ROBOTICS

STÄUBLI

CS8C Controller
Instruction manual

D28070504A – 26/03/2009
CS8C

Documentation addenda and errata can be found in the "readme.pdf" document delivered with the controller's CdRom.

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CHAPTER 1

INTRODUCTION

1.1. FOREWORD

The information contained in the present document is the property of **STÄUBLI** and it cannot be reproduced, in full or in part, without our prior written approval.

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If any difficulties are met with during operation or servicing of the robot that are not referred to in this document, or if further information is required, please contact the **STÄUBLI** After Sales Department, "Robot Division".

1.1.1. OBJECTIVE OF THIS MANUAL

The objective of this manual is to provide information concerning the installation, use and maintenance of the **Stäubli CS8C** controller. It provides help for the persons working on the equipment, for reference purposes only. This is because correct understanding of this document and use of the **Stäubli CS8C** controller imply that the staff concerned have acquired the necessary knowledge by following a "robots" training course provided by **Stäubli**.

The photos are used to make the document easier to understand, they cannot be construed as being of a contractual nature.

1.1.2. SPECIAL MESSAGES CONCERNING WARNINGS, ALERTS, AND INFORMATION

In this document, there are two formats for warnings and alerts. The messages contained in the boxes inform staff of the potential risks involved in carrying out an action.

These boxes are as follows (they are shown in decreasing order of importance):

Danger message

DANGER:

Instructions drawing the reader's attention to the risks of accidents that could lead to serious bodily harm if the steps shown are not complied with. In general, this type of indication describes the potential danger, its possible effects and the steps necessary to reduce the danger. It is essential to comply with the instructions to ensure personal safety.

Warning message

CAUTION:

Instructions drawing the reader's attention to the risks of material damage if the steps shown are not complied with. It is essential to comply with these instructions to ensure equipment reliability and performance levels.

Notes

Paragraphs of the "note" type provide very important information to help the reader to understand a description or a procedure.

Note:

Supplies further information, or underlines a point or an important procedure. This information must be memorized to make it easier to apply and ensure correct sequencing of the operations described.

1.2. DEFINITION OF THE ELEMENTS AROUND THE ROBOT CELL

Person: general term identifying all individuals likely to come close to the **Stäubli** robot cell.

Staff: identifies the persons specifically employed and trained to install, operate, and service the **Stäubli** robot cell.

User: refers to the persons or the company responsible for operating the **Stäubli** robot cell.

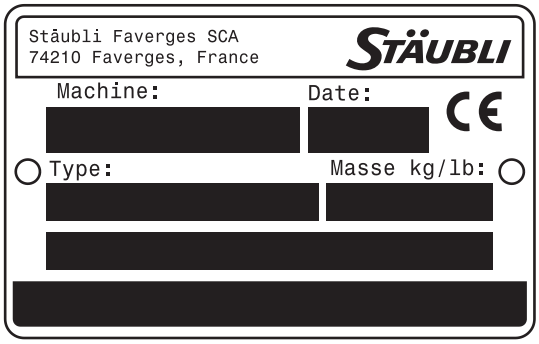
Operator: refers to the person who starts or stops the robot, or controls its operation.

CHAPTER 2

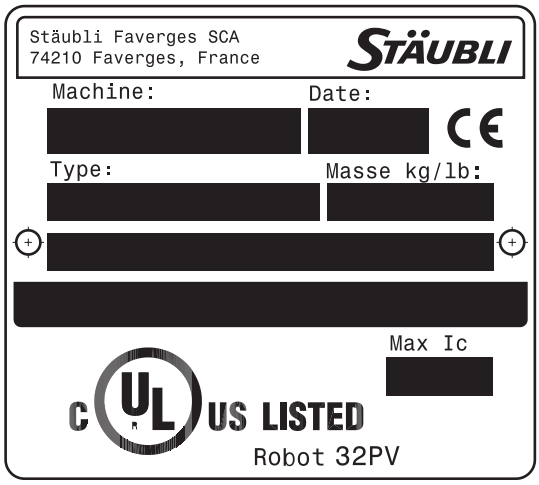
DESCRIPTION OF THE CONTROLLER

2.1. IDENTIFICATION

Manufacturer's plate on each robot.
A plate is provided on the controller and on the arm (see figure 2.1).



Standard version



UL version

Figure 2.1

For all requests concerning information, replacement part orders, or requests for intervention, please state the type and the serial number of the machine concerned, as set out on the manufacturer's plate.

2.2. LOCATION AND DESCRIPTION OF THE MAIN COMPONENTS

2.2.1. THE CONTROLLER

The **CS8C** controller is made up of a processor **(5)**, the intelligent part of the installation.
The processor controls the robot via digital power amplifiers **(1)** dedicated to each axis of the arm.
The electrical power is converted by the **PSM (7)** power section, the **RPS (2)** power supply, and the **ARPS (3)** power supply which supplies to each of the above elements the voltage required for correct operation from the mains voltage delivered by the electrical network.
The functions required for electrical safety are grouped together on the **RSI (4)** board.

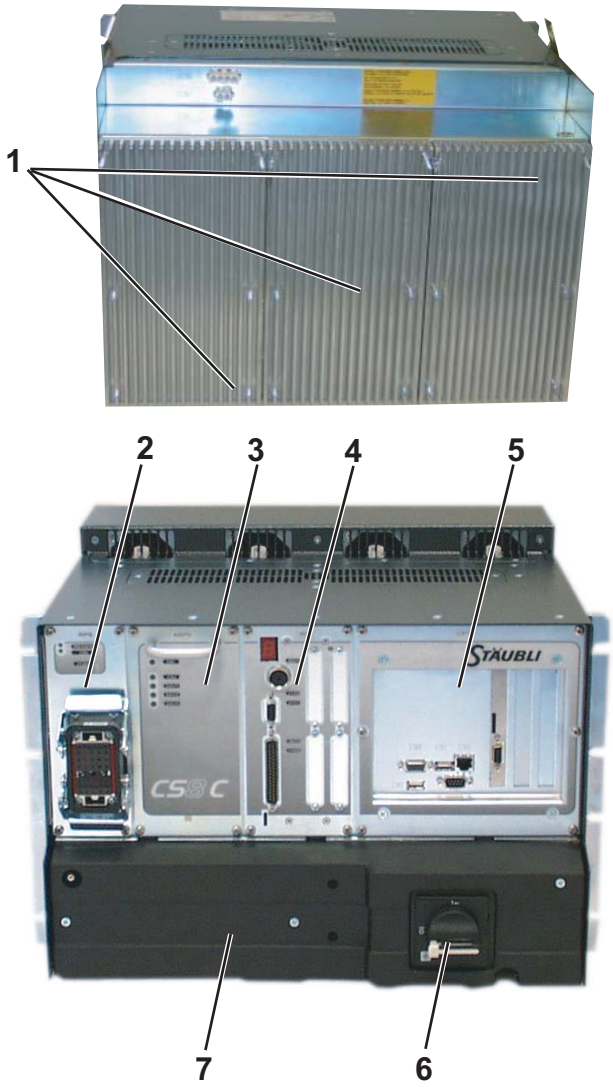


Figure 2.2

To disconnect the system from the power supply, set the master switch **(6)**, located on the front panel of the controller, to 0. Before doing so, you must stop the arm motion and switch off arm power supply.

2.2.2. THE MCP

General description
The **MCP** (Manual Control Pendant) can be used to enable arm power supply and control its movements.

Figure 2.3

Location and handling of the MCP
To power the arm in manual mode, the **MCP** must be placed on the holder provided for the purpose. The holder is fixed outside of the cell. It has two functions:

- Making the **MCP** easily accessible for the operator.
- Detecting the presence of the **MCP** outside the cell.

In the event that the **MCP** is used elsewhere than on its holder in manual mode, it is necessary to use the validation button (**#**) located under the **MCP**. The button's location enables it to be used by right-handed or left-handed persons alike.

2.2.3. WMS FRONT PANEL

Modes of operation are selected from the WMS front panel which has to be installed permanently outside of the cell. The removable 3-position keyswitch prevents from changing the mode when it is not allowed.

CHAPTER 3

SAFETY

3.1. REMINDER CONCERNING THE SAFETY STANDARDS

DANGER:

The robot is a fast moving machine. These movements can be dangerous. Always comply with the safety standards recommended for robot use and inform operators about the dangers faced.

The robot is a sub-assembly designed for integration in a robot cell. It has been designed and built to enable the "robot cell" unit to comply with regulatory provisions. Compliance of the robot cell is the responsibility of the prime contractor who very frequently is the owner.

The user must make sure that the staff programming, operating, maintaining or repairing the robot or the robot cell are correctly trained and show the skills necessary to carry out these tasks in full safety.

In France, for example, posters issued by the CRAM are available to remind operators of the safety rules applicable in the vicinity of robot stations.

The electrical equipment of the robot and the robot cell must comply with standard EN 60204-1 and specific standards if required, such as UL1740.

The characteristics of the power supply and the grounding terminals must comply with the manufacturers' specifications.

The robot and its controller are designed to meet a "Category III" safety level.

Standards applicable
Installation of the robot must be planned in accordance with the standard instructions.

• ISO 10218-1, 2006	Robots for industrial environment - Safety
• EEC 98 / 37 "Machine Safety" Directive	European Directive
• Standard EN 292	General principles
• Standard EN 294	Safety distances
• Standard EN 418	Emergency stop equipment
• Standard EN 953	Protective elements
• Standard EN 954-1	Machine safety
• Standard EN 349	Minimum clearances
• Standard EN 1050	Risk assessment
• Standard EN 1088	Locking devices
• Standard EN 60204-1	Electrical equipment on machines
• Standard EN 999	Speed on approach towards the human body
• Standard EN 61 000-6-4	Electromagnetic compatibility - Emission
• Standard EN 61 000-6-2	Electromagnetic compatibility - Immunity
• Standard CEI 34-1	Electrical rotating machines

For the UL version:

• Standard UL 1740	Robots and Robotics Equipment
• Standard RIA15-06	American National Standard for Industrial Robots and Robot Systems. Safety Requirements.
• Standard CSA Z434-03	Industrial Robots and Robot Systems. General Safety Requirements.
• Standard NFPA 79	Electrical standard for industrial machinery
• Standard NFPA 70	National Electrical Code

3.2. SAFETY DIRECTIVES CONCERNING TO THE WORK ENVIRONMENT

3.2.1. ANALYSIS OF SAFETY AROUND THE ROBOT CELL

Safety must be taken into account for the robot cell from the design and development stage on.
Before planning the installation of the robot cell, it is necessary to study the following points:

- Plan the safety strategies that reduce risks to an acceptable level.
- Define the tasks required for the foreseeable applications and assess the access and/or approach requirements.
- Identify the sources of risks including the failures and the failure modes associated with each of the tasks. The risks can involve:
    - the cell itself
    - its association with other items of equipment
    - the interactions between persons and the cell.
- Assess and estimate the risks stemming from cell operation:
    - programming risks
    - operating risks
    - risks during use
    - maintenance risks for the robot cell.
- Select the protective methods:
    - use of protective devices
    - installation of signalling means
    - compliance with safe working procedures.

These points are taken from the standards applicable to robots.

Note:
This list is not exhaustive. Above all, it is necessary to comply with the standards in force in your country.

DANGER:
To ensure reliability and precision in the robot's movements, the robot cell environment must comply with the levels of disturbance set out in the safety standards.

3.2.2. RULES CONCERNING THE ROBOT'S WORK AREA

The controlled area or isolation area in which the robot moves must be determined using protective devices (protective elements).

Note:
Protective elements are devices protecting persons from a dangerous area. See the standards currently in force concerning safety for industrial handling equipment.

DANGER:
At the time of an emergency stop, the final position of the arm can never be determined precisely because of the kinetic energy involved. It is thus necessary to make sure that no persons or obstructions are present in the robot's work area when the arm is powered up.

3.3. SAFETY DIRECTIVES CONCERNING TO STAFF PROTECTION

Stäubli robots work with computer controlled mechanisms, capable of moving at high speed and exerting considerable force. Like all robots and most industrial equipment, they must be controlled with great care by the user of the robot cell. All staff using **Stäubli** robots must be familiar with the warnings and recommendations given in this manual.

3.3.1. MECHANICAL AND ELECTRICAL DANGERS

This sign, applied on different parts of the robot, indicates that there is a potential electrical danger and that only qualified service personnel may install or service the robot system.

DANGER:

- **Only qualified service personnel may install or service the robot system.**
- **Ensure compliance with all local and national safety and electrical codes for the installation and operation of the robot system.**
- **Disconnect all the electrical and pneumatic power supplies before carrying out any work on the controller or the arm.**

To turn of power, set the **CS8C** main switch to the "0" position.

To prevent inadvertent during the service operation, the main switch must be locked in 0 position using a padlock whose key is to be kept by the person carrying out the service operation. The locked status must be shown by a sign. For example, put a "Do not operate" sign in place.

Before powering up the system, make sure that all the electrical protection systems have been fitted and that there is no risk of electric shocks.

Note:
When the main switch is set to 0, voltage remains present between the input terminals (mains supply filter) and the main switch input.

DANGER:

Each time the arm is powered on, keep one hand close to the "Emergency stop" button in order to be able to press it as quickly as possible in the event of a problem.

- For UL robots: When arm is powered-on, a light on the arm is on to indicate there is a potential danger. This light is also on when manual brake release is performed (on axis 1 on RX and TX robots, on axis 3 on Scara robots).
- Do not connect or disconnect components while the unit is under power. The connection between the controller and the robot arm can only be made if the controller has been switched off.
- Remove part or tool loaded on robot during maintenance operations.
- If unusual sounds or vibrations are noted on the robot arm, especially following a shock or some other incident, it is necessary to inspect the tool and gripper fastenings carefully and make diagnoses at low speed.

Note:
If a crash of the arm occurs, all safety components involved in the safety have to be checked carefully to verify they are still operating and not damaged: hard stop devices on the arm, electrical limit switches, calibration of the robot. Don't hesitate to call Stäubli service for any doubt.
Each time a calibration, adjustment or recovery procedure is done, the calibration of the arm has to be controlled carefully to verify that the robot is able to move in its expected angular range and not more. This verification has to be done at slow speed.

DANGER:

All persons are prohibited from remaining in the isolation area in which the robot arm operates. Certain robot working modes such as the "brake release" mode can lead to unforeseeable arm movements.

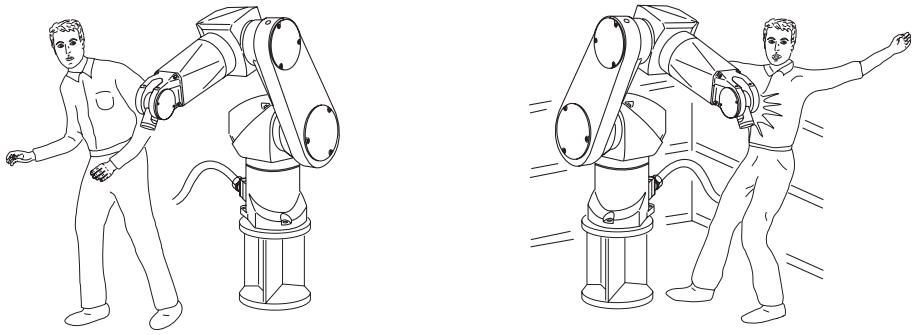


Figure 3.1

Following maintenance work, whether it involves mechanical, electrical, pneumatic or software operations, it is advisable to make sure that the robot functions correctly, first at low speed while the person stays outside the cell, and then under the normal conditions of use. In particular, make sure that all the protective and safety systems are correctly in place, and that calibration of the robot is correct.

3.3.2. ROBOT CELL SAFETY DEVICES

The safety devices must form an integral part of the design and installation of the robot cell. Operator training and compliance with the operating procedures constitute a major element in setting up the safety devices and systems.

Stäubli robots are equipped with various communication functions, helping the user to develop safety devices for the robot cell. These functions include the emergency stop circuits, the digital Input/Output lines, and the display system for error and warning messages (see the "Integration" chapter). When the system is used without the MCP, these messages/warnings can only be consulted via the application program (see chapter 5).

3.4. SAFETY DIRECTIVES CONCERNING TO PROTECTION OF THE EQUIPMENT

3.4.1. CONNECTIONS

- Before connecting the controller to the power supply, make sure that its nominal voltage does indeed correspond to the network voltage.
- When connecting the controller, use a cable whose cross-section corresponds to the power rating shown on the manufacturer's plate.
- Before removing or inserting an electronic component, switch off arm power and then switch off controller power and comply with the procedure.
- Take care to avoid blocking the air inlets and outlets for the controller airflow path.
- Never use the emergency stop to power down the arm under normal conditions of use.

3.4.2. INFORMATION ON ELECTROSTATIC DISCHARGES

What is an electrostatic discharge?
Everyone has felt the effects of static electricity on their clothes or when they touch a metal object, without being aware of the damage that can be done to electronic components by static electricity.
Our desire to integrate the notions of quality and reliability in our products makes it necessary to prevent electrostatic discharges from causing damage to them. This means that all the staff and login users must be informed.

Storage of a charge
An electric charge is created simply by combining a conductor, a dielectric and the ground (lowest reference potential, usually the ground in the case of an electrostatic charge).

Example: people, printed circuits, integrated circuits, components, conducting mats when separated from the ground by a dielectric.

Electrostatic discharges or ESD
Most people have experienced ESD by receiving an electric shock when walking on a carpet and touching a doorknob or when getting out of a car.

In most case, the following is true:

- To feel an ESD, a charge of at least 3500 V is required.
- To hear one, a charge of at least 5000 V is required.
- To see a spark, a charge of at least 10 000 V is required.

This shows that it is possible to develop charges of over 10 000 V before noticing an electrostatic discharge!

Risks created by an electrostatic discharge
A high ESD voltage (several thousand volts) creates danger for electronic components. A semi-conductor must be handled carefully to prevent destruction by ESD. It is estimated that ESD destroy only 10% of the components that they effect. The other 90% of components fall into the "deteriorated" category. A component may be damaged with simply 25% of the voltage required to destroy it.

These hidden faults can lead to problems that appear several days, weeks or even months after the incident. Components may also undergo a change in their operating characteristics. Initial tests are successfully passed but an intermittent error occurs under vibration or temperature constraints. The same components will pass the "on/off" test successfully, as carried out during repairs, but the problem will reappear again once on site.

Typical ESD voltages

SOURCE	LOW RELATIVE HUMIDITY 10 - 20%	AVERAGE RELATIVE HUMIDITY 40%	HIGH RELATIVE HUMIDITY 65 - 90%
Walking on carpet	35 kV	15 kV	1,5 kV
Walking on vinyl	12 kV	5 kV	0,3 kV
Working at the workstation	6 kV	2,5 kV	0,1 kV
Plastified instructions	7 kV	2,6 kV	0,6 kV
Polyethylene bags	20 kV	2 kV	1,2 kV
Cellular polyurethane	18 kV	11 kV	1,5 kV

CHARGE SOURCES	
Work surfaces	Packaging
Floors	Handling
Chairs	Assembly
Carriages	Cleaning
Clothes	Repairing

PARTS SENSITIVE TO STATIC CHARGES
Electronic cards Power supplies Encoders etc

3.4.3. PREVENTION OF DAMAGE DUE TO ELECTROSTATIC DISCHARGES

It is essential to guard against electrostatic discharges during an intervention concerning electronic components, sub-assemblies and complete systems.

Elimination of the danger due to ESD requires a combined team effort. By complying with the following instructions, you can substantially reduce the potential damage caused by ESD and ensure long-term reliability for the robot.

- Inform the staff of the risks stemming from ESD.
- Know the critical zones sensitive to ESD.
- Know the rules and procedures to deal with ESD.
- Always carry components and boards in a tray to protect them from electrostatic charges.
- Always ground yourself before working on a workstation.
- Keep non-conducting equipment (static charge generators) away from components and boards.
- Use tools providing protection from ESD.

STÄUBLI workstation
To handle electronic cards, **STÄUBLI** workstations are given a grounded coating that dissipates static electricity. An anti-static bracelet is required to handle boards or electronic components.

Work zones
Remove objects that generate static electricity charges from the work area, such as:

- plastic cups
- polystyrene
- notebooks
- plastic files and document holders.

Printed circuits, boards and electronic components must be kept in anti-static bags.

Anti-static wrist strap
Use an electrostatic wrist strap connected to the frame of the controller or to the frame of the arm and the ground during all handling of boards or components. The wrist straps are supplied as part of the standard equipment for the robot.

CAUTION:
Use an electrostatic wrist strap and an anti-static mat connected to the cabinet during all handling of boards or components.

CHAPTER 4

INSTALLATION

4.1. ROBOTIZED CELL ENVIRONMENT

Installation of the robot must be planned in accordance with the standard instructions.

(see paragraph 3.1)

> **DANGER:**
> **See the declaration of incorporation and conformity.**

This declaration of incorporation and conformity relates to the CE mark. For UL robots, UL mark information can be obtained on UL web site : http://www.ul.com. In the proposed menu list, select "Certifications" and fill in the UL file number with **e221459**

4.1.1. POSITIVE SAFETY

The robotized cell must be designed, built and installed in a way ensuring that no foreseeable failures of any components whatsoever (electric, electronic, mechanical or pneumatic) affects the safety functions. In the event of a problem, the robotized cell must remain in a safe state (see chapter 3, page 21).

The safety functions include especially:

- Limiting the range of movements
- The emergency stop and the controlled stop
- Low speed
- Locking of the protective devices

Example: Fit safety locking bolts (electric door openers, twin contacts) on all the openings. Part entrances and exits must be made safe: tunnels, light barriers,etc

The robot and its controller are designed to meet a "Category III" safety level.

4.1.2. POWER SOURCES

The electrical equipment of the robot and the robot cell must comply with standard EN 60204-1.

The characteristics of the power supply and the grounding terminals must comply with the manufacturers' specifications.

Each robotized cell must be equipped with means of separating each of its power sources.

4.2. ON-SITE PREPARATION

4.2.1. ELECTRICAL NETWORK

The system is linked to the mains power supply via a cable with 2 or 3 wires + ground connected to the controller. Various power supply voltages are possible: 200V, 208V, 230V, 400V, 440V, 480V (50/60Hz) ± 10 %. The choice of the power supply voltage and the type of network (single phase or three-phase) depend on the option selected and the type of arm used.

CAUTION:

Make sure that the voltage supplied corresponds to the voltage shown on the manufacturer's plate of the CS8C controller.

When making the connections, the ground wire must be connected first.

Power rating to be installed:

TX40	1,5 kVA
TX60	1,7 kVA
TX90	2 kVA
RX160	3 kVA
RS40B, 60, 80	1,7 kVA

Minimum wire cross section: 14 AWG / 2 mm^2

Maximum wire cross section: 8 AWG / 6 mm^2 (flex wire)

Maximum wire cross section: 7 AWG / 10 mm^2 (solid wire)

Maximum tightening torque applicable on terminal block screw: 1.8 Nm

DANGER:

Use a cable whose cross-section is suitable for the power rating shown on the manufacturer's plate and protect the line accordingly.

Note:

The controller is fitted with a filter to limit the induced disturbances (disturbances caused by the controller). The filter can cause major leakage current peaks that have to be taken into account when selecting the elements protecting the power supply circuit (using a time delay ground fault circuit breaker). Leakage current can reach up to 250 mA for 3 ms. Nominal leakage current for 3-phase and single phase configurations is below 3 mA.

4.2.2. PNEUMATIC NETWORK

For the arm, and if solenoid valves are used, it is necessary to provide a supply of compressed air, lubricated or not, at a maximum pressure of 7 bar and filtered to 10 µm.

4.2.3. WORK ENVIRONMENT

- Working temperature: 5 to 40°C (NF EN 60204-1) with controller cooling via a filtered fan.
- Storage temperature: -25 to 55° C.
- Humidity: 90% maximum without condensation.
- Maximum altitude: 2000 m.
- Vibrations: please consult us.
- Protection index: IP20.
- Clean environmental air: Class 10 000 (Federal Standard 209E).

If these conditions of cleanness and temperature in particular are not complied with, the controller must be integrated in a closed area in which the necessary conditions can be provided: A cooled industrial frame. If **CS8C** is enclosed in a IP54 cabinet, the door of this external chassis has to remain closed during operation.

The heat generated by the controller is 400 W.

4.2.4. CONTROLLER FOOT PRINT AND FITTINGS

The **CS8C** controller can be simply placed on the floor, in compliance with its environmental constraints, or fitted in a 19" frame as shown in the layout below, to meet the airflow constraints.

For easier maintenance, we recommend slides to hold the controller in place while it is not kept in a vertical position by its fastening points. The length of the Input/Output cables must also be taken into account.

Note:
In addition to the mechanical fastening of the controller, the brackets are also a good way to ground the controller to the cell's frame and have a common reference potential with all other equipements in the cell. The ground connection used on main input is providing personnal protection, the ground connection from the brakets is providing EMI protection.

4.2.4.1. **CS8C** FOR TX AND RS ARMS

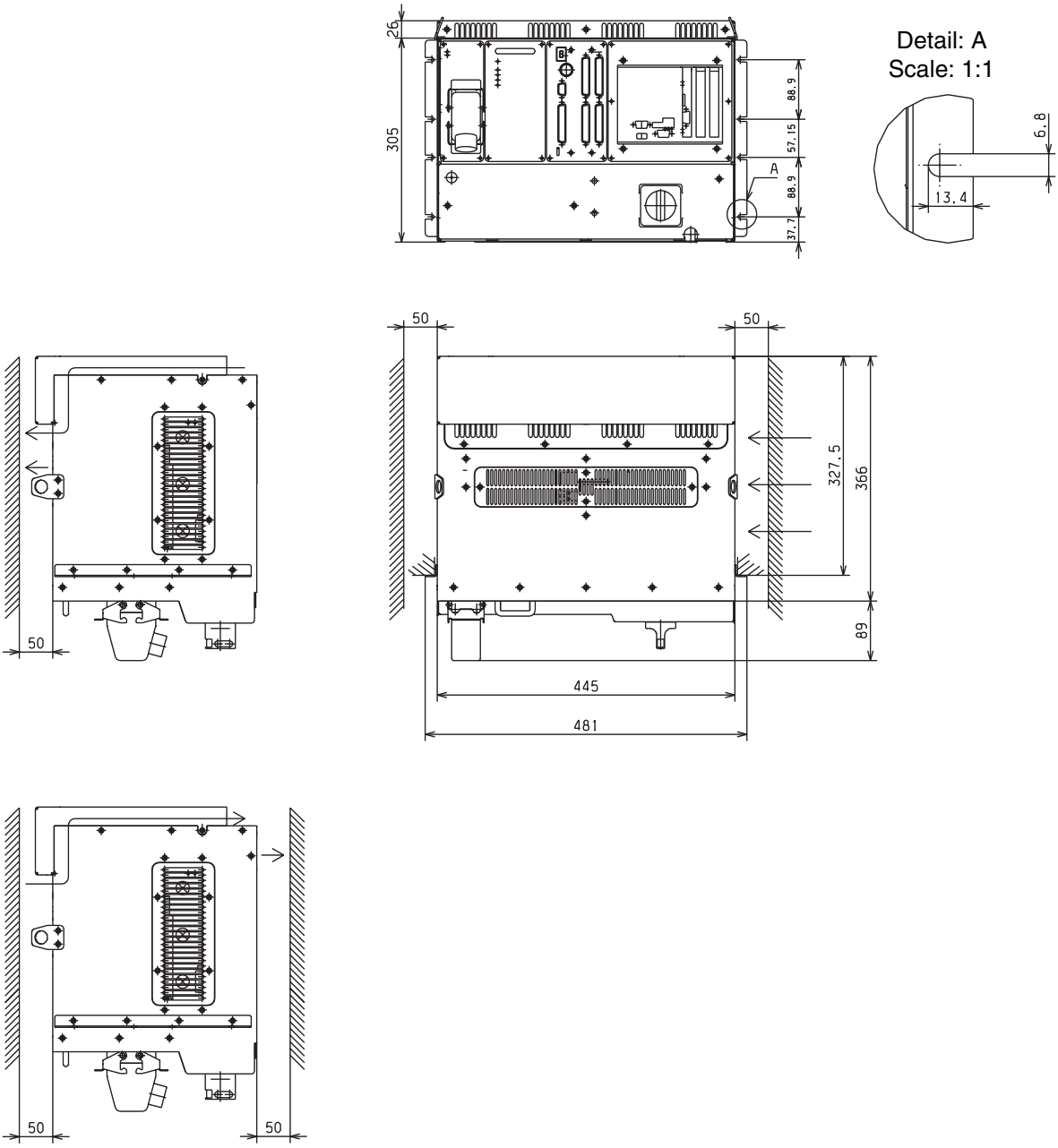


Figure 4.1

4.2.4.2. **CS8C** FOR RX160 ARM

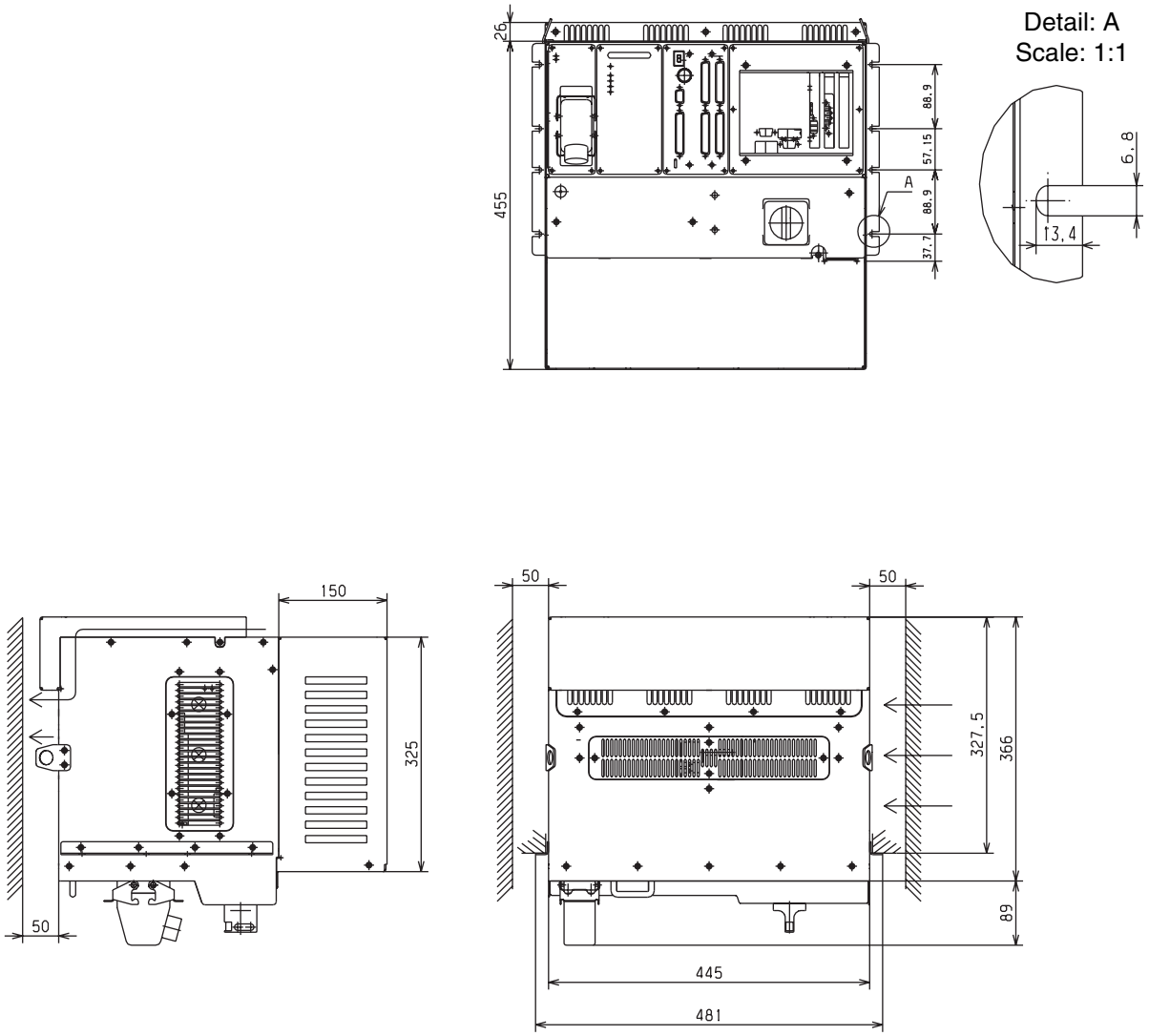


Figure 4.2

4.2.5. AIR CIRCULATION

The airflow, which is directed upwards in the standard version, can be directed downwards as an option, except in the **CS8C** controller for the **RX160**.

Note:
The surface used for the installation must be horizontal and free from vibrations.
*If the **CS8C** controller is integrated in an industrial frame ensuring that the surrounding air is dust-free, the filter **(3)** must be removed.*

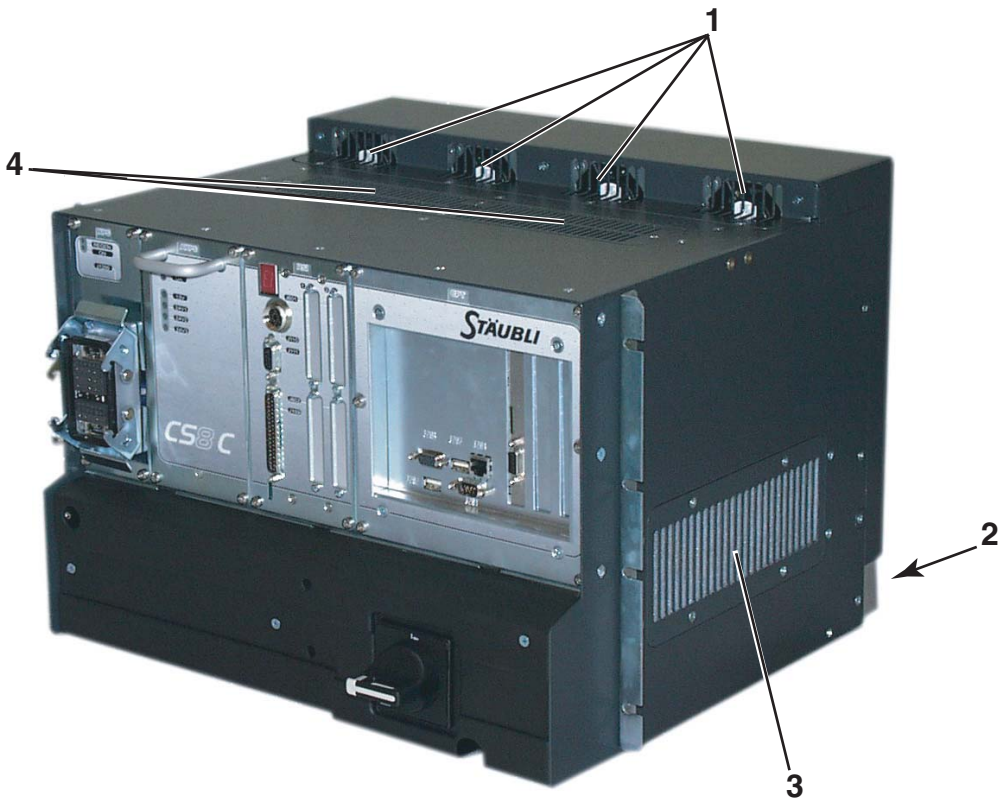


Figure 4.3

CAUTION:

Make sure that the controller is placed in such a way as to avoid obstructing the air inlets and outlets (1) (2) (3) (4) of the airflow path.

Also make sure that the controller is placed in a location where the air can circulate freely (figures 4.1, 4.2 and 4.3). If the controller overheats, this shortens the service life of the components and can lead to malfunctions.

Take care to avoid damaging the interconnection cable when handling the controller.

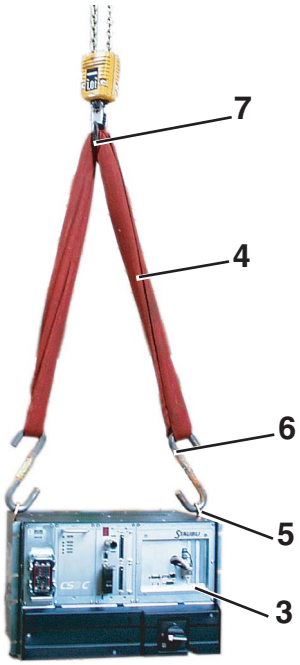
4.2.6. ACCESSIBILITY

When designing the safety enclosure, it is necessary to ensure the accessibility of all the mechanical and electrical elements (robot, sensors, mechanical assemblies, etc.).

4.3. UNPACKING AND HANDLING

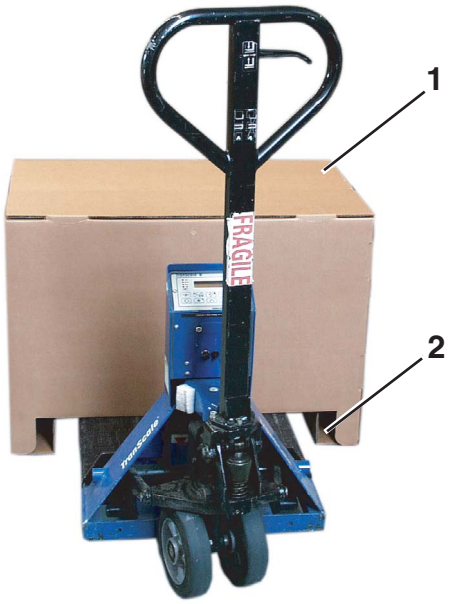
4.3.1. PACKAGING FOR THE **CS8C** CONTROLLER

	CS8C FOR TX, RS	CS8C FOR RX160
Standard packaging L x H x D Gross weight	900 x 640 x 570 mm 354 x 252 x 224 in 70 kg / 155 lb	900 x 815 x 570 mm 354 x 321 x 224 in 80 kg / 177 lb
International packaging L x H x D Gross weight	990 x 755 x 610 mm 390 x 297 x 240 in 84 kg / 185 lb	990 x 930 x 610 mm 390 x 366 x 240 in 94 kg / 208 lb
Net weight	With transformer: 50 kg / 110 lb Without transformer: 31 kg / 68lb	60 kg / 132 lb



4.3.2. HANDLING OF PACKING

By pallet truck under base **(2)**.



4.3.3. UNPACKING AND INSTALLING THE CONTROLLER

- Move the packing case as near as possible to the installation site.
- Open the case **(1)**.
- Fit a sling **(4)** (fabric sling 200 kg / 442 lb) using hooks **(6)** between the lifting rings **(5)** on the controller **(3)** and the hook on the lifting tackle **(7)**. The hooks **(6)** must also stand up to 200 kg / 442 lb.
- Slowly lift the controller using the lifting tackle and set it down beside the base **(2)**.
- The lifting rings **(5)** on the controller are removable.
- Take out the box containing the MCP and the upper wedges.
- Take out the documentation and side wedges.
- Take out the box containing the connecting cable.

4.4. FIXING THE MCP

4.4.1. CHARACTERISTICS

Protection class: IP54

Note:
The MCP must not be used in an explosive environment.

The **MCP** must be installed in accordance with the requirements of the installation. It must be accessible close to the workstation and outside the cell (see figure 4.4).

It is installed on the holder provided for the purpose. The holder must be fixed to an outside element of the cell (see figure 4.5). It must not be removable to prevent its use inside the cell. The fastening work must be carried out using the oblong holes 8 x 12 mm and screws of suitable size (see figure 4.5).

The **MCP** holder has two functions:

- To ensure that the **MCP** is easily accessible for the operator.
- To detect the presence of the **MCP** outside the cell when the arm is powered on.

Figure 4.4

CAUTION:
The MCP is made of plastic. This means that it can pick up electrostatic charges and be a source of electrostatic discharges to components located close by. This must be taken into account for sensitive components in the robot cell.

CAUTION:
If MCP is not connected to the controller, it shall be removed from the cell to avoid having a non-operating E-Stop push button.

Holder measurements:

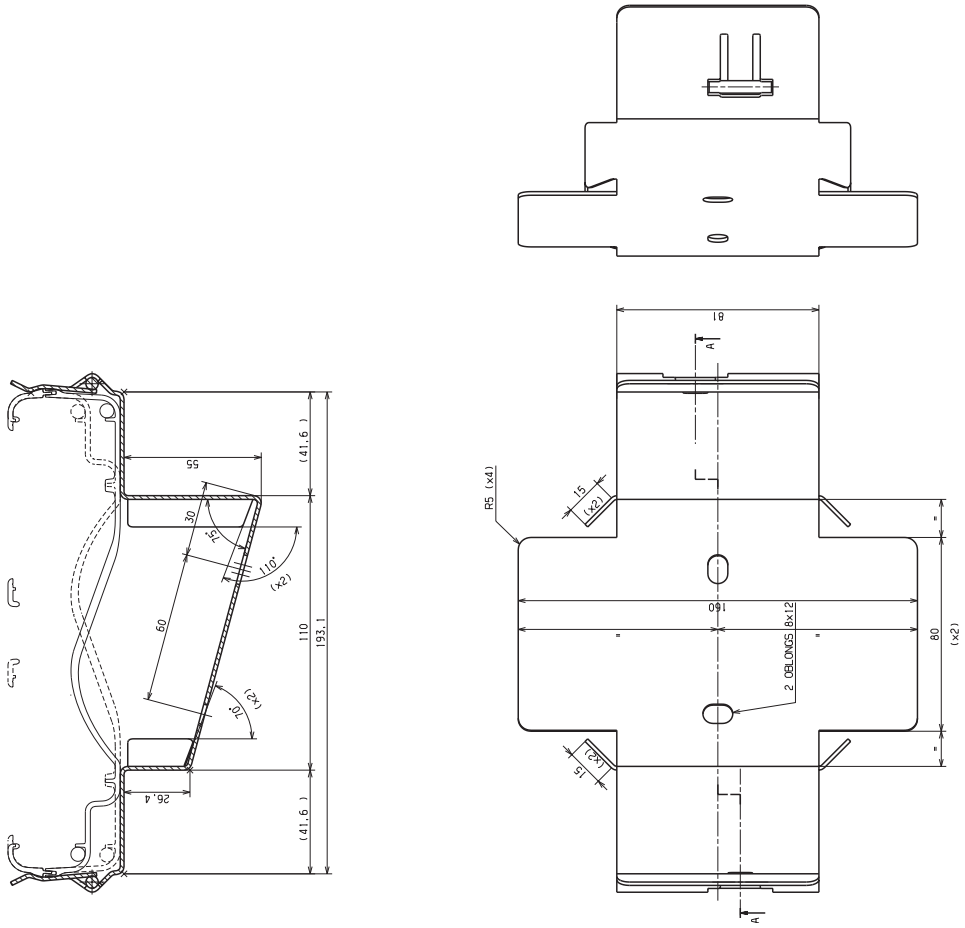


Figure 4.5

4.5. FIXING THE WMS

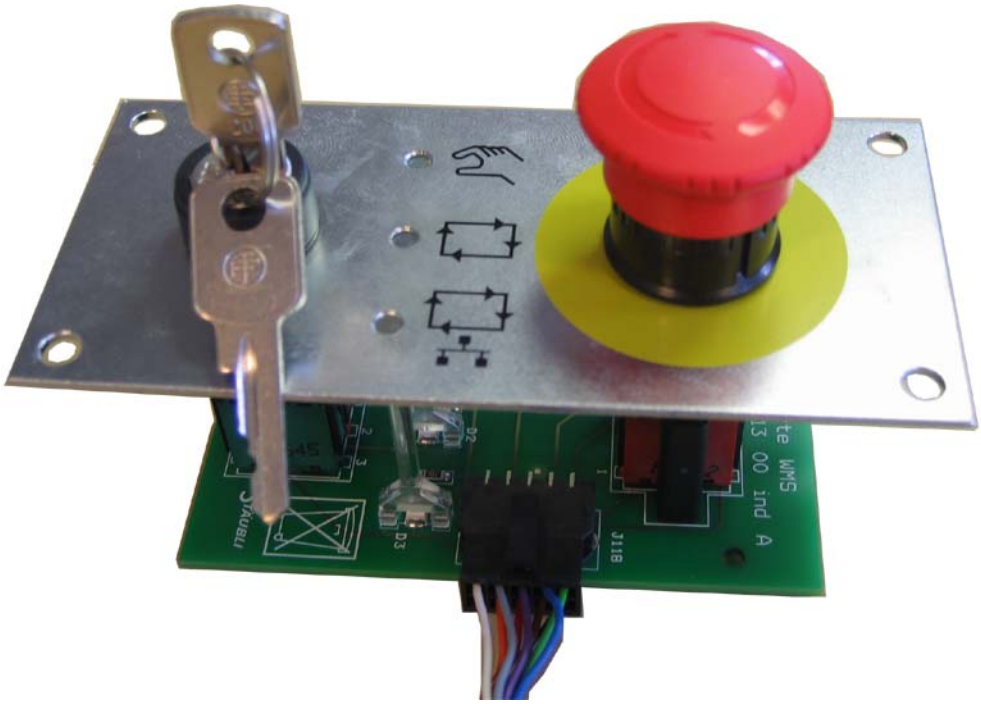


Figure 4.6

The WMS (Working Mode Selection) front panel must be installed permanently outside of the cell to be able to change the modes of operation from a safe location, outside of the cell.
To comply with the UL requirements, it cannot be provided or modified by the user / integrator.

The WMS is designed to be installed on a plate with following dimensions:

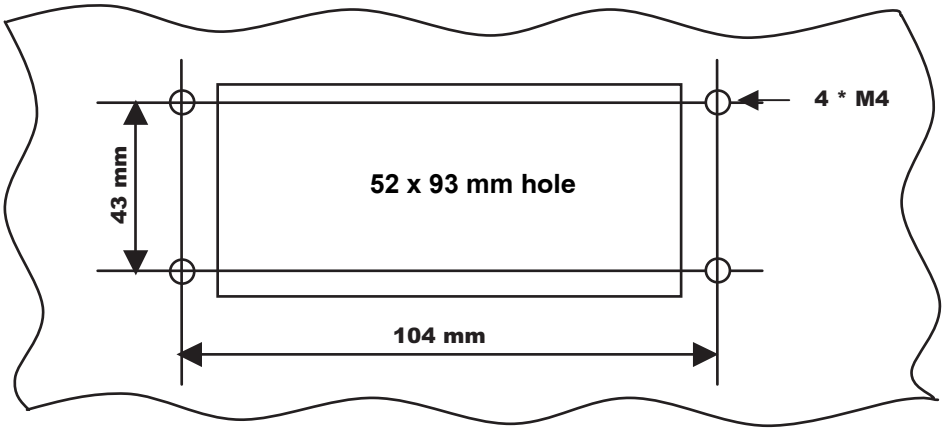


Figure 4.7

WMS overall dimensions:

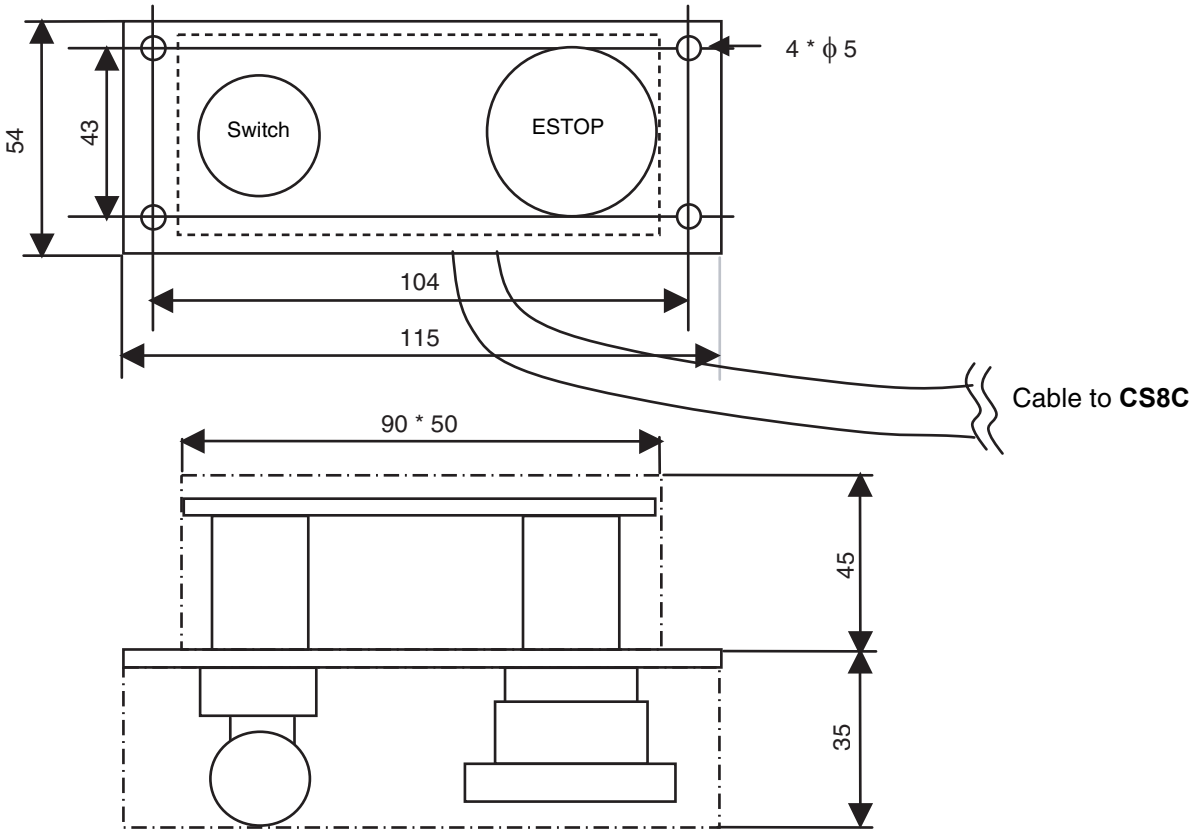


Figure 4.8

When installed, the board side has to be protected against direct contacts and dusty environment.

The cable between WMS and **CS8C** has a connector on both sides. It has to be connected to J113 on **CS8C** (RSI2 board).

4.6. CONNECTIONS

Service and maintenance on the robot has to be taken into account when wiring the controller : cables have to be long enough to be able to move components, cables should not obstruct air flow around the controller.

4.6.1. CONNECTION TO THE MAINS POWER SUPPLY

CAUTION:

Make sure that the voltage supplied corresponds to the voltage shown on the manufacturer's plate of the CS8C controller.

Use a cable appropriately rated to the power mentioned on the identification plate, and protect the line accordingly.

The mains input is connected via the terminal strip **(1)** that is underneath the cover. The cover can be removed after the fixing screws **(2)** have been taken out. The cable must be held in place by ties at **(4)**.

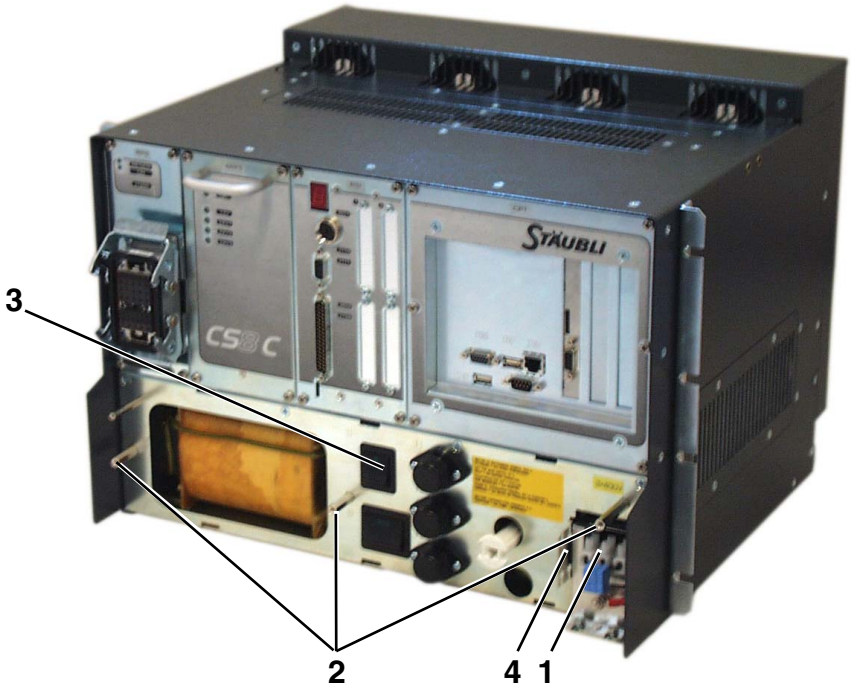


Figure 4.9

If voltage configuration of the controller is not the good one, it can be changed on the terminal trip (1) of the transformer:

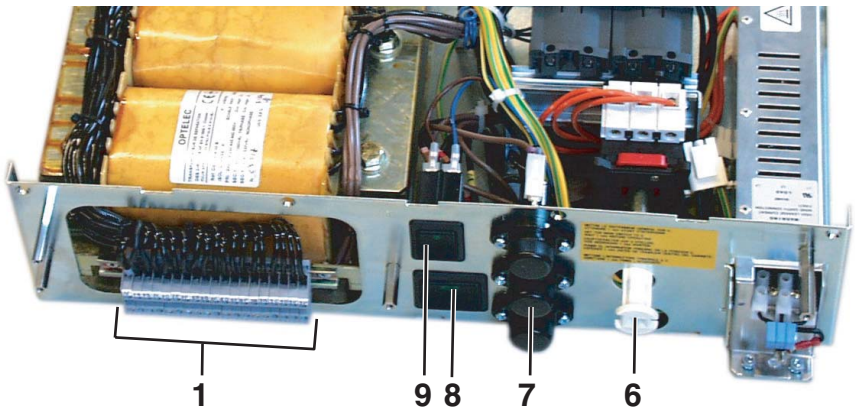


Figure 4.10

Three-phase voltage configuration:

200 V	208 V	230 V	400 V	440 V	480 V
7F 8F 9F	7E 8E 9E	7D 8D 9D	7C 8C 9C	7B 8B 9B	7A 8A 9A

Single-phase voltage configuration:

115 V	230 V
8G	8D

Note:
If voltage is changed, fuses F1, F2, F3 have to be adapted to the voltage

- Fuses are 10 x 38 mm type, 500V for standard controllers.
- For UL type controllers, replace fuses with UL type.

