Hunter Water Corporation A.B.N. 46 228 513 446

Standard Technical Specification for:

STS 550

GENERAL REQUIREMENTS FOR SCADA AND AUTOMATION SYSTEMS

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1 Purpose

This document describes the Principal's (Hunter Water Corporation (Hunter Water)) requirements for the configuration and programming of the supervisory control and data acquisition (SCADA) and automation systems. The scope includes:

(a) PAC/PLCs

(b) remote telemetry units (RTUs)

(c) SCADA

(d) human machine interfaces (HMI)

(e) control network layouts

(f) communications and telemetry.

All work shall comply with this standard using the software packages and versions as defined by the Principal.

The Principal shall not be bound to check any documents or software code submitted for errors, omissions, or compliance with the requirements of this specification or any other standards.

All software code produced for the Principal remains the property of the Principal and retains the right to refuse the use of software code due to any non-conformance.

2 Interpretation

For the purposes of this standard technical specification (STS), except where the context requires otherwise:

(a) 'Drawings' means the drawings detailing the work involved in the project in hand.

(b) ‘Include’ means including but not limited to, and is used to provide clarification or examples of the type and nature of items intended.

(c) 'Specification' means the specification detailing the work involved in the project in hand.

(d) ‘Code’ means the software programs related to the project in hand.

(e) ‘Standards’ means applicable industry standards include the Australian Standards (AS), Australian / New Zealand Standards (AS/NZS), American National Standards Institute (ANSI) and ISO Standards (ISO).

(f) 'Standard drawings' means the Principal’s drawings that are available for certain sites, devices, etc.

(g) 'Standard technical specifications' means the Principal’s technical specifications.

(h) 'Standard code' means the Principal’s standard code libraries.

(i) ‘Guides’ or ‘guidelines’ means the Principal’s documentation guides or guidelines.

Headings are for the convenience of the reader and shall not be used in the interpretation of this STS.

Unless the context requires otherwise, any expression such as ‘give notice’, ‘submit’, ‘approval’, or ‘directed’ means give notice to, submit to, approval by, or directed by the person nominated by the Principal or purchaser.

Unless the context states otherwise, any expression in this standard in the form of a direction means the Contractor shall perform the direction.

Approval does not imply acceptance of responsibility by the Principal for compliance with this technical specification. Unless approval has been issued in writing approval has not been granted.

Failure to comply with the requirements of this specification or any referred documentation may result in rejection. Where equipment and/or manufacture are rejected, notice should be given by the Principal in writing. All associated rectification work shall be completed by the Contractor at their cost.

2.1 Order of precedence

Specific requirements, including those in project specifications or standard drawings take precedence over this STS. Any deviation from this STS shall be approved in writing on a case-by-case basis by the Document Owner.

3 Roles and responsibilities

3.1 Document owner

The document owner of this STS is the Group Manager Information, Control & Energy or their successor.

3.2 Principal responsibilities

The Principal (Hunter Water), through its appointed representatives (which may be internal staff or a designated consultant), should be responsible for providing input from the various internal stakeholders for the Contractor to undertake the development of both the concept/detailed design, and construction as required by this technical specification. By providing information to the contractor, the principal is not and does not become responsible for the design or performance of any equipment or process.

Any request for a variation to STS 550 shall be made in accordance with the change management process in the Principal's Asset Standards Management Plan.

The document owner shall approve in writing the issue of any updated version of STS 550.

3.3 Contractor responsibilities

Ensure that all works carried out complies with the relevant Principal's standards. Where a noncompliance is required, or where clarification is required, then written approval shall be obtained from the Principal.

4 Definitions

Where the following term, abbreviation or expression occurs in this STS, it is defined as follows unless the context implies otherwise.

Term / Abbreviation / Expression	Definition
ACMM	Automatic Control and Monitoring Manual
Approved/Approval	Approved/Approval by the Principal in writing
Approved product	Included on a list prepared by the Principal of approved products and services
AS	Australian Standard
AS/NZS	Australian/New Zealand Standard
Automation	Collection of hardware, software code and communication systems that provides the means of remotely monitoring and controlling equipment
Commissioning/commissioned	Point at which any new hardware and software code is tested and proven ready to go live in production systems
Contract	Contract means the relevant contract(s), in the form of an agreement, purchase order or other arrangement, for the design, construction or ancillary works relating to the Principal's network or assets (or which will become the Principal's assets), for which compliance with this document is required
Directed	Directed by the Principal
Document Owner	The Principal's Group Manager Information, Control & Energy
Ellipse	The Principal's Enterprise Resource Planning (ERP) software
Equipment number	A configurable parameter in SCADA that is aligned with the plant number from Ellipse. All references to equipment number (within SCADA) shall be deemed to mean Ellipse plant number
FAT	Factory Acceptance Test
FTP	File Transfer Protocol
Function block	An item of code in a PLC/RTU that is repeatedly used
HO	The Principal's head office
HWACL	Hunter Water Automation and Control Library
HWPCL	Hunter Water Point Configuration Library
HWSCL	Hunter Water Standard Coding Library
IFC	Issued for Construction
IP	Internet Protocol
IT	Information Technology
ITP	Inspection Test Plan
Large site	Large sites are generally treatment plants and large pumping stations with more than six pumps
Medium site	Medium sites are usually pumping stations with less than seven pumps, reservoirs, Pressure Reducing Valves (PRVs), etc.
OT	Operational Technology
Plant number	A unique reference number in Ellipse for a piece of equipment or site
PAC/PLC	Programmable Automation Controller/Programmable Logic Controller

Term / Abbreviation / Expression	Definition
Principal	The Hunter Water Corporation (Hunter Water). Unless the context states otherwise, any reference in this technical specification to the Principal refers to the Principal's Authorised Person/s as nominated in the General Conditions of Contract or, where not nominated in the General Conditions of Contract, the person as nominated by the Principal to act on its behalf. Depending on what is required this may be a Project/Contract Manager, Subject Matter Expert, and/or the Document Owner. The default when not specified will be the Project/Contract Manager
Project/Contract Manager	The Principal's authorised person nominated to act on its behalf to manage the contract
Proprietary	A commercial supplier's standard design of equipment or process. For example, UV disinfection systems
RTU	Remote Telemetry Unit
SAT	Site Acceptance Test
SCADA	The Principal's Supervisory Control and Data Acquisition system
Small Station/Site	A small site contains a low power RTU that typically samples a level or flow at intervals of 15 minutes to 1 hour and reports the data to SCADA every 4 to 24 hours. A monitoring bore is a typical small site.
SFAT	Software Factory Acceptance Test
STS	Standard Technical Specification
Subject Matter Expert	The Principal's authorised person with specialised knowledge critical to the operation of the contract. The Subject Matter Expert may add support to the design, mobilisation, and management phases by ensuring specific knowledge is available to the contract. By default, for this technical specification it shall be a SCADA and/or automation resource as nominated by the Document Owner
TCP	Transmission Control Protocol
Telemetry	Technology that allows remote measurement and transparent conveyance of remote information
Unity Pro / Control Expert	Schneider software used to program their PAC/PLCs
VPN	Virtual Private Network
Work / works	Services to be performed, goods to be delivered, and any related actions or deliverables
WPS	Water Pumping Station
WTP	Water Treatment Plant
WWPS	Wastewater Pumping Station
WWTW	Wastewater Treatment Works

5 General requirements

In addition to STS 550, all work and equipment shall comply with the relevant:

(a) Commonwealth and New South Wales (NSW) legislation requirements at the time of commissioning:

(i) *Work Health and Safety Act 2011 (WHS Act)*

(ii) *Work Health and Safety Regulation 2017 (WHS Regulation)*

(b) Australian Standards

(c) the Principal's standard technical specifications

(d) the Principal's design manuals

(e) the Principal's guides and guidelines.

5.1 Legislative requirements

5.1.1 WHS compliance

The WHS Act and WHS Regulation requirements, including, but not limited to:

(a) Requirements to identify foreseeable hazards and either eliminate the hazard or minimise the risks through a hierarchy of controls, so far as is reasonably practical – see WHS Regulation, Chapter 3, Part 3.1.

(b) Requirements in relation to the design, manufacture, import, supply, installation, construction and / or commissioning of equipment. Whether these are directly applicable to the contractor, original equipment manufacturer, or indirectly to the Principal, these provisions shall be met, and a contractor shall provide all equipment, services and documentation within its scope of supply to meet these requirements. See WHS Regulation, Chapter 5. Plant and Structures.

(c) The application of the relevant SafeWork NSW (formerly WorkCover NSW) Codes of Practice.

5.1.1.1 SafeWork NSW Codes of Practice

SafeWork NSW approved Codes of Practice and Guidelines are practical guides to achieving the standards of health, safety, and welfare under the WHS Act and WHS Regulations. They may recommend suitable risk control measures for an identified foreseeable hazard. The application of any such control measures means that determination of the resultant residual risk rating is not required.

5.2 Standards

The legislation and Codes of Practice mentioned above provide the high-level requirements to meet compliance.

The Australian Standards are a technical guide that shall be followed unless alternative methods for compliance are provided and have been endorsed by the Principal.

Hence, Australian Standards are to be used as technical guides in accordance with the relevant Code of Practice. It shall be noted that compliance with the relevant Australian Standard does not necessarily mean compliance with the legislation or Code of Practice. Guidelines on their use is provided in the Codes of Practice.

If there is conflict or omission between the legislative requirements and Australian Standards, then the issue is to be risk assessed and managed as per the relevant Code of Practice and documentation shall be provided with the project information. Example of a common NSW Codes of Practice is *Managing the Risks of Plant in the Workplace*.

Any standards relevant to SCADA and automation equipment supplied to and operated by the Principal shall apply, including specific standards or suites of applicable standards referenced in *STS 500 General Requirements for Electrical Installations*.

All relevant Australian Standards shall apply, with the minimum of:

(a) *AS/NZS 3000 Electrical installations (known as the Australian/New Zealand Wiring Rules)*

(b) *AS/NZS 3008.1.1 Electrical installations - Selection of cables - Cables for alternating voltages up to and including 0.6/1 kV - Typical Australian installation conditions*

(c) *AS/NZS 1768 Lightning Protection*

(d) *AS/NZS 60950 Information technology equipment - Safety - General requirements*

(e) *AS/CA S009 Installation requirements for customer cabling (Wiring Rules)*

(f) *AS/CA S008 Requirements for customer cabling products*

(g) Communications Alliance (AS/CA) Technical Standards for telecommunications including but not limited to AS/NZS 4117 Surge protective devices for telecommunication applications.

5.3 Contractors

For the following work in this standard, use only contractors and sub-contractors listed on the Principal's approved contractors lists available on the Hunter Water website – www.hunterwater.com.au:

(a) Telemetry and Automation

(b) other contractors as approved by the Principal's Subject Matter Expert.

Personnel from these organisations shall have suitable qualifications and training and shall be approved on an individual basis by the Principal's Subject Matter Expert.

Any work also includes viewing, programming, or physically connecting with electronic devices, to any Hunter Water equipment or communications networks.

5.4 Materials and equipment

Use only equipment and materials listed in the Principal's *Approved products and manufacturers* document on the Hunter Water website – www.hunterwater.com.au:

(a) Approved electrical product manufacturers.

All materials and equipment used shall be from items stocked within Australia and shall be from local suppliers within the Newcastle region who provide support services for their products.

Where items are described by reference to a trade brand name or catalogue number, such a description is intended to indicate the type, quality, appearance, and method of construction required. An item of a similar or equal standard may be incorporated in the works, subject to written approval from the Principal's Subject Matter Expert.

Only equipment that is an approved product shall be permitted to connect to the SCADA and control networks as defined in section 12. If the Contractor wishes to use any materials and equipment not on

the approved products list, then the details shall be submitted to the Principal's Subject Matter Expert for consideration, but there is no guarantee that it will be accepted for use in any works. This includes any proprietary systems as per section 5.10.

5.5 Computer equipment

Computers used for software code development shall have adequate, current, and active anti-virus software and all operating system security patches shall be within 2 weeks of manufacturer's release. They shall also comply with section 5.13.

5.6 Software and configuration files

Any software programs required for the configuration or maintenance of installed equipment, and that the Principal does not own a copy of or already has a licence/maintenance agreement for, shall become the property of the Principal after commissioning. Any configuration files and code created by this software shall also become the property of the Principal after commissioning.

If any software code or configuration file changes are made to production units, at the end of each day of changes, the current version of the software code or configuration files are to be emailed in a 'zipped' format to the email address automation@hunterwater.com.au, and also cc'd to the Principal. Similarly, the Contractor shall send the final versions to the Principal as part of the STS 903 Work As Constructed Information Standard.

The format for the filename for each piece of software code or configuration file for a device is:

- <facility plant number>.xxx

If there are multiple devices of the same type at a facility, then it shall be suffixed:

- <facility plant number>-1.xxx

For example, if there are multiple radios at a site:

- <facility plant number>-1.cfg
- <facility plant number>-2.cfg

Please see Appendix G for more information on file types and some examples.

No software code that is for control shall be used in any devices other than the PAC/PLC and/or RTU. For example, there shall be no software code inside an HMI and/or VSD that controls a process and/or another device.

Any software code development shall be discussed with the Principal's Subject Matter Expert to determine the preferred method before commencing any work. For example, will it be based on standardised code, custom code, etc.? This may result in existing/modification/new standard code as per section 5.12, custom code, or a combination of different methods.

5.7 Firmware

All new hardware and any existing hardware with its software code being modified, is to be upgraded to the latest firmware versions available at 10 working days before the commencement of software work on a site, unless otherwise advised by the Principal. This shall always include the PAC/PLC CPU as a minimum whenever there is a change to the software code.

Firmware updates shall also include any devices that interact with the new or existing hardware. For example, if any new PAC/PLC communication cards (CPU, CRP, CRA, NOE, NOC, NOM, NUA, etc.) are added to the existing PAC/PLC infrastructure, then all PAC/PLC communications cards in the

installation shall be upgraded to the latest firmware versions. Similarly, if a new Ethernet switch is added then all the Ethernet switches in the associated Ethernet, RIO, or DIO network shall have their firmware updated.

However, if the latest firmware causes a conflict with the current approved version of any software code or hardware used by the Principal, then the latest non-conflicting version shall be used, in consultation with the Principal's Subject Matter Expert.

5.8 ACMM development

With all hardware and software code development, an Automatic Control and Monitoring Manual (ACMM) will be required. If a site already has an existing ACMM then it shall be updated with the new information or be based on the latest ACMM template, as directed by the Principal. For a new site the ACMM shall be based on the Principal's ACMM template or added as an addendum to the 'generic' ACMM for certain site types and processes. On request, the Principal will provide direction on the ACMM requirements, the existing site ACMM, the latest ACMM template, and/or the appropriate 'generic' ACMM.

An initial draft ACMM (developed by the Contractor's process designer) shall comprehensively detail additions or modifications to the existing/new plant control, including abnormal/failure conditions, and monitoring functionality so it is suitable to be used to develop the code.

Where an existing ACMM is issued by the Principal, the Contractor shall document all differences between the issued ACMM and the draft ACMM.

The draft ACMM, and any documented differences with the Principal issued ACMM, shall be submitted for review. The Contractor shall participate in a review workshop of the ACMM with the Principal, incorporate the Principal's comments to develop a draft 'for construction' ACMM revision and submit it for review.

Incorporate and respond to any Principal comments to produce a final 'for construction' ACMM. After commissioning, a 'work as constructed' ACMM is required and shall be submitted to the Principal.

5.9 Inspection and testing

The general requirements for inspection and testing are detailed in the Principal's *Testing, Commissioning and Process Proving Technical Specification (QT121)*. A Factory Acceptance Test (FAT), Software FAT (SFAT), and a Site Acceptance Test (SAT) will be required for works under contract as required. Specific requirements for automation are detailed below:

(a) Submit copies of all Inspection and Test Plans (ITPs) and the related test check sheets to the Principal before and after any factory or site testing.

(b) Submit copies of all proposed PAC/PLC programs, RTU programs, SCADA mimic screens, HMI screens and all other software code to the Principal. This shall be at approximately 35% and at 75% completion of the code. Additionally, the versions which will be used for the FAT, SFAT, and SAT shall be submitted at least 10 working days before the tests. A guide as to the minimum information required at each stage is found in Appendix D.

5.10 Proprietary equipment

Proprietary equipment is to be manufactured and supplied using components selected from the Principal's materials and equipment standards (section 5.4). No proprietary controllers are to be used, which includes but is not limited to, any device that requires software and an interface cable to

configure. For example, a PAC/PLC, automation controller, HMI, or monitoring relay not already listed in the Principal's materials and equipment standards shall not be used.

Any hardware and/or software code supplied is to be fully open and accessible to the Principal, i.e. no hardware or software code locks are to be used that would restrict the Principal's ability to modify or view any components of the hardware or software code without the assistance of external entities. Failure to comply with this clause will result in the proprietary equipment being rejected for use on the Principal's sites.

5.11 Integration guides

The Principal's equipment and process integration guides shall be followed wherever possible, the general principles contained within them are applicable to all work carried out by the Contractor.

The Contractor shall confirm what integration guides are available from the Principal.

5.12 Approved standard software code

Approved standard software code is available for most types of small to medium sites, which includes PAC/PLC, RTU, and SCADA which is built on the elements of the HWSCL detailed in section 6. For example, there is standard PAC/PLC, RTU, and SCADA software code for WWPS that aligns with an integration guide as per section 5.11.

The Contractor shall confirm with the Principal what approved standard software code is available and update all software code on a small or medium site to the latest approved standard software code when carrying out any software code work on a site. The latest approved standard software code will be the version available at 10 working days before software work on a site.

Sections of approved standard software code for some processes are also available for large sites and shall be updated in the site software code if it is within the process area being modified or added. The Contractor shall confirm with the Principal what approved standard software code is available.

Approval from the Principal's Subject Matter Expert shall be obtained before modification of existing standard software code or development of new standard software code. The Contractor shall confirm with the Principal about what testing procedures are required for any standard software code changes and complete them before commissioning of any production sites.

Individual software code elements (e.g. PAC/PLC DFBs, etc.) used within the approved standard software code are contained with the HWSCL detailed in section 6. The latest approved versions of the individual software code elements shall be used in any software development. The latest approved versions of the individual software code elements will be the versions available at 10 working days before software work on a site.

5.13 Cyber security

The Principal's SCADA and automation systems are part of an OT Information Security Management System (ISMS) framework. The OT ISMS complies with ISO 27001. Contractors shall assist the Principal in meeting their security obligations.

Any installed equipment that is configurable through software shall be managed with strong and unique passwords. The Contractor shall confirm with the Principal what are the requirements for password naming and control.

Also, particular attention shall be paid to disabling all unused access points and protocols on all installed hardware including but not limited to PLCs, RTUs, communication transceivers, and Ethernet switches. For example, Bluetooth, wireless, HTTP, FTP, etc.

Any relevant Principal cyber security policies shall also be followed.

6 Hunter Water Standard Code Library (HWSCL)

The Principal has a standard code library (HWSCL) containing software code elements for common automation controls and interfacing information for other devices. Software code elements within this library shall be made available on request via the Principal.

The library has two sections:

(a) HWACL – Hunter Water Automation and Control Library

(b) HWPCL – Hunter Water Point Configuration Library.

Further development of software code using the HWSCL shall be required wherever possible to suit each application and shall comply with all clauses within this STS. Approval from the Principal's Subject Matter Expert shall be obtained before development of new software code elements.

Where problems are found with the HWSCL, please contact the Principal's Subject Matter Expert.

6.1 HWACL

The HWACL contains Principal developed software code for the following devices:

(a) PAC/PLCs – Function blocks for commonly used devices, e.g. drives, power meters, weather stations, etc.

(b) RTUs – Configuration files, internal programs, function blocks, etc.

(c) SCADA – Configuration files, network information, etc.

(d) Communications devices – Configuration files, etc.

All PAC/PLC/RTU derived function blocks are 'read only' rather than completely locked to allow for software code debugging.

Most of the PAC/PLC/RTU derived function blocks in the HWACL are matched to a corresponding template in SCADA. The documentation provided with each block will detail its corresponding template, where it exists.

An example of the type of information that will be provided by the Principal is available in Appendix A.

6.2 HWPCL

The HWPCL contains the common mapped addresses (e.g. Modbus and DNP3) between the PAC/PLC, RTU and SCADA system corresponding to the function blocks and/or standard code in the HWACL.

The HWPCL is primarily directed at medium and small sites, but large sites use a similar structure as shown in 7.5.7. If there are any departures from the HWPCL, they must first be approved by the Principal's Subject Matter Expert, and the addresses that were used shall be provided to the Principal at the end of commissioning in the same format as the HWPCL.

7 Programmable automation controller/programmable logic controller (PAC/PLC)

All downloading, modification, or configuration of a PAC/PLC shall be performed while physically at the site, and no remote connections from non-Hunter Water external sources via VPN (or similar) are permitted.

7.1 PAC/PLC hardware layout

All proposed changes or additions to existing or new PAC/PLC rack hardware layouts shall be submitted for review and comment by the Principal's Subject Matter Expert. They shall first be submitted in a spreadsheet format and only transferred to CAD drawings after review and comment by the Principal. This shall include individual I/O allocation.

For most small and medium sites, the standard PAC/PLC hardware used is detailed within the Principal's drawing sets and is available from the Principal on request.

For all other sites, the PAC/PLC hardware shall be selected to meet the site/contract requirements as per section 5.4 based on the network architecture design information in section 12. This shall be accompanied by the draft automation network drawings, i.e. the Principal's SK8198 drawing set.

7.2 PAC/PLC software code layout

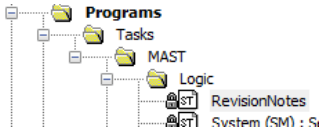
PAC/PLC software code, at a minimum, shall:

(a) Comply with all requirements within this document.

(b) Be neatly and logically arranged.

(c) Have all code well-spaced.

(d) Have a structured text task section at the start of the logic called 'RevisionNotes' that shows what changes have been made in each software code revision. It shall detail the changes made to each revision and retain the history of changes and match the identification in 7.5.2.

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(*****************************************************************************

Section Name:           RevisionNotes

Section Description:    This section should be used to describe program revisions

Rev     Date            Name                    Description
-----------------------------------------------------------------------------
2.6     2020-08-28      A. Citizen (PLC Corp)   -  HWC_060, HWC_065, HWC_091, HWC_100 and HWC_142 FBs updated
                                                - Removed PS00001 function block instance (HWC_122), added pit flooded enable + time delay
                                                - Changed VSD DTM last value setting to 'Set to Zero'
                                                - Adding scaling factors for Altivar torque and remote res level

