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MACHINE APPLICATION

Paper Cup Machine V1.0

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1. General Introduction

1.1. Overview

A paper cup forming machine is a specialized device designed to manufacture paper cups at high speed, which is mainly used in the Food & Beverage industry.

Its primary function is to process rolled paperboard or paper into various types of paper cups. The machine typically completes the production process through the following steps:

1. **Paper Feeding**: The machine first feeds paper or paperboard into the system via mechanical mechanisms.
2. **Printing or Coating**: In some models, the paper passes through printing equipment for pattern printing or is coated with protective layers (e.g., PE coating) to prevent liquid leakage.
3. **Paper Forming**: The machine heats, folds, and shapes the paper using stamping dies to create the basic structure of the cup, including folding and sealing the bottom and sidewalls.
4. **Thermal Pressing and Forming**: Heat and pressure are applied to fix the cup's shape and reinforce the seams.
5. **Finished Product Output**: Completed cups are automatically discharged and prepared for packaging.

Modern paper cup forming machines are mostly fully automated equipment, characterized by high efficiency and precision. Depending on product requirements, these machines can produce cups of varying capacities, specifications, and types, such as single-layer, double-layer, or heat-resistant designs.

Additionally, paper cup forming machines are generally classified into two types: vertical and horizontal. The table below shows a comparison between the two types:

Aspect	Vertical Paper Cup Machine	Horizontal Paper Cup Machine
Paper Feed Layout	Paper roll fed vertically and processes arranged top-to-bottom	Paper roll fed horizontally and processes arranged side-by-side
Floor Space	Has a compact design and smaller footprint, making it ideal for limited space	Requires more floor space, so it is suited for large production areas
Production Scale	Best for small to medium-scale production	Optimized for large-scale, continuous production
Efficiency	Moderate speed, may have design limitations	High efficiency, smooth workflow and stable production rhythm
Adaptability	Suitable for lightweight, small-sized cups and flexible needs	Handles large-capacity cups and is ideal for high-volume production

Table 1-1: Comparison between Vertical and Horizontal Paper Cup machines

In summary, vertical cup forming machines are better for small-batch and flexible production, while horizontal cup forming machines excel in large-scale, continuous manufacturing operations.

This application provides a modular and standardized programming example based on a simplified horizontal paper cup forming machine. The operational parameters of the machine can be easily adjusted thanks to its standardized interface, thus enhancing its flexibility and adaptability within production environments.

It utilizes a Siemens S7-1200 G2 PLC and S200 Basic drives to demonstrate a typical workflow and it aims to offer customers a template for creating or optimizing their own applications.

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1.1.1. Machine Process

As explained in the previous section, the main function of the paper cup forming machine is to take the pre-treated paper sheets, and through a series of heating, rolling, curling and bonding operations, ultimately produce formed paper cups.

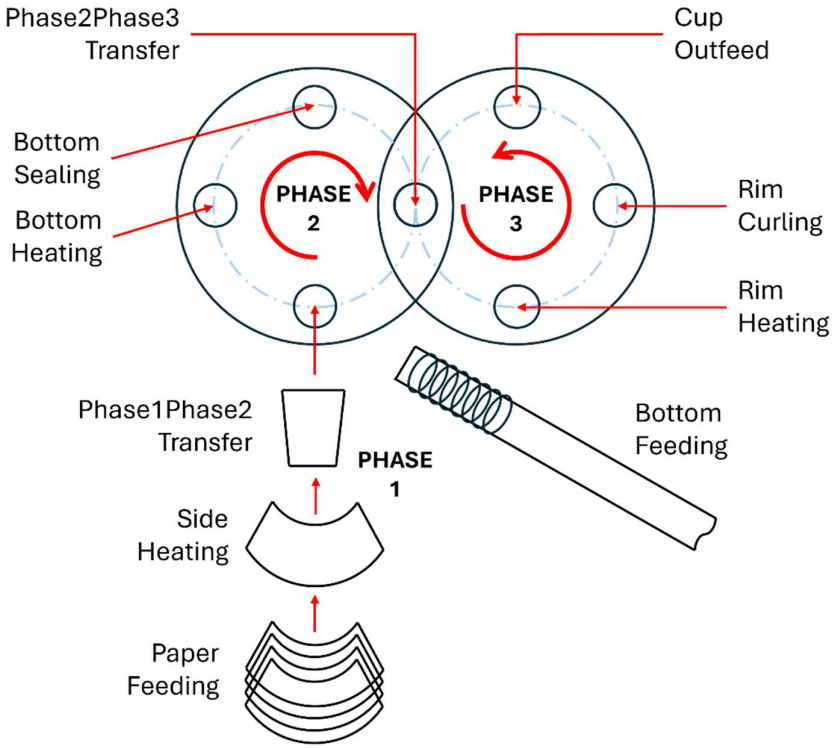


Figure 1-1: Machine process

In this application, the paper cup forming process can be divided into three distinct phases.

Phase 1: Paper Feeding, Side Heating and Rolling

In the first phase, the process begins by feeding pre-cut pieces of paper into the machine. Using vacuum suction and other mechanical means, the paper is transferred onto a rotating shaft and then moved to the paper rolling mechanism, where it is formed into a cylindrical shape. However, before forming, the paper sidewall is heated at the bonding area to soften the material and ensure strong adhesion. Once the paper is heated and partially formed, it is transferred to the next phase for bottom assembly.

Phase 2: Bottom Feeding, Heating and Sealing

During the second phase, the partially formed cup body receives its bottom part, which is fed through a dedicated bottom-feeding mechanism. The bottom is then heated and sealed to the cylindrical wall, creating a leak-proof joint. This phase involves precise alignment and thermal bonding to guarantee durability and consistent cup shape. After sealing, the cup is transferred to the third phase for finishing operations.

Phase 3: Rim Heating, Curling and Outfeed

The final phase focuses on finishing and quality assurance. The cup rim is heated and curled to form a smooth, rounded edge that enhances user comfort and structural strength. After rim curling, the cup outfeed mechanism screens every cup and automatically determines its destination. This ensures that only properly formed cups proceed to packaging, maintaining high quality standards.

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The machine can also be divided from a functional and mechanical perspective, grouping components based on their operational roles and structural characteristics.

Main Frame (Phases 1, 2 and 3)

The main frame serves as the structural and functional core of the machine. It accommodates the main axis, which acts as the reference point for synchronizing all other components, ensuring precise coordination throughout the forming process. This frame also houses most sensors and actuators. Sensors continuously monitor the presence and position of cups at each processing phase, enabling actuators responsible for heating, sealing, transferring, and curling to operate only when a cup is correctly positioned.

Paper Feeding (Phase 1)

The cup feeding mechanism manages the infeed of pre-cut paper sheets into the machine using a combination of air valve pressure and mechanical motion. The system moves the paper from the feeding station onto a rotating shaft, which then transports the paper toward the rolling mechanism.

Paper Rolling (Phase 1)

The paper rolling mechanism shapes pre-cut paper sheets into a cylindrical cup body using precision mechanical components and stamping dies. Prior to rolling, the paper is heated to the required temperature to activate bonding properties, ensuring strong adhesion between the overlapping edges.

Bottom Feeding (Phase 2)

The bottom paper feeding mechanism ensures precise placement of the bottom disc inside the partially formed cup. Integrated sensors detect the presence and correct positioning of the cup before initiating the operation. Once confirmed, a mechanical actuator inserts and secures the bottom disc into the cup body, preparing it for subsequent heating and sealing processes

Cup Outfeed (Phase 3)

The cup outfeed mechanism manages the final stage of the process by directing finished cups to their appropriate destinations according to quality assessments performed by integrated sensors. This system ensures that only compliant cups advance to subsequent operations, such as packaging, while defective cups are removed from the workflow. By combining automated screening with controlled transfer, the mechanism maintains product quality and optimizes downstream processes.

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1.2. Components used

This application example has been created with the following hardware and software components:

Units	Component	Short designation	Article Number	Firmware Version
1	PLC SIMATIC S7-1200 G2	CPU 1214C DC/DC/DC	6ES7 214-1AH50-0XB0	V1.0
1	Output Signal Board	DQ8 Signal board	6ES7 222-5BF50-0XB0	V1.0
1	Unified Basic Panel	MTP1200 Unified Basic	6AV2 123-3MB32-0AW0	Not applicable
5	Servo drive	SINAMICS S200 Basic PN	6SL5 610-1BB11-0AF0	V6.5
5	Synchronous Motor	1FL2 synchronous motor	1FL2104-4AG00-0HC0	Not applicable
5	Motion connection cables	MOTION-CONNECT 350 Power cable	6FX3502-7CD01-1AF0	Not applicable
1	Paper feeding sensor	Photoelectric sensor	Not applicable	Not applicable
3	Phase cup presence sensor	Photoelectric sensor	Not applicable	Not applicable
1	Bottom feeding sensor	Photoelectric sensor	Not applicable	Not applicable
1	Bottom starved sensor	Photoelectric sensor	Not applicable	Not applicable
1	Screening sensor	Photoelectric sensor	Not applicable	Not applicable
9	Heating, sealing, curling and transfer actuators	Actuator	Not applicable	Not applicable

Table 1-2: Hardware components

Component	License	Version	Article Number Download
SIMATIC STEP 7 V20 Engineering Software	SIMATIC STEP 7 Basic V20 Floating License	V20 Update 4	6ES7822-0AE24-0YA5
SIMATIC WinCC Unified Engineering V20	WinCC Unified Basic ES V20	V20 Update 4	6AV2151-0XA02-4LA5
SINAMICS Startdrive V20 Engineering Software	Startdrive Basic V20	V20	6SL3072-4LA02-0XG0

Table 1-3: Software components

The libraries listed below are already included by default in the Global Library **Automation Framework V2.2** https://support.industry.siemens.com/cs/ww/en/view/109817223**.** You can customize the selection, adding or removing libraries as needed.

Component	Version	SIOS Link
Axis Control (LAxisCtrl)	V1.4	https://support.industry.siemens.com/cs/ww/en/view/109925893
Library of Basic Controls (LBC)	V3.1	https://support.industry.siemens.com/cs/ww/en/view/109792175
Library of PLC data types (LPD)	V1.0	https://support.industry.siemens.com/cs/ww/en/view/109482396

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Component	Version	SIOS Link
SIMATIC OMAC PackML V2022 Mode&State Management and Machine Data Interface (LPMLV2022)	V1.0	https://support.industry.siemens.com/cs/ww/en/view/109821198
LSicar	V5.1	https://support.industry.siemens.com/cs/ww/en/view/109804254
Library for SNTP Server Functionality (LSNTP)	V4.0	https://support.industry.siemens.com/cs/ww/en/view/82203451
Library of Unit Control - LUC	V2.2	https://support.industry.siemens.com/cs/ww/en/view/109974940
Library of General Functions (LGF)	V5.1	https://support.industry.siemens.com/cs/document/109479728

Table 1-4: Library types

NOTE You can purchase these components from the Siemens Industry Mall.

This machine application consists of the following components:

Component	File name	Note
TIA Portal Project	_PaperCupMachine_PROJ_V1_0.zip	-
Manual	_PaperCupMachine _DOC_V1_0_en.pdf	This document
Bill of materials	_PaperCupMachine _BOM_V1_0.pdf	-
Device positioning and connections	_PaperCupMachine _Connection_V1_0.pdf	-
TIA Portal Selection Tool project	_PaperCupMachine _TST_V1_0.zip	-

Table 1-5: Project components

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1.3. Description of the project

The machine application provides a TIA Portal project that includes a Simatic S7-1200 G2 PLC, a MTP1200 Unified Basic Panel, and five SINAMICS S200 Basic PN to control the axes of the machine.