	THREE-PHASE 400-480 V	**THREE-PHASE 200-230 V**	**SINGLE PHASE 230 V**	**SINGLE PHASE 115 V**
TX40	4Am	6Am	10Am	16Am
TX60 - RS	4Am	8Am	10Am	16Am
TX90	6Am	12Am		
RX160	8Am	16Am		

CAUTION:
- **These fuses do not protect the mains power supply line which must be protected separately.**
- **Never replace these fuses with fuses of a higher rating or with different characteristics (see the "replacement parts" section).**

Note:
Am means "slow-acting fuse" according to IEC 269-1.2.
AT means "slow-acting fuse" and AF "quick-acting fuse" according to IEC 127-2.

4.6.2. CONNECTION BETWEEN THE ARM AND THE CONTROLLER

The arm is connected to the controller via 2 unpluggable connectors on the arm and on the controller. The connectors must be locked in place to ensure correct connections and the cable has to be attached to the cell's frame to avoid having mechanical constraints on connectors.

This connection includes optical fibers. When the cable is disconnected, during maintenance for example, cover the ends to avoid soiling the ends of the optical fiber. In the event of soiling, the only cleaning product to be used is water. Never use alcohol.

DANGER:

Do not stand with your eyes directly opposite the optical fiber when it is lit, in order to avoid damage to the eyes.

4.6.3. CONNECTING THE SIGNALS

The Input/Output signals are connected via the connectors located on the front panel of the controller.

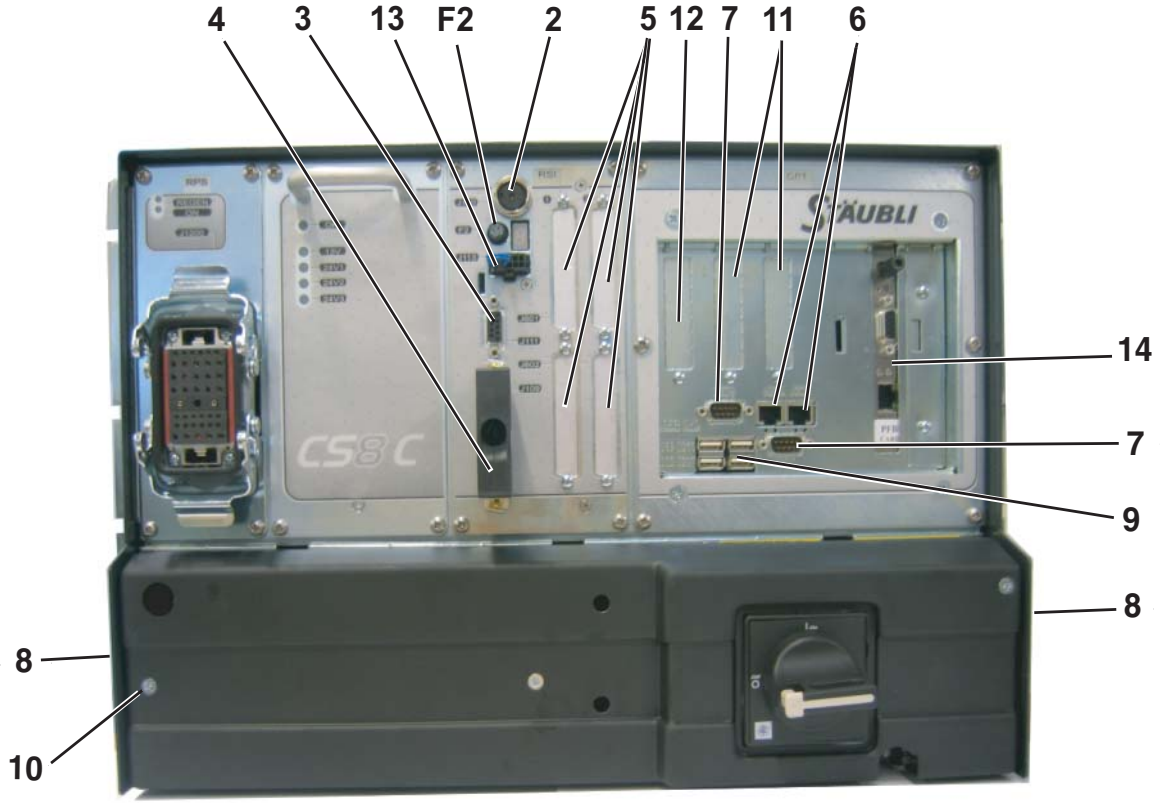


Figure 4.11

2: Connector for MCP

3: Fast Inputs/Outputs

4: Connection with cell (emergency stop, door, etc.)

5: Digital I/O options (BIO)

6: Ethernet links

7: Serial links

9: USB links

10: Anti-static wrist strap

11: Optional encoder input

12: CAN output for Scara robots

13: Connector for WMS front panel

14: Optional fieldbus board

The signals must be connected using shielded cables whose shield is grounded at the both ends. This is necessary both for the emergency stop signals (J109) and for the digital links (serial links, Ethernet, etc.).If screw terminal type connectors are preferred, an adaptor from Sub D to screw terminal is commercially available from several sources such as Phoenix Contact and others.

The brackets used to hold the controller in place also provides protection from electrical noise. It is thus useful for the fastenings (8) to be linked to the ground circuit of the cell as a whole.

Note:
For RS robots, there are also Inputs/Outputs available on the arm.

4.6.4. CABLE INLETS AND OUTLETS

The connections for the **CS8C** controller are on the front panel. They must then be protected by backshells with good levels of mechanical strength and the cables have to be attached to the frame of the cell to avoid constraints on connectors.

Note:
Grounded metal backshells provide improved protection from unwanted outside currents.

The cable layout must comply with a minimum radius of curvature for each type of cable. See the table below:

Minimum radius of curvature in mm	
Standard interconnection cable	100
Flat interconnection cable	static bend radius: 55 dynamic bend radius: 110
hand I / O cable	50
MCP and WMS cables	50
Other	Depending on the cables used

Note 1:
During installation, the ends of the interconnection cable should be covered to protect them from dust. The only cleaning product that can be used is water. Never use alcohol.

Note 2:
Flat interconnection cable requires more space on controller side. The flat cable has to be installed in a chain to guaranty a good operation and dynamic constraints have to be applied to the cable itself, not the connectors.

Flat cable characteristics:

- *Minimum dynamic bend radius: 110*
- *Max speed: 4 m/s*
- *Max accel: 8 m/s²*
- *5.000.000 cycles maximum*

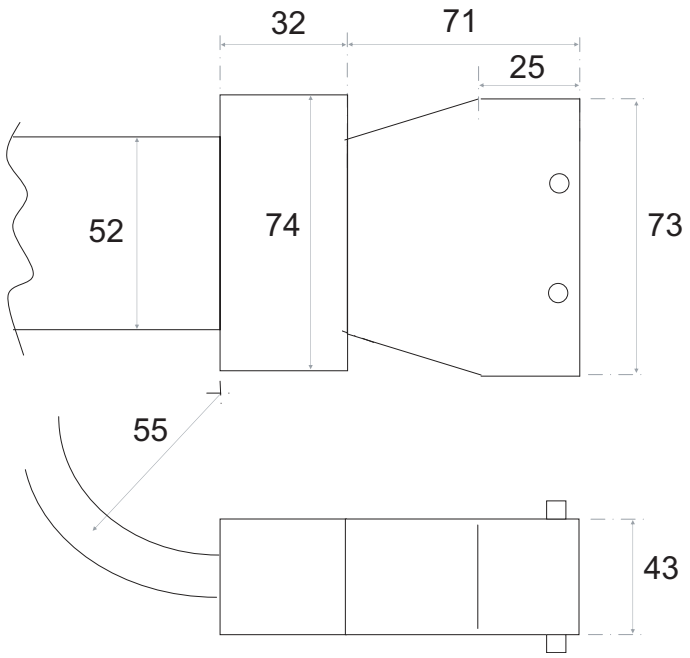


Figure 4.12

The length of the cables must be taken into account to facilitate maintenance.

Interconnection cable:

- Cable Ø: 25 mm
- Connector passage Ø: 90 mm

WMS cable:

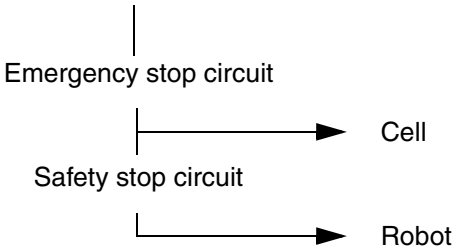
- Cable Ø: 7 mm
- Connector passage Ø: 25 mm

CHAPTER 5

INTEGRATION

5.1. EMERGENCY AND SAFETY STOP CHANNELS

In general, the "Emergency Stop Buttons" stop and remove power on the arm manipulator and all other equipments in the cell, where the "Safety Stop Buttons" stop and remove power on the arm manipulator only.



5.1.1. COMPOSITION OF THE EMERGENCY AND SAFETY STOP CHANNELS

(see figures 5.1 and 5.2)

The various elements forming the stop channel are as follows:

- The emergency stop **(MCPES 1-2)** on the **MCP**.
- The emergency stop **(WMSES 1-2)** from the WMS front panel.
- An emergency stop **(UESA 1-2)** to be wired according to the application.
- Two parallel channels corresponding to the automatic **(COMP)** and manual **(MANU)** modes, if controller configuration is "configuration 1" (see below) (figure 5.1).
  Each of these channels has to be used according to the application. As a general rule, in the channel concerning the Automatic mode, there is an emergency stop **(DOOR 1-2)** triggered by the cell door. In the channel given over to the Manual mode,there is also an emergency stop or an authorization for specific operation in Manual mode **(USER EN 1-2)**. These two emergency stop channels are specific to the application and depend to a great extent on the working mode selected.
- A **(UESB 1-2)** safety stop to be wired depending on the application.

All the contacts making up these various elements of the emergency and safety stop channels are duplicated.

Note 1:
The emergency stop is not the normal method for stopping the robot or disabling power on the arm.

Note 2:
The robot is delivered with a dummy plug connected to J109 (see figure 5.5).
When this connector is replaced with the final one, pay attention to the jumper between pins 18 and 37 (figure 5.2) which needs to be maintained, except if an external 24 V is required for EStop lines (see below).

Status of the emergency stop channels (**ESOUT1** and **ESOUT2**) are available for the application using one of the controller configuration below (figure 5.1).

CAUTION:

Status of these outputs shall be identical: either both closed if there is no EStop, or both open if there is an EStop. The coherency of these 2 outputs contacts has to be verified by the external safety device managing the cell. If there is an incoherence, the fault shall be corrected before restarting the robot. If there is no external safety device, this type of error is not automatically detected.

The incoherence information is also displayed on the Teach Pendant (if connected) and in the error logger.

The information available is:

- Either the status of **MCPES, WMSES** and **UESA** (configuration **1**: the doors of the cell not included).
- Or the status of **MCPES, WMSES**, **UESA** and (**USEREN** or **DOOR**) (configuration **2**: the doors of the cell are included). This is the default configuration when **CS8C** is delivered. To modify this configuration, refer to chapter "Software configuration".

The choice of position depends on the requirements of the application.
For applications requiring the emergency stop system status to remain valid even when the controller is switched

off, it is possible to power the emergency stop lines via an external 24 V supply provided between J109-37 and J109-19 (see diagrams below). The connection between J109-18 and J109-37 must be removed.
This mode of operation is only possible if controller is configured with "configuration 1" (see above).

Display on the control panel of the MCP
The status of the stop channels is displayed on the control panel.

> **Note:**
> *In this display, an active input **(ON)** shows that an emergency stop has been activated (channel in open position).*

Emergency stop channels

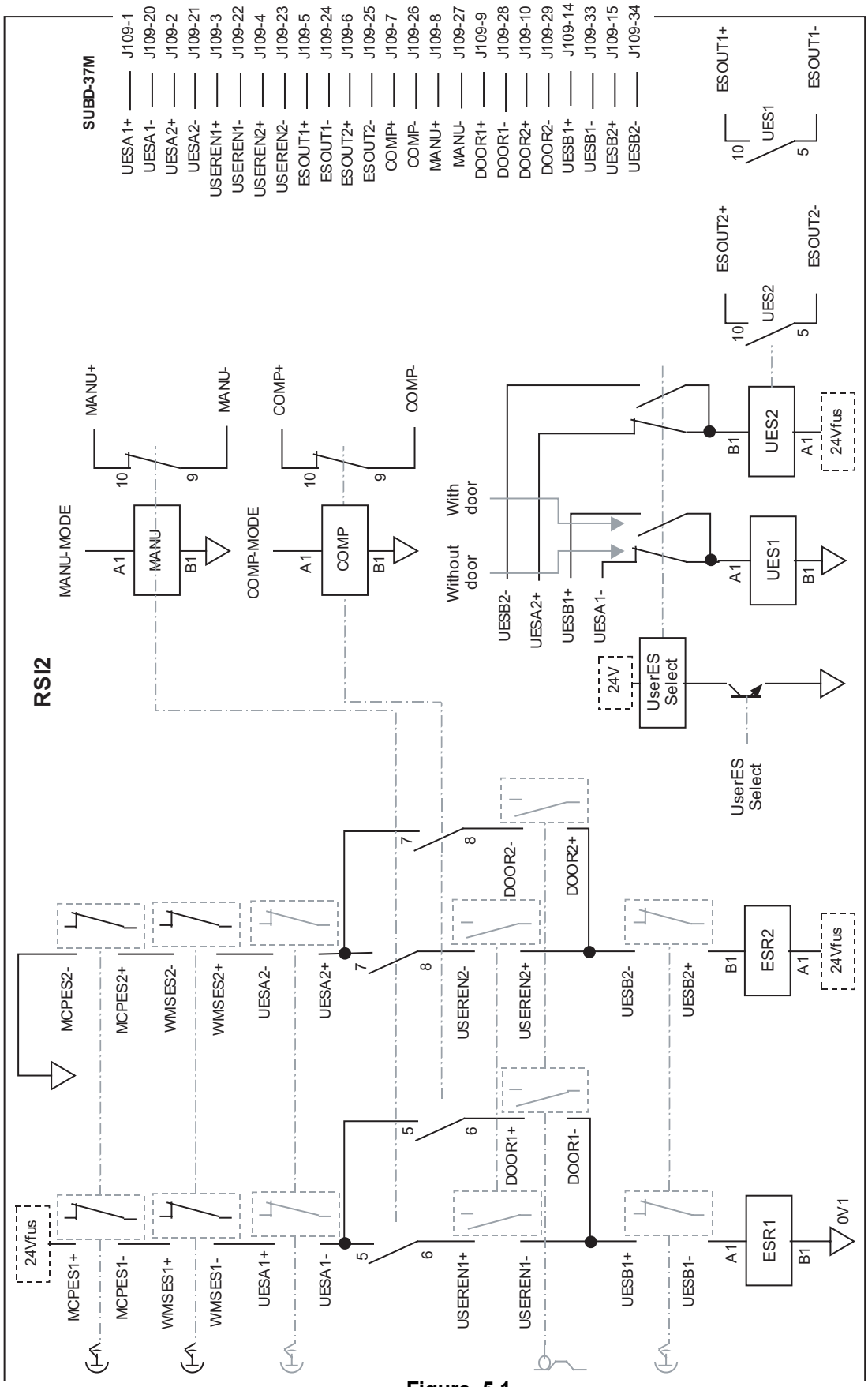


Figure 5.1

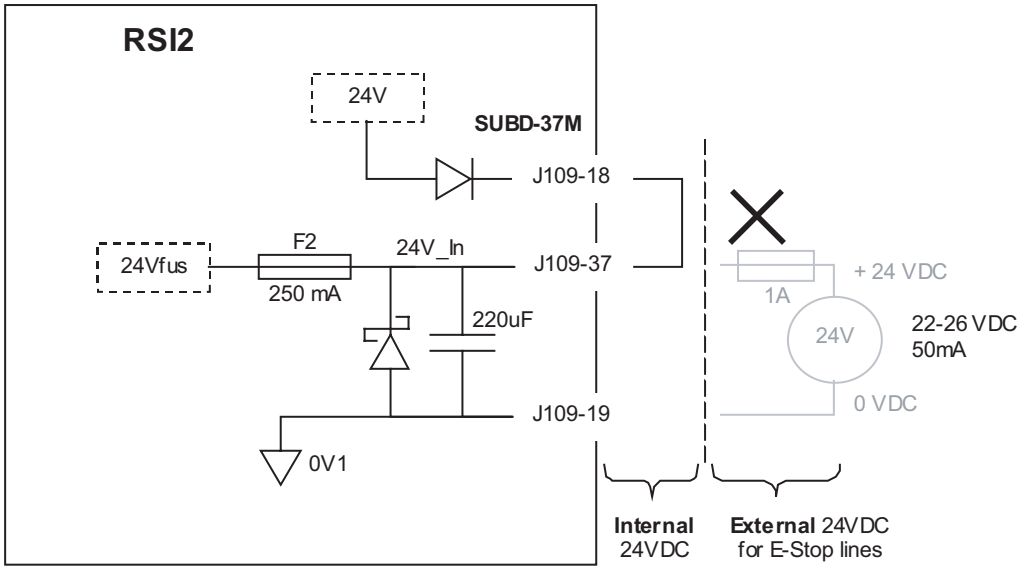

RSI2
24V
SUBD-37M
J109-18
24Vfus
F2
250 mA
24V_In
J109-37
220uF
J109-19
0V1
1A
+ 24 VDC
24V
22-26 VDC
50mA
0 VDC
Internal
24VDC
External 24VDC
for E-Stop lines

Figure 5.2

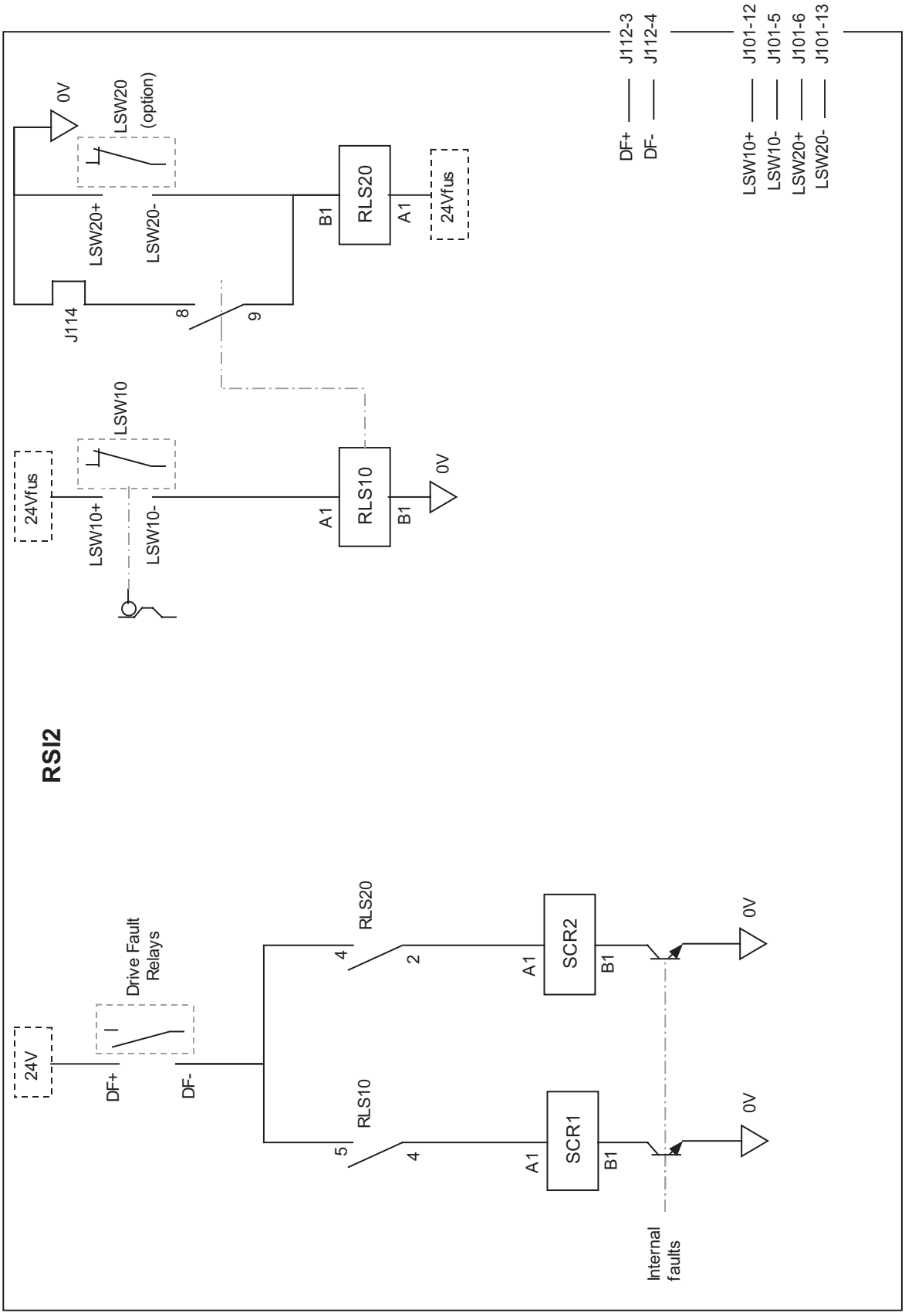

RSI2
24V
Drive Fault Relays
DF+
DF-
RLS20
RLS10
SCR2
SCR1
A1
B1
0V
Internal faults
LSW20 (option)
LSW20+
LSW20-
J114
LSW10
LSW10+
LSW10-
24Vfus
DF+
DF-
J112-3
J112-4
LSW10+
LSW10-
LSW20+
LSW20-
J101-12
J101-5
J101-6
J101-13

Figure 5.3

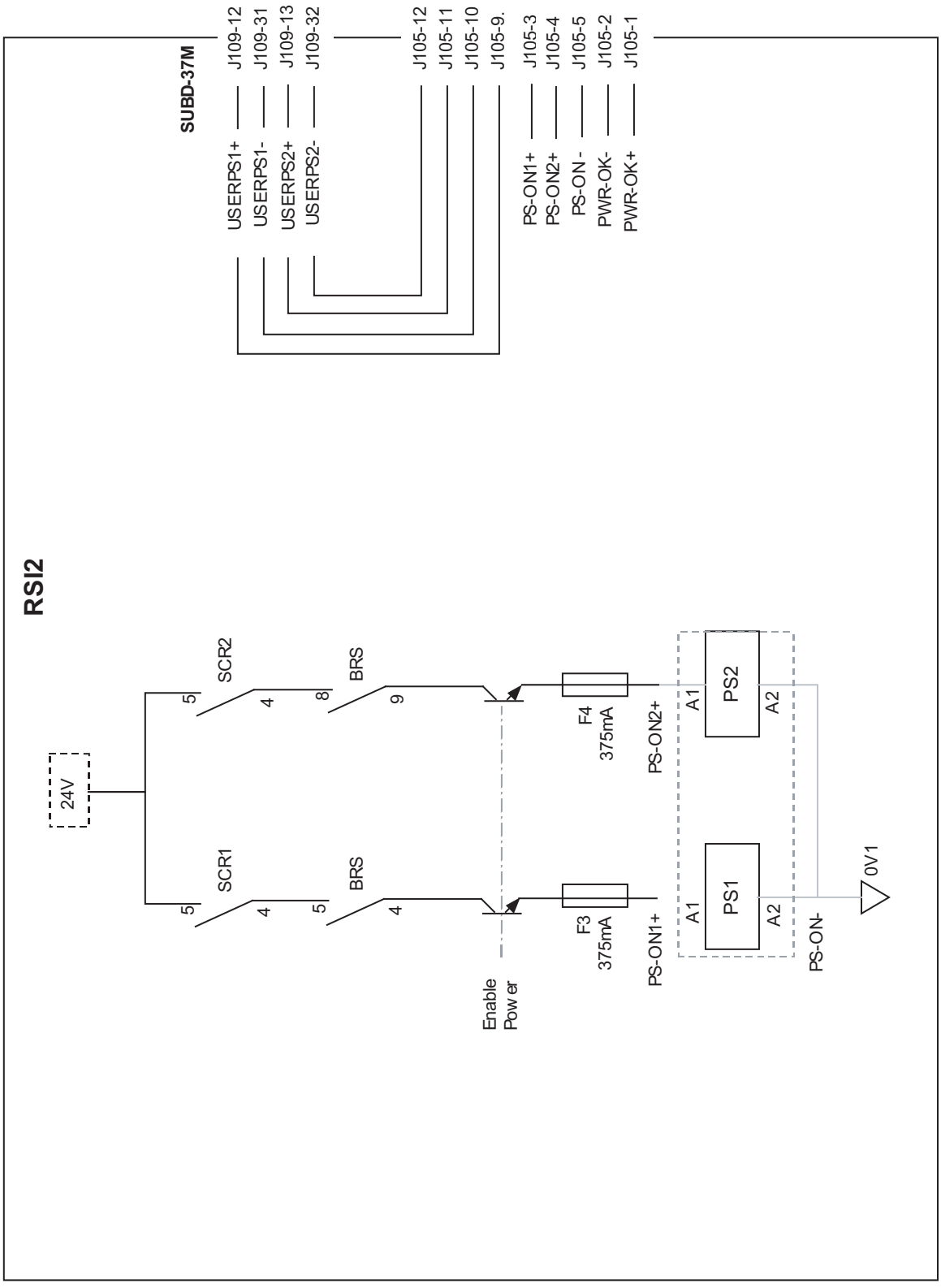


Figure 5.4

5.1.2. CONNECTION WITH CELL

Description of connection point
The **RSI** board is connected to the equipment in the cell via the **J109** connector on the board on the front panel of the **CS8C** controller.

All the contacts to be connected up in the emergency stop channels must be duplicated dry contacts. An emergency stop button must activate two contacts at the same time, and the maximum authorized time lapse between the opening of the two contacts is 100 ms. If this time lapse is exceeded, an error message is displayed.

All the information supplied by the **RSI** board are in the form of dry contacts.

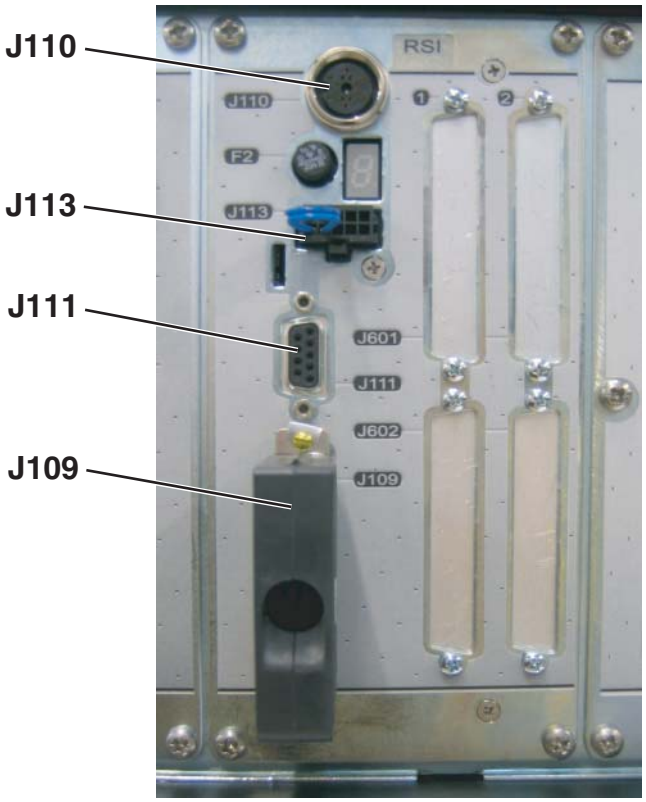


Figure 5.5

CAUTION:
The CS8C controller is supplied with a "shorting connector" for J109 that can be used to power up the robot without wiring up the emergency stops. This connector is provided for diagnosis purposes only. It must be replaced by suitable wiring on the emergency stop circuits.

Note:
If screw terminal type connectors are preferred, an adaptor from Sub D to screw terminal is commercially available from several sources such as Phoenix Contact and others.

5.2. BASIC INPUTS/OUTPUTS

To display the status of the Inputs/Outputs or to programme them, select the "I/O" branch in the control panel accessible via the main menu.

5.2.1. USER-IN INPUTS

2 inputs, User-in 1 and User-in 2, are available on the J109 connector.

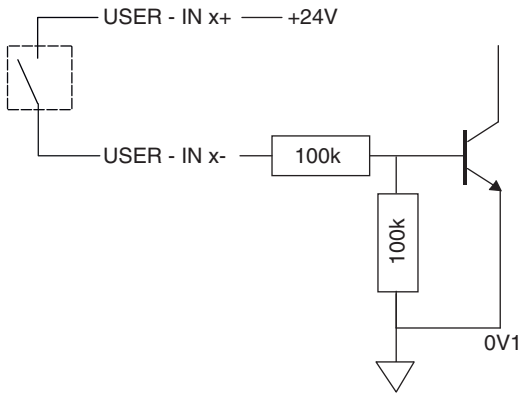


Figure 5.6

Characteristics

Operational voltage range	0 to 30 VDC
"Off" state voltage range	0 to 1 VDC
"On" state voltage range	4 to 30 VDC
Operational current range	0 to 240 µA
"Off" state current range	0 to 5 µA
"On" state current range	33 to 240 µA
Impedance	100 kΩ
Response time for equipment + software	6,5 ms maxi

5.2.2. FAST INPUTS/OUTPUTS

2 inputs (Fast-In 0 and Fast-In 1) and 1 output (Fast-Out 0) are provided on the J111 connector.

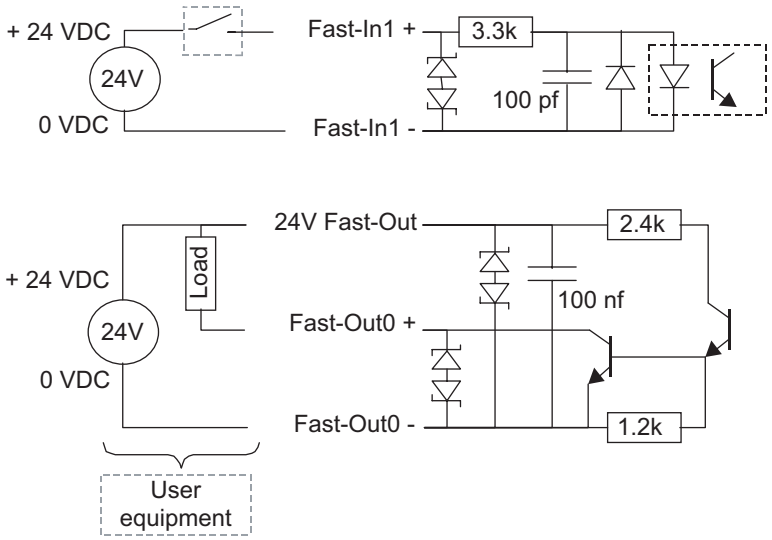


Figure 5.7

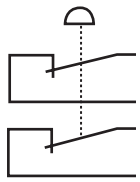
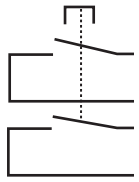
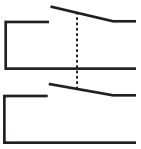
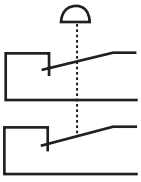
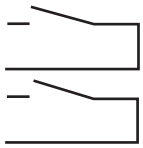
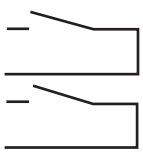
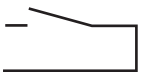
Characteristics
Inputs

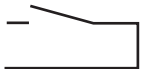
Operational voltage range	0 to 30 VDC
"Off" state voltage range	0 to 2 VDC
"On" state voltage range	6 to 30 VDC
Operational current range	0 to 9mA
"Off" state current range	0 to 0,5mA
"On" state current range	2 to 9mA
Impedance	3,3 kΩ
Response time for equipment + software	50 µs

Outputs

Power supply voltage range (24 V Fast-Out)	12 to 28 VDC
Current consumed	5,5 mA
Output voltage range	12 to 28 VDC
Range of use for current output	1 to 250mA
Voltage drop at output when I = 250 mA	1,2 V maxi
On state output resistance	1 Ω
Maximum leakage current in off state	5 µA
Response time for equipment + software	50 µs
Limit output current (overload)	2 A

Connection point table

External electrical diagram	Name of electrical diagram	J109 (Sub-D37M)	Pin name	Internal electrical diagram	Switch open	Switch closed
	UESA 1-2 Emergency stop	1 20 2 21	UESA1+ UESA1- UESA2+ UESA2-		Emergency stop	Normal operation
	USER EN1-2 Validation in Manual mode	3 22 4 23	USEREN1+ USEREN1- USEREN2+ USEREN2-		Emergency stop in Manual mode	Normal operation
	DOOR1-2 Validation in Auto mode	9 28 10 29	DOOR1+ DOOR1- DOOR2+ DOOR2-		Emergency stop in Auto mode	Normal operation
	UESB 1-2 Emergency stop	14 33 15 34	UESB1+ UESB1- UESB2+ UESB2-		Emergency stop	Normal operation
Note **(1)** Note **(3)**	ESOUT 1-2 Emergency stop channel status	5 24 6 25	ESOUT1+ ESOUT1- ESOUT2+ ESOUT2-		Emergency stop	Normal operation
Note **(3)**	COMP/MANU Working modes	7 26	COMP+ COMP-		Automatic mode	Automatic mode invalid
		8 27	MANU+ MANU-		Manual mode	Manual mode invalid
Note **(3)**	PS1 PS2 Arm power-up	12 31 13 32	USERPS1+ USERPS1- USERPS2+ USERPS2-		Arm not powered	Arm powered
	USER-IN X	16 35	USER-IN 1 + USER-IN 1 -			Note **(2)**

External electrical diagram	Name of electrical diagram	J109 (Sub-D37M)	Pin name	Internal electrical diagram	Switch open	Switch closed
	USER-IN X	11 30	USER-IN 0 + USER-IN 0 -			Note **(2)**
Note **(4)**		18 19 37	24 V for EStop lines	Note **(4)**		

Note **(1)**: This information is configurable (see chapter 5.1).

Note **(2)**: See **figure 5.6**.

Note **(3)**: Max. 48V AC/DC/ 0.5A.

Note **(4)**: Refer to chapter **5.1** and figure **5.2**.

5.2.3. ENCODER INPUT

5.2.3.1. TWO ENCODER INPUTS FOR STARC2

With STARC2 board configuration, an optional DUAL ABZ board can be installed to provide 2 encoder inputs per board. The encoders to be used must be of the incremental type with 5V differential A, B, Z signals (RS485 type). The 5V power supply is provided by the DUAL ABZ board, its level of current is limited to 250mA per encoder. Each board has External Encoder Latch signals that can be used for with the encoders. The connector used on the DUAL ABZ board is of the female SubD 25 point type.

These boards are installed in the computer (see figure 4.11, rep. **(11)**).

To install a new board:
- Extract and open computer part (CPT).
- Select board address with J324 jumper.
- Connect the board to STARC with cables provided with the board.

STARC2 + Dual ABZ encoder board

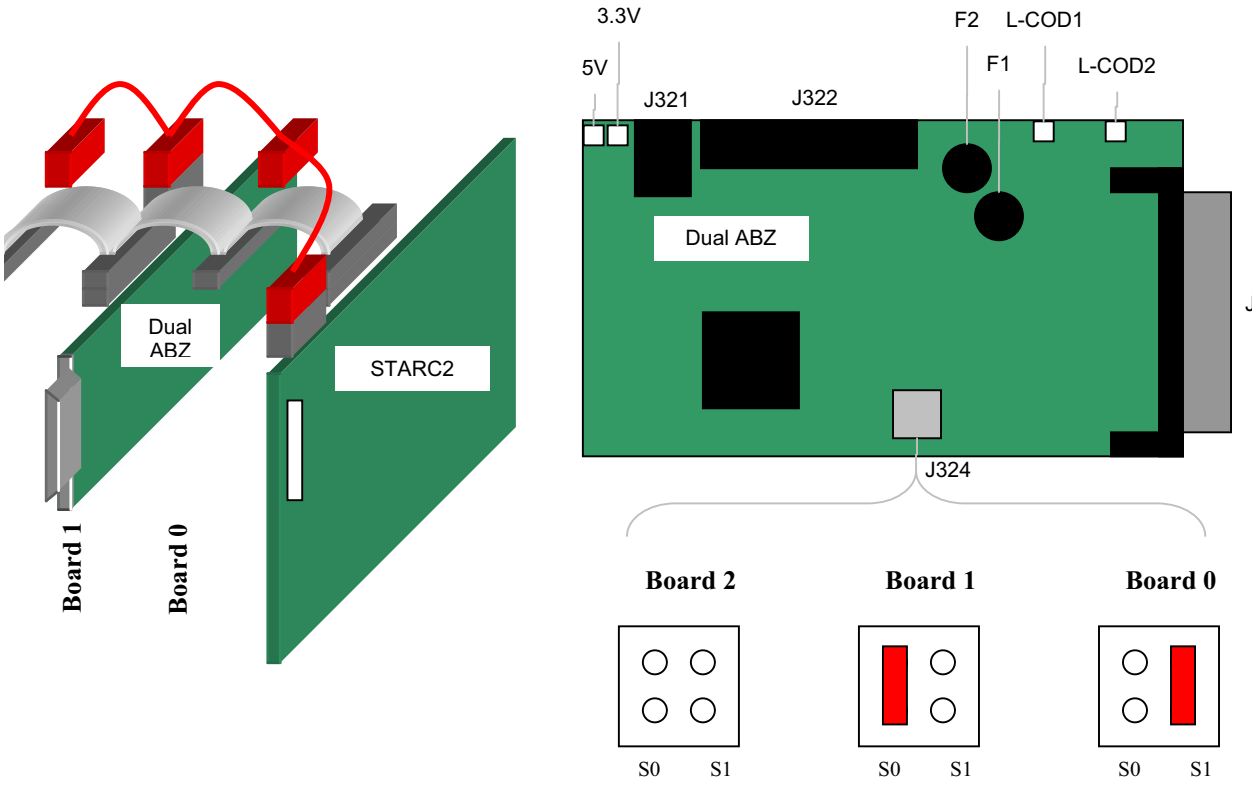


Figure. 5.8

Note:
Each encoder has a corresponding set of digital and analog Inputs/Outputs. The name of these Inputs/Outputs is the same for all encoders except for the first and second digits that represent respectively the digit of the optional board (0 to 2) and the digit of the encoder on the board (0 or 1):
***e01LatchSig** is the latch signal of the second encoder input on the first optional board.*

Note:
In this chapter, the Inputs/Outputs names are given for the first encoder input on the first board.

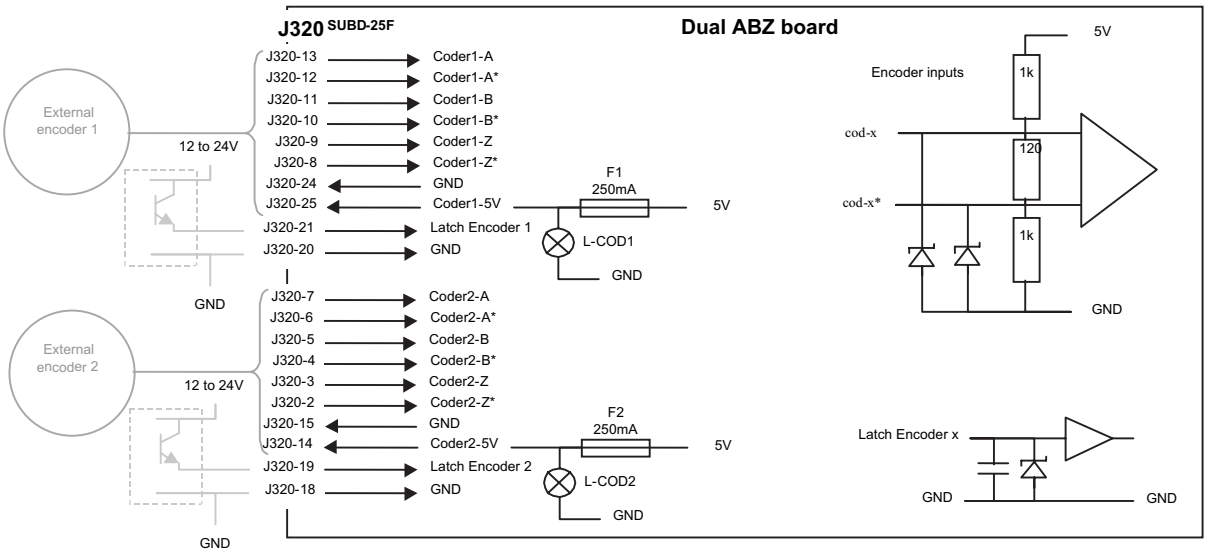


Figure. 5.9

Recovery (preset)
Encoder recovery is used to define the zero position of the joint connected to the encoder. It is necessary to begin by configuring the encoder resolution using the **e00Counts** analog output (in encoder points per rotation, coded on an unsigned 16-bit integer). The resolution is saved by the system (encoder.cfx file).

Note:
*When the encoder has moved by more than one turn, the system is able to detect its resolution that is then written to the **e00CountsMes** analog input.*

Note:
There are 4 pulses per encoder point. A 1024-point (or "counts") encoder thus has a resolution of 4096 pulses per rotation.

Recovery procedure (preset):
- Stop the encoder at a reference position defined by the application.
- Write the current encoder position in the **e00PrstPos** output (**Preset position**: signed 32-bit integer).
- Activate the **e00EnPrst (Enable preset)** output.

The current position **e00CurrPos (Current position)** then takes the value **e00PrstPos**, and the **e00EnPrst** Input/Output is deactivated.
The recovery sequence is not saved by the system; it is necessary to repeat it each time the controller is powered up.

Position reading
The position reading is done with the **e00CurrPos** analog input. The position is in degrees, with an accuracy of 360/(4***e00Counts**).

> **CAUTION:**
> **The internal encoder position counter uses only 32 bits. When the encoder position reaches 2^31*360/(4*e00Counts) degrees, an overshoot occurs and the position becomes -2^31*360/(4*e00Counts).**
> **No error is reported: The overshoot must be managed by software programming, either by using a preset to avoid it, or by correcting the position with an offset of 2^32*360*4*e00Counts degrees.**

The encoder position is updated every 4 ms. When a preset is done while the encoder is moving, it applies to the start of the current 4 ms time interval. The encoder position is updated only with the next time interval, where it is assigned the preset position plus the encoder movement of the last 4 ms. In that way, no encoder movement is lost with the preset.

Position capture (latching)
Position capture is used to record the encoder position on a rising signal for a fast input, and then read the position later.

Position capture procedure:
- Activate the **e00EnLatch** digital output.
- On the next rising or falling signal for the fast input **e00LatchSig**, the encoder position is recorded in the **e00LatchPos** analog input and the **e00Latch** digital input is activated to show that the capture has been executed. The **e00EnLatch** Input/Output is then automatically deactivated.

The precision of the capture is less than one microsecond. It is possible to cancel a capture request at any time by deactivating the **e00EnLatch** output.

> **Note:**
> *The position capture is made:*
> *- On the rising edge of the **e00LatchSig** signal if the **e00LatchEdgFall** digital output is set to False.*
> *- On the falling edge if the **e00LatchEdgFall** digital output is set to True.*
>
> *It is possible to filter out bounds on the latch signal by specifying a filter delay in milliseconds using the **e00LatchFilter** analog output: the latch is then effective only if the signal remains stable during the specified time. The latched position is then always the position at the rising or falling edge of the latch signal.*

Errors
An encoder reading error is signalled by the **e00HwErr** digital input. If the encoder is rotating too fast, it is not possible for the controller to know for certain how many rotations the encoder has made. In this case, the **e00OvsErr** signal is activated. The maximum encoder speed is 7500 rpm.

> **Note:**
> *When the encoder has moved by more than one turn, the system is able to detect its resolution that is then written to the **e00CountsMes** analog input. If this resolution does not match the specified resolution **e00Counts**, the encoder is in error and the **e00CountsErr** signal is activated.*
> *The **e00PowerErr** digital output is activated when the encoder power supply is not correct.*

To reactivate the encoder after an error, it is necessary to reset it using the **e00RstErr** digital output.

5.2.4. SYSTEM INPUTS

The following inputs are accessible on the VAL3 to detect various errors.

RSI board temperature
The **CBT_TEMP** input shows the temperature (°C) measured on the RSI board (in the controller). Correct controller operation can no longer be guaranteed if the temperature rises above 55°C. In this case, it is necessary to check the ventilation system on the **CS8C** controller (fans running, air inlets unobstructed).

Power supply for the controller
The **SECTEUR_OK** input is activated when the controller is powered up. When the power supply to the **CS8C** controller is cut off, the **SECTEUR_OK** signal is deactivated about 80ms before the power is actually cut off. The **SECTEUR_OK** input may also be deactivated temporarily if the power supply voltage is too low.

Arm temperature thresholds
Temperature sensors are fitted in the arm to protect the motors and mechanical elements in the event of a temperature rise that is too great. If the temperature of a motor rises above 120°C, the arm stops immediately. An excessively high temperature on the **DSI** board (75°C) or the castings (100°C) stops the arm after a time lapse of about ten seconds.

The **GLOBAL_PTC** input signals an overtemperature on one of the arm sensors. The **DSI_BOARD** input shows an overtemperature on the DSI board (at the base of the arm).

On **TX** arms, the **MOTOR_1_3_5**, **MOTOR_2_4_6** and **CASTING** inputs show an overtemperature on a motor and on the castings.

On the **RS** arms, the **MOTOR_1_3** and **MOTOR_2_4** inputs show an overtemperature for a motor.

CPU board temperature
The CPU_TEMP input shows the temperature (°C) measured on the CPU board (in the controller). Correct controller operation can no longer be guaranteed if the temperature rises above 85°C. In this case, it is necessary to check the ventilation system on the CPU controller (fans running, air inlets unobstructed).

5.3. RS ROBOTS

In the case of RS robots, Inputs/Outputs are available as an option on the forearm using the CIO board (first generation) or ARMIO board (second generation):

- 8 x 24V digital inputs
- 8 x 24V digital outputs
- 4 x ± 10V analog inputs
- 4 x 0/+10V analog outputs (only for ARMIO second generation)

These Inputs/Outputs are driven from the controller via a dedicated CAN bus. The CAN bus is connected to J211 on controller side and J1202 at the base of the arm. A user cable can be supplied as an option to take the intputs / outputs as close as possible to the tool flange through the ball screw.

> **CAUTION:**
> **If this cable is fitted, rotation of joint 4 must be limited to ± 180°. This limitation is configured at the factory if the option is supplied.**

An ASI bus can also be supplied as an option on the CIO board (not available on ARMIO board).

The "Control panel" page allows you to see the status of the CAN Inputs/Outputs.

> **Note:**
> *To display the status of the Inputs/Outputs or to programme them, select the "I/O" branch in the control panel accessible via the main menu.*

5.3.1. INSTALLATION OF THE OPTION

The option includes:

- A CAN board to be installed in the **CS8C** computer module. The board is provided with a cable and mounting screws.
- A cable between **CS8C** and the base of the arm.
- An I/O board for the arm.

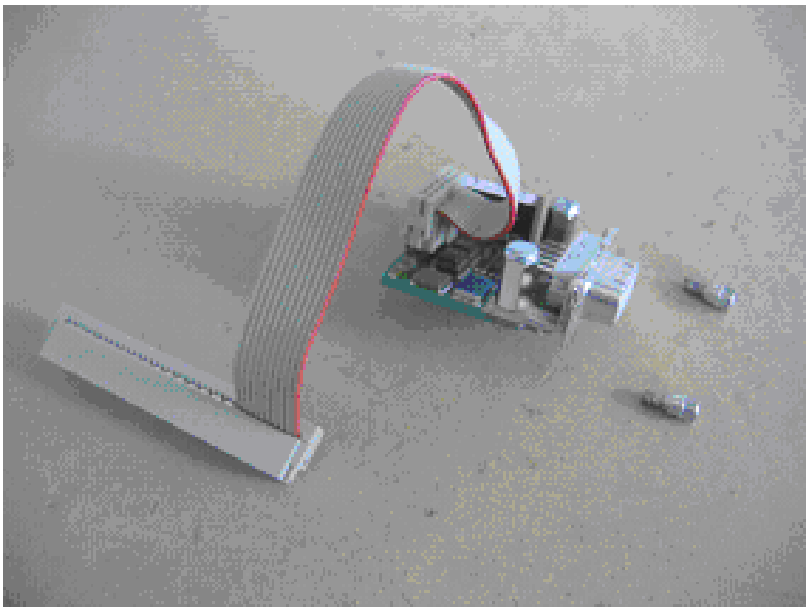


Figure 5.10

5.3.1.1. INSTALLATION OF CAN BOARD IN COMPUTER

- Refer to 8.9.2 to remove and open **CS8C** computer module.
- Plug the cable attached to the CAN board to CPU board.

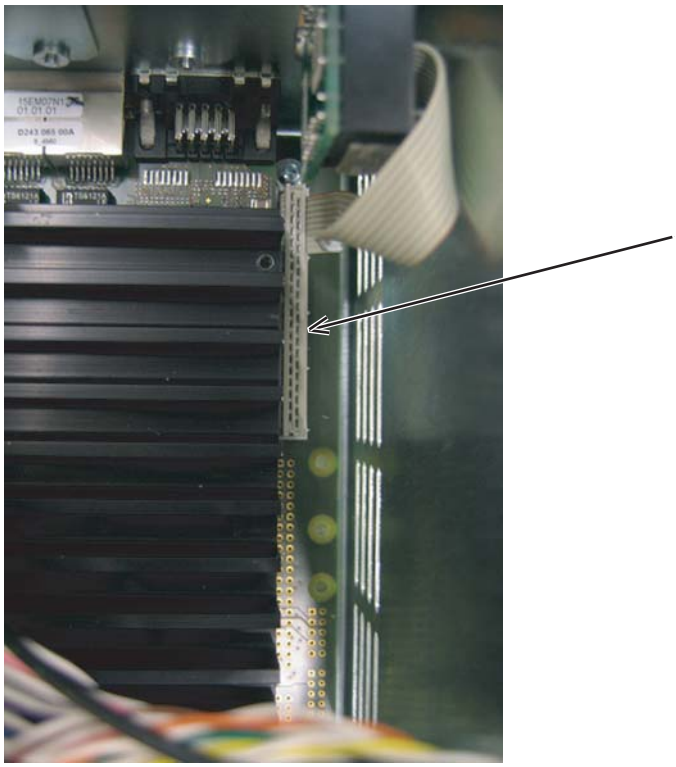


Figure 5.11

- Install the CAN board on B1 location of front plate using the 2 screws provided with the board.

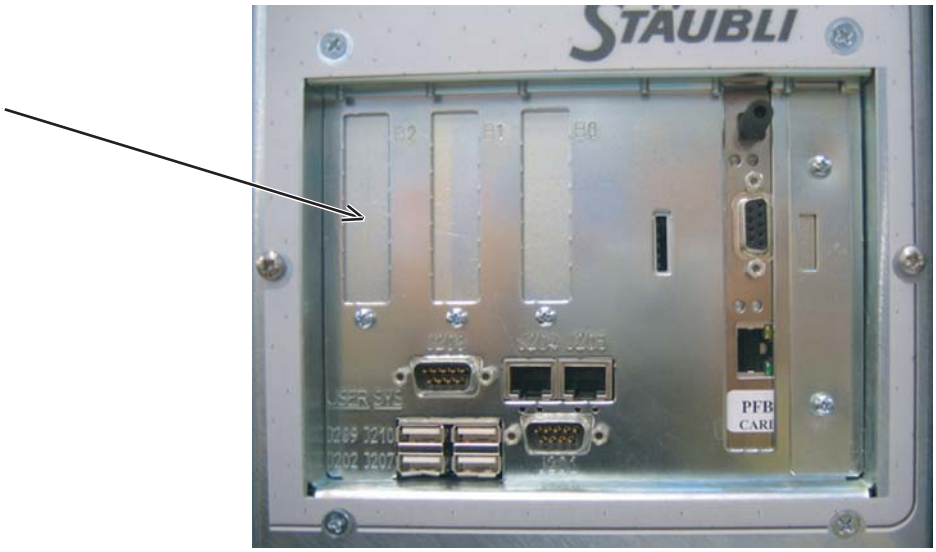


Figure 5.12

- Replace the cover and reinstall the **CS8C** computer module.

