ABB Robotics

Product manual
Process Interface

Power and productivity
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Product manual

Process Interface

IRC5

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0.0.1 Introduction

About this manual

This manual contains instructions for:

- Interface for Welding equipment.
- Electrical installation.
- Operation.
- Spare parts.

Operation

This manual is intended for use in conjunction with:

- Installation
- Operation
- Maintenance
- Repairs

Who should read this manual?

This manual is intended for:

- Operators
- Installation personnel
- Repair and maintenance personnel

Basic knowledge

Readers of this manual must be...

- familiar with industrial robots and the relevant terminology
- Familiar with the equipment.
- Skilled in mechanical and electrical installation/maintenance/repairs.

Reference documents

ABB IRC5 Controller

The IRC5 Controller is available in two versions:

- Single Cabinet Controller
- Dual Cabinet Controller

Document described in:

- Robotics manuals
- Manuals for arc welding robot systems

Welding equipment

- Power source
- Wire feeder
- Welding gun and hose package

Document described in:

- See product manuals for power source, wire feeder and welding gun.
- Mechanical cleaner
- TCP calibration tool

1: Safety

1.1: Introduction

Overview

The safety information in this manual is divided in two categories:

general safety aspects, important to attend to before performing any service work on the robot. These are applicable for all service work and are found in section *General safety information on page 7*.

specific safety information, pointed out in the procedure at the moment of the danger. How to avoid and eliminate the danger is either detailed directly in the procedure, or further detailed in separate instructions, found in section *Safety related instructions on page 22*.

1.2: General safety information

1.2.1 Safety in the robot system

Validity and responsibility

The information does not cover how to design, install and operate a complete system, nor does it cover all peripheral equipment, which can influence the safety of the total system. To protect personnel, the complete system must be designed and installed in accordance with the safety requirements set forth in the standards and regulations of the country where the robot is installed.

The users of ABB industrial robots are responsible for ensuring that the applicable safety laws and regulations in the country concerned are observed and that the safety devices necessary to protect people working with the robot system are designed and installed correctly. Personnel working with robots must be familiar with the operation and handling of the industrial robot, described in the applicable documents, e.g. Operating manual and Product Manual.

Connection of external safety devices

Apart from the built-in safety functions, the robot is also supplied with an interface for the connection of external safety devices. Via this interface, an external safety function can interact with other machines and peripheral equipment. This means that control signals can act on safety signals received from the peripheral equipment as well as from the robot.

Limitation of liability

Any information given in this manual regarding safety, must not be construed as a warranty by ABB that the industrial robot will not cause injury or damage even if all safety instructions are complied with.

Related information

Type of information	Detailed in document	Section
Installation of safety devices	Product manual for the robot	Installation and commissioning
Changing robot modes	Operators manual (RobotWare 5.0)	Operating modes
Restricting the working space	Product manual for the robot	Installation and commissioning

1.3: Safety risks

1.3.1 Safety risks during installation and service work on robot

Overview

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

General risks during installation and service

- The instructions in the Product Manual - Installation and Commissioning must always be followed.
- Emergency stop buttons must be positioned in easily accessible places so that the robot can be stopped quickly.
- Those in charge of operations must make sure that safety instructions are available for the installation in question.
- Those who install the robot must have the appropriate training for the robot system in question and in any safety matters associated with it.

Nation/region specific regulations

To prevent injuries and damage during the installation of the robot system, the regulations applicable in the country concerned and the instructions of ABB Robotics must be complied with.

Non-voltage related risks

- Safety zones, which have to be crossed before admittance, must be set up in front of the robot's working space. Light beams or sensitive mats are suitable devices.
- Turntables or the like should be used to keep the operator out of the robot's working space.
- The axes are affected by the force of gravity when the brakes are released. In addition to the risk of being hit by moving robot parts, you run the risk of being crushed by the parallel arm.
- Energy, stored in the robot for the purpose of counterbalancing certain axes, may be released if the robot, or parts thereof, are dismantled.
- When dismantling/assembling mechanical units, watch out for falling objects.
- Be aware of stored heat energy in the controller.
- Never use the robot as a ladder, i.e. do not climb on the robot motors or other part during service work. There is a serious risk of slipping because of the high temperature of the motors or oil spills that can occur on the robot.

To be observed by the supplier of the complete system

- The supplier of the complete system must ensure that all circuits used in the safety function are interlocked in accordance with the applicable standards for that function.
- The supplier of the complete system must ensure that all circuits used in the emergency stop function are interlocked in a safe manner, in accordance with the applicable standards for the emergency stop function.

1.3.1 Safety risks during installation and service work on robot

Complete robot

Safety risk	Description
Hot components!	 **Caution!** Motors and gears are HOT after running the robot! Touching the motors and gears may result in burns!
Removed parts may result in collapse of robot!	 **Warning!** Take any necessary measures to ensure that the robot does not collapse as parts are removed, e.g. secure the lower arm with fixtures if removing motor, axis 2.

Cabling

Safety risk	Description
Cable packs are sensitive to mechanical damage!	 **Caution!** The cable packs are sensitive to mechanical damage! They must be handled with care, especially the connectors, in order to avoid damaging them!

Gearboxes and motors

Safety risk	Description
Gears may be damaged if excessive force is used!	 **Caution!** Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!

1.3.2 Safety risks related to tools/workpieces

Safe handling

It must be possible to safely turn off tools, such as milling cutters, etc. Make sure that guards remain closed until the cutters stop rotating.

It should be possible to release parts by manual operation (valves).

Safe design

Grippers/end effectors must be designed so that they retain workpieces in the event of a power failure or a disturbance of the controller.

CAUTION!

Ensure that a gripper is prevented from dropping a workpiece, if such is used.

1.3.3 Safety risks related to pneumatic/hydraulic systems

General

Special safety regulations apply to pneumatic and hydraulic systems.

Residual energy

- Residual energy may be present in these systems. After shutdown, particular care must be taken.
- The pressure in pneumatic and hydraulic systems must be released before starting to repair them.

Safe design

- Gravity may cause any parts or objects held by these systems to drop.
- Dump valves should be used in case of emergency.
- Shot bolts should be used to prevent tools, etc., from falling due to gravity.

1.3.4 Safety risks during operational disturbances

General

- The industrial robot is a flexible tool which can be used in many different industrial applications.
- All work must be carried out professionally and in accordance with the applicable safety regulations.
- Care must be taken at all times.

Qualified personnel

- Corrective maintenance must only be carried out by qualified personnel who are familiar with the entire installation as well as the special risks associated with its different parts.

Extraordinary risks

If the working process is interrupted, extra care must be taken due to risks other than those associated with regular operation. Such an interruption may have to be rectified manually.

1.3.5 Risks associated with live electric parts

Voltage related risks, general

- Although troubleshooting may, on occasion, have to be carried out while the power supply is turned on, the robot must be turned off (by setting the mains switch to OFF) when repairing faults, disconnecting electric leads and disconnecting or connecting units.
- The mains supply to the robot must be connected in such a way that it can be turned off outside the robot's working space.

Voltage related risks, controller IRC5

A danger of high voltage is associated with the following parts:

- Be aware of stored electrical energy (DC link, Ultra Cap unit) in the controller.
- Units inside the controller, e.g. I/O modules, can be supplied with power from an external source.
- The mains supply/mains switch
- The transformers
- The power unit
- The control power supply (230 VAC)
- The rectifier unit (400-480 VAC and 700 VDC. Note: Capacitors!)
- The drive unit (700 VDC)
- The drive system power supply (230 VAC)
- The service outlets (115/230 VAC)
- The customer power supply (230 VAC)
- The power supply unit for tools, or special power supply units for the machining process.
- The external voltage connected to the control cabinet remains live even when the robot is disconnected from the mains.
- Additional connections.

Voltage related risks, robot

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

- The power supply for the motors (up to 800 VDC).
- The user connections for tools or other parts of the installation (max. 230 VAC, see chapter Installation and commissioning in the Product manual).

Voltage related risks, tools, material handling devices, etc.

