

# Safedoor

## User Manual

Assembly Instructions  
English (original)  
Version 2.0.0

Made **4**  
**CNC**



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# 1 Technical Sheet Safedoor

Safedoor is a unique automatic door system, especially designed for robotic tending of CNC machines. The Safedoor system is also an ideal solution for CNC tending without a robot, improving operator ergonomics.

The system contains actuator(s), and a controller which together enables safe, fast, and reliable operation of a CNC machine door.

With adjustable travel speed and built-in force monitoring it is capable of safe operation alongside human operators.

## Features

- Easy installation, programming, and risk assessment
- Optimized for integration with collaborative robots.
- Fast and silent operation.
- Automatic door size adjustment
- Force control optimized for safe and reliable operation.
- Emergency stop input for simultaneous stop when CNC and/or robot is emergency stopped.
- Capable of handling both single and double door CNC machines.
- Flexible mounting brackets for easy integration with different CNC machines.

	Minimum	Typical	Maximum	Unit
Stroke, S	600 (23.6)	-	1600 (63)	mm (in)
Installation length	S + 225 (S+8.86)	-	2*S + 225 (2*S + 8.86)	mm (in)
Adjustable Speed	250 (9.8)	375 (14.8)	500 (19.7)	mm/s (in/s)
Open/close time @ 750 mm		3.1*		s
Exerted force			150	N
Door weight		100 220	400 880	kg lb

\* Traversal speed depends on settings and dynamic parameters of the specific door. See *Configuration* on page 22.

## Specifications

IP rating, controller	IP66
IP rating, actuator	IP54
Digital interfaces	24V galvanically isolated I/Os
Robot Integrations	URCap, Universal Robots (Polyscope $\geq 3.14$ or 5.9) Omron Components, TM Robots (TMFLOW $\geq 1.76.3300$ ) Fanuc Plugin, CRX robots (Version $\geq 9.40P/06$ ) Doosan App, Series A, H and M Robots (Version $\geq V2.7.3$ ) ABB Add-in, Wizard blocks for GoFa, SWIFTI, single-arm-YuMi, IRB 1100 and IRB 1300 Kuka iiQKA.OS (Version $\geq 1.0$ ) Kassow CBun
Dimensions, controller	300 x 300 x 155 mm (11.8 x 11.8 x 6.1 inch)
Dimensions, actuator	S+253 x 160 x 90 mm (S+10 x 6.3 x 3.5 in)
Actuator cable	5 m (16.4 ft)
Weight, controller	6.6 kg (14.5 lb)
Weight, actuator	5 - 12 kg, depending on stroke (11 - 26 lb, depending on stroke)

## Typical applications

- CNC machine tending by collaborative robots
- CNC machine tending by operators, improving ergonomics
- Automatic operation of CNC machines with one or two doors

## Operating Conditions

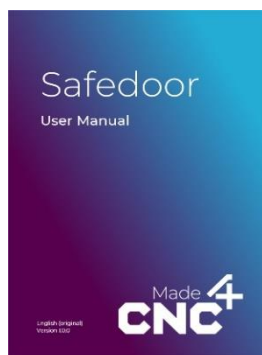
	Min.	Typical	Max.	Unit
Input voltage	90	230/110	260	VAC
Input voltage frequency	47	50/60	63	Hz
External fuse	6	-	16	A
Operating temperature, ambient	0	-	50	°C
	32	-	122	°F
Relative humidity (non-condensing)	10	-	95	%
Calculated MTBF (5 min cycle)	33,000			hours

## What is in the box?

The system is composed of two packages: one with the controller and another package per actuator. Depending on the type of CNC machine, you will need a controller package and either one or two actuator packages.

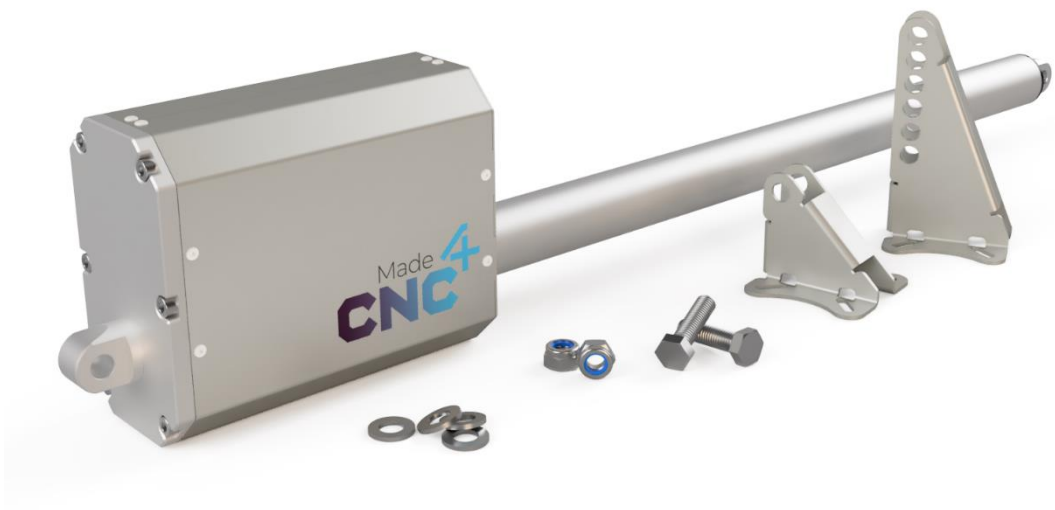
The controller package contains

- Safedoor Controller
  - Power supply (110/220VAC to 24VDC)
  - 5m power cable (N+L+PE)
  - Printed instruction manual
- USB stick, containing:
  - Digital instruction manual
  - URCap for [Universal Robots](#) (PolyScope v. 3.14 / 5.9 and above)
  - Components for [Omron TM Robots](#) (TMFLOW 1.76.3300 and above)
  - Plugin for [Fanuc CRX Robots](#) (Controller Software V9.40P/06 and above)
  - App for Doosan Series [A, M and H Robots](#) (Controller software V2.7.3 and above)
  - Add-in for ABB robots, Wizard blocks for [GoFa, SWIFTI, single-arm YuMi, IRB 1100 and IRB 1300](#), KUKA KR C5 Micro
  - Kassow CBun
- Operator panel with 5m cable



Each actuator package contains:

- Safedoor actuator:
  - Stroke, S, as designated on label,
  - 300 N (67.5 lbf)
  - 500 mm/s (19,7 in/s)
  - 5m cable
- Low mounting bracket
- Tall mounting bracket
- Bag of mounting fasteners:
  - 2x M12x45 bolts
  - 2x M12 lock nuts
  - 4x M12 washers



Please check that all the parts are present and without defects before starting the installation.

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## 2 Quick guide



### DANGER

You must read, understand, and follow all safety information in this manual, as well as the manuals for robot, CNC machine and all other associated machinery before initializing door motion. Failure to comply with safety information could result in severe injury or death.

### Actuator

1. Unpack the content of the box (See full list of supplied equipment on page 6)
2. Mount the tall bracket on the machine body.
3. Mount the low bracket on the door.
4. Make sure the two brackets are aligned and separated by at least 1210mm when the door is closed.
5. Mount the actuator between the brackets and secure it in place using the provided bolts, washers and lock nuts. Use the appropriate mounting holes in the tall bracket to ensure the actuator is leveled.
6. Tighten the bolts and ensure that the actuator is firmly seated in the brackets, unable to rotate axially in either end.
7. Route the actuator cable to the controller, through the cable gland and connect the motor cables to controller boards J4 / J5.
8. If installing two actuators, repeat the process for the second actuator on the second door.

See full description and other mounting options in the section Mechanical integration on page 12.



### INFO

The actuator must be able to fully reach the doors mechanical end stops in both directions. Therefore, the actuator cannot be fully retracted when the door is closed. The minimum spacing of 1210mm between the brackets must be respected.

### Controller

1. Mount the controller in a suitable location, typically close the CNCs control cabinet.
2. Connect the actuator cable to the controller PCB connector J4.
3. If installing two actuators, install the second actuators to J5.
4. Connect the CNC Not Active input from CNC Machine to the controller PCB connector J6.
5. If required, connect the outputs of an emergency stop circuit to J9.
6. If required, connect the operator open/close button panel to J8.
7. Connect the output signals in J3 to inputs on the robot.
8. Connect the input signals in J1 to outputs on the robot.

9. Connect “CNC Door Closed” to the CNC machines cycle start input.

For full list and description of inputs and outputs, see *IO functional description* page 18.

## Operator panel

1. Mount the operator panel on a flat surface where it is convenient for the operator to reach.
2. Route the cable from the panel to the controller cabinet.
3. Connect the button wires from the cable to J8 pins 1 and 2 on the Controller Board.
4. Connect power supply +24V to the cable and GND to J8 pin 3 (common).

See description in Button panel input group J8 on page 19.

## Configuration

1. Ensure the actuator and door can move freely and that the door will not lock.
2. Verify that that CNC Active input active.
3. Press and hold “Config / Clear” on the Controller Board for 3 seconds to initiate the configuration cycle.
4. Observe the doors and ensure that both doors move all the way to the fully open and closed positions. The door will move back and forth multiple times, as the system configures.
5. Observe that the two green LEDs on the controller board light up, indicating that the configuration cycle was completed successfully.

See full description in Configuration on page 22.



### **DANGER**

Safety features are not active during configuration. Stay clear of the door and observe it throughout the full cycle. Be prepared to remove power from the system, in case of an emergency.

For more guides and instruction videos, visit [www.made4cnc.com](http://www.made4cnc.com)



# 3 Mechanical integration

It is important to plan the mounting process carefully before starting the work. This section guides you through the decisions in the process.

## Mounting configuration

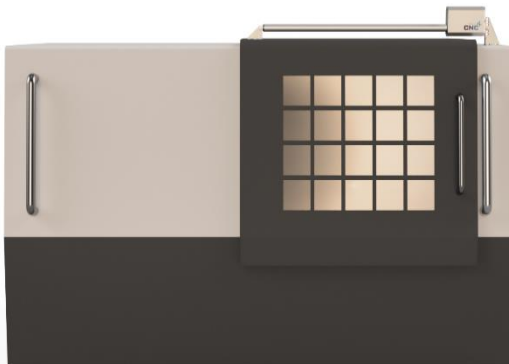
To accommodate various CNC machine designs, the Safedoor actuator and accompanying brackets offer a variety of different mounting options.

The two mounting brackets share similar mounting hole patterns and can both be used to fixate either end of the actuator.

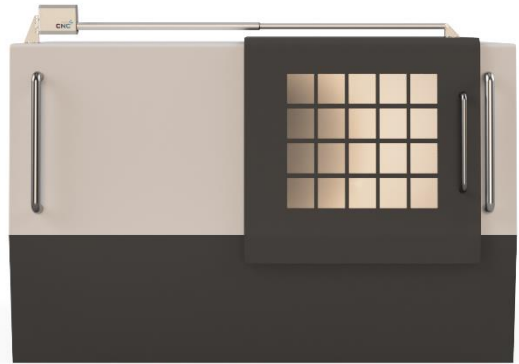
The low bracket is intended to be mounted on the highest of the two mounting points on the machine, and the tall bracket should be mounted on the lower mounting point. The tall bracket has multiple mounting positions for the actuator, allowing adjustment of the height to ensure the actuator is level with the door's direction of motion.

The end of the actuator with the motor-cabinet should always be mounted on the stationary side, i.e., on the CNC machine body. The rod end of the actuator should be mounted on the door of the CNC machine.

The actuator(s) can be mounted such that it is retracted when the door is closed and extended when the door is open – or extended when the door is closed and retracted when the door is open. Keep in mind that the wires in the motor connector J4 (J5 for secondary door) must be swapped when using the extended when closed option.

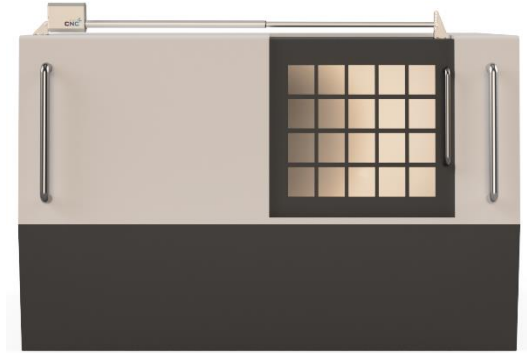


*Retracted when closed*



*Extended when closed*

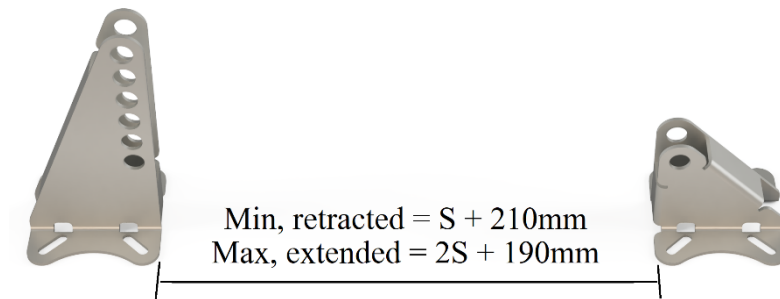
When the door is internal or the mounting point on the door, or for other reasons, is lower than the body of the CNC machine, the tall bracket should be mounted on the door, to allow the actuator to remain parallel with the doors line of motion.



*Internal door mounting.*

## Mounting the brackets

When determining the position of the mounting brackets, it is important to ensure that they are lined up correctly and that the distance between them is correct. When the two mounting brackets are closest together, there must be 1210mm between them to ensure proper operation of the actuator. The actuator will, when fully extended, push the brackets up to 2210mm apart.

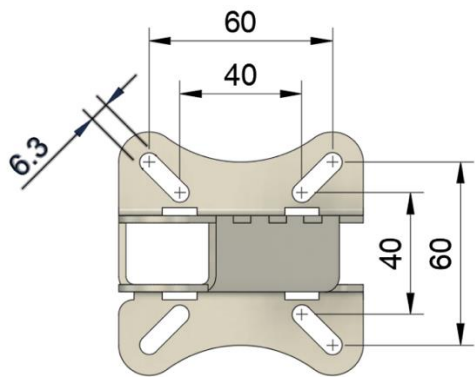


*Maximum and minimum bracket distances over the travel length of the door.*

The movement of the door must be mechanically limited so that the maximum and minimum distances are observed. If the mechanical stops provided by the CNC machine is not able to provide such stops, additional stops must be installed.

Once the positioning of the two mounting brackets have been determined, they can be mounted on the CNC machine body and door. The brackets should be mounted using the four slotted mounting holes provided on each bracket. The slotted holes

make it convenient to mount the brackets on various standard aluminum profiles and similar.



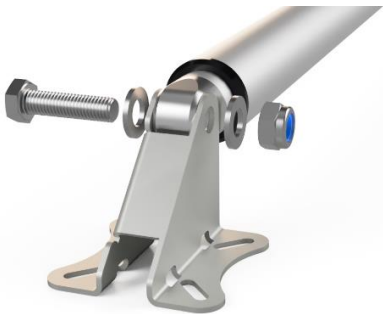
Bracket mounting dimensions in mm. Both brackets share the same mounting dimensions.

Mounting the actuator

The tall mounting bracket is made with several sets of mounting holes to allow height adjustment during the installation. Use the correct set of holes to adjust the actuator to a horizontally aligned position.



Each end of the actuator should be bolted into the brackets using the provided M12x45 bolts, M12 washers and M12 lock nuts. See the figure below. The bolts must be tightened firmly, and the actuator should not be able to jiggle when correctly mounted.



Safedoor actuators must only be installed to work with axial pushing and pulling forces. Lateral and radial loading is not permitted.

The actuators must be mounted in the supplied mounting brackets using the supplied bolts, tensioned to the specified torque, to ensure that neither of the actuator's ends are able to rotate in the mounting bracket. The minimum distance between the

mounting brackets must be respected, as the actuator cannot withstand retracting beyond this distance.



### **DANGER**

Loose bolts can cause the actuator to fall from the CNC door. Always make sure that bolts are firmly tightened.

The actuator can come apart, fall and/or take damage if the driven beyond its specified length. Always ensure that the minimum and maximum distance between brackets is complied with.

Mechanical stops must be provided by the CNC machine or installed by separately the integrator, to ensure the minimum distance is kept. The Safedoor system uses the mechanical stops to automatically detect the width of the door and thereby scheduling proper acceleration and deacceleration of the door prior to closure of the door. This ensures that the majority of the kinetic energy of the door is removed before the door closes, further reducing the severity of pinching and crushing hazards.

Do not connect the actuator's power cables before verifying that it is mechanically secured and unable to rotate axially in either of the attachment points.

## **Maintenance and repair**

All maintenance and repairs must be performed in compliance with this manual and latest service manual, which can be found on [www.made4cnc.com/support](http://www.made4cnc.com/support).

Repairs must be performed by authorized system integrations or made4CNC. Original spare parts must be used.