5.3.1.2. INSTALLATION OF CABLE

• The cable has to be connected to J211 on **CS8C** computer module and on J1202 on arm.

5.3.1.3. INSTALLATION OF I/O BOARD IN THE ARM

Remove the 2 side covers and the outer cover of the forearm.

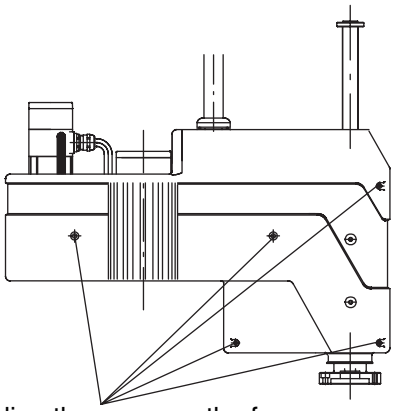
The board has to be attached by screws and connected to XB3 plug on the LPX5 board.

5.3.1.4. SOFTWARE SETUP

5.3.1.5. PROCEDURE FOR CONNECTING THE INPUTS/OUTPUTS IN THE FOREARM

CAUTION:
The RS40/60/80 arm must be switched off.

1) Remove the outer cover from the forearm.



Screws holding the cover on the forearm

2) Loosen the screws holding the cover in place and remove the cover.
3) The user cable comes out of the forearm cover:
    - Towards the top by cutting out an opening (d = 23.5 mm) in the cover and inserting a seal (e.g.PG16) in the opening.
4) Insert the cable through the connection and connect it to the terminals on the CIO/ARMIO board. Fit the connectors on the CIO/ARMIO board. Group and fasten the cables together (for a cable exit on the side, on the flat metal surface just below).

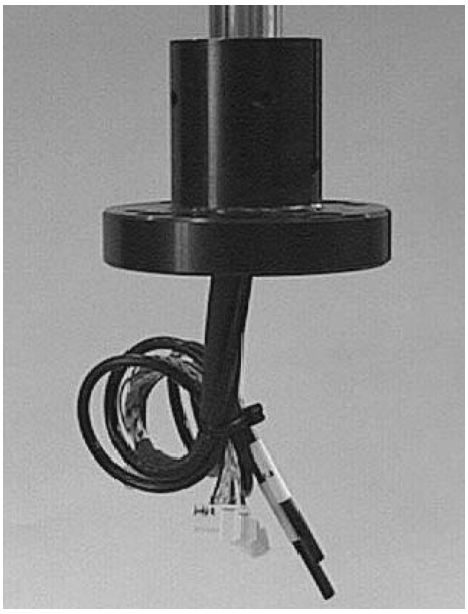
    Note:
    The connectors for the CIO/ARMIO *board are included in the pack (constructor Weidmüller, description 14 pin BL 3.5/14/F, order n° 160 676 0000).*

5) Put the cover back in place.
6) Fit the outer cover on the forearm.

5.3.1.6. CONNECTING THE INPUTS/OUTPUTS TO THE TOOL INTERFACE (OPTION)

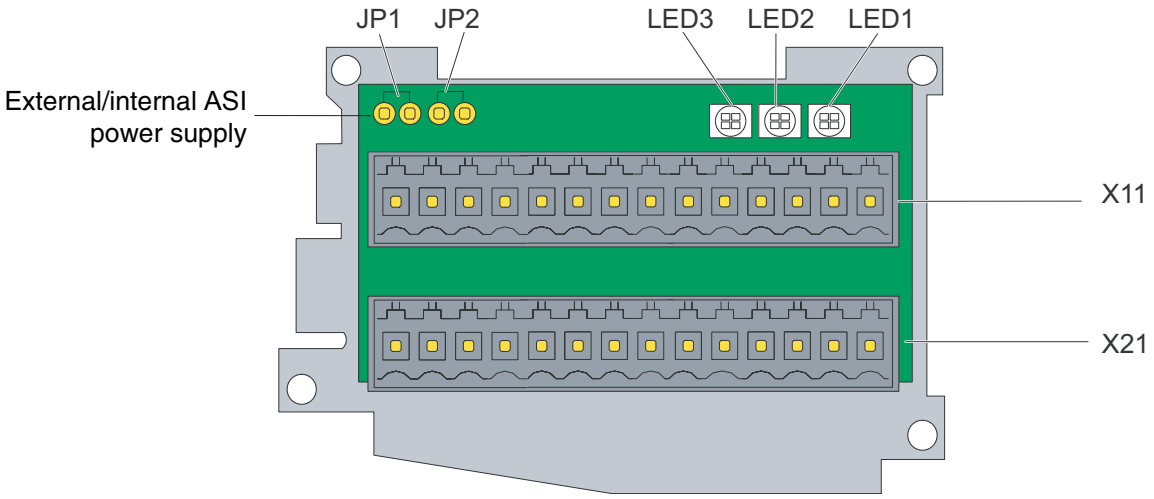
Type of connections Molex 2.50 mm SPOX:

- 2 x 8-pin, article: 22-01-1084
- 1 x 4-pin, article: 22-01-10449

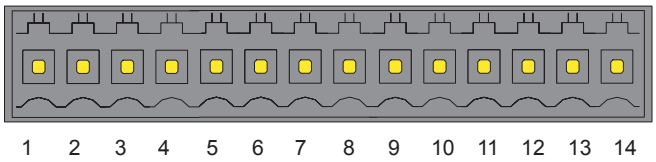


These connections are designed for use with the connection tool option (TC).

5.3.1.7. CIO BOARD

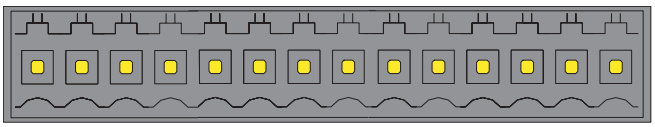


X11



PIN	CORRESPONDENCE
1	ASI-
2	ASI+
3	cDout0
4	cDout1
5	cDout2
6	cDout3
7	cDout4
8	cDout5
9	cDout6
10	cDout7
11	+24 VDC
12	0 V
13	Configuration bridge for the ASI power supply Remove the bridge if the ASI power supply is provided by an external source.
14	

X21

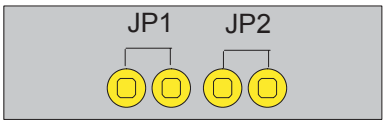


PIN	CORRESPONDENCE
14	cDin0
13	cDin1
12	cDin2
11	cDin3
10	cDin4
9	cDin5
8	cDin6
7	cDin7
6	cAin3
5	PE analog ground
4	cAin2
3	cAin1
2	PE analog ground
1	cAin0

Characteristics:

- Digital inputs:
    - Nominal voltage: 24 VDC (minimum 20 VDC, maximum 28 VDC)
    - Voltage for logical 0: 0 to 3 VDC
      Voltage for logical 1: 11 to 28 VDC
    - Input current: 6 mA maximum
    - Response time (hardware and software): 6 ms
- Digital ouputs:
    - Nominal voltage: 24 VDC (minimum 20 VDC, maximum 28 VDC)
    - Max. current per output: 0.5 A
    - Max. current for all outputs: 2 A
    - Response time (hardware and software): 6 ms maximum
- Analog inputs:
    - Input voltage: ± 10 V
    - Resolution: 78 mV
    - Accuracy: 5 %
    - Response time: 6 ms

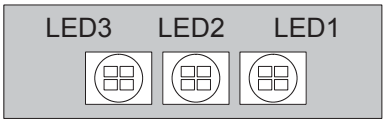
Hardware configuration



	MEANING
JP1, JP2 present	Power supply for the ASI bus provided via the CIO board
JP1, JP2 absent	External power supply for the ASI bus

If the ASI bus is powered via the CIO board, only 4 slaves can be connected.

If an outside power supply is used, 13 slaves can be connected. This power supply must conform to AS-I specification.



LIGHT EMITTING DIODES LED DISPLAY	MEANING
LED1 Green Red	 Logic signal OK Overload
LED2 Green Flashing green Red Steady OFF	 ASI data transfer Waiting for CAN data ASI voltage error CIO board without ASI module
LED3 Red Flashing red Fast flashing red Green Flashing green	 CAN bus not operational ID node not valid Module in passive error status Module in operational status Module in pre-operational status

The CIO board has configuration switches whose positions must be as follows:

- 1, 7, 8 = on
- 2, 3, 4, 5, 6 = off (see figure 5.13)

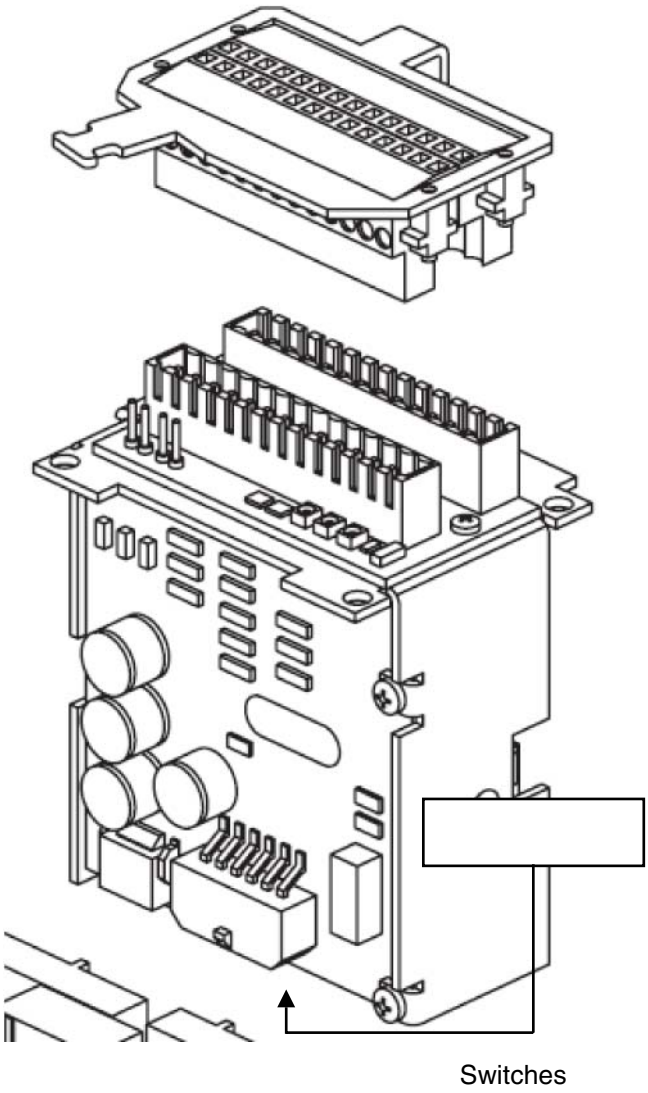
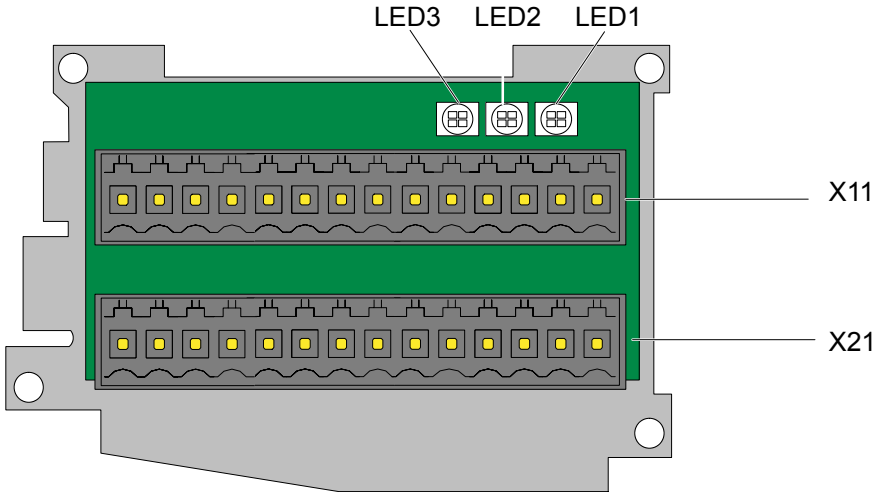
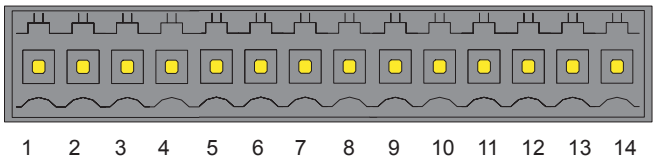


Figure 5.13

5.3.1.8. ARMIO BOARD

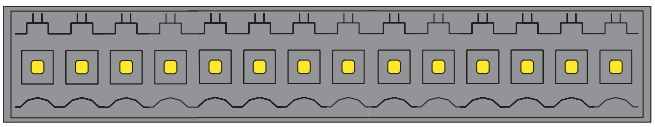


X11



PIN	CORRESPONDENCE
1	cAout 0
2	cAout 1
3	cDout0
4	cDout1
5	cDout2
6	cDout3
7	cDout4
8	cDout5
9	cDout6
10	cDout7
11	+24 VDC
12	0 V
13	cAout2
14	cAout3

X21



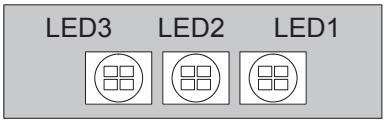
PIN	CORRESPONDENCE
14	cDin0
13	cDin1
12	cDin2
11	cDin3
10	cDin4
9	cDin5
8	cDin6
7	cDin7
6	cAin3
5	0 V analog
4	cAin2
3	cAin1
2	0 V analog
1	cAin0

Characteristics:

- Digital inputs:
    - Nominal voltage: 24 VDC (minimum 20 VDC, maximum 28 VDC)
    - Voltage for logical 0: 0 to 11 VDC
      Voltage for logical 1: 16 to 28 VDC
    - Input current: 11 mA maximum
    - Response time (hardware and software): 6 ms
- Digital ouputs:
    - Nominal voltage: 24 VDC (minimum 20 VDC, maximum 28 VDC)
    - Max. current per output: 0.5 A
    - Max. current for all outputs: 2 A
    - Response time (hardware and software): 6 ms maximum
- Analog inputs:
    - Input voltage: ± 10 V
    - Resolution: 78 mV
    - Accuracy: 5 %
    - Response time: 6 ms

- Analog outputs:
    - Output voltage: 0/+10 V
    - Resolution: 2,4 mV
    - Accuracy: 5 %
    - Response time: 6 ms

Hardware configuration



LIGHT EMITTING DIODES LED DISPLAY	MEANING
LED1 Green Red	 Logic power supply OK Overload on logic power supply
LED2 Green Red	 Power supply OK Overload on analog outputs
LED3 Red Flashing red Fast flashing red Green Flashing green	 CAN bus not operational ID node not valid Module in passive error status Module in operational status Module in pre-operational status

The ARMIO board has configuration switches whose positions must be as follows:

- 1, 7, 8, 9 = on
- 2, 3, 4, 5, 6 = off (see figure 5.13)76

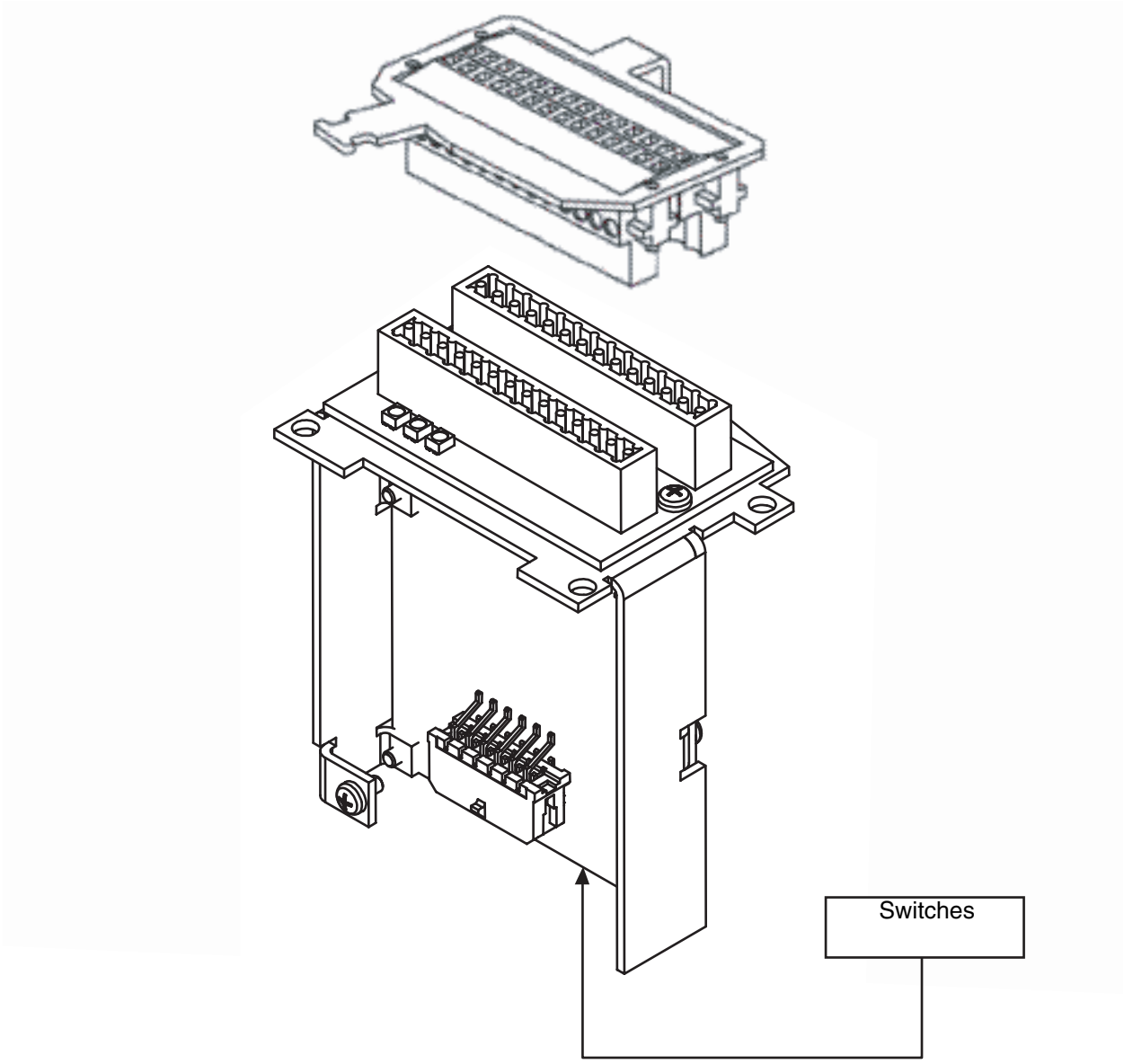


Figure 5.14

5.3.1.9. CONNECTIONS ON THE TOOL INTERFACE

The user cable is connected on the forearm to X11 and X21 before leading to the tool interface. Once the cable has been installed, connect the sockets X14.1, X14.2 and X14.3 as shown in the table below.

SOCKET	PIN	COLOUR	SOCKET	PIN	FUNCTION
X21	14	Grey	X14.1	1	cDin0
	13	White, green	X14.1	2	cDin1
	12	White, yellow	X14.1	3	cDin2
	11	White, brown	X14.1	4	cDin3
	10	White, orange	X14.1	5	cDin4
	9	Orange	X14.3	1	cDin5
	8	Yellow	X14.3	2	cDin6
	7	Green	X14.3	3	cDin7
X11	3	Grey	X14.2	1	cDout0
	4	White, black	X14.2	2	cDout1
	5	White, violet	X14.2	3	cDout2
	6	Blue	X14.2	4	cDout3
	7	Black	X14.2	5	cDout4
	8	White, grey	X14.2	6	cDout5
	9	White, blue	X14.2	7	cDout6
	10	White, red	X14.2	8	cDout7
X11	11	Red	X14.1	6	+24 V
	12	Violet	X14.3	4	0 V
	12	Brown	X14.1	7	0 V
X21	5	Green, yellow	PE	-	

5.4. AS-I DIGITAL INPUTS/OUTPUTS (RS ARMS)

Note:
The AS-I function doesn't exist on ARMIO board of second generation.

Description
The RS arms support additional digital inputs and outputs on the fore arm, through the use of the AS-I bus that is present on the CIO board (see chapter 5.3.1.7). This AS-I bus supports up to 13 AS-I slave modules of 4 digital inputs and 4 digital outputs.

WARNING:
- **Only 4 slave modules are supported when they are powered by the CIO board. You need an external power supply to support additional slave modules (up to 13).**
- **The AS-I bus of the CIO board supports the AS-I 1 specification: Analog Inputs/Outputs and AB modules are not supported.**
- **Each slave module must have an address on the AS-I bus (a value between 1 and 13). This address cannot be assigned with the CS8C controller. You need an external device to configure it. Such AS-I configuration tools can be found by AS-I devices manufacturers.**
- **The slave modules present on the AS-I bus cannot be detected automatically by the CS8C controller. You have to declare them to the controller (see Configuration hereafter).**

Configuration
AS-I Inputs/Outputs are configured in the /usr/configs/asi.cfx file. Each **CS8C** controller is supplied with an example in which the configurations are commented out. To activate a configuration:
- Rename the /usr/configs/asiExample.cfx file in /usr/configs/asi.cfx.
- Remove the slave configurations that are not needed.
- For each remaining slave configuration, remove the Inputs/Outputs configurations that are not needed.
- If desired modify the default name of each AS-I Input/Output, and select its logical mode (inverted / notInverted).
- Restart the **CS8C**.

It is possible to define analog Inputs/Outputs based on the digital Inputs/Outputs of an AS-I module (see provided asiExample.cfx file):
- The "channel" and "bitCount"' parameters define the first and the number of digital signals to use to build the analog signal.
- The format of the analog signal is either "signed" or "unsigned".
- The "coefA" and "coefB" parameters define the linear transformation to apply:
    - When writing on analog outputs, the linear transformation y = a.x + b is applied.
    - When reading an analog input or output, the linear transformation x = (y-b) / a is applied.

Any configuration errors in the asi.cfx file are listed in the events logger on start-up. You can check the status of the AS-I Inputs/Outputs in the Control Panel display.

5.5. DIGITAL BIO INPUT/OUTPUT BOARD (OPTIONAL EXTRA)

BIO 16I / 16O board description

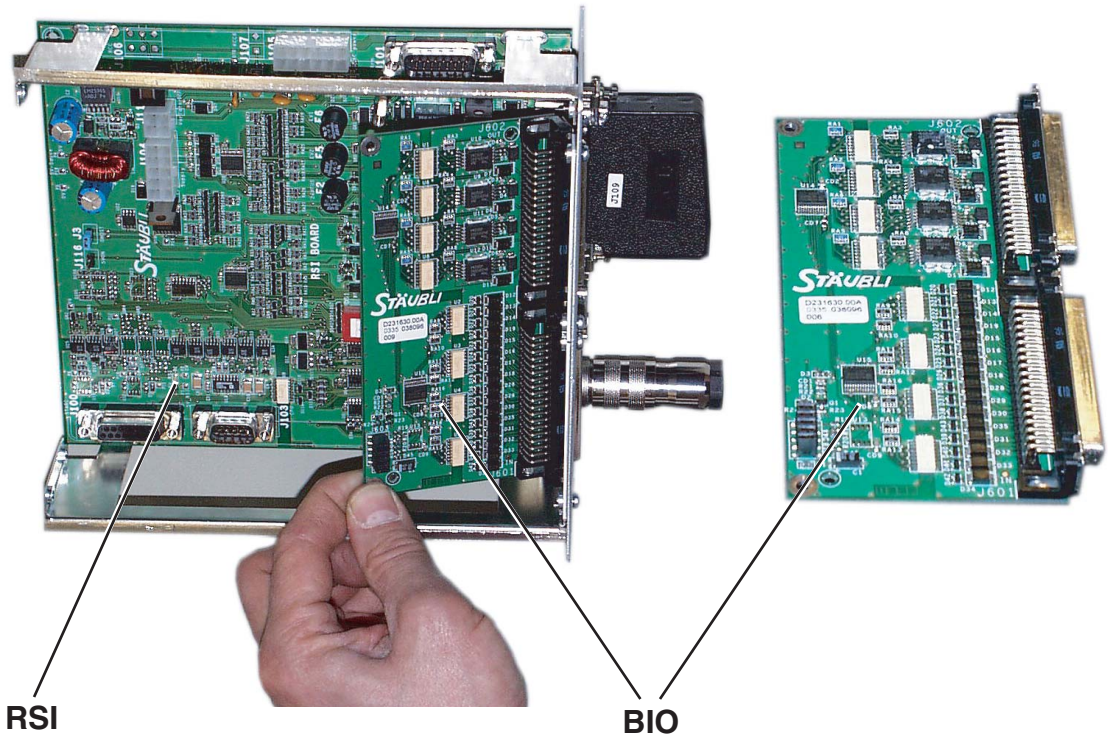


Figure 5.15

The kit is made up of a **BIO** board to be mounted on the **RSI** board. Up to 2 **BIO** boards can be used.

The **BIO** board is fitted with:

- 16 optocoupler inputs.

  The signals are numbered from 0 to 15 on each board and they correspond to inputs 0 to 15 and then 16 to 31.

- 16 optocoupler outputs protected against overcurrents.

  The signals are numbered from 0 to 15 on each board and they correspond to outputs 0 to 15 and then 16 to 31.

> **CAUTION:**
> **The Inputs/Outputs have to be powered by a rectified, filtered external power source (not supplied).**

Wiring the I / 0s

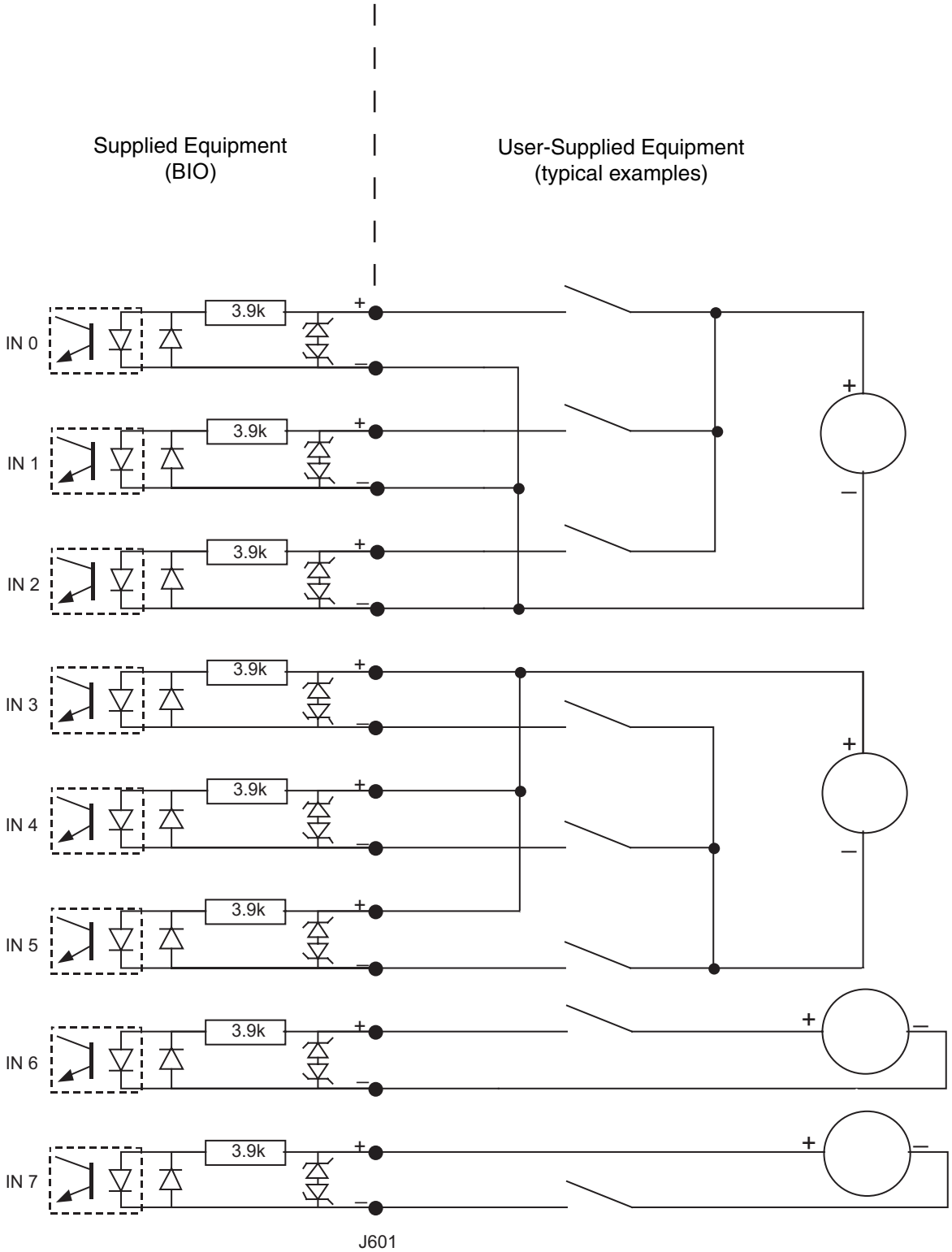
Wiring is described in the "Electric Wiring" manual.

Characteristics of the BIO Inputs

Each input channel is made up of an input and a corresponding return wire.
The connector pin out is given in the "Electrical Wiring" manual.

Operational voltage range	0 to 24 VDC
"Off" state voltage range	0 to 3 VDC
"On" state voltage range	11 to 24 VDC
Typical threshold voltage	Vin = 8 VDC
Operational current range	0 to 6 mA
"Off" state current range	0 to 0.5 mA
"On" state current range	2 to 6 mA
Typical threshold current	2.5 mA
Impedance (Vin / Iin)	3.9 KΩ minimum
Current at Vin = 24 VDC	Iin $\leq$ 6 mA
Equipment and software response time	15 ms maxi
Insulation voltage / Leakage current	2,5 kV / 4 mm

Note:
The characteristics of the input current are given for informational purposes only.



BIO board - Inputs

Figure 5.16

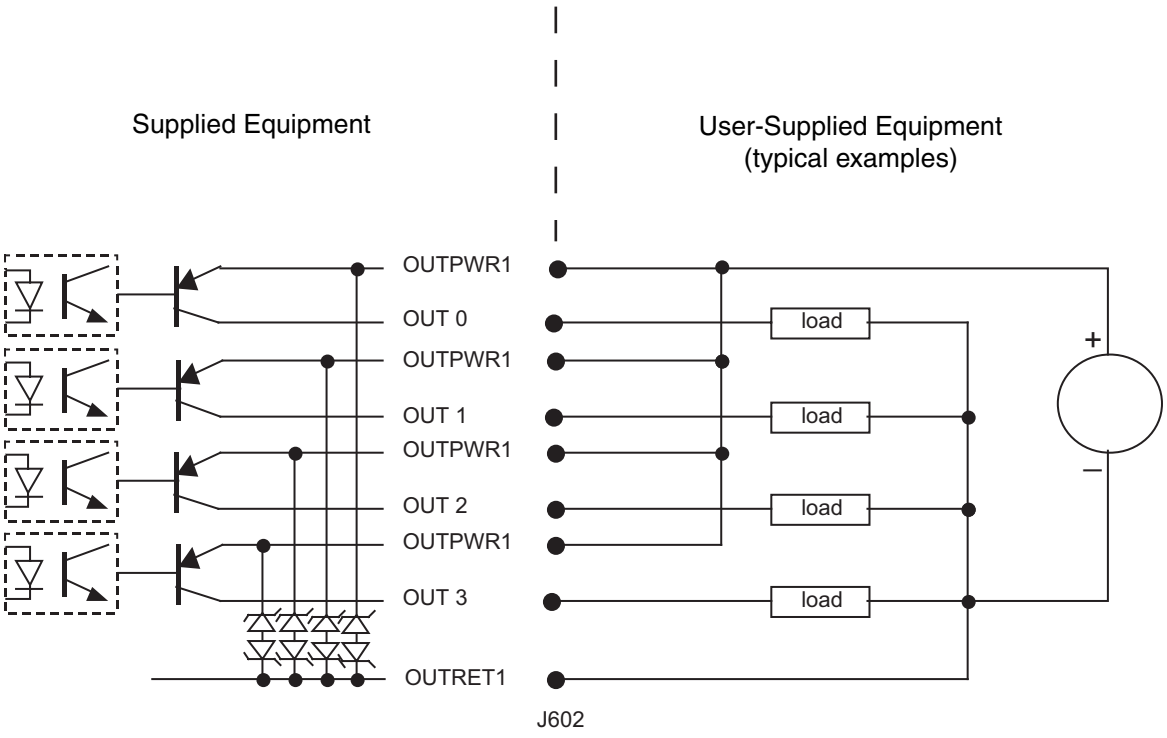
Note:
The inputs are numbered from 0 to n on each Input/Output board.

Characteristics of the BIO outputs

The 16 outputs are installed in 4 groups of 4. Each group is electrically isolated from the other groups and optically isolated from the controller. The 4 outputs of each group have a shared return connection. The outputs are protected from overvoltages and inverse voltages.

Note:
The connector pin out is given in the "Electrical Wiring" manual.

Parameter	Value
Power supply voltage range	10 VDC < Vsup < 30 VDC
Low voltage stop	5 VDC < Vusd < 8 VDC
Earth current	Ig < 60 mA
Functional current per channel	I_{out} < 700 mA, protected against short circuits
On state resistance (Iout = 0.5 A)	Ron < 0.32 W @ 85 °C (Ron = 0,4 W @ 125 °C)
Output off leakage current	Iout < 25 µA
Equipment and software response time	15 ms maxi
Output cut-off voltage on inductive charge (Iout = 0,5 A, L = 1 mA)	(Vsup - 65) < Vdemag < (Vsup - 45)
Maximum DC short circuit current	0.7 A < Ilim < 2.5 A
Peak short circuit current	Iovpk < 4 A
Insulation voltage / Leakage current	2.5 kV / 4 mm



BIO board - Outputs

Figure 5.17

Note:
The outputs are numbered from 0 to n on each input/output board.

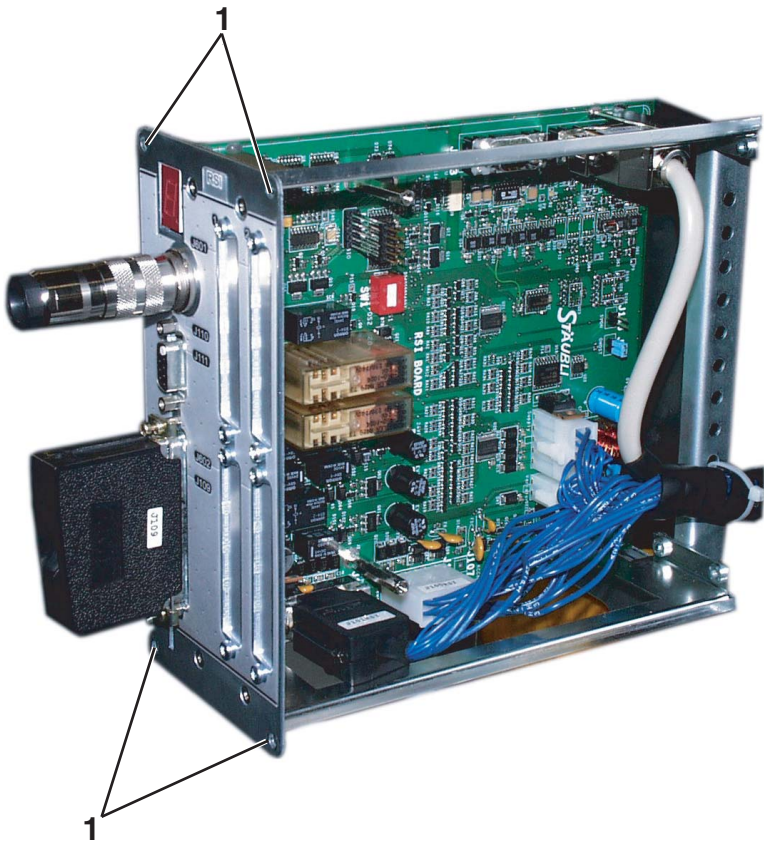


Figure 5.18

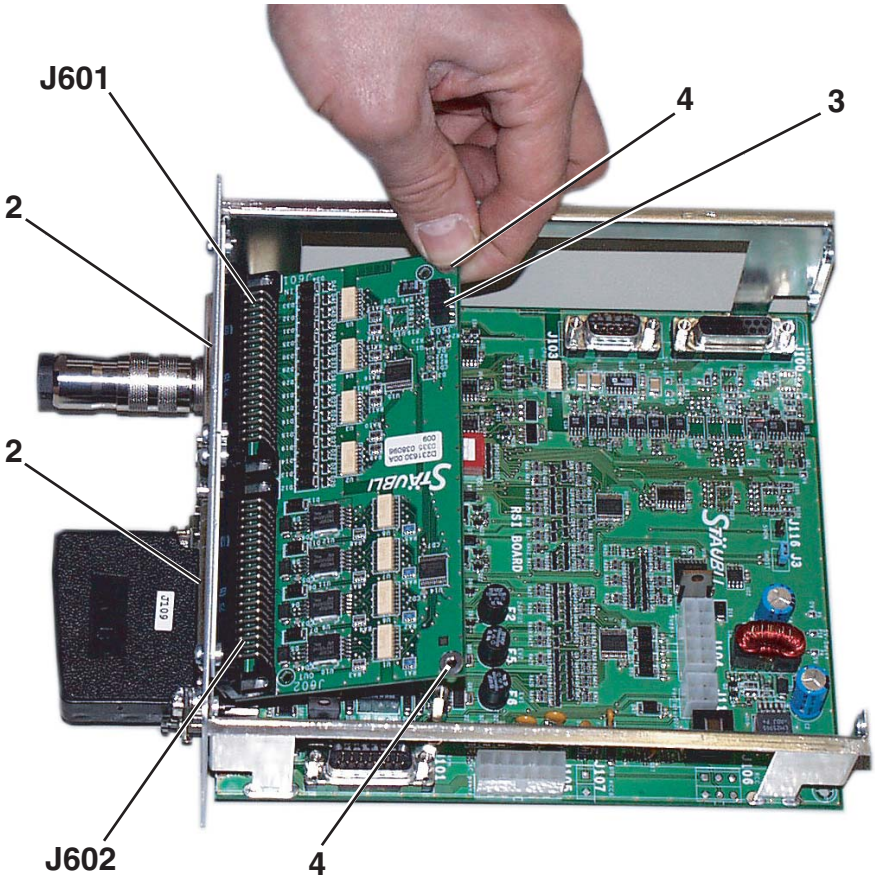


Figure 5.19

Installation of the BIO option (figures 5.18 and 5.19):

> **CAUTION:**
>
> **Before removing or inserting a board, disconnect the installation from the power supply, following the procedure.**
>
> **Furthermore, electronic boards must only be handled after an antistatic work area has been created. To do this, the After Sales Support technician (or the customer) must use an anti-static mat connected to the earth and to the cabinet, as well as wearing the anti-static bracelet supplied with the controller.**

- Remove the 4 fastening screws **(1)** from the **RSI** board and take it out of the controller.

Installing the first board:
- Insert the **J601** and **J602** connectors on the **BIO** board through the holes cut in the front panel of the **RSI (2)** board and then plug the **BIO** board into the **J603 (3)** connector.
- Secure the **BIO** board using the locks on the **J601** and **J602** connectors and the 2 fastening screws **(4)**.

Installing the second board:
- The second board is installed in accordance with the same principle, using the accessories supplied with the kit (spacers, connector).
- Replace the **RSI** board.
- The presence of the **BIO** board is detected automatically by the **CS8C** cabinet on start-up. The "Control panel" application enables you to see that the board is in place and check the status of its Inputs/Outputs.

> **Note:**
> *To display the status of the Inputs/Outputs or to programme them, select the "I/O" branch in the control panel accessible via the main menu.*

5.6. FIELD BUS

5.6.1. CHARACTERISTICS

There are various types of field bus (**DeviceNet, Profibus, CANopen, ModBus TCP client**).
Each of these options consists of a **PCI** format board located in the computer and a CD-ROM for installation of the PC configuration software program.

The elements making up the bus as such are not supplied.
The characteristics and wiring for the field bus are specific to the equipment selected. See the constructor's recommendations, especially for the terminal resistances at the end of the lines.

Wiring is described in the "Electric Wiring" manual.

> **CAUTION:**
> **The Profibus board requires a straight connector on the field bus cable. It is not possible to fit a 90° right angle connector.**

5.6.2. CONFIGURATION

The **CS8C** controller is configured for a field bus using a **PC ApplicomIO** software application supplied on a specific CD-ROM.
This tool enables you to configure the field bus board on the one hand, and to generate a **ConfigTag.xml** file on the other hand. The file must be copied by **Ftp** in the **/usr/applicom/io** directory of the **CS8C** controller. If this file is present on start-up, the Inputs/Outputs of the field bus are displayed on the control panel and are directly accessible via a **VAL3** application.

The Ethernet configuration procedure using the **ApplicomIO console 2.2** software is as follows:

1) Preparation of the configuration (**CS8C**)
   - The field bus board cannot be configured while it is operating. If the field bus board has already been configured in the **CS8C**, press the **"Init"** menu on the **MCP** (Control Panel > I/O > Fieldbus). Restart the **CS8C**. The field bus board is stopped and ready to be reconfigured.
   - Give the **CS8C** an **IP** address and check that it is accessible via the network from the **PC** on which the **ApplicomIO** software has been installed.
2) Remote creation of a configuration (ApplicomIO)
   - Create a new field bus configuration (File > Configuration Manager > New).
   - Enter the name of the new configuration.
   - Select "On remote computer (LAN TCP/IP)","IP address" and enter the **IP** address for the **CS8C**. Leave the port on **5001**, with the "Automatic transfer" menu selected.
3) Defining the field bus configuration (ApplicomIO)
   - Configure the board via the network (Description > Add board).
   - Detect the equipment ("Network detection" tab and then Network > Read network configuration).
   - Insert the equipment and configure the corresponding Inputs/Outputs.
   - The analog Inputs/Outputs can have an unsigned format (default configuration) or a signed one. The other **ApplicomIO** formats are not supported. The min/max value and processing configurations are supported. The "off time" value is ignored. During writing on analog outputs, the linear transformation $y = a.x + b$ is applied and then the result is saturated with the min/max values, and finally sent to the field bus. During reading of an analog Input or Output, the value read from the field bus is first saturated with the min/max values, and then the linear transformation $x = (y-b) / a$ is applied.
   - Save the configuration (File > Save).

4) **CS8C** configuration (ApplicomIO)

- Create the **XML** configuration file (File > Export > items -> XML).
- Initialize the board and download the configuration (File > Download in flash).

5) Checking the configuration (**CS8C**)

- Restart the **CS8C**.
- Check the field bus board Inputs/Outputs (Control Panel > I/O > Fieldbus).

5.6.3. DIAGNOSIS

Field bus errors are shown by messages on the MCP, which can also be accessed using the "events logger " application. These errors start with the word **"FIELDBUS"**, followed by a **CS8C** diagnosis, the identification of the board, the equipment and the channel concerned, and the Status (**Applicom** diagnosis).

The **CS8C** diagnoses are:

InitSoftware #Status	**/usr/applicom/io/configTag.xml** file missing.
BuildItem-#name	The ***#name*** item has not been created (incorrect name, already used, or insufficient memory).
Write #Board #Equip. #Channel #Status	Writing error on the field bus.
Read #Board #Equip. #Channel #Status	Reading error on the field bus.
EquipmentStatus #Board #Equip. #Status	Problem with an item of equipment on the field bus.
RefreshIn #Board #Status	Error during the board input update phase.
RefreshOut #Board #Status	Error during the board output update phase.
InitBoard #Board #Status	Error during initialization of the board **CS8C** driver. This error is always present for board 2, if there is only one field bus board.
ExitBoard	Error during reinitialization of the **CS8C** driver for the board.
BuildPort	Error during construction of a **CS8C** Input/Output port: The **/usr/applicom/io/ConfigTag.xml** file must contain contradictory information.
BoardId #Board Status=1	The **OEM** board number is not valid. Only boards purchased from **Stäubli** are accepted.
ConfigBoard #Status	Board initialization error. Check the **.ply** configuration file, and the board type configuration (Compact PCI **"CPCI"** boards are not accepted).
NetworkStatus #Board #Status	Problem with the field bus.
Version	Identification of the board version, its **BIOS** and the **playerIO**.

The **ApplicomIO** diagnoses are:

STATUS	DEFINITION
0	No anomaly detected. The function has been executed correctly.
1	**Function unknown** The function requested is not accepted.
2	**Address error** The address of the variable requested is incorrect.
3	**Data error** MODBUS: Incoherency in the frame content.
4	**Data inaccessible** MODBUS: The physical address does not exist, the module does not exist, or the data are protected. CANOPEN: For reading / writing objects in **SDO**, the equipment refuses access to the object requested: • The object does not exist • The object is read or write protected • The number of bytes written exceeds the size of the object For sending or receiving a **CAN** message: • The message cannot be sent • The receiving **COB-ID** is already used by the board or is not valid DEVICENET: The remote equipment is in error status. Check its status.
9	MODBUS: A MODBUS customer is trying to modify a write protected data item.
10	Negative layer 2 acknowledgement from the equipment **(NACK)**. PROFIBUS: **UE (User Error)**, error in the remote equipment.
11	Negative layer 2 acknowledgement from the equipment **(NACK)**. PROFIBUS: **RR (Remote Ressource)**, insufficient resources in the remote equipment or initialization parameters not valid.
13	Negative layer 2 acknowledgement from the equipment **(NACK)**. PROFIBUS: **RDL (Response FDL/FMA1/2 Data Low)**, remote equipment resources insufficient to deal with the data received, low priority response.
14	Negative layer 2 acknowledgement from the equipment **(NACK)**. PROFIBUS: **RDH (Response FDL/FMA1/2 Data High)**, remote equipment resources insufficient to deal with the data received, high priority response.
32	**Incorrect parameter sent to the function** Wrong number of variables.

STATUS	DEFINITION
33	**Response time exceeded** The equipment does not respond. Check its status and wiring. MODBUS: Equipment configured but not connected to the network. • Wiring problem, the CPU does not execute the communication blocks, connection not declared or incorrectly declared in the CPU • Incorrect **IP** address for the equipment or the gateway • Check that the Ethernet frame format configured in the remote equipment is **"ETHERNET II"** DEVICENET: • The **DeviceNet** master has no equipment to monitor in its configuration • The slave has not been configured by the master during the initialization phase • The slave has not been reached by the master during the time lapse defined by the master during the initialization phase PROFIBUS: The Input/Output configuration for the master does not correspond to the Input/Output configuration for the slave.
34	**Physical fault on the line** DEVICENET: No 24V supply detected. The **CAN** component of the **applicom** interface is **"bus off"**. Check the wiring and the **Baud Rate** for the network.
35	Data not available for cyclic reading.
36	**Equipment not configured** Define the equipment configuration using **applicomIO Console** and reinitialize the field bus board.
40	Writing or reading attempt deferred by a task, although the maximum number of tasks that can use the deferred mode at the same time has already been reached.
41	Writing or reading attempt made although the deferred request register is full.
42	Attempt to transfer a request deferred although the deferred request register is empty.
46	Board number not configured, or master / customer function attempting to use a channel with a master / slave configuration, or the other way round.
47	The field bus board is invalid or incorrectly initialized by the **IO_Init** function.
49	**Time delay fault for adding to the queue file** MODBUS: It was not possible to send the request due to a lack of resources (no communication channel available). This period corresponds to 4 times the value of the time-out for the current requests. Increase the time-out value, or the maximum number of simultaneous requests for the equipment in question.
51	Driver system problem.
53	DEVICENET: Synchronization problem on the line. The master **DeviceNet** is offline (no power supply detected or the **CAN** component of the **applicom** interface set to **"Bus Off"**). Check the wiring and the **Baud Rate** for the network.

STATUS	DEFINITION
55	**Response time exceeded - Message lost** Check the equipment status. MODBUS: Queuing time exceeds the value of the "time-out for requests being processed", connection made, question acknowledged but no response. DEVICENET: The equipment has accepted the connection but has not responded to the request.
59	• Protection key missing from the **applicom** interface • Use of ***applicom*** functions without prior initialization
63	Communication error on the serial port.
65	Connection refused. DEVICENET: The connection to the master **DeviceNet** is in progress or refused by the equipment.
66	Insufficient memory for the applicom interface. Insufficient resources for a further connection.
70	MODBUS: Connection closed by the equipment following a communication problem. Wiring problem, CPU off, the CPU is not executing the communication blocks. The equipment does not accept this messaging system. Check the equipment status. DEVICENET: Connection over. **MAC ID** duplication detected on the **DeviceNet** network. Modify the **MAC ID** of the master **DeviceNet**.
79	Profile incompatible. The equipment does not correspond to the configuration. Check the equipment and the bandwidth of the connections.
93	Driver not accessible.
97	Operating mode not accepted.
99	The **applicom** interface is already in use.
255	Local reading buffer not initialized by the **IO_RefreshInput** function.

5.7. PROGRAMMABLE LOGIC CONTROLLER (PLC OPTION)

The **CS8C** controller can be programmed using **IEC61131-3** standard PLC languages: IL, SFC (GRAFCET), FBD, LD, ST.

The PLC program must be written on a PC in the **PLC** programming environment supplied with **Stäubli Robotics Studio**. It can then be downloaded and executed on the **CS8C** controller.

The **PLC** option requires a **PLC** licence for the **SRS** programming environment, and a runtime licence for each **CS8C** controller.

Without a licence, it is possible to use the **PLC** programming environment for 30 minutes and execute the PLC program on a **CS8C** for 15 minutes.

5.7.1. INSTALLATION

SRS
The **PLC** programming environment is supplied with **SRS**. During installation, it is necessary to keep to the selected **PLC** option.
To activate the **PLC** programming licence, it is necessary to connect the **PLC** key to the PC and enter the licence number using the **SRS** utility (Tools > PLC > Licence).

CS8C
The **PLC** option can be activated on a **CS8C** using the **SRS** options manager (Tools > PLC > Options manager). After restarting, the option must be shown in the list of software component versions on the **MCP** (Control panel > Controller > Versions).

5.7.2. OPERATION IN THE **CS8C** CONTROLLER

PLC cycle
The **PLC** program in the **CS8C** has access to all the digital and analog inputs and outputs in the system. It can communicate with a **VAL3** program via the analog or digital outputs of the system.

The **PLC** cycle is carried out as follows:

1. Reading the inputs and outputs
2. Execution of a cycle in the **PLC** program
3. Writing the outputs
4. Waiting for the rest of the time lapse required to reach the specified cycle time

The cycle time for the **PLC** program is defined in the **PLC** development environment (Generate > Execution options). It can be modified at any time.
The **CS8C** supports cycle times that are multiples of 4ms. The sequencing accuracy of the **PLC** cycle (period between two successive **PLC** cycle starts) is about ± 0.1 ms.

When the specified cycle time is null, the system automatically adapts the **PLC** cycle time to the system CPU load, and more specifically to the **VAL3** program. The **PLC** program has then less priority than the **VAL3** program.

Starting
The **PLC** program is physically stored in the controller, in the **/usr/plc** directory. When the controller starts up, the **PLC** program stored in this location is started automatically. The only way of inhibiting the automatic start is to delete the file from the controller using **Ftp**.
During start-up, if an error is detected in the **PLC** program (**PLC** Input/Output not found in the **CS8C**, or **PLC** output corresponding to a **CS8C** input), the unit does not start up and the error is displayed in the "Events logger" utility of the **MCP**.

Overrun error
If execution of a **PLC** cycle takes longer than the specified cycle time, the current cycle ends normally, and then the following **PLC** cycle starts immediately. An **Overrun** error is generated (on the **dOverrun** digital output by default) to enable a reaction to the **PLC** or **VAL3** program.
The **dOverrun** digital output thus shows during each **PLC** cycle whether the previous cycle was carried out within the specified time lapse or not. The name of the output can be changed (see"Configuration"). The value 1 shows the **Overrun** error.

Input/Output error
If an Input/Output reading / writing error is detected, a **RwError** error is generated by the default **dRwError** digital output to enable a reaction by the **PLC** or **VAL3** program. The name of the output can be changed (see"Configuration").

