CarWash: Specification V3.33 (RS)

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BnR Generic pdf Template Version 2

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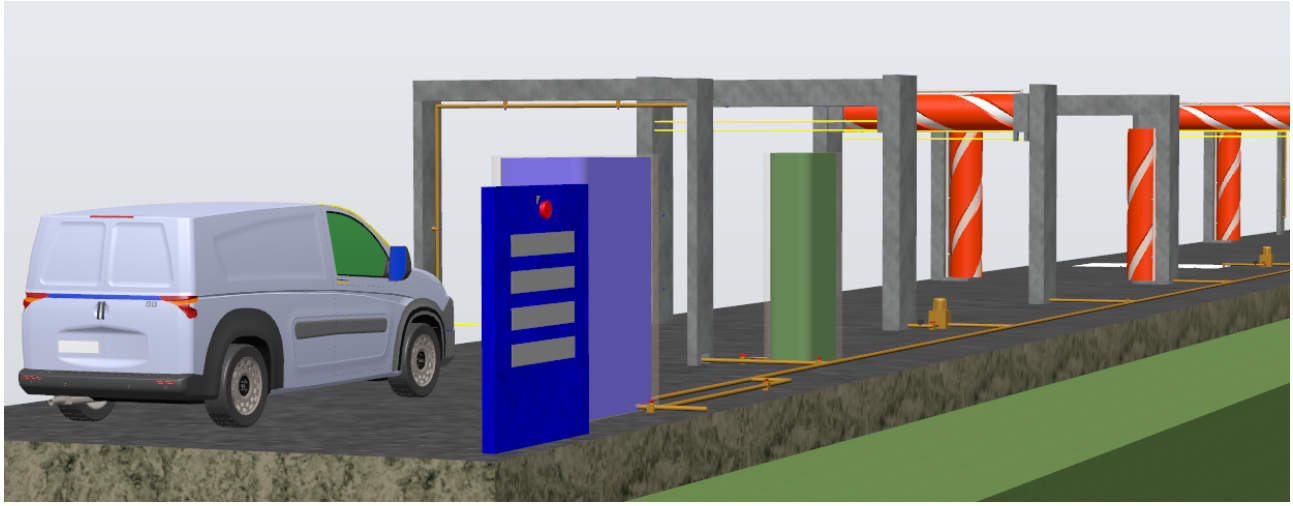
Automatic Car Wash - E-Camp Team Project



Date: 23 Feb 2023

- Project Organization and Goals (RS)
  Project Organization:
  - Supplier: Automation engineers from the E-Camp make up the development team
  - Customer: Role simulated by the E-Camp instructor

  Goals:
  - Team work
  - Create a modular project
  - Hold a presentation

- Machine Description (RS)
  The car wash plant consists of the following stations:
  Entrance, Chemicals, High Pressure, Horizontal Brush, Vertical Brush, Underbody, Polishing, Hot Wax, Drying, Exit

- Machine Variants (RS)
  The control/HMI solution for the car wash plant should be delivered in two variants:
  Compact (with hard-wired button control elements and program selector); Premium (with a 10 inch panel and a graphical HMI)

- Software Requirements (RS)
  Software requirements:
  Operate all stations; Program selection (some stations are optional); simple HMI;

- Hardware Requirements (RS)
  Technical data for the hardware required for the controller; input and output specifications

- Simulation (RS)
  The CarWash plant is simulated with a RobotStudio model.

- Acceptance Criteria (RS)
  Acceptance criteria for final test by customer

Project Organization and Goals (RS)

Project Organization

Application engineers from the E-Camp make up the development team and supply the hard- and software for an automatic Car Wash. The role of the customer is simulated by the E-Camp instructor. Some more B&R employees might attend (in the role of further customer representatives) for the presentations.

Name / Email	Company / Department	Task / Responsibility
Supplier	B&R E-Camp	Automation engineer
Customer Contact	B&R E-Camp Instructor	Objective clarification / Approve change requests
Customer Organization Members	B&R Office Employees	Provide customer perspectives during presentation

Source control management (Git/Bitbucket) and agile project management techniques (Jira) must be used:

Source control (Git):

- proper project structure (proper .gitignore, only relevant source folders go into Git)
- at least daily commits
- meaningful commit messages
- link commits to Jira issues

Agile project management (Jira):

- proper issue handling (reasonable use of Epics, Tasks, Stories, Bugs)
- keep Kanban board up-to-date throughout the project
- log working time on Jira issues
- link commits to Jira issues

Goals

The goal of this project is to develop the software for an automatic car wash and select suitable hardware for this system. Development is done in **team work**.

Keeping "TM231 – Coding Guidelines" and "TM233 - Application Design Guidelines" in mind, the objective is to create a universal and **modular software design**. Important issues in structuring are simple expandability, flexible configuration options and the reusability of the individual software components. It must be possible to test the individual software components and they must function independently of each other. The operation of the individual software components should be as simple as possible via a standardized interface.

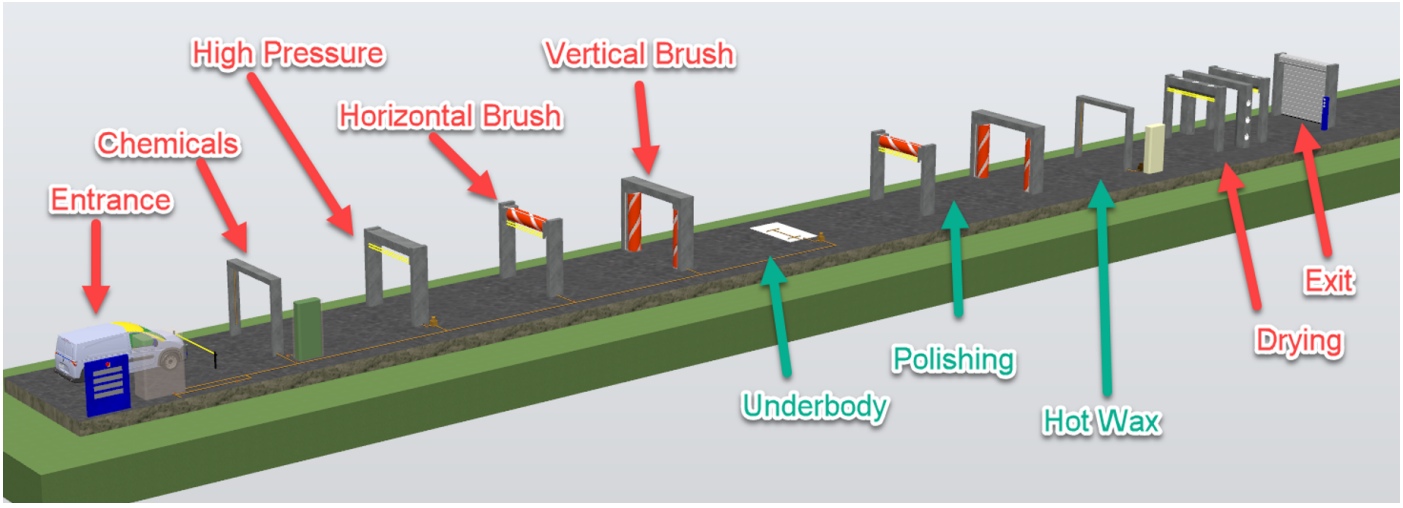
You will also be required to give a **presentation** on your results to the customer organization. The attendees will not necessarily be all engineers, so make sure the presentation is suited for all audiences. The presentation should include:

