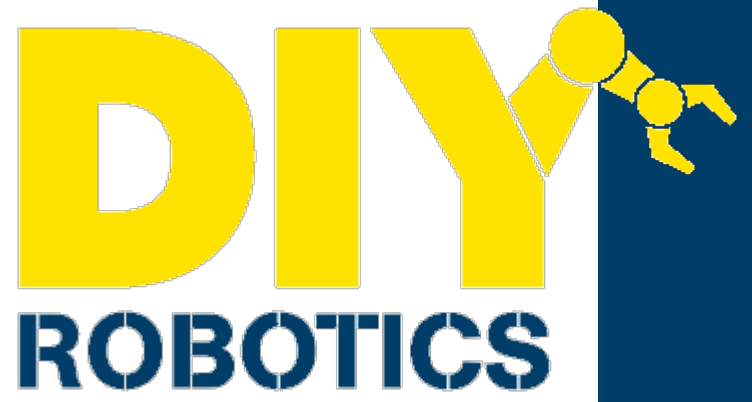


USER MANUAL

ASTRO
CELLS



AUGUST 2019

TABLE OF CONTENT

SECURITY AND RISK MANAGEMENT	3
1. Operator’s responsibilities	3
2. Security components.....	3
3. Lockout procedure	3
ROBOTIC CELL COMPONENTS.....	5
1. Robotic cell description	5
2. FANUC Robot	5
3. Command board	5
4. 24V Electrical Command Panel.....	6
a) General description.....	7
b) Inputs/Outputs (I/O)	7
5. Eletrical power panel (optionnal).....	7
6. Electrical hydraulic lifting system.....	8
7. Pneumatic system.....	8
TEACH PENDANT AND PROGRAMS.....	9
1. HMI	9
2. Basic programs	11
a) Background Logic Programs.....	11
b) Production cycle programs	12
c) Other programs.....	13
3. Dual Check Safety for collaborative robots (DCS)	14
4. Alarms.....	15
PRODUCTION IN AUTO MODE.....	16
1. Command board	16
2. Start a sequence in Auto mode	16
MAINTENANCE.....	17
1. Procedure for moving the cell.....	17
2. FANUC Robot.....	17

SECURITY AND RISK MANAGEMENT

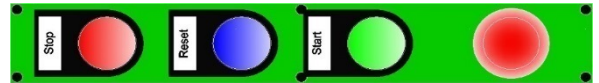
The robotic cell is designed to perform programmed tasks. These tasks must be performed safely. Therefore, the operator must respect certain safety rules. The manufacturer of the robotic cell has provided certain devices to ensure the safety of the operator. It is best to read this section carefully, as well as other sections, before using the robotic cell.

1. Operator's responsibilities

The operator must ensure that nothing obstructs the running of the different equipment of the machine. He must also point out any abnormalities of the machine that may be dangerous or any condition of the machine that seems abnormal. Negligence on the part of the operator could cause serious injury to himself or others.

2. Security components

The DIY Robotics cell has 3 different E-Stop buttons. There is one on the robot teach pendant, one on the robot controller and one on the command box. These buttons should only be used in case of an emergency. Pressing one of them causes the robot and all linked systems (custom installation by the customer) to an immediate stop. Repeated use of these devices may cause mechanical premature wear or damage to the robot.



3. Lockout procedure

Any maintenance intervention should be done with the power disconnect switch to OFF position and main air valve shut off. They should be locked closed. Shut the main air valve first. Make sure the air pressure indicates zero. Then, shut off the main power switch. Please refer to your company lockout procedure.

If any intervention is needed to be done on cell, refer to internal safety procedure of your company.

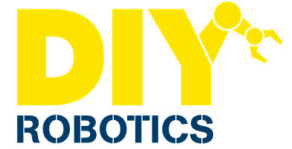
The main power switch is located on the robot controller. The main air inlet is the red valve on the pneumatic panel.