Device name	Device type	IP Address
PaperCupMachinePLC	SIMATIC CPU 1214C	192.168.0.1
PaperCupMachineHMI	MTP 1200 Unified Basic Panel	192.168.0.2
LeadingAxis	SINAMICS S200 PN	192.168.0.3
PaperFeedingAxis	SINAMICS S200 PN	192.168.0.4
PaperRollingAxis	SINAMICS S200 PN	192.168.0.5
CupOutfeedAxis	SINAMICS S200 PN	192.168.0.6
BottomFeedingAxis	SINAMICS S200 PN	192.168.0.7

Table 1-6: Machine application devices

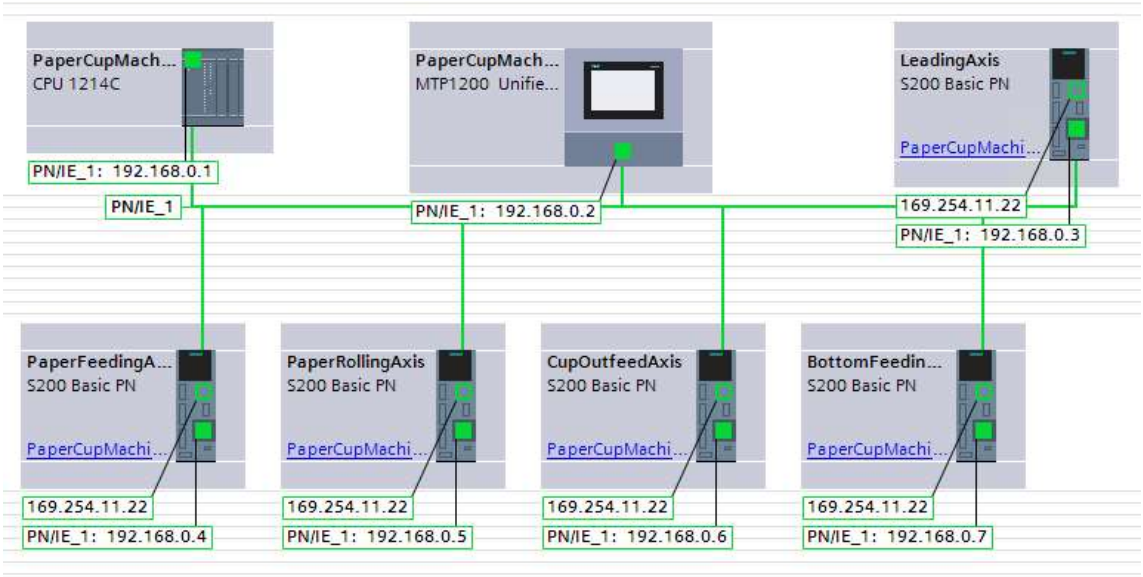


Figure 1-2: TIA Portal network view

The credentials configured in the project are detailed below:

User	Password	Note
Smith	Siemens!123	Administrator
Jones	Siemens!123	Maintenance
Roberts	Siemens!123	HMI Operator

Table 1-7: Project Users

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2. PLC Program Structure

The program of the Paper Cup Machine is developed by using the Automation Framework Basic (AFB).

The Automation Framework Basic is a framework that provides the basic structure of a PLC and HMI program and a standardized interface for controlling and monitoring the machine status, following the ISA-88 standard. The equipment is divided into three layers from top to bottom according to control: Unit, Equipment Module (EM), and Control Module (CM)

Unit:

The unit represents a physical piece of equipment in production, in this case, a Paper Cup machine. The unit contains equipment modules (EMs) which contain control modules (CMs).

Equipment module:

Once the unit boundary is defined, the lower-level modules of the equipment model can be identified. An EM is a functional group of control modules that can carry out a limited number of specific minor processing activities such as dosing, charging or temperature control. An EM is typically centered around a piece of process equipment such as vessel outlet/inlet manifold, process heater etc. The separation of a unit into functional EMs should already reflect the process actions from the process and procedural control model.

Control module

The CMs are the lowest level grouping of equipment in the physical model that can carry out basic control and have a direct relationship to the type of instrument/device that is being monitored and/or controlled. The CMs are typically directly connected to IO signals.

This structure allows a flexible combination and configuration of device functions to meet the production needs and application scenarios.

In this machine application, the equipment division is shown in Figure 2-1, which divides the whole Paper Cup machine into 1 Unit, 5 EMs and 21 CMs.

The following explains the main functions of each of the layers configured in the Paper Cup machine Unit:

- EM0 is a universal part reserved for unit wide functionality like preconditions, interfacing to circuit breakers or signal stacks or pneumatic system. This part is provided by the AF template and can be modified according to the specific requirements of the machine.
- EM1 is the mainframe system. It is divided into 11 CMs: three sensors for detecting the presence of cups in each phase, the LeadingAxis of the machine, and nine actuators that will perform actions based on the angular position of the LeadingAxis.
- EM2 is the paper feeding mechanism. It is divided into 3 CMs: the PaperFeedingAxis, which synchronizes speed with the LeadingAxis, a sensor for detecting the presence of paper sheets, and the actuator tasked with picking up the paper sheet and feeding them into the machine. This actuator will perform actions based on the LeadingAxis angular position.
- EM3 is the paper rolling mechanism. It only contains 1 CM: the PaperRollingAxis, which synchronizes with the LeadingAxis through a cam.
- EM4 is the cup outfeed mechanism. It is divided into 2 CMs: the CupOutfeedAxis, which synchronizes with the LeadingAxis through two cams, and a screening sensor, which checks the quality of the cups. Depending on the result of the screening, the cam used for synchronization is changed. One cam is used for good quality cups, and the other for defective cups.
- EM5 is the bottom paper feeding mechanism. It is divided into 4 CMs: the BottomFeedingAxis, which transports the bottom paper sheets, two sensors for detecting the presence of bottom paper sheets, and the actuator tasked with inserting the bottom into the cup. This actuator will perform actions based on the LeadingAxis angular position.

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Figure 2-1: ISA-88 equipment division of the Paper Cup machine

The development of the entire project program follows the OMAC PackML state machine:

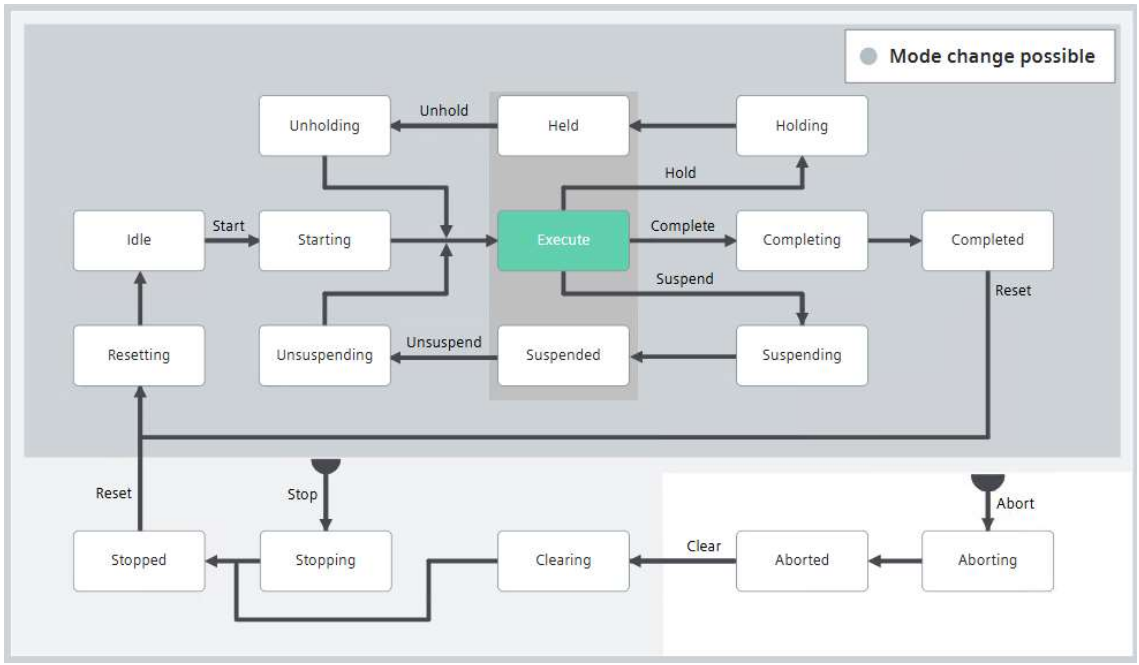


Figure 2-2: Base state model

The following modes, states and commands are supported by the OMAC PackML state machine used in the AF:

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Modes

0	Invalid
1	Production
2	Maintenance
3	Manual
4 .. 15	User definable

States

0	Undefined
1	Clearing
2	Stopped
3	Starting
4	Idle
5	Suspended
6	Execute
7	Stopping
8	Aborting
9	Aborted
10	Holding
11	Held
12	Unholding
13	Suspending
14	Unsuspending
15	Resetting
16	Completing
17	Completed

Commands

0	Undefined
1	Reset
2	Start
3	Stop
4	Hold
5	Unhold
6	Suspend
7	Unsuspend
8	Abort
9	Clear
10	Complete
11	StateComplete

Figure 2-3: Modes, states and commands that can be used in the AF

This state machine can be flexible reconfigured. However, that would imply major changes in the current AF implementation and shall be avoided if possible.

In this machine application, two operating modes have been configured:

- Production (mandatory): This is the production routine mode. If this mode is selected, the machine executes the relevant logic in response to commands. This commands mainly come from external systems or entered directly by the user.
- Manual (optional): This mode allows direct control of single machine modules. It may be used for commissioning of individual components, fault diagnostics of unplanned technical intervention, etc.

NOTE See the Automation Framework documentation for more details: https://support.industry.siemens.com/cs/ww/en/view/109817223

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2.1. PLC Program Overview

The PLC contains many of the main functions. Some of the most important nodes are highlighted below:

- Program blocks: Contain all the instructions and logic required to control the machine.
- Technology objects: Preconfigured and reusable blocks used to set up and control advanced functions like Motion Control, axis management or PID regulation.
- PLC tags: Used inputs and outputs are defined here.
- PLC data types: All user-defined data types used in the program.

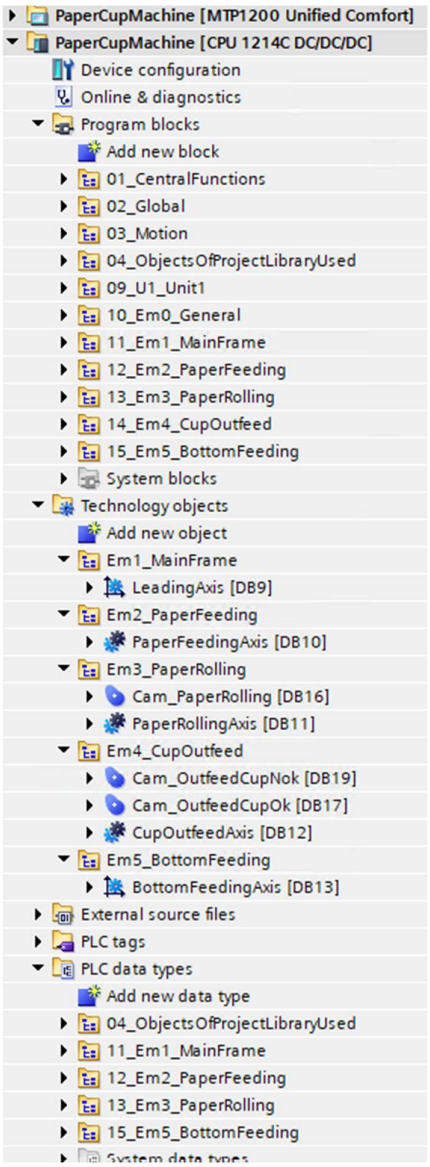


Figure 2-4: Program Overview

The structure of the main program blocks within each folder configured in the PLC is described in detail in the following sections.