Actuators and controllers are marked with a product generation number. Only combine actuators and controllers with same generation number. Ask technical support for generation details.

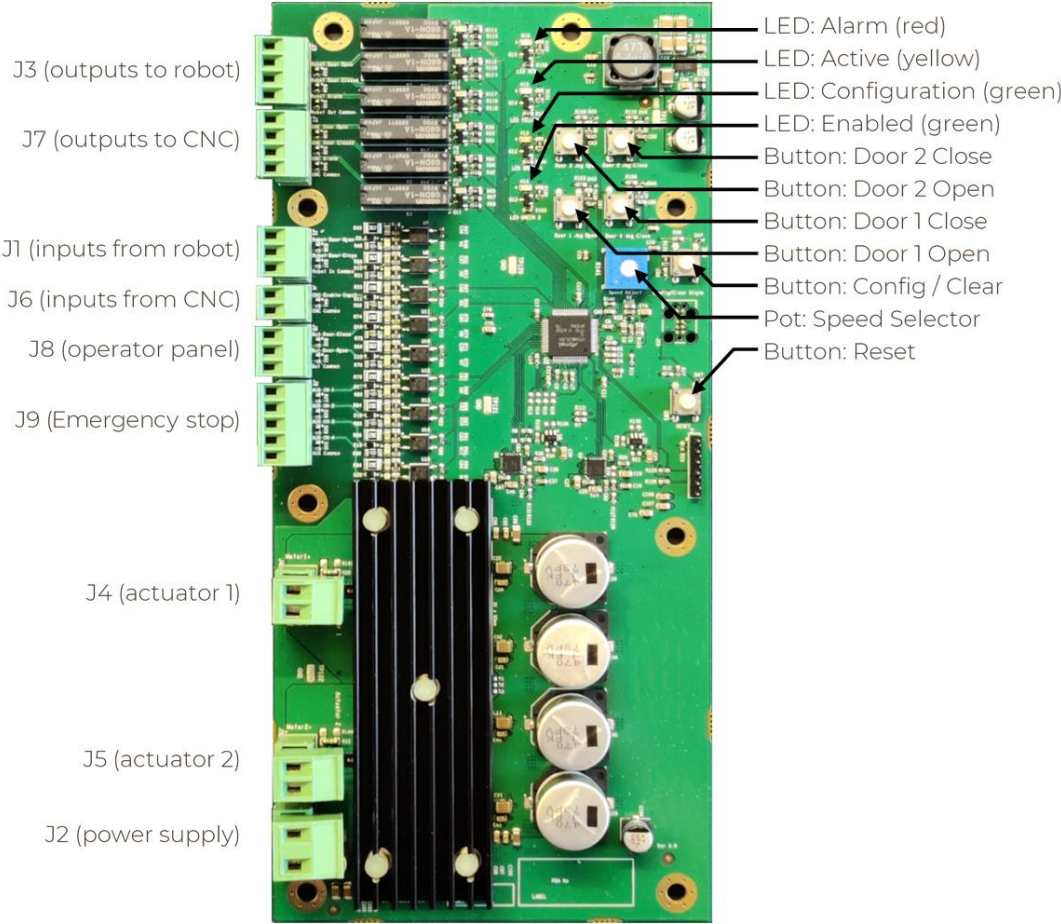


### **WARNING**

Combining actuators and controllers from different generations can change properties of the product significantly. Safety features might not be fully functional, which can result in injuries.

Use of non-original spare parts can change the safety features significantly. This can result in unacceptable impact forces and/or reduced product lifespan, which can result in injuries.

# 4 Electrical connections



## PCB controls

Name	Function
Button “Door 1 open”	Press and hold to open door 1.
Button “Door 1 close”	Press and hold to close door 1.
Button “Door 2 open”	Press and hold to open door 2.
Button “Door 2 close”	Press and hold to close door 2.
Button “Config / clear”	Press to clear alarms and to exit manual mode. Hold for 3 seconds to initiate configuration cycle.
Button “Reset”	Press to perform a hardware reset of the controller PCB.
Trim pot “Speed selector”	Determines the speed mode to be configured. See Speed settings on page 21.



## IO connections

Connection	Name	Signal type	Reference	Rating
J3 pin 1	Robot door opened	Digital output	J3 pin 4	24V <sub>dc</sub> / 1A <sub>dc</sub>
J3 pin 2	Robot door closed	Digital output	J3 pin 4	24V <sub>dc</sub> / 1A <sub>dc</sub>
J3 pin 3	Robot alarm	Digital output	J3 pin 4	24V <sub>dc</sub> / 1A <sub>dc</sub>
J3 pin 4	Robot 24V	Group common		
J7 pin 1	CNC door opened	Digital output	J7 pin 4	24V <sub>dc</sub> / 1A <sub>dc</sub>
J7 pin 2	CNC door closed	Digital output	J7 pin 4	24V <sub>dc</sub> / 1A <sub>dc</sub>
J7 pin 3	CNC alarm	Digital output	J7 pin 4	24V <sub>dc</sub> / 1A <sub>dc</sub>
J7 pin 4	CNC 24V	Group common		
J1 pin 1	Open door	Digital input	J1 pin 3	24V <sub>dc</sub>
J1 pin 2	Close door	Digital input	J1 pin 3	24V <sub>dc</sub>
J1 pin 3	GND	Group common	J1 pin 3	
J6 pin 1	CNC Not Active	Digital input	J6 pin 2	24V <sub>dc</sub>
J6 pin 2	CNC GND	Group common		
J8 pin 1	Button door close	Digital input	J8 pin 3	24V <sub>dc</sub>
J8 pin 2	Button door open	Digital input	J8 pin 3	24V <sub>dc</sub>
J8 pin 3	GND	Group common		
J9 pin 1	Emergency stop 1	Digital input	J9 pin 5	24V <sub>dc</sub>
J9 pin 2	Emergency stop 2	Digital input	J9 pin 5	24V <sub>dc</sub>
J9 pin 3	-	Digital input	J9 pin 5	24V <sub>dc</sub>
J9 pin 4	-	Digital input	J9 pin 5	24V <sub>dc</sub>
J9 pin 5	GND	Group common		
J4 pin 1	Actuator 1 pos	24V power		24V <sub>dc</sub> / 12A <sub>dc</sub>
J4 pin 2	Actuator 1 neg	24V power		24V <sub>dc</sub> / 12A <sub>dc</sub>
J5 pin 1	Actuator 2 pos	24V power		24V <sub>dc</sub> / 12A <sub>dc</sub>
J5 pin 2	Actuator 2 neg	24V power		24V <sub>dc</sub> / 12A <sub>dc</sub>
J2 pin 1	24V supply	24V power		24V <sub>dc</sub> / 21A <sub>dc</sub>
J2 pin 2	GND	24V power		24V <sub>dc</sub> / 21A <sub>dc</sub>

Each connector group is galvanically isolated from the rest of the controller board and from each other and implemented in compliance with IEC-61131-2 Type 3.

All digital outputs are normally opened relays. When activated the output is electrically connected to the respective reference pin.

All digital inputs are optocoupled and activates when a voltage of 24V with respect to the group common ground is applied.

# IO functional description

## Robot output group J3

The connector group J3 are used to signal the state of the door to the robot. It should be powered by connecting the robot 24V power to J3 pin 4.

Pin	Description
Pin 1: Robot door opened	Relay contactor is closed when the door is fully opened. This signal can be used to signal the robot that it can enter the CNC machine.
Pin 2: Robot door closed	Relay contactor is closed when the door is fully closed.
Pin 3: Robot alarm	Relay contactor is closed when the system is in an alarm state.
Pin 4: Robot 24V	Common supply for the J3 group. Relays in this group close circuits to this pin when active.

## CNC output group J7

The connector group J7 are used to signal the state of the door to the CNC machine. It should be powered by connecting the CNC 24V power to J7 pin 4.

Pin	Description
Pin 1: CNC door opened	Relay contactor is closed when the door is fully opened.
Pin 2: CNC door closed	Relay contactor is closed when the door is fully closed. This signal can be used to indicate to the CNC machine that it can start a new machining cycle.
Pin 3: CNC alarm	Relay contactor is closed when the system is in an alarm state.
Pin 4: CNC 24V	Common supply for the J3 group. Relays in this group close circuits to this pin when active.

## Door control input group J1

The connector group J1 are used to signal the door to open and close. Signals should be 24V when activated and 0V when not activated, with reference to J1 pin 3. The signals in J1 are edge triggered, meaning they respond to the change in voltage from 0V to 24V.

Pin	Description
Pin 1: Open door	Request door open. The door will start opening when a positive edge (0 -> 24V) is detected on this input. Note that signals on this input are ignored if the CNC Not Active signal in J6 pin 1 is not high.
Pin 2: Close door	Request door close. The door will start closing when a positive edge (0 -> 24V) is detected on this input. Note that signals on this input are ignored if the CNC Not Active signal on J6 pin 1 is not high. This signal should be activated when the work from outside the CNC machine has completed and the machine is clear of obstacles, and ready to run.

Pin 3: GND	Common GND for the J1 group. Signals in this group are activated when 24V with respect to this pin is presented on the inputs.
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## CNC input group J6

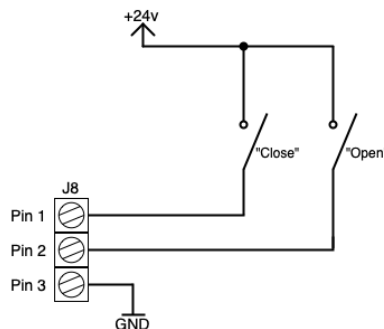
The connectors in group J6 are used to signal the door that it can safely open, as the CNC machine is not active and have unlocked the door.

Pin	Description
Pin 1: CNC Not Active	Should be activated by the CNC machine when the machining cycle has finished, and any door locks have been unlocked. The door will not attempt to open the door if this signal is not set.
Pin 2: CNC GND	Common GND for the J6 group. Signals in this group are activated when 24V with respect to this pin is presented on the inputs.

## Button panel input group J8

The connectors in group J8 are used to connect an external button panel, allowing manual operation of the door.

Pin	Description
Pin 1: Button close door	Should be connected to the button for manually closing the door. When activated, the door will close.
Pin 2: Button open door	Should be connected to the button for manually opening the door. When activated, the door will open.
Pin 3: GND	Common GND for the J8 group. Signals in this group are activated when 24V with respect to this pin is presented on the inputs.



Emergency stop input group J9

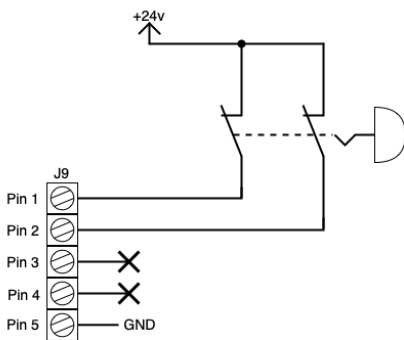
Emergency stop is only supported for controllers produced after 1/1 2022.

The connectors in group J9 comprise an emergency stop input which can be used to immediately stop door motion when CNC machine, robot and/or a separate button is put into emergency stop.

The emergency stop input is an optional feature as its use and requirements depends on the specific CNC application (See CNC manual, robot manual and risk assessment). The emergency stop input feature is automatically detected during configuration. If unused, leave the J9 terminals unconnected.

To restart motion after an emergency stop, first un-emergency stop (Both 24V signals are reestablished) and secondly provide a motion start signal from CNC machine and/or robot (All edge changes on signals from CNC and robot represents a reset to the emergency stop mode)

Pin	Description
Pin 1: Emergency stop 1	Can be connected to an independent output on an Emergency stop circuit. When activated (24V is removed), the system will be set in an emergency stop mode, immediately stopping door motion.
Pin 2: Emergency stop 2	Can be connected to an independent output on an Emergency stop circuit. When activated (24V is removed), the system will be set in an Emergency stop mode, immediately stopping door motion.
Pin 3: -	Pin 3 is unused. Leave unconnected.
Pin 4: -	Pin 4 is unused. Leave unconnected.
Pin 5: GND	Common GND for the J9 group. Signals in this group are activated when 24V with respect to this pin is presented on the inputs.



Actuator 1 connector J4

Connectors for powering the first door actuator. Note that the polarity should be inverted (i.e. the wires should be swapped), when the actuator is mounted in the extended when closed configuration.

Actuator 2 connector J5

Connectors for powering the second door actuator. See description for *Actuator 1 group J4* above.

## Supply connector J2

Connector to power supply unit, providing power for the controller board and the attached actuators.






### CAUTION

Pay attention to polarity when connecting signals and power to the controller board. Reversal of voltages may cause permanent damage to controller board, power-supply and any attached equipment.

## Speed settings

To allow the integrator to select the appropriate traversal speed for the installation, The Safedoor controller has three different speed settings. The speed is selected by turning the speed selector (see overview on page 16). The speed setting must be set prior to running a configuration cycle, as it is latched during the configuration. Changing the speed setting has no effect before a new configuration cycle is performed.

Setting	Description
	High speed: 500 mm/s The potentiometer is turned fully clockwise until meeting resistance.
	Medium speed: 375 mm/s The potentiometer is in center position, between the high- and low speed positions.
	Low speed: 250 mm/s The potentiometer is turned fully counterclockwise until meeting resistance.

*See page 16 for selector placement.*

## Manual operation (jogging)

During installation it can be beneficial to be able to drive the linear actuators manually. This can be done using the buttons on the controller PCB. When either of the buttons are pressed, the controller board enters Manual Operation Mode, and any action requested from the digital inputs are blocked until Manual Operation Mode is cancelled by pressing "Config / Clear".

Button	Description
Door 1 Jog Open	Press and hold to slowly move door 1 in opening direction.
Door 1 Jog Close	Press and hold to slowly move door 1 in closing direction.
Door 2 Jog Open	Press and hold to slowly move door 2 in opening direction.

Note that the “CNC Not Active” input must be set high to allow any motion.

## Configuration

A configuration cycle must be performed on the system after it has been installed. The configuration cycle is started by pressing and holding the **Config/Clear button for 3 seconds**. During the configuration the door will move back and forth for multiple times and at varying speeds. The cycle measures the width, resistance, weight, and other parameters on each door and stores it internally on the controller board. This data is later used to ensure proper speed ramping as well as high force detection, once the system is in service.

During configuration the following settings can be made:

**Emergency stop input:** At the beginning of the configuration, the system observes if either pin 1 or pin 2 in J9 is active. In this case, the system will configure to be used with emergency stop input enabled. See *Interfacing with an emergency stop circuit* on page 28.

**Max speed:** At the start of the configuration the position of the speed selector is observed and the appropriate speed limit is set. Changing the position of the speed selector after the configuration has no effect until a new configuration is initialized. See *Speed settings* on page 21.

**Trigger mode:** If either inputs in groups J1 and J8 are activated during configuration, the respective group will be configured in **hold to run** mode. In this mode, the door will start moving when the open/close signals are observed and stop when the signals are released, even if the door has not reached the opened/closed position. If the inputs are not activated during configuration each group will default to **edge-triggered** mode, where an open/close signal will initiate the appropriate motion. The motion will complete, even if the open/close signal is released during the motion. The setting is done per-group.

In addition, the system automatically configures these parameters:

**Stroke:** The distance between the opened and closed position. This allows the system to slow down the motion in due time before reaching the end of a travel.

**Dynamic model:** The mass, running resistance and other dynamic parameters are determined to model the expected forces during travel and optimize the motion profile accordingly.

**Maximum speed** is determined, ensuring that the total energy of the moving mass is kept at or below **10 Joules**. This limit is calculated as  $v = \sqrt{\frac{2 \cdot 10J}{m_d}}$ , where  $m_d$  is the dynamic mass in kg. The maximum speed will always be within the maximum speed set by the speed selector.

**Maximum acceleration** is determined to ensure that the acceleration force is kept at or below **150 Newtons** and the total power is kept at or below **300 Watts**.

When configuring an emergency stop circuit, having high signals on J9 will activate the emergency stop feature. If no signals are high, the emergency stop feature will not be activated (See Interfacing with an emergency stop circuit on page 28).

To perform a configuration, follow these steps carefully:

1. Ensure that the CNC door can move freely.
  - a. Linear rails must be clean, free from chips/dust/debris and well lubricated.
2. Ensure that the actuator is mounted correctly on the CNC machine.
  - a. The mounting brackets must be firmly mounted on the CNC machine.
  - b. The actuator must be level with the machine and door.
  - c. All bolts must be properly tensioned.
  - d. All electrical connections must be firmly tightened.
3. Ensure that the CNC machine is not operating, and that the “CNC Not Active” signal is provided and high.
4. If required, ensure that the emergency stop circuit is properly connected.
  - a. Ensure that emergency stop inputs receive a constant high signal.
5. Ensure that power and PE (protective earth) is connected.
  - a. AC power (110V or 220V) source must be connected to the power supply in the controller cabinet.
  - b. The power supply and the controller cabinet must be connected to PE (protective earth).
  - c. 24V supply and GND cables must be mounted between the power supply and the controller board.
6. Press and hold “Config / Clear” for 3 seconds to initiate the configuration cycle.
  - a. Observe the doors and ensure that both doors move all the way to both the fully opened and the fully closed position.
  - b. Configure hold-to-run modes as needed, by activating a input in the relevant group. E.g., twist the button on the operator panel during configuration to configure it as a hold to run input.
  - c. Observe that the two green LEDs on the controller board light up, indicating that the configuration cycle was completed successfully.
7. If an emergency stop circuit is connected, test to see if it stops the motion of the doors as intended.