- Project history (planning and fulfillment)
- Suggested hardware (provide detailed B&R hardware configuration to cover all IO datapoints)
- Software background info (architecture)
- Software operation info (showcase, how to operate)
- Feel free to add whatever will convince the customer of B&R and your solution

A time report on the spent hours (use Jira functionality: Tempo / Reports) should be prepared in case the customer asks for it during the final presentation.

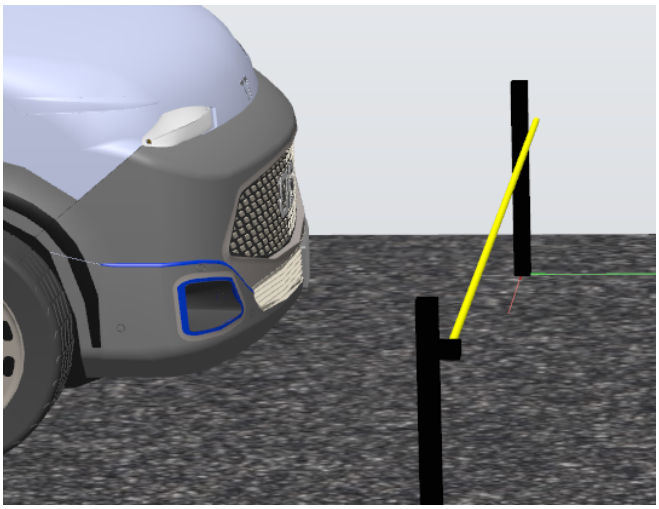
Machine Description (RS)

The Car Wash system can be divided into **individual stations**, which can either be present or absent depending on the chosen washing program. The stations are: Entrance, Chemicals, High Pressure, Horizontal Brush, Vertical Brush, Underbody (optional), Horizontal and Vertical Polishing (optional), Hot Wax (optional), Drying, Exit



Entrance

At the entrance, the vehicle is placed into a guiding track where a conveyor chain handles the forward movement of the vehicle (see "Auxiliary devices"). As soon as the photocell is interrupted, the sequence control begins and executes the selected washing program.



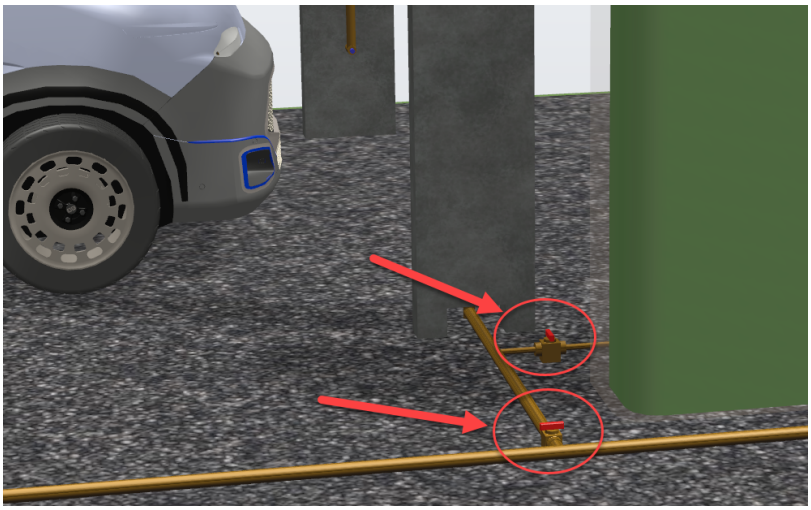
The vehicle is pulled past the light barrier by the conveyor belt. While passing the light barrier, the degree of soiling is measured using an ultrasonic transducer, which detects the reflectivity of the vehicle surface. A clean car has a higher reflectivity than a dirty car.

IO Type	Name	Description
DI	diEntranceSensor	Photocell: Entrance sensor
AI	aiEntranceSoilLevel	Level of soiling: 0V = no reflection (dirty), 10V = full reflection (clean)

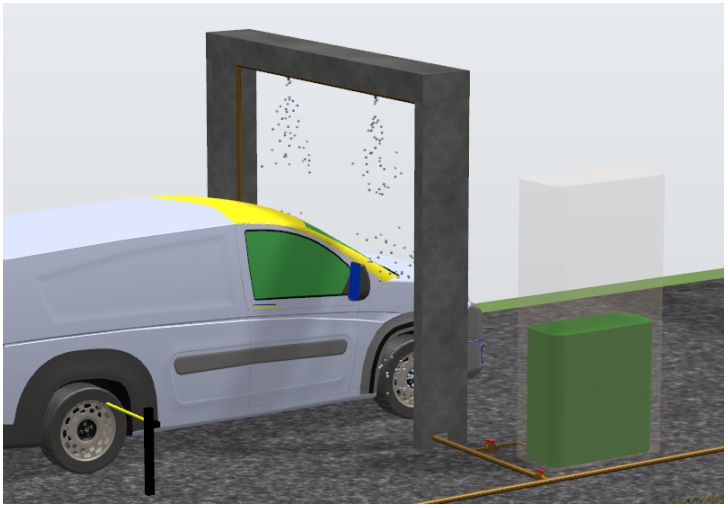
Chemicals

During the chemical cleaning, the vehicle is sprayed from 6 spray nozzles (2 from above and 2 from each side) with a mixture of water and cleaning agent. The spray nozzles are connected with one another. Water feed is activated a solenoid valve. The addition of a certain amount of chemicals is controlled via a separate

analog valve. The concentration of cleaning agent must be set in 6 steps, depending on the dirtiness of the car.



