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APPLICATION EXAMPLE

Automation of a Wastewater Treatment Plant with WinCC Unified

WinCC Unified / Telecontrol Server Basic / CFL / MTPIntegrator / PM-ANALYZE

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Table of Contents

1. Introduction

This application example describes the automation of a wastewater treatment plant using the CFL library and the MTP integrator, the connection of a remote station (stormwater overflow basin) to a central control system via TCSB, and the integration of PM-Analyze for the acquisition, analysis, and visualization of process data.

However, an OPC UA connection between the control system and the Telecontrol Server is established for the integration of the datapoints from the remote station. For this reason, faceplates from the MTP Integrator library are used.

https://support.industry.siemens.com/cs/ww/en/view/39863979

1.1. Overview

This application example describes the automation of a wastewater treatment plant with SIMATIC S7 1500 and WinCC Unified as the SCADA system. The SIMATIC CFL and MTP Integrator libraries are used – these modules provide a modular automation solution tailored to the water industry. In addition, a stormwater overflow basin remote station is connected to the central control system of the wastewater treatment plant via Telecontrol Server Basic (TCSB). This ensures continuous monitoring and control of the remote plant component. Another important part of the solution is the integration of the PM-Analyze software, which is used to record, log, analyze, and visualize process data.

The overview graphic shows the whole wastewater treatment plant with its various plant components. The inlet, the screening chamber and the aeration tank are each displayed in more detail in separate panel screens to enable targeted monitoring and control of the individual segments. The outlying facility can also be monitored and controlled via its own panel screen. There are also special views for user inputs and counter values, which visualize operating hours and other relevant system data.

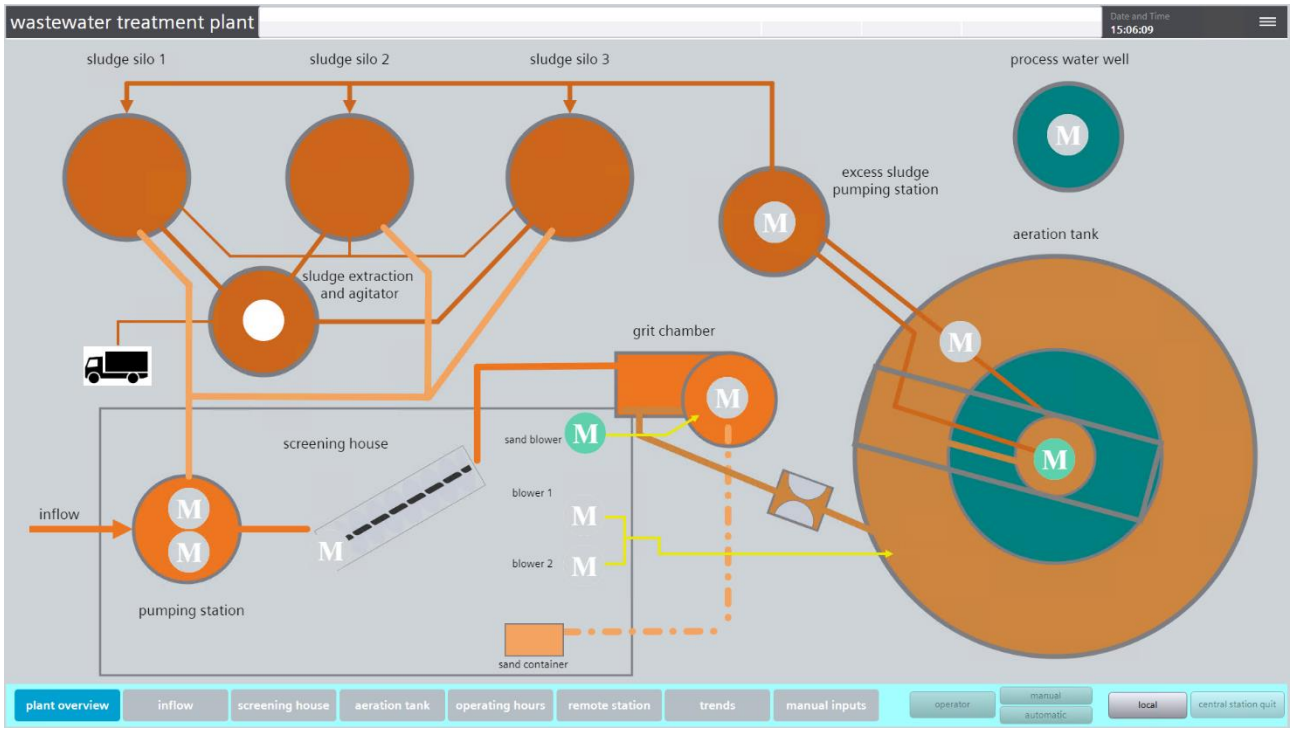


Figure 1-1: Overview of the wastewater treatment plant control system

1.2. Principle of Operation

The wastewater treatment plant is monitored and controlled by an ET 200SP. A WinCC Unified Comfort Panel is installed on-site for local operation. The PLC is connected to the HMI panel and the control system via the Ethernet. This is implemented via a switch (XB008).

The stormwater overflow basin is equipped with an ET 200SP and a CP 1542-1 IRC for telecontrol communication. The remote stations are connected to the central control system via a VPN tunnel using a mobile wireless modem (M876-4). For this purpose, the CP module establishes a telecontrol connection to the Telecontrol Server Basic on the SIMATI IPC. This makes the datapoints available to the WinCC Unified Runtime in the form of an OPC UA Server.

A 7-inch WinCC Unified Comfort Panel is also available in the remote stations for local operation.

The Control Functions Library (CFL) is used both at the wastewater treatment plant and in the remote station. Thanks to the WinCC Unified system, the operating environment of the HMI panels and the PCS is always identical. Because the CFL is based on MTP, the MTP Integrator library can be used to visualize the stormwater overflow basin on the PCS. The faceplates of this library are visually similar to those of the CFL.

The control system (SCADA system) consists of a PC with the following software components: WinCC Unified PC Runtime V20, Telecontrol Server Basic V3.1.2 (TCSB) and PM-Analyze V10.5.

This solution implements reliable, transparent, and efficient automation of the wastewater treatment plant with comprehensive control and analysis options.

The following Figure shows the most important components of the configured solution:

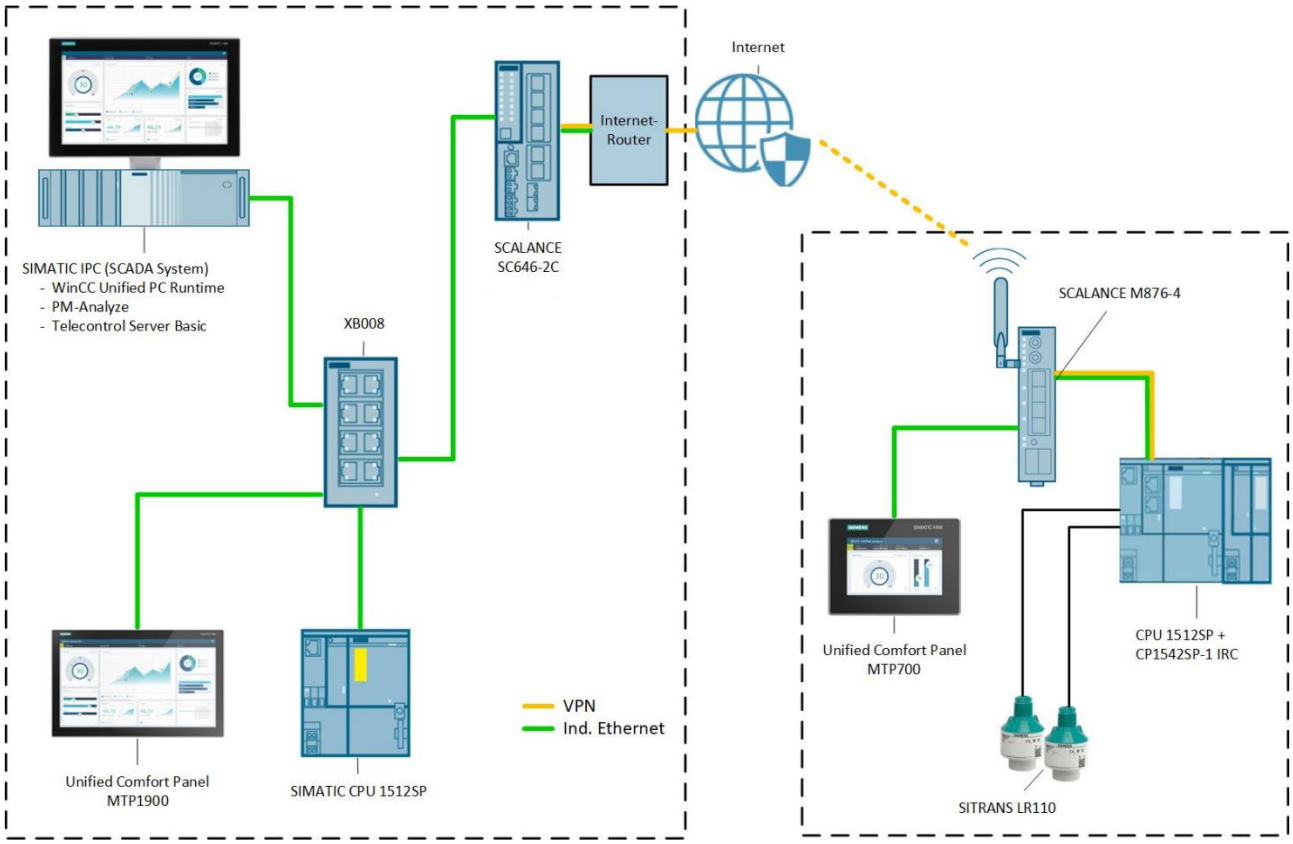


Figure 1-2: Layout diagram – left side: Wastewater treatment plant – central station (CS), right side: Stormwater overflow basin – remote terminal unit (RTU)

1.3. Components Used

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

Component	Quantity	Article number	Note
STEP 7 Professional V20	1	6ES7822-1AA24-0YA5	Engineering Software TIA Portal
WinCC Unified PC RT V20	1	6AV2154-1FB02-4AA0	SCADA system: Control system, SIMATIC PC Station with Windows 11 operating system.
Telecontrol Server Basic V3.1.2	1	6NH9910-0AA31-0AA0	
PM-Analyze V10.5 Server	1	9AE7112-1SS01-1AA0	
PM-Analyze V10.5 Client	1	9AE7112-1SC01-1AA0	
SCALANCE SC646-2C	1	6GK5646-2GS00-2AC2	Wastewater treatment plant firewall
SIMATIC XB008	1	6GK5008-0BA10-1AB2	Wastewater treatment plant unmanaged switch
SIMATIC CPU 1512SP-1 PN	2	6ES7512-1DM03-0AB0	
SIMATIC CP 1542SP-1 IRC	1	6GK7542-6VX00-0XE0	
SIMATIC MTP1900 Unified Comfort	1	6AV2128-3UB06-0AX1	Wastewater treatment plant Unified Comfort Panel
SIMATIC MTP700 Unified Comfort	1	6AV2128-3GB06-0AX1	Stormwater overflow basin Unified Comfort Panel
SCALANCE M876-4	1	6GK5876-4AA10-2BA2	Stormwater overflow basin modem
Control Function Library (CFL) V4.0	1	6AV2156-1EM02-3LA0	
SIMATIC MTP Integrator	1	6AV2156-4TM30-0LA0	MTP Integrator library included in the installation of the MTP Integrator

The listed components can be obtained from the Siemens Industry Mall, for example.

This application example consists of the following components:

Component	File name	Note
TIA project	109988590_WastewaterWinCC_Unified_PROJ_TIAP_V20_V1_0.zip	
Documentation	109988590_WastewaterWinCC_Unified_DOC_en.pdf	
PM-Analyze Project & Reports	109988590_WastewaterWinCCC_Unified_PM-Analyze_Reports.zip	

2. Engineering

2.1. Hardware Configuration

This section describes the hardware configuration of the wastewater treatment plant and the connected outlying facility (RÜB). The system is divided into two network areas: the wastewater treatment plant (WTP) and the outlying facility.

