

TMS1649

Water Booster Site

GRUNDFOS HYDRO MPC

STANDARD FUNCTIONAL SPECIFICATION

Version 6.1

RACI Approval

|  |  |  |  |
| --- | --- | --- | --- |
| Name and position | Role | Signature | Date |
| Mark Parusel  Leader Operations Strategy | Accountable |  |  |
| Gerard Anderson  Senior Electrical Engineer | Responsible |  |  |
| Leah Sertorio  Leader Water Network Management | Consulted |  |  |
| Igor Jungic  Leader Operations Control | Consulted |  |  |
| Chris Muller  A / Network Control Systems Lead | Consulted |  |  |
| Sam Bagraith  Leader Network Master Planning | Informed |  |  |
| Graham McConigal  Senior Strategic Asset Manager | Informed |  |  |
| Gavin Flood  Program Director Water Network | Informed |  |  |

**RACI Role Definitions**

|  |  |
| --- | --- |
| Role | Description |
| Responsible | Person who does the work to achieve the task |
| Accountable | Person who approves the work. Note: Responsible is accountable to Accountable |
| Consulted | Two-way communications |
| Informed | One-way communications |

Revision Control

|  |  |  |  |
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| Revision Number | Date | Revision Details | Responsible Officer |
| 0.6 | November 2016 | 60% Design - Initial Draft for QUU Review | James Morrison |
| 1.0 | March 2017 | 100% Design - Updates from 60% Design Review | James Morrison |
| 1.1 | May 2017 | Added Safety Function Monitoring | Alex Witthoft |
| 2.0 | June 2017 | Updates prior to RTU Coding | James Morrison |
| 3.0 | Nov 2017 | FOR CONSTRUCTION  Note: This iteration of the Hydro MPC Water Booster Electrical and Control System Standard Design has been developed for QUU contract C796, which requires installation of a new Grundfos Hydro MPC system and switchboard at four locations:   * WB145 Kelvin Grove Rd (existing site) * WB157 Greendale Way (existing site) * WB198 Mt Petrie Rd (new site) * WB199 Mt Alford (existing site)   The core of this standard design comprises this functional specification and a set of electrical drawings. | James Morrison |
| 4.0 | Feb 2018 | Changes made during RTU Bench Testing | James Morrison |
| 5.0 | Sep 2018 | Updates following commissioning of first two sites (WB157 Greendale Way, WB198 Mt Petrie Rd) | James Morrison |
| 6.0 | Sep 2018 | Addition of Dual Discharge Pressure Transmitter, Jockey Pump, Emergency Stop and Emergency Stop Safety Function Failure Monitoring Options.  Removal of low-range clamping for flow values.  Removal of Pump Temperature and Auto Mode Selected values.  Removal of references to Boonah Elpro system.  For Review. | James Morrison |
| 6.1 | Oct 2018 | Updates following QUU review | James Morrison |

Document Consultation

Please review this document and add your comments where necessary. To ensure that this project is completed on time, please forward your comments by the requested date to:

Document Administrator

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Executive Summary

A water booster station increases the pressure in a zone of the water reticulation network to ensure that customers receive water delivery within QUU’s Standard of Service commitment. A water booster site incorporates one or more electric pumps installed on the water main.

This functional specification details the functional requirements for a water booster station using a Grundfos Hydro MPC multi-stage pump system with up to 5 main pumps and one jockey pump fitted with variable speed drives. It has been developed based on the following documents:

* Standard Water Booster 2 x VSD (2015 – PKE31)
* Standard MPC Water Booster v1.01 (2010)
* QUU SD West Standard MPC Water Booster v1.04 (2013),

with changes as required to accommodate the new Grundfos CU352 pump controller.

This standard design details common functionality to be implemented at all sites, and a number of options which can be included as required at each site. A separate site-specific functional specification will be developed for each site that will detail selected standard design options and any non-standard functionality. In addition, it includes site-specific design requirements such as pressure control setpoints, instrument ranges and offsets as well as site-specific equipment and instrumentation.

At a standard MPC Water Booster Station, low-level pump control, including pump starting, stopping and speed control, is handled by the Grundfos pump controller. The Grundfos pump controller also provides monitoring of the pumps and station suction and discharge pressure. A Remote Telemetry Unit (RTU) is used to provide supervisory control of the Grundfos pump controller, and communications with the SCADA system to allow remote control and monitoring of the site.

At a standard MPC Water Booster Station, the pump controller operates in three modes, selected by the RTU:

* Local Mode, where the pump system can be controlled at the switchboard via the controller’s in-built HMI
* Constant pressure (closed loop) control mode, where the pumps control station discharge pressure to a setpoint provided by the RTU
* Constant speed (open loop) control mode, where the pump controller controls pumps to achieve a percentage of maximum system output, as supplied as a setpoint by the RTU.

The station is designed, and is normally selected, to run autonomously under the control of the RTU to achieve a desired discharge pressure setpoint. Depending on the needs of a site, up to six (6) different **remote** modes of operation may be enabled for station control, selected via the SCADA mimic by the Control Room Operator:

1. **Delivery Pressure Mode** **(Normal operating mode)** - The pump set is controlled to a discharge pressure setpoint using the pressure sensor on the delivery main.
2. **Peer Pressure Mode** - The pump set is controlled to a discharge pressure setpoint based on the desired pressure at a remote site and the difference between readings at the active discharge pressure sensor and remote pressure sensor. (The remote pressure transmitter is situated at a strategic point within the water booster zone, and is typically a standard pressure gauge site which communicates the pressure to the water booster site via peer to peer communications.)
3. **Scheduled Delivery Pressure** **Mode**– The pump set is controlled via time profile which provides discharge pressure set points.
4. **Flow Modulation Mode** - The pump set is controlled to a discharge pressure setpoint based on the flow read by the flow meter on the delivery main.
5. **Remote Fire Mode** – The pump set is controlled to the zone default fire pressure parameter set in the RTU.
6. **Manual Mode** – The pump set runs to achieve a % system output as defined by a setpoint from SCADA. The pump set can be started and stopped via SCADA.

The station is also designed, and may be selected, to operate under two (2) different **local** control modes.

1. **Local Mode** - The pump set is controlled directly via the HMI on the CU352 unit.
2. **Local Fire Mode** - The pump set is controlled to the zone default fire pressure parameter set in the RTU. QFRS (Queensland Fire & Rescue Service) officers can place the water booster in Local Fire Mode when dealing with an emergency. (This mode is deprecated, and a fire switch will not be installed on future switchboards.)

In addition to these selectable modes, there is a **system** control mode which allows the station to continue to operate without discharge pressure feedback, should all installed discharge pressure transmitters fail. This mode brings the total number of modes to nine (9).

1. **Fixed speed mode** - The pump set runs to achieve a % system output, dependent on station flow.

The RTU is necessary to implement all modes of operation.

This standard functional specification has been written for standard MPC Water Booster sites connecting to the Brisbane Mosaic SCADA system (UUTS).

The main components of the site control system are:

* The Grundfos Hydro MPC Pump Controller, with Human Machine Interface (HMI).
* The Remote Terminal Unit (RTU),
* The UUTS (Urban Utilities Telemetry System) SCADA system

The Grundfos pump controller provides low-level pump control, as well as monitoring of pumps and suction and discharge pressures. It is installed in the site switchboard, and communicates with the RTU. The pump controller also allows local control of the Grundfos pump system by personnel on site via an inbuilt HMI panel.

The RTU to be installed as part of this standard is the Schneider SCADAPack 535e. (This standard is the first to incorporate Schneider SCADAPack 535e RTUs, due to the phasing out of the SCADAPack ES RTU, previously used on Water Booster sites.) The RTU is installed in the switchboard on site and is responsible for high-level control of the pumps, as well as capture of monitoring information from the pump controller, pumps, flow meter and pressure transmitters, and other station status information.

Modbus TCP protocol is used for communication between the RTU and the Grundfos pump controller. DNP3 protocol is used for communications with the UUTS SCADA system and other (peer) sites.

Communications between the RTU and the Master SCADA system is typically via private radio network, but a 4G modem may be used where radio communications are not practical.

The RTU is interrogated periodically via the telemetry network to update the status of the station to the SCADA master station and to upload the previous period’s historical data. The RTU also requests an immediate upload of current status information when any critical event occurs at the station.

The SCADA master station will alert the control room operator of any abnormal conditions at the station via alarms. Calculations are also performed by the RTU and telemetered to the SCADA master station to aid planning and fault finding for the station and surrounding water network.

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Acronyms

|  |  |
| --- | --- |
| RTU | **R**emote **T**elemetry **U**nit |
| SCADA | **S**upervisory **C**ontrol **A**nd **D**ata **A**cquisition |
| mAHD | **m**etres above **A**ustralia **H**eight **D**atum |

# 

# INTRODUCTION

## Document Purpose

This document defines the functional requirements for the control, monitoring, and telemetry of a standard water booster site based on a Grundfos Hydro MPC system.

The Functional Specification shall incorporate the specific detail required for configuration and implementation of the site control system. This includes all RTU functionality.

The objectives of the Functional Specification are:

* It is a reference document suitable for use by operation and maintenance personnel. It is not intended to be an operating manual.
* It incorporates the specific implementation features of the installed equipment.
* It captures the requirements of standard TMS1202 – Control System Implementation[[1]](#endnote-1).
* The document shall provide adequate detail to program, configure, test and fault find the RTU software.

This standard document will reside in Q-Pulse (TMS). Site-specific functional specifications will reside in TRIM.

## Site Functional Specification Document Set

The functional specification of a particular water booster site’s operation and control can be determined by the following set of documents:

* + - 1. Standard Functional Specification (this document)
         1. Standard Alarm List (Appendix)
         2. Standard SCADA Points List (Appendix)
         3. Standard Setpoints List (Appendix)
      2. Site-specific electrical drawings
      3. Site-specific functional specification

The standard documentation details generic requirements for a water booster site based on a Grundfos Hydro MPC system, including a range of design options.

The separate site-specific functional specification defines which standard design options apply and details any non-standard design elements. In addition, it includes site-specific design requirements such as pressure control setpoints, instrument ranges and offsets as well as site-specific equipment and instrumentation.

The site-specific electrical drawings detail the control elements, wiring connections and labelling, the physical layout of the switchboard, and the list of installed electrical/control equipment.

# STANDARD DESIGN OPTIONS

The standard design for the MPC water booster site incorporates up to 5 main pumps and one jockey pump, controlled by the MPC CU352 controller, and associated equipment. The standard design incorporates a range of design options, the inclusion of which is determined by individual site requirements. The following table is a list of the standard design options available. Each option is described in detail in the subsequent sections.

For details of technical requirements for water boosters, please see TMS1638 Water Booster Pump Station Standard Technical Specification.

Table 1 – Standard Options for an MPC Water Booster Site

|  |  |  |
| --- | --- | --- |
| **Option ID** | **Description** | **Value** |
| A | Auto Transfer Switch & Generator | YES / NO |
| B | CT Metering | YES / NO |
| C | RTU Type | SCADAPack 535e |
| D1 | Pump 3 Installed | YES / NO |
| D2 | Pump 4 Installed | YES / NO |
| D3 | Pump 5 Installed | YES / NO |
| D4 | Jockey Pump installed | YES / NO |
| E1 | Discharge Flowmeter Installed | YES / NO |
| E2 | Bypass Flowmeter Installed | YES / NO |
| E3 | Redundant Discharge Pressure Transmitter Installed | YES / NO |
| F | Radio Type | Trio / Other |
| G | Modem | 3G / 4G / Other / None |
| H | PSTN Modem | YES / NO |
| I | Fire Mode Switch | YES / NO |
| J | Card Reader | NO (NOT USED) |
| K1 | Pump Box Sump Pump | YES / NO |
| K2 | Flow Meter Pit Sump Pump | YES / NO |
| L1 | Pump Box Sump Pit Level Probe | YES / NO |
| L2 | Flow Meter Pit Level Probe | YES / NO |
| M | Pump Box Ventilation Fan | YES / NO |
| N | Area Lighting | YES / NO |
| O | Dual 24VDC Power Supplies | NO (NOT USED) |
| P | Power Meter | NO (NOT USED) |
| Q | Pressure Vessel | YES / NO |
| R1 | Peer Pressure Mode Enabled | YES / NO |
| R2 | Scheduled Delivery Pressure Mode Enabled | YES / NO |
| R3 | Flow Modulation Mode Enabled | YES / NO |
| U | Emergency Stop Installed | YES / NO |
| V | Emergency Stop Safety Function Failure Monitoring | YES / NO |

NOTE: Grey options are hardware options and do not alter the RTU code functionality.

## Option A - ATS & Generator

Option A indicates that the site has a semi-permanently connected generator that automatically runs the station on generator supply following an Energex power failure. This upgrade provides an automatic transfer switch (ATS) to disconnect Energex and connect the generator. Extra physical I/O and SCADA alarms are configured in the RTU to provide feedback on the status of the semi-permanent generator.

## Options D1-D3 - MPC Main Pumps

All Standard MPC-based stations have at least two main pumps. Options D1-D3 indicate the presence of up to three additional main VSD pumps controlled by the MPC system. It is assumed that MPC pump positions will be filled sequentially, starting at D1.

## Option D4 - MPC Jockey Pump

Option D4 indicates the presence of a jockey VSD pump controlled by the MPC system.

## Option E1 - Discharge Flowmeter

Option E1 allows for monitoring of a station discharge flowmeter. This option is generally selected and is a requirement for flow modulation mode.

## Option E2 - Bypass Flowmeter

Option E2 allows for monitoring of a flow meter in addition to the station discharge flowmeter.

This flowmeter is named “Bypass” because its intended use is to monitor flows to an adjacent water supply zone which does not require boosted pressure, but which is fed from the same source as the water booster. Hence, the flows “bypass” the water booster. It is sometimes also referred to as a “Low Zone” flowmeter, since the pressure to that zone is not boosted.

However, this flow meter is not used in control of the station and is monitored only. Thus, this option can be used for monitoring and alarming of any flow meter that is in a location convenient for connection to the RTU.

## Option E3 – Redundant Discharge Pressure Transmitter

Option E3 allows for installation of a redundant discharge pressure transmitter. This option is generally selected for MPC water boosters commissioned after 2018.

## Option I - Fire Mode Switch

Option I is enabled where a booster station switchboard has a fire switch (2 position Fire/Control selector switch). This option enables the “Local Fire” station mode. All standard sites have “Remote Fire” mode, regardless of whether this option is selected or not.

Where a fire switch is not installed, the RTU code behaves as if the site has a fire switch, always in the “Control” position. See section 4.2 Control Modes for more information.

**This mode is deprecated, and a fire switch will not be installed on future switchboards.**

## Option J - Card Reader

Option J and associated card reader functionality is excluded from this standard.

## Option L1 - Pump Box Pit Level Probe

Option L1 indicates that the site has a level sensor installed in the pump box pit.

## Option L2 - Flow Meter Pit Level Probe

Option L2 indicates that the site has a level sensor installed in the flow meter pit.

## Option P - Power Meter

Option P and associated power meter functionality is excluded from this standard.

## Option Q - Pressure Vessel

Option Q indicates that a pressure vessel (accumulator) is installed at the site. This option serves no functional purpose, but where selected, a pressure vessel will be displayed on the SCADA mimic.

## Option R1 - Peer Pressure Control

Option R1 enables Peer Pressure Control Mode (see section 4.2 Control Modes). Where a booster station has a remote (peer) pressure gauge, this mode allows pressure at this point to be controlled by the station.

## Option R2 - Scheduled Delivery Pressure Control

Option R2 enables Scheduled Delivery Mode (see section 4.2 Control Modes). This mode allows the station to automatically modify its discharge pressure setpoint based on time of day, to handle varying network flow demands.

## Option R3 - Flow Modulation Control

Option R3 enables Flow Modulation Mode (see section 4.2 Control Modes). This mode allows the station to modify its discharge pressure setpoint depending on flow demand.

## Option U - Emergency Stop Fitted

Option U indicates whether an emergency stop or a control stop is fitted in the site switchboard. It does not affect RTU code since RTU actions are the same for both.

**All emergency stop functionality is achieved independent of the RTU.**

## Option V - Emergency Stop Safety Function Failure Monitoring

Option V enables Emergency Stop Safety Function Failure Monitoring. It is only enabled in conjunction with Option U. See section *7.3.3.1 Station Safety Function Fault Indication Lamp (Option V)*.

## Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| Option A – ATS & Generator Fitted | NO |  |
| Option D1 – MPC Pump 3 Fitted | YES |  |
| Option D2 – MPC Pump 4 Fitted | Site-specific |  |
| Option D3 – MPC Pump 5 Fitted | Site-specific |  |
| Option D4 – MPC Jockey Pump Fitted | Site-specific |  |
| Option E1 – Discharge Flowmeter Fitted | YES |  |
| Option E2 – Bypass Flowmeter Fitted | Site-specific |  |
| Option E3 – Redundant Discharge Pressure Transmitter Fitted | Site-specific |  |
| Option I – Fire Mode Switch Fitted | Site-specific |  |
| Option L1 – Pump Box Sump Pit Level Probe | Site-specific |  |
| Option L2 – Flow Meter Pit Level Probe | Site-specific |  |
| Option Q – Pressure Vessel | YES |  |
| Option R1 - Peer Pressure Mode | Site-specific |  |
| Option R2 - Scheduled Pressure Mode | Site-specific |  |
| Option R3 – Flow Modulation Mode | Site-specific |  |
| Option U - Emergency Stop Fitted | Site-specific |  |
| Option V - Emergency Stop Safety Function Failure Monitoring | Site-specific |  |

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| NIL |  |  |  |  |  |

## Calculations and Statistics

|  |  |
| --- | --- |
| Point | Description |
| NIL |  |

## SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| Option A – ATS & Generator Fitted | Digital Status |  |  |  |
| Option D1 – MPC Pump 3 Fitted | Digital Status |  |  |  |
| Option D2 – MPC Pump 4 Fitted | Digital Status |  |  |  |
| Option D3 – MPC Pump 5 Fitted | Digital Status |  |  |  |
| Option D4 – MPC Jockey Pump Fitted | Digital Status |  |  |  |
| Option E1 – Discharge Flowmeter Fitted | Digital Status |  |  |  |
| Option E2 – Bypass Flowmeter Fitted | Digital Status |  |  |  |
| Option E3 – Redundant Discharge Pressure Transmitter Fitted | Digital Status |  |  |  |
| Option I – Fire Mode Switch Fitted | Digital Status |  |  |  |
| Option L1 – Pump Box Sump Pit Level Probe | Digital Status |  |  |  |
| Option L2 – Flow Meter Pit Level Probe | Digital Status |  |  |  |
| Option Q – Pressure Vessel | Digital Status |  |  |  |
| Option R1 - Peer Pressure Mode | Digital Status |  |  |  |
| Option R2 - Scheduled Pressure Mode | Digital Status |  |  |  |
| Option R3 – Flow Modulation Mode | Digital Status |  |  |  |
| Option U - Emergency Stop Fitted | Digital Status |  |  |  |
| Option V - Emergency Stop Safety Function Failure Monitoring | Digital Status |  |  |  |

# EQUIPMENT AND INSTRUMENTATION LISTS

## Equipment

|  |  |
| --- | --- |
| **Device** | **Option** |
| Pump 1 | Mandatory |
| Pump 2 | Mandatory |
| Pump 3 | D1 |
| Pump 4 | D2 |
| Pump 5 | D3 |
| Jockey Pump | D4 |
| Pressure Vessel | Q |
| Fire Switch | I |
| ATS & Generator | A |

## Instrumentation

|  |  |
| --- | --- |
| **Instrument** | **Option** |
| Suction Pressure Transmitter | Mandatory |
| Discharge Pressure Transmitter | Mandatory |
| Redundant Discharge Pressure Transmitter | E3 |
| Delivery Flow Meter | E1 |
| Bypass Flow Meter | E2 |
| Pump Box Pit Level Probe | L1 |
| Flow Meter Pit Level Probe | L2 |

## Auxiliary Indication

|  |  |
| --- | --- |
| **Signal** | **Option** |
| Supply Authority (Energex) Power Failure Relay | Mandatory |
| Station Mains Power Failure Relay | Mandatory |
| Surge Diverter and Filter Alarm Relay | Mandatory |
| RTU Power Supply – Power On Signal | Mandatory |
| RTU Power Supply – Battery Ok Signal | Mandatory |
| Switchboard and Pump Box Door Limit Switches | Mandatory |
| Control Stop | U |
| Emergency Stop | U |
| Emergency Stop Safety Function Failure Lamp | V |

# CONTROL PHILOSOPHY

The standard MPC water booster pump station boosts water pressure in its zone (reticulation network connected to its discharge) using a bank of up to five main pumps, with or without an additional jockey pump, all fitted with VSDs and controlled by the MPC CU352. The zone pressure is monitored at the delivery of the booster station (after the pump reflux valves).

## Station Mode Selection

This section should be read in conjunction with Figure 1 - Mode selection flow chart.

### Station Modes

The station is designed, and is normally selected, to run autonomously under the control of the RTU to achieve a desired discharge pressure setpoint. Depending on the needs of a site, up to six (6) different **remote** modes of operation may be enabled for station control, selected via the SCADA mimic by the Control Room Operator:

1. **Delivery Pressure Mode** **(Normal operating mode)** - The pump set is controlled to a discharge pressure setpoint using the active pressure sensor on the delivery main.
2. **Peer Pressure Mode** **(Option R1)** - The pump set is controlled to a discharge pressure setpoint based on the desired pressure at a remote site and the difference between readings at the active discharge pressure sensor and remote pressure sensor. (The remote pressure transmitter is situated at a strategic point within the water booster zone, and is typically a standard pressure gauge site which communicates the pressure to the water booster site via peer to peer communications.)
3. **Scheduled Delivery Pressure** **Mode (Option R2)** – The pump set is controlled via a time profile which provides discharge pressure set points.
4. **Flow Modulation Mode** **(Option R3)** - The pump set is controlled to a discharge pressure setpoint based on the flow read by the flow meter on the delivery main.
5. **Remote Fire Mode** – The pump set is controlled to the zone default fire pressure parameter set in the RTU.
6. **(Remote) Manual Mode** – The pump set runs to achieve a % system output as defined by a setpoint from SCADA. The pump set can be started and stopped via SCADA.

The station is also designed, and may be selected, to operate under two (2) different **local** control modes.

1. **Local Mode** - The pump set is controlled directly via the HMI on the CU352 unit.
2. **Local Fire Mode** **(Option I)** - The pump set is controlled to the zone default fire pressure parameter set in the RTU. QFRS (Queensland Fire & Rescue Service) officers can place the water booster in Local Fire Mode when dealing with an emergency. (This mode is deprecated, and a fire switch will not be installed on future switchboards.)

In addition to these selectable modes, there is a **system** control mode which allows the station to continue to operate without discharge pressure feedback, should all installed discharge pressure transmitters fail. This mode brings the total number of modes to nine (9).

1. **Fixed speed mode** - The pump set runs to achieve a % system output, dependent on station flow.

### Mode Selection

Modes 7 and 8 are selected via two selector switches on the on-site switchboard. The Control Room Operator cannot remotely operate the on-site switches. The two switches are the:

* Fire/Control Switch
* Local/Remote Switch

The fire switch has two positions – Fire and Control.

* Fire position (Fire Mode Digital Input On) – Station is in Local Fire Mode (provided the discharge pressure transmitter is healthy).
* Control position (Fire Mode Digital Input Off) - When in control position, the local/ remote switch becomes operational. Control position is the normal position of the switch. **Where no fire switch is installed (i.e. Option I – Fire Switch is not selected), the Control position is permanently assumed by the RTU.**

The local/remote switch has two positions – local and remote.

* Local Position (Remote Mode Digital Input Off) - Station is in Local Mode
* Remote Position (Remote Mode Digital Input On) – Station is in "remote" mode, the control room officer can select one of up to six control modes (if enabled via site options) via SCADA System commands –
  + Delivery pressure mode (Normal operating mode)
  + Peer pressure mode (if enabled)
  + Scheduled Delivery Pressure mode (if enabled)
  + Flow modulation mode (if enabled)
  + Remote Fire mode
  + (Remote) Manual Mode

The flow chart below shows how the current station mode is determined.

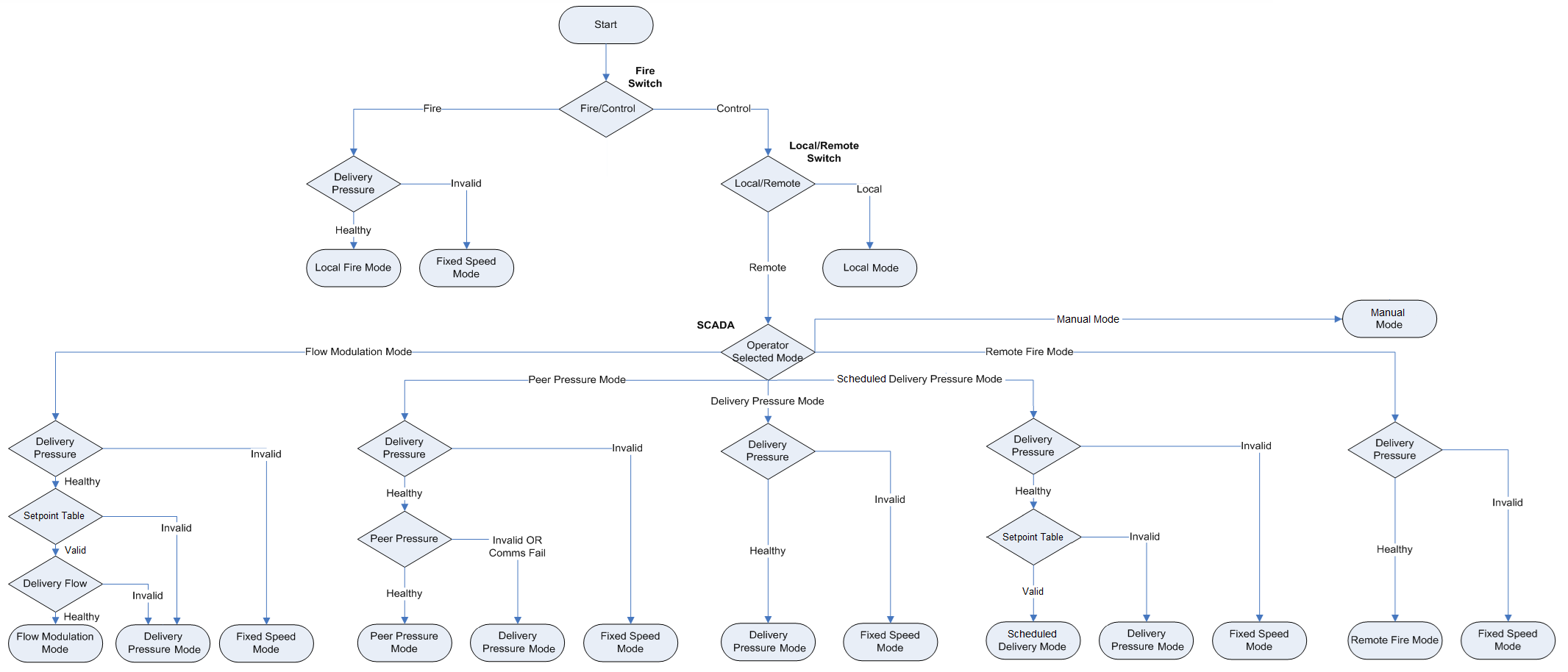


Figure 1 - Mode selection flow chart

Note: Delivery Pressure is considered healthy if at least one discharge pressure transmitter signal is valid and the MPC Primary Sensor Fault is not active.

Delivery Pressure is considered invalid if all installed discharge pressure transmitters are invalid or the MPC Primary Sensor Fault is active,

### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| stn1FireMode | Station Fire Mode Selected | DI |
| stn1RemoteMode | Station Remote Mode Selected | DI |

### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| Station Local Mode | 1\* | The inverse of the Station Remote Mode Selected digital status input. |
| Station Local Fire Mode | 1\* | This signal is determined by the state of the Actual Station Mode Status Integer value (8 = Local Fire Mode) |
| Fire Switch Active | 1\* | The Station Fire Mode Selected digital input is directly fed back via the Fire Switch Active signal to the SCADA system. |
| Delivery Pressure Mode | Event | This signal is determined by the state of the Actual Station Mode Status Integer value (1 = Delivery Pressure Mode) |
| Peer Pressure Mode | Event | This signal is determined by the state of the Actual Station Mode Status Integer value (2 = Peer Pressure Mode) |
| Scheduled Delivery Pressure Mode | Event | This signal is determined by the state of the Actual Station Mode Status Integer value (3 = Scheduled Delivery Mode) |
| Flow Modulation  Mode | Event | This signal is determined by the state of the Actual Station Mode Status Integer value (4 = Flow Modulation Mode) |
| Remote Fire Mode | 1\* | This signal is determined by the state of the Actual Station Mode Status Integer value (5 = Remote Fire Mode) |
| Remote Manual Mode | 1\* | This signal is determined by the state of the Actual Station Mode Status Integer value (6 = Remote Manual Mode) |
| Fixed Speed Mode | 1\* | This signal is determined by the state of the Actual Station Mode Status Integer value (9 = Fixed Speed Mode) |

\*These points are alarms, as they denote abnormal station behaviour

### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| Station Remote Control Mode Select Default | 1 | - |

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| Station Remote Control Mode Select | Analog | 1 | 6 | 1 |  |

### Calculations and Statistics

|  |  |
| --- | --- |
| Point | Description |
| Actual Station Mode Status Integer | Actual Station Mode (1-9) |

### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| Station Remote Control Mode Select Default | Analog Status |  |  |  |
| Station Local Mode | Digital Status |  | Alarm (1) |  |
| Station Local Fire Mode | Digital Status |  | Alarm (1) |  |
| Fire Switch Active | Digital Status |  | Alarm (1) |  |
| Delivery Pressure Mode | Digital Status |  | Event |  |
| Peer Pressure Mode | Digital Status |  | Event |  |
| Scheduled Delivery Pressure Mode | Digital Status |  | Event |  |
| Flow Modulation  Mode | Digital Status |  | Event |  |
| Remote Fire Mode | Digital Status |  | Alarm (1) |  |
| Remote Manual Mode | Digital Status |  | Alarm (1) |  |
| Fixed Speed Mode | Digital Status |  | Alarm (1) |  |
| Actual Station Mode Status Integer | Analog Status |  |  | Y |
| Station Remote Control Mode Select | Analog Setpoint |  |  | Y |
| Station Remote Control Mode Select Feedback | Analog Status |  |  | Y |

## Control Modes

### Mode 1 - Delivery Pressure Mode

Delivery Pressure Mode controls the station discharge pressure to a fixed setpoint.