Interaction with the VAL3 program
When the **PLC** cycle time is not null:
Execution of the **PLC** program takes priority over the **VAL3** program. The **VAL3** program is only executed once the **PLC** program is waiting, between two **PLC** cycles.

> **CAUTION:**
> **If the delay between two PLC cycles is not long enough, execution of the VAL3 program can be slowed down considerably. It is then necessary to increase the PLC cycle time to leave more time for the VAL3, or to specify a null cycle time for the PLC (see "CPU load").**

Execution of a **VAL3** program can be interrupted at any time by a repeat of a **PLC** cycle. If synchronization is required between the **PLC** and the **VAL3**, it has to be programmed using the Inputs/Outputs.

When the **PLC** cycle time is null:
Execution of the **VAL3** program takes priority over the **PLC** program. The **PLC** program is only executed once the **VAL3** program is waiting, between two **VAL3** cycles.

Inputs/Outputs are refreshed with each **PLC** cycle, each **VAL3** synchronous cycle and each **VAL3** asynchronous cycle.

PLC utility for the MCP
The main menu of the **CS8C** includes a **"PLC"** utility that displays the main characteristics of the **PLC** program being executed:

- Requested **PLC** cycle time (as defined in the **PLC** programming environment)
- Measurement of the execution period for the last **PLC** cycle (this period includes the execution time for the critical system tasks)
- Maximum execution time measured for the **PLC** cycles since the previous **PLC** start
- **TCP** port for communication with the **PLC** programming environment

CPU load
The ratio between the execution period for the previous **PLC** cycle and the requested **PLC** cycle time gives the current **CPU** load for the **PLC** program. The ratio between the maximum execution period for the **PLC** cycle and the requested **PLC** cycle time gives the maximum **CPU** load for the **PLC** program.
The unused **CPU** load is allocated as a priority to the **VAL3**, and then to non-critical system tasks (screen refreshing, Ethernet communication). As a rough guide, it is necessary to leave about 30% of the **CPU** load to obtain correct execution of a **VAL3** program and the system. For a very simple **VAL3** program, we can let the **PLC** use 90% of the **CPU** load. For a complex **VAL3** program, the **PLC** program should not exceed 50% of the **CPU** load.

Configuration
The **CS8C** parameters of the **PLC** option are:

- The name of the digital output to be used for the **Overrun** error (**dOverrun** by default).
- The **TCP** port used for communication with the **PLC** programming environment (1100 by default).
- The name of the digital output to be used for the **RwError** error (**dRwError** by default).
- The percentage of idle time between two **PLC** cycles, when the **PLC** cycle time is null (50% by default). For instance, if the last **PLC** cycle took 16ms and "idleTime" is 50%, 8 ms are left to the system before a new **PLC** cycle is started.

These parameters are defined in the **/usr/configs/plc.cfx** file, which can be modified by **Ftp**.

5.7.3. PLC PROGRAMMING IN SRS

Definition of the Inputs/Outputs
The Inputs/Outputs must be declared in the **PLC** program as global datas with **CS8_IO** profile:
Right-click on the variable and then on Properties.

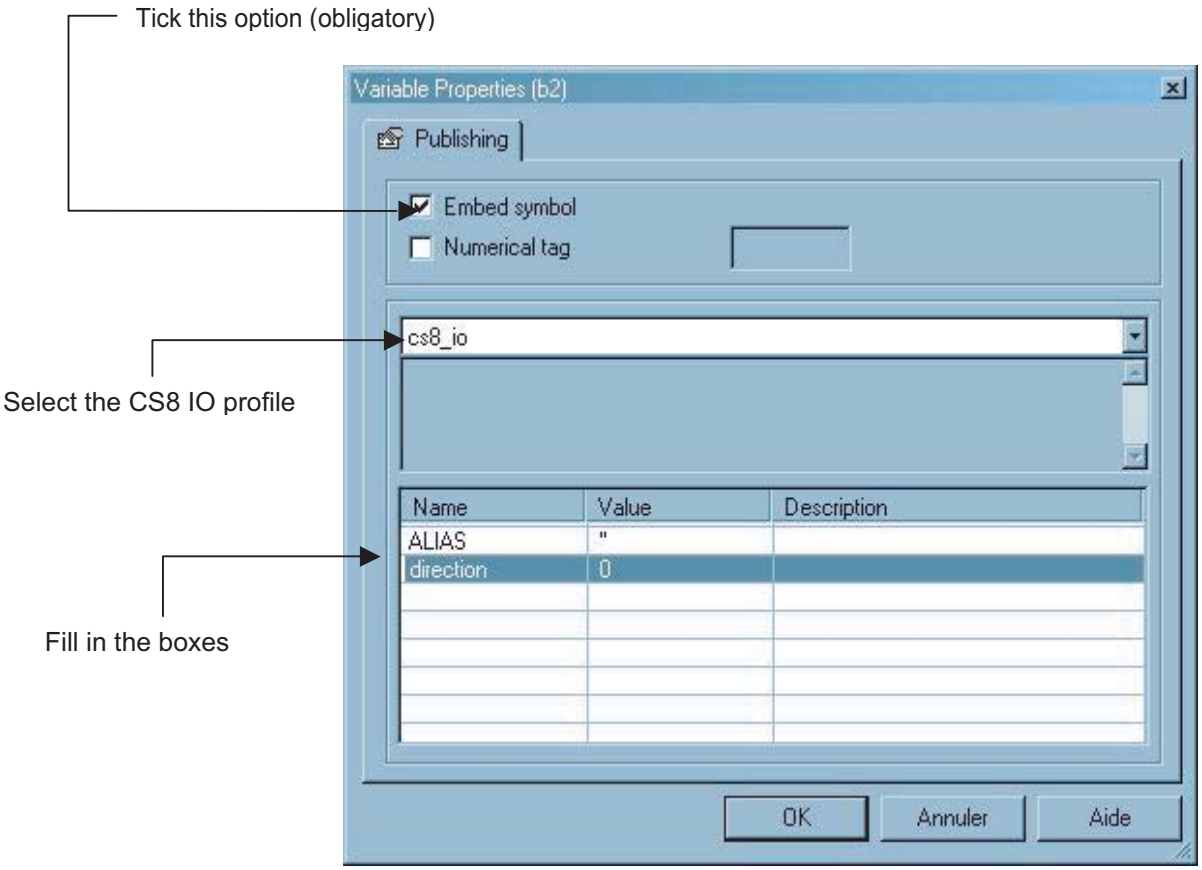


Figure 5.20

- The **ALIAS** field can be used to give a **PLC** variable name that is different from the Input/Output linked to it. If this field is empty (**''**: 2 simple quotes) the name of the **PLC** variable is the same as that of the Input/Output.
- The **direction** field must be set to 0 for an input and 1 for an output.

Automatic creation of the **PLC** variables on the basis of the Inputs/Outputs for the **CS8C** controller can be carried out using the **SRS** import tool (Tools > PLC > Import) (see figure 5.21).

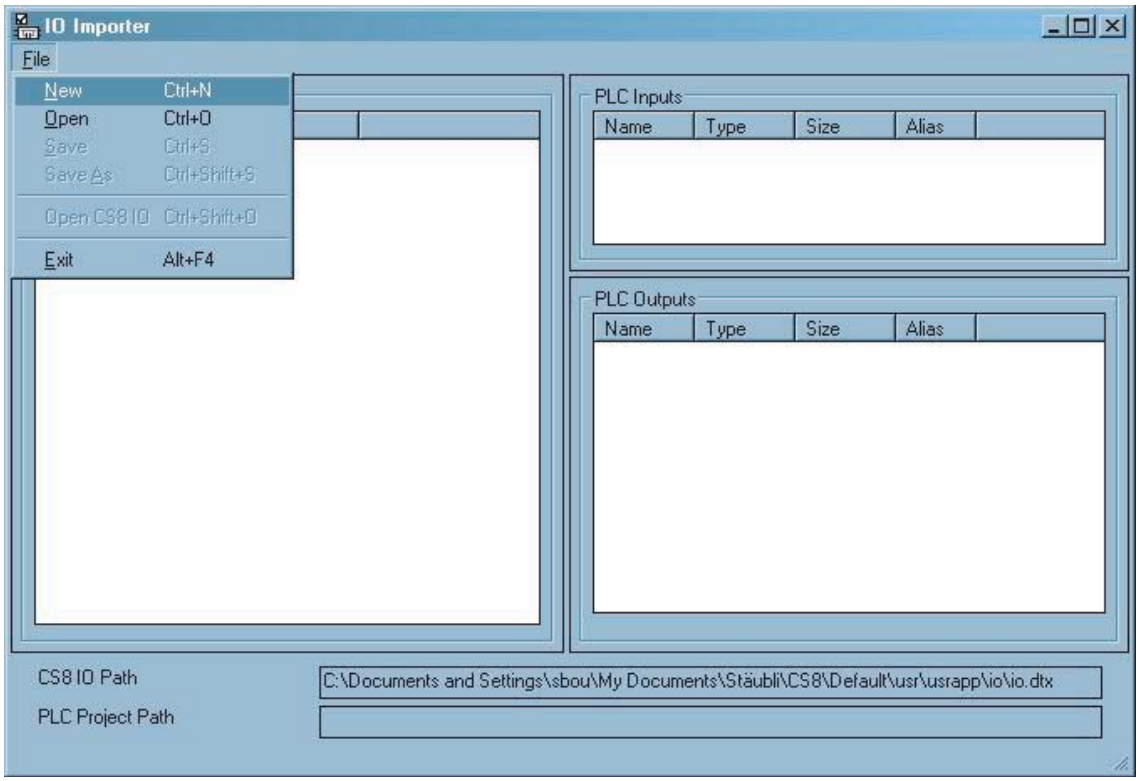


Figure 5.21

- If necessary, update the **CS8C** emulator inputs and outputs using the **SRS** downloading tool.
- Create or load the desired **PLC** application (File > Create / Open a PLC project). The **CS8C** Inputs/Outputs emulated are then displayed in the left-hand frame.

> **CAUTION:**
> **Make sure that the PLC programming environment has been closed before making any modifications to a PLC project.**

- Select the desired Inputs/Outputs from the **CS8C** list and drag them to the desired frame (outputs or inputs).
- Save the **PLC** project. The next time the program is opened in the **PLC** programming environment, the selected Inputs/Outputs are predefined.

Downloading a PLC program

PLC programs are downloaded from the **PLC** development environment:

- Log on to the **CS8C** controller (**IP** address, **TCP** port)
- Click on the download button

The progam is then sent to the controller and it starts immediately.

If a **PLC** program is already being executed, it may be necessary to stop it via the programming environment before downloading the new program.

The download also copies the **PLC** program on the **CS8C**, which means that the last program downloaded is executed automatically when the controller is started up.

Archiving the PLC program

> **CAUTION:**
>
> **The source files of the PLC program must be archived with care.**
>
> **The CS8C controller contains only a binary format that does not enable the source files to be found.**

The source files are necessary to log on to the controller again and take over control of the **PLC**.

5.8. ETHERNET LINK

5.8.1. CONFIGURATION

The **CS8C** has 2 Ethernet ports, J204 and J205. The IP address of each of these ports can be modified via the control panel. The modification takes effect immediately. On delivery, the first port is configured with the address 192.168.0.254 (mask 255.255.255.0) and the second one with the address 172.31.0.1 (mask 255.255.0.0).

It is also possible to get automatically an IP address from the network (with DHCP protocol).

CAUTION:

The DHCP protocol may not always assign the same IP address to the controller. The DHCP mechanism should therefore not be used when the IP address of the controller is used by other peripheral equipment.

The two Ethernet ports must correspond to different sub-networks. Two IP addresses on the same sub-network are not supported.

The **CS8C** controller can reach other Ethernet sub-networks, through gateways configurable from the Control Panel.
Each gateway is defined with:

- The IP address of the device used as gateway. The address must belong to the same sub-network as the **CS8C** controller.
- The IP address of the sub-network to reach. A null address "0.0.0.0" can be used to define a default gateway, to reach all sub-networks that are not handled by a specific gateway.

5.8.2. FTP PROTOCOL

The **CS8C** controller is an Ftp server that enables file exchanges over the Ethernet. All that is required is to define the IP address of the **CS8C** controller to enable it to be accessed via Ftp, and use a network login and password corresponding to a user profile as defined on the **CS8C**. The reading and writing access rights depend on the login user profile selected (see paragraph 5.10.3).
A free client Ftp is supplied on the **SRS** CD-ROM.

5.8.3. MODBUS TCP PROTOCOL

The **CS8C** controller can be configured to exchange Inputs/Outputs via the Ethernet using the **Modbus Tcp** protocol. In this case, the **CS8C** controller is considered as a Modbus **Server**.

The **CS8C** controller is configured for **Modbus Tcp** using the **PC SRS** software supplied on the **CS8C** CD-ROM (Tools > Modbus IO Config). This tool is used to generate a **modbus.xml** file that has to be saved in the **/usr/applicom/modbus** directory of the **CS8C** emulator. Then the file has to be transferred to the **CS8C** controller using the **SRS** transfer tool (Emulator > I/O > Modbus). If this file is present on start-up, the corresponding **Modbus Tcp** Inputs/Outputs are displayed on the control panel and are directly accessible via a **VAL3** application.

The "**Modbus TCP/IP Client"** software option for your PC provides access to **Modbus** Inputs/Outputs declared on **CS8C** from PC software using OPC Client, ActiveX, DLL interface (f.i Visual Basic, Delphi, Visual C++, LabView, ...). The **SRS** CD-ROM provides a trial version of the software in the folder "DirectLink 3.9".

Configuration
The configuration procedure for the **Modbus Tcp** Inputs/Outputs using the **SRS Modbus IO Config** tool is as follows:

- Create a new configuration ("New") or load an existing configuration ("Load")
- In the "Items configuration", "Add Item" tab
- Define the name, type, size and access for each item
- Save the configuration ("General parameters", "Save" tab)
- Copy the file on the **CS8C** under **/usr/applicom/modbus/modbus.xml**
- Restart the **CS8C**
- Check the modbus Inputs/Outputs (Control panel > I/O > Modbus)

Diagnosis
Modbus Tcp errors are shown by messages on the **MCP**, which can also be displayed using the "events logger " application. These errors begin with the word **"MODBUS"** followed by a **CS8C** diagnosis, identification of the channel concerned, and the Status (**applicom** diagnosis).

The **CS8C** diagnoses are:

InitLib #Status	**/usr/applicom/modbus/modbus.xml** file missing
BuildItem #name	The **#name** item has not been created (incorrect name, already used, or insufficient memory).
Write #Channel #Status	Writing error
Read #Channel #Status	Reading error
StartServer	It has not been possible to start the **Modbus** server. The **modbus.xml** file must be invalid.
StopServer	It has not been possible to stop the **Modbus** server

The diagnoses given by the Status are the same as those given for the **Modbus** field bus (see chapter 5.6).

5.8.4. ETHERNET SOCKETS (TCP)

The **CS8C** controller can be configured to communicate via the Ethernet using sockets (TCP). The **CS8C** controller accepts up to 40 sockets simultaneously, in client mode or server mode. The Ethernet sockets are configured via the "Control panel" application (Control panel > I/O / Socket). **UDP** sockets are not supported.

The parameters of a server socket are:

- The connection port between 0 and 65535.

CAUTION:

The ports between 0 and 1000 are reserved.

- The maximum number of simultaneous clients.
- The time lapse prior to triggering of an error message (maximum time lapse reached in reading or for a connection). A zero value suppresses the time lapse control.
- The end of string character.

Details of the last two parameters are given in the **VAL3** reference manual (SIO type).

The parameters of a client socket are the same, with the extra element of the IP address of the server socket to be reached. A "Test" menu can be used to test the connection with the server.

A server socket is activated ("opened") in the **CS8C** each time a **VAL3** program uses it, and deactivated ("closed") when the last customer logs off. When the maximum number of clients has been reached for a server socket, other clients attempting to log on are accepted but the communication is interrupted immediately by the server.

CAUTION:

If no VAL3 program has accessed the server sockets in the CS8C, they are not activated, and all attempts by a customer to connect will remain fruitless. In particular, the "Test" menu used on a CS8C controller to test a server socket on another CS8C controller produces an error message if no VAL3 application is running on that controller.

5.9. SERIAL PORT

Two serial ports are available on the **CS8C** controller (J203, COM1 and J201, COM2) to exchange data between a **VAL3** application and an equipment item in the cell.

The serial links are configured via the Input/Output display on the Control panel.
The parameters that can be configured in the Series link are:

- The transmission speed (from 110 to 115200 bauds)
- The number of data bits (from 5 to 8)
- The number of stop bits (1 or 2)
- Parity (even, odd or no parity)
- For J201 (COM2), the RS232/RS422 configuration. Default configuration is RS232.
- The flow control (none / hardware) (Influences COM1 only)
- The time lapse prior to triggering of an error message (maximum reading time lapse). A zero value suppresses the time lapse control
- The end of string character

Details of the last two parameters are given in the **VAL3** reference manual (SIO type).

CAUTION:

- **Check the configuration of the Series link to the external equipment before connecting to the electricity supply.**
- **When the controller is powered up, characters are sent via COM1 (start-up information for BIOS, etc.) and they may disrupt operation of equipment connected to J203. This point must be taken into account in the application.**

5.10. SOFTWARE CONFIGURATIONS

The software configuration can be used to modify certain characteristics of the controller, program user profiles to limit access to certain functions, and program Inputs/Outputs to enhance **CS8C** integration in the cell.

5.10.1. CONFIGURATION OF THE CONTROLLER CHARACTERISTICS

The Control panel application gives the various system characteristics. The serial number of the controller is displayed with the list of installed software and hardware versions.
Certain characteristics can be modified (depending on the login user profile selected):

- The software limits linked to the arm or the cell. The software limits linked to the arm must correspond to the mechanical limit switches.
- The unit of length (millimeter or inch)
- The language (see hereafter)
- The date and time, fixed or (s6.4) from SNTP time server
- The address and IP mask of each Ethernet port (fixed or from DHCP)
- The list of gateways to reach other Ethernet sub-network
- The current user profile and the user profile when the **CS8C** is started
- The port number for different system Ethernet socket servers (**SRS** remote maintenance, **telnet**, **ApplicomIO fieldbus** console, **SRS 3DStudio**)
- The maximum Cartesian speed in manual mode (up to 250 mm/s)
- The status of the emergency stop channels (**ESOUT1** and **ESOUT2**) with or without DOOR signal (see chapter 5.1.1)

Language configuration:

The controller is delivered with some predefined translations (English, German, French, Italian, Spanish, Chinese, Japanese, etc.). Each translation is defined in a .cfx XML file with Unicode UTF8 encoding, located in the /sys/configs/resources directory. The file itself consists in a set of string definitions, such as:

<String name="invalidBinaryOperator" value="Invalid binary operator for these types" /> where the name attribute is a translation identifier (to be kept unchanged), and the value attribute is the corresponding translation. The help attribute, if any, defines the help message associated with the main text.

It is possible to remove/add/modify a translation by removing/creating/modifying the corresponding .cfx file. Missing texts in a language definition file are replaced with the default English translation, therefore a user-defined translation file can be used on a newer VAL3 version: only new texts will not be translated correctly.

The Unicode UTF8 format of the language definition file makes it possible to use any Unicode character or symbol in it. However, the correct display of the characters on MCP depends on the installed fonts on the MCP. Currently, ASCII, Turkish, Czech, Hungarian, Polish, Scandinavian, Chinese, Japanese and Korean characters are supported.

5.10.2. CONFIGURATION OF THE ARM CHARACTERISTICS

The arm characteristics are displayed in the Control Panel. The serial number of the arm is displayed with the list of installed software and hardware versions. This list also details the "Arm" version that shows:

- The arm type with its mechanical version, such as TX90-S1.
- The arm tuning version, such as R2.
- The arm mounting (floor / wall or ceiling).
- Possibly arm mechanical options.

The controller is delivered with the configuration of the arm delivered with it. If another arm is attached to the controller, the arm characteristics, defined in the /usr/configs/arm.cfx configuration file, should be updated: This can be done with the "Exp." export and "Imp." import buttons from the calibration menu.

If some arm characteristics must be updated, you need to edit the arm configuration file /usr/configs/arm.cfx that is exported with the "Exp." export button from the calibration menu.

Arm mounting configuration
The arm mounting configuration is used by the controller for gravity compensation. It can be updated by changing the value of the "mount" parameter in the arm.cfx file:

```
<String name="mount" value="floor" />
```

The value can be set to "floor" (floor mounting), "ceiling" (ceiling mounting), or "wall" (any mounting). When the wall mounting is defined, the controller uses the gravity vector configured in the /usr/configs/cell.cfx file, and displayed in history utility at boot time.

CAUTION:

- **For a wall mouting, the coordinates of the gravity vector in World must be correct !**
- **Default value (gravity along the X direction of World) may not fit the reality !**
- **Ceiling and wall mounting are not possible for all models of arm. Refer to robot arm documentation.**

5.10.3. CONFIGURATION OF THE USER PROFILES

The user profiles are configured using the **PC SRS** tool supplied on the CD-ROM for the **CS8C**. Each profile is defined by a configuration file that must be installed on the **CS8C** under **/usr/configs/profiles**. There is no limit to the number of profiles.

Profiles are selected via the control panel or using the **Shift-User** keyboard shortcut.

S6.1 The setProfile() instruction can also be used to change the user profile in a VAL3 program.

The file name determines the corresponding profile name. An user profile configuration is defined using the following key words:

Key word	Description
password	Profile password.
connectionPassword	Profile password for network connections (Ftp and remote maintenance).
writeAccess	Writing access to the **VAL3** applications and the **CS8C** configuration (using the **MCP** or via Ftp). If writing access is activated, reading access is also activated.
readAccess	Reading access to **VAL3** applications via the **MCP** or Ftp (opening, editing without modification, exporting controller data, connection for the remote maintenance tool).
armWriteAccess	Writing access to the specific data for the arm (software limits, adjustment offsets, user marks).
recovery	Access to the recovery from the calibration menu.
ioWriteAccess	Activation of the **"On"/"Off"** menus for the Inputs/Outputs in manual mode. Does not prevent use of keys (1), (2) and (3).
123KeysControl	Access to programming for keys (1), (2) and (3).
manualMode	Access to manual working mode.
localMode	Access to local working mode.
remoteMode	Access to remote working mode.
monitorSpeed	Access to the **MCP** monitor speed.
powerButton	Activation of the power button in remote mode (only power cut-off remains possible, manual connection to the power supply remains prohibited).
moveHoldKey	Activation of the **Move/Hold** button in remote mode.
stopKey	Activation of the **"Stop"** button for the VAL3 application.
menuKey	Activation of the **"Menu"** browsing button in the MCP interface.

The controller is supplied with 2 profiles:

- "default" (with empty profile and network passwords) providing complete access except for arm configuration
- "maintenance" (with "spec_cal" as the login and network password) that provides complete access

Of course, the profiles can be adapted or deleted. If no profiles are defined, the default profile does not have any access restrictions. This means that the network connections must use the "default" login with an empty password.

5.10.4. CONFIGURATION OF SYSTEM INPUTS/OUTPUTS

System Inputs/Outputs are configured in the **/usr/configs/iomap.cf** file. Each **CS8C** controller is supplied with an example **/usr/configs/iomapExample.cf** in which the configurations are commented out. To activate a configuration, it is necessary to:

- Rename the **iomapExample.cf** file as **iomap.cf**
- Remove the **"//"** comments in front of the key words to be configured and replace the description after the **"="** by the name of an Input/Output. For example: **enablePower = usrIn0**
- Restart the **CS8C**

Any configuration errors in the **iomap.cf** file are listed in the events logger on start-up.

Configuration of system inputs
Certain **CS8C** functions require a user signal for which the default wiring can be reprogrammed:

Key word	Description	Type	Default wiring
estopAcknowledge	Acknowledgement of the emergency stop in manual mode	Digital input	Internal signal concerning detection of the **MCP** on its holder
	The emergency stop is acknowledged if this signal is activated when the arm is powered on. ⚠ **DANGER:** **Current standards require that power must be switched on from outside the cell after an emergency stop. This digital input must thus be linked to an item of equipment outside the cell.**		
enablePower	Signal that the system has been powered on in remote mode (see chapter 6.6.3)	Digital input	No wiring

When the **MCP** is replaced by its shorting plug, it is possible to simulate pressing certain keys using inputs:

Key word	Description	Type
remoteMonitorSpeed	Monitor speed selection [0, 100]	Analog input
remoteMoveHold	Replacement of the **Move/Hold** button	Digital input

Access to the system statuses and signals

The status signals for the safety system are set to **"On"** when an emergency stop has been activated.

> **CAUTION:**
> **The wiring of the safety system makes it impossible to know the state of each signal when several eStop signals are activated. The software then returns the last known state.**

Key word	Description	Type
limitSwitch	Signal that a limit switch has been reached on a joint	Digital output
driveFault	Variable speed controller fault signal	
initSwitch	Software command signal opening the safety system	
watchdog	Fault signal from the watchdog on the **RSI** board	
fuse24V	Status of the 24V supply at fuse F2	
estopMCP	Emergency stop signal from the **MCP**	
estopWMS	Emergency stop signal from the **WMS**	
estopUser1-2	Emergency stop signal from **UESA** on the safety system	
estopUser3-4	Emergency stop signal from **UESB** on the safety system	
userEnable	Emergency stop signal from **USER EN** on the safety system **Caution:** **The USER EN signal is not valid in local or remote mode. Its state is then not updated.**	
door	Emergency stop signal from **DOOR** on the safety system **Caution:** **The DOOR signal is not valid in manual mode. Its state is then not updated.**	
brakeSelect	Signal from the joint selector at the base of the arm	
brakeRelease	Signal requesting brake release at the base of the arm	
deadman	Status of the **MCP** enable button	
park	Signal concerning detection of the **MCP** on its holder	
power	Arm power status	
dummyPlug	Signal that the **MCP** is replaced with a shorting plug	
temperature	Temperature (°C) measured on the **RSI** board	Analog output
popup	Messages displayed on the **MCP**	Serial port

Configuration for the "remoteMCP" option

This option can be used to make a full simulation of the **MCP** when it is replaced by its shorting plug. It thus enables an **MCP OEM** to be connected to the **CS8C** controller.

CAUTION:

The "remoteMCP" option must be used with great care to meet the requirements of the safety standards in force. In particular:

- **A mutual supervision software mechanism must be set up between the MCP OEM and the CS8C. It stops the robot as soon as the MCP OEM switches to fault status and checks that the status of the robot on the MCP OEM is correct.**
- **The redundant entries for the enable button and the presence detector on the holder must be wired to separate signals.**

Key word	Description	Type
remoteEnablePower	Signal for manual connection to the power supply	Digital input
remoteTestMode	Signal for activation of the test mode	
remoteManualMode	Signal for activation of the manual mode	
remoteLocalMode	Signal for activation of the local mode	
remoteRemoteMode	Signal for activation of the remote mode	
remoteDeadman1	Signal from the enable button (1/2)	
remoteDeadman2	Signal from the enable button (2/2)	
remotePark1	Signal showing presence on the holder (1/2)	
remotePark2	Signal showing presence on the holder (2/2)	
remoteJogJointMode	Signal showing activation of the **"Joint"** mode for manual movement	
remoteJogFrameMode	Signal showing activation of the **"Frame"** mode for manual movement	
remoteJogToolMode	Signal showing activation of the **"Tool"** mode for manual movement	
remoteJogUserMode	Signal showing activation of the **"User"** mode for manual movement	
remoteJogMove1	Speed of manual movement along the 1 or X axis	Analog input [-100, +100]
remoteJogMove2	Speed of manual movement along the 2 or Y axis	
remoteJogMove3	Speed of manual movement along the 3 or Z axis	
remoteJogMove4	Speed of manual movement along the 4 axis or in RX rotation	
remoteJogMove5	Speed of manual movement along the 5 axis or in RY rotation	
remoteJogMove6	Speed of manual movement along the 6 axis or in RZ rotation	
remoteSpeedLimit	Signal for incrementation of the maximum speed authorized in test mode	Digital input

CHAPTER 6

OPERATION

6.1. POWERING UP THE CONTROLLER

To start the controller, set the switch **(1)** to position **"1"** (figure **6.1**).

Figure 6.1

> **DANGER:**
>
> **Before carrying out any work on the components inside the controller, it is essential to set the master switch (1) to position "0".**

See the Safety chapter 3.3 for the procedure to isolate the system from the electrical power supply.

> **DANGER:**
>
> **When the master switch (1) is on "0", the cables and the filter located upstream from the switch remain live.**

When the electricity supply to the controller is switched on, the **MCP** screen and all the LEDs flash on and off.

Next, a **"Stäubli CS8"** message is displayed on the screen, and then the main menu is shown after about 2 minutes.

6.2. PRESENTATION OF THE MCP

6.2.1. GENERAL PRESENTATION

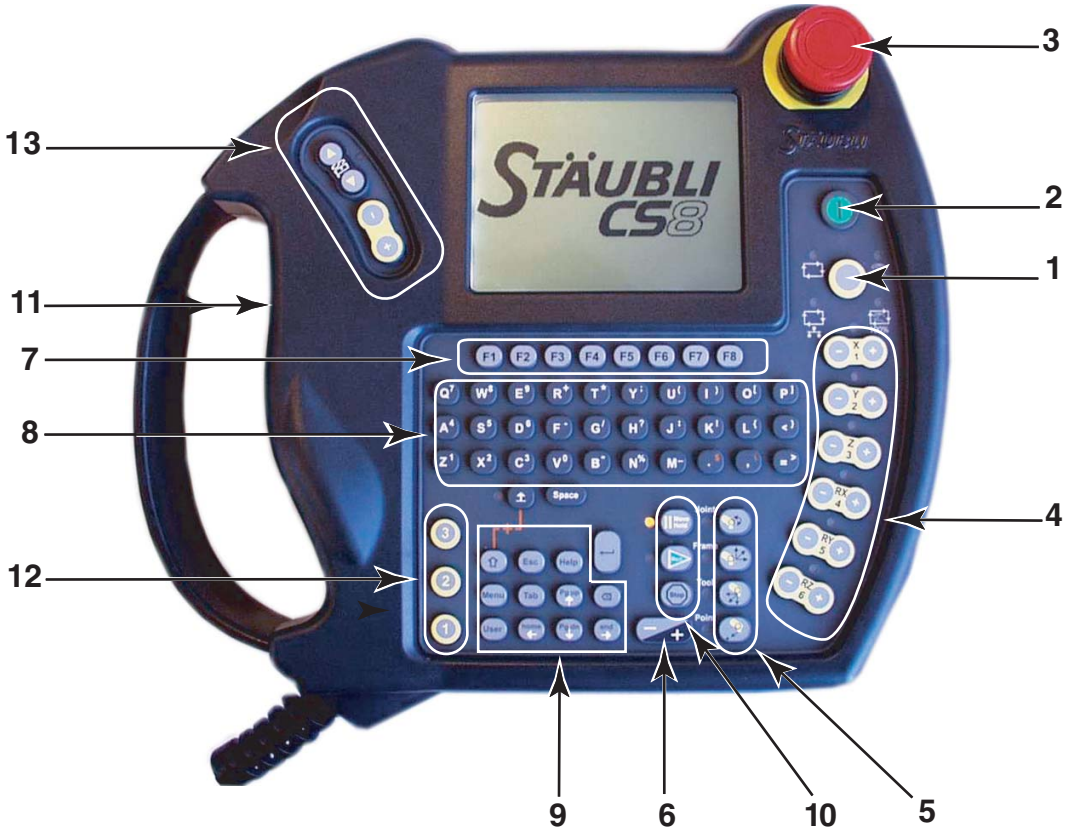


Figure. 6.2

Working mode (1)
The working mode selected on the **WMS** operator interface is displayed around the button located opposite the working mode icons. The selected mode is also displayed on the **WMS** front panel.

Button turning on arm power (2)
This illuminated button enables you to connect the arm to the power supply or disconnect it. When the green indicator light comes on steady, this shows that arm power is on. In manual mode, if the **MCP** has not been placed on its holder, the enable button **(11)** must be pressed.

Enable button (11)
This button has three positions, and it states are:
- Open when the button is not pressed.
- Closed in the intermediate position.
- Open in the fully depressed position, which corresponds to tenseness in the user. These contacts stay open until the button is released.

This button can be used to authorize connecting arm power in manual mode (see paragraph 6.3), but only when it is in intermediate position. The 2 other positions prevent the arm from being powered up or cut off the power supply if the arm is under power in manual mode. In automatic mode, the position of the button is not taken into account.
The pendant is designed to enable the button to be pressed by right-handed operators (holding the **MCP** one way up) or by left-handed operators (holding the **MCP** the other way).

Emergency stop (3)
The emergency stop must only be used in the event of absolute necessity for an unforeseen stop in your application.

Movement keys (4)
These keys are active in manual mode and they enable you to generate arm movements per axis or using Cartesian coordinates, depending on the movement mode selected (see paragraph 6.6).

LEDs and Luminous indicator keys

> ⚠ **DANGER:**
> **When the MCP power is on all the LED (L) flash to enable you to check that they are working correctly.**
> **If a LED is found to be faulty, the MCP must be replaced for safety reasons.**

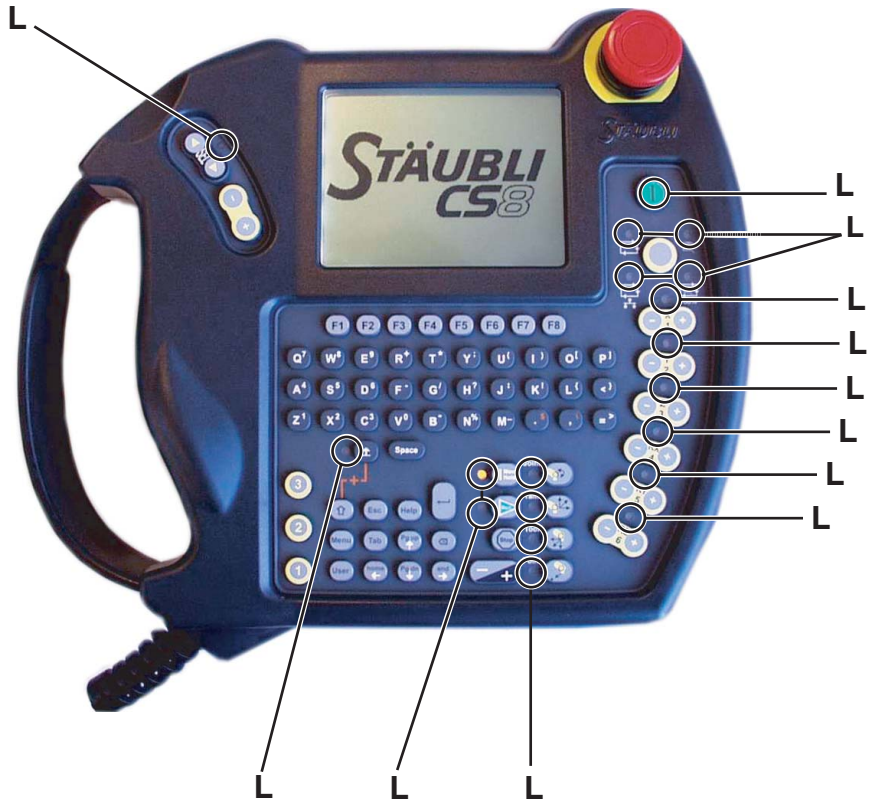


Figure 6.3

Movement mode selection keys (5)

Joint Frame Tool Point

When the arm power is on and in manual mode, each of these 4 keys enable you to select the desired movement mode (**Joint**, **Frame**, **Tool** or **Point**). The indicator light associated with the key shows the current mode.

Speed adjustment key (6)

This key enables you to vary the speed within the limits imposed by the movement mode. It can be deactivated, depending on the current user profile (see chapter 5.10.3).

The speed is shown in the **MCP** status display bar.

> **Note:**
> *The speeds vary in accordance with predefined values (with a factor of about 2 each time the key is pressed). The current speed is incremented or decremented by 1%, by pressing **Shift** at the same time as the speed key.*

Fonction keys (7)
These are used to select the menus displayed above them.

Alphanumerical keys (8)
These keys are used to enter the data for your application.

Interface and navigation keys (9)

The functions of these keys are described in paragraphs 6.2.3 and 6.2.4.

Application control keys (10)

These keys are used to start or stop an application and to enable arm movements. The functions of these keys are set out in paragraph 6.2.2.

Enable button (11).
This is used in manual mode in the event that the **MCP** is used other than on its holder. This button can be used in three positions. In the release position or when it is pressed down fully (pressed hard), the arm power is cut off. In between these two positions, power is supplied to the arm (see paragraph 6.6.1).

Digital output activation keys (12)

In manual mode, these keys change the status of the digital outputs that are associated with them (see paragraph 6.2.4).

jog keys (13)

These keys are activated in manual mode and they enable you to generate arm movements, per axis or using Cartesian coordinates, depending on the movement mode selected **(Joint, Frame, Tool)**, with one hand (see paragraph 6.7).

6.2.2. CONTROL KEYS

Stop key

This key stops the current application. Depending on the user profile, it may be inactive (see chapter 5.10.3).

Run key

This key enables you to start an application.

Move / Hold key

- In manual mode, the arm movements are allowed when the **Move / Hold** key is pressed. The arm stops immediately on the programmed trajectory as soon as the key is released.
- In local and remote modes, the movements can be stopped and the robot set to pause mode, by pressing the **Move / Hold** key. Press the key again to reactivate the movements.
- In remote mode, the **Move / Hold** key may be inactive depending on the user profile (see chapter 5.10.3).

In manual and local modes, the robot is always in pause phase when the arm power is switched on. In remote mode, arm movements are authorized as soon as it is powered.

> **DANGER:**
> **When the green light is on and an application has been started, the robot arm can carry out movements at any time.**

Shift + User keys

When these two keys are pressed together, the user profile change page is displayed.

6.2.3. INFORMATION AND HELP KEYS

Online help

By pressing the **Help** key, you can access online help at any time. In the "online help" mode, the function keys are desactivated. On the other hand, by pressing the function keys, you can call up a display window explaining the associated function.

To exit the "online help" mode and reactivate the function keys, press the Help key or the Esc key again.

Menu key
This key enables you to return to the main menu. Depending on the user profile, it may be inactive (see chapter 5.10.3).

User key
By pressing this key, you can call up the **VAL3** user display page (e.g. if the entry icon ? appears).

Pick list

The pick list enables you to access the element you are looking for directly in all the lists shown on the display unit.

All you have to do is use the keyboard to enter the first letter or letters of the name of the element you are looking for. The selector moves to the first element whose initial characters correspond to the search criteria.

This key enables you to move on to the following element corresponding to the search criteria.

6.2.4. NAVIGATION KEYS

Arrow keys
Besides the classic browsing functions, these keys have some other functions that are specific to the **CS8C** controller.

"End" key
Expands an element when it has been contracted (preceded by the "+" sign).

Home key
Contracts an element that has been expanded (preceded by the "-" sign).

Shift lock key
Provides access to the second function of each key (except for $ and \).

Shift + End keys
By pressing both these keys at the same time, you can move to the end of the list.

Shift + Home keys
By pressing both these keys at the same time, you can select the first item on the list.

Shift + Pg up keys
By pressing both these keys at the same time, you can move up one page in the display.

Shift + Pg dn keys
By pressing both these keys at the same time, you can move down one page in the display.

Shift + Shift Lock keys
By pressing both these keys at the same time, you can access capital letters and the characters **$** and \.

Note:
The full stop "." and the comma "," can be accessed in normal mode and in capital mode.

Esc key
Cancels the entry and restores the initial value in the box, or exits the current page.

Return key
Starts the action associated with the element selected.
Enables you to modify the box selected (see paragraph 6.2.5).
Validates the box being modified.

tab key
Enables you to switch quickly from one box to another.

backspace key
This key has the classic function of deleting the character to the left of the cursor.

Keys activating the digital outputs "1", "2", or "3"
In manual mode, these keys change the status of the digital outputs that are associated with them.

The keys can be associated with the digital output using the control panel on the Input/Output display.

To allocate a key for a digital output, select the output in the list of Inputs/Outputs on the control panel and then press the "**Shift**" key and the "1", "2", or "3" key at the same time. This operation may be inactive, depending on the user profile (see chapter 5.10.3).

6.2.5. MCP DISPLAY

The display is made up of three areas: (see figure 6.4)

Status bar
The status bar **(A)** gives the following information whatever the current navigation status:

- System activity indicator **(1)**. When the indicator is present on the status bar, the system is not available for the operator.
- Indicator showing the presence of new information messages **(2)**. Its presence shows that one or more new information messages have been stored in the events logger. This indicator always flashes and it remains active until the user has consulted the information.
- Entry indicator **(3)**. It flashes when a VAL3 application is awaiting an operator entry in the application page. It stays active as long as the application under consideration is active and until the entry is made.
- Operating indicator for the programmable logic controller **(PLC) (4)**.

s6.5
- Arm movement status indicator **(5)**. 'M' indicates arm movement, 'S' indicates a stop, '@' indicates, for manual movements, that the arm has reached its target position. The indicator is blank when there is no pending move.
- Arm movement speed indicator **(6)**. It is applicable to all the movements (manual and programmed).

The work page
The work page **(B)** is the part of the display screen located between the status bar and the menu sector. This page is used to exchange all the information concerning the current application (display, information windows, entries). The work page always has a title located on the line just below the status bar (see figure 6.4).

Menus
The menus **(C)** enable you to carry out a specific action for the element selected or the navigation page. To trigger the action, press the key located below the corresponding label.

> **Note:**
> *For ergonomic reasons and for certain interface elements, a default menu is defined (action associated with the menu most often used). This action can be triggered by pressing the* ***Return*** *or* ***End*** *keys, together with the corresponding menu key.*

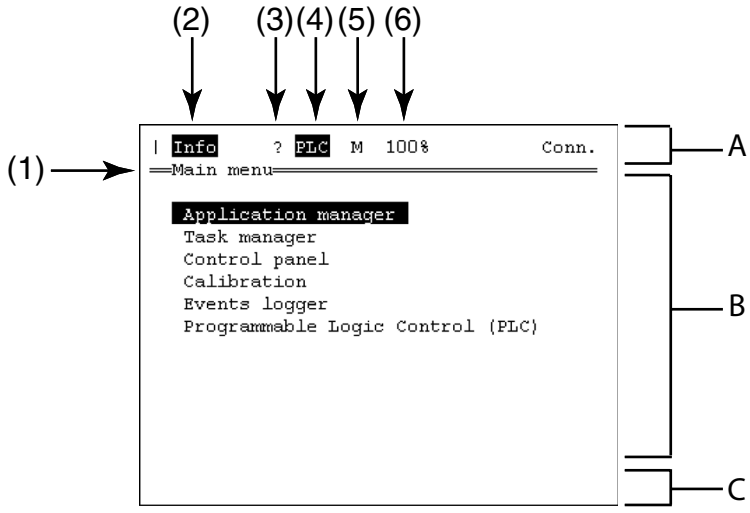


Figure 6.4

Entry boxes
Entry boxes are areas on the display via which the user communicates information to the system when the system requires it.

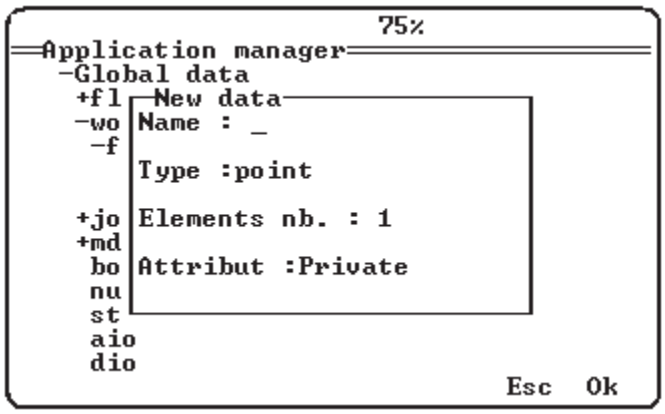


Figure 6.5

Press the **Return** key; this makes the cursor visible.

Modify the box (enter the information)

Validate the entry by pressing **Return** or cancel the modifications by pressing **Esc**.

Press the **OK** key on the menu to validate the display as shown, as a whole.

The **backspace** key enables you to delete the character to the left of the cursor.

Drop down lists.
When the information required by the system consists of a selection from a predefined list, the interface proposes a selection of all the possible values in the list.

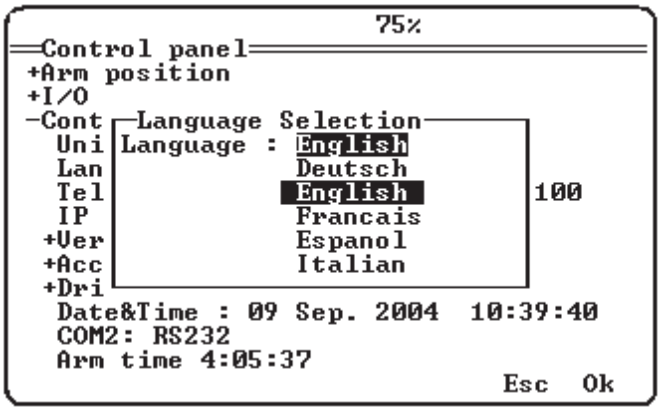


Figure 6.6

Press the **Return** key to display the list.

Use the **Pg up / Pg dn** keys or the lexical search to move around the list.

Validate the entry by pressing **Return** or cancel the modifications by pressing **Esc**.

Use the **OK** key in the pop-up menu to validate the entries displayed.

6.3. ARM POWER-UP

DANGER:

Before powering up the arm, make sure that the cell is completely free from obstructions and that there is no one within the work area of the robot. When power is switched on, the robot arm is liable to follow unforeseen trajectories.

DANGER:

Each time the arm is powered on, keep one hand close to the "Emergency stop" button in order to be able to press it as quickly as possible in the event of a problem.

Under normal operating conditions, the operating method is as follows:

Select the Manual Mode from the WMS front panel. The selected mode is displayed on WMS front panel and on the **MCP (1)**.
(see paragraph 6.2.1)

Press button **(3)** to switch the arm power on. This action is taken into account if the enable button **(2)** has been put into its middle position in the last 15 seconds or if the **MCP** has been placed on its holder in the last 15 seconds. If it is not possible to switch the arm power on, because the enable button was pressed more than 15 seconds previously, it is necessary to release it and then press it again.

If it is not possible to switch the arm power on because the **MCP** has been on its holder for more than 15 seconds, it is necessary to remove it and then put it back on its holder.

The button indicator light flashes for a few seconds and then comes on steadily; this means that the arm power has now been switched on and it is ready to carry out movements.

Press the button **(3)** again to switch the arm power off and apply the brakes. It is then necessary to repeat the procedure for switching the arm power on to make movements possible.

The power is also cut off if the enable button is released, if the **MCP** is removed from its holder, or if WMS key position is changed (working mode changed).

Figure 6.7

6.4. EMERGENCY STOP

CAUTION:

The emergency stop is not the normal method for stopping arm movements; it must only be used in a case of absolute necessity for a stop not provided for in your application.

An emergency stop leads to a sudden cut-off of power to the arm (and other equipements in the cell), which, if it is repeated too often, leads to damage and reduced motor service life.

When the emergency stop button is pressed, the power is removed from the arm and the brakes are applied. The other equipment in the cell is also cut off from the power supply (depending on the cell wiring).
Following an emergency stop, a specific procedure is required to restore power to the arm:

- The operator must leave the danger zone.
- The **MCP** must be resting on its holder, fixed permanently outside the cell (a contact inside the **MCP** enables this operation to be checked).

Restarting

DANGER:

When the robot is restarted, all persons are prohibited from remaining in the isolation area in which the arm moves.

Once those concerned have made certain that safety conditions have been restored, the arm power procedure can be carried out using the **MCP**.

Note:
*This operation must be carried out with the **MCP** on its holder when in manual mode.*

- Release the emergency stop button by turning it clockwise 1/4 turn.
- Restore power to the arm in accordance with the standard procedure, using the arm power button on the **MCP**.

DANGER:

If the MCP is not connected to the controller, it must not be left near the cell, because its emergency stop button no longer works.

6.5. CALIBRATION, ADJUSTMENT, RECOVERY

CAUTION:

Each time an adjustment or recovery procedure is done, the calibration of the arm has to be checked carefully to verify that the robot is able to move in its expected angular range and not more then that range. This verification has to be done at slow speed.

6.5.1. DEFINITIONS

Stäubli arms are **calibrated** in the factory, to determine the specific 'zero' arm position with maximum precision. Calibration quality is essential for arm accuracy, i.e. its ability to respect the required Cartesian positions.

If drive elements (motor, encoder) have been replaced, or in the event of mechanical slippage due to a shock, the specific "zero" arm position can be displaced on one or more joints: it is then necessary to **adjust** the joints to restore the arm's original precision.

If one or more axis have been displaced, there are simple procedures for resetting them, using pre-established reference positions. If more than two joints have been displaced, or if no reference positions are available, it is not possible to adjust the arm correctly and it is necessary to carry out a full readjustment procedure.

CAUTION:

It is important to provide for an adjustment procedure in the cell and define the associated reference positions beforehand.

The arm position at any given moment is shown by:

- The position measured for each motor (encoder).
- The "zero" resetting offsets
  These offsets are stored in the respective encoders of each motor. A backup is saved in the arm.cfx file of the controller, a copy of which is supplied on the CdRom delivered with each arm.

During start-up, if a zero offset from a motor encoder is different from the one in the arm.cfx file (f.i. replacement of the arm linked to the controller), it is necessary to determine which offset is correct. This is done in the recovery operation.

The motor encoder also stores a phase offset for the encoder-motor combination. In the same way as for the zero offsets, the motor phase offsets are saved in the arm.cfx file of the controller. During start-up, if a motor phase offset on a motor encoder is different from the one in the arm.cfx file, it is necessary to state which offset is correct, using the recovery operation.

6.5.2. RECOVERY PROCEDURE

The recovery application is accessed via the main menu on the MCP.

This is used to update arm or controller data if an inconsistency is detected between the data on a motor encoder and the data in arm.cfx file of the controller.

The procedure consists of determining which set of data is correct, using a series of questions:

- If you have simply replaced the arm linked to the controller, the arm.cfx file of the controller corresponds to the former arm. You can then use the recovery menu to update it.

CAUTION:

The arm.cfx file contains other specific data for the arm (modified software limits, factory marks, user marks) that are not updated during this operation. When replacing an arm, it is preferable to recover the arm.cfx file for the new arm and install it on the controller ("Imp" Import menu for the calibration application).

- If you have replaced a motor or an encoder, the maintenance procedure you followed should have updated the offsets on the motor encoder and in the arm.cfx file. The recovery menu thus invites you to repeat the procedure to deal with the problem.
- If you have not changed anything on the arm or the controller, the problem may be due to a faulty motor encoder (data loss) or a corrupt arm.cfx file on the controller. Check the contents of the arm.cfx file ("Exp" Export menu in the recovery application) and compare it with the original file. If it is corrupt, restore it from a backup, or using the recovery menu to simulate an arm replacement. If the file is correct, the fault may be the motor encoder, which can be reprogrammed using the recovery menu.

CAUTION:

The motor phase offsets for the encoders are critical, and if incorrect they can make a motor uncontrollable. Never update an encoder if you are not sure of the data.

6.5.3. ADJUSTMENT PROCEDURE

Before adjusting one or more joints on the robot, it is necessary to set the joints to a reference position beforehand, with the highest possible level of precision. The exact coordinates of the reference position must be determined in advance.

Sequence of operations:

- Select the reference position (press Return and then use the arrows).
- If the reference position has not been entered beforehand ("Here" menu), it is possible to enter its coordinates manually ("Edit" menu).
- Use the arrows to select the desired joint.
- Press 'Adj.' to carry out the adjustment process.
- Check that the arm has been reset correctly by moving to a known point at low speed.

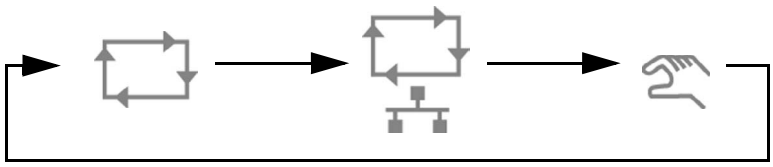
Once the axis has been reset, you will be asked to save the new adjustment offsets for the arm on an external device.

You can reset all 6axis at the same time by using the arrows to select the reference position instead of a joint.

6.6. WORKING MODES

Selection of Working Mode is made from WMS front panel. The 3-position keyswitch allows to choose one of the 3 modes (local, remote or manual). The selected mode is indicated on a light on the WMS front panel and on the **MCP**.

Depending on the application, it is possible that some working modes are not allowed according to the user profile (see chapter 5.10.3). In that case, neither the lights on WMS front panel, nor those on **MCP** are On. Another mode has to be selected from the 3-position keyswitch on the WMS front panel.



Local mode Remote mode Manual mode

6.6.1. MANUAL MODE

The manual mode is required in the following cases:

- Manual arm movements.