NOTE See the Automation Framework documentation for more details: https://support.industry.siemens.com/cs/ww/en/view/109817223

2.1.1. 01_CentralFunctions

The "01_Central Functions" contain system wide functionality, settings and diagnostics which affect the entire system or are hierarchically above the unit level.

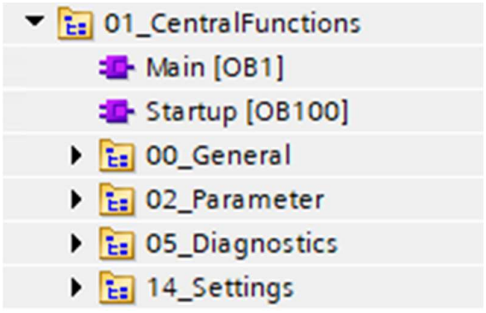


Figure 2-5: Central Functions Overview

2.1.2. 02_Global

The "02_Global" folder contains global data of all units and their equipment modules. It is purely passive, since it contains no program logic. It has a relation to ObjectsOfProjectLibraryUsed as it uses PLC data types from the libraries.

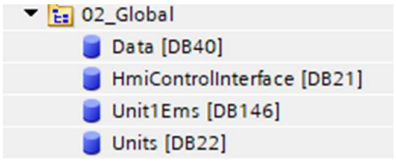


Figure 2-6: Global Overview

2.1.3. 03_Motion

The "03_Motion" folder contains the Motion OBs. These execute the motion Technology Objects like axes. Each Motion OB can only exist once in the entire PLC.

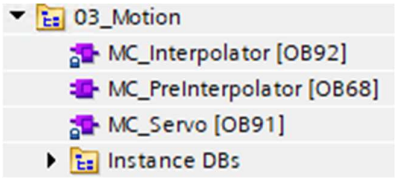


Figure 2-7: Motion Overview

2.1.4. 04_ObjectsOfProjectLibraryUsed

The "04_ObjectsOfProjectLibraryUsed" folder contains the local instances of the libraries that are used in the PLC program. It only contains blocks that are used by others.

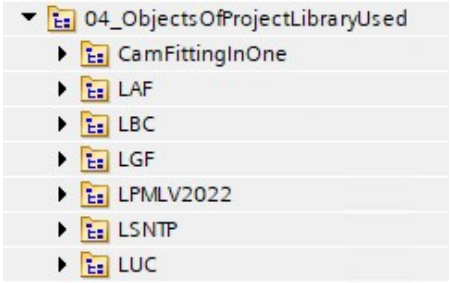


Figure 2-8: ObjectsOfProjectLibraryUsed Overview

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2.1.5. 09_U1_Unit1

The " 09_U1_Unit1 " describes the general structure, interfaces, commands, and data flow. Primarily, the unit manages the configuration of the mode state manager, handles supplementary signals and processes, and manages internal alarms. This Unit contains the following blocks:

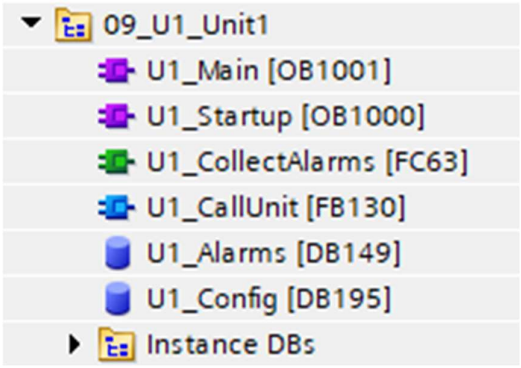


Figure 2-9: Unit Overview

2.1.6. 10_Em0_General

The "10_Em0_General" usually contains non-complex logic and no sequences. It includes all common equipment condition monitoring and logic control.

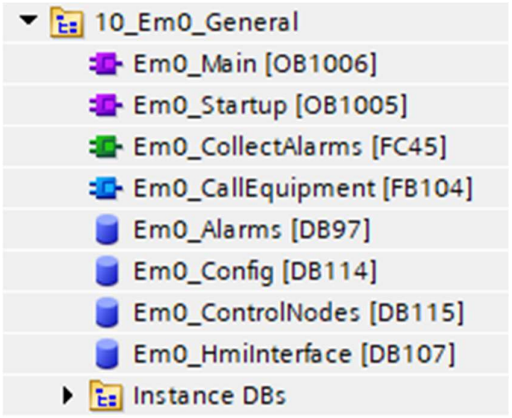


Figure 2-10: Em0_General Overview

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2.1.7. 11_Em1_MainFrame

The "11_Em1_MainFrame" contains the control logic for the LeadingAxis and the other CMs, as well as the condition monitoring, alarm collection, and simulation logic for testing the machine when no hardware is connected.

The “ActuatorManagement” FB, which is part of the control logic of this EM, is tasked with activating or deactivating the different actuators depending on the LeadingAxis angular position.

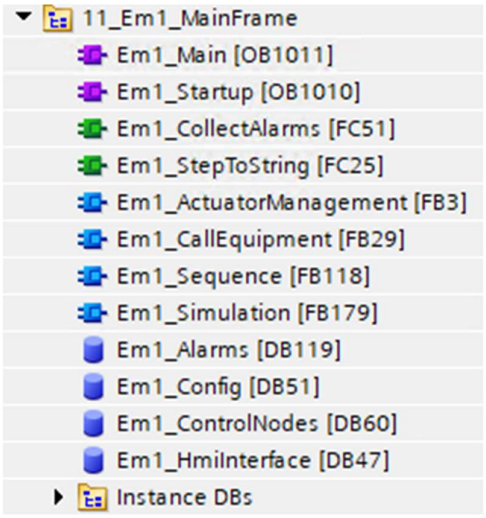


Figure 2-11: Em1_MainFrame Overview

2.1.8. 12_Em2_PaperFeeding

The "12_Em2_PaperFeeding" contains the control logic for the PaperFeedingAxis and the other CMs, as well as the condition monitoring, alarm collection, and simulation logic.

The “ActuatorManagement” FB, which is part of the control logic of this EM, is tasked with activating or deactivating the different actuators depending on the LeadingAxis angular position.

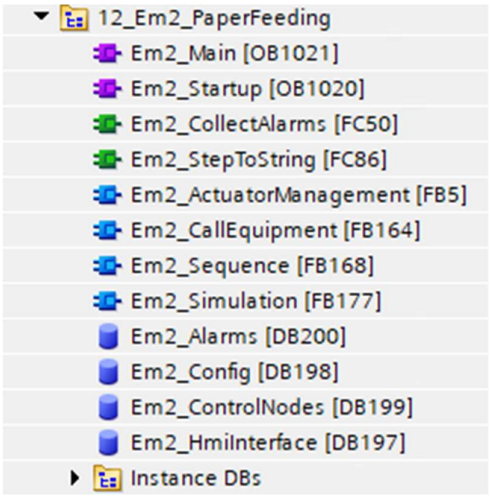


Figure 2-12: Em2_PaperFeeding Overview

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2.1.9. 13_Em3_PaperRolling

The "13_Em3_PaperRolling" contains the control logic for the PaperRollingAxis, as well as the condition monitoring and alarm collection.

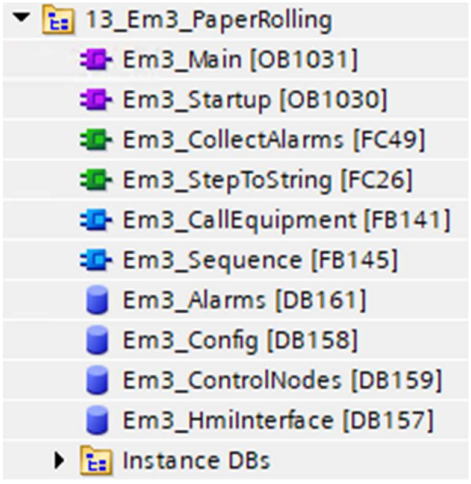


Figure 2-13: Em3_PaperRolling Overview

2.1.10. 14_Em4_CupOutfeed

The "14_Em4_CupOutfeed" contains the control logic for the CupOutfeedAxis and the other CMs, as well as the condition monitoring, alarm collection, and simulation logic.

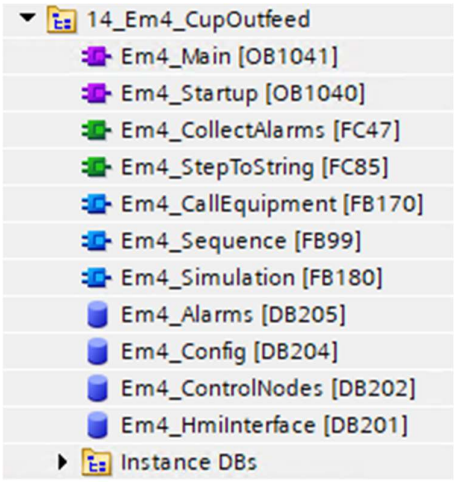


Figure 2-14: Em4_CupOutfeed Overview

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2.1.11. 15_Em5_BottomFeeding

The "15_Em5_BottomFeeding" contains the control logic for the BottomFeedingAxis and the other CMs, as well as the condition monitoring, alarm collection, and simulation logic.

The "ActuatorManagement" FB, which is part of the control logic of this EM, is tasked with activating or deactivating the different actuators depending on the LeadingAxis angular position.

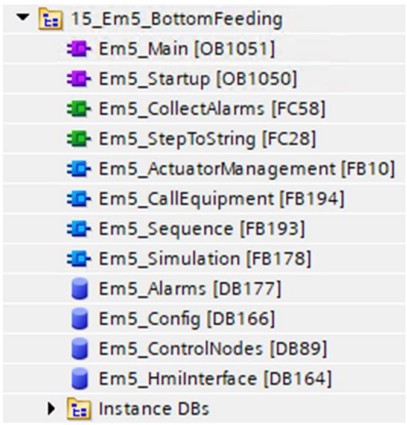


Figure 2-15: Em5_BottomFeeding Overview

2.1.12. Technology Objects

The Technology Object control the movement of real objects (e.g., a drive) and notify status information (e.g., the current position). The configuration of the Technology Objects represents the characteristics of the real objects. The configuration data is stored in a data block. Thanks to Technology Objects, the configuration and programming of complex systems can be simplified, improving development efficiency and system reliability.

In this machine application, three types of Technology Objects have been used:

- **TO_PositioningAxis**: It is used to position a drive with position control. With the Motion Control instructions, positioning commands are sent to the axis from the user program. In this machine application, the **LeadingAxis** and **BottomFeedingAxis** are using TO_PositioningAxis.
- **TO_SychronousAxis**: It contains all the functions of the Positioning Axis technology object. Additionally, the axis can be connected to a master value, allowing the axis to follow the position variation of a master axis in synchronization. In this machine application, the **PaperFeedingAxis**, **PaperRollingAxis** and **CupOutfeedAxis** are all using TO_SynchronousAxis, and their master axis is the LeadingAxis.
- **TO_Cam**: It defines a function f(x) using interpolation points or segments. The cam disc represents the mathematical synchronous relationship between a master and a slave axis. In this machine application, the **Cam_PaperRolling** defines the relationship between the LeadingAxis and the PaperRollingAxis and both the **Cam_OutfeedCupOk** and **Cam_OutfeedCupNok** define the relationship between the LeadingAxis and the CupOutfeedAxis.