The wastewater treatment plant consists of several automation and visualization components that all operate in the same network (0 network: 192.168.0.x), which is why communication between these devices takes place via PROFINET using a SIMATIC XB008.

The outlying facility (the remote station) is connected to the central wastewater treatment plant via a VPN connection. Because communication takes place via the internet, a SCALANCE SC646 is connected between the local network of the wastewater treatment plant and the internet to secure the data traffic.

The controller and visualization components in the outlying facility are also integrated in a common network (1 network: 192.168.1.x).

The network structure with a local Ethernet network in the wastewater treatment plant, a VPN connection to the outlying facility, and an SC646 security switch for secure data traffic ensures efficient and protected communication between the two sites. This enables central monitoring and control of the entire wastewater treatment plant as well as reliable data transmission from the remote stations.

Device name	Device type	IP address
SC646	SCALANCE SC646-2C	192.168.0.1
XB008	SIMATIC XB008	192.168.0.2
PLC	SIMATIC CPU 1512SP-1 PN	192.168.0.10
SCADA	SIMATIC PC station	192.168.0.100
HMI	MTP1900 Unified Comfort	192.168.0.11
Modem_Remote	SCALANCE M876-4	192.168.1.1
PLC_Remote	SIMATIC CPU 1512SP-1 PN	192.168.1.10
CP_Remote	SIMATIC CP 1542SP-1 IRC	192.168.1.20
HMI_Remote	MTP700 Unified Comfort	192.168.1.11

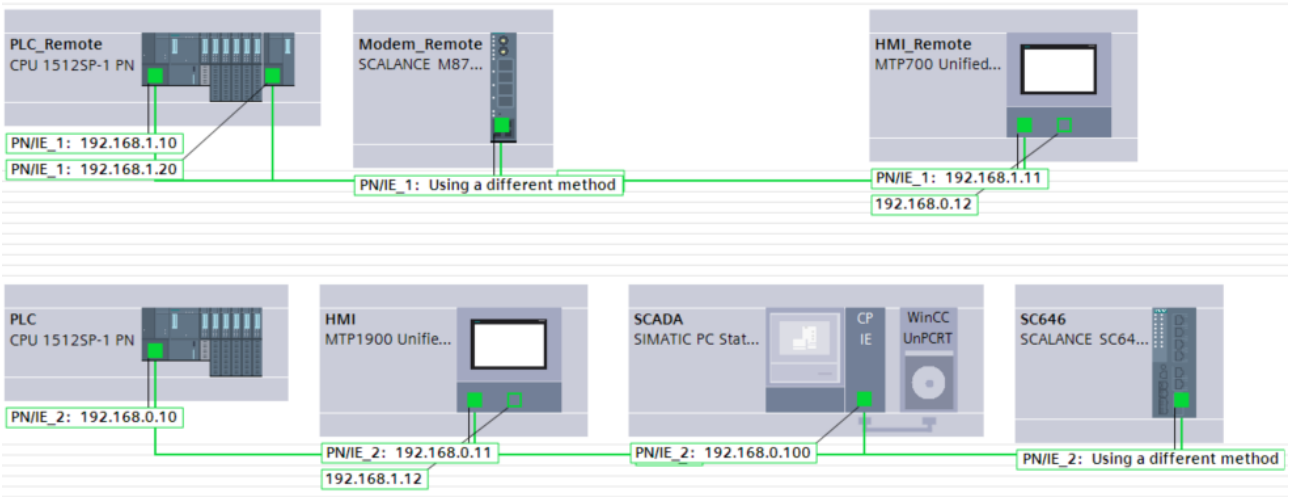


Figure 2-1: Devices & networks

Procedure for setting up HMI communication

The following are the main steps for setting up a connection between a CPU and a WinCC Unified Panel:

1. Create an HMI connection using drag&drop in networking mode between PLC and HMI in the TIA Portal under the "Devices & networks" tab
2. Ensure that the PLC and HMI panel are on the same network or connected via a router
3. Load the PLC (hardware and software)
4. Load the HMI project into the HMI panel

NOTE

If communication isn't working:

- Check the time on both devices. It must be synchronous and up-to-date.
- Check the IP settings and PG/PC interface.

A more detailed description can be found in the SIMATIC HMI WinCC Unified manual:
SIMATIC HMI WinCC Unified manual

2.2. SIMATIC Control Function Library (CFL)

The Control Function Library is a global library for the TIA Portal, which provides function blocks for S7 1200/1500 and suitable faceplates for WinCC Unified.

Further CFL configuration examples can be found under the following links:
TIA Portal SIMATIC CFL sample project
Hydrogen TIA Portal SIMATIC CFL application examples

2.2.1. Installation and Integration of the Library

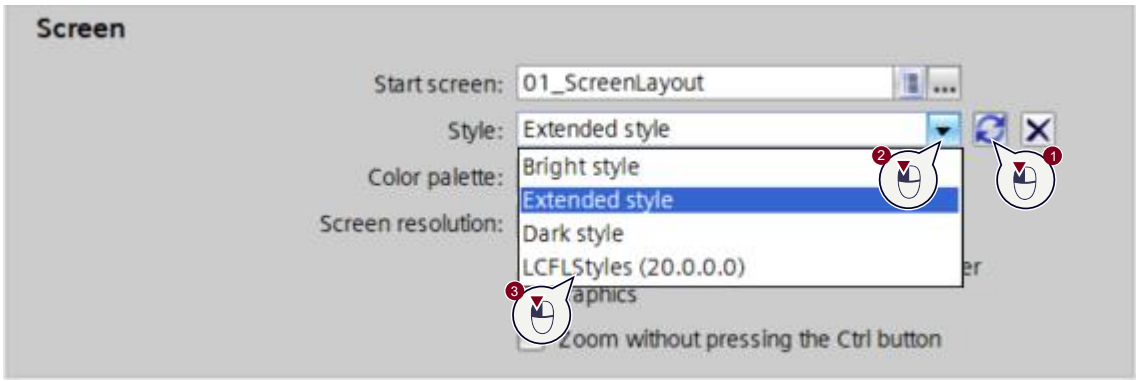
The CFL library can be downloaded from the SIOS portal. Once the setup has been completed, the CFL can be found in the TIA Portal under "Libraries > Global libraries". In order to be able to use the library in the project, the associated types and master copies are added to the project library via drag&drop.

2.2.2. Importing a Style

NOTICE As of version V3.1, the CFL requires a style import, because elements that are used on the drive symbols are otherwise only displayed in the standard color of the TIA Portal (gray).

Once the library is installed, a Corporate Designer project (*LCFLStylesV4_0.cdp*) with the corresponding style file (*LCFLStyles.cd20*) is provided under the following path: "C:\Program Files\Siemens\Automation\Portal V20*lib**Sys**Control Function Library**UserFiles*"

1. To import the style into the desired project, the style file is copied and stored in the corresponding TIA project directory under "C:\Documents\Automation\Projectname\UserFiles\Styles". If the 'Styles' directory does not yet exist here, it must be created again.
2. The Runtime settings of the PC runtime or the Unified HMI Panels are now opened in the TIA Portal. The new style must be used here. Under "General > Screen > Style", the update icon must first be clicked to update the styles. The drop-down menu is then expanded using the arrow and the CFL style "LCFLStyles (20.0.0.0)" is selected.



NOTE For a successful style import, the Runtime version of the device must match the Runtime version of the style.

Further information on style handling can be found in the SIOS portal or under the following link:
SIMATIC WinCC Unified Corporate Designer

2.2.3. Configuration with the CFL

To optimize engineering, the CFL library blocks are embedded in function blocks (FBs), allowing recurring functions to be implemented efficiently.

The following table lists all implemented CFL blocks with a description of their process function. Each control module is represented in the project by an instance DB in the PLC program and a faceplate on the HMI/PLC screen.

The Controller of the wastewater treatment plant is considered first:

Control mode	CFL FB	Description
BG022 (FC100)	BinMon	Monitoring control voltage 230V
BG024 (FC101)	BinMon	Monitoring control voltage 24V
BG026 (FC102)	BinMon	Monitoring of buildings
BG040 (FC3)	BinManInt AnaManInt Aggr8	Automatic inlet on/off control Setting runtime, setting pause time Aggregate manager feed pumps
BG041 (FC103)	MonBinDrv BinMon AnaMon	Feed pump 1 Monitoring (temperature monitor, leakage) Motor current
BG042 (FC104)	MonBinDrv BinMon AnaMon	Feed pump 2 Monitoring (temperature monitor, leakage) Motor current
BG047 (FC105)	BinMon	Monitoring level
BG051 (FC106)	MonBinDrv BinMon	Screen Monitoring (fault, level max, emergency stop)
BG052 (FC107)	MonBinDrv AnaMon	Sand trap fan Motor current
BG053 (FC108)	MonBinDrv BinMon AnaMon	Sand feed pump Monitoring (temperature monitor, leakage, temperature limiter) Motor current
BG058 (FC109)	AnaMon	pH measurement inlet, feed temperature measurement
BG059 (FC110)	AnaMon	Flow rate measurement Monitoring (fault)
BG061 (FC4)	BinManInt Aggr8	Control automatic fan on/off Aggregate manager fan
BG061 (FC112)	MonAnaDrv	Screw fan 1
BG062 (FC113)	MonAnaDrv	Screw fan 2
BG063 (FC114)	MonBinVlv BinMon	Start-up relief valve Monitoring (fault)
BG064 (FC115)	BinMon	Monitoring fan, fan compartment
BG067 (FC116)	AnaMon BinMon	Oxygen measurement Monitoring (fault)
BG068 (FC117)	AnaMon BinMon	Redox measurement Monitoring (fault)
BG068 (FC118)	AnaMon BinMon	Temperature measurement Monitoring (fault)
BG069 (FC7)	AnaMon BinMon	Turbidity measurement Monitoring (fault)

Control mode	CFL FB	Description
BG071 (FC119)	MonBinDrv BinMon AnaMon	Floating sludge pump Monitoring (temperature monitor, leakage) Motor current
BG072 (FC120)	MonBinDrv BinMon AnaMon TimeSwitch8	Return sludge pump Monitoring (temperature monitor, leakage) Motor current Automatic timing
BG073 (FC121)	BinMon	Monitoring precipitant station
BG078 (FC122)	AnaMon BinMon	pH measurement procedure Monitoring (fault)
BG079 (FC123)	AnaMon BinMon	Flow measurement at outlet Monitoring (fault)
BG081 (FC124)	MonBinDrv BinMon AnaMon	Excess sludge pump Monitoring (temperature monitor, leakage) Motor current
BG082 (FC125)	MonBinDrv BinMon AnaMon	Sludge pump Monitoring (temperature monitor) Motor current
BG083 (FC126)	BinMon	Sludge press monitoring
BG091 (FC127)	MonBinDrv BinMon AnaMon	Sludge pump Monitoring (dry running) Motor current

The following CFL blocks have been used in the outlying facility:

Control mode	CFL FB	Description
RÜB041 (FC3)	MonBinDrv BinMon AnaMon	Vortex jet 1 Monitoring (temperature monitor, temperature limiter) Motor current
RÜB042 (FC6)	MonBinDrv BinMon AnaMon	Vortex jet 2 Monitoring (temperature monitor, temperature limiter) Motor current
RÜB047 (FC4)	AnaMon BinMon	Stormwater overflow basin level Monitoring (measurement)
RÜB048 (FC7)	AnaMon BinMon	Overflow Monitoring (measurement)

Remark on the simulation

Since this application example is a simulative implementation, various simulation networks were implemented. One example of this is the starting behavior of a motor: instead of a direct feedback signal from the motor, the feedback forward signal is delayed by a timer so that it is only activated after two seconds have elapsed. This type of simulated auxiliary function is marked accordingly in the program with "simulation".

In addition, the input/output tags can be controlled via the corresponding data blocks in order to simulate a deviating behavior of the system. The simDB_xxxx data block for general simulations and the simTimerDB_xxxx data block for time-controlled processes are available for this purpose. These data blocks can be found under Program blocks in the respective folders, e.g., Program blocks > 01_inflow > simulation.