The person doing the work should keep the keys in their possession to prevent someone else from pressurizing the air system or inadvertently turning on the cell. Refer to your employer's internal health and safety procedure to properly apply this lockout procedure

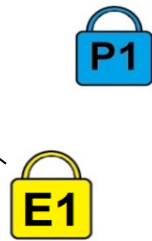
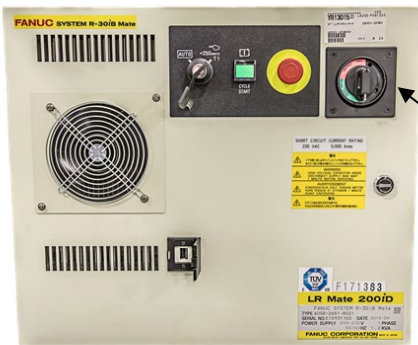


LOCKOUT PROCEDURE

ASTRO



IMPORTANT: ONLY PERSONNEL WHO RECEIVED TRAINING IS AUTHORIZED TO PERFORM THIS PROCEDURE



Energy source	Identifications	Tasks	Verifications
PNEUMATIC		1D–Close the main inlet valve 1E–Padlock the valve	1F–Try to turn the valve ON and check the air pressure gauge, it should indicate 0.
ELECTRICAL		1G–Shut down the electrical power with the main power switch on the robot controller 1H–Padlock the main switch handle.	1I–Try to turn the main power switch to ON position.

ROBOTIC CELL COMPONENTS

1. Robotic cell description

Astro robotic cells are available in 36 inches by 36 inches size. These cells are equipped with wheels providing them to be moved easily anywhere needed.

2. FANUC Robot

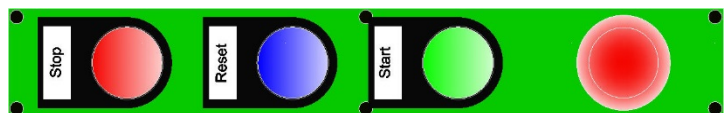
The robotic cell is equipped with a **FANUC CR-4iA**, **CR-7iA** or **CR-7iA / L** robot depending on what choice the customer made.

	CR-4iA	CR-7iA	CR-7iA / L
Number of axes	6	6	6
Reach	550 mm	717 mm	911 mm
Payload	4 Kg	7 Kg	7 Kg
Maximum speed	500 mm/s	500 mm/s	500 mm/s



3. Command board

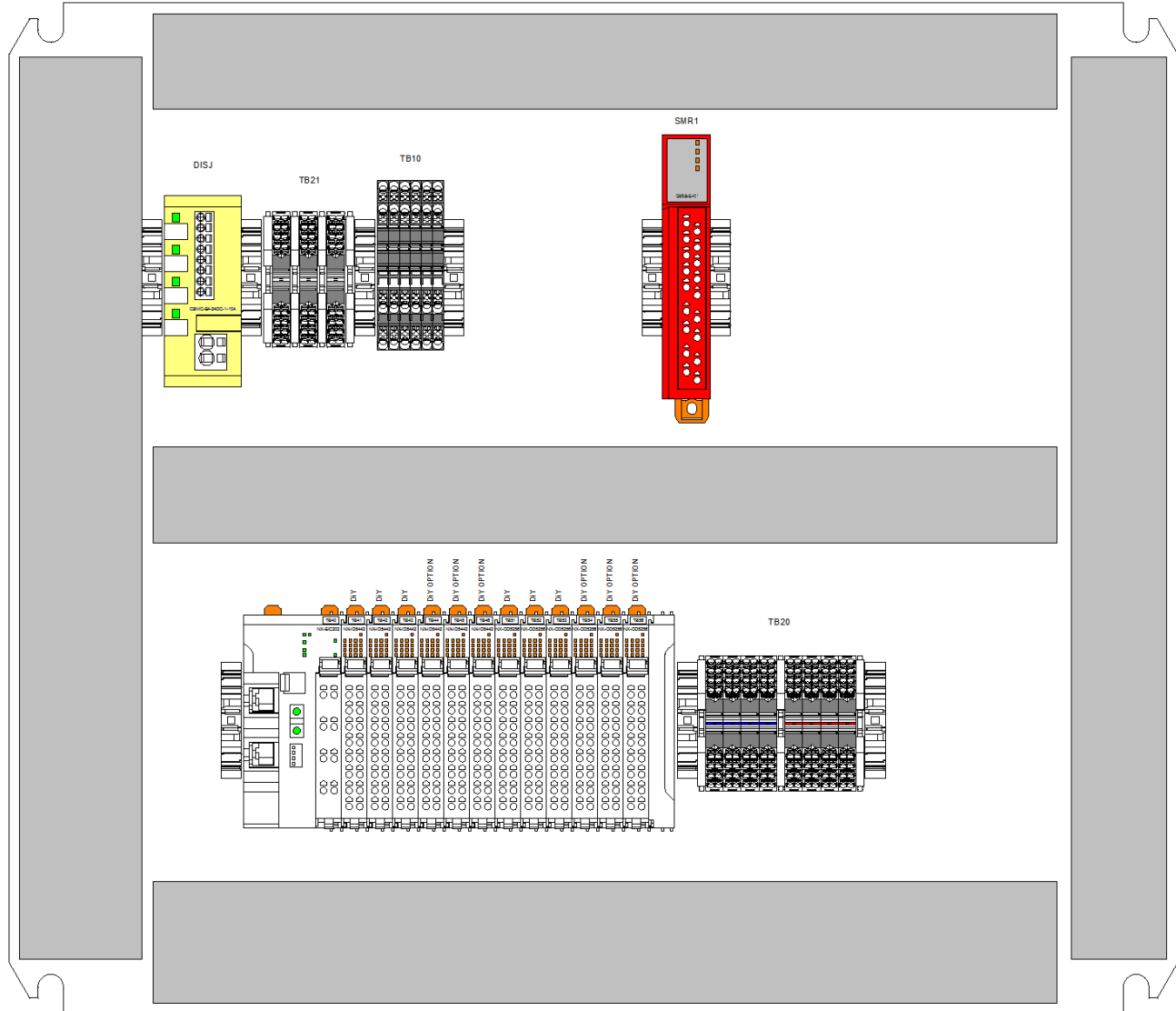
The command board allows the operator to manage the robotic cell operations. This command board has 4 buttons: An E-Stop button, a Stop button, a Rearm/Lock button and a Start cycle button.