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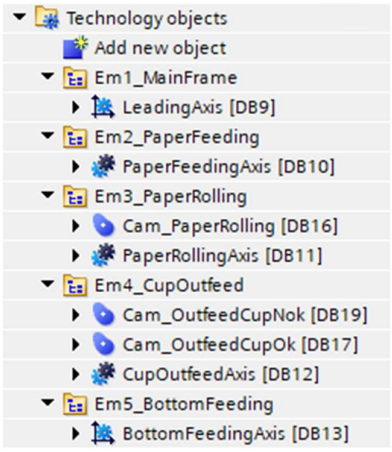


Figure 2-16: Technology Objects Overview

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2.2. Sequence Introduction

According to ISA-88, the device is divided into one Unit that contains six EMs and multiple CMs. The EM0 is provided by the Automation Framework template and the EM1, EM2, EM3, EM4 and EM5 are implemented specifically for this machine application.

The EmX_Sequence program block under each EM is mainly used to program the device logic at the EM layer. The CMs are called in the EmX_CallEquipment.

The sequence of the EM program for the "Starting" and "Execute" states of the OMAC State Model is shown in Figure 2-17.

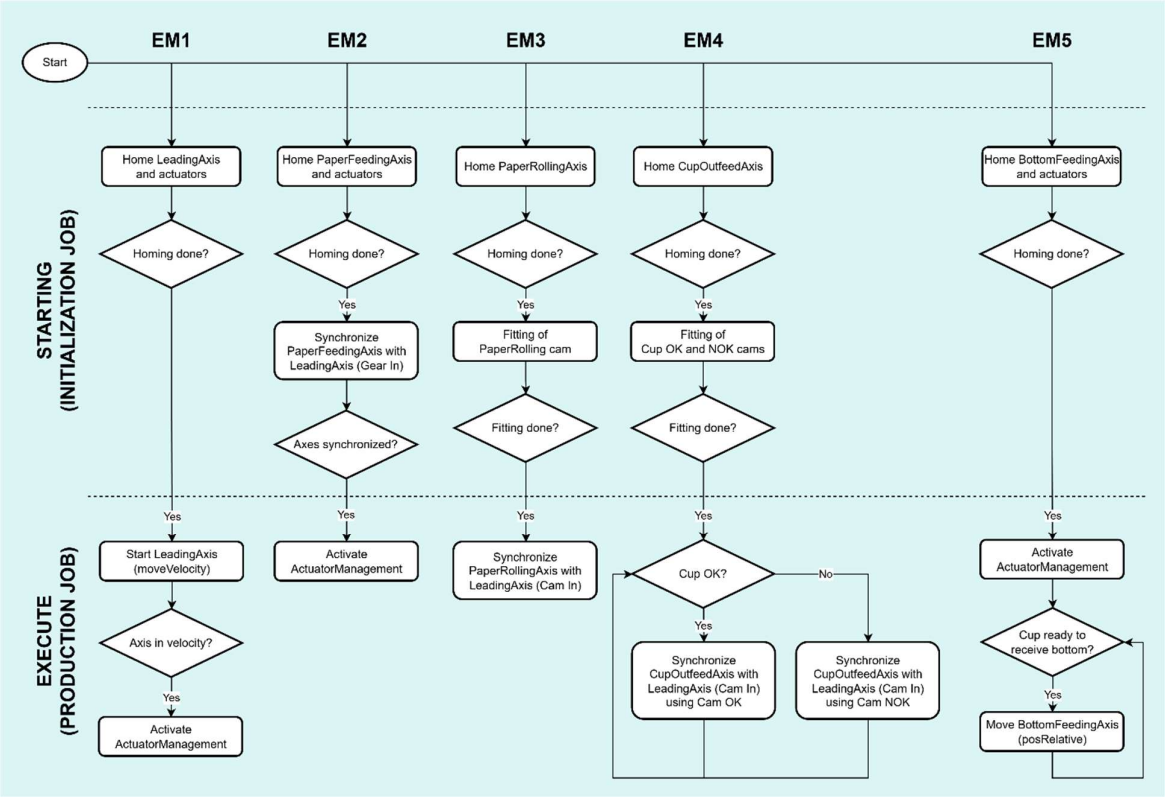


Figure 2-17: Program flow

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2.3. Paper Cup Machine Program Blocks

In this machine application, two special function blocks are used: **CamFittingCn** and **ActuatorManagement**. Both are explained below.

2.3.1. CamFittingCn

The CamFittingCn FB is used for fitting of the different cams used in the project. The Cam technology object in the S7-1200G2 controller is limited to supporting only point-based elements, without line segments. This FB overcomes that limitation by enabling users to easily generate cam curves that incorporate both points and line segments.

This FB is called on EM3 for fitting of the Cam_PaperRolling cam, and twice on EM4 for fitting of the Cam_OutfeedCupOk and Cam_OutfeedCupNok. As shown in the picture below, the FB has an interface like that of other control modules in the project.

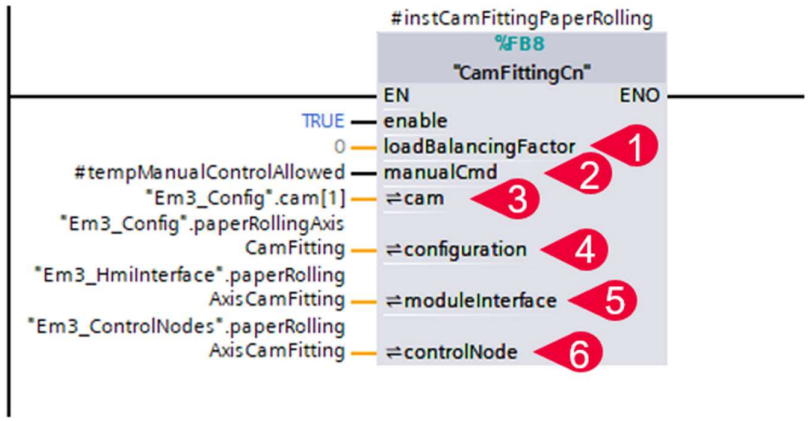


Figure 2-18: CamFittingCn FB Description

Number	Signal	Main Functionality	Description
1	loadBalancingFactor	Configuration parameter	Load balancing coefficient, 1-1000: The higher the value, the fewer scan cycles are required to execute FB, but the longer the time required for a single scan cycle.
2	manualCmd	Input from process	TRUE: Manual control allowed
3	cam	Configuration parameters	Cam TO. Cam that will be fitted
4	configuration	Configuration parameters	Parameters for specifying the cam profile and the elements that make it up
5	moduleInterface	HMI interface	Connection to HMI
6	controlNode	Input/Output to process	Variables for control and monitoring of the block

Table 2-1: CamFittingCn FB Description

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2.3.2. ActuatorManagement

The ActuatorManagement FB is responsible for controlling actuators within various EMs based on the angular position of the LeadingAxis. In the Paper Cup machine, actuator activation is largely determined by the LeadingAxis position, so it must be ensured that each actuator operates only while the axis is within a specified angular range.

This FB is implemented in EM1, EM2, and EM5, which are the EMs that include actuators requiring position-based activation. While the internal logic of the block varies for each EM to accommodate different actuator configurations, the interface remains consistent across all three instances.

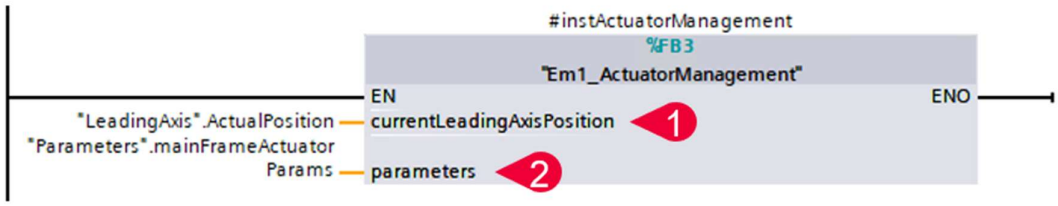


Figure 2-19: ActuatorManagement FB Description

Number	Signal	Main Functionality	Description
1	currentLeadingAxisPosition	Input from process	[°] Current angular position of the LeadingAxis
2	parameters*	Configuration parameters	Angular ranges in which the actuators should be activated

Table 2-2: ActuatorManagement FB Description

NOTE

Parameters marked with an asterisk (*) will be explained in further detail in the section dedicated to the parameter screens in the HMI chapter.

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3. HMI Introduction

3.1. Overview of the main Screen

The HMI project is configured based on Automation Framework. It provides a modular and customizable HMI template for WinCC Unified to reduce programming efforts.

The following chapter will introduce the HMI details.

NOTE For more details, refer to the following documentation:

Automation Framework: https://support.industry.siemens.com/cs/ww/en/view/109817223
LBC (Library of Basic Controls): https://support.industry.siemens.com/cs/ww/en/view/109792175

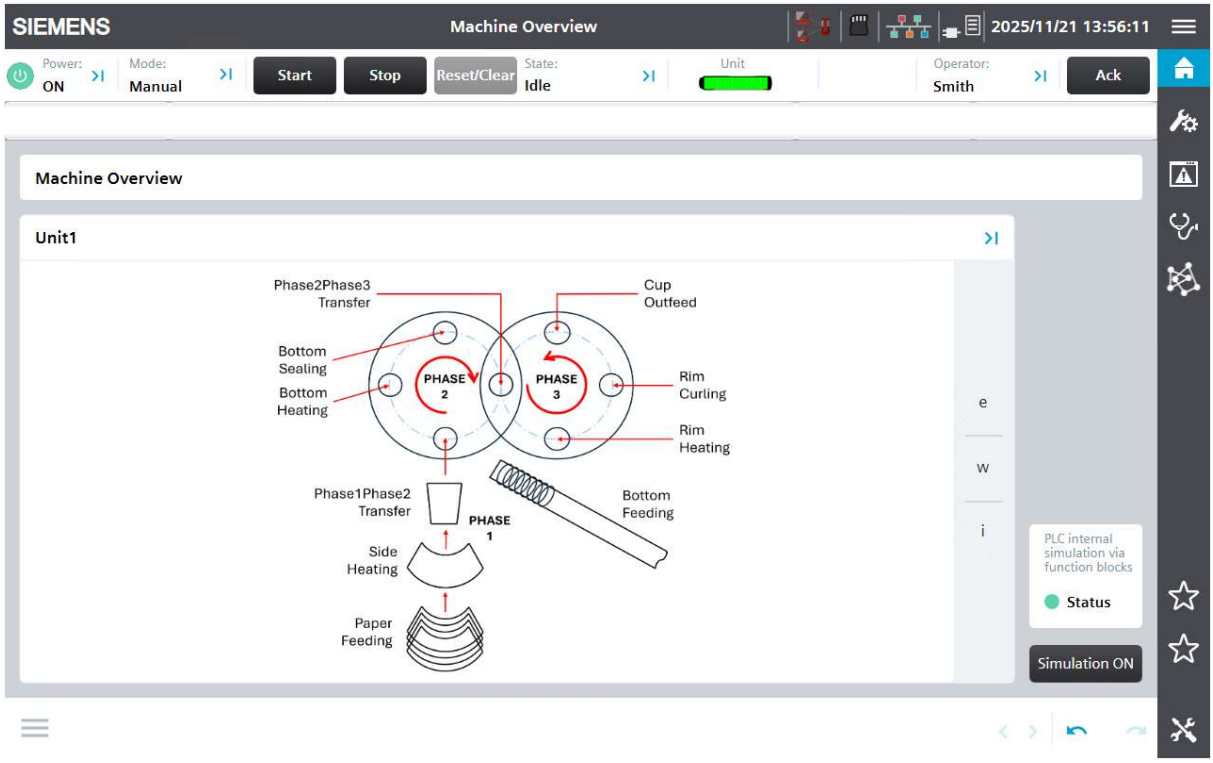


Figure 3-1: HMI Main Screen

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Automation Framework Screen Layout

Determines how the different screens are positioned and organized in the HMI.

