# PLC Control and Data reading

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## History

|  |  |  |
| --- | --- | --- |
| **Date** | **Changed by** |  |
| 2021-11-3 | V.Lao | Added new addresses |
| 2021-10-21 | V.Lao |  |
| 2021-08-12 | V.Lao |  |
| 2021-04 | V.Lao |  |

## System Overview

The system for water/light has 3 components:

* User interface
* Controller + IO modules
* Devices

|  |  |  |
| --- | --- | --- |
| **User/Application interface** | **Controller** | **Devices** |
| SCADA | Delta AS300 PLC + IO modules | Proportional valves |
| Server |  | Light on/off control |
| Test applications |  | Light intensity control |
|  |  | Water temp sensor |
|  |  | Pump VFD |
|  |  | Power meter |
|  |  | Overflow sensor |

There are 2 main types of Bay/Rack: Type A & B. There may be more variations in each type in the mechanical layout, but they are similar to the PLC and the electrical components.

|  |  |  |
| --- | --- | --- |
|  | **Type A** | **Type B** |
| **No. of shelves** | 12 (1x12) | 14 (1x6, 1x8) |
| **No. of pumps** | 1 | 2 |
| **No. of sections** | 1 | 2 |
| **Fill drain mode** | No | Yes (1st pump), No (2nd pump) |
| **Static mode** | Yes | Yes for both pumps/sections |
| **Scheduling** | Yes | Yes |

Scheduler

* Defines time to activate/deactivate the light, water, ventilation
* Time for triggering is either user-set or provided by software algorithm
* PLC System can have only one pair of ON/OFF schedule time, but software can update the schedule time as necessary
* Once a schedule has been set and “Applied”, the PLC is now independent and does not need to be connected to the SCADA/server at all times. Even if the connection is severed, the PLC will follow the set “applied” schedule indefinitely, until its’ own power is cut off.

SCADA

* Provides the human machine interface (HMI) and the record of the different components like sensors, light, water control and status.

E-stop

* Emergency stop should cut-off the power to the water, light and ventilation
* It should also indicate to the PLC of the event so that the PLC can handle the situation and reset any state it is currently in.
* *Feedback from electrical system not implemented yet*

PLC

* Controls the water system ( pump control VFD, PV, water temp, water pressure, flow meter)
* Read water level sensor
* Read water temperature sensor
* Read power meter
* Control lights
* Control scheduler

## Application of settings

All settings can be set at the any time. But they will ONLY take effect once it is applied. This prevents the PLC from resetting the values that are tied to addresses once the HMI is unplugged, by applying any changes only when intended. To apply any settings:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | ***Start address*** | ***Type A*** | ***Type B*** | ***Description*** |
| CTRL\_apply\_update | 321.0 | BOOL | BOOL | For applying any new setting, set this flag to TRUE. This setting will automatically reset to FALSE, once the update is applied to the PLC. |

**Note:** CTRL\_apply\_update can be read, but is immediately reset to FALSE once the PLC acknowledged the change. So reading it is pointless and will always return FALSE.

## Shelf Control

Mode description:

1. Auto – use in scheduling, must turn on scheduling of each shelf
2. Semi auto – Control PV setting is from the look-up table, Only need to turn on/off
3. Manual – Set percentage to turn on PV, 0 is off, 100 is fully open

