Safedoor

Robot Instructions Manual

Made 4 CNC

English (original)
Version 2.1.0

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This user manual provides detailed instructions for the installation, configuration, and operation of the Safedoor system, designed for robotic tending of CNC machines. It is intended for use by system integrators and operators with a technical background.

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Introduction

Welcome to the Safedoor System!

Congratulations on choosing the Safedoor automatic door system. This document provides specific instructions for integrating Safedoor with various robots through electrical interfaces and software plug-ins. Our system is designed to enhance the safety and efficiency of CNC machine operations, ensuring a reliable and ergonomic solution.

About This Manual

This guide is a self-contained document, offering detailed steps for the installation, configuration, and operation of the Safedoor system when interfacing with different robotic systems. It focuses on the specific procedures and plug-ins required for various robot brands. However, it is not a substitute for the main User Manual.

For comprehensive safety information, general installation guidelines, and other essential instructions, please refer to the main Safedoor User Manual. It is crucial to review the User Manual thoroughly to ensure safe and proper use of the Safedoor system.

Manual Overview

The document is structured into the following sections:

URCap: Detailed instructions for installing and configuring the Safedoor system with Universal Robots, including setup, toolbar usage, and specific programming nodes.

Omron Components: Steps for installing and configuring the Safedoor system with Omron robots, including configuration nodes and operational nodes.

Fanuc Plugin: Instructions for installing and configuring the Safedoor system with Fanuc robots, including handling error messages and specific program instructions.

Doosan App: Guidelines for using the Safedoor system with Doosan robots, covering installation, workcell item configuration, and skill setup.

ABB Add-in: Installation and configuration steps for integrating the Safedoor system with ABB robots, including specific operational blocks.

Smart Component: Installation guide for the Smart Component of the Safedoor system.

Kuka Setup Guide: Comprehensive setup guide for Kuka robots, including electrical connections and software program setup.

Kassow CBun: Instructions for installing and configuring the Safedoor system with Kassow robots, including open and close commands.

Who Should Use This Manual?

This guide is intended for system integrators, robotics engineers, and technical personnel responsible for the installation, configuration, and operation of the Safedoor system with various robotic systems. Familiarity with CNC machine operations, robotic programming, and electrical installation practices is highly recommended. Maintenance personnel who will be involved in the ongoing operation and troubleshooting of the Safedoor system will also find this guide valuable.

Contact Information

For further assistance or inquiries, please contact Safedoor Technical Support:

Phone:	+45 28257281
Email:	support@made4cnc.com
Website:	www.made4cnc.com

Thank you for choosing Safedoor. We are committed to providing you with the highest quality products and support to ensure your complete satisfaction



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" in the *Safedoor User Manual*), follow these steps to install and configure the URCap on a Universal Robots robot.

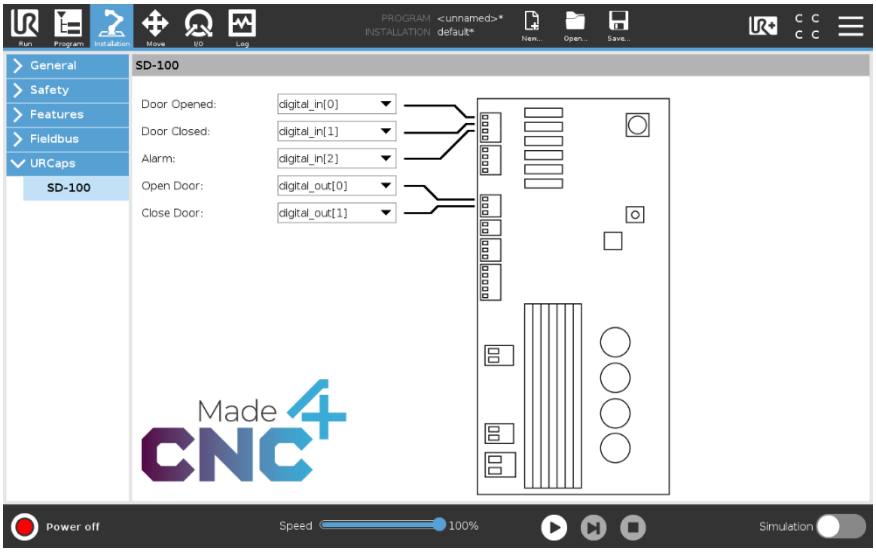
Installation

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.