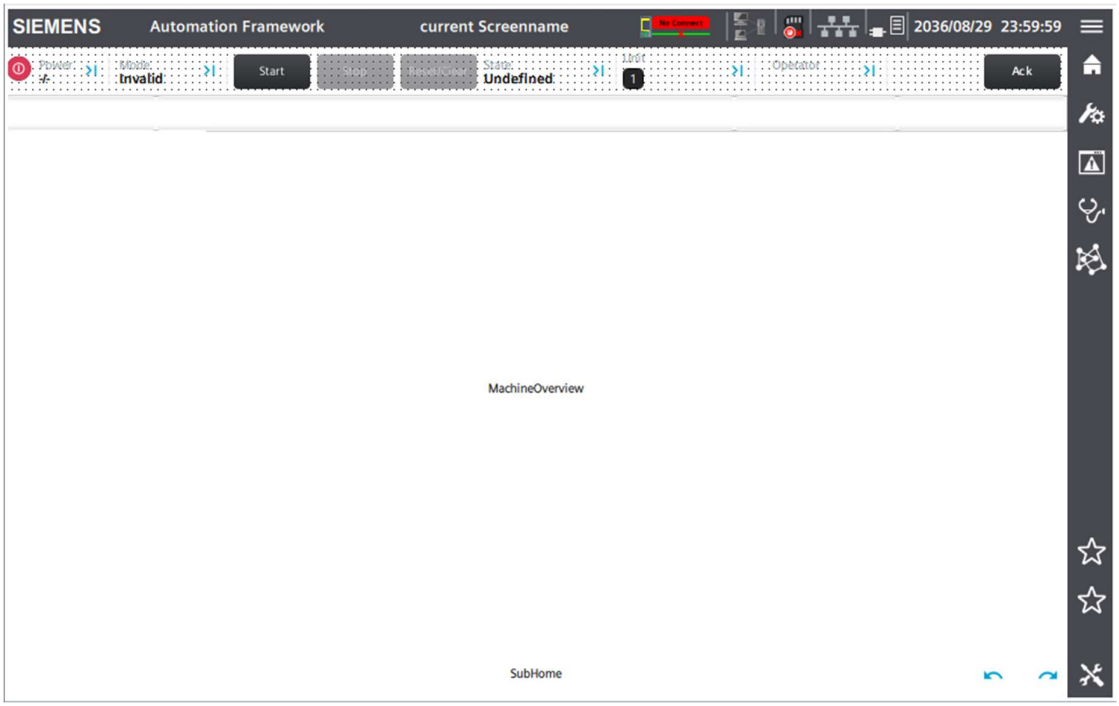


Figure 3-2: Automation Framework Screen Layout

Header

Displays the most important information: power status, current state and mode, logged user, Date & Time, SIMATIC memory card status, etc. Allows user to change the operating mode of the machine, send status commands, power the machine on or off, acknowledge alarms, and change the currently logged in user.

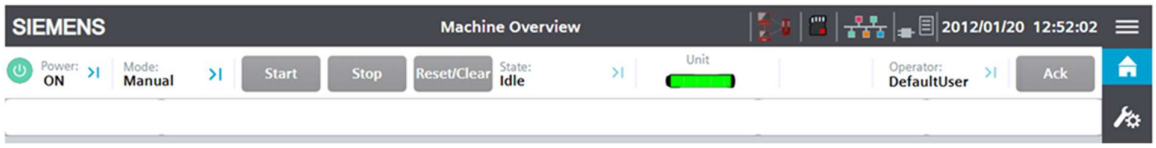


Figure 3-3: Automation Framework header

Main Navigation

The Main Navigation consists of two parts: The icon bar, which is permanently visible, as well as a textual view which can be switched on via the Burger menu.

This navigation is pre-configured for various key features with its name and graphic accordingly

6. **Home**: Shows the machine overview screen.
7. **Parameters**: Contains the screens for configuring the parameters of the different equipment modules of the Paper Cup machine.
8. **Messages**: Shows current and historical alarms and messages.
9. **Diagnostics**: Contains various predefined, ready-to-use diagnostic screens (system diagnostics, PROFINET diagnostics and Drives).
10. **StateModel**: Includes screens to visualize the OMCA state model and the mode state history.
11. **Bookmarks**: Allows the user to save up to two screens to directly jump to from the main navigation.
12. **PLC Settings**: Contain screens for general PLC information as well as specific TIA Portal project information.

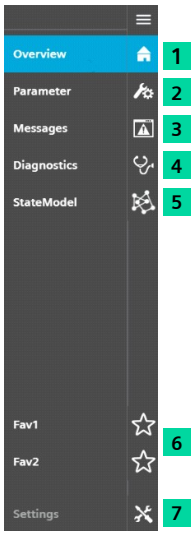


Figure 3-4: Automation Framework Main Navigation

Machine Overview

The machine overview is the highest level of the machine visualization on the HMI. It allows to visualize and operate the units configured in the project. In the case of the Paper Cup machine, there is only one unit.

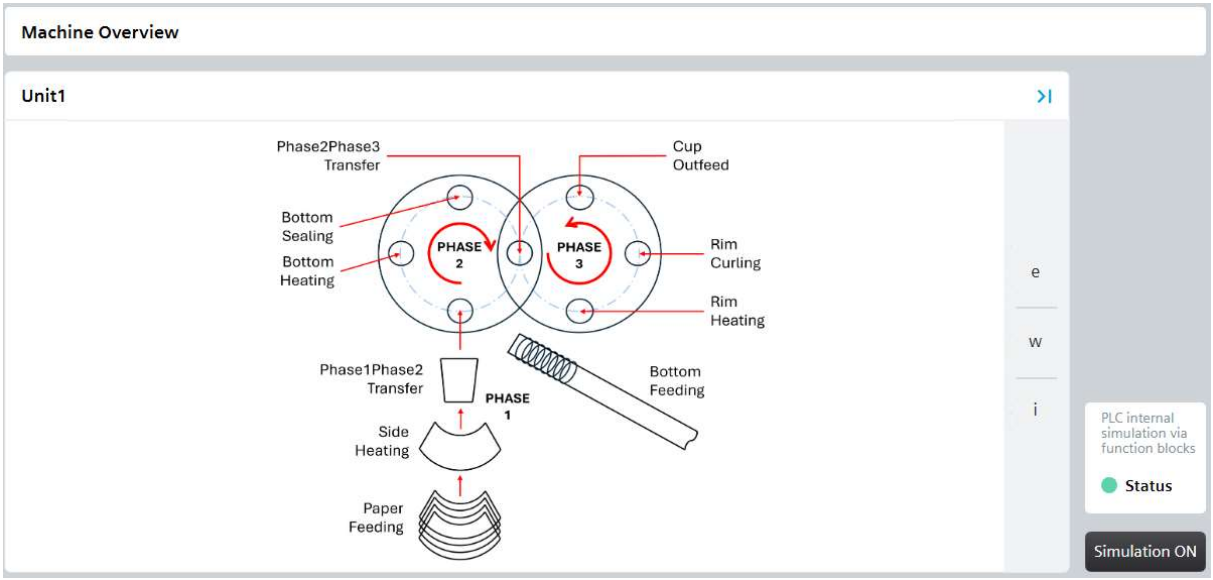


Figure 3-5: Automation Framework Machine Overview

The simulation button is added to the machine overview screen on the right corner. This button changes appearance based on the state.



Figure 3-6: Simulation button

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3.2. Description of screen content

3.2.1. Machine Overview

This screen displays the model of the device, and shows some status information of the Paper Cup machine.

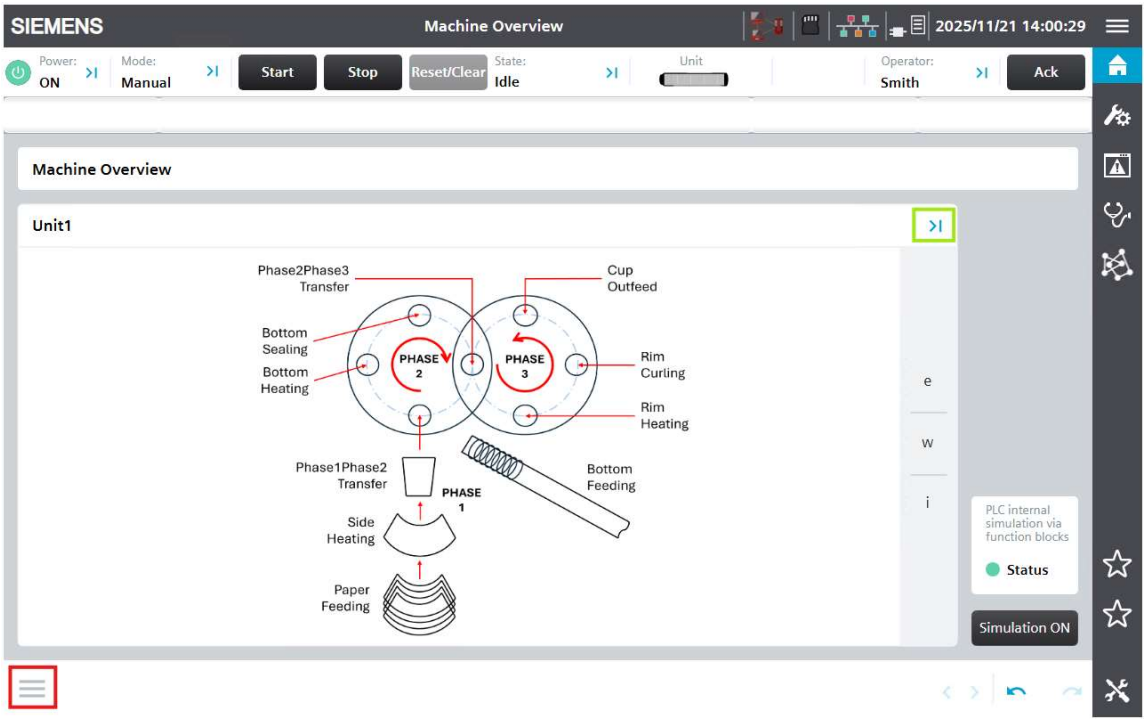


Figure 3-7: Machine overview

3.2.2. Unit 1 Overview

In this screen, the different equipment modules (EMs) that make up the unit are shown, together with their status.

To access it, user can either click on the blue arrow (marked by a green box in Figure 3-7), or on the subnavigation bar by clicking on the button at the bottom left corner (marked by a red box in Figure 3-7).

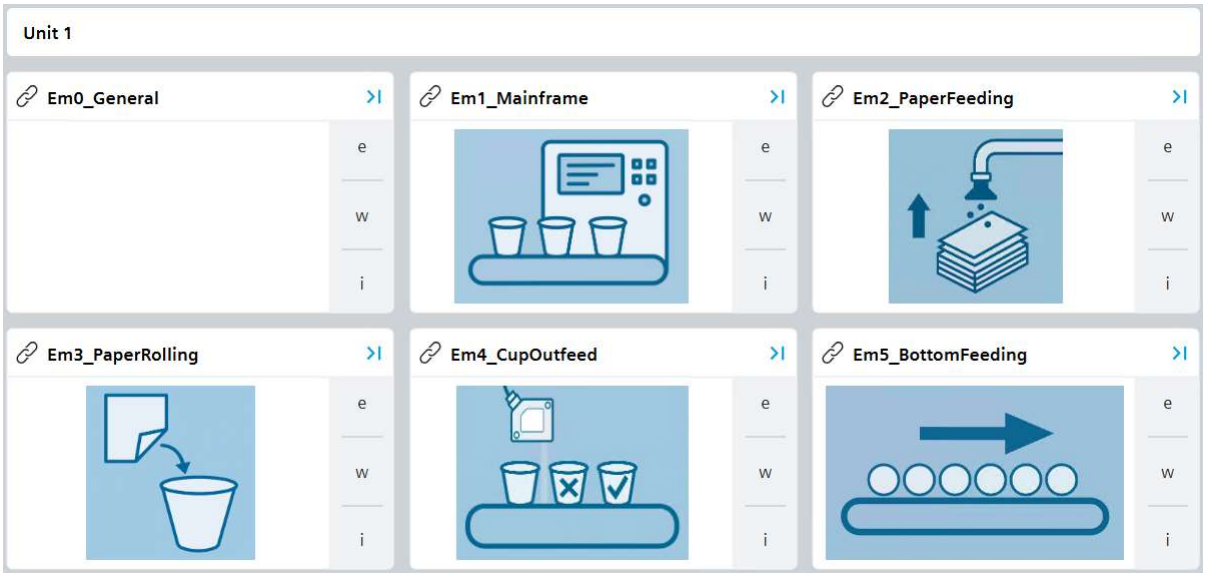


Figure 3-8: Unit1 Overview

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3.2.3. EM Overview

This screen shows all the control modules (CMs) that make up the corresponding equipment module, as well as some general status information of the EM (on the right side). To access it, users can click on the blue arrows of each EM, as seen in Figure 3-8.