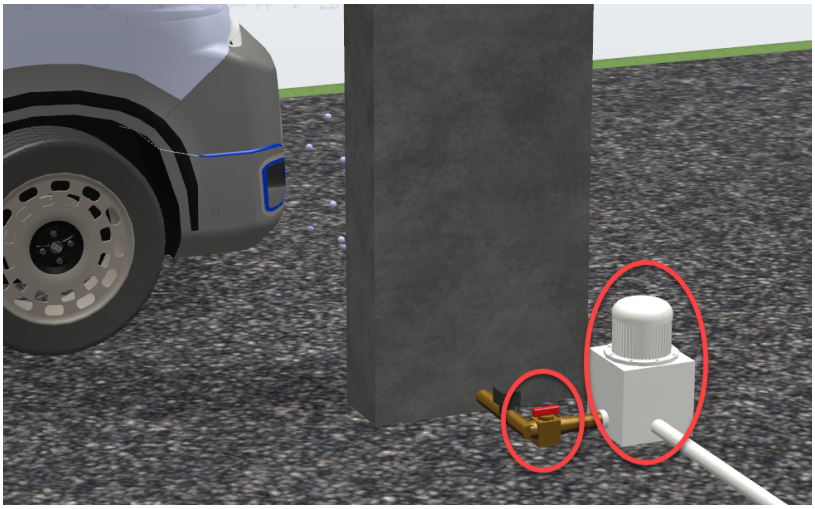
The chemicals tank should be refilled automatically once the tank level (indicated by an analog input) drops below 10% fill level.



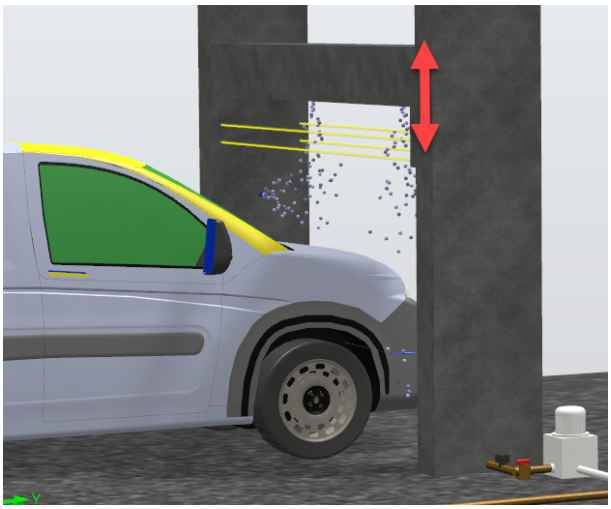
IO Type	Name	Description
AI	aiChemLevel	Fill level of chemicals tank: 0V = empty, 10V = full
DO	doChemWaterValve	Spray mixture of water and cleaning agent
DO	doChemRefill	Refill chemicals tank
AO	aoChemValve	Addition of cleaning agent: 0V = lowest concentration, 10V = highest concentration

High pressure

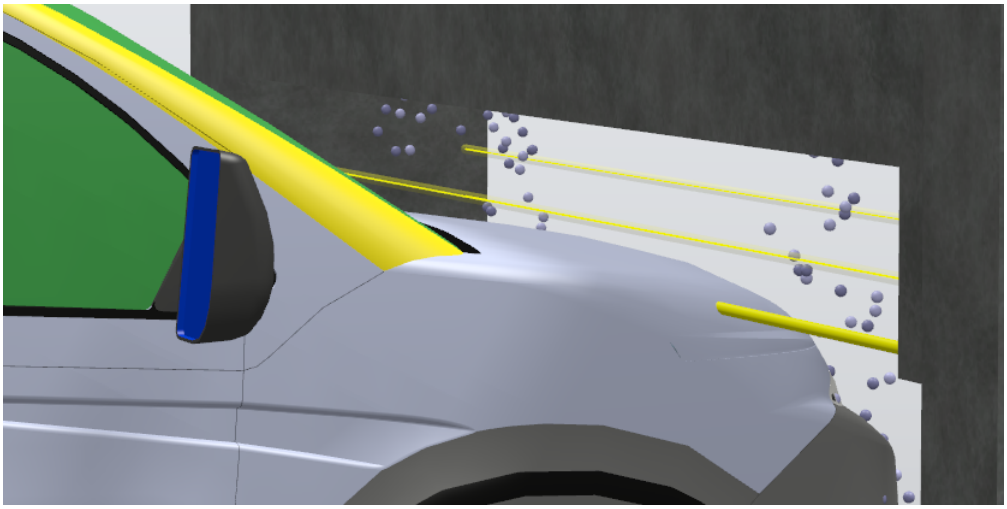
During high pressure cleaning, the vehicle is sprayed with water using 6 high-pressure nozzles (2 from above and 2 from each side). The nozzles are connected together, supplied via a central high-pressure pump, and activated using a solenoid valve:



The side nozzles are permanent fixtures. The upper nozzles can be moved down vertically and adapted to the height of the vehicle, lifting and lowering are each handled by two separate relays. Configure the lowering/lifting speed to a fixed value between 0 and 0.5 m/sec, so that the car can pass smoothly through the station:



The vehicle's profile is determined using four light barriers of which are two in a vertical row at the front of the nozzle rail and two in a vertical rail at the back of the nozzle rail:



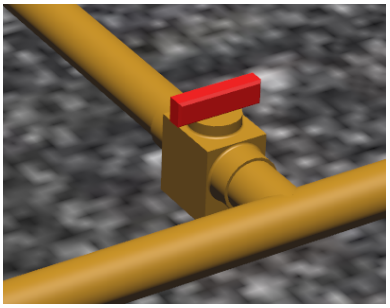
Hint

Make sure that the software takes into account non-permissible conditions at the light barriers.

IO Type	Name	Description
DI	diHighPressSensorFront1	Front light barrier, "1" is always used for the lower light barrier
DI	diHighPressSensorFront2	Front light barrier, "2" is always used for the upper light barrier
DI	diHighPressSensorBack1	Back lower light barrier
DI	diHighPressSensorBack2	Back upper light barrier
DI	diHighPressNozzlesUp	End switch: nozzle rail is fully up
DI	diHighPressNozzlesDown	End switch: nozzle rail is fully down
DO	doHighPressNozzlesUp	Relay for lifting the nozzle rail
DO	doHighPressNozzlesDown	Relay for lowering the nozzle rail
DO	doHighPressPump	Central high pressure pump
DO	doHighPressValve	Solenoid valve to activate high pressure spray
AO	aoHighPressVelocity	Velocity of the high pressure rail, unit [m/s], max: 0.5 m/s