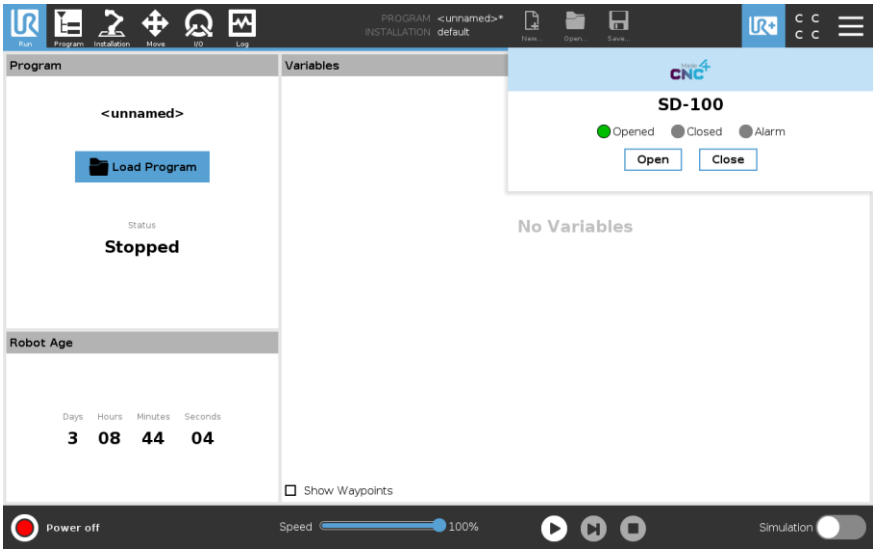
It is advised to verify the installation and settings, by using open- and close buttons on the toolbar (see Toolbar on page 9), before continuing. Verity that the indicators “Opened” and “Closed” light up when the door is in the respective positions.

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” in the *Safedoor User Manual*), 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

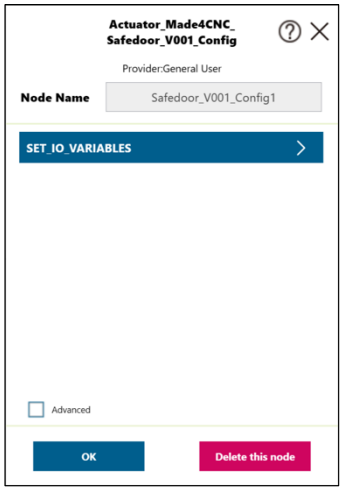
The components are now installed on the Omron Robot. To activate the newly installed components: Navigate to "Settings" → "Components" and scroll to the bottom of the list. Select the 3 components, imported in the previous section. Finish by pressing the save button. The Safedoor Components are now ready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

Config Node

The *Config Node* imports and configurates 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" in the *Safedoor User Manual*) 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.

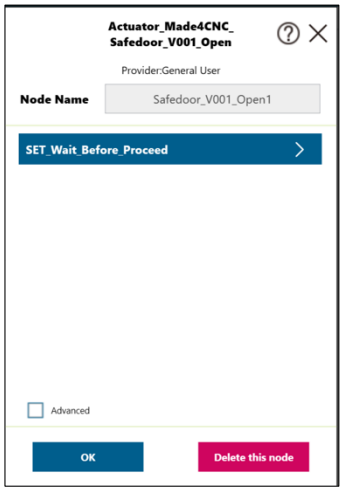
Open Door Node

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.



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.

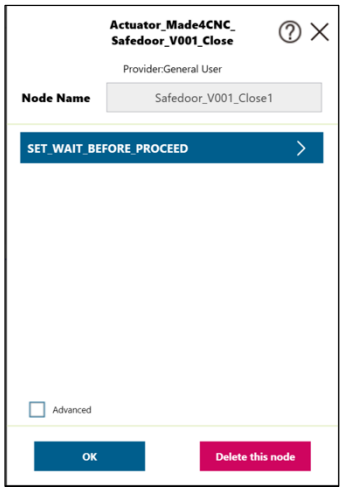
Close Door Node

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.



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” in the *Safedoor User Manual*), 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.ipl”
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 “Software Specifications” in the *Safedoor User Manual*.

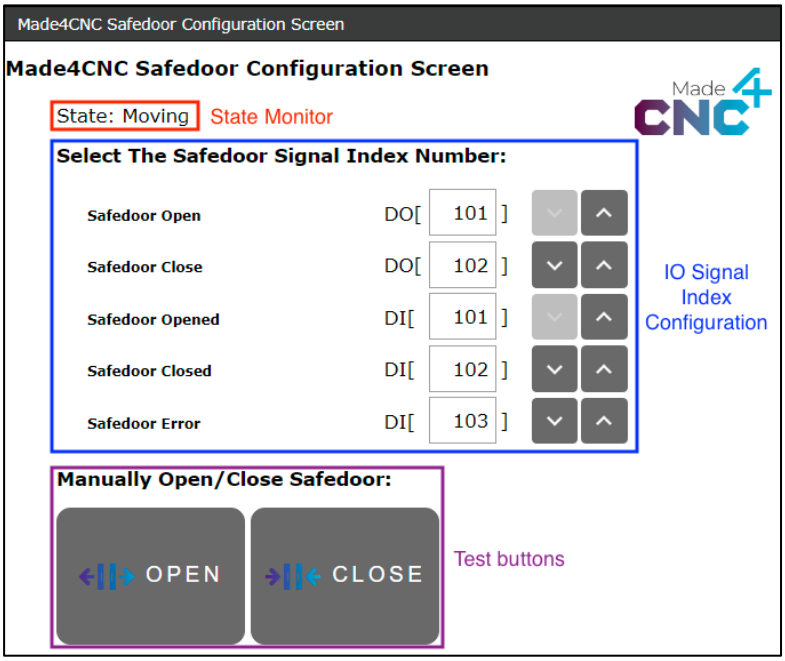
Configuration Screen

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 Safedoor User Manual* 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.