Each CM has its own simplified faceplate, which allows to perform some basic controls of the CM when the machine is in manual mode and displays some basic information. In the Paper Cup machine, three types of CMs are used, all of them belonging to the Library of Basic Controls (LBC):

1. **Digital Signal**: Used for processing the signals from the different photoelectric sensors of the machine. The simplified faceplate shows whether the sensor is detecting, and allows users to reset the CM.
2. **Two Way Actuator**: Used for operating the different actuators of the machine. The simplified faceplate shows whether the actuator is active, and allows users to stop (deactivate), start (activate) and reset the CM.
3. **Axis Control Basic**: Used for operating the different axes of the machine. The simplified faceplate shows the current velocity and position, and allows users to enable, jog the axis forward and backwards, and reset the CM.

NOTE For more details about the used CMs, refer to the documentation of the LBC: https://support.industry.siemens.com/cs/ww/en/view/109792175

Figure 3-9, Figure 3-10, Figure 3-11, Figure 3-12 and Figure 3-13 show the overview screen of the five EMs of the project.



Figure 3-9: EM1 MainFrame Overview

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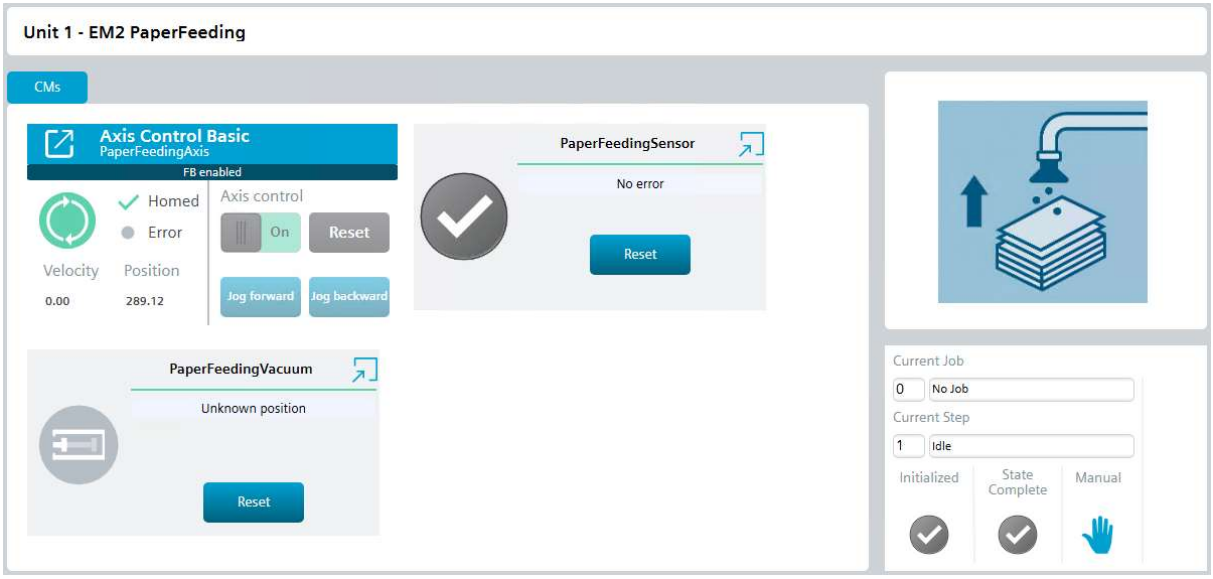


Figure 3-10: EM2 PaperFeeding Overview

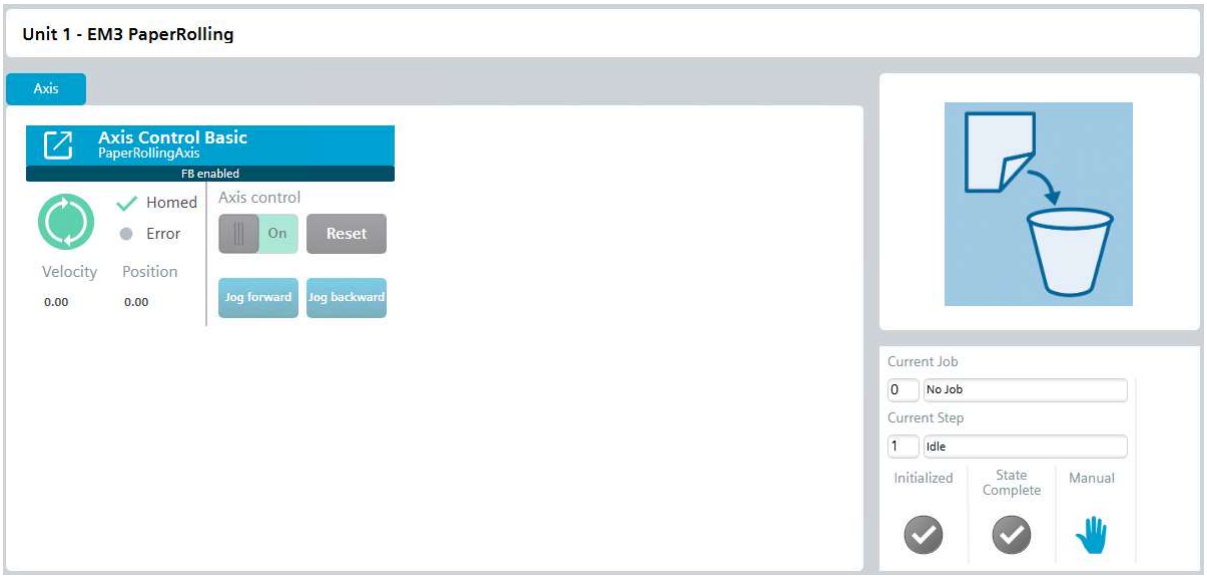


Figure 3-11: EM3 PaperRolling Overview

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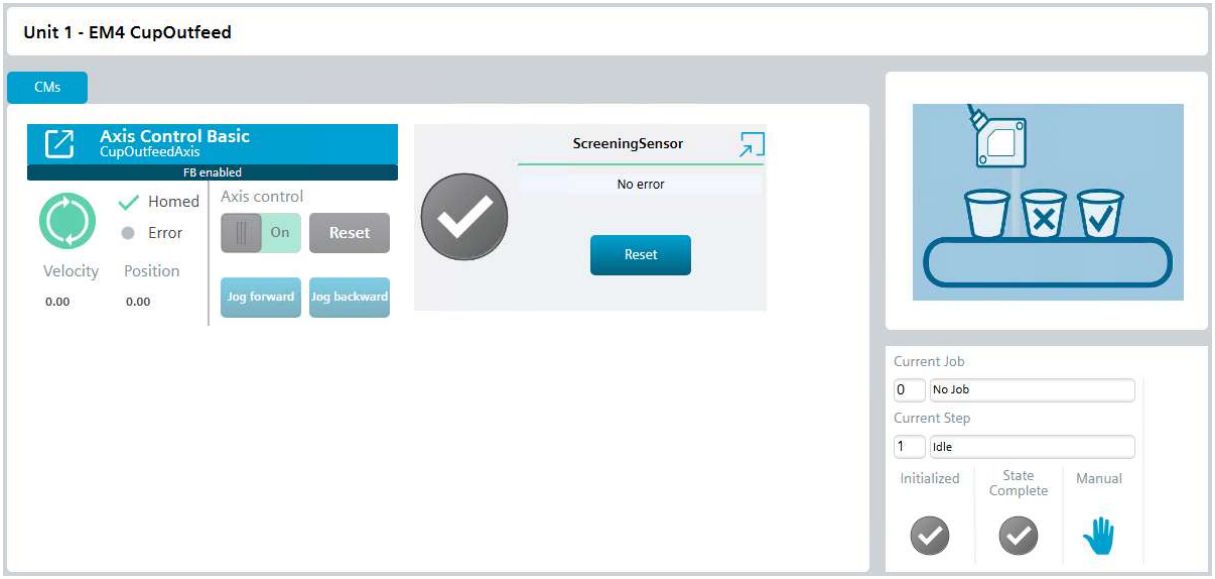


Figure 3-12: EM4 CupOutfeed Overview

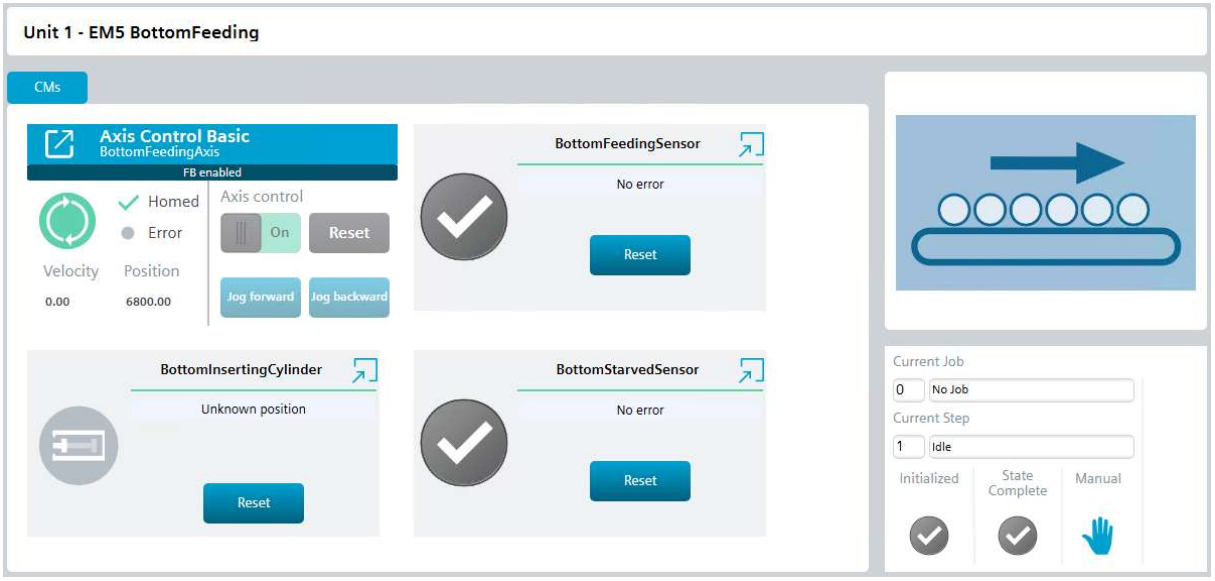


Figure 3-13: EM5 BottomFeeding Overview

NOTE Due to screen space limitations, not all CMs are displayed simultaneously. To address this, multiple navigation tabs have been configured in some EMs.

Additionally, clicking on the hand symbol of the bottom right corner of the EM Overview screen will open the faceplate for manual control of the EM. This faceplate allows users to test the sequence, link or unlink the EM from the unit, and change the operating mode and state, all without influencing the rest of the EMs of the machine.