Configuring the Aggr8 aggregate manager

Central management or control of several motors is realized via the aggregate manager block of the CFL. It is used to control the connected devices and ensures efficient management of the drives.

In the application example, the motors, which are controlled via the aggregate manager, are connected via the interconnector interfaces. The following two steps are necessary:

1. Connection of the driveInterconnector[x] structure tag from the aggregate manager configuration to the respective Interconnector-InOut of the BinMonDrv block, whereby each motor is assigned its own driveInterconnector
2. Configuration of the aggregate manager (in the application example, this can be found in the respective instance DB of the AggM_ function block in the area of the static tags, e.g., CS040_aggregateManager_inflow_LCFL_DB.Config)
   - Name/designation of the units (e.g., "Feed pump 1")
   - Drive type (drive symbol -> 1)
   - Activation of the drive connector (Activated -> true)
   - Setting the drive direction (forward ->)

For motors that are not connected to an aggregate manager, the Interconnector-InOut is linked to the standaloneDrive structure tag from the motor configuration.

Configuration of the TimeSwitch8

The time switch enables the time-controlled switching on and off of up to 8 channels, whereby the time configuration can be configured either in the PLC or via the HMI. By means of different cycle types (e.g., daily, weekly, hourly), the behavior of the timing channels can be flexibly adapted to the respective requirements.

In this application, the Time Switch is used to turn on the return slurry pump every hour for a calculated interval. This is implemented as follows:

1. Configuration of the time switch (in the application example, this can be found in the respective instance DB of the TimeSwitch_ function block in the area of the static tag CS072_returnSludgePump_TimeSwitch_LCFL_DB.Config.settings.settings[0])
   - cycleType (hourly -> 11)
   - timeOn (start time 0 o'clock -> TOD#00 :00 :00)
   - duration (duration of activation is variable and is recalculated by the PLC every hour)
2. Transfer of the runtime calculated by the PLC to the Time Switch configuration (duration)

   "BG072_Rücklaufschlammpumpe_TimeSwitch_LCFL_DB".Config.settings[0].duration := #tempLZ;
3. Connection of the on1 output to the return pump

Local/remote operator authorization

A local/remote concept has been implemented to prevent simultaneous operation of the wastewater treatment plant and the remote site via the control system and the respective HMI panel. Accordingly, "Local" allows for on-site operation, while "Remote" allows the plant components to be controlled from the control system. This is realized via a toggle button in the subnavigation, which adjusts the OS level of the faceplates to the operating level.

Here, the process picture of the outlying facility is displayed in two views: once from the SCADA system and once from the local HMI panel (HMI_Remote).
The depiction shows that the system is set to "Local":

- This is signaled in the control system by a yellow alarm on the screen.
- The Acknowledge button is active on the HMI Panel, while it is disabled on the control system.
- The "Local" status is displayed on the switch button.

Consequently, the faceplates can currently be controlled from the outlying facility.

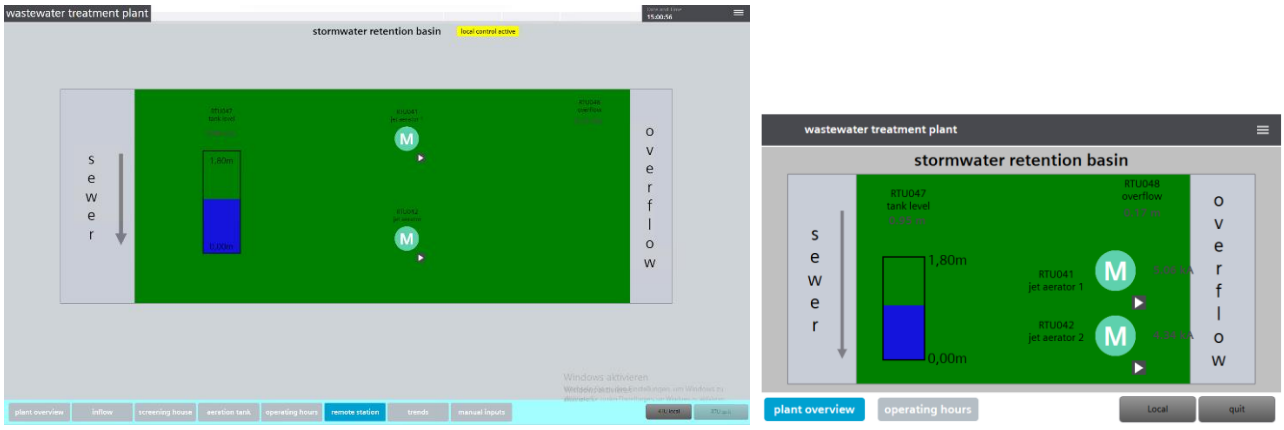


Figure 2-2: Comparison of SCADA/HMI operator authorization local/remote

In real plants, there is no button in the control system to switch between remote and local, only a status display. The switchover to local mode is performed directly on site at the HMI panel. After completing local operation, the controller is set back to remote so that the control system takes over.

In the simulated application example, the switch button was integrated into the SCADA system solely for testing and simulation purposes. This makes it possible to simulate the local/remote switchover using only the SCADA system, without the need for a simulation of the HMI panel.

More detailed information on this controller can be found in Section 3.1.

2.3. Telecontrol Server Basic (TCSB)

2.3.1. Configuration of the Telecontrol Server Basic and the CP module

The stormwater overflow basin is connected to the control system via Industrial Remote Connection using Telecontrol Server Basic.

The settings of the TCSB and the CP module are configured in accordance with the stored application example.

The following application example shows how communication between a CPU and WinCC Unified is set up via TCSB.

TCSB application example

If the project needs to be recreated with the existing files, the following connection settings must be configured in TCSB:

- Project name: DemoApplication
- Project number: 1
- Station name: RTU
- Station number: 1
- Slot: 2
- Telecontrol password: Telecontrol123 !

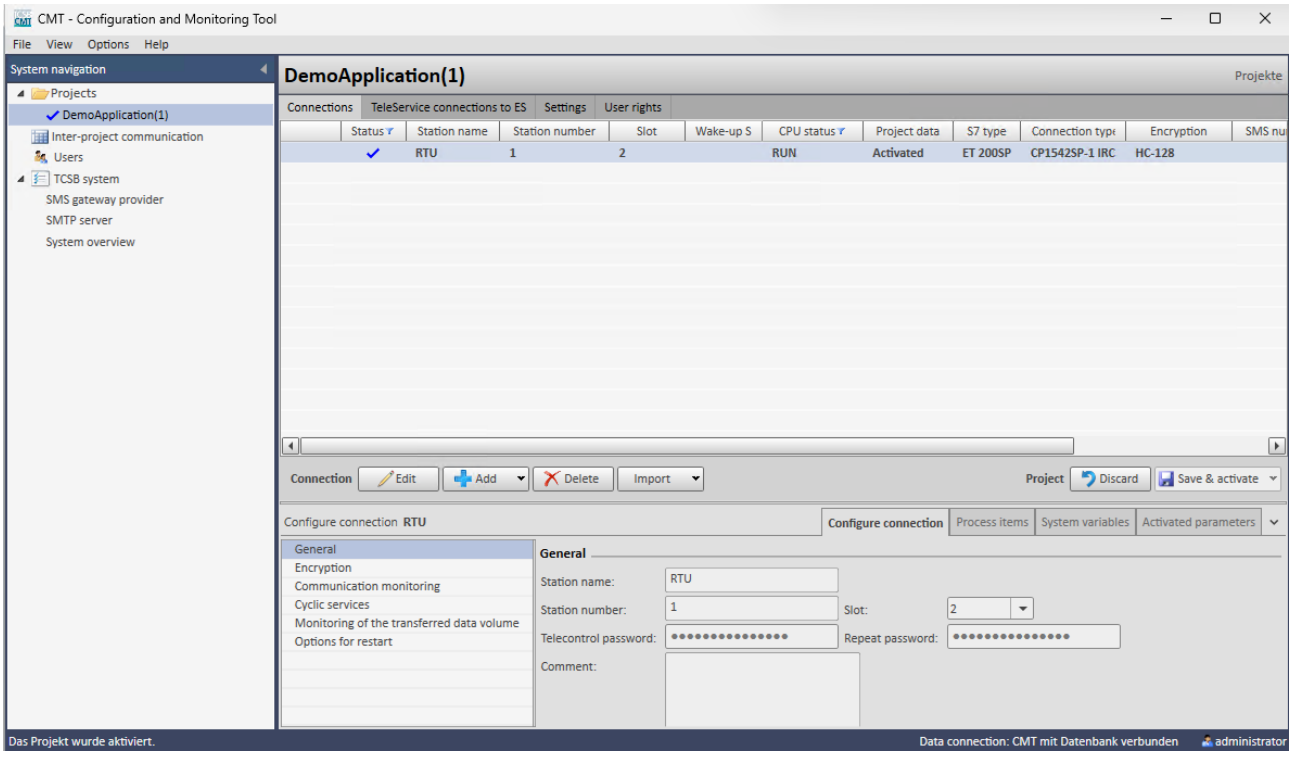


Figure 2-3: Connection established in CMT

A new user account is also created for the OPC UA Client of the WinCC Unified Runtime. This user data is required when configuring the OPC UA connection of the WinCC Unified PC runtime.

- Username: user
- Password: winCCunified1 !

NOTE If different settings are parameterized, the corresponding parameters must be adjusted in the TIA Portal project (hardware configuration and OPC paths of the tags).

2.3.2. Configuring the Datapoints for the CP Module

No programming of program blocks is required for the CP 1542SP-1 IRC to transfer usage data between the station and the control panel. This is datapoint-based communication. Consequently, the correct datapoints for alarms, visualization, measured values, commands, etc. must be exchanged between the CPU and the remote station – the telecontrol server – via the CP.

With CFL, all tags from the static area with the structure "HMI.mtpData" and "HMI.enabled" are created as individual datapoints in the CP.

1. Insert the desired tags of the respective data block by drag & drop into the menu "PLC_Remote > Local modules > CP_Remote > Datapoints"
2. Adjust the datapoint type
   - Digital input: Tags that are transferred from the CP to TCSB (for example, status).
   - Digital output: Tags that are transferred from the TCSB to the CP (e.g., commands).
   - Analog input: Analog tags that are transferred from the CP to TCSB (for example, measured values).
   - Analog output: Analog tags that are transferred from the TCSB to the CP (e.g., set point from SCADA)
3. Adjust the trigger

   The trigger settings control the conditions under which new tag values are transferred from the TCSB to the control system.
   - Threshold value trigger: All analog inputs have a threshold value trigger of 0.01, all digital inputs of 1. TCSB only transfers the new tag values if there is a difference between the HMI tag and the tag in the TCSB. This reduces unnecessary transfers and ensures that only significant changes are passed on.
   - Cyclic trigger: All analog and digital inputs are updated hourly to ensure that a datapoint is stored in the archive even if there is no value change.
4. Overall loading of the PLC

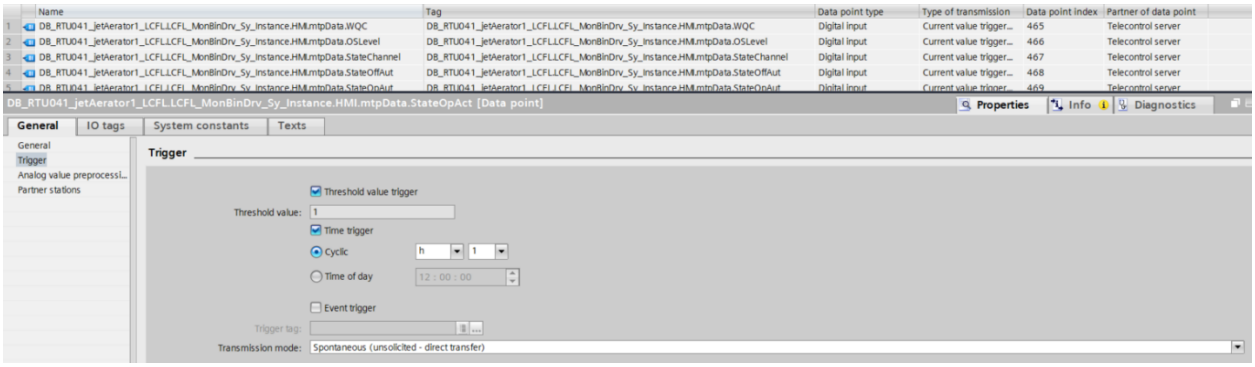


Figure 2-4: CP datapoints

2.3.3. Configuring the WinCC Unified PC Runtime

OPC UA connection

In order to be able to monitor and control the RÜB from the WinCC Unified PC Runtime after configuration is complete, an OPC UA connection must be established between the PC Runtime and the OPC UA Server.