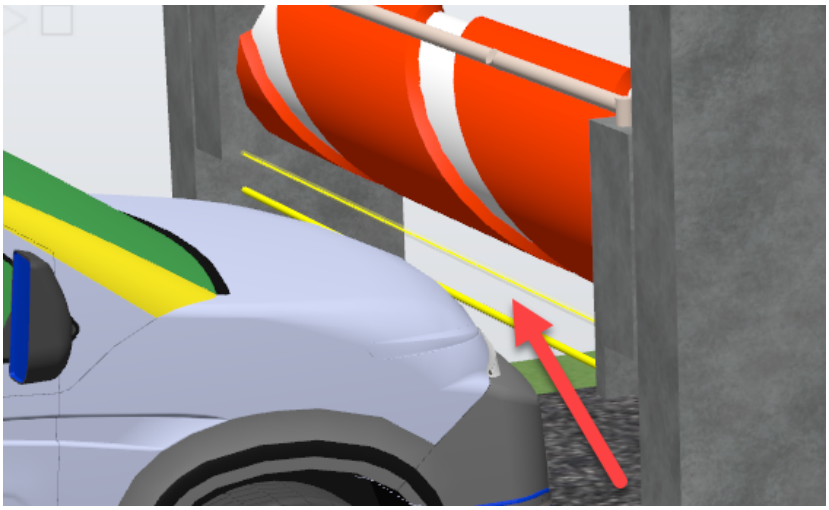
Horizontal brush

The horizontal brush is a rotating roller with an attached cleaning cloth. It is responsible for cleaning the upper side of the vehicle. The brush is turned with an electric motor.
The brush is coated with water via spray nozzles. They are enabled by a solenoid valve:



The brush can be moved down vertically and adapted to the height of the respective vehicle. Lifting and lowering are handled by two separate relays.

The vehicle's profile is determined using four light barriers of which are two in a vertical row at the front of the nozzle rail and two in a vertical rail at the back of the nozzle rail:



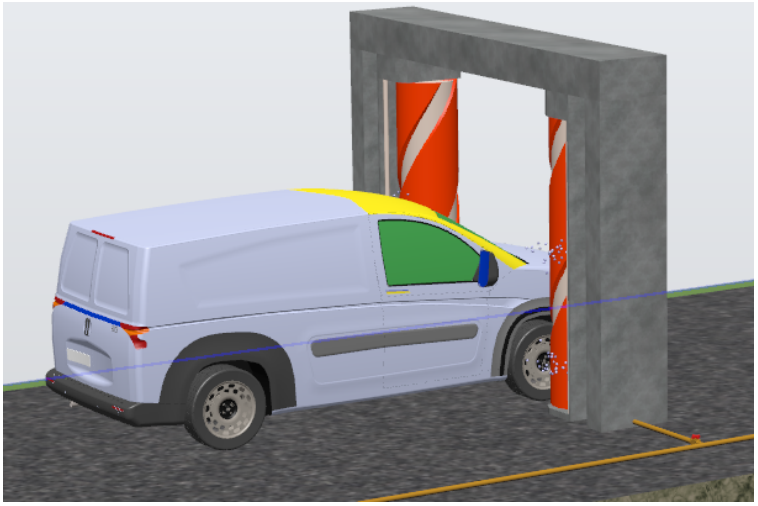
IO Type	Name	Description
DI	diHBrushSensorFront1	Front lower light barrier
DI	diHBrushSensorFront2	Front upper light barrier
DI	diHBrushSensorBack1	Back lower light barrier
DI	diHBrushSensorBack2	Back upper light barrier
DI	diHBrushUp	End switch: horizontal brush is fully up
DI	diHBrushDown	End switch: horizontal brush is fully down
DO	doHBrushUp	Relay for lifting the horizontal brush
DO	doHBrushDown	Relay for lowering the horizontal brush
DO	doHBrushMotor	Activate electric motor to turn the horizontal brush
DO	doHBrushValve	Solenoid valve for activating water spray nozzles
AO	aoHBrushVelocity	Velocity for the vertical brush movement, unit [m/s], max: 0.5 m/s

Hint

Make sure that the software takes into account non-permissible conditions at the light barriers.

Vertical brushes

The vertical brushes are rotating rollers with an attached cleaning cloth. They are responsible for cleaning the sides of the vehicle. Each brush is turned by an electric motor. The brushes are coated with water via spray nozzles. The spray nozzles are activated by a solenoid valve.



The brushes can be opened and closed crossways to the vehicle's forward motion. The positioning of each brush is controlled by a servo motor.

Sequence:

1. Each brush has two force sensors, one in the direction of movement and one across it.
2. Brushes must be in closed position when the vehicle arrives.
3. If the vehicle moves towards the closed brushes, the *directional force* increases in the direction of movement.
4. If the *directional force* exceeds 70 N, then the brush must be opened until the *directional force* sinks to 70 N again.
5. While moving through the brushes, the opening of the brushes must be controlled in a way that the *cross force* remains at a constant value of 120 N. Once the vehicle has passed through, this ensures that both brushes are closed again.

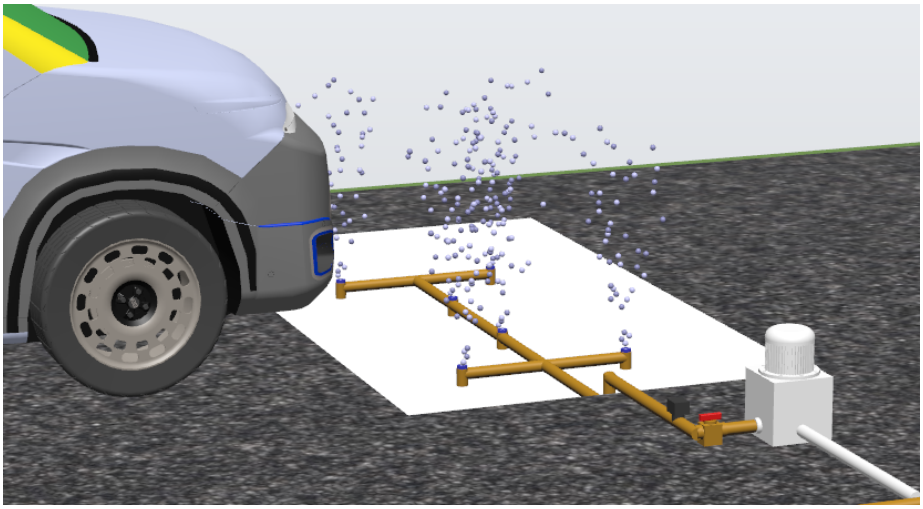
IO Type	Name	Description
DI	diVBrushLClose	End switch: left vertical brush is closed
DI	diVBrushLOpen	End switch: left vertical brush is open
DI	diVBrushRClose	End switch: right vertical brush is closed
DI	diVBrushROpen	End switch: right vertical brush is open
AI	aiVBrushLForce	Left force sensor in direction of movement, range 0 - 10V = 0 - 200 N (in 9 steps)
AI	aiVBrushLCrossForce	Left cross force sensor, range 0 - 10V = 0 - 200 N (in 9 steps)
AI	aiVBrushRForce	Right force sensor in direction of movement, range 0 - 10V = 0 - 200 N (in 9 steps)
AI	aiVBrushRCrossForce	Right cross force sensor, range 0 - 10V = 0 - 200 N (in 9 steps)
DO	doVBrushValve	Solenoid valve to activate spray nozzles of vertical brushes
DO	doVBrushMotor	Activate electric motor to turn the vertical brushes
AO	aoVBrushLPosition	Vertical left brush set position, unit [m], valid range: 0 - 1 m
AO	aoVBrushRPosition	Vertical right brush set position, unit [m], valid range: 0 - 1 m

Hint

Be aware of problems with the force sensors and handle possible alarm conditions in the application. Also make sure that the software takes into account non-permissible conditions at the light barriers.