4. 24V Electrical Command Panel

Notes:

- Any modifications or addition to the electrical cell system must be done by qualified technical staff.
- Refer to the electrical drawings of the DIY Robotic cell provided before making any modifications or additions to the electric system.
- Refer to the material list provided for parts numbers and manufacturers.



a) General description

- **DISJ 24V**
24 VDC breaker module. Splits in 4 different breaker protected channels the 24 VDC power supply.
- **TB20**
24 V1 0V distribution terminals.
- **TB21**
24 V2 – 24V3 – 24V4 distribution terminals.
- **SMR1**
Safety relay dedicated for the E-Stop.
- **I/O Block TB40 / TB41 / TB42 / TB43 / TB51 / TB52 / TB53**
Digital input and output signal module (see section 7.a Inputs and outputs).
- **TB10 SMR1**
E-Stop lines terminal blocks. If you want to add another E-stop device, replace the jumpers by the device you want to implement. See the electrical drawing for more details.

b) Inputs/Outputs (I/O)

The image on the right is given as an example: The basic electrical system provides three digital input units which are identified TB41 and TB43 allowing a total of 48 digital inputs. The tag names are DI[1] to DI[48] on the robot teach pendant. Inputs DI[1] to DI[5] are already assigned. They are used in the provided basic programs. Signals DI[6] to DI[48] are available for other device signals assignments such as buttons and sensors.

The basic electrical system also provides three digital output units which are identified TB51 and TB53 allowing a total of 48 digital output signals. The tag names are DO[1] to DO[48] on the robot teach pendant. If any other digital output units would be added, they would be named TB54, TB55 and so on. Outputs DO[1] to DO[16] are already assigned. They are used in the provided basic programs. Signals DO[16] to DO[48] are available for other device signals assignment.

5. Electrical power panel (optional)

This electrical panel is installed only when required. If the cell owner wants to install options requiring more power than the one provided with the cell, then this panel can also be installed.

6. Electrical hydraulic lifting system

The hydraulic lifting system consists of a pump feeding 4 cylinders allowing, with a switch, to raise or lower the main platen of the cell. This adjustment of the main platen substantially improves the ergonomics of the cell relative to the height of the operator. The voltage supply for this system is 230 VAC.



7. Pneumatic system

Notes:

- Any modification or addition to the pneumatic system of the robotic cell must be done by qualified personnel.
- Refer to the pneumatic drawings provided with the DIY Robotics cell for any changes to the pneumatic system.
- Refer to the material list provided with the DIY Robotics cell for part numbers and manufacturers.

