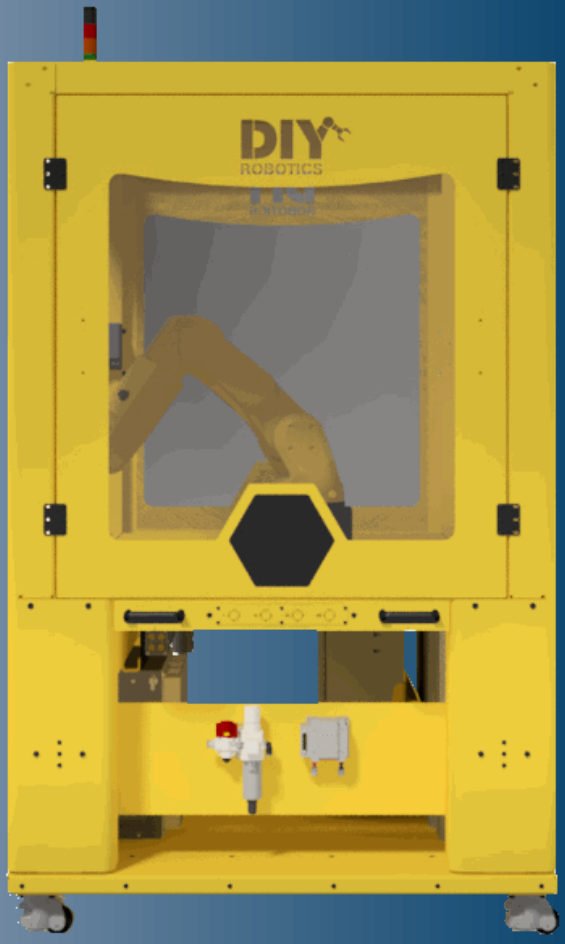
User Manual

Comet Cells

DIY ROBOTICS



August 2019

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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 in order 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 to others.

2. Security components

Devices have been installed to increase the safety of the operator when using the robotic cell.

a) Emergency stop buttons

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 to an immediate stop. Repeated use of these devices may cause mechanical premature ware or damage to the robot.

If an Orbit or Drawer option is selected

b) Sheet metal panels and polycarbonate

Modular sheet metal and polycarbonate panels are an integral part of the robotic cell safety features. Never move the robot in AUTO mode if any of these panels are removed or not securely attached to the cell structure.

Modular sheet metal and polycarbonate panels were installed according to the customer's request. Any changes afterward must be made so all panels are attached securely and firmly to the cell structure.

3. Lockout procedure

Any maintenance intervention should be done with the power disconnect switch to OFF position and the 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 inside the cell, refer to the 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.

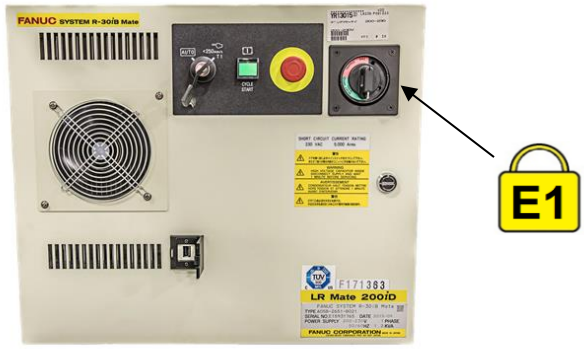
The person doing the work should keep the keys in their possession to prevent someone else from locking the door, pressurizing the air system or inadvertently turning on the cell. Refer to your employer's internal health and safety procedure to properly apply this lockout procedure

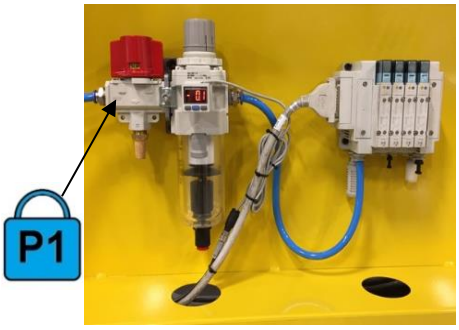
Lockout procedure

Robotic Cell

Comet

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





Energy source	Identifications	Tasks	Verifications
PNEUMATIC	P1	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	E1	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