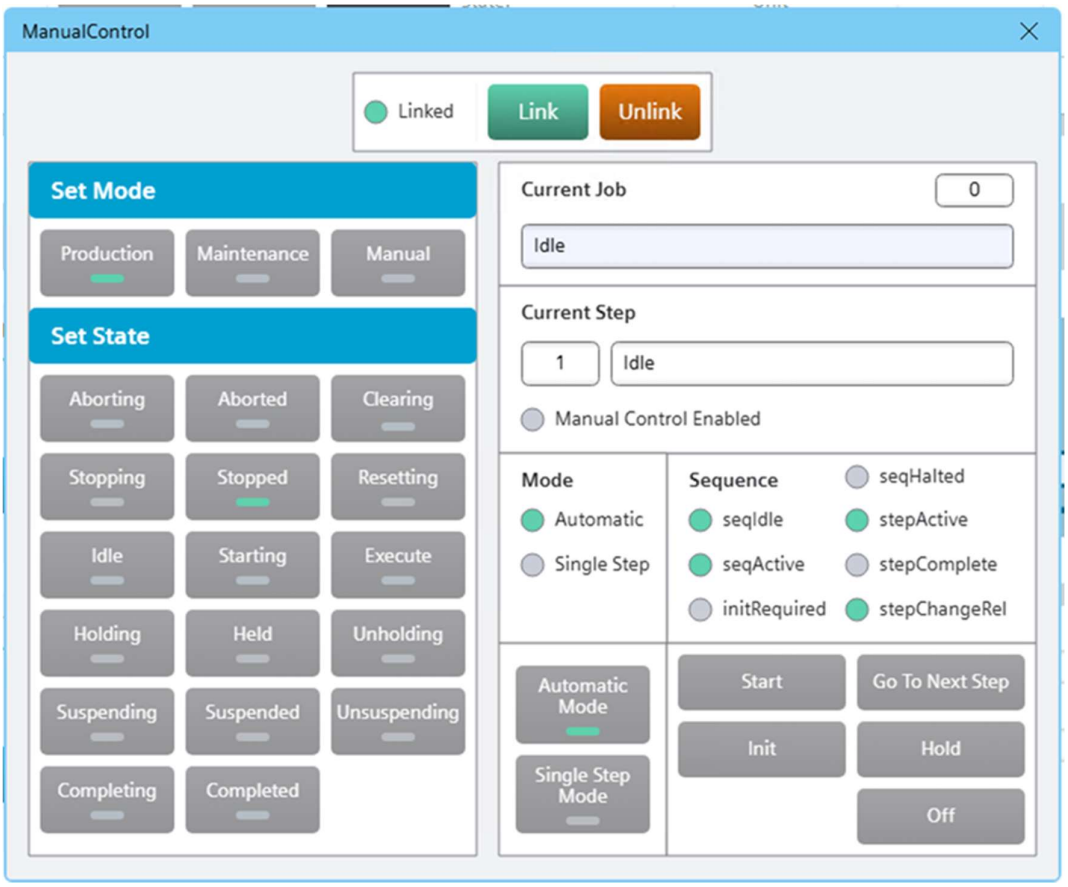


Figure 3-14: EM Manual Control Faceplate

3.2.4. CM Overview

For each CM within the EM, an advanced faceplate can also be accessed, providing enhanced manual control capabilities and allowing for detailed configuration adjustments. To access it, users can click on the button on the top left corner of the simplified faceplate (marked by a red box in Figure 3-9).

As an example, the advanced faceplate of the AxisControl CM is shown in Figure 3-15. As seen in the image, the advanced faceplate allows users to send more advanced commands to the axis and modify its settings, and provides more detailed status information.

The advanced faceplates for the DigitalSignal and TwoWayActuator CMs are not shown in this documentation, but like the AxisControl faceplate, allow users to interact with the CM in additional ways, and change its configuration.

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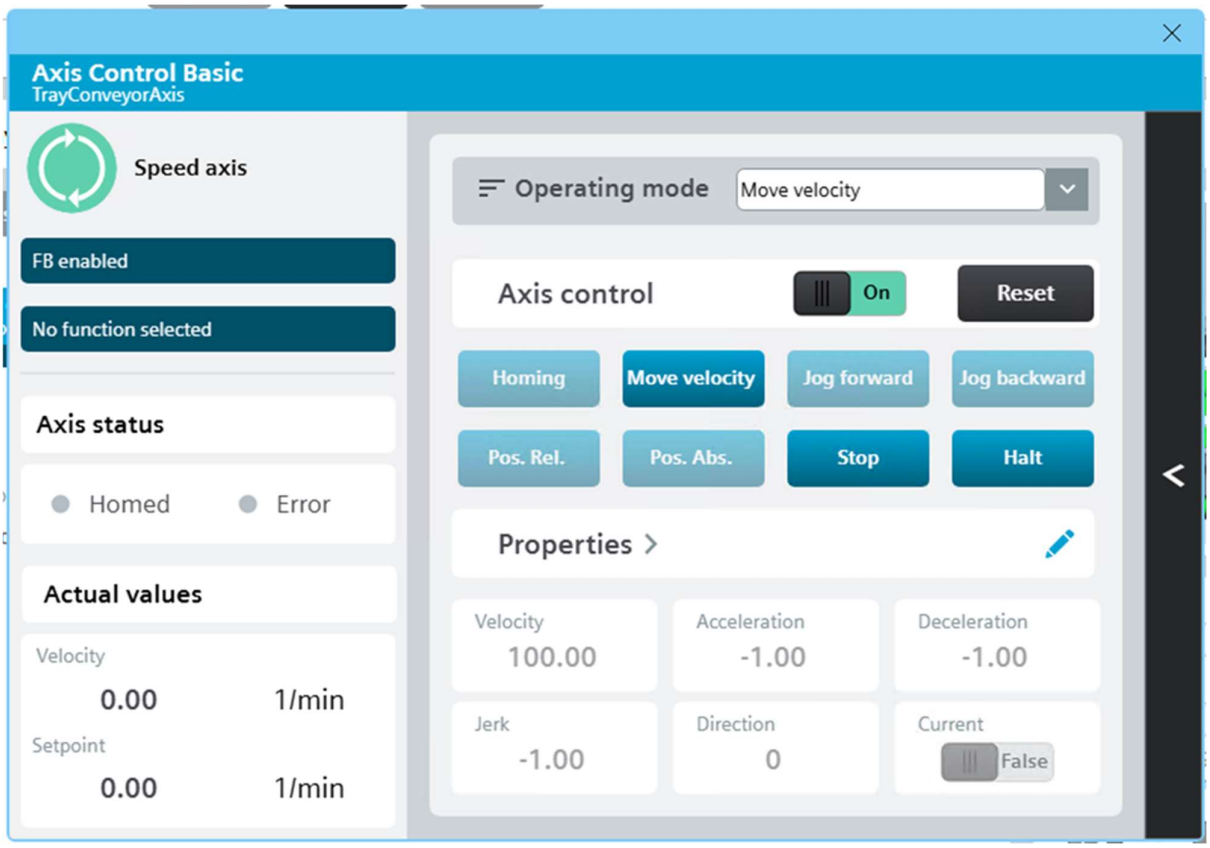


Figure 3-15: CM AxisControl advanced faceplate

3.2.5. Parameters Screen

To access this screen, the user can click on the second icon in the main navigation (Figure 3-4), which is a wrench.

The Paper Cup utilizes a recipe-based configuration system to define operational parameters. Users can create, store, and recall recipes, and they can be loaded into the PLC during runtime, as the parameters are evaluated in each PLC cycle. This dynamic configuration capability is key to the machine's flexibility in meeting diverse production demands.

The parameters are organized into logical sets, grouping those that share close functional relationships and/or are used in the same EM. This structured categorization facilitates easier configuration and ensures consistency across related settings. The parameter set can be selected from a list, as shown in Figure 3-16.

Some of these parameters have already been mentioned in previous sections of this document, precisely in chapter Paper Cup Machine Program Blocks. In the following pages, a more detailed explanation of all parameters sets is provided.

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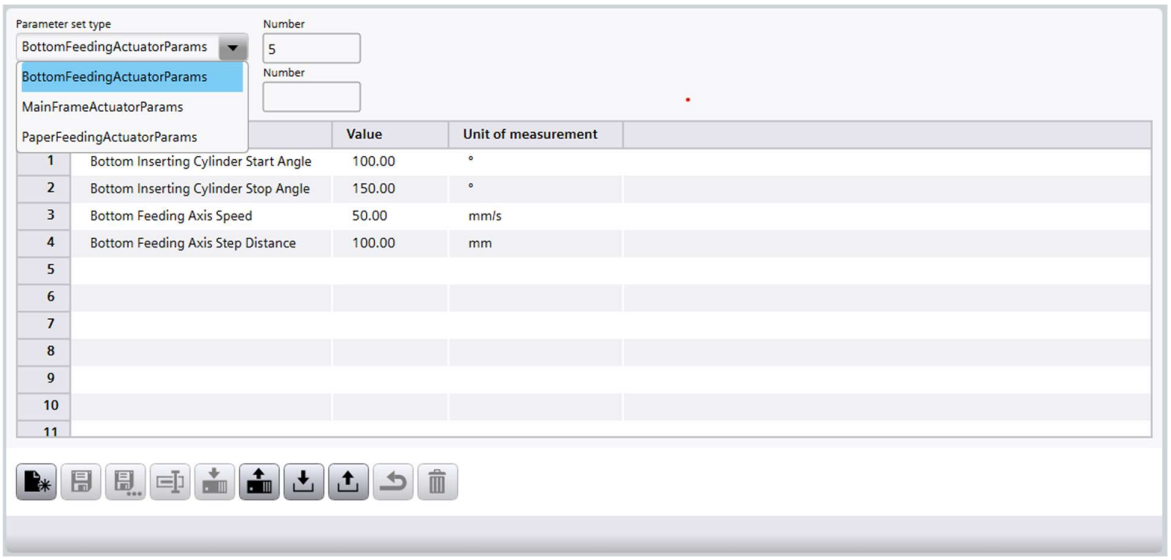


Figure 3-16: Parameter configuration screen

Main Frame Actuator Parameters

These are the parameters related to the main frame (EM1). They define the activation ranges of the different actuators considering the angular position of the LeadingAxis. When the LeadingAxis angular position is between the start and stop angles defined in the parameters, the actuator will activate (go to work position), otherwise, it will deactivate (go to home position).

Name	Unit	Description
Actuator Start Angle	°	Leading axis angle position in which the actuator activates (go to work position)
Actuator Stop Angle	°	Leading axis angle position in which the actuator deactivates (go to home position)

Table 3-1: Main Frame Actuator Parameters

Paper Feeding Actuator Parameters

These are the parameters related to the paper feeding system (EM2). Like the Main Frame actuator parameters, the activation ranges of the actuators in relation to the LeadingAxis are also defined here.

Bottom Feeding Actuator Parameters

These are the parameters related to the bottom feeding system (EM5). Likewise, the activation ranges of the actuators in relation to the LeadingAxis are defined here. But, additionally, it contains some parameters for the BottomFeedingAxis. They are explained below.

Name	Unit	Description
Bottom Feeding Axis Speed	mm/s	Speed setpoint for the bottom feeding axis
Bottom Feeding Step Distance	mm	Step distance for the bottom feeding axis

Table 3-2: Bottom Feeding Actuator Parameters

NOTE For more information about the operation of the Parameter set control, refer to WinCC Unified documentation:
https://support.industry.siemens.com/cs/ww/en/view/109821886

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4. Initiating project runtime

4.1. PLC

This machine application can run either on a real or simulated SIMATIC S7-1200 G2 PLC.