  The operator controls the arm movements using the **MCP**.

- Test/fine tuning of an application.

  In this case, it is a program that determines the arm movements.

The manual mode enables the robot to be moved at low speed (250 mm/s maximum).
Jog interface is made using the movement keys (see paragraph 6.7).

Program movements are only carried out if the **Move / Hold** key has been pressed. The movements stop as soon as the key is released (see paragraph 6.2.2).

Power is only maintained on the arm if the enable button is kept pressed down to its intermediate position or if the **MCP** is resting on its holder (see paragraph 6.2.1).

When the manual mode is selected, the other modes are disabled and the movements cannot be initiated via outside equipment.

6.6.2. LOCAL MODE

The local mode enables the robot to be moved without any human intervention at the maximum speed defined for the application. The movements are the result of a scenario written in a program.

> ⚠ **DANGER:**
>
> **When the robot is in local mode, all persons are prohibited from remaining inside the isolation area in which the arm moves.**

The robot is only operational when the following conditions are combined:

- The arm is powered up.
- A movement application has been loaded in the memory and is being executed.

The movement order is given via the **MCP** using the **Move / Hold** key (see paragraph 6.2.2).

The arm movements are controlled exclusively by the application.

Only the operator can only stop or start the movement and adjust the running speed using the "+/-" key.

6.6.3. REMOTE MODE

The remote mode operates in a similar way to the local mode.
The differences are as follows:

- The arm is powered on via an external system (controller, external **MCP**) on the VAL3 system signal, or using the **enablePower** instruction (see the VAL3 language reference manual).
- The **Move / Hold** movement order can be generated automatically as soon as the arm power has been turned on (see the **autoConnectMove** instruction in the VAL3 language reference manual).
- The **Move / Hold** button may be deactivated depending on the user profile.
- The power cut-off button may be deactivated depending on the user profile (see chapter 5.10.3).

The **enablePower** system signal must be configured beforehand to enable it to be linked to a digital input (see chapter 5.10).

- To connect the arm to the power supply, turn on the **enablePower** signal for 200ms
- Turn on the **enablePower** signal again to cut off the power supply to the arm

DANGER:

When the robot is in remote mode, all persons are prohibited from remaining inside the isolation area in which the arm moves.

6.7. JOG INTERFACE

6.7.1. PRESENTATION

The jog interface is a utility dedicated to the manual control of robot movements and the teaching of robot positions.

When arm power is disabled, the jog interface can be accessed by pressing a movement mode selection key (**Joint**, **Frame**, **Tool** or **Point**), whatever the current robot working mode. When arm power is enabled, the jog interface can be accessed with the same keys, but only in manual mode.

The jog interface displays the context of the movement under manual control. This context is important to avoid unexpected movements. Therefore when the jog interface is exited, the movement mode is also reset automatically. It is however possible to exit the jog interface while keeping the movement mode active by pressing Shift-Esc.

Figure 6.8

- To select manual mode, turn the 3 position keyswitch to the appropriate position. The selected mode is indicated both on WMS front panel and on **MCP (1)**.

Manual mode icon

- Carry out the procedures for switching on power in manual mode (see paragraph 6.3).
- Select the movement mode (**Joint**, **Frame**, **Tool**, or **Point**) ; the corresponding indicator light **(4)** comes on.
- Press one of the movement keys (5 or 6) or, in **Point** mode, press the **Move / Hold** key.

Note:
In manual mode, the speed of movement is limited to 250 mm/s.

When one of the movement modes is selected, the jog interface page is shown automatically on the **MCP** display (see figure 6.9).
To exit the page, press the **Esc** key. To return to the page, select a movement mode (**Joint**, **Frame**, **Tool**, **Point**).

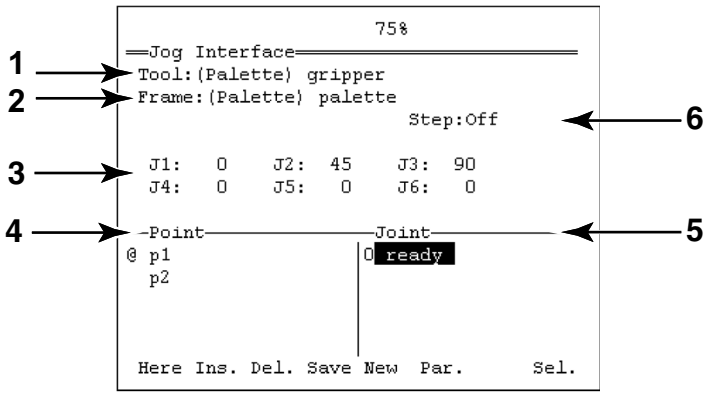


Figure 6.9

Description of the jog interface page
(see figure 6.9)

Whatever the movement mode selected, this page enables you to see:

- The current tool **(1)**.
- The current frame **(2)**.
- The current position depending on the movement mode selected **(3)**.
- In the **Joint**, **Frame** and **Tool** modes, a list of the Cartesian points for the current frame **(4)**.
- In the **Point** mode, a list of all the Cartesian points for the application **(4)**.
- A list of the points for the joints **(5)**.

s6.5 • For joint positions and cartesian points, a position marker may preceed the name of the data:
  - '@' indicates that the robot is exactly at the position.
  - '~' indicates that the robot is near the position.
  - '0' indicates that the position is null.
  - '!' indicates that the position is not reachable with the current tool.

s6.5 • The step mode **(6)**, and, if enabled, the current step size. When the step mode is active, each manual movement is a step of the specified size (in mm or degree). The step size can be easily modified by using the < and > keys. It is also possible to move of several steps in one movement by pressing quickly several times the jog key. By pressing 3 times the jog key, the robot performs a step of 3 times the initial step distance. The display of the step size is updated with each key strike, and is reset to its default value when the movement is completed.

Menus
(see figure 6.9)

- **Sel.** (Selection) menu
  This menu displays a window in which it is possible to select the current tool and the current frame in the application data list.

s6.5 • **Par.** (parameters) menu
  This menu is used to edit the manual movement parameters (step mode and step size).

- **Here** menu
  This menu is used for teaching points. By pressing the key, you can modify the position of the point selected. A confirmation window is then used to validate the selection.

- **New** menu
  This is used to create a new data or Cartesian variable. A confirmation window enables you to give the variable a name and validate it.

- **Save** menu
  Used to save the application.

- **Ins. & Del.** Menu
  Enables you to insert a new element in a table, delete an element from the table, or delete a variable.

6.7.2. MOVEMENT IN JOINT MODE (JOINT)

After the arm has been powered up, press the **Joint** button **(1)** on the **MCP**. The corresponding indicator light comes on.

The keys **(3)** enable you to carry out movements in joint (**Joint**) mode for the various axis (1, 2, 3, etc.). These movements are carried out in the positive direction (set of keys with the "+" sign) or the negative direction (set of keys with the "-" sign). It is possible to move several axis at once. Only the indicator light for the last joint key pressed (+ or -) and the minijog indicator light then come on.

If one of the **SEL** keys on the minijog **(4)** is pressed, the joint number selected changes and the corresponding indicator light comes on in the set of keys **(3)**.

If one of the "+/-" keys on the minijog is pressed, the joint selected moves.

Note:
*When the **Joint** mode has been selected, only the yellow indications are to be taken into account in the set of movement keys **(2 - 3 - 4)**. The black indications (X, Y, Z) are reserved for the other movement modes.*

Figure 6.10

6.7.3. MOVEMENT IN CARTESIAN MODE (FRAME, TOOL)

After the arm has been powered up, press the **Frame** button **(1)** on the **MCP**. The corresponding indicator light comes on.

Figure 6.11

By pressing the keys in the set of movement keys **(2)** or one of the **Sel** keys on the minijog **(5)**, it is possible to carry out movements along the three axis of the current coordinate system (**Frame** as default setting). These movements are carried out in the positive direction (set of keys with the "+" sign) or the negative direction (set of keys with the "-" sign).

The movements can be made in translation and rotation:
(see figures 6.12, 6.13, 6.14)

- In Translation (X, Y, Z keys):

  A movement in the direction of the X axis is called X+, and a movement in the opposite direction to the X axis is called X- (the same is the case for the Y and Z axes).

- In Rotation (RX, RY and RZ keys):

  Rotation around the X axis in the direction of X+ is called RX+, and a rotation in the opposite direction from the X axis is called RX- (the same is the case for the Y and Z axes).

Specific case (Arm RS):
RZ rotation is only possible if the Z axis of the current position coincides with the Z axis of the World mark. RX and RY rotations are without any effect.

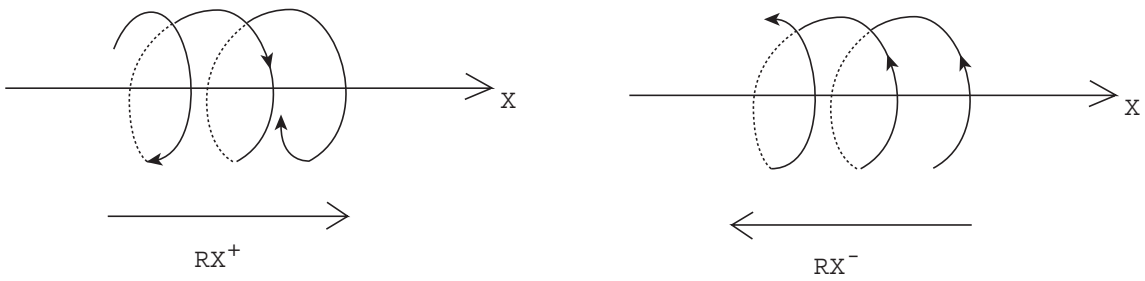
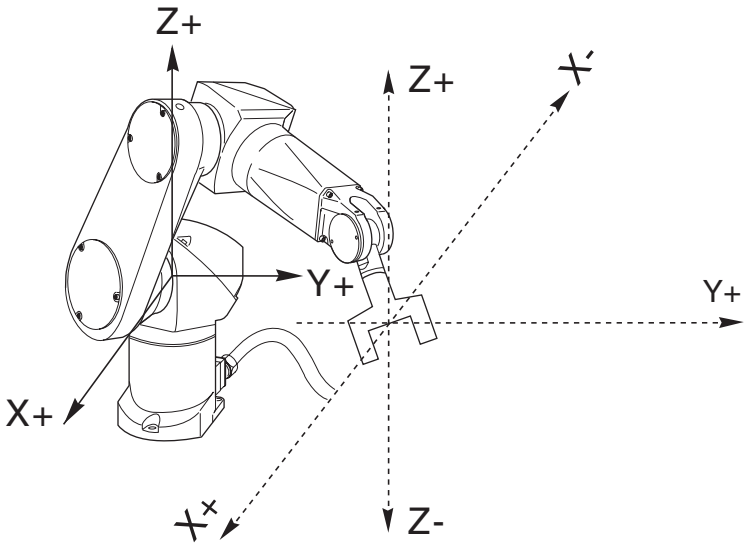
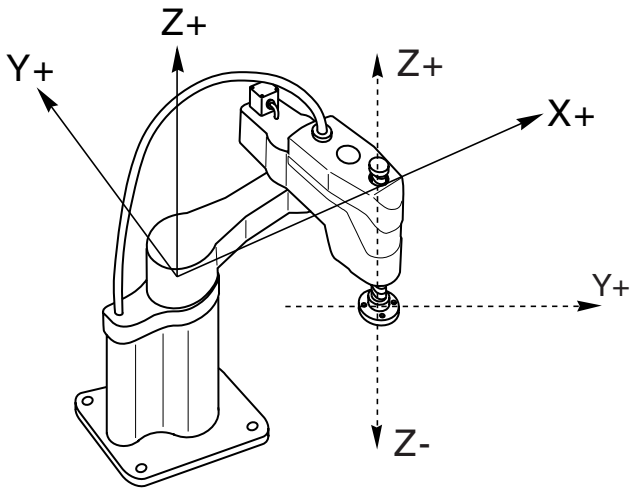


Figure 6.12

If the **Tool** key **(3)** has been pressed, the movements are made parallel to the axis of the current tool (**Flange** as default setting).



6.13



6.14

6.7.4. MOVEMENTS IN POINT MODE

The **POINT** mode is used for movements to a point of the application. To display the points of an application, you will first be asked to select a tool in that application.

When the **POINT** movement mode is selected, the display shows:

- The active movement mode **(1)**:
  - **Line** mode, the movements towards the target are made in a straight line.
  - **Joint** mode, the movements are made from point to point.
  - **Align** mode, the Z axis of the tool is lined up with the closest axis to the current marker. The end of the tool rotates without translation.
- The approach parameters **(2)**. The approach can be inactive **(OFF)** or active **(ON**).

s6.5 • The current step mode **(3)**, and, if enabled, the current step size. When the step mode is active, each manual movement is a step of the specified size (in mm or degree). The step size can be easily modified by using the < and > keys.

Further menu keys are dealt with in **Point** mode:

- **Mode** key

  This key enables you to switch successively from **Joint** mode to **Line** mode, on to **Align** mode and then back to **Joint** mode.

- **Par.** (parameters) key

  This key calls up a window in which it is possible to configure the approach and the step parameters for the movement. The approach can be specified along X, Y, Z, RX, RY and RZ.

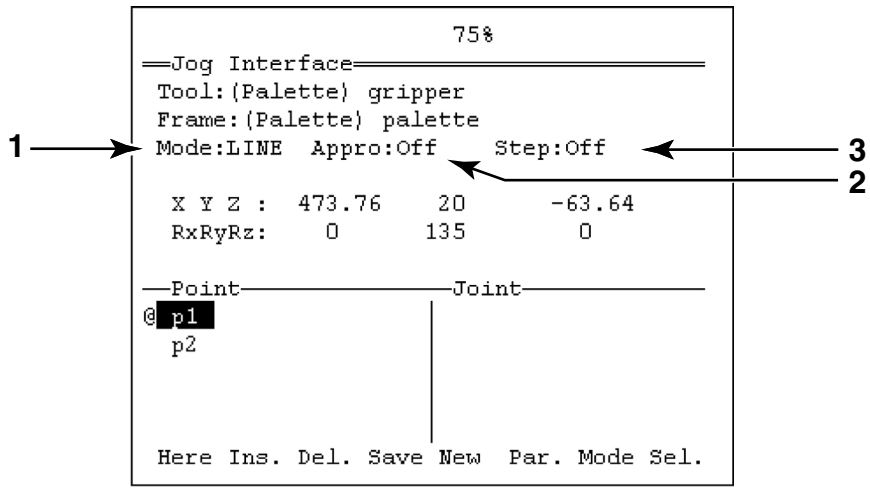


Figure 6.15

The minijog indicator light **(5)** and that of the last axis selected **(2)** remain off in this mode. Nothing happens when the keys of the minijog**(5)** or the movement keys **(2)** are pressed.

6.8. STARTING AN APPLICATION

6.8.1. STARTING UP IN LOCAL MODE

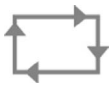
The local mode is the mode most commonly used in production.

> **DANGER:**
>
> **In local mode, the robot arm makes high speed movements. These movements can be dangerous. Always comply with the safety standards recommended for robot use and inform operators about the dangers faced.**

> **DANGER:**
>
> **If an application has been configured in "Automatic start" mode, it starts as soon as the controller is powered up.**

Once the application has been opened:

- Turn the 3-position keyswitch to the appropriate position. The selected mode is indicated both on WMS front panel and on **MCP (1)**.



Local mode icon

- Carry out the powering up validation procedure in manual mode (see paragraph 6.3).

  When the powering up process has been completed, the button comes on steadily.
- To start the application, press the Run key.

Run key

- Command the movement by pressing the **Move / Hold** key

Move / Hold key

6.8.2. STARTING UP IN MANUAL MODE

Once the application has been opened: (see paragraph 6.10.1)

- Turn the 3-position keyswitch to the appropriate position. The selected mode is indicated both on WMS front panel and on **MCP (1)**.

Manual mode icon

- Keep the validation button in its intermediate position or place the **MCP** on its holder (see paragraph 6.2.1).
- Switch the arm power on by pressing the arm power button.
- To start the application, press the **Run** key.

Run key

- Command the movement by pressing the **Move / Hold** key

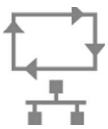
Move / Hold key

6.8.3. STARTING UP IN REMOTE MODE

In remote mode, the arm is powered up by an external system (external **MCP**, automatic controller) via a dedicated digital input. The arm can also be powered up using the **EnablePower** instruction (see the Reference Manual for the **VAL3** language).

Once the application has been opened: (see paragraph 6.10.1)

- Turn the 3-position keyswitch to the appropriate position. The selected mode is indicated both on WMS front panel and on **MCP (1)**.



Remote mode icon

- To start the application, press the Run key.

Run key

6.9. STOPPING MOVEMENTS

When the robot is carrying out programmed movements, it is always possible to stop them, using the **MCP**. Depending on the stop mode selected by the user, the system can adopt several types of behaviour.

6.9.1. STOPPING/STARTING MOVEMENTS USING THE MOVE / HOLD KEY

Move / Hold key

- In manual mode, the arm movements are activated when the **Move / Hold** key is pressed. As soon as the key is released, the arm stops immediately on the programmed trajectory.
- In local and remote modes, the movements can be stopped and the robot set to pause mode, by pressing the **Move / Hold** key. Press the key again to reactivate the movements.
- In remote mode, the **Move / Hold** key may be inactive depending on the user profile (see chapter 5.10.3).

Movements on restarting
When programmed movements are stopped by pressing the **Move / Hold** key or during an arm power failure,the system memorizes a stopping point.
When movements are restarted, the arm goes back to the stopping point using point to point movement, at a speed limited to 250 mm/s.
The restarting movement is commanded by pressing the **Move / Hold** key in local and manual modes. The restarting movement can be automatic in "Remote" mode.

> **Note:**
> *The **Move / Hold** key does not stop the current application, it simply suspends the arm movements. The robot is then in pause mode.*

Stopping using the powering up/ power switch-off button
When switching off the power (See paragraph 6.3), the movements are first suspended as with the **Move / Hold** key, and then the system applies the brakes and cuts off the power supply to the arm. To restart movements, follow the particular procedure for the working mode selected (see paragraph 6.3).

> **Note:**
> *The arm power can be switched off via the **MCP** in all the working modes.*

6.9.2. STOPPING/STARTING MOVEMENTS USING THE STOP KEY

Stop key

To stop the current application, press the **Stop** key and validate using the **OK** key in the pop-up menu. This key may be inactive depending on the user profile (see chapter 5.10.3).

To restart, press the **Run** key; the controller restarts the application from the beginning.

Run key

Note:
Depending on the type of application, the arm may continue to move until it has finished the current cycle.

6.9.3. STOPPING MOVEMENTS VIA THE EMERGENCY STOP BUTTON

(see paragraph 6.4)

During an emergency stop, the standard imposes a fast cut-off of the arm power supply, which may lead to a less efficient control of the trajectory than that obtained using the power supply cut-off button. This means that the emergency stop must not be used as a normal method for stopping the robot or switching off the power supply to the arm.

Once those concerned have made certain that safety conditions have been restored, the arm power procedure can be carried out using the **MCP**.

Note:
This operation must be carried out with the MCP on its holder (outside the cell) in manual mode.

6.10. VAL3 APPLICATION MANAGER

6.10.1. OPERATIONS CONCERNING APPLICATIONS

The application manager can be accessed via the main menu.
In the application manager, the **New** menu enables you to create a new application and to give its storage location (hard disk, USB key).

An application contains:
(see figure 6.16)
- The libraries **(1)**
  The **io** library is necessary to use the controller Inputs/Outputs.
- The global variables **(2)**
  The global datas for the application are classified according to type (see the Reference Manual for the **VAL3** language). The **Tool** type variables are to be found under the **Flange** variable. The **Frame, Point** type variables are to be found under the **World** variable.
- The progams **(3)**
  - The **Start** program that is called up by the system when the application starts up.
  - The **Stop** program that is called up by the system when the application stops.

  These two programs do not have any parameters, and they cannot be deleted or renamed.

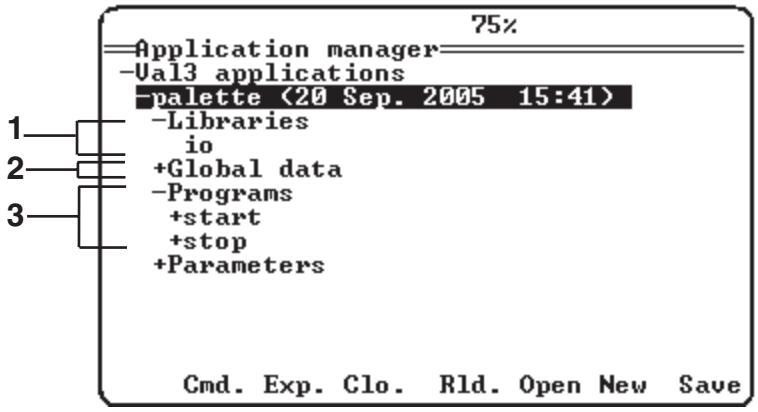


Figure 6.16

Opening an existing application
- Press the **Open** key in the pop-up menu
- Select the application
- Press the **Ok** key in the pop-up menu

Closing an application
This action is only possible in the applications opening page.

- Select the application and then press the **Clo.** key in the pop-up menu.

  If there are modifications under way that have not been backed up, a confirmation window can be used to record or delete the modifications.

Deleting an application
This action is only possible via the opening page of the application.

- Press the **Del.** key in the pop-up menu.
  This operation is irreversible; it is preceded by a confirmation window.

Reloading an application
When the files on disk of an opened application have been modified through the network, it is possible to quickly update the application in memory by using the menu Rld. (Reload). This action is equivalent to the closing / re-opening of the application.

Opening mode for an application
Behaviour for applications when the controller is started up can be configured in the application selection window.

Three types of behaviour can be selected by pressing the **Mode** contextual menu key:

- Manual: No action on the application.
- Autoload: The application is opened automatically.
- Autostart: The application is opened and then started up automatically.

> **Note:**
> *It is not possible to apply the "Autostart" mode to more than one application at a time.*

Saving a VAL3 application
The **Save** pop-up menu enables you to save the **VAL3** application in full in its original location.

All the information is saved as soon as the key has been pressed:

- The global datas and their current value.
- The application programs.
- The configuration data for the application.

During the saving process, the system is not available and the system activity indicator is displayed on the status bar.

Exporting a VAL3 application
To save the application under another name or in another storage location, use the **Exp.** menu.

Online commands
The **Cmd.** menu provides access to an online command enabling you to display the variable values (using the "?") and execute a **VAL3** instruction line.

> **CAUTION:**
> **The use of an online command during execution of a program may modify its behaviour.**

6.10.2. MODIFYING AN APPLICATION

Library, data, program creation and edition

- To declare a new library, go to the library mode of the application, press the **Add** key in the pop-up menu, then select the library to load and enter the corresponding identifier for the project.
- To create a new data, select the type of variable and press the **New** key in the pop-up menu.
- To add a frame or a point in a frame, go to it and press the **New** key in the pop-up menu.
- To add a tool, go to a tool and press the **New** key in the pop-up menu.

For further information on modifying programs, consult the Reference Manual for the **VAL3** language.

> **Note:**
> *It is not possible to delete a variable, a program, a point or a tool if they are used in a program. It is not possible to add a parameter or a local variable to a program if the application is active.*

Program editor

The **VAL3** program editor can be accessed via the list of programs in the application manager; it enables you to modify programs (to insert, delete, or modify an instruction).

Each instruction added to the editor is checked. If it is not valid, an error message is displayed and the instruction is refused. In the event of an error, see the reference manual for VAL3 language to correct the instruction concerned.

The editor proposes a program tree, which means that the instructions set up (if, while, for) are displayed in the form of a node that can be expanded or contracted.

Example:

COLLAPSED	EXPANDED

+ if nb>12	- if nb>12
	  - switch nb
	  - case 5
	  break
	  + case 7
	  endSwitch
	else
	  put("error")
	endif

The editor makes sure at all times that the program is coherent. This means that when a compound statement (if, while, for …) is deleted, the corresponding instruction is deleted.

Example:

if nb>0
put("True")
else
put("false")
endif
	Removal of if	put("True")
		put("false")

if nb>0
put("True")
else
put("false")
endif
	Removal of else	if nb>0
		put("True")
		put("false")
		endif

It is possible to mark instructions in order to globalize certain actions (copy, delete).

- If a composite statement is selected, all the instructions between the start and the end are also selected.
- Deselection of a composite statement deselects only that statement.

This means, for example, that to mark all the instructions contained between a "while" and an "endWhile", all that has to be done is to mark " While" twice.

Example:

while put ("Press any key") get() endwhile	**Selection of "While" or "endWhile".** All the instructions are selected and the selection goes after "endWhile"	# while **#** put ("Press any key") # get() # endwhile
# while **#** put ("Press any key") # get() # endwhile	**Deselection of "While" or "endWhile".** Automatic deselection of "While" and "endWhile"	while **#** put ("Press any key") # get() endWhile

There is a clipboard enabling you to copy instructions. Make sure that the instructions are valid in the program in which they are pasted. Be careful with the local variables!

When adding or modifying an instruction, a list of menus makes it easier to enter. (see figure 6.17)

- **His.** enables you to select an instruction in the list of the last 20 instructions entered.
- **Loc.** enables you to search for or create a local variable or a parameter.
- **I/O** enables you to select an Input/Output.
- **Prg.** enables you to select or create a new program.
- **Glo.** enables you to select or create a global variable.
- **VAL3** enables you to select an instruction in the list of **VAL3** instructions.

It is possible to insert a breaking point in an instruction (see paragraph 6.10.3).
To exit, press the **Esc** key.

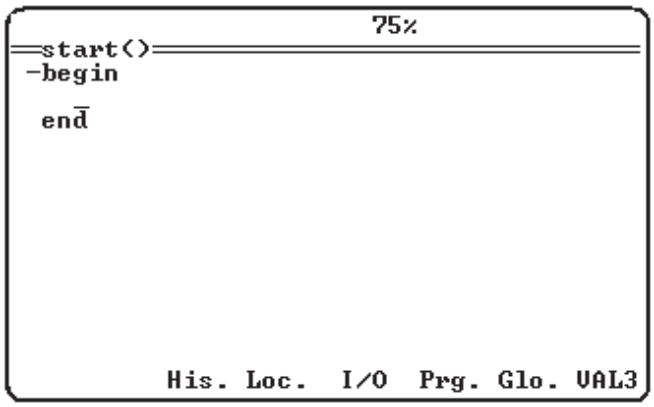


Figure 6.17

6.10.3. DEBUGGING AN APPLICATION

The **VAL3** task manager (accessible via the main menu) provides access to a debugging program that supplies the tools necessary to fine-tune tasks.
To access the debugging program, select a task and press the **Dbg** key in the pop-up menu. When the debugging session starts, the task selected is suspended immediately and a display page is opened (see figure 6.19).
In the debugging page, the ">" program pointer**(1)** shows the next instruction to be carried out.

- The **Bpts** menu enables you to associate a break point **(2)** with an instruction, via a window, or to delete a break point that has already been positioned. The stopping point is shown by the * icon opposite the instruction concerned.
- The ; menu enables you to add the selected instruction as a comment.
- The **Data** menu provides access to the variables for the instruction selected.
- The **->** * menu enables you to move the task pointer **(1)**; this action does not execute any instructions.
- The {} * menu activates the step-by-step mode. In this mode, the program is executed as it is shown in the display (per display line).
- The { * } menu activates the detailed step-by-step mode. In this mode, each step is equal to a VAL3 instruction and the sets of instructions (if, while…) are expanded.
- The **Rsm./Sus.** menu enables you to suspend and restart execution of the task without exiting the debugging program.
- The **Save** menu enables you to save the application.

To exit the debugging page, press the **Esc** key.

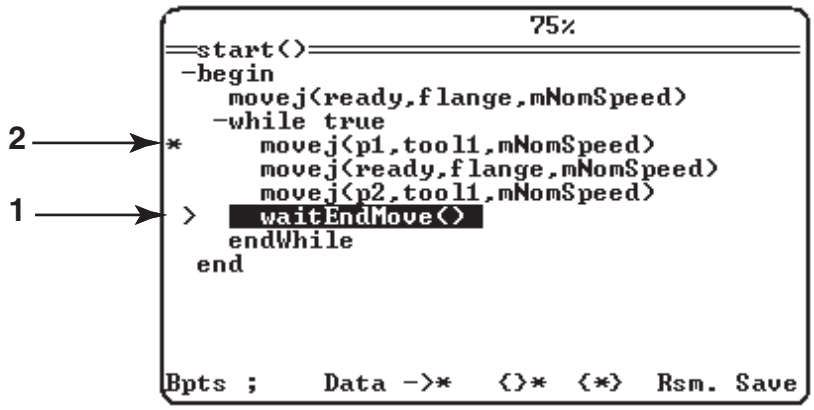


Figure 6.18

6.10.4. METHODS FOR DIAGNOSIS

System events
System events can be shown in several ways in the **MCP** display:

- **By showing a window with an explanatory message in natural language concerning the system error or event.**
- By a history, which provides access to the last 100 system events classified in chronological order with their date and time. The messages are stored in the events logger that is accessible via the main menu.
- By showing the "information" indicator in the status bar. This shows that a new event has been added to the history without opening a window to warn the user. The "information" indicator is removed when the user has consulted the events list.
- By showing the "information" indicator in the status bar. This shows that a **VAL3** application is awaiting an operator entry in the application page. It stays active as long as the application under consideration is active and until the entry is made.

Task status
The **VAL3** task manager is accessible via the main menu and it can be used to display a list of tasks and their status (for further information concerning errors, press the **Help** key).

Input/Output status
To display the Input/Output statuses, select the "I/O" branch in the control panel accessible via the main menu (see paragraph 6.2.5).
This branch is used to display the status of the Inputs/Outputs of the controller boards defined in the system (**RSI**, **BIO** boards, field buses, **Modbus TCP**).

Indicator lights for system boards
To find out the meanings of the indicator lights for the **RSI** board and the other system boards (see chapter 8).

Examples of frequent events and means of diagnosis

EVENT	DIAGNOSIS
 **In spite of starting up the application using the "Run" key, the robot does not move.**	• Check the indicator light associated with the **"Move / Hold"** key. • Check that the task has not been suspended using a stopping point (see paragraph 6.10.3). • Check that the task is not in error (the Task manager is accessible via the main menu). • Check that the application is not in waiting mode (? icon in the status bar, see paragraph 6.2.5).
The application has started, but nothing is shown on the LED display.	The information shown for a **VAL3** program can only be seen via the user page (see paragraph 6.2.5). See also the **"userPage"** instruction in the Reference Manual for the **VAL3** language.
A page is displayed automatically each time a movement mode is selected.	This jog interface management page is indeed displayed each time the movement mode is changed (see paragraph 6.6). To return to the previous page, press the**"Esc"** key.
The fact of pressing the "Rsm." (Resume) pull-down menu key for a task does not have any effect.	• Check whether the task is in error status. • Check whether the task has been stopped at a break point. If this is the case, delete the break point or use the **Rsm.** menu via the debugging program (see paragraph 6.10.3).

EVENT	DIAGNOSIS
The robot does not go to the right place	If the robot does not carry out the movements as programmed when the **"Move / Hold"** key is pressed: • check whether the controller is in **"Point"** manual mode (associated indicator light on); in this case the robot moves to the last point selected for a jog interface. To return to the programmed movements, exit the **"Point"** mode (see paragraph 6.6).
 **When an application is stopped using the "Stop" key, the "Run" indicator light stays on.**	There must be a task still being debugged. • Exit the debugging program, and then kill the task in the task manager.
 **When the "1" or "2" keys are pressed, the solenoid valves are not switched.**	• Check that these keys have not been assigned to other outputs.

6.11. TEACHING FRAMES

This paragraph constitutes a frame teaching procedure using the three-point method.

This method enables you to define the orientation of the new frame in a precise way by recording three points:

- The frame origin (O)
- A point (Ox) located on the X axis of the frame on the positive x side
- A point (Oxy) on the plane formed by the X and Y axis on the positive y side

The method used is as follows:

- After creating a new **Frame** type data, use the **Teac** key in the menu to call up a "Teaching" display (see figure 6.19).
- Position the point of the robot tool at the desired point of origin using jog interfaces and press the **Here** key in the pop-up menu.
- Repeat the operation for "X axis" and "Y axis" and then validate the orientation of the new frame **(1)**.
- Save the modifications.

The frame coordinates are displayed in the box **(2)**.
The point values and marker orientations can be modified using the **Edit** menu.

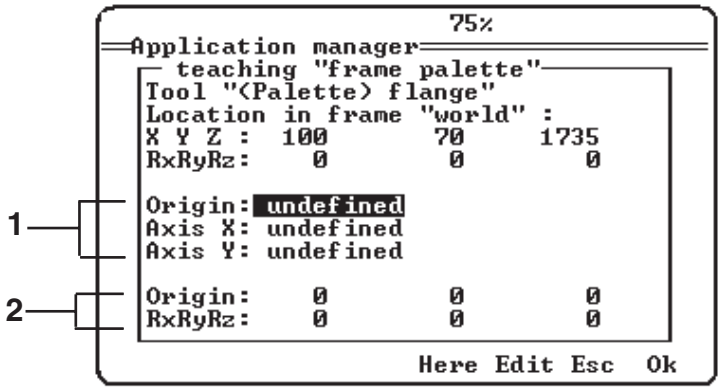


Figure 6.19

6.12. TEACHING POINTS

Teaching points, the method used is as follows:

- Create a new data of **"point"** type.
- Use the **Here** pop-up menu to call up the "Teaching p1" display (see figure 6.9).
- Move the tool to the location and position where the teaching is to be done.
- Validate the position using the **"Ok"** key in the pop-up menu.
- Save the modifications.

The "Configuration" box **(1)** can be filled in in two ways:

- "**No**": The point configuration remains unchanged.
- "**Yes**": The point is taught with the current arm configuration (see the "Reference Manual for VAL3 language").

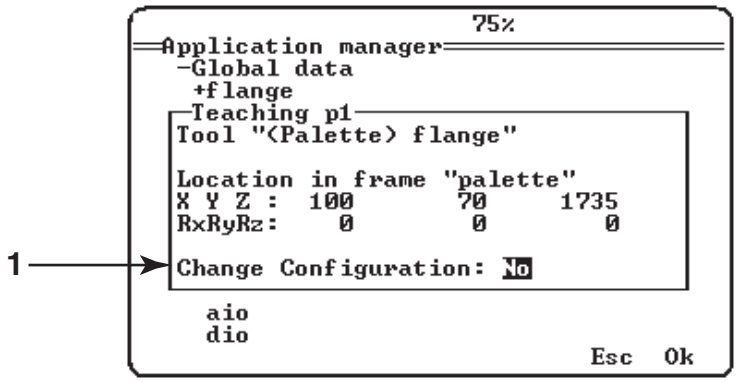


Figure 6.20

6.13. MOTION DESCRIPTOR EDITOR

When editing a motion descriptor in the application manager, a simplified view is displayed where only speed and blending type can be modified. The ">>" menu gives access to the advanced interface where all motion descriptor parameters can be modified.

A change in the velocity parameter of the simplified interface modifies both the joint velocity and joint acceleration/deceleration, so that the arm behavior remains harmonious. The accel and decel parameters should indeed be roughly the square of the vel parameter. For instance, a velocity of 120% = 1.2 is best adapted with accel and decel of 1.2 x 1.2 = 1.44 = 144%. Higher values for accel and decel give a more aggressive, but shakier arm behaviour.

When the accel and decel parameters are modified in the advanced interface, this relation with the velocity parameter may not be effective any more. In that case, when the simplified interface is displayed with the "<<" menu, the speed parameter is displayed as "User". It can still be edited to recover the default relation between joint velocity and acceleration/deceleration.

6.14. CONTROLLER BACKUP

A complete system backup on network (to a Ftp server) or on USB can be done from the Control Panel utility ('Bkup' menu on the Controller configuration node).

The backup takes several minutes, its duration depends on the number of user application files.

CHAPTER 7

PC UTILITIES

7.1. STÄUBLI ROBOTICS STUDIO (SRS)

SRS is the Stäubli software package containing all the tools available to develop and maintain a robotics application.

7.1.1. INSTALLATION

SRS is supplied on a specific CdRom. Execute **setup.exe**.

7.1.2. FUNCTIONALITIES

The **SRS** functionalities are set out below. Some of them require a "USB dongle" for activation.

CS8C emulator
Used for full emulation of a **CS8C** controller and for configuration.

Transfer
Used for easy transfer of a **VAL3** application or input/output files to or from a **CS8C** via Ethernet communication:
- Used to proceed a full backup of a **CS8C**.

Configuration tools
These various tools can be used to:
- Modify the **CS8C** controller options (activation or demonstration mode)
- Modify **SRS** options
- Editing user profiles
- Emulator configuration
- Conversion of **VAL3** applications from **s3.0** format to **s4.0** format

VAL3 Studio option (demonstration version available)
Enables editing of **VAL3** applications with an advanced editor. The editor deals with the variables, the programs and the libraries. It includes a syntax checking system that can be used to check the applications at any time. The tool is supplied in demonstation form. It includes all the functionalities except saving.

PLC option (demonstration version available)
See chapter 5.7

Remote maintenance option (no demonstration version)
Enables work to be carried out remotely on a **CS8C** controller. The tool acts in the same way as a remote **MCP**, on which the following keys are inactive:
- Working mode
- Power on
- Move / Hold
- Run
- Stop
- Monitor speed (+ / -)
- Activation of digital outputs (1 / 2 / 3)
- Manual movement mode (Joint / Frame / Tool / Point)
- Jog interface

To log on remotely, it is necessary to give:
- The **IP** address of the controller
- The connecting port (800 by default). This **TCP** port can be modified in the **CS8C** control panel.
- A user profile
- The Ftp password for the user profile

The connection is refused if the profile has not been defined on the **CS8C** or if the wrong password is entered.

7.2. FTP ACCESS FROM A PC

This action enables you to download **VAL3** applications from a **PC** to a controller and update certain configuration files that are accessible to users.

7.2.1. FTP CLIENT

A FTP client is accessible using Windows (95, 98, NT, 2000, XP). To set up a connection:

- Open an online command session and enter: **ftp w.x.y.z** (w x y z corresponds to the IP address of the controller) (see chapter 5.8 Ethernet link).
- Then when the **"User"** prompt is displayed, enter the name of a user profile, and when the password prompt is displayed, enter the network password for the profile (see chapter 5.10.3).
- Go to the **USR** reader using the **cd /usr** command and then carry out the desired actions.

Note:
*The freeware "**Ftp surfer**" is supplied with the robot CD ROM.*

7.2.2. IP ADDRESS CONFIGURATION

The IP address of the controller is configured via the control panel. This is accessible via the main menu. The IP address is in the controller node (see chapter 5.8).

7.2.3. FUNCTIONS VIA FTP

All the information available for the user is on the disk called **"usr"**.

Updating the configuration file:
Using a FTP client.
Connect up to the controller and go to the **/usr/configs** directory.
The files enabling login user configuration of the controller are as follows:

- "**arm.cfx**" contains the configuration concerning the arm (recovery, marks). This file is only accessible for a backup prior to maintenance.
- "**cell.cfx**" contains the configuration linked to the cell (language, max. Cartesian speed, etc...).
- "**network.cfx**" contains the network configuration of the controller (IP address, systemp TCP ports, gateways...).
- "**controller.cf**" contains the controller configuration.
- "**ep.cf**" contains the configuration linked to the (autostart, autoload) applications.
- **bio.cfx, bio2.cfx, mio.cfx, sio.cfx, can.cfx, encoder.cfx, cio.cfx, asi.cfx** contain the Input/Output configurations.
- **plc.cfx** contains the configuration of the **PLC** program

DANGER:

All ill-considered modifications made to the configuration can lead to bodily injury or serious material damage.

7.3. FTP ACCESS TO A PC

This function enables centralization of the **VAL3** applications on a PC (backup on a CD, just one storage location, etc).

To do so, it is necessary for an **FTP** server to be executed on the **PC** to share a directory containing the **VAL3** applications. Stäubli supplies the free Cesar FTP server enabling this functionality but cannot be held responsible in the event of incorrect use of the software. To install the server, see paragraph 7.3.1.

Configuration of an FTP node on the MCP
On the home page of the application, press the key of the **"Ftp"** pop-up menu to move on to the next page:

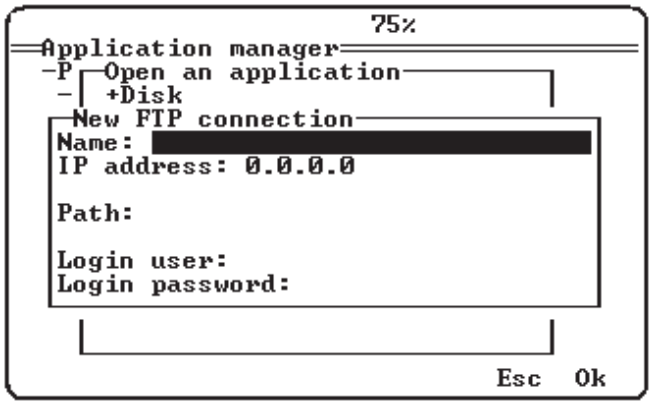


Figure 7.1

- The name enables you to give the FTP connection a name.
- The IP address corresponds to the IP address of the PC on which the FTP server is executed.
- The path corresponds to the shared directory on the FTP server. With Cesar FTP, if the shared directory is **c:\temp\VAL3\apps**, enter only **\apps**.
- The user corresponds to the user name created on the FTP server
- The login password must correspond to the FTP user password (Be careful with upper and lower case letters).

Once the parameters have been entered, validate the page using **"OK"**. In the applications opening page, there is now a new node corresponding to the FTP server that has just been created. The applications that can be seen in this node are used in the same way as local VAL3 applications.

> **Note:**
> *To enable a backup of the applications, the Ftp connection must be conserved. However, it is not necessary to run the application.*

7.3.1. INSTALLING CESAR FTP

This paragraph does not set out to explain the FTP connections, it simply supplies a guide to installing the software and creating the login user account.

- Execute the CesarFTP.exe file to be found on the robot CD-ROM and follow the installation instructions.
- Once the software has been installed, create a new user.
- In the user creation window, add the sharing of the directory containing the **VAL3** applications (**File Access Right** button). To add it, drag and drop the directory onto the user.
- Select the default directory by right clicking and then **"set as default"**.
- Close the files window, and validate the new login user.

> **Note:**
> *For further information, see the software documentation.*

CHAPTER 8

MAINTENANCE

8.1. HOW TO USE THIS MANUAL ?

8.1.1. SAFETY RECOMMENDATIONS

The recommendations for safety are found in the chapter 3 "Safety". They have to be read and understood. In case of doubt or incomprehension, contact the STÄUBLI technical support. Refer to the service organization label inside the controller.

Even if it is not specified at every step of trouble shooting, each component change or component disconnection has to be made with the main switch of the **CS8C** in the 0 position (off).

Some of the diagnostic steps require to power to be turned on or off. Do not forget to turn it off before changing components.

8.1.2. REQUESTED LEVEL

Service personnel have to have the experience to be able to perform electrical and mechanical interventions. Refer to the regulations currently in force in the country concerned.

8.1.3. INTERVENTION LEVELS

The different troubleshooting steps represented below use 3 intervention levels:

- Level 1 (by default): Operations that can be carried out by a maintenance technician without specific STÄUBLI training.
- Level 2: Operations that can be carried out by a maintenance technician who has undergone specific STÄUBLI training.
- Level 3: Operations that must be carried out by the STÄUBLI After-Sales Service.

8.1.4. SERVICE METHODOLOGY

The following chapters give a general methodology to trouble shoot the robot. It is based first on visual indicators provided by the controller (led, display) and on indications provided on **MCP** (popup messages, statuses).

For each point, it is assumed that previous ones have been checked and operate properly.

8.1.5. ELECTRICAL DRAWINGS

Electrical drawings provided in this manual are for information only. The electrical drawings of the robot is provided in a separate manual.

8.2. GLOSSARY

ABZ	ABZ Encoder board	ABZ Encoder board
ARPS	Auxiliary Robot Power Supply (logical voltages)	Auxiliary Robot Power Supply (logical voltages)
BIO	Basic Inputs Outputs	Basic Inputs Outputs
BRB	Brake Release Board	Brake Release Board
BRK	Brake	Brake
COD	Arm Encoder	Arm Encoder
CPT	Computer	Computer
DIG	Digital part of the amplifier	Digital part of the amplifier
DOOR	Door contact	Door contact
DSI	Dual Sensor Interface board in Arm	Dual Sensor Interface board in Arm
EV	Solenoid valve	Solenoid valve
IC	Interconnect Cable	Interconnect Cable
LSW	Limit Switch	Limit Switch
MCP	Manual Control Pendant	Manual Control Pendant
MCPES	Manual Control Pendant Emergency Stop	Manual Control Pendant Emergency Stop
MOT	Motor	Motor
PSM	Power Supply Module (power voltage)	Power Supply Module (power voltage)
PWR	Power part of the amplifier	Power part of the amplifier
RPS	Robot Power Supply	Robot Power Supply
RSI	Robot Safety Interface	Robot Safety Interface
STARC	Stäubli Advanced Robot Control	Stäubli Advanced Robot Control
Th	Thermo Sensor	Thermo Sensor
UESA	User Emergency Stop	User Emergency Stop
UESB	User Safety Stop	User Safety Stop
USEREN	User validation	User validation
WMS	Working Modes Selection front panel	Working Modes Selection front panel
WMSES	Working Modes Selection Emergency Stop	Working Modes Selection Emergency Stop

8.3. COMPONENT LOCATION

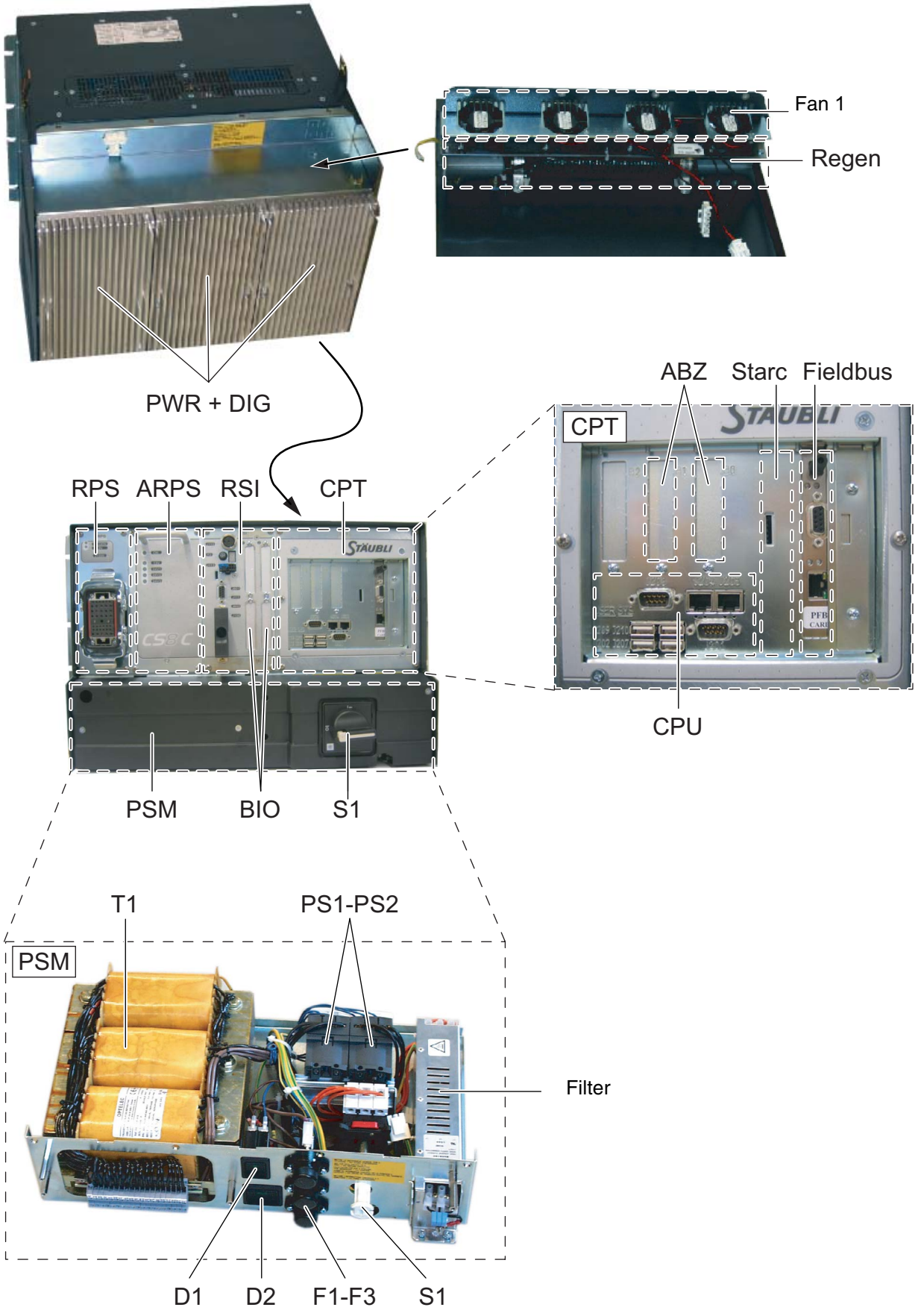


Figure 8.1

8.4. SAFETY

To disconnect the system from the power supply, set the master switch (6) located on the front of the controller to 0. Before doing so, you must stop the arm motion and switch off arm power supply.

DANGER:

Disconnect all the electrical and pneumatic power supplies before carrying out any work on the controller or the arm. Wait for at least 1 min before starting to work.

See the Safety chapter 3.3 for isolation of the system.

CAUTION:

Use an anti-static wrist strap and an anti-static mat connected to the controller for all work involving handling of boards or components.

Take all the necessary precautions as set out in paragraph 3.4.3 to avoid the risk of electrostatic charges.

During maintenance and/or diagnostic operations, if parts are replaced or exchanged between different systems, make sure that they are fully compatible (hardware and software compatibility). Check, at low speed, that the robot is operating correctly, especially for calibration.

8.5. INPUT VOLTAGE

8.5.1. DESCRIPTION

The following components are located in PSM (Power Supply Module) located at the bottom of the cabinet.

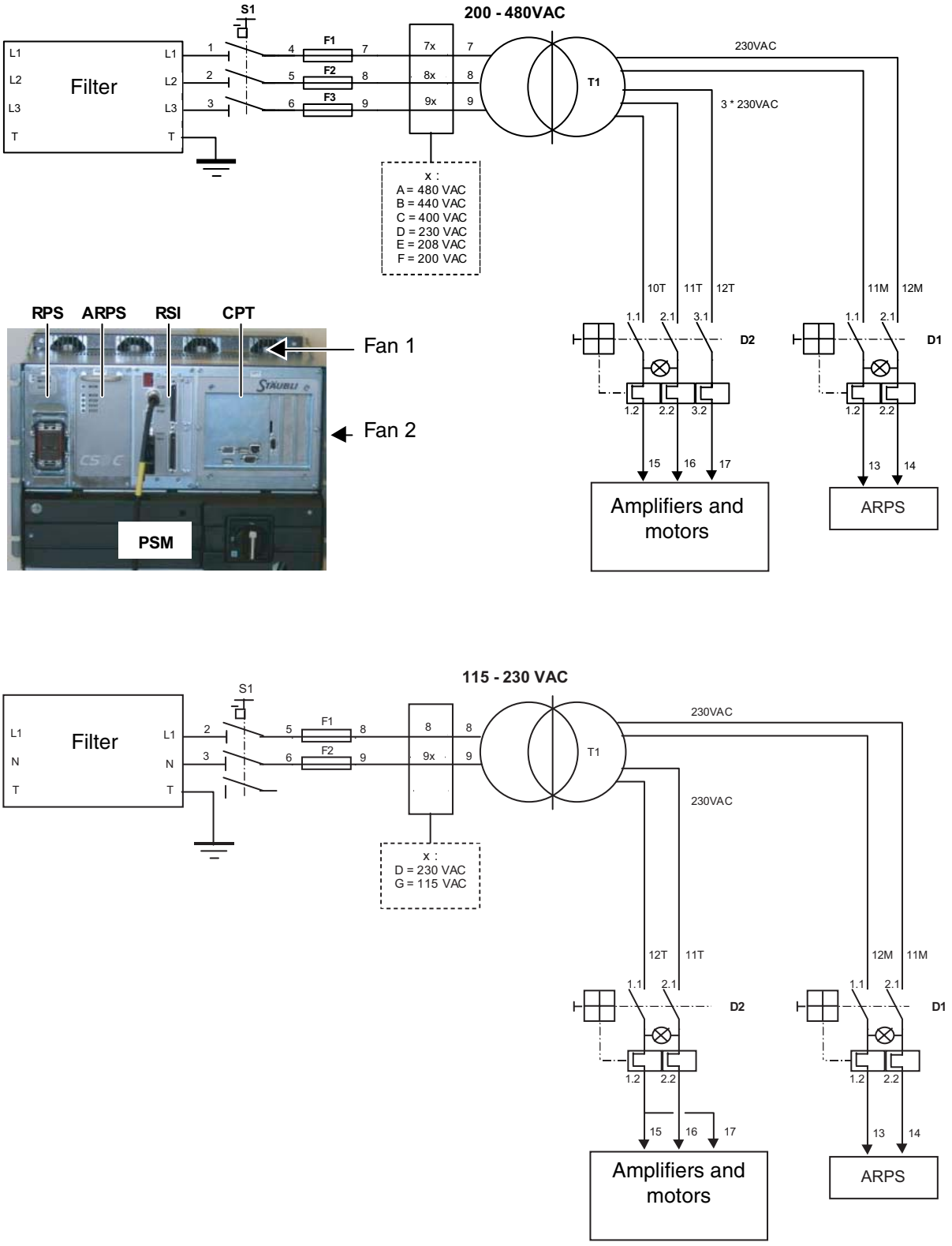


Figure 8.2

8.5.2. ACCESS

Remove 3 screws **(4)** to remove cover.