2.5     2020-02-07      J. Bloggs (Best Eng)    - Updated ReservoirControl to prevent offline Res affecting speed calculation
                                                - Updated comments in setup_default section
                                                - Updated default DTM drive number for each pump
```

Figure 1: Example – PLC 'RevisionNotes'

Where the 'RevisionNotes' section is locked as part of standard code for a generic site type (e.g. WWPS, WPS, etc.), a second section shall be created called 'SiteRevisionNotes'. This section shall contain the details of the changes made to the site.

Examples of information to include are:

- which code sections have been modified and how
- any changes to communications or device parameters, e.g. VSDs, instrumentation
- any changes to firmware
- any changes to the HWACL library used.

(e) All sections created in FBD language shall be of dimensions 180 columns wide x 480 rows high.

(f) Have a comment block placed at the beginning of each section of code. It shall contain the task section name, description, and revision history.

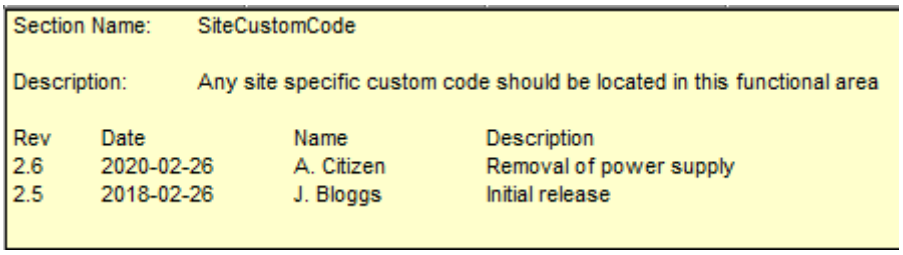


Figure 2: Example – PLC comment block

(g) Have each sub area in the task section separated by a header (comment block) that contains the name of the sub area; where its minimum width is to be equal to the code produced.

(h) Include additional comments defining the purpose of the logic. They are to be placed above or to the side of the area of code, and not obscure any components of the code.

(i) Have variable names displayed in full, with blocks and interconnecting lines not overlapping or obscuring any other items.

(j) For all new sites (and existing sites where possible) using Control Expert software, the project settings shall be as defined in the approved project settings file 'HWC_UnityProjectSettings.xso'. This file is available on request via the Principal.

(k) For proprietary package equipment supplied to the Principal, the PAC/PLC project software code and all elements contained within shall be fully open and accessible as per section 5.10. In addition, the following project settings are required:

- General | PLC embedded data | Upload information shall have the check box ticked
- General | PLC embedded data | Comments shall have the check box ticked
- General | PLC embedded data | Animation tables shall have the check box ticked.

Examples of Control Expert PAC/PLC code layout are provided in Appendix B.

7.3 PAC/PLC programming software

The current Principal approved version of the PAC/PLC programming software shall be used. Where a later Principal approved version is released during the term of a contract, then at the time of final commissioning that version shall be used.

The PAC/PLC project shall be built in the same version as the programming software used.

7.4 PAC/PLC IP address

The PAC/PLC IP addresses will be provided on request via the Principal. A complete list shall be supplied to the Principal by the Contractor for the devices indicating what IP addresses, subnet masks, and gateway addresses are required. This shall be accompanied by the draft IFC automation network drawings, i.e. the Principal's SK8198 drawing set.

The Contractor shall confirm that there are no conflicts with any IP addresses by performing ping tests, or more thorough network auditing as required (see section 12.1(c)), before connecting any network device.

7.5 PAC/PLC naming conventions

7.5.1 PAC/PLC program file names

The Control Expert PAC/PLC program file name is to conform to the naming convention described below:

(a) <facility plant number>.sta – the archived project

(b) <facility plant number>.dtx – the project data file

(c) <facility plant number>.stu – the project file.

Where the facility plant number contains the – (dash) character it shall be included in the filenames. Please see Appendix G for more information and some examples.

Any request for variation to this naming format shall be approved via the Principal's Subject Matter Expert.

7.5.2 PAC/PLC program comment

The PAC/PLC project name shall use the <facility plant number> format as described in section 7.5.1.

The Properties | Identification fields of the PAC/PLC project shall reflect the current version of the program and be the same as the revision notes version in 7.2. Figure 3 shows a project version of 2.6. The 'Automatically incremented' radio object shall be checked so that the counter in 'Build' is incremented:

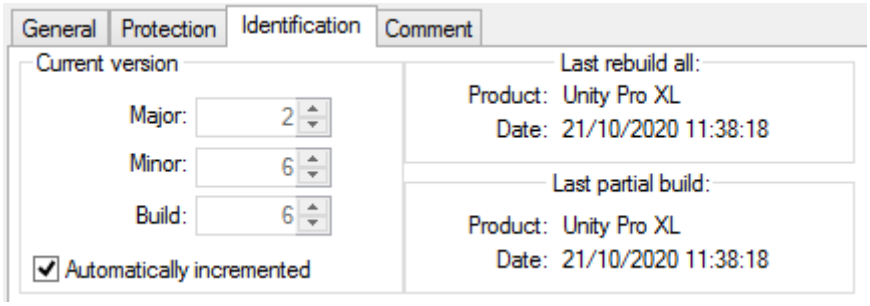


Figure 3: Example – project properties identification

The Properties | Comment field of the PAC/PLC project shall display the first line as <Facility Name>. Subsequent lines may describe any feature of that project or shall be left blank.

For example:

(a) for a treatment plant:

(i) project name – ST-DUN

(ii) project comment – Dungog WWTW.

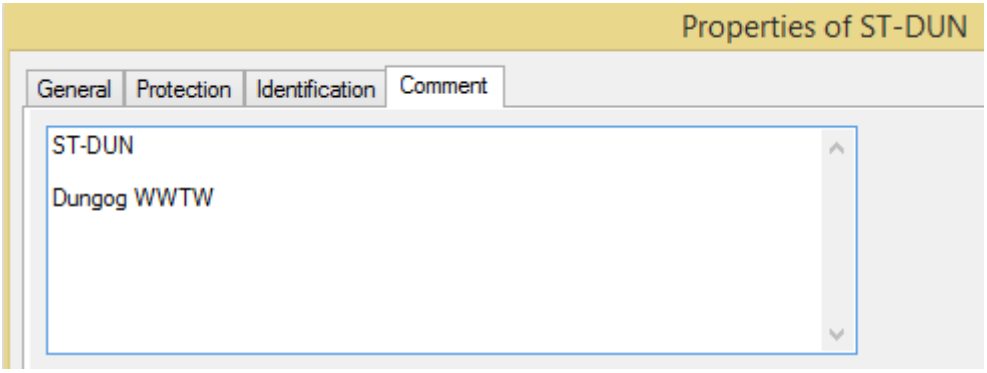


Figure 4: Example – project properties comment

(b) for a pumping station:

(i) project name – SS-BEL-001-PS1

(ii) project comment – Belmont 1 WWPS.

7.5.3 PAC/PLC functional modules

The PAC/PLC functional modules are defined as follows:

(a) System (SM) – contains I/O mapping and communications routines between the PAC/PLC and other devices.

(b) Process Area (PA) – is the top logical level for the processes. It contains functional modules that are logical units in the plant process. For example, there might be separate functional modules for inlet works, sludge handling, chemical dosing, UV disinfection, etc.

Further sub-levels of functional modules can be added for logical separation of equipment. For example, inlet works → screening → screen conveyor 1 → conveyor motor MO1234.

(c) Setup (SU) – mainly used in approved standard software code as per section 5.12. Contains PAC/PLC configuration values, usually in Structured Text.

(d) Site Options (SO) – mainly used in approved standard software code as per section 5.12. It contains options not used at every site but that are still relatively common.

(e) Site Custom (SC) – mainly used in approved standard software code as per section 5.12. It is used for custom code specifically related to that site.

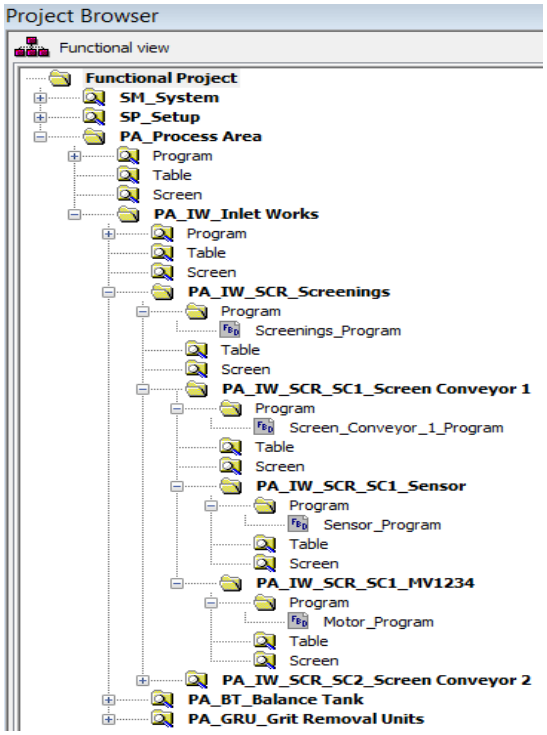
7.5.4 PAC/PLC program structure

The PAC/PLC program structure shall be configured to follow the hierachy in 7.5.3 by using the functional view. This shall then translate across to the structural view and be sorted so that related sections are grouped together.

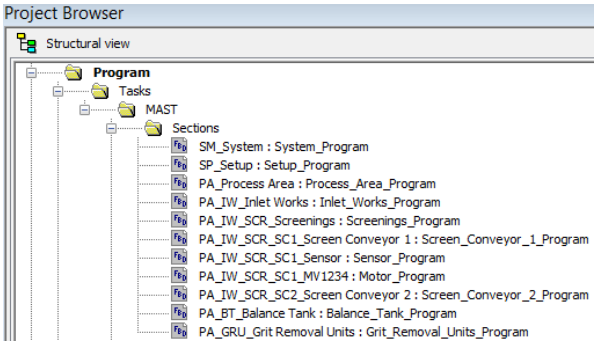
Abbreviations for each section can be used to keep the total functional module name below the character limit of thirty-two. Plant names shall be used wherever possible for control modules, and for other modules where it is warranted. The sections shall be sorted into appropriate location in each view, mostly also alphabetically, and not just added at the bottom of the list by default.

An example of the possible program structures for Control Expert are as follows:

Large site PAC/PLC functional view



Large site PAC/PLC structural view



Or, a more simpler functional view structure:

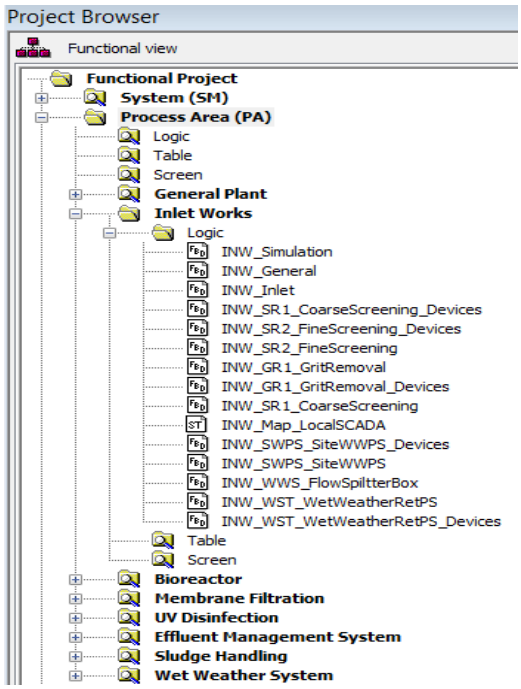
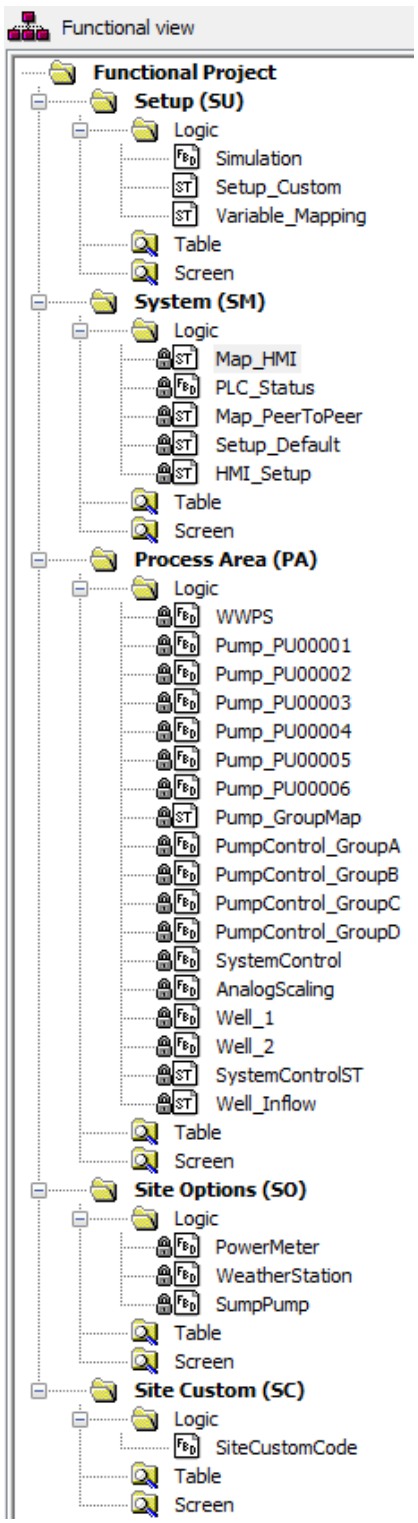


Figure 5: PAC/PLC large site program structure

Medium site PAC/PLC functional view



Medium site PAC/PLC structural view

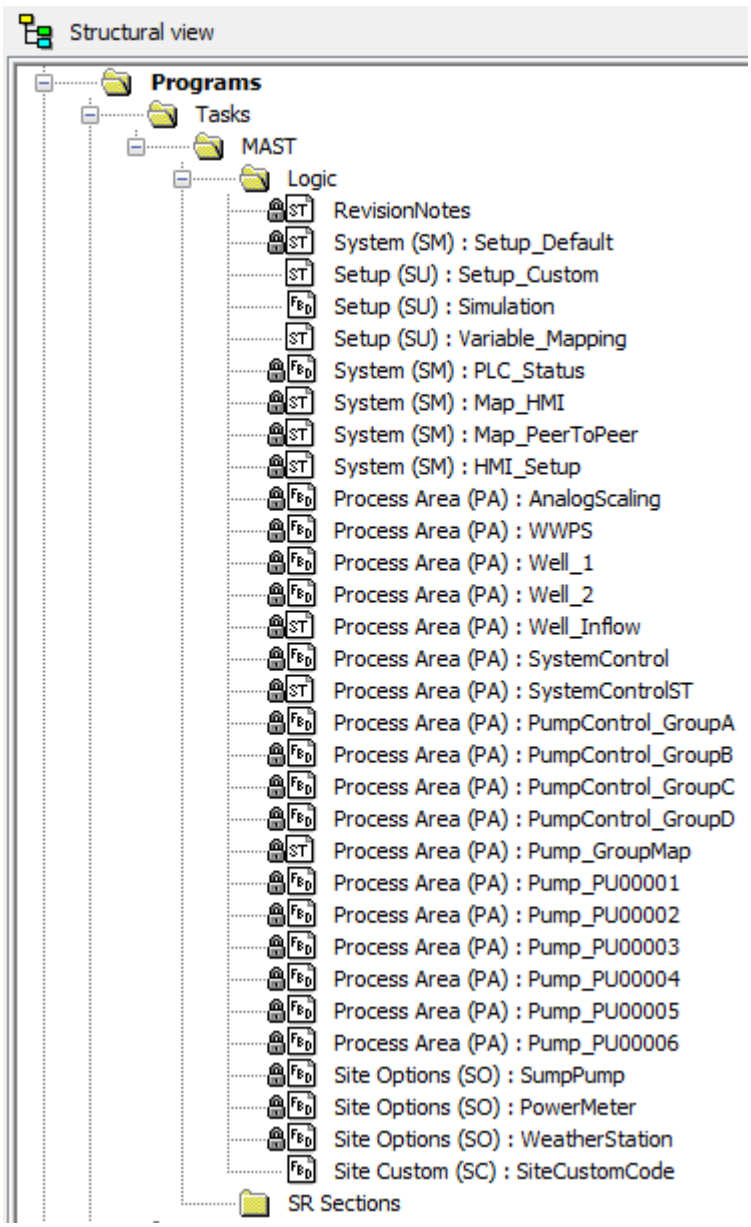


Figure 6: PAC/PLC medium site program structure

7.5.5 PAC/PLC derived function block naming

The following naming convention shall be followed for derived function blocks:

(a) For large sites – (complete device plant number minus facility plant number) = <equipment type identifier>

For example – ST-BUR-ABR-WA1-PUSW123 shall be displayed as PUSW123.

A suffix can be added if there are multiple function blocks, e.g. PUSW123 _TeSys_T.

(b) For medium sites where the same PAC/PLC code is repeated at each facility use the same naming convention but replace the plant number with the following:

<control module identifier><incrementing five-digit number>

For example – PU00001

- PU is the control module identifier (pump)
- 00001 is the first pump used in the program.

A suffix can be added if there are multiple function blocks, e.g. PU00001_DOL.

The derived function blocks shall also have comment describing the equipment and any other relevant information:

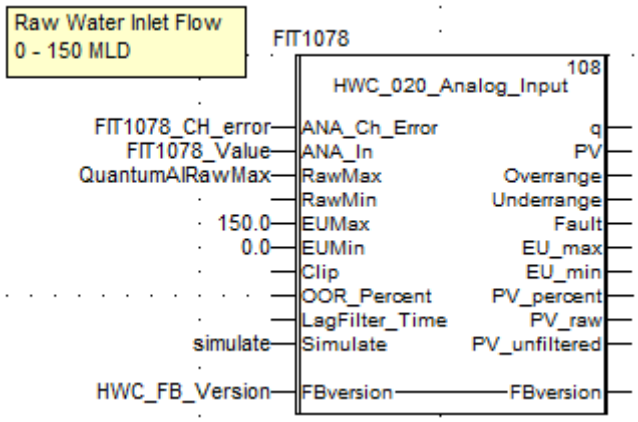


Figure 7: Derived function block comment in code section

A similar description shall also be included in the ‘General attributes’ of the instance of the derived function block for the ‘Comments’ section:

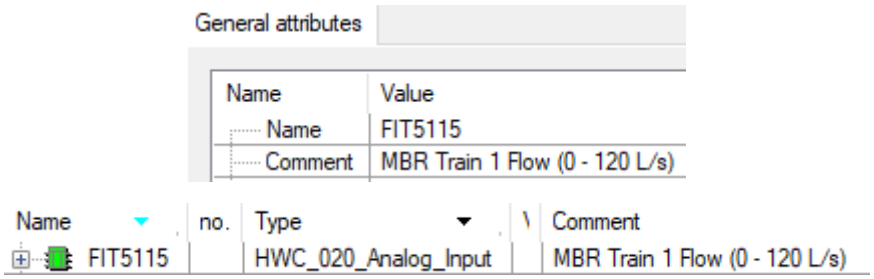


Figure 8: Derived function block comment in general attributes

Any communications structures should also follow the same naming as the function block with "_Comms" as a suffix. For example, the DTM structure for PU00001 is as below:

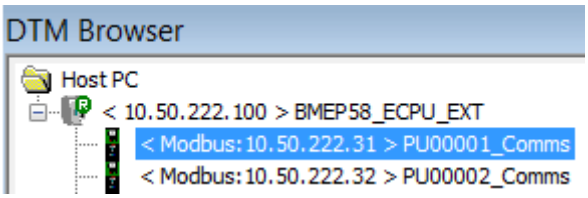


Figure 9: DTM structure naming

7.5.6 PAC/PLC variables

PAC/PLC variables come in a variety of types:

- Elementary Data Types (EDT) – BOOL, WORD, INT, REAL, DATE, etc.
- Derived Data Types (DDT) – is a set of elements of the same type (ARRAY) or of various types (structure).
- Derived Data Types that reference inputs/outputs (IODDT) – are predefined by the manufacturer, and contain language objects of the EDT family belonging to the channel of an application-specific module.
- Device Derived Data Types (Device DDT) – is a DDT predefined by the manufacturer and not modifiable by user. It contains the I/O language elements of an I/O module.

7.5.6.1 PAC/PLC variable comments

All PAC/PLC variables created are to include a detailed description of their functions in their comment field. This includes both exposed and internal function block variables. This comment shall also include engineering units, where applicable.

For booleans, this comment shall indicate the state of the variable when its value is 1 (TRUE), for other types it shall be as descriptive as possible:

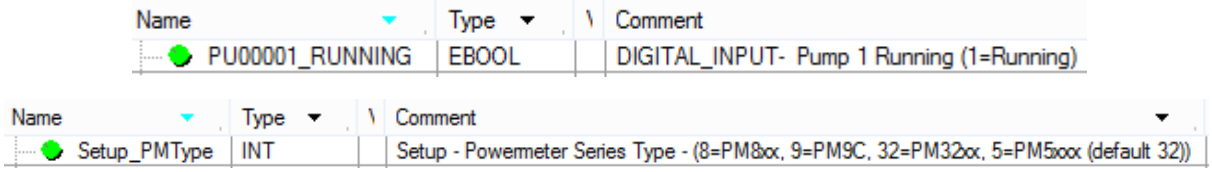


Figure 10: PAC/PLC variable comments

7.5.6.2 Naming of Control Expert EDT/DDT elements

(a) In general, PAC/PLC variable names shall use the equipment type identifier or control module identifier with a variable descriptor as a suffix:

(complete device plant number minus facility plant number)_<variable descriptors>

Example – LSL5245_FLT is the PAC/PLC variable name for a low level switch calculated fault.

A table of variable descriptors is provided in Appendix E.

(b) Where a variable is from I/O, all letters in the variable name are in upper case:

Examples: PU00001_CONTACTOR (pump 1 contactor 1 = closed)

PU00001_RUN (pump 1 run relay output 1 = run)

(c) Where an internal variable is used, without being part the function block structure but is related, the variable is to be addressed using the function block name as the first part of the reference, and then the second part as a description. If the description is more than one word, the name shall be written joined with the first letter of each word in upper case:

Example – WW00001_A_LT_ANA_Ch_Error

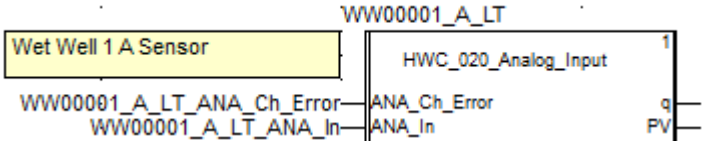


Figure 11: PAC/PLC internal variable naming

(d) Where an internal variable that is more general and is not specifically related to one control module is used, the variable name shall be written as all words joined together, with the first letter of each word in upper case. A suffix can also be added to distinguish between different processes:

Example – SC1_AllPumpsSpeedReference

(e) Where a variable is used purely internally within a function block, the variable name shall be written as all words joined together, with the first letter of each word in upper case and with a prefix of '_':

Example – _DeviceHealthy

7.5.6.3 IODDT and device DDT

All PAC/PLC I/O modules shall use the default IODDT and device DDT names as allocated automatically and not use topological addressing.

For example, an 8-channel analogue input card located in slot 6 of the main PLC rack will have the device DDT name of "PLC0_d0_r0_s6_AMI0810" as shown in Figure 12.

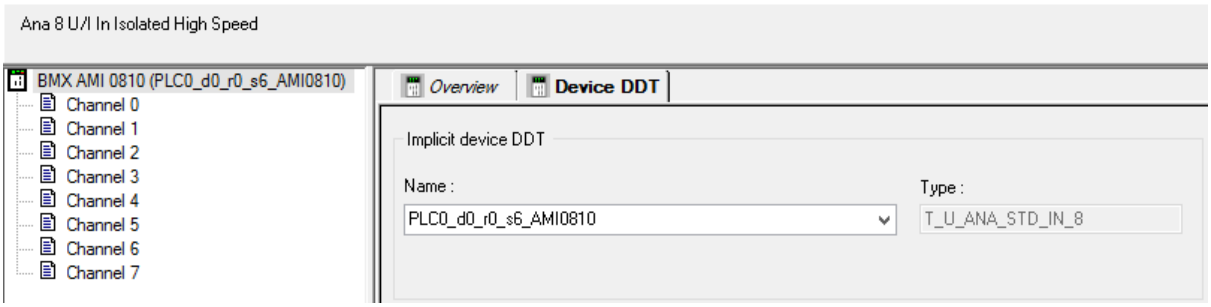


Figure 12: PAC/PLC main rack device DDT

The same module in RIO rack drop 4 slot 10 will be “EIO2_d4_r0_s10_AMI0810” as shown in Figure 13.

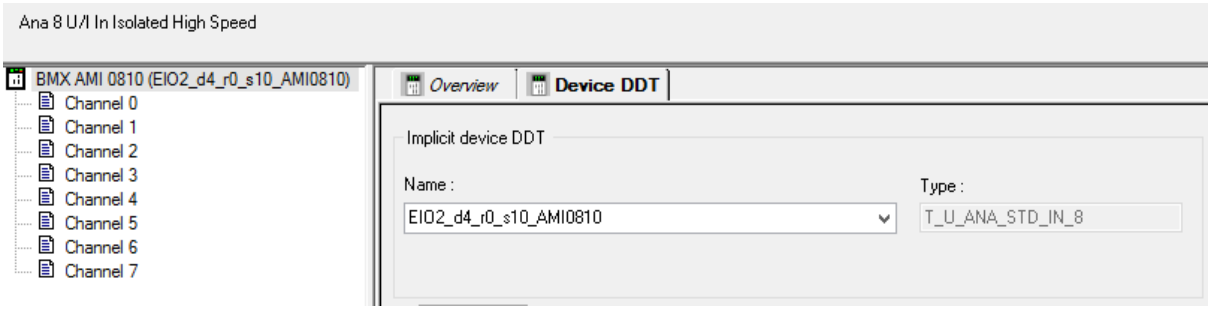
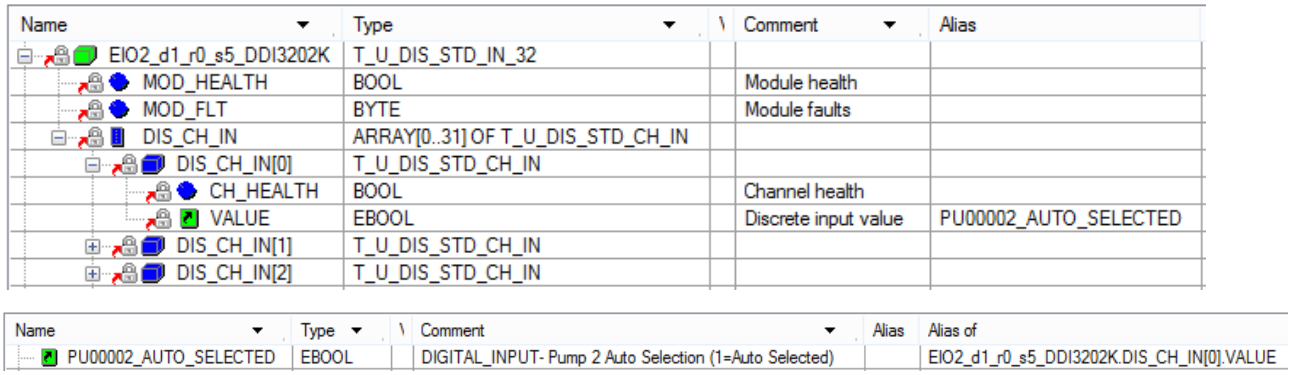


Figure 13: PAC/PLC remote rack device DDT

7.5.6.4 PAC/PLC I/O aliasing

Rack I/O shall use aliasing to associate variables to I/O channel values and states. An example of a digital input with aliasing is shown in Figure 14.

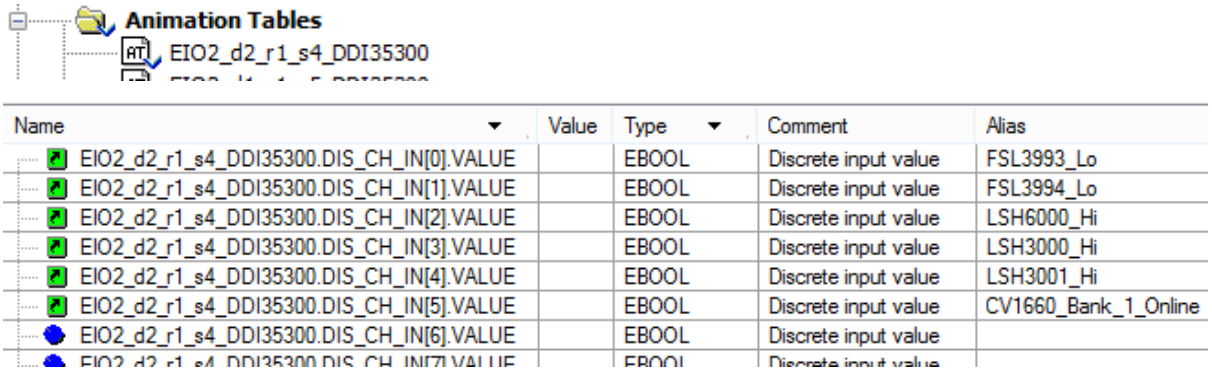


Name	Type	Comment	Alias
EIO2_d1_r0_s5_DDI3202K	T_U_DIS_STD_IN_32		
MOD_HEALTH	BOOL	Module health	
MOD_FLT	BYTE	Module faults	
DIS_CH_IN	ARRAY[0..31] OF T_U_DIS_STD_CH_IN		
DIS_CH_IN[0]	T_U_DIS_STD_CH_IN		
CH_HEALTH	BOOL	Channel health	
VALUE	EBOOL	Discrete input value	PU00002_AUTO_SELECTED
DIS_CH_IN[1]	T_U_DIS_STD_CH_IN		
DIS_CH_IN[2]	T_U_DIS_STD_CH_IN		

Name	Type	Comment	Alias	Alias of
PU00002_AUTO_SELECTED	EBOOL	DIGITAL_INPUT- Pump 2 Auto Selection (1=Auto Selected)		EIO2_d1_r0_s5_DDI3202K.DIS_CH_IN[0].VALUE

Figure 14: Rack I/O device DDT

Wherever aliasing is used, an animation table shall be created for each I/O module, in order of channel and including spare I/O assigned as shown in Figure 15. This allows easier searching by I/O channel.



Name	Value	Type	Comment	Alias
EIO2_d2_r1_s4_DDI35300.DIS_CH_IN[0].VALUE		EBOOL	Discrete input value	FSL3993_Lo
EIO2_d2_r1_s4_DDI35300.DIS_CH_IN[1].VALUE		EBOOL	Discrete input value	FSL3994_Lo
EIO2_d2_r1_s4_DDI35300.DIS_CH_IN[2].VALUE		EBOOL	Discrete input value	LSH6000_Hi
EIO2_d2_r1_s4_DDI35300.DIS_CH_IN[3].VALUE		EBOOL	Discrete input value	LSH3000_Hi
EIO2_d2_r1_s4_DDI35300.DIS_CH_IN[4].VALUE		EBOOL	Discrete input value	LSH3001_Hi
EIO2_d2_r1_s4_DDI35300.DIS_CH_IN[5].VALUE		EBOOL	Discrete input value	CV1660_Bank_1_Online
EIO2_d2_r1_s4_DDI35300.DIS_CH_IN[6].VALUE		EBOOL	Discrete input value	

Figure 15: I/O animation table example

7.5.7 PAC/PLC memory addressing

The memory addresses using %M or %MW in the PAC/PLC shall be aligned with the HWPCL in section 6.2, with additional address areas for large sites. All memory addresses shall be associated with located variables in arrays or individually in the EDT/DDT structure. No unlocated variables shall

be used in connection with any %M or %MW memory addresses, or direct addressing using %M or %MW in any code.

It shall be possible to sort the data editor by the 'Address' column to check for conflicting memory addressing, and to show that a particular %M or %MW memory address is used. Care shall be taken not to locate a variable that causes conflicting memory addressing. All double words shall start on even number boundaries, i.e. %MWx0, %MWx2, %MWx4, etc. and not %MWx1, %MWx3, %MWx5, etc.

The table below is the memory address allocation for large sites:

Name	Type	Comment	Starting Address
RTU_DI_AsINT_1	INT	Array for BOOL type DNP3 DI values – area 1	%MW1000
RTU_DO_AsINT_1	INT	Array for BOOL type DNP3 DO values – area 1	%MW2000
RTU_AI_AsDINT_1	DINT	Array for DINT type DNP3 AI values – area 1	%MW3000
RTU_AI_AsREAL_1	REAL	Array for REAL type DNP3 AI values – area 1	%MW3000
RTU_AO_AsDINT_1	DINT	Array for DINT type DNP3 AO values – area 1	%MW4000
RTU_AO_AsREAL_1	REAL	Array for REAL type DNP3 AO values – area 1	%MW4000
Peer1_AO_AsREAL	REAL	Array used to send DNP3 data to peer 1	%MW6100
Peer1_DO_AsINT	INT	Array used to send DNP3 data to peer 1	%MW6150
Peer1_AI_AsREAL	REAL	Array used to receive DNP3 data from peer 1	%MW7100
Peer1_DI_AsINT	INT	Array used to receive DNP3 data from peer 1	%MW7150
<e.g. totaliser, timer value, power meter data, etc.>		Use for variables that need to be located to be data retentive	%MW9000
<e.g. HMISetup_ClockDay>		Used for automatic configuration of the HMI	%MW10000
RTU_DI_AsINT_2	INT	Array for BOOL type DNP3 DI values – area 2	%MW11000
RTU_DO_AsINT_2	INT	Array for BOOL type DNP3 DO values – area 2	%MW12000
RTU_AI_AsDINT_2	DINT	Array for DINT type DNP3 AI values – area 2	%MW13000
RTU_AI_AsREAL_2	REAL	Array for REAL type DNP3 AI values – area 2	%MW13000
RTU_AO_AsDINT_2	DINT	Array for DINT type DNP3 AO values – area 2	%MW14000
RTU_AO_AsREAL_2	REAL	Array for REAL type DNP3 AO values – area 2	%MW14000
<e.g. PLT>		'FunctionalArea' arrays for retentive variable structures for Modbus scanners from local SCADA	%MW15000 onwards

Name	Type	Comment	Address
RTU_DI_AsINT_1	ARRAY[0..62] OF INT	Array used to store BOOL type ...	%MW1000
RTU_DO_AsINT_1	ARRAY[0..62] OF INT	Array used to store BOOL type ...	%MW2000
RTU_AI_AsDINT_1	ARRAY[0..499] OF DINT	Array used to store DINT type S...	%MW3000
RTU_AI_AsREAL_1	ARRAY[0..499] OF REAL	Array used to store REAL type ...	%MW3000
RTU_AO_AsDINT_1	ARRAY[0..499] OF DINT	Array used to store DINT type S...	%MW4000
RTU_AO_AsREAL_1	ARRAY[0..499] OF REAL	Array used to store REAL type ...	%MW4000
Peer1_AO_AsREAL	ARRAY[0..9] OF REAL	Array used to send data to Peer 1	%MW6100
Peer1_DO_AsINT	ARRAY[0..9] OF INT	Array used to send data to Peer 1	%MW6150
Peer1_AI_AsREAL	ARRAY[0..9] OF REAL	Array used to receive data from ...	%MW7100
Peer1_DI_AsINT	ARRAY[0..9] OF INT	Array used to receive data from ...	%MW7150
INW_Inlet_OverflowTimeSeconds	DINT		%MW9000
INW_WWS_OverflowTimeSeconds	DINT		%MW9002
PM00001_HMI	HWC_PowerMeter_HMI	Powermeter HMI Data Structure	%MW9100
HMISetup_StatusCommand	WORD	0-ClockValid, 8-SetDefaults	%MW10002
HMISetup_ClockDayOfWeek	INT		%MW10003
HMISetup_ClockMonth	INT		%MW10004
HMISetup_ClockDay	INT		%MW10005
HMISetup_ClockYear	INT		%MW10006
HMISetup_ClockHour	INT		%MW10007
HMISetup_ClockMinute	INT		%MW10008
HMISetup_ClockSecond	INT		%MW10009
PLT	FunctionalArea	General Plant (includes Facility ...	%MW15000
CDS	FunctionalArea	Chemical Dosing System	%MW15500
INW	FunctionalArea	Inlet Works	%MW16000

Figure 16: Example of a large site memory addressing

Name	Type	Comment	Address
PLT	FunctionalArea	General Plant (includes Facility Support Services)	%MW15000
StatusByte	BYTE	Status of this area	%MW15000
State	BOOL	A device in this area is running	%MW15000.0
Health	BOOL	The area is healthy	%MW15000.1
Status	BOOL	The area is Available (Healthy and not Inhibited)	%MW15000.2
Inhibited	BOOL	The area is inhibited	%MW15000.3
SeqCall	BOOL	1=Call to sub areas to run	%MW15000.4
CommandByte	BYTE	Commands to this area	%MW15000
Inhibit	BOOL	Inhibit command	%MW15000.8
Reset	BOOL	Reset command	%MW15000.9
Simulate	BOOL	Simulate command	%MW15000.10
SeqReq	BOOL	Request to run this functional area	%MW15000.11
LSCADA_Byte	ARRAY[0..17] OF BYTE	Status and Commands of the Sub Areas	%MW15001
LSCADA_Word	ARRAY[0..9] OF WORD	Local SCADA interface for words and bits	%MW15010
LSCADA_Int	ARRAY[0..79] OF INT	Local SCADA interface for Integers	%MW15020
LSCADA_Real	ARRAY[0..199] OF REAL	Local SCADA interface for Reals	%MW15100

Figure 17: 'FunctionalArea' array structure

The 'FunctionalArea' array structure aligns with the local SCADA Modbus scanner objects in 9.8.2.2, and SCADA templates on large sites.

Any memory addresses that are for external data exchange from the PAC/PLC shall have internal variables mapped to the memory address array ranges using structured text. Comments shall show the DNP3, Modbus, and internal memory address:

```
(* Boolean status to RTU *)

(*   DNP3       Modbus   *)                                    (*Plant Status*)

(* 1001     401001.0 *)      RTU_DI_AsINT_1[0].0 := PLC_Status.Fault_CPU;
(* 1002     401001.1 *)      RTU_DI_AsINT_1[0].1 := PLC_Status.Fault_IC;
(* 1003     401001.2 *)      RTU_DI_AsINT_1[0].2 := 0;
(* 1004     401001.3 *)      RTU_DI_AsINT_1[0].3 := PLC_EIO_Drop1.Fault;
(* 1005     401001.4 *)      RTU_DI_AsINT_1[0].4 := PLC_EIO_Drop2.Fault;
(*  3091     403181 *)       RTU_AI_AsREAL[90] := PLC_Status.ErrorCode;
(*  3092     403183 *)       RTU_AI_AsREAL[91] := PLC_Status.OSVersion;
(*  3093     403185 *)       RTU_AI_AsREAL[92] := PLC_Status.UnityVersion;
(*  3094     403187 *)       RTU_AI_AsREAL[93] := PLC_Status.BuildVersionDate;
(*  3095     403189 *)       RTU_AI_AsDINT[94] := HWC_FB_Version_hmi.Id_Version_Report1;
(*  3096     403191 *)       RTU_AI_AsDINT[95] := HWC_FB_Version_hmi.Id_Version_Report2;
```

Figure 18: Variable mapping to external addresses using DNP3 (e.g. RTU)