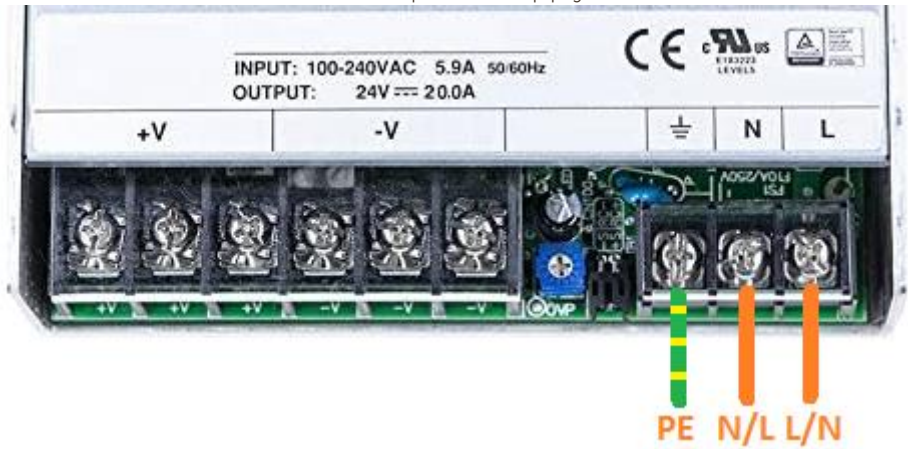


### **DANGER**

Force monitoring is not active during all phases of the configuration. Take necessary precautions, observe- and stay clear of the door until the configuration is completed.

# Mains connection

230V / 110V is connected to the internal power supply as shown below.

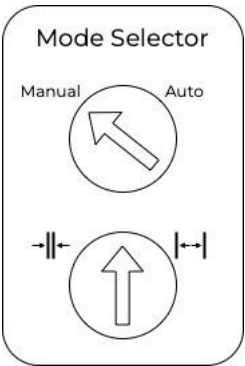


The placement of L (line) and N (neutral) is not important and can be done as preferred by the integrator. Wires and cable must be rated to carry at least the current of the fuse group of the connected power source, and this fuse must be between 6A and 16A.

Connection of protective earth to the PE terminal is mandatory, and the power source must be fitted with a residual-current device.

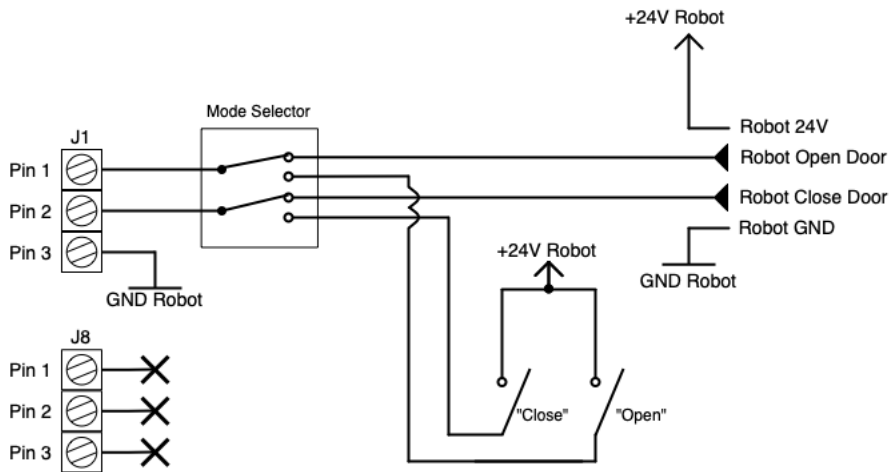
## Mode Selector (Optional)

If desired in a specific installation, it is possible to add a switch to work as a mode selector to change between manual and automatic control. As default Safedoor accepts commands from both robot and operator buttons, and it completes a movement before accepting a new input. By adding a mode selector, inputs from the robot are disabled when manual mode (Manual) is enabled, allowing only the operator buttons as input. When automatic mode (Auto) is enabled, only inputs from the robot can control the door.



When a mode selector is added the hold-to-run feature is disabled to make operation more convenient for the operator. The diagram below shows how to wire a mode selector button to the Safedoor Controller.





The integrator can choose any brand of industrial 24V capable DPDT / 2NO+2NC button for mode selection. For convenience the system has been tested with the components listed in the table below. Button to be built into a box; space efficient solder terminals:

Brand	Part Number	Description
IDEC	<a href="#">LBW7S-2T6</a>	Turn button, 16mm, Solder Terminals
IDEC	<a href="#">LBW6K-2ST6A</a>	Turn key, 16mm, Solder terminals

If solder connections are undesired, the Siemens button below is a good choice. Be aware that the body on the backside is fairly large, as the four screw terminal blocks stack in two layers:

Brand	Part Number	Description
Siemens	<a href="#">3SU1052-2BF60-0AA0</a>	Turn button (Part 1 of 6)
Siemens	<a href="#">3SU1550-0AA10-0AA0</a>	Turn button (Part 2 of 6)
Siemens	<a href="#">3SU1400-1AA10-1BA0</a>	Contacts NO (x2) (Part 3&4 of 6)
Siemens	<a href="#">3SU1400-1AA10-1CA0</a>	Contacts NC (x2) (Part 5&6 of 6)

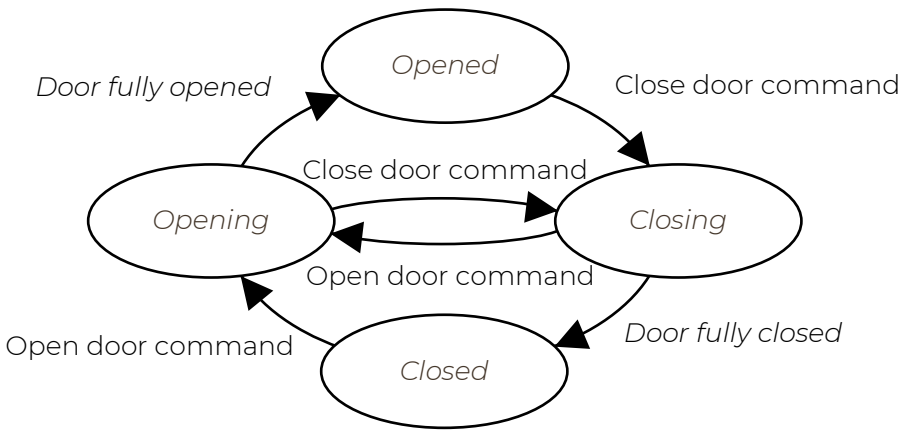
It is recommended to consider drilling holes in the CNC machine front to fit the two buttons because of their difference in dimensions

# 5 Software specification

## Operating states

The software on the Controller Board performs motion control and force monitoring of the actuators and communicate with the CNC machine, robot, operator panel and other equipment through digital inputs and outputs.

During normal operation, the Safedoor Controller has four operating states; Opening, Opened, Closing and Closed.



When in *Opening* state, the door is accelerated to the configured maximum speed. The speed is maintained until the door approaches the fully opened position. Then it is slowed down and reaches the fully opened position safely. Once the controller senses that the door is fully opened it transitions into *Opened*. If a command to close the door is giving during the motion, the door will enter the *Closing State* and reverse its motion. In addition, the door will slow down to a stop mid travel, if the input initiating the *Opening State* is configured as hold-to-run and is released during the motion. The motion can be resumed in either direction by a new open/close command.

When the Controller is in *Opened* state the outputs *CNC Door Opened* and *Robot Door Opened* are activated. In this state the Controller waits for either *Robot Open Door* or *Button Open Door* to be set while *CNC Not Active* is also set. The Controller then clears the outputs and transitions to the *Closing* state.

When in *Closing* state, the door is accelerated to the configured maximum speed. The speed is maintained until the door approaches the fully closed position. Then it is slowed down and closed safely. Once the controller senses that the door is fully closed it transitions into *Closed* state and sets the outputs *CNC Door Closed* and *Robot Door Closed* active.

When in *Closing* state, the door is accelerated to the configured maximum speed. The speed is maintained until the door approaches the fully closed position. Then it is slowed down and reaches the fully closed position safely. Once the controller senses that the door is fully closed it transitions into *Closed*. If a command to open the door is giving during the motion, the door will enter the *Opening State* and reverse its motion. In addition, the door will slow down to a stop mid travel, if the input initiating the

*Closing State* is configured as hold-to-run and is released during the motion. The motion can be resumed in either direction by a new open/close command.

Note that the Controller will not respond to the inputs signals as described above if:

- 1) The controller is in Manual Mode after using the Jogging buttons. When done jogging, press Config / Clear to return to normal operation.
- 2) The controller is not configured or is currently running a configuration cycle. See Configuration on page 22.
- 3) An alarm has occurred. Once the cause of the alarm has been identified and rectified, the alarm can be cleared by pressing Config / Clear. See Alarm LED (red) on page 27.

## LEDs

The Controller Board has four LEDs, indicating the state of the Controller. Below is a description of each of the LED's; please refer to the Controller Board overview on page 16 for placement of the LEDs.

### Alarm LED (red)

The Alarm LED is off during normal operation. If a problem, which requires the operator's intervention, is detected the Controller switches to the *Alarm State* and the *Alarm LED* will flash one of the patterns below, to indicate the cause. The *Alarm* state is retained until the cause of the alarm is removed and the *Reset / Config* button is pressed.

Blink pattern	Cause	Description
Solid on	Manual mode	Either of the Jog buttons was pressed and the Controller Board is in Manual Mode.
Single flash	Temperature Alarm	The motor driver's temperature exceeded 60C. Make sure the rails are clean and the door can move without excessive resistance.

### Active LED (yellow)

The Active LED is on when the system is currently opening or closing the door. The LED is also on if a configuration cycle is being performed or if the door is being jogged manually.

### Configuration LED (green)

The configuration LED is ON when the system has been properly configured. If not, it will flash to indicate that configuration is required before the system can be used.

### Enable LED (green)

The *Enable LED* is on, when the *CNC Not Active* input is on, and the system can move the door.

## Interfacing with CNC machines

When interfacing with the CNC machine, the system needs to be aware of the CNC's operating state, i.e. if the CNC is currently running a cycle and the doors need to remain

closed, or if the cycle is completed and the door can be opened. This information should be given by setting the *CNC Not Active* signal high when the CNC is not operating, and the door can be opened. When the machine starts a cycle, it should clear this signal and remain cleared till the cycle is complete and the mechanical locks on the door have been unlocked.

The *CNC Door Opened* and *CNC Door Closed* signals can be used to signal the CNC to e.g. start a new cycle when the doors have been closed.

## **Interfacing with robots**

The robot interface, composed of J1 and J3, allows the robot to determine the current state of the CNC machine, as well as initiating door motion. When the door opens, *Robot Door Opened* is set and the robot can start its part replacement cycle. When done, it can use the *Robot Close Door* signal the door to close. When the door is fully closed, the *CNC Door Closed* signal is set, which can be used to trigger Cycle Start on the CNC.

## **Interfacing with an emergency stop circuit**

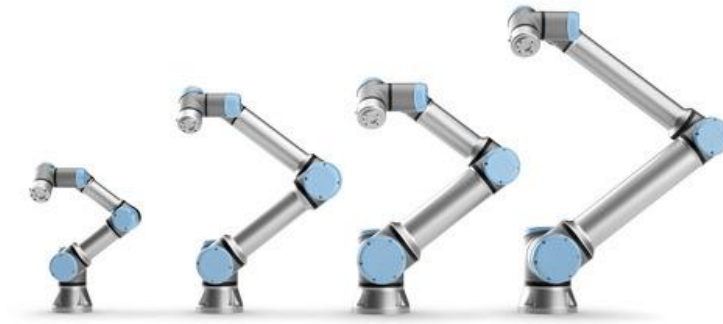
Optionally an emergency stop circuit can be connected to J9. This can be used to immediately stop door motion when CNC machine, robot and/or a separate button is put into emergency stop. In the emergency stop mode the system will prevent any motion of the door.

The presence of an external emergency stop circuit is captured during the configuration cycle (See Configuration on page 22). If either of the inputs “J9 pin 1” or “J9 pin 2” are high during the configuration, the system will register that an external emergency stop circuit is connected and will expect said circuit to be connected during operation. When neither of the signals are active (24V not present) during configuration, emergency stop mode is deactivated and the system will ignore the inputs during operation.

When configured with an external emergency stop circuit present, the system will monitor the emergency stop inputs during operation. Only when both signals are high will the system allow motion of the doors.

It is important to verify that the configuration captured the presence of an external emergency stop circuit, prior to placing the system into service. This can be done by activating the emergency stop while the door is in motion and verifying that it stops immediately.

Once the external emergency stop is deactivated and both inputs go high, the system exits emergency stop mode and proceeds to normal operation. Door motion will not start automatically when exiting emergency stop mode, even if a signal to move (robot/button open/close door) is high; a transition from low to high on one of these inputs are needed to reinitiate motion.



## URCap

The Safedoor URCap enables easy and reliable setup and operation, when using Safedoor in conjunction with a Universal Robots collaborative robot. After the Safedoor system is installed and configured (see Quick guide on page 10), follow these steps to install and configure the URCap on a Universal Robots robot.

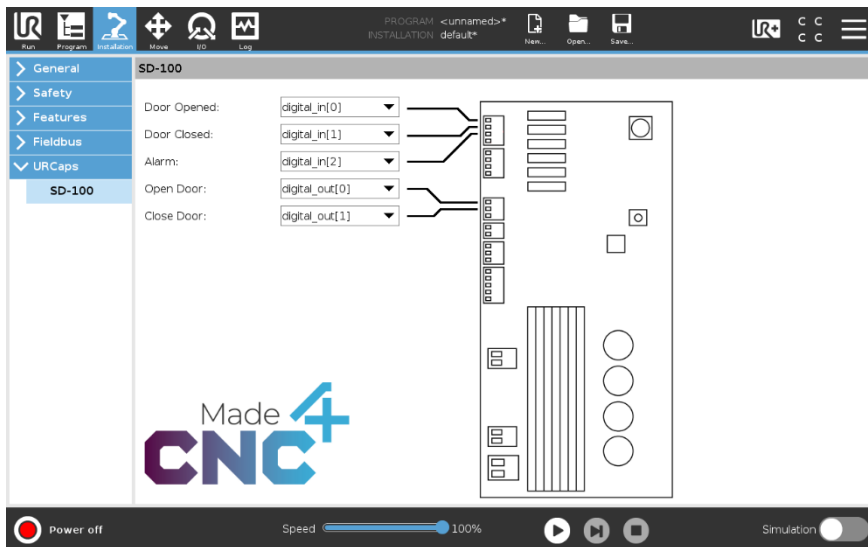
### Installation

Install the URCap by inserting the provided USB stick into the USB port on the robot teach pendant. Follow these steps to install the URCap on the robot system:

1. Main menu → Setup Robot → URCaps
2. Press “+”
3. Select “USB” → “Safedoor.urcap”
4. Press “Open”
5. Press “Restart”
6. Polyscope will now restart and load the installed URCap.

### Installation screen

The installation screen contains settings related to the installation of the Safedoor system. It can be found by navigating to *Installation* → *URCaps* → *Safedoor*. Make sure all inputs and outputs are configured to represent the actual wiring.



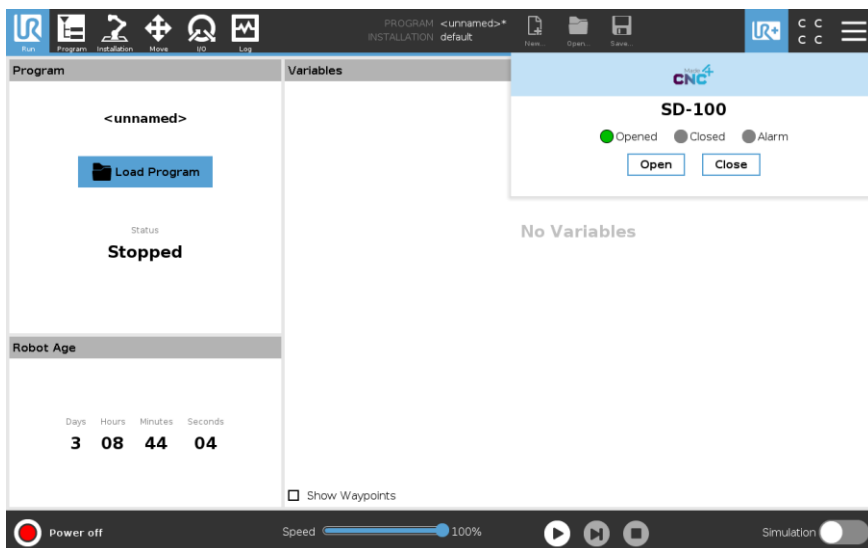
It is advised to verify the installation and settings, by using open- and close buttons on the toolbar (see Toolbar on page 30), before continuing. Verify that the indicators “Opened” and “Closed” light up when the door is in the respective positions.