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 *J1 pin 1* Input: "*Open door*"	101
CLOSDO	DO	Stores the output pin placement for the *J1 pin 2* Input: "*Close door*"	102
OPENEDI	DI	Stores the input pin placement of the *J3 pin 1* output: "*Robot door opened*"	101
CLOSEDI	DI	Stores the input pin placement for the *J3 pin 2* output: "*Robot door closed*"	102
ERRDI	DI	Stores the input pin placement for the *J3 pin 3* 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

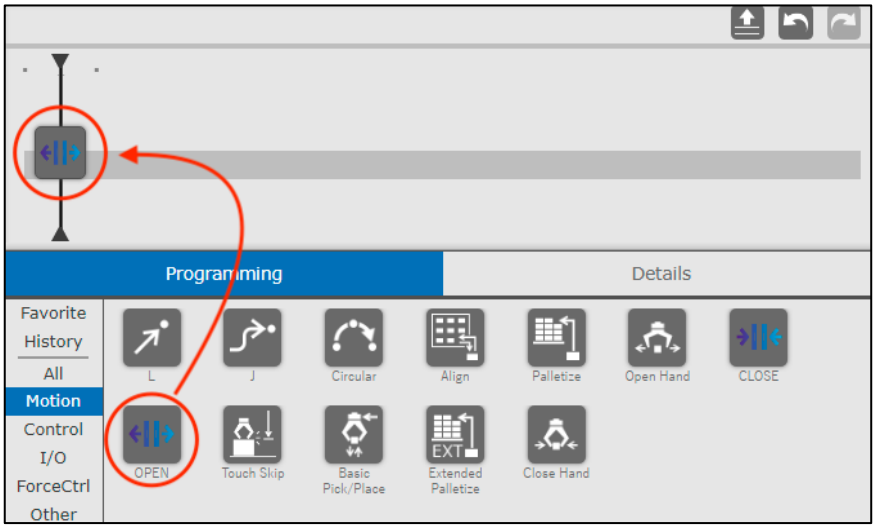
The *Open Instruction* serves the purpose of requesting the door to open. Per default, this instruction waits until it receives the "*Opened*" [OPENEDI] signal, before proceeding the program flow. This allows the Robot to safely enter the CNC machine in subsequent instructions.

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".

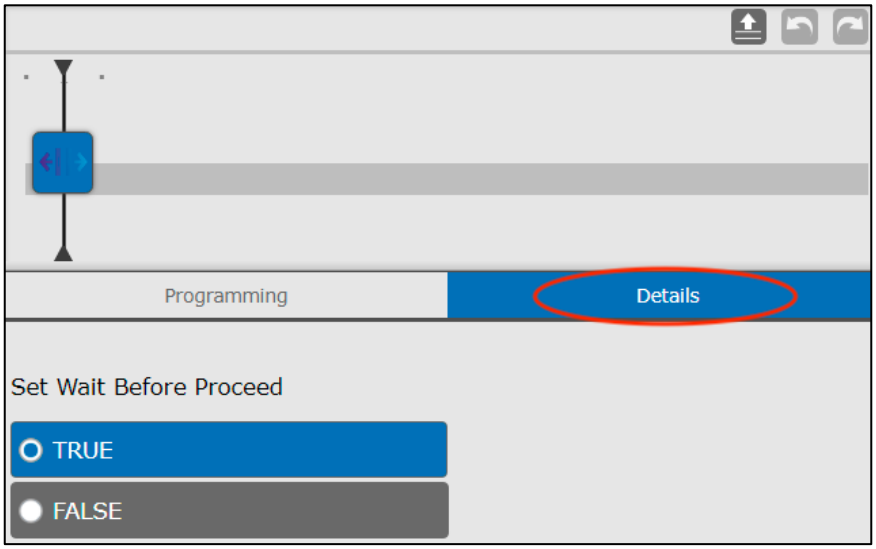
The instruction monitors the error input from the Safedoor Controller to alert if an error occurs while running. See Made4CNC Plugin Error Message *on page 21 for details.*



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 Procced" 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

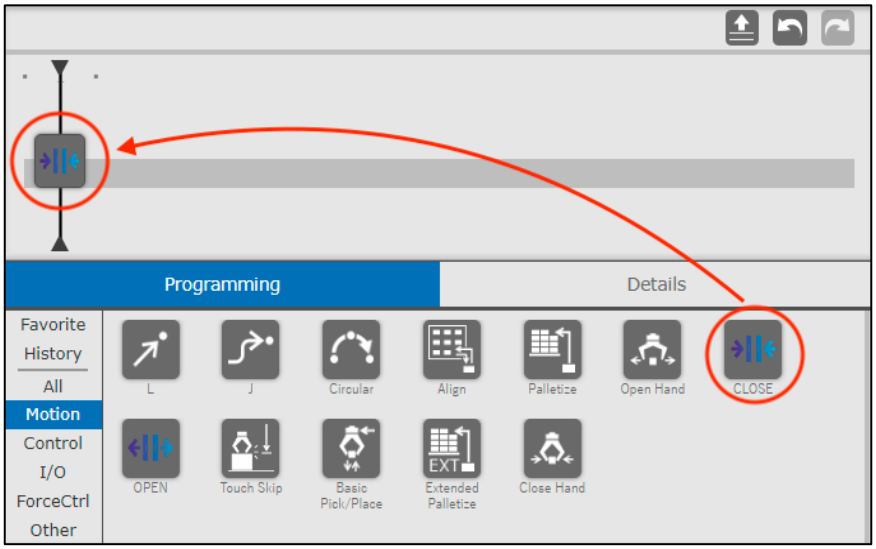
The *Close Instruction* serves the purpose of requesting the door to close. Per default, this instruction does not wait until it receives the "*Closed*" [CLOSEDI] signal, before proceeding the program flow.