```
(* INW.StatusWord *)(* INW.CommandWord *)
(* mw15001      *)       INW.LSCADA_Byte[0] := INW_Inlet.StatusByte;    (* Sub Functional Area Status and Commands*)

(* mw15000      *)       (* PLT.StatusByte *)(* PLT.CommandByte *)
(* mw15001      *)       PLT.LSCADA_Byte[0] := PLT_CA1.StatusByte;      PLT_CA1.SCADACommandByte := PLT.LSCADA_Byte[1];
(* mw15002      *)       PLT.LSCADA_Byte[2] := PLT_PW1.StatusByte;      PLT_PW1.SCADACommandByte := PLT.LSCADA_Byte[3];

(* Reset all the Reset commands      *)
PLT.LSCADA_Byte[1].1 := 0;
PLT.LSCADA_Byte[3].1 := 0;

(* mw15010.0    *)      PLT_Shutdown_cmd := PLT.LSCADA_Word[0].0;       (* Commands from SCADA *)
(* mw15010.1    *)      PLT_PW1_TankTopUp_cmd := PLT.LSCADA_Word[0].1;
(* mw15010.2    *)       bnotused := PLT.LSCADA_Word[0].2;
```

Figure 19: Variable mapping to external addresses using Modbus (e.g. local SCADA)

7.5.8 PAC/PLC HWACL derived function blocks

All derived function blocks within the HWACL use the following naming convention:

HWC_<FB number>_<group>_<component>
For example – HWC_070_Drive_Control

The HWACL derived function block name will be defined by the Principal.

For any input or output pins, the name shall be written as all words joined together, with the first letter of each word in upper case. A suffix or prefix can also be added to distinguish between different processes:

For example – PV_FilteredOutput_Bank1

The functionaility of the function block pins are identified in the function block by using comments.

7.6 PAC/PLC software code

All software code shall be written using the information within the HWSCL. If there is something in the HWSCL that requires a modification to make it suitable for use, then the Contractor shall discuss it with the Principal's Subject Matter Expert.

Code will only use the following *IEC 61131 Programmable controllers* programming formats listed below. These formats are presented in order of usage preference:

(a) function block

(b) structured text.

If there is functionality that is repeated more than once on a site, then custom derived function blocks complying with section 7.6.1 may be developed.

All software code shall be written to be capable of a complete plant restart should a critical component of the PAC/PLC fail and is replaced, e.g. the plant shall restart using the normal plant procedure after a PAC/PLC CPU fails and a new one is installed, configured, and has the code downloaded to it. This is commonly referred to as a 'Black Start'.

No forced conditions or other impediments shall be part of the software code.

7.6.1 Project specific function blocks

Function blocks may be developed if the required code does not exist within the HWSCL. At a minimum:

(a) Approval from the Principal's Subject Matter Expert is required prior to code development and a decision made as to whether it will become a part of the HWSCL or a custom function block to be only used in the one project.

(b) Code will be placed inside a derived function block.

(c) The first section in each block shall be called 'Main' and contain revision history for the block as well as detailed block information.

(d) The new function block may contain function blocks from the default Control Expert library. Where code is required from an existing Principal's function block, the code will be made available on request. A Principal's function block is not to be embedded inside a new function block, except for 'HWC_001_FB_VersionControl'.

(e) Positive logic is to be used, e.g. PU0001_Health (1=Health), or PU0001_CommsAlm (1=Alarm).

(f) Integrated simulation code shall be used inside function blocks.

(g) Display all external inputs and outputs of the function block in separate mapping sections. This includes input, output, and inputs/outputs pins:

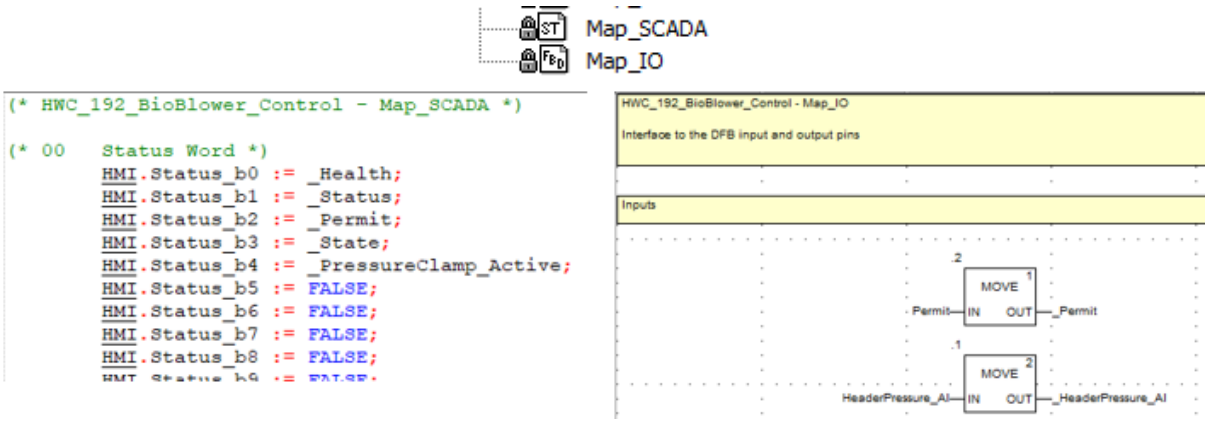


Figure 20: Derived function block external inputs and outputs mapping

(h) Naming shall meet the requirements of section 7.5.

(i) Code layout shall be as per section 7.2.

(j) The function block comment shall briefly describe the function block operation.

(k) All variables within the function block are to include comments describing the operation of the variable as per section 7.5.6.1.

(l) For function blocks being created for the HWSCL, documentation shall use the template provided in Appendix A.

(m) A corresponding SCADA template is required for function blocks where data is interfaced with SCADA.

(n) The final version of the function block, documentation, and SCADA template are to be approved by the Principal's Subject Matter Expert before being used at commissioning.

7.6.1.1 Project specific function block naming convention

For custom function blocks, the following naming convention shall be used:

CST_<function name>
Example: CST_Device_Control

7.6.2 Communication with devices

For M580 based PAC/PLCs, communication to other devices (e.g. VSDs, DOL starters, Ethernet switches, etc.), shall be via the device type manager (DTM). This can be via device specific DTMs, generic DTMs, or EDS files.

Examples of preferred current DTM types and devices are:

- Schneider Altivar VSD – device specific DTM
- ABB VSD – generic EtherNet/IP DTM
- Schneider TeSys T DOL – device specific DTM
- Schneider Modicon Ethernet switch – custom EDS file.

For M340 based PAC/PLCs, the method of communication is 'IO Scanning' from the CPU or comms module.

7.6.3 Data exchange between intelligent controllers

Where there is data exchange between intelligent controllers (e.g. PAC/PLC to PAC/PLC, PAC/PLC to UV Controller, etc.), a watchdog between the devices shall monitor the communications state. An alarm shall be generated in SCADA when communications is lost and/or data is no longer being exchanged.

Where data is exchanged between intelligent controllers, it shall be clearly labelled/commented so that it references what it maps to in the other controllers, e.g. the data's origin, destination, location, and data registers.

```
(*Inputs from UV9100 PLC - REAL *)
(* %MW8000 Vendor PLC *)
        UVS_UV9100FlowRate := UV9100_Comms.Inputs.REAL_IN[0];
        UVS_UV9100Dose := UV9100_Comms.Inputs.REAL_IN[1];
        UVS_UV9100UVIntensity := UV9100_Comms.Inputs.REAL_IN[2];
        UVS_UV9100Starts24hrs := UV9100_Comms.Inputs.REAL_IN[3];
        UVS_UV9100RelativeOutput := UV9100_Comms.Inputs.REAL_IN[4];

(* Boolean status to RTU *)

(*   DNP3       Modbus  *)
(* 1001 - 1016  401001 *)       RTU_DI_Values[0] := WORD_TO_INT(PU00001_HMI.StatusWord);
(* 1017 - 1032  401002 *)       RTU_DI_Values[1] := WORD_TO_INT(PU00001_HMI.AlarmWord);
(* 1033 - 1048  401003 *)       RTU_DI_Values[2] := WORD_TO_INT(PU00002_HMI.StatusWord);
(* 1049 - 1064  401004 *)       RTU_DI_Values[3] := WORD_TO_INT(PU00002_HMI.AlarmWord);
```

Figure 21: Commenting of data between intelligent controllers

7.6.4 Totaliser reset times

Where PAC/PLC code contains totalisers that are reset on a daily schedule, the reset shall occur at midnight. An exception to this is on water sites where an 8 am reset is required for flow meters but shall be confirmed with the Principal for each instance.

7.6.5 General coding practices

General coding practices to minimise error states, maximise reliability, and provide secure conditions shall be followed. At a minimum:

(a) Check that the PAC/PLC is in the normal run mode state. This is usually monitored by a watchdog from the next upstream device, i.e. RTU or SCADA.

(b) Leave operational logic in the PLC wherever feasible rather than SCADA, HMIs, or other field devices (e.g. VSDs).

(c) Detect any out of bounds data inputs and alarm. For example, data that would cause divide by zero errors, over/underflows, negative counters, etc.

(d) Validate setpoints from outside the PAC/PLC. For example, restrict the value within the acceptable range for the process by using minimum and maximum logic. Where possible, the same restrictions should also be at the operator setpoint input device (e.g. SCADA).

(e) Validate and alert for paired inputs/outputs. For example, start/stop, forward/reverse, open/close, etc. Ensure that both signals are not asserted together. Alarm when input/output states occur that are physically not feasible. Consider making paired signals independent or adding delay timers when toggling outputs could be damaging to actuators.

(f) Validate inputs based on physical plausibility. For example, monitor expected physical durations for too slow/fast, monitor repeated activities for expected patterns (e.g. no change, pump cycles), etc. Alarm for deviation events.

(g) Disable unneeded/unused communication ports and protocols. More specific information can be found in section 7.11.

(h) Restrict other connected devices to be read only of the PAC/PLC data. For example, the PAC/PLC shall be the Modbus RTU (serial) master, the PAC/PLC shall read/write to the

HMI/VSD, etc. There is an exception to this rule for SCADA/RTUs when gathering data from the PAC/PLC.

7.7 Alarms to SCADA

Where the PAC/PLC is used to generate alarms for the SCADA system. Details for handling the different types are in the sections below.

7.7.1 Analogue alarms

Where an RTU is used to communicate with the HO SCADA system, the analogue value is mapped to the RTU and passed to the SCADA system where the alarms are generated. Alarms shall be placed within DNP3 classes as appropriate as per section 8.6.

For all SCADA systems, analogue alarms shall be generated off the original PAC/PLC analogue variable via the point configuration alarm limits within SCADA as per section 9.9.

If there are actions within the PAC/PLC code triggered from analogue values that cause an abnormal condition, then a separate digital alarm shall also be generated for this to SCADA as per section 7.7.2.

7.7.2 Digital alarms

Where an RTU is used to communicate with the SCADA system, digital alarms generated by the PAC/PLC shall be assigned to the correct DNP3 class within the RTU. Alarms shall be placed within DNP3 classes as appropriate as per section 8.6.

For all SCADA systems, digital alarms are generated directly from fault/abnormal conditions within the PAC/PLC program and shall be configured using the point alarm limits within SCADA as per section 9.9.

7.8 Commissioning

During commissioning, any errors in the software code identified during a build, or fault lamps on the PAC/PLC modules shall be corrected. The Principal is to be notified of any pre-existing issues before commissioning.

The site shall be confirmed to be operating as expected with the operators before leaving the site after any changes. See section 9.11 for more details.

7.9 Decommissioning

All code which is no longer needed in the PLC after work is complete shall be removed, which also includes redundant variables and function blocks. If this is not possible for any reason, please contact the Principal.

7.10 Code handling

7.10.1 Off-site

Prior to programming, a copy of the existing site and/or approved standard PAC/PLC software code shall be requested via the Principal.

During the project, operational circumstances may require the Principal to modify the PAC/PLC software code. The Contractor shall check for and include any modifications made in the site code

before work, after receiving a copy of the code, and include this in the final commissioned code version. The Principal shall be consulted on the method of resolution for any conflicts.

7.10.2 On-site

Please refer to section 5.6 for what is required if changes are made to an active system.

Details of the required files for a Control Expert PAC/PLC can be found in section 7.5.1.

7.11 Security

7.11.1 CPU and communication module services

Access via FTP, TFTP, HTTP, IPsec, DHCP/BOOTP, SNMP, and EIP shall be disabled in all communications access points by default. Permission to enable these connections shall be approved via the Principal's Subject Matter Expert.

An exception to this is when TFTP is required for RIO on M580 systems.

Where the FDR (Fast Device Replacement) feature is used, all devices shall be on the control network only.

7.11.2 Function blocks

All code blocks within the HWACL are password protected and are 'read only'.

7.11.3 Physical access

Principal supplied keys will be required to access locations containing automation equipment.

8 Remote telemetry unit (RTU)

8.1 RTU hardware layout

All RTU hardware layouts shall be submitted for review and comment by the Principal's Subject Matter Expert.

For most small and medium sites, the standard RTU hardware used is detailed within the Principal's drawing sets and is available from the Principal on request.

For all other sites, the RTU hardware shall be selected to meet the site / project requirements as per section 5.4 based on the network architecture design information in section 12.

8.2 RTU programming software

The current Principal approved version of the RTU programming software shall be used. Where a later Principal approved version is released during the term of a contract, then at the time of final commissioning that version shall be used.

The RTU project shall be built in the same version as the programming software used.

The following software is required to program the SCADAPack series of RTUs:

(a) For SCADAPack 334E –

(i) E-Series Configurator – version 8.19.1 (minimum). The actual firmware version for the RTU at time of commissioning shall be confirmed with the Principal.

(ii) ISaGRAF – version 3.40 (Versions 5.x or 6.x shall not be used), or another version as approved by the Principal.

(iii) SCADAPack ISaGRAF Target library – version 3 only, or another version as approved by the Principal.

(b) For SCADAPack 47x/57x –

(i) RemoteConnect and SCADAPack x70 Utilities – version 3.1.5 (minimum). The actual firmware version for the RTU at time of commissioning shall be confirmed with the Principal.

The following software is required to program the Point Orange series of RTUs:

(c) Poco+ – version 3.6.0 (minimum). The actual firmware version for the RTU at time of commissioning shall be confirmed with the Principal.

All other RTU software shall be approved via the Principal's Subject Matter Expert.

8.3 RTU program file naming conventions

Please see Appendix G for more information on file types, and some examples.

8.3.1 SCADAPack 334E

The RTU files required for a complete backup of a SCADAPack 334E RTU are:

(a) <facility plant number>.rtu – generated by a save from the SCADAPack E-Configurator programming software

(b) <facility plant number>.pia – generated by a project archive from ISaGRAF Project Manager. There could be up to two files if both ISaGRAF locations have been used.

RTU files for ISaGRAF (the .PIA file) shall not contain the – (dash) character (if it exists) and shall be limited to eight (8) characters plus the file extension. All other RTU program file names and extensions are to be approved via a request to the Principal.

8.3.2 SCADAPack 47x/57x

The RTU file required for a complete backup of a SCADAPack 47x/57x RTU is:

- <facility plant number>.rcz – generated by an export project from the RemoteConnect programming software. Inside this compressed archive file are the files:
    - <facility plant number>.prj
    - <facility plant number>.sta
    - version.txt

8.3.3 Point Orange

The RTU file required for a complete backup of a Point Orange RTU is:

- <facility plant number>.pcc – generated by a save from the Poco+ programming software.

8.4 RTU software code

RTUs shall use the approved standard software code as per section 5.12. Any custom code will require approval from the Principal's Subject Matter Expert before commencement and follow the guidance in this standard.

All software code shall be written to be capable of a complete plant restart should a critical component of the RTU fail and is replaced. For example, the plant shall restart using the normal plant procedure after an RTU fails and a new one is installed, configured, and has the software code downloaded to it. This is commonly referred to as a 'Black Start'.

All RTUs are to be monitored in HO SCADA via their outstation objects.

No forced conditions or other impediments shall be part of the software code.

For the SCADAPack 334E series of RTUs, Modbus Scanner functionality shall be used so that the RTU is the Modbus master to communicate with any other controller; for example, a PAC/PLC.

There are several files required for configuration of an SCADAPack 334E depending on the site:

(a) "ISA11.x8m" – this is a compiled ISaGRAF file for execution in the Target 1 resource in the SCADAPack, created from the project archive file ISA11.PIA in ISaGRAF Project Manager. All RTUs are to be monitored in SCADA, the ISA11.x8m file shall be configured in the 'Configuration Setup' function of the SCADA 'Outstation' object so that it can be downloaded to the RTU from SCADA.

(b) "ISA21.x8m" – this is a compiled ISaGRAF file for execution in the Target 2 resource in the SCADAPack, created from the project archive file ISA21.PIA in ISaGRAF Project Manager. All RTUs are to be monitored in SCADA, the ISA21.x8m file shall be configured in the 'Configuration Setup' function of the SCADA 'Outstation' object so that it can be downloaded to the RTU from SCADA.

Where the SCADAPack 334E doesn't communicate with another controller (e.g. PAC/PLC), the following file is usually required:

(c) "modbus_points.inc" – this file contains any additional mapping of DNP3 points to be read from the RTU by SCADA. All RTUs are to be monitored in SCADA, the modbus_points.inc file shall be configured in the 'Configuration Setup' function of the SCADA 'Outstation' object so that it can be downloaded to the RTU from SCADA.

ISaGRAF project names shall be restricted to eight (8) characters to maintain compatibility between all versions.

ISaGRAF section names shall be restricted to eight (8) characters to maintain compatibility between all versions.

ISaGRAF variable names shall be restricted to sixteen (16) characters to be compatible between all versions.

ISaGRAF is not to be used on large sites to re-map PAC/PLC variables to HO SCADA DNP3 SCADAPack points.

The HWPCL contains all mapped addresses between the PAC/PLC, RTU and SCADA for the core functions in the medium and small sites. For other sites it shall be used as a guide.

8.5 RTU addressing

The RTU requires an IP address and a DNP3 address which shall be provided on request via the Principal.

The Contractor shall confirm that there are no conflicts with any IP addresses by performing ping tests or more thorough network auditing as required (see section 12.1(c)), before connecting any network device.

8.6 DNP3

DNP3 supports static and event data:

(a) static data is called Class 0 data

(b) event data can have a class of 1, 2, or 3.

DNP3 supports several data object types, e.g. 'binary input' and 'analogue input': with the corresponding events, e.g. 'binary input change' and 'analogue change'. Table 1 Section 8.6.3 indicates poll rates for each DNP3 point data class.

8.6.1 Class 0 event

Class 0 data – static or current status of data. The RTU Outstation does not generate and store events for the point.

The outstation returns the current value of the point whenever SCADA performs a Class 0 or Integrity poll. Since a large amount of data will be returned in a Class 0 poll, it shall be performed the least often.

8.6.2 Class *n* event

Class *n* data – The outstation generates events of the specified class (1, 2, or 3) for the point.

The outstation stores the event in its internal buffer, with a time stamp that indicates the time that the event was generated.

8.6.3 Point data classes

The DNP3 point data classes shall be configured as follows in SCADA.

Table 1: DNP3 point data class

Class	Class Description	Event Type	Event Buffer Size	Poll Rate
0	All outputs from SCADA, and any analogue inputs that are for information only e.g. pump inhibit, rainfall, firmware version	N/A	N/A	4 h
1	All binary input points e.g. pump state, no available pumps	Unsolicited / Buffered	1,000	30 min
2	All analogue input points e.g. pump current	Unsolicited / Buffered	1,000	2 h
3	Analogue points that require faster updates on-screen e.g. well level	Unsolicited / Buffered	10	30 min

8.7 Commissioning

During commissioning, any errors in the RTU shall be corrected and not be present when it goes live in production. SCADA shall not be relied on for this check but instead the appropriate programming software shall be used to check the live status of the RTU.

The site shall be confirmed to be operating as expected with the operators before leaving the site after any changes. See section 9.11 for more details.

8.8 Decommissioning

All code which is no longer needed in the RTU after work is complete is to be removed. If this is not possible for any reason, please contact the Principal.

8.9 Code handling

8.9.1 Off-site

Prior to programming, a copy of the existing site and/or approved standard RTU software code shall be requested via the Principal.

During the project, operational circumstances may require the Principal to modify the RTU software code. The Contractor shall check for and include any modifications made in the site code before work, after receiving a copy of the code, and include this in the final commissioned code version. The Principal shall be consulted on the method of resolution for any conflicts.

8.9.2 On-site

Please refer to section 5.6 for what is required if changes are made to an active system.

Details of the required files for an RTU can be found in section 8.3.

8.10 Security

8.10.1 Physical access

Principal supplied keys will be required to access locations containing automation equipment.

9 Supervisory control and data acquisition (SCADA)

The Principal has developed a standard code library for interfacing between the SCADA and automation and control systems. Refer to Section 6 for details.

9.1 SCADA software

The current Principal approved version of the SCADA software shall be used for all code development. Where a later approved version is released and installed in the SCADA system during the term of a contract, then at the time of final commissioning that version shall be used.

Additional service releases (for the current major version) will be installed, if required, by the Principal to address 'bug' fixes or to add new functionality that may be present in the service release.

9.2 SCADA database structure

The SCADA database structure is defined to ensure all database objects are managed within the appropriate location. The main database is head office SCADA (HO SCADA) which monitors the whole network. For HO SCADA, refer to the following table:

Table 2: HO SCADA database structure

Database Location	Description
~Config	SCADA database configuration, templates, and settings
~General Information	Database-wide information and functionality
~System	Checks of the server health
Bulk Distribution	Bulk Distribution network sites
Bulk Source	Bulk Source network sites
Coalfields	Coalfields network sites
Commissioned	Groups that are in production and being monitored by operations but being modified and/or under review
De-Commissioned	Decommissioned groups for review prior to deletion
Dungog Shire	Dungog Shire network sites
East Lakes	East Lakes network sites
High Voltage	High voltage equipment
Newcastle	Newcastle network sites
Not Commissioned	Not commissioned groups that are still under development and not yet monitored by operations
Operator Documents	For storage of custom trends
Port Stephens	Port Stephens network sites
Radio Bases	All the radio base network sites
Reports	Custom reports
Summary	High level overview of network systems
Weather Monitoring	Weather Monitoring network sites

Database Location	Description
West Lakes	West Lakes network sites
Worker Duress	Worker Duress monitoring Burwood Beach trial
WTP	Water Treatment Plant sites
WWTW	Wastewater Treatment Plant sites
Z Testing	An area for developers to test code

The local SCADA database structure is to reflect the functional view structure of the PAC/PLC, as per section 7.5.4, with some additional groups as per the following table.

Table 3: Local SCADA database structure

Database Location	Description
~Config	SCADA database configuration and settings
~General Information	Database-wide information and functionality
~System	Checks of the server health
Commissioned	Groups that are in production and being monitored by operations but being modified and/or under review
De-Commissioned	Decommissioned groups for review prior to deletion
Not Commissioned	Not commissioned groups that are still under development and not yet monitored by operations
Operator Documents	For storage of custom trends
Z Testing	An area for developers to test code

All these groups are subject to change; requests for new database groups shall be submitted to the Principal's Subject Matter Expert for approval.

9.3 SCADA point naming convention and site structure

Only approved templates shall be used to create new SCADA code. Any departure from using the approved templates shall require prior approval via the Principal's Subject Matter Expert.

9.3.1 Head office SCADA

Head office SCADA (HO SCADA) sites are created by either instancing a zone template inside the appropriate district group, or (for treatment plants) by creating a new site group inside the functional group. Site groups are developed using approved equipment templates and reflect the program structure of the PAC/PLC.

9.3.1.1 District group

All district group point names within HO SCADA require the following naming convention:

<district group>.<site>.<control module>.<point>

Table 4: HO SCADA district group point names

Name	Definition	Examples
<district group>	Group in the database structure where the site is geographically located	Coalfields
<site>	The name of the site	Aberdare 1 WWPS
<control module>	The name of the control module on-site. A numerical suffix shall be always used even if it is the only device of its type on the site	Pump 1, Power Meter 1, AIV 2, etc.
<point>	The name of the device attributes or database point. If it is a device attribute it shall reflect the name used in the PAC/PLC	Health

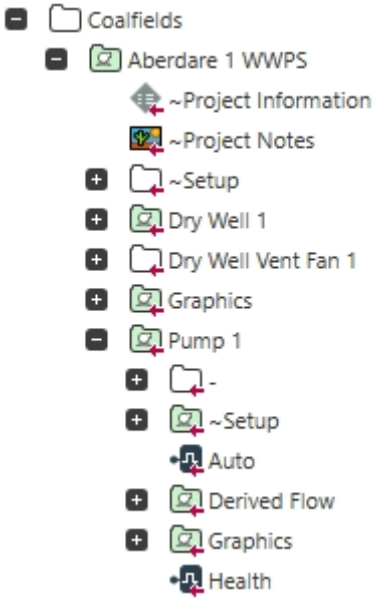


Figure 22: HO SCADA district group point names

9.3.1.2 Functional group

All functional group point names within HO SCADA require the following naming convention:

<functional group>.<site>.<cell>.<unit>.<equipment>.<control module>.<point>

Table 5: HO SCADA functional group point names

Name	Definition	Example
<functional group>	Group in the database structure where the site is functionally related to	WWTW
<site>	The name of the site	Belmont WWTW
<cell>	The name of the cell on-site	Inlet Works
<unit>	The name of the unit on-site	Screenings
<equipment>	The name of the equipment on-site	Screen Conveyor 1
<control module>	The name and plant number of the control module on-site	Motor 1 – MO1234

Name	Definition	Example
<point>	The name of the device attributes or database point. If it is a device attribute it shall reflect the name used in the PAC/PLC	Health

9.3.2 Local SCADA

Local SCADA structures are developed using approved equipment templates and reflect the program structure of the PAC/PLC, as per section 7.5.4.

All point names within local SCADA require the following naming convention:

<cell>.<unit>.<equipment>.<control module>.<point>

Table 6: Local SCADA point names

Name	Definition	Example
<cell>	The name of the cell on-site	INW - Inlet Works
<unit>	The name of the unit on-site	Inlet - Coarse Screening
<equipment>	The name of the equipment on-site	Coarse Screen RS2201
<control module>	The name and plant number of the control module on-site	MF2201 Screen 1
<point>	The name of the device attributes or database point. If it is a device attribute it shall reflect the name used in the PAC/PLC	Auto

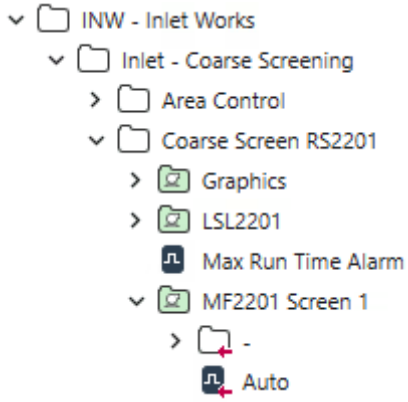


Figure 23: Local SCADA point names

9.4 SCADA template configuration

SCADA equipment templates are created and configured to match an appropriate PAC/PLC function block or common process. Zone templates are then developed using a combination of equipment templates and additional common templates for further SCADA functionality.

Development of new SCADA templates requires approval from the Principal's Subject Matter Expert before creation, and review and final approval before being used at commissioning. Approved templates are in the group '~Config.Templates – Approved', but any templates that are in a location that contains the words 'DO NOT USE' shall not be used in site development.

9.4.1 Common templates

SCADA common templates fulfil a variety of SCADA functions, many of which are used in further template creation, e.g. a standard mimic title bar. The specific use of these common templates is defined in the following sections.

9.4.1.1 Component templates

There are several types of component templates:

(a) ‘Common’ – contains templates used across all sites, e.g. titlebar, info, etc.

(b) ‘Equip’ – specifically related to physical equipment, e.g. drive, flow meter, RTU, etc.

(c) ‘Proc’ – processes, e.g. PID, well control, etc.

SCADA component templates require the following convention for point names:

<template name>.<point>

Table 7: Component template point names

Name	Definition	Example
<template name>	The name of the name of the SCADA template object related to the name of the PAC/PLC function block or general function	HWC_EQUIP_DRIVE_SCADAPack
<point>	The name of the device attributes or database point within the template that refers to the appropriate internal/RTU/PAC/PLC variable	Auto

Only the most common PAC/PLC variables are to be included in the component template to reduce the SCADA point count; less commonly used ones shall be included in an ‘Example’ instance of the template and only used when required. The example instances are located in ‘~Config.Templates - Approved.~Examples’.

Each component template requires the following:

(d) An instance of the ‘Graphics’ common template:

  (i) Any animated symbols, popups, faceplates, or other mimics for the equipment template are to be added to this ‘Graphics’ instance.

(e) A ‘-‘ group:

  (i) Any points or logic in the template which are not displayed on a popup or faceplate are to be located within this group.

(f) A ‘~Setup’ group:

  (i) An instance of the ‘HWC_COMMON_EQUIP_SETUP’ template.

  (ii) If there are any points or logic in the template that require enabling or disabling, then they shall be added to a mimic called ‘Setup’ which contains an instance of ‘Setup Common’ plus the symbol ‘Setup InOut Service’ as required.

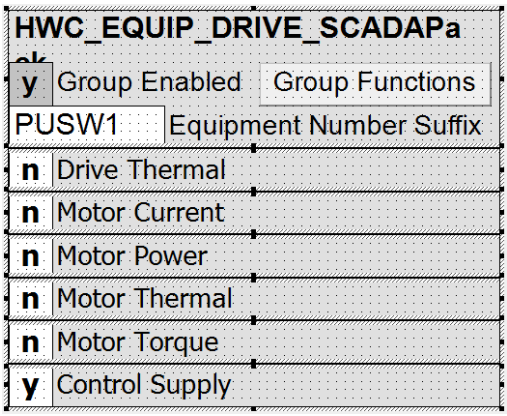


Figure 24: Example of component template 'Setup' mimic

Any mimics developed shall adhere to standards outlined in section 9.5.

Property overrides for the new component template shall be limited and only used where appropriate.

9.4.1.2 HO SCADA zone templates

Zone templates are high level templates that represent a complete physical network site in HO SCADA and are largely a collection of smaller component templates. SCADA zone templates for use in HO SCADA require the following convention for point names:

<Template Name>.<Component Instance>.<Point>

Table 8: Zone template point names

Name	Definition	Example
<Template Name>	The name of the SCADA template object	HWC_ZONE_WPS
<Component Instance>	The name of the instanced component template used as part of the site	'Pump 1' from component template HWC_EQUIP_DRIVE_SCADAPack
<Point>	The name of the device attributes or database point within the template that refers to the appropriate internal/RTU/PAC/PLC variable	Auto

Additional points that are required in the zone template are to be added to the '-' group of each component instance.

Each zone template requires:

(a) An instance of the 'Graphics' common template, and within it the following:

(i) An instance of the 'Titlebar' common template, named 'Titlebar'.

(ii) A blank mimic named 'Custom Content' where the 'Document Content' property is property overridden in the template.

(iii) A trend object named 'Standard Trends', configured with traces the Principal deems to be standard for the site template. The pen colours selected shall be easily seen and with good contrast versus the background.

(iv) A mimic named 'Overview', configured as the site overview mimic.

(b) A '~Setup' group:

(i) Containing the groups and functionality like other zone templates.

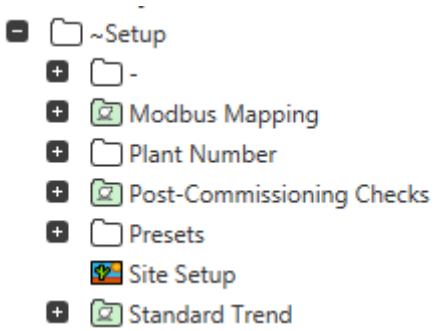


Figure 25: Example of zone template 'Setup' group

Any mimics developed shall adhere to standards outlined in Section 9.5.

Property overrides for the new zone template shall be limited and only where appropriate.

9.5 SCADA point configuration

There are some basic parameter settings for SCADA points that are common across all groups of point types.

The point shall be configured so that the following actions are recorded in the event log:

(a) Any alarms, including those associated with the point, but not the state of the point, i.e. set 'Severity' to "Email" in the general point settings.

(b) Addition and removal of any notes.

(c) Any changes to point configuration.

(d) Any changes to set points.

(e) Any changes to control values but not if this is from automatic logic, e.g. communications watchdog counters.

The basic settings for different types of DNP3 SCADAPack E points are shown in the figures below. More information for each setting can be found in the SCADA help files.

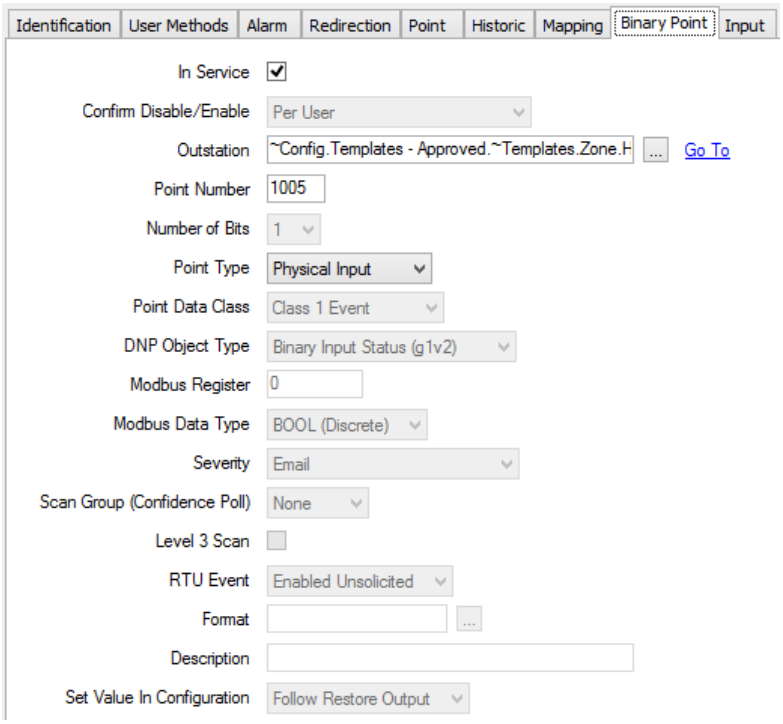


Figure 26: Typical basic point configuration for digital input

Any analogue points that are alarmed shall have ‘Tune Limits’ enabled, the only exception is on physical relative levels, e.g. reservoir level, wet well overflow level.

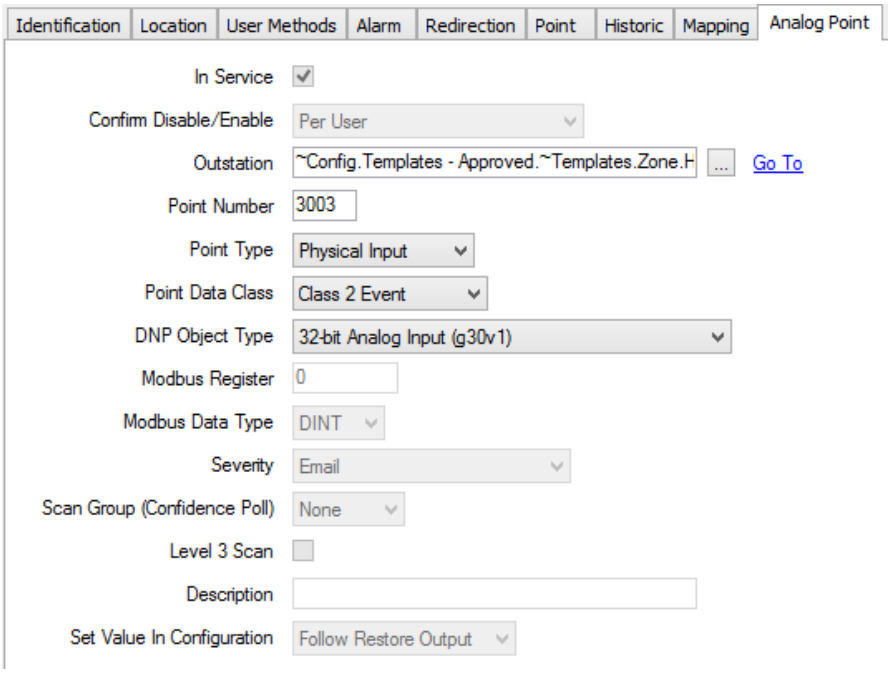


Figure 27: Typical basic point configuration for analogue input

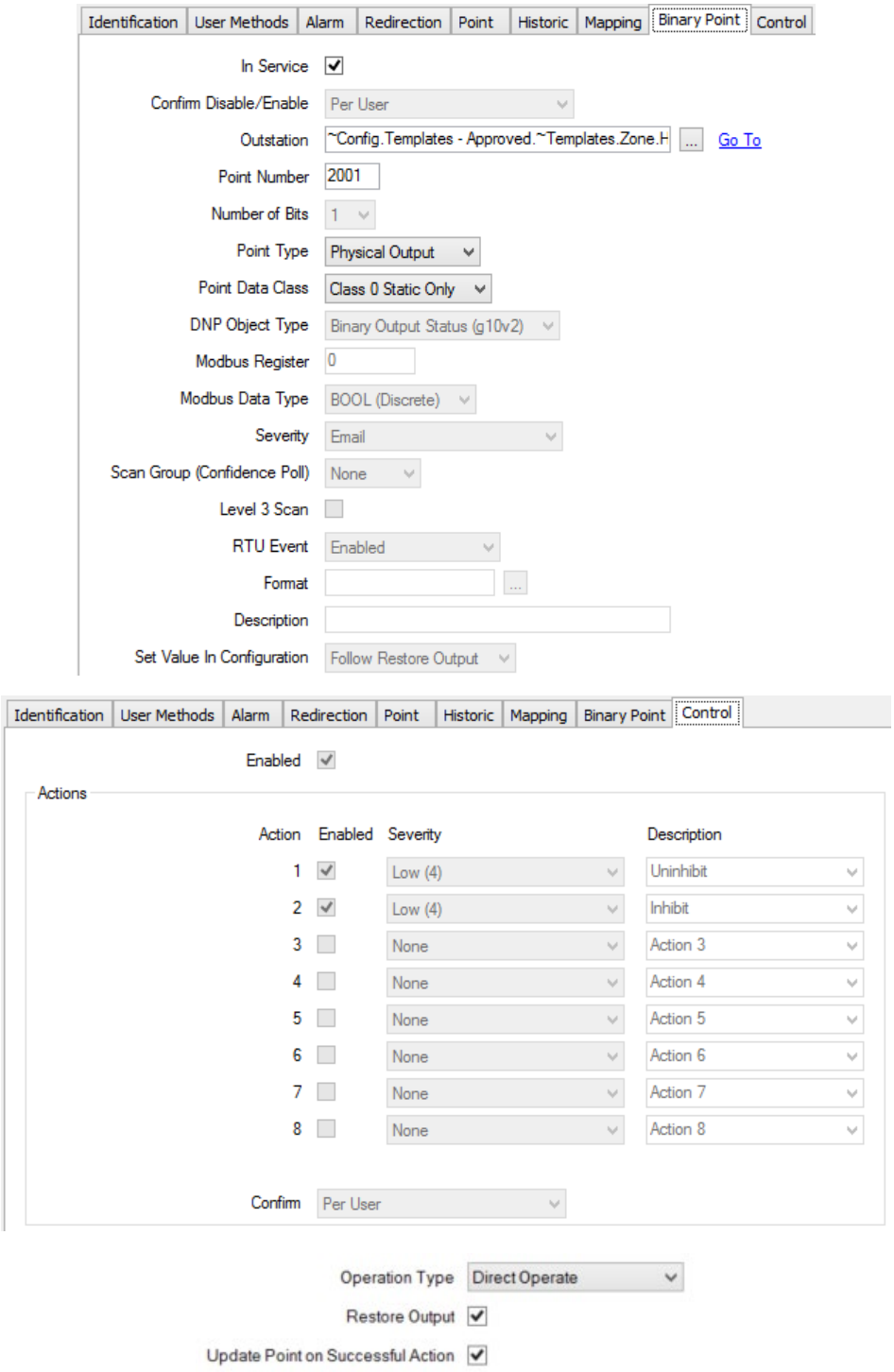


Figure 28: Typical basic point configuration for digital output

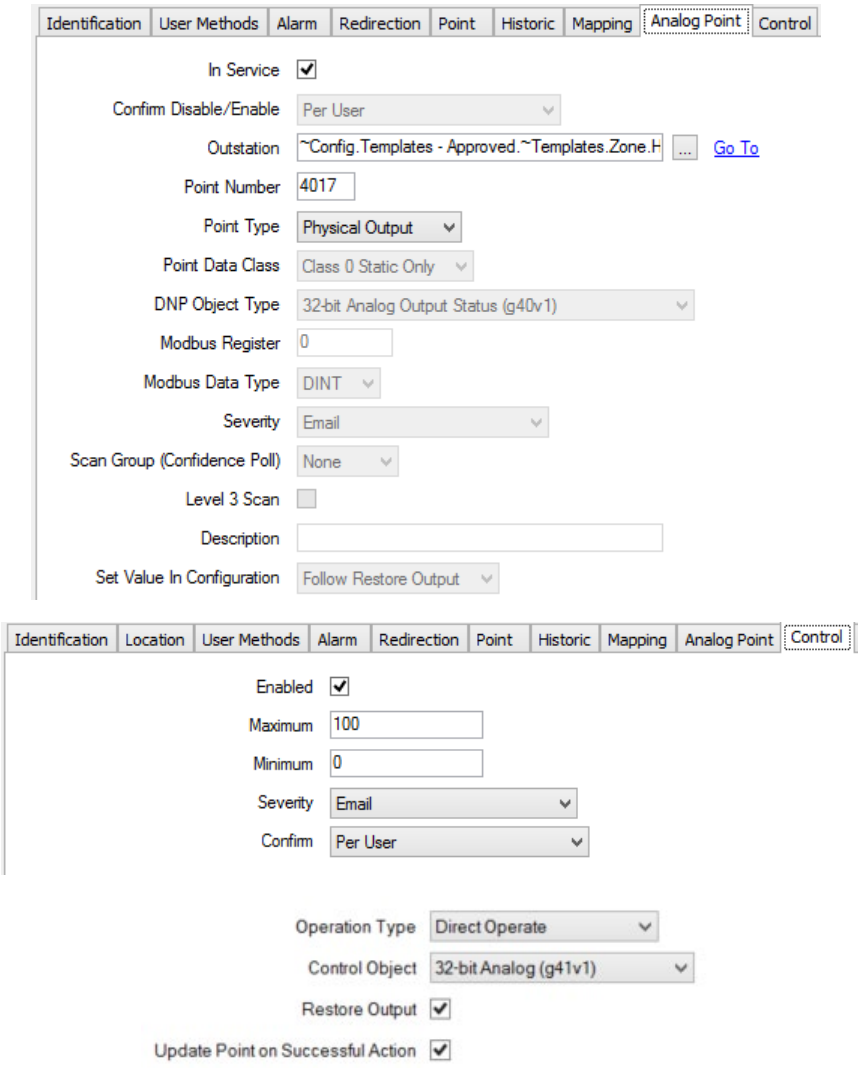


Figure 29: Typical basic point configuration for analogue output

The ‘Restore Output’ and ‘Update Point on Successful Action’ check boxes shall always be selected on a DNP3 output point.

Historic records with ‘Point Data Class’ set to “Class 0 Static Only” will only be stored if ‘Update Point on Successful Action’ is selected, and the ‘Historic Data Filter’ in ‘Logged Data’ is set to “Static and Event Data”. This is required to be configured for all class 0 points, and historic data to be enabled.

Where Modbus master scanner functionality is used in the SCADAPack 334E, the ‘Mapping’ tab shall be configured. Refer to Appendix H and the HWPCL for the mapping required for all ‘DNP3 SCADAPack E’ point types.

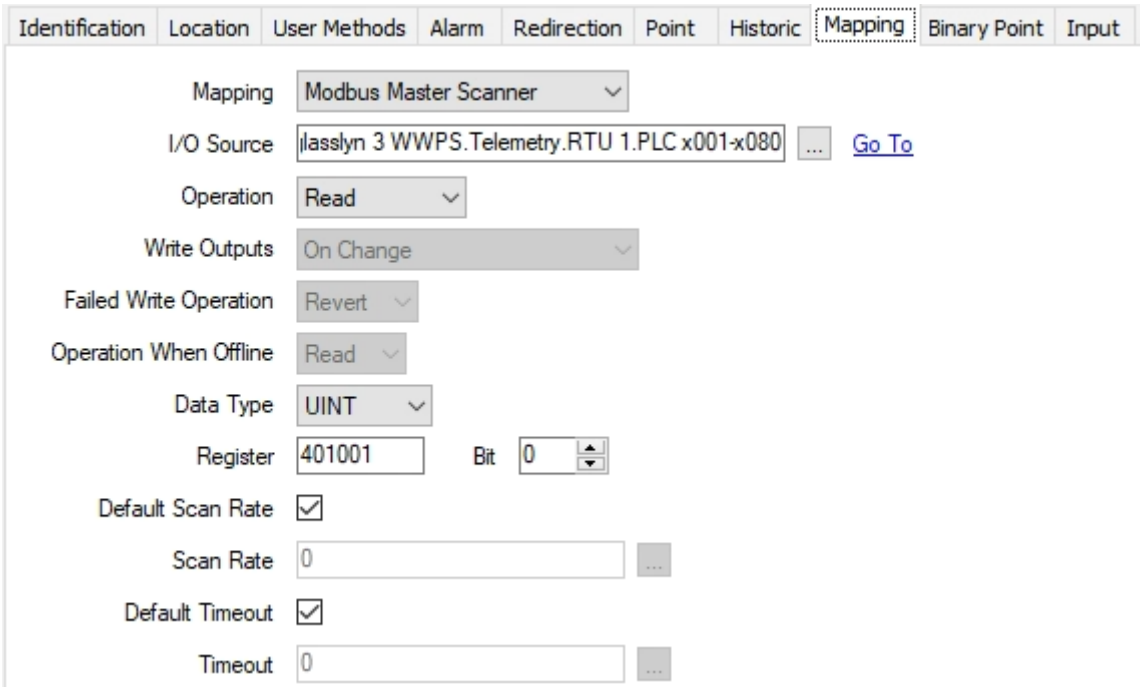


Figure 30: Typical basic point configuration for SCADAPack 334E Modbus Scanner functionality

The configuration for Modbus, internal and SCADAPack 47x/57x points is like the above but have their own particular requirements. For clarification, please consult with the Principal.

9.6 SCADA mimic development

All new mimics shall follow the same format as those already contained within ‘~Config.Templates – Approved’. Only the mimics in the approved group are to be used on any new work, please contact the Principal Subject Matter Expert for guidance as required. This shall include such configuration items as:

(a) colours

(b) background

(c) shadow lines

(d) font

(e) size

(f) borders

(g) titles/headers.

More detail is in the sections following.

9.6.1 Symbol display mimics

Symbols and device display mimics require:

(a) Colours shall be referenced to existing SCADA colour objects (~Config.Templates - Approved.~Colours).

(b) If the symbol or display contains functionality upon clicking, it shall have a black outline or border if clicking on the object results in anything other than a standard object menu.

(c) Use ‘Tahoma’ font for all text.

9.6.2 Device popup mimics

Device popup and faceplate mimics require:

(a) The standard popup Titlebar symbol (‘Title Lge’) shall be used.

(b) All value displays shall use existing symbols from the approved templates.

(c) Colours shall be referenced to existing SCADA colour objects (~Config.Templates - Approved.~Colours).

(d) Use ‘Tahoma’ font for all text.

(e) Embedded mimics and symbols shall retain their original size.

9.6.3 Non-commissioned equipment

Where only partial equipment has been permanently installed or allocated (in preparation for a future expansion), the following applies:

(a) The device and device indication is to be provided on the mimic in the correct position.

(b) All points are to be tested and commissioned as far as practical and then have their ‘In Service’ check box unchecked.

(c) Notes added to SCADA to detail expected availability dates for the device where possible.

Where equipment has been provisioned for but not installed, the following applies:

(d) The device and device indication is to be provided on the mimic in the correct position.

(e) Indication of the devices (or devices) are to be shown as ‘greyed out’ objects.

(f) All points, if any, are to have their ‘In Service’ check box unchecked.

(g) Notes added to the SCADA device object to explain that this device is for future provisioning.

9.6.4 Site overview mimics

Site overview mimics require:

(a) Two layers:

  (i) ‘Custom’

  (ii) ‘Inset’.

(b) An ‘Inset’ mimic created which is then added to the ‘Inset’ layer. It contains the standard site objects.

(c) The ‘Display’ mimic from the ‘Graphics.Titlebar’ instance shall be embedded at the top of the page in the ‘Inset’ mimic.

(d) Any items not part of the standard site ‘Inset’ mimic shall be inserted in the ‘Custom’ layer.

(e) All items (except the background) on the screen shall have functional significance.

(f) Any points which have state severity set to 'Alarm' shall be displayed on either a mimic or popup. The 'Alarm View' shall be set to bring up the associated mimic or popup as per section 9.9.3.1.

(g) General site status displays are to be located to the left of the screen, animated symbols in the centre.

(h) Points which are primarily not intended to display essential station operational functions or alarms, shall not be displayed on the mimic graphics overview. These points are deemed to be for informative purposes only and shall be displayed on a relevant popup.

(i) All value displays shall make use of existing approved symbols.

(j) Colours shall be referenced to existing SCADA colour objects (~Config.Templates - Approved.~Colours).

(k) Use 'Tahoma' font for all text.

(l) Embedded mimics and symbols shall retain their original size.

9.7 SCADA logic

The use of SCADA logic shall be kept to a minimum and requires approval via the Principal's Subject Matter Expert before configuration.

The preference is to perform as much logic as possible at the control level device (e.g. PAC/PLC, RTU, etc.) to minimise disruption to system function in the case of telemetry failure.

SCADA logic, at a minimum, shall:

(a) Comply with all requirements within this document.

(b) Be neatly and logically arranged.

(c) Have all code well-spaced.

(d) Have a comment block placed at the beginning of each section of code. It shall contain the program name, description, and version history.

