the teach pendant: Connect the interface of the teach pendant to the ② port (front of the electrical control unit) as shown in the figure below.
- Connection of the electrical control unit to the power supply: plug the ④ connector in the diagram below into the electrical control unit's power cable, and connect the other end of the cable to the 110VAC/220VAC power supply.
- Press the power switch on the electrical control unit ③, then press the power button on the left side of the teach pendant to power up the electrical control unit. When the electrical control unit is powered up, the robot is powered up at the same time and the Comau S.p.A. software starts automatically

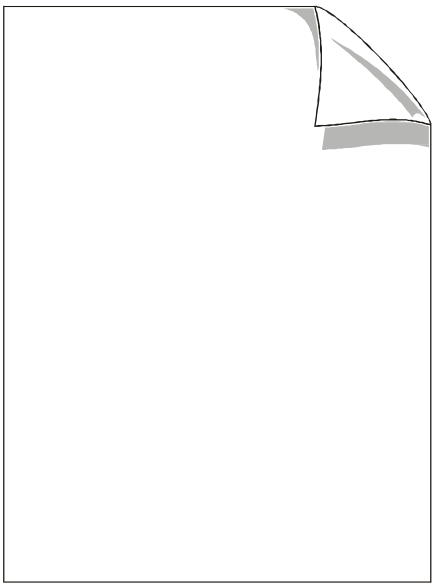


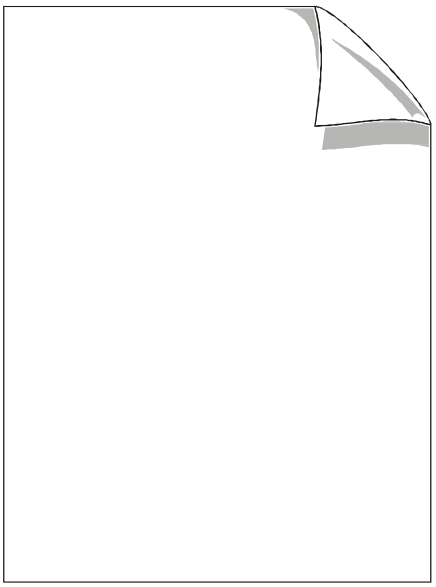
Electrical Safety Specifications

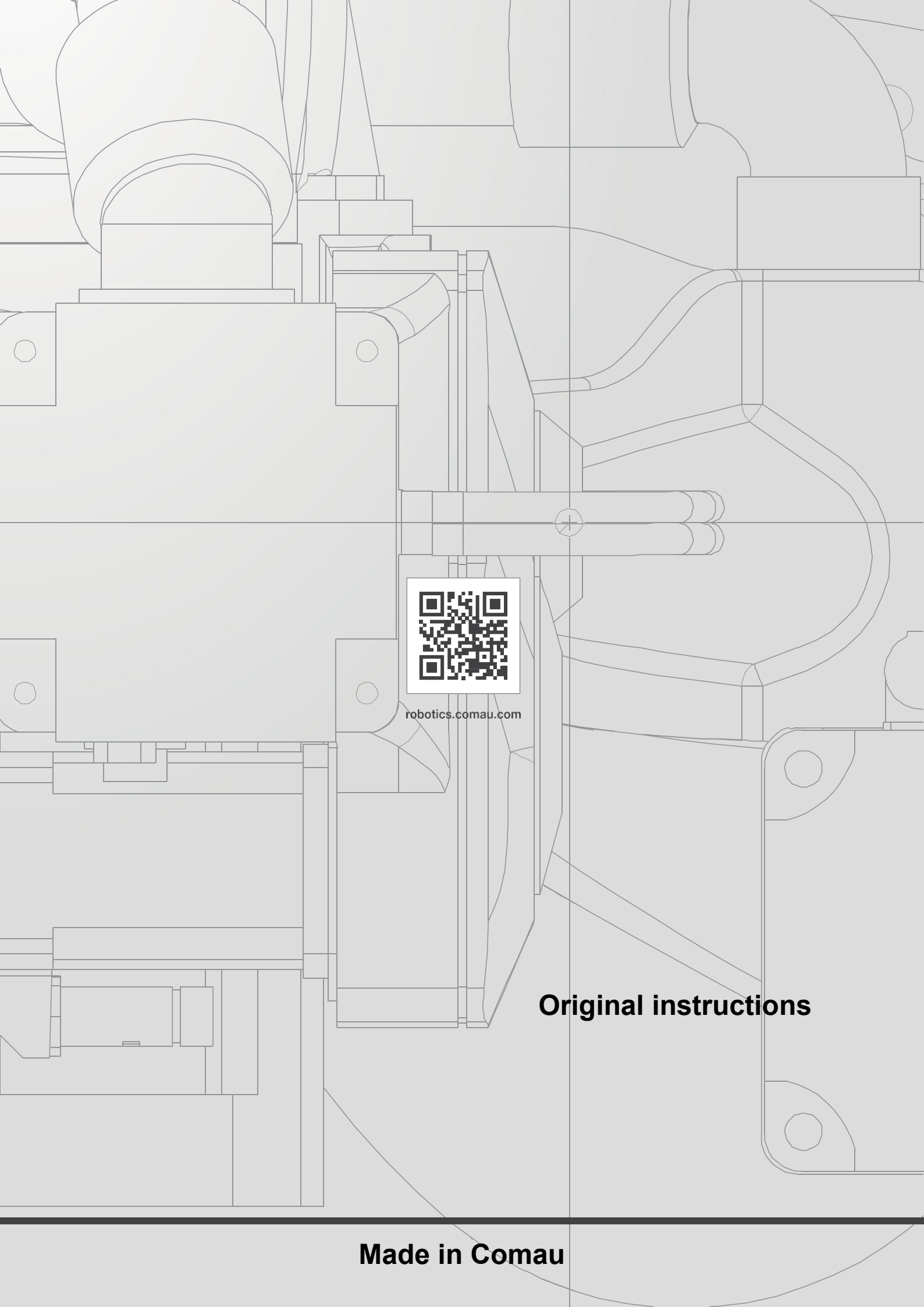
Secure inpute	Descriptione
Robot emergency stop	Execute a Category 1 stop, the system sends a signal to the robot body, which then halts motion and cuts off the 48V power supply
Emergency stop buttone	Execute a Category 1 stop, the system sends a signal to the robot body, which then halts motion and cuts off the 48V power supply
System emergency stop	Perform a category 1 shutdown*
Protection stop	Performing a category 2 shutdown*

Glossary

- **Stop Category 0:** Robot motion is stopped by immediate removal of power to the robot. It is an uncontrolled stop, where the robot can deviate from the programmed path as each joint brake as fast as possible. This protective stop is isused if a safety-related limit is exceeded or in case of a fault in the safety-related parts of the control system. For more information, see ISO 13850 or IEC 60204-1.
- **Stop Category 1:** Robot motion is stopped with power available to the robot to achieve the stop and then removal of power when the stop is achieved. It is a con-trolled stop, where the robot will continue along the programmed path. Power is removed as soon as the robot stands still. For more information, see ISO 13850or IEC 60204-1.
