Greenhouse control with SIMATIC S7-1200

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1 Introduction

1.1 Overview

Manually watering plants can be very time-consuming. Especially in the hot and dry seasons, the well-being of plants should be ensured on a daily basis. Not only does it take an enormous amount of time, but you also compromise your flexibility. If you are absent for a longer period of time, you need someone to take care of the plants. This solution demonstrates how you can automate your irrigation with a SIMATIC S7-1200.

Figure 1-1

Divide the area to be watered into zones. Information on the division into individual irrigation zones can be found from the manufacturers of irrigation systems. Each of your zones has a modular design and can be irrigated in two different operating modes. Control your zones via timer or in manual mode. You take the water from a water tank or the public water supply system.

Thanks to its modularity and flexible expandability, you can use the application example for a wide variety of irrigation tasks. Whether in greenhouses or agriculture, in private or public gardens, even in sports facilities, this example is used.

It will show you how to adapt this example to your application by adding more zones. This application example is limited to the software solution and does not deal with irrigation-specific hardware.

Your benefits at a glance:

• Efficient use of water and increase in yield
• Unlimited expansion
• Remote access via web server
• Operation via several parallel connections possible (e.g. via panel, web server, buttons, reed contacts)
1.2 How it works

The area to be irrigated is divided into four modular zones, each controlled by the CPU (1) via a solenoid valve (2).

Each zone is assigned parameters that can be set independently of one another. One such parameter is, for example, the duration for which a zone is irrigated. The individual parameters are described in detail in the chapter 2.3 Operation.

The irrigation system provides two different operating modes:

- Manual mode
- Automatic, time controlled

Figure 1-2

Manual operation mode

Using the corresponding buttons on the HMI or on the smartphone (3), it is possible at any time to start, pause and cancel watering of the individual zones manually (can only be aborted in the HMI).

Automatic mode (time controlled)

The adjustable time (depends on the system time of the CPU) defines the start time from which the zones are watered one after the other.
1 Introduction

Level monitoring

The water source is a tank (4), which is monitored by two floats. Alternatively, a well can also be used.

The level monitoring prevents the water tank from becoming empty and the pump from being damaged. The level monitoring only prevents the pump from running dry and not the water tank from overflowing.

Monitoring provides three states: red, yellow and green

As soon as the level falls below the lower float switch "floatBottom", the monitoring is in the "red" state. Watering is interrupted both in manual and automatic mode. It is only continued when the level exceeds the top float switch "floatTop" again and the monitoring has assumed the status "green". Therefore, position the top float switch at a height that makes sense for you.

Figure 1-3 water tank and level monitoring

1.3 Components used

The Application Example was created with these hardware and software components:

Table 1-1

<table>
<thead>
<tr>
<th>Component</th>
<th>Number</th>
<th>Article number</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU 1212C DC/DC/DC</td>
<td>1</td>
<td>6ES7212-1AE40-0XB0</td>
<td>Alternatively, any other S7-1200 CPU can be used.</td>
</tr>
<tr>
<td>KTP900 Basic</td>
<td>1</td>
<td>6AV2123-2JB03-0AX0</td>
<td></td>
</tr>
<tr>
<td>Standard 24 V solenoid valve</td>
<td>-</td>
<td>-</td>
<td>The number depends on the requirements.</td>
</tr>
<tr>
<td>Commercially available float switch</td>
<td>2</td>
<td>-</td>
<td>Projected with close contact</td>
</tr>
<tr>
<td>Commercially available multi-stage submersible pump</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
1 Introduction

This application example consists of the following components:

Table 1-2

<table>
<thead>
<tr>
<th>Component</th>
<th>File name</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIA Portal project</td>
<td>109757060_GreenhouseControl_PROJ.zip</td>
<td>V15</td>
</tr>
<tr>
<td>Greenhouse control with the S7-1200</td>
<td>109757060_GreenhouseControl_DOC_de.pdf</td>
<td>This document</td>
</tr>
</tbody>
</table>

1.3.1 Magnetic valve

Each zone is assigned a magnetic valve. The magnetic valve opens and supplies the zone with water when it receives a logical TRUE signal from the controller. A commercially available 24 V valve can be used. Connect valves 1-4 to outputs Q0.0 - Q0.3. Make sure that the valve fits the diameter of your water pipes.