Tools, material handling devices, etc., may be live even if the robot system is in the OFF position. Power supply cables which are in motion during the working process may be damaged.

1.4: Safety actions

1.4.1 Safety fence dimensions

General

Install a safety cell around the robot to ensure safe robot installation and operation.

Dimensioning

Dimension the fence or enclosure to enable it to withstand the force created if the load being handled by the robot is dropped or released at maximum speed. Determine the maximum speed from the maximum velocities of the robot axes and from the position at which the robot is working in the work cell (see Product Specification - Description, Robot Motion).

Also consider the maximum possible impact caused by a breaking or malfunctioning rotating tool or other device fitted to the manipulator.

1.4.2 Fire extinguishing

NOTE!

Use a CARBON DIOXIDE (CO_2) extinguisher in the event of a fire in the robot (manipulator or controller)!

1.4.3 Emergency release of the robots/manipulators axes

Description

In an emergency situation, any of the robot's/manipulators axes may be released manually by pushing the brake release buttons on the robot.

How to release the brakes is detailed in the robots product manual.

The robot arm may be moved manually on smaller robot models, but larger models may require using an overhead crane or similar.

Increased injury

Before releasing the brakes, make sure that the weight of the arms does not increase the pressure on the trapped person, further increasing any injury!

1.4.4 Brake testing

When to test

During operation the holding brakes of each axis motor wear normally. A test may be performed to determine whether the brake can still perform its function.

How to test

The function of each axis' motor holding brakes may be checked as detailed below:

1. Run each manipulator axis to a position where the combined weight of the manipulator arm and any load is maximized (max. static load).
2. Switch the motor to the MOTORS OFF position with the Operating mode selector on the controller.
3. Check that the axis maintains its position.

   If the manipulator does not change position as the motors are switched off, then the brake function is adequate.

1.4.5 Risk of disabling function "Reduced speed 250 mm/s"

NOTE!

Do not change "Transm. gear ratio" or other kinematic parameters from the FlexPendant or a PC. This will affect the safety function Reduced speed 250 mm/s.

1.4.6 Safe use of the FlexPendant

NOTE!

The enabling device is a push button located on the side of the FlexPendant which, when pressed halfway in, takes the system to MOTORS ON. When the enabling device is released or pushed all the way in, the robot is taken to the MOTORS OFF state.

To ensure safe use of the FlexPendant, the following must be implemented:

- The enabling device must never be rendered inoperative in any way.
- During programming and testing, the enabling device must be released as soon as there is no need for the robot to move.
- The programmer must always bring the FlexPendant with him/her, when entering the robot's working space. This is to prevent anyone else taking control of the robot without the programmer knowing.

1.4.7 Work inside the manipulator's working range

WARNING!

If work must be carried out within the robot’s work envelope, the following points must be observed:

- The operating mode selector on the controller must be in the manual mode position to render the enabling device operative and to block operation from a computer link or remote control panel.
- The robot’s speed is limited to max. 250 mm/s when the operating mode selector is in position < 250 mm/s. This should be the normal position when entering the working space. The position 100% ”full speed” may only be used by trained personnel who are aware of the risks that this entails.
- Pay attention to the rotating axes of the manipulator! Keep a distance to the axes in order not to get entangled with hair or clothing. Also be aware of any danger that may be caused by rotating tools or other devices mounted on the manipulator or inside the cell.

1.4.8 Translate the information on safety and information labels

Labels on the product

Both the manipulator and the controller are marked with several safety and information labels, containing important information about the product. The information is useful for all personnel handling the robot system, eg. during installation, service or operation.

Translation possibilities

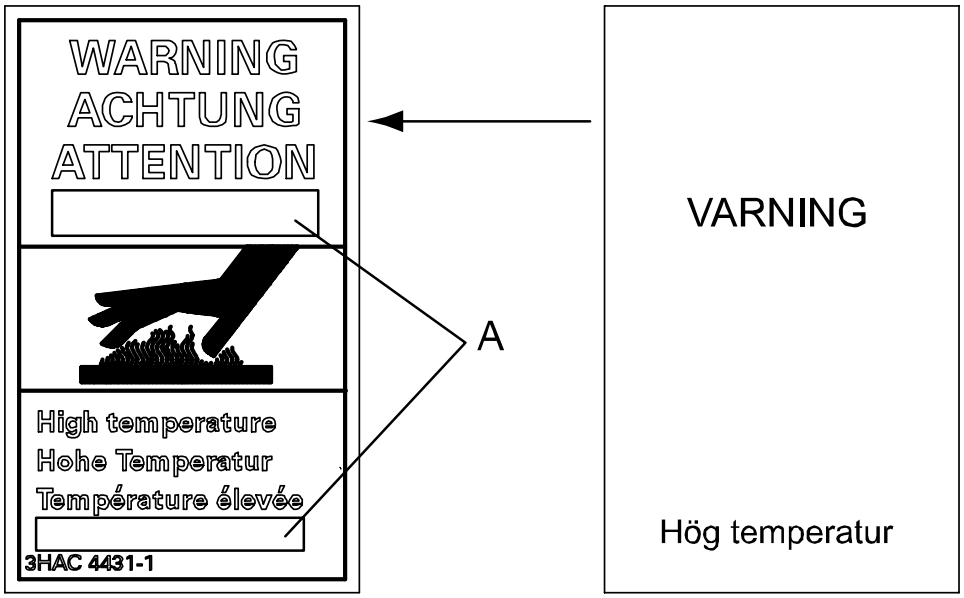
The labels fitted to the product contain space for adding a fourth language underneath the three standard languages (English, German and French).

Add a local language to the label by:

- using a transparent sticker over the standard label with text added in a fourth language. Drawings detailing the design (text, figure, dimensions) of the standard labels can be ordered from ABB. Notice that each label is identified according to the article number located in the lower corner of the label.

Example of transparent sticker

The figure below shows the location of the free space on one of the labels on the robot, where the fourth language can be added. The figure also shows a transparent sticker, containing the text in Swedish.



xx0500002517

A	Free space for adding a fourth language

1.5: Safety related instructions

1.5.1 Safety signals, general

General

This section specifies all dangers that may arise from performing the work detailed in the manual. Each danger is detailed in its own section consisting of:

- A caption specifying the danger level (DANGER, WARNING or CAUTION) and the type of danger.
- A brief description of what will happen if the operator/service personnel **do not** eliminate the danger.
- An instruction of how to eliminate the danger to facilitate performing the activity at hand.

Danger levels

The table below defines the captions specifying the danger levels used throughout this manual.

Symbol	Designation	Signification
 danger	DANGER	Warns that an accident *will* occur if the instructions are not followed, resulting in a serious or fatal injury and/or severe damage to the product. It applies to warnings that apply to danger with, for example, contact with high voltage electrical units, explosion or fire risk, risk of poisonous gases, risk of crushing, impact, fall from height etc.
 warning	WARNING	Warns that an accident *may* occur if the instructions are not followed, that can lead to serious injury, possibly fatal, and/or great damage to the product. It applies to warnings that apply to danger with, for example, contact with high voltage electrical units, explosion or fire risk, risk of poisonous gases, risk of crushing, impact, fall from height etc.
 Electrical shock	ELECTRICAL SHOCK	The electrocution or electrical shock symbol indicates electrical hazards which could result in severe personal injury or death.
 caution	CAUTION	Warns that an accident may occur if the instructions are not followed, that can result in injury and/or damage to the product. It also applies to warnings of risks that include burns, eye injury, skin injury, hearing damage, crushing or slipping, tripping, impact, fall from height etc. Furthermore, it applies to warnings that include function requirements when fitting and removing equipment, where there is a risk of damaging the product or causing a breakdown.

1.5.1 Safety signals, general

Symbol	Designation	Signification
 Electrostatic discharge (ESD)	ELECTROSTATIC DISCHARGE (ESD)	The electrostatic discharge (ESD) symbol indicates electrostatic hazards which could result in severe damage to the product.
 Note	NOTE	Note symbols alert you to important facts and conditions.
 Tip	TIP	Tip symbols direct you to specific instructions, where to find additional information or how to perform a certain operation in an easier way.