NOTE A simulated PLC is used for the next steps, which means a PLC instance must already be running in PLCSIM beforehand.

Download the project to the PLC instance

4. Download the project on the PC
5. Open it in TIA Portal V20.
6. Click on the folder icon and unzip the project into the opened folder.
7. Make sure we have a connection with the hardware PLC and select it in TIA Portal.

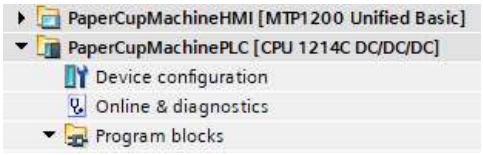


Figure 4-1: TIA Portal Screenshot

8. Click on the "Download to Device" button.
9. Select the PG/PC interface and the connection and load the project

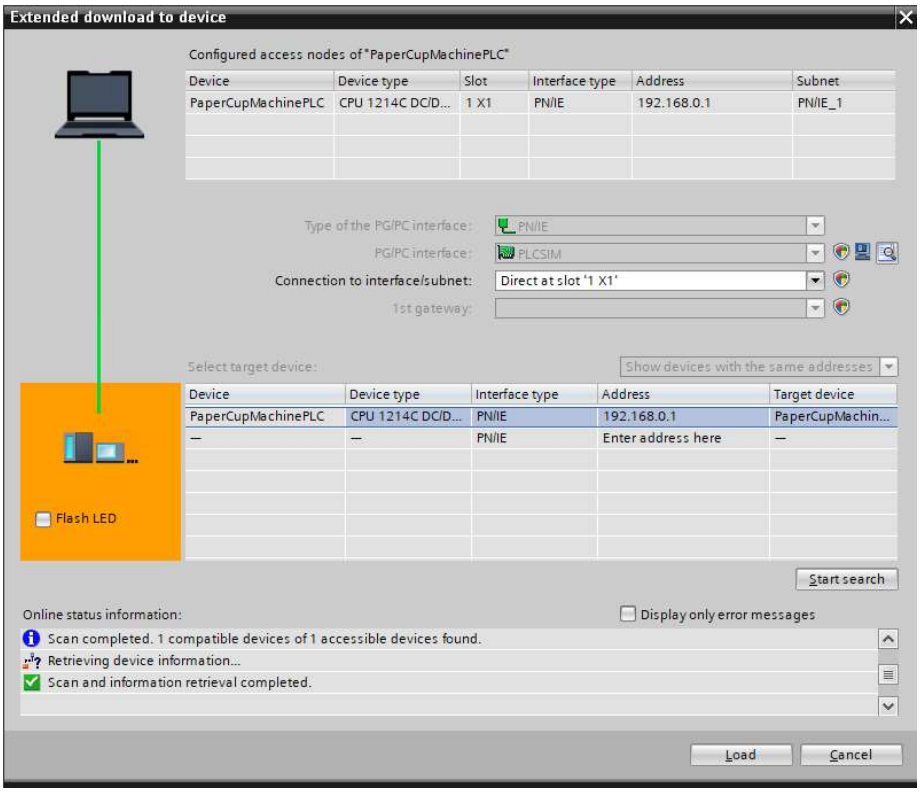


Figure 4-2: TIA Portal Screenshot

10. Load the project clicking on "Load."

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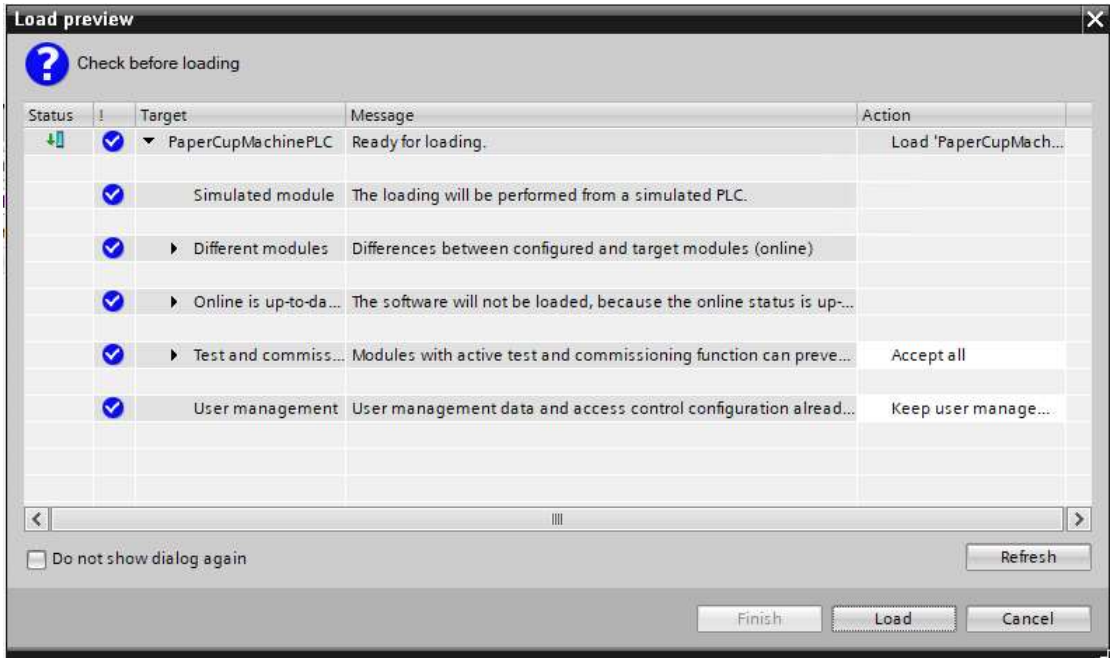


Figure 4-3: TIA Portal screenshot

11. Click on "Go Online" to ensure that the CPU is in RUN and there are no errors.

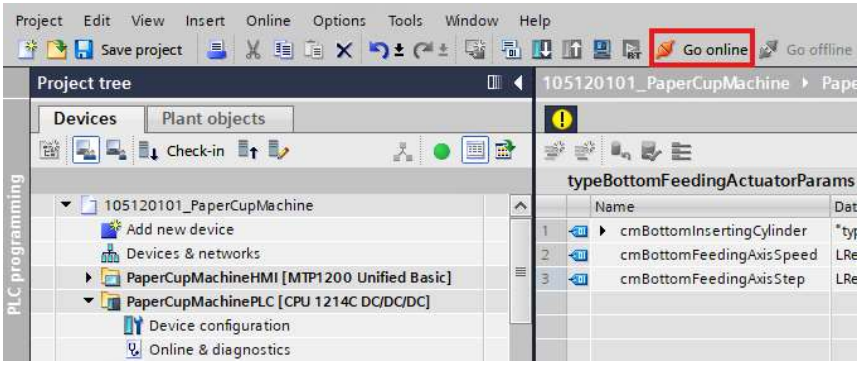


Figure 4-4: TIA Portal screenshot

4.2. HMI Runtime

Screen running can be performed by the following steps. Before running the screen, make sure the PLC program is downloaded and running without errors. Otherwise, it will not be possible to establish a connection between the HMI and the PLC.

Download the project to the HMI

12. Select the PaperCupMachineHMI in TIA Portal.

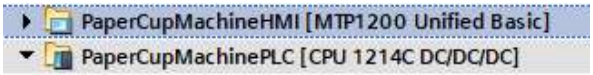


Figure 4-5: TIA Portal screenshot

13. Download the HMI program to real HMI clicking the "Download to Device " button or clicking the "Start simulation" button to simulate the screen on the PC.

14. Once the HMI is running, press the "Request Operation" button to control the machine.

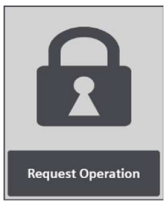
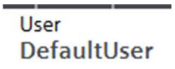


Figure 4-6: HMI screenshot

15. To log in, click on "User" 

and enter the credentials provided previously in the documentation and press "Sign in":

- Username: Add username
- Password: Add password



Figure 4-7: HMI screenshot

16. Click the "Mode" button to switch the mode to production mode

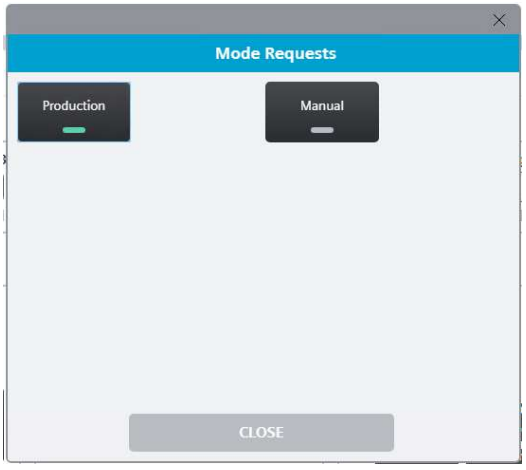


Figure 4-8: HMI screenshot

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17. If the machine is to be simulated, the simulation button can be clicked.



Figure 4-9: HMI screenshot

18. Click the state "Reset/Clear" button, then the "Start" button can be clicked. The device state should display "Execute" if the machine has been able to start correctly. Possible errors during the starting state might be due to wrong configuration parameters or axes being in error state.

    Any doubts can be clarified by consulting the "State Model" screen , which shows all the necessary steps to control the machine during the entire cycle.

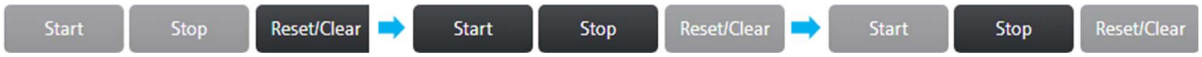


Figure 4-10: HMI screenshot

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5. Appendix

5.1. Service and support

SiePortal

The integrated platform for product selection, purchasing and support - and connection of Industry Mall and Online support. The SiePortal home page replaces the previous home pages of the Industry Mall and the Online Support Portal (SIOS) and combines them.

- Products & Services
  In Products & Services, you can find all our offerings as previously available in Mall Catalog.
- Support
  In Support, you can find all information helpful for resolving technical issues with our products.
- mySieportal
  mySiePortal collects all your personal data and processes, from your account to current orders, service requests and more. You can only see the full range of functions here after you have logged in.

You can access SiePortal via this address: sieportal.siemens.com

Technical Support

The Technical Support of Siemens Industry provides you fast and competent support regarding all technical queries with numerous tailor-made offers – ranging from basic support to individual support contracts.
Please send queries to Technical Support via Web form: support.industry.siemens.com/cs/my/src

SITRAIN – Digital Industry Academy

We support you with our globally available training courses for industry with practical experience, innovative learning methods and a concept that's tailored to the customer's specific needs.
For more information on our offered trainings and courses, as well as their locations and dates, refer to our web page: siemens.com/sitrain

Industry Online Support app

You will receive optimum support wherever you are with the "Industry Online Support" app. The app is available for iOS and Android:

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5.2. Links and literature

No.	Topic
\1\	Siemens Industry Online Support https://support.industry.siemens.com
\2\	Link to this entry page of this application example https://support.industry.siemens.com/cs/ww/en/view/109996034
\3\	Programming Style Guide https://support.industry.siemens.com/cs/ww/en/view/81318674
\4\	Standardized guidelines https://support.industry.siemens.com/cs/ww/en/view/109756737
\5\	Guidelines for library processing in the TIA Portal https://support.industry.siemens.com/cs/ww/en/view/109747503
\6\	Automation Framework https://support.industry.siemens.com/cs/ww/en/view/109817223
\7\	Library of Basic Controls (LBC) https://support.industry.siemens.com/cs/ww/en/view/109792175
\8\	WinCC Unified – Creating and configuring parameter set control https://support.industry.siemens.com/cs/ww/en/view/109821886
\1\	Siemens Industry Online Support https://support.industry.siemens.com

5.3. Change documentation

Version	Date	Modification
V1.0	11/2025	First version

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