This section describes the most important points for configuring the WinCC Unified OPC UA Client:

Open the connection settings of the PC runtime in the TIA Portal

1. Create a new connection with the "OPC UA" communication driver
2. OPC UA Server connection settings
   - OPC UA Server: opc.tcp://<ipAddress of the Server-URL> :<Port of the Server-URL>
   - Security policy: Basic256Sha256
   - Message Security Mode: Sign and encrypt

   This configuration ensures that data is encrypted, authenticated, and transmitted without alteration.

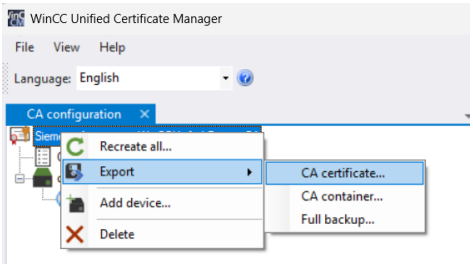
   NOTE Port, security policy, and message security mode must match the configuration in the CMT!
   The configuration set here provides the highest possible level of security.

3. Uncheck the box next to Anonymous and enter the user data from 2.3.1, as anonymous access is not permitted in CMT.

   NOTE User data must match a user login in CMT.

Due to the security policy settings, the following steps must be observed:

1. Overall loading of the PC runtime with reset to start values
2. Switch to SIMATIC Runtime Manager > Project settings > Certificates tab > Right-click on the TCSB certificate to accept trust (OPC.SimaticNET.TCSB)
3. Switch to the WinCC Unified Certificate Manager > Export CA certificate (public certificate in DER format) and install it in the trusted root certification authorities.



4. Install OPC UA Client Certificate using the WinCC Unified Certificate Manager
5. Copy the CA certificate (.der and .crl) that has already been exported to the CERT directory of the TCSB/CMT. To do this, save the ".der" file under "C:\ProgramData\Siemens\OPC_TCSB\PKI\CA\CERTS" and the ".crl" file in the crl folder.
6. WinCC Unified Runtime sends a request to TCSB > Accept 'OPC UA Client for SIMATIC WinCC' certificate.

For the tag values to be transferred to Runtime, they must change once (threshold value trigger) or be updated by a cyclical trigger.

Tag connection

The tag connections for the WinCC Unified PC RT are configured below. In this example, a new tag table (Remote) was created for this purpose under HMI tags.

1. Create a new tag (define the tag name and adjust the data type to the original one)
2. Select connection (established OPC UA connection with assigned connection name)
3. Browse the tag address

   To do this, open the drop-down menu using the small arrow and select the desired tag under Server ...:

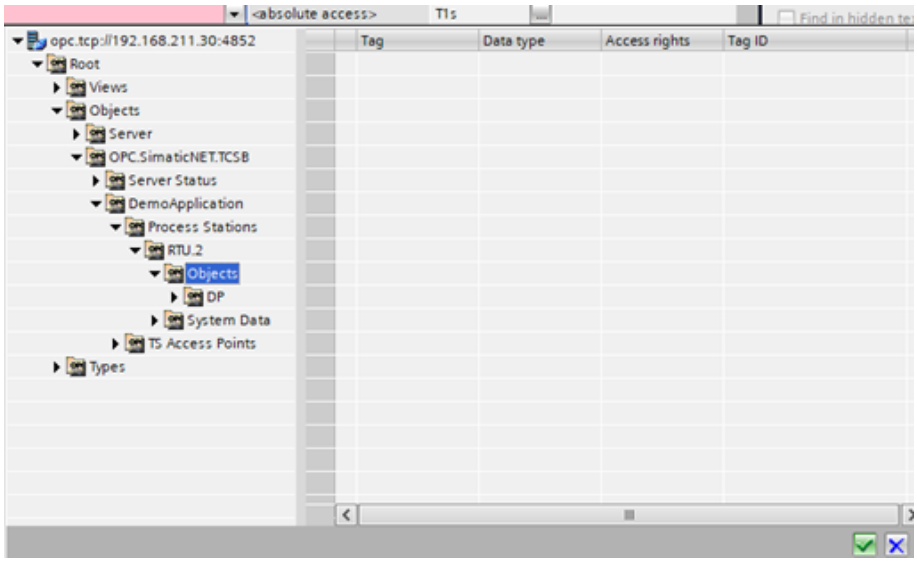


Figure 2-5: Browsing the OPC tags

The address is structured as follows:
ns=2;s=TCS:[<projectname>.<stationname>.<slot>]DP, <address>

NOTE The first connection attempt may fail. This is because the certificate was rejected by the TCSB OPC server. In this case, switch back to the CMT of TCSB and accept the certificate in the OPC settings.

In the "TCSB System > OPC > OPC UA Certificates" tab in the CMT, the new certificate request must be accepted by right-clicking > Accept on the first connection attempt.

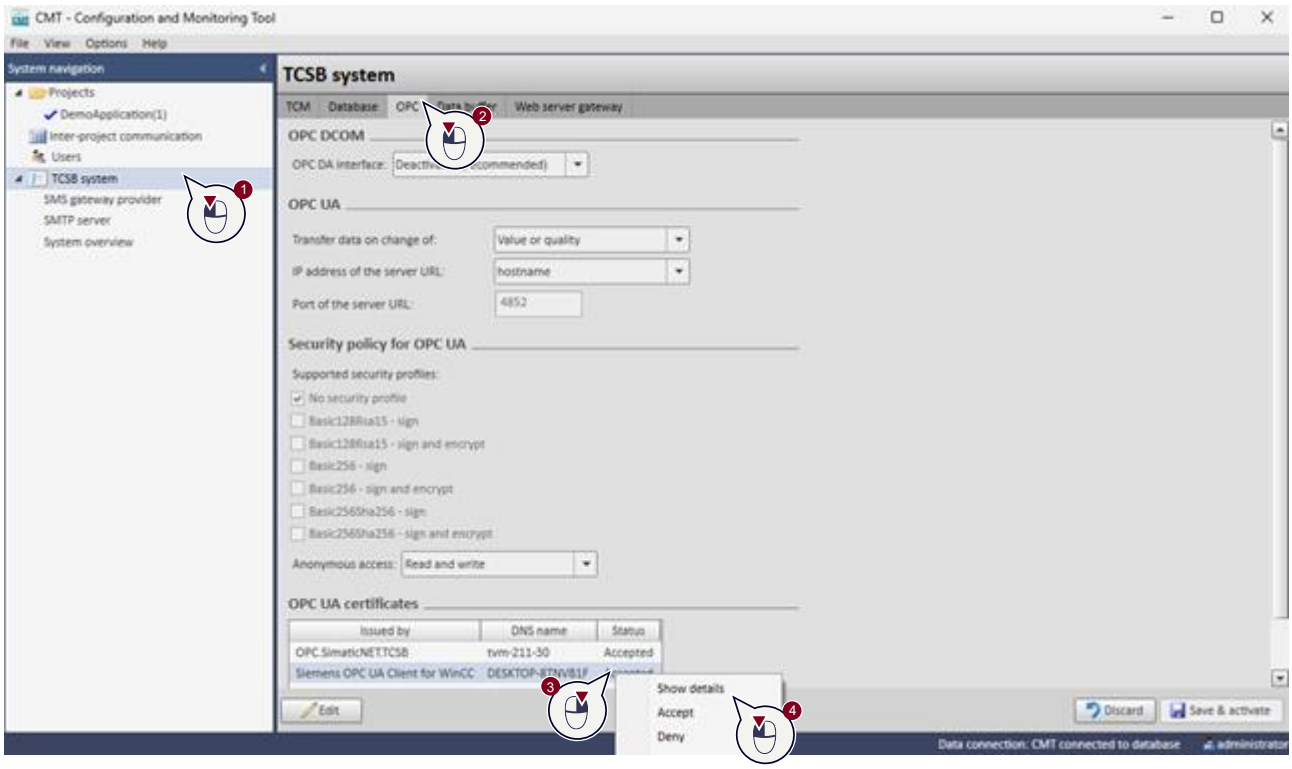


Figure 2-6: TCSB – Accepting the certificate

2.4. MTP Integrator Library

Once the previous steps have been completed, the MTP Integrator library can be integrated. Integration is carried out in the same way as for CFL (see 2.2.1).

The MTP Integrator library contains faceplates that are based on the look and feel of the CFL library. In contrast, they rely entirely on the MTP structure, i.e., the tags from the mtpData structure must be linked separately.

In this example, this is particularly necessary due to the datapoint-based transmission. The library blocks are used on the control system to control and visualize the remote station (screen "remote station").

To do this, the tags transferred via the OPC connection are linked to the interface of the faceplates in the settings window.

In addition, certain commands (acknowledge, off, manual, automatic) and set points (AH, AL, WH, WL) are treated differently. This procedure is described in detail below to ensure smooth integration and functionality.

Configuration of commands and setpoints

- Commands: The commands depend on the user authority. When the user triggers a command, it is transmitted to the PLC. To ensure that the command does not remain pending, it is reset after 5 seconds by the task scheduler of the Unified PC Runtime.

```
export function Task_RTU041_quit_Update(triggerDataSet) {
  let quit = Tags("DB_RTU041_jetAerator1_LCFL_LCFL_MonBinDrv_Sy_Instance_HMI_mtpData_ResetOp").Read();
  if(quit = true){
    HMIRuntime.Timers.SetTimeout(() => {
      Tags("DB_RTU041_jetAerator1_LCFL_LCFL_MonBinDrv_Sy_Instance_HMI_mtpData_ResetOp").Write(false);
    }, 5000);
  }
}
```

Figure 2-7: Task Scheduler – Resetting a Command

- Setpoints: The adjustment of the set points depends on the current user authority for the system:
  - Entire system in remote operation → control via the control system:

    The set points can be adjusted in the control system, provided that the controls are located there.
    This checks whether there is a difference between the current set point flag (SWHM) and the set point of the control system.
    If so, the current set point flag takes the value from the control system. This is also transferred to the PLC via TCSB.
    The PLC continuously checks whether the system is in remote mode. If this is the case, the value received via TCSB is written to the instance DB of the CFL library block (see Main network 1).
  - System in local operation (onsite) → control via the HMI panel:

    In this mode, the setpoints can be adjusted directly from the HMI panel.
    In this case, the control system has no influence on the value change, but is informed of the current target value.


```
export function Task_RTU047_limitAH_Update(triggerDataSet) {

  let SCADA = !Tags("SyHMIControl_Instance_local").Read();
  let SW_PLS = Tags("setpointsSCADA_AHFeedbackSetpoint");
  let SW_HMI = Tags("DB_RTU047_limitValTank_LCFL_LCFL_AnaMon_Instance_HMI_mtpData_VAHLim");
  let SWHM =  Tags("AH_SWHM");
  let AH = Tags("AH");

  if(SCADA && (SWHM != SW_PLS)){
    SW_PLS.Write(AH.Read());
    SWHM.Write(AH.Read());
  }

  if(!SCADA && (SW_HMI !=SWHM)){
    SWHM.Write(SW_HMI.Read());
    AH.Write(SW_HMI.Read());
  }

}
```

Figure 2-8: Task scheduler – Change of target values

- OS level: The OS level regulates the user authority between the control system (SCADA) and the local control level (HMI panel). The OS level can be changed in two ways:
  - Via the Remote/Local button (OSLvl_RTUxxx_in):

    Switching the Remote/Local button changes the OS level on the PLC (e.g., by setting Local/Remote).
    The new OS level is then transferred from the PLC to the MTP integrator Faceplate
  - By obtaining the local operator authorization (OSLvl_RTUxxx_out):

    If an operator obtains the local operator authorization on the control system, the change is transmitted to the PLC via TCSB.
    The PLC checks whether the value has changed. If so, it is updated in the corresponding instance block of the CFL-FB.

```
export function Task_OSLvl_RTU041_in_Update(triggerDataSet) {
  let osScada = Tags("OSLvl_RTU041");
  let osHMI = Tags("DB_RTU041_jetAerator1_LCFL_LCFL_MonBinDrv_Sy_Instance_HMI_mtpData_OSLevel");

  osScada.Write(osHMI.Read());
}
```

Figure 2-9: Task scheduler – Changing the OS Level in the control system

```
export function Task_OSLvl_RTU041_out_Update(triggerDataSet) {
  let osScada = Tags("OSLvl_RTU041");
  let osSPS = Tags("setpointsSCADA_RTU041_OS");

  osSPS.Write(osScada.Read());

}
```

Figure 2-10: Task scheduler – Changing the OS Level in the control system

2.5. PM-Analyze

PM-Analyze is a software for monitoring and analyzing production systems and plants that records, archives, and evaluates data. It enables the visualization, diagnosis, and optimization of operating processes in industrial environments.