Figure 8.3

To access the components of the **PSM**, remove the screws **(1)** and pull it forward.

CS8C TX/RS

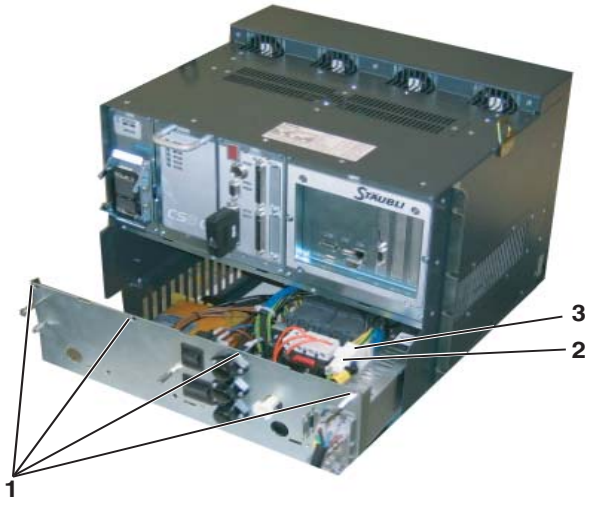


Figure 8.4

CS8C RX160

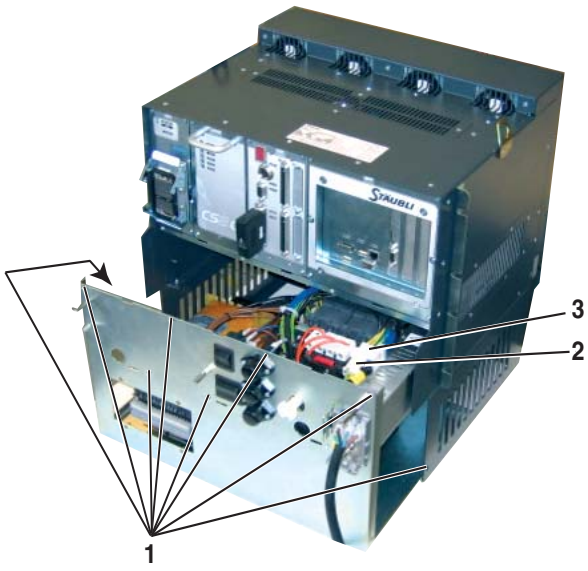


Figure 8.5

CAUTION:

- **To remove it completely, disconnect connectors (2) and (3).**
- **The PSM is heavy; take all necessary precautions to avoid dropping it and to avoid making efforts in an incorrect position.**

8.5.3. TROUBLE SHOOTING

8.5.3.1. CASE 1

Problem:

All lights of ARPS are off.

Solution:

- Check that main switch S1 is on position 1 and that input voltage is provided to **CS8C** (external line).
- Switch off **CS8C**.
- Turn off main switch S1 to position 0.
- Check input fuses (F1, F2, F3):
  - Fuses are 10 x 38 mm type, 500V for standard controllers.
  - For UL type controllers, replace fuses with UL type.

	THREE-PHASE 400-480 V	THREE-PHASE 200-230 V	SINGLE PHASE 230 V	SINGLE PHASE 115 V
TX40	4Am	6Am	10Am	16Am
TX60 - RS	4Am	8Am	10Am	16Am
TX90	6Am	12Am		
RX160	8Am	16Am		

CAUTION:

- **These fuses do not protect the mains power supply line which must be protected separately.**
- **Never replace these fuses with fuses of a higher rating or with different characteristics (see the "replacement parts" section).**

Note:
Am means "slow-acting fuse" according to IEC 269-1.2.
AT means "slow-acting fuse" and AF "quick-acting fuse" according to IEC 127-2.

- Check D1 circuit breaker.

8.5.3.2. CASE 2

Problem:

D1 circuit breaker light is off.

Solution:

- Check that D1 circuit breaker is on position 1.
  - If D1 circuit breaker does not remain on position 1, change ARPS and / or D1 circuit breaker.
- Check input fuses (F1, F2, F3):
  - Fuses are 10 x 38 mm type, 500V for standard controllers.
- Check voltages at the input of the controller (L1, L2, L3).
- Check voltages after the transformer. At this point, voltages are 230 VAC ±10% for all the input voltages.
- Change D1 circuit breaker.

To change D1 or D2 circuit breakers, remove PSM.

DANGER:

Main switch S1 should be in off position AND main power to the controller has to be disconnected.

Orange wires inside PSM indicate that dangerous voltage remains even if S1 is off.

Remove 3 screws **(4)** to remove cover.

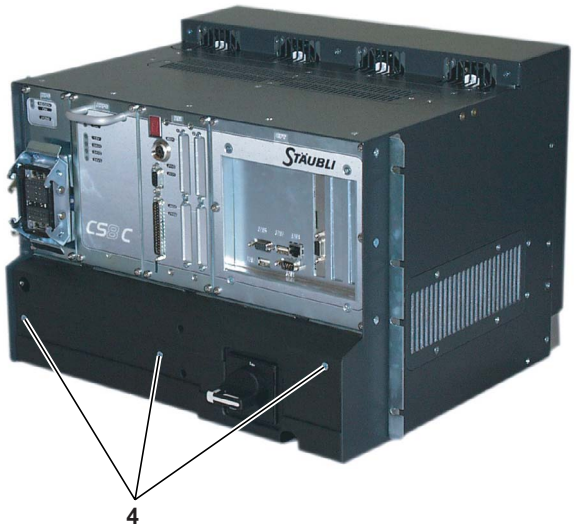


Figure 8.6

To access the components of the **PSM**, remove the screws **(1)** and pull it forward.

CS8C TX/RS

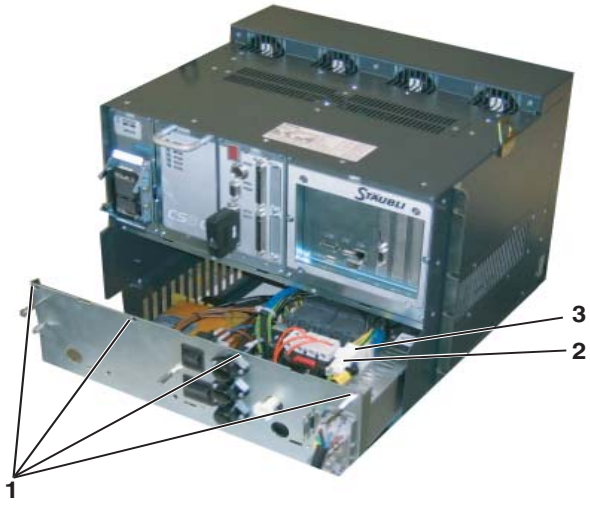


Figure 8.7

CS8C RX160

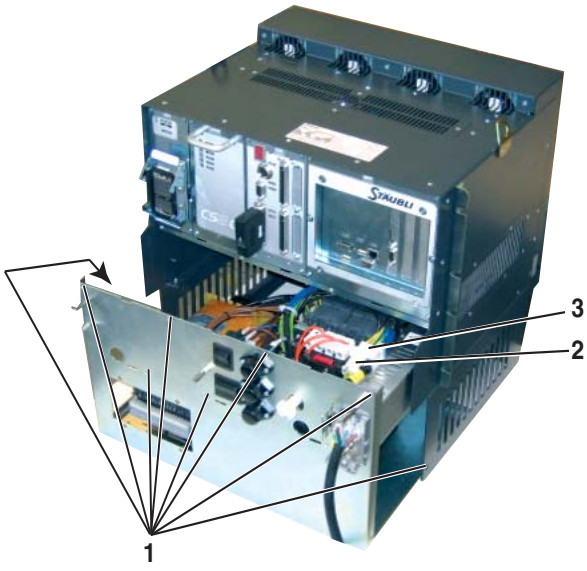


Figure 8.8

CAUTION:

- **To remove it completely, disconnect connectors (2) and (3).**
- **The PSM is heavy; take all necessary precautions to avoid dropping it and to avoid making efforts in an incorrect position.**

The frame of circuit breaker can be separated from the front face with a screw driver allowing it to be pulled back.

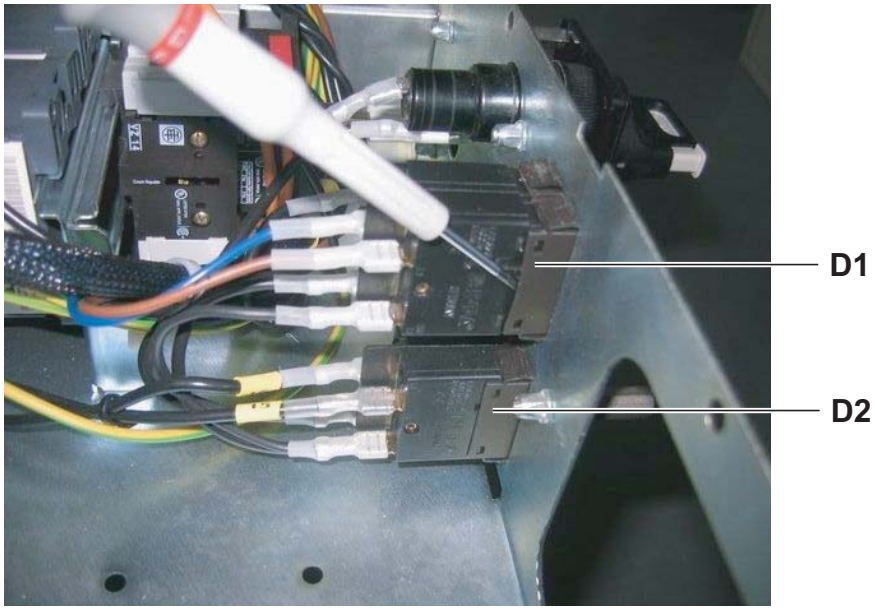


Figure 8.9

Push on **(1)** to separate it from the front face **(3)** and disconnect the wires **(2)**.

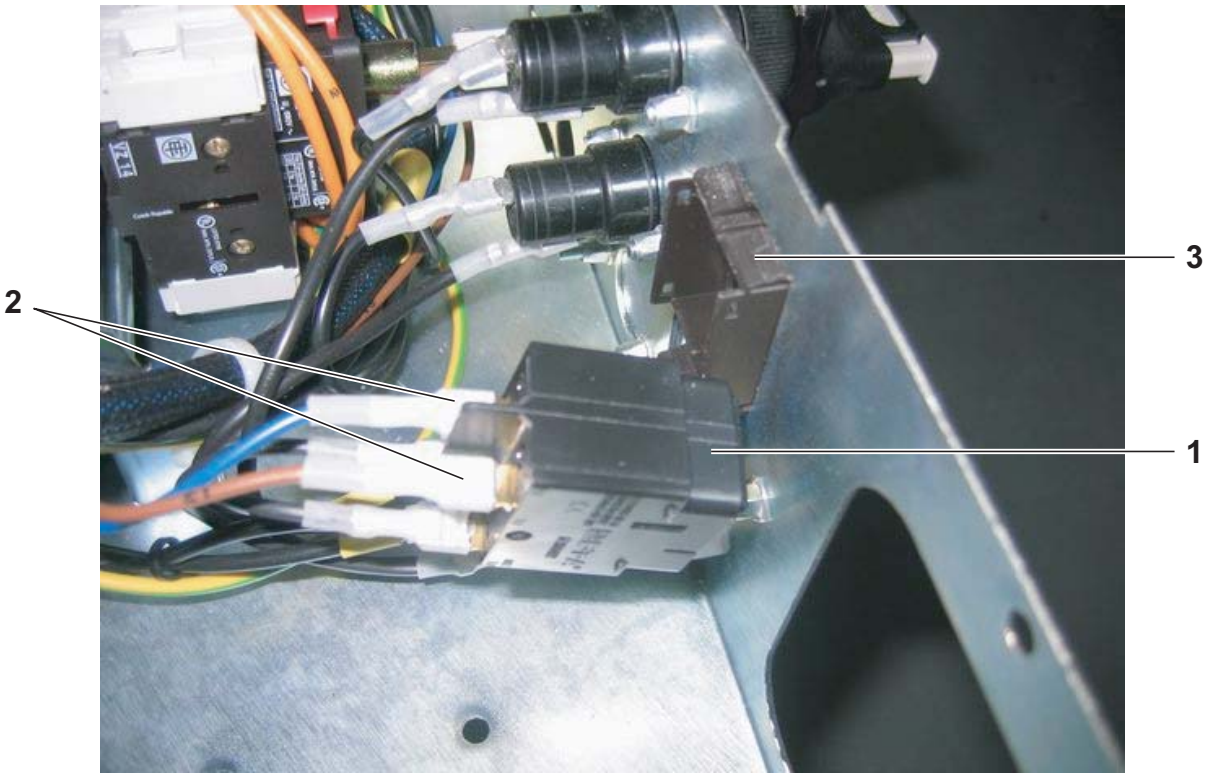


Figure 8.10

8.5.3.3. CASE 3

Problem:

D2 circuit breaker light is off.

Solution:

- Check that D2 circuit breaker is on position 1.
  - If D2 circuit breaker does not remain on position 1, change D2 circuit breaker.
- Check input fuses (F1, F2, F3):
  - Fuses are 10 x 38 mm type, 500V for standard controllers.
- Check voltages at the input of the controller (L1, L2, L3).
- Check voltages after the transformer. At this point, voltages are 230 VAC ±10% for all the input voltages.
- Change D2 circuit breaker.

8.6. ARPS AUXILIARY ROBOT POWER SUPPLY

8.6.1. DESCRIPTION

ARPS is powered with 230 VAC from the D1 circuit breaker. Its outputs are overload protected, which means that output voltages are automatically set to 0 when there is a short circuit in the components it supplies.

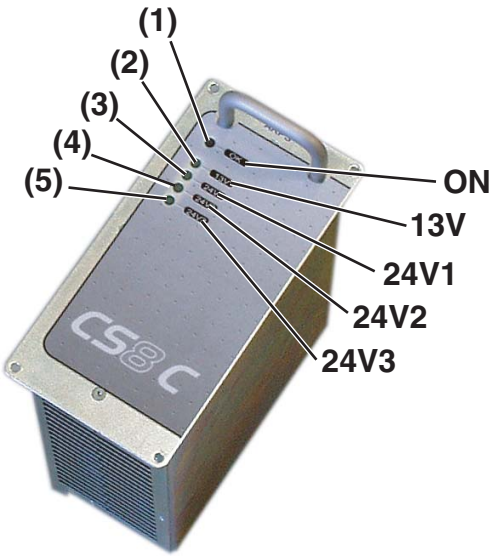


Figure 8.11

Normal status, arm power off:

GREEN LEDS	STATUS
ON	ON
13V	ON
24V1	ON
24V2	OFF
24V3	ON

Normal status, arm power on:

GREEN LEDS	STATUS
ON	ON
13V	ON
24V1	ON
24V2	ON
24V3	ON

8.6.2. ACCESS

- Turn off main switch S1 to position 0.
- Remove the 4 screws **(1)** and pull the ARPS.

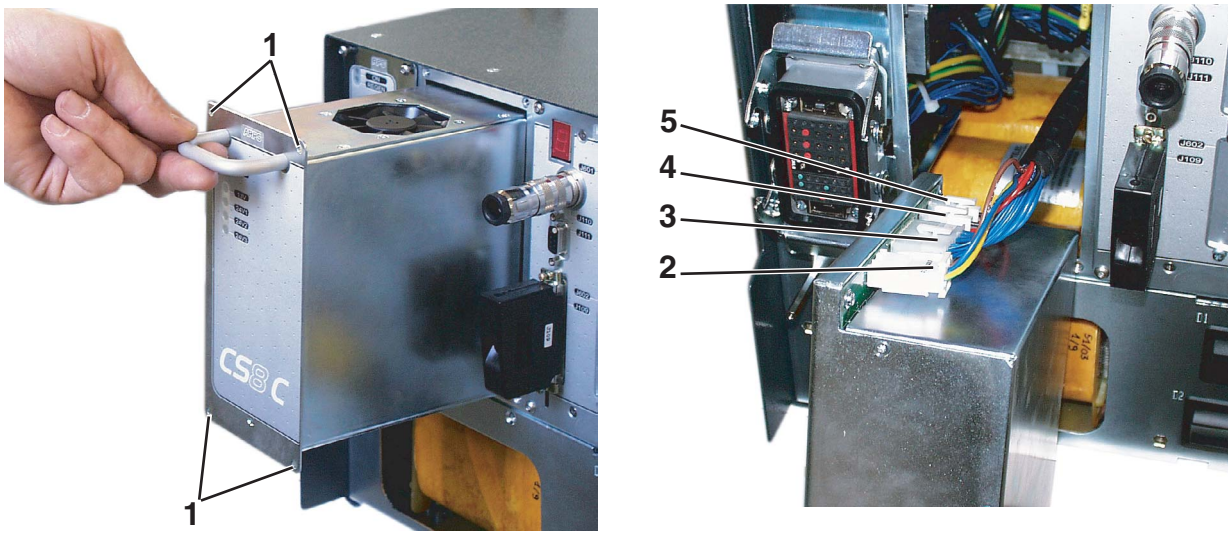


Figure 8.12

8.6.3. TEST POINTS

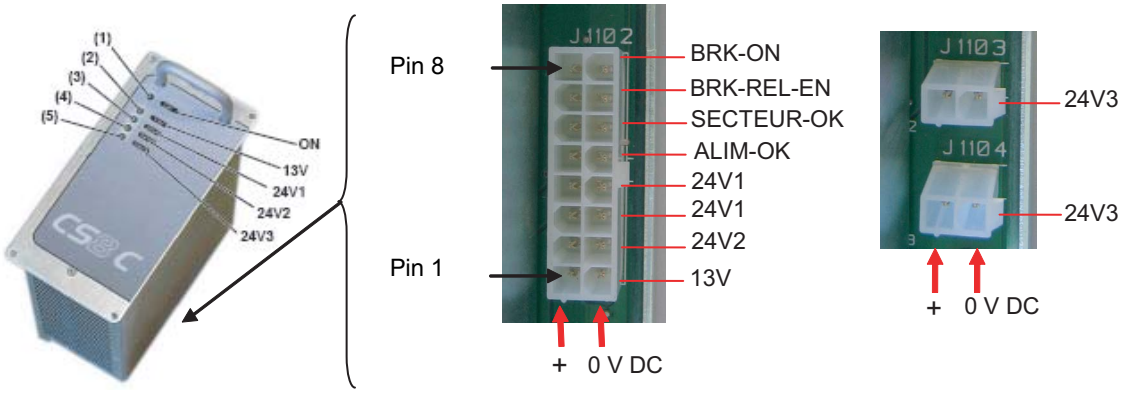


Figure 8.13

8.6.4. TROUBLE SHOOTING

8.6.4.1. CASE 1

Problem:

ON indicator remains off.

Solution:

- Refer to chapter 8.5 to check input voltages:
  - Check that main switch S1 is on position 1.
  - Check fuses (F1, F2, F3).
  - Check D1 circuit breaker.
- Change the ARPS.

8.6.4.2. CASE 2

Problem:

13V, 24V1 or 24V3 light remains off.

Solution: Step 1

- Unplug J1102 (3), J1103 (4), J1104 (5) connector at ARPS outputs (see figure 8.12):
  - If the indicator lights remain off, change ARPS.
  - If the indicator lights come on again, there is a short circuit on the corresponding outputs.

Solution: Step 2

- Plug only J1104 (24V3) for internal fans (fan 2 and fan 3):
  - If 24V3 light goes off, check wiring and fans.
  - Change the defective part.

Access to fans

> **DANGER:**
> **When fans are defective, cooled parts can be very hot.**

The fan **2 (2)** is accessed by removing the screws **(1)** holding the grille and the air filter in place.

The fan 3 **(3)** for the **RPS** power supply can be accessed by removing the amplifier for joints **3-6** (see pages 181 and 182).

To remove it, take out the 2 screws **(4)**.

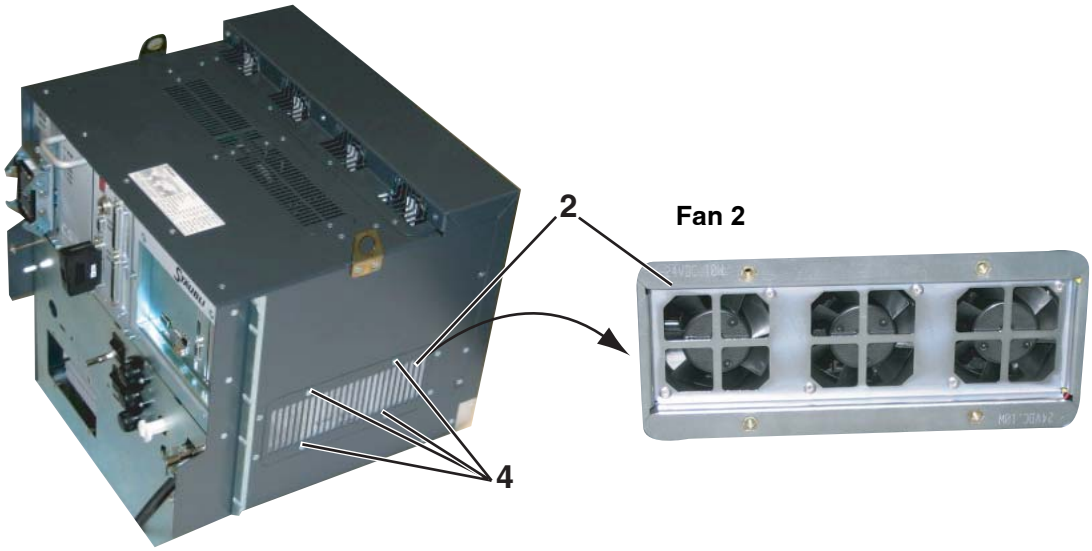


Figure 8.14

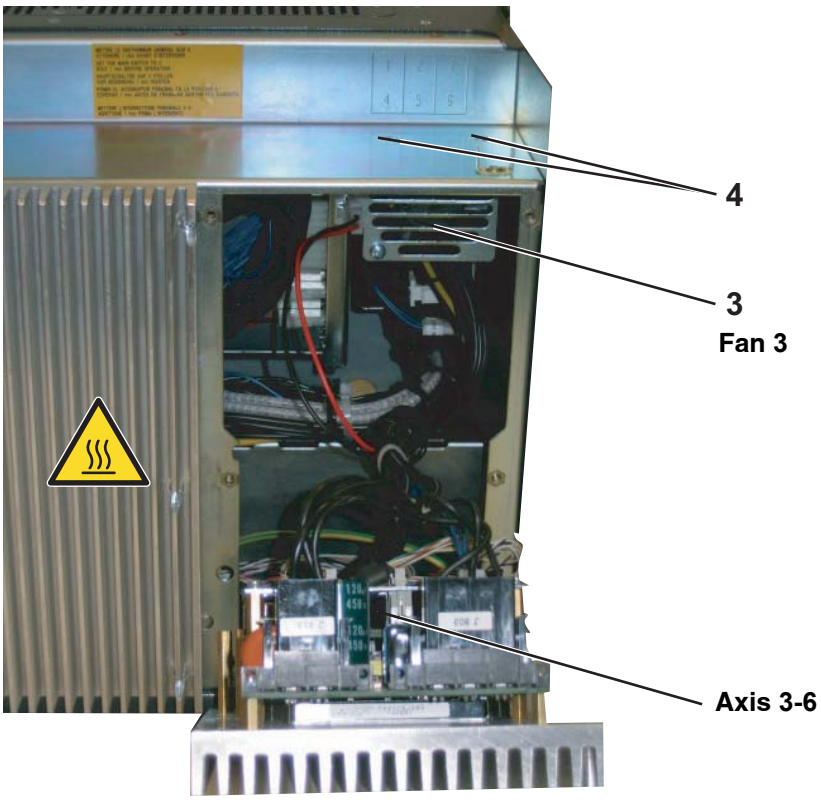


Figure 8.15

Solution: Step 3

- Plug only J1103 (24V3 for fan 1 on top of **CS8C**)
- If 24V3 light goes off, check wiring and fans.
- Change the defective part.

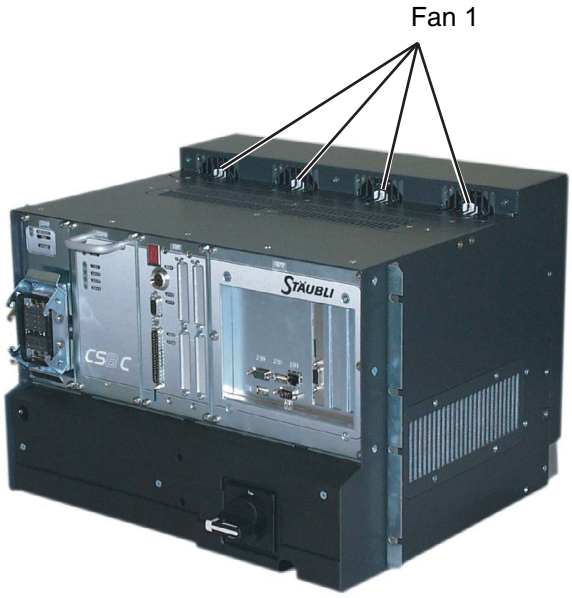


Figure 8.16

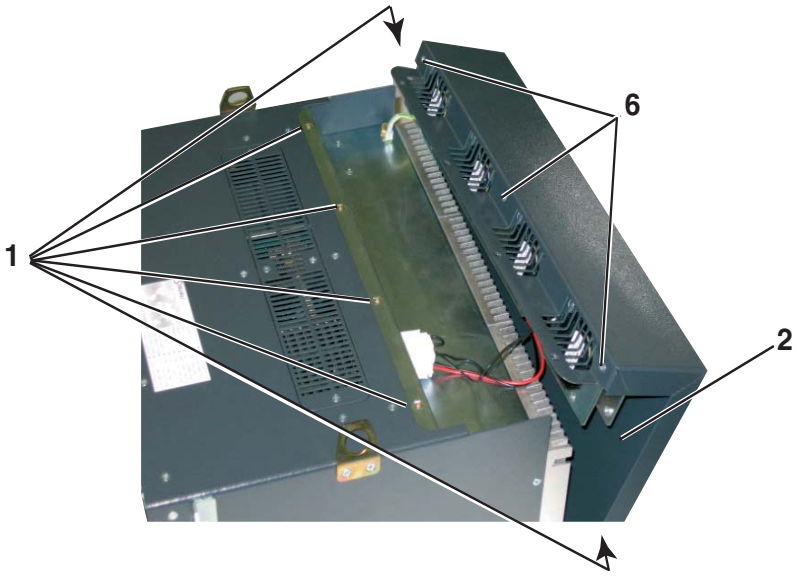


Figure 8.17

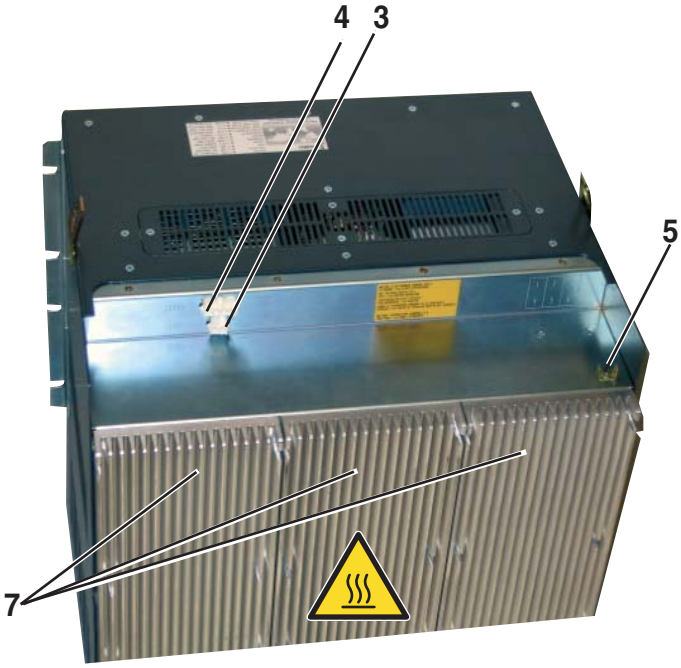


Figure 8.18

Figure 8.19

DANGER:

- **The cover (2), the resistor (8) and the amplifiers (7) may be very hot, especially in the event of a ventilation malfunction.**
- **This disassembly operation provides access to the regeneration resistor powered at 400 V during normal operation. It is essential to cut off all power supplies before carrying out this operation. Wait for at least 1 mn before starting to work.**

- Remove the 6 screws **(1)**.
- Partially remove the cover **(2)**
- Remove the connectors J1301 **(3)**, J1303 **(4)** and the ground wire **(5)**.
- The 4 fans can be accessed by removing the screws **(6)**.

Advanced information

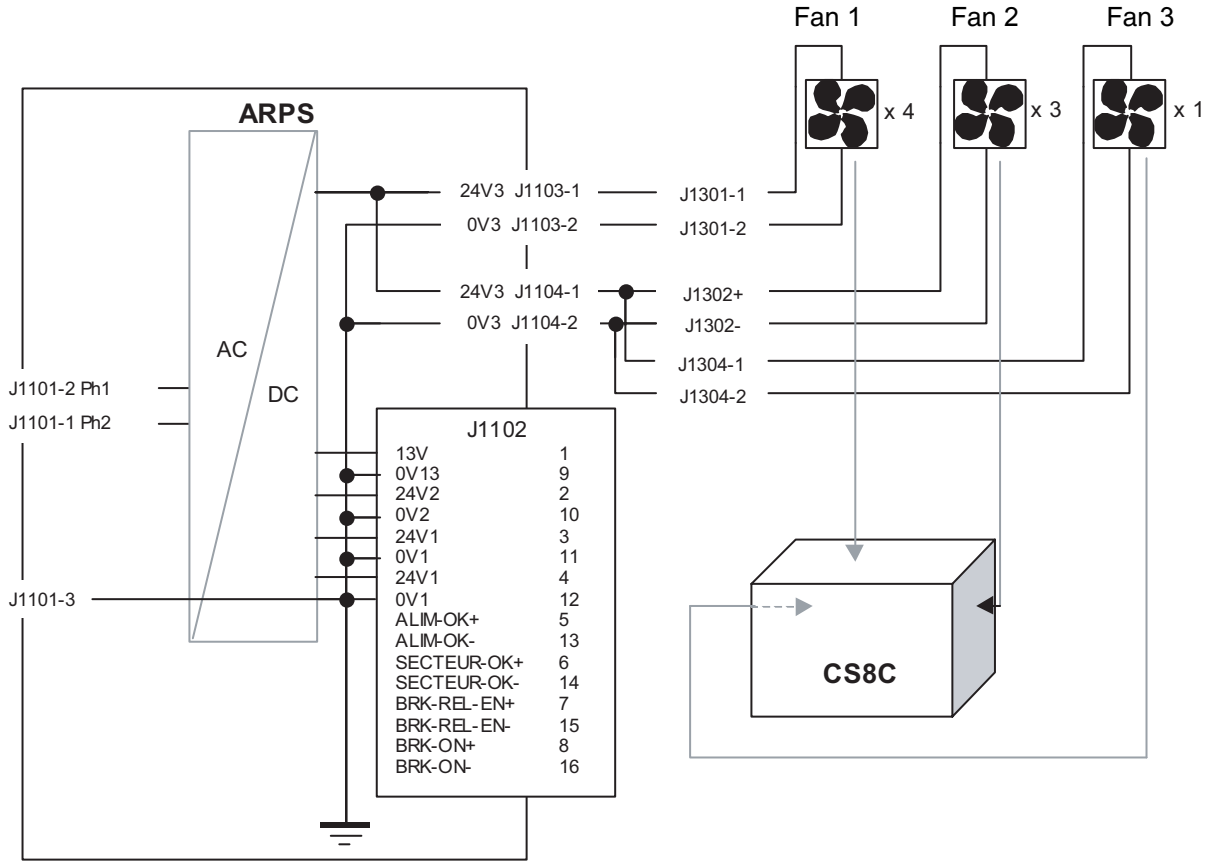
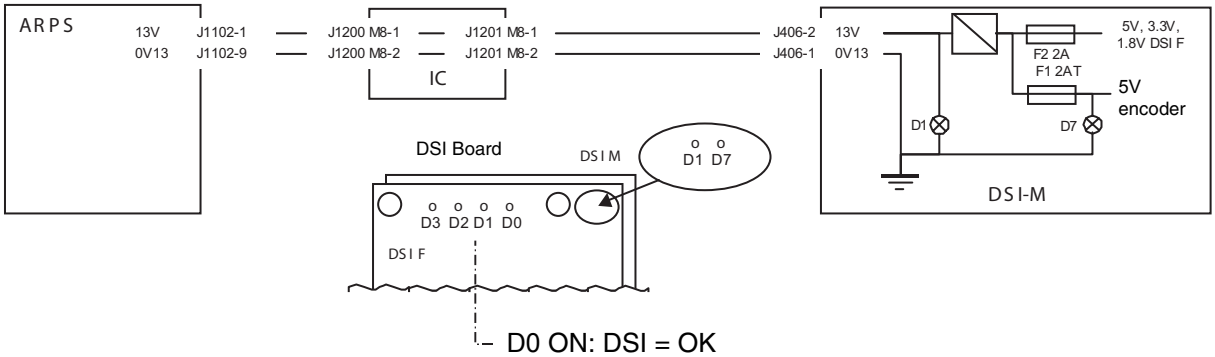


Figure 8.20

Solution: Step 4

- Plug only J1102 (24V1 for RSI, drives and CPT ; 24V2 for brakes ; 13V for DSI inside arm).
  - If 13V light goes off, repeat the same operation with the interconnection cable disconnected.
    - If 13V light comes on, there is a short circuit either in the cable or in the DSI in the arm. Change the defective part.
    - If 13V light remains off, the short circuit is inside **CS8C**. Check wiring from J1102 and J1200: short circuit, damaged wire ...



– D0 ON: DSI = OK
D1 ON: Encoder = OK
D2 ON: Thermo = OK
D3 Slow: Init. Fast. = OK

Figure 8.21

Solution: Step 5

- Plug only J1102 (24V1 for RSI, drives and CPT ; 24V2 for brakes ; 13V for DSI inside arm).
  - If 24V1 light goes off, repeat the same operation with powered components disconnected one by one: CPU, RSI, drives in order to differentiate the defective component or wiring.

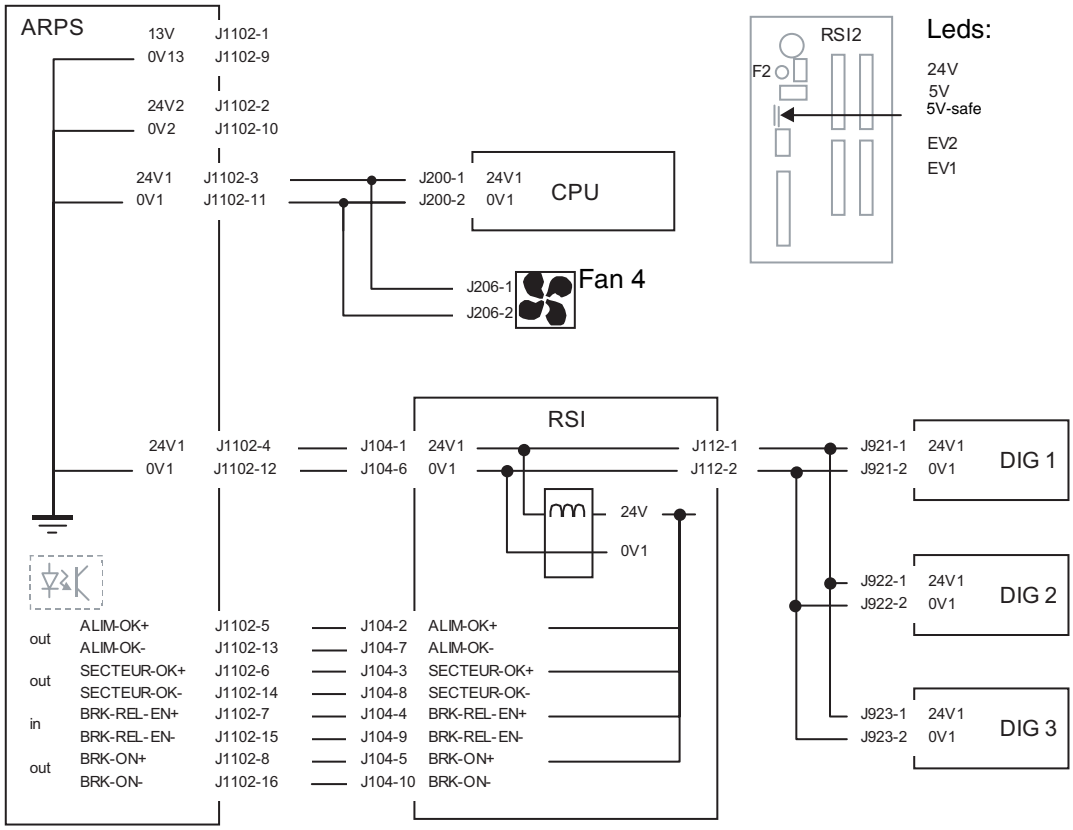

ARPS
13V
0V13
24V2
0V2
24V1
0V1
J1102-1
J1102-9
J1102-2
J1102-10
J1102-3
J1102-11
J200-1
J200-2
CPU
J206-1
J206-2
Fan 4
RSI2
F2
Leds:
24V
5V
5V-safe
EV2
EV1
RSI
J1102-4
J1102-12
J104-1
J104-6
J112-1
J112-2
24V
0V1
J921-1
J921-2
DIG 1
J922-1
J922-2
DIG 2
J923-1
J923-2
DIG 3
out
ALIM-OK+
ALIM-OK-
out
SECTEUR-OK+
SECTEUR-OK-
in
BRK-REL-EN+
BRK-REL-EN-
out
BRK-ON+
BRK-ON-
J1102-5
J1102-13
J1102-6
J1102-14
J1102-7
J1102-15
J1102-8
J1102-16
J104-2
J104-7
J104-3
J104-8
J104-4
J104-9
J104-5
J104-10

Figure 8.22

8.6.4.3. CASE 3

Problem:

24V2 light remains off when enabling power on arm.

Solution: Step 1

1) Brake command signal (BRK_REL_EN) not received by ARPS.
2) Brake command is not taken into account by ARPS.

Refer to chapter 8.6.7, BRK-x signals.

Solution: Step 2

3) Short circuit on brakes or wiring.
   Check if all brakes are operating in Manual Brake Release mode:

> **DANGER:**
> **Refer to safety chapter (3).**
> **Pay attention to risks related to the size of the robot, the size of the payload, and so on when using Brake Release mode.**

- If 24V2 light goes off when a specific brake is released, check this particular brake and its wiring from the robot base to the brake.
- If 24V2 light goes off whatever is the selected brake, check brake release board in the robot base and the wiring from ARPS to the arm.

Note:
Changing a brake requires an intervention level 2 or 3 depending if brake is integrated or not in the motor.

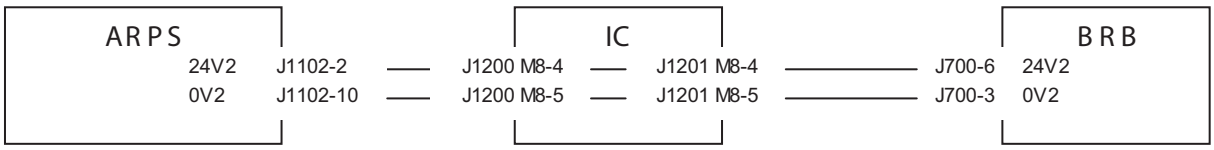


Figure 8.23

8.6.4.4. ADVANCED INFORMATION

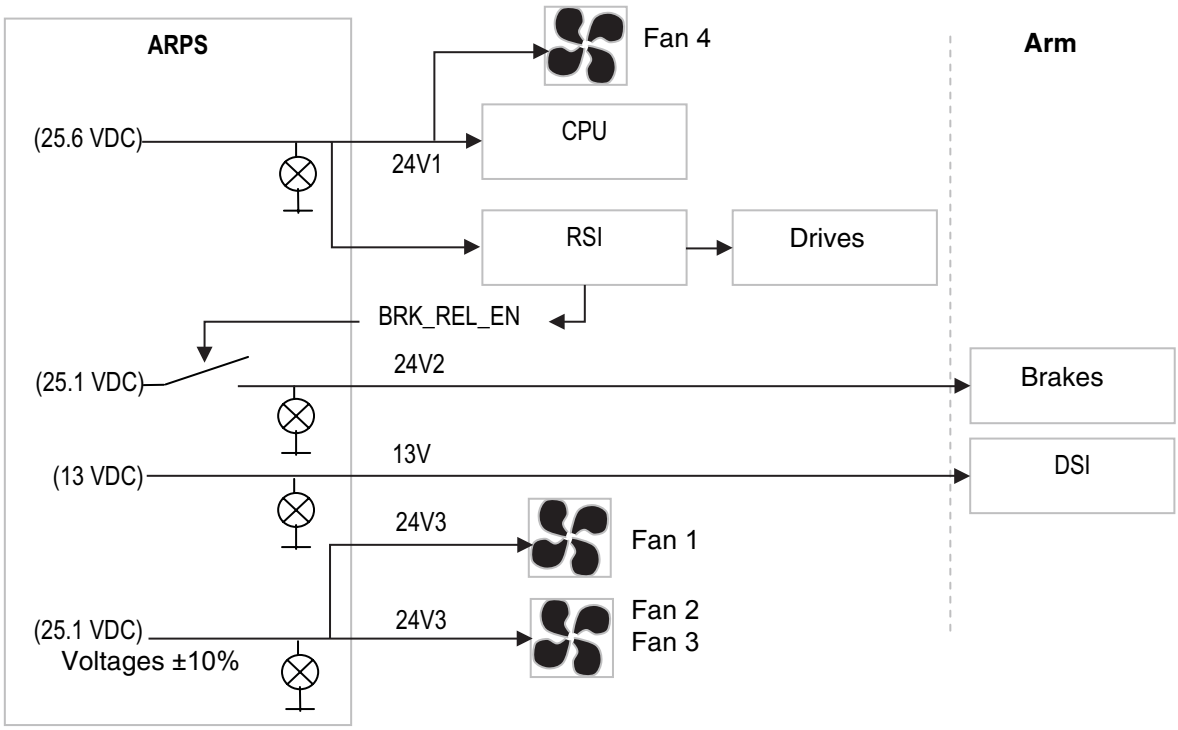
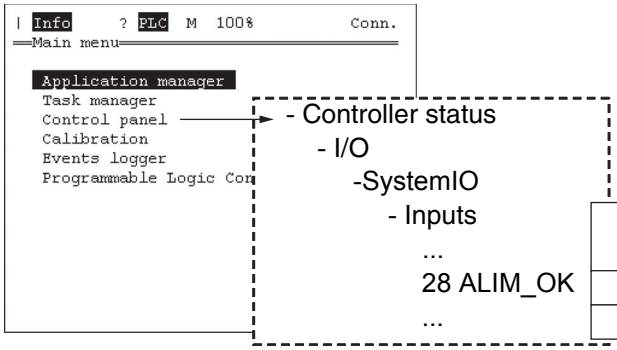


Figure 8.24

8.6.5. ALIM_OK SIGNAL

8.6.5.1. DESCRIPTION



Status	Signal from ARPS to RSI
ON	Normal status
OFF	Fault

Figure 8.25

8.6.5.2. ACCESS

See chapter 8.6.2, page 177.

8.6.5.3. TROUBLE SHOOTING

Problem:

ALIM_OK status = OFF : There is a fault detected by ARPS and corresponding output is set to 0 V.

Solution:

1) It can be a short circuit on one output (see chapter 8.6.4, page 178).
2) Or it is an internal fault: Change the ARPS.

8.6.5.4. ADVANCED INFORMATION

This output is a 24 VDC signal.

When there is no fault (status in control panel = ON) ALIM_OK signal is set to 24 V.

When there is a fault (status in control panel = OFF) ALIM_OK signal is set to 0 V.

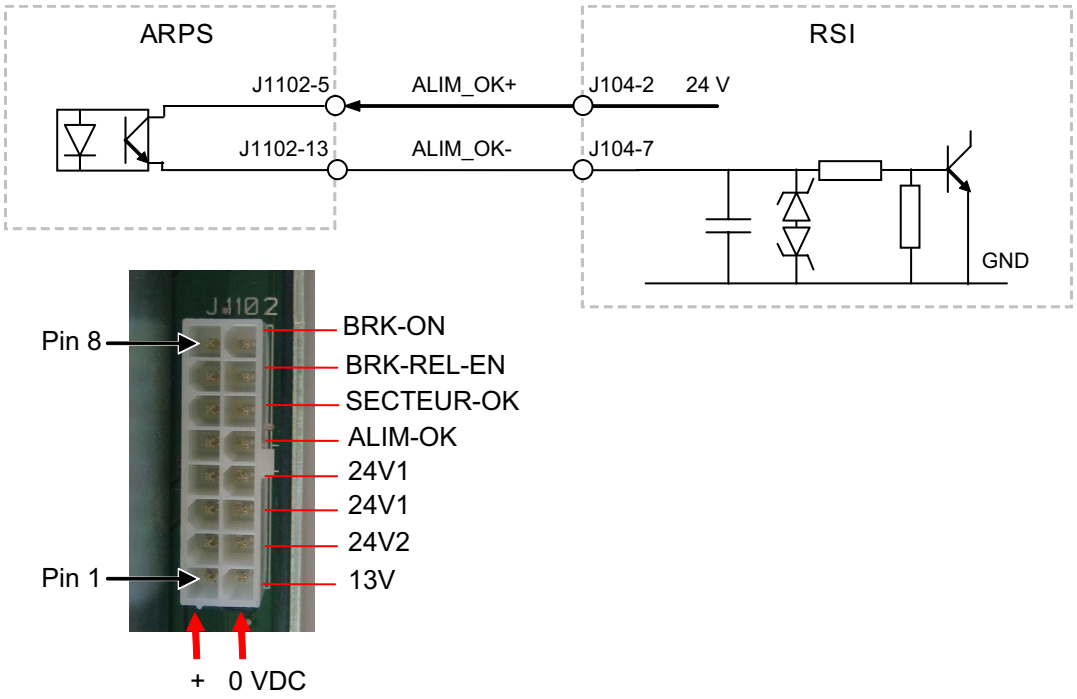
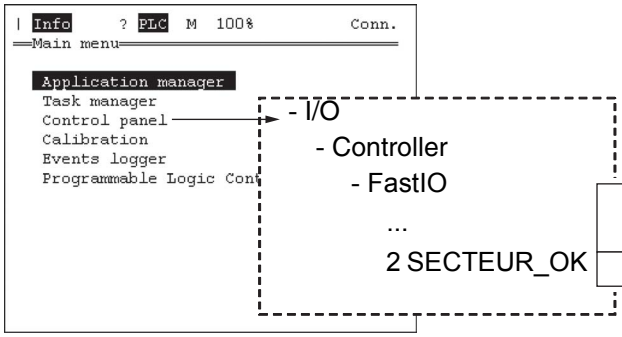


Figure 8.26

8.6.6. SECTEUR_OK SIGNAL

8.6.6.1. DESCRIPTION



Status	Signal from ARPS to RSI
ON	Normal status

Figure 8.27

This signal provides the status of input voltage of ARPS.
Normal status: Input voltage of ARPS is correct (>190 VAC).
Status = OFF: There is a power supply failure detected by ARPS.
Failure means that input voltage is <190 VAC for more than 20 ms.
In that case, 24V1 output is maintained for ~100 ms, 13V output is maintained for ~ 300 ms, there is no voltage backup on 24V2 and 24V3 outputs.

8.6.6.2. ACCESS

See chapter 8.6.2, page 177.

8.6.6.3. TROUBLE SHOOTING

Problem:

SECTEUR_OK status = OFF : As this condition shut off the controller, this status is recorded in the error logger.

Solution:

- Check input voltage to the ARPS.
- Check main voltage quality. A voltage drop can be caused by bad connections in the line or by too much of a power draw by the other equipment on the same line.

8.6.6.4. ADVANCED INFORMATION

This output is a 24 VDC signal.

When there is no fault (status in control panel = ON) SECTEUR_OK signal is set to 24 V.

When there is a fault (status in control panel = OFF) SECTEUR_OK signal is set to 0 V.

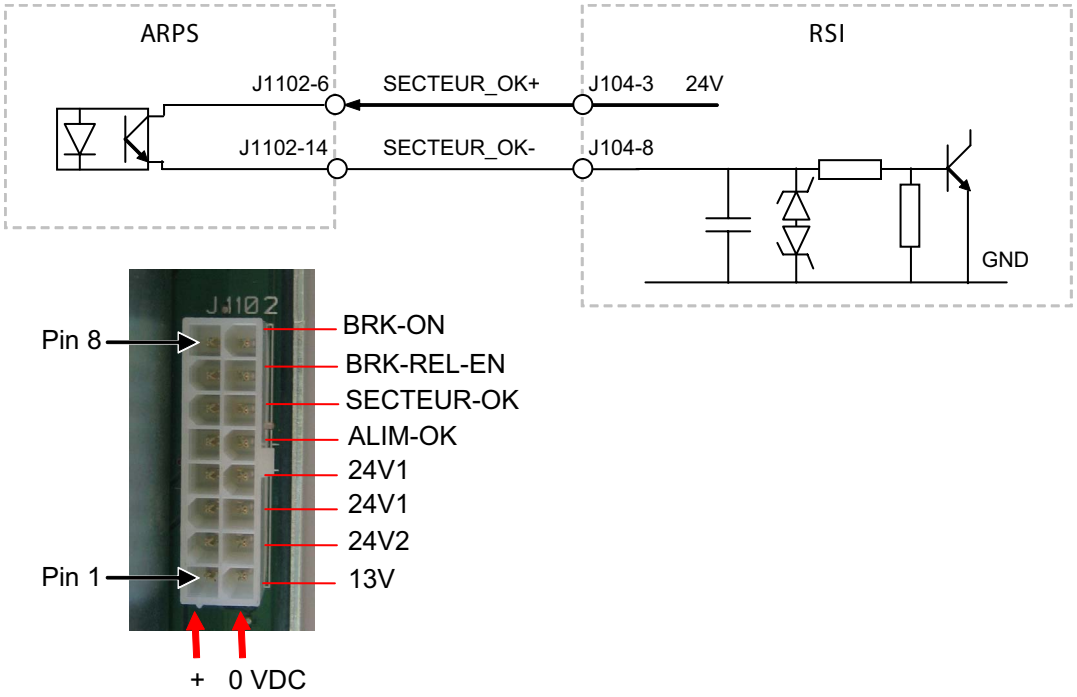


Figure 8.28

8.6.7. BRK_x SIGNALS

8.6.7.1. DESCRIPTION

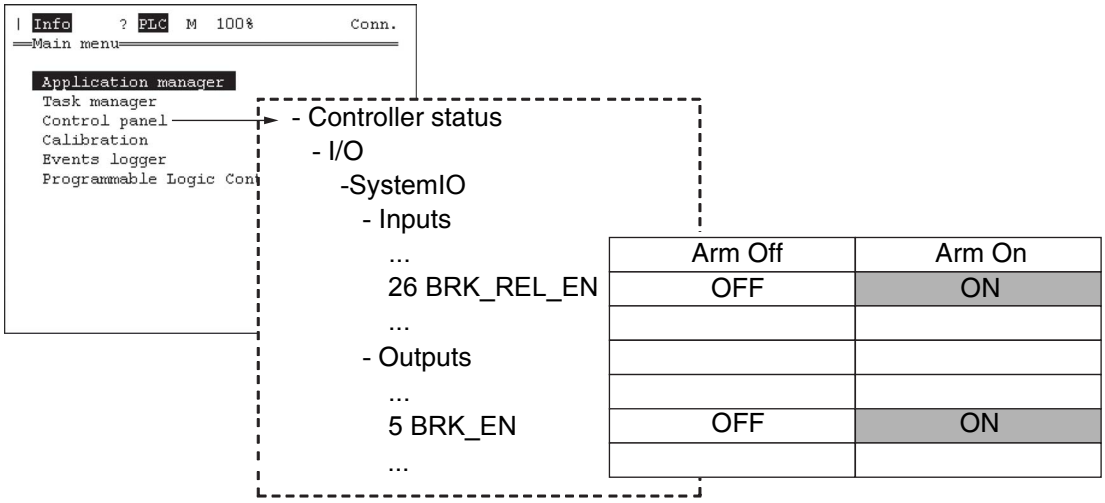


Figure 8.29

These signals provide status of command and feedback signals for the brakes. Brakes are off when arm power is disabled. Brakes are on when arm power is enabled.