The alarm signal can be tested by blocking the CNC door and attempting to close it, using the “Close” button. The Alarm signal must be cleared by pressing the “Config / Clear” on the controller board.

## Toolbar

The toolbar provides an overview of the door state as well as access to controls. The controls should not be used while running a program but can be useful while programming the robot.

The toolbar can be accessed by pressing the “UR+” logo in the top-right corner of the screen:



The toolbar is currently only available on Universal Robots eSeries robots.

## Open Door node

This program node can be inserted into the program tree, and it will request the door to open. Per default, this node will block until the door is opened and the robot can safely enter the CNC machine.

The “*Open Door*” program node can be inserted in the “*Program*” panel, at the currently selected location in the program tree, by clicking “*URCaps*” → “*Open Door*” in the structure panel.

The program node will clear the “*Close Door*” signal and set the “*Open Door*” signal. It will wait for the “*Door Closed*” signal to be cleared by the Controller Board, indicating that the signal to open the door was properly received and the motion initiated, before continuing to the next program node.



When the check box “*Wait for door to be opened before proceeding*” is checked, the program will not continue beyond this program node before the door is fully opened and the input signal set as “*Door Opened*” in the installation screen is high.

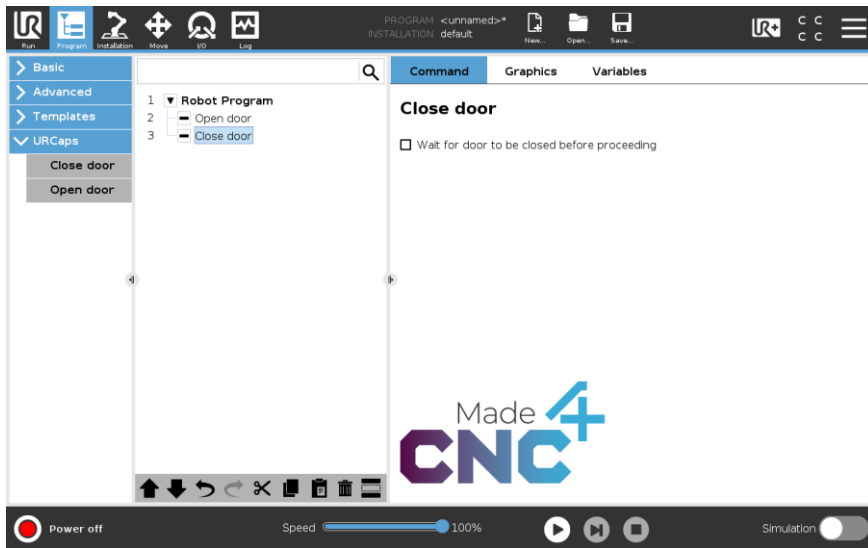
When the check box “*Keep open and block external control*” is checked the program will continuously set the “*Open Door*” signal high, preventing external overrides of this signal. Only subsequent “*Close Door*” program node will remove this blockage and allow the door to close.

## Close door node

This program node can be inserted into the program tree, and it will request the door to close.

The “Close Door” program node can be inserted in the “Program” panel, at the currently selected location in the program tree, by clicking “URCaps” → “Close Door” in the structure panel.

The program node will clear the “Open Door” signal and set the “Close Door” signal. It will wait for the “Door Open” signal to be cleared by the Controller Board, indicating that the signal to close the door was properly received and the motion initiated, before continuing to the next program node. The program node will also clear any external control blockage set by previous “Open Door” program nodes.



When the check box “Wait for door to be closed before proceeding” is checked the program will not continue beyond this program node before the door is fully closed and the Controller Board has set the “Door Closed” signal high.





## Omron Components

The Safedoor Omron Components enable easy and reliable setup and operation, when using Safedoor in conjunction with an Omron Collaborative Robot. After the Safedoor system is installed and configured (see Quick guide on page 10), follow these steps to install and configure the components on an Omron Robot.

The Safedoor components are created using TMFLOW version 1.82.5100 and is compatible with TMFLOW version 1.76.3300 and above.

### Installation

Before installing the Safedoor Components, the provided USB stick should be renamed to TMROBOT, before the Omron Robot will recognize it.

To do so, follow these steps:

1. Plug the USB into a PC
2. Find and right click on the USB in the file explorer
3. Press “Properties” in the drop-down menu
4. Find the property “name” and change it to: “TMROBOT”

If the Component ZIP is downloaded from the made4cnc.com website, and put onto a personal USB, do the previous steps to format it correctly, and continue to these steps:

5. Download the “Omron Component” zip file from made4cnc.com
6. Drag the zip file onto the respective USB
7. Right click the zip file and select “Extract Here”
8. Ensure that the extracted folder is named “TM\_Export”

To install the Safedoor Components on an Omron Robot, start by inserting the prepared USB Stick in the Omron Robot. Then follow these steps:

1. “Menu” → “System” → “Import/Export”
2. Select device to be the inserted USB
3. Press the top left Import button
4. On the “Robot List”, select “Made4CNC”

- 5. Press Component
- 6. Select all 3 components with the prefix: "Actuator\_Made4CNC\_Safedoor\_"
- 7. Press the Import button in the bottom right corner

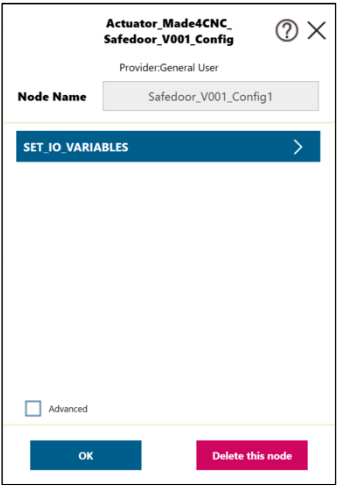
The components are now installed on the Omron Robot. To activate the newly installed components: Navigate to "Settings" → "Components" and scroll to the bottom of the list. Select the 3 components, imported in the previous section. Finish by pressing the save button. The Safedoor Components are now ready to use.

**Config Node**

The *Config Node* imports and configures the global variables defining the I/O used by the *Open Door* and *Close Door* Nodes to interface with the *Safedoor Controller*. It also starts a non-pause thread, responsible for monitoring the error output from the Safedoor Controller

The *Config Node* can be inserted in the "Flow program" by dragging the "Safedoor\_Config" icon from the "Node Menu" into the "Flow Editing Area".

The *Config Node* needs to run once before any of the other Safedoor Components. The node should only be run once throughout a flow program. The node sets the I/Os used by the other Safedoor Nodes, *Safedoor\_Open* and *Safedoor\_Close*. When using the *Config Node*, the global I/O variables can be set through the edit component screen, in the SET\_IO\_VARIABLES method.



If these variables are not manipulated, they will keep their default values.  
See table below for variable names and default values.

All variable names have the prefix: *g\_Actuator\_Made4CNC\_Safedoor\_*.

Name	Type	Description	Default Value
IO_J3_1	Int	Store the input pin placement of the J3 pin 1 output: "Robot door opened"	5
IO_J3_2	Int	Store the input pin placement for the J3 pin 2 output: "Robot door closed"	6
IO_J3_3	Int	Store the input pin placement for the J3 pin 3 output: "Robot alarm"	7
IO_J1_1	Int	Store the output pin placement for the J1 pin 1 Input: "Open door"	6
IO_J1_2	Int	Store the output pin placement for the J1 pin 2 Input: "Close door"	7
Error	String[]	Stores an Error message if the Safedoor system outputs an error signal.	""

The variable names reference the I/O of the Safedoor Controller (See IO connections on page 17.) and should be configured to correspond to the desired I/O of the Omron Robot.

The *Config Node* creates a thread that monitors the error output of the *Safedoor Controller*. If this signal goes high, the program will stop, and store an error message in the global variable: *g\_Actuator\_Made4CNC\_Safedoor\_Error*.

Whenever the *Config Node* is run, the value of the error variable will be reset. Therefore, if the value of the variable is desired, it should always be read before activating the *Config Node* again.

## Open Door Node

The *Open Door Node* serves the purpose of requesting the door to open. Per default, this node waits until it receives the “Door Opened” signal, before proceeding the flow. This allows the Robot to safely enter the CNC machine.

The *Open Door Node* can be inserted in the “Flow program” by dragging the “Safedoor\_Open” icon from the “Node Menu” into the “Flow Editing Area”.

**Important:** The *Safedoor\_Config* Node needs to have run **once** before the *Open Door Node* can function.

The node will set the variable “IO\_J1\_1” (Open Door) and clear the variable “IO\_J1\_2” (Close Door). The node will wait for the “Door Close” signal to be cleared by the Controller Board, indicating that the signal to open the door was properly received and the motion initiated, before continuing to the next program node.



The screenshot shows a configuration window for the 'Actuator\_Made4CNC\_Safedoor\_V001\_Open' node. At the top, there is a title bar with the node name and a close button. Below the title bar, the provider is listed as 'General User'. The 'Node Name' field is set to 'Safedoor\_V001\_Open1'. A blue button labeled 'SET\_Wait\_Before\_Proceed' with a right arrow is visible. At the bottom, there is an 'Advanced' checkbox which is currently unchecked. Two buttons are at the very bottom: a blue 'OK' button and a red 'Delete this node' button.

Editing the node allows the user to determine if the program should wait until the door is opened, before proceeding the flow. In the edit menu, changing the default value of the boolean variable: “*Wait\_Before\_Proceed*”, will accomplish this. The variable determines whether the component will continue the program flow while opening the door, or if it will wait until it is fully open before continuing.

If the value is set to “*true*”, the node will wait till the door is fully opened before proceeding.

If the value is set to “*false*”, the flow will proceed directly after sending the “*Open Door*” signal.

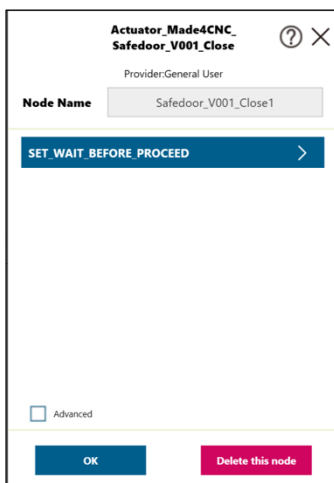
## Close Door Node

The *Close Door Node* serves the purpose of requesting the door to close. Per default, this node waits until it receives the “*Door Closed*” signal, before proceeding the flow.

The *Close Door Node* can be inserted in the “*Flow program*” by dragging the “*Safedoor\_Close*” icon from the “*Node Menu*” into the “*Flow Editing Area*”.

**Important:** The *Safedoor\_Config* Node needs to have run **once** before the *Close Door Node* can function.

The node will set the variable “*IO\_J1\_2*” (Close Door) and clear the variable “*IO\_J1\_1*” (Open Door). The program node will wait for the “*Door Open*” signal to be cleared by the Controller Board, indicating that the signal to close the door was properly received and the motion initiated, before continuing to the next program node.



The screenshot shows a configuration window for the 'Actuator\_Made4CNC\_Safedoor\_V001\_Close' node. At the top, there is a title bar with a question mark icon and a close button. Below the title, it says 'Provider: General User'. The 'Node Name' field is set to 'Safedoor\_V001\_Close1'. A large blue button labeled 'SET WAIT BEFORE PROCEED' with a right-pointing arrow is visible. At the bottom, there is an 'Advanced' checkbox which is currently unchecked. Two buttons are at the very bottom: a blue 'OK' button and a red 'Delete this node' button.

Editing the node allows the user to determine if the program should wait until the door is closed, before proceeding the flow. In the edit menu, changing the default value of the boolean variable: “*Wait\_Before\_Proceed*”, will accomplish this. The variable determines whether the component will continue the program flow while closing the door, or if it will wait until it is fully closed before continuing.

If the value is set to “true”, the node will wait till the door is fully closed before proceeding.

If the value is set to “false”, the flow will proceed directly after sending the “*Close Door*” signal.



## Fanuc Plugin

The Safedoor Fanuc Plugin enables easy and reliable setup and operation, when using Safedoor in conjunction with a Fanuc CRX Collaborative Robot. After the Safedoor system is installed and configured (see Quick guide on page 10), follow these steps to install and configure the plugin on a Fanuc Robot.



### INFO

The Safedoor plugin is created with a plugin specific alarm message which requires that the software of the given robot controller is version "V9.40P/06" or newer.

The Safedoor plugin consists of a configuration screen, a KAREL file, an open instruction, and a close instruction. The Configuration screen is found under: "Menu ≡ → PLUGINS → Made4CNC Safedoor". The KAREL file initializes 5 variables in the robots' non-volatile memory. The two instructions can be found on the tablets' icon pallet, as the colored icons shown below:



OPEN



CLOSE

These icons are labeled under "*Motion*" in the Icon Pallet.

## Installation

Before installing the plugin, firstly open the provided USB Stick on a PC. Then follow these steps to move the plugin file to the USB root:

1. Go to: "FANUC" → "CRX\_PLUGIN"
2. Select the file names "Made4CNC.ipf"
3. Drag the file to the root of the USB stick

Now, to install the plugin, start by inserting the provided USB stick into the USB slot of the Fanuc Robot, then follow these steps:

1. Boot up the robot connected to a Tablet Teach Pendant
2. Go to: "Menu ≡" → "Plugins" → "Install"

3. Select the plugin named "Safedoor [Made4CNC]"
4. Press install
5. Restart the controller by cycling the power

When starting the robot, the provided plugin should appear under:

- "Menu ≡" → "Plugin" → "Plugin List"

Indicating correct installation, the icons for the instructions should now be available in the icon pallet.

### Made4CNC Plugin Error Message

The Made4CNC plugin contains a single error message:

- [Made4CNC\_SD-001] Safedoor Controller Error

if this error message occurs, it means there is an alarm signal from the Safedoor controller. To troubleshoot this, see section: "Alarm LED (red) on page 27".

### Configuration Screen

The configuration screen can be accessed through "Menu ≡" → "PLUGINS" → "Made4CNC Safedoor". The purpose of the screen is to configure the digital IOs connecting the Robot Controller to the Safedoor system. The screen also contains state monitoring of the actuator and test buttons for the digital outputs.

The state monitor shows the current state of the actuator. The reasons for occurrences of possible state messages are described in the table below:

State Message	Reason For Occurrence
Error	The DI for "Safedoor Error Status" is high, indicating an Alarm is being signaled from the Safedoor controller. (See "Alarm LED (red) on page 27" for troubleshooting)
Input Error	An IO reading error has occurred, caused by both DI "Opened" and "Closed" being read as high simultaneously
Moving	The actuator is neither in an open nor closed state
Open	The DI for "Safedoor Opened" is high
Closed	The DI for "Safedoor Closed" is high
Registering	Occurs when none of the above cases are present

The indexes of the DI and DO used by the instructions, are set on the IO Signal Index Configuration element. The arrows to the right of the given IO are used to change its index value. The IO Signal Index Configuration element lets you input a number between 101-120 for DI and 101-116 for DO. These inputs correspond to the physical DI 1-20 and DO 1-16 on the robot controller.

Made4CNC Safedoor Configuration Screen

Made4CNC Safedoor Configuration Screen

State: Moving

State Monitor

Select The Safedoor Signal Index Number:

Safedoor Open	DO[	101	]	▼	▲
Safedoor Close	DO[	102	]	▼	▲
Safedoor Opened	DI[	101	]	▼	▲
Safedoor Closed	DI[	102	]	▼	▲
Safedoor Error	DI[	103	]	▼	▲

IO Signal Index Configuration

Manually Open/Close Safedoor:

◀||▶

OPEN

▶||◀

CLOSE

Test buttons

Upon installation, the IO signal indexes will be set to predefined default values. See table below for default values for the indexes alongside an input type, KAREL variable name and description:

Name	Type	Description	Default Value
OPENDO	DO	Stores the output pin placement for the <i>J1 pin 1</i> Input: “Open door”	101
CLOSDO	DO	Stores the output pin placement for the <i>J1 pin 2</i> Input: “Close door”	102
OPENEDI	DI	Stores the input pin placement of the <i>J3 pin 1</i> output: “Robot door opened”	101
CLOSEDI	DI	Stores the input pin placement for the <i>J3 pin 2</i> output: “Robot door closed”	102
ERRDI	DI	Stores the input pin placement for the <i>J3 pin 3</i> output: “Robot alarm”	103

The default values maps to the corresponding DI 1, 2 and 3 and DO 1, 2 on the robot controller.