Note that the ff. arrays start at index 0.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | ***Start address*** | ***Type A*** | ***Type B*** | ***Description*** |
| CTRL\_pv\_value | 4000 | ARRAY [12] OF WORD | ARRAY [14] OF WORD | Set PV value in % in manual mode |
| CTRL\_PV\_on | 4465.0 | ARRAY [12] OF BOOL | ARRAY [14] OF BOOL | Turn on/off PV in semi auto mode |
| CTRL\_section\_mode | 4460 | ARRAY [3] OF WORD | ARRAY [3] OF WORD | 1 – auto, 2 – semi, 3 -manual |
| CTRL\_light\_on | 4080.0 | ARRAY [12] OF BOOL | ARRAY [14] OF BOOL | Light on/off in semi auto and manual |
| CTRL\_light\_intensity | 4085 | ARRAY [12] OF WORD | ARRAY [14] OF WORD | Light intensity in % for both semi auto and manual mode |
| CTRL\_pump\_mode | 4100 | ARRAY [3] OF WORD | ARRAY [3] OF WORD | 1 – auto, 2 – flowrate, 3 – rev/hz |
| CTRL\_pump\_rpm\_setpoint | 4105 | ARRAY [3] OF WORD | ARRAY [3] OF WORD | Input in Hz |
| CTRL\_pump\_flowrate\_setpoint | 4110 | ARRAY [3] OF WORD | ARRAY [3] OF WORD | Input in l/min |
| CTRL\_pump\_on | 4400.0 | ARRAY [3] OF BOOL | ARRAY [3] OF BOOL | Turn on/off pump (on as default) |
| FEEDBACK\_valve\_setting | 4640 | ARRAY [12] OF WORD | ARRAY [14] OF WORD | Proportional valve reading |
| FEEDBACK\_pump\_on | 4655.0 | ARRAY [3] OF BOOL | ARRAY [3] OF BOOL | Whether pump is switched on. This does not indicate whether it is spinning or not. It merely indicates whether it is turned on or not. Check rpm and flowrate instead to see whether it is actually spinning. |
| FEEDBACK\_led | 4020.0 | ARRAY [12] OF WORD | ARRAY [14] OF WORD | On/off |
| FEEDBACK\_led\_intensity | 4022 | ARRAY [12] OF WORD | ARRAY [14] OF WORD | ADC value |
| FEEDBACK\_pump\_rpm | 4358 | ARRAY [3] OF WORD | ARRAY [3] OF WORD | Current freq of the pump VFD |
| FEEDBACK\_pump\_flowrate | 4361 | ARRAY [3] OF WORD | ARRAY [3] OF WORD | Current flowrate of the pump VFD |
| FEEDBACK\_power\_meter\_KW | 4710 | REAL | REAL | Power consumption in KW |
| FEEDBACK\_power\_meter\_Ia | 4715 | REAL | REAL | Current A |
| FEEDBACK\_power\_meter\_Ib | 4720 | REAL | REAL | Current B |
| FEEDBACK\_power\_meter\_Ic | 4725 | REAL | REAL | Current C |
| FEEDBACK\_pump\_mode | 4750 | ARRAY [3] OF WORD | ARRAY [3] OF WORD | Pump current mode (max 3 pumps) |
| FEEDBACK\_section\_mode | 4755 | ARRAY [3] OF WORD | ARRAY [3] OF WORD | Current section mode |

**NOTE:** Anything set here can be read back, but what is read back is NOT an indication that it is indeed set. It will just indicate what it has been commanded to do. To check what is actually running in real time, read the feedback information.

## Scheduling

To use scheduler, set *CTRL\_section\_mode* to *Auto*, set all on/off time and value for both PV and light, set *CTRL\_shelf\_use\_scheduler* to true.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | ***Start address*** | ***Type A*** | ***Type B*** | ***Description*** |
| CTRL\_scheduler\_pvon\_hh | 4500 | ARRAY [12] OF WORD | ARRAY [14] OF WORD | Set PV on hour |
| CTRL\_scheduler\_pvon\_mm | 4515 | ARRAY [12] OF WORD | ARRAY [14] OF WORD | Set PV on min |
| CTRL\_scheduler\_pvoff\_hh | 4530 | ARRAY [12] OF WORD | ARRAY [14] OF WORD | Set PV off hour |
| CTRL\_scheduler\_pvoff\_mm | 4545 | ARRAY [12] OF WORD | ARRAY [14] OF WORD | Set PV off min |
| CTRL\_scheduler\_lighton\_hh | 4560 | ARRAY [12] OF WORD | ARRAY [14] OF WORD | Set light on hour |
| CTRL\_scheduler\_lighton\_mm | 4575 | ARRAY [12] OF WORD | ARRAY [14] OF WORD | Set light on min |
| CTRL\_scheduler\_lightoff\_hh | 4590 | ARRAY [12] OF WORD | ARRAY [14] OF WORD | Set light off hour |
| CTRL\_scheduler\_lightoff\_mm | 4605 | ARRAY [12] OF WORD | ARRAY [14] OF WORD | Set light off min |
| CTRL\_shelf\_use\_scheduler | 4620.0 | ARRAY [12] OF BOOL | ARRAY [14] OF BOOL | Use scheduler for each shelf (must be in auto mode) |
| CTRL\_scheduler\_pv\_value | 4660 | ARRAY [12] OF WORD | ARRAY [14] OF WORD | PV value in percent |
| CTRL\_scheduler\_light\_intensity | 4680 | ARRAY [12] OF WORD | ARRAY [14] OF WORD | Light value in % |