2.5.1. Installing and Licensing

To install and license PM-ANALYZE, the following points must be completed:

1. Download the ISO file (PM-Analyze V10.5.0) and start the setup using the install.hta file
2. If a SQL Server instance does not yet exist, a SQL Server Express instance can be installed via the setup menu under the SQL Express Edition tab.
3. PM-Analyze is then installed, whereby the installation type "Server - PM-Analyze V10.5 Update 1 incl. PM-Server & PM-Agent" is selected. An already installed SQL Server instance is required for this step.
4. Once the installation has been completed, PM-Analyze must be licensed. To do this, open the PM License Manager and install the required licenses via the "License" tab. In the application example, a license for PM-Analyze is required. In the ISO file under Common/Licences/Trail you can find a 90-day demo license. This unlocks the full range of functions.

2.5.2. Configuring the PM Server

After completion of the installation and licensing described in 4.1, the configuration of the PM Server is carried out in this section.

Creating a new project

To create a new project, the Create Project Wizard is started via the plus symbol in the navigation bar. The project name must be assigned here and the project directory under which the project is saved must be selected.

Configuration of the new WinCC_Unified station

Next, a new station is added. This can be done either in the automatically opened popup (Station Wizard) or by right-clicking Stations > New station. In this application example, a PM-Agent Unified Station with the name WinCC_Unified was configured. WinCC Unified is selected for the Runtime system and "Single station system in the network" is selected for the station type. The network address or computer name from which the configuration and runtime data for the station originate must then be entered. In this case, Runtime runs on the same PC as PM-Analyze, which is why localhost can also be used here.

Click the "Test" button in the connection overview of the configured station under CS RT Agent to establish the connection to the Runtime Agent. Under Status, you can see the current status of the station: The certificates of the connections are fine. However, the product key is not set and the CS and RT status is not OK.

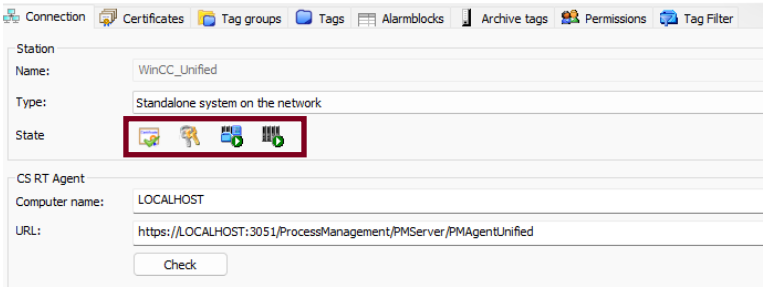


Figure 2-11: Station connection settings

To fix this, switch to the PM-Agent Unified Control Center. Here, you first have to select WinCC Unified in the "Select target agent" popup. The PM-Agent service in the tile in the upper left corner must also have the status "PM-Agent is running". Finally, right-click the "Connection sharing" tile to accept the existing connection request.

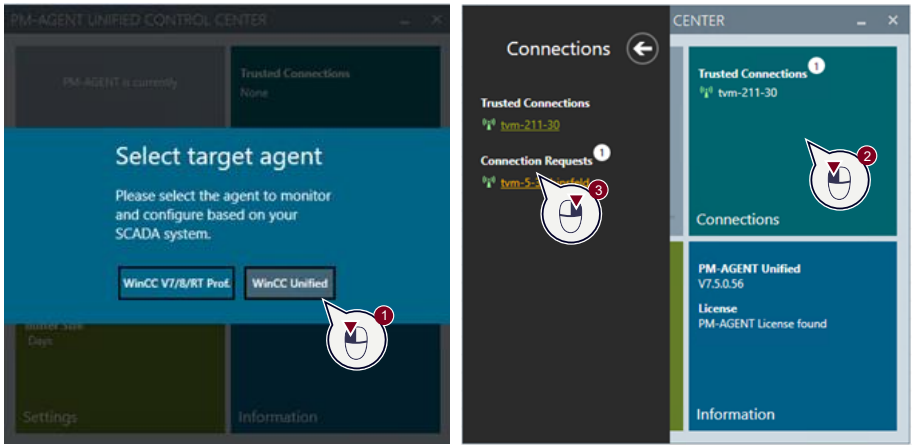


Figure 2-12: PM-Agent

Back in the PM-SERVER, the status should now be represented by green icons as shown in Figure 2-11, which visualizes the OK connection.

In addition, a filter is created in the Tag filter tab so that only tags of certain types (32-bit signed, 32-bit floating point, 64-bit signed, 64-bit floating point) are included. This prevents Boolean tags from being imported, for example.

Right-click the configured station to open the Tag Import Wizard using the "Import tags" button. Once this has been completed, the import is carried out automatically. The imported tags are now in the Tags tab.

As with the tags, the alarm blocks are also imported via a right-click.

Creating tags for the manual input forms

All values for the manual input forms are created under @Manuals. In the Tag definition tab, a new tag can be created by right-clicking in the window. The name, the group and the tag type must be defined for this. The tags are then automatically sorted into the specified groups in the project directory.

Creating a new state model for the manual input forms

In order to be able to select preselected values via a drop-down menu in the manual input form, state models must be created. To do this, right-click to create a new model. You can then assign the desired name and define states, rules, and colors.

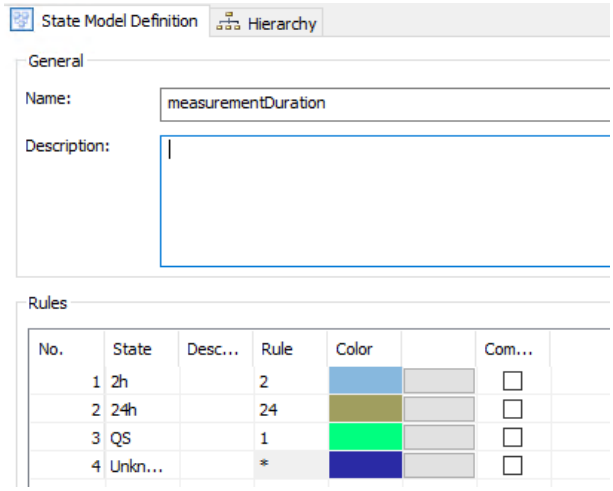


Figure 2-13: State model

Creating a new schedule

Under Schedules, right-click to create a new static schedule with the following parameters:

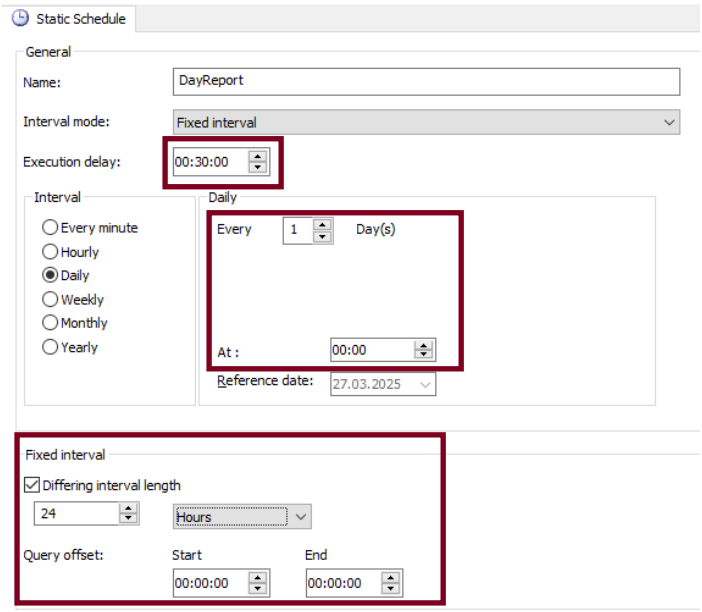


Figure 2-14: Static schedule

The schedule is executed daily at 00:30. The values from 00:00 are processed.

The "Fixed interval" setting defines which period of data is used for the query. In this case, these are the values for the last 24 hours.

Creating a new calculation

To add a new calculation, a new calculation scheme is added under Calculations. The implementation involves assigning a name and creating a structure. Function blocks can be dragged from the menu on the right side into the editing area. Double-clicking the blocks allows you to configure them.

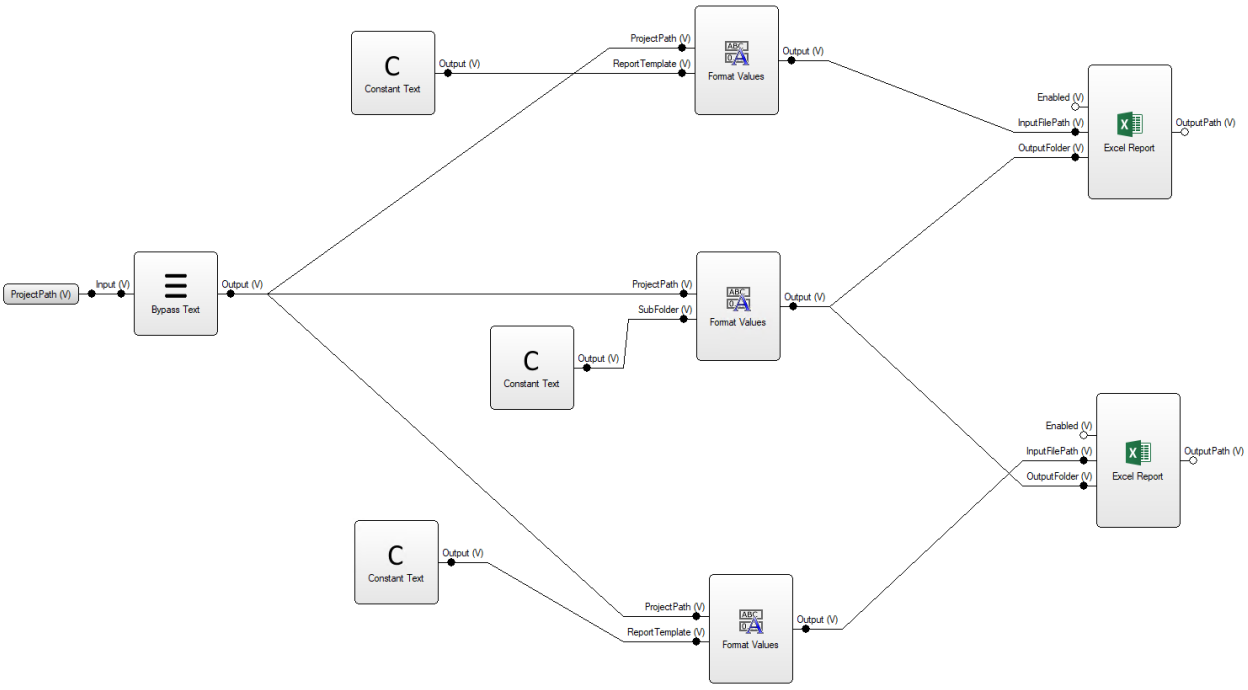


Figure 2-15: DayReport

A new calculation can be added by right-clicking the created calculation scheme. A name is assigned here and the pins are linked to tags that are used in the calculation scheme.