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".

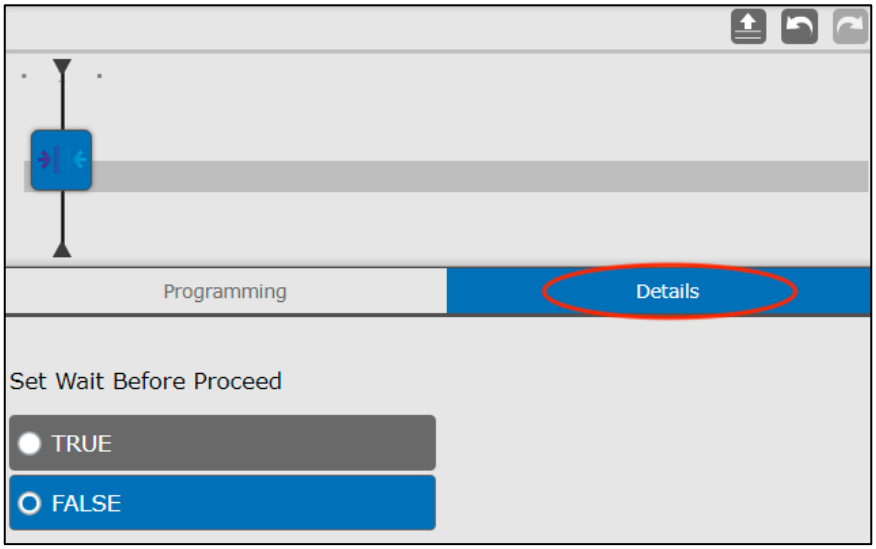
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INFO

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 Procced" 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” in the *Safedoor User Manual*), 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

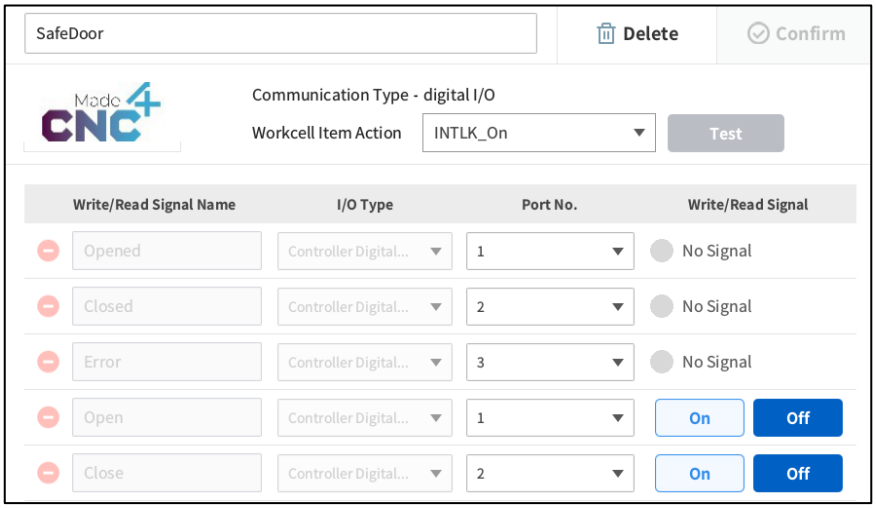
The Safedoor Workcell Item (WCI) must be included in your task for the Safedoor skills to work. In the configuration of the WCI the digital IO port numbers can be set, and the Open and Close signals can be digitally set.

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 configurated 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



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.

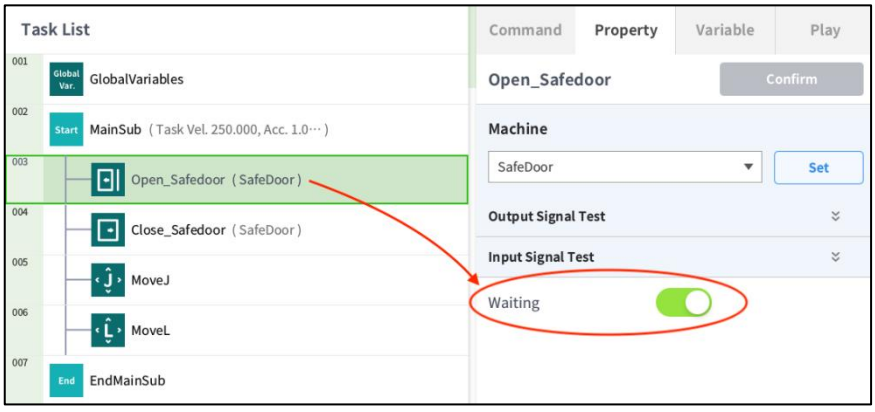
The skill monitors the error input from the Safedoor Controller and alerts if an error occurs while running.