It is the normal station operating mode, and is the default remote mode. (Mode Selection control default value is 1.)

#### Mode Conditions

For Delivery Pressure Mode to be active the following conditions must be met:

* If the Fire Switch site option is enabled, the Fire switch must be in the “Control” position.
* The Local/Remote switch must be in the “Remote” position
* Mode Selection variable is set to 1 (Integer set by the control room operator via the SCADA system), OR the RTU has placed the station in Delivery Mode from Peer Pressure Mode, Flow Modulation Mode or Scheduled Delivery Mode due to a failure of one of the conditions of those modes (see sections below for details).
* Discharge Pressure Invalid signal not active (i.e. at least one discharge pressure transmitter signal is valid) and MPC Primary Sensor Fault not active.

#### Mode Description

This mode allows the control room operator to directly set and adjust the delivery pressure setpoint.

Each site has a default setting for delivery pressure, the Zone Default Pressure. This default value provides the pressure required during peak hour flow conditions at the zone’s critical pressure point as per standard of service requirements.

#### Mode Failure Conditions

##### Delivery Pressure Invalid

If the delivery pressure is invalid (all installed discharge pressure transmitters invalid) or the MPC Primary Sensor Fault is active, the RTU will change the station control mode to Fixed Speed Mode.

The RTU will change the station control mode back to Delivery Pressure Control mode on restoration of a healthy delivery pressure signal (i.e. at least one discharge pressure transmitter signal is valid and MPC Primary Sensor Fault is not active).

Note: The MPC Primary Sensor Fault is latched in the RTU and requires an operator reset to clear it before the RTU can return the station to Delivery Pressure Mode.

#### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| NIL |  |  |

#### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| NIL |  |  |

#### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| Zone Default Pressure | Site-specific | mAHD |
| Zone Minimum Pressure | Site-specific | mAHD |
| Zone Maximum Pressure | Site-specific | mAHD |

Note:

The Zone Minimum Pressure is the minimum allowed discharge pressure setpoint for the station. It is a station parameter provided by QUU.

The Zone Maximum Pressure is the maximum allowed discharge pressure setpoint for the station. It is a station parameter provided by QUU.

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| Delivery Pressure Setpoint | Analog | Zone Minimum Pressure | Zone Maximum Pressure | Zone Default Pressure | mAHD |

#### Calculations and Statistics

|  |  |
| --- | --- |
| Point | Description |
| NIL |  |

#### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| Zone Default Pressure | Analog Status | mAHD |  |  |
| Zone Minimum Pressure | Analog Status | mAHD |  |  |
| Zone Maximum Pressure | Analog Status | mAHD |  |  |
| Delivery Pressure Setpoint | Analog Control | mAHD |  |  |
| Delivery Pressure Setpoint Feedback | Analog Status | mAHD |  | Y |

### Mode 2 - Peer Pressure Control Mode (Option R1)

Peer Pressure Mode requires a peer pressure gauge site (remote to the water booster) to measure and send the pressure at the boosted zone’s critical point to the water booster at regular intervals. The control room operator will be able to control the pressure at this critical pressure point using the booster.

See section 7.1.5 for details of the peer pressure received by the RTU.

#### Mode Conditions

For Peer Pressure Control Mode to be active the following conditions must be met:

* Peer pressure control must be enabled as a site option.
* If the Fire Switch site option is enabled, the Fire switch must be in the “Control” position.
* The Local/Remote switch must be in the “Remote” position
* Mode Selection variable is set to 2 (Integer set by the control room operator via the SCADA system).
* Peer Pressure Control Fault (internal flag) not active (Peer communications not timed out and peer pressure not invalid).
* Discharge Pressure not invalid (i.e. at least one discharge pressure transmitter signal is valid) and MPC Primary Sensor Fault not active.

#### Mode Description

If all the above conditions are met, then peer pressure mode is active and the RTU calculates the required discharge pressure setpoint(RPS2) as follows:

#### Variables

|  |  |  |
| --- | --- | --- |
| **Symbol** | **Name** | **Description/Comment** |
| DP | Average Local Discharge Pressure (mAHD) | 15 second average (1s samples) for the active discharge pressure transmitter. |
| PP | Peer Pressure (mAHD) | 15 second average (1s samples) calculated by the peer pressure site RTU and transmitted according to the rules detailed in Section 7.1.5.2. |
| SL | System loss (m) | Calculated when DP changes by more than DPdev OR when a peer transmission is received. |
| PPSP | Peer Pressure Set Point (mAHD) | As set by the control room operator |
| RPS2 | Required Booster Discharge Pressure Set Point (mAHD) | Required Delivery Pressure Set Point for Mode 2 (Calculated) |
| DPdev | Discharge Pressure Deviation | Change in DP required to be exceeded for RPS2 to be recalculated |

Table 2 - Peer Pressure Control Mode Variables

#### System Loss Calculation

The system loss is calculated via the following formula:

*SL = DP – PP*

This calculation is performed when either:

* The DP changes by more than DPdev OR
* The PP value is updated (i.e. received from the peer site).

Under normal operating conditions, system loss will be positive. A negative system loss (system gain) is the result of either a pressure transmitter calibration error OR a network configuration problem (such as a boundary valve to an adjacent, higher pressure zone being open).

##### Required Pressure Setpoint Calculation

The required pressure setpoint is calculated using the following formula:

*RPS2 = PPSP + SL*

Even though this value is calculated continuously, it will only change if either the PPSP or the SL change. The PPSP will only change if the operator sends a new set point and the SL will only change if the DP changes by more than the DPdev or the received PP changes.

The calculated RPS2 value is clamped at its maximum to the zone maximum pressure, to ensure a network restriction between the water booster and its peer pressure gauge (resulting in a large SL) does not cause the booster to over-pressurize the local network while trying to meet the remote pressure setpoint.

History for the RSP2 value shall be trended.

Note: On RTU Startup. Prior to receipt of valid peer pressure, the RPS2 value is set to the delivery pressure mode setpoint. The RPS2 value will also be set to the delivery pressure mode setpoint while the Peer pressure control Fault (internal flag) or delivery pressure invalid alarm are active.

#### Mode Failure Conditions

##### Peer Pressure Control Fault (Internal Flag)

If the peer pressure is invalid (status sent by peer site), or the peer communications have timed out, the RTU will change the station control mode to Delivery Pressure Mode.

The RTU will change the station control mode back to Peer Pressure Control mode on restoration of peer communications and a valid peer pressure signal.

##### Delivery Pressure Invalid

If the delivery pressure is invalid (all installed discharge pressure transmitters invalid), or the MPC Primary Sensor Fault is active, the RTU will change the station control mode to Fixed Speed Mode.

The RTU will change the station control mode back to Peer Pressure Control mode on restoration of a healthy delivery pressure signal (i.e. at least one discharge pressure transmitter signal is valid and MPC Primary Sensor Fault is not active).

Note: The MPC Primary Sensor Fault is latched in the RTU and requires an operator reset to clear it before the RTU can return the station to Peer Pressure Mode.

#### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| NIL |  |  |

#### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| Peer Pressure Control Fault Alarm | 1 | A Peer Pressure Control Fault Alarm is raised if the last operator-selected mode was peer pressure mode, and {the peer pressure is invalid (status sent by peer site) or the peer communications have timed out (i.e. If the water booster site has not received a peer communication within the peer communications fail alarm delay time [typically 30mins])}.  (i.e. A Peer Pressure Control Fault Alarm is raised if the Peer Pressure Control Fault [internal status] is active and the last operator-selected mode was peer pressure mode.) |

#### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| Discharge Pressure Deviation | 1 | m |
| Peer Pressure Setpoint Default | Site-specific | mAHD |
| Peer Pressure Setpoint Max | Site-specific | mAHD |
| Peer Pressure Setpoint Min | Site-specific | mAHD |

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| Peer Pressure Setpoint | Analog | Peer Pressure Setpoint Default | Peer Pressure Setpoint Max | Peer Pressure Setpoint Min | mAHD |

#### Calculations and Statistics

|  |  |
| --- | --- |
| Point | Description |
| System Loss | Calculated when Average Local Discharge Pressure changes by the discharge pressure deviation OR when a peer transmission is received. |
| Peer Pressure Mode Required Pressure Setpoint (RPS2) | Calculated delivery pressure setpoint based on system loss. |

#### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| Peer Pressure Control Fault Alarm | Digital Status |  | Alarm (1) |  |
| Discharge Pressure Deviation | Analog Status | m |  |  |
| Peer Pressure Setpoint | Analog Control | mAHD |  |  |
| Peer Pressure Setpoint Feedback | Analog Status | mAHD |  | Y |
| System Loss | Analog Status | m |  | Y |
| Required Pressure Setpoint (RPS2) | Analog Status | mAHD |  | Y |
| Peer Pressure Setpoint Default | Analog Status | mAHD |  |  |
| Peer Pressure Setpoint Max | Analog Status | mAHD |  |  |
| Peer Pressure Setpoint Min | Analog Status | mAHD |  |  |

### Mode 3 – Scheduled Delivery Pressure Mode (Option R2)

Scheduled Delivery Pressure Mode allows the station to automatically modify its discharge pressure setpoint based on time of day, to handle varying network flow demands.

#### Mode Conditions

For Scheduled Delivery Pressure Mode to be active the following conditions must be met:

* Scheduled Delivery Pressure Mode must be enabled as a site option.
* If the Fire Switch site option is enabled, the Fire switch must be in the “Control” position.
* The Local/Remote switch must be in the “Remote” position
* Mode Selection variable is set to 3 (Integer set by the control room operator via the SCADA System).
* Discharge Pressure Invalid signal not active (i.e. at least one discharge pressure transmitter signal is valid) and MPC Primary Sensor Fault not active.
* The Scheduled Delivery Mode time vs pressure lookup table (see below) is valid.

#### Mode Description

Each booster site has a site-specific time versus pressure lookup table which is operator configurable. The lookup table has 5 rows (0-4) that allow the operator to set up to 5 discrete time windows and 5 corresponding pressure setpoints for a 24hr period.

|  |  |  |  |
| --- | --- | --- | --- |
| **#** | **Enabled** | **Start Time (24 hr time)** | **Required Pressure Setpoint (RPS3)**  **(mAHD)** |
| 0. | Y | 0000 | 20 |
| 1. | Y | 0430 | 80 |
| 2. | Y | 1200 | 60 |
| 3. | N | 0 | 0 |
| 4. | N | 0 | 0 |

Table 3 - Example Pressure verses Time Lookup Table

The first two rows (0 and 1) are always enabled. Time window 0 always starts at 0000hrs. Only contiguous rows can be enabled. Once a row is disabled, all rows below are automatically disabled by the RTU. Disabled rows shall be greyed out in SCADA. Note that the first enabled row follows the last enabled row, since the time windows operate in a daily cycle.

In SCADA, the Operator shall be able to enter only valid 24hr time entries from a suitable time-popup selection box. Invalid time entries shall not be permitted by the SCADA system.

The start time shall be effective on the initial second of the minute specified, i.e. 0430 hrs means the profile window starts at 0430 and 0 seconds.

Profile times and setpoints are validated in the RTU.

**Table checks**

1. The start time in each row 0-4 (if enabled) must be greater than the row before (i.e. times increase down the table).

#### Mode Failure Conditions

##### Time versus Pressure Lookup Table invalid

If operator entries in the time versus pressure lookup table are checked by the RTU and deemed invalid (e.g. Times on enabled rows do not increase from rows 0-4) then the Water booster shall default to Delivery Mode.

The RTU will not automatically change the mode back to Scheduled delivery mode, even if the table becomes valid.

##### Delivery Pressure Invalid

If the delivery pressure is invalid (all installed discharge pressure transmitters invalid), or the MPC Primary Sensor Fault is active, the RTU will change the station control mode to Fixed Speed Mode.

The RTU will change the station control mode back to Scheduled Delivery Pressure mode on restoration of a healthy delivery pressure signal (i.e. at least one discharge pressure transmitter signal is valid and MPC Primary Sensor Fault is not active).

Note: The MPC Primary Sensor Fault is latched in the RTU and requires an operator reset to clear it before the RTU can return the station to Scheduled Delivery Pressure Mode.

#### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| NIL |  |  |

#### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| Scheduled Delivery Mode Lookup Table Invalid | 1 | This alarm is active if the current entries in the scheduled delivery mode lookup table do not pass RTU verification. This alarm is suppressed where Scheduled Delivery Mode is not enabled as a site option. |

#### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| Window 0 Pressure Setpoint Default | Site-specific | mAHD |
| Window 1 Start Time Default | Site-specific | Time |
| Window 1 Pressure Setpoint Default | Site-specific | mAHD |
| Window 2 Enabled Default | Site-specific |  |
| Window 2 Start Time Default | Site-specific | Time |
| Window 2 Pressure Setpoint Default | Site-specific | mAHD |
| Window 3 Enabled Default | Site-specific |  |
| Window 3 Start Time Default | Site-specific | Time |
| Window 3 Pressure Setpoint Default | Site-specific | mAHD |
| Window 4 Enabled Default | Site-specific |  |
| Window 4 Start Time Default | Site-specific | Time |
| Window 4 Pressure Setpoint Default | Site-specific | mAHD |

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| Window 0 Pressure Setpoint | Analog | Zone Minimum Pressure | Zone Maximum Pressure | SS\* | mAHD |
| Window 1 Start Time | Analog | 0000 | 2359 | SS | Time |
| Window 1 Pressure Setpoint | Analog | Zone Minimum Pressure | Zone Maximum Pressure | SS | mAHD |
| Window 2 Enabled | Digital |  |  | SS |  |
| Window 2 Start Time | Analog | 0000 | 2359 | SS | Time |
| Window 2 Pressure Setpoint | Analog | Zone Minimum Pressure | Zone Maximum Pressure | SS | mAHD |
| Window 3 Enabled | Digital |  |  | SS |  |
| Window 3 Start Time | Analog | 0000 | 2359 | SS | Time |
| Window 3 Pressure Setpoint | Analog | Zone Minimum Pressure | Zone Maximum Pressure | SS | mAHD |
| Window 4 Enabled | Digital |  |  | SS |  |
| Window 4 Start Time | Analog | 0000 | 2359 | SS | Time |
| Window 4 Pressure Setpoint | Analog | Zone Minimum Pressure | Zone Maximum Pressure | SS | mAHD |

\*SS=Site-Specific

#### Calculations and Statistics

|  |  |
| --- | --- |
| Point | Description |
| Scheduled Pressure Mode Required Pressure Setpoint | Calculated delivery pressure setpoint based on current time. |

#### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| Scheduled Delivery Mode Lookup Table Invalid | Digital Status |  | Alarm (1) |  |
| Window 0 Pressure Setpoint | Analog Control | mAHD |  |  |
| Window 1 Start Time | Analog Control | Time |  |  |
| Window 1 Pressure Setpoint | Analog Control | mAHD |  |  |
| Window 2 Enabled | Digital Control |  |  |  |
| Window 2 Start Time | Analog Control | Time |  |  |
| Window 2 Pressure Setpoint | Analog Control | mAHD |  |  |
| Window 3 Enabled | Digital Control |  |  |  |
| Window 3 Start Time | Analog Control | Time |  |  |
| Window 3 Pressure Setpoint | Analog Control | mAHD |  |  |
| Window 4 Enabled | Digital Control |  |  |  |
| Window 4 Start Time | Analog Control | Time |  |  |
| Window 4 Pressure Setpoint | Analog Control | mAHD |  |  |
| Window 0 Pressure Setpoint Feedback | Analog Status | mAHD |  | Y |
| Window 1 Start Time Feedback | Analog Status | Time |  | Y |
| Window 1 Pressure Setpoint Feedback | Analog Status | mAHD |  | Y |
| Window 2 Enabled Feedback | Digital Status |  | Event |  |
| Window 2 Start Time Feedback | Analog Status | Time |  | Y |
| Window 2 Pressure Setpoint Feedback | Analog Status | mAHD |  | Y |
| Window 3 Enabled Feedback | Digital Status |  | Event |  |
| Window 3 Start Time Feedback | Analog Status | Time |  | Y |
| Window 3 Pressure Setpoint Feedback | Analog Status | mAHD |  | Y |
| Window 4 Enabled Feedback | Digital Status |  | Event |  |
| Window 4 Start Time Feedback | Analog Status | Time |  | Y |
| Window 4 Pressure Setpoint Feedback | Analog Status | mAHD |  | Y |
| Scheduled Pressure Mode Required Pressure Setpoint | Analog Status | mAHD |  | Y |
| Window 0 Pressure Setpoint Default | Analog Status | mAHD |  |  |
| Window 1 Start Time Default | Analog Status | Time |  |  |
| Window 1 Pressure Setpoint Default | Analog Status | mAHD |  |  |
| Window 2 Enabled Default | Digital Status |  |  |  |
| Window 2 Start Time Default | Analog Status | Time |  |  |
| Window 2 Pressure Setpoint Default | Analog Status | mAHD |  |  |
| Window 3 Enabled Default | Digital Status |  |  |  |
| Window 3 Start Time Default | Analog Status | Time |  |  |
| Window 3 Pressure Setpoint Default | Analog Status | mAHD |  |  |
| Window 4 Enabled Default | Digital Status |  |  |  |
| Window 4 Start Time Default | Analog Status | Time |  |  |
| Window 4 Pressure Setpoint Default | Analog Status | mAHD |  |  |

### Mode 4 - Flow Modulation Mode (Option R3)

Flow Modulation Mode allows the station to modify its discharge pressure setpoint depending on flow demand. This mode allows the station to compensate for increased network losses at higher flows, without using peer pressure monitoring.

#### Mode Conditions

For Flow Modulation Mode to be active the following conditions must be met:

* Discharge Flow Meter must be enabled as a site option.
* Flow Modulation Mode must be enabled as a site option.
* If the Fire Switch site Option is enabled, the Fire switch must be in the “Control” position.
* The Local/Remote switch must be in the “Remote” position
* Mode Selection variable is set to 4 (Integer set by the control room operator via the SCADA System).
* Discharge Flowmeter Invalid signal not active (Flow meter is healthy).
* Discharge Pressure Invalid signal not active (i.e. at least one discharge pressure transmitter signal is valid) and MPC Primary Sensor Fault not active.
* The Flow Modulation Mode flow vs pressure lookup table (see below) is valid.

#### Mode Description

Each booster site will have a site-specific flow versus pressure lookup table which is operator configurable and validated by the RTU. The lookup table will have 8 rows. The first two rows (Rows 0 and 1) of the table are always enabled. The operator may choose to enable and populate the remaining rows to set up to 8 discrete pressures for 8 flow ranges.

Note: only contiguous rows can be enabled. If a row is disabled, all rows below are automatically disabled by the RTU.

Disabled rows shall be greyed out in SCADA.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **#** | **Enabled** | **Flow Rate (l/s)** | **Required Pressure Setpoint (RPS4)**  **(mAHD)** | **Flow Hysteresis (l/s)** | **HysteresisTime Delay (s)** |
| 0. | Y | X0 = 0 | Y0 | N/A | N/A |
| 1. | Y | X1 | Y1 | H1 | D1 |
| 2. | Y/N | X2 | Y2 | H2 | D2 |
| 3. | Y/N | X3 | Y3 | H3 | D3 |
| 4. | Y/N | X4 | Y4 | H4 | D4 |
| 5. | Y/N | X5 | Y5 | H5 | D5 |
| 6. | Y/N | X6 | Y6 | H6 | D6 |
| 7. | Y/N | X7 | Y7 | H7 | D7 |

Table 4 - Flow versus Pressure Lookup Table

In addition to the flow and pressure value, each row has a deadband or hysteresis value defined so that the flow must fall significantly for the pressure setpoint to revert to the previous band. Also, the flow must remain below the hysteresis level for the row’s hysteresis delay before the step down in pressure occurs.

The RTU steps the pressure setpoint up and down sequentially between rows. Even if the flow drops to X0=0, the pressure setpoint will only drop to that of the previous row, and must remain there for the row’s hysteresis delay before dropping again.

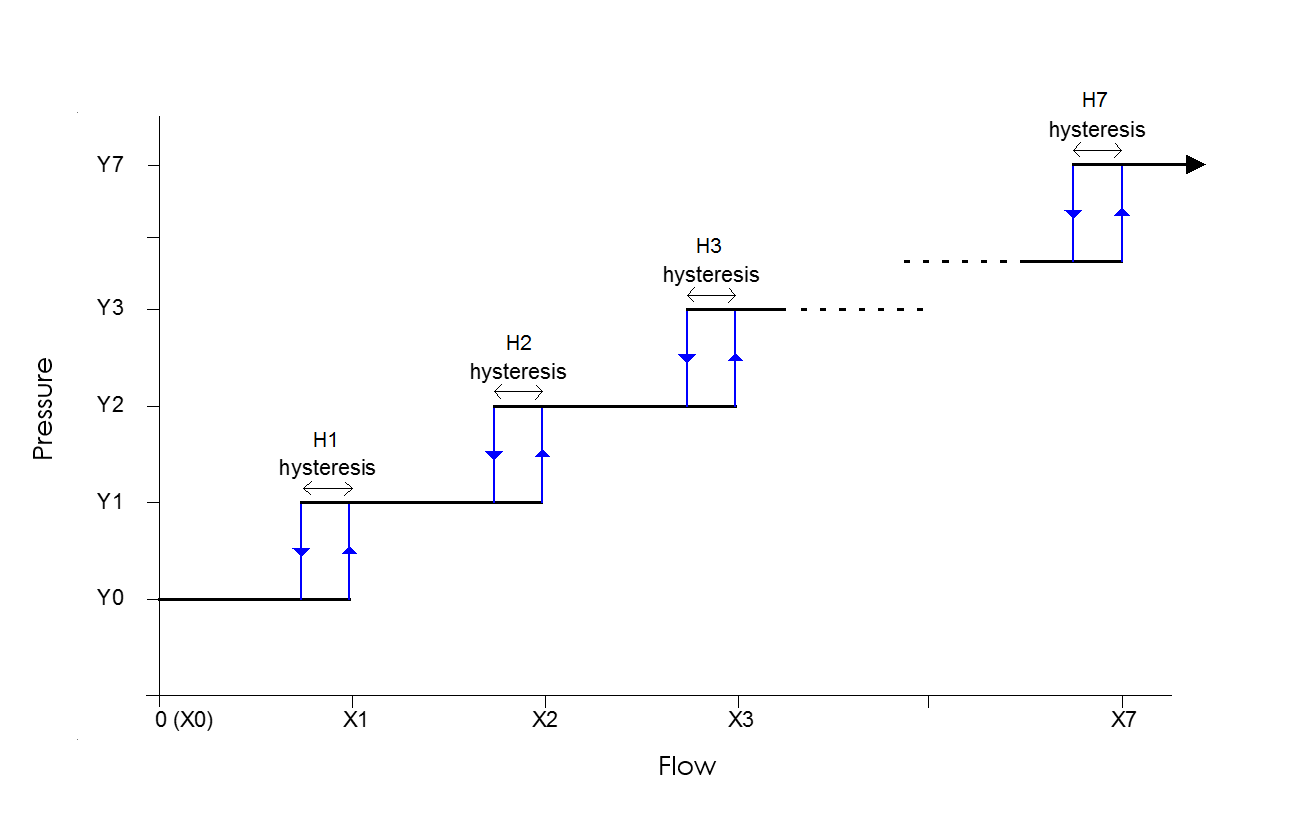
**Table checks**

1. The flow value X for rows 1-7 (if enabled) must be greater than the row before (i.e. increase down the table).
2. The pressure value Y for rows 1-7 (if enabled) must be greater than the row before (i.e. increase down the table).
3. For enabled rows, the hysteresis value for a given row must be less than the difference between that row’s flow value and the flow value of the row before.

Note that the flow hysteresis and delay values for row 0 are not applicable, since the minimum flow used by flow modulation mode (X0) is 0l/s. (i.e. pressure setpoint does not drop below Y0).

*Figure 2, below,* illustrates the step changes and the hysteresis value.

Figure 2 - Flow Modulation Setpoint Diagram



#### Example

If the current state is that Flow >= X1 and Flow < X2 and the Required Pressure Setpoint (RPS4) = Y1

Then, if the flow increases to the next bracket (i.e. Flow >= X2 and Flow < X3) then RPS4 = Y2. (This change is immediate to provide required pressure for firefighting.)

Then, if the flow then decreases back below the hysteresis for the current row, (i.e. Flow < [X2-H2]) and remains below the hysteresis for the current row hysteresis delay (D2), then RPS4 = Y1.

**Note: There is the risk of a burst from over-pressurisation of the network, if the zone users drastically reduce water usage before hysteresis delays allow the system to react to the decreased flow demand. The hysteresis time and set point values need to be carefully nominated to avoid these issues.**

#### Mode Failure Conditions

##### Flow versus Pressure Lookup Table invalid

If operator entries in the flow versus pressure lookup table are checked by the RTU and deemed invalid (e.g. pressures on enabled rows do not increase from rows 0-7) then the Water booster shall default to Delivery Mode.

The RTU will not automatically change the mode back to Flow Modulation Mode, even if the table becomes valid.

##### Delivery Flow Invalid

If the delivery flow is invalid, the RTU will change the station control mode to Delivery Pressure Mode.

The RTU will change the station control mode back to Flow Modulation mode on restoration of a valid delivery flow signal.

##### Delivery Pressure Invalid

If the delivery pressure is invalid (all installed discharge pressure transmitters invalid) or the MPC Primary Sensor Fault is active, the RTU will change the station control mode to Fixed Speed Mode.

The RTU will change the station control mode back to Flow Modulation mode on restoration of a healthy delivery pressure signal (i.e. at least one discharge pressure transmitter signal is valid and MPC Primary Sensor Fault is not active).

Note: The MPC Primary Sensor Fault is latched in the RTU and requires an operator reset to clear it before the RTU can return the station to Flow Modulation Mode.

#### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| NIL |  |  |

#### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| Flow Mode Lookup Table Invalid | 1 | This alarm is active if the current entries in the flow mode lookup table do not pass RTU verification. This alarm is suppressed where Discharge Flow Meter and Flow Modulation Mode are not enabled as site options. |

#### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| Flow Modulation Mode Maximum Flow | Site-specific | l/s |
| Flow Modulation Mode Minimum Flow | Site-specific | l/s |
| Flow Modulation Mode Maximum Hysteresis | Site-specific | l/s |
| Flow Modulation Mode Minimum Hysteresis | Site-specific | l/s |
| Flow Modulation Mode Maximum Hysteresis Delay | Site-specific | s |
| Flow Modulation Mode Minimum Hysteresis Delay | Site-specific | s |
| Flow Mode Row 2 Enabled Default | Site-specific |  |
| Flow Mode Row 3 Enabled Default | Site-specific |  |
| Flow Mode Row 4 Enabled Default | Site-specific |  |
| Flow Mode Row 5 Enabled Default | Site-specific |  |
| Flow Mode Row 6 Enabled Default | Site-specific |  |
| Flow Mode Row 7 Enabled Default | Site-specific |  |
| Flow Mode Flow Rate X1 Default | Site-specific | L/s |
| Flow Mode Flow Rate X2 Default | Site-specific | L/s |
| Flow Mode Flow Rate X3 Default | Site-specific | L/s |
| Flow Mode Flow Rate X4 Default | Site-specific | L/s |
| Flow Mode Flow Rate X5 Default | Site-specific | L/s |
| Flow Mode Flow Rate X6 Default | Site-specific | L/s |
| Flow Mode Flow Rate X7 Default | Site-specific | L/s |
| Flow Mode Pressure Setpoint Y0 Default | Site-specific | mAHD |
| Flow Mode Pressure Setpoint Y1 Default | Site-specific | mAHD |
| Flow Mode Pressure Setpoint Y2 Default | Site-specific | mAHD |
| Flow Mode Pressure Setpoint Y3 Default | Site-specific | mAHD |
| Flow Mode Pressure Setpoint Y4 Default | Site-specific | mAHD |
| Flow Mode Pressure Setpoint Y5 Default | Site-specific | mAHD |
| Flow Mode Pressure Setpoint Y6 Default | Site-specific | mAHD |
| Flow Mode Pressure Setpoint Y7 Default | Site-specific | mAHD |
| Flow Mode Flow Hysteresis H1 Default | Site-specific | L/s |
| Flow Mode Flow Hysteresis H2 Default | Site-specific | L/s |
| Flow Mode Flow Hysteresis H3 Default | Site-specific | L/s |
| Flow Mode Flow Hysteresis H4 Default | Site-specific | L/s |
| Flow Mode Flow Hysteresis H5 Default | Site-specific | L/s |
| Flow Mode Flow Hysteresis H6 Default | Site-specific | L/s |
| Flow Mode Flow Hysteresis H7 Default | Site-specific | L/s |
| Flow Mode Hysteresis Delay D1 Default | Site-specific | s |
| Flow Mode Hysteresis Delay D2 Default | Site-specific | s |
| Flow Mode Hysteresis Delay D3 Default | Site-specific | s |
| Flow Mode Hysteresis Delay D4 Default | Site-specific | s |
| Flow Mode Hysteresis Delay D5 Default | Site-specific | s |
| Flow Mode Hysteresis Delay D6 Default | Site-specific | s |
| Flow Mode Hysteresis Delay D7 Default | Site-specific | s |