Comet robotic cells are available in two sizes which are the Comet 33 that has a 3ft x 3ft base floor and the Comet 44 that has a 4ft x 4ft base floor. These cells are equipped with wheels providing them to be moved easily anywhere needed. Some facades can be completely open, which allows the robot to work in collaboration. The robotic cell is configured according to the customer's needs.

2. FANUC Robot

The robotic cell is equipped with a **FANUC** Lr-Mate 4S, Lr-Mate 200*i*D or Lr-Mate 200*i*D / 7L robot depending on what choice the customer made.

	Lr-Mate 4S	Lr-Mate 200iD	Lr-Mate 200iD / 7L
Number of axes	6	6	6
Reach	550 mm	717 mm	911 mm
Payload	4 Kg	7 Kg	7 Kg
Maximum speed	4 m/s	4 m/s	4 m/s

3. Lockable side doors

The robotic cell is equipped with side doors. The number of doors is determined when the purchase is made according to the customer's needs. Each door is equipped with a security lock system with a validation key code.

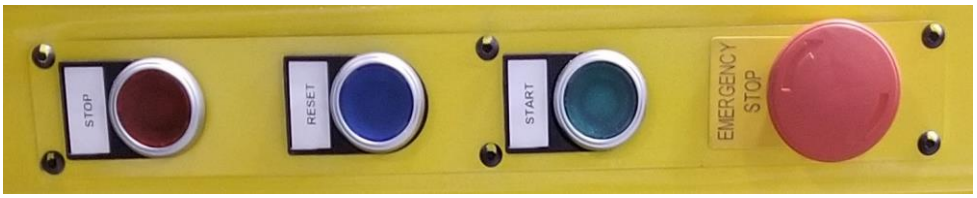
4. Tower light

The tower light indicates, in AUTO mode, the robotic cell status in real-time. Here is the meaning of each colors:

- Buzzer: Cell in fault status
- Red : Cell I fault status, see HMI
- Orange : Required action must be taken by operator
  ****To be programmed****
- Green : Cell running

5. Command box

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



In case of Orbit or Drawer option installed, the command box will be like this one :

6. EUROMAP Connectors (optional)

The European Committee of Machinery Manufacturers for Plastics and Rubber Industries (EUROMAP) issued recommendations allowing the implementation of simple and safe interfaces for injection molding machines. Two of these recommendations are used by DIY Robotics cells (handling device) to allow communication with other external machines such as injection molding machines.

EUROMAP67 is a recommendation that defines the electrical interface between an injection molding machine and a robot manipulator. The EUROMAP67 connector therefore allows communication between the robot cell and an external machine (injection molding machine or other machine). Several devices exchange signals through this connector such as: emergency stops, machine interlocks, ejection signals, mold position and action signals, and others.

Take note that in AUTO mode, it is not possible to move the robot if the EUROMAP67 connector is unplugged.

For more information on the EUROMAP67 recommendation, please refer to the technical PDF document or the website ***http://www.euromap.org/***.