Option: Underbody

For underbody cleaning, the vehicle is sprayed with water from 6 high-pressure nozzles. The nozzles are connected together, supplied via a high-pressure pump, and activated using a solenoid valve:

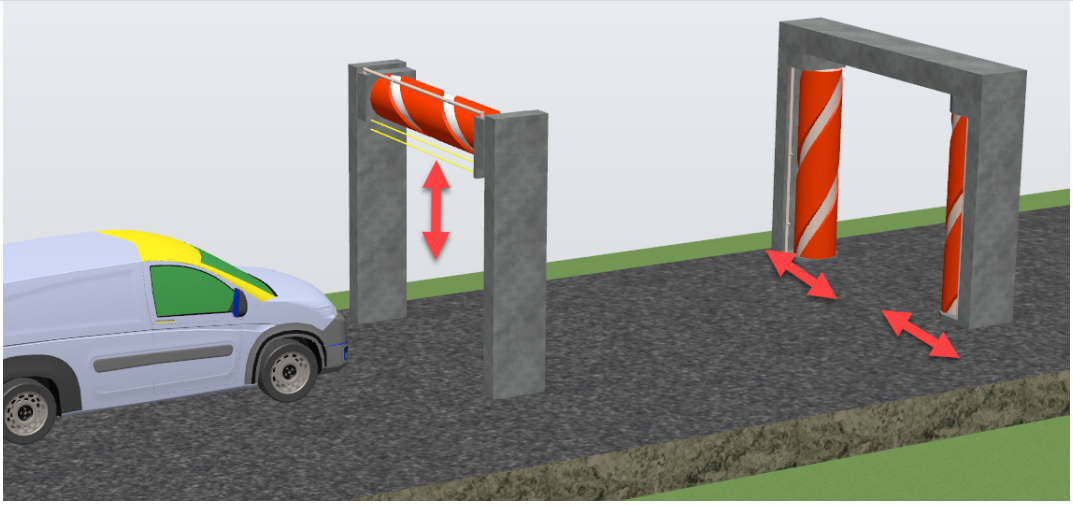


IO Type	Name	Description
DO	doUnderbodyValve	Solenoid valve to activate underbody spray nozzles
DO	doUnderbodyPump	High pressure pump for underbody spray supply

Option: Polishing

The horizontal polishing brush is a rotating roller with an attached polishing cloth. It is responsible for polishing the upper side of the vehicle. The brush is driven with an electric motor. The brush can be moved up and down and adjusted to the height of the respective vehicle. The vehicle's profile is determined using four light barriers of which are two in a vertical row at the front of the brush and two in a vertical row at the back of the brush. Lifting and lowering are handled by two separate relays.

IO Type	Name	Description
DI	diHPolishSensorFront1	Same functionality as horizontal brush
DI	diHPolishSensorFront2	
DI	diHPolishSensorBack1	
DI	diHPolishSensorBack2	
DI	diHPolishBrushUp	
DI	diHPolishBrushDown	
DO	doHPolishBrushUp	
DO	doHPolishBrushDown	
DO	doHPolishBrushMotor	
AO	aoHPolishBrushVelocity	



The vertical polishing brushes are rotating rollers with an attached polishing cloth. They are responsible for polishing the sides of the vehicle. Each brush is driven with an electric motor. The brushes can be moved opened and closed crossways to the vehicle's forward motion.

The control for opening and closing should be handled in the same way as for the vertical brushes.

IO Type	Name	Description
DI	diVPolishLClose	Same functionality as vertical brushes
DI	diVPolishLOpen	
DI	diVPolishRClose	
DI	diVPolishROpen	
AI	aiVPolishLForce	
AI	aiVPolishLCrossForce	
AI	aiVPolishRForce	
AI	aiVPolishRCrossForce	
DO	doVPolishMotor	

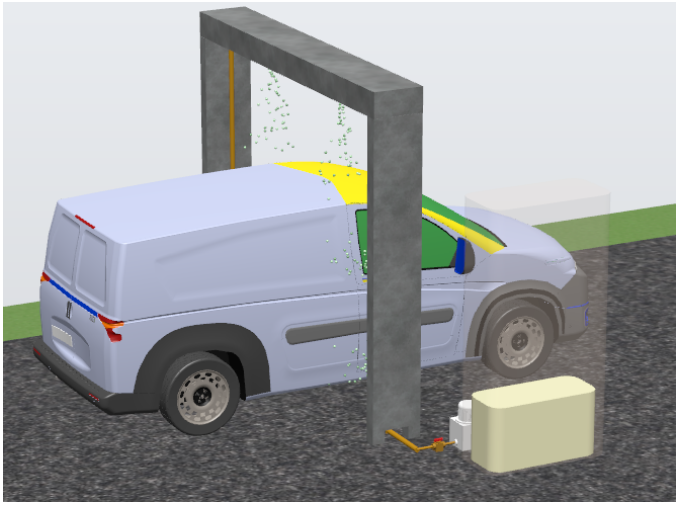
IO Type	Name	Description
AO	aoVPolishLPosition	
AO	aoVPolishRPosition	

Hint

Be aware of problems with the force sensors and handle possible alarm conditions in the application. Also make sure that the software takes into account non-permissible conditions at the light barriers.