1.5.2 DANGER - Moving manipulators are potentially lethal!

Description

Any moving manipulator is a potentially lethal machine.

When running the manipulator, it may perform unexpected and sometimes irrational movements. However, all movements are performed with great force and may seriously injure any personnel and/or damage any piece of equipment located within the manipulator working range.

Elimination

	Action	Note/Illustration
	Before attempting to run the manipulator, make sure all *emergency stop equipment* is correctly installed and connected.	Emergency stop equipment such as gates, tread mats, light curtains, etc.
	If possible, use the hold-to-run button whenever possible. The hold-to-run button is used in manual mode, not in automatic mode.	How to use the hold-to-run control in RobotWare 5.0 is detailed in section *How to use the hold-to-run function* in the *Operating manual - IRC5 with FlexPendant*.
	Make sure no personnel are present within the manipulator working range before pressing the start button.	

1.5.3 DANGER - First test run may cause injury or damage!

Description

Since performing a service activity often requires disassembly of the robot there are several safety risks to take into consideration before the first test run.

Elimination

Follow the procedure below when performing the first test run after a service activity (repair, installation or maintenance):

	Action
1.	Remove all service tools and foreign objects from the robot and its working area!
2.	Install all safety equipment properly!
3.	Make sure all personnel are standing at a safe distance from the robot, i.e. out of its reach behind safety fences, etc.!
4.	Pay special attention to the function of the part previously serviced!

1.5.4 WARNING - The unit is sensitive to ESD!

Description

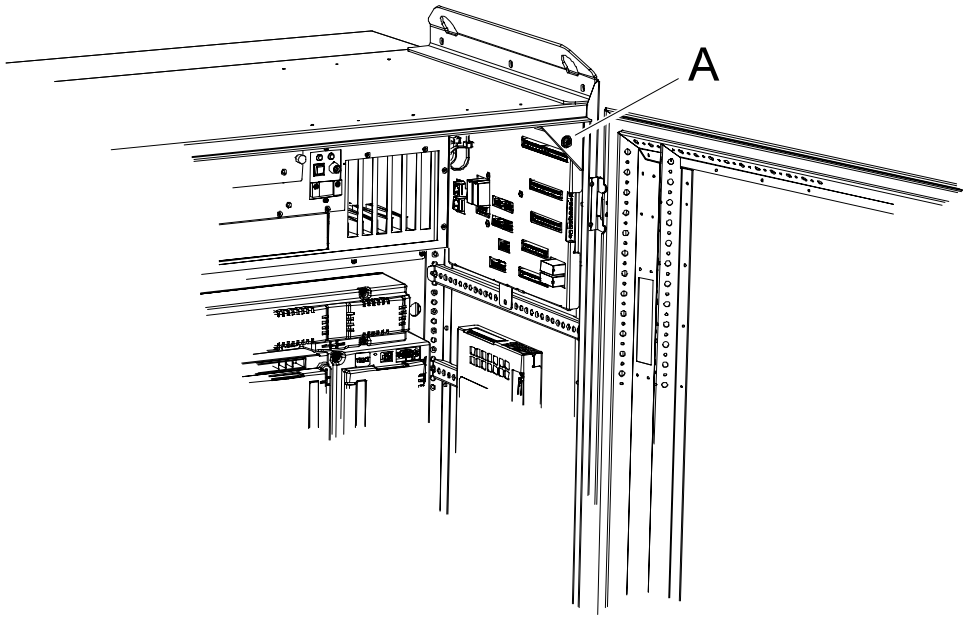
ESD (electro static discharge) is the transfer of electrical static charge between two bodies at different potentials, either through direct contact or through an induced electrical field. When handling parts or their containers, personnel not grounded may potentially transfer high static charges. This discharge may destroy sensitive electronics.

Elimination

	Action	Note
1.	Use a wrist strap	Wrist straps must be tested frequently to ensure that they are not damaged and are operating correctly.
2.	Use an ESD protective floor mat.	The mat must be grounded through a current-limiting resistor.
3.	Use a dissipative table mat.	The mat should provide a controlled discharge of static voltages and must be grounded.

Location of wrist strap button

The wrist strap button is located in the top right corner as shown in the illustration below.



xx0500002171

A	Wrist strap button

1.5.5 WARNING - Safety risks during work with gearbox oil

Description

When handling the gearbox oil, there are several dangers to both personal injuries and product damages! Following safety information must be regarded before performing any work with the oil in the gearboxes!

Warnings and elimination

Warning	Description	Elimination / Action
 - Hot oil!	Changing and draining gearbox oil may require handling hot oil of up to 90 °C!	Make sure that protective gear like goggles and gloves are always worn during this activity.
 - Possible pressure build up in gearbox!	When opening the oil plug, there may be pressure present in the gearbox, causing oil to spray from the opening!	Open oil plug carefully and keep away from the opening. Do not overfill the gearbox when filling.
 - Do not overfill!	Overfilling of gearbox oil can lead to internal over-pressure inside the gearbox which in turn may: damage seals and gaskets completely press out seals and gaskets prevent the manipulator from moving freely.	Make sure not to overfill the gearbox when filling with oil! After filling, check the correct oil level.
 - Do not mix types of oil!	Mixing types of oil may cause severe damage to the gearbox!	When filling gearbox oil, do not mix different types of oil unless specified in the instruction. Always use the type of oil specified by the manufacturer!
 - Heat up the oil!	Warm oil drains quicker than cold oil.	When changing gearbox oil, first run the robot for a time to heat up the oil.

Warning	Description	Elimination / Action
 - Specified amount depends on drained volume!	The specified amount of oil is based on the total volume of the gearbox. When changing the oil, the amount of refilled oil may differ from the specified amount, depending on how much oil has previously been drained from the gearbox.	After refilling, check the oil level.

1.5.5 WARNING - Safety risks during work with gearbox oil

2: System Description

2.1: General

The welding equipment is adapted for control from robot IRB1400/1600/2400, with control system IRC5.

The picture shows a typical system.

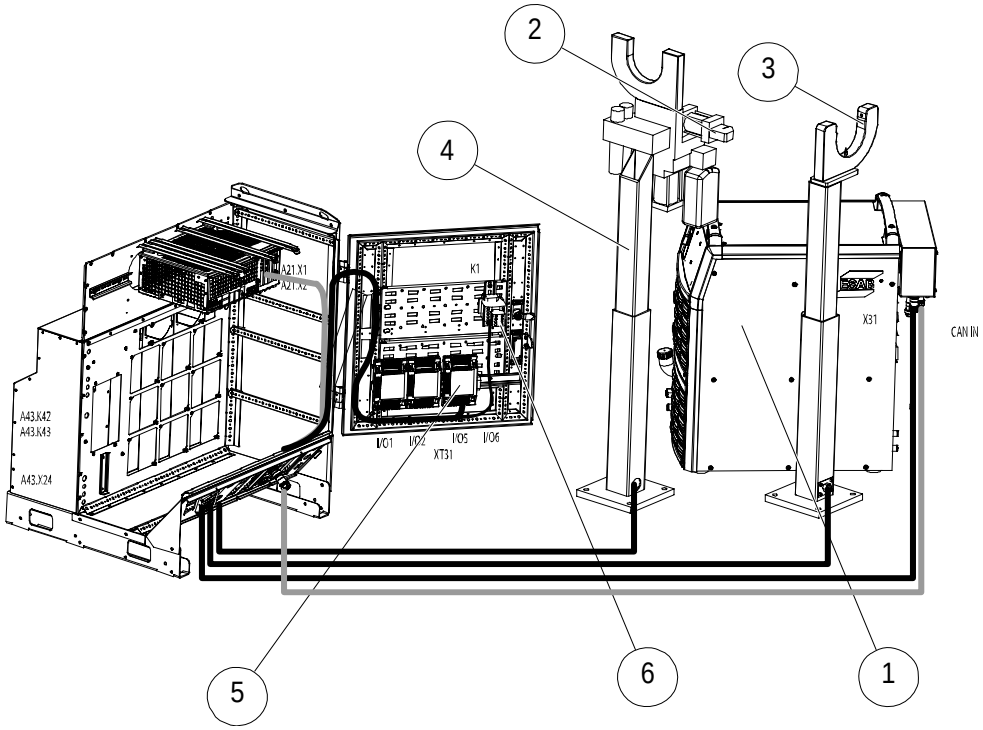


Figure 1:

	Description
1	AristoMig 4000i/5000i Power source (Welding equipment consisting power source, wire feeder, welding gun and options. Only the power source is shown in the picture)
2	Wire cutter (option).
3	TCP-calibration tool (option).
4	Mechanical cleaner (option).
5	I/O board for the control of the TCP calibration tool and mechanical cleaner.
6	Safety interlock

2.1.1 Cable connections

Process Cables

The components in the welding equipment are connected to terminals inside the controller. Cable throughs can be found on the cabinet front.