The test buttons found on the configuration page consist of an “Open” and “Close” button, used to test the setup of the system. *The buttons only set the designated Dos high/low, without monitoring the digital inputs, contrary to the program instructions provided.*



## Open Instruction

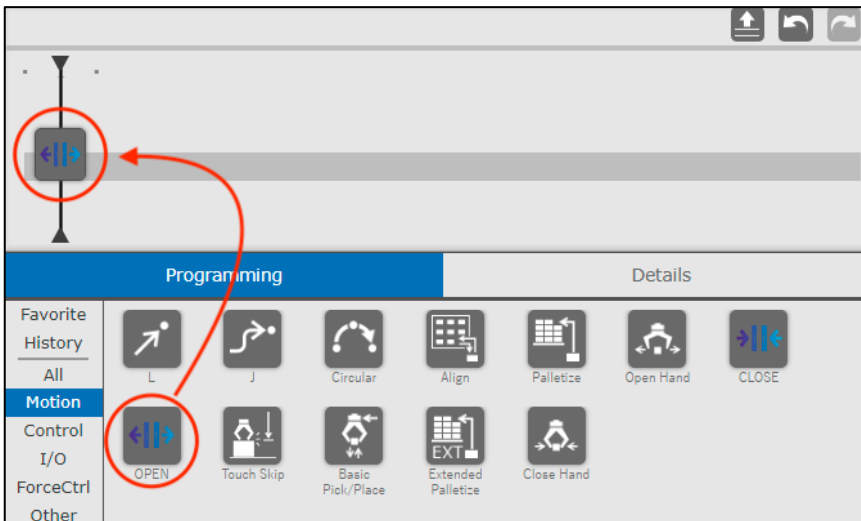
The *Open Instruction* serves the purpose of requesting the door to open. Per default, this instruction waits until it receives the “Opened” [OPENEDI] signal, before proceeding the program flow. This allows the Robot to safely enter the CNC machine in subsequent instructions.

The *Open Instruction* can be found under the category “Motion” in the *icon pallet*. It can be inserted in the current program by dragging the icon labeled “OPEN” from the icon pallet onto the *program line*.

The instruction will set the IOs defined on the Configuration Screen, making the Safedoor system open the door. It does this by setting the “Open” [OPENDO] signal to high and clearing the “Close” [CLOSDO] signal.

The instruction will wait for the “Closed” [CLOSEDI] signal to be cleared by the Safedoor controller, indicating that the signal to open the door was properly received and the motion initiated, before evaluating “Wait Before Proceed”.

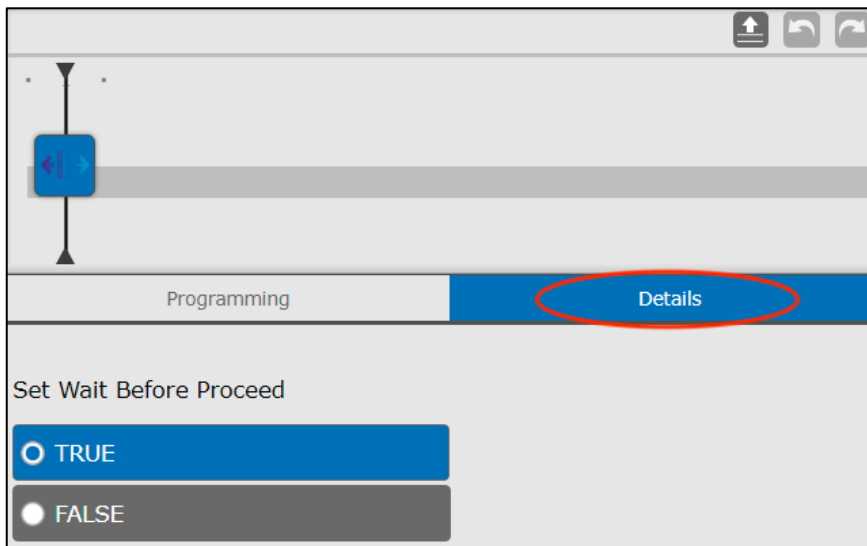
*The instruction monitors the error input from the Safedoor Controller to alert if an error occurs while running. See Made4CNC Plugin Error Message on page 39 for details.*



### INFO

The instructions use the registers 51-55 in the robots' memory. Any overlap with other TP programs can cause problems.

Editing the instruction details allows the user to determine if the program should wait until the door is fully opened before proceeding the flow. To edit the instruction details, press the “Details” tab to bring up the instruction details screen.



The details screen, as seen above, allows changing the behavior of the instructions' flow. Setting the boolean value determine if the instruction should “Wait Before Proceed”, when running. This will decide whether the instruction will continue the program line flow parallel with opening the door, or if it will wait until the door is fully opened, before continuing.

*The default value of “Wait Before Proceed” is TRUE.*

If the value is set to “TRUE”, the instruction will wait until the door is fully opened before proceeding.

If the value is set to “FALSE”, the flow will proceed directly after setting the “Open” signal.

## Close Instruction

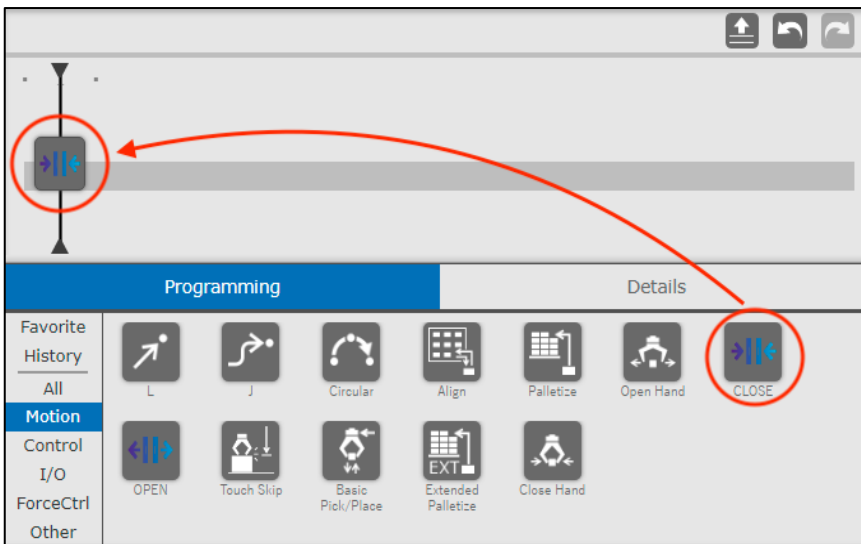
The *Close Instruction* serves the purpose of requesting the door to close. Per default, this instruction does not wait until it receives the “Closed” [CLOSEDI] signal, before proceeding the program flow.

The *Close Instruction* can be found under the category “Motion” in the *icon pallet*. It can be inserted in the current program by dragging the icon labeled “CLOSE” from the icon pallet onto the *program line*.

The instruction will set the IOs defined on the Configuration Screen, making the Safedoor system close the door. It does this by setting the “Close” [CLOSDO] signal to high and clearing the “Open” [OPENDO] signal.

The instruction will wait for the “Open” [OPENEDI] signal to be cleared by the Controller Board, indicating that the signal to close the door was properly received and the motion initiated, before evaluating “Wait Before Proceed”.

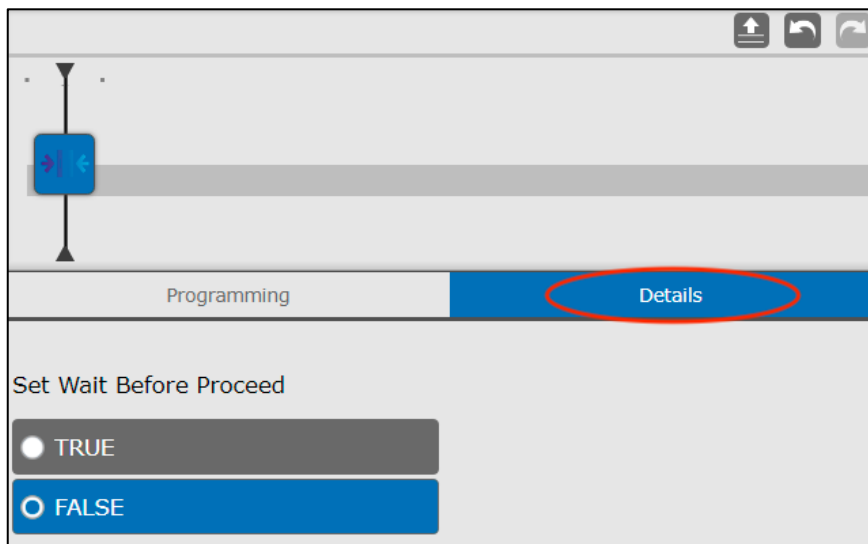
*The instruction monitors the error input from the Safedoor Controller to alert if an error occurs while running. See Made4CNC Plugin Error Message on page 39 for details.*



### INFO

The instructions use the registers 51-55 in the robots' memory. Any overlap with other TP programs can cause problems.

Editing the instruction details allows the user to determine if the program should wait until the door is fully closed before proceeding the flow. To edit the instruction details, press the “Details” tab to bring up the instruction details screen.



The details screen, as seen above, allows changing the behavior of the instructions' flow. Setting the boolean value determine if the instruction should "Wait Before Proceed", when running. This will decide whether the instruction will continue the program line flow parallel with closing the door, or if it will wait until the door is fully closed, before continuing.

*The default value of "Wait Before Proceed" is FALSE.*

If the value is set to "TRUE", the instruction will wait until the door is fully closed before proceeding.

If the value is set to "FALSE", the flow will proceed directly after setting the "Close" signal.



## Doosan App

The Safedoor Doosan App enables easy and reliable setup and operation when using Safedoor in conjunction with a Doosan Collaborative Robot. After the Safedoor system is installed and configured (see **Quick guide** on page 10), follow these steps to install and configure the plugin on a Doosan Robot.

*Note: The Doosan App is supported on Software V2.7.3 and above. We recommend using the App with V2.8.2 or newer for the best experience.*

The Safedoor App consists of a Workcell Item (WCI) and two skills. The WCI is of the type “Machine, Turning Center”. The two skills contain functionality to Open and Close the Safedoor.

When creating a task, the skills are found in the *Command* tab under the label *Machine Skill*.

## Installation

To install the plugin, start by inserting the provided USB stick into the USB slot of the Doosan Robot, then follow these steps:

1. Boot up the Doosan Robot
2. Go to: “Settings”
3. Scroll to the bottom of the sidebar
4. Go to “Workcell Item, Skill Install & Uninstall” → “Install”
5. Select file: “Safedoor.dr3”
6. Press install
7. Reboot the Robot

Indicating correct installation and setup, the Safedoor WCI will show when adding a new “Machine” → “Turning center” inside the WCI overview.

Safedoor WCI

The Safedoor Workcell Item (WCI) must be included in your task for the Safedoor skills to work. In the configuration of the WCI the digital IO port numbers can be set, and the Open and Close signals can be digitally set.

The WCI contains 5 digital IOs, composed of 3 inputs and 2 outputs. The 3 inputs give the app feedback about whether the door is Opened, Closed or if an error has occurred. The 2 outputs are Open and Close. They responsible for letting the App send an Open or Close signal to the Safedoor controller.

Configuration of WCI

When starting the WCI, it must be configured and activated before use. To do this, do the following:

- 1. "Workcell manager" → "Machine" → "+"
- 2. Select "Turning Center" → "Safedoor"
- 3. Press Select
- 4. Configure the WCI (See Picture Below) and press Confirm
- 5. Enable WCI by toggling the switch above the configuration window

SafeDoor

Delete

Confirm

Made4CNC+

Communication Type - digital I/O

Workcell Item Action

INTLK\_On

Test

Write/Read Signal Name	I/O Type	Port No.	Write/Read Signal
<div>Opened</div>	Controller Digital...	1	No Signal
<div>Closed</div>	Controller Digital...	2	No Signal
<div>Error</div>	Controller Digital...	3	No Signal
<div>Open</div>	Controller Digital...	1	<div>On</div> <div>Off</div>
<div>Close</div>	Controller Digital...	2	<div>On</div> <div>Off</div>

The picture above shows the WCI configuration screen with the 5 IOs with their default values. To set the port number of a signal, select the desired port number in the dropdown box in the row containing signal. Here it is also possible to manually set the 2 output signals by choosing either On or Off.


Above the IOs, is a dropdown menu with the label "Workcell Item Action" with a test button. This dropdown box contains the functions provided by the WCI. The functions *Closed*, *Opened*, *Error*, *Close* and *Open* are only used internally in skills, and are therefore of no use as a WCI Action.

Creating a task with the Safedoor WCI

When creating a task using the newly configured WCI follow these steps:

1. Press "Task Builder"
2. Select the "  " icon
3. Select the configured Safedoor WCI and press the ">" button
4. Press "Next" → "Confirm"

If the WCI is being inserted into an already created task, do so by following these steps:

1. Make sure you are inside the task editing
2. Press the " ≡ " icon to the left of the task name
3. Press "Selected Workcell Item"
4. Select the "  " icon
5. Select the configured Safedoor WCI and press the ">" button
6. Press "Next" → "Confirm"

Now the WCI is active in that task, and the skills can be used in conjunction with the WCI.

## Open Door Skill

The *Open Door* skill serves the purpose of requesting the door to open. Per default, this skill waits until it receives the “*Opened*” signal, before proceeding the task flow. This allows the Robot to safely enter the CNC machine in subsequent instructions.

The *Open* Skill can be found under the category “Machine Skills” in the *Command List*. It can be inserted in the current program by pressing the icon labeled “*Open\_Safedoor*” in the command list.

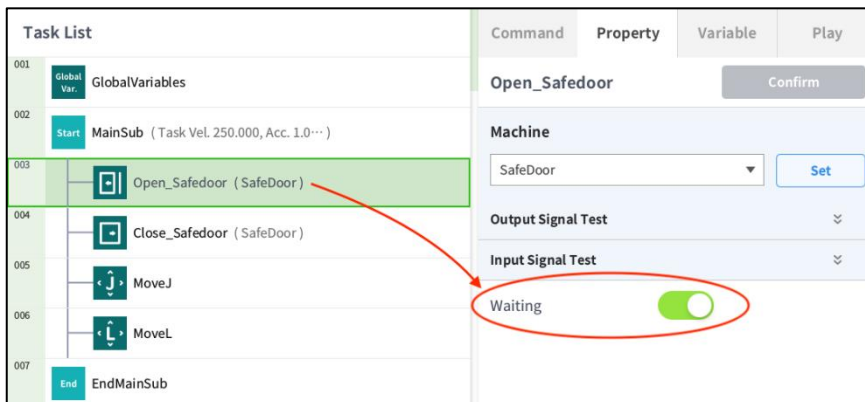
*The skill monitors the error input from the Safedoor Controller and alerts if an error occurs while running.*

## Configuring the Skill

To insert the skill in a task firstly the WCI needs to be selected for the given task (See Safedoor WCI page 46). Before the skill can be used, it needs to be configured by following these steps:

1. Select the skill that needs to be configured
2. Select the “Property” tab
3. In the dropdown labelled “Machine” select the Safedoor WCI and press “Set”
4. Press Confirm

The skill is now ready to use.



The property tab, as seen above, also allows changing the behavior of the skills' flow. Setting the “*Waiting*” switch determine whether the skill will continue the Task flow parallel with opening the door, or if it will wait until the door is open, before continuing.

*The default state of the “Waiting” switch is On.*

If the switch is On, the skill will wait until the door is fully opened before proceeding.

If the switch is Off, the flow will proceed directly after setting the “*Open*” signal.



## Close Door Skill

The *Close Door* skill serves the purpose of requesting the door to close. Per default, this skill does not wait until it receives the “Closed” signal, before proceeding the task flow.

The *Close Skill* can be found under the category “Machine Skills” in the *Command List*. It can be inserted in the current program by pressing the icon labeled “Close\_Safedoor” in the command list.

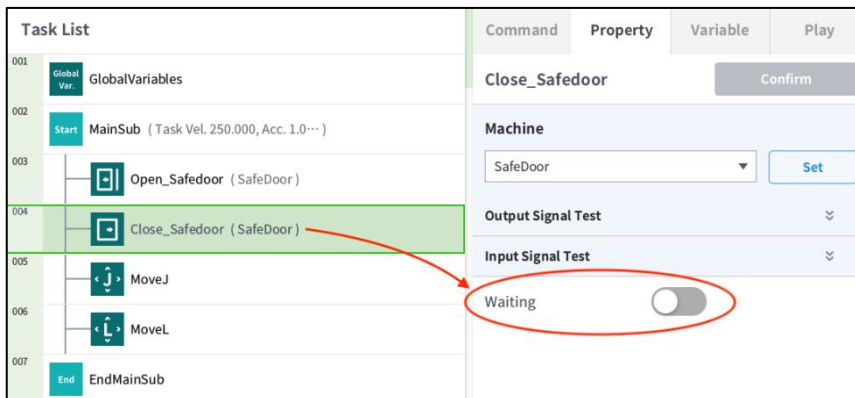
*The skill monitors the error input from the Safedoor Controller and alerts if an error occurs while running.*

## Configuring the Skill

To insert the skill in a task firstly the WCI needs to be selected for the given task (See Safedoor WCI page 46). Before the skill can be used, it needs to be configured by following these steps:

1. Select the skill that needs to be configured
2. Select the “Property” tab
3. In the dropdown labelled “Machine” select the Safedoor WCI and press “Set”
4. Press Confirm

The skill is now ready to use.