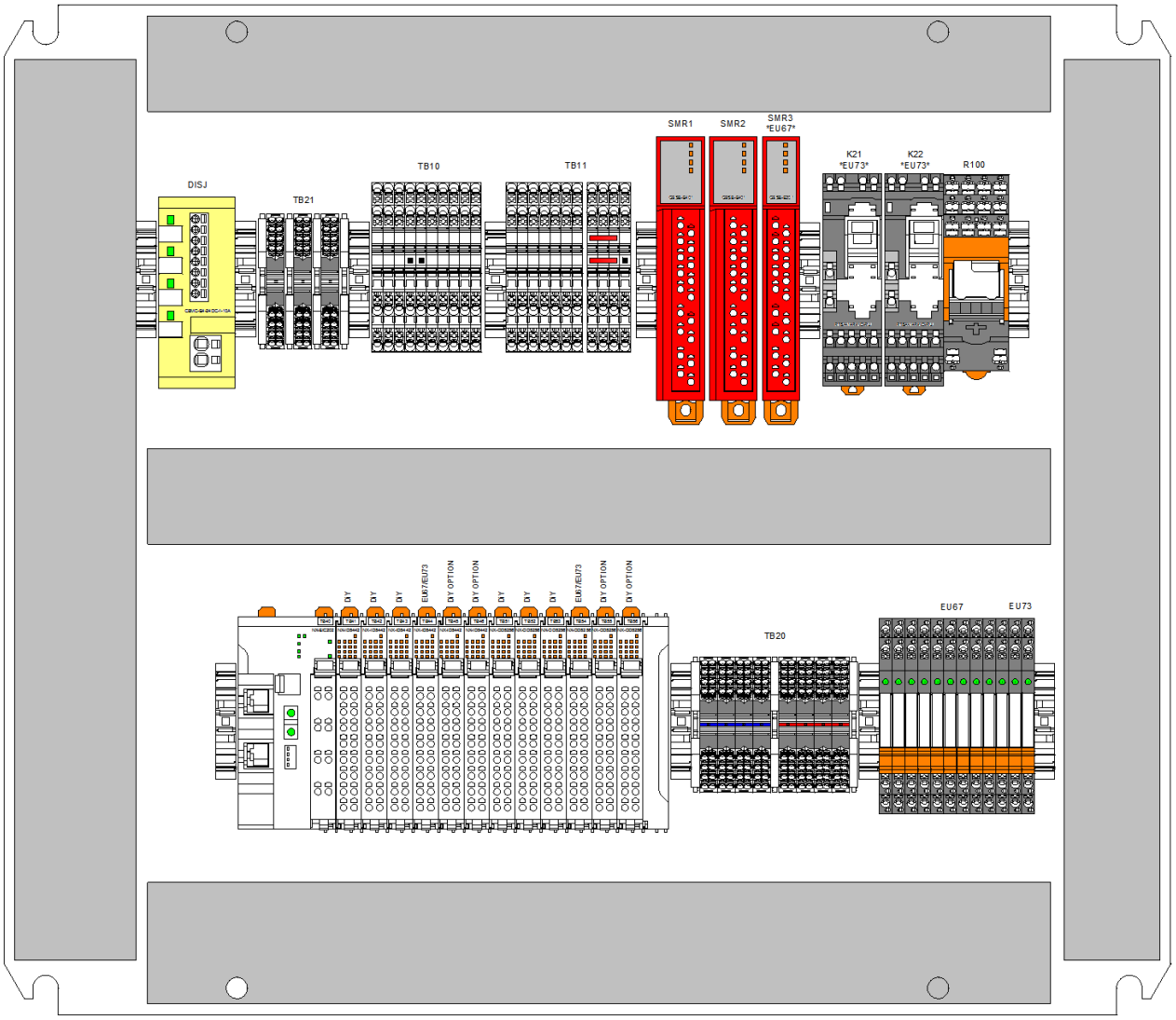
EUROMAP73 is a second recommendation that defines the electrical interface between an injection molding machine and an external safety device. The EUROMAP73 connector therefore allows the external machine (the injection molding machine) to replace the rear access door device with the access door device of the robotic cell.

For more information, refer to the technical EUROMAP73 PDF documentation available on this website: ***http://www.euromap.org/***.