Tip!

See "Circuit diagram Process Interface AristoMig - - IRC5 Design2006"

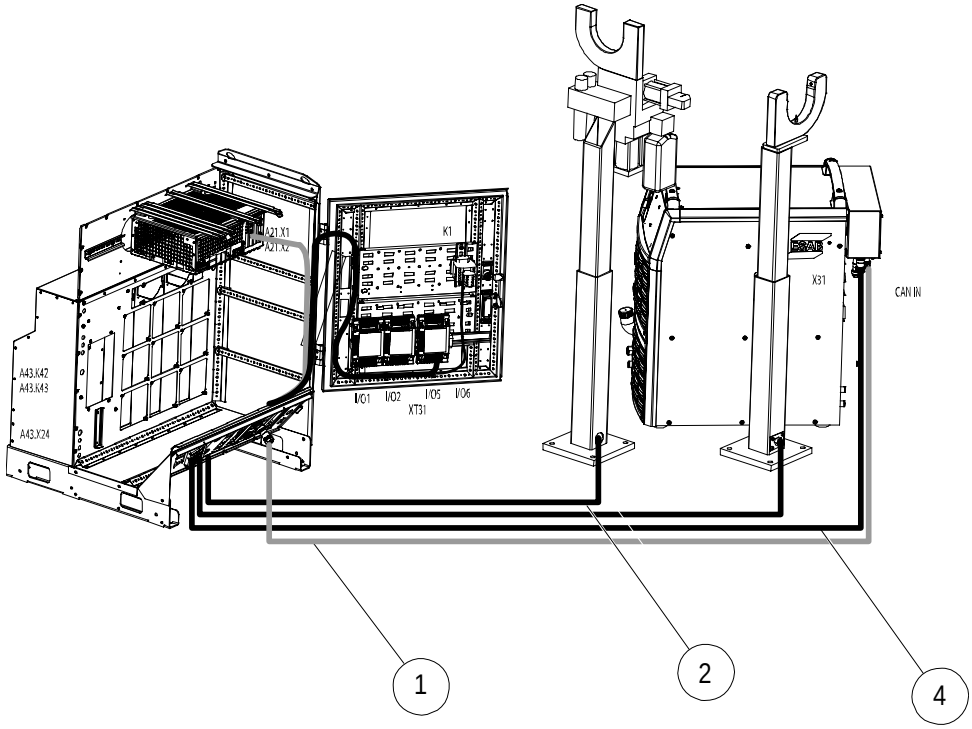


Figure 2: interface cables

	Description
1	Can cable Welding Power Source 1 (Drop line connection, for additional power sources, is located inside the power source)
2	Mechanical cleaner 1 or TCP calibration tool 1
4	Safety signals (MON) Power Source 1

Connection of CAN-bus/ DeviceNet

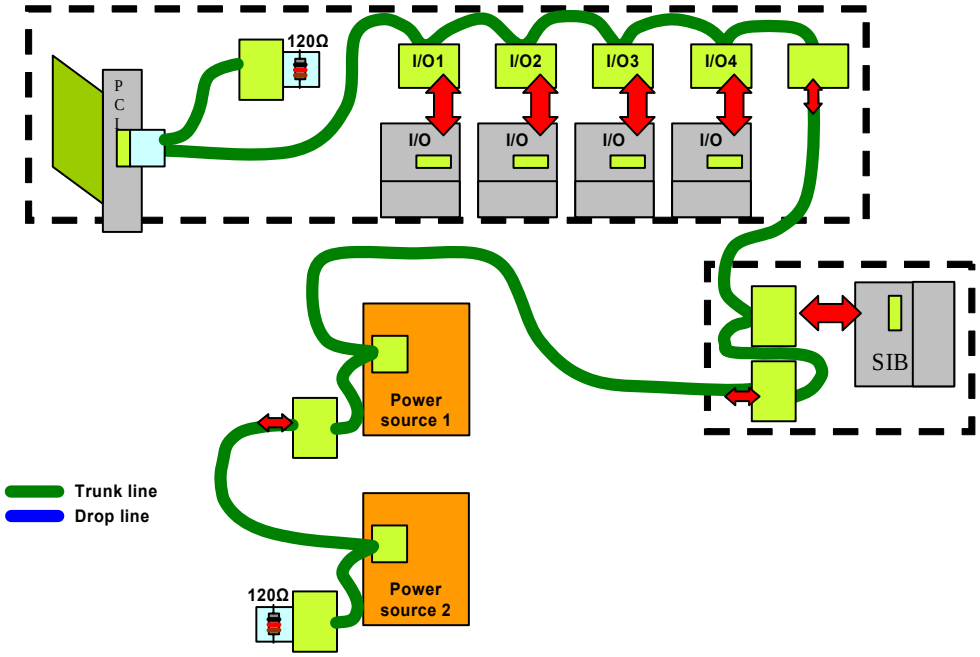


Figure 3:

2.1.1 Cable connections

3: System Safety

3.1: Personal safety

General

Moving functions that are stipulated by the EU's machine directory as able to cause personal injury, are interlocked via the robot's hold to run device and emergency stop circuitry.
Such functions are:

- Manual wire feed
- Torch cleaning

Interlocking

Where national legislation requires that welding power sources also be interlocked, the interlocking system can be complemented with a relay that opens the welding power source control circuit.

Manual wire feed

For manual wire feed that is conducted from the welding torch or wire feed unit's push button, wire can be fed without actuation of the continuous pressure device for a maximum of 6 m/minute. The longer the button is held down, the higher the speed.

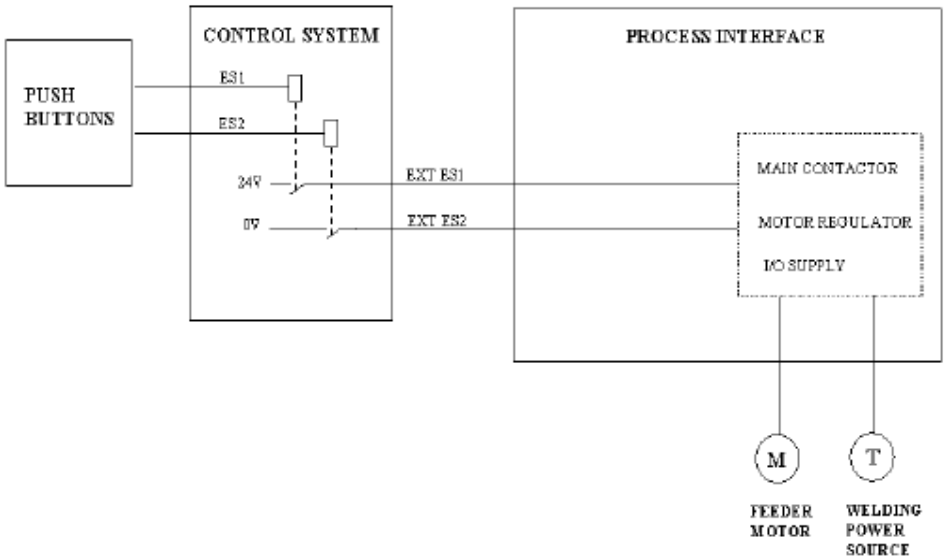


Figure 4:

3.2: Operation and connections

3.2.1 Emergency stop

General

All emergency stop buttons in the system are connected in series by default and directly affect the control system's emergency stop loop. On welding equipment belonging to the standard assortment, emergency buttons are included on:

- Single Cabinet Controller/Dual Cabinet Controller/external operator panel IRC5.