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| Row 2 Enabled | Digital |  |  | SS |  |
| Row 3 Enabled | Digital |  |  | SS |  |
| Row 4 Enabled | Digital |  |  | SS |  |
| Row 5 Enabled | Digital |  |  | SS |  |
| Row 6 Enabled | Digital |  |  | SS |  |
| Row 7 Enabled | Digital |  |  | SS |  |
| Flow Rate X1 | Analog | Flow Mode Min Flow | Flow Mode Max Flow | SS | L/s |
| Flow Rate X2 | Analog | Flow Mode Min Flow | Flow Mode Max Flow | SS | L/s |
| Flow Rate X3 | Analog | Flow Mode Min Flow | Flow Mode Max Flow | SS | L/s |
| Flow Rate X4 | Analog | Flow Mode Min Flow | Flow Mode Max Flow | SS | L/s |
| Flow Rate X5 | Analog | Flow Mode Min Flow | Flow Mode Max Flow | SS | L/s |
| Flow Rate X6 | Analog | Flow Mode Min Flow | Flow Mode Max Flow | SS | L/s |
| Flow Rate X7 | Analog | Flow Mode Min Flow | Flow Mode Max Flow | SS | L/s |
| Pressure Setpoint Y0 | Analog | Zone Minimum Pressure | Zone Maximum Pressure | SS | mAHD |
| Pressure Setpoint Y1 | Analog | Zone Minimum Pressure | Zone Maximum Pressure | SS | mAHD |
| Pressure Setpoint Y2 | Analog | Zone Minimum Pressure | Zone Maximum Pressure | SS | mAHD |
| Pressure Setpoint Y3 | Analog | Zone Minimum Pressure | Zone Maximum Pressure | SS | mAHD |
| Pressure Setpoint Y4 | Analog | Zone Minimum Pressure | Zone Maximum Pressure | SS | mAHD |
| Pressure Setpoint Y5 | Analog | Zone Minimum Pressure | Zone Maximum Pressure | SS | mAHD |
| Pressure Setpoint Y6 | Analog | Zone Minimum Pressure | Zone Maximum Pressure | SS | mAHD |
| Pressure Setpoint Y7 | Analog | Zone Minimum Pressure | Zone Maximum Pressure | SS | mAHD |
| Flow Hysteresis H1 | Analog | Flow Mode Min Hysteresis | Flow Mode Max Hysteresis | SS | L/s |
| Flow Hysteresis H2 | Analog | Flow Mode Min Hysteresis | Flow Mode Max Hysteresis | SS | L/s |
| Flow Hysteresis H3 | Analog | Flow Mode Min Hysteresis | Flow Mode Max Hysteresis | SS | L/s |
| Flow Hysteresis H4 | Analog | Flow Mode Min Hysteresis | Flow Mode Max Hysteresis | SS | L/s |
| Flow Hysteresis H5 | Analog | Flow Mode Min Hysteresis | Flow Mode Max Hysteresis | SS | L/s |
| Flow Hysteresis H6 | Analog | Flow Mode Min Hysteresis | Flow Mode Max Hysteresis | SS | L/s |
| Flow Hysteresis H7 | Analog | Flow Mode Min Hysteresis | Flow Mode Max Hysteresis | SS | L/s |
| Hysteresis Delay D1 | Analog | Flow Mode Min Hyst Delay | Flow Mode Max Hyst Delay | SS | s |
| Hysteresis Delay D2 | Analog | Flow Mode Min Hyst Delay | Flow Mode Max Hyst Delay | SS | s |
| Hysteresis Delay D3 | Analog | Flow Mode Min Hyst Delay | Flow Mode Max Hyst Delay | SS | s |
| Hysteresis Delay D4 | Analog | Flow Mode Min Hyst Delay | Flow Mode Max Hyst Delay | SS | s |
| Hysteresis Delay D5 | Analog | Flow Mode Min Hyst Delay | Flow Mode Max Hyst Delay | SS | s |
| Hysteresis Delay D6 | Analog | Flow Mode Min Hyst Delay | Flow Mode Max Hyst Delay | SS | s |
| Hysteresis Delay D7 | Analog | Flow Mode Min Hyst Delay | Flow Mode Max Hyst Delay | SS | s |

#### Calculations and Statistics

|  |  |
| --- | --- |
| Point | Description |
| Flow Modulation Mode Required Pressure Setpoint | Calculated delivery pressure setpoint based on discharge flow. |

#### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| Flow Mode Lookup Table Invalid | Digital Status |  | Alarm (1) |  |
| Flow Modulation Mode Maximum Flow | Analog Status | l/s |  |  |
| Flow Modulation Mode Minimum Flow | Analog Status | l/s |  |  |
| Flow Modulation Mode Maximum Hysteresis | Analog Status | l/s |  |  |
| Flow Modulation Mode Minimum Hysteresis | Analog Status | l/s |  |  |
| Flow Modulation Mode Maximum Hysteresis Delay | Analog Status | s |  |  |
| Flow Modulation Mode Minimum Hysteresis Delay | Analog Status | s |  |  |
| Row 2 Enabled | Digital Control |  |  |  |
| Row 3 Enabled | Digital Control |  |  |  |
| Row 4 Enabled | Digital Control |  |  |  |
| Row 5 Enabled | Digital Control |  |  |  |
| Row 6 Enabled | Digital Control |  |  |  |
| Row 7 Enabled | Digital Control |  |  |  |
| Flow Rate X1 | Analog Control | L/s |  |  |
| Flow Rate X2 | Analog Control | L/s |  |  |
| Flow Rate X3 | Analog Control | L/s |  |  |
| Flow Rate X4 | Analog Control | L/s |  |  |
| Flow Rate X5 | Analog Control | L/s |  |  |
| Flow Rate X6 | Analog Control | L/s |  |  |
| Flow Rate X7 | Analog Control | L/s |  |  |
| Pressure Setpoint Y0 | Analog Control | mAHD |  |  |
| Pressure Setpoint Y1 | Analog Control | mAHD |  |  |
| Pressure Setpoint Y2 | Analog Control | mAHD |  |  |
| Pressure Setpoint Y3 | Analog Control | mAHD |  |  |
| Pressure Setpoint Y4 | Analog Control | mAHD |  |  |
| Pressure Setpoint Y5 | Analog Control | mAHD |  |  |
| Pressure Setpoint Y6 | Analog Control | mAHD |  |  |
| Pressure Setpoint Y7 | Analog Control | mAHD |  |  |
| Flow Hysteresis H1 | Analog Control | L/s |  |  |
| Flow Hysteresis H2 | Analog Control | L/s |  |  |
| Flow Hysteresis H3 | Analog Control | L/s |  |  |
| Flow Hysteresis H4 | Analog Control | L/s |  |  |
| Flow Hysteresis H5 | Analog Control | L/s |  |  |
| Flow Hysteresis H6 | Analog Control | L/s |  |  |
| Flow Hysteresis H7 | Analog Control | L/s |  |  |
| Hysteresis Delay D1 | Analog Control | s |  |  |
| Hysteresis Delay D2 | Analog Control | s |  |  |
| Hysteresis Delay D3 | Analog Control | s |  |  |
| Hysteresis Delay D4 | Analog Control | s |  |  |
| Hysteresis Delay D5 | Analog Control | s |  |  |
| Hysteresis Delay D6 | Analog Control | s |  |  |
| Hysteresis Delay D7 | Analog Control | s |  |  |
| Row 2 Enabled Feedback | Digital Status |  |  | Y |
| Row 3 Enabled Feedback | Digital Status |  |  | Y |
| Row 4 Enabled Feedback | Digital Status |  |  | Y |
| Row 5 Enabled Feedback | Digital Status |  |  | Y |
| Row 6 Enabled Feedback | Digital Status |  |  | Y |
| Row 7 Enabled Feedback | Digital Status |  |  | Y |
| Flow Rate X1 Feedback | Analog Status | L/s |  | Y |
| Flow Rate X2 Feedback | Analog Status | L/s |  | Y |
| Flow Rate X3 Feedback | Analog Status | L/s |  | Y |
| Flow Rate X4 Feedback | Analog Status | L/s |  | Y |
| Flow Rate X5 Feedback | Analog Status | L/s |  | Y |
| Flow Rate X6 Feedback | Analog Status | L/s |  | Y |
| Flow Rate X7 Feedback | Analog Status | L/s |  | Y |
| Pressure Setpoint Y0 Feedback | Analog Status | mAHD |  | Y |
| Pressure Setpoint Y1 Feedback | Analog Status | mAHD |  | Y |
| Pressure Setpoint Y2 Feedback | Analog Status | mAHD |  | Y |
| Pressure Setpoint Y3 Feedback | Analog Status | mAHD |  | Y |
| Pressure Setpoint Y4 Feedback | Analog Status | mAHD |  | Y |
| Pressure Setpoint Y5 Feedback | Analog Status | mAHD |  | Y |
| Pressure Setpoint Y6 Feedback | Analog Status | mAHD |  | Y |
| Pressure Setpoint Y7 Feedback | Analog Status | mAHD |  | Y |
| Flow Hysteresis H1 Feedback | Analog Status | L/s |  | Y |
| Flow Hysteresis H2 Feedback | Analog Status | L/s |  | Y |
| Flow Hysteresis H3 Feedback | Analog Status | L/s |  | Y |
| Flow Hysteresis H4 Feedback | Analog Status | L/s |  | Y |
| Flow Hysteresis H5 Feedback | Analog Status | L/s |  | Y |
| Flow Hysteresis H6 Feedback | Analog Status | L/s |  | Y |
| Flow Hysteresis H7 Feedback | Analog Status | L/s |  | Y |
| Hysteresis Delay D1 Feedback | Analog Status | s |  | Y |
| Hysteresis Delay D2 Feedback | Analog Status | s |  | Y |
| Hysteresis Delay D3 Feedback | Analog Status | s |  | Y |
| Hysteresis Delay D4 Feedback | Analog Status | s |  | Y |
| Hysteresis Delay D5 Feedback | Analog Status | s |  | Y |
| Hysteresis Delay D6 Feedback | Analog Status | s |  | Y |
| Hysteresis Delay D7 Feedback | Analog Status | s |  | Y |
| Flow Modulation Mode Required Pressure Setpoint (RPS4) | Analog Status | mAHD |  | Y |
| Flow Mode Row 2 Enabled Default | Digital Status |  |  |  |
| Flow Mode Row 3 Enabled Default | Digital Status |  |  |  |
| Flow Mode Row 4 Enabled Default | Digital Status |  |  |  |
| Flow Mode Row 5 Enabled Default | Digital Status |  |  |  |
| Flow Mode Row 6 Enabled Default | Digital Status |  |  |  |
| Flow Mode Row 7 Enabled Default | Digital Status |  |  |  |
| Flow Mode Flow Rate X1 Default | Analog Status | L/s |  |  |
| Flow Mode Flow Rate X2 Default | Analog Status | L/s |  |  |
| Flow Mode Flow Rate X3 Default | Analog Status | L/s |  |  |
| Flow Mode Flow Rate X4 Default | Analog Status | L/s |  |  |
| Flow Mode Flow Rate X5 Default | Analog Status | L/s |  |  |
| Flow Mode Flow Rate X6 Default | Analog Status | L/s |  |  |
| Flow Mode Flow Rate X7 Default | Analog Status | L/s |  |  |
| Flow Mode Pressure Setpoint Y0 Default | Analog Status | mAHD |  |  |
| Flow Mode Pressure Setpoint Y1 Default | Analog Status | mAHD |  |  |
| Flow Mode Pressure Setpoint Y2 Default | Analog Status | mAHD |  |  |
| Flow Mode Pressure Setpoint Y3 Default | Analog Status | mAHD |  |  |
| Flow Mode Pressure Setpoint Y4 Default | Analog Status | mAHD |  |  |
| Flow Mode Pressure Setpoint Y5 Default | Analog Status | mAHD |  |  |
| Flow Mode Pressure Setpoint Y6 Default | Analog Status | mAHD |  |  |
| Flow Mode Pressure Setpoint Y7 Default | Analog Status | mAHD |  |  |
| Flow Mode Flow Hysteresis H1 Default | Analog Status | L/s |  |  |
| Flow Mode Flow Hysteresis H2 Default | Analog Status | L/s |  |  |
| Flow Mode Flow Hysteresis H3 Default | Analog Status | L/s |  |  |
| Flow Mode Flow Hysteresis H4 Default | Analog Status | L/s |  |  |
| Flow Mode Flow Hysteresis H5 Default | Analog Status | L/s |  |  |
| Flow Mode Flow Hysteresis H6 Default | Analog Status | L/s |  |  |
| Flow Mode Flow Hysteresis H7 Default | Analog Status | L/s |  |  |
| Flow Mode Hysteresis Delay D1 Default | Analog Status | s |  |  |
| Flow Mode Hysteresis Delay D2 Default | Analog Status | s |  |  |
| Flow Mode Hysteresis Delay D3 Default | Analog Status | s |  |  |
| Flow Mode Hysteresis Delay D4 Default | Analog Status | s |  |  |
| Flow Mode Hysteresis Delay D5 Default | Analog Status | s |  |  |
| Flow Mode Hysteresis Delay D6 Default | Analog Status | s |  |  |
| Flow Mode Hysteresis Delay D7 Default | Analog Status | s |  |  |

### Mode 5 - Remote Fire Mode

This mode, like Local Fire Mode, controls the station discharge pressure to the Zone Default Fire Pressure (parameter in the RTU).

#### Mode Conditions

For Remote Fire Mode to be active the following conditions must be met:

* If the Fire Switch site option is enabled, the Fire switch must be in the “Control” position.
* The Local/Remote switch must be in the “Remote” position
* Mode Selection variable is set to 5 (Integer set by the control room operator via the SCADA system).
* Discharge Pressure Invalid signal not active (i.e. at least one discharge pressure transmitter signal is valid) and MPC Primary Sensor Fault not active.

#### Mode Description

This mode allows the control room operator to remotely engage fire mode.

#### Mode Failure Conditions

##### Delivery Pressure Invalid

If the delivery pressure is invalid (all installed discharge pressure transmitters invalid) or the MPC Primary Sensor Fault is active, the RTU will change the station control mode to Fixed Speed Mode, and the System Performance setpoint will be set to the Fixed Speed Fire System Performance %.

The RTU will change the station control mode back to Remote Fire mode on restoration of a healthy delivery pressure signal (i.e. at least one discharge pressure transmitter signal is valid and MPC Primary Sensor Fault is not active).

Note: The MPC Primary Sensor Fault is latched in the RTU and requires an operator reset to clear it before the RTU can return the station to Remote Fire Mode.

#### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| NIL |  |  |

#### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| NIL |  |  |

#### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| Zone Default Fire Pressure | Site-specific | mAHD |
| Fixed Speed Fire System Performance % | Site-specific | % |

Note:

The Zone Default Fire Pressure is the discharge pressure setpoint selected to provide necessary pressure for the zone in fire flow situations. It is a station parameter provided by QUU.

The Fixed Speed Fire System Performance % is the percentage of pump station output (system performance) deemed to provide necessary pressure to the zone for fire flow conditions. It is a station parameter provided by QUU.

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| NIL |  |  |  |  |  |

#### Calculations and Statistics

|  |  |
| --- | --- |
| Point | Description |
| NIL |  |

#### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| Zone Default Fire Pressure | Analog Status | mAHD |  |  |

### Mode 6 - Manual Mode

#### General

In manual mode the control room operator can operate the station in open loop control to a system performance setpoint (%). The operator can also start and stop the pump set.

Note: Manual Mode is considered a “limp” or “emergency” mode, to be used only while a site failure is being rectified or to handle unexpected network requirements. For this reason, pumps are not stopped on suction pressure low low alarm.

For sites where certain conditions should not be ignored even in manual mode, these conditions can be coded into the Process Interlock code block.

#### Mode Selection

For Manual Mode to be active the following conditions must be met:

* If the Fire Switch site option is enabled, the Fire switch must be in the “Control” position.
* The Local/Remote switch must be in the “Remote” position
* Mode Selection variable is set to 6 (Integer set by the control room operator via the SCADA system).

#### Operator Commands

The control room operator can start and stop the pump set and run the station at a manually set system performance setpoint (%) using controls on the station SCADA control popup.

#### Mode Failure Conditions

None.

#### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| NIL |  |  |

#### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| NIL |  |  |

#### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| Fixed Speed Normal System Performance % | Site-specific | % |
| Manual Mode System Performance Setpoint Min | 0 | % |
| Manual Mode System Performance Setpoint Max | 100 | % |

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| Manual System Performance Setpoint | Analog | Manual Mode System Performance Setpoint Min | Manual Mode System Performance Setpoint Max | Fixed Speed Normal System Performance % | % |

#### Calculations and Statistics

|  |  |
| --- | --- |
| Point | Description |
| NIL |  |

#### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| Manual System Performance Setpoint | Analog Control | % |  |  |
| Manual System Performance Setpoint Feedback | Analog Status | % |  | Y |
| Fixed Speed Normal System Performance % | Analog Status | % |  |  |
| Manual Mode System Performance Setpoint Min | Analog Status | % |  |  |
| Manual Mode System Performance Setpoint Max | Analog Status | % |  |  |
| Manual Mode Pump Set Start | Digital Control |  |  |  |
| Manual Mode Pump Set Stop | Digital Control |  |  |  |

### Mode 7 - Local Mode

This mode allows a field electrician on site to operate the pump set via the HMI on the CU352.

#### Mode Conditions

For Local Mode to be active the following conditions must be met:

* If Fire Switch site option is enabled, the Fire switch must be in the “Control” position.
* The Local/Remote switch must be in the “Local” position.

#### Mode Description

The only way Local Mode can be activated is by a field electrician attending the site,

NOTE:

1. It is possible to change MPC settings via the MPC’s HMI, allowing control of the MPC system via its HMI regardless of the above conditions.
2. Under Local Mode the control room operator is unable to control the MPC system. Sending an MPC Alarm Reset command from SCADA while in Local Mode will reset MPC alarms latched in the RTU, but will not send an alarm reset request to the MPC controller. A field officer is required to initiate this mode AND revert back to remote functionality of the site.
3. **Note: When under HMI (Local) control, the MPC uses a different set of setpoints to those used under Remote (Modbus) control, so a change to HMI control may cause an immediate change to station behaviour (as would a change back to Modbus control).**

#### Mode Failure Conditions

None.

#### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| NIL |  |  |

#### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| NIL |  |  |

#### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| NIL |  |  |

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| NIL |  |  |  |  |  |

#### Calculations and Statistics

|  |  |
| --- | --- |
| Point | Description |
| NIL |  |

#### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| NIL |  |  |  |  |

### Mode 8 – Local Fire Mode

This mode, like Remote Fire Mode, controls the station discharge pressure to the Zone Default Fire Pressure (parameter in the RTU).

This mode is a legacy mode retained from past water booster installations.

#### Mode Conditions

For Local Fire Mode to be active the following conditions must be met:

* Fire switch site option must be enabled
* The Fire switch must be in the “Fire” position (A field officer or QFRS officer has attended site and is using the local Fire switch to place the station in Local Fire Mode.)
* Discharge Pressure Invalid signal not active (i.e. at least one discharge pressure transmitter signal is valid) and MPC Primary Sensor Fault not active.

#### Mode Description

The only way Local Fire Mode can be activated or deactivated is by a field officer or QFRS officer attending the site.

NOTE: Under Local Fire Mode an MPC Alarm Reset command from SCADA will both reset MPC alarms latched in the RTU, and send an alarm reset request to the MPC controller.

#### Mode Failure Conditions

##### Delivery Pressure Invalid

If the delivery pressure is invalid (all installed discharge pressure transmitters invalid) or the MPC Primary Sensor Fault is active, the RTU will change the station control mode to Fixed Speed Mode, and the System Performance setpoint will be set to the Fixed Speed Fire System Performance %.

The RTU will change the station control mode back to Local Fire mode on restoration of a healthy delivery pressure signal (i.e. at least one discharge pressure transmitter signal is valid and MPC Primary Sensor Fault is not active).

Note: The MPC Primary Sensor Fault is latched in the RTU and requires an operator reset to clear it before the RTU can return the station to Local Fire Mode.

#### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| NIL |  |  |

#### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| NIL |  |  |

#### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| Zone Default Fire Pressure | Site-specific | mAHD |
| Fixed Speed Fire System Performance % | Site-specific | % |

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| NIL |  |  |  |  |  |

#### Calculations and Statistics

|  |  |
| --- | --- |
| Point | Description |
| NIL |  |

#### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| NIL |  |  |  |  |

### Mode 9 - Fixed Speed Mode

Fixed Speed Mode allows the station to operate in open loop control without discharge pressure feedback. The pump set is run at a system performance setpoint (%), selected by the RTU based on flow.

#### Mode Conditions

For Fixed Speed Mode to be active the following conditions must be met:

* The station must have been selected to be in one of the following modes:
* Delivery Pressure Mode
* Peer Pressure Control Mode
* Scheduled Delivery Pressure Mode
* Flow Modulation Mode
* Remote Fire Mode
* Local Fire Mode
* Discharge Pressure Invalid signal active (all installed discharge pressure transmitters invalid) or MPC Primary Sensor Fault active.

#### Mode Description

Fixed speed mode is not operator selectable. It is a backup mode automatically selected by the RTU on failure of all installed discharge pressure transmitters (i.e. all installed discharge pressure transmitters invalid or MPC Primary Sensor Fault active.).

Where, barring failure of all installed discharge pressure transmitters, the station would be in Remote Fire Mode or Local Fire Mode, the system performance setpoint (%) will be set to the Fixed Speed Fire System Performance %.

The Fixed Speed Fire System Performance % is the percentage of pump station output (system performance) deemed to provide necessary pressure for fire flow conditions. It is a station parameter provided by QUU.

Where, barring failure of all installed discharge pressure transmitters, the station would be in:

* Delivery Pressure Mode
* Peer Pressure Control Mode
* Scheduled Delivery Pressure Mode
* Flow Modulation Mode

the system performance setpoint (%) will be based on the current flow (if the discharge flow meter is enabled as a site option).

If the station discharge flow meter is enabled and not invalid and is greater than or equal to the station Fire Flow Threshold, the system performance setpoint (%) will be set to the Fixed Speed Fire System Performance %.

The Fire Flow Threshold is the minimum flow at which the station is deemed to be in fire flow conditions. It is a station parameter provided by QUU.

If the station discharge flow meter is enabled and not invalid and is less than the station Fire Flow Threshold, or if the flow meter is invalid or not enabled, the system performance setpoint (%) will be set to the Fixed Speed Normal System Performance %.

The Fixed Speed Normal System Performance % is the percentage of pump station output (system performance) deemed to provide necessary pressure to the zone for normal flow conditions. It is a station parameter provided by QUU.

Note, if the Fixed Speed Fire System Performance % is selected (flow greater than or equal to the station Fire Flow Threshold), the flow must stay below the Fire Flow Threshold (or be invalid) for a delay (default 5 min) before The Fixed Speed Normal System Performance % is restored.

#### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| NIL |  |  |

#### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| NIL |  |  |

#### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| Fixed Speed Normal System Performance % | Site-specific | % |
| Fixed Speed Mode Fire Flow Threshold | Site-specific | l/s |
| Fixed Speed Fire System Performance % | Site-specific | % |
| Fixed Speed Mode Return to Normal System Performance Delay | 300 | s |

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| NIL |  |  |  |  |  |

#### Calculations and Statistics

|  |  |
| --- | --- |
| Point | Description |
| NIL |  |

#### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| Fixed Speed Normal System Performance % | Site-specific | % |  |  |
| Fire Flow Threshold | Analog Status | l/s |  |  |
| Fixed Speed Fire System Performance % | Analog Status | % |  |  |
| Return to Normal System Performance Delay | Analog Status | s |  |  |

### Remote Mode Selection on Return from Locally selected Modes

Where the water booster is running in a remote mode (e.g. flow modulation mode) and a local mode (i.e. Local Mode or Local Fire Mode) is selected at the switchboard, on return of the booster to remote operation, the RTU will (provided conditions for the last–selected remote mode are met) return the station to the last–selected remote mode. Where no mode has been selected by an operator, the station will (provided conditions for Delivery Pressure Mode are met) enter Delivery Pressure mode, the default remote mode.

### Setpoint Clamping

Operator-supplied Pressure setpoints for Delivery Mode and Scheduled Delivery Mode, and the pressure values in the Flow Modulation setpoint lookup table, are all clamped between specified minimum and maximum delivery (zone) pressure values for the site.

The Peer Control Mode calculated delivery pressure setpoint is also clamped between specified minimum and maximum delivery (zone) pressure values for the site. (Note: this internal clamping of a calculated setpoint does not trigger a setpoint clamped alarm.)

Note:

The Zone Minimum Pressure is the minimum allowed discharge pressure setpoint for the station.

The Zone Maximum Pressure is the maximum allowed discharge pressure setpoint for the station.

In the Flow Modulation setpoint lookup table:

* Flow values are clamped to Flow Modulation Mode Minimum and Maximum Flow limits.
* Flow Hysteresis values are clamped to Flow Modulation Mode Minimum and Maximum Flow Hysteresis limits.
* Flow Hysteresis Delay values are clamped to Flow Modulation Mode Minimum and Maximum Flow Hysteresis Delay limits.

## Station Pump Set Control

### Local Mode Control

This mode allows personnel on site to operate the pump set via the HMI on the CU352.

The RTU does not control the MPC system in this mode. The station will behave as local HMI settings and setpoints dictate.

**Note: When under HMI (Local) control, the MPC uses a different set of setpoints to those used under Modbus control, so a change to HMI control may cause an immediate change to station behaviour (as would a change back to Modbus control).**

### MPC Pump Set Availability (All Modes Except Local Mode)

Certain alarm conditions pertaining to the MPC system must be healthy before the RTU will request the MPC system to run. The MPC pump set is considered ‘available’ to be run by the RTU if all these conditions are met.

The RTU will only command the MPC pump set to run if it is available to run. If the MPC pump set becomes unavailable to run at any time while it is running, it will be requested to stop immediately.

All of the following conditions must be true for the MPC pump set to be available:

* Station Mains power (Downstream of ATS) healthy (RTU Digital Input).
* Station Emergency (OR Control) Stop not active (RTU Digital Input).
* MPC Communications Fault not active (Calculated in RTU).
* At least one MPC pump’s hardwired VSD fault bit is healthy. (for pumps 3-5, and the jockey pump, pump hardwired VSD fault bit must be healthy AND pump option must be selected)

### Process Interlock Code Block (All Modes Except Local Mode)

In the interests of achieving a compromise between a “one size fits all” RTU code, where all conceivable site configurations are accommodated, and site-specific RTU code, an interlock program will be written into the code, allowing a single point of modification to achieve process interlocking for the MPC pump set. The program will consist of a run permit coil and associated contacts (where applicable). The run permit flag will be monitored by other programs in the code to decide whether the MPC pump set can be run.

The interlocks defined in the interlock code block are in addition to all interlocks specified in this specification, which will be coded elsewhere in the RTU program, and are not to be modified or overridden.

These site-specific interlocks shall be described in the site-specific functional specification.

Process Interlocks can apply in any mode except local mode. Mode states can be incorporated into the interlock logic to determine whether a condition applies in a given mode.

### Manual Mode Control

In Remote Manual Mode, the MPC system can be remotely controlled manually from Start/Stop buttons and system performance setpoint on the SCADA system.

If the pump set is available and its process interlocks are healthy (and, where the site has a generator and ATS installed, the Generator Pump inhibit is not active [see section *4.5.3 Summary: pump inhibit during generator transfer*]) when the start command is sent from SCADA, the pump set will be commanded to run. This run command will be latched until the pump set becomes unavailable, its process interlocks become unhealthy, the Generator Pump inhibit is active (where the site has a generator and ATS installed), or the stop command is sent from SCADA.

#### Bumpless Transfer

On entry into remote manual mode from another remote mode or Local Fire Mode, the MPC system will continue to run if it was running in the previous mode, or will stay stopped if it was not running in the previous mode.

Note: Bumpless transfer of system performance % cannot be achieved since the MPC’s Constant Speed Mode (See section 4.4.1.3 below) performance setpoint does not relate to the Relative Performance feedback value (e.g. 50% Constant Speed Mode performance setpoint does not yield 50% Relative Performance). Therefore, the Manual Mode System Performance Setpoint will not be continually updated by the RTU while in another remote mode or Local Fire Mode. Instead, on entry into Remote Manual Mode, the last operator-selected Manual Mode System Performance Setpoint will be used.

### Pressure Control Mode or Fixed Speed Mode Control

Pressure Control Modes are modes where the MPC system controls to a discharge pressure setpoint, i.e.:

* Delivery Pressure Mode
* Peer Pressure Control Mode
* Scheduled Delivery Pressure Mode
* Flow Modulation Mode
* Remote Fire Mode
* Local Fire Mode

When the station is running (Actual Mode) in a Pressure Control Mode or Fixed Speed Mode, the equipment shall be automatically controlled by the RTU as per control logic for that mode.

#### MPC System Run Conditions

In all modes except Local Mode and Remote Manual Mode, the MPC system will be requested to run if all of the following conditions are met:

1. The MPC pump set is available
2. The MPC pump set process interlocks are healthy
3. If the site has a generator and ATS installed, the Generator Pump inhibit is not active
4. The suction pressure is valid AND the suction pressure low low alarm is not active, OR The suction pressure is invalid.

### Emergency (OR Control) Stop Pushbutton

All pumps can be stopped locally in any mode via the station Emergency (OR Control) Stop pushbutton, located on the switchboard, which can be operated by personnel on site.

Note: RTU actions are the same whether an emergency stop or control stop is fitted.

**All emergency stop functionality is achieved independent of the RTU.**

### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| NIL |  |  |

### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| NIL |  |  |

### 

### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| NIL |  |  |

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| NIL |  |  |  |  |  |

### Calculations and Statistics

|  |  |
| --- | --- |
| Point | Description |
| NIL |  |

### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| NIL |  |  |  |  |

## MPC Control & Monitoring

Control and management of MPC pumps is handled by the MPC controller unit (CU352), which communicates with the RTU via Modbus TCP. The RTU can change setpoints and modes of the MPC system, as well as monitoring MPC pump and system status, via this Modbus communications link.

Operating and control modes described below refer to those available via Modbus control. Modes available via local HMI operation are not covered in this document.

### MPC System Operation

#### On / Off

The MPC booster system can be turned on and off. When is set to off, all pumps are stopped. When it is set to on, pumps may be running or not, depending on system requirements.

#### Operating Mode

The MPC system has three Operating Modes:

1. Auto-control, where the booster controls to a setpoint according to the selected control mode.
2. OpenLoopMin
3. OpenLoopMax

The RTU will only command the MPC to be in Auto-control mode.

#### Control Modes

The MPC System has nine Control Modes:

1. Constant Speed
2. Constant Frequency
3. Constant Head
4. Constant Pressure
5. Constant Differential Pressure
6. Proportional Pressure
7. Constant Flow
8. Constant Temperature
9. Constant Level

Normally, the RTU will command the MPC to run in Constant Pressure Control Mode, however, on failure of all installed delivery pressure transmitters (all installed discharge pressure transmitters invalid or MPC Primary Sensor Fault active), or when the site is in Remote Manual Mode, the RTU will command the MPC to run in Constant Speed Mode.

#### Local/Remote Selection

The MPC system can be controlled by either the RTU or the MPC HMI, located on the CU352. The control source for the MPC System can be selected by the RTU, via the Modbus connection to the CU352, as either Remote (controlled by the Modbus Master), or Local (controlled via HMI). The RTU will select the control source based on the position of the switchboard Local/Remote switch.

Note: It is possible to change MPC settings via the MPC’s HMI, allowing control of the MPC system via its HMI regardless of the RTU’s control source selection.

#### Warnings and Alarms

The MPC controller monitors the health of its pumps, instrumentation, and process variables such as inlet and outlet pressure. The MPC system has two levels of events: Warnings and Alarms.

A warning occurs when the event (e.g. Pump Overload Alarm) will not prevent the System from continuing in its current state.

An Alarm occurs when the system is unable to continue in its current state, and is associated with an Event Action, where the MPC controller will change operating mode. (e.g. On a discharge pressure high alarm, The MPC system will transition to ‘Stop’ Mode.)