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 29). 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.

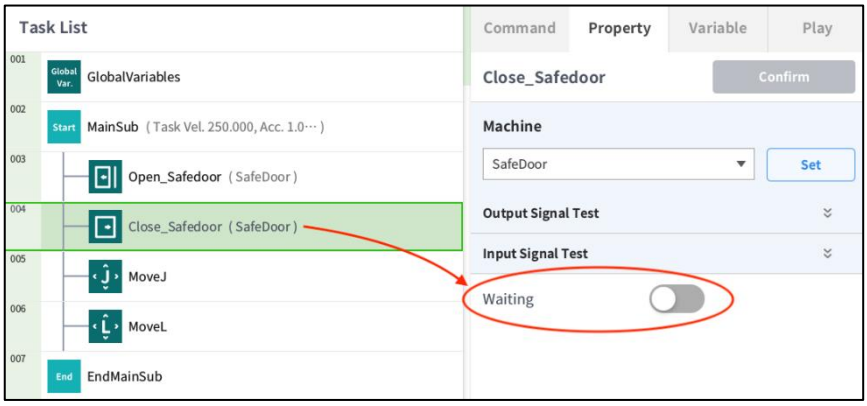
The skill monitors the error input from the Safedoor Controller and alerts if an error occurs while running.

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 29). 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” in the *Safedoor User Manual*), 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”

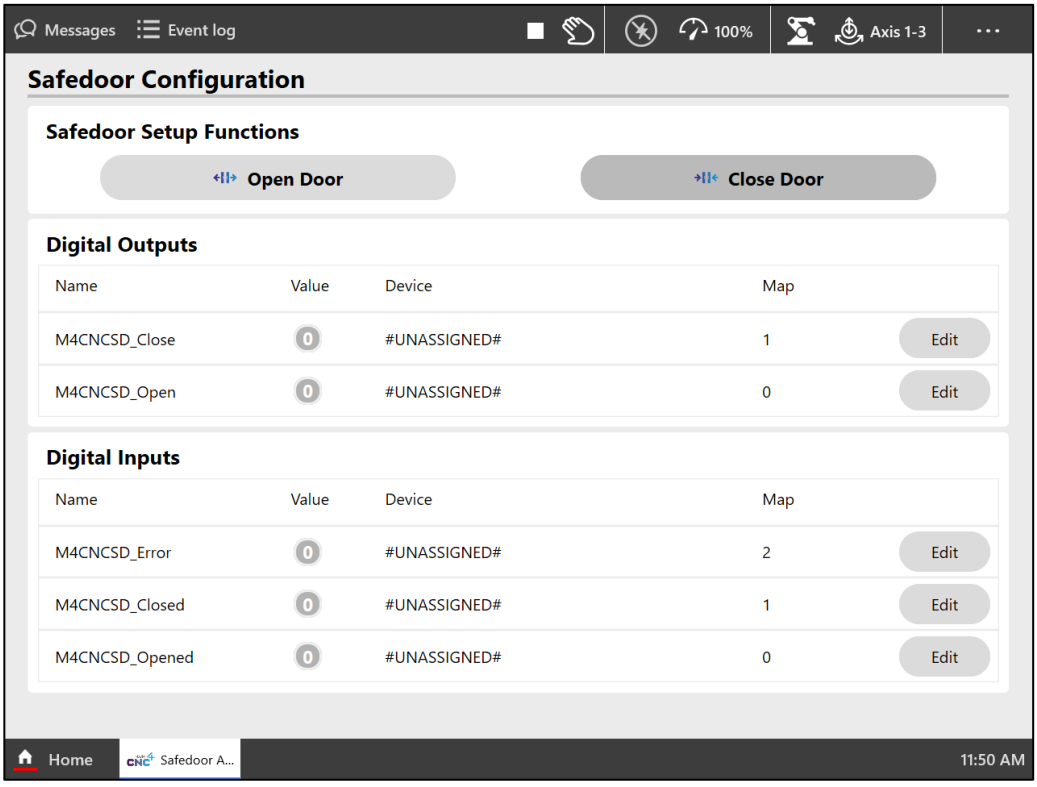
On CRB collaborative robot (Requires RoboWare V. > 7.7)

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.



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)*

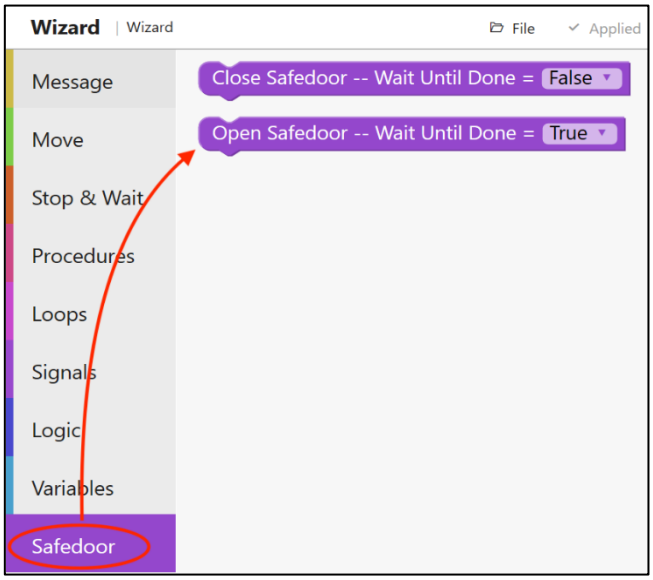
The configuration screen supports multiple languages. Currently the supported languages are:

- 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 Procced" is True [1].