Emergency stop on welding power source

If the process equipment is fitted with emergency stop buttons, they can be connected in series with other buttons in the system.The equipment is normally interlocked via the emergency stop relay on the control system's panel board A81.

Example: The following figure shows in principle how the emergency stop loop is used for control of connected equipment.

Note!

For more detailed information on the emergency stop loop's design, please refer to the product manual for the robot controller IRC5.

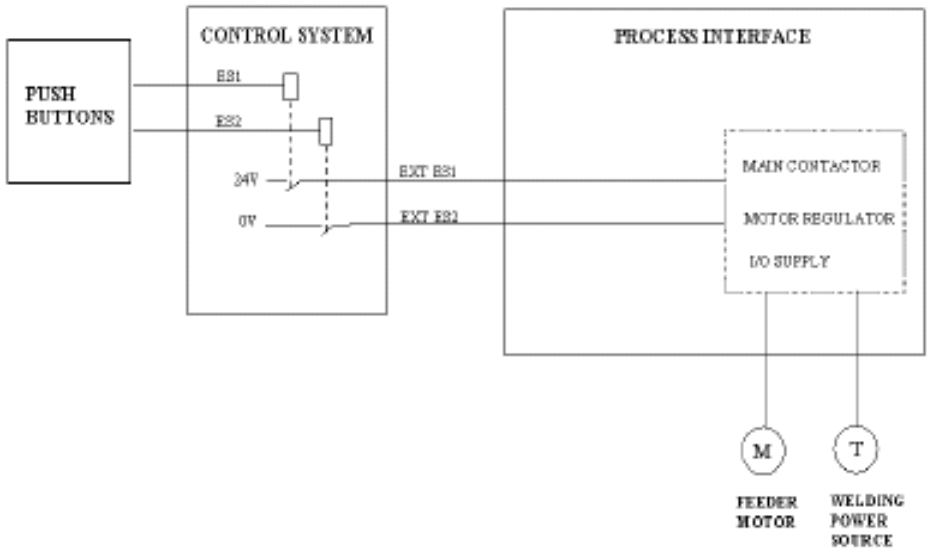


Figure 5:

3.2.2 Extended emergency stop function (option)

General

The option for extended emergency stop function provides the capability to supplement the equipment with components. Optional redundant auxiliary relays can then be easily connected for this purpose. The following figure shows in principle how the emergency stop loop with the optional extended emergency stop function is used for control of connected equipment.

Tip!

For more detailed information on the emergency stop loop's design, please refer to the product manual for the robot controller IRC5.

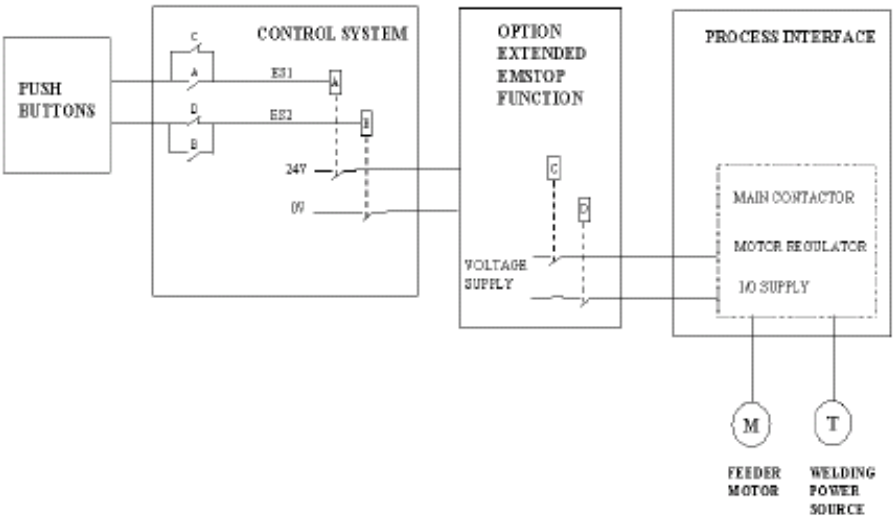


Figure 6:

3.2.3 Run Chain loop

General

The following figure shows in principle how the run chain loop is used for control of connected equipment.

Tip!

For more detailed information on the run chain loop's design, please refer to the product manual for the robot controller IRC5.

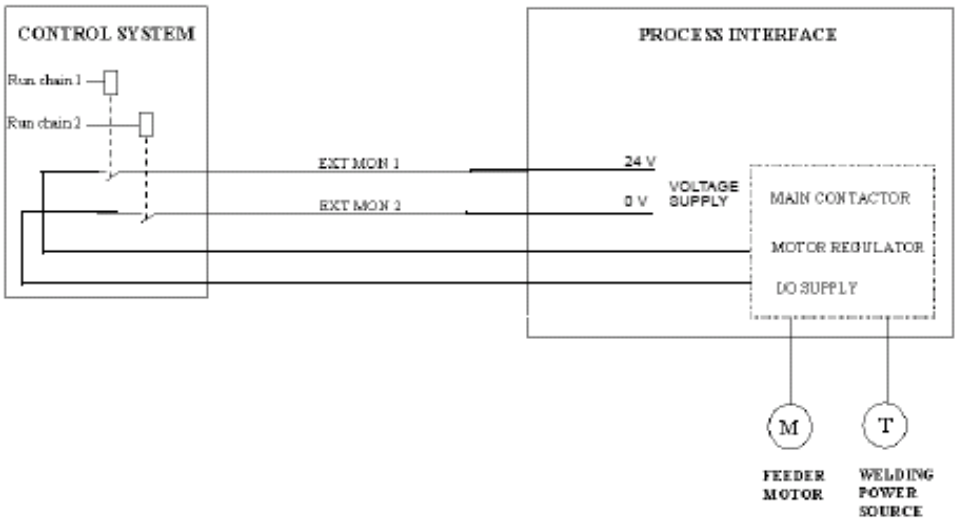


Figure 7:

4: Connections

4.1: Connections MultiMove

4.1.1 CanBus connections MultiMove

Connection Illustration

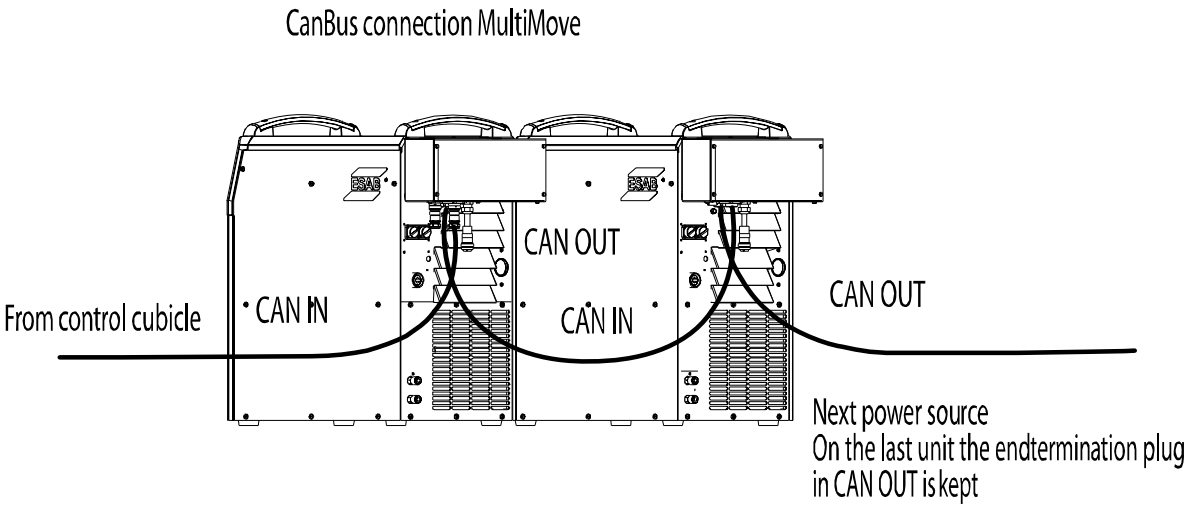


Figure 8: TC/TSC type ABB

Connection Table, TC/TSC type ABB

Wire No.	Spec.	Con.Point A	Con.Point B/ Term		Remark
1	7x0,5mm^2	From control cubicle			
1.1	WH	From control cubicle	TC/TSC X1	4	+24V
1.2	BH	From control cubicle	TC/TSC X1	2	0V
1.3	GN	From control cubicle	TC/TSC X1	11	Lubrication
1.4	YE	From control cubicle	TC/TSC X1	10	Cleaning
1.5	GY	From control cubicle	TC/TSC X1	1	Wire cutter
1.6	PK	From control cubicle	TC/TSC X1	7	Cleaning finished
1.7	BU	From control cubicle	TC/TSC X1	16	Bulls Eye
SHIELD			Not con.		
7.1	BN	From bulls eye	TC/TSC X1	5	+24V(2)
7.2	BU		TC/TSC X1	3	0V(2)
7.3	WH		TC/TSC X1	16	Bulls Eye(2)
7.4	BK		Not con.		

2. Bulls eye is optional

4.1.1 CanBus connections MultiMove

Connection Table, TC/TSC type Binzel

Wire No.	Spec.	Con.Point A	Con.Point B/ Term		Ref.	Remark
1	7x0,5mm^2	From control cubicle				
1.1	WH	From control cubicle	TC/TSC X1	1	7.1 BN	+24V
1.2	BH	From control cubicle	TC/TSC X1	5	7.2 BU	0V
1.3	GN	From control cubicle	TC/TSC X1	7		Lubrication/Lift motor
1.4	YE	From control cubicle	TC/TSC X1	6		Clamp & run motor
1.5	GY	From control cubicle	Not con.			
1.6	PK	From control cubicle	TC/TSC X1	2		Torch released
1.7	BU	From control cubicle	TC/TSC X1	10		Bulls Eye (Option)
SHIELD			Not con.			
7.1	BN	From bulls eye	TC/TSC X1	1	1.1 WH	+24V(2)
7.2	BU		TC/TSC X1	5	1.2 BN	0V(2)
7.3	WH		TC/TSC X1	10		Bulls Eye(2)
7.4	BK		Not con.			

2. Bulls eye is optional

Connection Table, Bulls Eye stand alone

Wire No.	Spec.	Con.Point A	Con.Point B/ Term		Remark
1	7x0,5mm^2	From control cubicle			
1.1	WH	From control cubicle	-Bulls eye: Brown		+24V
1.2	BH	From control cubicle	-Bulls eye: Blue		0V
1.3	GN	From control cubicle	Not con.		
1.4	YE	From control cubicle	Not con.		
1.5	GY	From control cubicle	Not con.		
1.6	PK	From control cubicle	Not con.		
1.7	BU	From control cubicle	-Bulls eye: White		Optional Bulls eye
SHIELD			Not con.		

5: Spare Part List

5.1: Overview

This section contains spare part list for:

- Safety Interlock
- Torch cleaner

5.1.1 Safety Interlock

Spare Part List

Pos.	Qty.	Component	Description
2	1	3HEA8004447-001	Contactor DILM 12-10 (24V DC)
3	1	3HEA800447-003	Auxiliary contact 1NO/3NC DILA-XHI13
10		3HAC029777-001	Cable safety enable AW
20		3HAC029686-001	Cable TC/TSC
30	1	3HAC025917-001	Digital I/O DSQC 652

5.1.1 Safety Interlock

Illustration Safety Interlock

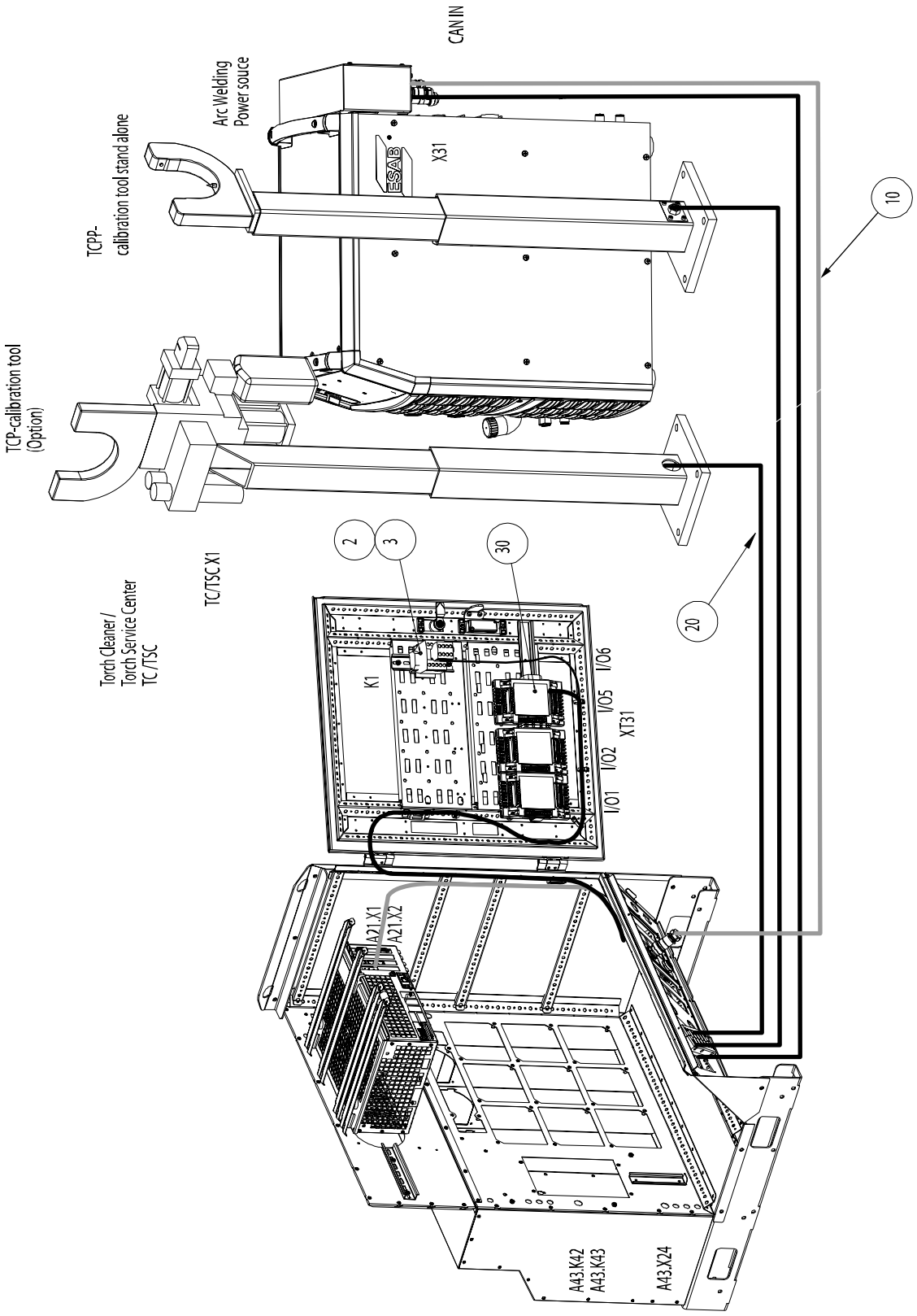


Figure 9: Safety Interlock

5.1.2 Torch cleaner

Spare Part List

Pos.	Qty.	Component	Description
1	1	500973883	Torch cleaner
2	1	487119113	Spacer
2	1	487119110	Spacer
3	1	3HAC029098-003	Reamer
3	1	3HAC029098-004	Reamer