The pneumatic system is equipped with a main air inlet valve, a pressure regulator, a pressure sensor with a digital display and a valve block.

Signals DO[9] to DO[16] allows controlling the four-station valve block. These valves are dedicated to controlling pneumatic components such as grippers, cylinders and other pneumatic devices. The DI[5] digital input refers to the main air pressure. If the signal is ON then the air pressure is Ok. If the signal is OFF then check the main air inlet valve or the main pneumatic connection. Refer to the air pressure sensor manual for pressure signal trig adjustment.



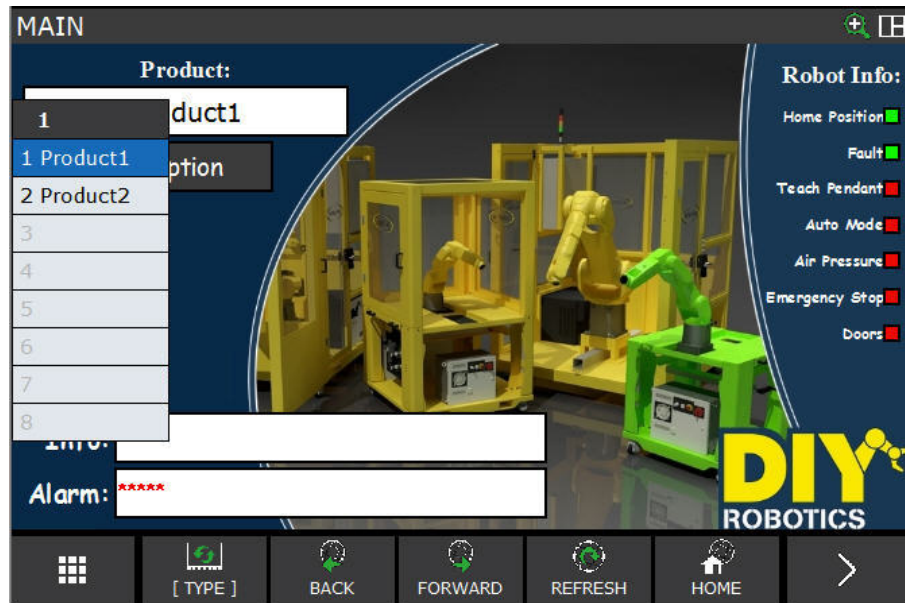
TEACH PENDANT AND PROGRAMS

1. HMI

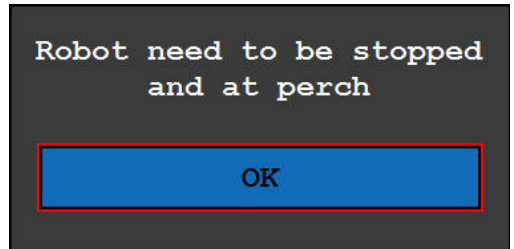
The HMI is available through the robot teach pendant. Press the MENU key and then the MAIN button on the touch screen to access the production MAIN page in order to give the operator fast access to production information.



In the upper left corner of the page, press the "Product" button to select a product.



The choice of a new product can only be made if the robot is in its "Home" position and the selector switch is in the ON position. If this is not the case then the following message will appear:



If you want to create a new product, press the "Option" button and the "New" button. A new product will then be created with the prefix "Product" followed by the next number.

If you want to name the product more explicitly, then type the name and press the ENTER button on the teach pendant.

If you wish to delete a product, press "Option", choose desired the product and press "Delete".



Note that when creating a new product, programs starting with PDEMO from the standard program list will be copied in full with the product name created as a prefix. For example, PDEMO_HOMING will be copied as, if the product name is "Product1", PRODUCT1_HOMING.

The Info section displays the steps that the robot is running. If the cell is in alarm, the Alarm section indicates the nature of the cell.

The Robot Info section on the right of the page informs the operator of the status of the robotic cell. You can quickly check if the robot is in Home position, if the robot is at fault, if the selector switch of the teach pendant is OFF, if the controller is in Auto mode, if the pressure of the pneumatic system is adequate, if an emergency stop button is activated and if the cell is armed.