1.3.2 Float switch

The level of the water tank is monitored by two vertically distributed float switches. You can use commercially available 24 V float switches for this purpose. The close contact of the "floatTop" top float switch is connected to input I0.0 and the "floatBottom" lower float switch is connected to input I0.1. For further information refer to Chapter 1.2 Level monitoring.
2 Engineering

This chapter contains the project planning and the program adaptations to the respective user case as well as the operation of the application example.

2.1 Configuration

The project planning includes the presentation of the functions and components of the S7 project and explains the connection of the HMI.

2.1.1 Overview

The structure of the S7 project can be found in the Figure2-1

Figure2-1: Structure of the S7 project
2.1.2 **Data Block "Control"**

All data relevant for program processing is stored in the "Control" data block.

Table 2-1: Tags

<table>
<thead>
<tr>
<th>Tag</th>
<th>Data type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>autoFinished</td>
<td>BOOL</td>
<td>Signal that the last zone has been watered in the time-controlled automatic mode; watering for the day is thus complete.</td>
</tr>
<tr>
<td>state</td>
<td>INT</td>
<td>Water level; 1 = red, 2 = yellow, 4 = green (see chapter 1.2 Level monitoring)</td>
</tr>
<tr>
<td>autoEnableAll</td>
<td>BOOL</td>
<td>For TRUE signal the automatic mode is activated, for FALSE signal the automatic mode is deactivated.</td>
</tr>
<tr>
<td>pauseAll</td>
<td>BOOL</td>
<td>With a TRUE signal, all zones are paused; with a subsequent FALSE signal, the zones are resumed at the point at which they were paused.</td>
</tr>
<tr>
<td>stopFloats</td>
<td>BOOL</td>
<td>If the water level is &quot;red&quot;, watering is interrupted. Watering will not continue until the water level is &quot;green&quot; again (see chapter 1.2 Level monitoring).</td>
</tr>
<tr>
<td>errorFloats</td>
<td>BOOL</td>
<td>The tag TRUE indicates that the level evaluation in the tank is inconsistent. The level evaluation is inconsistent if the lower float &quot;floatBottom&quot; is FALSE but the top float is &quot;floatTop&quot; TRUE.</td>
</tr>
<tr>
<td>startTimeHour</td>
<td>USINT</td>
<td>The hour in which the scheduled automatic mode starts.</td>
</tr>
<tr>
<td>startTimeMinute</td>
<td>USINT</td>
<td>The minute the scheduled automatic mode starts.</td>
</tr>
</tbody>
</table>

The "Control" DB also contains the tags "zone1" to "zone4" of the data type typeZoneControl. The data type contains the specific parameters of the individual zones.

Table 2-2: typeZoneControl

<table>
<thead>
<tr>
<th>Tag</th>
<th>Data type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>manStart</td>
<td>BOOL</td>
<td>Starts irrigation in the manual operation mode</td>
</tr>
<tr>
<td>manStop</td>
<td>BOOL</td>
<td>Stops watering in manual mode</td>
</tr>
<tr>
<td>manPause</td>
<td>BOOL</td>
<td>Pauses irrigation in the manual operation mode</td>
</tr>
<tr>
<td>autoEnable</td>
<td>BOOL</td>
<td>Enabling a zone to participate in automatic mode</td>
</tr>
<tr>
<td>autoTrigger</td>
<td>BOOL</td>
<td>Indicates that irrigation of the previous zone is complete</td>
</tr>
<tr>
<td>durationMan</td>
<td>USINT</td>
<td>Duration of watering in manual mode (in minutes)</td>
</tr>
<tr>
<td>durationAutoTime</td>
<td>USINT</td>
<td>Duration of watering in time-controlled automatic mode (in minutes)</td>
</tr>
<tr>
<td>frequency:</td>
<td>USINT</td>
<td>Frequency of watering in time-controlled automatic mode (in days); e.g. frequency = 3: Zone is irrigated every 3 days</td>
</tr>
<tr>
<td>zoneTimeAct</td>
<td>STRING</td>
<td>Current watering time of a zone</td>
</tr>
<tr>
<td>zoneTimeMax</td>
<td>STRING</td>
<td>Maximum watering time of a zone</td>
</tr>
</tbody>
</table>
2.1.3 Function "Floats"

The "Floats" function evaluates the level of the water tank via the float switches. If the water tank is empty, the pump must stop, otherwise it may be damaged. For further information refer to Chapter 1.2 Level monitoring.