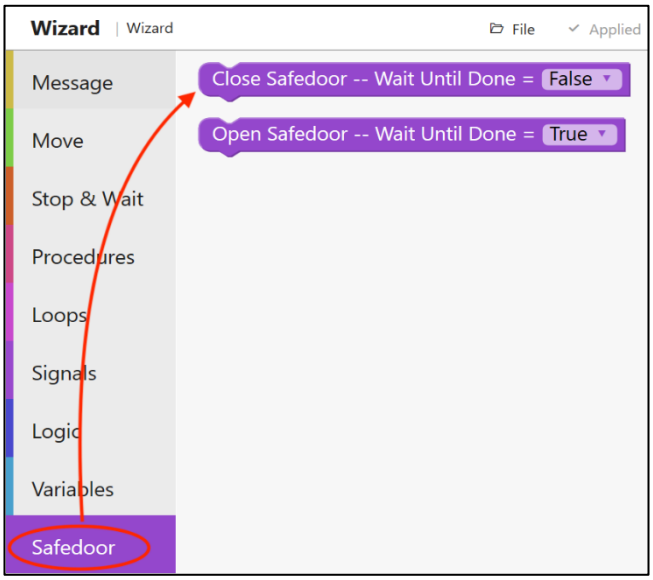
If the value is set to "True" [1], the instruction will wait until the door is fully closed before proceeding.

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.

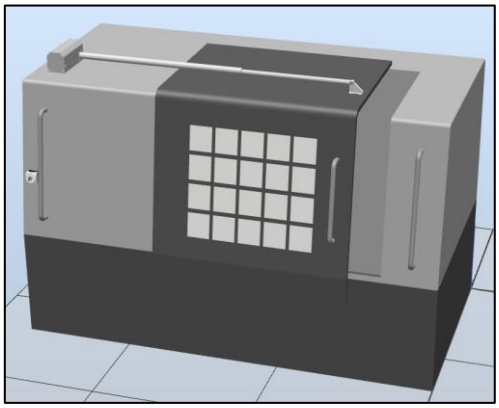
The default value of "Wait Before Procced" is False [0].

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

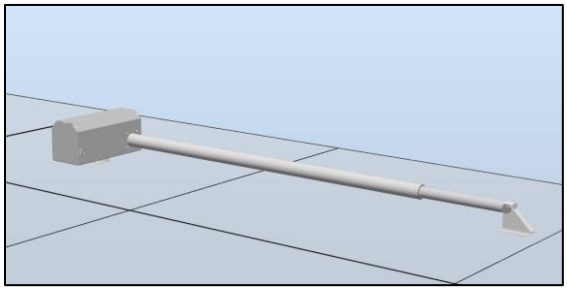
If the value is set to "False", the flow will proceed directly after setting the "*Close*" [0] signal.

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 “Software Specification” in the *Safedoor User Manual*).

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” in the *Safedoor User Manual* 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” in the *Safedoor User Manual*. *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.

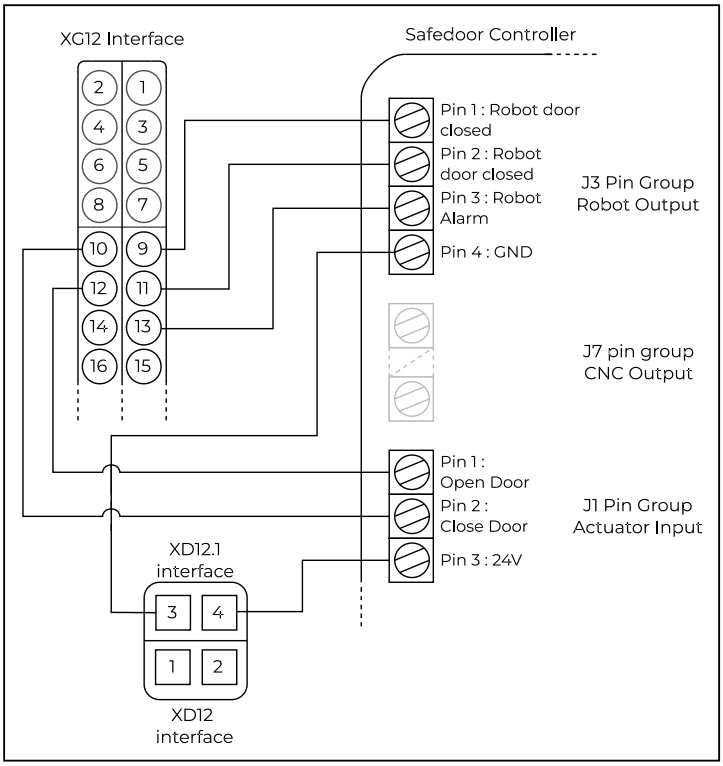


Figure 03: Connection Example

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	XD12.1 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	XD12.1 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