5.1.2 Torch cleaner

Illustration Torch cleaner

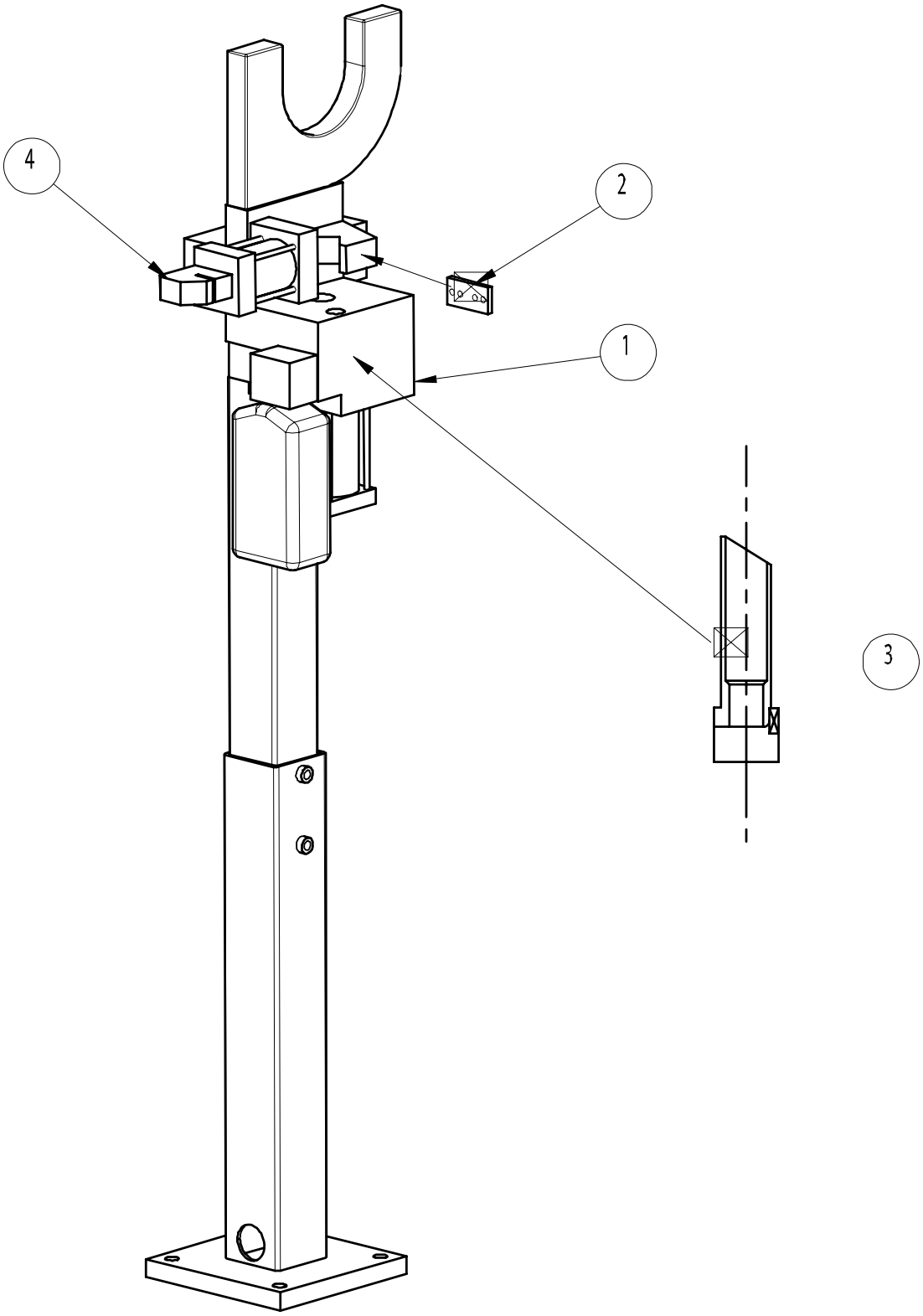


Figure 10: Torch cleaner

6: Illustrations

6.1: Wire feed unit

6.1.1 IRB 1600ID

Illustration Wire feeder IRB 1600ID

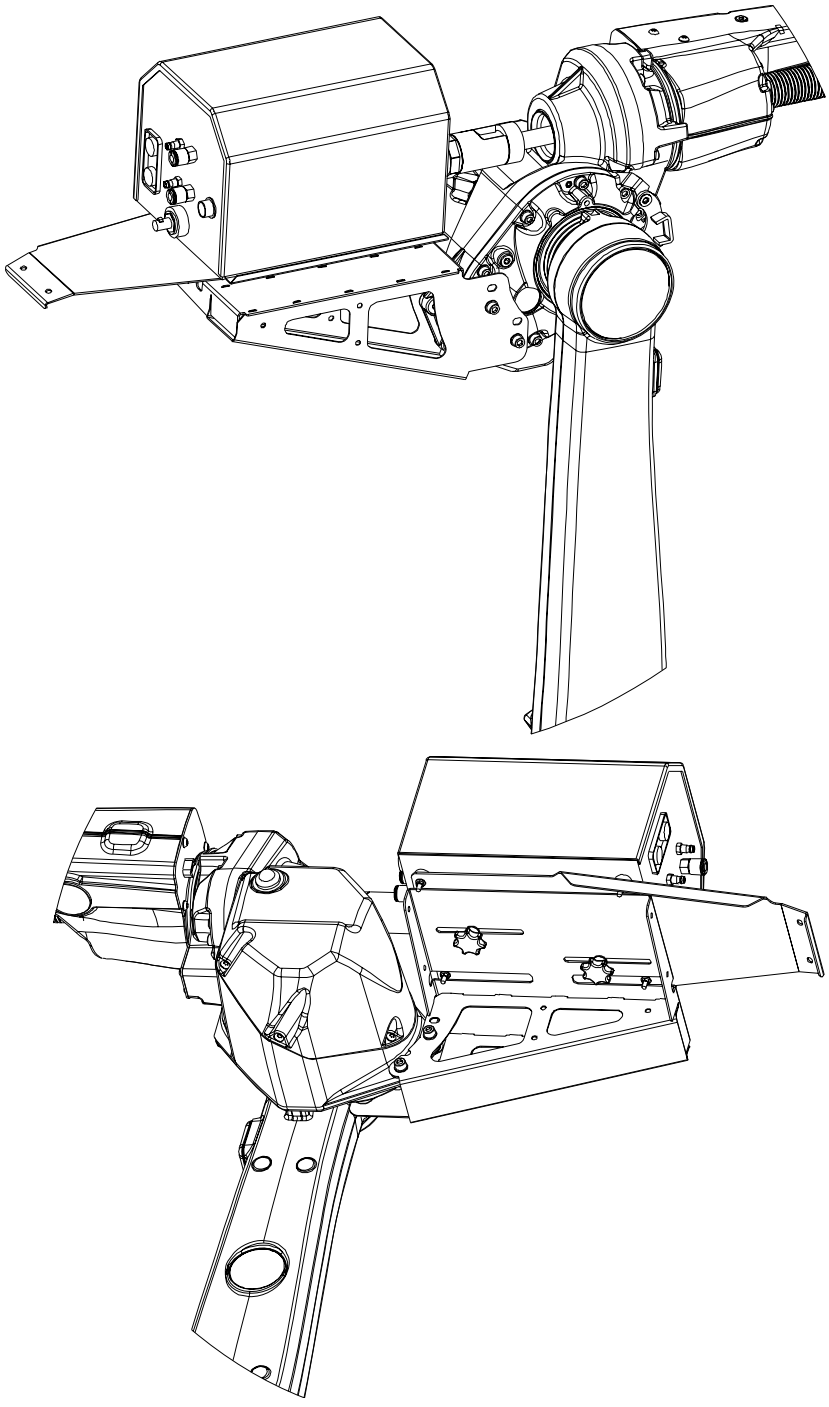


Figure 11: Wire feeder IRB 1600ID

6.1.2 IRB 1600