```
(*-------------------------------------------------------------------------------------------*)
(* Program Name: Auto Config Download - SCADAPack RTUs (DNP)                                 *)
(*-------------------------------------------------------------------------------------------*)
(* Author: Adrian Lee - Schneider Electric                                                   *)
(* Created: 24/02/2014 (Based on PDS/Symax program)                                          *)
(* Description: This program will download configuration for one outstation each time it is  *)
(* executed. If it fails to download an outstation several times it will send an email out to *)
(* the SCADA administrators listing the failed outstations.                                  *)
(*                                                                                           *)
(* Modified 28/08/2015 - Adrian Lee (Schneider Electric)                                     *)
(*  Rewrote program to be more readable and workaround the 'DownloadRequired' flags issue where *)
(*  it doesn't get reset after a successful download.                                        *)
(*-------------------------------------------------------------------------------------------*)
```

Figure 31: Example – SCADA logic comment block

(e) Include additional comments defining the purpose of the logic. They are to be placed above or to the side of the area of code.

(f) Review the minimum interval setting so that it is not running too frequently.

9.7.1 Linked ODBC tables

Linked ODBC tables shall not be used within any logic programs running on the Principal's SCADA systems. This is because any network delays or connection issues to the remotely accessed ODBC

data source will cause long read locks on the database, severely impacting database performance and potentially causing system instability.

9.7.2 SQL queries

All SQL queries within logic programs shall be placed into a 'VAR NOCACHE' block and be kept as small as possible to avoid significant impacts to database performance. Any logic running in a normal 'VAR' block will cause the logic program to hold a write-lock on the database, which will disrupt all other database processes and can cause severe performance and stability issues. Queries within a "VAR NOCACHE' will only hold a read-lock on the database which is less impactful on the database but can cause issues if the query is significantly large and takes seconds to execute.