2. Basic programs

Many basic programs were implemented to ease the robot programming tasks (see the list below). A brief description of each of them is done in this section. These programs should be used to help the programmer with his tasks. Logic and robot path points should be added to these programs in order to accomplish the desired task.

- BGLALARMS
- BGLLIGHT
- BGLOGIC1
- BSTARTRESETLOCK
- Z_MAIN
- RENAME_PROG0
- RENAME_PROG1
- PDEMO_MAINSEQ
- PDEMO_PARAM
- PDEMO_INIT
- PDEMO_PICK
- PDEMO_DROP
- PDEMO_REJECT
- PDEMO_HOMING
- POWERUP
- SHIP
- INTLK_ON
- INTLK_OFF
- HOME_DIRECT
- ZERO

a) Background Logic Programs

The robot controller allows executing simultaneously, in loop, many programs (motionless programs). They are called “Background Logic programs”. In the basic program list, there are 4 background logic programs which all starts with BGL... characters. Other background logic programs can be added. Once programmed, they have to be activated. In order to do so, select: MENU → SETUP → BG Logic.

BGLALARMS

The BGLALARMS program is responsible for activating and resetting the alarms and buzzers.

BGLLIGHT

The BGLLIGHT program manages the lights of the beacon, the yellow door button(s) and the buttons on the command box. Note that programming the yellow beacon light is at the discretion of the user.

BGLOGIC1

The BGLOGIC1 program is responsible for several distinct logics:

- Management of logic flags (internal programming).
- Product selection management with the HMI.
- EUROMAP67 signal management.
- Stop production button management.

BSTARTRESETLOCK

The BSTARTRESETLOCK program executes the initialization, reset and start sequences of the robotic cell.

b) Production cycle programs

A sequence composed of several programs has been implemented to be able to run a production cycle for a specific product. Most of these programs are product-specific, which is why they contain the prefix product name (here PDEMO, the product name implemented in the base program). Each product run in the robotic cell should have its own series of specific programs.

Z_MAIN

The Z_MAIN program is automatically executed following the activation of the production start button. This program checks the status of the cell, selects the correct programs by executing RENAME_PROG0 and RENAME_PROG1, and starts the production run by executing PDEMO_MAINSEQ.

RENAME_PROG0 et RENAME_PROG1

The programs RENAME_PROG0 and RENAME_PROG1 select the programs corresponding to the product selected by the operator on the HMI.

PDEMO_MAINSEQ

The program PDEMO_MAINSEQ is the main sequence of the production. This program first executes PDEMO_PARAM and PDEMO_INIT to initialize the production, then runs the PDEMO_PICK and PDEMO_DROP programs in loops to perform production cycles.

PDEMO_PARAM

The program PDEMO_PARAM is executed at the very beginning of production in order to initialize the registers, flags and I / O used.

****To be completed by customer according to product needs****

PDEMO_INIT

The program PDEMO_INIT is executed at the beginning of production to perform some initial tasks (reject parts from the first cycle of the injection press, for example).

****To be completed by customer according to product needs****

PDEMO_PICK

The program PDEMO_PICK is responsible for taking parts in an external machine.

****To be completed by customer according to product needs****

PDEMO_DROP

The program PDEMO_DROP is responsible for the deposit of parts.

****To be completed by customer according to product needs****

PDEMO_REJECT

The PDEMO_REJECT program is responsible for dropping rejected parts somewhere.

****To be completed by customer according to product needs****

PDEMO_HOME

The program PDEMO_HOME is responsible for bringing the robot home safely.

****To be completed by customer according to product needs****

c) Other programs

POWERUP

The POWERUP program is automatically executed when the robot controller is started. This program runs the UALM_LOG program, which is necessary for the user interface to work properly, and then starts a timer (TIMER) used by the Background Logic.

SHIP

The SHIP program moves the robot to a safe position for delivery or for any movement of the robotic cell. Note that this position does not take into account the “eoa” (end of arm tooling) of the robot or any other object that can be added later. Make sure that no objects conflict with the robot when using this program.

INTLK_ON

The INTLK_ON program makes it possible to deactivate all dangerous actions associated with a work area or a machine other than the robot itself. Make sure you understand this program before using it.

INTLK_OFF

The INTLK_OFF program is used to reactivate actions taking place in a work area or to be executed by a machine other than the robot itself. Make sure you understand this program before using it.