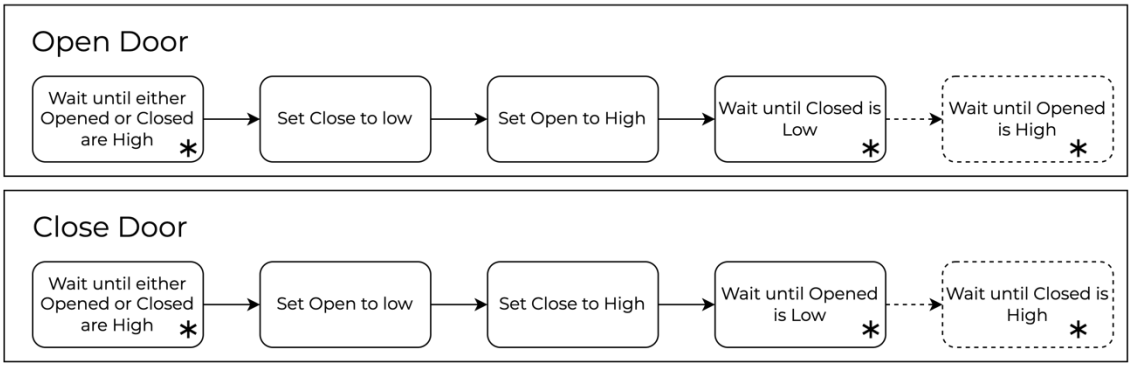
In this section it is described how to setup software programs to create collaboration between the Safedoor System and KR C5 micro.

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:

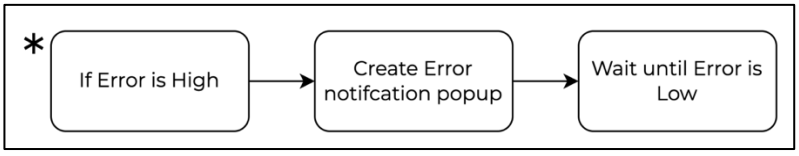


The 1st step ensures that the Safedoor system is in either of its final states (And not moving), before setting the output signals

The 2nd 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:

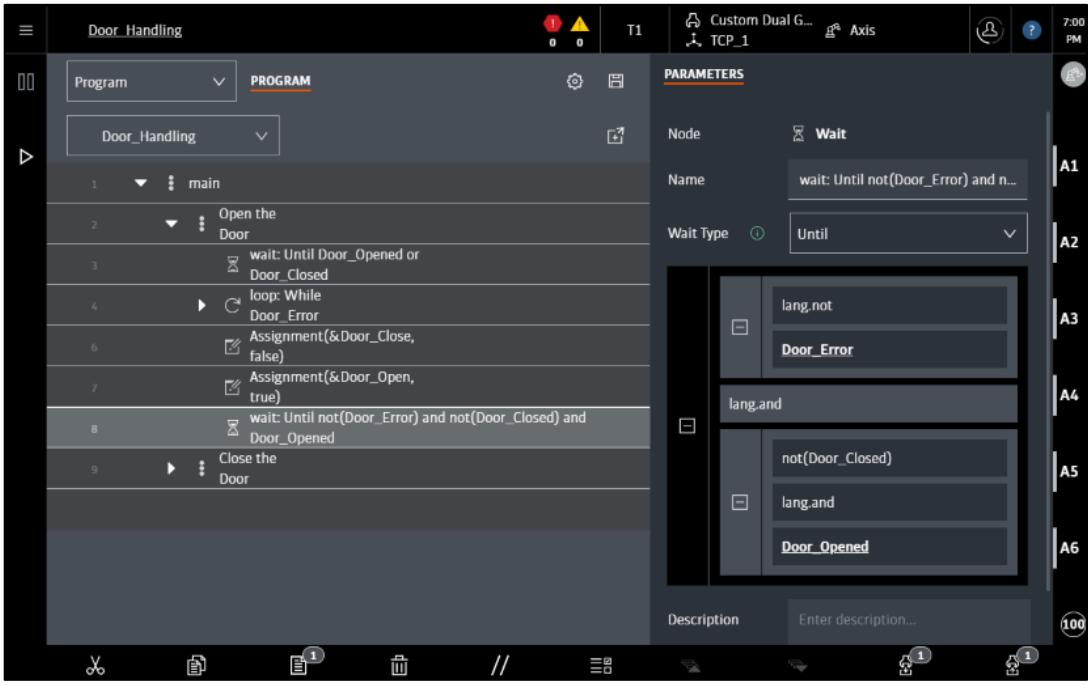


The intent of the error monitoring is to ensure that the program flow safely stops, if any error occurs on the Safedoor system.