```
PROGRAM AcceptDelayedSuppressedClearedAlarms
    VAR NOCACHE
        UnacceptedPointAlarms AT %S(SELECT Id FROM CDBPoint WHE
        UnacceptedOutstationAlarms AT %S(SELECT Id FROM CAdvOut
    END_VAR;
```

Figure 32: Example of 'VAR NOCACHE' block

Any logic that has a query in it shall be approved by the Principal's Subject Matter Expert.

9.8 SCADA site configuration

There are some differences with site configuration between HO SCADA and local SCADA systems. The former largely uses RTUs to communicate with remote sites, whereas the latter mainly uses direct Ethernet connections to the local PAC/PLCs, although there can also be some connections to other remote RTUs.

9.8.1 HO SCADA site creation and modification

A new site on HO SCADA uses an instance of a 'HWC_ZONE_x' template and configuration is required to ensure that all functionality is available.

Integration guides are available for certain types of sites and shall be requested via the Principal.

All HO SCADA work requires that both a '~Project Information' table, and a '~Project Notes' mimic is created and populated:

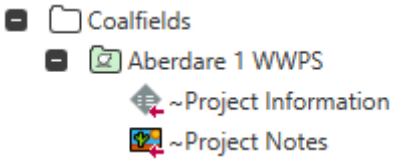


Figure 33: '~Project Information' table and '~Project Notes' mimic

All work on HO SCADA, telemetry, or automation systems on a site requires an update to the '~Project Information' parameter table. Open the properties of the table and populate it with the following information:

(a) 'Parameter 1' – work description - what work was carried out

(b) 'Parameter 2' - software developer - the company responsible for the software development

(c) 'Parameter 3' – Hunter Water contact - the name of the Principal's project/contract manager

(d) ‘Parameter 4’ - date - the date of the major change to the site in YYYY-MM-DD 24-hour ISO 8601 format, e.g. creation or modification

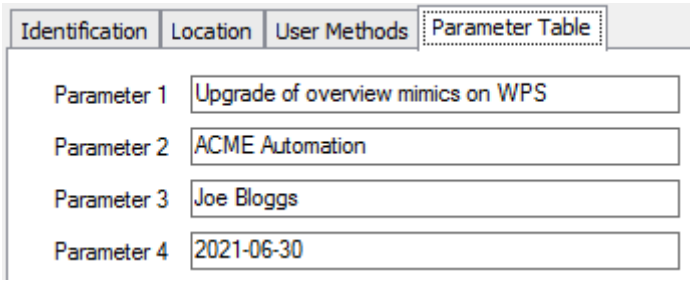


Figure 34: Example of ‘~Project Information’ table

A ‘~Project Notes’ mimic shall be created that details the following minimum details, in most recent date order from the top of the page:

(e) “Date – ” the date of any major changes, e.g. site creation, commissioning, etc.

(f) “Project Description – ” the project the work is related to.

(g) “Work Performed – ” a description of the work done.

(h) “Software Developer – ” the name of the Contractor performing the automation work.

(i) “HWC Contact – ” the name of the Principal.

(j) place any notes from previous work below the new entry.

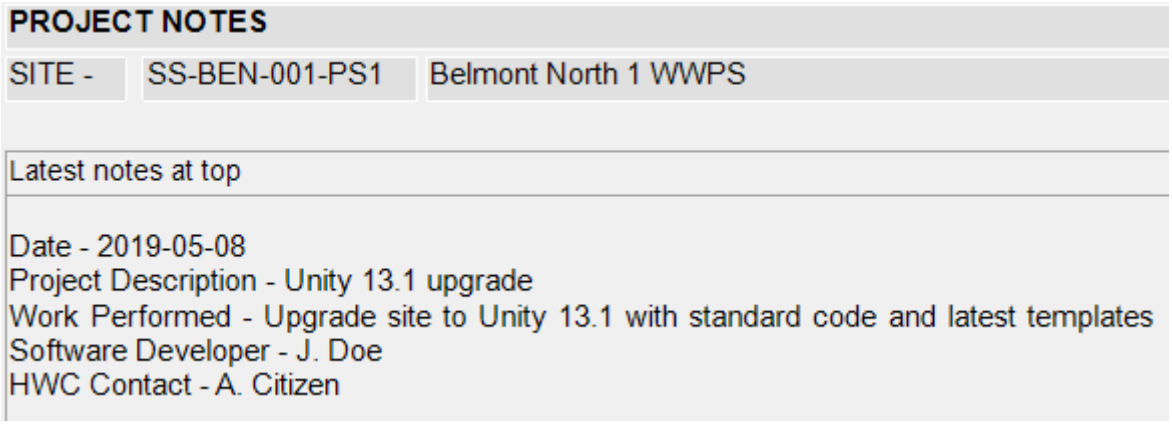


Figure 35: Example of ‘~Project Notes’ mimic

9.8.2 Telemetry configuration

9.8.2.1 HO SCADA

The outstation object (‘<site>.Telemetry.RTU 1.Outstation’) of a new site instance shall be configured in order to match the on-site hardware configuration. The following information supplied by the Principal shall be configured:

(a) the DNP3 address

(b) the outstation set

(c) the network host address to the IP address.

Most other fields shall not be overridden.

'DNP3 SCADAPack E Modbus Slave Device' objects shall be created to match the DNP3 mapping as per section 7.5.7. DNP3 point objects will then attach to the matching device object based on the on the last three figures of the DNP3 address. For example, DNP3 address 1001 (%MW1000.0) attaches to "PLC x001-x080", similarly 14498 (%MW14994) attaches to "PLC x481-x560".

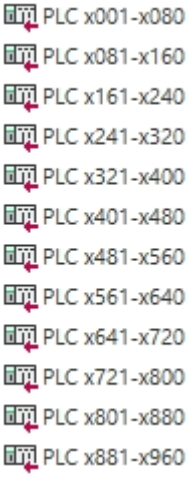


Figure 36: HO SCADA 'DNP3 SCADAPack E Modbus Slave Device' object naming

9.8.2.2 Local SCADA

The object for a new communications method shall be configured to match the on-site hardware configuration. The following objects shall be configured:

(a) the scanner (for Modbus)

(b) the channel (for Modbus)

(c) the network host address with the IP address (for Modbus) as supplied by the Principal

(d) the Modbus simple scanner object shall be used

(e) Modbus scanner objects shall be named to match the functional areas in the PLC code as per section 7.5.7 an example is shown in Figure 37:

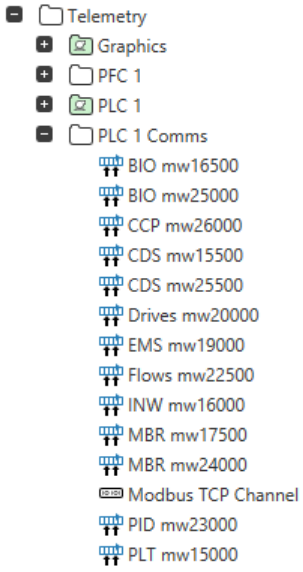


Figure 37: Example of local SCADA Modbus scanner object naming

(f) typical settings are in Figure 38:

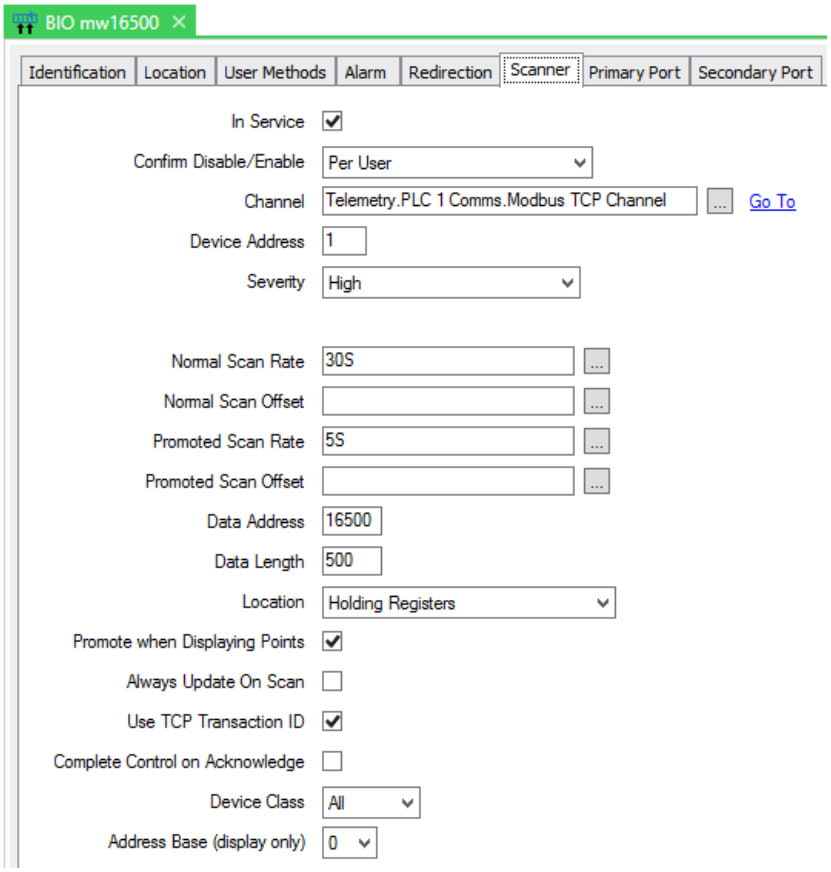


Figure 38: Example of local SCADA Modbus scanner object configuration

Care shall be taken not to make the scan rate too frequent, “5S” shall be the minimum value used for either the normal or promoted value.

Most other fields shall not be overridden.

9.8.3 Titlebar configuration

9.8.3.1 HO SCADA

Configuration is required within the new site instance for the ‘Titlebar’ to function correctly as follows:

(a) Configure the Equipment Number (‘Identification’ tab) for the site instance object, e.g. the ‘Sandgate 1A WWPS’ template instance object has a plant number of ‘SS-SAN-01A-PS1’.

(b) Execute the ‘Update Equipment Number’ logic located under ‘Graphics.Titlebar.Ellipse’.

(c) Configure the ‘Hydraulic View’ object (under ‘Graphics.Titlebar’) with a link to the hydraulic overview object.

(d) Configure the upstream and downstream network site links associated with the site by populating the ‘Upstream’ and ‘Downstream’ points (under ‘Graphics.Titlebar.Site Links’) with full names of the overview mimics for those sites.

9.8.3.2 Local SCADA

Configuration is required for the current titlebar in use at any new sites or addition of equipment at the treatment plant. This may include:

(a) Configuring the ‘Equipment Number’ (‘Identification’ tab) for the group object, e.g. ‘Burwood Beach WWTW’ has a plant number of “ST-BUR”.

(b) Adding locations to a ‘Menu’ button.

(c) The titlebar may also be like the one in section 9.8.3.1, and require a similar setup procedure.

9.8.4 Point equipment (plant) number

All points within the HO SCADA site that are in service, shall be populated with a plant number. Within Geo SCADA this field is titled ‘Equipment Number’. Plant numbers for the point listing should be provided by the Principal from plant numbers in Ellipse on request.

The ‘Equipment Number’ configuration is found on the ‘Identification’ tab of the properties of each point. Note that there are setup scripts within HO SCADA that can assist with ‘Equipment Number’ configuration.

9.8.5 HO SCADA navigation configuration

Global sections of the HO SCADA database configuration need to be updated to allow navigation to and from the site to be consistent with all other sites. The following is required:

(a) If applicable, the hydraulic symbol for the site (‘Graphics.Hydraulic’) shall be embedded on the hydraulic overview and displayed to align with other sites both horizontally and vertically.

(b) The main menu mimic (‘$Root.Default’) needs to be updated to provide navigation to the site. Configure the advanced pick-action menu on the appropriate menu button to include a navigation hyperlink to the overview (‘Graphics.Overview’) of the new site. Ensure sites in the same graphical location are grouped, e.g. Sandgate, and ensure the menu is displayed alphabetically.

(c) These changes may require assistance via the Principal due to security access restrictions.

9.8.6 Update of associated information

There are other sections in the SCADA system that shall require updating or adding as the result of new work in the related area. The Contractor shall investigate similar previous work on the SCADA system and apply the same principles and changes for the new work. This could include but is not limited to:

(a) telemetry overviews – for example, radio base installed/modified

(b) weather monitoring – for example, rain gauge installed/modified

(c) treatment plant maintenance mode status

(d) treatment plant alarm suppression status

(e) energy dashboards – for example, large site power meter installed/modified

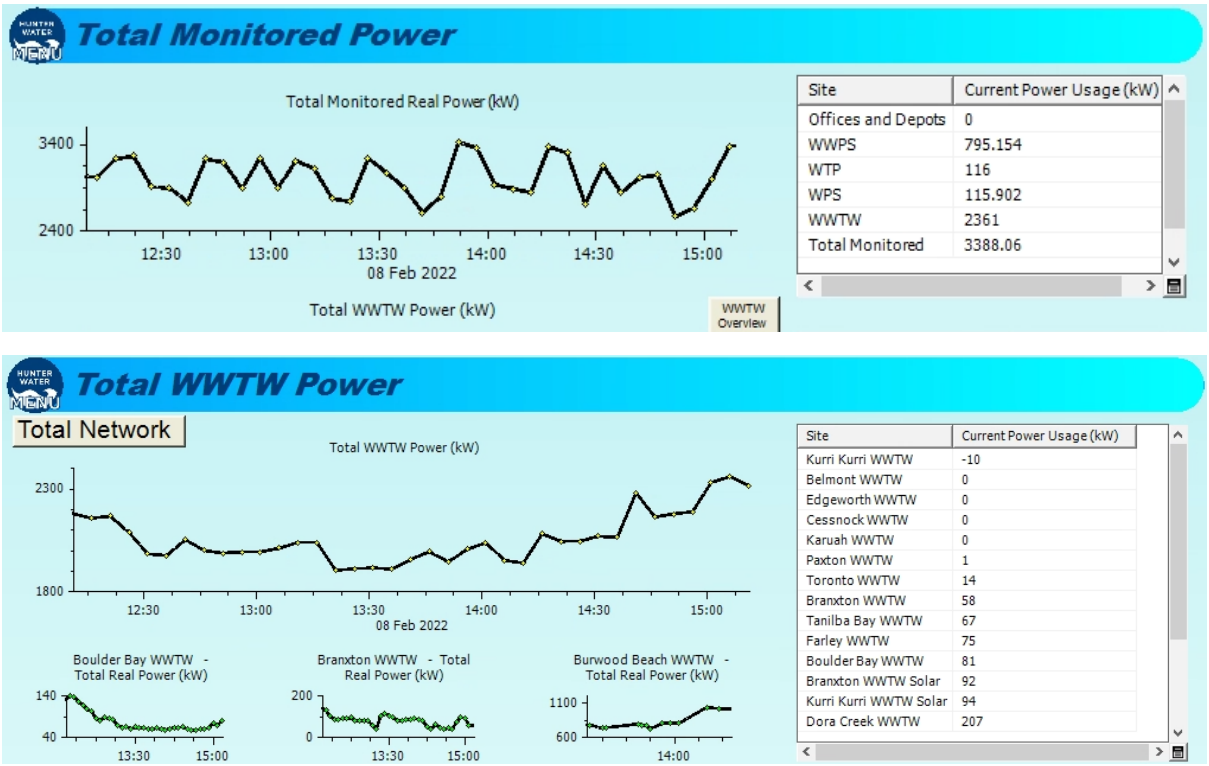


Figure 39: Example of HO SCADA energy dashboard

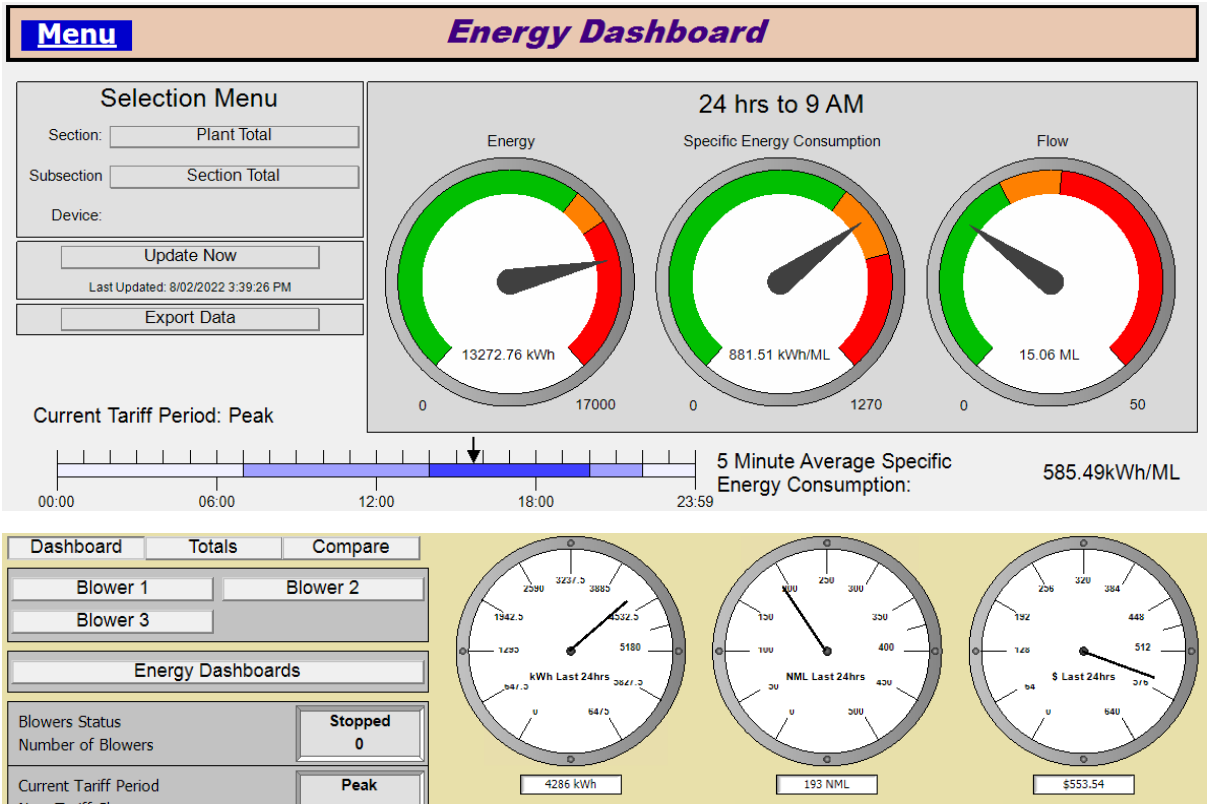


Figure 40: Example of local SCADA energy dashboard

(f) HV overviews – for example, HV switchgear addition or network reconfiguration

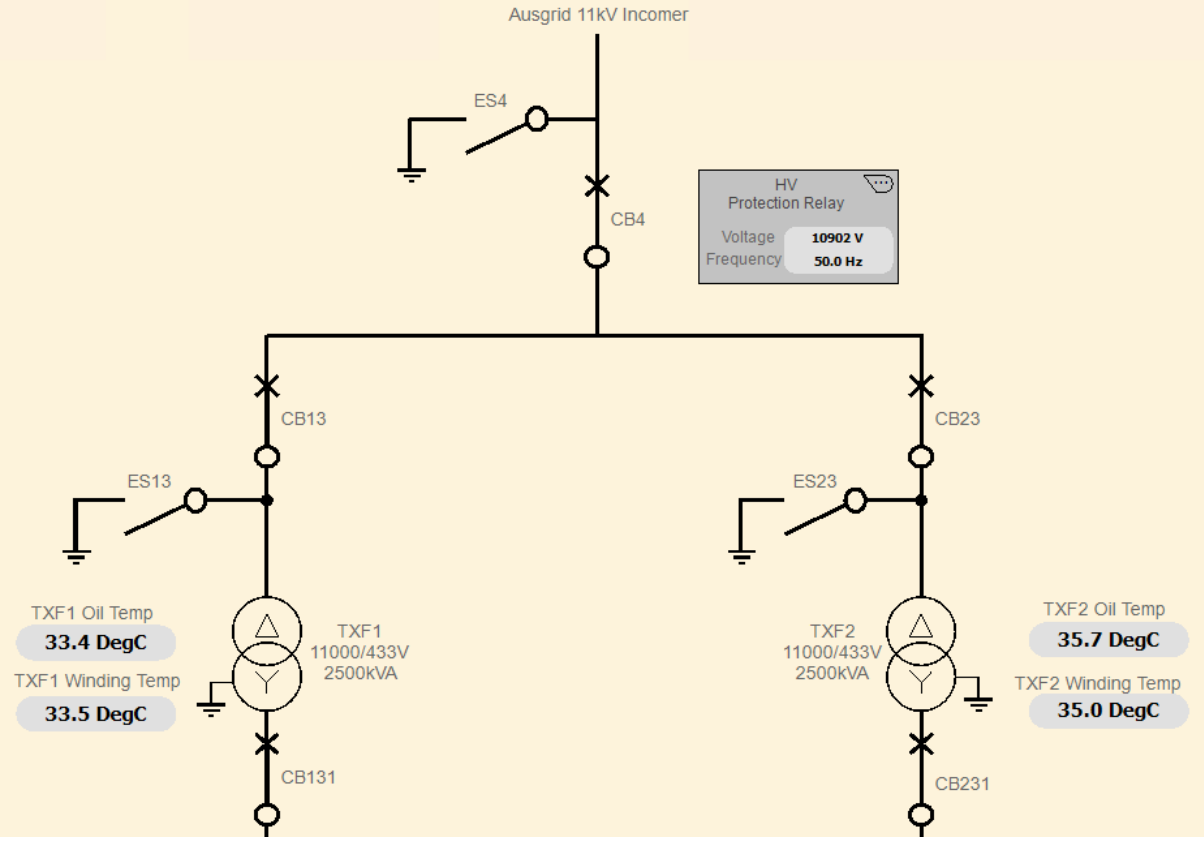


Figure 41: Example of local SCADA HV overview

(g) LV overviews – for example, LV switchgear addition or network reconfiguration

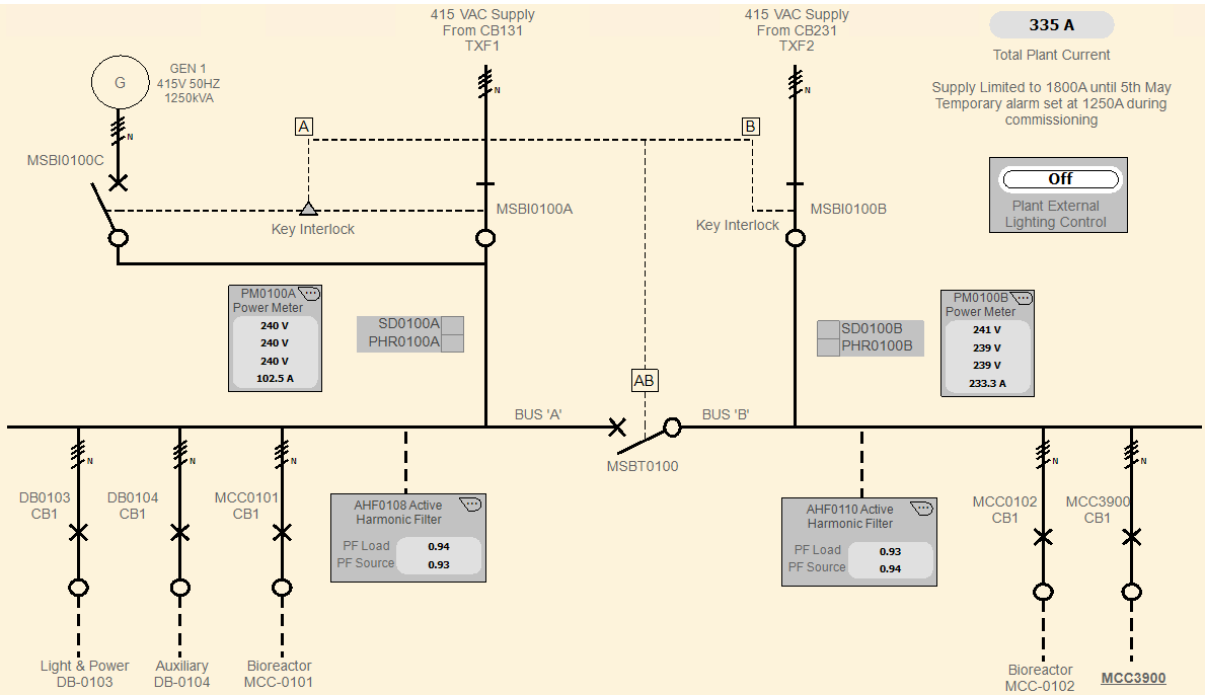


Figure 42: Example of local SCADA LV overview

(h) control/PLC network overviews – for example, large site control network additions or reconfiguration

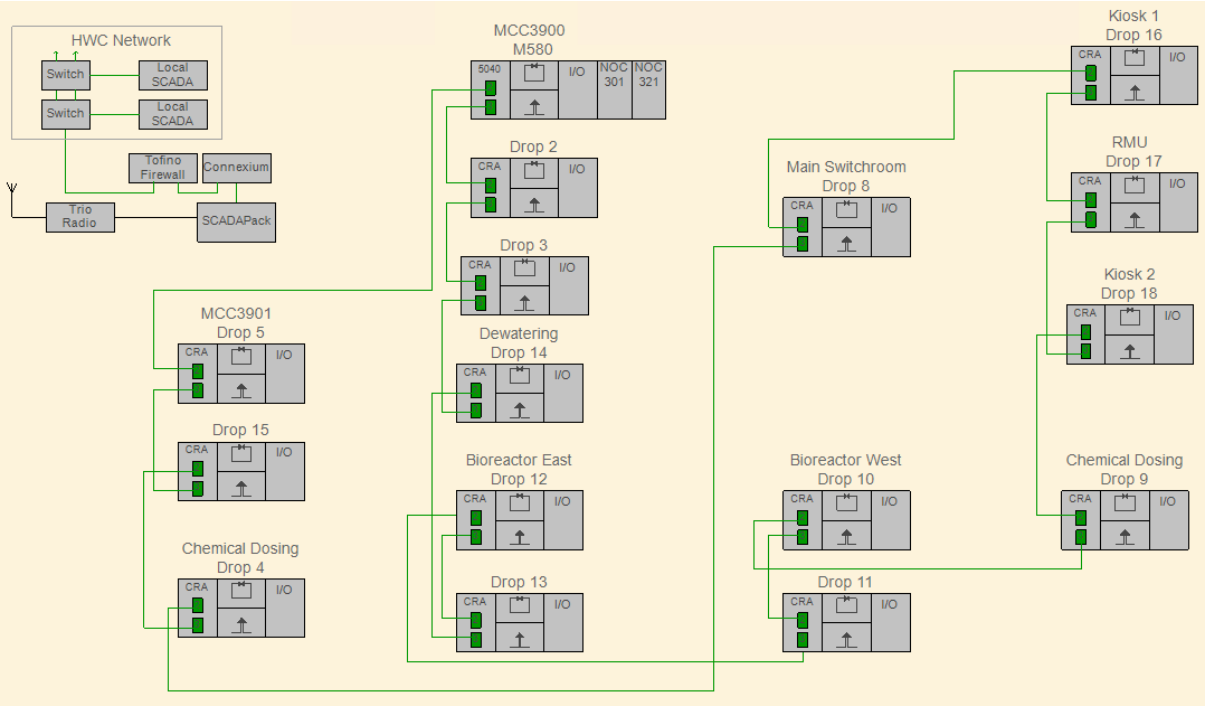


Figure 43: Example of local SCADA control network overview

(i) hydraulic overviews – for example, network site addition or SCADA template update

(j) critical control points – for example, CCP added to a site

(k) chemical hazard lists – for example, a new chemical process added to a site

(l) water storage volume calculations – for example, reservoir maximum volume modified

(m) individual or group site information – for example, modification to an alarm in a template that requires an update to the help view

(n) scheme overviews – for example, a change to the Central Coast Inter-Regional Water Transfer (CCIRWT) system

(o) device data to HO SCADA for hardware for the 'Asset Data Retrieval' system. Example minimum device data is:

Table 9: SCADA device data

Equipment	Data Points Transferred						
HMI	Firmware Version	Base Code Version	Model Number				
Modem (Cellular)	Firmware Version	Serial Number	Model Number	SIMICCID	IMEI		
PAC/PLC Network Cards (large sites)	Firmware Version	IP Address	Model Number				

Equipment	Data Points Transferred						
PAC/PLC	PLC OS Version (Firmware)	Base Code Version	PLC Build Version (Date)	PLC Unity Version	Model Number		
Radio	Firmware Version	Serial Number	Model Number				
RTU (Point Orange)	Firmware Version	Modem Firmware	Serial Number	Build Version (Date)	Model Number	SIMICCID	IMEI
RTU (SCADAPack)	Firmware Version	Serial Number	Base Code Version	Model Number			

9.9 Alarms

SCADA alarms are standard per device template. Alarm and event severities shall be as defined in the template point or modified as per the ACMM for the site as below.

Alarm severities are defined for the asset type by the Principal and shall be confirmed during the development of the ACMM and software code.

(a) alarm severities are:

- Email
- Suppressed Delayed Minor
- Suppressed Delayed Low
- Suppressed Delayed Medium
- Suppressed Delayed High
- Suppressed Minor
- Suppressed Low
- Suppressed Medium
- Suppressed High
- Delayed Minor
- Delayed Low
- Delayed Medium
- Delayed High
- Minor (4)
- Low (3)
- Medium (2)
- High (1)
- Critical (1).

Alarms defined below are provided for example only:

- Email – for redirection to an email address, or for logging in the event list
- Minor – pump health, pump MAS warning
- Low – pump unavailable
- Medium – no pumps available, well level static
- High – intruder alarm
- Critical – treatment bypass, critical control point breach, fire alarm.

If the severity of an alarm is deemed to be one of those that are delayed, the following extra configuration shall be completed once per point:

(b) alarm redirections shall be enabled

(c) a new redirection is to be configured as per the following:

- 'Trigger Type': "Auto"
- 'Trigger State': "Unacknowledged Uncleared"
- 'Action': "~Config.Redirections.Delay Time Change of Priority"
- 'Low Severity': "Delayed Low"
- 'High Severity': "Delayed High"
- 'Direction': "Not Dependent On Direction"
- 'Delay': "<value provided by the Principal or from ACMM>"
- 'Abort State': "Cleared"
- 'Active From': "00:00"
- 'Active To': "00:00".

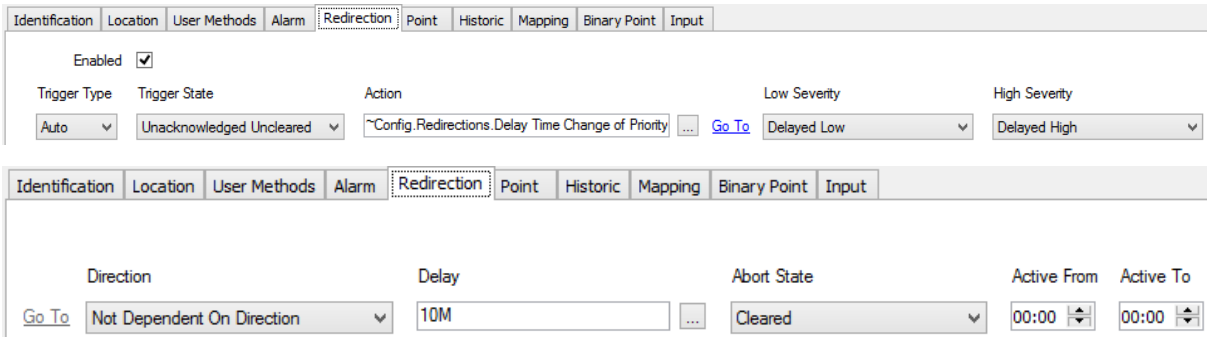


Figure 44: Alarm redirection

9.9.1 Alarm point data population

All points within the SCADA site that are configured with an alarm shall include 'Action Text' as well as 'Request Class' in the 'Alarm' tab, and the corresponding plant number in the 'Equipment Number' field on the 'Identification' tab as per section 9.8.4.

The ‘Action Text’ configuration can be found on the ‘Alarm’ tab of the properties of each point:

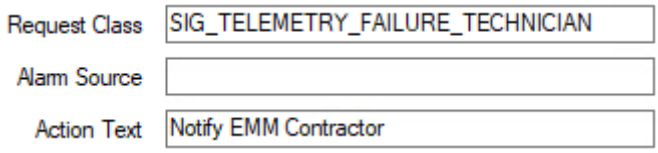


Figure 45: ‘Action Text’ and ‘Request Class’

Action text and request class for each point shall be provided by the Principal.

9.9.2 Alarm display

9.9.2.1 Mimic text

Where a point in alarm is to be displayed on a SCADA mimic as text, the text colour is to be changed from black (normal state) to the alarm priority colour and also flash (alarm state) – reference existing SCADA colour objects (‘~Config.Templates - Approved.~Colours’).

9.9.2.2 Mimic equipment object

Where a point in alarm is to be displayed on a SCADA mimic as an equipment object, the location of the point in alarm is to be displayed using a red and ‘ringing’ alarm bell beside the mimic equipment object. Acknowledged uncleared alarms shall be displayed using a red static (not ‘ringing’) alarm bell.

Figure 46: Alarm bell on mimic equipment object

9.9.2.3 Equipment or object hyperlink

Where a point in alarm is displayed on a SCADA popup or list that is accessed via a hyperlink, the link to the point in alarm is to be displayed using a red and ‘ringing’ alarm bell beside the hyperlink. Acknowledged uncleared alarms shall be displayed using a red (not ringing) alarm bell.

Figure 47: Alarm bell on equipment or object hyperlink

9.9.2.4 More information button ‘…’

Where a point in alarm is to be displayed in a list accessed by the more information button (‘…’), the button shall be red and flashing. Acknowledged uncleared alarms shall be displayed using a red (not flashing) button.

Figure 48: Alarm bell on more information button ‘…’

9.9.3 Views

All points within the SCADA site shall be configured with a ‘Default View’ at the functional group level. In addition, those points that are also configured with an alarm shall have the ‘Alarm View’ configured at the functional group level.

9.9.3.1 Alarm View

The alarm view shall be configured with the mimic or popup where the alarm is displayed.

The ‘Alarm View’ configuration can be found on the ‘Alarm’ tab of the properties of each point. If nothing is configured in this field then the alarm view inherits that which is set at the functional group level, or the first parent group that contains a location for the alarm view.

9.9.3.2 Default View

The default view (inherited from the containing group) shall be an overview for the site where the point is located.

The ‘Default View’ configuration can be found on the ‘Group’ tab of the properties of the containing group object.

9.9.4 Alarm configuration

Where alarms are required which are not part of a standard device or standard template, they are to be configured in accordance with the following principles:

(a) Each alarm shall be relevant to an out of the ordinary operational state or equipment fault.

(b) Each alarm shall be in the database structure in a location to best indicate the root cause of the out of the ordinary state or equipment fault.

(c) The alarm system shall be designed and configured to minimise multiple alarms being generated from a single operating condition or equipment fault, e.g. by use of consequential alarm settings.

(d) The alarm system shall be configured to minimise nuisance alarms. This may require the use of other alarm functionality, e.g. hysteresis, delayed alarms, persistence into and out of alarms, etc.

(e) The ‘RTU Event’ shall be set to “Enabled Unsolicited”.

(f) In an analogue point, the highest levels are to be populated first, i.e. “4 High” and/or “4 Low” as in Figure 50. There shall be no gaps between configured alarms and ‘Overrange’ and/or ‘Underrange’.

(g) In an analogue point, all unused alarm levels are to be set with the ‘Description’ as “Normal”.

Some basic examples:

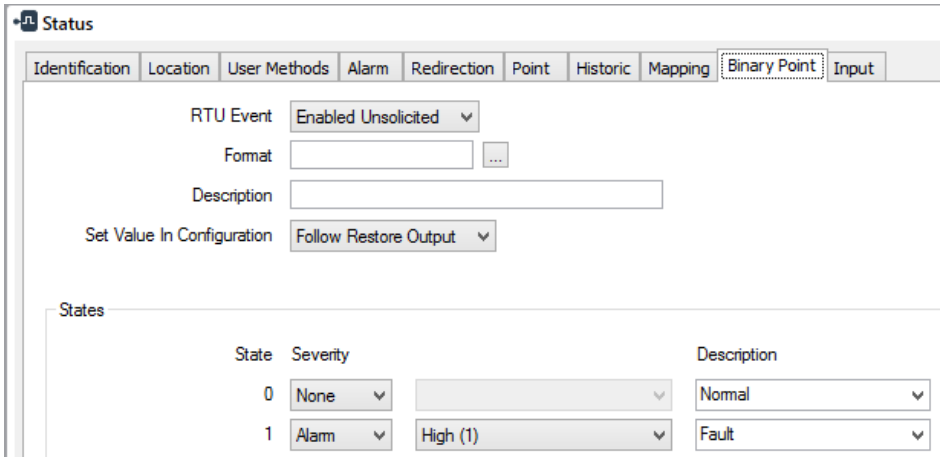


Figure 49: Binary alarm configuration

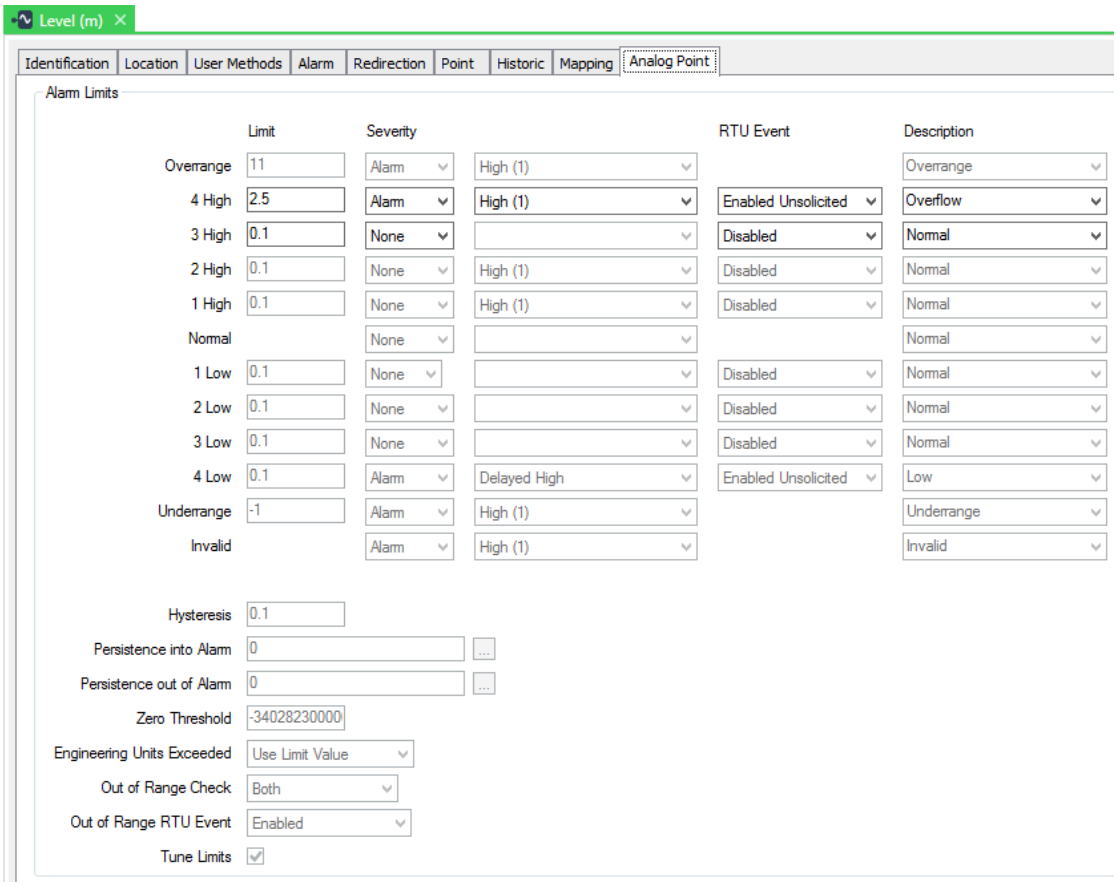


Figure 50: Analogue alarm configuration

9.10 Relative versus absolute addressing

Relative addressing within objects shall only be used when referencing another object within the same site. For all other situations absolute addressing shall be used.

For example, if a wastewater pumping station is looking at the rain gauge in the wastewater treatment plant it shall use absolute addressing (e.g. “Commissioned.Rutherford 2 WWPS.Graphics.Overview”). If a logic program in a site is looking at the status of a pump within the same site then it shall use relative addressing (“..Graphics.Overview”).

9.11 Commissioning

Before any commissioning or site work involving the modification of software, hardware, or processes, the Contractor shall inform the appropriate stakeholders in advance of the work. At least five working days' notice is required, but treatment plants may require a minimum of ten days. This shall always include the Principal's Project/Contract Manager, who shall then inform the following groups as appropriate for the site type:

- System Control
- Treatment Operations
- Network Operations
- SCADA Support (OT)
- Digital (IT)

Sites or equipment are to be developed and commissioned in the 'Not Commissioned' group and only moved into the correct group when they are ready to be monitored by the operators. For example, for large sites this would be the production group but the 'Commissioned' group for other site types.

If upgrading sites and/or points, all historic data currently available shall be retained. For clarification of what is required to be retained please contact the Principal.

Detailed information for commissioning handover is contained within integration guides and the Principal's *Testing, Commissioning and Process Proving Technical Specification (QT121)*. The relevant documents for the work being commissioned shall be adhered to and any relevant checklists submitted.

The following items, at a minimum, are required before the SCADA site/equipment can be moved from the 'Not Commissioned' group into the 'Commissioned' group:

(a) Equipment numbers:

  (i) All points that are associated with points in the PAC/PLC and/or alarm points shall have an equipment number configured. This also includes the site equipment number.

  (ii) Any group that contains the above points shall also have the equipment number configured.

(b) Action text:

  (i) All points that are configured with an alarm shall have action text configured.

(c) Network links:

  (i) If applicable, all upstream and downstream links for a site shall be configured.

  (ii) Any references to other sites or equipment are to be updated.

(d) Alarm displays:

  (i) All points that can alarm shall be configured as per section 9.9.2.

  (ii) No false alarms are allowed to be active in new work or in any old, decommissioned code.

  (iii) There shall be no multiple or nuisance alarms being generated from a single operating condition or equipment fault as per section 9.9.4.

(e) Views:

(i) The alarm view for each point shall be the mimic or popup where the alarm is displayed as per section 9.9.3.1.

(ii) The default view for each point shall be the overview mimic for the site where the point is located as per section 9.9.3.2.

(f) Hydraulic views for network sites:

(i) If applicable, each site shall be configured with a hydraulic view.

(g) Menu navigation:

(i) Menus on the SCADA system shall be configured to appropriately provide navigation to the site.

(h) Events:

(i) A check of the events generated by the changes shall be made and any unnecessary ones removed by configuration of objects.

(ii) Old site instances related to any work are also to be checked, and any event generating points disabled.

(i) Telemetry points:

(i) The communications object (e.g. 'Outstation') for any external telemetry points shall have 'Display Points' reviewed, and any problems rectified.

(j) Logic:

(i) All logic is to be checked for errors or overruns.

(k) Project information:

(i) The '~Project Information' table is populated as per section 9.8.

(ii) The '~Project Notes' mimic for any changes made has been updated with the date of commissioning as per section 9.8.

A mimic which automates the checking of some of the above is available in SCADA on selected templates but can be used anywhere as required for certain checks. Please refer to the *Commissioning Script Mimic Guide* document for further information.

Note that no SCADA objects used for an operational site shall be left in non-production areas of SCADA (e.g. 'Not Commissioned', 'Z Testing', etc.) after commissioning. This includes any templates, mimics, symbols or other objects.

After any changes, and before leaving site for the day, the Contractor shall confirm with the operators that the site is operating as expected. On a site with a local SCADA system, a comparison of digital and analogue setpoints before and after the changes shall be performed to check for differences. For example, a data extraction from SCADA into Excel and then use the 'MATCH' function. If any differences are found the Contractor shall discuss the correct setpoint value with the site operator.

9.12 Decommissioning

All objects which are no longer needed in SCADA are to be moved to the 'De-Commissioned' group. References to these objects are to be resolved so that the objects can be archived. If this is not possible for any reason, please contact the Principal.

9.13 Code handling

Redundant servers are used across the SCADA network at head office and treatment plant sites. These servers are backed up using a scheduled automated process, and any changes made to the system will be captured.

9.14 Security

Persons that need access to SCADA systems can request access by applying via the Principal. Only the minimum access level to SCADA to perform the work will be granted.

10 Human machine interface (HMI)

The Principal uses HMIs throughout the network. When using an HMI or remote terminal, the following shall be adhered to:

(a) The Principal has several standard HMI code projects that shall be used where available. For other applications please contact the Principal.

(b) Where HMIs or remote terminals are to be used to provide diagnostic feedback to operator/technicians, no user authentication is required. HMIs shall not perform any control functions or be used to enter setpoints, unless they are specific displays just for one piece of equipment and don't directly connect to the control network, e.g. VSD, power meter displays.

(c) Only the HMIs on the approved Principal's equipment lists are to be used. All other HMIs require approval via the Principal's Subject Matter Expert.

10.1 HMI software

The current Principal approved version of Vijeo Designer for Schneider HMIs shall be used.

Where a later Principal approved version of Vijeo Designer is released during the term of a project, then at the time of final Commissioning, that version shall be used.

Other HMI software requires approval via the Principal's Subject Matter Expert.

10.2 HMI naming conventions

10.2.1 HMI program file names

The HMI program file name is to conform to the naming convention described below:

(a) <facility plant number>.vdz – the archived project from the Vijeo programming software.

Please see Appendix G for more information on file types, and some examples.

10.3 HMI programming

The basic project configuration process is as follows:

(a) hardware configuration (HMI and device IP addresses)

(b) configure real-time clock for the HMI to be updated from the plant PAC/PLC real-time clock

(c) master reference variables configuration (used on master template pages)

(d) equipment variables configuration (final device variables/addresses)

(e) master template graphics pages (one page per different type of device)

(f) general graphics pages (main menu, plant status, etc.)

(g) where a piece of equipment does not exist, it shall be removed from all graphics pages.

The following sections refer to large sites with 15" HMI screens but similar principles shall be followed for other site types with different sized screens.

10.3.1 Multiple units per site

Where multiple HMIs exist on a single site, all HMI 'Targets' shall be combined into the one HMI project file.

All HMIs on a site shall display the complete site operation and not just those processes in its local area, and all of them shall be updated for any new work. For example, if the HMI is in a switchroom dedicated to UV disinfection, it shall still show the operation of all other processes on the site as well as UV. Each site HMI shall be based on the same 'Target', so they are as close as possible in display and operation, with the main differences being only the communications parameters to individually identify each unit. One 'Target' per site shall be created/modified and then the 'Duplicate Target' functionality (within Vijeo Designer) utilised to create a 'Target' for the remaining physical HMIs on the site.

At the end of any work, all site HMIs will be identical visually and functionally with the same information.

10.3.2 Real-time clock

The HMI real-time clock (RTC) shall be synchronised to the site PAC/PLC. This shall be achieved using the approved PAC/PLC derived function block, and approved HMI logic. These are available upon request via the Principal.

10.3.3 Main menu page

The main menu page displays buttons used to navigate to other graphics pages for plant equipment. The buttons on the main menu page are arranged in three groups, 'PLANT', 'POWER MONITORING' and 'DEVICES'.

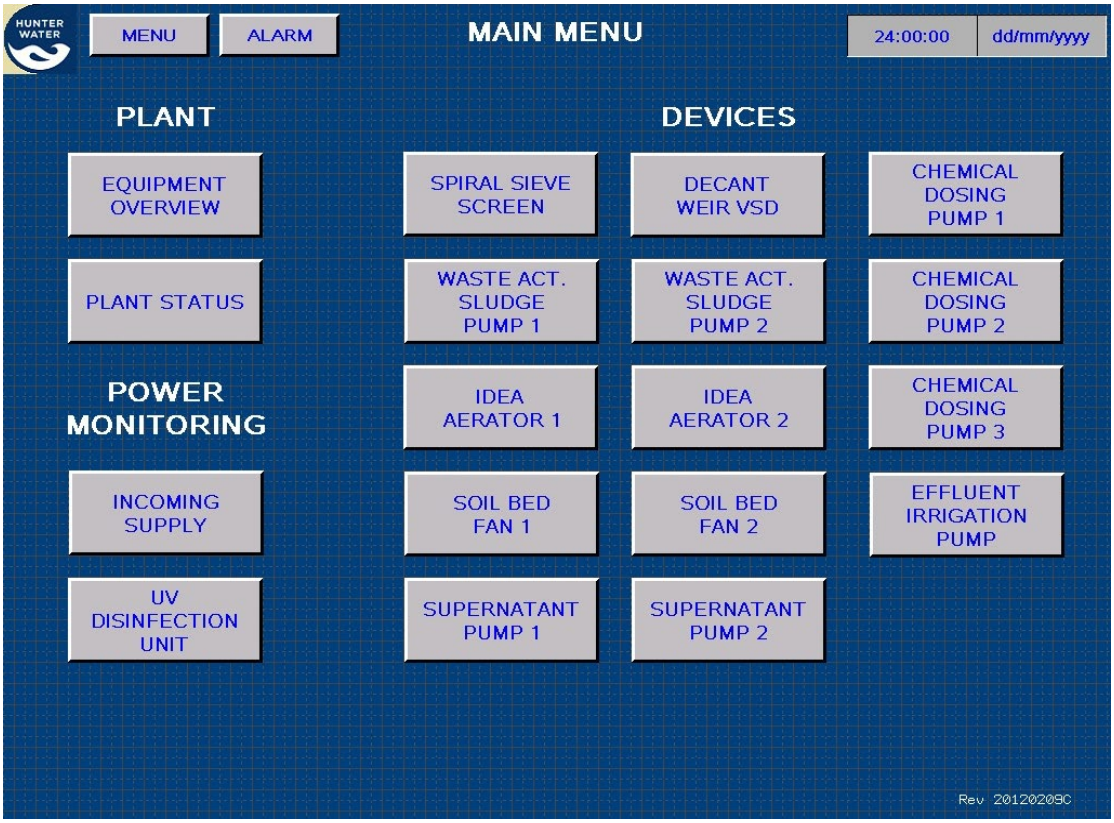


Figure 51: HMI main menu page

10.3.4 HMI plant/equipment overview page

The plant/equipment overview page is a quick reference page that displays the current general status and load of all individual plant motor driven equipment. Each item of equipment has a fault, ready, and running status as well as load information.

The plant/equipment overview page has indication for each of the following general conditions of each drive:

(a) 'FAULT' – orange lamp indicates fault; grey indicates no fault present.

(b) 'READY' – green lamp indicates ready (inputs to the TeSys T or variable speed drives (VSDs) combined with the internal status of the TeSys T or VSD); grey indicates not ready.

(c) 'RUN' – red lamp indicates running; grey indicates not running.

Note: 'READY' does not indicate that the drive is ready to start. It is a hardware indication that the field input wiring to the TeSys T or VSD is on AND the TeSys T or VSD controllers are ready. It is not an indication that the drive is ready for a PAC/PLC start.

Figure 52: HMI plant/equipment overview page

10.3.5 HMI plant status page

The plant status page displays the setup/settings for processes, and the analogue instrument readings. Settings cannot be changed and are for display purposes only.

The 'ANALOGS' group displays the current value of each instrument in its native engineering units.

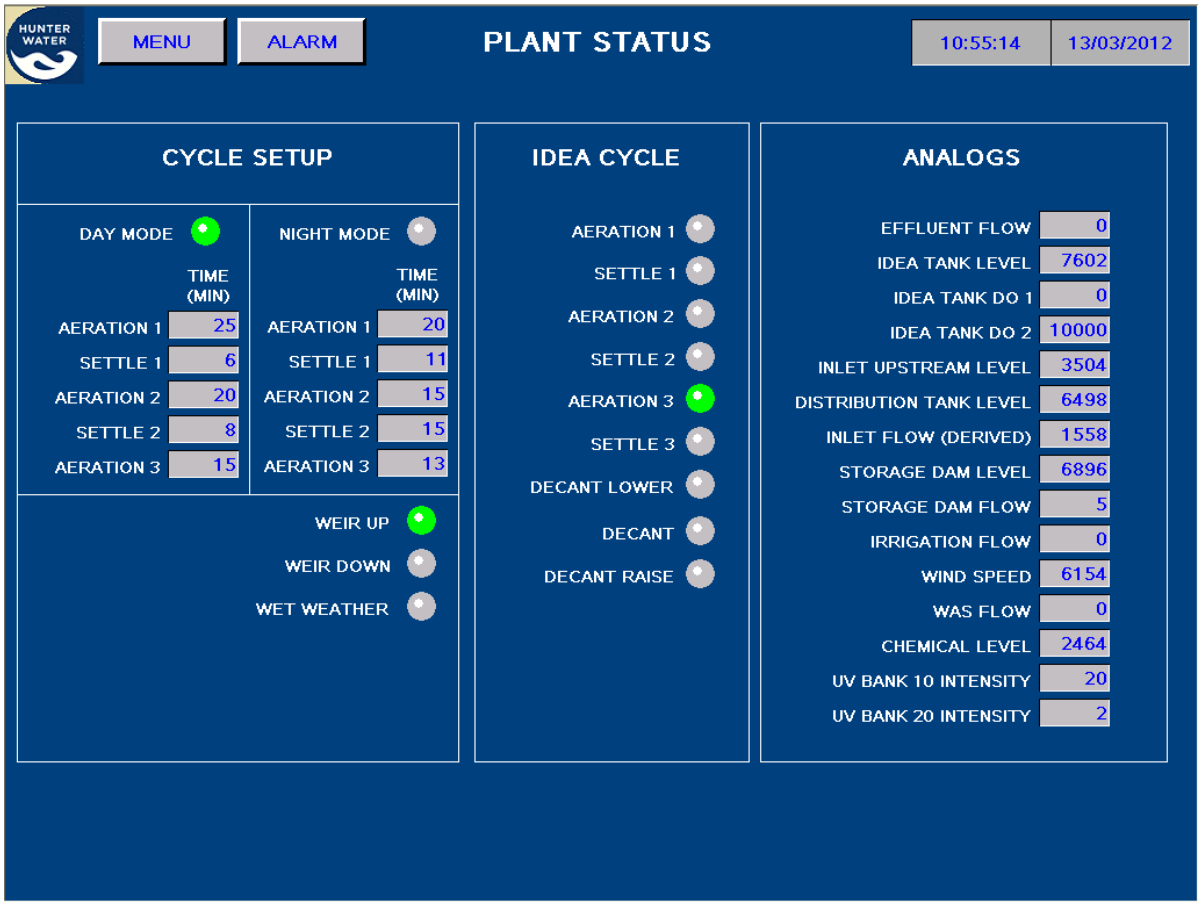


Figure 53: HMI plant status page

10.3.6 HMI incoming supply page

The incoming supply page displays power supply real-time readings of current, voltage, power, power factor, and harmonic distortion.

Figure 54: HMI incoming supply page

10.3.7 HMI VSD page

The VSD page below illustrates the typical setup for a Principal's VSD. The VSD page displays general information about the VSD and the motor, digital I/O, VSD status, and fault history.

On the device overview page indication is as follows:

(a) grey/green for off/on for non-faults

(b) grey/red for off/on for fault indication.

The ‘FAULT HISTORY’ section shows the last three faults along with the time and date when they occurred.

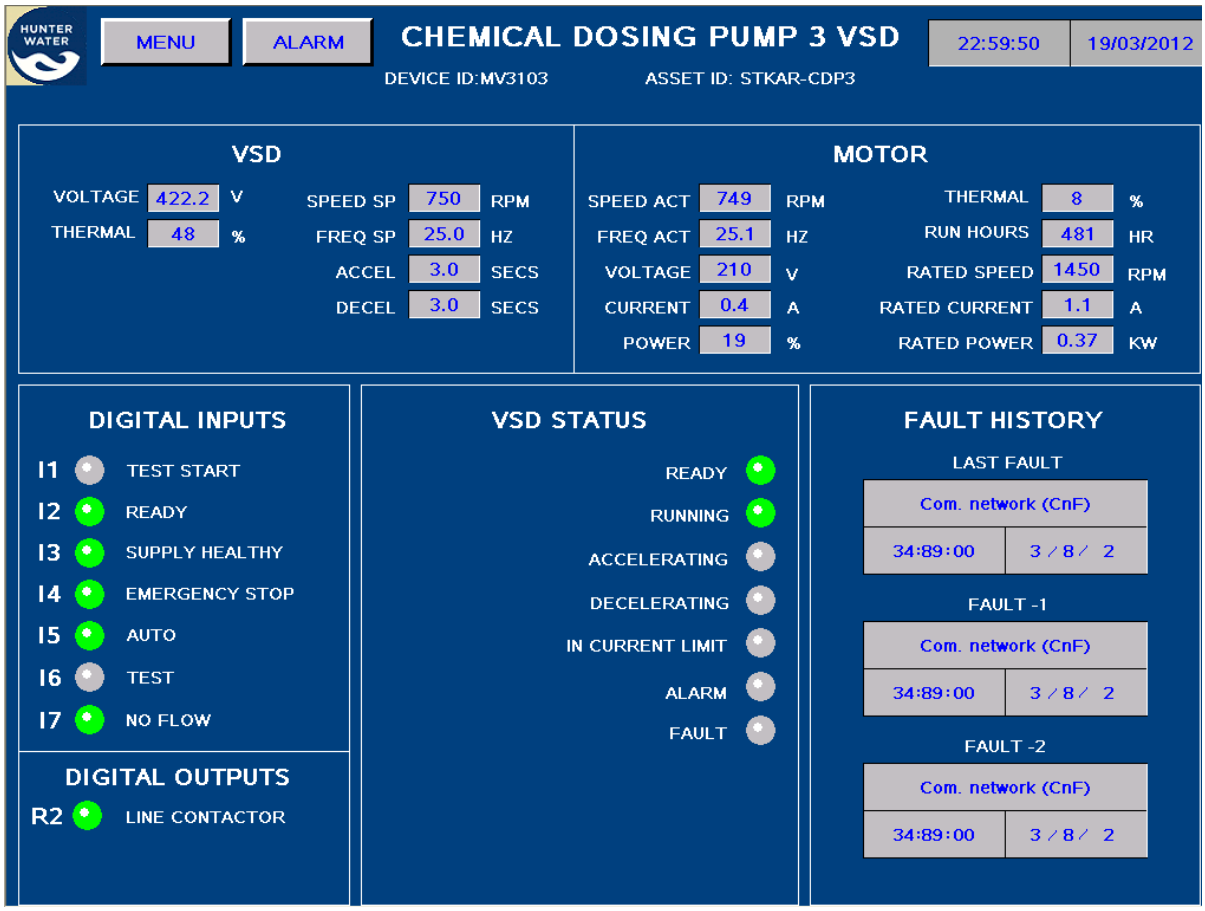


Figure 55: HMI VSD page

10.3.8 HMI alarm page

The alarms page is a standard in-built ‘System Error Log’ page. It will display in-built system faults as well as configured faults for each item of plant equipment.

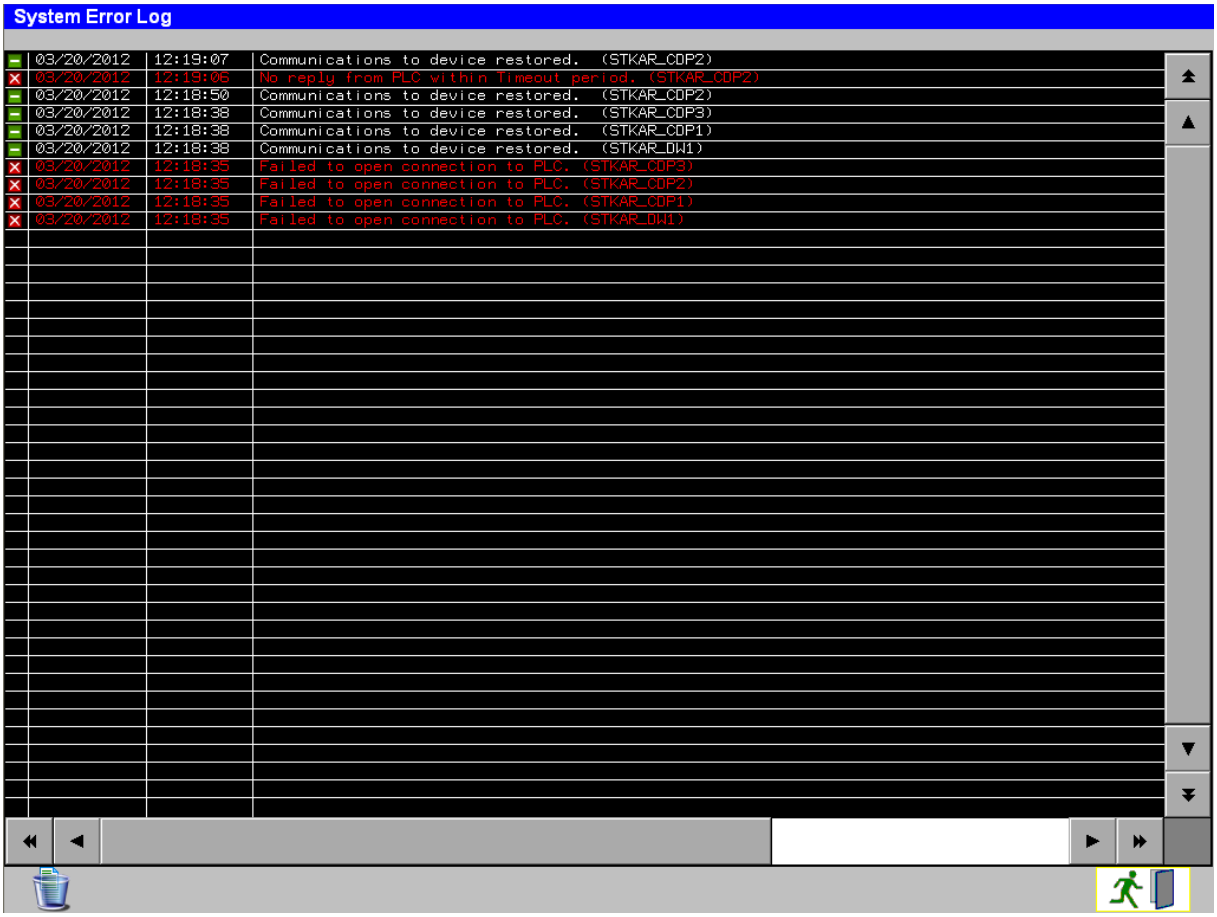


Figure 56: HMI alarm page

10.4 Code handling

10.4.1 Off-site

Prior to programming, a copy of the existing site and/or approved standard HMI software code shall be requested via the Principal.

During the project, operational circumstances may require the Principal to modify the HMI software code. The Contractor shall check for and include any modifications made in the site code, after receiving a copy of the code before work, and include this in the final commissioned code version. The Principal shall be consulted on the method of resolution for any conflicts.

10.4.2 On-site

Please refer to section 5.6 for what is required if changes are made to an active system.

Details of the required files for an HMI can be found in section 10.2.

11 Other automation devices

11.1 Software

The current Principal approved version of the other automation device software shall be used.

Where a later Principal approved version of other automation device software is released during the term of a project, then at the time of final commissioning, that version shall be used.

Other automation device software requires approval via the Principal's Subject Matter Expert.

11.2 Naming conventions

11.2.1 Program file names

Where multiple configuration files are required, all files required shall be provided to the Principal.

The program file name is to conform to the naming convention described below:

(a) <facility plant number>.<extension> – the project file

(b) <facility plant number>.<extension> – other required configuration file(s).

Please see Appendix G for more information on file types, and some examples.

12 SCADA and control networks design

This section is an overview of the detail contained in the *Hunter Water PLC/RTU and Control Network Design Guide* document, the latest version can be requested from the Principal. The document shall be followed to comply with this STS.

12.1 Large sites

Some large sites have their own local SCADA systems with associated SCADA and control networks. They also communicate with the HO SCADA network via telemetry and WANs.

General information about the large site network architecture:

(a) The SCADA and control networks shall be represented graphically on local SCADA and HMIs, and alarms configured indicating failures of all active components. If a local SCADA system does not exist on site, then the same information shall instead be placed on HO SCADA. The information shown shall be enough to troubleshoot the abnormal operation of any SCADA and control network device, e.g. firewalls, switches, routers, network connected devices, telemetry, PLCs, I/O modules, etc. It is not meant to show the status of I/O devices themselves.

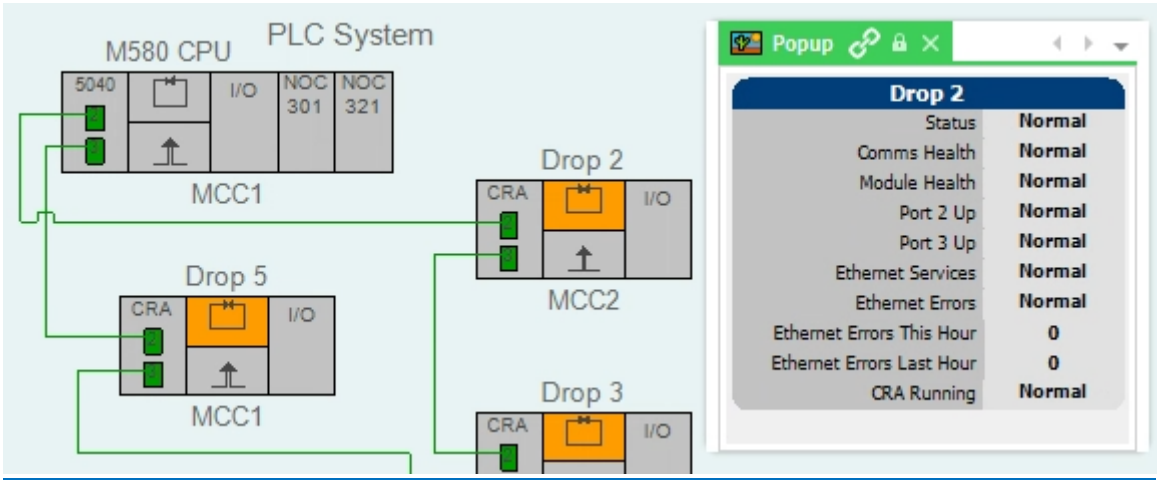


Figure 57: Graphical control network example

(b) All changes to the SCADA and control networks shall be detailed on the *Automation (PLC/SCADA) Network Overview* electrical drawings (SK8198) which show a logical diagrammatic view of the major devices and network connections. More detailed schematics shall be included in the individual site electrical schematics and show at a minimum:

(i) all physical components and cable routing

(ii) FOBOT connections

(iii) patch panel connections

(iv) switch port connections and spares

(v) cable numbers and schedules

(vi) wire numbers

(vii) device port connections

(viii) power connections.

Note – no cross-references from the detailed schematics shall be made to SK8198 and vice versa.

(c) If there are changes to the control network planned, then before the detailed design process commences, an audit of the current state of the control network architecture shall be carried out using the appropriate Schneider software, at the time of writing this is *ConneXium Network Manager* and/or *Hirschmann Industrial HiVision Network Management Software* for the Ethernet networks. This should be restricted to the networks that the proposed work will interact with, which the draft automation network drawing (SK8198) should show (see section 7.1). The same audit shall be performed at the end of commissioning, before handover to the Principal, to confirm that all the work has been completed to current standards. Please contact the Principal to arrange for the audit to be performed by Hunter Water.

For example, if adding a new VSD to a DIO network, the DIO network shall be checked for:

(i) PAC/PLC I/O or communication errors

(ii) IP address conflicts

(iii) the latest firmware for all DIO modules, switches, devices, etc.

(iv) DIO Ethernet switch settings. For example, RSTP, only one ring manager, abnormal traffic, exception log inspection, etc.

12.1.1 Control network

The control network encompasses all communications network devices and connections that are related to the control of operating plant. This includes:

(a) PAC/PLCs

(b) passive devices, e.g. power meters, etc.

(c) active control devices, e.g. variable speed drives (VSDs), TeSys T motor control, remote I/O, active harmonic filters, etc.

(d) HMIs

(e) network switches/routers concerned with Remote I/O (RIO) and Distributed I/O (DIO)

(f) RTUs

(g) communications devices, e.g. radio transceivers, cellular modem/routers, etc.

Any equipment that is located outside of switchrooms or attached buildings and is required to be connected to PLC I/O, shall be terminated into externally located remote I/O cubicles on the control network and not direct hard-wired back to PLC I/O in the switchrooms. The remote I/O cubicles shall connect into the site control network via RIO and shall contain DIO sub-networks as required.

12.1.2 SCADA network

The SCADA network encompasses all network devices and connections from head office via the WAN/LAN down to the control network. This includes:

(a) WAN communications, e.g. cellular modem/router, microwave, dark fibre, ADSL, or VDSL

(b) Ethernet network hardware, e.g. switches, routers, etc.

(c) SCADA servers

(d) SCADA viewing PCs.

Any SCADA network designs shall be reviewed by Hunter Water IT group via the Principal.

A similar ring structure as per the control network is also valid for the SCADA network.

12.2 Medium sites

Medium sites have their own control networks and telemetry to communicate with the HO SCADA network.

The control network encompasses all communications network devices and connections that are related to the control of operating plant. This includes:

(a) PAC/PLCs

(b) passive devices, e.g. power meters, etc.

(c) active control devices, e.g. variable speed drives (VSDs), TeSys T motor control, remote I/O, active harmonic filters, etc.

(d) HMIs

(e) network switches/routers concerned with Remote I/O (RIO) and Distributed I/O (DIO)

(f) RTUs

(g) communications devices, e.g. radio transceivers, cellular modem/routers, etc.

12.3 Small sites

Small sites have their own limited control networks and telemetry to communicate with the HO SCADA network.

12.4 General specifications

12.4.1 Network architecture design

The SCADA and control networks design shall be subject to the following:

(a) All designs for the SCADA and control networks shall be submitted for review by the Principal's Subject Matter Expert before any purchasing, programming or construction activities take place. Any SCADA network designs shall also be reviewed by Hunter Water IT group.

(b) A to-scale plan view of the site shall be submitted showing the physical locations of any proposed remote I/O racks, switchrooms, internal/external remote I/O rack cubicles, underground conduits/pits, optical fibre cable runs, major network devices (e.g. VSDs), and the number/type of any binary/analogue I/O. At a minimum, it shall clearly show the

difference between the proposed new design and the interactions with the existing site configuration.

(c) Any SCADA or control network switches shall support, and be connected in, ring topology so that a single fault in one copper Ethernet or optical fibre pair will not cause any of the network to be unavailable. All existing and new control network switches shall be configured so that there is no conflict between them.

(d) All Ethernet switches shall as a minimum have one spare port for software programming purposes.

(e) Single points of failure are to be avoided.

(f) Standalone Ethernet media converters shall not be used unless approved via the Principal's Subject Matter Expert. Any protocol and/or physical media conversion shall be done by using approved PAC/PLC modules or Ethernet switches.

(g) Where devices act in a duty/standby arrangement:

(i) The essential PAC/PLC I/O for each device is, at a minimum, to be connected to different I/O cards or duplicated on a separate device. For example, Pump 1 I/O is to be on one card, and Pump 2 I/O is to be on a separate card.