7. 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.
- **R1-R9**
  Individual relays dedicated to the EUROMAP67 interface signals.
- **R10-R11**
  Individual relays dedicated to the EUROMAP73 interface signals.
- **R100**
  Multiple contact relays dedicated to the EUROMAP73 interface signals.
- **SMR1**
  Safety relay dedicated for the E-Stop.
- **SMR2**
  Safety relay dedicated to the fence lines.
- **SMR3**
  Safety relay dedicated to Euromap 67.
- **K20**
  Multiple linked contact safety relay (line 1) activated by the SMR2 safety relay.
- **K21**
  Multiple linked contact safety relay (line 2) activated by the SMR2 safety relay.
- **I/O Block TB40 / TB41 / TB42 / TB43 / TB51 / TB52 / TB53**
  Digital input and output signal module (see section 7.a Inputs and outputs).
- **I/O Block TB44 / TB54**
  Digital input and output signal module dedicated to Euromap 67 and 73.
- **TB10 SMR1, SMR3**
  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.
- **TB11 SMR2**
  Fence lines terminal blocks. If you want to add another fence device, such as a key switch, replace the jumpers by the device you want to implement. See the electrical drawing for more details.

b) Inputs/Outputs (I/O)

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. If any other digital input units would be added (for example a EUROMAP67 interface), they would be named TB44, TB45 and so on. Inputs DI[1] to DI[7] and

DI[209] to DI[218] are already assigned. They are used in the provided basic programs. Signals DI[8] to DI[48] and DI[219] to DI[224] 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 (for example a EUROMAP67 interface), they would be named TB54, TB55 and so on. Outputs DO[1] to DO[16] and DO[209] to DO[219] are already assigned. They are used in the provided basic programs. Signals DO[17] to DO[48] and DO[220] to DO[224] are available for other device signals assignment.

8. Electrical power panel (optional)

This electrical panel is installed only when required. For example, if the Orbit option is selected, then this panel becomes necessary in order to install the drive controller to operate the swivel door.

Also, 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.

9. Electrical hydraulic lifting system (optional)

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.

10. 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.

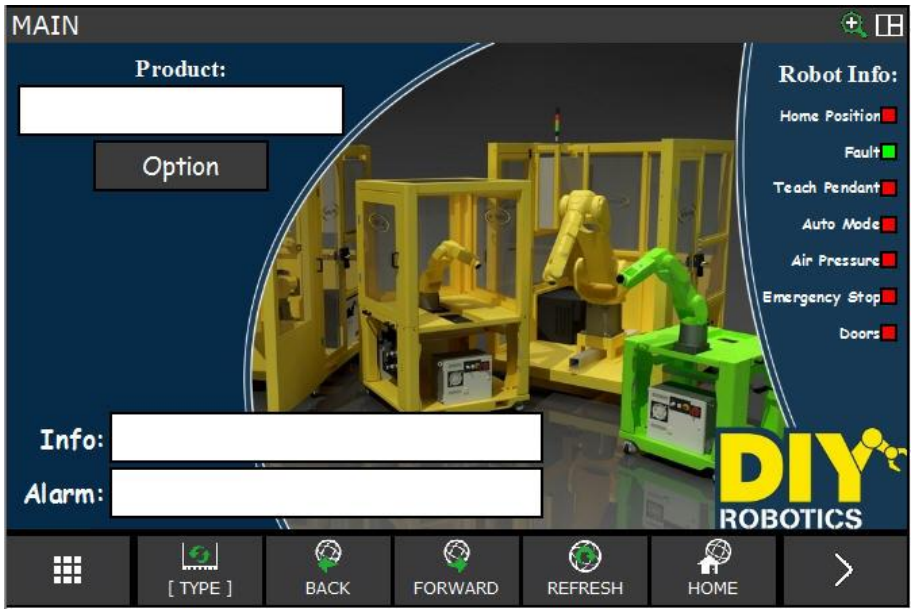
The pneumatic system is equipped with a main air inlet valve, a pressure regulator, a pressure sensor with a digital display and a valve block.

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[6] 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.