In the MPC controller, the alarm and event action characteristics of some events are configurable. It may be possible to configure an event as either a warning or alarm, or disable the event. It may also be possible to select an alarm as auto-reset or manual reset. In addition, the event action of an alarm may be able to be changed. These MPC settings will be configured at commissioning to suit the protection requirements of the specific site.

Note: The “Fault, Primary Sensor” alarm occurs when the CU352 is operating in Constant Pressure mode (and presumably, other modes reliant on discharge pressure feedback for their operation) and the single discharge pressure transmitter has failed (or, where redundant transmitters are installed, both discharge pressure transmitters have failed). The default event action for the “Fault, Primary Sensor” alarm (i.e. failure of discharge pressure monitoring while in Constant Pressure mode) is “Stop”. The RTU will detect failure of the discharge pressure transmitter (or both transmitters, where two are installed) either via the “Fault, Primary Sensor” alarm from the MPC or its own discharge pressure invalid alarm(s), and will place the MPC system into Constant Speed mode.

The RTU can read alarm and warning status bits and codes from the MPC controller via Modbus, and the operator can reset latched alarms where applicable via the RTU (see section *4.4.9 MPC Alarm Reset*). There is also a hardwired digital Fault signal to the RTU from the MPC controller. The hardwired fault signal is set when there is an alarm detected by the MPC controller.

Note: RTU Alarms derived from the MPC Alarm Code register are latched and require an operator reset since the display of a given alarm code in the register may be momentary only. (e.g. an alarm may be superseded by a higher priority or more recent alarm).

### RTU Control of MPC System

Where the RTU requires the MPC System to be in a certain mode, the RTU code performs a read of the MPC system modes to ensure the MPC is in the required mode. See section *6.1.3.7 MPC Mode Command Fail Alarm*.

Likewise, where the RTU requires a setpoint to be used by the MPC system, the RTU performs a read of the MPC’s actual setpoint to ensure the MPC is using the correct value. See section *6.1.3.7 Setpoint Mismatch Alarm*.

### Pressure Control Modes

This section describes RTU control of the MPC system in any mode where the MPC system is used to control to a discharge pressure setpoint, i.e.:

* Delivery Pressure Mode
* Peer Pressure Control Mode
* Scheduled Delivery Pressure Mode
* Flow Modulation Mode
* Remote Fire Mode
* Local Fire Mode

When the station is in a Pressure Control Mode (Actual Station Mode), the RTU will set the MPC Modbus control registers as follows:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Modbus Register | Bit | Name | Value | Value Description | Comment |
| 00101 | 0 | RemoteAccessReq | 1 | Remote | Set Booster to Remote Mode |
| 00103 | N/A | OperationMode | 0 | Auto-control | Set booster to control to setpoint |
| 00102 | N/A | Control Mode | 4 | Constant Pressure | Set booster to control to pressure setpoint |

The RTU can confirm that the MPC is in remote and in Constant Pressure mode by reading the following Modbus status Registers:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Modbus Register | Bit | Name | Value | Value Description | Comment |
| 00201 | 8 | AccessMode | 1 | Remote | MPC is in Remote Mode |
| 00204 | N/A | OperationMode | 0 | Auto-control | Booster is controlling to a setpoint |
| 00203 | N/A | ControlMode | 4 | Constant Pressure | Booster is controlling to a pressure setpoint |

If the RTU is in a Pressure Control Mode (Actual Station Mode) and the MPC is not in Constant Pressure Mode (i.e. AccessMode = Remote, OperationMode = Auto-control and ControlMode = Constant Pressure), then after 10s, an MPC mode command fail alarm is raised and latched. The alarm is reset when MPC mode settings match the current RTU mode.

#### MPC Pressure Setpoint

When the station is in a Pressure Control Mode (Actual Station Mode), the RTU will set the MPC Modbus control registers as follows:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Modbus Register | Bit | Name | Value | Value Description | Comment |
| 00104 | N/A | Setpoint | 0 to 10000 | 0 to 100% of sensor range |  |

The RTU can confirm that the MPC is operating to the desired setpoint by reading the following Modbus status Registers:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Modbus Register | Bit | Name | Value | Value Description | Comment |
| 00308 | N/A | Actual Setpoint | 0 to 10000 | 0 to 100% of sensor range |  |

If the RTU is in a Pressure Control Mode and the MPC Mode Command Fail alarm is not active and the difference between the delivery pressure setpoint for that mode in the RTU and the Actual Setpoint in the MPC is greater than 50 counts (default), then after 10s, a Setpoint Mismatch alarm will be raised and latched. The alarm is reset when the difference is less than or equal to 50 counts.

### Fixed Speed and Remote Manual Modes

In Fixed Speed and Remote Manual modes, the MPC system runs in open loop control to a “performance” setpoint. (This performance setpoint is apparently a percentage of maximum system flow output, with a value of 100% causing all pumps to run at max speed.)

Fixed speed mode is selected by the RTU only, following failure of the discharge pressure sensor. Remote Manual Mode is selected by the operator via SCADA.

#### Grundfos MPC Mode

When Fixed Speed or Remote Manual mode is selected, the RTU will set the MPC Modbus control registers as follows:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Modbus Register | Bit | Name | Value | Value Description | Comment |
| 00101 | 0 | RemoteAccessReq | 1 | Remote | Set Booster to Remote Mode |
| 00103 | N/A | OperationMode | 0 | Auto-control | Set booster to control to setpoint |
| 00102 | N/A | Control Mode | 0 | Constant Speed | Set booster to control to speed setpoint |

The RTU can confirm that the MPC is in remote and in Constant Speed mode by reading the following Modbus status Registers:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Modbus Register | Bit | Name | Value | Value Description | Comment |
| 00201 | 8 | AccessMode | 1 | Remote | MPC is in Remote Mode |
| 00204 | N/A | OperationMode | 0 | Auto-control | Booster is controlling to a setpoint |
| 00203 | N/A | ControlMode | 0 | Constant Speed | Booster is controlling to a speed setpoint |

If the RTU is in Fixed Speed or Remote Manual mode and the MPC is not in Constant Speed Mode (i.e. AccessMode = Remote, OperationMode = Auto-control and ControlMode = Constant Speed), then after 10s, an MPC mode command fail alarm is raised and latched. The alarm is reset when MPC mode settings match current RTU mode.

#### MPC Performance Setpoint

When the station is in a fixed speed or remote manual mode, the RTU will set the MPC Modbus control registers as follows:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Modbus Register | Bit | Name | Value | Value Description | Comment |
| 00104 | N/A | Setpoint | 0 to 10000 | 0 to 100% of system performance |  |

The RTU can confirm that the MPC is operating to the desired setpoint by reading the following Modbus status Registers:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Modbus Register | Bit | Name | Value | Value Description | Comment |
| 00308 | N/A | Actual Setpoint | 0 to 10000 | 0 to 100% of system performance |  |

If the RTU is in Fixed Speed or Remote Manual mode and the MPC Mode Command Fail alarm is not active and the difference between the system performance setpoint for that mode in the RTU and the Actual Setpoint in the MPC is greater than 50 counts (default), then after 10s, a Setpoint Mismatch alarm will be raised and latched. The alarm is reset when the difference is less than or equal to 50 counts.

### MPC action on failure of all installed discharge pressure transmitters

The default action of the MPC system on failure of all installed discharge pressure transmitters while in Constant Pressure mode (i.e. “Fault, Primary Sensor” alarm) is to stop. The RTU will detect failure of all installed discharge pressure transmitters either via the “Fault, Primary Sensor” alarm from the MPC or its own discharge pressure invalid alarm(s), and will place the MPC system into Constant Speed mode.

There is no clear, immediate indication available from the CU352 to the RTU that all installed discharge pressure transmitters have failed. A value of 89 in the Alarm Code register indicates failure of all installed discharge pressure transmitters (primary sensor) while in a mode which relies on monitoring of discharge pressure for control. If the RTU reads 89 in the Alarm Code (or Warning Code) register, the RTU knows that the MPC believes all installed discharge pressure transmitters to be invalid, and the RTU will activate and latch a Primary Sensor Fault alarm in the RTU. If the station is running in a Pressure Control mode, the RTU will change the station mode to Fixed Speed mode.

### Pump action on loss of communications with MPC controller

To allow supply of water to the zone on failure of the MPC Controller (CU352), one or more pumps may be set up to run at min or max speed (internal VSD setting) on loss of Genibus communications with the CU352.

This control is independent of the RTU, and is configured in the pump VSDs themselves.

This is achieved by configuring the relevant VSDs to run (at min or max speed) on activation of VSD digital input 2, and wiring digital input 2 closed so it is always read as on by the VSD.

Due to hierarchy of VSD control signals, the VSD will obey commands from the CU352 while Genibus communications is healthy, and then default to obeying the command from digital input 2 on loss of Genibus communications.

Pumps not required to run on loss of genibus communications do not have digital input 2 (or 3 or 4) configured and/or do not have digital input 2 (or 3 or 4) wired closed.

Note: digital input 1 is the external start/stop input, and must be closed for the pump to run.

### Local Mode

When in local mode, the station is controlled by settings and setpoints entered via the HMI located on the CU 352.

When the station is in Local Mode (Actual Station Mode), the RTU will set the MPC Modbus control registers as follows:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Modbus Register | Bit | Name | Value | Value Description | Comment |
| 00101 | 0 | RemoteAccessReq | 0 | Local | Set Booster to Local Mode |

The RTU can confirm that the MPC is in local mode by reading the following Modbus status Registers:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Modbus Register | Bit | Name | Value | Value Description | Comment |
| 00201 | 8 | AccessMode | 0 | Local | Booster is in Local Mode |

If the RTU is in Local mode and the MPC is not in Local Mode (i.e. AccessMode = Remote), then after 10s, an MPC mode command fail alarm is raised and latched. The alarm is reset when MPC mode settings match current RTU mode.

#### Grundfos MPC Mode

Local mode does not cause the RTU to change the Operation Mode or Control Mode of the MPC, however, these modes may be changed from the HMI.

The RTU continues to write the Operation Mode and Control Mode from the previous station control mode to the MPC, and the values are ignored by the MPC while it is in Local Mode.

**Note: When under HMI (Local) control, the MPC uses a different set of setpoints to those used under Remote (Modbus) control, so a change to HMI control may cause an immediate change to station behaviour (as would a change back to Modbus control).**

### On/Off Control

#### Local Mode

In local Mode, the RTU sets the On/Off Mode to Off. (Modbus values are ignored by the MPC while it is in Local Mode.)

#### Manual Mode

In Manual Mode, If the pump set is available and its process interlocks are healthy (and, where the site has a generator and ATS installed, the Generator Pump inhibit is not active) when the start command is sent from SCADA, the RTU will set the On/Off Mode to On. If the pump set becomes unavailable, its process interlocks become unhealthy, the Generator Pump inhibit is active (where the site has a generator and ATS installed), or the stop command is sent from SCADA, the RTU will set the On/Off Mode to Off.

#### Pressure Control Mode or Fixed Speed Mode

In Pressure Control or Fixed Speed Modes, the MPC system will be requested to run (On/Off Mode set to On) if all of the following conditions are met:

1. The MPC pump set is available,
2. The MPC pump set process interlocks are healthy
3. If the site has a generator and ATS installed, the Generator Pump inhibit is not active
4. The suction pressure is valid AND the suction pressure low low alarm is not active, OR The suction pressure is invalid.

#### Grundfos MPC Mode

Depending on whether the booster is to run or stop, the RTU will set the MPC Modbus control registers as follows:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Modbus Register | Bit | Name | Value | Value Description | Comment |
| 00101 | 1 | OnOffReq | 1/0 | On/Off | Turn booster on/off |

The RTU can confirm that the MPC is in the required state by reading the following Modbus status Registers:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Modbus Register | Bit | Name | Value | Value Description | Comment |
| 00201 | 9 | OnOff | 1/0 | On/Off | Booster is on/off |

If the OnOff status value does not match the OnOffReq control value, then after 10s, an MPC mode command fail alarm is raised and latched. The alarm is reset when settings match.

### MPC Alarm Reset

In any mode except local mode, an operator can attempt to reset an MPC alarm via the “MPC Alarm Reset” button in SCADA.

In any mode except local mode, when this command is received from SCADA, the RTU will set the MPC Modbus control registers as follows:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Modbus Register | Bit | Name | Value | Value Description | Comment |
| 00101 | 2 | ResetAlarm | 1 | Resetting Alarm |  |

The Modbus command is sent only once. (Command is resent if “MPC Alarm Reset” button in SCADA is clicked again.)

Note: Sending an MPC Alarm Reset command from SCADA while in any mode will reset MPC alarms latched in the RTU.

### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| NIL |  |  |

### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| NIL |  |  |

### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| NIL |  |  |

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| NIL |  |  |  |  |  |

### Calculations and Statistics

|  |  |
| --- | --- |
| Point | Description |
| NIL |  |

### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| NIL |  |  |  |  |

## Generator and Auto-Transfer Switch

An optional upgrade to a water booster station is to have a semi-permanently connected generator that automatically runs the station on generator supply following an Energex power failure. This upgrade provides an automatic transfer switch (ATS) to disconnect Energex and connect the generator. Extra physical I/O and SCADA alarms are configured in the RTU to provide feedback on the status of the semi-permanent generator.

Note: If this Option is not enabled then a permanent generator is not implemented and the switchboard will have a generator connection cubicle to provide for quick connection of a mobile generator during extended power outages. The non-permanent generator is manually operated and supplies power via a generator circuit breaker that is mechanically interlocked with the Energex circuit breaker. The water booster station will operate normally while the site power is supplied from the generator.

### Transition from Energex to Generator

When the station loses Energex power, the generator will start automatically after a 30 second delay. Once the generator has been running for a defined period of time (*Start-up Time* typically 2 minutes) then the auto-transfer switch will automatically change from Energex supply to Generator supply.

The pumps, if running (which is likely for a water booster), would have stopped on the loss of Energex supply. Once the generator has been running for at least 2 min (to allow it to warm up), the station will resume normal operation on Generator supply, starting the MPC system as required.

### Transition from Generator Back to Energex

When stable Energex supply has been restored to the station, defined by a site-specific time (default 2 minutes), the auto-transfer switch will automatically change from Generator supply back to Energex supply.

As the Generator supply and the Energex supply will not be synchronised, all pumps will be stopped at least 25 seconds before the auto-changeover is expected (which allows for ramp down). This function is implemented to prevent cumulative damage to the VSDs that would be caused by transferring to an ‘out of phase’ supply. Additionally, this function will ensure that the pump circuit breaker does not trip due to any back EMF generated.

Once the changeover has occurred, the station must be on Energex supply for 30 seconds before the pumps are allowed to start.

To prevent the ATS from performing multiple changeovers in a short time frame (which can be caused by ‘noisy’ Energex supply), the following delay in changeover is also implemented:

ATS transfer back to Energex is only permitted once every 10 minutes. This is achieved by activating the Generator Exercise digital output for 10 minutes if Energex supply failure is detected within 10 minutes of the previous changeover. The activation of this digital output will ensure that the Energex supply is not detected as healthy for at least 10 minutes since the last changeover.

The RTU shall implement the above by monitoring the site mains fail alarm relay (PFRS) to determine the stability of the Energex supply.

### Summary: pump inhibit during generator transfer

Pump inhibit is active if:

1. if ATS is in normal mode and
   1. ATS has been in Normal Mode for less than 30s; or
   2. ATS transfer to Generator is expected: i.e. Energex has failed (or Generator Exercise digital output is active), and the generator is running, and it is 25s or less until the ATS will transfer.
2. or ATS is not in normal mode and
   1. The generator has been running for less than 2 min; or
   2. ATS transfer to Normal Position is expected: i.e. Energex power is healthy (and Generator Exercise digital output is not active), and it is 25s or less until the ATS will transfer.

### Generator Exercise Sequence

For the semi-permanent generator connection, the control room operator can test the generator by sending a “Generator Test Start” command. This command will activate the generator test sequence which will energise the Generator Exercise relay to simulate an Energex failure. The test will ensure that the generator will start, the ATS will switch and the generator is capable of running the pump set. There are numerous checks during the sequence to ensure correct operation. The failure of any of these checks will raise the generator test fail alarm.

Note: Sequence entry and abort conditions are listed below.

#### Test Sequence Steps

| **Test Step** | **Description** | **Action** | **Advance to Next Step if** | **Failure** |
| --- | --- | --- | --- | --- |
| Step 0 | Waiting for Test Start | Control room operator attempts to start the test by sending the “Generator Test Start” command. | All entry conditions are satisfied (including no abort conditions active) | If all entry conditions (including no abort conditions active) are not satisfied, the test is aborted and the test fail alarm is raised. The “Last test failed – entry conditions” flag is set. |
| Step 1 | Waiting for Generator to start | On entering Step 1, RTU energises the Generator Exercise Relay.  An Energex power failure will be detected by the ATS, which will start the generator after Gen startup time (30s). **This is NOT controlled by the RTU.** | Generator Run DI Signal Received within (Gen Start-up Time(30s) + 15s) = 45s of entering the step. | If the generator running signal is not received by this time, the test is aborted and the test fail alarm is raised. The “Last test failed – generator failed to start” flag is set. |
| Step 2 | Waiting for ATS to Switch to Generator | The RTU stops the MPC system, to allow ramp down of pumps prior to ATS changeover. (lockout time is 25s)  The ATS will switch to generator power. **This is NOT controlled by the RTU.** | ATS has switched to Generator (i.e. Transfer switch normal mode digital input is off) within (ATS Transfer to Generator Time (120s) + 15s) = 135s of entering the step. | If the ATS has failed to switch to generator after this time, then the test is aborted and the test fail alarm is raised**.** The “Last test failed – ATS Fail to switch to generator” flag is set. |
| Step 3 | Wait for pumps to start | Once the generator has been running for 2min, the RTU will command the MPC system to start. The MPC system will not necessarily run a pump, but it is very likely that it will do so. | A pump is running within (Gen Start to Pump Run Time (120s) - ATS Transfer to Generator Time (120s) + Pump Startup time (60s) = 60s of entering the step  Note: if (Gen Start to Pump Run Time - ATS Transfer to Generator Time) < 0, the subtraction is clamped to 0. | If a pump is not running after this time, the test is aborted and the test fail alarm is raised. The “Last test failed – MPC pump fail to run” flag is set. |
| Step 4 | Run station on generator for Time | The station shall run on generator for the specified Generator Test Run Time (30min). | *Generator Test Run Time* (30min). has elapsed | While in step 4, if the MPC system becomes unavailable, then the test is aborted and the test fail alarm is raised**.** The “Last test failed – MPC not available” flag is set. |
| Step 5 | Wait for ATS to return to Energex | On entering Step 5, The RTU will De-energise the generator exercise relay.  The RTU stops the MPC system prior to ATS changeover (lockout time is 25s), to allow ramp down of pumps. Pumps will not be allowed to start again until ATS is in Normal Mode for 30s.  After the 120 seconds has elapsed since the generator exercise relay is deactivated, the ATS controller will transfer back to Energex power. **This is NOT controlled by the RTU.** | ATS normal mode DI is active, within Mains OK to ATS Transfer Delay (120s) + 15s = 135s of entering the step | Check that ATS normal mode DI is active within this time otherwise, the test is aborted and the test fail alarm is raised**.** The “Last test failed – ATS fail to return to Energex” flag is set. |
| Step 6 | Wait for Generator to Stop | Once the ATS has switched back to Energex, the generator will continue to run for 300 seconds. | generator running signal (to the RTU) deactivates within generator run-on time (300s) + 30s (to allow for generator ramp down) = 330s of entering the step | If generator running signal (to the RTU) does not deactivate within this time then the test is aborted and the test fail alarm is raised**.** The “Last test failed – Generator Fail to Stop” flag is set. |

***Other Faults***

**If the generator running signal is lost while in steps 2 to 5,** the test is aborted and the test fail alarm is raised**.** The “Last test failed – Generator Premature Stop” flag is set.

In addition, **if the ATS returns to normal while in steps 3 or 4,** the test is aborted and the test fail alarm is raised. The “Last test failed – Premature Return to Energex flag is set.

**If the station mains power fail alarm activates in step 3, 4 or 5 (i.e. while the ATS is not in normal mode),** the test is aborted and thetest fail alarm is raised**.** The “Last test failed – Generator Power Fail” flag is set.

***Entry Conditions***

In addition to any of the abort conditions below, the RTU will not commence the generator exercise test if any of the following entry conditions are true:

* MPC All Pumps Unavailable (calculated in RTU) is active
* MPC Mode Command Fail Alarm is active
* MPC Setpoint Mismatch Alarm is active
* Station Mains Power (I.e. DI status, on pump side of ATS) is not healthy
* The MPC pump set is not available
* Discharge pressure is low (active transmitter low alarm is active)

***Abort Conditions***

The generator exercise test will abort if it is running and any of the following abort conditions are true:

* A stop request has been issued by the SCADA master station
* Energex Mains Power (i.e. DI status) is not heathy
* Generator fault is active
* ATS and generator not in auto fault is active
* generator CBs not closed
* generator low fuel is active
* generator not onsite fault is active
* Station Emergency (OR Control) Stop is active
* Station is in Local Mode
* Station is in Local Fire Mode
* Station is in Remote Fire Mode
* Station is in Remote Manual Mode
* RTU suction pressure low low (run dry protection) alarm is active
* Active Discharge pressure is:
  + high,
  + low (and at least one pump has been running for more than the pressure alarm inhibit delay time [default 15 seconds]) or
  + invalid (i.e. all installed discharge pressure transmitters are invalid.)
* MPC primary sensor fault is active
* MPC CU352 Internal Fault
* MPC CIM Fault
* MPC Communications Fail Alarm
* Any generator test failed flag is active

If the test is aborted at any time, the test sequence de-energises the generator exercise relay, the test fail alarm is raised, and the sequence exits immediately.

The below alarms are active outside the generator test sequence, and will alert the operator if the ATS does not return to Energex power or the generator does not stop following an aborted test. (see Alarm and Events section for more detail).

* ATS Fail to return to Energex
* Generator Fail to Stop

In addition, pump inhibit logic, used to prevent damage to pump starters when swapping between non-synchronised Energex and generator supplies, is active at all times, and so will protect pump starters even after the generator test sequence has aborted.

***Last Test Failed Flags***

These flags will be set on exit from the generator test sequence if it does not complete successfully:

1. Test not Started (Entry Conditions not met)
2. Generator Fail to Start
3. Generator Premature Stop
4. ATS fail to switch to generator
5. ATS premature return to Energex
6. Generator power fail
7. MPC Not available
8. MPC pump fail to run
9. ATS fail to return to Energex
10. Generator fail to stop
11. Test Stopped by Operator
12. Other Abort Condition

### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| gen1Exercise | Generator Exercise Relay | DO |

### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| Generator Last Test Failed | 1 | See description below. |
| Generator Last Test Failed - Test not Started (Entry Conditions not met) | Event | See description below. |
| Generator Last Test Failed - Generator Fail to Start | Event | See description below. |
| Generator Last Test Failed - Generator Premature Stop | Event | See description below. |
| Generator Last Test Failed - ATS fail to switch to generator | Event | See description below. |
| Generator Last Test Failed - ATS premature return to Energex | Event | See description below. |
| Generator Last Test Failed - MPC Not available | Event | See description below. |
| Generator Last Test Failed – Generator Power Fail | Event | See description below. |
| Generator Last Test Failed - MPC pump fail to run | Event | See description below. |
| Generator Last Test Failed - ATS fail to return to Energex | Event | See description below. |
| Generator Last Test Failed - Generator fail to stop | Event | See description below. |
| Generator Last Test Failed - Test Stopped by Operator | Event | See description below. |
| Generator Last Test Failed - Other Abort Condition | Event | See description below. |
| Generator Test Sequence Active | Event | See description below. |
| Generator Failed to Start | 1 | See description below. |
| ATS Fail to Transfer to Generator | 1 | See description below. |
| ATS Fail to Return to Energex | 1 | See description below. |
| Generator Fail to Stop | 1 | See description below. |
| Generator Exercise Relay Active | Event | See description below. |
| Generator Pump Inhibit | Event | See description below. |
| Energex Lockout Active | Event | See description below. |

#### Last Test Failed and Cause Statuses

For semi-permanent generator connection, the control room operator can test the generator by sending a ‘Generator Test Start’ command. The test will simulate an Energex failure. If anything in the sequence does not operate as expected, or the test is stopped by the operator, an alarm is raised. For a full description of the generator test failed alarm and the associated test sequence fault indicators refer to section 4.5.4 Generator Exercise Sequence.

#### Generator Fail to Start

The Generator Fail to Start alarm is active if Energex Power (digital input) has been unhealthy, or the Generator Exercise digital output active, for 75s and the generator is not running.

This alarm is latched and requires a Generator Alarm Reset from SCADA to clear.

#### ATS Fail to Transfer to Generator

The ATS Fail to Transfer to Generator alarm is active if Energex Power (digital input) has been unhealthy, or the Generator Exercise digital output active, for 135s AND the ATS is in Normal Mode (or the ATS is not in normal mode and stations mains power (digital input) is not healthy) AND the Generator Fail to start alarm is not active.

This alarm is latched and requires a Generator Alarm Reset from SCADA to clear.

#### ATS Fail to Return to Energex

The ATS Fail to Return to Energex alarm is active if Energex Power (digital input) is healthy and the Generator Exercise digital output not active, for 65s and the ATS is not in Normal Mode.

This alarm is latched and requires a Generator Alarm Reset from SCADA to clear.

#### Generator Fail to Stop

The Generator Fail to Stop alarm is active if Energex Power (digital input) is healthy and the Generator Exercise digital output not active, for 245s and the ATS Fail to return to Energex alarm is not active and the generator is running.

This alarm is latched and requires a Generator Alarm Reset from SCADA to clear.

#### Generator Exercise Relay Active

RTU is activating the Generator Exercise Relay.

#### Generator Pump Inhibit

Pumps are being prevented from running in preparation for ATS transfer. See section 4.5.2 Transition from Generator Back to Energex.

#### Energex Lockout Active

The RTU is activating the Generator Exercise Relay to prevent restoration of Energex power being detected by the ATS. See section 4.5.2 Transition from Generator Back to Energex.

### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| Delay between Energex fail and Generator Start | 30 | s |
| Delay between Gen start and ATS Transfer to Generator | 120 | s |
| Delay between Gen start and Pump Run | 120 | s |
| Delay between Energex Restore and ATS Transfer to Normal | 120 | s |
| Pre ATS changeover pump lockout delay before transfer | 25 | s |
| Delay between ATS return to Normal and Pump Run | 30 | s |
| Energex lockout window (Generator Exercise Relay activated if Energex fails within this time after ATS returns to normal) | 600 | s |
| Energex Lockout duration (Generator Exercise Relay activated for this time if Energex fails within the Energex lockout window) | 600 | s |
| Delay between ATS return to Normal and generator stop | 300 | s |
| Gen Test Pump Startup Time | 60 | s |
| Gen Test Generator Run Time | 1800 | s |

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| NIL |  |  |  |  |  |

### Calculations and Statistics

|  |  |
| --- | --- |
| Point | Description |
| NIL |  |

### SCADA Points

| Point | Type | Units | Digital Alarm/Event | Analog Event Logging |
| --- | --- | --- | --- | --- |
| Generator Test Start | Digital Control |  |  |  |
| Generator Test Stop | Digital Control |  |  |  |
| Generator Alarm Reset | Digital Control |  |  |  |
| Generator Last Test Failed | Digital Status |  | Alarm(1) |  |
| Generator Last Test Failed - Test not Started (Entry Conditions not met) | Digital Status |  | Event |  |
| Generator Last Test Failed - Generator Fail to Start | Digital Status |  | Event |  |
| Generator Last Test Failed - Generator Premature Stop | Digital Status |  | Event |  |
| Generator Last Test Failed - ATS fail to switch to generator | Digital Status |  | Event |  |
| Generator Last Test Failed - ATS premature return to Energex | Digital Status |  | Event |  |
| Generator Last Test Failed - MPC Not available | Digital Status |  | Event |  |
| Generator Last Test Failed – Generator Power Fail | Digital Status |  | Event |  |
| Generator Last Test Failed - MPC pump fail to run | Digital Status |  | Event |  |
| Generator Last Test Failed - ATS fail to return to Energex | Digital Status |  | Event |  |
| Generator Last Test Failed - Generator fail to stop | Digital Status |  | Event |  |
| Generator Last Test Failed - Test Stopped by Operator | Digital Status |  | Event |  |
| Generator Last Test Failed - Other Abort Condition | Digital Status |  | Event |  |
| Generator Test Sequence Active | Digital Status |  | Event |  |
| Generator Failed to Start | Digital Status |  | Alarm(1) |  |
| ATS Fail to Transfer to Generator | Digital Status |  | Alarm(1) |  |
| ATS Fail to Return to Energex | Digital Status |  | Alarm(1) |  |
| Generator Fail to Stop | Digital Status |  | Alarm(1) |  |
| Generator Exercise Relay Active | Digital Status |  | Event |  |
| Generator Pump Inhibit | Digital Status |  | Event |  |
| Energex Lockout Active | Digital Status |  | Event |  |
| Delay between Energex fail and Generator Start | Analog Status | s |  |  |
| Delay between Gen start and ATS Transfer to Generator | Analog Status | s |  |  |
| Delay between Gen start and Pump Run | Analog Status | s |  |  |
| Delay between Energex Restore and ATS Transfer to Normal | Analog Status | s |  |  |
| Pre ATS changeover pump lockout delay before transfer | Analog Status | s |  |  |
| Delay between ATS return to Norm and Pump Run | Analog Status | s |  |  |
| Energex lockout window | Analog Status | s |  |  |
| Energex Lockout duration | Analog Status | s |  |  |
| Delay between ATS return to Normal and generator stop | Analog Status | s |  |  |
| Gen Test Pump Startup Time | Analog Status | s |  |  |
| Gen Test Generator Run Time | Analog Status | s |  |  |

# GENERAL

## Alarms and Events

### Alarm and Event Definitions

Alarms are abnormal occurrences which must be brought to the attention of the control room operator, such as a low zone pressure. In general, events are normal occurrences which occur during healthy operation of the plant, such as a pump starting. However, events can also be used to indicate which of a number of failures contributed to an aggregate alarm.

### SCADA Alarms

#### Unsolicited and Buffered “Events” (Brisbane Sites using DNP3 Communications)

Changes to the value of digital status points sent by the RTU to SCADA via DNP3 can be configured to be unsolicited or buffered events. An unsolicited event will initiate a transmission to the master station, while buffered events are recorded by the RTU and uploaded to the master station when the site is polled by the master station (either periodically or following receipt of an unsolicited event), or when the buffer is full.