Option: Hot wax

Hot liquid wax is sprayed on the vehicle from 6 nozzles. The nozzles are connected together, supplied via a central pump and activated using a solenoid valve:



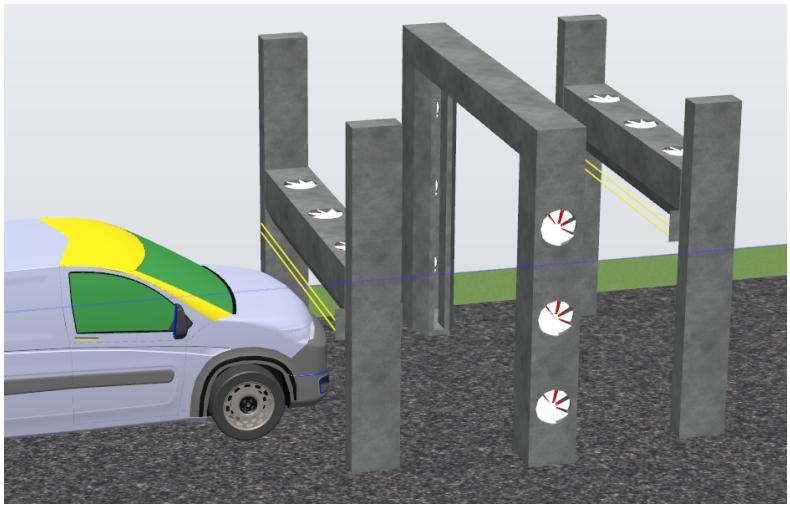
The how wax tank should be refilled automatically if the tank level (indicated by an analog input) falls below 10%.

IO Type	Name	Description
AI	aiWaxLevel	Fill level of hot wax tank: 0V = empty, 10V = full
DO	doWaxValve	Solenoid valve to spray hot liquid wax
DO	doWaxPump	Pump for wax supply
DO	doWaxRefill	Refill wax tank

Drying

The vehicle is dried with heating blowers, one device is blowing from the side (vertical dryer) and two devices are blowing from top (horizontal dryers). For each device, the heater and the blower are each enabled separately via a relay.

A heating unit must always be switched on together with a blower, otherwise the heater gets damaged.



The side devices (vertical dryer) are permanent fixtures.

The upper devices (horizontal dryers) can be moved up and down vertically and adapted to the height of the respective vehicle. The vehicle's profile is determined using four light barriers of which are two in a vertical row at the front of the dryer rail and two in a vertical row at the back of the dryer rail. Lifting and lowering are handled by two separate relays.

IO Type	Name	Description
DI	diHDry1SensorFront1	Same functionality as horizontal brush
DI	diHDry1SensorFront2	
DI	diHDry1SensorBack1	
DI	diHDry1SensorBack2	
DI	diHDry1Up	
DI	diHDry1Down	
DO	doHDry1Up	
DO	doHDry1Down	
DO	doHDry1Blower	Blower relay
DO	doHDry1Heater	Heater relay
DO	aoHDry1Velocity	

IO Type	Name	Description
DO	doVDryBlower	Blower relay
DO	doVDryHeater	Heater relay

IO Type	Name	Description
DI	diHDry2SensorFront1	Same functionality as horizontal brush
DI	diHDry2SensorFront2	
DI	diHDry2SensorBack1	
DI	diHDry2SensorBack2	
DI	diHDry2Up	
DI	diHDry2Down	
DO	doHDry2Up	
DO	doHDry2Down	
DO	doHDry2Blower	Blower relay

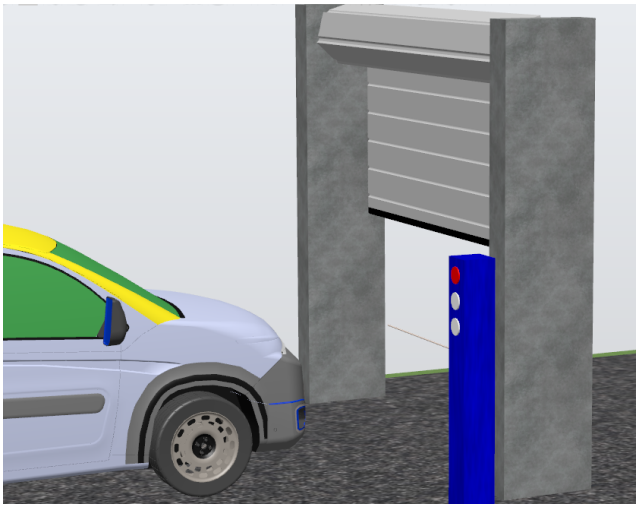
IO Type	Name	Description
DO	doHDry2Heater	Heater relay
DO	aoHDry2Velocity	

Hint

Make sure that the software takes into account non-permissible conditions at the light barriers.

Exit

The exit area consists of 2 devices: a traffic light and a tracked gate. The traffic light can signal red, orange and green. The tracked gate is controlled by a relay for opening and a relay for closing.



Usually, the orange light is activated. The orange light is turned off and the red light is turned on as soon as a vehicle enters the drying device. The gate should be opened as soon as the vehicle leaves the drying. The green light should be turned on (and the red light turned back off) as soon as the the gate is fully open and the vehicle has passed the second horizontal drying device. Once the car has left the station, close the exit door, turn off the green light and turn on again the orange light.

IO Type	Name	Description
DI	diExitSensor	Photocell: Exit sensor placed right after the exit door
DI	diExitDoorUp	End switch: Exit door is fully open
DI	diExitDoorDown	End switch: Exit door is fully closed
DO	doExitGreenLight	Green light
DO	doExitOrangeLight	Orange light
DO	doExitRedLight	Red light
DO	doExitDoorUp	Relay for opening the exit door
DO	doExitDoorDown	Relay for closing the exit door

Auxiliary devices

The conveyor chain is responsible for moving the vehicle through the car wash. It is located in a groove that the vehicle's left wheels drive onto at the beginning. The conveyor chain is driven by an electric motor and moves the vehicle through the car wash at a constant speed. The conveyor chain must be turned on as soon as a program started. The conveyor chain must be turned off as soon as a program ended. A position sensor always reports the actual position of the car.

IO Type	Name	Description
AI	aiCarPosition	Position of the car on the conveyor, unit [m]
DO	doConveyorMotor	Conveyor chain to move the vehicle through the car wash

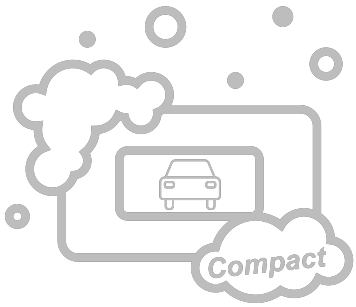
The main water supply for the car wash plant must be switched on automatically if a program is started. An analog input detects the fill level of tank. It must be refilled once the level drops below 10 % by opening the tank valve for refilling.

IO Type	Name	Description
AI	aiWaterLevel	Fill level of water tank
DO	doWaterValve	Main water supply for the car wash plant
DO	doWaterRefill	Refill the water tank

Machine Variants (RS)

The Car Wash system should support two hardware variants:

Compact



In the Compact variant, the control of the system (program selection and status indication) should be done with hardware buttons. The E-Camp instructor will provide you the exact hardware information.