Illustration Wire feeder IRB 1600

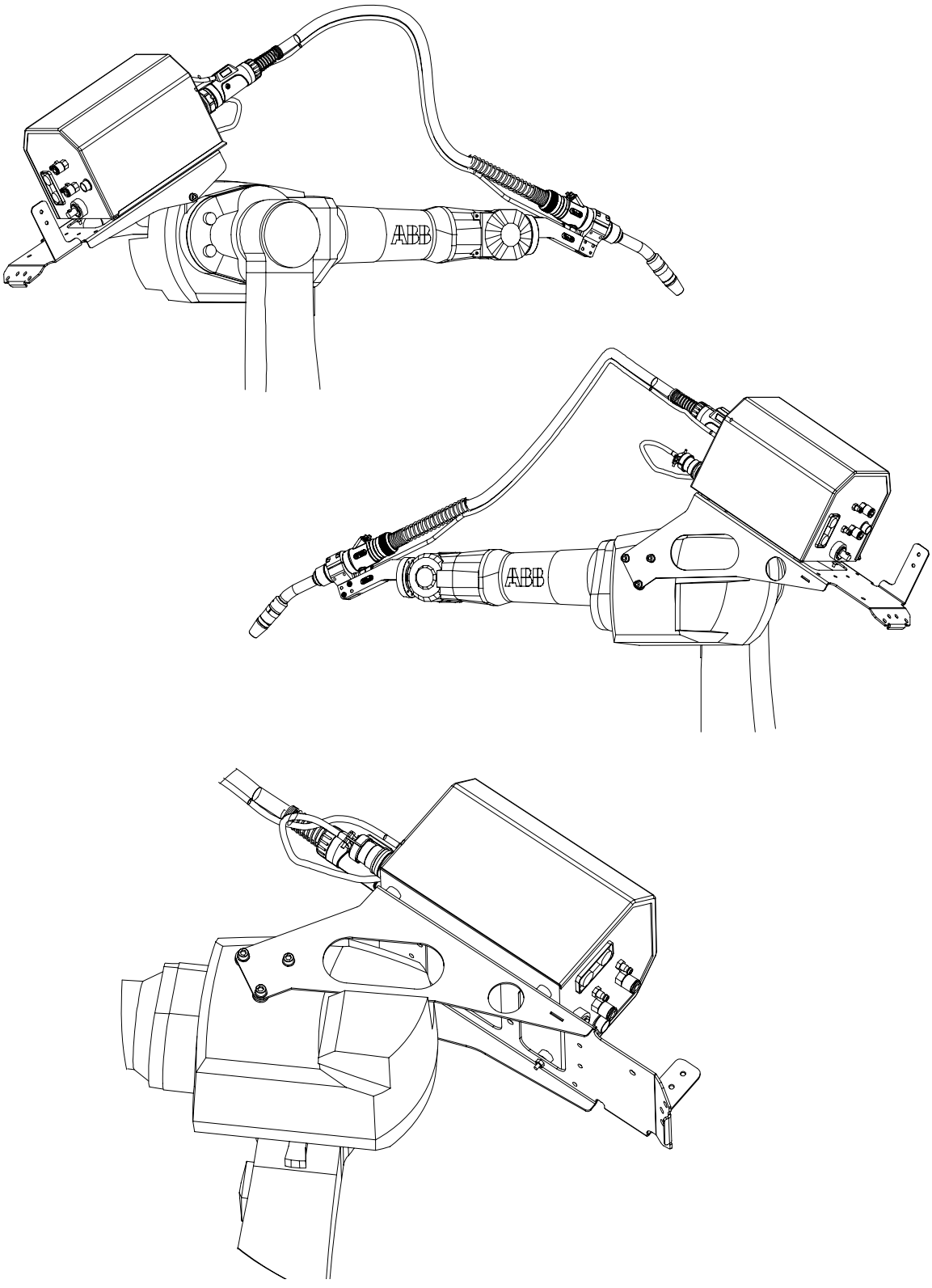


Figure 12: Wire feeder IRB 1600

6.1.3 IRB 2400

Illustration Wire feeder IRB 2400

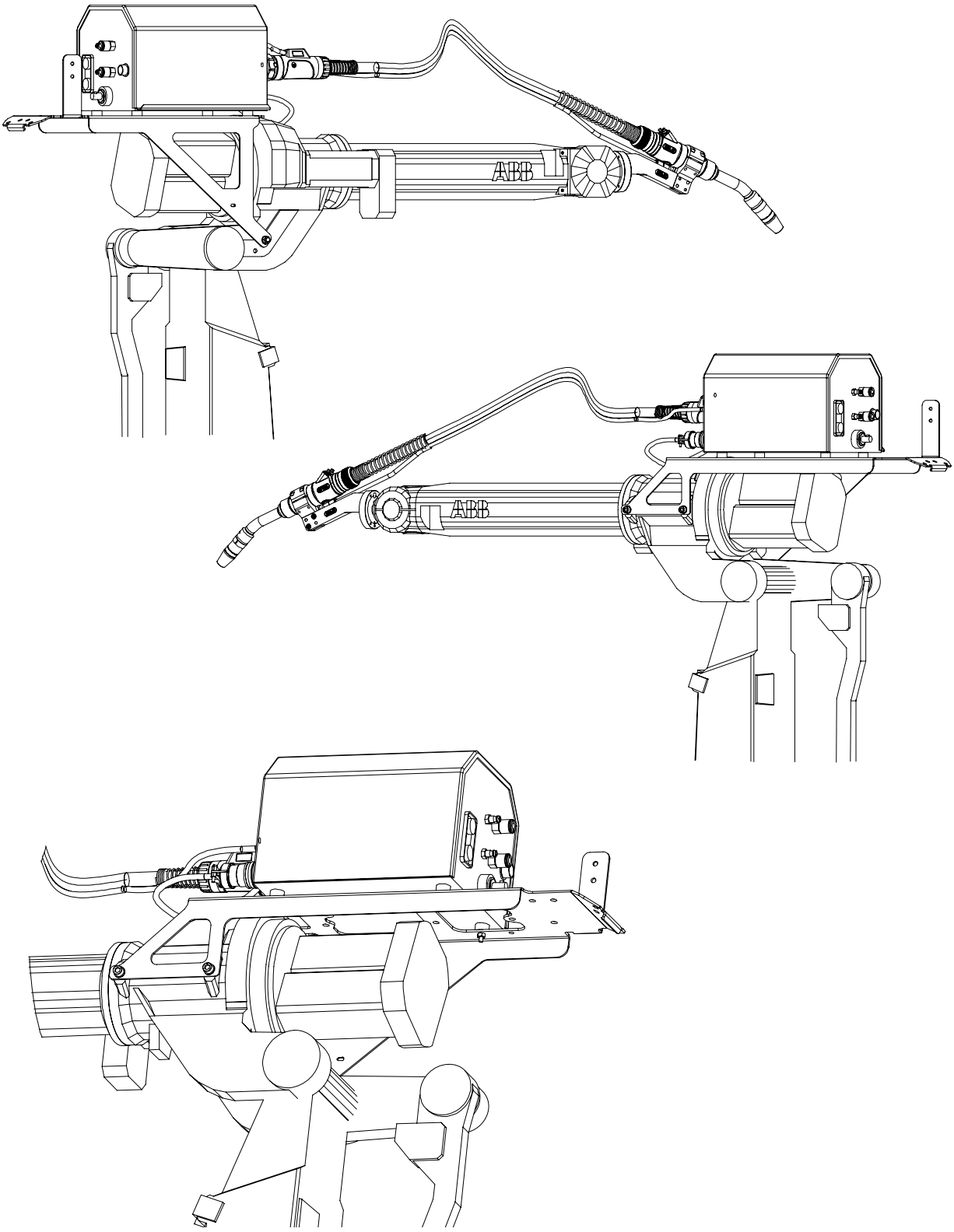


Figure 13: Wire feeder IRB 2400

6.1.3 IRB 2400

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