Note
If you operate the system directly at a water connection instead of a water tank, you can remove the "Floats" function from the program.

Table 2-3: FC "Floats"

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Data type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>floatTop</td>
<td>Bool</td>
<td>Top float</td>
</tr>
<tr>
<td>floatBottom</td>
<td>Bool</td>
<td>Bottom float</td>
</tr>
<tr>
<td>state</td>
<td>USInt</td>
<td>State</td>
</tr>
<tr>
<td>stop</td>
<td>Bool</td>
<td>If both floats are active, &quot;stop&quot; is TRUE</td>
</tr>
<tr>
<td>error</td>
<td>Bool</td>
<td>If the bottom float is not active and the top float is active, &quot;error&quot; TRUE</td>
</tr>
</tbody>
</table>

The following truth table shows you an overview of the states and which integer is output in the "state" output.

Table 2-4: Truth table "state"

<table>
<thead>
<tr>
<th>floatTop</th>
<th>floatBottom</th>
<th>State (Name)</th>
<th>state (Int)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>red</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>error</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>yellow</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>green</td>
<td>4</td>
</tr>
</tbody>
</table>
2.1.4 Function block "Timer"

The FB "Timer" provides the start signal for the Automatic mode (time controlled) in the form of an impulse.

<table>
<thead>
<tr>
<th>FB Timer</th>
</tr>
</thead>
<tbody>
<tr>
<td>USINT onHour</td>
</tr>
<tr>
<td>USINT onMinute</td>
</tr>
<tr>
<td>BOOL autoEnableAll</td>
</tr>
</tbody>
</table>

Table 2-5: FB "Timer"

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Data type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td></td>
<td></td>
</tr>
<tr>
<td>onHour</td>
<td>USInt</td>
<td>Hour in which time-controlled automatic operation is to start (format: hh)</td>
</tr>
<tr>
<td>onMinute</td>
<td>USInt</td>
<td>Minute in which time-controlled automatic operation is to start (format: mm)</td>
</tr>
<tr>
<td>autoEnableAll</td>
<td>Bool</td>
<td>Automatic mode is activated for TRUE signal, automatic mode is deactivated for FALSE signal</td>
</tr>
<tr>
<td>Output</td>
<td></td>
<td></td>
</tr>
<tr>
<td>signal</td>
<td>Bool</td>
<td>Impulse at a selected time</td>
</tr>
</tbody>
</table>

2.1.5 Function block "IrrigationControl"

The "IrrigationControl" function block is responsible for watering the zones and switches the individual solenoid valves. A zone is transferred from the "Control" data block to each instance of the FB.

<table>
<thead>
<tr>
<th>FB IrrigationControl</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOOL stop</td>
</tr>
<tr>
<td>VARIANT control</td>
</tr>
<tr>
<td>BOOL valve</td>
</tr>
<tr>
<td>BOOL done</td>
</tr>
</tbody>
</table>

Table 2-6: FB "IrrigationControl"

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Data type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td></td>
<td></td>
</tr>
<tr>
<td>stop</td>
<td>Bool</td>
<td>Watering pauses at TRUE signal</td>
</tr>
<tr>
<td>Output</td>
<td></td>
<td></td>
</tr>
<tr>
<td>valve</td>
<td>Bool</td>
<td>Valve of the respective zone</td>
</tr>
<tr>
<td>done</td>
<td>Bool</td>
<td>Trigger which means that time-controlled automatic operation is completed for this zone</td>
</tr>
<tr>
<td>In/Out</td>
<td></td>
<td></td>
</tr>
<tr>
<td>control</td>
<td>Variant</td>
<td>Contains parameters for the individual zones (refer to Table 2-2: typeZoneControl)</td>
</tr>
</tbody>
</table>
2.1.6 HMI tags

Table 2-7 contains an overview of all PLC tags linked to an HMI tag. You have the possibility to control and observe all tags from there. The addition \([1...4]\) means that this HMI tag exists for all 4 zones.