The static schedule performs the calculations every day at 00:30. The Excel report function block writes the time range into the specified cells and executes the formulas. The Excel file is then saved automatically. All formulas are replaced by the calculated values.

Creating a process value archive

You can also create a process value archive by right-clicking. A name, the archive type, the stations and the maximum archiving interval must be defined in the Process Value Archive Wizard. Using the menu on the permission side, it is possible to add the desired tags from the stations to the archive via drag&drop. The tag name and the unit can then be adjusted. If an archive contains values from an aggregation, it cannot be deleted. This is indicated by the lock symbol on the archive icon.

Creating an aggregation scheme

Right-click Aggregations to add a new aggregation scheme (e.g., Average). The trigger delay for the aggregation levels and the delay for re-aggregation are adjusted. The user-defined intervals can now be created and configured in the "Aggregation levels" tab. The aggregation levels can then be selected individually in the project directory and a calculation can be created. The aggregation scheme is then set by right-clicking again. The aggregation levels can no longer be changed.

NOTE Once the aggregation scheme is set, it cannot be undone. The aggregation levels can no longer be changed.

The tags that are to be aggregated can now be added to the "Aggregations" tab using drag&drop via the menu on the right-hand side.

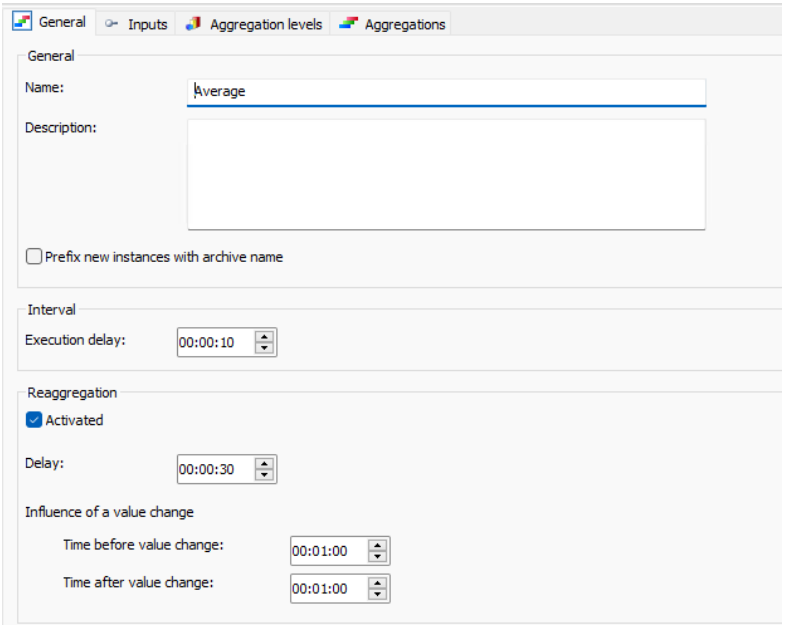


Figure 2-16: Average aggregation scheme

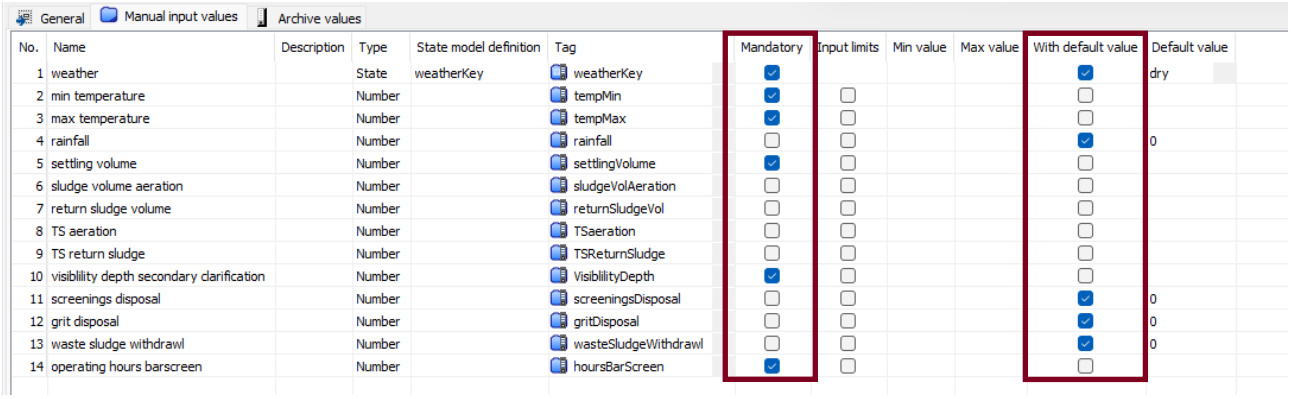
Creating an alarm archive

Under Alarms, right-click to open the Alarm Column Wizard. The desired stations and message columns must be selected here.

Similarly, a new alarm archive is added under Alarm archives via the Alarm Archive Wizard.

Creating the manual input forms

Right-click to create a new manual input form. The name is then defined and the desired tags are added. An example is shown in the figure below. The input values can be configured according to the requirements via "Mandatory field" and "With default value".



No.	Name	Description	Type	State model definition	Tag	Mandatory	Input limits	Min value	Max value	With default value	Default value
1	weather		State	weatherKey	weatherKey	☑				☑	dry
2	min temperature		Number		tempMin	☑	☐			☐	
3	max temperature		Number		tempMax	☑	☐			☐	
4	rainfall		Number		rainfall	☐	☐			☑	0
5	settling volume		Number		settlingVolume	☑	☐			☐	
6	sludge volume aeration		Number		sludgeVolAeration	☐	☐			☐	
7	return sludge volume		Number		returnSludgeVol	☐	☐			☐	
8	TS aeration		Number		TSaeration	☐	☐			☐	
9	TS return sludge		Number		TSReturnSludge	☐	☐			☐	
10	visiblility depth secondary clarification		Number		VisiblilityDepth	☑	☐			☐	
11	screenings disposal		Number		screeningsDisposal	☐	☐			☑	0
12	grit disposal		Number		gritDisposal	☐	☐			☑	0
13	waste sludge withdrawl		Number		wasteSludgeWithdrawl	☐	☐			☑	0
14	operating hours barscreen		Number		hoursBarScreen	☑	☐			☐	

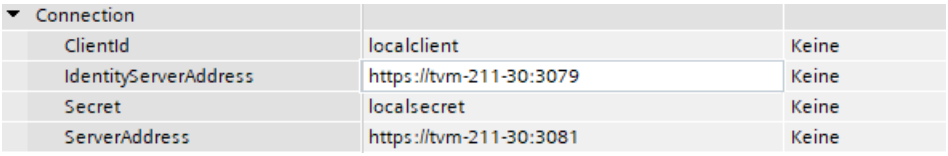
Figure 2-17: Manual input form (daily)

2.5.3. Configuring the WinCC Unified PC Runtime

This section contains documentation on the configuration of the PM-Analyze KeyPerformanceIndicators and PM-Analyze Labvalues Control custom Web Controls. Both web controls are located in the project folder UserFiles > CustomControls.

Now you have the option of dragging from the Tools > Custom controls tab onto the desired screen.

The connection parameter interface of the Control is connected as follows:



Connection		
ClientId	localclient	Keine
IdentityServerAddress	https://tvm-211-30:3079	Keine
Secret	localsecret	Keine
ServerAddress	https://tvm-211-30:3081	Keine

Figure 2-18: Custom Web Control interface

The parameters are as follows:

- ClientId: Devices that can access the Web Control; can be configured in the Client ID PM-API Control Center under PM-IDP > Clients
- IdentityServerAddress: Address Identity Provider
- Secret: Client Secret from the PM API Control Center under PM IDP > Clients
- ServerAddress: Address Rest API

To set localclient and localsecret, go to the PM-IDP tab > clients in the PM API Control Center and click "Change"

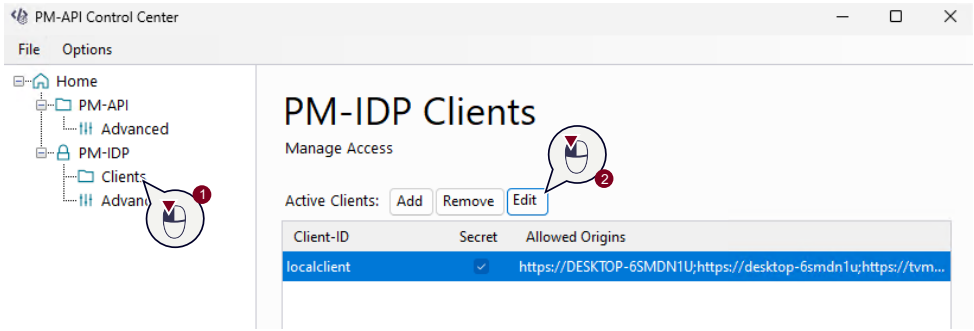


Figure 2-19: PM-API Control Center

The following pop-up window opens:

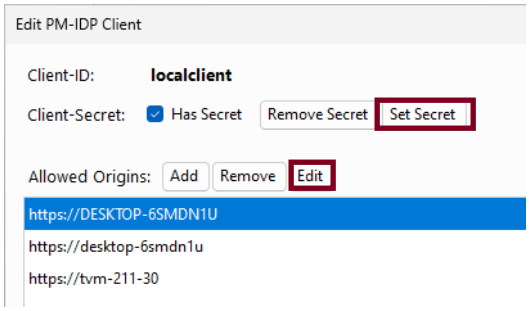


Figure 2-20: Editing a PM-IDP Client

The new Client Secret can be set via the "Set" button in Client Secret. In the application example, "localsecret" is entered here, while the devices with authorized origin for the user localclient can be edited via "Change".

3. Operation

This section describes the basic operation of the application example – from commissioning to controlling the system via the control system or the HMI panel:

1. Opening the project and customizing the hardware

   After downloading the archived TIA Portal project, it can be dearchived and loaded in the TIA Portal V20 via the Project > Open tab. As project security had to be created for TCSB (see Section 2.3.1), the project is accessed with the following project user data:

   NOTE

   User type: Local user
   Username: admin
   Password: Siemens1234!

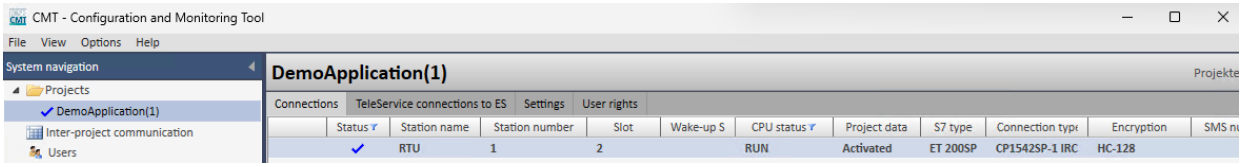
   Before the Controllers, the Unified PC Runtime and the HMI Panels are now loaded, the IP addresses of the hardware must be checked in the "Devices & networks" view and, if necessary, adapted them to your hardware (see Section 2.1). This can be done either by changing the IP addresses in the hardware or by making an adjustment in the TIA Portal project.

2. CMT configuration and loading

   In order to connect the remote stations to the control system, the CMT is configured accordingly for telecontrol communication. To do this, a new connection and a new user must be created with the parameters specified in Section 2.3.1 (see also the application example linked there). Alternatively, it is also possible to adapt the data stored in the TIA Portal project, such as the Telecontrol password, the IP address of the partner station, etc., to the configuration in the CMT.

   The PLCs (hardware and software configuration), the SCADA control system and the Unified HMI Panels are then fully loaded.

   If configured correctly, the connection status in the CMT should now change to "Connected" after a short time. This can be recognized by the blue checkmark.



3. Start of the PC Runtime

   The PC runtime is accessed via the browser. To do this, the address "https://<hostname>" is entered, after which the WinCC Runtime is started via the corresponding button. Valid user data must be entered to log in.

   If connection problems occur – which can be recognized by greyed out, pixelated fields in Runtime, for example – point 2.1 can be used for troubleshooting. As soon as all components are loaded and all connections are established, the system is operated via the screens.