The property tab, as seen above, also allows changing the behavior of the skills' flow. Setting the “Waiting” switch determine whether the skill will continue the Task flow parallel with closing the door, or if it will wait until the door is closed, before continuing.

*The default state of the “Waiting” switch is Off.*

If the switch is On, the skill will wait until the door is fully closed before proceeding.

If the switch is Off, the flow will proceed directly after setting the “Close” signal.



## ABB Add-in

The Safedoor ABB Add-in enable easy and reliable setup and operation, when using Safedoor together with an ABB Collaborative Robot. After the Safedoor system is installed and configured (see Quick guide on page 10), follow these steps to install, configure and use the Add-in on an Abb Robot.

Contained in the Add-in is a configuration web-app and two Coblox. The configuration screen is used to configure the signals used in the two Coblox. The Coblox are used in the programming wizard to visualize the rapid program.

*The rapid functions used by the Coblox can also be used directly in the program code.*

Complimenting the Add-in is two smart components containing both 3d models and logic of the Safedoor system by itself, as well as on a *mocked* CNC machine.

### Installation

There are two ways to install an Add-in on an ABB collaborative robot depending on RoboWare version and preference.

#### Using RobotStudio installation manager

1. Connect your computer to the same network as the robot.
2. In RobotStudio go to “Controller” tab → “Add controller”
3. Select the desired controller
4. Go to “Add-ins” tab → “Install Package”
5. Navigate location of the Safedoor ABB add-in
6. Select and press “Open”
7. Go to “Controller” tab → “Installation Manager”
8. Select desired controller
9. On “Distribution” step → “add” → Select “open.made4cnc.safedoor” → “OK”
10. Go to “Options” step → “Applications” tab
11. Extend “Made4CNC” and “Safedoor” → Check the “Safedoor” checkbox
12. Go to “Confirmation” step → Press “Apply”

#### On CRB collaborative robot (Requires RoboWare V. > 7.7)

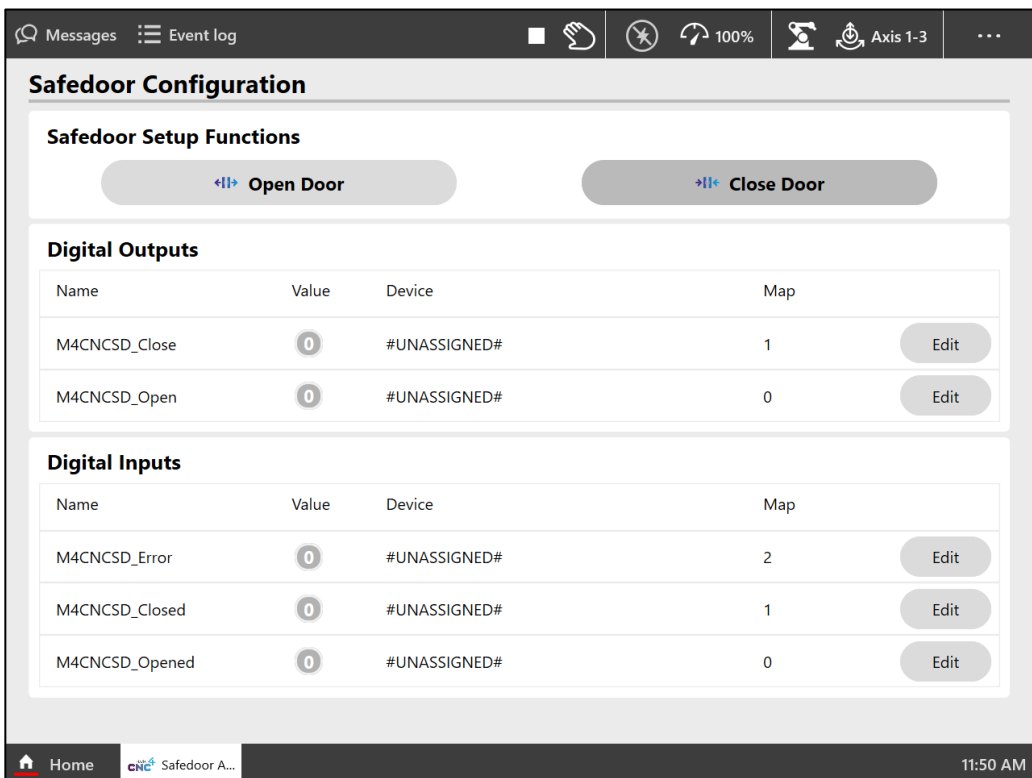
1. Insert USB stick in the FlexPendant
2. Turn on Robot Controller and Flexpendant
3. Go to “Add-In Installer” → Press “+ Add Add-In”

4. On the inserted USB, select the file named: “ABB Safedoor Add-in”
5. Press “Select” → “Next”
6. Make sure the “Safedoor” checkmark is checked
7. Press “Next” → Press “Apply” → Press “Install”

To indicate correct installation, the Safedoor App should be shown on the FlexPendant main screen.

## Configuration screen

The configuration screen for the ABB Add-in can be accessed through the main screen on the FlexPendant, in the app named: “Safedoor App”. The purpose of the app is to map the 5 virtual IOs (used for the rapid functions) to their respective devices and digital IOs. The screen contains function buttons to manually Open and Close the Safedoor.



**Safedoor Configuration**

**Safedoor Setup Functions**

◀▶ Open Door      ▶▶ Close Door

**Digital Outputs**

Name	Value	Device	Map	
M4CNCSD_Close	0	#UNASSIGNED#	1	Edit
M4CNCSD_Open	0	#UNASSIGNED#	0	Edit

**Digital Inputs**

Name	Value	Device	Map	
M4CNCSD_Error	0	#UNASSIGNED#	2	Edit
M4CNCSD_Closed	0	#UNASSIGNED#	1	Edit
M4CNCSD_Opened	0	#UNASSIGNED#	0	Edit

Home    M4CNC Safedoor A...    11:50 AM

The *Safedoor Setup Functions* allow for using of the functionality of the connected Safedoor system without running a program. This is done by manipulating the “Open” and “Close” signals, without program error handling.

The digital IO tables represent the used signals. Each row in the table describes a signal each with their individual “Edit” button, which allows for setting the values of the signal. *The picture above shows the default state of the signals.*

When a signal is edited, a reboot button will appear on the bottom of the screen. This button restarts the controller from the configuration screen. *(This does not work when simulating a virtual controller in RobotStudio)*

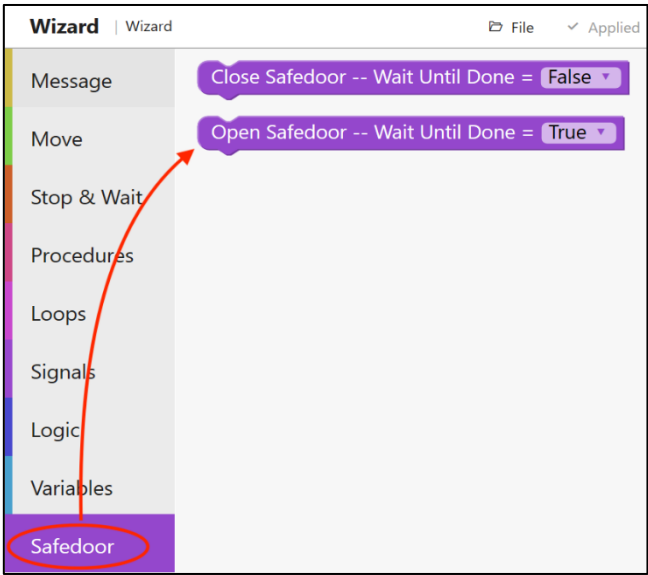
The configuration screen supports multiple languages. Currently the supported languages are:

- English (default)
- German
- Danish
- Swedish

**Open Door Block**

The *Open Door* Block serves the purpose of requesting the door to open. Per default, this skill waits until it has received the “*Opened*” signal, before proceeding the task flow. This allows the Robot to safely enter the CNC machine in subsequent instructions.

The *Open* Block can be found under the category “Safedoor” in the category list. To insert it to the program, drag it from the popup onto the wizard programming pallet.



The Block monitors the error input from the Safedoor Controller and alerts if an error occurs while running. The program will wait until the error signal is low before proceeding the flow.



The rapid logic for the block can be used directly in rapid code with the command: "Open\_Door [X]" where X is the value of "Wait Until Done". False=0, True=1.

Changing the parameter value of "Wait Until Done" using the dropdown on the Block allows the user to decide whether the Block will continue the program line flow parallel with closing the door, or if it will wait until the door is fully closed before continuing.

The default value of "Wait Before Proceed" is True [1].

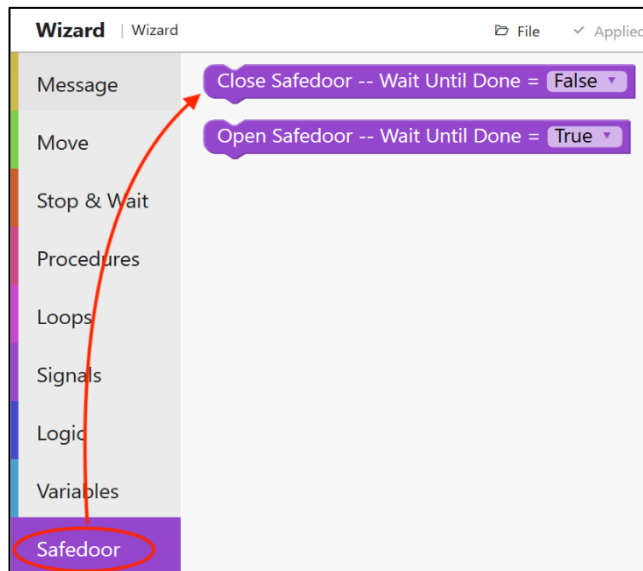
If the value is set to "True" [1], the instruction will wait until the door is fully closed before proceeding.

If the value is set to "False", the flow will proceed directly after setting the "Close" [0] signal.

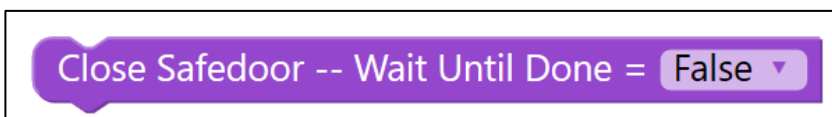
### Close Door Block

The *Close Door* Block serves the purpose of requesting the door to close. Per default, this skill does not wait until it has received the "Closed" signal before proceeding the task flow.

The *Close* Block can be found under the category "Safedoor" in the category list. To insert it to the program, drag it from the popup onto the wizard programming pallet.



The Block monitors the error input from the Safedoor Controller and alerts if an error occurs while running. The program will wait until the error signal is low before proceeding the flow.



*The rapid logic for the block can be used directly in rapid code with the command: "Close\_Door [X]" where X is the value of "Wait Until Done". False=0, True=1.*

Changing the parameter value of "Wait Until Done" using the dropdown on the Block allows the user to decide whether the Block will continue the program line flow parallel with closing the door, or if it will wait until the door is fully closed before continuing.

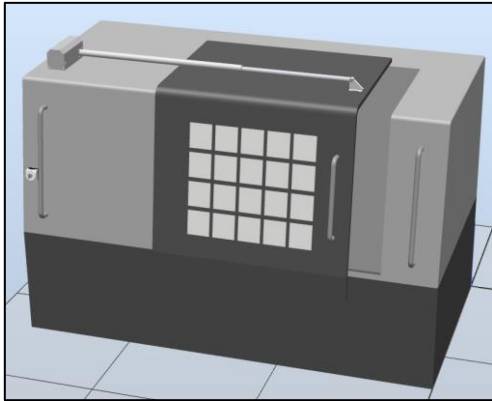
*The default value of "Wait Before Proceed" is False [0].*

If the value is set to "True" [1], the instruction will wait until the door is fully closed before proceeding.

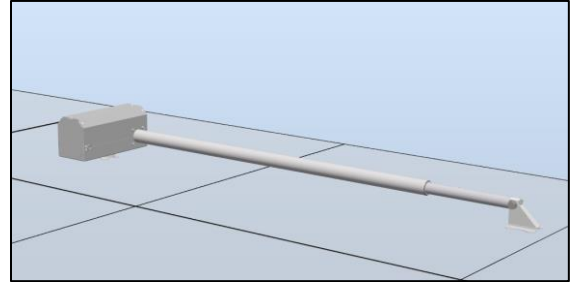
If the value is set to "False", the flow will proceed directly after setting the "Close" [0] signal.

## Smart Component

Along with the Add-in, we offer RobotStudio smart components. Smart components are simulated versions of the Safedoor system, containing a mock version of the logic found in the Safedoor. These components can be used to simulate the use of the Safedoor system in RobotStudio. We provide two smart components: One with the Safedoor System on a mocked CNC machine, and one with just the Safedoor system.



*Safedoor Component on a mock CNC*



*The Safedoor Component*

## Installation Guide

When inserting the smart components into RobotStudio, ensure that a USB stick with the Safedoor smart component is inserted into the used computer before following these steps:

1. Import Library
2. Navigate to inserted USB stick
3. Go to folder "ABB" → "Safedoor Smart Component"
4. Select one of the components and press "Open"

The smart component has one more input than the actual system. This is the "Sim\_Error" input used to simulate an error. This is created as the logic of the smart component doesn't trigger errors in the same way as the actual system (See section Alarm LED (red) on page 27).

The components both have a property called "Invert\_Direction", which inverts the movement direction of the extending arm, when the "Open" or "Close" signal is received.

The Safedoor Component without the CNC machine has an additional property, called "distance", which determines the stroke length of the extending arm. It has a value range of: [ 0.10 - 1.00 ], with the default value: [ 1.00 ].

If the "Open" and "Close" inputs are manually manipulated through the property tab some anomalies may occur where the simulated Safedoor actuator may overextend in either direction. If this happens, the simulated Safedoor actuator is returned to its retracted position automatically to prevent simulation issues.



# Kuka Setup Guide

## Connections

Before setting up the connections between Safedoor and KR C5 Micro, be sure to follow the *Quick guide* on page 10 to ensure correct functionality of Safedoor.

When the Safedoor has been set up correctly, connect the Safedoor Controller to the KR C5 Micro according to the table below. The table uses the names: “Signal Name”, “Safedoor Port Name” and “KR C5 Port Connection”.

*Safedoor Signal Name* refers to the name by which the connection will be referred to throughout the guide. *Safedoor Connection* refers to the name of the IO as described in the *IO connections* on page 17. *KR C5 Micro Connection* refers to the possible port connections between the *Safedoor Connection* and the KR C5 Controller.

## Safedoor KRC5 Micro Connections

Safedoor Signal Name	Safedoor Connection	KR C5 Micro Connection
Open	J1 Pin 1	Any even Port Number between 10 – 40 on the XG12 Interface
Close	J1 Pin 2	Any even Port Number between 10 – 40 on the XG12 Interface
Robot 24V	J1 Pin 3	Port Number 4 on the XD12.1 Interface
Opened	J3 Pin 1	Any uneven Port Number between 9 – 39 on the XG12 Interface
Closed	J3 Pin 2	Any uneven Port Number between 9 – 39 on the XG12 Interface
Error	J3 Pin 3	Any uneven Port Number between 9 – 39 on the XG12 Interface
Robot GND	J3 Pin 4	Port Number 3 on the XD12.1 Interface

The Safedoor IOs are galvanically isolated, and support both NPN and PNP, and therefore support both high-side and low-side configurations of the XG12 interface.



## Connection Example

Figure 03 shows an example of how the Safedoor controller can be wired to the KR C5 Micro.