HOME_DIRECT

The HOME_DIRECT program positions the robot in its HOME position. This program takes the shortest path to bring the robot back to home. Make sure nothing interferes with the robot before and while using this program.

****To be completed by customer according to product needs****

3. Dual Check Safety for collaborative robots (DCS)

A Dual Check Safety (DCS) function has been implemented in the basic programming. This feature, with collaborative robots, prevents them to collide with surrounding objects or humans. A predefined payload (#1) has been set to 0,5 Kg permitting the robot to move but with extreme sensitivity to any collision. This basic set up is done so the robot can be jog. It is not a production set up. You must modify the EOAT payload definition and the Collaborative DCS set up according to your needs and environment.

See Fanuc Edoc documentation for more details.

The DCS function is defined following this path: MENU → SYSTEM → DCS.

4. Alarms

Six alarms were set in the basic programming. Refer to the table below for their description. If desired, other alarms can be added by the user.

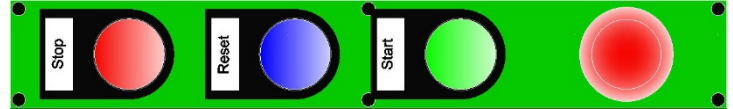
The alarms are defined following this path: MENU → SETUP → User Alarm.

ALARMS	DESCRIPTION	TROUBLE SHOOTING
[1] Low Air Pressure	The pneumatic air pressure is abnormally low.	<ul style="list-style-type: none"> • Check that the air inlet is connected to the pneumatic system of the cell and that the main valve is open. • Adjust air pressure at 90 Psi.
[2] Simulated I/O	There is simulated I/O's	<ul style="list-style-type: none"> • Unsimulate all I/O's by pressing the following keys: FCTN → --NEXT-- → UNSIM ALL I/O
[3] Robot Not At Perch	The robot is not at Home position.	<ul style="list-style-type: none"> • If the program Pxxx_Homing is implemented, use it to return the robot to the "Home" position. Otherwise, manually return the robot to the "Home" position. • The HOME position is defined in: MENU → SETUP → Ref Position
[6] No Selected Product	No product was selected before pressing the Start button.	<ul style="list-style-type: none"> • Return to the MAIN page and select a product. Press the "Start" button to start the cycle

PRODUCTION IN AUTO MODE

1. Command board

In case of any emergency, press the E-Stop button which will induce an immediate stop of the robot and of all linked systems. The Stop button will provide a complete stop of the production after the ongoing cycle is completed. The blue button allows to rearm the robotic cell and lock the doors in AUTO mode. Finally, the green button starts the robotic cell in AUTO mode.



2. Start a sequence in Auto mode

Before starting the production in AUTO mode, make sure that all systems are working properly. Here are some points that should be checked out:

- Make sure that the selected product selected in the teach pendant matches the desired production to be made.
- Make sure that the main air pressure is OK. The main air pressure should be set to 90 psi at all time to assure good system working conditions.
- Check if the robotic cell is stable and leveled. If it should be anchored, make sure it is properly done.
- Make sure that nothing interferes with the robot path.
- Make sure the robot is at HOME position before starting the production.

All sub-systems added to the robotic cell by the customer should also be checked before starting the production in AUTO mode.

After making all these verifications, you are now ready to start the production. Follow these instructions to initialize the cell and start the production:

- Make sure no E-Stop buttons are pressed. If so, released them all.
- Put the selector switch of the teach pendant to OFF position and the robot controller key selector switch to AUTO.
- The blue light of the reset button on the command box should be flashing. Press it and the robot will be reset.
- The green light of the start button should now be flashing. Press this button to start the production.

MAINTENANCE

Set the robot controller in manual mode (T1) to inspect the robotic cell for proper operation of all systems.

1. Procedure for moving the cell

Close the main air inlet valve. Switch off the power supply with the main switch of the robot controller. Disconnect the power supply cable and the pneumatic supply. Using the keys on the casters, pull up the four legs of the cell. Then the cell should be able to roll without difficulty. If necessary, use a forklift, taking care to manipulate the cell in the appropriate places under it.

2. FANUC Robot

For maintenance on the robot, refer to the manuals provided by the robot manufacturer.