<table>
<thead>
<tr>
<th>HMI tag</th>
<th>Data type</th>
<th>PLC tag</th>
</tr>
</thead>
<tbody>
<tr>
<td>autoEnableAll</td>
<td>Bool</td>
<td>Control.autoEnableAll</td>
</tr>
<tr>
<td>pauseAll</td>
<td>Bool</td>
<td>Control.pauseAll</td>
</tr>
<tr>
<td>startTimeHour</td>
<td>USInt</td>
<td>Control.startTimeHour</td>
</tr>
<tr>
<td>startTimeMinute</td>
<td>USInt</td>
<td>Control.startTimeMinute</td>
</tr>
<tr>
<td>stateFloats</td>
<td>USInt</td>
<td>Control.state</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HMI tag</th>
<th>Data type</th>
<th>PLC tag</th>
</tr>
</thead>
<tbody>
<tr>
<td>autoEnableZone[1…4]</td>
<td>Bool</td>
<td>Control.zone[1…4].autoEnable</td>
</tr>
<tr>
<td>durationAutoTimeZone[1…4]</td>
<td>USInt</td>
<td>Control.zone[1…4].durationAutoTime</td>
</tr>
<tr>
<td>durationManZone[1…4]</td>
<td>USInt</td>
<td>Control.zone[1…4].durationMan</td>
</tr>
<tr>
<td>frequencyZone[1…4]</td>
<td>USInt</td>
<td>Control.zone[1…4].frequency</td>
</tr>
<tr>
<td>manActTimeZone[1…4]</td>
<td>String</td>
<td>Control.zone[1…4].zoneTimeAct</td>
</tr>
<tr>
<td>manMaxTimeZone[1…4]</td>
<td>String</td>
<td>Control.zone[1…4].zoneTimeMax</td>
</tr>
<tr>
<td>manPauseZone[1…4]</td>
<td>Bool</td>
<td>Control.zone[1…4].manPause</td>
</tr>
<tr>
<td>manStartZone[1…4]</td>
<td>Bool</td>
<td>Control.zone[1…4].manStart</td>
</tr>
<tr>
<td>manStopZone[1…4]</td>
<td>Bool</td>
<td>Control.zone[1…4].manStop</td>
</tr>
</tbody>
</table>

To start up the watering system, load the hardware configuration of the PLC, the HMI and then the respective programs onto the units.
2.2 Program adaptation to the user application

2.2.1 General information

On the PLC side, a zone consists of an instance of the "IrrigationControl" function block in OB1 and the corresponding tags in the "Control" database.

On the HMI side, a zone consists of two images for display and parameterization. In addition, the status of all zones is displayed in the image "Overview" (see chapter 2.3.1 - point 2). In this screen you also have the option of activating manual mode for individual zones. In addition, HMI-side tag values are transferred from the "Control" database to the panel via HMI tags.

The web server consists of an html file, which is responsible for the structure and formatting of the website. Various JavaScript files ensure that the website builds up dynamically. Various JSON files are responsible for data exchange between web server and PLC.

The number of zones in this application example has been set to four. If you need another zone, proceed as follows:

2.2.2 PLC

1. Under "Program blocks" in the "Control" database, duplicate a zone, e.g. zone1. The name of the newly created zone is automatically adjusted to "zone5".

2. Create a new Boolean output "valve5" in the PLC tags for controlling the additional valve.
3. Create a new network in OB1 after the instance of zone 4 and drag and drop the FB "IrrigationControl" from the program blocks. Name the new instance "InstZone5" and confirm with "OK".

4. Parameterize "InstZone5" as shown in the figure. Also assign the "autoTrigger" tag for zone 5 to the formal parameter "done" from zone 4. In this way, the "autoTrigger" tag of the following zone 5 signals that automatic watering of the previous zone 4 has been completed and watering of zone 5 can begin.
2.2.3 HMI

HMI tags

1. Add a new tag table to the HMI tags and name this "PLC2HMIZone5". Fill the tag table with the tags for zone 5 as shown.