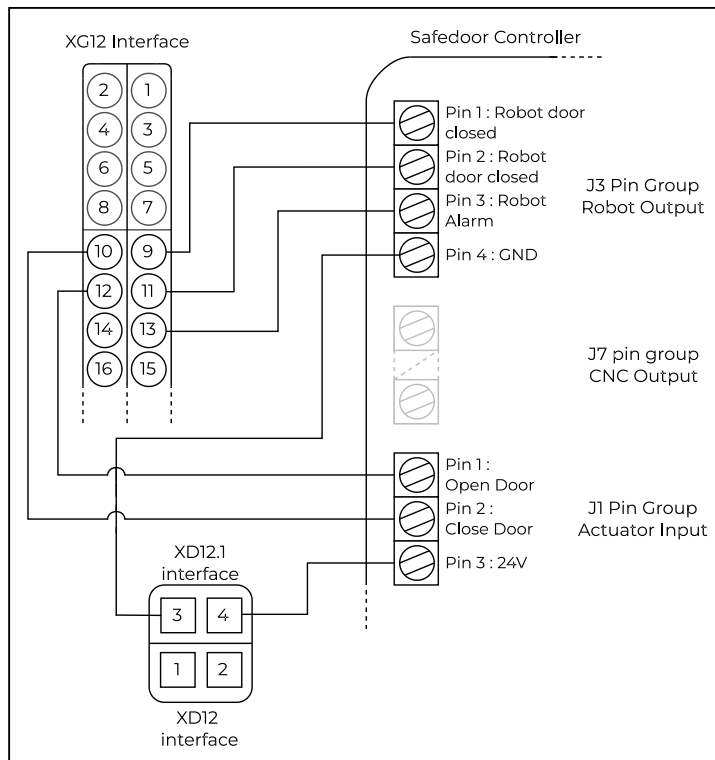


Figure 03: Connection Example

The table below contains the example connections made in figure 03.

Suggested Signal Name	Safedoor Signal Name	Safedoor Connection	KR C5 Micro Connection
OpenCNC	Open	J1 Pin 1	XG12 Port 12
CloseCNC	Close	J1 Pin 2	XG12 Port 10
-	Robot 24V	J1 Pin 3	XDI2.1 Port 4
OpenedCNC	Opened	J3 Pin 1	XG12 Port 9
ClosedCNC	Closed	J3 Pin 2	XG12 Port 11
ErrorCNC	Error	J3 Pin 3	XG12 Port 13
-	Robot GND	J3 Pin 4	XDI2.1 Port 3

I/O Configuration on the Kuka Cobot  
For IO configuration, see official Kuka documentation here:  
<https://xpert.kuka.com/ID/CS316>.

Software Program Setup

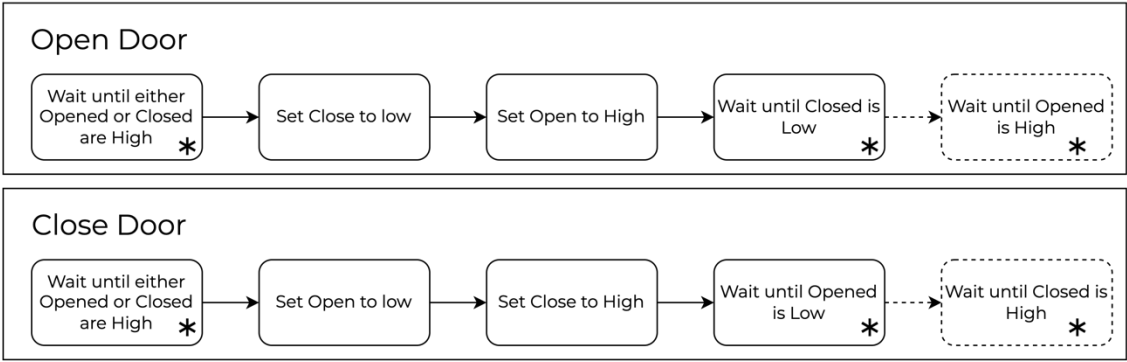
In this section it is described how to setup software programs to create collaboration between the Safedoor System and KR C5 micro.

The software programs for the KR C5 micro will serve the purpose of opening or closing the door correctly, with monitoring of the SD *Error* signal.

Open & Close Door Program

The programs will work by setting the IOs connected to the Safedoor Controller, making the actuator open or close. It opens by clearing the “Close” signal and setting the “Open” signal high and closes by clearing the “Open” signal and setting the “Close” signal high while also checking the state of the system before making decisions.

A recommended program flow for each action is shown below, ensuring the system is in a valid state before proceeding its flow:

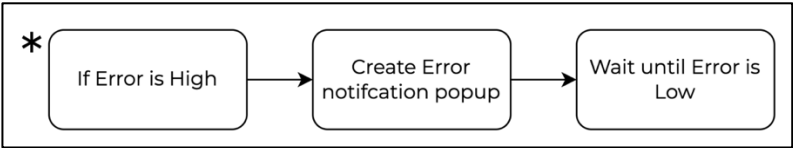


The 1<sup>st</sup> step ensures that the Safedoor system is in either of its final states (And not moving), before setting the output signals

The 2<sup>nd</sup> step waits till the Closed/Opened signal is cleared, indicating that the signal to move the door was properly received and the motion initiated.

The last step, marked with dashed lines, are an optional addition. It makes the program flow wait until the door is in its final state before proceeding. *It is recommended to add this to the Open Door program, as it ensures that the robot can safely enter the CNC machine.*

On the steps marked with an asterisk, it’s recommended to add monitoring of the *Error* signal. A recommended error monitoring flow is shown below:

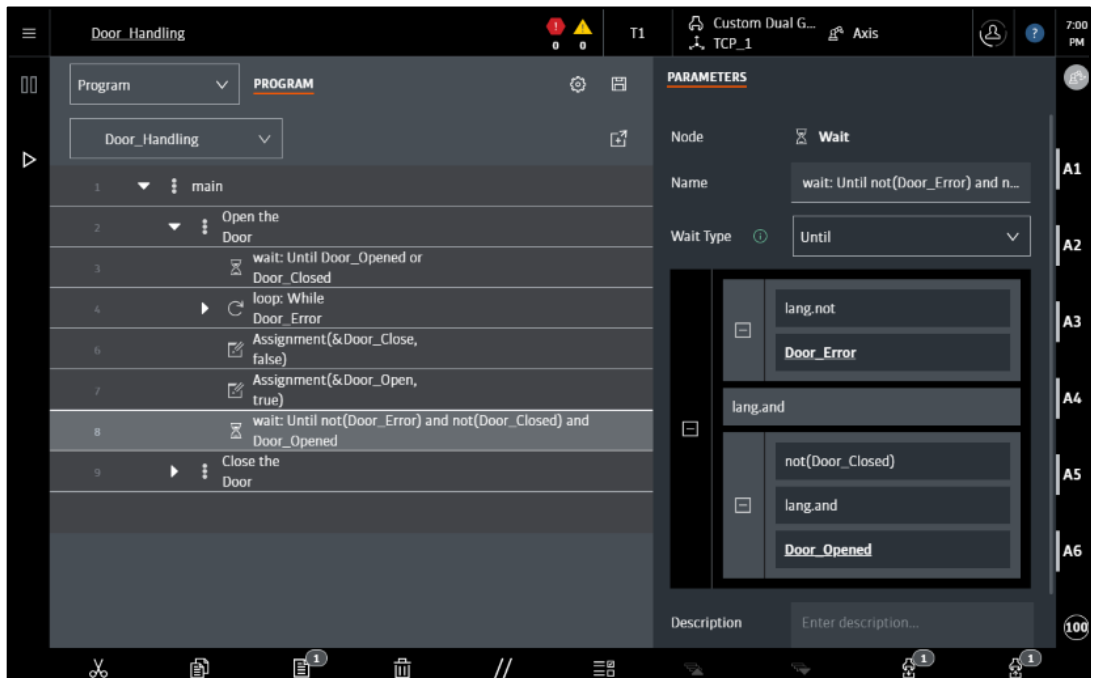


The intent of the error monitoring is to ensure that the program flow safely stops, if any error occurs on the Safedoor system.

## Example Program Implementation

The example shows how an open door program implementation for the Safedoor could look like:

*(Please note that the example does contain the wait until opened code block)*



The screenshot displays the CNC control interface for a program named "Door\_Handling". The interface is divided into several sections:

- Top Bar:** Shows the program name "Door\_Handling", a status bar with red and yellow warning icons, and a "T1" label. It also includes a "Custom Dual G..." button and a "TCP\_1" label.
- Left Panel:** Contains a "Program" dropdown menu set to "Door\_Handling" and a list of program steps:
  1. main
  2. Open the Door
  3. wait: Until Door\_Opened or Door\_Closed
  4. loop: While Door\_Error
  6. Assignment(&Door\_Close, false)
  7. Assignment(&Door\_Open, true)
  8. wait: Until not(Door\_Error) and not(Door\_Closed) and Door\_Opened
  9. Close the Door
- Right Panel (PARAMETERS):** Shows the configuration for the "Wait" node:
  - Node:** Wait
  - Name:** wait: Until not(Door\_Error) and n...
  - Wait Type:** Until
  - Logic Tree:**
    - lang.not (Door\_Error)
    - lang.and (not(Door\_Closed), lang.and (Door\_Opened))
  - Description:** Enter description...
- Bottom Bar:** Contains various icons for program control, including a play button, a stop button, and a refresh button.



## Kassow CBun

The Safedoor Kassow CBun enable easy and reliable setup and operation, when using Safedoor together with a Kassow Robot. After the Safedoor system is installed and configured (see Quick guide on page 10), follow these steps to install, configure and use the CBun on the Kassow Robot.



### INFO

*The \*.cbun file will upon installation be compiled to the operating system version on the specific robot*

The Safedoor CBun consists of one command with two actions which contain the functionality to control the Safedoor from the Kassow Robot. The CBun is configured upon activation, where the signals that are used in the command's actions are set. The actions are used when programming the robots. They are used to handle Opening and Closing the Safedoor.

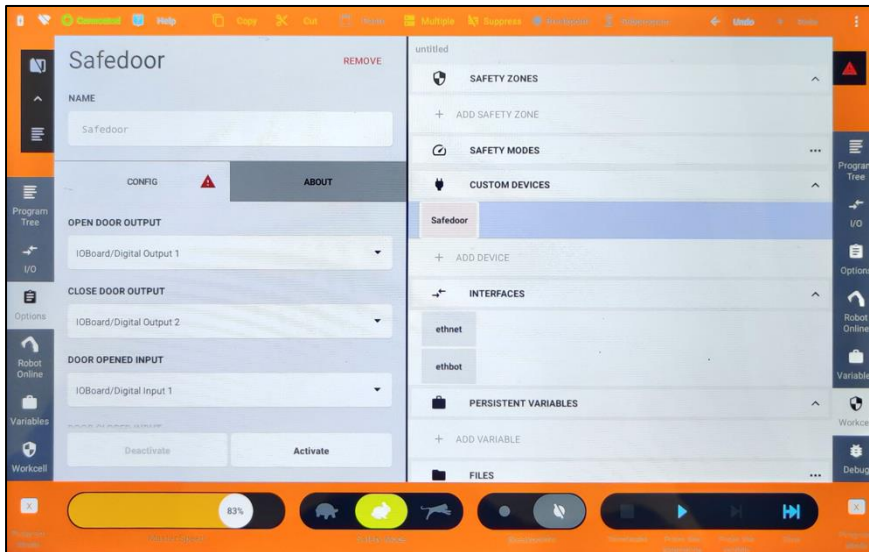
## Installation

Before installation, ensure are logged in as a user profile: Programmer, Safety Admin, Integrator, or Admin to make sure you have permissions for installing CBuns.

1. Insert the provided USB into a USB input slot on the Kassow robot controller
2. Navigate to: "Settings" → "CBuns"
3. In the upper left corner press the "+" button "load module"
4. In the installation modal, press "🔍 Robot" to show all available devices
5. Select the USB containing the Safedoor CBun
6. Go to the directory named "Safedoor Cbun"
7. Select the list item named "🔧 Safedoor"
8. Confirm the installation by pressing the "Install" button

## Configuring the CBun

An instance device of a CBun is created when used in a workcell and therefore must be configured whenever a new instance is added. When setting up an instance of the Safedoor CBun, 5 parameters are set, which determine the signal indexes used by the functions imported with the CBun.



The 5 indexes are locations on the IOBoard on the kassow controller.

Two of these indexes are digital outputs, Open and Close, which maps the indexes on the controller which connects to the Open and Close inputs on the Safedoor controller.

The last three indexes are digital inputs, Opened, Closed and Error, which gets their respected signals from the Safedoor controllers' outputs.

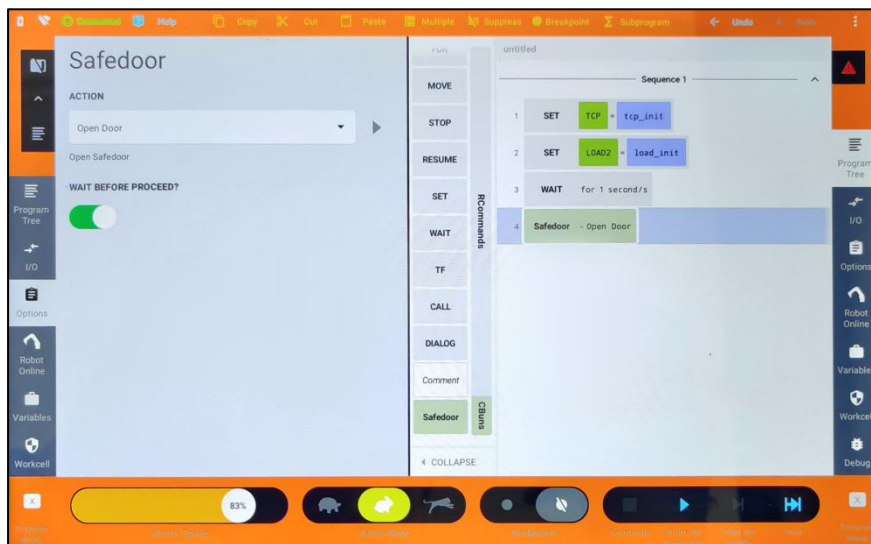
When setting the signals, it is crucial that none of the signals are identical, as this will cause the program to not function as intended.

## Open Action

The *Open* serves the purpose of requesting the door to open.

The *Open* action can be used activating of the Safedoor CBun in the workcell. It can be found in the "Safedoor" command under in the "CBuns" section of the list of commands of the current workcell. To insert it to the program, drag it from command list onto the program tree.

The action monitors the error input from the Safedoor Controller and alerts if an error occurs while running. The action will wait until the error signal is low before proceeding the flow.



Changing the parameter value of “Wait before proceed?” using the switch in the action options allows the user to decide whether the action will continue the program tree flow parallel with opening the door, or if it will wait until the door is fully opened before continuing.

If the option is set to on, the action will wait until the door is fully opened before proceeding.

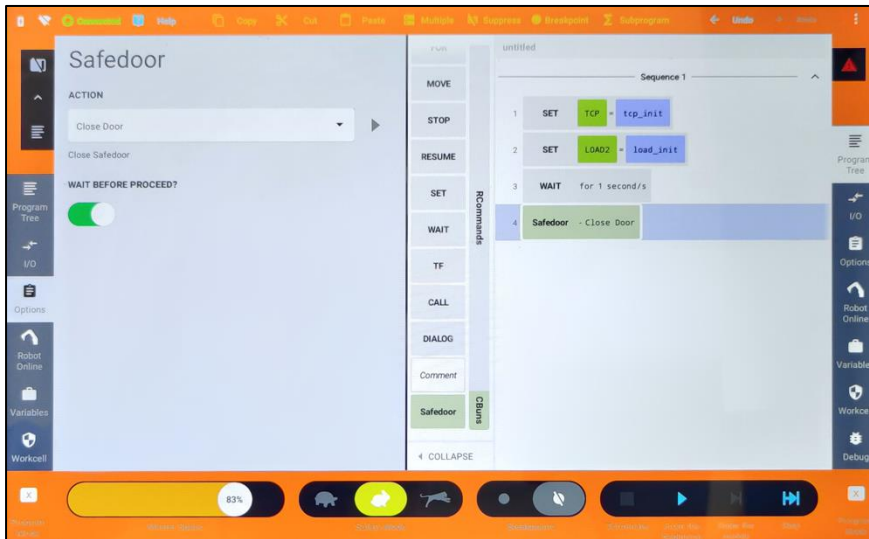
If the option is set to off, the flow will proceed directly after setting the “Open” signal.

## Close Command

The *Close* serves the purpose of requesting the door to open.

The *Close* action can be used activating of the Safedoor CBus in the workcell. It can be found in the “Safedoor” command under in the “CBuns” section of the list of commands of the current workcell. To insert it to the program, drag it from command list onto the program tree.

The action monitors the error input from the Safedoor Controller and alerts if an error occurs while running. The action will wait until the error signal is low before proceeding the flow.



Changing the parameter value of “Wait before proceed?” using the switch in the action options allows the user to decide whether the action will continue the program tree flow parallel with closing the door, or if it will wait until the door is fully closed before continuing.

If the option is set to on, the action will wait until the door is fully closed before proceeding.

If the option is set to off, the flow will proceed directly after setting the “Close” signal.