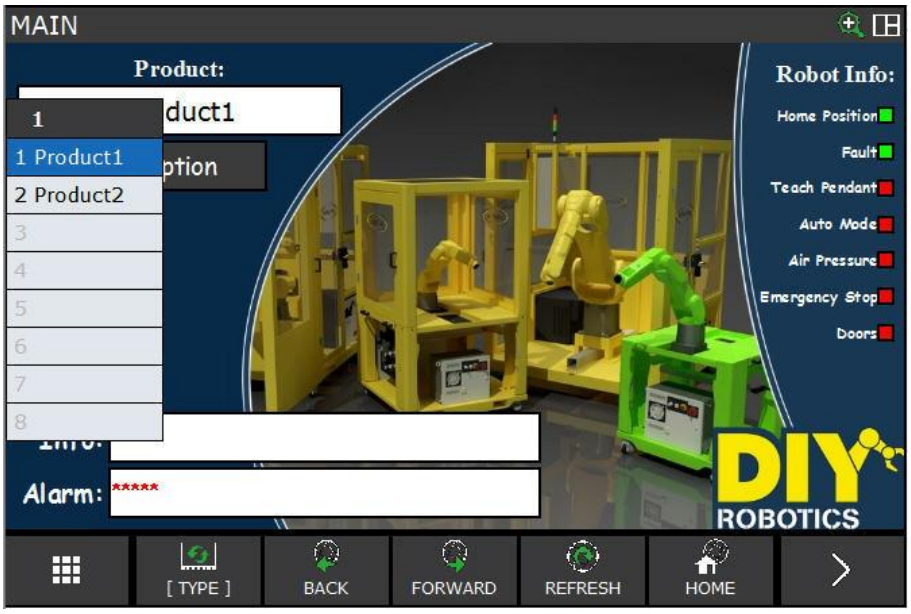
TEACH PENDANT AND PROGRAMS

1. HMI

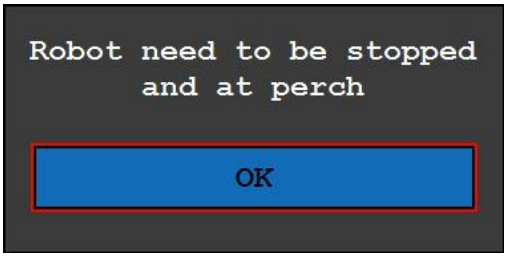
The HMI is available through the robot teach pendant. Press the MENU key and then the MAIN button on the touch screen to access the production MAIN page in order to give the operator fast access to production information.



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 to execute simultaneously, in loop, many programs (motionless programs). They are called “Background Logic programs”. In the basic program list, there is 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 buzzer.

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.

BGLLOGIC1
The BGLLOGIC1 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 molding machine, 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 “eoat” (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 is an example of using Euromap67 signals to disable the closing of an external machine (like an injection molding machine). Make sure you understand this program before using it.

INTLK_OFF
The INTLK_OFF program is an example of using Euromap67 signals to reactivate the closing of an external machine (an injection molding machine, for example). 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. Space Check function