Premium

In the Premium variant, the control of the system (program selection and status indication) should be done with a graphical HMI on a 10 inch panel. The HMI screens should be designed as specified in the chapter Software Requirements (RS). The E-Camp instructor will provide you the exact hardware information.

HQ Hardware Variants (RS)

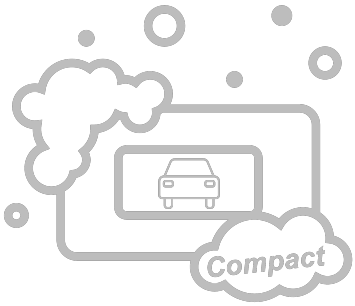
The car wash plants are available in two different variants:

- Compact
- Premium

From process point of view and functionality, both are the same. The differentiation is in the user experience.

Compact variant

The goal of the Compact variant is to have a cost effective solution. This is ensured by using the following setups and I/O assignments:



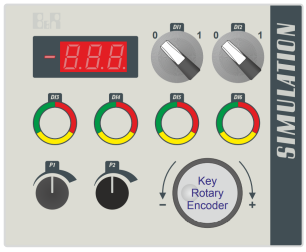
ETAL210.1050-1

The ETAL210.1050-1 is the chosen PLC. The local X2X bus is used for extension and connecting die IOs for the ETAL120.1050-1.

ETAL120.1050-1

The ETAL120.1050-1 is representing the status of the traffic light at the exit.

4SIM.10-01



Choose the washing program

The washing programs are selected by the provided DIs:

- DI3 - Mini
- DI4 - Midi
- DI5 - Maxi
- DI6 - Multi

After a washing program is selected and confirmed (see: *Confirm the washing program*) the corresponding key rings must be activated.

Color code

- OFF - no program selected
- GREEN - program selected
- ORANGE - program selected and started
- RED - E-Stop status (red as long as pressed)

Start the washing program

The Key Rotary Encoder is also supporting a push button which is used for starting the selected washing program.

Status of current station

The 7-segment display is used to show the current / active station as number.

- 0 - no car
- 1 to 11 - from entrance (1) to exit (11) according to the machine description

Premium version

The goal of the Premium variant is to have the entire operator experience on a single HMI device by using the following setup:

ETAL210.1050-1

The ETAL210.1050-1 is used as PLC.

ETAL611.1T10-1

The ETAL611.1T10-1 is the operator panel. The entire control is handled via this single HMI device according to the specifications of Operation and visualization.

Software Requirements (RS)

Controller

The software must control the sequence for the car wash. Depending on the position of the vehicle, the respective units need to be activated. The car wash begins when the vehicle enters the car wash (interrupts the photocell at the entrance) and ends when the vehicle leaves the system at the exit. If the program selection option is not installed, then the complete program takes place automatically.

In the basic design, only one vehicle at a time can be handled, i.e., the next vehicle must wait until the vehicle in front of it exits the system and the program is ended.

Program selection:

There are four different wash programs to choose from. The program must be selected (one button for each program) before the vehicle enters the system:

1. Mini: Chemicals – High pressure – Brushes – Drying
2. Midi: Chemicals – High pressure – Brushes – Hot wax – Drying
3. Maxi: Chemicals – High pressure – Brushes – Underbody – Hot wax – Drying
4. Multi: Chemicals – High pressure – Brushes – Underbody – Polish – Hot wax – Drying

After a car has been washed successfully an entry in a text file, which is available on an FTP server, must be edited. This text file stores information how often a program has run successfully. It could look like this:

```
Program Mini: 00011 times executed
Program Midi: 00105 times executed
Program Maxi: 01974 times executed
Program Multi: 00011 times executed
```

Additional options

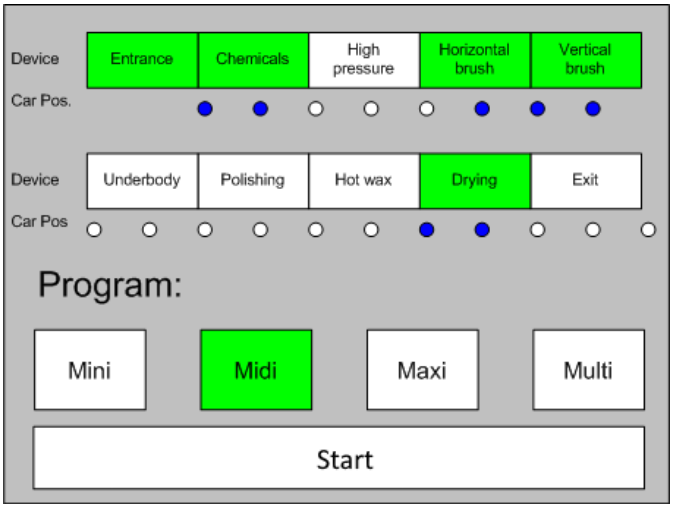
- **Length** of the vehicle:
  The software must be able to take vehicles of different lengths into consideration. The devices should only be enabled as long as it takes for the vehicle to pass through. This also allows each vehicle to be precisely tracked through the car wash plant.
- **Emergency stop**:
  Aborts the program and brings to the system to an immediate standstill.
  Resumes the interrupted program once it is released.
- Install an extensive **Alarm Handling**, for all possible errors and react in an appropriate way. There can be an error in every station (look at the hints in the Machine Description (RS)). Talk with the customer (trainer) to find solutions close to the wishes of the customer to handle different situations.
- **Time monitoring** / tracking the position of a vehicle and checking whether the devices are activated at the correct times according to the vehicle's position.
- **Extended HMI** (animations, design, ...)

Feel free to add own ideas for improvement the Car Wash plant (sensors, actuators) and the application, discuss them with the customer in the regular meetings.

Operation and visualization

Premium variant: Touch screen display:

The car wash is activated by a main power switch, which brings the system into a ready state. A 10" touch screen display is used for operation and visualization. It should display all basic functions and indicators on a single screen. One of the four buttons can be pressed to select the program. The selected program is indicated by a different colored button. Once the start button is pressed, the car should start moving and the program selection cannot be changed anymore. The devices can be shown on the display graphically or as rectangles with text labels. The operating state (active / inactive) of each individual device is indicated by a change in the background color or additional status symbols. In addition, the position of the vehicle in the system should be shown schematically (software engineer decides the design).



Compact variant: Button control:

Similar functionality like above (program selection; indication which program and which device is currently active; information when program finished) should be provided with the help of hardware control elements (buttons, illuminated key rings, ...). The exact hardware will be specified by the E-Camp instructor. Further details can be found in the chapter Machine Variants (RS).

Hardware Requirements (RS)

This section will specify the technical data for the hardware required for the controller.
All I/O signal processing should have a maximum reaction time of 20 ms.