![Tag Table Image](image)

Figure "10_Overview"

1. Under "Screens > Application > 02_Greenhouse_Control" open the image "10_Overview". Click with the left mouse button on the "Layout" task card and then on the eye to the right of "Layer_3". This activates the visibility of the buttons in the image with which you can start the zones manually.

![Layout Task Card Image](image)
2. Copy zone 4 and paste it next to it.

Then change the name from "Zone 4" to "Zone 5".
3. Click on the button of Zone 5 and then click on "Events" in the properties. Adjust the tags to zone 5 under "Press" and "Release".
4. Deactivate the visibility of the buttons in Layer_3 for further adjustments in the "Layout" task card.

5. Select the valve of zone 5 and adjust the tag to zone 5 under "Properties > General".
6. Select the I/O field under the valve that outputs the current watering time. Adjust the tags to zone 5 under "Animations > Tag connections > Process value" and under "Animations > Display > Visibility".
7. Mark the text field in which "to" is written. Adjust the tags to zone 5 under "Animations > Display > Visibility".
8. Select the lowest I/O field that outputs the maximum watering time. Adjust the tags to zone 5 under "Animations > Tag connections > Process value" and under "Animations > Display > Visibility".
2 Engineering

Navigation

1. Under "Screens" duplicate "14_Zone4" and "24_SettingsZone4". Customize the names as shown in the figure.

2. Open "Screen management > Templates > TemplateSubNav". At the bottom of the screen, copy the "Zone 4" button to the free space to the right and name it "Zone 5".
3. Click on the button "Zone 5" and then click on "Animations" in the properties. Change the "Range" of the "SubNavigationState" tag to "6" under "Display > Appearance" so that you can see in the HMI in which zone you are currently.
4. "Events > Click" In the "ActivateScreen" function, change the "Screen name" to "15_Zone5" to open the corresponding image later when you press the button.

5. Open the image "15_Zone5". Under "Properties > Events > Loaded", change the value of the "SetTag" function to "6".
Figure "15_Zone5"

1. Click on the button via "Start" and then in the properties on Events. Under "Press", adjust the HMI tags to zone 5 as shown in the figure.
2. Then click on "Release" and adjust the HMI tag to zone 5.

3. Click on the "Pause" button and adjust the tags to zone 5 under "Click".
4. Click on the “Stop” button and adjust the tags to zone 5 under “Press”.

5. Click on the valve that displays the status. Then adjust the tag to Zone 5 under “Properties > General”.

![Diagram of greenhouse control system with buttons and tags for Zone 5]
6. Click on the left of the two I/O fields below the valve. During operation, it displays the current time of the corresponding zone. Under "Properties > General", adjust the tag to zone 5.
7. Click on the text field with the slash under the valve. Adjust the tags to zone 5 under "Animations > Display > Visibility".
8. Click on the left of the two I/O fields below the valve. During operation, it displays the current time of the corresponding zone. Under "Properties > General", adjust the tag to zone 5.
9. Click on the button via "Settings" and then in the properties on events. Under "Click", adjust the image name to zone 5 as shown in the figure.

Figure "25_SettingsZone5"

1. Open the image "25_SettingsZone5" and adjust the heading to zone 5.
2. Click on the I/O field next to the text "Duration" in the "Manual Mode" area and adjust the tag to Zone 5 under "Properties > General".
3. Click the "back" button and adjust the image name ("Screen name") to zone 5 under "Events > Click".
4. Click on the button in the "Automatic Mode" area and adjust the tag to Zone 5 under "Properties > General".
5. Click on the I/O field next to the text "Duration" in the "Automatic Mode" area and adjust the tag to Zone 5 under "Properties > General".
6. Click on the I/O field next to the text "Frequency" in the "Automatic Mode" area and adjust the tag to Zone 5 under "Properties > General".
7. Activate the visibility of "Layer_1" (1) in the "Layout" task card by clicking on the inactive eye (2). There is an "Overlay" which prevents the adjustment of parameters of the automatic mode if it is not activated.
8. Mark the "Overlay" and adjust the tag to zone 5.
9. Then deactivate visibility (2) again if you want to edit the screen elements behind it later.
2 Engineering

2.2.4 Web server

In the project directory under "Userfiles" you will find all files that are relevant for the web server. The following shows how to change the program codes of the HTML, JavaScript and JSON files to add another zone to the web server.