   It should be noted that the 'Overview' process screen only provides an overview and does not enable direct operation.

4. Opening the PM-Analyze project

   First, the PM-Analyze project must be unpacked. Then switch to the PM Server and open the .PM project file via the "Open" folder icon in the top toolbar.

   If Runtime is running on a different PC, it is necessary to adjust the connection settings accordingly.

   Finally, as described in 2.5.2 Configuration of the new WinCC_Unified station, the connection must be established via the "Test" button and the certificate accepted in the PM-Agent.

3.1. Basic Operating Functions

Switching between remote and local

The central "Local/Remote" button in the sub-navigation controls whether the system is operated via the control system (SCADA) or the local HMI panel:

- Remote Mode: User authority lies with the control system (SCADA), all faceplates can be controlled from there
- Local Mode: Controllers are operated via the local HMI Panel

Figure 3-1: SCADA local/remote

If the user authority does not lie with the current Operator Panels, the operator can obtain the control authorization by clicking the button or directly via the corresponding icon in the pop-up of each individual faceplate (icon in the top right-hand corner).

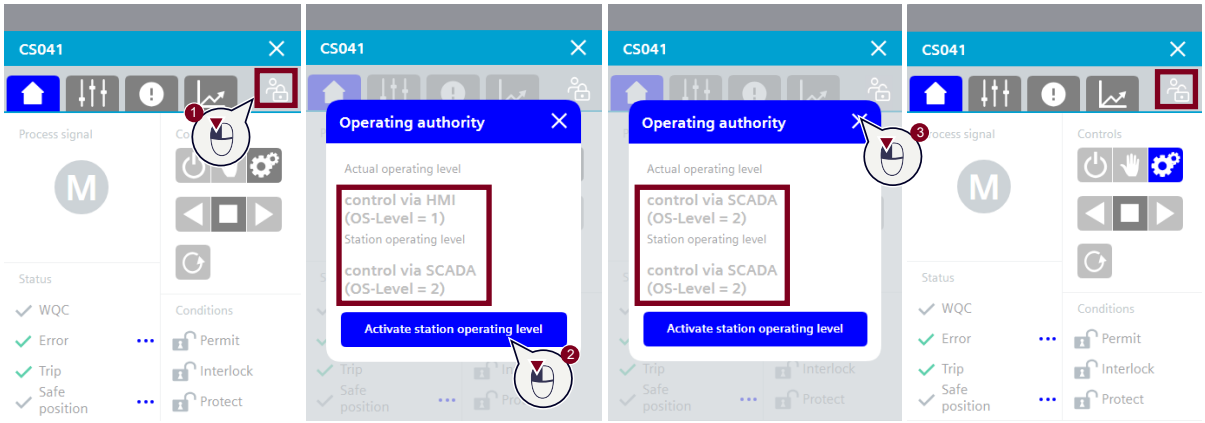


Figure 3-2: Operator authorization via pop-up

Switching between automatic and manual

The application example is configured so that the operator can select the operating mode of each drive individually (Off, Manual, Automatic). Since switching all drives at the same time is cumbersome, three central buttons have been integrated into the sub-navigation. These allow all drives to be set to manual or automatic at the same time, making operation much easier.

If remote control of the system is activated (see "Switching between remote and local"), i.e. the wastewater treatment plant/central station is set to remote, the operator can choose between the two operating options "operator" and "buttons" on the SCADA system.

- "Buttons" control: The operator can use the central manual and automatic buttons to set the desired operating mode for all units simultaneously. The active mode is always highlighted in green so that the status of the system can be seen at all times.
- "Operator" control: If the operator wants to control individual units again, the controller can be switched back to individual drive control via the operating mode switch.

This flexible switching option enables efficient control of the entire system and significantly reduces the time and effort required by the operator.

This controller is illustrated in three graphics below:

1. **Individual operator operation** – In the first screen, the system is in "operator" mode, so that each drive can be controlled individually via the associated pop-up. The hand icon is selected (dark blue) and allows the manual selection of the operating mode for each drive.
2. **Switch to the central button control** – Clicking the button switches the control to "buttons". In this mode, the operating mode for individual drives can no longer be changed in the pop-up. This is made clear by the dark gray colored hand icon.
3. **Set all drives to automatic** – In the third screen, all drives were switched to automatic mode at the same time. The automatic button now lights up green and the motors are in automatic mode, which can be seen with the dark gray gears.

Button control can be deactivated by clicking the "buttons" button again.

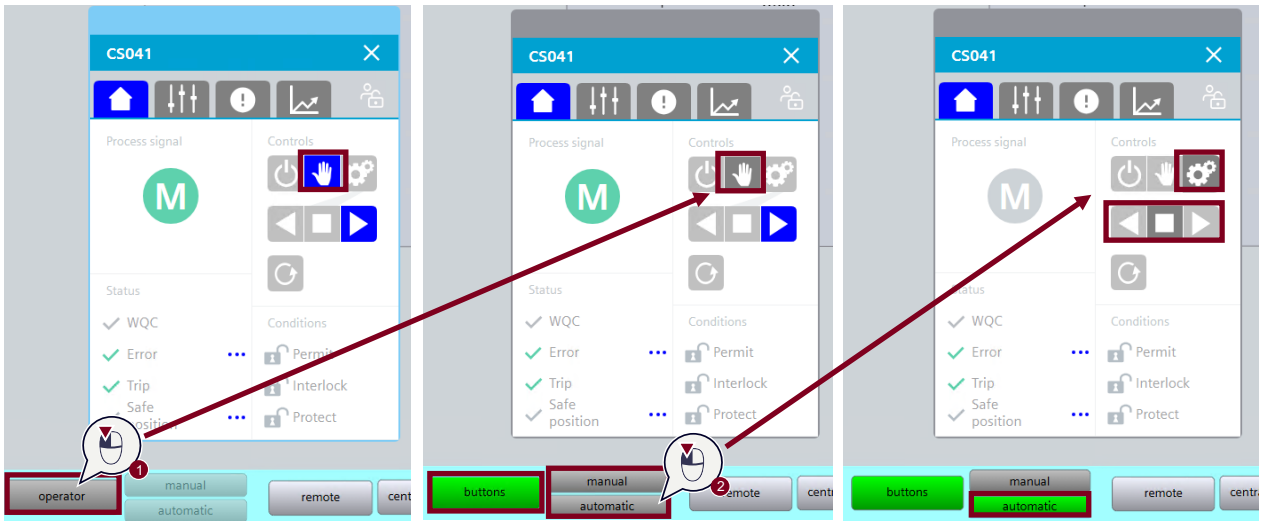


Figure 3-3: Operator/buttons operating mode

3.2. Example: Switching a Motor On

After the PLC has been fully loaded (see Operation – CMT configuration and loading), all drives are initially in the safety position and must be acknowledged before they can be operated. There are two options for acknowledgment:

- Confirm each drive individually : Open the drive pop-up > Set the drive to manual > Press the Acknowledge button in the pop-up
- Acknowledge all drives at once : Activate button control > Set all drives to automatic > Click the Acknowledge button in the subnavigation
  This method is faster and more efficient because it unlocks all drives at once.

1. Obtain operator authorization (depending on the mode remote or local, see Section 3.1)
2. If necessary, rectify fault and acknowledge drive (pop-up: lock icon for Permit, Interlock, and Protect must be open)
3. Set the motor to manual mode by clicking, if this is not already selected
4. Select the forward direction of rotation
5. Motor starts up
6. Motor running

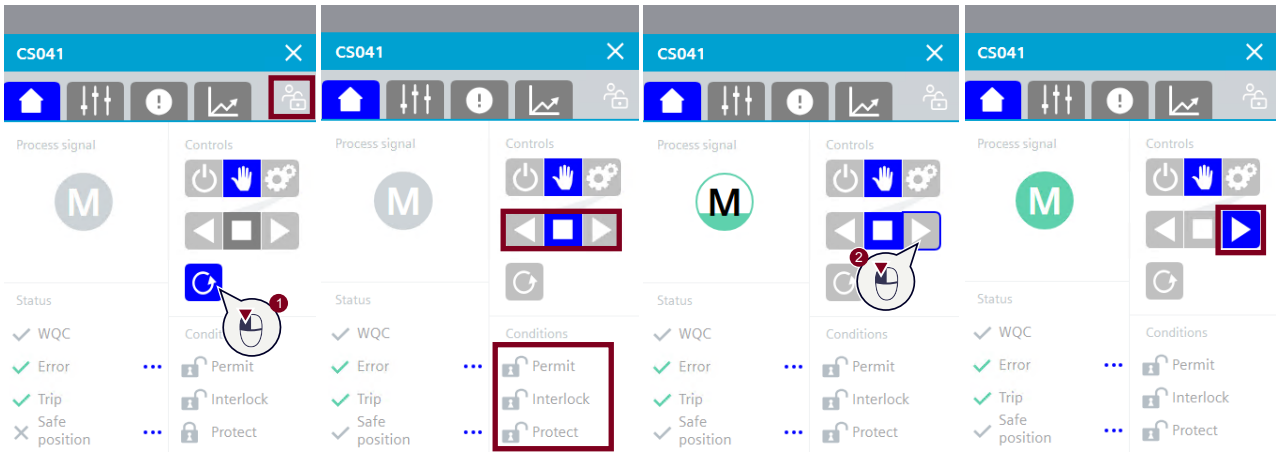


Figure 3-4: Switching a motor on

3.3. Automatic Operation

This section contains a brief description of the most important automatic functions of the application example:

Wastewater treatment plant

- Feed pump station: If the automatic function is switched on by the operator, all aggregates are ready for operation and are set to automatic, the aggregate manager will activate a pump when the limit value for the waste water shaft level is reached, depending on the setpoint entries for the run/pause time. Once the set runtime is over, there is a pause. A new request is then made with a switchover to the redundancy pump. For simulation purposes, the limit value is programmed so that it is cyclically activated for 30 minutes and deactivated for 30 minutes.
- Sand trap fan: If there is no fault and the grit trap fan is in automatic operation, the fan runs continuously.
- Sand feed pump: This drive is switched on every hour on the hour for the duration set in the user input field "Sand feed pump runtime' (see SCADA calculation operation).
- Compressor: The automatic compressor is realized by means of a simulated sequence. If the operator activates the automatic compressor via the corresponding faceplate on the combined tank screen and all units are ready for operation, the PLC jumps to the 'Start-up' step. A blower is requested here using the aggregate manager. It starts at a starting frequency of 25 Hz, which increases every second up to the specified frequency (default setting example: 40 Hz). The O2 measurement is simulated at the same time. It increases linearly with frequency. If a value of 3.0 mg/l is reached, the system switches to the next step: "Nitrification". Here, the oxygen value is kept constant with the aid of a controller (PID Compact), while the redox measurement is simulatively increased. If the measurement exceeds a value of 300, "denitrification" now takes place. A blower is no longer needed. Consequently, they are switched off. Oxygen and redox values are continuously decreasing. From a redox value less than or equal to 150, the ramp-up phase starts again.
- Start-up relief valve: If the first fan starts up or the last running fan is in shutdown mode, the valve is opened for 1 minute if it is in automatic operation and there are no faults.
- Floating sludge pump: The floating sludge pump is switched on 30 minutes after the return sludge pump is activated (always at xx:30) for a time that can be set on the HMI/SCADA.
- Return sludge pump: With the help of the CFL library block TimeSwitch8, the genset is switched on every hour on the hour for a calculated runtime. The runtime is calculated from the flow rate per hour and an adjustable factor on the HMI/SCADA.
- Process water pump: If the process water pump is ready for automatic operation and the "Pressure On" signal is received, the pump is switched on automatically. To be able to simulate this behavior, the tag "Pressure On" is simulated in the PLC program. It is always activated 5 minutes after the hour change for 5 minutes.

Remote stations – Stormwater overflow basin

- Vortex jet: If there is no malfunction and the respective vortex jet is in automatic operation, it runs when there is water in the pool and the level is less than or equal to 1 meter.

3.4. Data Archiving

Operating the PM-Analyze TableView Web Control

The PM-Analyze TableView Web Control is available in the "Values" screen of the SCADA system.