Overall

Be aware that all photocell sensors have a Boolean output, which is TRUE if the photocell is active and FALSE if its inactive. This also applies to the relays and the solenoid valves. All speeds are in m/s and the forces are in N.

Entrance

Photocell produces a digital output: 0 / 24 VDC, interruption causes high signal.

Measuring the level of soiling:
Ultrasonic transducer: analog input: 0-10 V, 0 V → no reflection, 10 V → full reflection. Test shows: Clean vehicle → 10 V, very soiled vehicle → 0 V.

Chemicals

2x Solenoid valve: 24 VDC / 400 mA (for refill and normal operation)
Chemicals concentration valve: Analog output 0-10V
Fill level of chemicals tank: Range: 0..100% of tank, analog input 4..20 mA

High pressure

Solenoid valve: 24 VDC / 1.5 A
Relay for high pressure pump: 230 VAC / 100 mA.
4 photocells: Digital input: 0 / 24 VDC, interruption causes high signal.
2 relays for lifting / lowering the nozzles: 24 VDC / 100 mA.

(not necessary to provide output needed for the set velocity of the rail)

Horizontal brush

Relay for drive motor: 24 VDC / 100 mA.
Solenoid valve: 24 VDC / 400 mA.
4 photocells: Digital input: 0 / 24 VDC, interruption causes high signal.
2 relays for lifting / lowering the brushes: 24 VDC / 100 mA.

(not necessary to provide output for the set velocity of the horizontal brush)

Vertical brushes

2 relays for drive motors: 24 VDC / 100 mA.
Solenoid valve for spray nozzles: 24 VDC / 400 mA.
2 servo drives and 2 synchronous motor for swiveling (opening / closing) the brushes: nominal speed: 3,000 rpm, stall torque: 0.360 Nm, without brake
4 force sensors: Range: 0..200 N, output: Strain gauge measuring bridge.
Permitted force in the direction of movement: 70 N
Permitted force sideways against the direction of movement: 120 N.

Under body option

Solenoid valve: 24 VDC / 1.5 A
Relay for high pressure pump: The same high pressure pump is used as for the high pressure cleaning.

Polish option

Horizontal polish brush:

Relay for drive motor: 24 VDC / 100 mA.
4 photocells: Digital input: 0 / 24 VDC, interruption causes high signal.
2 relays for lifting / lowering the nozzles: 24 VDC / 100 mA.

(not necessary to provide output for the set velocity of the rail)

Vertical polish brushes:

2 relays for drive motors: 24 VDC / 100 mA.
2 servo drives and 2 synchronous motor for swiveling (opening / closing) the polish brushes: nominal speed: 3,000 rpm, stall torque: 0.360 Nm, without brake
4 force sensors: Range: 0..200 N, output: Strain gauge measuring bridge.
Permitted force in the direction of movement: 70 N.
Permitted force sideways against the direction of movement: 120 N.

Hot wax

2x Solenoid valve: 24 VDC / 400 mA (for refill and normal operation)
Relay for pump: 24 VDC / 100 mA.
Fill level of chemicals tank: Range: 0..100% of tank, analog input 4..20 mA

Drying

3 relays for blowers: 24 VDC / 200 mA.
3 relays for heating: 230 VAC / 100 mA.
2 x 4 photocells: Digital input: 0 / 24 VDC, interruption causes high signal.
2 x 2 relays for raising / lowering the dryers: 24 VDC / 100 mA.

(not necessary to provide output for the set velocity of the rail)

Exit

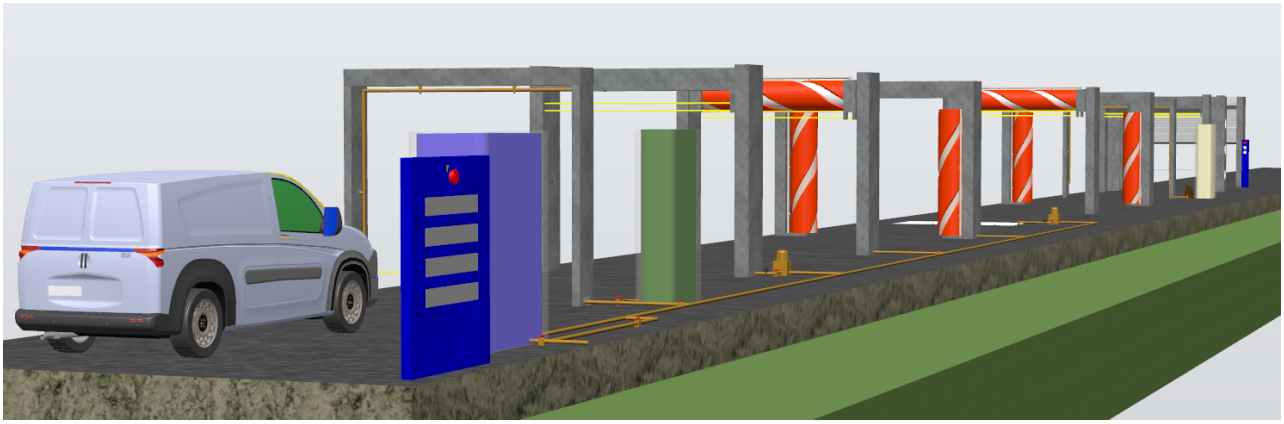
Tracked gate, traffic light and exit sensor:
3 lights: 230 V / 60 W. Controlled directly if possible, otherwise via relay: 24 VDC / 100 mA.
2 relays for raising / lowering the tracked gate: 24 VDC / 100 mA
Photocell produces a digital output: 0 / 24 VDC, interruption causes high signal.

Auxiliary devices

Relay for conveyor chain: 24 VDC / 100 mA.
Position sensor of car on conveyor chain: any external encoder, suggest a solution.
Fill level sensor: Range: 0..100% of tank, analog input 4..20 mA
Water supply: 2 solenoid valves for water supply (public and tank): 24 VDC / 400 mA.

Simulation (RS)

The CarWash plant is simulated with a RobotStudio model:



You will be provided with the model and a project that already contains all inputs and outputs that are available for interaction with the model. Communication is performed via OPC UA.

These inputs and outputs should not be used directly in the programs. They should rather be assigned to corresponding variables in the software modules for further processing (either by PV mapping or by copy routines in the programs).

Acceptance Criteria (RS)

Criteria for Acceptance

Number	Description	Signature	Comment
1	Completed software design before programming start		
2	Car can proceed through all stations with all required options		
3	System can recover from errors		
4	Source code follows clean coding guidelines		
5	Daily major feature updates pushed to version control repo		

The following signatures confirm that this document is clearly understood and correct:

_____	_____
Customer (signature & date)	B&R (signature & date)