**HTML**

**Note** Comments are implemented in the HTML programming language as follows:

```html
<!-- Comment-->
```

The code passages with which you extend the web server by a fifth zone are commented out and marked with the preceding text "Add new zone" (see figure below). Use the system function "Find" (shortcut: <Ctrl> + <F>), which is integrated in most text editors, to find the corresponding places in the program code better.

Open the file "Greenhouse_Control_JQMobile.html" in a text editor. Find the places in the program code where "Add new zone" is written. Delete the selected part of the comment, as shown in the figure, to comment in the contained code elements.

```html
<!-- Add new zone

<label name="control\zone1\manStart\id='man_5\class='ManualButton" />

</label>

```

**JavaScript**

**Note** Comments are realized in the programming language JavaScript as follows:

```javascript
/* Comment*/
```

The code passages with which you extend the web server here by a fifth zone are commented out and marked with the preceding text "Add new zone" (see illustration below). Use the system function "Find" (shortcut: <Ctrl> + <F>), which is integrated in most editors, in order to find the corresponding places in the program code better.

Open the file "dataGreenhouse.js". Find the places in the program code where "Add new zone" is written. Delete the selected part of the comment, as shown in the figure, to comment in the contained code elements.

```javascript
/*Add new zone

\zone1\manStart\id='man_5\class='ManualButton\)

\zone1\manStart\id='man_5\prop='checked" enable\disabled';
```

Greenhouse control

Entry ID: 10975060, V1.0, 05/2018
The following shows the contents of each JSON file. The program code required to add a new zone is marked in yellow in the following figure. It must be added manually.

- **dataGreenhouse.json:**

```json
{"Enable_Manual" : {
    "Pause_All" : "Control".pauseAll:,
    "Zone_1" : "Control".zone1.manStart:,
    "Zone_2" : "Control".zone2.manStart:,
    "Zone_3" : "Control".zone3.manStart:,
    "Zone_4" : "Control".zone4.manStart:,
    "Zone_5" : "Control".zone5.manStart:,
},
"Enable_Automatic" : {
    "Zone_1" : "Control".zone1.autoEnable:,
    "Zone_2" : "Control".zone2.autoEnable:,
    "Zone_3" : "Control".zone3.autoEnable:,
    "Zone_4" : "Control".zone4.autoEnable:,
    "Zone_5" : "Control".zone5.autoEnable:,
},
"Time_Manual" : {
    "Zone_1" : "Control".zone1.durationMan:,
    "Zone_2" : "Control".zone2.durationMan:,
    "Zone_3" : "Control".zone3.durationMan:,
    "Zone_4" : "Control".zone4.durationMan:,
    "Zone_5" : "Control".zone5.durationMan:,
},
"Time_Automatic" : {
    "Zone_1" : "Control".zone1.durationAutoTime:,
    "Zone_2" : "Control".zone2.durationAutoTime:,
    "Zone_3" : "Control".zone3.durationAutoTime:,
    "Zone_4" : "Control".zone4.durationAutoTime:,
    "Zone_5" : "Control".zone5.durationAutoTime:
}
```
• enableAutomaticGreenhouse.json

```json
{"Enable_Automatic": {
    "Zone_1": "Control.zone1.autoEnable",
    "Zone_2": "Control.zone2.autoEnable",
    "Zone_3": "Control.zone3.autoEnable",
    "Zone_4": "Control.zone4.autoEnable",
    "Zone_5": "Control.zone5.autoEnable"
}}
```