(ii) The failure of one PAC/PLC I/O card shall not stop the functioning of other I/O, or the control system in general.

12.4.2 Hardware design

The SCADA and control networks hardware design shall be subject to the following:

(a) Any equipment used is to be selected from the Principal's approved materials and equipment as per section 5.4; any variations shall require approval from the Principal's Subject Matter Expert.

(b) Any equipment not on the Principal's approved materials and equipment list shall not be connected to the SCADA or control networks using any Ethernet IP addressing protocols, unless approved by the Principal's Subject Matter Expert.

(c) For treatment plants and large sites there are separate communications cubicles for the SCADA and control networks in all physical locations, i.e. switchrooms, process buildings, etc.

(d) For medium and small sites, the SCADA and control network equipment is usually contained within the same cubicle.

(e) All cubicle layouts and locations shall be submitted for review and comment by the Principal before procurement or construction commences.

(f) No Quantum PLC equipment shall be added to any new or existing infrastructure, which includes I/O modules. Quantum I/O modules already installed may be used for new I/O connections. The Quantum PLC system is End of Commercialisation (EoC) and is being replaced by other options.

Please refer to *STS 500 General Requirements for Electrical Installations* for more information.

12.4.3 Cabling and terminations

Please refer to *STS 500 General Requirements for Electrical Installations* for information about cabling and terminations.

12.4.4 Large sites

Specific requirements for large sites are:

(a) Where devices act in a duty/standby arrangement:

(i) Multiple devices performing the same function, e.g. pump VSDs, are to be split between at least two network Ethernet switches, i.e., if there are four pump VSDs then pumps 1 and 2 can be connected to switch 1, and pumps 3 and 4 connected to switch 2.

(ii) Where practicable, essential I/O shall be connected to a separate PAC/PLC rack that does not share a common power supply between PAC/PLC racks.

(b) Communications to any large site SCADA servers from the PAC/PLC is over the SCADA network.

(c) Communications to the HO SCADA servers from the PAC/PLC is using the DNP3 protocol via an RTU on the SCADA network that acts as a protocol converter/gateway.

(d) Where practicable, the SCADA main and standby servers shall be physically located in separate buildings so that one single disastrous event does not compromise both servers.

12.4.5 Medium and small sites

Specific requirements for medium and small sites are:

(a) Communications to the HO SCADA servers from the PAC/PLC is using the DNP3 protocol via an RTU that acts as a protocol converter/gateway.

(b) All Ethernet switches shall as a minimum have one spare port for software programming purposes.

13 Communications

All designs for communications shall be submitted for review by the Principal before any programming, purchasing or construction activity takes place.

13.1 Network assets

The Principal maintains a variety of assets at remote sites. These assets require telemetry systems for communication to HO SCADA. Remote site assets include:

(a) radio bases

(b) pumping stations

(c) reservoirs

(d) high level tanks

(e) flow meters

(f) AIV/PRV/PSVs

(g) rain gauges

(h) chemical dosing facilities

(i) other minor instruments.

Current preferred telemetry communications systems are summarised below, this may change with the evolving technology landscape.

13.1.1 Licensed microwave

Licensed microwave is the primary communications path used between radio bases, and at some treatment/large plants for the SCADA network WAN.

13.1.2 Fixed line VDSL/fibre

Fixed line NBN(VDSL)/fibre is the primary communications path used at some treatment/large plant sites for the SCADA network WAN.

13.1.3 Licensed digital radio

Licensed digital radio is the preferred communications method between non-treatment/large plant sites and the SCADA network WAN, for example, pumping stations. It is also used as the tertiary communications path between treatment/large plants and the SCADA network WAN. Any other methods of communication for these site types shall require written approval from the Principal's Subject Matter Expert.

A radio survey is required to be performed by the Principal before any digital radio communications can be used as per section 13.8.

13.1.4 Cellular

Cellular is an alternate communications method between non-treatment/large plant sites and the SCADA network WAN, and could be used where licensed digital radio is not available. The use of cellular communications shall require written approval from the Principal's Subject Matter Expert. The Principal will provide a SIM card for use in the modem/router when cellular is used.

A signal level survey is required to be performed by the Principal before any cellular communications can be used as per section 13.9.

13.1.5 Dual communications

Critical network sites by default use two communications methods for redundancy. This is typically a combination of digital radios connected to geographically separate digital radio repeater bases.

Guidance can be sought from the Principal as to what is a critical site.

13.2 Treatment/large plants

Treatment/large plants potentially have multiple communication paths to the SCADA network WAN:

(a) a primary fixed line NBN(VDSL)/Fibre link/microwave

(b) a secondary cellular link

(c) a tertiary digital radio link.

In the event of failure of the primary path, communication shall automatically switch to the secondary path, and then to the tertiary path (RTU only) upon failure of the secondary path.

There may also be some radio communications in peer-to-peer configuration to other sites and instruments.

For critical processes, “No Change” alarms shall be used to monitor the process variable points to detect PLC/RTU/comms lockups and other problems.

13.3 DNP3

The DNP3 protocol is used for communication between RTUs and HO SCADA, as well as peer-to-peer devices, and non-time critical communications between HO and local SCADA systems.

13.4 PAC/PLC to RTU communications

Communications from the PAC/PLC to the RTU is dependent on the PAC/PLC platform:

(a) Control Expert PAC/PLCs use Modbus TCP/IP.

13.5 PAC/PLC to remote device communications

The Principal supports a number of network types for devices communicating with the PAC/PLC. These are listed below:

(a) Ethernet – usually Modbus TCP or Ethernet/IP protocols.

(b) Modbus RTU serial – commonly used for legacy devices but also to be used for non-approved devices for cyber security, even if an Ethernet option is available.

13.6 External organisations

Sometimes connections to external organisations from the Principal’s systems are required. These fall in to two main categories:

(a) physical – wired connections between PAC/PLCs, RTUs , servers, etc.

(b) wireless – IoT, cellular, etc.

13.6.1 On-site physical connections

A typical example would be a trade waste connection from an industrial process into the Principal's wastewater system. Monitoring of the external organisation site pumping station would be required, e.g. pump starts, pump enable, flow, etc.

The general requirements are:

(a) It is the external organisations responsibility to get the data to the Principal's site.

(b) No Principal's equipment will be installed at the external organisation's site.

(c) Connections to the Principal's automation system will be electrically isolated:

  (i) If by Modbus RTU, the connection will have a section of optical fibre with media converters at each end.

  (ii) If by hardwired I/O, opto-isolators are to be used between the systems.

(d) The use of Modbus RTU will require that the Principal's automation system is the master.

(e) No Ethernet connections are to be made between the two systems.

13.6.2 Off-site wireless connections

A typical example would be data sent from the Principal's site via an IoT device to an external organisation's cloud database.

The general requirements are:

(a) All connections are to be reviewed by Hunter Water IT group.

(b) No data or control signals are to be sent to the Principal's site; it shall be one-way traffic to the external organisation only.

13.7 Peer-to-peer communications

Peer-to-peer data transfer is sometimes required between sites, and the preferred method is between RTUs directly rather than routing through SCADA. Standard ISaGRAF code exists for the SCADAPack 334E for this functionality, as well as matching SCADA templates for both the transmitting and receiving RTUs. More information can be found in the document *HW Peer Communications Guide*.

13.7.1 Licensed digital radio network

When a site initiates peer-to-peer communications, the data is sent out onto the network via base repeaters to the peer site. Everything on the network segment hears the data but only the destination site will reply.

13.7.2 Cellular network

When a site initiates peer-to-peer communications, the data is sent out onto the network but rather than being sent to SCADA, it is sent to the peer site via the cellular 'cloud' and the Principal's WAN.

13.7.3 Alternative peer-to-peer communications

Where licensed digital radio or cellular technologies are not available, use of alternative technologies may be requried to provide peer-to-peer communication, e.g. microwave or point-to-point radio systems.

The use of these technologies is defined on a case by case basis and requires approval from the Principal's Subject Matter Expert.

13.7.4 SCADA peer-to-peer communications

Peer-to-peer communications via SCADA shall only be allowed after all other alternatives have been exhausted.

If SCADA peer-to-peer communication is the only viable alternative, the Contractor shall obtain written approval to use such an inter-station communication method. This approval shall be requested via the Principal's Subject Matter Expert.

A group shall be created which contains all the SCADA controlled peer-to-peer communication points. This group name shall be 'SCADA Peer Comms'.

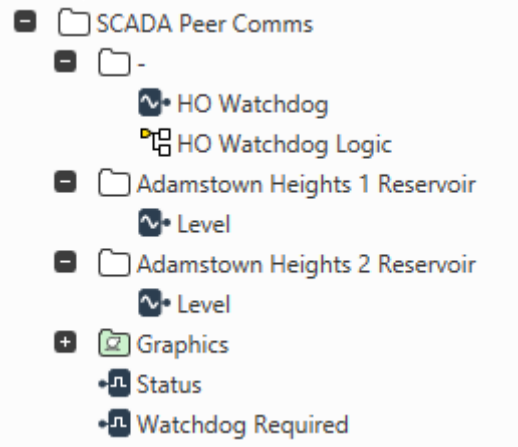


Figure 58: SCADA peer-to-peer communications

13.8 Digital radio fade margin

The performance of a digital radio path is specified as a fade margin, and is the difference, in dB, between the magnitude of the received signal at the receiver input and the minimum level of signal determined for reliable operation.

This fade margin is to allow for further signal degradation due to atmospheric and other radio phenomenon.

All fade margin calculations shall be proved with a physical survey. A survey report shall be requested via the Principal and shall detail the following minimum requirements:

(a) site name

(b) date of radio survey

(c) site coordinates stating the coordinate format

(d) recommended radio base site (if applicable)

(e) distance and bearing from site name to recommended radio base site (if applicable)

(f) RSSI signal received at both the remote and the base site

(g) frequency of ‘Outstation’ radio (if applicable)

(h) recommended antenna

(i) recommended antenna mounting height

(j) GIS plan (if applicable)

(k) additional plans (if applicable)

(l) elevation profile of recommended path

(m) packet test commissioning record

(n) photos from site survey

(o) any other related comments.

The minimum signal level for reliable operation varies dependant on the modulation method and RF speed. Reliable operation shall be available with an RSSI of -85 dBm (or better). Signal levels above this (up to -90 dBm) may be considered with approval by the Principal’s Subject Matter Expert, but only if there is not a viable solution to achieving the desired standard. Signal levels above -90 dBm will not be considered and would require an alternative communication solution to be developed.

All antennas shall be mounted to meet with the following requirements:

(p) Not be orientated so that the signal path goes over the top of, or within 3 m to the side of, any structures on site, especially when those structures are metallic. For example, metal reservoir roofs, metal building roofs, foil lined tiled roofs, etc.

(q) Any signal path must clear vertically any vegetation within 50 metres by at least 2 metres.

(r) Be 3 metres above any accessible walkway, or area used for maintenance, to avoid exposure to radiation generated by the antenna.

(s) If more than one antenna is on the same mast, they must be separated vertically by at least 2.5 metres.

Survey reports are only valid if the final proposed physical location of the antenna is no more than 10 metres horizontally from the surveyed position, and for 18 months before commissioning. A new survey report and design changes may be required outside these conditions.

13.9 Cellular signal strength

The performance of a cellular connection for 4G is measured using Reference Signal Received Power (RSRP)(dBm), Reference Signal Received Quality (RSRQ)(dBm), and the Signal to Noise Ratio (SNR)(dB).

For cellular communications at a site, all performance calculations shall be proved with a physical survey for sites where control and/or timely data retrieval is required. All large and medium sites as well as those small sites that have event-based data points fall under this description. An example of an event-based data point would be security switch sensors. For sites that fall outside of this description, it shall be confirmed with the Principal’s Subject Matter Expert if a survey is required.

A survey report shall be requested via the Principal and shall detail the following minimum requirements:

(a) site name

(b) date of cellular survey

(c) site coordinates stating the coordinate format

(d) recommended cellular transmission tower (if applicable)

(e) distance and bearing from site name to recommended cellular transmission tower (if applicable)

(f) signal readings at the remote site. For example, RSRP / RSRQ / SNR

(g) recommended antenna (if applicable)

(h) recommended antenna mounting height (if applicable)

(i) GIS plan (if applicable)

(j) additional plans (if applicable)

(k) elevation profile of recommended path (if applicable)

(l) photos from site survey

(m) any other related comments.

The acceptable signal levels for 4G are:

- RSRP ≥ -90 dBm for cellular router/modems, but ≥ -105 dBm for Point Orange RTUs
- RSRQ ≥ -12 dBm for cellular router/modems, but ≥ -14 dBm for Point Orange RTUs
- SNR ≥ 10 dB.

Signal levels outside of the above levels may be considered with approval by the Principal's Subject Matter Expert, but only if there is not a viable solution to achieving the desired standard.

Survey reports are only valid if the final proposed physical location of the antenna is no more than 10 metres horizontally from the surveyed position, and for 18 months before commissioning. A new survey report and design changes may be required outside these conditions.

14 Document control

Document Owner: Group Manager Info Controls & Energy

Document Approver: Executive Manager Customer Delivery

Version	Author	Details of change	Approval date	Approved by	Next scheduled review
1	D. Griffin	Initial release	18 Dec 14	PRC	Nov 2016
2	I. Blackwell	Complete update	26 Feb 18	C. Murtagh	Feb 2020
3	I. Blackwell	General review of all sections. Major changes to section 12 (networks)	21 Jul 22	R. MacNeil	As per Corporate Standard HW2013-421/22.002
4	I. Blackwell	General review and modifications to multiple sections	24 April 2025	G Robinson	As per Corporate Standard HW2013-421/22.002

Appendix A. Example PAC/PLC function block documentation

HWC_160_PID

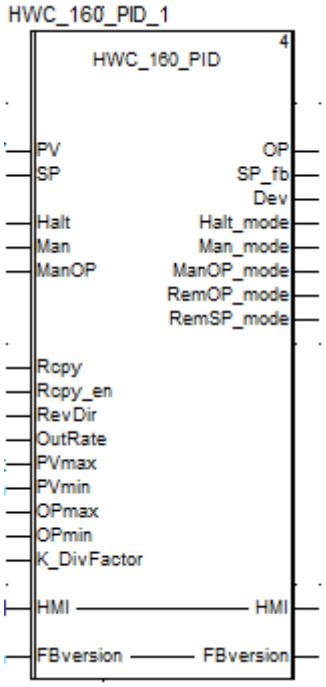
FB Id Number	160
Platform	All

1.0 Function description

This function block implements a PID controller algorithm. Internally the function block uses the Unity library function PIDFF. See the Unity help files for details on the operation of the PIDFF controller.

This function block provides the SCADA interface, mode control, setup, and interface to the PIDFF block.

2.0 Representation in FBD



3.0 Parameter description

HWC_PID		<DFB>		PID Controller
<inputs>				
PV	3	REAL	0.0	Process variable
SP	4	REAL	0.0	Setpoint
Halt	6	BOOL	FALSE	Halt Controller (hold output at current value)
Man	7	BOOL	FALSE	Halt controller and set output to OPman value
ManOP	8	REAL	0.0	Output value when set to manual
Rcpy	12	REAL	0.0	Copy of the manipulated variable
Rcpy_en	13	BOOL	FALSE	Enable use of the Rcpy input (default FALSE)
RevDir	14	BOOL	FALSE	1=Reverse Acting (default FALSE)
OutRate	15	REAL	9999.9	Output change limit (Units/sec)
PVmax	16	REAL	100.0	Process Value Maximum (default 100)
PVmin	17	REAL	0.0	Process Value Minimum (default 0)
OPmax	18	REAL	100.0	Upper output limit (default 100)
OPmin	19	REAL	0.0	Lower output limit (default 0)
<outputs>				
OP	3	REAL		Controller Output
SP_fb	4	REAL		Setpoint Feedback
Dev	5	REAL		Deviation
Halt_mode	6	BOOL		Stop controller and hold the output
Man_mode	7	BOOL		Manual Mode Output (output set from SCADA or FB input)
ManOP_mode	8	BOOL		Output set to ManOP value
RemOP_mode	9	BOOL		Output set to RemOP value from SCADA
RemSP_mode	10	BOOL		SP from SCADA data
<inputs/outputs>				
HMI	22	HWC_PID_HMI		data to/from SCADA
FBversion	24	HWC_FB_Version		
<public>				
HWC_FB_Identi...		BYTE		Function Block Identifier Code
HWC_FB_Version		BYTE		Function Block Version Number

The HMI variable is of the structure type HWC_PID_HMI

HMI	22	HWC_PID_HMI		data to/from SCADA
Status		WORD		0/Auto, 1/Man
Auto		BOOL		Auto mode selected
Man		BOOL		Manual mode selected
ConfigError		BOOL		PIDFF Status bit 4 - Configuration Error
OP_at_min		BOOL		PIDFF Status bit 5 - OP at minimum value
OP_at_max		BOOL		PIDFF Status bit 6 - OP at maximum value
PV_ConfigE...		BOOL		PIDFF Status bit 7 - PV Configuration Error
Command		WORD		1/ManOP, 2/RemoteSP
ManOP		BOOL		Manual Output select
RemSP		BOOL		Remote Setpoint select (SCADA)
RemOP		BOOL		Remote Output select (SCADA)
Halt		BOOL		Hold the output at the current value
PV		REAL		Process Variable
SP		REAL		Setpoint