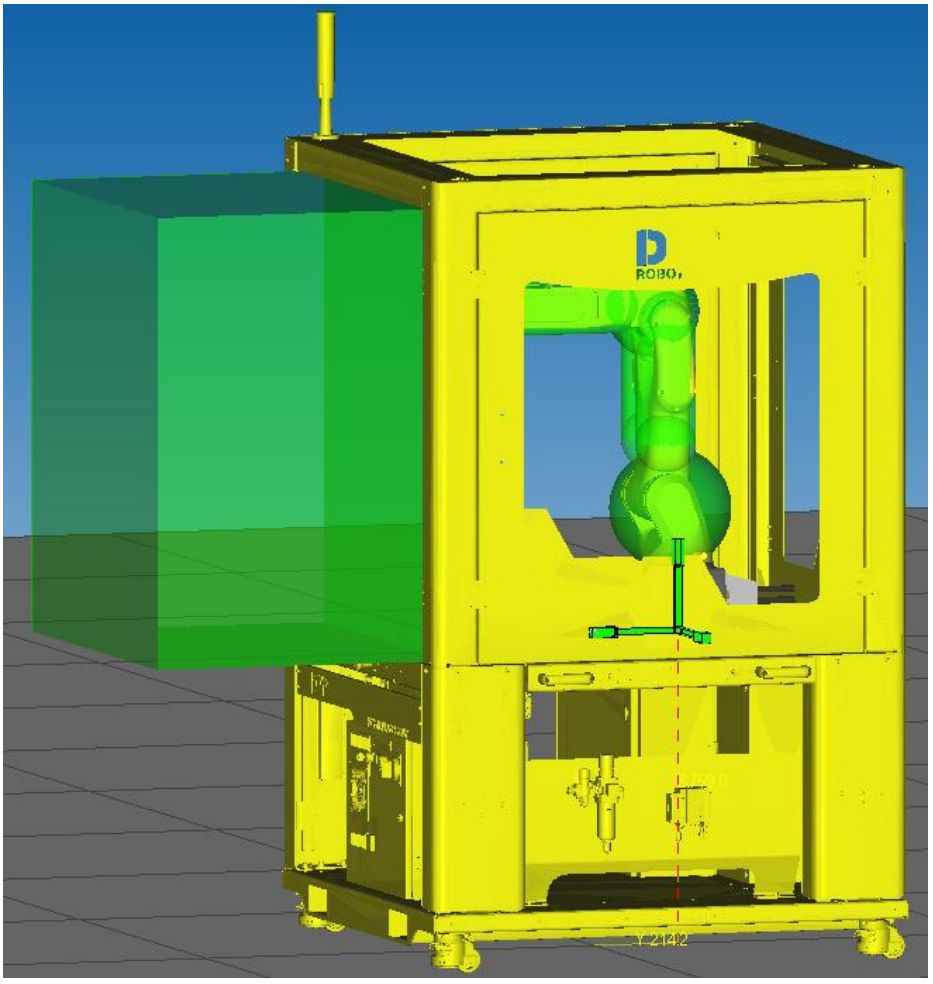
A Space Check function has been implemented in basic programming. This function prevents the robot from entering a pre-established area if he is not allowed to. For instance, this function prevents the robot from entering the mold area when the DI [209] Mold Open signal is OFF. This signal is an input signal from the Euromap67 cable intended to communicate with an external machine (an injection molding machine, for example). The external machine allows or prohibits the robot access to the zone by the signal DI [209].

The Space Check function also supports the DO [209] Mold Area Free signal. This signal is an output signal of the Euromap67 cable intended to indicate to the external machine whether the robot is in the preestablished zone or not.

The pre-established area is shown in the figure below by the large green rectangular prism. As soon as the robot leaves the cell by the open facade, it enters the pre-established zone of the Space Check function. It is essential to readjust the dimensions of the pre-established area according to your installations and your needs before using the Space Check function.

If needed, other Space Check zones can be set by the user.

The Space Check functions are defined in: MENU → SETUP → Space Fnct.



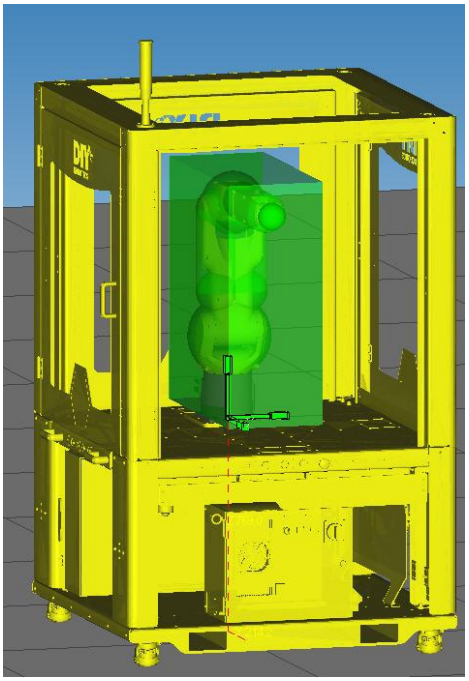
4. Dual Check Safety (DCS)

A Dual Check Safety (DCS) function has been implemented in the basic programming. This feature prevents the robot from colliding with predefined restriction areas or prevents the robot from exiting a predefined working area.