• enableManualGreenhouse

```json
{"Enable_Manual": {
    "Pause_All": "Control.pauseAll",
    "Zone_1": "Control.zone1.manStart",
    "Zone_2": "Control.zone2.manStart",
    "Zone_3": "Control.zone3.manStart",
    "Zone_4": "Control.zone4.manStart",
    "Zone_5": "Control.zone5.manStart"
}}
```
• timeAutomaticGreenhouse.json

```json
{ "Time_Automatic" :
  "Zone_1" : "=\"Control\".zone1.durationAutoTime",
  "Zone_2" : "=\"Control\".zone2.durationAutoTime",
  "Zone_3" : "=\"Control\".zone3.durationAutoTime",
  "Zone_4" : "=\"Control\".zone4.durationAutoTime",
  "Zone_5" : "=\"Control\".zone5.durationAutoTime"
}
```

• timeManualGreenhouse.json

```json
{ "Time_Manual" :
  "Zone_1" : "=\"Control\".zone1.durationMan",
  "Zone_2" : "=\"Control\".zone2.durationMan",
  "Zone_3" : "=\"Control\".zone3.durationMan",
  "Zone_4" : "=\"Control\".zone4.durationMan",
  "Zone_5" : "=\"Control\".zone5.durationMan"
}
```
Once you have adapted all files, open the device configuration of the PLC in the TIA Portal. Under "Properties > General > Web server > User-defined pages" (1) click on the button "Generate blocks" (2) and confirm the dialog that opened with "Yes" (3). Translate the project and load it into the PLC.
2.3 Operation

2.3.1 WinCC

1. On the start screen, press "Start Application".

2. You are now in the "Overview". The picture is explained in more detail under point 6. Via the navigation bar (1) you reach the control of the individual zones, in this example zone 1.
3. First click on "Settings" to adjust the other parameters.
4.

Table 2-9

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Set the duration of watering in manual mode here.</td>
</tr>
<tr>
<td>2.</td>
<td>Here you can switch automatic mode on or off for the respective zone. If the zone is not activated, it can only be watered manually.</td>
</tr>
<tr>
<td>3.</td>
<td>Set the duration for the scheduled automatic mode. This selection is only available when the zone is enabled for automatic mode (2).</td>
</tr>
<tr>
<td>4.</td>
<td>At the frequency, you set the daily rhythm of how often a zone is to be watered. For example, if you want to water a zone every three days, set frequency to &quot;3&quot;. If you want to water a zone daily, set &quot;1&quot;. This selection is only available when the zone is enabled for automatic mode (2).</td>
</tr>
<tr>
<td>5.</td>
<td>Once you have made the settings, click on the &quot;back&quot; button to return to the previous screen.</td>
</tr>
</tbody>
</table>

**Note**

It is not advisable to change the duration of a zone while it is active. The newly set values are immediately displayed in the HMI as the maximum value, although the timer still follows the old values.
5. Table 2-10

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Start manual mode.</td>
</tr>
</tbody>
</table>
| 2.   | Pause the manual mode.  
If it is paused, it can be continued by pressing "Start". |
| 3.   | Stop manual mode.  
The time is reset and can start again from the beginning. |
| 4.   | The symbol of a valve indicates the status of the valve.  
When the valve is open, it is green. If the valve is closed, it is grey. |
| 5.   | The time entry is made up as follows:  "Current value of the timer" / "Set maximum value". |
6. Use the navigation bar to return to the overview

Table 2-11

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Set the start time from when the zones are to be watered one after the other in the time-controlled automatic mode.</td>
</tr>
<tr>
<td>2.</td>
<td>The status of the water tank. For further information refer to Chapter 1.2 Level monitoring.</td>
</tr>
<tr>
<td>3.</td>
<td>If the status of the water tank was red, this is documented in the messages. For further information refer to Chapter 1.2 Level monitoring.</td>
</tr>
<tr>
<td>4.</td>
<td>Press the button marked in red to start manual mode. The symbol of a valve also indicates the status of the valve. When the valve is open, it is green. If the valve is closed, it is grey. The current time and the maximum time are displayed below the valve. The time is displayed in both manual and automatic mode. Note that you cannot activate the buttons when the water tank is empty.</td>
</tr>
<tr>
<td>5.</td>
<td>Pressing the &quot;Pause Zones&quot; button interrupts the operation of all zones. After pressing, the name of the button changes to &quot;Start Zones&quot; and the color changes to blue. Tap the button again to continue operation as before the interruption. If you press one of the buttons from point 4 during the pause time, the zone is marked for manual operation. The zone will be watered as soon as the break is over.</td>
</tr>
<tr>
<td>6.</td>
<td>If you press the &quot;Disable Auto Mode&quot; button, you deactivate the automatic mode for all zones. After pressing, the name of the button changes to &quot;Enable Auto Mode&quot; and the color of the button changes to blue. Tap the button again to return to automatic mode. It is not possible to deactivate the automatic mode while it is active.</td>
</tr>
</tbody>
</table>
7. If you want to stop watering a zone in time-controlled automatic mode, proceed as follows:
Open the corresponding zone (1) via the navigation bar. Click on "Stop"(2). The current zone is terminated and the next zone in time-controlled automatic mode is activated.
2.3.2 Web server