Note:
These signals operate the same way in Manual Brake Release mode which is easier to test.

DANGER:
Refer to safety chapter (3).
Pay attention to risks related to the size of the robot, the size of the payload, and so on when using Brake Release mode.

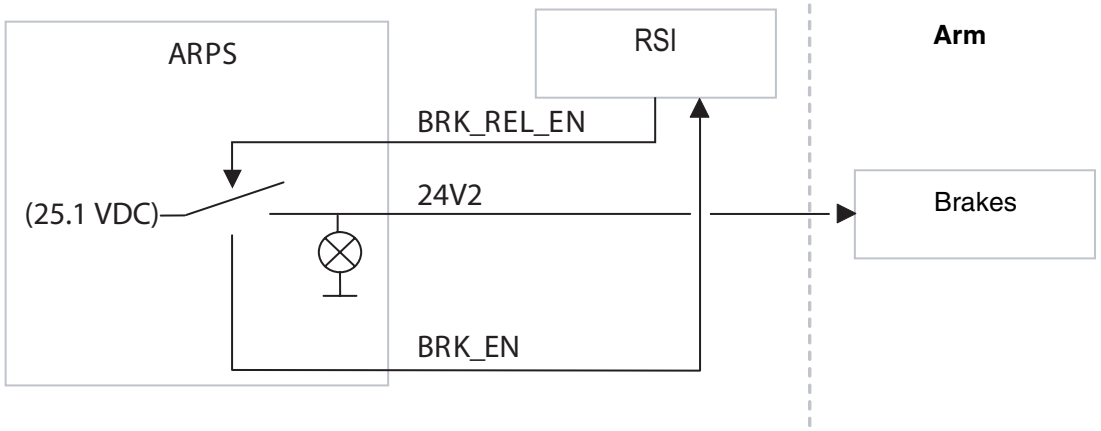


Figure 8.30

8.6.7.2. ACCESS

See chapter 8.6.2, page 177.

8.6.7.3. TROUBLE SHOOTING

Case 1

Problem:

When trying to enable power on arm, 24V2 led on front of ARPS remains off. BRK_REL_EN remains off: no brake command issued to ARPS.

Solution:

- Change the RSI.

Case 2

Problem:

When trying to enable power on arm, 24V2 led on front of ARPS remains off. BRK_REL_EN is on and BRK_ON remains off.

Solution:

- Check 24V2 led on ARPS:
  - If it is on, brakes are activated but there is no feedback to RSI:
    - Check wiring between ARPS and RSI.
    - Change the RSI.
  - If it off, ARPS is not receiving the command from RSI:
    - Check wiring between ARPS and RSI.
    - Change the ARPS.

8.6.7.4. ADVANCED INFORMATION

Input and output are 24 VDC signals.

BRK_REL_EN is active (status in control panel = ON) when BRK_REL_EN signal is set to 0V.

In that case, BRK_ON feedback signal goes to 24 VDC (RSI input = ON, status in control panel = ON).

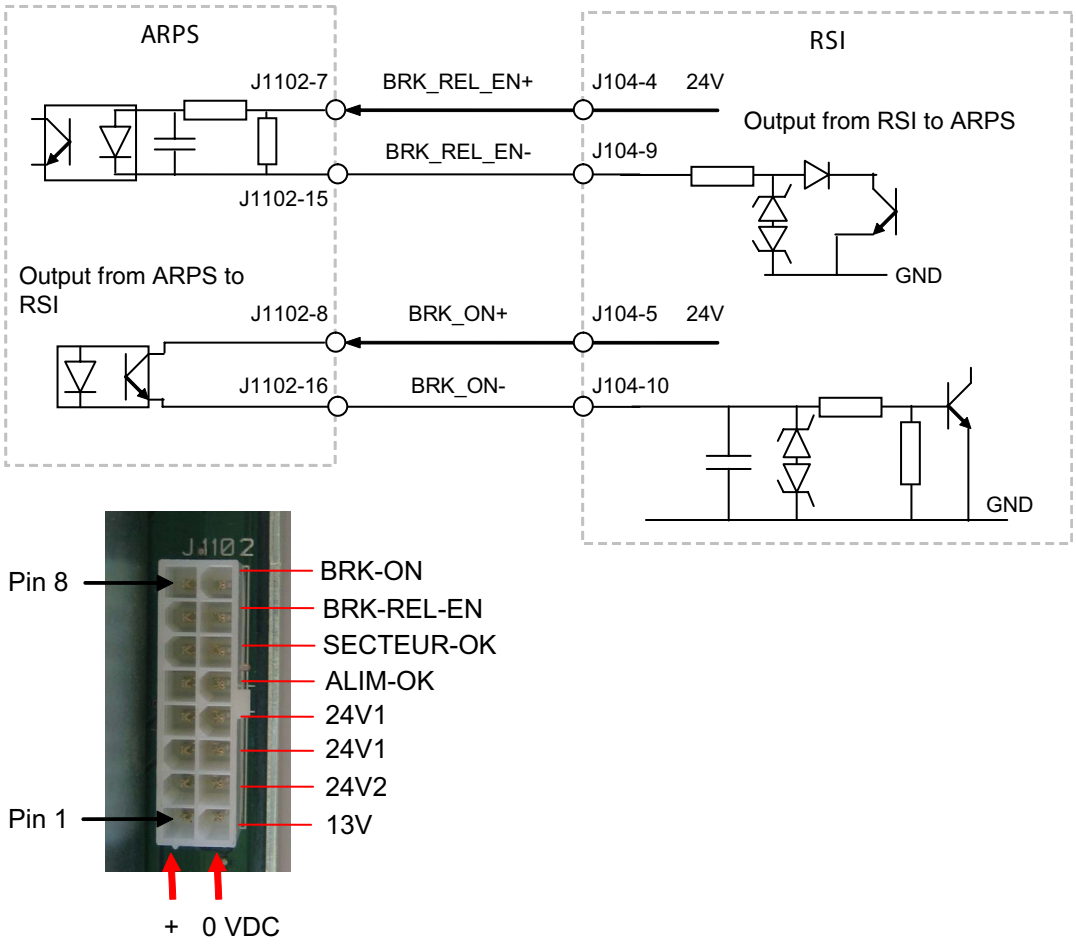


Figure 8.31

8.7. RPS POWER SUPPLY

8.7.1. DESCRIPTION

RPS is the 325 VDC power supply for the drives. It is powered through D2 circuit breaker and contacts on the PS1, PS2 relays closed by the RSI board when arm is powered on. It has an overvoltage protection mechanism called regeneration.

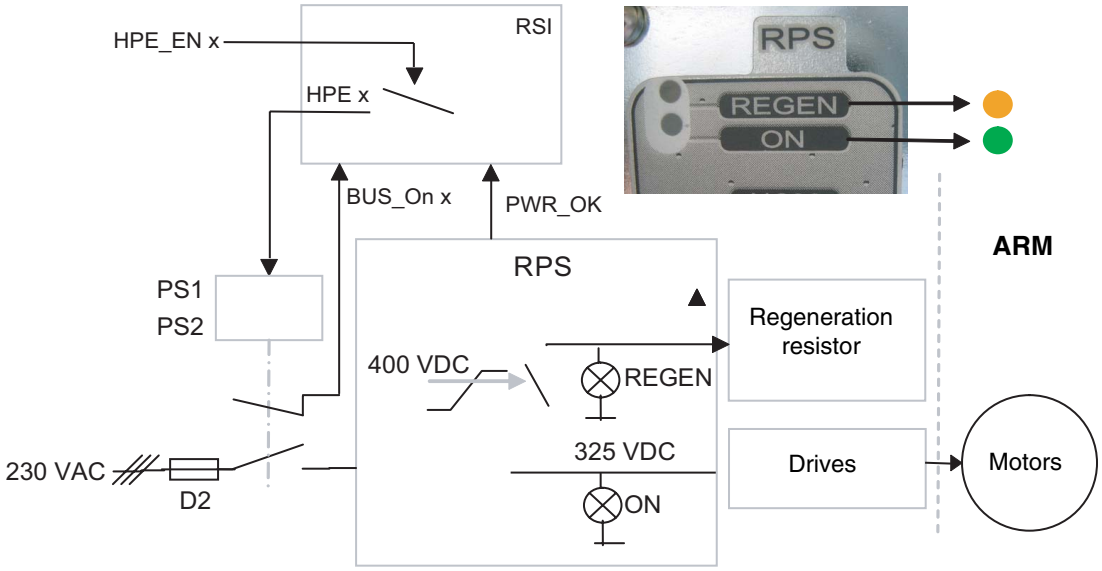


Figure 8.32

Normal operation:

STATUS	ON LIGHT	REGEN LIGHT
Arm not powered	OFF	OFF
Arm powered on	ON	OFF
Arm powered, motion with high deceleration	ON	ON

8.7.2. ACCESS

CAUTION:

When the power supply to the arm is cut off, the output voltage is still present even when the indicator light goes off.

Wait for at least 1 min before starting to work.

8.7.2.1. **CS8C** FOR TX OR RS ROBOTS

- Set aside the ARPS power supply (see chapter 8.6.2, page 177).
- Remove the 4 screws **(1)** holding the RPS325 power supply.
- Remove the 4 screws **(2)** holding the J1200 **(5)** connector.
- Release the connector **(5)** and the cable clamps **(6)**.

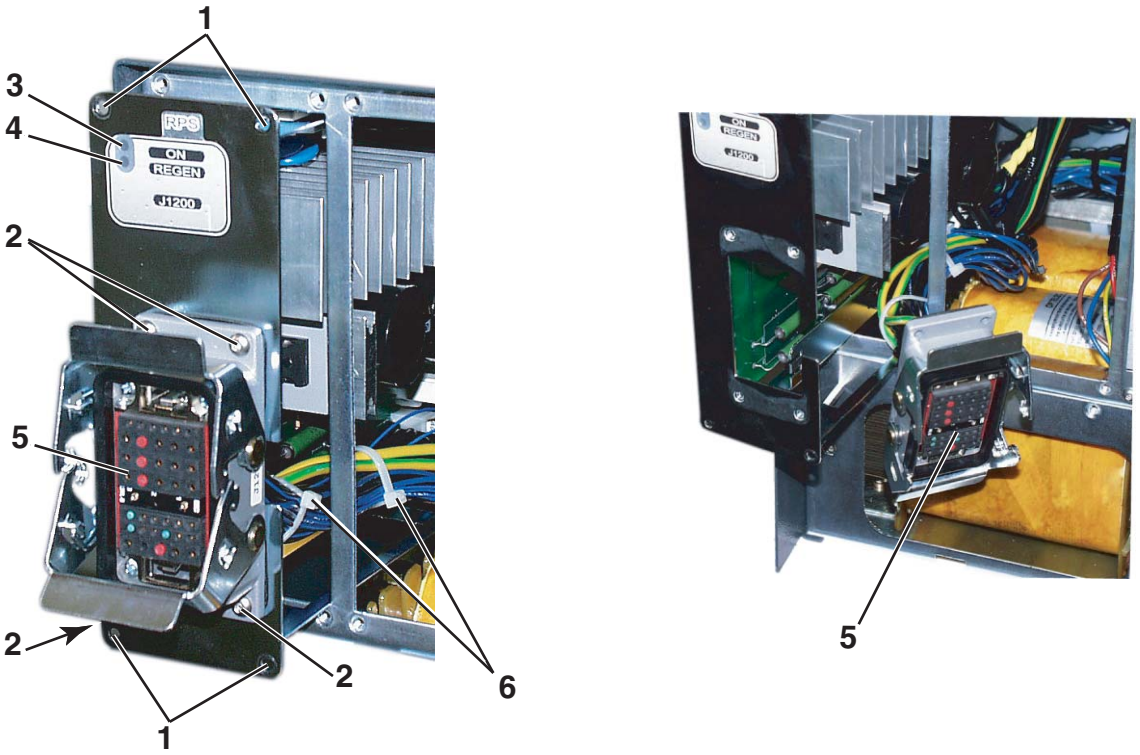
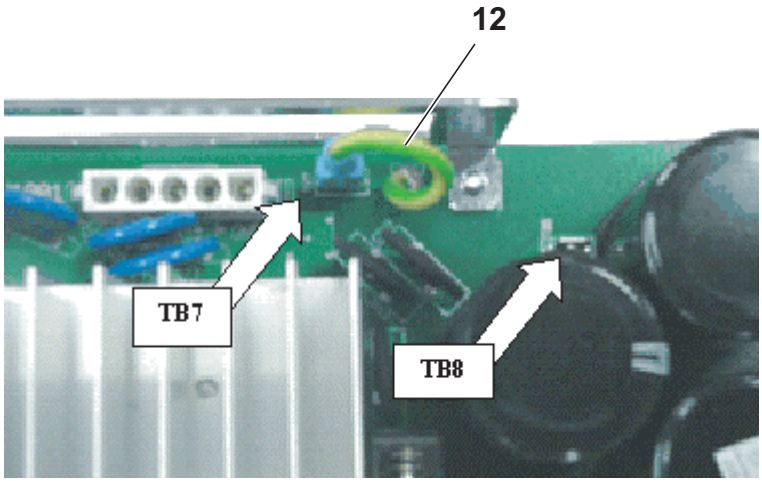


Figure 8.33

- When replacing the RPS325 power supply, make sure the wire **(12)** is correctly placed, in the same position as on the original power supply.



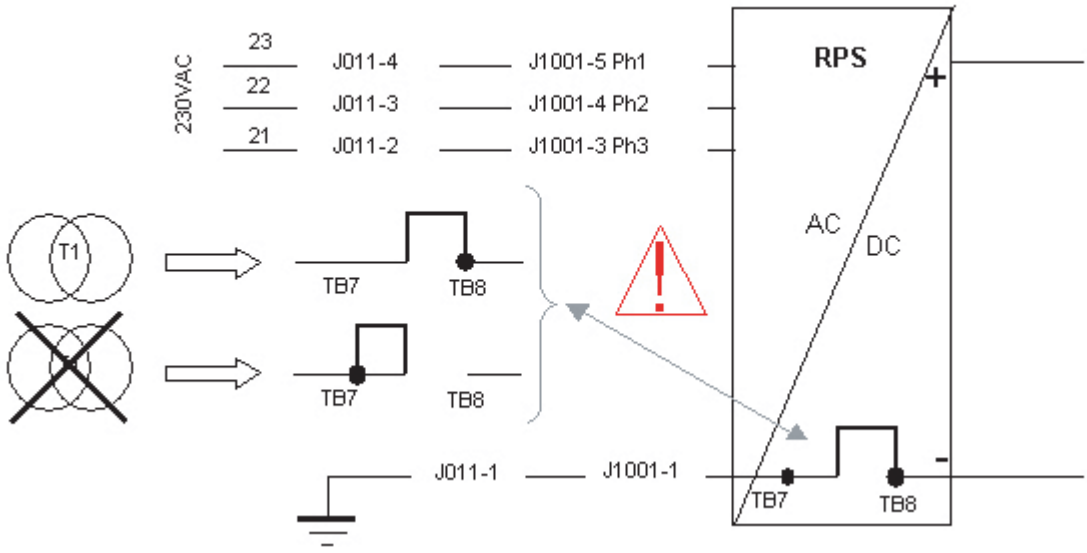


Figure 8.34

8.7.2.2. **CS8C** FOR RX160 ROBOTS

- To access the connectors, remove the **ARPS (3)** power supply wires held in place by 4 screws **(4)** (see chapter 8.6.2) and the metal plate **(5)** holding the socket and kept in place by 4 screws **(6)**.

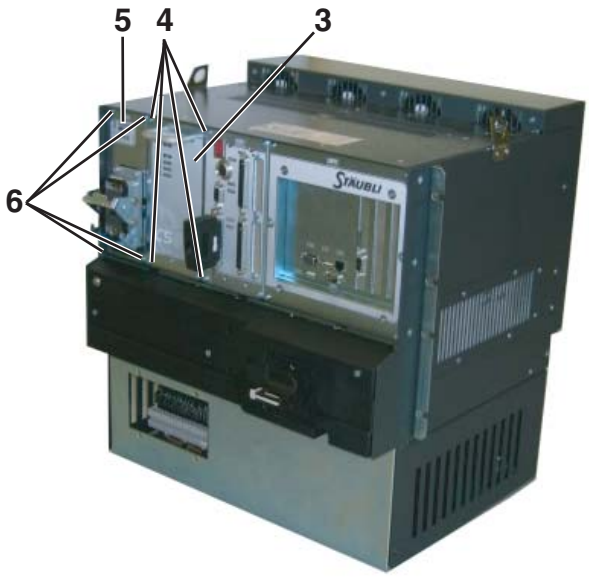


Figure 8.35

- Disconnect the connectors J1001 **(1)**, J1002 **(2)**, J1003 **(3)**, J1004 **(4)**, J1005 **(5)**.

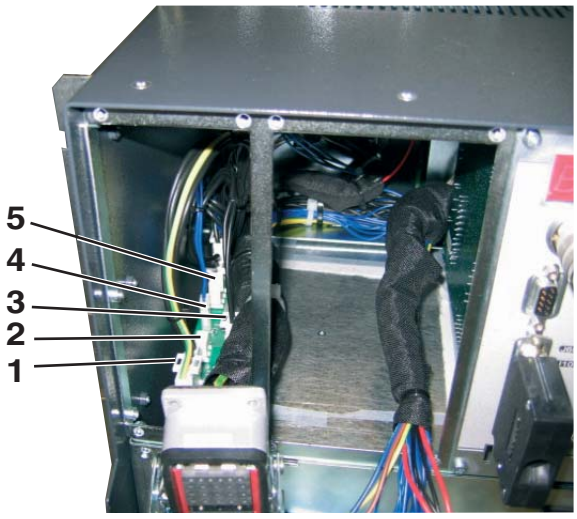


Figure 8.36

- Remove the plastic cover **(2)** held in place by 3 screws **(1)**.

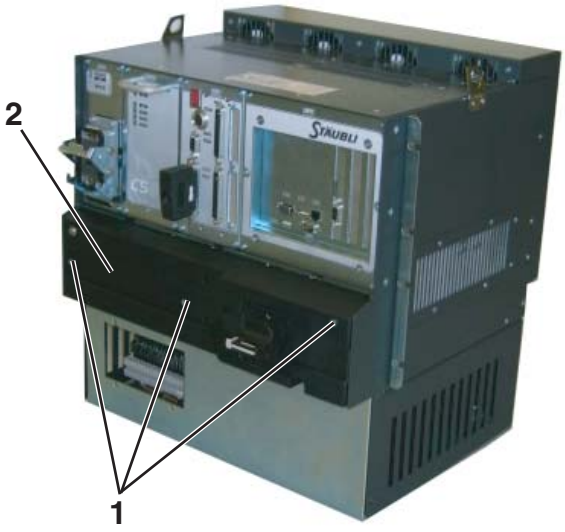


Figure 8.37

- Remove the 8 screws **(2)** holding the **PSM (6)** power module in place.

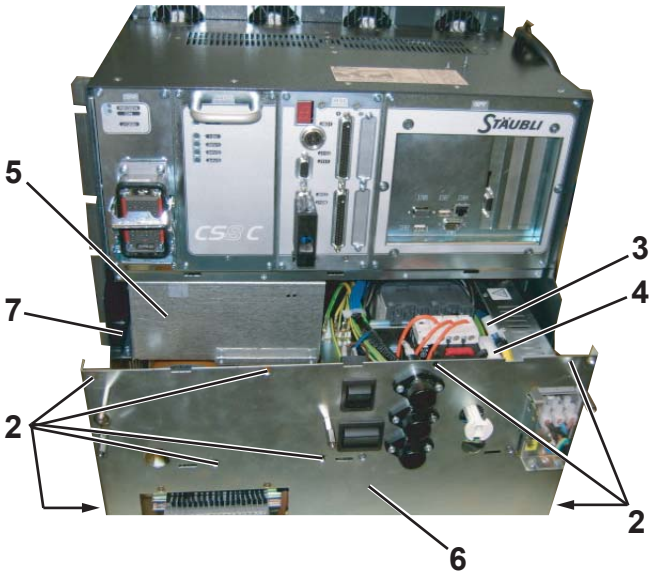


Figure 8.38

CAUTION:
The PSM is heavy; take all necessary precautions to avoid dropping it and to avoid making efforts in an incorrect position.

- Pull the **PSM (6)** forward to take it out. To remove it completely, disconnect connectors J010 **(3)** and J011 **(4)**.
- To access the **RPS (5)** power supply, lift it up in front to extract it from the fixing point **(7)**, and then pull it to free it from the rear lug.

8.7.3. TROUBLE SHOOTING

8.7.3.1. CASE 1

Problem:

ON indicator light remains off when arm is powered.

Solution: Step 1

- Check D2 circuit breaker inside PSM:
  - If it is off, turn it on. It may be due to a temporary overload on power part.
  - If it comes back to off position, change D2.
  - If its light remains off when it is turned on:
    - Check fuses F1, F2, F3.
    - Change D2.

Solution: Step 2

- Check the operation of PS1/PS2: Output command signals and feedback information can be checked from MCP Control Panel and RSI 7-segments error codes.

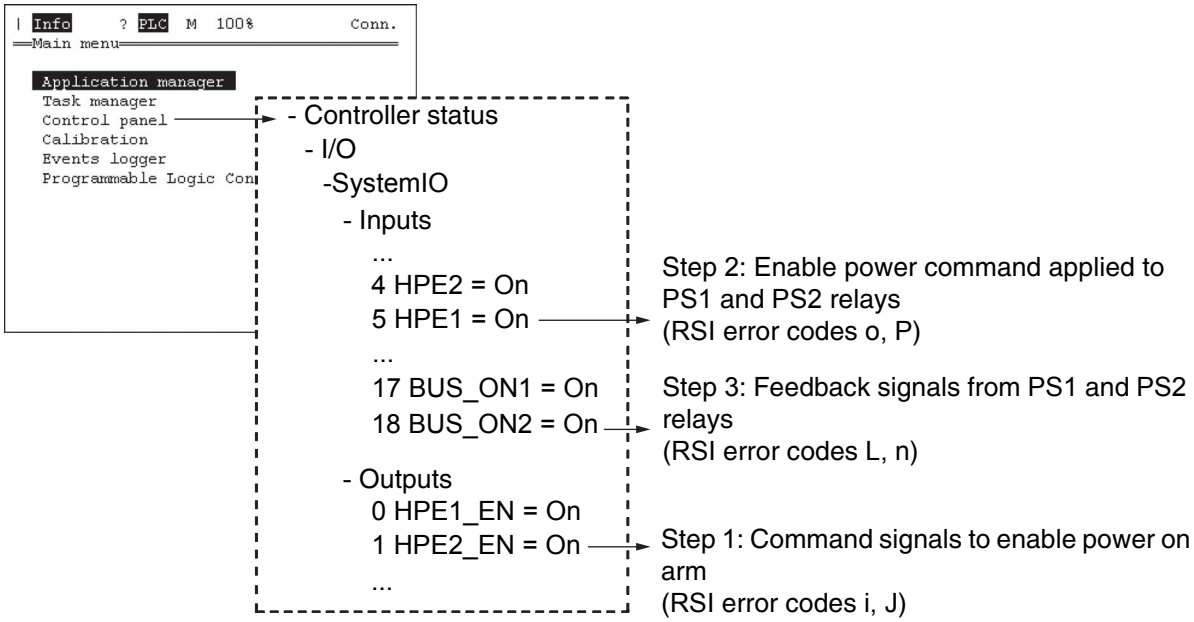


Figure 8.39

HPEx_EN	HPEx	BUS_ONx	ACTION
Arm is Off			
OFF	OFF	OFF	Normal status when arm is Off
ON	OFF	-	Change the RSI
OFF	ON	-	Change the RSI
OFF	OFF	ON	Bad connection in the wiring between RSI and PS1/PS2 or PS1/PS2 defective
Arm enable power sequence requested			
OFF	OFF	OFF	Change the RSI
ON	OFF	OFF	Change the RSI
ON	ON	OFF	PS1/PS2 relays are not operating or there is a bad connection in the wiring between RSI and PS1/PS2
Arm is On			
ON	ON	ON	Correct status when arm is powered on

Solution: Step 3

- Check PWR_OK signal from MCP Control Panel.
- If PWR_OK signal is off, change RPS.

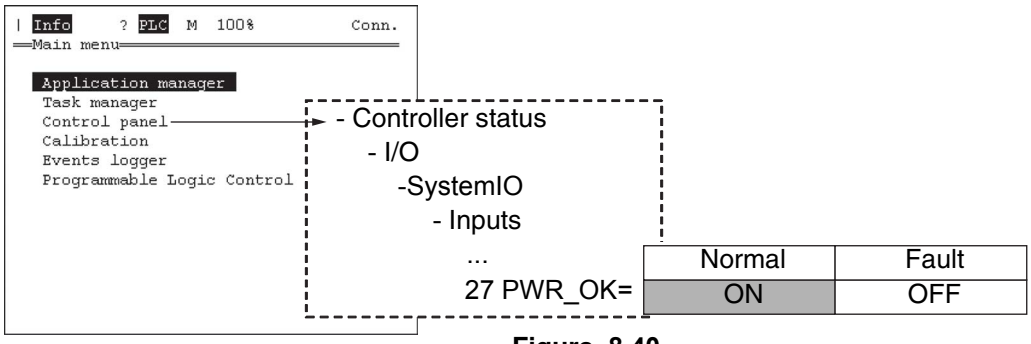


Figure 8.40

8.7.3.2. CASE 2

Problem:

REGEN indicator light (yellow) remains on.

Solution:

- Change RPS and check that regeneration resistor has not been damaged.

Regeneration resistor is located at the back of **CS8C**.

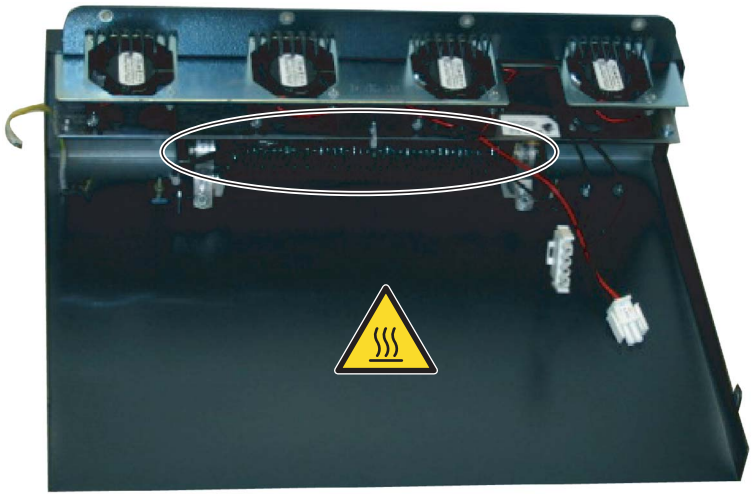


Figure 8.41

8.7.3.3. CASE 3

Problem:

Not able to move the arm due to the error message "... under voltage ..." or "... envelop error ...". The DC bus voltage applied to the amplifiers is too low or power requested from amplifier is too high.

Solution: Step 1

- Check that main voltage is correct according to identification plate of the controller. In case of 3-phase, it is important to verify voltages on the 3 phases.
- Check fuses F1, F3.
- Check D2 circuit breaker.

Solution: Step 2

- If error occurs only when arm is accelerating very high:
  - Check that payload conforms to the arm specifications.
  - Reduce speed and/or acceleration parameters in the application program.

Solution: Step 3

- Check in manual brake release mode that there are no damages to the mechanics.

DANGER:

Refer to safety chapter (3).

Pay attention to risks related to the size of the robot, the size of the payload, and so on when using Brake Release mode.

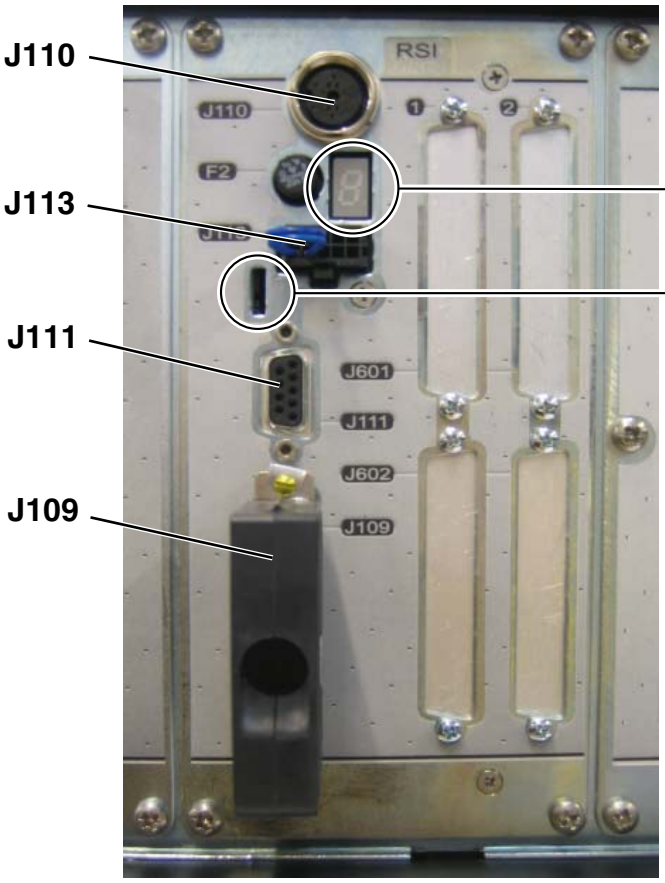
8.8. RSI

Note:
*First **CS8C** controller generations were equipped with RSI(1) board which changed to RSI2 from 2007. "RSI" applies for both RSI(1) and RSI2 where RSI(1) or RSI2 applies specifically to a dedicated board version.*

8.8.1. DESCRIPTION

RSI board manages all hardware signals for safe operation of the robot.

RSI2 board front view:



A 7-segment display indicates status of internal signals. Refer to page 209 for error codes.

Power status is indicated with green lights:
D49: 24 V power supply
D50: 5 V internal power supply
D52: 5 V power supply from STARC2 board
D74: Valve 2 through F5 fuse
D73: Valve 1 through F6 fuse

Refer to pages 204 and 208 for trouble shooting.

Figure 8.42

8.8.2. ACCESS

- Remove the 4 screws **(1)** and pull the RSI **(2)**.

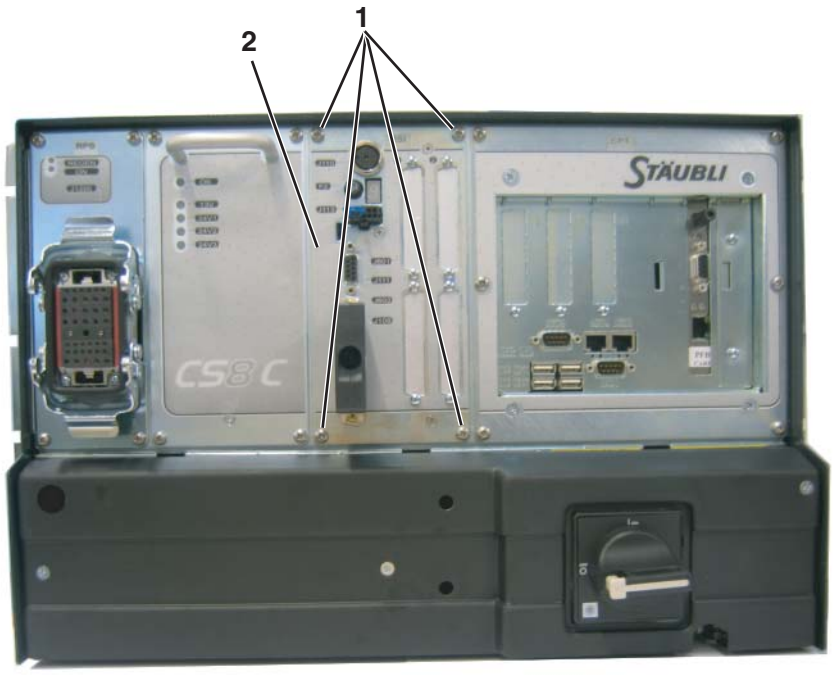


Figure 8.43

8.8.3. TROUBLE SHOOTING

8.8.3.1. CASE 1

Problem:

D49 remains off (24V1 from ARPS).

Solution:

- Check ARPS (see chapter 8.6, page 176).
- Check wiring between ARPS J1102 and RSI J104.

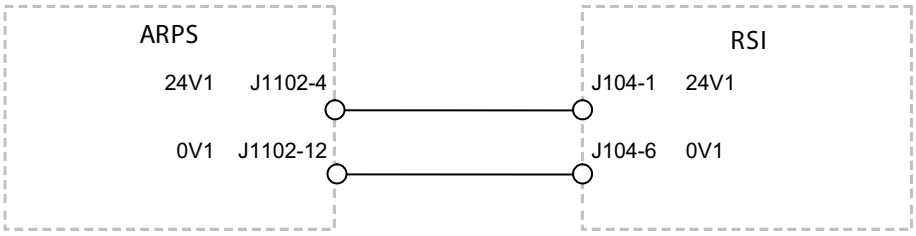


Figure 8.44

- Change the RSI.

8.8.3.2. CASE 2

Problem:

D52 remains off (5V from STARC).

Solution:

- Check 5V on STARC (see chapter 8.9, page 232).
- Check wiring between STARC J302 and RSI J100.
- Change the RSI.

8.8.3.3. CASE 3

Problem:

D52 is on and D50 remains off.

Solution:

- Refer to STARC chapter (8.9) if there is an error message from STARC (STARC has the possibility to shut off 5V on RSI in case of major error).
- Check wiring between STARC J302 and RSI J100.
- Change the RSI.

8.8.3.4. CASE 4

Problem:

D73 (EV1) or D74 (EV2) remains Off when corresponding I/O on front panel is set to On.

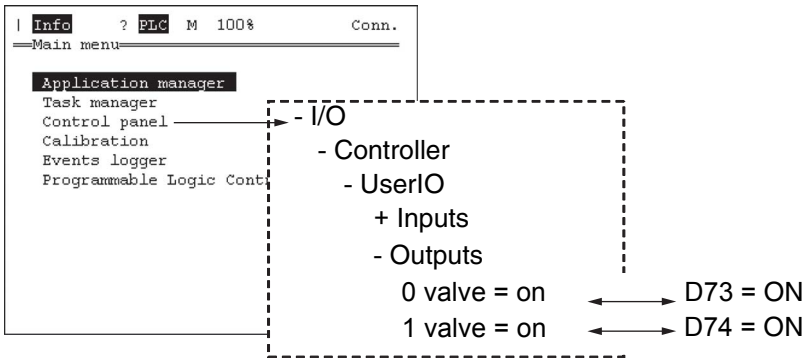


Figure 8.45

Solution:

- Check F5 and F6 fuses on RSI. If fuses are blown, check that there is no short circuit in the wiring from RSI to the arm and no short circuit in the valves.
- Change the RSI.

8.8.3.5. ADVANCED INFORMATION

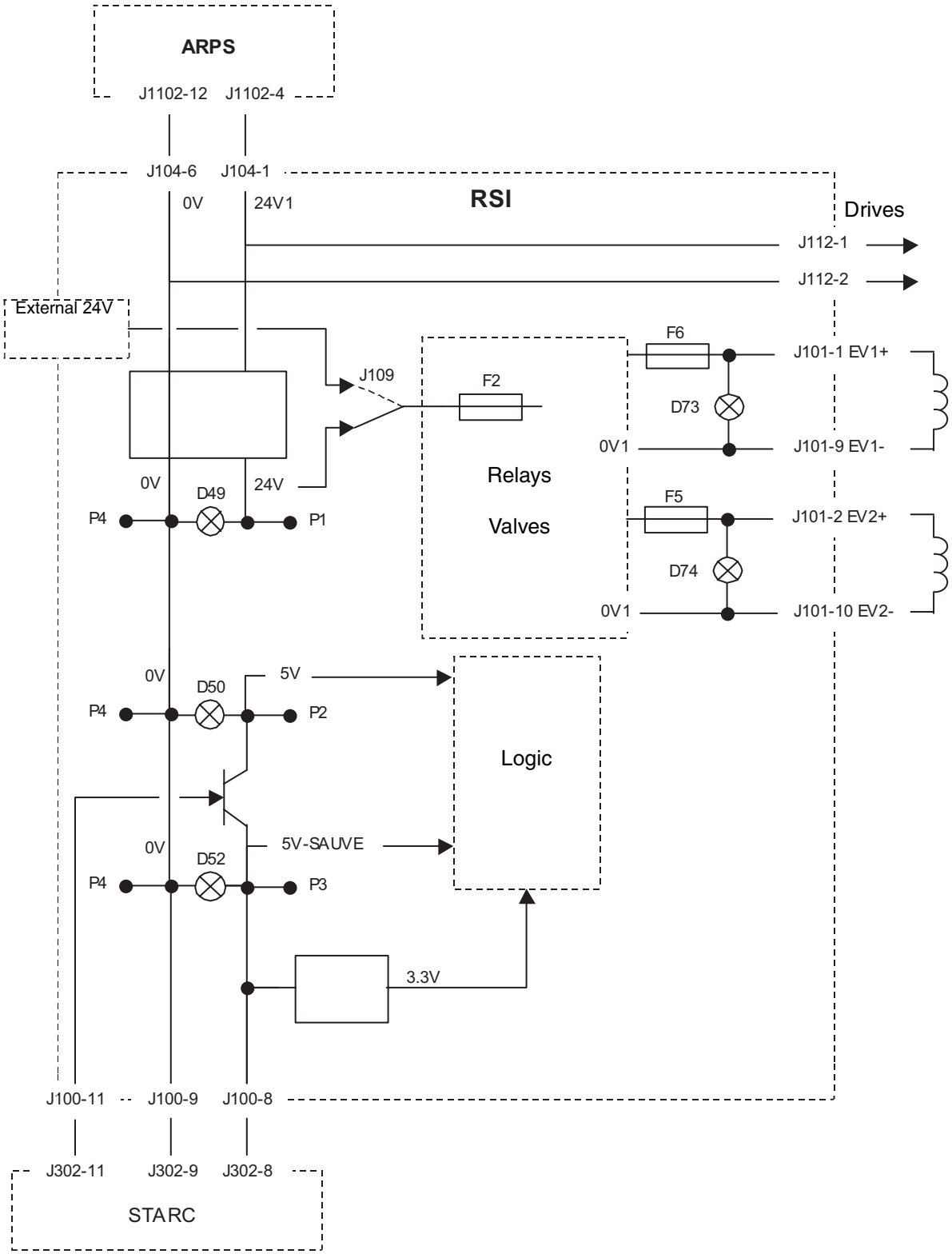


Figure 8.46

8.8.3.6. CASE 5

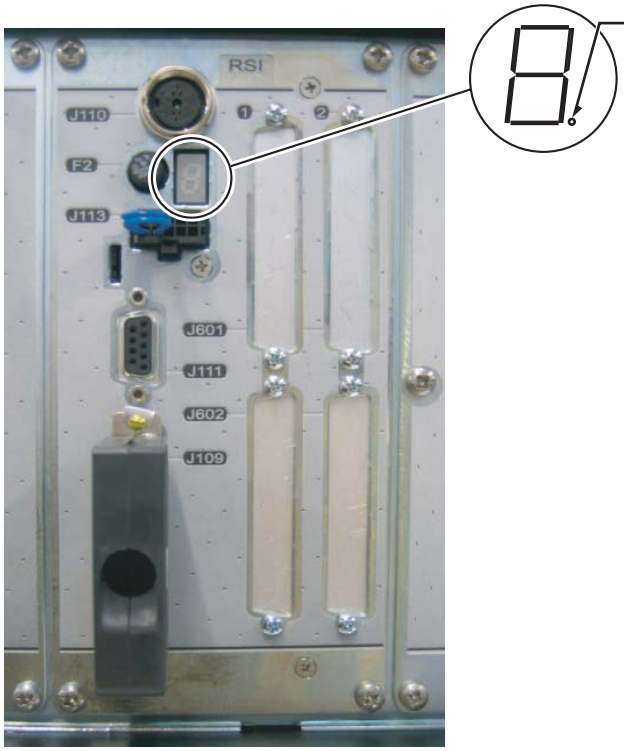
Problem:

RSI display is off, no indication.

Solution:

- If D52 is off: See chapters 8.5, 8.6, 8.7, pages 169, 176, 194.
- If D49, D50 and D52 are On:
  - Check that STARC board is operating (see chapter 8.9, page 232).
  - Change it if necessary.
  - Check wiring between STARC J302 and RSI J100.
  - Change the RSI.

8.8.4. ERROR CODES ON 7-SEGMENT DISPLAY



E - **E** flashing (page 211)
r - **r** flashing (page 211)
0 **(0)** (page 212)
5 - 5 + pt left flashing (page 212)
. - **(i)** (page 213)
0 **(0)** (page 213)
1 **(1)** (page 213)
2 **(2)** (page 214)
3 **(3)** (page 214)
4 **(4)** (page 216)
5 **(5)** (page 217)
6 **(6)** (page 218)
7 **(7)** (page 218)
8 **(8)** (page 219)
9 **(9)** (page 219)
A **(A)** (page 222)
a **(a)** (page 222)
b **(b)** (page 223)
C **(C)** (page 223)
c **(c)** (page 224)
d **(d)** (page 224)
e **(e)** (page 225)
E **(E)** (page 226)
F **(F)** (page 226)
H **(H)** (page 226)
h **(h)** (page 227)
U **(U)** (page 227)
y **(y)** (page 227)
. **(i)** (page 227)
J **(J)** (page 228)
L **(L)** (page 228)
n **(n)** (page 228)
o **(o)** (page 229)
P **(P)** (page 229)
r **(r)** (page 230)
t **(t)** (page 231)
u **(u)** (page 231)

Figure 8.47

When switching on controller, the RSI display goes through intermediate steps where the 7-segment and right point are alternatively flashing.

DISPLAY APPEARANCE	STATUS
E - **E** flashing	The **RSI** board is waiting to be synchronised with the **STARC** board
r - **r** flashing	The **STARC** board is waiting to be synchronised with the computer
5 - 5 + pt left flashing	Waiting for the "Safety" task to start
. - **(i)**	Waiting for the power supply to be switched on

This sequence lasts approximately 2 minutes.

Trouble shooting when display remains on intermediate error codes with 7-segment and point alternatively flashing.

8.8.4.1. CASE 1

Problem:

E - **E** flashing	The **RSI** board is waiting to be synchronised with the **STARC** board

Solution:

- If it remains on this status:
  - Check STARC board (see chapter 8.9, page 232).
  - If STARC is OK:
    - Check wiring between STARC J302 and RSI J100.
    - Change the RSI.

8.8.4.2. CASE 2

Problem:

r - **r** flashing	The **STARC** board is waiting to be synchronised with the computer

Solution:

If it remains on this status, the issue is related to STARC board (see chapter 8.9, page 232).

8.8.4.3. CASE 3

Problem:

0 **(0)**	**NACK I2C** error: Communication problem between the **STARC** and **RSI** boards

Solution:

- Check wiring between STARC J302 and RSI J100. If this error occurs when arm is powered, pay attention to the correct shielding of this cable.

View of computer card cage:

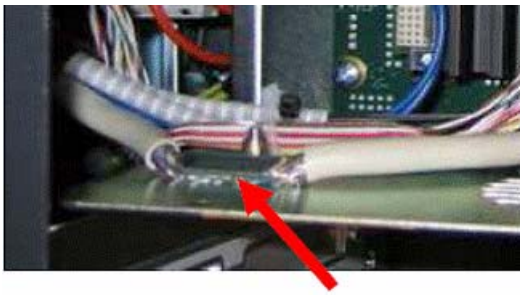


Figure 8.48

- This error can also be created from external noisy signals coming to the **RSI** board: E-Stop lines, I/O signals ...

8.8.4.4. CASE 4

Problem:

5 - 5 + pt left flashing	Waiting for the "Safety" task to start

Solution:

- If it remains on this status, change CPU board.

Note:
Changing a CPU board requires an intervention level 2 or 3 to set up parameters of the new CPU (level 2 if CPU is preconfigured, level 3 if not).

8.8.4.5. CASE 5

When initialisation ends up properly, display is:

- **(i)** Waiting for the power supply to be switched on

Note:
From this step, left point is flashing fast.

8.8.4.6. CASE 6

Problem:

- **(0)** Regeneration thermoswitch: Contact J1303, 3-4 open

Solution:

- RSI(1) case: Either J117 on RSI or J1303, 3-4 at the back of **CS8C** are defective (bad contacts) (the regeneration thermoswitch is not implemented).
- RSI2 case: This input does not exist.

8.8.4.7. CASE 7

Problem:

- **(1)** **RSI** board power supply problem: J104, 1-6 or internal power supplies

Solution:

RSI is powered from ARPS 24V1 output.

- If 24V1 led on ARPS is Off:
  - See chapter 8.6, page 176.
- If 24V1 led on ARPS is On:
  - Check wiring between ARPS J1102 and RSI J104.

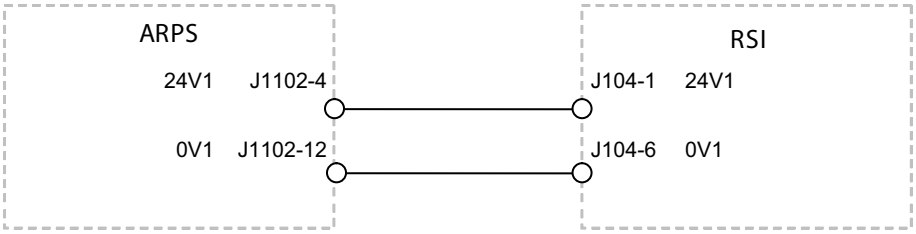


Figure 8.49

- If wiring is OK, change RSI.

8.8.4.8. CASE 8

Problem:

2 **(2)** **Watch Dog** open: Computer failure

Solution:

- A major failure has been detected on the CPU:
  - Reboot controller.
- If this error code remains:
  - Change the CPU.

Note:
Changing a CPU board requires an intervention level 2 or 3 to set up parameters of the new CPU (level 2 if CPU is preconfigured, level 3 if not).

8.8.4.9. CASE 9

Problem:

3 **(3)** Electric stop activated in the arm: J101, 5-12

Solution:

An open electric limit switch condition has been detected.

Note 1:
The presence and number of electrical limit switches depends on arm type (see figure 8.51).

Note 2:
With RSI(1) board, limit switch circuit is powered from 24V.
With RSI2 board, limit switch circuit is powered from 24Vfus.

- Check first F2 fuse on front of RSI2 (refer to error code #7).
- Check that arm is inside the defined range through MCP Front Panel information.

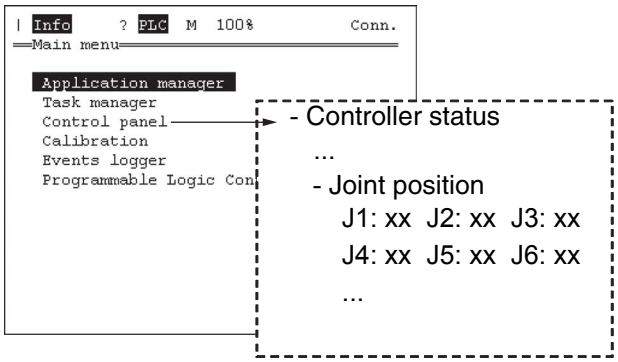


Figure 8.50

The maximum angular range is defined in the robot' product characteristics.

- If arm is inside its predefined range, check wiring inside the arm.

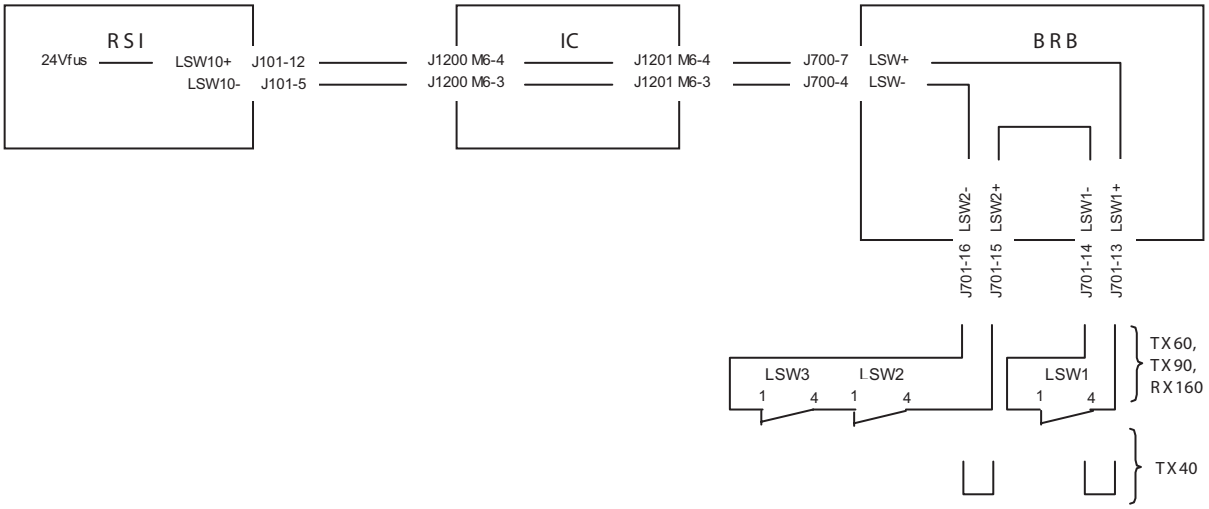


Figure 8.51

- Check wiring from RSI to the arm base (mainly the interconnection cable).
- If wiring is OK, change RSI board.

Problem:

4 **(4)**	Amplifier fault: Contact **DF** open on J112, 3-4. The events history can be used to find the number of the amplifier concerned, and it provides further information on the fault. The control panel can also be used to display the status of the various variable speed drives.

Solution:

- Before checking faults on drives, check first that STARC board is operating properly (see chapter 8.9, page 232).
- Check on MCP Control Panel which drive is faulty and change the drive.

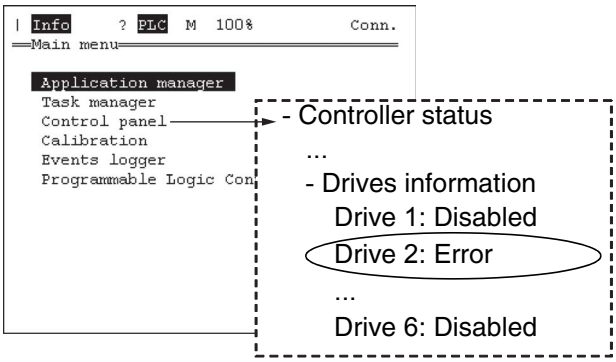


Figure 8.52

- If there is no fault on drives, check wiring between drives and RSI.

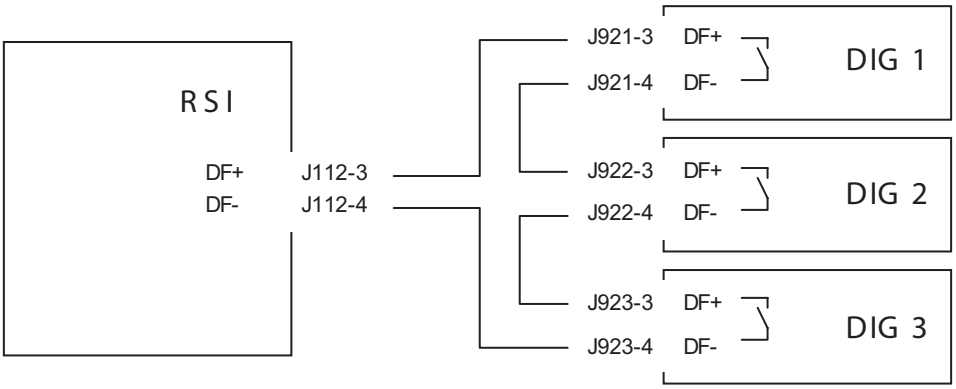


Figure 8.53

8.8.4.11. CASE 11

Problem:

5 **(5)**	**ShortR-EN** command not activated: The safety management task is not operational (computer). This error is displayed if the software has detected a blocking fault on start-up. The controller thus has no working mode, and the events history provides details on the fault detected (invalid arm configuration, etc.)

Solution:

- Reboot controller.
- If error remains, check events history in the error logger.

This signal can be activated from the CPU in case of malfunction of brakes. If it is the case:

- Check ARPS and RSI, especially the brake command signals (see chapter 8.6, page 176).