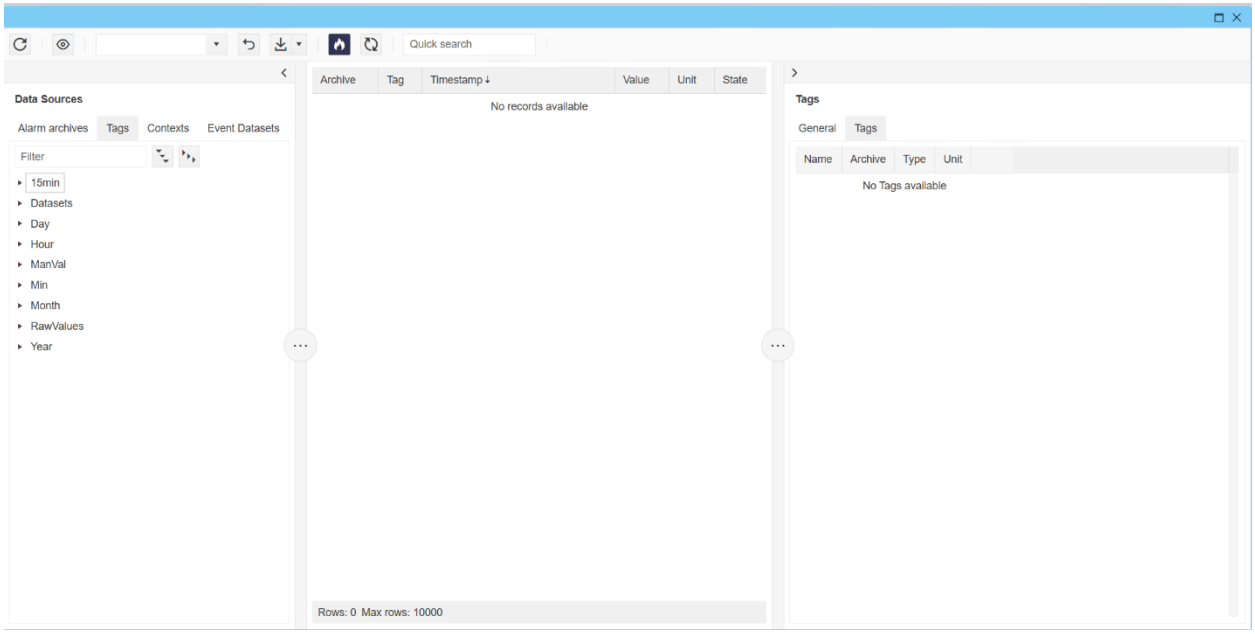


Figure 3-5: PM-Analyze Table View Web Control

- Left area: Here you can choose between the data sources. The alarm archive created in 2.5.2 is available under Alarm archive, while the configured process value archives with the tags created in them are displayed under Tags.
- Middle area: Tabular display of archive values. The tags from the left pane can be moved here via drag&drop. The corresponding archive values are then displayed. It is possible to sort them by archive, tag, timestamp, value, unit, and status in ascending or descending order.
- Right area: Here you can configure the values shown in the table. The update cycle and time period can be specified/changed. For alarm archives, you can also select or deselect each column of the table and set up a dynamic filter. The tags from the process value archives, on the other hand, can be deleted again using the corresponding delete icon in the Tags tab.

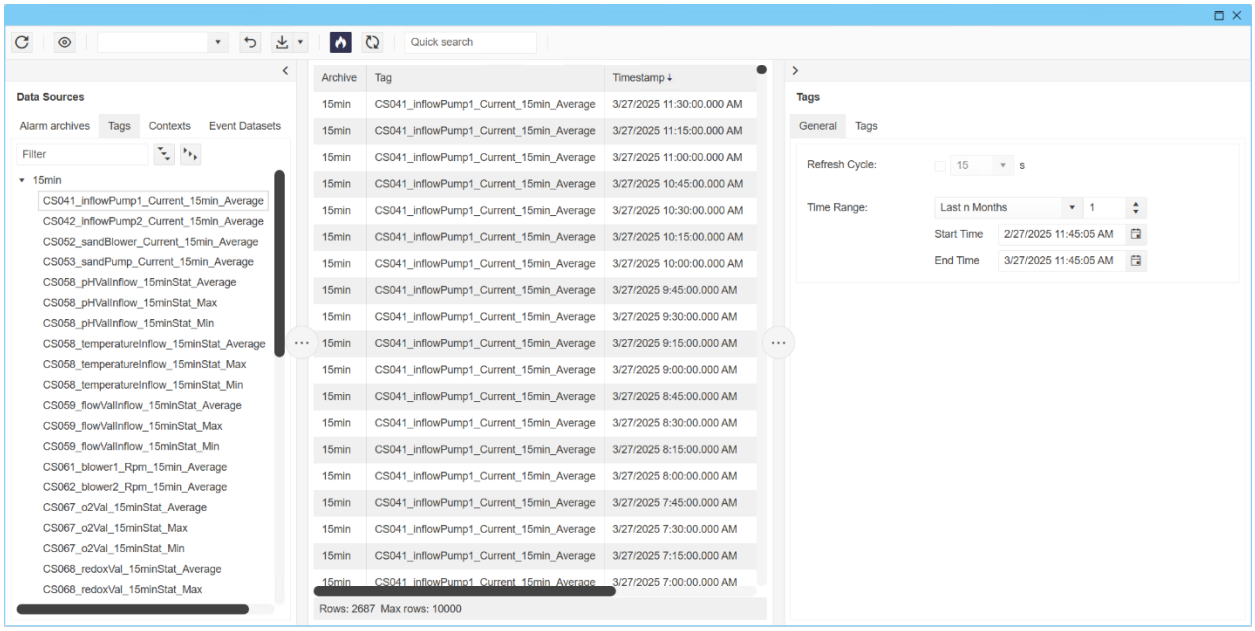


Figure 3-6: PM-Analyze Table View Web Control configuration example

Operation of the PM-Analyze Labvalues Web Control

The PM-Analyze Labvalues Web Control is available in the "Manual entries" screen of the SCADA system.

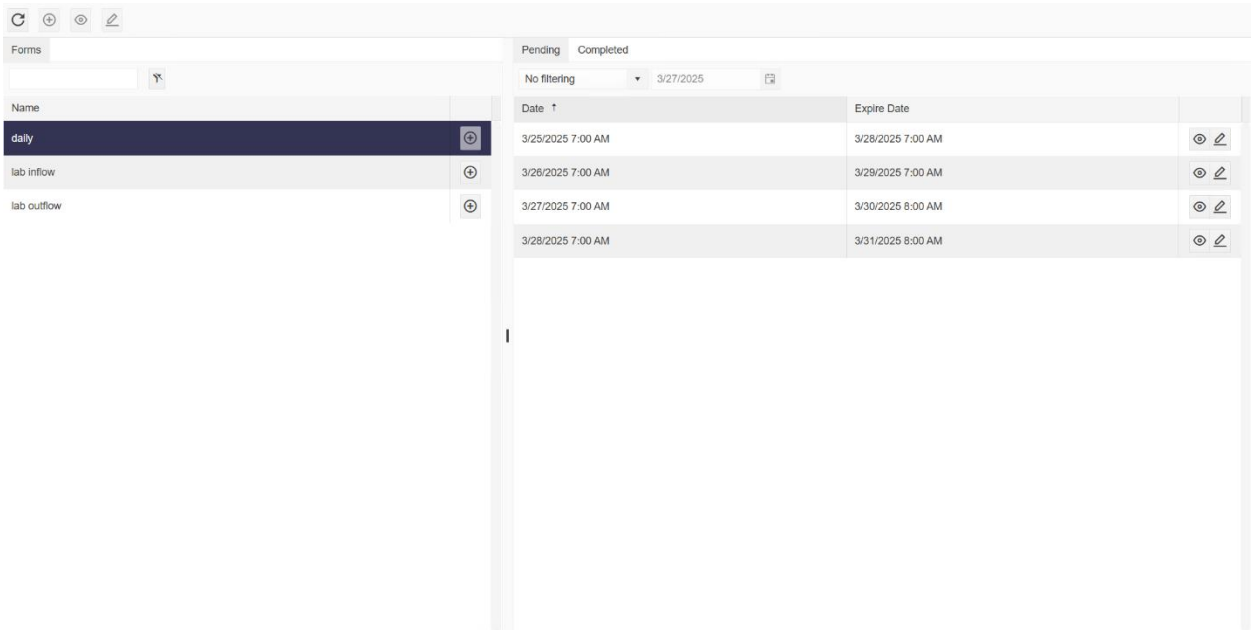


Figure 3-7: PM-Analyze Labvalues Web Control

- Left area: The manual input forms configured in the PM Server are displayed here. Use + to select the desired input form to fill out. A pop-up window opens where you can enter the values (see Fig. 3-8).
- Right area: Completed and open input forms are displayed in this area. With both types, it is possible to display only forms from a specific period/date. In addition, forms that have not yet been completed can be edited further using the pencil icon.
- Popup: Enter the values, including the mandatory fields, and set the start values (see configuration in Section 2.5.2).

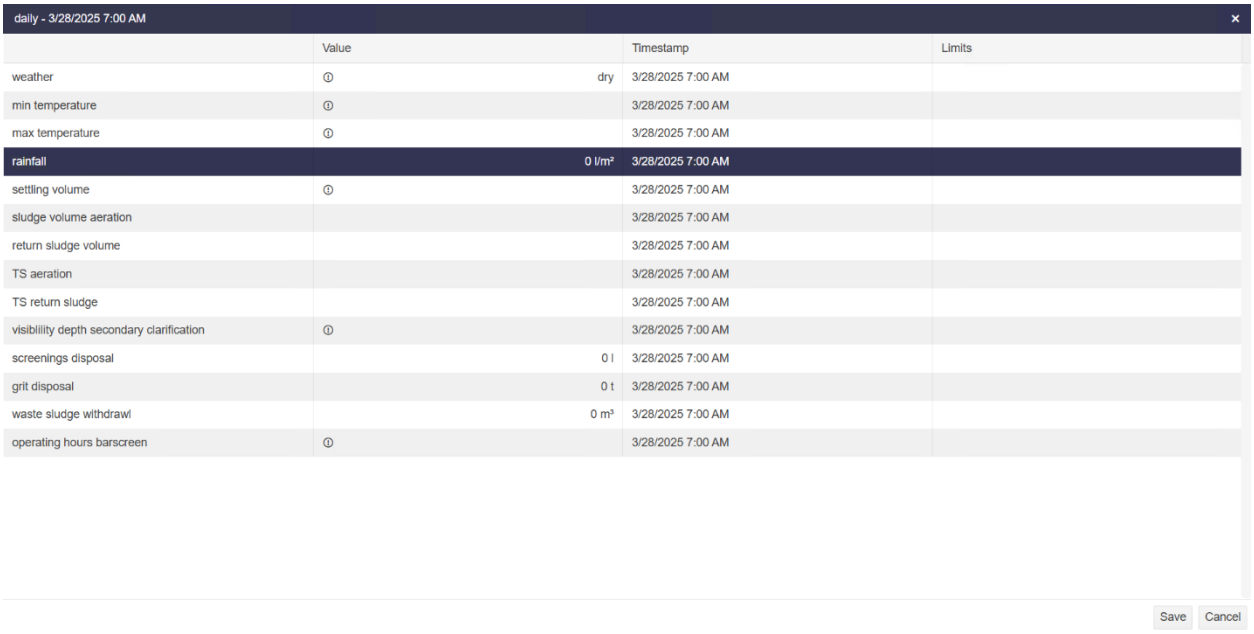


Figure 3-8: PM-Analyze Labvalues Web Control – Manual input form daily

4. Appendix

4.1. 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:

4.2. Links and literature

No.	Topic
\1\	Siemens Industry Online Support https://support.industry.siemens.com
\2\	Link to the article page of the application example https://support.industry.siemens.com/cs/ww/en/view/109988590
\3\	Calculating OEE using PM-ANALYZE https://support.industry.siemens.com/cs/ww/en/view/109769969

4.3. Change documentation

Version	Date	Change
V1.0	06/2025	First edition