1. Open the browser of your smartphone or programming device and enter the IP address of your CPU in the address bar. Then click on ENTER.

2. Click on "User-defined pages" in the menu bar on the left side and then on "Homepage of the application Greenhouse_Control". The application's web page opens in a new browser tab.
3. Click on the "Duration Manual Mode (min)" tab to specify the time a zone is to be irrigated in manual mode. Set the time in minutes using the input area (1) or the slider (2). The range of values is 1-10 minutes.

**Note**

It is not advisable to change the duration of a zone while it is active. The newly set values are immediately displayed in the HMI as the maximum value, although the timer still follows the old values.
4. Click on the "Duration Automatic Mode (min)" tab to specify the time a zone is to be watered in the time-controlled automatic mode. Set the time in minutes using the input area (1) or the slider (2). The range of values is 1-10 minutes.

Note: It is not advisable to change the duration of a zone while it is active. The newly set values are immediately displayed in the HMI as the maximum value, although the timer still follows the old values.
5. In the "Manual Mode" tab, start manual operation of the individual zones via checkboxes (1). Note the following:
If a checkbox is activated, it becomes inactive and can no longer be deactivated.
The zone is not deactivated until the set time of the zone has elapsed.
The "Pause button" (2) can be used to pause but not stop the complete watering of all zones.
6. In the "Automatic Mode Enable" tab, you enable the individual zones for the time-controlled automatic mode. Activate the checkbox next to the respective zone.

7. If you control the application exclusively with the web server, you can set the time at which the time-controlled automatic mode starts directly in the TIA Portal. To do this, open the "Control" data block in the TIA Portal. Enter your desired time in the tags "startTimeHour" (1) and "startTimeMinute" (2), in the example it is 07:30.
3 Appendix

3.1 Service and Support

Industry Online Support

Do you have any questions or need assistance?

Siemens Industry Online Support offers round the clock access to our entire service and support know-how and portfolio.

The Industry Online Support is the central address for information about our products, solutions and services.

Product information, manuals, downloads, FAQs, application examples and videos – all information is accessible with just a few mouse clicks:

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www.siemens.com/industry/supportrequest

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For more information on our offered trainings and courses, as well as their locations and dates, refer to our web page:

www.siemens.com/sitrain

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Our range of services includes the following:

- Plant data services
- Spare parts services
- Repair services
- On-site and maintenance services
- Retrofitting and modernization services
- Service programs and contracts

You can find detailed information on our range of services in the service catalog web page:

https://support.industry.siemens.com/cs/sc

Industry Online Support app

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

https://support.industry.siemens.com/cs/ww/en/sc/2067
### 3.2 Links and Literature

Table 3-1

<table>
<thead>
<tr>
<th>No.</th>
<th>Topic</th>
<th>Topic</th>
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<tbody>
<tr>
<td>1\1</td>
<td>Siemens Industry Online Support</td>
<td><a href="https://support.industry.siemens.com">https://support.industry.siemens.com</a></td>
</tr>
<tr>
<td>2\2</td>
<td>Link to the article page of the application example</td>
<td><a href="https://support.industry.siemens.com/cs/ww/en/view/109757060">https://support.industry.siemens.com/cs/ww/en/view/109757060</a></td>
</tr>
</tbody>
</table>

### 3.3 Change documentation

Table 3-2

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1.0</td>
<td>05/2018</td>
<td>First version</td>
</tr>
</tbody>
</table>