Digital status points are categorised in the SCADA master station as Alarms (Priority 1, 2 and 3) and Events. Priority 1 Alarm points are configured as unsolicited events in the RTU, while Priority 2 and 3 alarms and Events are configured as buffered events.

Alarms and events for the station are listed throughout this document and marked as Alarms (Priority 1, 2 and 3) and Events as applicable.

#### Alarm and Event Logging

For alarms, the active and inactive transitions and acknowledge action shall be logged to the alarm log on SCADA. For events, the active and inactive transitions shall be logged to the event log on SCADA.

Pump running signals shall also be trended on SCADA and logged in SCADA history files to allow overlay of other process values.

## Calculations

The RTU performs calculations for both control of the station and analysis of the station's performance. The calculated values are stored in ordinary RTU memory and are lost when the RTU restarts (except for totaliser values, which are stored in retentive memory).

### Data Logging

See section *5.3 Analog Trend Data Logging* below.

## Analog Trend Data Logging

Since the RTU is not in continual communication with SCADA, analog values for which data between polls is to be stored are logged using DNP3 analog events in the RTU and transmitted to UUTS SCADA when the site is polled or when the event buffer has stored a certain number of events.

Historically, DNP3-based RTUs have used Trend-Sampler functionality (configured in the E-configurator software). A sample rate and deviation were specified for each analog point to be logged. At each sample interval the current value was compared with the last recorded value, and if the current value and the last recorded value differed by more than the deviation, the current value was recorded. Logged values were stored in a text file (.csv) in the RTU, for upload by SCADA at the same time as a full poll. Specification of a sample rate meant the rate of data collection could be directly limited, since values could be recorded no faster than this sample rate.

Current QUU requirements dictate that analog events be used for analog data logging. This has the advantage that data values will be returned more frequently, since they will be read on change of state (COS) poll, and not just when a full poll occurs.

Built-in mechanisms exist in the E-configurator for analog event generation based on deviation. Two types of Event Deviations are configurable: Absolute and Integration. Both of these methods of event generation are unsuitable for logging for process signals such as pressures and flows in the context of a water booster using a low-bandwidth communications medium such as the UUTS Trio Radio network. When logging constantly changing (noisy) signals such as pressures and flows at a water booster, these algorithms can record large numbers of events in a short time period and increase site communications traffic to undesirable levels. Without the specification of a sample rate, it is difficult to limit the maximum rate of event logging while still recording data of a reasonable resolution and logging frequency.

Additionally, it is not desirable to use absolute deviation (without any time delay or sampling) for logging of water booster process values since, in practice, the event deviation becomes the resolution of the recorded trend, and unless the deviation is very small (undesirable on a low bandwidth radio network), the trend becomes very blocky and oscillates between adjacent multiples of the deviation.

Given the unsuitability of in-built mechanisms for analog event generation in the context of a water booster using a low-bandwith communications medium, event generation for many analogs is handled by RTU logic.

Only values logged on change (e.g. setpoint feedback, station current mode) and those for which a simple deviation is appropriate (i.e. totaliser values) use inbuilt functionality.

### Code-Based Analog Event Generation Logic

To ensure that a fixed maximum logging rate is enforced on each analog, logic much like that used by the Trend Sampler will be executed in the RTU code. However, this logic will generate DNP3 analog events rather than logging data to a file.

For each analog value to be logged using RTU code, a sample rate and absolute deviation will be supplied via the RTU parameter file, and RTU code will generate analog events.

At each sample interval (1s steps) the current value is compared with the last recorded value, and if the current value and the last recorded value differ by more than the deviation, an analog event will be recorded. In addition, an event will be recorded if the value it is at the minimum or maximum limit of the analog’s range, to prevent trends never reaching minimum or maximum or max values because the deviation has not been breached (e.g. a flow trend never reaching zero).

For each analog value to be logged, at midnight, a sample is taken and the sample interval is restarted, so samples are always taken at multiples of the sample time since midnight.

#### Ad-hoc Event Generation

In addition to the recording of events on deviation, an event can also be triggered in the RTU code if it is desirable that an event be recorded other than by deviation logic.

This functionality is used in the code to log totaliser values just before reset at midnight.

#### Analog Event Settings

The table below shows setting sfor each analog event logged in the RTU.

As discussed above, totalisers, setpoint feedback points and other points to be logged on change of state are logged using the E-configurator software’s inbuilt deviation mechanism. All other points are logged using analog events triggered by RTU code.

| Tag | Unit | Code Sample Rate (s) | Code Deviation | E-Config Event Deviation | E-Config Deviation Type |
| --- | --- | --- | --- | --- | --- |
| Actual Station Mode Status Integer |  |  |  | 0 | Absolute |
| Peer Mode System Loss | m | 60 | 1 | None | None |
| Peer Mode Required Pressure Setpoint (RPS2) | mAHD | 60 | 1 | None | None |
| Scheduled Delivery Mode Required Pressure Setpoint (RPS3) | mAHD |  |  | 0 | Absolute |
| Flow Modulation Mode Required Pressure Setpoint (RPS4) | mAHD |  |  | 0 | Absolute |
| Generator Test Current Test Step |  |  |  | 0 | Absolute |
| MPC Inlet Pressure | mAHD | 60 | 1 | None | None |
| MPC Outlet Pressure | mAHD | 60 | 1 | None | None |
| Operation Mode |  |  |  | 0 | Absolute |
| Control Mode |  |  |  | 0 | Absolute |
| MPC Alarm Register |  |  |  | 0 | Absolute |
| MPC Warning Register |  |  |  | 0 | Absolute |
| MPC Setpoint mAHD | m | 15 | 1 | None | None |
| MPC Setpoint % | % | 15 | 1 | None | None |
| MPC Actual Setpoint mAHD | m | 15 | 1 | None | None |
| MPC Actual Setpoint % | % | 15 | 1 | None | None |
| MPC Relative Performance | % | 60 | 1 | None | None |
| MPC Pump X Pump Alarm Code |  |  |  | 0 | Absolute |
| MPC Pump X Speed | % | 60 | 1 | None | None |
| MPC Pump X Current | A | 60 | 0.1 | None | None |
| MPC Pump X Power | kW | 60 | 0.1 | None | None |
| MPC Pump X Starts Today |  |  |  | 0 | Absolute |
| MPC Pump X Starts Yesterday |  |  |  | 0 | Absolute |
| MPC Pump X Run Hours | Hrs |  |  | 0.25 | Absolute |
| MPC Pump X Run Hours Yesterday | Hrs |  |  | 0 | Absolute |
| Suction Pressure | m | 60 | 1 | None | None |
| Suction Pressure mAHD | mAHD | 15 | 1 | None | None |
| Differential Pressure | m | 60 | 1 | None | None |
| Peer Pressure mAHD | mAHD | 15 | 1 | None | None |
| Delivery Flow | L/s | 15 | 1 | None | None |
| Delivery Flow kL/day | kL/day | 60 | 86.4 | None | None |
| Delivery Flow Volume | kL |  |  | 1 | Absolute |
| Delivery Flow Volume Yesterday | kL |  |  | 0 | Absolute |
| Low Zone/Bypass Flow | L/s | 15 | 1 | None | None |
| Low Zone/Bypass Flow kL/day | kL/day | 60 | 86.4 | None | None |
| Low Zone/Bypass Flow Volume | kL |  |  | 1 | Absolute |
| Low Zone/Bypass Flow Volume Yesterday | kL |  |  | 0 | Absolute |
| Generator Fuel Level | % | 15 | 2 | None | None |
| Wire to Water Efficiency | % | 60 | 0.01 | None | None |
| RTU System Error Register |  |  |  | 0 | Absolute |
| Fixed Speed Mode Current Performance Setpoint | % |  |  | 0 | Absolute |
| Main Delivery Pressure | m | 60 | 1 | None | None |
| Main Delivery Pressure mAHD | mAHD | 15 | 1 | None | None |
| Backup Delivery Pressure | m | 60 | 1 | None | None |
| Backup Delivery Pressure mAHD | mAHD | 15 | 1 | None | None |
| Station Remote Control Mode Select Feedback |  |  |  | 0 | Absolute |
| Delivery Pressure Setpoint Feedback | mAHD |  |  | 0 | Absolute |
| Peer Pressure Setpoint Feedback | mAHD |  |  | 0 | Absolute |
| Scheduled Delivery Window 0 Pressure Setpoint Feedback | mAHD |  |  | 0 | Absolute |
| Scheduled Delivery Window 1 Start Time Feedback | Time |  |  | 0 | Absolute |
| Scheduled Delivery Window 1 Pressure Setpoint Feedback | mAHD |  |  | 0 | Absolute |
| Scheduled Delivery Window 2 Start Time Feedback | Time |  |  | 0 | Absolute |
| Scheduled Delivery Window 2 Pressure Setpoint Feedback | mAHD |  |  | 0 | Absolute |
| Scheduled Delivery Window 3 Start Time Feedback | Time |  |  | 0 | Absolute |
| Scheduled Delivery Window 3 Pressure Setpoint Feedback | mAHD |  |  | 0 | Absolute |
| Scheduled Delivery Window 4 Start Time Feedback | Time |  |  | 0 | Absolute |
| Scheduled Delivery Window 4 Pressure Setpoint Feedback | mAHD |  |  | 0 | Absolute |
| Flow Mode Flow Rate X1 Feedback | L/s |  |  | 0 | Absolute |
| Flow Mode Flow Rate X2 Feedback | L/s |  |  | 0 | Absolute |
| Flow Mode Flow Rate X3 Feedback | L/s |  |  | 0 | Absolute |
| Flow Mode Flow Rate X4 Feedback | L/s |  |  | 0 | Absolute |
| Flow Mode Flow Rate X5 Feedback | L/s |  |  | 0 | Absolute |
| Flow Mode Flow Rate X6 Feedback | L/s |  |  | 0 | Absolute |
| Flow Mode Flow Rate X7 Feedback | L/s |  |  | 0 | Absolute |
| Flow Mode Pressure Setpoint Y0 Feedback | mAHD |  |  | 0 | Absolute |
| Flow Mode Pressure Setpoint Y1 Feedback | mAHD |  |  | 0 | Absolute |
| Flow Mode Pressure Setpoint Y2 Feedback | mAHD |  |  | 0 | Absolute |
| Flow Mode Pressure Setpoint Y3 Feedback | mAHD |  |  | 0 | Absolute |
| Flow Mode Pressure Setpoint Y4 Feedback | mAHD |  |  | 0 | Absolute |
| Flow Mode Pressure Setpoint Y5 Feedback | mAHD |  |  | 0 | Absolute |
| Flow Mode Pressure Setpoint Y6 Feedback | mAHD |  |  | 0 | Absolute |
| Flow Mode Pressure Setpoint Y7 Feedback | mAHD |  |  | 0 | Absolute |
| Flow Mode Flow Hysteresis H1 Feedback | L/s |  |  | 0 | Absolute |
| Flow Mode Flow Hysteresis H2 Feedback | L/s |  |  | 0 | Absolute |
| Flow Mode Flow Hysteresis H3 Feedback | L/s |  |  | 0 | Absolute |
| Flow Mode Flow Hysteresis H4 Feedback | L/s |  |  | 0 | Absolute |
| Flow Mode Flow Hysteresis H5 Feedback | L/s |  |  | 0 | Absolute |
| Flow Mode Flow Hysteresis H6 Feedback | L/s |  |  | 0 | Absolute |
| Flow Mode Flow Hysteresis H7 Feedback | L/s |  |  | 0 | Absolute |
| Flow Mode Hysteresis Delay D1 Feedback | s |  |  | 0 | Absolute |
| Flow Mode Hysteresis Delay D2 Feedback | s |  |  | 0 | Absolute |
| Flow Mode Hysteresis Delay D3 Feedback | s |  |  | 0 | Absolute |
| Flow Mode Hysteresis Delay D4 Feedback | s |  |  | 0 | Absolute |
| Flow Mode Hysteresis Delay D5 Feedback | s |  |  | 0 | Absolute |
| Flow Mode Hysteresis Delay D6 Feedback | s |  |  | 0 | Absolute |
| Flow Mode Hysteresis Delay D7 Feedback | s |  |  | 0 | Absolute |
| Manual System Performance Setpoint Feedback | % |  |  | 0 | Absolute |
| Suction Pressure High Alarm Setpoint Feedback | mAHD |  |  | 0 | Absolute |
| Suction Pressure Low Alarm Setpoint Feedback | mAHD |  |  | 0 | Absolute |
| Suction Pressure Low Low Alarm Setpoint Feedback | mAHD |  |  | 0 | Absolute |
| Delivery Pressure High Alarm Setpoint Feedback | mAHD |  |  | 0 | Absolute |
| Delivery Pressure Low Alarm Setpoint Feedback | mAHD |  |  | 0 | Absolute |
| Peer Pressure High Alarm Setpoint Feedback | mAHD |  |  | 0 | Absolute |
| Peer Pressure Low Alarm Setpoint Feedback | mAHD |  |  | 0 | Absolute |
| Delivery Flow High Alarm Setpoint Feedback | L/s |  |  | 0 | Absolute |
| Delivery Flow Low Alarm Setpoint Feedback | L/s |  |  | 0 | Absolute |
| Low Zone/Bypass Flow High Alarm Setpoint Feedback | L/s |  |  | 0 | Absolute |
| Low Zone/Bypass Flow Low Alarm Setpoint Feedback | L/s |  |  | 0 | Absolute |

### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| NIL |  |  |

### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| NIL |  |  |

### Parameters and Setpoints

**Parameters**

Note: These parameters are not passed through to SCADA.

| Parameter | Default | Units |
| --- | --- | --- |
| Backup Delivery Pressure mAHD Trend Deviation | 1 | mAHD |
| Backup Delivery Pressure mAHD Trend Sample Rate | 15 | s |
| Backup Delivery Pressure Trend Deviation | 1 | m |
| Backup Delivery Pressure Trend Sample Rate | 60 | s |
| Delivery Flow kL/day Trend Deviation | 86.4 | kL/day |
| Delivery Flow kL/day Trend Sample Rate | 60 | s |
| Delivery Flow Trend Deviation | 1 | L/s |
| Delivery Flow Trend Sample Rate | 15 | s |
| Differential Pressure Trend Deviation | 1 | m |
| Differential Pressure Trend Sample Rate | 60 | s |
| Generator Fuel Level Trend Deviation | 2 | % |
| Generator Fuel Level Trend Sample Rate | 15 | s |
| Low Zone/Bypass Flow kL/day Trend Deviation | 86.4 | kL/day |
| Low Zone/Bypass Flow kL/day Trend Sample Rate | 60 | s |
| Low Zone/Bypass Flow Trend Deviation | 1 | L/s |
| Low Zone/Bypass Flow Trend Sample Rate | 15 | s |
| Main Delivery Pressure mAHD Trend Deviation | 1 | mAHD |
| Main Delivery Pressure mAHD Trend Sample Rate | 15 | s |
| Main Delivery Pressure Trend Deviation | 1 | m |
| Main Delivery Pressure Trend Sample Rate | 60 | s |
| MPC Actual Setpoint % Trend Deviation | 1 | % |
| MPC Actual Setpoint % Trend Sample Rate | 15 | s |
| MPC Actual Setpoint mAHD Trend Deviation | 1 | m |
| MPC Actual Setpoint mAHD Trend Sample Rate | 15 | s |
| MPC Inlet Pressure Trend Deviation | 1 | mAHD |
| MPC Inlet Pressure Trend Sample Rate | 60 | s |
| MPC Outlet Pressure Trend Deviation | 1 | mAHD |
| MPC Outlet Pressure Trend Sample Rate | 60 | s |
| MPC Pump X Current Trend Deviation | 0.1 | A |
| MPC Pump X Current Trend Sample Rate | 60 | s |
| MPC Pump X Power Trend Deviation | 0.1 | kW |
| MPC Pump X Power Trend Sample Rate | 60 | s |
| MPC Pump X Speed Trend Deviation | 1 | % |
| MPC Pump X Speed Trend Sample Rate | 60 | s |
| MPC Relative Performance Trend Deviation | 1 | % |
| MPC Relative Performance Trend Sample Rate | 60 | s |
| MPC Setpoint % Trend Deviation | 1 | % |
| MPC Setpoint % Trend Sample Rate | 15 | s |
| MPC Setpoint mAHD Trend Deviation | 1 | m |
| MPC Setpoint mAHD Trend Sample Rate | 15 | s |
| Peer Mode Required Pressure Setpoint (RPS2) Trend Deviation | 1 | mAHD |
| Peer Mode Required Pressure Setpoint (RPS2) Trend Sample Rate | 60 | s |
| Peer Mode System Loss Trend Deviation | 1 | m |
| Peer Mode System Loss Trend Sample Rate | 60 | s |
| Peer Pressure mAHD Trend Deviation | 1 | mAHD |
| Peer Pressure mAHD Trend Sample Rate | 15 | s |
| Suction Pressure mAHD Trend Deviation | 1 | mAHD |
| Suction Pressure mAHD Trend Sample Rate | 15 | s |
| Suction Pressure Trend Deviation | 1 | m |
| Suction Pressure Trend Sample Rate | 60 | s |
| Wire to Water Efficiency Trend Deviation | 0.01 | % |
| Wire to Water Efficiency Trend Sample Rate | 60 | s |

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| NIL |  |  |  |  |  |

### Calculations and Statistics

|  |  |
| --- | --- |
| Point | Description |
| NIL |  |

### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| NIL |  |  |  |  |

## Operator Controls

Copies of all analog operator setpoints and digital selection bits are sent back to the SCADA system as feedback points to allow the control room operator to view the current setpoints being used by the RTU for control of the site.

### Data Logging

All operator digital commands are to be logged to the event log.

All setpoint feedback points shall be trended in SCADA and logged in SCADA history files.

## Setpoint Clamping

Each setpoint that is modifiable from SCADA shall have upper and lower limit values provided in the parameter file.

Where the control value lies outside the upper and lower limits, the control value will be clamped to the nearest limit, and a Setpoint Clamped Alarm will be raised and latched. This is the case whether the control value was sent from SCADA or initialised using a default value in the parameter file.

### Clamping of Time setpoints

Time setpoints are entered as a 4 digit integer value (e.g. 1255 = 12:55pm). The first two digits are clamped to between 00 and 23, and the last two digits clamped between 00 and 59.

### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| NIL |  |  |

### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| Setpoint Clamped Alarm | 1 | If the RTU clamps a setpoint, an alarm will be raised to notify the operator. This alarm is latched and can be reset by the operator from SCADA using the RTU Setpoint Clamped Alarm Reset command. |

### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| NIL |  |  |

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| NIL |  |  |  |  |  |

### Calculations and Statistics

|  |  |
| --- | --- |
| Point | Description |
| NIL |  |

### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| Setpoint Clamped Alarm | Digital Status |  | Alarm(1) |  |
| Setpoint Clamped Alarm Reset | Digital Control |  |  |  |

# EQUIPMENT

## MPC System

### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| stn1MPCOK | MPC Healthy | DI |

### Modbus I/O

The following signals are sent and received by the RTU to/from the MPC Controller via Modbus TCP communications. For details on each signal, refer to Grundfos document “Modbus for Grundfos Booster – 5153608.pdf.

|  |  |
| --- | --- |
| **Name** | **Description** |
| MPC status | On Off  Access Mode (Local, Remote)  Operating Mode (Auto-control, OpenLoopMin, OpenLoopMax)  Control Mode (Constant Pressure, Constant Speed, etc.)  Alarm Flag  Warning Flag  Alarm Code  Warning Code  Actual Setpoint (pressure or speed %)  Inlet Pressure  Outlet Pressure  Relative Performance |
| MPC control | On Off Request  Remote Access Request (Local, Remote)  Operating Mode (Auto-control, OpenLoopMin, OpenLoopMax)  Control Mode (Constant Pressure, Constant Speed, etc.)  Setpoint (pressure or speed %)  Reset alarm command |

### Alarms and Events

The following alarms and events are associated with the MPC system. Refer to section *4.4 MPC Control & Monitoring* for further information.

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| MPC Available | 1 | See description in section 4.3.2. |
| MPC Comms Fail | 1 | See description below. |
| MPC Fault | 1 | See description below. |
| MPC Warning | 2 | See description below. |
| MPC in Remote | Event | See description below. |
| MPC System On | Event | See description below. |
| MPC Mode Command Fail Alarm | 1 | See description below. |
| MPC Setpoint Mismatch Alarm | 1 | See description below. |
| Water Shortage 1 | 2 | See MPC Alarms and Warnings below. |
| Water Shortage 2 | 1 | See MPC Alarms and Warnings below. |
| Pressure High | 1 | See MPC Alarms and Warnings below. |
| Pressure Low | 1 | See MPC Alarms and Warnings below. |
| Pressure Relief | 2 | See MPC Alarms and Warnings below. |
| All Pumps Alarm | 1 | See MPC Alarms and Warnings below. |
| External Fault | 1 | See MPC Alarms and Warnings below. |
| Dissimilar Sensor Signals | 2 | See MPC Alarms and Warnings below. |
| Primary Sensor Fault | 1 | See description below. |
| Sensor Fault | 2 | See MPC Alarms and Warnings below. |
| Communication Fault | 2 | See MPC Alarms and Warnings below. |
| Phase Failure | 2 | See MPC Alarms and Warnings below. |
| Pump Undervoltage | 2 | See MPC Alarms and Warnings below. |
| Pump Overvoltage | 2 | See MPC Alarms and Warnings below. |
| Pump Overload | 2 | See MPC Alarms and Warnings below. |
| Motor Temperature High | 2 | See MPC Alarms and Warnings below. |
| Pump Other Fault | 2 | See MPC Alarms and Warnings below. |
| CU352 Internal Fault | 1 | See MPC Alarms and Warnings below. |
| IO351 Internal Fault | 1 | See MPC Alarms and Warnings below. |
| VFD Not Ready | 2 | See MPC Alarms and Warnings below. |
| Ethernet Fault | 2 | See MPC Alarms and Warnings below. |
| Limit 1 Exceeded | 2 | See MPC Alarms and Warnings below. |
| Limit 2 Exceeded | 2 | See MPC Alarms and Warnings below. |
| Pressure build-up fault | 1 | See MPC Alarms and Warnings below. |
| Pumps outside Duty Range | 2 | See MPC Alarms and Warnings below. |
| Pilot Pump Fault | 2 | See MPC Alarms and Warnings below. |
| MPC CIM Fault | 1 | See description below. |
| All Pumps Unavailable | 1 | This alarm indicates that all station pumps are unavailable (i.e. available alarm is unhealthy for all enabled pumps) (see description for individual pump available alarms in next section) |

#### Communications fail alarm

This alarm indicates that Modbus communications between the RTU and CU352 have failed.

The health of Modbus communications can be checked by reading the Device Communication Status register for the Modbus Slave Device in the RTU.

The MPC Communications Fail alarm is activated if the value of the Device Communication Status register for the Modbus Slave Device is not equal to 4 (4 = Device is online) for the Modbus fault delay time. (default 60s).

#### MPC Fault

This alarm indicates that the MPC controller is registering a fault condition, either via the Modbus alarm bit or the hardwired MPC fault digital input. The Modbus alarm bit is ignored if the Modbus Communications Fault Alarm is active. The hardwired fault signal is de-bounced in the RTU using the MPC controller hardwired fault delay (default 2 sec).

The MPC Fault alarm is suppressed if the station mains power healthy digital input is not healthy.

The RTU receives the MPC alarm status by reading the following Modbus status Registers:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Modbus Register | Bit | Name | Value | Value Description | Comment |
| 00201 | 10 | Alarm | 1 | Alarm | 0 = No Alarm |

#### Warning

This is indicated by the status of the Modbus warning bit. This alarm is suppressed by the MPC Fault Alarm, or if the Modbus Communications Fault Alarm is active.

The RTU receives the MPC warning status by reading the following Modbus status Registers:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Modbus Register | Bit | Name | Value | Value Description | Comment |
| 00201 | 11 | Warning | 1 | Warning | 0 = No Warning |

#### MPC System On

The MPC System On event is a copy of the OnOff bit, received by the RTU from the MPC via Modbus.

The RTU receives the MPC On/Off status by reading the following Modbus status Registers:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Modbus Register | Bit | Name | Value | Value Description | Comment |
| 00201 | 9 | OnOff | 1 | On | 0 = Off |

#### MPC in Remote

The MPC in Remote event is a copy of the AccessMode bit, received by the RTU from the MPC via Modbus.

The RTU receives the AccessMode status by reading the following Modbus status Registers:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Modbus Register | Bit | Name | Value | Value Description | Comment |
| 00201 | 8 | AccessMode | 0 | Local | Booster is in Local Mode |

#### MPC Mode Command Fail Alarm

If the RTU is in a given mode and the MPC status registers do not match those listed above in each mode description (see section 4.4), then after 15s (default), an MPC mode command fail alarm is raised and latched. The alarm is reset when MPC mode settings match current RTU mode.

#### Setpoint Mismatch Alarm

If the station is in any mode but Local Mode, the MPC Mode Command Fail Alarm is not active, and the difference between the current mode setpoint in the RTU and the actual setpoint in the MPC is greater than 50 counts (default), then after 15s (default), a setpoint mismatch alarm will be raised and latched. The alarm is reset when the difference is less than or equal to 50 counts (default).

e.g. :

* + - 1. While a pressure control mode is selected, the operator pressure setpoint (minus elevation) is compared with the MPC setpoint.
      2. While Fixed Speed Mode or Remote Manual Mode is selected, the system performance setpoint is compared with the MPC setpoint.

Note: the deadband is necessary because the actual setpoint feedback from the MPC may not exactly match the control variable, even when the system is successfully controlling to the supplied setpoint.

#### Fault, Primary Sensor (MPC Discharge Pressure Monitoring Fault)

The alarm is raised and latched if the MPC system indicates a primary feedback device failure.

Note: there is no clear, immediate indication available from the CU352 to the RTU that the MPC considers all installed discharge pressure transmitters to have failed. The RTU can only detect this failure using alarm/warning codes provided by the MPC system.

The RTU can detect that the MPC considers all installed discharge pressure transmitters to have failed while the CU352 is operating in a pressure control mode if the code in the alarm or warning register is 89 (as per “Signal fault, primary sensor” alarm in the MPC Alarms and Warnings table below).

#### CIM Fault

This alarm indicates a fault with the CIM (Communications Interface Module) the RTU uses to communicate with the CU352.

If the alarm code in the alarm register is 159, this alarm is raised and latched.

#### MPC Alarms and Warnings

The following MPC Alarms and Warnings are derived from the Alarm Codes.

In each case, if any of the alarm codes for the relevant alarm as shown in the below table (e.g. water shortage 1 alarm code is 206), are shown in the Alarm code register, then the Alarm/Warning is raised and latched.

Provided the Alarm code is not present in the Alarm register, these alarms can be reset via the MPC Alarm Reset command from SCADA.

Note: In the case of “Fault, Primary Sensor.”, the warning register is also monitored for the matching alarm code.

### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| MPC Communications Fault Delay | 15 | s |
| MPC controller hardwired fault delay | 2 | s |
| MPC/RTU Control Mode and Setpoint Mismatch Alarm Delay | 30 | s |
| MPC/RTU Setpoint Mismatch Alarm Deadband | 50 |  |
| MPC Inlet Pressure Offset\* | -1000 | counts |

\*This parameter not fed back to SCADA

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| NIL |  |  |  |  |  |

### Calculations and Statistics

The following values are read from the MPC CU352 unit via the Modbus interface.

|  |  |
| --- | --- |
| Point | Description |
| Operation Mode | Actual MPC Operating Mode. Copy of MPC Modbus register 204. (0: Auto-control) |
| Control Mode | Actual MPC Control Mode. Copy of MPC Modbus register 203. (0: Constant Speed, 4: Constant Pressure) |
| MPC Alarm Register | Copy of MPC Modbus register 205 |
| MPC Warning Register | Copy of MPC Modbus register 206 |
| MPC Setpoint mAHD | Current Setpoint in the RTU being sent to the MPC, Modbus register 104. (% of closed-loop feedback sensor range, scaled to mAHD) |
| MPC Setpoint % | Current Setpoint in the RTU being sent to the MPC, Modbus register 104. (% of total system performance) |
| MPC Actual Setpoint mAHD | Actual setpoint being used in the MPC to control the pump set. From MPC Modbus register 308. (% of closed-loop feedback sensor range, scaled to mAHD) |
| MPC Actual Setpoint % | Actual setpoint being used in the MPC to control the pump set. From MPC Modbus register 308. (% of total system performance) |
| MPC Relative Performance | MPC System Output in %. From MPC Modbus register 303.  Note: from observation on site, this value seems to approximately equal the current speed of running pumps. (i.e If one pump is running at 70%, or all pumps are running at 70%, the relative performance will be about 70%). |
| MPC Inlet Pressure | Suction Pressure as determined by the MPC. From MPC Modbus register 315.  Note: For whatever reason, register 315 shows 1000 for 0 bar and 11000 for 10 bar rather than 0 and 10000 as the “0.001 bar” Scale stated in “Modbus for Grundfos Booster – 5153608.pdf” might suggest. Hence, an offset value (default -1000) is applied to the raw modbus register value prior to applying the scaling factor. |
| MPC Outlet Pressure | Discharge Pressure from the active discharge pressure transmitter, as determined by the MPC. From MPC Modbus register 341.  Note: Unlike for MPC Inlet Pressure above, register 341 shows 0 for 0 bar and 10000 for 10 bar as would be expected from the “0.001 bar” Scale stated in “Modbus for Grundfos Booster – 5153608.pdf”. |

### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| MPC Available | Digital Status |  | Alarm(1) |  |
| MPC Comms Fail | Digital Status |  | Alarm(1) |  |
| MPC Fault | Digital Status |  | Alarm(1) |  |
| MPC Warning | Digital Status |  | Alarm(2) |  |
| MPC in Remote | Digital Status |  | Event |  |
| MPC System On | Digital Status |  | Event |  |
| MPC Mode Command Fail Alarm | Digital Status |  | Alarm(1) |  |
| MPC Setpoint Mismatch Alarm | Digital Status |  | Alarm(1) |  |
| Water Shortage 1 | Digital Status |  | Alarm(2) |  |
| Water Shortage 2 | Digital Status |  | Alarm(1) |  |
| Pressure High | Digital Status |  | Alarm(1) |  |
| Pressure Low | Digital Status |  | Alarm(1) |  |
| Pressure Relief | Digital Status |  | Alarm(2) |  |
| All Pumps Alarm | Digital Status |  | Alarm(1) |  |
| External Fault | Digital Status |  | Alarm(1) |  |
| Dissimilar Sensor Signals | Digital Status |  | Alarm(2) |  |
| Primary Sensor Fault | Digital Status |  | Alarm(1) |  |
| Sensor Fault | Digital Status |  | Alarm(2) |  |
| Communication Fault | Digital Status |  | Alarm(2) |  |
| Phase Failure | Digital Status |  | Alarm(2) |  |
| Pump Undervoltage | Digital Status |  | Alarm(2) |  |
| Pump Overvoltage | Digital Status |  | Alarm(2) |  |
| Pump Overload | Digital Status |  | Alarm(2) |  |
| Motor Temperature High | Digital Status |  | Alarm(2) |  |
| Pump Other Fault | Digital Status |  | Alarm(2) |  |
| CU352 Internal Fault | Digital Status |  | Alarm(1) |  |
| IO351 Internal Fault | Digital Status |  | Alarm(1) |  |
| VFD Not Ready | Digital Status |  | Alarm(2) |  |
| Ethernet Fault | Digital Status |  | Alarm(2) |  |
| Limit 1 Exceeded | Digital Status |  | Alarm(2) |  |
| Limit 2 Exceeded | Digital Status |  | Alarm(2) |  |
| Pressure build-up fault | Digital Status |  | Alarm(1) |  |
| Pumps outside Duty Range | Digital Status |  | Alarm(2) |  |
| Pilot Pump Fault | Digital Status |  | Alarm(2) |  |
| MPC CIM Fault | Digital Status |  | Alarm(1) |  |
| All Pumps Unavailable | Digital Status |  | Alarm(1) |  |
| MPC Alarm Reset | Digital Control |  |  |  |
| MPC Communications Fault Delay | Analog Status | s |  |  |
| MPC controller hardwired fault delay | Analog Status | s |  |  |
| MPC/RTU Control Mode and Setpoint Mismatch Alarm Delay | Analog Status | s |  |  |
| MPC/RTU Setpoint Mismatch Alarm Deadband | Analog Status |  |  |  |
| Operation Mode | Analog Status |  |  | Y |
| Control Mode | Analog Status |  |  | Y |
| MPC Alarm Register | Analog Status |  |  | Y |
| MPC Warning Register | Analog Status |  |  | Y |
| MPC Setpoint mAHD | Analog Status | mAHD |  | Y |
| MPC Setpoint % | Analog Status | % |  | Y |
| MPC Actual Setpoint mAHD | Analog Status | mAHD |  | Y |
| MPC Actual Setpoint % | Analog Status | % |  | Y |
| MPC Relative Performance | Analog Status | % |  | Y |
| MPC Inlet Pressure | Analog Status | mAHD |  | Y |
| MPC Outlet Pressure | Analog Status | mAHD |  | Y |

## MPC Pumps

### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| pmp1VFDHealthy | MPC Pump 1 VFD Healthy | DI |
| pmp2VFDHealthy | MPC Pump 2 VFD Healthy | DI |
| pmp3VFDHealthy | MPC Pump 3 VFD Healthy | DI |
| pmp4VFDHealthy | MPC Pump 4 VFD Healthy | DI |
| pmp5VFDHealthy | MPC Pump 5 VFD Healthy | DI |
| pmpPVFDHealthy | MPC Pilot Pump VFD Healthy | DI |

### Modbus I/O

The following signals are sent and received by the RTU to/from the MPC Controller via Modbus TCP communications. For details on each signal, refer to Grundfos document “Modbus for Grundfos Booster – 5153608.pdf”.

|  |  |
| --- | --- |
| **Name** | **Description** |
| MPC pump status (for each pump) | Pump Present (MPC)  Pump Fault (MPC)  Comms Fault (MPC)  Auto Mode Selected (MPC)  Access Mode (Local, Remote) (Pump)  Fault (Pump)  Running (Pump)  Alarm Code (Pump)  Speed (Pump)  Line Current (Pump)  Power (Pump) |

### Alarms and Events

Note: The following assumes that the pumps are assigned as Pump 1, Pump 2, Pump 3, Pump 4, Pump 5 and Pilot Pump. If these designations change, the RTU programmer will need to use the appropriate Modbus registers.

Each of the Alarms/events designated Pump X in the table below apply to Pumps 1-5 and the Pilot Pump.

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| MPC Pump X Available Alarm | 2 | See description below. |
| MPC Pump X Running | Event | See description below. |
| MPC Pump X Present | Event | Copy of Modbus status bit. |
| MPC Pump X Pump Fault (MPC) | Event | Copy of Modbus status bit. |
| MPC Pump X Comms Fault\* | 1 | Copy of Modbus status bit. |
| MPC Pump X Auto Mode | Event | Copy of Modbus status bit. |
| MPC Pump X Access Mode | Event | Copy of Modbus status bit. |
| MPC Pump X Pump Fault (Pump) | Event | Copy of Modbus status bit. |
| MPC Pump X VSD Healthy | Event | See description below. |

\*MPC Pump X Comms Fault is Priority 1 since the pump VSD may be trying to run independently of the CU352.

#### Available

An MPC pump is available if the MPC pump is present, is not faulted (via hardwired RTU input or Modbus flags), and is properly configured to run under control of the MPC controller as a part of the pump set, as detected via Modbus flags.

The following conditions must be met for a pump to be available:

* Pump is present
* Pump is not faulted (either from MPC’s or pump’s point of view)
* Pump communication fault not active
* Pump is in auto-control mode
* Pump is in Remote Mode
* Hardwired VSD Healthy digital input (debounced with 2s off delay) is active
* Station Mains power (Downstream of ATS) is healthy (RTU Digital Input).
* Station emergency (OR control) stop not active (RTU Digital Input)
* MPC Communication Fault Alarm not active

The RTU receives the MPC’s interpretation of pump statuses by reading the following Modbus status Registers:

Note:

Bit 0: Pump 1

Bit 1: Pump 2

Bit 2: Pump 3

Bit 3: Pump 4

Bit 4: Pump 5

Bit 5: Pump 6 (Not applicable)

Bit 6: Pilot pump

Bit 7: Back-up pump (Not applicable)

If any of the values are as shown below, the relevant pump will not be available.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Modbus Register | Bit | Name | Value | Value Description | Comment |
| 00208 | X | PumpsPresent | 0 | NOT Present | 1 = Present |
| 00210 | X | PumpsFault | 1 | Pump has alarm |  |
| 00211 | X | PumpsCommsFault | 1 | Pump has comms error |  |
| 00213 | X | PumpsAutoMode | 0 | Pump NOT in auto control mode | 1 = Pump in auto control mode |

The RTU receives pumps statuses from the pumps themselves by reading the following Modbus status Registers.

Note:

Register 00401: Pump 1

Register 00411: Pump 2

Register 00421: Pump 3

Register 00431: Pump 4

Register 00441: Pump 5

Register 00451: Pump 6 (Not applicable)

Register 00461: Pilot pump

Register 00471: Back-up pump (Not applicable)

If any of the values are as shown below, the relevant pump will not be available. (Pump 1 registers shown)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Modbus Register | Bit | Name | Value | Value Description | Comment |
| 00401 | 0 | AccessMode | 0 | Local | 1 = Remote (Controlled by Booster System) |
| 00401 | 2 | Fault | 1 | Fault | 0 = No Fault |

The pump unavailable alarm is for information only, since the CU352 handles pump control.

#### Running

This event indicates that the corresponding MPC pump is running, and mirrors the pump’s running Modbus flag.

Where the MPC Communications Fail alarm is active, or station mains power (downstream of ATS) is not healthy (digital input status), this status will be set to false.

The RTU receives pump running statuses by reading the following Modbus status Registers:

Note: Register 00401: Pump 1, etc. as above.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Modbus Register | Bit | Name | Value | Value Description | Comment |
| 00401 | 1 | Running | 1 | On | 0 = Off |

#### VSD Healthy

This event is active if the corresponding MPC pump’s hardwired healthy RTU digital input is active. The event is deactivated when the RTU digital input is not active for 2s.

#### Pump Events

Each of the individual pump statuses which are used in calculating the pump available alarm are to be provided to SCADA for information.

### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| MPC Pump Speed % Scale Factor\* | 0.01 |  |
| MPC Pump Current Scale Factor\* | 0.1 |  |
| MPC Pump Power Scale Factor\* | 0.01 |  |

\*These parameters are not fed back to SCADA

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| NIL |  |  |  |  |  |

### Calculations and Statistics

Each of the calculations designated Pump X in the table below apply to Pumps 1-5.

|  |  |
| --- | --- |
| Point | Description |
| MPC Pump X Pump Alarm Code | Current MPC Pump Alarm Code |
| MPC Pump X Speed | MPC Pump Speed in % |
| MPC Pump X Current | MPC Pump Line Current in A |
| MPC Pump X Power | MPC pump power in kW |
| MPC Pump X Starts Today | Total Number of Starts today. Reset at midnight AFTER the last value has been stored in history. |
| MPC Pump X Starts Yesterday | Yesterday’s Starts Today value immediately prior to reset at midnight. |
| MPC Pump X Run Hours | Total Run Hours today. Reset at midnight AFTER the last value has been stored in history. |
| MPC Pump X Run Hours Yesterday | Yesterday’s Run Hours value immediately prior to reset at midnight. |

The following values are to be read via Modbus and provided to SCADA for information:

Note:

Register 0040x: Pump 1

Register 0041x: Pump 2

Register 0042x: Pump 3

Register 0043x: Pump 4

Register 0044x: Pump 5

Register 0045x: Pump 6 (Not applicable)

Register 0046x: Pilot pump

Register 0047x: Back-up pump (Not applicable)

Pump 1 registers shown.

|  |  |
| --- | --- |
| Modbus Register | Name |
| 00402 | AlarmCode |
| 00405 | Speed |
| 00406 | LineCurrent |
| 00407 | Power |

### SCADA Points

Each of the calculations designated Pump X in the table below apply to Pumps 1-5.

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| MPC Pump X Available Alarm | Digital Status |  | Alarm(2) |  |
| MPC Pump X Running | Digital Status |  | Event | Y |
| MPC Pump X Present | Digital Status |  | Event |  |
| MPC Pump X Pump Fault (MPC) | Digital Status |  | Event |  |
| MPC Pump X Comms Fault | Digital Status |  | Alarm(1) |  |
| MPC Pump X Auto Mode | Digital Status |  | Event |  |
| MPC Pump X Access Mode | Digital Status |  | Event |  |
| MPC Pump X Pump Fault (Pump) | Digital Status |  | Event |  |
| MPC Pump X VSD Healthy | Digital Status |  | Event |  |
| MPC Pump X Pump Alarm Code | Analog Status |  |  | Y |
| MPC Pump X Speed | Analog Status | % |  | Y |
| MPC Pump X Current | Analog Status | A |  | Y |
| MPC Pump X Power | Analog Status | kW |  | Y |
| MPC Pump X Starts Today | Analog Status |  |  | Y |
| MPC Pump X Starts Yesterday | Analog Status |  |  | Y |
| MPC Pump X Run Hours | Analog Status | Hrs |  | Y |
| MPC Pump X Run Hours Yesterday | Analog Status | Hrs |  | Y |

## Generator and ATS

### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| stn1ATSNormPos | Transfer Switch Normal Position | DI |
| gen1fault | Generator Fault | DI |
| gen1warning | Generator Warning | DI |
| gen1lowFuel | Generator Low Fuel | DI |
| gen1medFuel | Generator Medium Fuel | DI |
| gen1Running | Generator Running | DI |
| gen1CanopyClsd | Generator Canopy Doors Closed | DI |
| gen1CBsClosed | Generator CBs Closed | DI |
| stn1genATSAuto | Generator and ATS in Auto | DI |
| gen1onSite | Generator On Site | DI |

### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| Generator and ATS Not in Auto | 1 | See description below. |
| Generator CBs Tripped | 1 | See description below. |
| Generator Fault | 1 | See description below. |
| Generator Canopy Open | 1 | See description below. |
| Generator Low Fuel | 1 | See description below. |
| Generator Mid Fuel | 2 | See description below. |
| Generator Off Site | 1 | See description below. |
| Generator Online | 1 | See description below. |
| Generator Running | Event | See description below. |
| Generator Warning | 2 | See description below. |

#### Generator or ATS Not in Automatic

This signal is the inverse of the RTU digital input which is true if both the generator and ATS are in auto (i.e. generator and ATS will operate on loss of power). When either the generator or ATS are switched to manual mode the alarm is activated to alert the operator that the generator and ATS will no longer start/operate automatically.

This alarm is suppressed if the generator is not on site.

#### Circuit Breakers Tripped

This signal is the inverse of the generator local CB closed status digital input, which is active if generator circuit breakers CB1 and CB2 are closed.

This alarm is suppressed if the generator is not on site.

#### Fault

The generator common fault signal (into the RTU) is active when any one of a range of critical faults occurs.

The generator common fault status input is directly fed back to the generator common fault indication on the SCADA master station. As the RTU also receives some of the individual alarms that make up this common fault the common fault signal to the SCADA master station is suppressed if any of the following signals are also received by the RTU.

* Generator CB tripped

#### Canopy Open

The canopy open alarm is active if the generator is on site and the canopy doors closed digital input signal is off.

#### Low Fuel

The generator low fuel alarm is directly fed to the generator low fuel indication on the SCADA master station.

#### Mid Fuel

The generator medium fuel status input is directly fed to the generator medium fuel indication on the SCADA master station.

#### Off Site

The generator on site signal (into the RTU) is a simple bridged connection in the disconnect plug on the generator to indicate that the generator control cable is connected to a generator. This signal is inverted and fed back as the generator off site indication on the SCADA master station.

#### Online

This signal is the inverse of the Transfer Switch in Normal Mode input into the RTU. It indicates that the ATS is in the generator position.

#### Running

The generator running signal (into the RTU) is directly fed to the generator run indication on the SCADA master station.

#### Warning

The generator warning signal is active when any one of a range of warning signals is present on the generator. The generator warning signal is directly fed back to the generator warning fault indication on the SCADA master station.

### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| NIL |  |  |

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| NIL |  |  |  |  |  |

### Calculations and Statistics

|  |  |
| --- | --- |
| Point | Description |
| NIL |  |

### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| Generator and ATS Not in Auto | Digital Status |  | Alarm(1) |  |
| Generator CBs Tripped | Digital Status |  | Alarm(1) |  |
| Generator Fault | Digital Status |  | Alarm(1) |  |
| Generator Canopy Open | Digital Status |  | Alarm(1) |  |
| Generator Low Fuel | Digital Status |  | Alarm(1) |  |
| Generator Mid Fuel | Digital Status |  | Alarm(2) |  |
| Generator Off Site | Digital Status |  | Alarm(1) |  |
| Generator Online | Digital Status |  | Alarm(1) |  |
| Generator Running | Digital Status |  | Event |  |
| Generator Warning | Digital Status |  | Alarm(2) |  |

# INSTRUMENTATION AND MONITORING

## Analog Instrumentation

### Analogue Signal Processing

#### Analogue Clamping

Before it is used to calculate the engineering value of the signal, the raw analogue input signal is clamped to the 4-20mA limits if it lies outside the 4-20mA range.

The invalid hysteresis value is the range of the signal multiplied by the site invalid hysteresis percentage.

#### Analogue Conversion to Engineering Unit

The Analogue input card converts the 4-20mA signals received to a raw count of [Raw Min] to [Raw Max] which are dependent on the brand and model of PLC/RTU selected for the site. For SCADAPack 535e RTUs, Raw Min = 0, Raw Max = 10000. This raw count is converted in the code to engineering units using the following formula:

Eng Unit = (Raw signal – Raw Min)/(Raw Max – Raw Min) x (Eng Max – Eng Min) + Eng Min

#### Analogue Filtering

The engineering values are filtered using a five element FIFO (first in, first out) stack sampled every 1 second to produce a rolling average. The average is reset by filling all five elements with the current value when the RTU restarts or a signal becomes valid after a period of invalidity.

### Standard Analogue Alarms and Events

Unless stated otherwise, all analogues will have the following standard alarms configured.

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| Invalid | Per Instrument | The signal is deemed invalid if it is less than (4mA – dead band) or greater than (20mA + dead band) for 2 seconds.  Once the invalid alarm has been activated it can only be reset when the signal is both greater than or equal to 4mA and less than or equal to 20mA for 5 seconds. The time delays ensure that a signal is truly invalid before an alarm is set and that it is stable before it is reset. The dead band is calculated using the site invalid hysteresis value multiplied by the range.  Any Analogue signal not backed up by the RTU battery has its invalid alarm suppressed if the station mains healthy input is off. Note: Only the invalid alarm to SCADA is suppressed. The invalid signal used to suppress high and low alarms is unaffected. |
| Low Alarm | Per Instrument | The low alarm is generated if the analogue signal is not invalid and remains less than or equal to the low limit set point for the duration of the alarm low delay on time (default 5 seconds). It is deactivated when the signal is greater than the low limit set point plus the dead band for the duration of the alarm low delay off time (default 5 seconds).  The dead band is calculated using the alarm hysteresis value multiplied by the range. |
| High Alarm | Per Instrument | The high alarm is generated if the analogue signal is not invalid and remains greater than or equal to the high limit set point for the duration of the alarm high delay on time (default 5 seconds). It is deactivated when the signal is less than the high limit set point minus the dead band for the duration of the alarm high delay off time (default 5 seconds).  The dead band is calculated using the alarm hysteresis value multiplied by the range. |

#### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| Site Invalid Hysteresis Percentage | 1 | % |
| Site Invalid Alarm On Delay | 2 | s |
| Site Invalid Alarm Off Delay | 5 | s |
| Site Alarm Hysteresis Percentage | 2 | % |

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| NIL |  |  |  |  |  |

#### Calculations and Statistics

|  |  |
| --- | --- |
| Point | Description |
| NIL |  |

#### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| Site Invalid Hysteresis Percentage | Analog Status | % |  |  |
| Site Invalid Alarm On Delay | Analog Status | s |  |  |
| Site Invalid Alarm Off Delay | Analog Status | s |  |  |
| Site Alarm Hysteresis Percentage | Analog Status | % |  |  |

### Suction Pressure Transmitter

The suction pressure transmitter is used to monitor booster suction pressure, and to prevent the pumps from running dry.

#### Physical I/O

|  |  |  |
| --- | --- | --- |
| Name | Description | Type |
| pre1rawSignal | Booster Suction Pressure Transmitter | AI |

#### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| Suction Pressure Invalid | 1 | The invalid alarm is standard as per section 7.1.2 Standard Analogue Alarms and Events.  NOTE: As the suction pressure transmitter is backed up by the battery, the invalid alarm is not suppressed if the station mains healthy input is off. |
| Suction Pressure Low Low Alarm (Pump Run Interlock) | 1 | The low low alarm is as per standard low alarm in section 7.1.2 Standard Analogue Alarms and Events.  The low low alarm for the suction pressure transmitter is inhibited for the pressure alarm inhibit time (default 15s) following start or stop of a pump, unless the alarm is already active. (This is so, when the pump set is tripped on low low suction pressure, stopping of the pump set does not inhibit the low alarm and allow the pump set to start.) |
| Suction Pressure Low Alarm | 1 | The low alarm is standard as per section 7.1.2 Standard Analogue Alarms and Events.  The low alarm for the suction pressure transmitter is inhibited for the pressure alarm inhibit time (default 15s) following start or stop of a pump. |
| Suction Pressure High Alarm | 1 | The high alarm is standard as per section 7.1.2 Standard Analogue Alarms and Events.  The high alarm for the suction pressure transmitter is inhibited for the pressure alarm inhibit time (default 15s) following start or stop of a pump. |

#### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| Pressure Alarm Inhibit Delay | 15 | S |
| Suction Pressure Elevation | Site-specific | mAHD |
| Suction Pressure Range | Site-specific | m |
| Suction Pressure High Alarm On Delay | 5 | s |
| Suction Pressure High Alarm Off Delay | 5 | s |
| Suction Pressure Low Alarm On Delay | 5 | s |
| Suction Pressure Low Alarm Off Delay | 5 | s |
| Suction Pressure Low Low Alarm On Delay | 30 | s |
| Suction Pressure Low Low Alarm Off Delay | 5 | s |
| Suction Pressure High Alarm Setpoint Default | Site-specific | mAHD |
| Suction Pressure High Alarm Setpoint Max | Site-specific | mAHD |
| Suction Pressure High Alarm Setpoint Min | Site-specific | mAHD |
| Suction Pressure Low Alarm Setpoint Default | Site-specific | mAHD |
| Suction Pressure Low Alarm Setpoint Max | Site-specific | mAHD |
| Suction Pressure Low Alarm Setpoint Min | Site-specific | mAHD |
| Suction Pressure Low Low Alarm Setpoint Default | Site-specific | mAHD |
| Suction Pressure Low Low Alarm Setpoint Max | Site-specific | mAHD |
| Suction Pressure Low Low Alarm Setpoint Min | Site-specific | mAHD |

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| Suction Pressure High Alarm Setpoint | Analog | SS | SS | SS | mAHD |
| Suction Pressure Low Alarm Setpoint | Analog | SS | SS | SS | mAHD |
| Suction Pressure Low Low Alarm Setpoint | Analog | SS | SS | SS | mAHD |

#### Calculations and Statistics

|  |  |
| --- | --- |
| Point | Description |
| Suction Pressure | Suction pressure in metres. The engineering value will be calculated as per standard analogue signal processing described in section 7.1.1. |
| Suction Pressure mAHD | The pressure probe measures pressure relative to the atmosphere at the probe’s location. To allow the control room operators to compare different water sites, the pressure relative to the Australian Height Datum (i.e. pressure in mAHD) is calculated and sent back to the SCADA system using the following formula: |

#### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| Pressure Alarm Inhibit Delay | Analog Status | s |  |  |
| Suction Pressure | Analog Status | m |  | Y |
| Suction Pressure mAHD | Analog Status | mAHD |  | Y |
| Suction Pressure Elevation | Analog Status | mAHD |  |  |
| Suction Pressure Range | Analog Status | m |  |  |
| Suction Pressure High Alarm On Delay | Analog Status | s |  |  |
| Suction Pressure High Alarm Off Delay | Analog Status | s |  |  |
| Suction Pressure Low Alarm On Delay | Analog Status | s |  |  |
| Suction Pressure Low Alarm Off Delay | Analog Status | s |  |  |
| Suction Pressure Low Low Alarm On Delay | Analog Status | s |  |  |
| Suction Pressure Low Low Alarm Off Delay | Analog Status | s |  |  |
| Suction Pressure High Alarm Setpoint | Analog Control | mAHD |  |  |
| Suction Pressure Low Alarm Setpoint | Analog Control | mAHD |  |  |
| Suction Pressure Low Low Alarm Setpoint | Analog Control | mAHD |  |  |
| Suction Pressure High Alarm Setpoint Feedback | Analog Status | mAHD |  | Y |
| Suction Pressure Low Alarm Setpoint Feedback | Analog Status | mAHD |  | Y |
| Suction Pressure Low Low Alarm Setpoint Feedback | Analog Status | mAHD |  | Y |
| Suction Pressure High Alarm | Digital Status |  | Alarm (1) |  |
| Suction Pressure Low Alarm | Digital Status |  | Alarm (1) |  |
| Suction Pressure Low Low Alarm | Digital Status |  | Alarm (1) |  |
| Suction Pressure Invalid Alarm | Digital Status |  | Alarm (1) |  |
| Suction Pressure High Alarm Setpoint Default | Analog Status | mAHD |  |  |
| Suction Pressure High Alarm Setpoint Max | Analog Status | mAHD |  |  |
| Suction Pressure High Alarm Setpoint Min | Analog Status | mAHD |  |  |
| Suction Pressure Low Alarm Setpoint Default | Analog Status | mAHD |  |  |
| Suction Pressure Low Alarm Setpoint Max | Analog Status | mAHD |  |  |
| Suction Pressure Low Alarm Setpoint Min | Analog Status | mAHD |  |  |
| Suction Pressure Low Low Alarm Setpoint Default | Analog Status | mAHD |  |  |
| Suction Pressure Low Low Alarm Setpoint Max | Analog Status | mAHD |  |  |
| Suction Pressure Low Low Alarm Setpoint Min | Analog Status | mAHD |  |  |

### Delivery Pressure Transmitters

Where only one discharge pressure transmitter is used, it is installed as the main discharge pressure sensor, and its analog signal is sent to both the RTU and CU352 using a signal splitter.

Where a redundant discharge pressure transmitter (Option E3) is installed, the water booster station has two discharge pressure transmitters (main and backup). Analog signals from both transmitters are sent to both the RTU and CU352 using signal splitters.

#### MPC (CU352)

Where only one discharge pressure transmitter is used, The MPC uses the pressure signal to control the discharge pressure to a setpoint. The MPC provides the following alarm/warning codes via its alarm and/or warning registers:

1. Sensor Fault (88): The signal from one of the analog sensors is out of range. (Could apply to suction pressure transmitter)
2. Primary Sensor Fault (89): Fault of the feedback control sensor or its settings. (If the MPC is in a control mode which uses the discharge pressure transmitter for feedback control, this is taken to indicate that the MPC considers the discharge pressure transmitter to have failed.)

Where dual discharge pressure transmitters (Option E3) are installed, the MPC uses the main and redundant pressure signals to control the discharge pressure to a setpoint, and determines for itself which pressure signal to use (i.e. which is the active sensor). No indication is available to the RTU as to which pressure transmitter the MPC is using as “active”. However, the MPC provides the following alarm/warning codes via its alarm and/or warning registers:

1. Sensor Fault (88): The signal from one of the analog sensors is out of range. (Could apply to suction pressure transmitter)
2. Dissimilar Sensor Signals (204): Primary and redundant feedback sensor values are inconsistent.
3. Primary Sensor Fault (89): Fault of the feedback control sensor or its settings. (If the MPC is in a control mode which uses the discharge pressure transmitters for feedback control, this is taken to indicate that the MPC considers both discharge pressure transmitters to have failed.)

#### RTU

The RTU uses the discharge pressure transmitter(s) for both alarming and station control.

The RTU calculates engineering values and alarms for both transmitters individually, and also calculates a number of aggregate values based on which transmitter it deems to be active or both transmitters.

Where dual discharge pressure transmitters (Option E3) are installed: If the main transmitter is valid or both transmitters are invalid, then the main transmitter is the active transmitter. If the main transmitter is invalid but the backup transmitter is valid, the backup transmitter is the active transmitter.

If only a single discharge pressure transmitter is installed, then it will be installed as the main transmitter (pressure 2 IO position), and it will always be the active transmitter.

Note: the RTU determines the active discharge pressure transmitter used for alarming and calculations based on information available to it. Technically, this may be different to the discharge pressure transmitter the MPC is using for pump speed control and display of discharge pressure on the MPC HMI.

#### Physical I/O

|  |  |  |
| --- | --- | --- |
| Name | Description | Type |
| pre2rawSignal | Booster Main Delivery Pressure Transmitter | AI |
| pre4rawSignal | Booster Backup Delivery Pressure Transmitter | AI |

#### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| Main Delivery Pressure Transmitter Invalid | 2 if dual transmitters installed, 1 otherwise. | The invalid alarm is standard as per section 7.1.2 Standard Analogue Alarms and Events.  NOTE: As the delivery pressure transmitter is backed up by the battery, the invalid alarm is not suppressed if the station mains healthy input is off. |
| Main Delivery Pressure Transmitter Low Alarm | 1 | The low alarm is standard as per section 7.1.2 Standard Analogue Alarms and Events.  This alarm is inhibited if the Main Pressure transmitter is not the active transmitter. |
| Main Delivery Pressure Transmitter High Alarm | 1 | The high alarm is standard as per section 7.1.2 Standard Analogue Alarms and Events.  The high alarm for the delivery pressure transmitter is inhibited for the pressure alarm inhibit time (default 15s) following start or stop of a pump.  This alarm is inhibited if the Main Pressure transmitter is not the active transmitter. |
| Backup Delivery Pressure Transmitter Invalid | 2 | The invalid alarm is standard as per section 7.1.2 Standard Analogue Alarms and Events.  NOTE: As the delivery pressure transmitter is backed up by the battery, the invalid alarm is not suppressed if the station mains healthy input is off.  Suppressed if Option E3 not enabled. |
| Backup Delivery Pressure Transmitter Low Alarm | 1 | The low alarm is standard as per section 7.1.2 Standard Analogue Alarms and Events.  This alarm is inhibited if the Backup Pressure transmitter is not the active transmitter. |
| Backup Delivery Pressure Transmitter High Alarm | 1 | The high alarm is standard as per section 7.1.2 Standard Analogue Alarms and Events.  The high alarm for the delivery pressure transmitter is inhibited for the pressure alarm inhibit time (default 15s) following start or stop of a pump.  This alarm is inhibited if the Backup Pressure transmitter is not the active transmitter. |
| Both Delivery Pressure Transmitters Invalid | 1 | This alarm is active if Option E3 is not enabled and the main delivery pressure transmitter invalid alarm is active, or if Option E3 is enabled and both Delivery pressure transmitter invalid alarms are active. |
| Active Delivery Pressure Low Alarm | Internal | This alarm is active if the Low alarm for the active Delivery transmitter is active.  Internal – used for control logic only. Not sent to SCADA. |
| Active Delivery Pressure High Alarm | Internal | This alarm is active if the high alarm for the active Delivery transmitter is active.  Internal – used for control logic only. Not sent to SCADA. |
| Delivery Pressure Sensor Difference Alarm | 2 | This alarm is active if Option E3 is enabled, both Delivery Pressure transmitters are valid, and the difference of their mAHD values is greater than the delivery pressure sensor difference deadband. |

#### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| Pressure Alarm Inhibit Delay | 15 | S |
| Main Delivery Pressure Transmitter Elevation | Site-specific | mAHD |
| Main Delivery Pressure Transmitter Range | Site-specific | m |
| Backup Delivery Pressure Transmitter Elevation | Site-specific | mAHD |
| Backup Delivery Pressure Transmitter Range | Site-specific | m |
| Delivery Pressure High Alarm On Delay | 5 | s |
| Delivery Pressure High Alarm Off Delay | 5 | s |
| Delivery Pressure Low Alarm On Delay | 5 | s |
| Delivery Pressure Low Alarm Off Delay | 5 | s |
| Delivery Pressure High Alarm Setpoint Default | Site-specific | mAHD |
| Delivery Pressure High Alarm Setpoint Max | Site-specific | mAHD |
| Delivery Pressure High Alarm Setpoint Min | Site-specific | mAHD |
| Delivery Pressure Low Alarm Setpoint Default | Site-specific | mAHD |
| Delivery Pressure Low Alarm Setpoint Max | Site-specific | mAHD |
| Delivery Pressure Low Alarm Setpoint Min | Site-specific | mAHD |
| Delivery Pressure Sensor Difference Deadband | Site-specific | mAHD |

Note: Low and High Alarm on/off delays are used for both main and backup transmitters.