## Fill Drain setting

To use fill drain mode, set CTRL\_pump\_fill\_drain\_mode to True for specific pump, set the fill and drain duration and flow rate. Make sure to set which PV to turn on as well. Then apply.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | ***Start address*** | ***Type A*** | ***Type B*** | ***Description*** |
| CTRL\_pump\_fill\_drain\_mode | 4050.0 | Not supported | ARRAY [3] OF BOOL | Enable fill drain mode |
| CTRL\_pump\_fill\_mode\_flowrate | 4055 | Not supported | ARRAY [3] OF WORD | Flowrate in l/min while filling |
| CTRL\_pump\_drain\_mode\_flowrate | 4060 | Not supported | ARRAY [3] OF WORD | Flowrate in l/min while draining (0 is recommended) |
| CTRL\_pump\_fill\_duration | 4065 | Not supported | ARRAY [3] OF WORD | Duration in seconds |
| CTRL\_pump\_drain\_duration | 4070 | Not supported | ARRAY [3] OF WORD | Duration in seconds |

## Example usage

Manually turn on light for shelf 3 to 50%:

* CTRL\_shelf\_use\_scheduler[2] to False (Default is false, but we need to make sure to set it as it may have been change previously)
* CTRL\_section\_mode[0] to 2 (semi)
* CTRL\_light\_on[2] to True
* CTRL\_light\_intensity[2] to 50
* CTRL\_apply\_update to True

Turn on PV of shelf 1 in semi auto mode:

* CTRL\_shelf\_use\_scheduler[0] to False (Default is false, but we need to make sure)
* CTRL\_section\_mode[0] to 2 (semi)
* CTRL\_pump\_on[0] to True
* CTRL\_pump\_mode[0] to 1 (auto)
* CTRL\_pv\_on[0] to True
* CTRL\_apply\_update to True

Turn on PV in shelf 1 in manual mode to 100% (fully open):

* CTRL\_shelf\_use\_scheduler[0] to False (Default is false, but we need to make sure)
* CTRL\_section\_mode[0] to 3 (manual)
* CTRL\_pump\_on[0] to True
* CTRL\_pump\_mode[0] to 1 (auto)
* CTRL\_pv\_value[0] to 100
* CTRL\_apply\_update to True

Schedule shelf 1 water to turn on at 1pm and stop at 1:30pm with a flowrate of 30 l/min

* CTRL\_shelf\_use\_scheduler[0] to True (Default is false, but we need to make sure)
* CTRL\_scheduler\_pvon\_hh[0] to 13
* CTRL\_scheduler\_pvon\_mm[0] to 0
* CTRL\_scheduler\_pvoff\_hh[0] to 13
* CTRL\_scheduler\_pvoff\_mm[0] to 30
* CTRL\_scheduler\_pv\_value[0] to 30
* CTRL\_pump\_on[0] to True
* CTRL\_pump\_mode[0] to 1 (auto)
* CTRL\_apply\_update to True

## Pump error and recovery settings

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Addr** | **Type A** | **Type B** | **Description** |
| FEEDBACK\_pump\_abnormal | 4115.0 | ARRAY [3] OF BOOL | ARRAY [3] OF BOOL | Abnormal speed detected (exceed threshold defined in REF\_pump\_spin\_limit) |
| FEEDBACK\_pump\_abnormal\_termination | 4116.0 | ARRAY [3] OF BOOL | ARRAY [3] OF BOOL | Pump stopped due to constant abnormality for a number of seconds defined in REF\_pump\_spin\_limit\_shutdown\_time |
| CTRL\_pump\_reset\_abnormality | 4117.0 | ARRAY [3] OF BOOL | ARRAY [3] OF BOOL | Reset the abnormality (once manual check is performed and problem fixed) |

If pump stopped running when all the settings are correct, check the abnormality feedback.

* If FEEDBACK\_pump\_abnormal\_termination[n] is True
* Do some manual inspection and physically fix the problem
* CTRL\_pump\_reset\_abnormality[n] to True, where n is the pump index (1st pump is 0)

## Reference constants

These values are system constants and read-only values. Some can be changed, but must take extreme caution.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Address | Type | Description |
| REF\_Rack\_type | 300 | WORD | Type A = 1 Type B = 2 Undefined = others |
| REF\_version\_major | 301 | WORD | Version info |
| REF\_version\_minor | 302 | WORD |  |
| REF\_version\_revision | 303 | WORD |  |
| REF\_rack\_id | 304 | WORD |  |
| REF\_rtc | 310 | ARRAY [7] OF WORD | Array of current date and time, first to last:  Year  Month  Day  Hour  Minute  Seconds  Day of week |
| REF\_pump\_spin\_limit | 4700 | ARRAY [3] OF WORD | Speed threshold defined in 0.01 Hz. For example if 30Hz is desired, set to 3000. |
| REF\_pump\_spin\_limit\_shutdown\_time | 4705 | ARRAY [3] OF WORD | Abnormality duration (in seconds)before shutting down the pump |

More to come …