In the case of the Comet cell, two work areas have been defined restricting the movements of the robot. These areas correspond to the green areas of the attached figures.

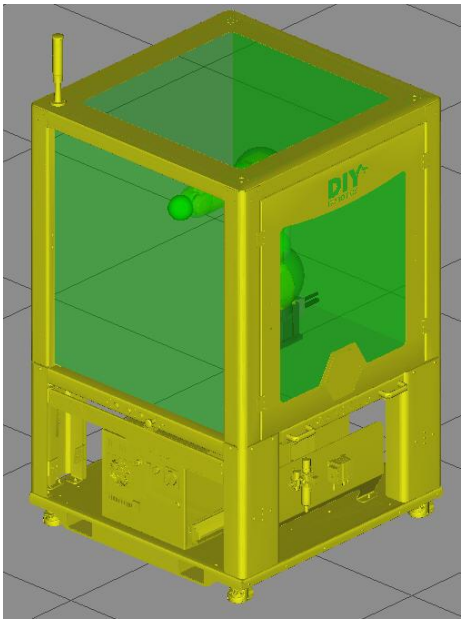
The first figure shows the containment area of the robot as programmed by DIY Robotics. This area must be disabled before using the robot.

Containment area



The second figure shows the robot work area corresponding to the interior of the cell. The parameters of this zone will have to be readjusted if the robot has to perform tasks on an external machine such as an injection molding machine.

Work area



Also, note that the DCS function provided in the basic programming will have to be modified and revalidated after adding an “eoat” (end of arm tooling) to the robot.

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

5. 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.

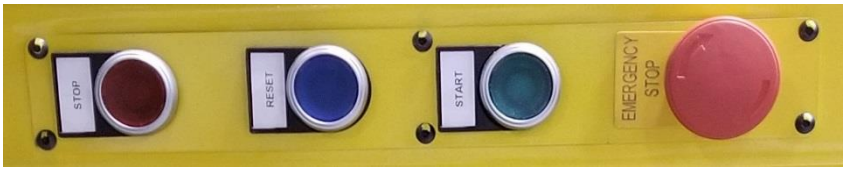
The alarms are defined following this path: MENU → SETUP → User Alarm.

ALARMS	DESCRIPTION	TROUBLE SHOOTING
[1] Low Air Pressure	The pneumatic air pressure is abnormally low.	• 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	• 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.	• 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
[4] Space Check Disabled	SpaceCheck function is disabled.	• Enable SpaceCheck in: MENU → SETUP → Space fnct.
[6] No Selected Product	No product was selected before pressing the Start button.	• Return to the MAIN page and select a product. Press the "Start" button to start the cycle

PRODUCTION IN AUTO MODE

1. Command panel or box

In case of any emergency, press the E-Stop mushroom 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/unlock the doors in AUTO mode. Finally, the green button starts the robotic cell in AUTO mode.



2. Cell door lock procedure

To lock the doors, simply press the blue button on the command box or panel. To unlock the doors, simply press and hold for 3 seconds the same button. Pressing the blue button locks all doors. When you press and hold the blue button, all doors will unlock. The flashing blue button indicates that the door(s) is not locked. When the door(s) is locked, the blue button stays illuminated.

3. Starting production 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 in the HMI 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 times 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 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.
- Close all doors.
- 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 and the doors will lock. The light of the blue button should now be steady ON.
- 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, the pneumatic supply and the two EUROMAP cables (if these options have been chosen). 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.