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| Delivery Pressure High Alarm Setpoint | Analog | SS | SS | SS | mAHD |
| Delivery Pressure Low Alarm Setpoint | Analog | SS | SS | SS | mAHD |

Note: Low and High Alarm setpoints are used for both main and backup transmitters.

#### Calculations and Statistics

|  |  |
| --- | --- |
| Point | Description |
| Main Transmitter Delivery Pressure | Delivery pressure in metres. The engineering value will be calculated as per standard analogue signal processing described in section 7.1.1. |
| Main Transmitter Delivery Pressure mAHD | The pressure probe measures pressure relative to the atmosphere at the probe’s location. To allow the control room operators to compare different water sites, the pressure relative to the Australian Height Datum (i.e. pressure in mAHD) is calculated and sent back to the SCADA system using the following formula: |
| Backup Transmitter Delivery Pressure | As per Main Transmitter Delivery Pressure |
| Backup Transmitter Delivery Pressure mAHD | As per Main Transmitter Delivery Pressure mAHD |
| Active Transmitter Delivery Pressure mAHD | Delivery Pressure mAHD of the active transmitter.  Internal – used for control logic only. Not sent to SCADA. |
| Active Transmitter Average Delivery Pressure mAHD (15s Average) | Average Delivery Pressure mAHD (15s, 1s samples) of the active transmitter.  Internal – used for control logic only. Not sent to SCADA. |
| Differential Pressure | Active Delivery Pressure mAHD minus Suction Pressure mAHD. |

#### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| Pressure Alarm Inhibit Delay | Analog Status | s |  |  |
| Main Transmitter Delivery Pressure | Analog Status | m |  | Y |
| Main Transmitter Delivery Pressure mAHD | Analog Status | mAHD |  | Y |
| Main Delivery Pressure Transmitter Elevation | Analog Status | mAHD |  |  |
| Main Delivery Pressure Transmitter Range | Analog Status | m |  |  |
| Backup Transmitter Delivery Pressure\* | Analog Status | m |  | Y |
| Backup Transmitter Delivery Pressure mAHD\* | Analog Status | mAHD |  | Y |
| Backup Delivery Pressure Transmitter Elevation\* | Analog Status | mAHD |  |  |
| Backup Delivery Pressure Transmitter Range\* | Analog Status | m |  |  |
| Delivery Pressure High Alarm On Delay | Analog Status | s |  |  |
| Delivery Pressure High Alarm Off Delay | Analog Status | s |  |  |
| Delivery Pressure Low Alarm On Delay | Analog Status | s |  |  |
| Delivery Pressure Low Alarm Off Delay | Analog Status | s |  |  |
| Delivery Pressure Sensor Difference Deadband\* | Analog Status | mAHD |  |  |
| Delivery Pressure High Alarm Setpoint | Analog Control | mAHD |  |  |
| Delivery Pressure Low Alarm Setpoint | Analog Control | mAHD |  |  |
| Delivery Pressure High Alarm Setpoint Feedback | Analog Status | mAHD |  | Y |
| Delivery Pressure Low Alarm Setpoint Feedback | Analog Status | mAHD |  | Y |
| Main Delivery Pressure Transmitter High Alarm | Digital Status |  | Alarm (1) |  |
| Main Delivery Pressure Transmitter Low Alarm | Digital Status |  | Alarm (1) |  |
| Main Delivery Pressure Transmitter Invalid Alarm | Digital Status |  | Alarm(2) if dual transmitters, Alarm(1) otherwise |  |
| Backup Delivery Pressure Transmitter High Alarm\* | Digital Status |  | Alarm (1) |  |
| Backup Delivery Pressure Transmitter Low Alarm\* | Digital Status |  | Alarm (1) |  |
| Backup Delivery Pressure Transmitter Invalid Alarm\* | Digital Status |  | Alarm (2) |  |
| Both Delivery Pressure Transmitters Invalid Alarm\* | Digital Status |  | Alarm (1) |  |
| Delivery Pressure Sensor Difference Alarm\* | Digital Status |  | Alarm (2) |  |
| Differential Pressure | Analog Status | m |  | Y |
| Delivery Pressure High Alarm Setpoint Default | Analog Status | mAHD |  |  |
| Delivery Pressure High Alarm Setpoint Max | Analog Status | mAHD |  |  |
| Delivery Pressure High Alarm Setpoint Min | Analog Status | mAHD |  |  |
| Delivery Pressure Low Alarm Setpoint Default | Analog Status | mAHD |  |  |
| Delivery Pressure Low Alarm Setpoint Max | Analog Status | mAHD |  |  |
| Delivery Pressure Low Alarm Setpoint Min | Analog Status | mAHD |  |  |

\*These points only included in SCADA if dual discharge pressures are installed.

### Peer Pressure

#### I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| pre3pressureMAHD | Peer Pressure | Analog Status (via Telemetry) |
| pre3invalid | Peer Pressure Invalid | Digital Status (via Telemetry) |
| peer1toggle | Peer Transmission Toggle bit | Digital Status (via Telemetry) |

#### Pressure mAHD

A scaled, averaged peer pressure value in mAHD is received periodically from the peer pressure site via telemetry.

To reduce the communication bandwidth that the peer pairs require, the peer pressure gauge will only transmit the pressure according to the following rules:

* The peer pressure gauge will transmit the average peer pressure (average of 1 second samples over the last 15 seconds). This will prevent communications due to transients, and possible overloading of the communications network. (i.e. because the peer pressure is averaged, a short spike in pressure may not affect the average sufficiently to exceed the pressure transmit deviation and trigger a transmission.)
* The average peer pressure will be transmitted ONLY IF:
* (The peer pressure transmit delay time (typically 2 minutes) has elapsed since the last transmission) AND (The average peer pressure has changed by more than the peer pressure transmit deviation (typically 1 metre) when compared to the last transmitted pressure, or the pressure invalid status has changed)

OR

* 15 minutes has elapsed since the last transmitted peer pressure.

#### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| Peer Pressure Low Alarm | 1 | The low alarm is standard as per section 7.1.2 Standard Analogue Alarms and Events.  The low alarm for the peer pressure transmitter is inhibited while a peer communications timeout (internal flag) is active, the peer pressure invalid (raw DI) is active, or the station’s operator selected mode is not peer pressure control mode., |
| Peer Pressure High Alarm | 1 | The high alarm is standard as per section 7.1.2 Standard Analogue Alarms and Events.  The high alarm for the peer pressure transmitter is inhibited while a peer communications timeout (internal flag) is active, the peer pressure invalid (raw DI) is active, or the station’s operator selected mode is not peer pressure control mode |
| Peer Pressure Invalid | 1 | This alarm signal is received from the peer site. It is inhibited while a peer communications timeout (internal flag) is active, or the station’s operator selected mode is not peer pressure control mode. Note: The Peer Pressure Invalid raw DI is used in the code for peer pressure control mode logic. |
| Peer Communications Timeout | 1 | If the site has not received a transmission from the peer site for the peer communications timeout delay, the peer communications timeout alarm will activate. A new transmission is detected by the RTU via the update of a toggle bit by the peer site.  This alarm is suppressed if the site’s operator selected mode is not peer pressure control mode. Note: there is no suppression on the internal timeout flag used for peer pressure control mode logic and for suppression of the alarms above. |

#### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| Peer Communications Timeout Delay | 30 | min |
| Peer Pressure High Alarm On Delay | 0 | s |
| Peer Pressure High Alarm Off Delay | 0 | s |
| Peer Pressure Low Alarm On Delay | 0 | s |
| Peer Pressure Low Alarm Off Delay | 0 | s |
| Peer Pressure High Alarm Setpoint Default | Site-specific | mAHD |
| Peer Pressure High Alarm Setpoint Max | Site-specific | mAHD |
| Peer Pressure High Alarm Setpoint Min | Site-specific | mAHD |
| Peer Pressure Low Alarm Setpoint Default | Site-specific | mAHD |
| Peer Pressure Low Alarm Setpoint Max | Site-specific | mAHD |
| Peer Pressure Low Alarm Setpoint Min | Site-specific | mAHD |
| Peer Pressure Alarm Range | Site-specific | m |

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| Peer Pressure High Alarm Setpoint | Analog | SS | SS | SS | mAHD |
| Peer Pressure Low Alarm Setpoint | Analog | SS | SS | SS | mAHD |

#### Calculations and Statistics

|  |  |
| --- | --- |
| Point | Description |
| NIL |  |

#### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| Peer Communications Timeout Delay | Analog Status | s |  |  |
| Peer Pressure High Alarm On Delay | Analog Status | s |  |  |
| Peer Pressure High Alarm Off Delay | Analog Status | s |  |  |
| Peer Pressure Low Alarm On Delay | Analog Status | s |  |  |
| Peer Pressure Low Alarm Off Delay | Analog Status | s |  |  |
| Peer Pressure mAHD | Analog Status | mAHD |  | Y |
| Peer Pressure High Alarm Setpoint | Analog Control | mAHD |  |  |
| Peer Pressure Low Alarm Setpoint | Analog Control | mAHD |  |  |
| Peer Pressure High Alarm Setpoint Feedback | Analog Status | mAHD |  | Y |
| Peer Pressure Low Alarm Setpoint Feedback | Analog Status | mAHD |  | Y |
| Peer Pressure High Alarm | Digital Status |  | Alarm (1) |  |
| Peer Pressure Low Alarm | Digital Status |  | Alarm (1) |  |
| Peer Pressure Invalid Alarm | Digital Status |  | Alarm (1) |  |
| Peer Communications Timeout Alarm | Digital Status |  | Alarm (1) |  |
| Peer Pressure High Alarm Setpoint Default | Analog Status | mAHD |  |  |
| Peer Pressure High Alarm Setpoint Max | Analog Status | mAHD |  |  |
| Peer Pressure High Alarm Setpoint Min | Analog Status | mAHD |  |  |
| Peer Pressure Low Alarm Setpoint Default | Analog Status | mAHD |  |  |
| Peer Pressure Low Alarm Setpoint Max | Analog Status | mAHD |  |  |
| Peer Pressure Low Alarm Setpoint Min | Analog Status | mAHD |  |  |
| Peer Pressure Alarm Range | Analog Status | m |  |  |

### Flowmeters

#### Delivery Flow Meter

The delivery flow meter transmitter measures booster discharge flow. It is used by the RTU to modulate the pressure set point under flow modulation mode.

#### Low Zone/Bypass Flow Meter

The low zone/bypass flow meter transmitter typically measures flow to an adjacent unboosted zone or bypass flow around the booster.

#### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| flw1rawSignal | Delivery Flow Meter | AI |
| flw2rawSignal | Bypass Flow Meter | AI |

#### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| Delivery Flow Invalid | 1 | The invalid alarm is standard as per section 7.1.2 Standard Analogue Alarms and Events. |
| Delivery Flow Low Alarm | 2 | The low alarm is standard as per section 7.1.2 Standard Analogue Alarms and Events.  The flow low alarm is inhibited unless a pump is running, and is inhibited for the delivery flow meter alarm inhibit time (default 30s) following start or stop of a pump. |
| Delivery Flow High Alarm | 1 | The high alarm is standard as per section 7.1.2 Standard Analogue Alarms and Events.  The flow high alarm is inhibited for the delivery flow meter alarm inhibit time (default 30s) following start or stop of a pump. |
| Delivery Flow Volume Invalid | Event | When the invalid alarm is set the volume invalid is also set until midnight. At midnight, the accumulated volume and the volume invalid values are reset. |
| Low Zone/Bypass Flow Invalid | 2 | The invalid alarm is standard as per section 7.1.2 Standard Analogue Alarms and Events. |
| Low Zone/Bypass Flow Low Alarm | 2 | The low alarm is standard as per section 7.1.2 Standard Analogue Alarms and Events. |
| Low Zone/Bypass Flow High Alarm | 2 | The high alarm is standard as per section 7.1.2 Standard Analogue Alarms and Events. |
| Low Zone/Bypass Flow Volume Invalid | Event | When the invalid alarm is set the volume invalid is also set until midnight. At midnight, the accumulated volume and the volume invalid values are reset. |

#### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| Delivery Flow Alarm Inhibit Delay | 30 | S |
| Delivery Flow Range | Site-specific | l/s |
| Delivery Flow High Alarm On Delay | 5 | s |
| Delivery Flow High Alarm Off Delay | 5 | s |
| Delivery Flow Low Alarm On Delay | 5 | s |
| Delivery Flow Low Alarm Off Delay | 5 | s |
| Delivery Flow High Alarm Setpoint Default | Site-specific | l/s |
| Delivery Flow High Alarm Setpoint Max | Site-specific | l/s |
| Delivery Flow High Alarm Setpoint Min | Site-specific | l/s |
| Delivery Flow Low Alarm Setpoint Default | Site-specific | l/s |
| Delivery Flow Low Alarm Setpoint Max | Site-specific | l/s |
| Delivery Flow Low Alarm Setpoint Min | Site-specific | l/s |
| Low Zone/Bypass Flow Range | Site-specific | l/s |
| Low Zone/Bypass Flow High Alarm On Delay | 5 | s |
| Low Zone/Bypass Flow High Alarm Off Delay | 5 | s |
| Low Zone/Bypass Flow Low Alarm On Delay | 5 | s |
| Low Zone/Bypass Flow Low Alarm Off Delay | 5 | s |
| Low Zone/Bypass Flow High Alarm Setpoint Default | Site-specific | l/s |
| Low Zone/Bypass Flow High Alarm Setpoint Max | Site-specific | l/s |
| Low Zone/Bypass Flow High Alarm Setpoint Min | Site-specific | l/s |
| Low Zone/Bypass Flow Low Alarm Setpoint Default | Site-specific | l/s |
| Low Zone/Bypass Flow Low Alarm Setpoint Max | Site-specific | l/s |
| Low Zone/Bypass Flow Low Alarm Setpoint Min | Site-specific | l/s |

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| Delivery Flow High Alarm Setpoint | Analog | SS | SS | SS | l/s |
| Delivery Flow Low Alarm Setpoint | Analog | SS | SS | SS | l/s |
| Low Zone/Bypass Flow High Alarm Setpoint | Analog | SS | SS | SS | l/s |
| Low Zone/Bypass Flow Low Alarm Setpoint | Analog | SS | SS | SS | l/s |

#### Calculations and Statistics

| Point | Description |
| --- | --- |
| Delivery Flow Rate | The flow rate is measured in L/s. The engineering value will be calculated as per standard Analogue signal processing described in section 7.1.1. |
| Delivery Flow Rate kL/Day | A conversion is performed to get the equivalent flow rate in kilolitres per day.  Flow (kL/day) = Flow (l/s) \* 86.4 |
| Delivery Volume | The volume for the flow meter is calculated using the flow integrated over time (each second) and reset to 0 at midnight. |
| Delivery Volume Yesterday | The Volume Yesterday value is the previous day’s volume and is a record of the volume at midnight prior to the volume value being reset. |
| Low Zone/Bypass Flow Rate | As per Delivery Flow |
| Low Zone/Bypass Flow Rate kL/Day | As per Delivery Flow |
| Low Zone/Bypass Volume | As per Delivery Flow |
| Low Zone/Bypass Volume Yesterday | As per Delivery Flow |

#### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| Delivery Flow Alarm Inhibit Delay | Analog Status | s |  |  |
| Delivery Flow Range | Analog Status | L/s |  |  |
| Delivery Flow High Alarm On Delay | Analog Status | s |  |  |
| Delivery Flow High Alarm Off Delay | Analog Status | s |  |  |
| Delivery Flow Low Alarm On Delay | Analog Status | s |  |  |
| Delivery Flow Low Alarm Off Delay | Analog Status | s |  |  |
| Delivery Flow | Analog Status | L/s |  | Y |
| Delivery Flow kL/day | Analog Status | kL/day |  | Y |
| Delivery Flow Volume | Analog Status | kL |  | Y |
| Delivery Flow Volume Yesterday | Analog Status | kL |  | Y |
| Delivery Flow High Alarm Setpoint | Analog Control | L/s |  |  |
| Delivery Flow Low Alarm Setpoint | Analog Control | L/s |  |  |
| Delivery Flow High Alarm Setpoint Feedback | Analog Status | L/s |  | Y |
| Delivery Flow Low Alarm Setpoint Feedback | Analog Status | L/s |  | Y |
| Delivery Flow Invalid | Digital Status |  | Alarm (1) |  |
| Delivery Flow Low Alarm | Digital Status |  | Alarm (2) |  |
| Delivery Flow High Alarm | Digital Status |  | Alarm (1) |  |
| Delivery Flow Volume Invalid | Digital Status |  | Event |  |
| Delivery Flow High Alarm Setpoint Default | Analog Status | l/s |  |  |
| Delivery Flow High Alarm Setpoint Max | Analog Status | l/s |  |  |
| Delivery Flow High Alarm Setpoint Min | Analog Status | l/s |  |  |
| Delivery Flow Low Alarm Setpoint Default | Analog Status | l/s |  |  |
| Delivery Flow Low Alarm Setpoint Max | Analog Status | l/s |  |  |
| Delivery Flow Low Alarm Setpoint Min | Analog Status | l/s |  |  |
| Low Zone/Bypass Flow Range | Analog Status | L/s |  |  |
| Low Zone/Bypass Flow High Alarm On Delay | Analog Status | s |  |  |
| Low Zone/Bypass Flow High Alarm Off Delay | Analog Status | s |  |  |
| Low Zone/Bypass Flow Low Alarm On Delay | Analog Status | s |  |  |
| Low Zone/Bypass Flow Low Alarm Off Delay | Analog Status | s |  |  |
| Low Zone/Bypass Flow | Analog Status | L/s |  | Y |
| Low Zone/Bypass Flow kL/day | Analog Status | kL/day |  | Y |
| Low Zone/Bypass Flow Volume | Analog Status | kL |  | Y |
| Low Zone/Bypass Flow Volume Yesterday | Analog Status | kL |  | Y |
| Low Zone/Bypass Flow High Alarm Setpoint | Analog Control | L/s |  |  |
| Low Zone/Bypass Flow Low Alarm Setpoint | Analog Control | L/s |  |  |
| Low Zone/Bypass Flow High Alarm Setpoint Feedback | Analog Status | L/s |  | Y |
| Low Zone/Bypass Flow Low Alarm Setpoint Feedback | Analog Status | L/s |  | Y |
| Low Zone/Bypass Flow Invalid | Digital Status |  | Alarm (2) |  |
| Low Zone/Bypass Flow Low Alarm | Digital Status |  | Alarm (2) |  |
| Low Zone/Bypass Flow High Alarm | Digital Status |  | Alarm (2) |  |
| Low Zone/Bypass Flow Volume Invalid | Digital Status |  | Event |  |
| Low Zone/Bypass Flow High Alarm Setpoint Default | Analog Status | l/s |  |  |
| Low Zone/Bypass Flow High Alarm Setpoint Max | Analog Status | l/s |  |  |
| Low Zone/Bypass Flow High Alarm Setpoint Min | Analog Status | l/s |  |  |
| Low Zone/Bypass Flow Low Alarm Setpoint Default | Analog Status | l/s |  |  |
| Low Zone/Bypass Flow Low Alarm Setpoint Max | Analog Status | l/s |  |  |
| Low Zone/Bypass Flow Low Alarm Setpoint Min | Analog Status | l/s |  |  |

### Generator Fuel Level

The generator fuel level measures the level in the generator fuel tank.

#### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| lvl1rawSignal | Generator Fuel Level | AI |

#### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| Generator Fuel Level Invalid | 2 | The invalid alarm is standard as per section 7.1.2 Standard Analogue Alarms and Events. |

Note: No level alarms are calculated as the generator provides Fuel Mid and Fuel Low digital inputs into the RTU.

#### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| NIL |  |  |

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| NIL |  |  |  |  |  |

#### Calculations and Statistics

|  |  |
| --- | --- |
| Point | Description |
| Generator Fuel Level | The generator fuel level is measured in % (i.e. 4-20mA = 0-100%). The engineering value will be calculated as per standard Analogue signal processing described in section 7.1.1. |

#### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| Generator Fuel Level | Analog Status | % |  | Y |
| Generator Fuel Level Invalid | Digital Status |  | Alarm (2) |  |

## Digital Instrumentation

### Pit Level Sensors

This optional equipment allows monitoring of water level in the pump box and flow meter pits on site. Activation of the sensor indicates excessive water ingress into the pit (above the capacity of the sump pump to remove it), or that the sump pump has failed.

#### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| pit1flooded | Pump Box Pit Flooded | DI |
| pit1probeOK | Pump Box Pit Probe Healthy | DI |
| pit2flooded | Delivery Flow Meter Pit Flooded | DI |
| pit2probeOK | Delivery Flow Meter Pit Probe Healthy | DI |
| pit3flooded | Bypass / Low Zone Flow Meter Pit Flooded | DI |
| pit3probeOK | Bypass / Low Zone Flow Meter Pit Probe Healthy | DI |

#### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| Pump Box Pit Flooded | 1 | The alarm activates once the pump box pit flooded digital input has been active for the pit flooded alarm on delay time (typically 10 seconds), and remains on for the pit flooded alarm off delay time (typically 10 seconds) after the sensor signal becomes healthy. |
| Delivery Flow Meter Pit Flooded | 1 | As for Pump Box Pit Flooded alarm |
| Bypass / Low Zone Flow Meter Pit Flooded | 1 | As for Pump Box Pit Flooded alarm |
| Pump Box Pit Flooded Probe Unhealthy | 1 | The Pump Box Pit Flooded Probe Unhealthy alarm is active if the Pump Box Pit Probe Healthy digital input is off. |
| Delivery Flow Meter Pit Flooded Probe Unhealthy | 1 | As per Pump Box Pit Flooded Probe Unhealthy alarm |
| Bypass / Low Zone Flow Meter Pit Flooded Probe Unhealthy | 1 | As per Pump Box Pit Flooded Probe Unhealthy alarm |

#### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| Pit Flooded Alarm On Delay | 10 | s |
| Pit Flooded Alarm Off Delay | 10 | s |

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| NIL |  |  |  |  |  |

#### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| Pump Box Pit Flooded | Digital Status |  | Alarm (1) |  |
| Delivery Flow Meter Pit Flooded | Digital Status |  | Alarm (1) |  |
| Bypass / Low Zone Flow Meter Pit Flooded | Digital Status |  | Alarm (1) |  |
| Pump Box Pit Flooded Probe Unhealthy | Digital Status |  | Alarm (1) |  |
| Delivery Flow Meter Pit Flooded Probe Unhealthy | Digital Status |  | Alarm (1) |  |
| Bypass / Low Zone Flow Meter Pit Flooded Probe Unhealthy | Digital Status |  | Alarm (1) |  |
| Pit Flooded Alarm On Delay | Analog Status | s |  |  |
| Pit Flooded Alarm Off Delay | Analog Status | s |  |  |

## Auxiliary Monitoring

### RTU

The RTU is responsible for control and monitoring of all equipment on site, and for Brisbane sites, for communications with the SCADA system.

See section 10 for detail of the RTU.

#### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| NIL |  |  |

#### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| Abnormal Operation | 1 | An abnormal operation alarm identifies that the RTU has restarted. This restart is determined by the presence of the ‘first scan’ flag. A first scan can occur when the RTU has reset itself due to a fault condition. Any abnormal operation should be investigated by a technical officer from Control Systems Maintenance.  The alarm can only be reset by control room operator using the RTU abnormal operation reset command from the SCADA. |
| Heartbeat Failed (UUTS Only) | 1 | (Alarm generated in UUTS SCADA)  A counter increments every 5 seconds and is sent to the SCADA master station. The SCADA master station periodically checks that this ‘Heartbeat’ counter has incremented. The time between checks is the ‘Heartbeat Period’, (nominally 15 minutes). If the ‘Heartbeat’ value has not been updated after a number of ‘Heartbeat Periods’, then a Heartbeat Failed alarm is generated by the SCADA master station to alert the control room operator. The number of periods in which the heartbeat must have updated is the ‘Heartbeat Count’ (nominally 3).  The Heartbeat Failed alarm is not generated while a RTU Device Failed Alarm (SCADA-generated alarm) is active or the RTU has been put ‘out of service’. The conditions that usually result in a Heartbeat Failed alarm are;   * The RTU has stopped operating * The RTU is not being actively polled by the SCADA master station |
| Initialisation Error | 1 | This alarm is active if:   * The RTU address is not found in the parameter file (or is specified twice), or if the RTU address in the parameter file does not match the RTU address in the E-Configurator file. * The parameter file cannot be opened or closed, or a line in the parameter file is not in a valid format or cannot be successfully loaded into an RTU variable. * The log file cannot be opened, written or closed. |
| RTU System Error | 1 | RTU system point 50020 is a system error code. If this point is not zero, the RTU System Error Alarm is active.  The RTU Fault Reset control is used to clear the System Error Code Register and hence reset the RTU System Error Alarm. |
| RTU Onboard IO Fault | 1 | This alarm is active If the 6601 Composite I/O Status Point for the RTU’s onboard IO is not true. |
| RTU Expansion IO Fault | 1 | This alarm is active If the 6601 Composite I/O Status Point for the expansion module IO is not true. |
| Isagraf Stopped | 1 | RTU system point 50100 Application Status (Running 0, Halted 1) is sent to SCADA to indicate that the RTU code is halted. |
| Operate Failed | Event | This event indicates that a writeback to a SCADA control (e.g. for setpoint clamping or clearing of alarm reset bits) has failed. |
| Generate Event Failed | Event | This event indicates that the RTU failed to generate an event used to log a totaliser value on RTU restart and at midnight. |

#### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| RTU Address | Site-specific | N/A |

The RTU DNP3 address from the parameter file is fed directly back to the SCADA system. If this value does not match the site’s actual RTU address, the site may be using initial values related to another site.

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| NIL |  |  |  |  |  |

#### Calculations and Statistics

|  |  |
| --- | --- |
| IO Point | Description |
| RTU Heartbeat | The heartbeat value increments by 1 count every 5 seconds. |
| RTU System Error Code | RTU system point 50020 is a system error code. If this point is not zero, the RTU System Error Alarm is active. The RTU system error code is provided to SCADA for troubleshooting.  The RTU Fault Reset control is used to clear the System Error Code Register and hence reset the RTU System Error Alarm. |

#### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| RTU Address | Analog Status |  |  |  |
| RTU Heartbeat | Analog Status |  |  | Y |
| Abnormal Operation Alarm | Digital Status |  | Alarm (1) |  |
| Heartbeat Failed Alarm | Digital Status |  | Alarm (1) |  |
| Initialisation Error Alarm | Digital Status |  | Alarm (1) |  |
| RTU System Error | Digital Status |  | Alarm (1) |  |
| Abnormal Operation Reset | Digital Control |  |  |  |
| RTU Onboard IO Fault | Digital Status |  | Alarm (1) |  |
| RTU Expansion IO Fault | Digital Status |  | Alarm (1) |  |
| Isagraf Stopped | Digital Status |  | Alarm (1) |  |
| Operate Failed | Digital Status |  | Event |  |
| Generate Event Failed | Digital Status |  | Event |  |
| RTU System Error Code | Analog Status |  |  | Y |
| RTU Fault Reset | Digital Control |  |  |  |

### Power Monitoring

The site requires mains power to operate the water pump(s) and MPC controller. The RTU requires DC power and is powered via dual 240VAC/24VDC power supplies equipped with backup batteries. These batteries also supply backup power to the communications device(s) (e.g. Trio radio), the pressure transmitter(s), and flow meter (where a 24VDC flow transmitter is installed), and are sized to provide 24 hours backup power when new.

Note: Details for Elpro sites to be updated following commissioning of the Elpro site.

The switchboard at a water booster site has various monitoring installed to determine the power status for the entire switchboard.

#### Supply Authority Power Relay

The Supply Authority mains power relay monitors power to the switchboard before the normal supply main switch. It detects supply authority power failure.

#### Station Mains Power Relay

The Station mains power relay monitors power to the switchboard after the sub-distribution circuit breaker. It detects a loss of supply from the supply authority or generator downstream of the sub-distribution circuit breaker.

#### Surge Diverter and Filter Alarm Relay

The surge diverter and filter alarm relay monitors the health of the surge diverter and filter. It detects whether a power surge has damaged the switchboard surge protection devices.

#### RTU Power Supply

The RTU power supply consists of dual, battery-backed 240VAC-24VDC power supplies used to power the RTU, RTU I/O, communication device (e.g. radio), flow (if 24VDC) and pressure transmitter(s). (For Elpro sites, the RTU power supply will likely power the gateway RTU – TBC.)

#### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| stn1energexPower | Station Supply Authority power healthy | DI |
| stn1mainsPower | Station mains power healthy | DI |
| stn1surgeDivOK | Station surge diverter healthy | DI |
| rtu1powerOK | 24VDC Power Supplies DC OK | DI |
| rtu1batteryOK | 24VDC Power Supplies Battery OK | DI |

#### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| Supply Authority Power Fail Alarm | 1 | If the supply authority mains power monitoring relay (before the main incomer circuit breaker) is indicating a fault, then after a 75 second delay, the Supply Authority mains fail signal will activate. The 75 second delay is to eliminate alarms due to momentary losses of power. |
| Mains Power Fail Alarm | 1 | If the station mains power monitoring relay (after the sub-distribution circuit breaker) is indicating a fault then after a 75 second delay, the Station mains fail signal will activate. The 75 second delay is to eliminate alarms due to momentary losses of power.  The control room operator is alerted of a site power outage. The control room operator is able to monitor the site pressures (and flow if 24VDC) and is alerted to any high or low alarms from these signals until the battery goes flat. |
| Surge Diverter and Filter Fault Alarm | 1 | The surge diverters and surge filter have a combined healthy status fed back to the RTU. If this signal indicates a fault, and the station mains power digital input is still active, then after a 2 second delay the surge diverter fault is activated. |
| RTU Power Fail Alarm | 1 | This alarm is based on the “DC OK” relay outputs from the dual 24VDC power supplies, which alarm on loss of AC mains power or failure of off-line AC/DC converter / battery charger. If the ”DC OK” signal from both power supplies is not healthy, and the station mains power digital input is healthy, then after the RTU power fail alarm delay (Typically 15 seconds), the RTU Power Fail alarm is activated. |
| RTU Battery Fail Alarm | 1 | This alarm indicates whether the power supplies have a healthy battery system connected and that the batteries are adequately charged. It is based on the “Battery OK” relay outputs from the dual 24VDC power supplies, which alarm on battery low voltage 11V, failure of battery fuse or battery disconnected. If the battery system signal from either power supply is in the fault state then the RTU Battery Fail alarm becomes active after the RTU battery fail alarm delay (typically 15 seconds). |

#### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| Supply Authority Power Fail Alarm Delay | 75 | s |
| Mains Power Fail Alarm Delay | 75 | s |
| Surge Diverter and Filter Fault Alarm Delay | 2 | s |
| RTU Power Fail Alarm Delay | 15 | s |
| RTU Battery Fail Alarm Delay | 15 | s |

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| NIL |  |  |  |  |  |

#### Calculations and Statistics

|  |  |
| --- | --- |
| IO Point | Description |
| NIL |  |

#### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| Supply Authority Power Fail Alarm Delay | Analog Status | s |  |  |
| Mains Power Fail Alarm Delay | Analog Status | s |  |  |
| Surge Diverter and Filter Fault Alarm Delay | Analog Status | s |  |  |
| RTU Power Fail Alarm Delay | Analog Status | s |  |  |
| RTU Battery Fail Alarm Delay | Analog Status | s |  |  |
| Supply Authority Power Fail Alarm | Digital Status |  | Alarm (1) |  |
| Mains Power Fail Alarm | Digital Status |  | Alarm (1) |  |
| Surge Diverter and Filter Fault Alarm | Digital Status |  | Alarm (1) |  |
| RTU Power Fail Alarm | Digital Status |  | Alarm (1) |  |
| RTU Battery Fail Alarm | Digital Status |  | Alarm (1) |  |

### Emergency (OR Control) Stop Pushbutton

All pumps can be stopped locally in any mode via the station Emergency (OR Control) Stop pushbutton, located on the switchboard, which can be operated by a field officer on site.