- **Stop Category 2:** A controlled stop with power left available to the robot. The safety related control system monitors that the robot stays at the stop position. For more information, see IEC 60204-1.
- **Category 3:** The term "Category" should not be confused with the term "Stop Cate-gory". "Category" refers to the type of architecture used as basis for a certain "Performance Level". A significant property of a "Category 3" architecture is that a single fault cannot lead to loss of the safety function. For more information, see ISO 13849-1.
- **Performance Level:** A Performance Level (PL) is a discrete level used to specify the ability of safety-related parts of control systems to perform a safety functions under foreseeable conditions. PLd is the second highest reliability classification, meaning that the safety function is extremely reliable. For more information, see ISO 13849-1.
- **Diagnostic coverage (DC):** is a measure of the effectiveness of the diagnostics implemented to achieve the rated performance level, For more information, see ISO 13849-1.
- **MTTFd:** The Mean time to dangerous failure (MTTFd) is a value based on calculations and tests used to achieve the rated performance level. For more information, see ISO 13849-1.
- **Integrator:** The integrator is the entity that designs the final robot installation. The integrator is responsible for making the final risk assessment and must ensure that the final installation complies with local laws and regulations.
- **Risk assessment:** A risk assessment is the overall process of identifying all risks and reducing them to an appropriate level. A risk assessment should be documented. Consult ISO 12100 for further information.
- **Collaborative robot application:** The term “collaborative" refers to collaboration between operator and robot in a robot application. See precise definitions and descriptions in ISO 10218-1 and ISO 10218-2.







Original instructions

Made in Comau