# 6 Safety

## System integrator responsibilities

The system integrator is responsible for ensuring that the applicable safety laws and regulations in the country where the product is incorporated are followed and that all significant hazards in the complete automated system are eliminated. This includes, but is not limited to:

- Performing a risk assessment for the complete system, including CNC machine and/or robot
- Interfacing other machinery and additional safety devices, if defined according to the risk assessment
- Setting up the appropriate safety settings in the robot- and CNC software and other relevant safety controllers
- Ensuring that the user will not modify any safety measures
- Validating that the total system is working correctly and according to system requirements
- Writing instructions for use (To be read by daily operators etc.)
- Marking the installation with the relevant signs and contact information system integrator
- Collection all documentation in a technical file; including the risk assessment and this manual

## Intended use

The Safedoor system is intended to be installed on a CNC machine to automatically open and close one or two sliding doors of the CNC machine. The CNC machine must have mechanical stops at both ends of the door(s) linear travel and it must provide a safe locking mechanism, ensuring that the door cannot be opened while the CNC machine is operating.

The door can be opened to 1000mm and weight up to 400kg. Opening speed is maximum 500mm/s and will stop when meeting certain resistance. The Safedoor Actuators and Controller should only be used under conditions specified in the *Technical Sheet* on page 4.

The Safedoor Controller is installed with electrical 24V signals between controller and CNC machine and/or robot. The wiring must be carried out by qualified personnel, e.g. an electrician qualified to install wires in CNC machines and robots. When connecting to external machinery, such as CNC machines, robots and other industrial- and automation equipment, only signals intended for external communication. Note that some CNC machines have dedicated communication ports, specific digital I/Os, etc., designated for incorporation with an automated door function.

Any use of the Safedoor system deviating from the intended use is deemed to be impermissible misuse. This includes, but is not limited to:

- Use in potentially explosive atmospheres
- Use in non-industrial environments



- Use before conducting risk assessment
- Use where risk of clamping a human's head and/or neck is significant
- Use outside permissible operational conditions and specifications
- Use where the door(s) presents a cutting and/or impact risk
- Use where safety features of the CNC machine door(s) are bypassed or compromised
- Use as climbing or lifting aid
- Use where the actuator is constantly soaked in oil or other liquids
- All operators must be trained in correct use of the equipment, including all relevant safety precautions.

## **Risk assessment**

The system integrator must perform a risk assessment on the complete CNC machine and/or robot application. The Safedoor Controller and Actuators is only components in an automation application and the safe use of the Safedoor system rely on the integrators ability to design a safe application.

The Safedoor system is designed with these risk reduction features:

- Three different speed settings, allowing the integrator to reduce the travel speed if required by the risk assessment. The lower travel speed, the lower impact from the inertia (weight) of the door.
- Force limiting, reducing pinch and crushing hazards.
- Non-backdrivable gear, ensuring the door does not move unintended.

The safety of the overall automated system depends on the design and shape of individual CNC machine doors. The integrator of the Safedoor system must consider if the CNC machine doors are suitable for automatic operation, and if needed according to the integrators risk assessment edges of the door must be upgraded with soft padding or the edges must be smoothed to have suitable contact surfaces. All changes to the CNC machine itself must be done in according to guidelines and requirements for such CNC machine.

The weight (inertia) of the CNC door and thereby potential impact with such door must be considered in the risk assessment. Light doors with large and flat closing surfaces poses less risk than heavy doors with thin/smaller closing surfaces. The integrator must also consider how the Safedoor Actuator is mounted and ensure that the mounting itself do not create any additional risks, e.g. risk of clamping.

In applications where the Safedoor system is used together with a robot, the integrator must consider if a potential collision between the door(s) and robot can create any additional hazards and mitigate any risk from such hazards as required by the risk assessment.

It is the responsibility of the integrator to conduct a risk assessment of the final installation, including the Safedoor system, the CNC machine and any other

equipment used. All hazards as well as the severity of these must be identified and assessed before placing the installation into service.

Below is a list of the potential hazards that Made4CNC has identified as significant and that must be considered by the integrator:

- Collision between moving parts and human body parts (e.g. head and neck)
- Clamping between moving parts and robot or other equipment (e.g. head and neck)
- Consequences due to improper mounting and/or loosening of bolts/screws
- Consequences due to lack of maintenance
- Contact between door(s) and robotics equipment and/or workpiece

Maintenance and safety checks must be performed with appropriate and regular intervals, and at least once time per year. The integrator must define such appropriate intervals to the user and/or operator, e.g. in the information for use.

It is recommended that national standards and guidelines are observed in the design phase of the complete installation, and that the principles for risk assessment defined in ISO 12100 are followed.

When relevant, the max speed of the door can be determined by ISO 14120 stating a maximum force 150N and a kinetic energy of 10J for the Safedoor system combined with properties of the CNC door.

The table below shows examples of weight and speed settings that fits with ISO 14120. These numbers are guidelines only; please refer to ISO 14120 for application specific requirements.

Door Weight [kg]	Speed [m/s]
0-80	0,50
80-131.5	0,39
131.5-255	0,28

**Shared signals and power off**

It is recommended that installations as a whole are connected with shared emergency stop functionally, so that a push of any emergency stop button stops motion of all machines in the reasonable proximity, as determined by the risk assessment.

It must be considered if a shared Lockout-Tagout function is required, where all mains power (230V/110V) to all parts of the installation can be disconnected at the same time (e.g. the CNC machine, the robot and the Safedoor system all together). It is recommended to follow ISO 14118.

**Exerted force**

The table below shows the typical actuator force at different levels of door openings. The data is based on tests carried out by third party test facility (Force Technology) and can be used as guidelines when performing risk assessment.

Opening [mm]	Force [N]
--------------	-----------

15	108
40	124
80	170
120	299
150	383

If it is found by risk assessment that the combination of physical properties of the CNC door and moving parts of Safedoor actuator and/or a robot result in risks that cannot be sufficiently reduced with safety features provided by Safedoor System and/or the robot then additional risk reduction measures must be added. Such measures could include protective devices such as laser scanners or light curtains in combination with mechanical shielding.

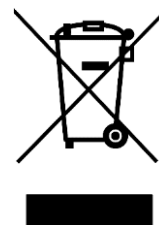
## Environmental safety

The Safedoor system, including Actuators and Controllers, and any other Made4CNC product must be decommissioned and disposed in accordance with applicable national laws, regulations and standards.

The product is manufactured with restricted use of hazardous substances to protect environment and operators, as defined by the EU “RoHS” Directive 2001/65/EU. The restrictions include lead, cadmium, mercury, chromium VI, polybrominated biphenyls and polybrominated diphenyl ethers.

National requirements apply to importers according to EU “WEEE” Directive 2012/19/EU. Follow this link for more information.

<https://www.ewrn.org/national-registers/national-registers>



## General safety instructions

Generally, all laws, regulations and legislations of the country of installation and use must be complied with. Observe all guidelines in this manual and the warnings below:

# 7 Warranties

## **Product warranty**

Without prejudice to any claims the customer (user) may have in relation to the dealer or retailer, the customer shall be granted a manufacturer's warranty under the conditions set out below:

In the case of new devices and their components exhibiting defects resulting from manufacturing and/or material faults within 12 months of entering into services (maximum 15 month after shipment), Made4CNC shall provide the necessary spare parts, while the customer shall provide the working hours to replace the spare parts, either replace the failed part with another part in similar state of wear and tear or repair said failed part.

This warranty shall be invalid if the defect is attributable to improper treatment and/or failure to comply with information contained in the user guides. This warranty shall not apply to or extend to service performed by an authorized dealer or the customer themselves (including installation, software downloads and configuration). Purchase documentation, together with the date of purchase, shall be required as evidence for invoking the warranty. Claims under this warranty must be submitted within one month of the defect becoming evident. Ownership of products, devices, components and spare parts replaced by and returned to Made4CNC shall vest in Made4CNC. Any other claims resulting out of or in connection with the product shall be excluded from this warranty. Nothing in this warranty shall attempt to limit or exclude a customer's statutory rights nor the manufactures liability for death or personal injury resulting from its negligence. Insofar as no warranty default exists, Made4CNC reserves the right to charge the customer for the replacement or repair. The above provision does not imply change in the burden of proof to the detriment of the customers. In case of a device exhibiting defects, Made4CNC shall not be liable for any incidental, special, indirect or consequential damages, including but not limited to, loss of profit, loss of use, loss of production or damages to other equipment.

## **Disclaimer**

Made4CNC continues to improve the reliability and performance of its products, and therefore reserve the right to upgrade the product without any prior notice. Made4CNC takes thorough care that the content of this manual is precise and correct but takes no responsibility of any erroneous or missing information.

**DANGER**

All wiring and connections must be performed by personal qualified to work with mains voltage (230V/110V). Electrical shock can result in death.

Do not touch any electrical components inside the controller besides the dedicated buttons.

Do not take the internal power supply apart. It operates with internal voltages up to 500V, and voltage can be present for up to 24 hours after disconnection.

Do not use the product if any electrical or mechanical components are damaged or modified. Made4CNC disclaims any and all liability if the product is modified in any way. Made4CNC cannot be held responsible for any damages caused to the product or any other equipment due to programming errors or malfunction of the Safedoor product.

Do not modify any safety features of the CNC door(s). The CNC machine must be prevented from operating when the door is open. CNC machine operation with open door(s) can result in death or serious injury.

Improper maintenance or installation can cause the product to separate unexpectedly. Schedule maintenance with a fixed and appropriate period of time not longer than one year.

# 8 Certifications

Declarations, certificates and standards are listed in this section.

## Applied standards

Standards used under the development of the product is listed in this section. EU Directive numbers noted in square brackets indicates that the standard is harmonized under that directive.

### ISO 12100:2010

#### EN ISO 12100:2010 (E) [2006/42/EC]

*Safety of machinery – General principles of design – Risk assessment and risk reduction*

The product is evaluated in accordance with the principles of these standards.

### ISO 14120:2015

#### EN ISO 14120:2015 (E) [2006/42/EC]

*Safety of machinery - Guards - General requirements for the design and construction of fixed and movable guards*

The product is evaluated in accordance with the principles of these standards.

### IEC 60529:2013

#### EN 60529/A2:2013

*Degrees of protection provided by enclosures (IP Code)*

This standard defines enclosure ratings regarding protection against dust and water.

The actuator and the controller are designed with an IP classification according to this standard. See stickers on the controller cabinet and actuator.

### IEC 61131-2:2017

#### EN 61131-2:2017 [Pending harmonization 2014/30/EU]

*Programmable controllers*

24 V I/O signals from/to the controller are designed for reliable communication with robots, CNC machines and PLCs conforming to this standard.

### ISO 13732-1:2007

#### EN ISO 13732-1:2008 [2006/42/EC]

*Ergonomics of the thermal environment. Methods for the assessment of human responses to contact with surfaces.*

Part 1: Hot surfaces

The product is designed so that the surface temperature of the product is kept under the ergonomic limits defined by this standard.

### IEC 61000-6-2:2016

#### IEC 61000-6-4:2018

#### EN 61000-6-2:2019 [Pending harmonization 2014/30/EU]

#### EN 61000-6-4:2019 [Pending harmonization 2014/30/EU]

*Electromagnetic compatibility (EMC)*

*Part 6-2: Generic standards – Immunity for industrial environments*

*Part 6-4: Generic standards – Emission standard for industrial environments*

The product is evaluated according to the limits and principles in these standards.

**IEC 60068-2-1:2007**

**IEC 60068-2-2:2007**

**IEC 60068-2-27:2008**

**IEC 60068-2-64:2008**

**EN 60068-2-1:2007**

**EN 60068-2-2:2007**

**EN 60068-2-27:2009**

**EN 60068-2-64:2008**

*Environmental testing*

*Part 2-1: Tests – Test A: Cold*

*Part 2-2: Tests – Test B: Dry heat*

*Part 2-27: Tests – Test Ea and guidance: Shock*

*Part 2-64: tests -Test Fh: Vibration broadband random and guidance*

The product is designed and prepared to pass tests defined in these standards.

**IEC 60664-1:2020**

**EN 60664-1:2020 [2014/35/EU]**

*Insulation coordination for equipment within low-voltage supply systems*

*Part 1: Principles, requirements and tests*

This standard is observed during development of the electrical circuits inside the product.

**ISO 10218-2:2011**

**EN ISO 10218-2:2011 [2006/42/EC]**

**ANSI/RIA R15.06**

**CAN/CSA-Z434-14**

*Robots and robotic devices – Safety requirements for industrial robots*

*Part 2: Robot systems and integration*

This standard is relevant for robotic applications and should be observed by integrators when integrating this product in conjunction with one or more robots. The product evaluated and prepared for integrations according to these standards.

**ISO/TS 15066:2016**

**RIA TR R15.606**

*Robots and robotic devices — Collaborative robots*

This technical specification is relevant for collaborative robot applications and should be observed by integrators when integrating this product in conjunction with one or more cobots. The product evaluated and prepared for integrations according to the normative requirements in this technical specification.

# CE/EU Declaration of incorporation

According to European Machinery Directive 2006/42/EC annex II 1.B.

The manufacturer:

Made4CNC ApS  
Helgavej 26  
DK-5230 Odense M  
DENMARK  
[www.made4cnc.com](http://www.made4cnc.com)

declares that the product:

Model:	Safedoor
Type:	Controller with Actuator(s)
Generation:	2
Serial, controller:	SDC2-000000 to SDC2-999999
Serial, actuator:	SDA2-000000 to SDA2-999999

configured with one controller and one or two actuators fulfills the following essential health and safety requirements of the Machinery Directive 2006/42/EC:

1.1.2, 1.1.3, 1.1.5, 1.2.1, 1.2.6, 1.5.1, 1.5.2, 1.5.6, 1.5.8, 1.5.10, 1.6.3, 4.1.2.3

The product is partly completed machinery according to Machinery Directive 2006/42/EC and may not be put into service before the machinery in which it will be incorporated is declared in conformity with the provisions of 2006/42/EC and complies with national law.

Compliance with all essential requirements of 2006/42/EC requires a final risk assessment that also takes CNC machine, robot(s) and other equipment into account.

Technical documentation is prepared according to Directive 2006/42/EC annex VII part B and is available in electronic form to national authorities upon legitimate request. Undersigned is based on the manufactures address and authorized to compile this documentation.

Additionally, the product declares in compliance with the following directives, according to which the product is CE marked:

- 2014/30/EU – Electromagnetic Compatibility Directive (EMC)
- 2011/65/EU – Restriction of the use of hazardous substances (RoHS)

Relevant essential health and safety requirements of the following EU directives are also applied:

- 2014/35/EU – Low Voltage Directive (LVD)
- 2012/19/EU – Waste of Electrical and Electronic Equipment (WEEE)

Odense, April 28<sup>th</sup>, 2023

Corporate management



Peter Nadolny Madsen  
Chief Executive Officer



# UK Declaration of incorporation

According to European Machinery Directive 2006/42/EC annex II 1.B.

The manufacturer:

Made4CNC ApS  
Helgavej 26  
DK-5230 Odense M  
DENMARK  
[www.made4cnc.com](http://www.made4cnc.com)

declares that the product:

Model:	Safedoor
Types:	Controller with Actuator(s)
Generation:	2
Serial, controller:	SDC2-000000 to SDC2-999999
Serial, actuator:	SDA2-000000 to SDA2-999999

configured with one controller and one or two actuators fulfills the following essential health and safety requirements of the Supply of Machinery (Safety) Regulations 2008:

1.1.2, 1.1.3, 1.1.5, 1.2.1, 1.2.6, 1.5.1, 1.5.2, 1.5.6, 1.5.8, 1.5.10, 1.6.3, 4.1.2.3

The product is partly completed machinery and must not be put into service before the machinery in which it will be incorporated is declared in conformity with the provisions of Supply of Machinery (Safety) Regulations 2008.

Compliance with all essential requirements of Supply of Machinery (Safety) Regulations 2008 requires a final risk assessment that also takes CNC machine, robot(s) and other equipment into account.

The partly completed machinery must not be put into service until the final machinery into which it is to be incorporated has been declared to be in conformity with the provisions of the Supply of Machinery (Safety) Regulations 2008.

Furthermore, the partly completed machinery fulfils the Electromagnetic Compatibility Regulations 2016 (UK EMC Regulations), the Restriction of the Use of Certain Hazardous Substances in Electrical Equipment Regulations 2012 (UK RoHS) and all health and safety requirements in the Electrical Equipment (Safety) Regulations 2016 are met.

Odense, April 28<sup>th</sup>, 2023

Corporate management



Peter Nadolny Madsen  
Chief Executive Officer





Safedoor is an innovative and safe solution to enable robotized tending of existing CNC machines.

The Actuator is specially designed for the purpose, allowing fast, continuous operation of CNC machine doors. The intelligent Controller monitors that all aspects of the doors motion are smooth and reliable.

The built-in safety features allow safe human / machine collaboration without the need to safety fencing. This makes the Safedoor system ideal for collaborative robot applications.