OP		REAL		Output
K		REAL		Tuning - Gain
Ti		REAL		Tuning - Integral Time (minutes)
Td		REAL		Tuning - Derivative Time (minutes)
Bias		REAL		Tuning - Bias
RemoteSP		REAL		Setpoint from SCADA
RemoteOP		REAL		Output from SCADA

4.0 Detailed description

This block provides PID (proportional integral derivative) control for use in process applications. The 'OP' output is adjusted according to the 'PV' (process variable) and SP (set point) inputs, depending on the tuning parameters K (gain), Ti (integral), Td (derivative) and Bias.

This block uses the HWC_FB_VersionControl function to monitor its current version number. Further information on version control may be found in the document detailing the HWC_FB_VersionControl function block.

5.0 Verification tests

The following tests were carried out for FB correct operation using Unity Pro 7.0 and test verification results logged using the Trending tool within Unity Pro. The test report is in the attached document below.

This block has also been tested on-site at WTGRAMCD.

5.1 Test schedule

Test Number	Test
7.0	Verify Bias Operation
6.0	Verify Bumpless Operation
5.0	Verify Manual output in Rcpy mode
4.0	Verify Rcpy functionality
3.0	Function Tests - Auto
2.0	Function Tests - Manual
1.0	Default initial values expected

5.2 Test report

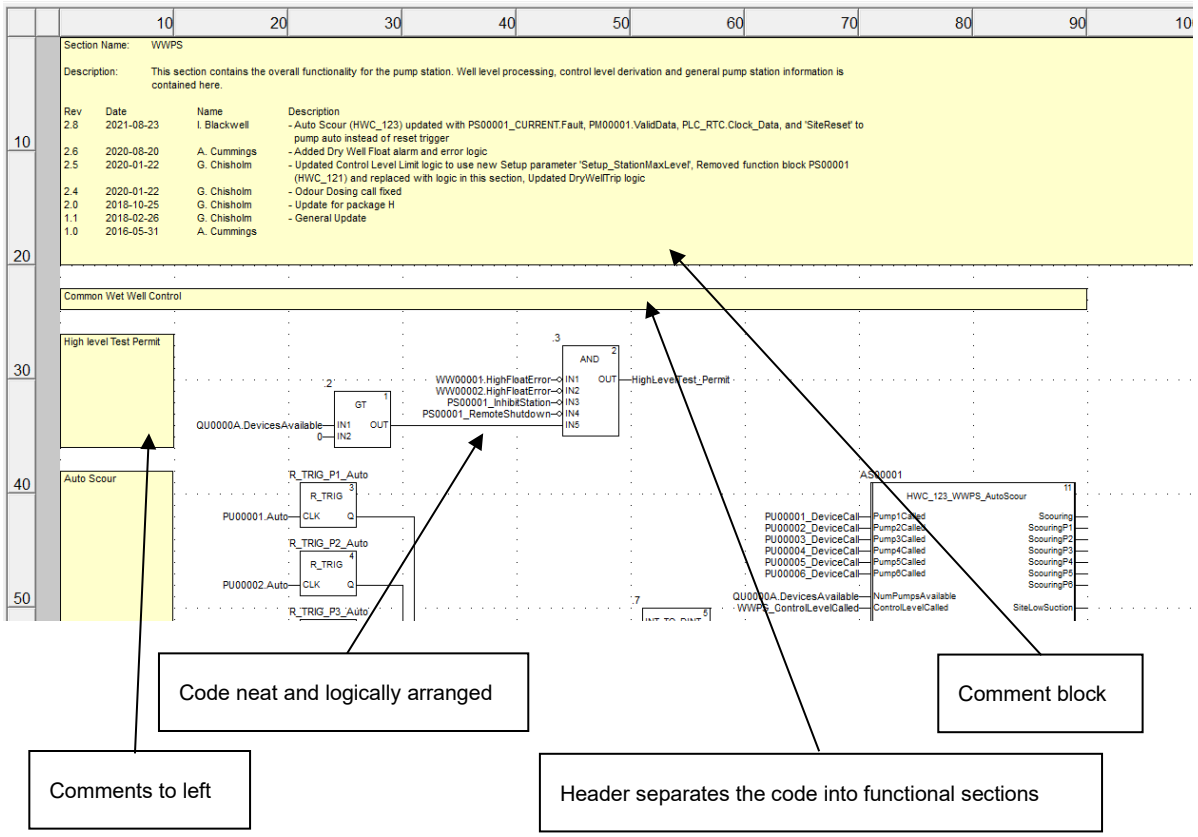
TestReport.xlsx

6.0 Version history

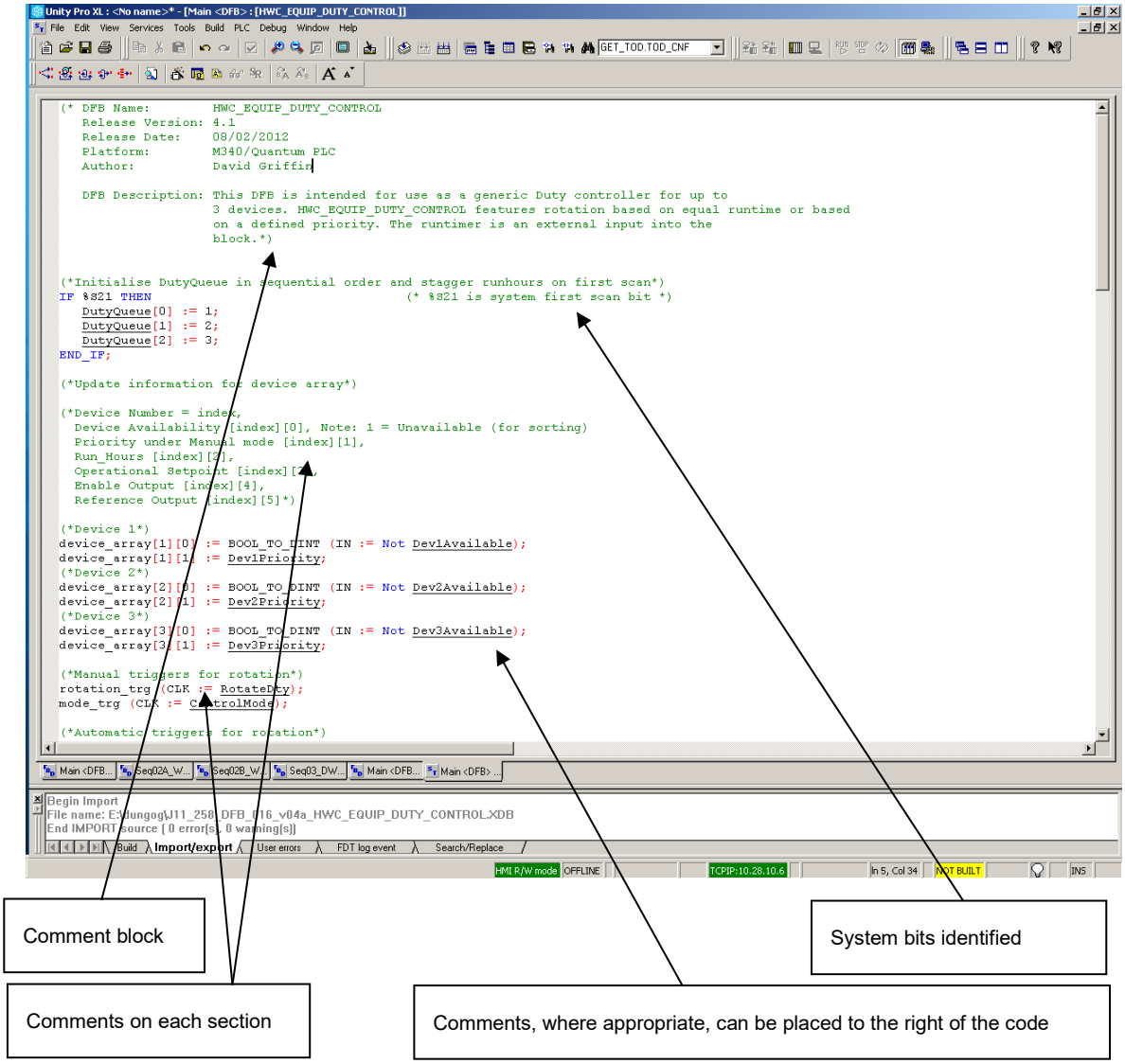
Version	Date	Name	Company	Description
12	2015-11-20	Your Name	Your Company Name	Update Bumpless Operation and bias function
11	2015-11-02	Your Name	Your Company Name	Modify Rcpy mode for manual operation
10	2015-01-15	Your Name	Your Company Name	Initial Release

Appendix B. Sample PAC/PLC code layout

Function block layout – this applies to project specific code creation and functional project code.



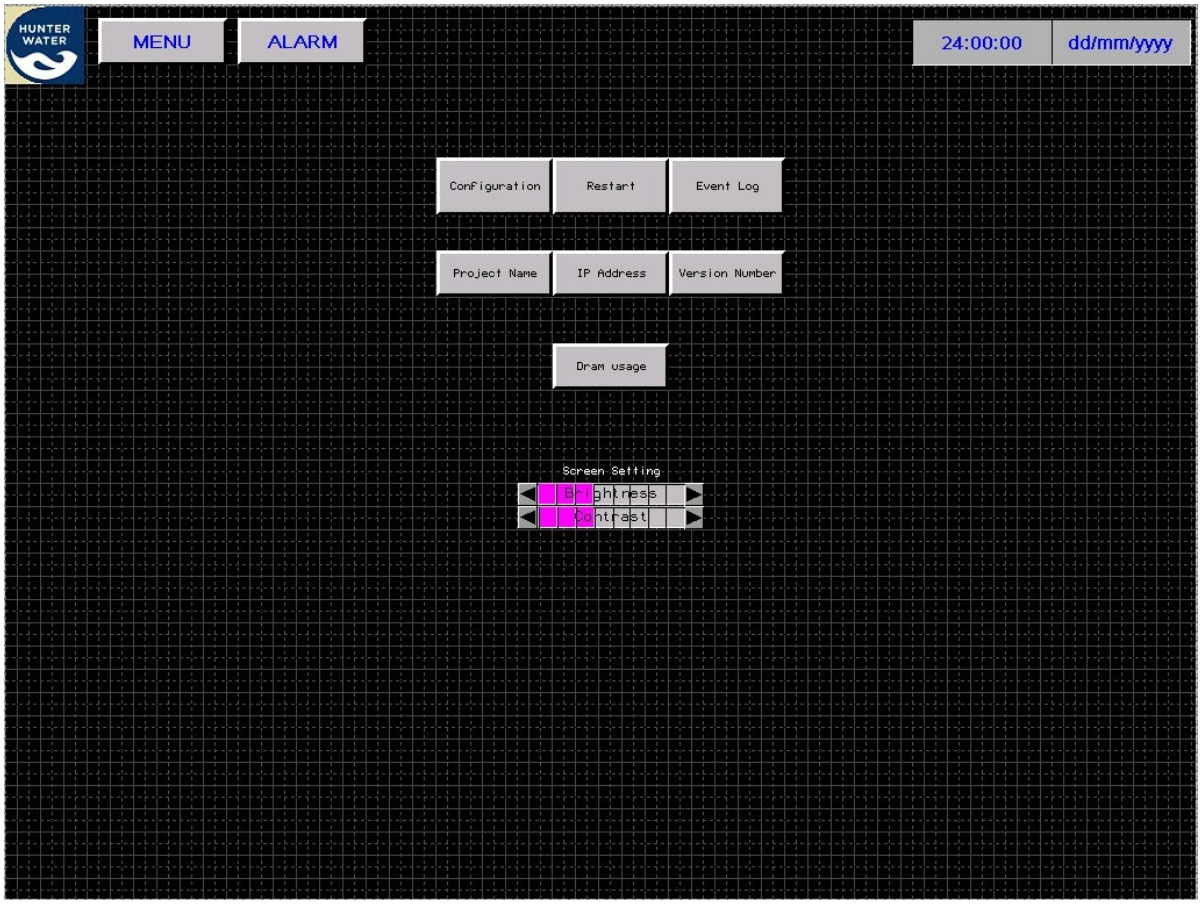
Structured text layout



Appendix C. HMI screen configuration

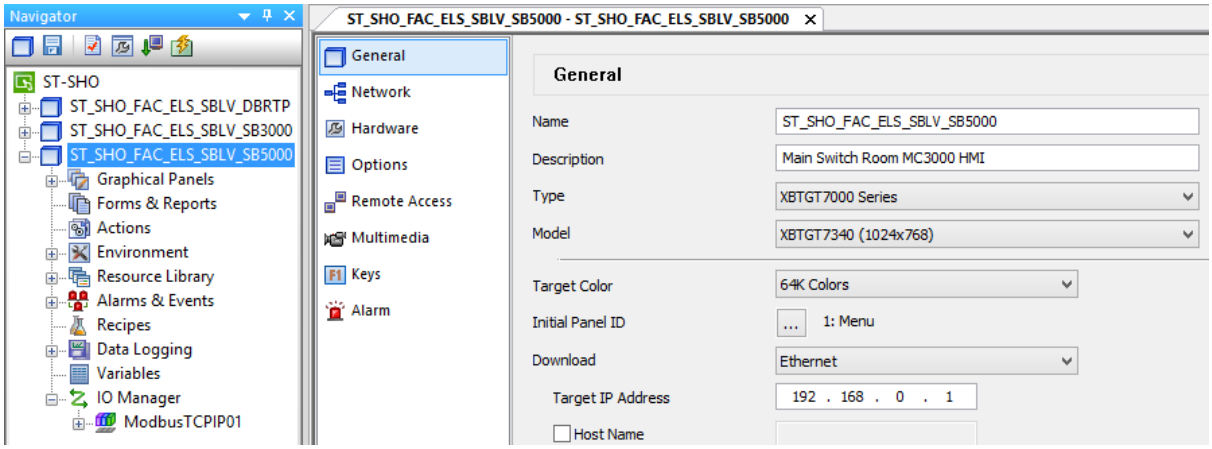
C.1 HMI configuration screen

The HMI configuration panel is accessed by the two-corner method. Pressing and holding on two corners will bring up the display shown below. This page is used for setting up HMI project configuration and general display attributes, e.g. IP address, screen brightness, etc.

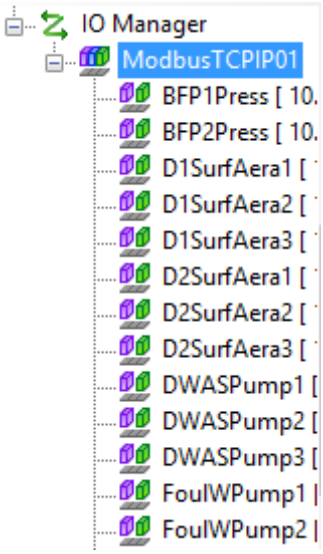


C.2 Hardware configuration

Hardware devices are configured using the general configuration screen. This includes the HMI configuration, project name, IP address, etc.



MCC devices connected via Ethernet are added (TeSys T, VSD, power meter, etc.).

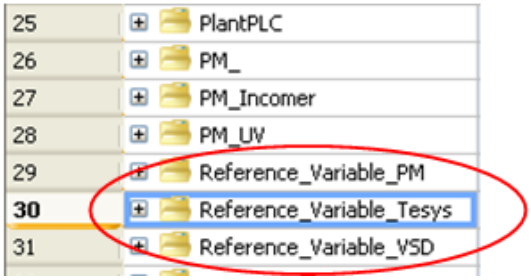


C.3 Reference variables configuration

The master reference variables are created in folders (one for each type of template page). These reference variables have no real address. Real variables data is passed to these reference variables when the relevant template page is opened.

The reference variables include strings, digitals, and analogues. They are internal variables to the HMI and used on the master template pages.

Typical reference variable folders



Typical reference variables

	Name	Data Type	Data Source	Scan Group	Device Address	Alarm Group	Logging Group
30	Reference_Variable_Tesys						
	Asset_No	STRING	Internal				None
	AverageCurrent	UINT	Internal				
	AverageCurrentA	DINT	Internal				
	ControllerTemp	INT	Internal				
	Description	STRING	Internal				None
	Device_ID	STRING	Internal				None
	DiagnosticFlt	BOOL	Internal				
	FaultN_1	UINT	Internal				
	FaultN_2	UINT	Internal				

Each reference variable is configured so that the relevant real equipment variable can be substituted into the reference variable when the page is opened. The value of ‘Parameter 1’ replaces “%s” in the reference string. Refer to page open section for explanation of ‘Parameter 1’.

This resultant variable name equals the final real variable name. When the page is opened, the real equipment variable will be displayed.

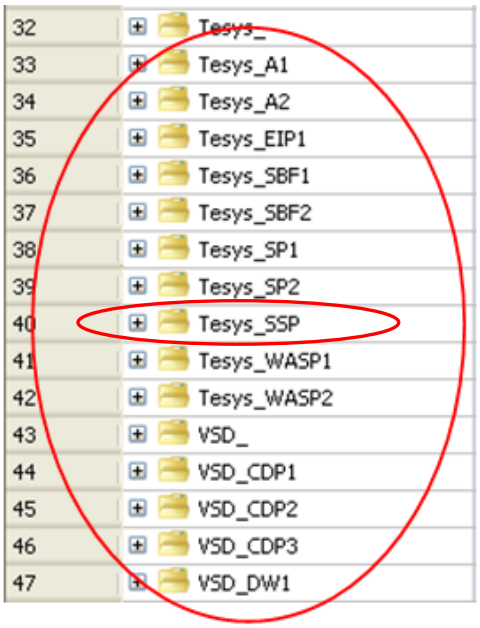
E.g. if 'Reference_Variable_Tesys.Name' = "SSP" then 'Tesys_SSP.AverageCurrent' will be displayed.

Variable	
Name	AverageCurrent
Description	AverageCurrent
Data Type	UINT
Source	Internal
Reference	Enabled
Reference String	Tesys_%s.AverageCurrent
Parameter 1	Reference_Variable_Tesys.Name
Parameter 2	

The value of Parameter 1 replaces %s in the reference string.

C.3.1 Equipment variables configuration

Equipment variables are created in drive specific folders and with the same variable names as the reference variables folder names. They are external variables with real address locations.

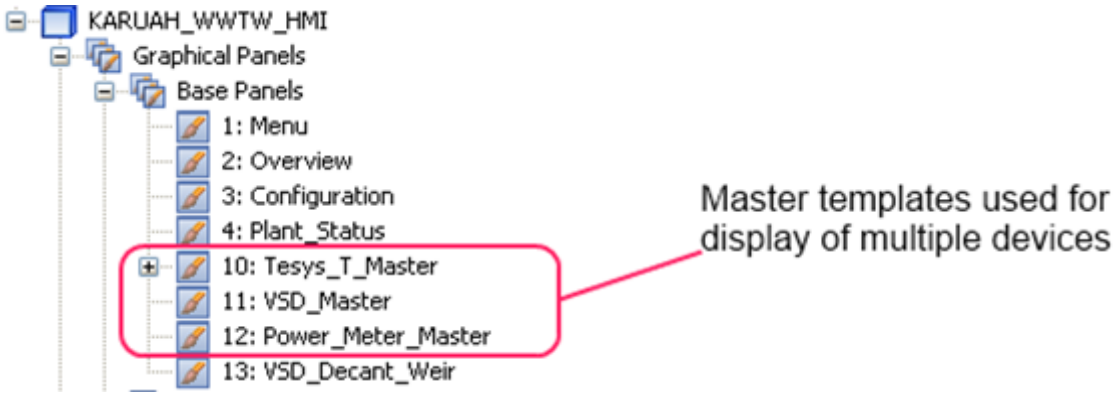


Typical real variables configuration

	Name	Data Type	Data Source	Scan Group	Device Address	Alarm Group	Logging Group
40	Tesys_SSP						
	AverageCurrent	UINT	External	STKAR_SSP	%MW466	Disabled	None
	AverageCurrentA	DINT	External	STKAR_SSP	%MW500	Disabled	None
	ControllerTemp	INT	External	STKAR_SSP	%MW472	Disabled	None
	DiagnosticFlt	BOOL	External	STKAR_SSP	%MW453:X1	AlarmGroup1	None
	FaultN_1	UINT	External	STKAR_SSP	%MW180	Disabled	None
	FaultN_2	UINT	External	STKAR_SSP	%MW210	Disabled	None
	FaultResetRequired	BOOL	External	STKAR_SSP	%MW455:X5	AlarmGroup1	None
	Input1	BOOL	External	STKAR_SSP	%MW457:X0	Disabled	None
	Input2	BOOL	External	STKAR_SSP	%MW457:X1	Disabled	None

C.4 Master template page configuration

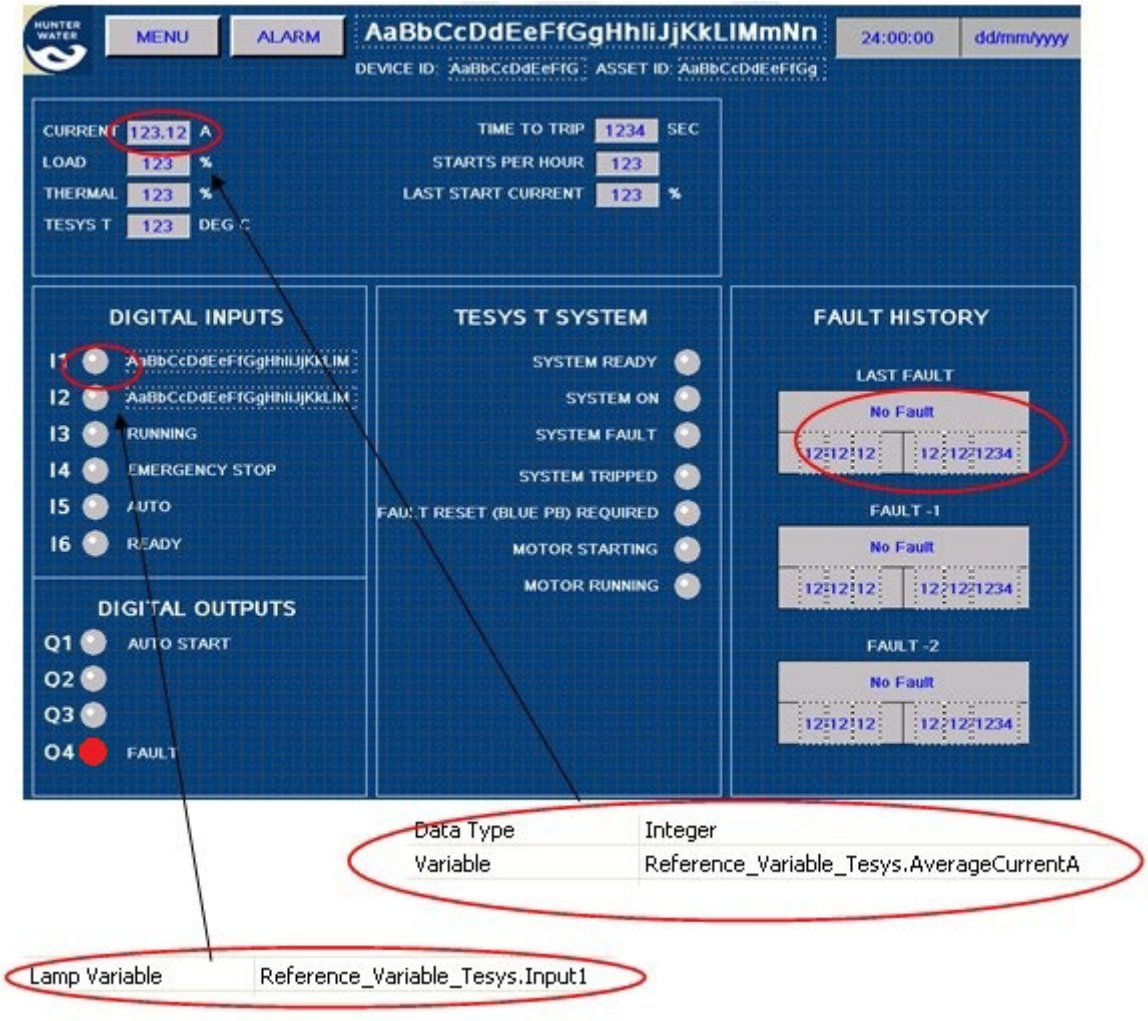
Master template pages are configured as part of the graphics base panels pages configuration.



A master template page contains all the relevant data for a specific type of device (TeSys T, VSD or power meter). It has a mixture of text, digital and analogue data.

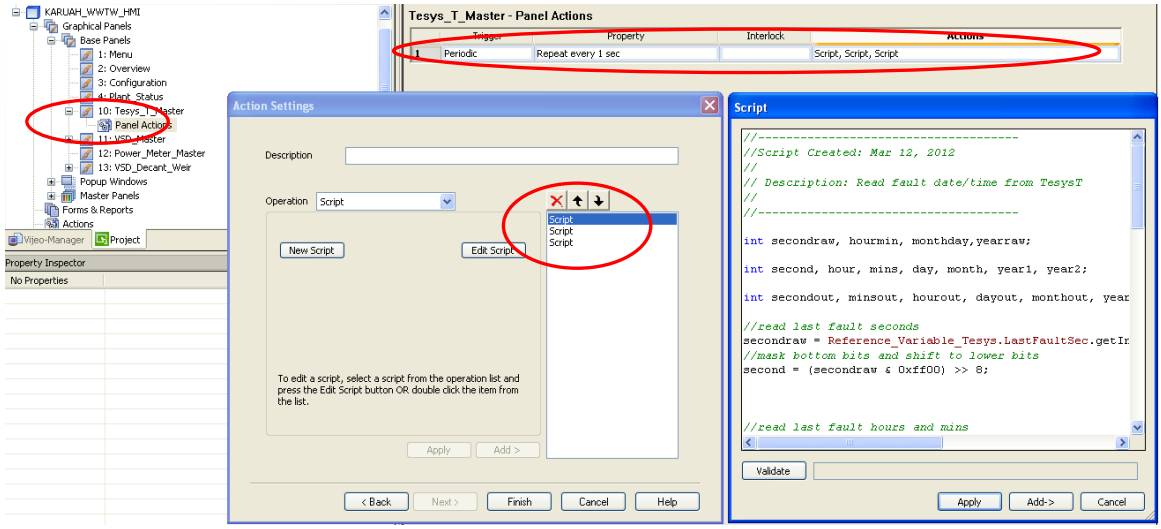
All variable text or data is configured using the reference variables (master internal variable names). These include title, indication lamps, analogue data, fault history with date and time, etc.

Typical Tesys T master template page



Fault history is read from the device as a number. This number is converted to text for display. Refer to Fault List section for details of faults.

Fault history also uses scripts to read various addresses that make up the date and time for the fault in order to display it in the correct format on the screen. Scripts are configured in 'Panel Actions' as part of the master template page.



C.5 General graphics pages configuration

There are a number of general graphics pages these include:

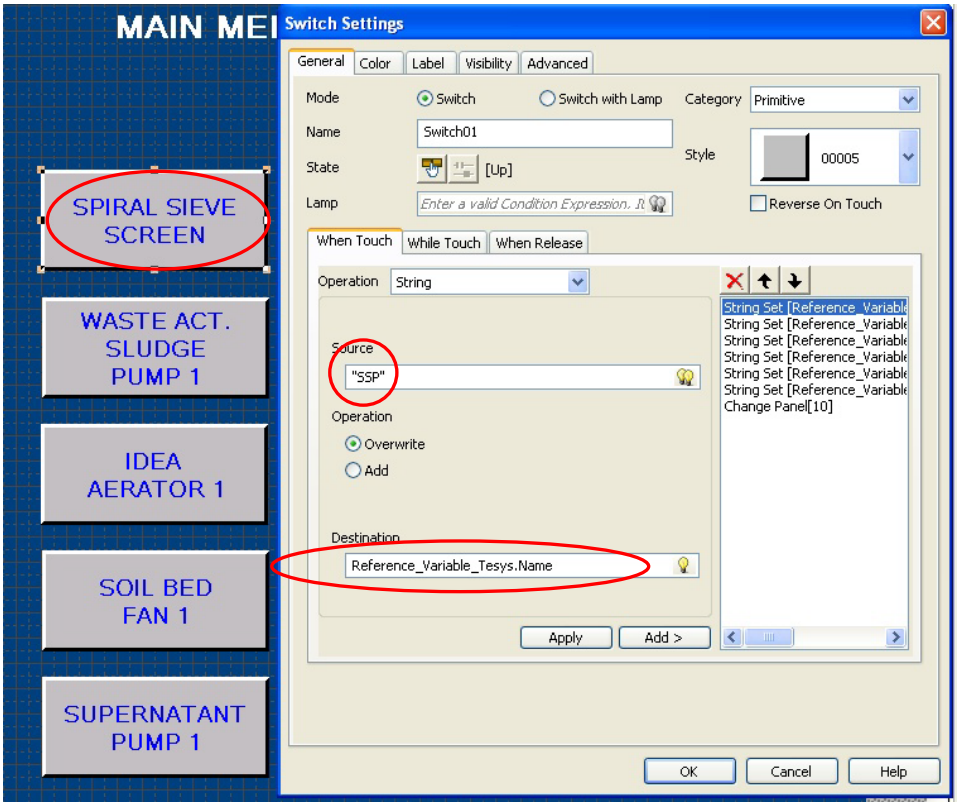
(a) main menu

(b) plant overview

(c) plant status.

The main menu and plant overview pages allow the selection of equipment pages. The button configuration for each item of equipment has all the master template page setup data to allow the real variables data to be passed to all the reference variables locations on the page when the page is opened.

Typical button configuration



Selecting the spiral sieve screen button will display the switch settings page. The ‘String Set’ function is used to load strings into reference variables. These reference variables are used to pass values to the templates and to create the references to the specific hardware devices.

C.6 Alarms configuration

There are two types of alarms, system fault alarms, and configured alarms. System faults are auto generated by the HMI as in-built functions for hardware faults (e.g. communications errors).

All configured alarms are setup up in the real variables configuration. There is only one alarm group “AlarmGroup1”.

Name	Data Type	Data Source	Scan Group	Device Address	Alarm Group
StartsPerHour	UINT	External	STKAR_A1	%MW514	Disabled
SystemFault	BOOL	External	STKAR_A1	%MW455:X2	AlarmGroup1
SystemOn	BOOL	External	STKAR_A1	%MW455:X1	AlarmGroup1
SystemReady	BOOL	External	STKAR_A1	%MW455:X0	AlarmGroup1
SystemTripped	BOOL	External	STKAR_A1	%MW455:X4	AlarmGroup1
SystemWarning	BOOL	External	STKAR_A1	%MW455:X3	AlarmGroup1
ThermalCapacity	UINT	External	STKAR_A1	%MW465	Disabled

Appendix D. Minimum information required for inspection and testing

Refer to section 5.9 for clarification on what the different stages refer to.

Completion stages

	35%	75%	10 working days before FAT/SFAT/SAT

PLC	• proposed rack architecture layout
	• proposed variable structure including EDT/DDT
	• proposed functional view
	• submit requests for custom code/DFBs
		• rack and device IP address and configuration
		• logic programs showing:
		  ○ naming conventions
		  ○ task section structure and order
		  ○ mapping to HO/local SCADA
		  ○ revision blocks in each section of code
		  ○ consistent code layout and comments
		• showing only pre-approved custom code/DFBs being used
		• items raised in the 35% review addressed
			• all code is functional and ready for FAT/SFAT/SAT
			• items raised in 75% review addressed

RTU	• proposed approved code • submit requests for custom code	• showing only pre-approved custom code being used • items raised in the 35% review addressed	• all code is functional and ready for FAT/SFAT/SAT • items raised in the 75% review addressed

	35%	75%	10 working days before FAT/SFAT/SAT

SCADA	• proposed mimic screen arrangements showing:
	  ○ equipment layout and orientation
	  ○ equipment tags
	  ○ buttons and links
	  ○ page title banner
	• proposed popup mimics showing:
	  ○ text boxes
	  ○ headings
	  ○ buttons and links.
	• only approved templates used
	• submit requests for any custom templates, symbols, etc.
	• show database group hierarchy
		• finalised mimic screen arrangements
		• finalised popup mimics
		• object properties populated showing:
		  ○ equipment numbers
		  ○ point configuration and alarms
		  ○ Modbus scanner channels
		• correct colour objects and equipment status
		• no graphic elements overlapping or off-screen
		• only pre-approved custom objects being used
		• items raised in the 35% review addressed
			• all code is functional and ready for FAT/SFAT/SAT
			• items raised in the 75% review addressed

HMI	• proposed approved HMI code
	• submit requests for custom code
	• proposed screen arrangement showing:
	  ○ buttons
	  ○ equipment status
	  ○ text boxes
	  ○ title banner
	• main menu
	• alarm page
		• only pre-approved custom code being used
		• items raised in the 35% review addressed
			• all code is functional and ready for FAT/SFAT/SAT
			• items raised in the 75% review addressed

Appendix E. Variable descriptors table

In addition to the suffixes defined in the Hunter Water P&ID Drawing Package (for example, MO for a variable speed motor), the following table defines what to call variables that aren't specifically associated with P&ID elements.

Descriptor	Description
Auto	Auto device operation
AVL	Available
CB	Circuit breaker
CF	Common fault
CLK	Clock
Close	Command to close
Closed	Closed position indication
DTY	Duty control mode
ELV	Extra low voltage
ERR	Error
FDB	Feedback
FLT	Fault
FTSP	Fail to Stop
FTST	Fail to Start
FWD	Forward
Health	Health
HRS	Hours
HV	High voltage
ITL	Interlock
JF	Jog forward
JR	Jog reverse
Local	Local control
LV	Low voltage
Man	Manual device operation
MIN	Minutes

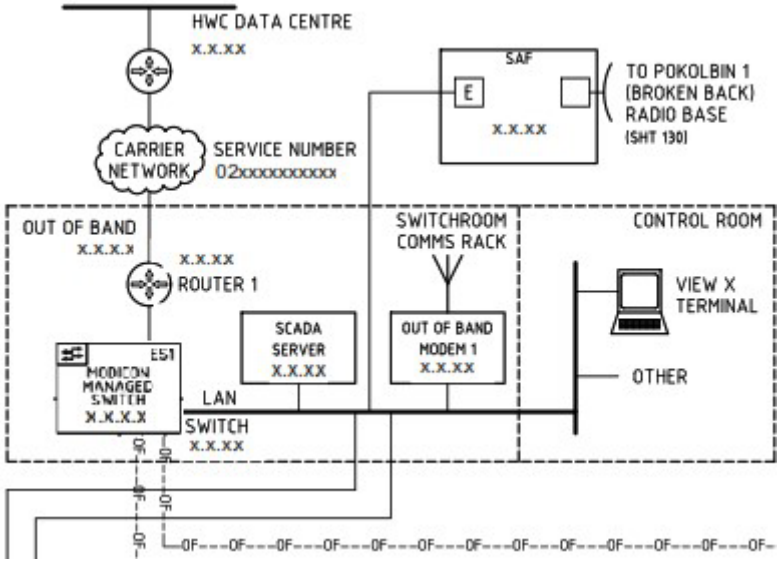
Descriptor	Description
OL	Electrical overload
Open	Command to open
Opened	Opened position indication
PB	Pushbutton
PV	Process variable
RECL	Recloser
Remote	Remote control
REV	Reverse
RST	Reset
Run	Run command
Running	Run status indication
SEC	Seconds
SP	Set point
SPD	Speed
Start	Start
Status	Status
STB	Standby control mode
Stop	Stop command
Stopped	Stop status
Test	Test device operation
TX	Transformer
Trip	Trip
TRQ	Torque
UL	Under load
Volts	Voltage

Appendix F. Automation (PLC/SCADA) network overview

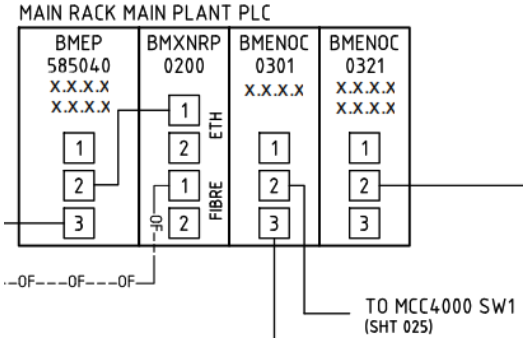
The automation (PLC/SCADA) network overview (SK8198) is a special type of electrical drawing. It shows the logical network connections between automation components, and any interaction with IT networks. The detailed electrical schematic drawings are developed from this drawing and give greater detail of the actual physical connections.

Individual components and connections are to be represented with the following information:

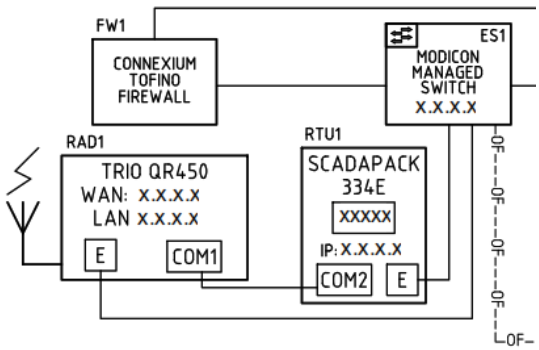
- SCADA network – show communications methods, routers, switches, model name, IP addresses, SCADA servers/clients, Ethernet copper and optical fibre links, etc.



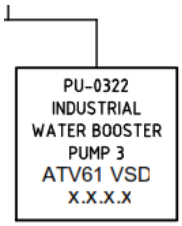
- PAC/PLCs – show full part numbers, IP addresses, Ethernet copper and optical fibre links, serial links, etc.



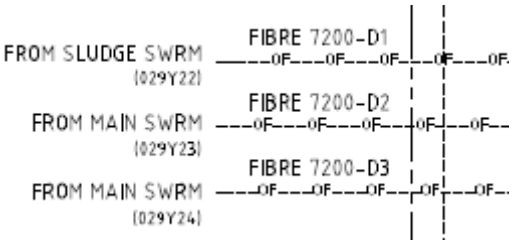
- Telemetry – show model name, device designation, DNP3/IP addresses, Ethernet copper and optical fibre links, serial links, etc.



- Devices – show P&ID designation, process description, model/type, and IP address, etc.



- Optical fibre links – show identifying numbering of optical fibre pairs when referencing between drawing sheets so that connections can be followed easily.



- All equipment shall be shown in their physical MCC/panel, and if they are also in a switchroom. This shall be shown by dotted lines enclosing them.

More details on electrical drawings can be found in *STS 904 Preparation of Electrical Engineering Drawings*.

Note that IP addresses shall be shown on the SK8198 drawing sets only, and not on any other electrical schematics. There is a specific layer for the IP addresses that shall be used.

Appendix G. Software and configuration files naming

The table below shows common software and configuration files used in Hunter Water that are required to be saved as transmitted as per section 5.6. The Principal will provide the facility plant number on request. If it is unclear what the filename should be then please contact automation@hunterwater.com.au.

	Model	Required files	Examples

PLC	Schneider M340, M580, and Quantum	• <facility plant number>.sta – the archived project
		• <facility plant number>.dtx – the project data file
		• <facility plant number>.stu – the project file
			• Burwood Beach WWTW facility plant number is ST-BUR:
			  ○ ST-BUR.sta
			  ○ ST-BUR.dtx
			  ○ ST-BUR.stu.
			• Belmont 1 WWPS facility plant number is SS-BEL-001-PS1:
			  ○ SS-BEL-001-PS1.sta
			  ○ SS-BEL-001-PS1.dtx
			  ○ SS-BEL-001-PS1.stu.

RTU	Schneider SCADAPack 334E	• <facility plant number>.pia – generated by a project archive from ISaGRAF Project Manager. Note that there is some standard code that will keep their filename and are not required to be returned to Hunter Water, e.g. peer comms is “peercomm.pia”	• Burwood Beach WWTW facility plant number is ST-BUR:
			  ○ stbur1.pia
			• Belmont 1 WWPS facility plant number is SS-BEL-001-PS1:
			  ○ ssbel001.pia

RTU	Schneider SCADAPack 47x/57x	• <facility plant number>.rcz – generated by an export project from the RemoteConnect programming software. Inside this compressed archive file are the files:
		  ○ <facility plant number>.prj
		  ○ <facility plant number>.sta
		  ○ version.txt
			• Tomago 6 Bore PS facility plant number is HS-TOM-006-BS1:
			  ○ HS-TOM-006-BS1.rcz

RTU	Point Orange IoT	• <facility plant number>.pcc – generated by a save from the Poco+ programming software	• Adamstown 1 Flow Meter facility plant number is WN-ADA-FLM-001: ○ WN-ADA-FLM-001.pcc
HMI	Schneider Magelis	• <facility plant number>.vdz – the archived project from the Vijeo programming software	• Burwood Beach WWTW facility plant number is ST-BUR: ○ ST-BUR.vdz

	Model	Required files	Examples
Ethernet switch	Schneider Modicon	• <facility plant number>-<switch number>.xml – from the switch web page	• Burwood Beach WWTW facility plant number is ST-BUR: o ST-BUR-ES3.xml
VSD	ABB	• <facility plant number for VSD>.dcparamsbak – generated by a save from the Drive Composer pro programming software	• Aberdare 1 WWPS facility plant number for pump 1 VSD is SS-ABE-001-PS1- DCVD1: o SS-ABE-001-PS1-DCVD1.dcparamsbak
VSD	Schneider Altivar series	• <facility plant number for VSD>.psx – generated by a save from the SoMove programming software	• Medowie 1 WPS facility plant number for pump 2 VSD is WS-MED-001-PS1-DCVD2: o WS-MED-001-PS1-DCVD2.psx
Soft starter	Schneider Altistart series	• <facility plant number for SS>.psx – generated by a save from the SoMove programming software	• Woodberry 1 WWPS facility plant number for pump 3 SS is SS-WOO-001-PS1-DCSO3: o SS-WOO-001-PS1-DCSO3.psx
DOL starter	Schneider Tesys T	• <facility plant number for motor>.psx – generated by a save from the SoMove programming software	• Woodberry 1 WWPS facility plant number for pump 3 motor is SS-WOO-001-PS1-MOLV3: o SS-WOO-001-PS1-MOLV3.psx
Level transmitter	VEGA	• <Facility plant number for level instrument>.PW6 – generated by a save from the PACTware programming software	• Jesmond 1 WWPS instrument plant number for level instrument 1 is SS-JES-001-PS1-ITLE1: o SS-JES-001-PS1-ITLE1.PW6 • Fern Bay 3 WWPS instrument plant number for level instrument 1412 is SS-FER-003-CDS-ITLE1412: o SS-FER-003-CDS-ITLE1412.PW6
Other instruments	Various	• If a configuration file cannot be extracted, then all the user modified parameters are to be listed in a spreadsheet	• Thornton 4 PRV facility plant number for flow meter is WN-THO-CV4-PRV-FMNE1: o WN-THO-CV4-PRV-FMNE1.xlsx

Appendix H. Modbus master scanner point mapping configuration

The table below shows how to configure the mapping tab for 'DNP3 SCADAPack E' points in Geo SCADA.

	Dig In	**Dig Out**	**Ana In - DINT**	**Ana In - REAL**	**Ana Out - DINT**	**Ana Out - REAL**
Mapping	Modbus master scanner	Modbus master scanner	Modbus master scanner	Modbus master scanner	Modbus master scanner	Modbus master scanner
I/O Source	<site>.Telemetry.RTU x.PLC x	<site>.Telemetry.RTU x.PLC x	<site>.Telemetry.RTU x.PLC x	<site>.Telemetry.RTU x.PLC x	<site>.Telemetry.RTU x.PLC x	<site>.Telemetry.RTU x.PLC x
Operation	Read	Read/Write	Read	Read	Read/Write	Read/Write
Write Outputs	On Change	On Change	On Change	On Change	At Scan Rate and On Change	At Scan Rate and On Change
Failed Write Operation	Revert	Revert	Revert	Revert	Revert	Revert
Operation When Offline	Read	Write	Read	Read	Write	Write
Data Type	UINT	UINT	DINT	Real	DINT	Real
Register	4xxxxx	4xxxxx	4xxxxx	4xxxxx	4xxxxx	4xxxxx
Bit	0 to 15	0 to 15	N/A	N/A	N/A	N/A
Default Scan Rate	ticked	ticked	ticked	ticked	ticked	ticked
Scan Rate	0	0	0	0	0	0
Default Timeout	ticked	ticked	ticked	ticked	ticked	ticked
Timeout	0	0	0	0	0	0