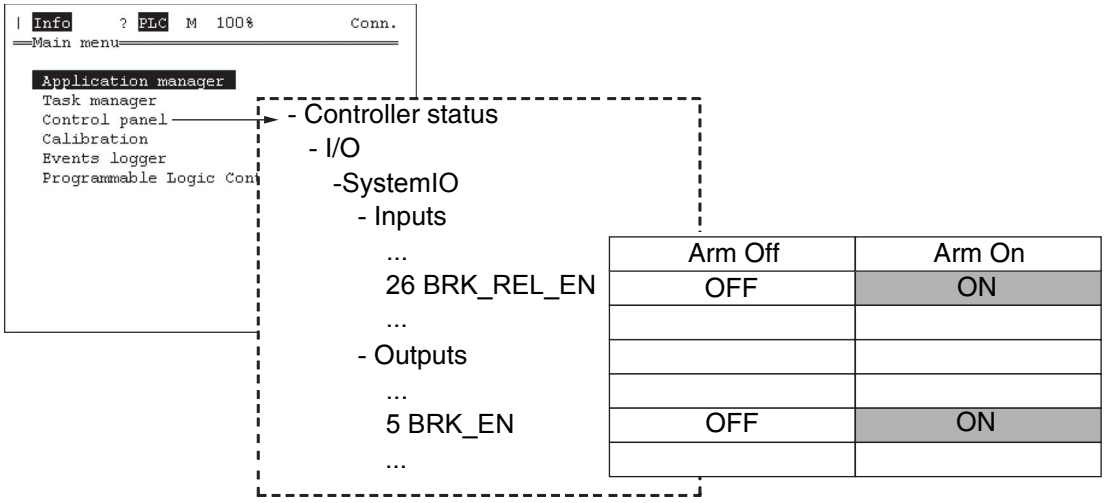


Figure 8.54

- If there is no error related to the brakes, check STARC and CPU boards (see chapter 8.9, page 232).

8.8.4.12. CASE 12

Problem:

6 **(6)** The **ShortR-EN** signal is not taken into account by the **RSI** board

Solution:

- Change the RSI.

8.8.4.13. CASE 13

Problem:

7 **(7)** Fuse **F2** unserviceable or no 24V supply on J109-37

Solution:

Internal voltage (24Vfus) for E-Stop lines is off.

- If E-Stop lines are powered from **CS8C**:
  - Check that there is no short circuit between E-Stop lines.
  - Change F2 fuse.
- If E-Stop lines are powered from an external device:
  - Check that external 24 V is provided between J109-19 (+24 V) and J109-37 (0 V).
  - Check that there is no short circuit between E-Stop lines.
  - Change F2 fuse.

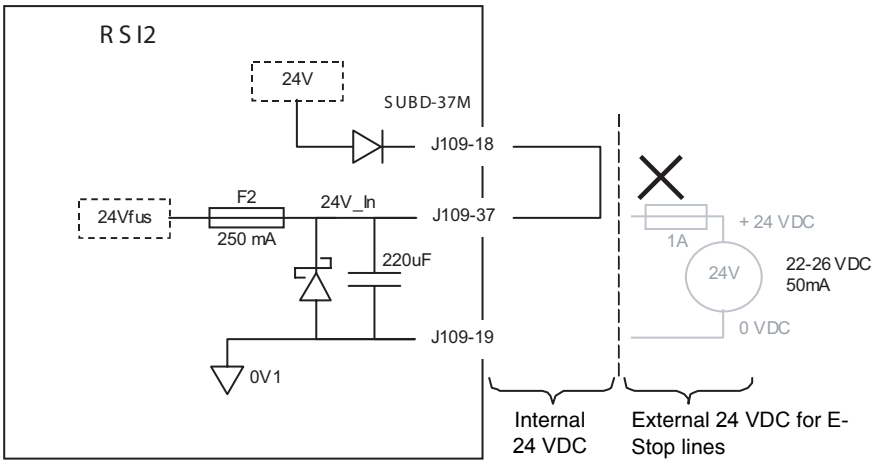


Figure 8.55

8.8.4.14. CASE 14

Problem:

8 **(8)**	**MCP** emergency stop 1 activated: Contact **MCPES1**, J110 S-J or **WMS** emergency stop activated: Contact **WMSES1**, J113, 1-2
9 **(9)**	**MCP** emergency stop 2 activated: Contact **MCPES2**, J110 T-U or **WMS** emergency stop activated: Contact **WMSES2**, J113, 6-7

Solution:

There is one E-Stop contact open on MCP (Manual Control Pendant) or WMS (Working Mode Selection) devices.

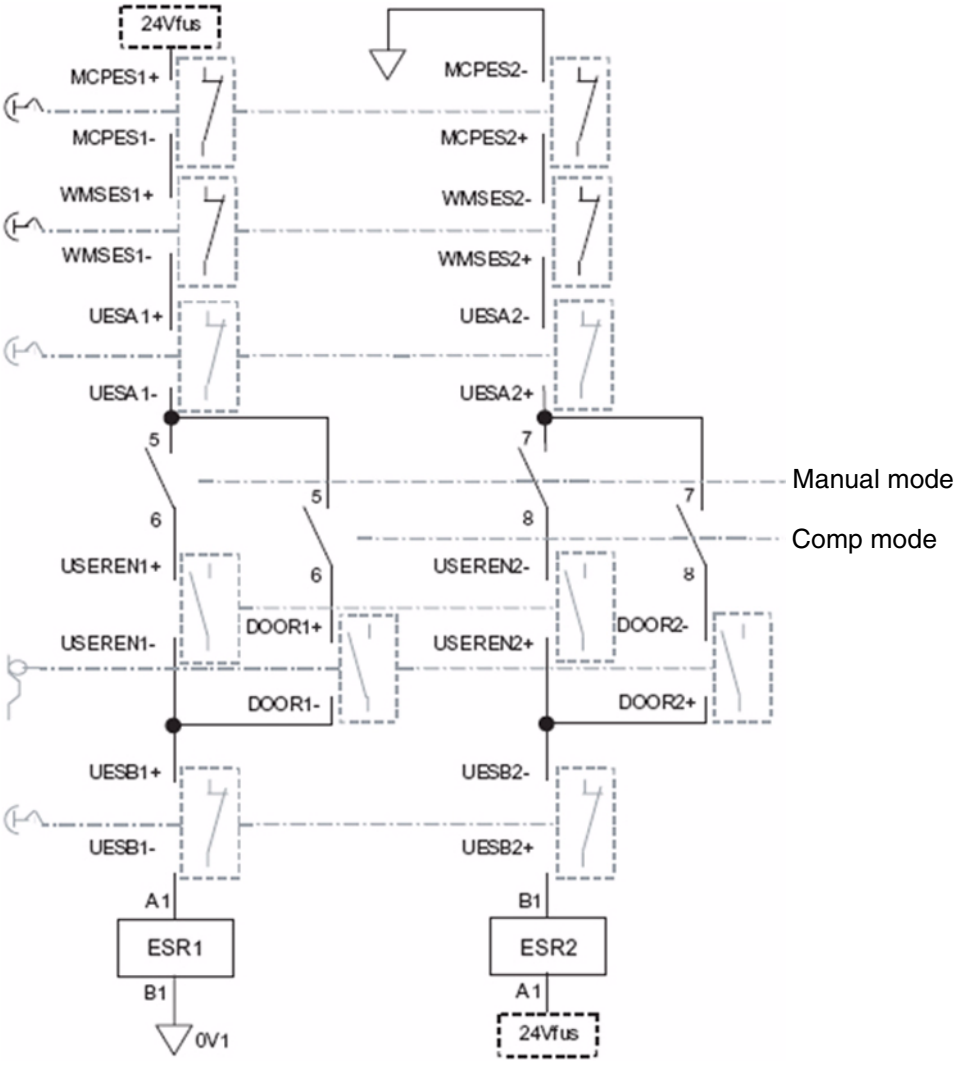


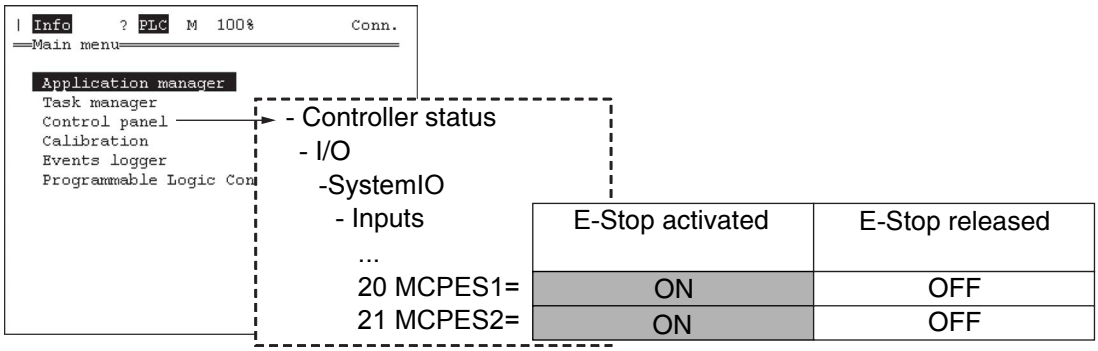
Figure 8.56

- MCP is connected on J110:
  - Check that MCP connector is properly plugged and screwed on J110.
  - Check that MCP E-Stop is released:
    - If error remains, disconnect MCP and replace it with J110 dummy plug provided with **CS8C**:
      - If error disappears, change MCP.
      - If error remains, change RSI.

DANGER:

If only one E-Stop contact is operating, the robot will be stopped but unsafely. It is mandatory to repair the E-Stop line to get both contacts operating: No error code on RSI and same status on both E-Stop lines on MCP Control Panel.

Note:
Status of MCP E-Stop push button can be obtained from MCP Control Panel:



	E-Stop activated	E-Stop released
20 MCPES1=	ON	OFF
21 MCPES2=	ON	OFF

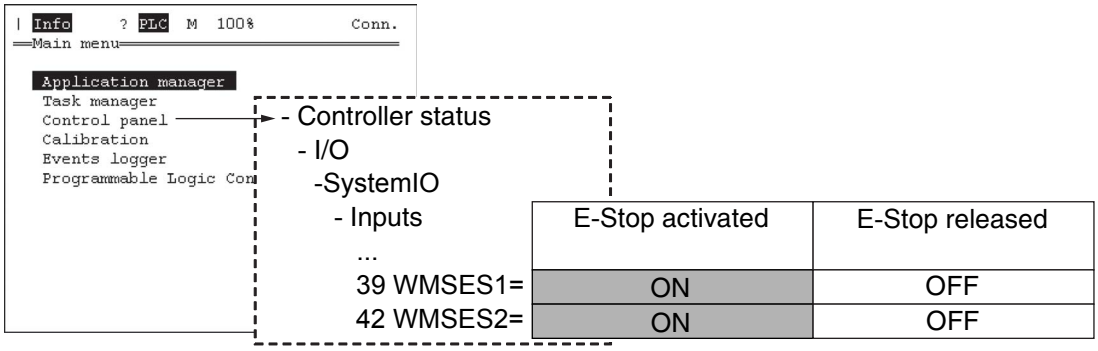
Figure 8.57

- WMS is connected on J113:
  - Check that WMS connector is properly plugged on J113.
  - Check that WMS E-Stop is released:
    - If error remains, disconnect WMS and replace it with J113 dummy plug provided with **CS8C**:
      - If error disappears, change WMS or its cable.
      - If error remains, change RSI.

DANGER:

If only one E-Stop contact is operating, the robot will be stopped but unsafely. It is mandatory to repair the E-Stop line to get both contacts operating: No error code on RSI and same status on both E-Stop lines on MCP Control Panel.

Note:
Status of WMS E-Stop push button can be obtained from MCP Control Panel:



	E-Stop activated	E-Stop released
39 WMSES1=	ON	OFF
42 WMSES2=	ON	OFF

Figure 8.58

8.8.4.15. CASE 15

Problem:

(A)	User emergency stop **A1** activated: Contact **UESA1**, J109, 1-20
(a)	User emergency stop **A2** activated: Contact **UESA2**, J109, 2-21

Solution:

This E-Stop is coming from the cell and is connected to RSI J109.

- Check wiring from this E-Stop to J109 1-20 and 2-21.

DANGER:

If only one E-Stop contact is operating, the robot will be stopped but unsafely. It is mandatory to repair the E-Stop line to get both contacts operating: No error code on RSI and same status on both E-Stop lines on MCP Control Panel.

Note:
Status of manual brake release switch can be obtained from MCP Control Panel:

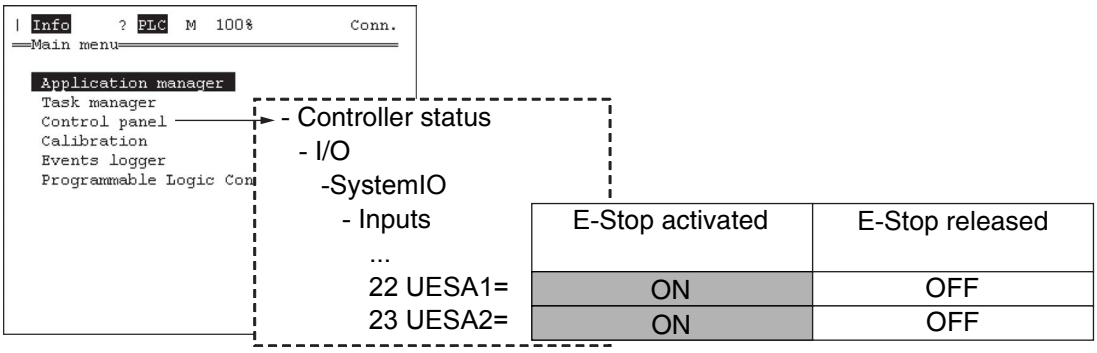


Figure 8.59

8.8.4.16. CASE 16

Problem:

b **(b)**	User emergency stop **UEN1/DOOR1** activated: Contact **USEREN1/DOOR1**, J109, 3-22/9-28
C **(C)**	User emergency stop **UEN2/DOOR2** activated: Contact **USEREN2/DOOR2**, J109, 4-23/10-29

Solution:

This E-Stop is coming from the cell and is connected to RSI J109. It is Door contact when robot is in COMP mode (automatic mode); it is UserEn contact when robot is in Manual mode.

- Check wiring from these E-Stop to J109 3-22, 4-23, 9-28 and 10-29.

DANGER:

If only one E-Stop contact is operating, the robot will be stopped but unsafely. It is mandatory to repair the E-Stop line to get both contacts operating: No error code on RSI and same status on both E-Stop lines on MCP Control Panel.

Note:
Status of UEN and DOOR can be obtained from MCP Control Panel:

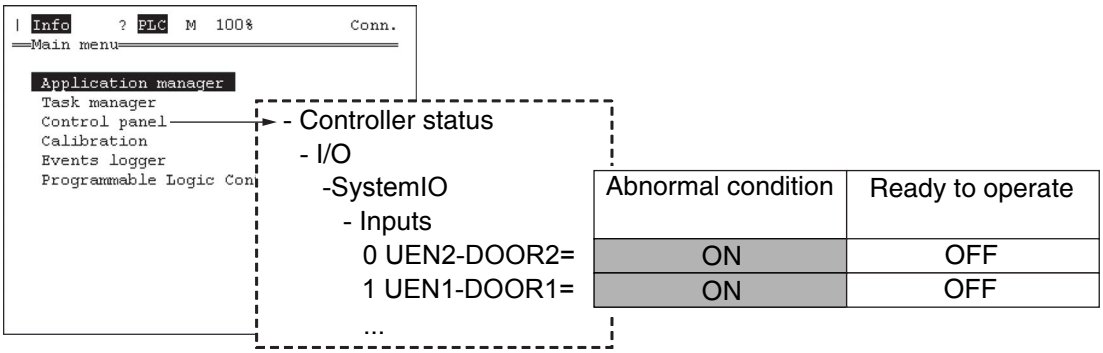


Figure 8.60

8.8.4.17. CASE 17

Problem:

c **(c)**	User emergency stop **B1** activated: Contact **UESB1**, J109, 14-33
d **(d)**	User emergency stop **B2** activated: Contact **UESB2**, J109, 15-34

Solution:

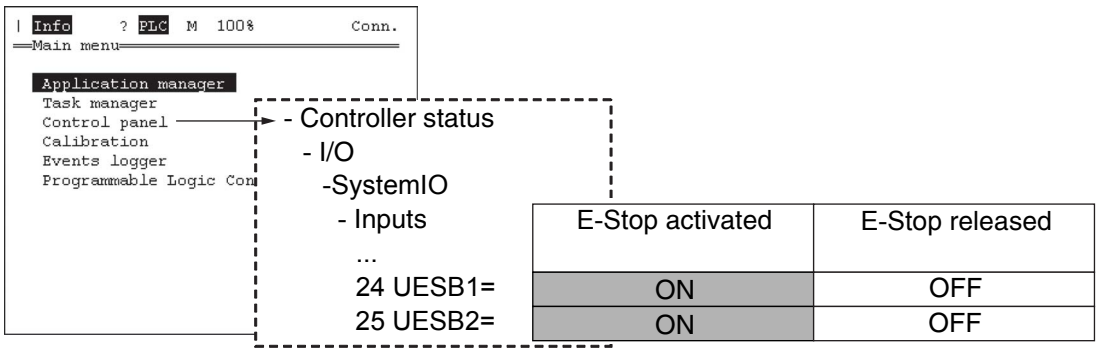
This E-Stop is coming from the cell and is connected to RSI J109.

- Check wiring from this E-Stop to J109 14-33 and 15-34.

DANGER:

If only one E-Stop contact is operating, the robot will be stopped but unsafely. It is mandatory to repair the E-Stop line to get both contacts operating: No error code on RSI and same status on both E-Stop lines on MCP Control Panel.

Note:
Status of manual brake release switch can be obtained from MCP Control Panel:



E-Stop activated	E-Stop released
ON	OFF
ON	OFF

Figure 8.61

8.8.4.18. CASE 18

Problem:

(e)	Manual brake control selected: The rotary switch at the base of the arm is not set to 0

Solution:

- Check that rotary switch at the base of the arm is in position 0.
- If error remains, shut-off **CS8C**, disconnect J1201 plug at the base of the arm and check arm wiring with an ohm-meter.

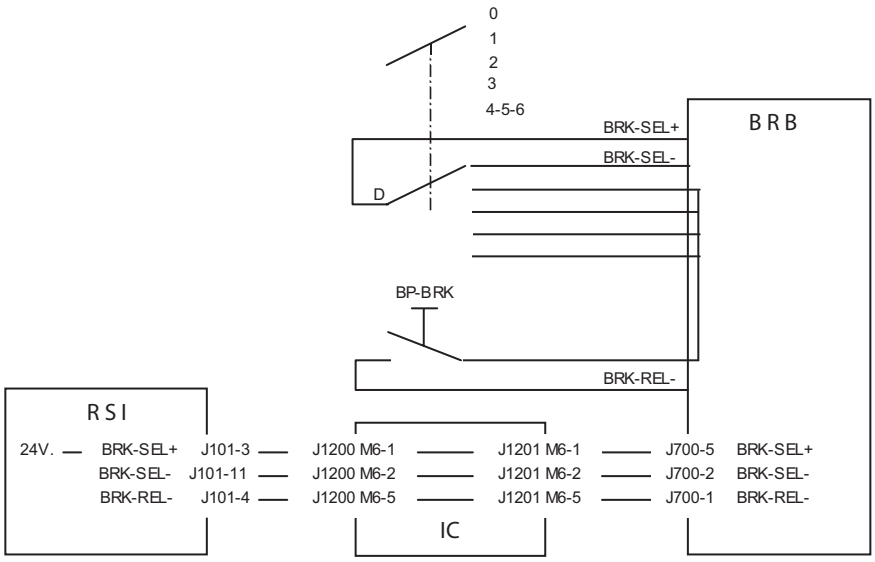


Figure 8.62

TEST BETWEEN	ROTARY SWITCH	
	POSITION 0	OTHER POSITION
M6-1 and M6-2	Close	Open
M6-1 and M6-5	Open	Closed when push button pressed

- If the above check-up is not correct, change arm harness.
- If it is correct, repeat the same test from J200 (controller side) with J1201 connected on the arm.
- If the above check-up is not correct, change controller-to-arm cable.
- If it is correct, change RSI.

Note:
Changing arm harness requires an intervention level 2.

Note:
Status of manual brake release switch can be obtained from MCP Control Panel.

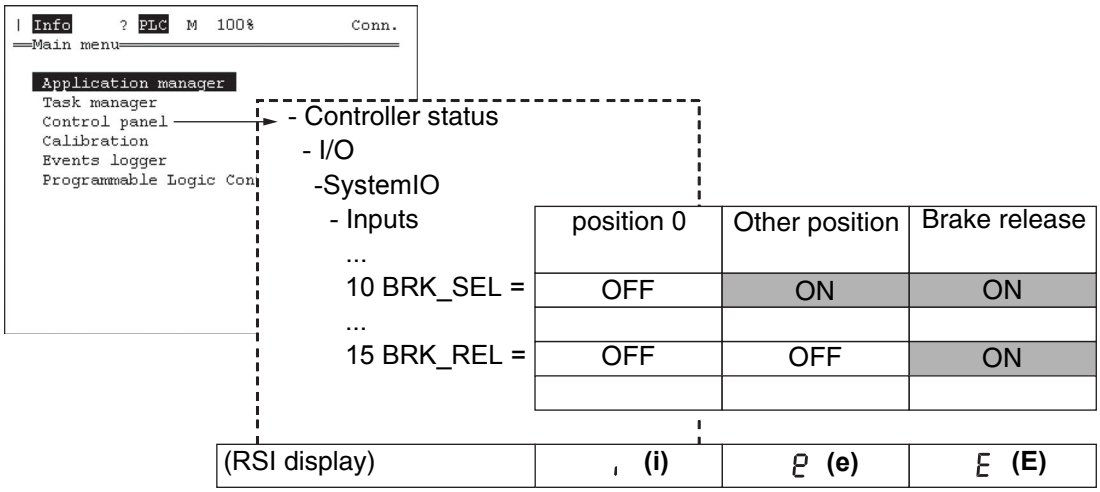


Figure 8.63

8.8.4.19. CASE 19

Problem:

(E)	Manual brake control activated: One of the brakes has been released manually

Solution:

- Refer to the case above.

8.8.4.20. CASE 20

Problem:

(F)	Manual brake control channel 1: The **BRS** 4-8 contact is not closed
(H)	Manual brake control channel 2: The **BRS** 9-13 contact is not closed

Solution:

- If manual brake release circuit is correct (see above), change RSI.

8.8.4.21. CASE 21

Problem:

h **(h)**	MCP: Enable button or parking contact not activated

Solution:

- Check that enable button on MCP is correctly pressed or that MCP is properly inserted on its cradle.
- If OK, change MCP.

8.8.4.22. CASE 22

Problem:

U **(U)**	**E-Stop 1** order memorised: An emergency stop on line 1 has been recorded by the **RSI** board. This fault is reset the next time the arm is powered up
y **(y)**	**E-Stop 2** order memorised: An emergency stop on line 2 has been recorded by the **RSI** board. This fault is reset the next time the arm is powered up

Solution:

- If this error code remains when next enable power sequence is initiated, change RSI.

> **DANGER:**
> **To ensure that the system is operating properly after this error has occurred, it is necessary to perform several E-Stop sequences with arm power enabled and robot stopped.**

8.8.4.23. CASE 23

When the robot is waiting for an enable power sequence, the display is:

(i)

The following error codes are related to an enable power sequence.

8.8.4.24. CASE 24

Problem:

i	**(i)**	Power-up command 1 not activated by the computer
J	**(J)**	Power-up command 2 not activated by the computer

Solution:

- Change the RSI.

8.8.4.25. CASE 25

Problem:

L	**(L)**	Power up sequence 1 not activated: No **PS-ON1+** signal on J105-3
n	**(n)**	Power up sequence 2 not activated: No **PS-ON2+** signal on J105-4

Solution:

- Change the RSI.

8.8.4.26. CASE 26

Problem:

o **(o)**	Power up sequence 1 not effective: **OV** on J105-7: relay **PS1** not activated or faulty contact
P **(P)**	Power up sequence 2 not effective: **OV** on J105-8: relay **PS2** not activated or faulty contact

Solution:

PS1/PS2 relays are not operating or there is a bad connection in the wiring between RSI and PS1/PS2.

The error codes above can be obtained from MCP Control Panel.

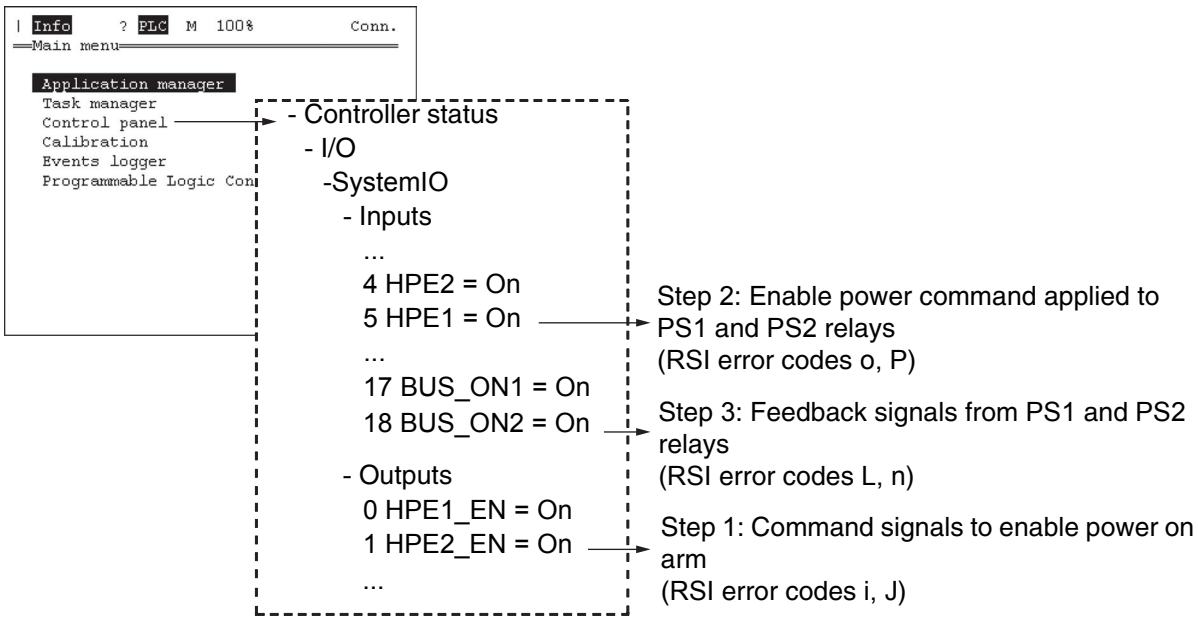


Figure 8.64

HPEx_EN	HPEx	BUS_ONx	ACTION
Arm is Off			
OFF	OFF	OFF	Normal status when arm is Off
ON	OFF	-	Change the RSI
OFF	ON	-	Change the RSI
OFF	OFF	ON	Bad connection in the wiring between RSI and PS1/PS2 or PS1/PS2 defective
Arm enable power sequence requested			
OFF	OFF	OFF	Change the RSI
ON	OFF	OFF	Change the RSI
ON	ON	OFF	PS1/PS2 relays are not operating or there is a bad connection in the wiring between RSI and PS1/PS2
Arm is On			
ON	ON	ON	Correct status when arm is powered on

8.8.4.27. CASE 27

Problem:

⌐ **(r)** **RPS** power supply not activated: Contact J105, 1-2 open

Solution:

In that case, the most common error displayed on MCP popup message is:

Internal error:
DRIVE-BusUnderVoltage

Refer to RPS chapter (8.7) to verify F1-F3 fuses, 3-phase circuit breaker and RPS.

8.8.4.28. CASE 28

Problem:

⊦	**(t)**	Braking command not activated by the computer.

Solution:

The enable arm power sequence has stopped because brake release command is not activated: Change the RSI.

8.8.4.29. CASE 29

Problem:

⊔	**(u)**	Power supply to the brakes not activated: Contact J104, 5-10 open.

Solution:

Refer to ARPS chapter (8.6) to differentiate between ARPS issue or RSI issue.

8.9. STARC BOARD

8.9.1. DESCRIPTION

STARC board does motion control, communicating with encoders for axes positions and amplifiers for motors commands.

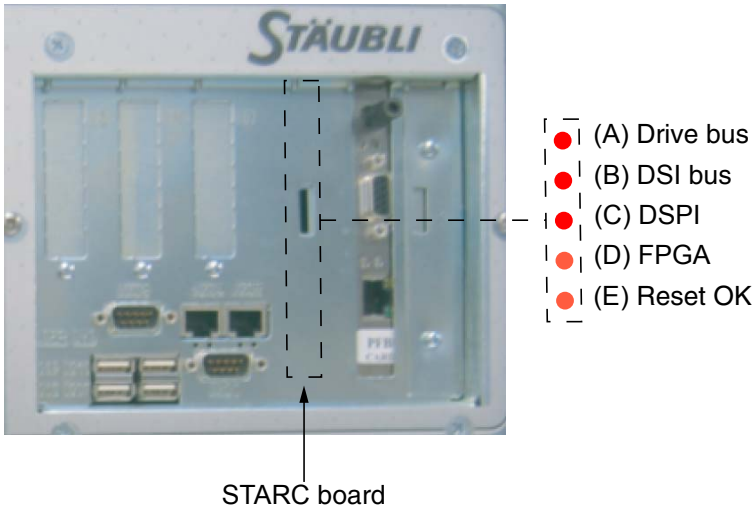


Figure 8.65

Leds A and B are blinking slowly (~ 1 s period) during boot sequence of controller.

They are blinking fast (~ 0.5 s period) when ready to operate.

8.9.2. ACCESS

- Turn off main switch S1 to position 0.
- Set aside the computer after removing the 6 fixing screws (1).
- Remove the 6 screws (2) and open the computer card cage.

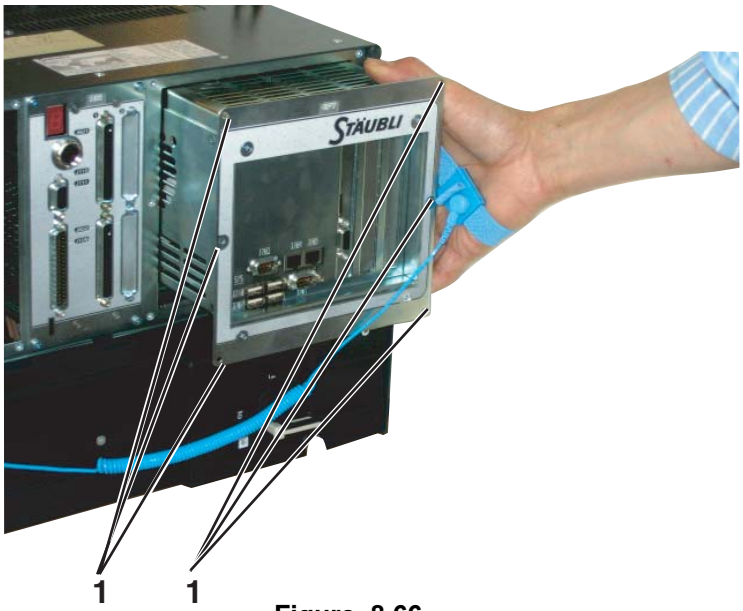


Figure 8.66

DANGER:

The heat-sink of the CPU board may be hot, especially in the event of a ventilation failure.

- The STARC board can be removed after taking out the fastening screw (3).
- The PCI boards are locked on back edge with an adjustable plate. This plate can be re-ajusted if necessary when board is replaced.

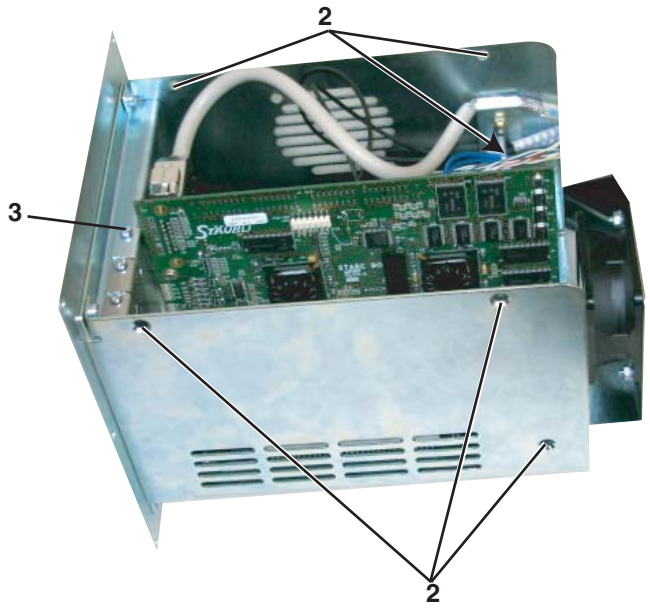


Figure 8.67

8.9.3. TROUBLE SHOOTING

8.9.3.1. CASE 1

Problem:

No lights at all on STARC.

- ○ (A)
- ○ (B)
- ○ (C)
- ○ (D)
- ○ (E)

Solution:

- Check first 24V1 on ARPS (see chapter 8.6, page 176).
- Check STARC internal power supplies leds.
  - If 5 V or 3.3 V led is off, change the CPU.
  - If one of the other leds is off, change the STARC.

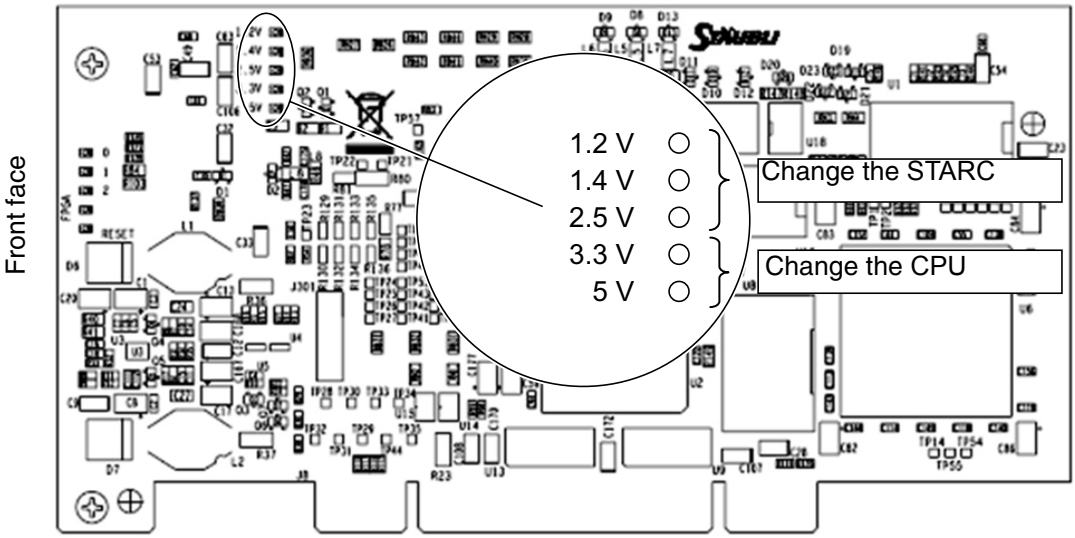


Figure 8.68

8.9.3.2. CASE 2

Problem:

Led E is on, Led D is off: Initialization of the board is faulty (FPGA programming issue).

○ (A)
○ (B)
○ (C)
○ (D)
● (E)

Solution:

- Reboot controller.
- If problem remains, change STARC board.

8.9.3.3. CASE 3

Problem:

Led E and D are on, Led C is off: STARC processor was not able to start.

○ (A)
○ (B)
○ (C)
● (D)
● (E)

Solution:

- Reboot controller.
- If problem remains, change STARC or CPU board.

Note:
Changing a CPU board requires an intervention level 2 or 3 to set up parameters of the new CPU (level 2 if CPU is preconfigured, level 3 if not).

8.9.3.4. CASE 4

Problem:

Leds E, D and C are on, Led B is blinking slowly (~ 1s period) whatever the status is of led A (blinking slow or fast): There is a communication problem between STARC and the DSI in the arm base.
In that case, it is not possible to enable power on the arm.

○ (A)
● (B) Slow
● (C)
● (D)
● (E)

Solution:

When led B is blinking slowly, all encoders (sensor) and all PTC sensors are not operating.
The information displayed on MCP control panel is the following:

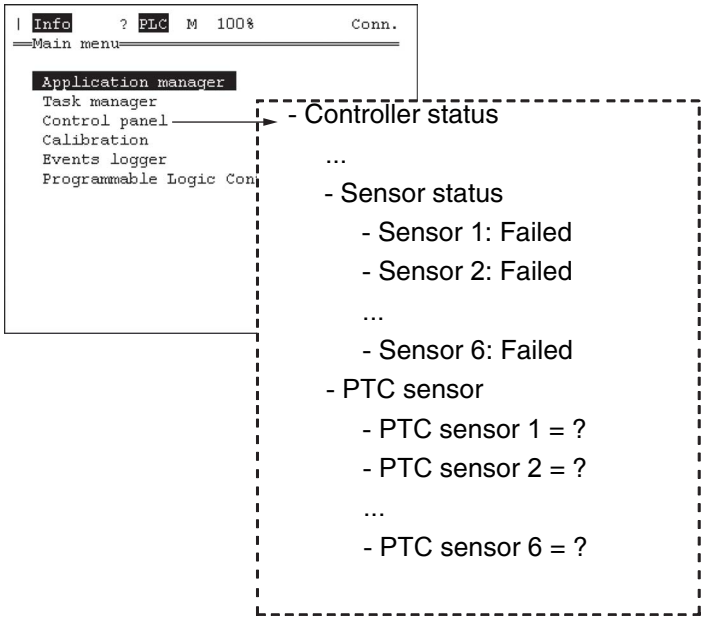


Figure 8.69

It is a generic problem which is not likely due to a specific encoder or a specific PTC sensor.

- Either the communication through optical fibber between STARC and DSI is not operating:
  - Change interconnection cable from **CS8C** to arm.
- Or the DSI board in the arm base is not operating:
  - Change the DSI.

Note:
Changing a DSI board requires an intervention level 2.

Optical fiber

- Check optical fiber between STARC board and arm to ensure that there is no visible damage and no dust on optical fibber connectors, especially for the interconnection cable.

DANGER:

Do not stand with your eyes directly opposite the optical fiber when it is lit, in order to avoid damage to the eyes.

- Check that there is red light coming out from STARC J306 connector. If there is not light or if it seems very dim:
  - Change STARC board.
- Check that there is not an angle on optical fiber inside **CS8C** or inside arm.

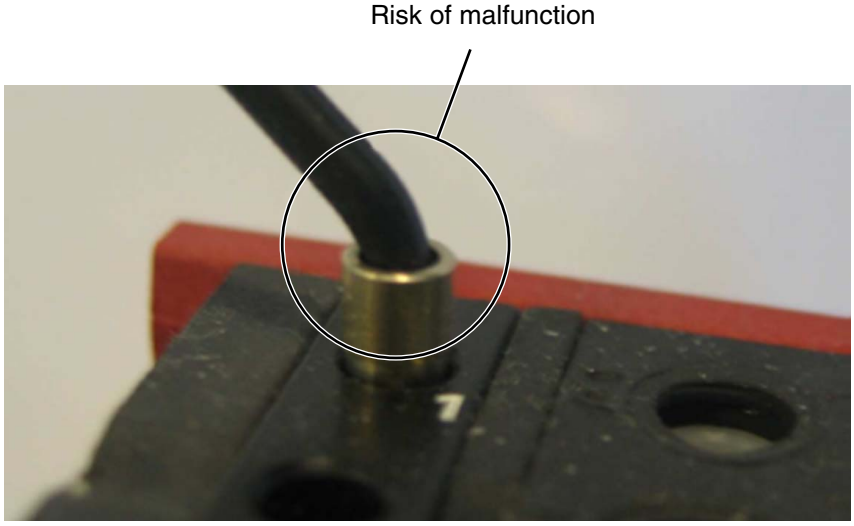


Figure 8.70

- Check that there is red light coming back on STARC optical fiber connector J307.
- Change defective part if necessary.

Note:
Changing arm harness requires an intervention level 3.

DSI

If optical fiber looks good:

- Check that the 13 V led on ARPS is On (see chapter 8.6, page 176).

If ARPS 13 V light is on:

- Open the robot base and check the D1 light on DSI.

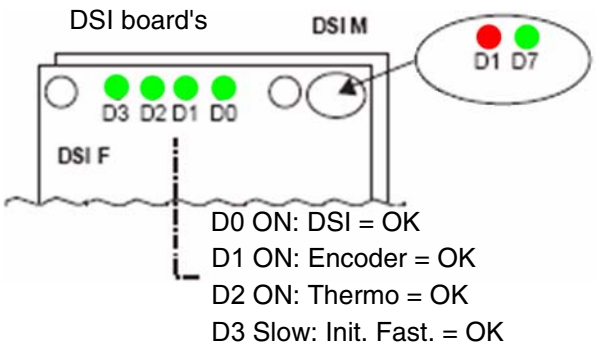


Figure 8.71

If D1 is off:

- Check the 13 V wiring between ARPS and DSI.

If D1 is on:

- Change the DSI.

Note:
Changing a DSI board requires an intervention level 2.

DSI advanced information

Common lines for all encoders:

- 13 V power supply.
- DSI.
- Optical fiber.
- 5 V from DSI to encoders.

Individual lines:

- DSI to encoder communication.

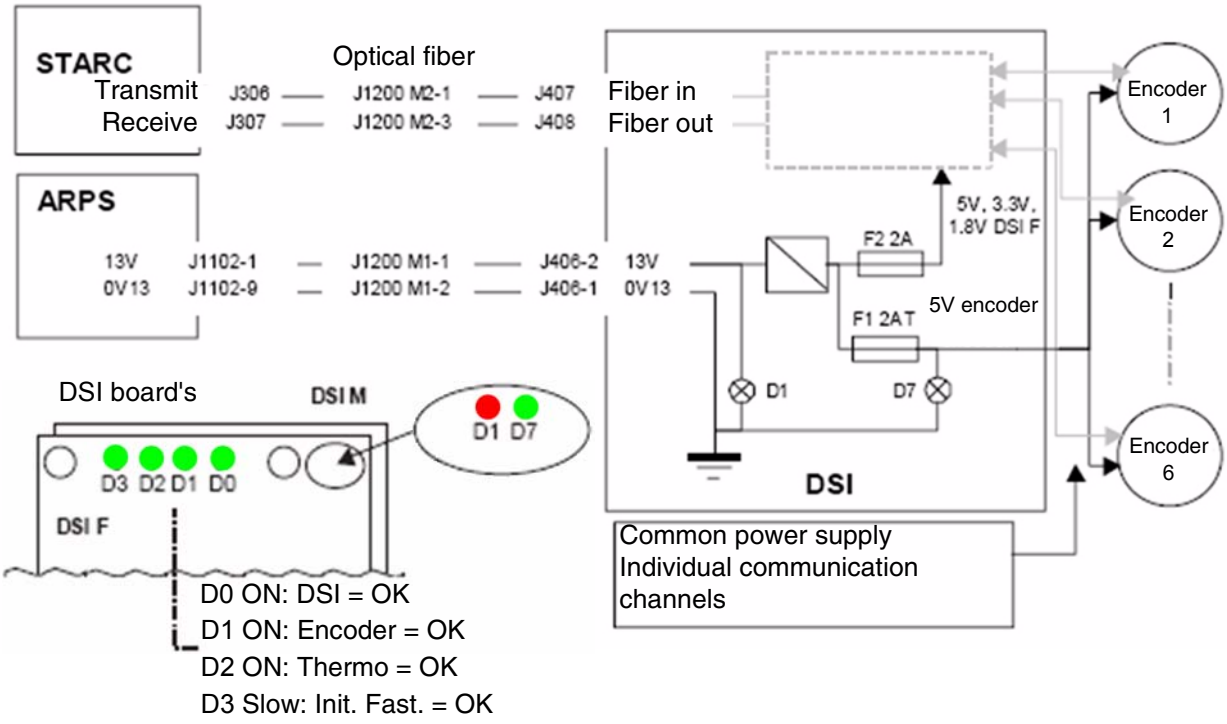


Figure 8.72

8.9.3.5. CASE 5

Problem:

Led A is blinking slowly (~ 1 s period) after the boot sequence: There is a communication problem with the amplifiers.

- (A) Slow
- (B) Fast
- (C)
- (D)
- (E)

Note:

If both leds A and B are blinking slowly, check first the led B issue (previous paragraph).

Solution:

When only led A is blinking slowly the STARC to drives communication is not operating, the information displayed on MCP control panel is the following:

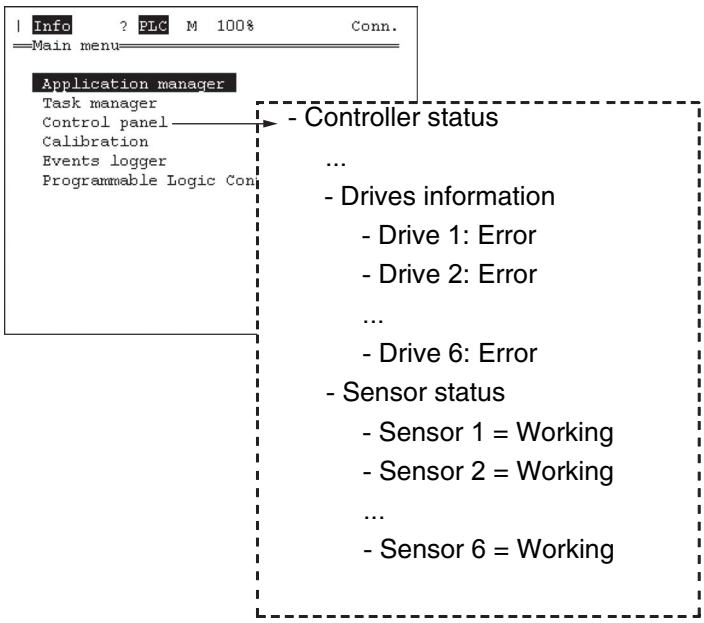


Figure 8.73

Step 1

- Check flat cable between STARC board and the drives.

If cable has some damage:

- Change the cable.

Step 2

- Check that each drive is properly powered with 24 V: Led = On.
  - If one drive has a led off, check 24 V power supplier cables.
  - If power supplies are OK, change drive(s).

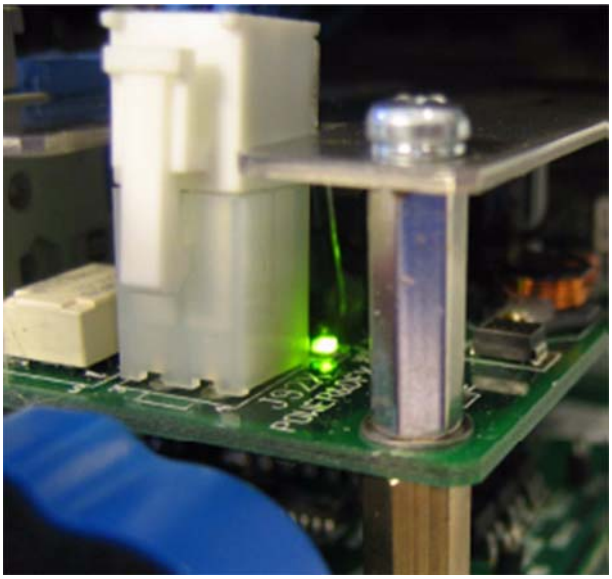


Figure 8.74

Step 3

- Change the STARC.

8.10. PREVENTIVE MAINTENANCE

DANGER:

Disconnect all the electrical and pneumatic power supplies before carrying out any work on the controller or the arm. Wait for at least 1 mn before starting to work.

8.10.1. VENTILATION

The air filter on the ventilaton system must be cleaned and/or replaced as and when necessary, depending on its level of fouling.

8.10.2. RECOMMENDED SPARE PARTS

- 10.3 x 38 fuse, rating depending on the voltage and the type of arm:

	THREE-PHASE 400-480 V	THREE-PHASE 200-230 V	SINGLE PHASE 230 V	SINGLE PHASE 115 V
TX40	4Am	6Am	10Am	16Am
TX60 - RS	4Am	8Am	10Am	16Am
TX90	6Am	12Am	–	–
RX160	8Am	16Am	–	–

- 250 mA and 500 mA microfuse.
- **STARC** board.
- Amplifier (drive): one of each type.

TX40	TX60	TX90	RX160	RS
4/9 + 4/9	4/9 + 8/22	4/9 + 8/22	8/22 + 15/45	4/9 + 8/22

- **BIO** board.
- **RSI** board.
- **CPU** board.
- **MCP**.
- Air filter.

APPENDIX

APPENDIX 1

Protection of the power line for the CS8C controller

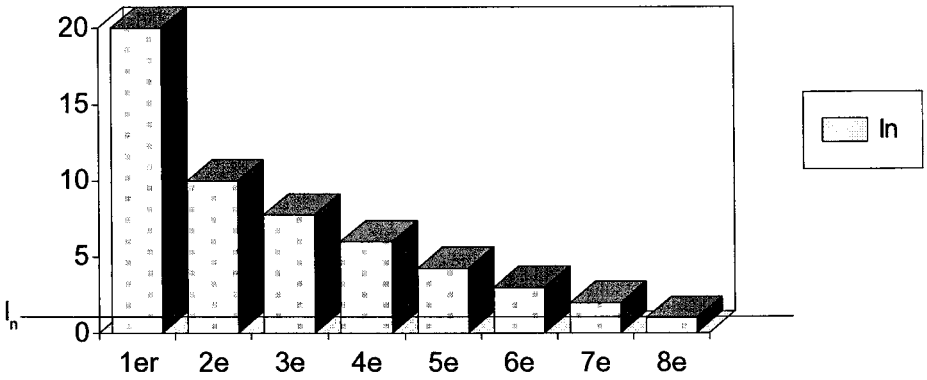
I. CONTROLLER CHARACTERISTICS

The **CS8C** controller is protected at its input from risks of short-circuits by Am type fuses.

The load on the primary circuit depends on the type of arm installed, the voltage rating of the power supply and the type of network (single phase or three-phase) (load = current in the controller power supply circuit when the arm is operating).

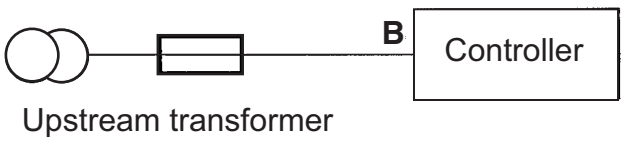
Robot	Power installed
TX40	1,5 kVA
TX60	1,7 kVA
TX90	2 kVA
RX160	3 kVA
RS	1,7 kVA

When the controller is powered on, a surge current is generated. The current reaches the level of continuous duty after ª 8 periods, i.e. ≈ 160 ms for a 50 Hz power frequency. The first peak of the surge current is ª 20 x In.



II. PROTECTION UPSTREAM FROM THE CONTROLLER

The protections upstream from the controller are used to protect the secondary circuits of the upstream transformer from overcurrents and short-circuits.



You need to install one of the following:

- the gl fuses
- a magneto thermic breaker, type U
- a magneto thermic breaker, type D

Choice of the protection: the NF C 15-100 standard provides the calculation method for the protection against surges and short-circuits.

Summary:

1) Protection against surges:

The degree of protection must be less or equal to secondary surge current of the upstream transformer. This current depends on the electrical installation of the customer.

2) Protection against short-circuits:

Calculate minimum short-circuit current at the furthest point in the installation (in B) and choose the protection level so as to get a disconnection time < 5 s for this current.

$$Icc\ mini = \frac{Us}{\frac{Us^2}{P} \times \frac{Ucc\%}{100} + \frac{2\rho l}{S}}$$

Us = secondary voltage of the upstream transformer
P = power of the upstream transformer
Ucc% = short-circuit voltage of the upstream transformer in %

These characteristics are printed on the identification plate of the upstream transformer

l = length of the line (in metres).
S = section of the line (in mm²). The wire sections must be chosen according to the current demand, the temperature rise, the potential difference on the line, ...
ρ = 0.027 Ω mm²/m for copper

Size of gl fuse: In<=Icc mini / 4
Breaker, type U: In<=Icc mini / 8
Breaker, type D: In<=Icc mini / 3.5

3) Use the functioning curves of both the breakers and the fuses to check that the power disconnection happens in less than 5 s for the selected size:

Example:

Us = 400V
P = 10 kVA
Ucc% = 4%
l = 20 m
S = 6 mm²
ρ = 0.027 Ω mm²/m

$$Icc\ mini = \frac{400}{\left(\frac{400^2}{10^4} \times \frac{4}{100}\right) + \frac{2 \times 0.027 \times 20}{6}} = 488\ A$$

For a breaker, type U: In<=488 / 8 = 61 A.

the size immediately lower is 52 A.

At the short-circuit current, the disconnection happens in less than 5 s.