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)





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” in the *Safedoor User Manual*), 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

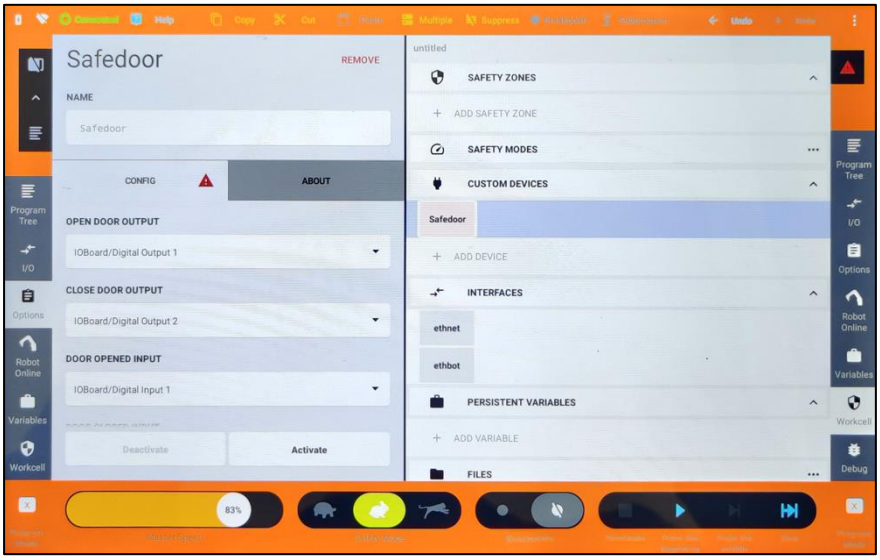
Before installation, ensure are logged in as a user profile: Programmer, Safety Admin, Integrator, or Admin to make sure you have permissions for installing CBuns.

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.

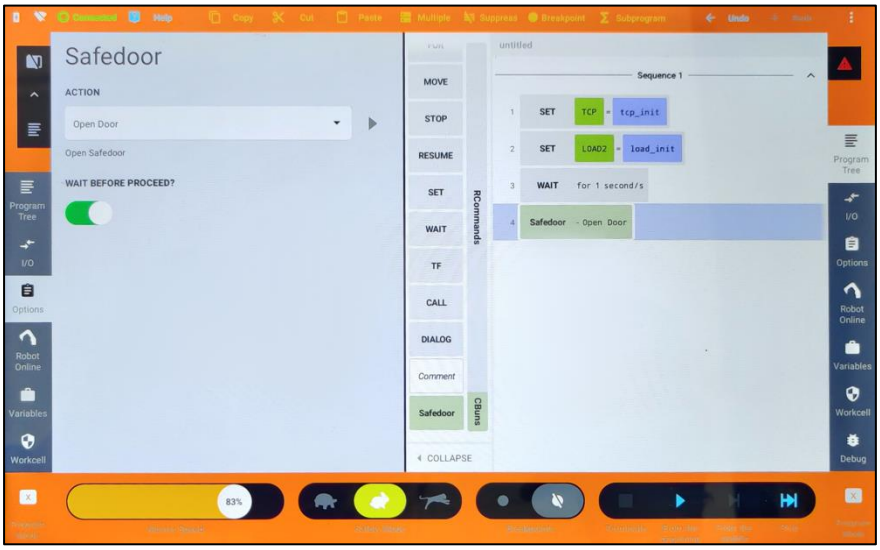
When setting the signals, it is crucial that none of the signals are identical, as this will cause the program to not function as intended.

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.

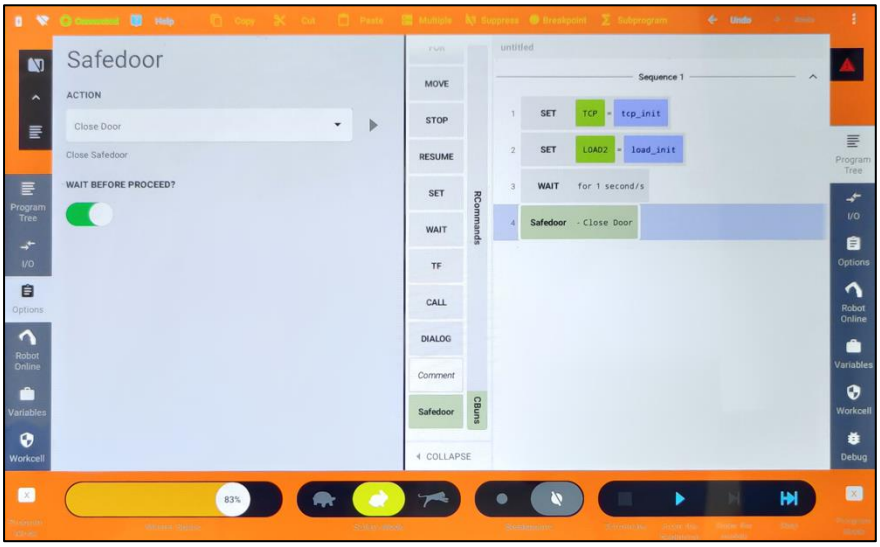
If the option is set to off, the flow will proceed directly after setting the “*Open*” signal.

Close Command

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

The *Close* action can be used activating of the Safedoor 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 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.

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.