Option U is enabled if an emergency stop is fitted in the site switchboard, and not enabled if a control stop is installed.

Note: RTU actions are the same whether an emergency stop or control stop is fitted. The same RTU digital input (Emergency/Control Stop Healthy) is used for monitoring of either.

**All emergency stop functionality is achieved independent of the RTU.**

#### Station Safety Function Fault Indication Lamp (Option V)

NOTE: This safety function status indication lamp is part of the station compliance with category 2 emergency stop circuit (Default required by QUU – category can only be lowered if a Safety in Machine Risk assessment is carried out on the site and this results in a category less than 2)

The station safety function fault indication lamp will be OFF unless a loss of safety function is detected.

This loss of safety function is defined as follows:

* The Station Emergency Stop Healthy (stn1EStopHealthy) digital input (DI01) is not active AND
* Any of the Pump Healthy Digital Inputs are Active

If these conditions are true, then after a 1s delay, the lamp will flash at a rate of 500ms OFF, followed by 500ms ON, providing a flashing indication that the safety system (Emergency Stop) has NOT operated as intended (i.e. it has been pressed but the line contactor is still closed.)

Note: this function is only enabled if Option V - Emergency Stop Safety Function Failure Monitoring is enabled.

#### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| stn1EStopHealthy | Station Emergency Stop Healthy OR Control Stop Inactive | DI |
| stn1SafetyFault | Safety Function Fault Indication Lamp | DO |

#### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| Emergency/Control Stop Alarm | 1 | The emergency stop healthy/control stop inactive status input is inverted and fed back via the Emergency/Control Stop Alarm signal to the SCADA system. |

#### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| NIL |  |  |

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| NIL |  |  |  |  |  |

#### Calculations and Statistics

|  |  |
| --- | --- |
| IO Point | Description |
| NIL |  |

#### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| Emergency Stop Alarm\* | Digital Status |  | Alarm (1) |  |
| Control Stop Alarm\* | Digital Status |  | Alarm (1) |  |

\* Note: Both of these SCADA points have the same RTU DNP index. The Emergency Stop Alarm point is only included in SCADA if option U is enabled. Control Stop Alarm point is only included in SCADA if option U is not enabled.

### Site Security Monitoring

This alarm indicates that someone, authorised or not, has opened a switchboard door or the pump enclosure. The doors to the switchboard each have a limit switch to indicate the status of that door, and the pump enclosure is monitored by two limit switches. All of these limit switches are wired to give a combined signal that indicates whether all the doors are closed or at least one door is open.

#### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| stn1DoorsClsd | Station Doors Closed | DI |

#### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| Door Open | 2 | The inverse of the Station Doors Closed status input is fed back via the Door Open indication signal to the SCADA system. |
| Intruder Alarm | 1 | If the Station Doors Closed Input is off for the intruder alarm delay time (default 5 min), the Intruder Alarm will activate.  For Brisbane sites using UUTS SCADA, the delay allows time for the Control Room operator to log an on-site operator into a site and disable the intruder alarm. This will be done via the maintenance mode (refer to Appendix D: Maintenance Mode). |

#### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| Intruder Alarm Delay | 5 | min |

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| NIL |  |  |  |  |  |

#### Calculations and Statistics

|  |  |
| --- | --- |
| IO Point | Description |
| NIL |  |

#### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| Intruder Alarm Delay | Analog Status | min |  |  |
| Door Open | Digital Status |  | Event |  |
| Intruder Alarm | Digital Status |  | Alarm (1) |  |

### Station Efficiency Monitoring

#### Physical I/O

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Type** |
| NIL |  |  |

#### Alarms and Events

| SCADA Status | Alarm Priority | Description |
| --- | --- | --- |
| NIL |  |  |

#### Parameters and Setpoints

**Parameters (Site-Specific Constants)**

| Parameter | Default | Units |
| --- | --- | --- |
| NIL |  |  |

**Setpoints**

| Setpoint | Type | Min | Max | Default | Units |
| --- | --- | --- | --- | --- | --- |
| NIL |  |  |  |  |  |

#### Calculations and Statistics

|  |  |
| --- | --- |
| IO Point | Description |
| Wire to Water Efficiency | Wire to Water Efficiency = (Discharge Pressure [mAHD] – Suction Pressure [mAHD]) \* Delivery Flow [l/s] /(102.2\* total pump power [kW])  (Total pump power is sum of pump power values from MPC for all installed pumps) |

#### SCADA Points

| Point | Type | Units | Digital Alarm/Event (Priority) | Analog Event Logging |
| --- | --- | --- | --- | --- |
| Wire to Water Efficiency | Analog Status | N/A |  | Y |

# STANDARDS

The control system for the standard MPC water booster site shall adhere to all relevant Standards and Regulations as listed in Section 2 of QUU Standard *TMS1202 Control System Implementation[[2]](#endnote-2)*.

# CONTROL SYSTEM HARDWARE

The main control system hardware components for a standard MPC-based water booster site are listed in the table below:

Table 5 - Control System Hardware Components

|  |  |  |  |
| --- | --- | --- | --- |
| **Device** | **Make** | **Model** | **Catalog Number** |
| MPC Controller | Grundfos | CU 352 |  |
| RTU | Schneider | SCADAPack 535e with 6601 IO Expansion Module | TBUP535‐EA56‐AB10S & TBUX297585S |
| Radio | Trio | D Series | TBUR-DR900-06A02D00 |

These devices and their interfaces to the RTU can be seen on Sheet 01 “Control System Network Diagram” the standard electrical drawing set.

# RTU

## Overview

The RTU to be installed for monitoring and control of the water booster site is the Schneider SCADAPack 535e with a 6601 I/O Expansion Module installed.

The SCADAPack 535e has the following on-board I/O: 16 DI, 8 DO, 6 AI, 2 AO.

The 6601 IO Expansion Module duplicates these I/O.

The RTU is capable of Ethernet and serial communications. This allows connection to:

1. the MPC controller (Modbus TCP),
2. the UUTS SCADA and peer site via the Trio telemetry radio (DNP3 over RS232), and
3. the programming laptop (RS232 or TCP/IP communications).

## RTU Code

RTU code is developed using Schneider Workbench, an IEC 6113-compliant software development tool.

Code is written mainly in a combination of ladder logic and function block diagram, with some function blocks and/or program blocks used for calculations and file I/O written in structured text where appropriate.

The current version of Workbench used for programming the SCADAPack 535e is 6.4.

## RTU Configuration

SCADAPack E Configurator software is used for setup and configuration of the SCADAPack 535e RTU.

The software allows:

* Assignment of functions to RTU ports.
* Setup of DNP3 communications and points, including triggering of unsolicited alarms and trend sampling.
* Setup of Modbus TCP communications with the MPC Controller.

### File Naming Convention

E Configurator Files are site-specific, and shall be named in the following format:

WBXXX\_YYYY-MM-DD.rtu

where:

WBXXX is the site identifier (e.g. WB144)

YYYY-MM-DD is the date the file was last modified.

## Site-Specific Values

Although each water booster station is built according to a standard, there are site-specific parameters (e.g site options, default setpoints) which must be used by the RTU code.

These values are supplied to the RTU via a parameter file, rather than being hard-coded, allowing RTU code to remain standard across sites (except for any required modifications to the interlock code block).

On RTU startup, variables in the code are loaded with the initial values specified in the parameter file. Where retentive memory has been cleared, e.g. due to download of a new program, these values can be used to overwrite inputs from SCADA allowing operator setpoints to be initialised to default values.

For Brisbane sites, most site parameters are fed back as status points to the SCADA master station to allow them to be easily viewed by the control room operator. These points are not logged in the RTU, but are trended in SCADA so changes can be tracked.

A listing of site parameters and initial setpoint values can be found in Appendix B.

# RTU PROGRAM

## Program Structure

The Workbench code for the standard MPC water booster site is broken into programs which represent pieces of equipment or tasks. For complex pieces of equipment or tasks, logic may be divided into more than one program, with each program performing a subtask. Function blocks or functions are used where possible to remove duplication of code.

### Program Blocks

#### Devices

Each device (or group of devices if they are relatively simple and can be logically grouped), has its own program block.

##### Instruments (including power and security monitoring)

For instruments, the program provides all calculations, monitoring and alarming.

Program Blocks have been written for the following instrumentation:

* Discharge Flow Meter
* Bypass/Low Zone Flow Meter
* Suction Pressure Transmitter
* Main Discharge Pressure Transmitter
* Backup Discharge Pressure Transmitter
* Peer Pressure Transmitter
* Generator Fuel Level
* Power Monitoring Equipment
* Security Monitoring Signals

Each physical Analog input has its own program which contains over/underrange checking (invalid alarm), scaling to engineering units, high/low alarming and associated calculations.

##### Equipment

Program Blocks have been written for the following equipment:

* Pump 1-5 and Jockey Pump
* MPC (including aggregate pump monitoring)
* Generator/ATS

The program block provides monitoring and alarming, and calculations relating to the equipment. Refer to the relevant section in the Functional Specification document for each piece of equipment.

#### Control Functions

Program Blocks shall be written for the following control functions:

* Mode Selection
* Setpoint Calculation for Pressure Control Modes
* MPC Control
* Generator Pump Inhibit and Energex Lockout
* Generator Test

The Setpoint Calculation for Pressure Control Modes block provides a discharge pressure setpoint for the MPC system. The discharge pressure setpoint may be calculated, or just passed through from a parameter or operator setpoint. (e.g. flow modulation mode provides a pressure setpoint based on current discharge flow). The MPC Program includes calculation of the Fixed speed mode open loop system performance setpoint for the MPC system.

#### Auxiliary Functions

Program Blocks have been written for the following auxiliary functions:

* Reading Parameter values from the parameter file on RTU startup
* Initialisation of control setpoints on RTU startup (if required)
* Setpoint Clamping
* RTU Monitoring
* Timers
* Generation of events for totaliser logging
* Emergency/Control stop monitoring
* MPC communications monitoring and data mapping
* Calculation of station efficiency
* MPC Interlock
* Pit Level monitoring
* E-stop safety function monitoring
* Feedback of current control setpoints to SCADA
* Backwriting of clamped or overridden SCADA controls
* Reset of Digital Controls from SCADA
* RTU Heartbeat

### Alarming

Where alarms are associated with a piece of equipment which already has its own program, alarms are calculated in that program. Where alarms are not already monitored in other logic, they may be grouped with other similar alarming in a program. (e.g. The Site Power block, which monitors phase fail relays, surge diverter and filter, 24VDC power supply and battery status.)

## Standard Design Options

This standard MPC Water Booster code also incorporates a range of design options, the activation of which is determined by individual site requirements. The list of the standard design options available can be seen in Section 2.

Selected design options are communicated to the Workbench code via digital values stored in the site’s parameter file. The RTU Code will enable/disable functionality as required based on the values of the options points.

In some cases, no action is necessary, but in other cases, signals may need to be inhibited or actions prevented.

Site options are used to enable or disable certain control modes. Where a mode is disabled, the RTU code is prohibited from entering that mode.

## Memory Structure

### Variable Naming Convention

The programmer shall use the following I/O naming convention (based on the QUU standard I/O Naming Convention for PLCs as defined in TMS1229 Section 7.1.1) to identify I/O points within the RTU.

The standard tag name format is as follows (description of elements can be found in the table below):

***EeeNTtXxxxxxxxx***

Table 6 - Tag Name Elements

|  |  |  |  |
| --- | --- | --- | --- |
| **Field** | **Chars** | **Description** | **Example** |
| Eee | 3 | Equipment Type | Global Variables:  Pump: pmp  Pressure: pre  No device: xxx  Local variable: xxl  Function block parameter: xxp |
| N | 1 | Equipment Number | Pump 1: pmp1 |
| Tt | 2 | Tag Type | HMI and SCADA interface tags:  ds Digital SCADA/HMI Status Bit  dc Digital SCADA/HMI Command Bit  as Analog SCADA/HMI Analog Status (Value)  ac Analog SCADA/HMI Analog Command (Set point)  Physical IO tags:  di Digital input  dq Digital output  ai Analog input  dq Analog Output  Additional examples:  gb Digital General bit  gr INT General register  tm INT Timer  pb Digital parameter (site constant) bit  pr Int/REAL parameter (site constant) register  Note: functional block parameters use same tag types as physical I/O e.g. xxp1aiRawValue. |
| Xxxxxxxxxx | <=10 | Variable Description | Running (status to SCADA) e.g. pmp1dsRunning |

All RTU I/O shall be addressed within the software by reference to these names, rather than IO addressing.

For Brisbane sites, UUTS SCADA uses a different convention for point naming, but terms used in Equipment Types and Variable Descriptions in the RTU should align as much as possible with Plant and Quantity names respectively in the MOSAIC SCADA system. Equipment Numbers in the RTU should align with “Desig” values in the SCADA.

### Variable Scope

Refer to TMS1202 Control System Implementation for Network Assets section 6.5.3 *Variable Scope* for appropriate use of local and global variables.

### Initialisation

Note: For each operator-adjustable setpoint shown in the setpoint tables in the sections above, the setpoint’s default (initialisation) value, as well as minimum and maximum clamp limits are shown. These three values are themselves site-specific constants, since they are loaded from the parameter file at startup and do not change during PLC/RTU code execution.

#### Site Constants

Site constants are defined as parameters or values which do not change during program execution, but may be different from site to site.

They include:

* Default setpoint values and setpoint upper and lower limit values
* Site parameters, such as analog alarm and invalid hysteresis values, RTU address, site options selections, etc.

On the first scan following an RTU restart, site constants are read from the parameter file and loaded into RTU variables for use by the RTU program.

#### Operator Setpoints

Each operator–modifiable setpoint value used by the code has 5 associated variables.

1. **SCADA Control:** The input from the SCADA system via communications. Inputs are stored in non-volatile memory so their value is retained during RTU restart and power cycling.
2. **Default Value:** A variable which holds the default setpoint value, loaded on first scan in the initialisation block. This value is fed back to SCADA as a reference for the operator.
3. **Upper Limit:** A variable which holds the maximum allowed setpoint value, loaded on on first scan in the initialisation block. This value is fed back to SCADA as a reference for the operator.
4. **Lower Limit:** A variable which holds the minimum allowed setpoint value, loaded on on first scan in the initialisation block. This value is fed back to SCADA as a reference for the operator.
5. **RTU Setpoint:** The setpoint variable itself, used for control in the code. This variable is necessary because writing to the SCADA Control Value does not take effect until the following scan.

Default values, and upper and lower limits for setpoints are specified in the parameter file. On the first scan following an RTU restart, these values are read in and loaded into the *Default Value, Upper Limit* and *Lower Limit* variables for each setpoint, as per Site Constants section above.

In the RTU, an input variable is configured which is not written to by the SCADA. This dummy input variable is used by the RTU to determine whether setpoints have been initialised with their default values. On RTU first scan, if this dummy input variable is 0, it will be deemed that input non-volatile memory has been wiped (for example, due to a cold restart), and *Default Values* will be written to *RTU Setpoint* variables. The dummy input will also be set to “12345”, to signal that setpoints have been initialised. If, on RTU first scan, the dummy input is “12345”, it will be deemed that the setpoint values prior to RTU restart have been retained, and *SCADA Control* variables will be written to *RTU Setpoint* variables

Note: It is assumed that default values are at or within upper and lower limit values.

At the end of the RTU scan, if the *SCADA Control* value is not equal to the *RTU Setpoint*, the *SCADA Control* value will be overwritten by the *RTU Setpoint* value, hence initialising the *SCADA Control* value itself.

See flow diagram below for setpoint initialisation process.

Note: On the first scan, an RTU Abnormal Operation alarm will be raised, alerting the operator that the RTU has restarted. The operator can then check the setpoint feedback values (i.e. the current values of the *SCADA Control* variables) against the SCADA control points, the Default value and Upper and lower limit feedback points to determine whether he/she wishes to adjust or resend any setpoints.

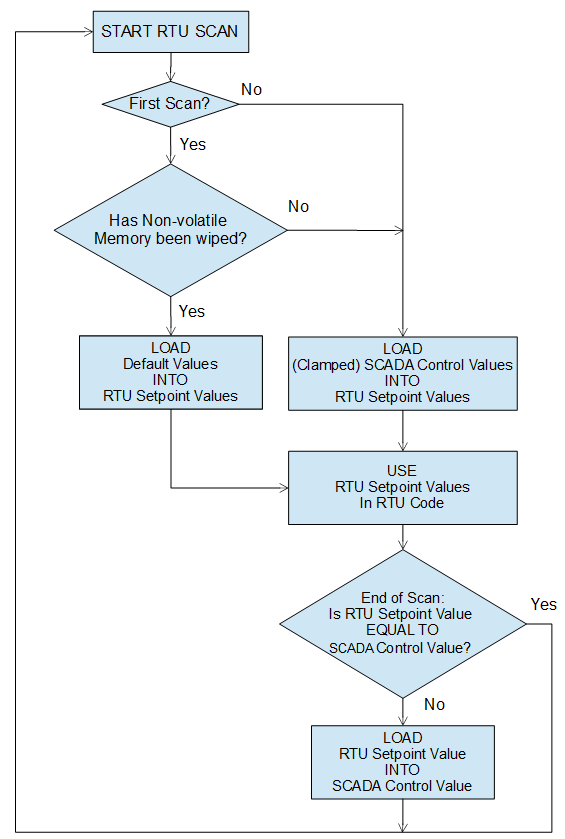


Figure 3 - Setpoint Initialisation and Clamping Flowchart

### System State Variables

Where the system requires a record of system state across restarts (e.g. for pump run hours), this variable will be stored in retentive memory.

### Setpoint Clamping

Each setpoint that is modifiable from SCADA shall have three values provided in the parameter file:

1. Default (Initial) Value
2. Upper Limit
3. Lower Limit

On first scan, if it is detected that input retentive memory has been wiped, the *RTU Setpoint* variable will be initialised with the Default Value.

Note: It is assumed that default values are at or within upper and lower limit values.

Subsequently, where the *SCADA Control* value sent from SCADA lies outside the Upper and Lower limits, the value from the *SCADA Control* variable will be clamped to the nearest limit, and copied into the *RTU Setpoint* variable.

At the end of the RTU scan, if the *SCADA Control* value is not equal to the *RTU Setpoint*, the *SCADA Control* value will be overwritten by the *RTU Setpoint* value, hence initialising or clamping the *SCADA Control* value itself.

## Communications Interfaces

All RTU Communications is achieved using I/O boards in Workbench configuration which map variables to DNP3 points as defined in the associated E Configurator file for the RTU.

DNP3 Communications with UUTS SCADA and Peer sites is achieved using these DNP3 points directly. Settings for triggering of unsolicited transmission and event logging for SCADA points are defined in the associated E Configurator file.

For Modbus TCP communications with the MPC, a modbus scanner configured in the E Configurator file copies data between local RTU DNP3 addresses and MPC modbus addresses.

## General Programming Requirements

### Code Comments

Refer to TMS1229 PLC Programming and Configuration Standard section 7.2 *Rung Comments* for requirements regarding commenting of RTU code.

### File Naming Convention

Refer to document *ISaGRAF Naming Convention* for requirements regarding RTU code file naming.

### Testing and Commissioning

Refer to TMS1202 Control System Implementation section 7 *Quality Assurance, Inspection & Testing* for requirements regarding control system testing and commissioning.

### Documentation

Refer to TMS1202 Control System Implementation section 8 *Documentation* for requirements regarding control system documentation.

# RTU COMMUNICATONS

## COMMUNICATIONS PROTOCOLS AND EQUIPMENT

### DNP3 Communications to SCADA and Peer Site

The RTU communicates with the UUTS SCADA Master Station and Peer Site using DNP3 protocol over a serial (RS-232) connection provided by the Trio radio. The RTU connects to the radio using a proprietary RJ45 to DB9 cable from Port 1.

Peer communication is implemented by relaying signals via the SCADA Master rather than rebroadcast of communications traffic from radio base stations as has been the case historically. Note: No peer communications are currently being used for any Brisbane sites.

### Modbus TCP Communications to MPC Controller

The RTU communicates with the CU352 via Modbus TCP protocol. The RTU connects to the CU352 via a standard UTP (Ethernet) cable from port Eth1.

### Serial or Ethernet Connection to Programming Laptop

To connect to the RTU via serial communications, the RTU programmer connects a COM port of the programming laptop to ports Serial1 or Serial2 (Port Serial3 may be used for Modbus RTU comms) of the RTU using a proprietary DB9 Female to RJ45 plug RS-232 crossover cable. A serial connection is generally only used to configure Ethernet communications, which are used from then on.

The programmer may connect to the RTU via Ethernet using a standard UTP (Ethernet) cable connected to RTU port Eth2 or Eth3. (Eth1 is assigned to the MPC on the standard electrical drawings.)

Ethernet is used for programming and debugging Workbench code.

## DNP3 and Physical I/O

All RTU Communications is achieved using I/O boards in Workbench configuration which map variables to DNP3 points as defined in the associated E Configurator file for the RTU.

Physical I/O are declared and mapped in Workbench in the same way as DNP3 points.

### DNP3 I/O Address Map

Below is an overview of the address ranges used for each I/O point type.

Table 7 - DNP3 I/O Address Map

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Range** | **Point Type (relative to RTU)** | **Type**  **(E Configurator)** | **DNP3 Static Object Type**  **(E Configurator)** | **I/O Board Type**  **(SCADAPack Workbench 6)** | **Purpose** |
|  |  |  |  |  |  |
| Physical IO |  |  |  |  |  |
| 1-32 [999] | Digital Inputs | Input | g1v1 Binary Input | RTU\_BIN\_READ | Physical RTU Digital Inputs |
| 1-16 [999] | Digital Outputs | Output | g10v2 Binary Output | RTU\_BIN\_WRITE | Physical RTU Digital Outputs |
| 1-12 [999] | Analog [Integer] Inputs | Input | g30v1 32bit Analog In | RTU\_RAW\_READ | Physical RTU Analog Inputs |
| 1-4 [999] | Analog [Integer] Outputs | Output | g40v1 32bit Analog Out | RTU\_RAW\_WRITE | Physical RTU Analog Outputs |
|  |  |  |  |  |  |
| **Communication Points - SCADA [MPC Water Booster Station]** | | | | | | |
| 10500-10999 | Digital Inputs | Derived | g1v1 Binary Input | RTU\_BIN\_READ | Digital Controls from SCADA |
| 10000-10499 | Digital Outputs | Derived | g1v1 Binary Input | RTU\_BIN\_WRITE | Digital Status to SCADA |
| 10500-10999 | Analog [Integer] Inputs | Derived | g30v2 16bit Analog In | RTU\_RAW\_READ | Analog [Integer] Controls [Setpoints] from SCADA |
| 10000-10499 | Analog [Integer] Outputs | Derived | g30v2 16bit Analog In | RTU\_RAW\_WRITE | Analog [Integer] Status to SCADA |
| 15500-15999 | Analog [Real] Inputs | Derived | g30v5 Eng Float AI | RTU\_ENG\_READ | Analog [Real] Controls [Setpoints] from SCADA |
| 15000-15499 | Analog [Real] Outputs | Derived | g30v5 Eng Float AI | RTU\_ENG\_WRITE | Analog [Real] Status to SCADA |
|  |  |  |  |  |  |
| **Communication Points - MPC Modbus** | | | | | | |
| 12000-12009 | Digital Inputs | Derived |  | RTU\_BIN\_READ | MPC - Comms Stats - Digitals |
| 12010-12099 | Misc. Reserved for MPC Digital Comms | Derived |  | RTU\_BIN\_READ,RTU\_BIN\_WRITE |  |
| 12010-12099 | Misc. Reserved for MPC Digital Comms | Derived |  | RTU\_BIN\_READ,RTU\_BIN\_WRITE |  |
| 12000-12009 | Analog [Integer] Inputs | Derived |  | RTU\_RAW\_READ | MPC - Comms Stats - Integers |
| 12010-12089 | Analog [Integer] Inputs | Derived |  | RTU\_RAW\_READ | MPC Status Inputs [Integers] |
| 12090-12099 | Analog [Integer] Outputs | Derived |  | RTU\_RAW\_WRITE | MPC Control Outputs [Integers] |
| 17000-17099 | Misc. Reserved For MPC Real Comms | Derived |  | RTU\_ENG\_READ,RTU\_ENG\_WRITE |  |
| 17000-17099 | Misc. Reserved For MPC Real Comms | Derived |  | RTU\_ENG\_READ,RTU\_ENG\_WRITE |  |
| 17000-17099 | Misc. Reserved For MPC Real Comms | Derived |  | RTU\_ENG\_READ,RTU\_ENG\_WRITE |  |
|  |  |  |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Range** | **Point Type (relative to RTU)** | **Type**  **(E Configurator)** | **DNP3 Static Object Type**  **(E Configurator)** | **I/O Board Type**  **(SCADAPack Workbench 6)** | **Purpose** |
|  |  |  |  |  |  |
| **Communication Points - Peer Pressure Gauge Comms** | | | | | |
| 12600-12609 | Digital - Reserved | Derived |  | RTU\_BIN\_READ,RTU\_BIN\_WRITE |  |
| 12610-12619 | Digital - Peer Pressure Comms | Derived |  | RTU\_BIN\_READ |  |
| 12620-12699 | Digital - Reserved | Derived |  | RTU\_BIN\_READ,RTU\_BIN\_WRITE |  |
| 12600-12609 | Analog [Integer] - Reserved | Derived |  | RTU\_RAW\_READ,RTU\_RAW\_WRITE |  |
| 12610-12629 | Analog [Integer] - Reserved | Derived |  | RTU\_RAW\_READ,RTU\_RAW\_WRITE |  |
| 12620-12699 | Analog [Integer] - Reserved | Derived |  | RTU\_RAW\_READ,RTU\_RAW\_WRITE |  |
| 17600-17609 | Analog [Real] - Reserved | Derived |  | RTU\_ENG\_READ,RTU\_ENG\_WRITE |  |
| 17610-17619 | Analog [Real] - Peer Pressure Comms | Derived |  | RTU\_ENG\_READ |  |
| 17620-17699 | Analog [Real] - Reserved | Derived |  | RTU\_ENG\_READ,RTU\_ENG\_WRITE |  |
|  |  |  |  |  |  |
| **System Points** | | | | | |
| 50000+ |  |  |  |  |  |
|  |  |  |  |  |  |
| **Site Constants** | | | | | |
| N/A |  |  |  |  |  |

### 

### DNP3 Triggered and Buffered Events

DNP3 Points to UUTS SCADA (Brisbane Sites) are assigned a class as defined below.

Table 8 - DNP3 Point Data Classes

|  |  |  |
| --- | --- | --- |
| **DNP3 Point Data Class** | **Usage** | **Usage** |
| Local | No Event | Physical RTU I/O and unused points. |
| Class 0 (static) | No Event | Current data only |
| Class 1 | Triggered Event - Triggers transmission to SCADA | Priority 1 Alarms |
| Class 2 | Buffered Event | NOT USED |
| Class 3 | Buffered Event | Priority 2 and 3 Alarms, Events (e.g. pump start/stop)  Logged Analog Values |

Priority 1 alarms are configured to be unsolicited, which means that a change in state of that point causes a transmission to SCADA. Each DNP3 point must be configured individually to be unsolicited or not. By convention, only Class 1 points are configured as unsolicited, and only Class 1 is configured (at class level) to allow unsolicited transmissions.

Priority 2 and 3 Alarms, events, and logged analog values, are configured as Buffered Events, which means values are recorded in a buffer, and only transmitted to SCADA on a Poll (Full or Change of State), or when the event buffer has stored a certain number of events.

## Communications With SCADA

Communication between the Water Booster site and SCADA is via private radio network.

### DNP3 Points

Communications between the RTU and UUTS Master Station is done using DNP3 protocol. See “Table 8 - DNP3 I/O Address Map” above for address range information.

### Communications Failure (UUTS sites only)

Health of communications with the master station is not monitored by the RTU, but is monitored by the SCADA system using a heartbeat mechanism. See “Heartbeat Failed” alarm in section 7.3.1.2

## Peer Communications

Communications from the Peer site to the RTU is done is the same way as communications from the RTU to UUTS SCADA, using DNP3 over serial (RS232) communications via the Trio serial data Radio.

Peer communication is implemented by relaying signals via the SCADA Master rather than rebroadcast of communications traffic from radio base stations as has been the case historically. While two-way communication with the peer site is possible, only one-way communication (peer to local site) is used.

See “Table 8 - DNP3 I/O Address Map” above for address range information.

### Communications Failure

Detection of lost communications with the peer site is imperative while the site is running in Peer Pressure Control mode.

The health of the communications link from the peer site is monitored by the local RTU via a toggle bit which is alternatively set and reset at each update by the peer site. If the toggle bit has not changed for a set time, communications with the peer site is deemed to have failed. (See Peer Communications Timeout section 7.1.4.3)

# UUTS SCADA

## Overview

Each standard MPC water booster communicates with UUTS SCADA to allow remote monitoring and control of the site by operators in the QUU control room, and via remote access connections to the UUTS SCADA using Citrix.

The site RTU communicates to the UUTS master station using DNP3 protocol via Trio data radio.

The UUTS SCADA interface for a standard MPC water booster site includes:

* Site Schematic Page (see Figure 4, below)
* Equipment Popups
* Control Popup, for selecting station mode and manual pump set control (see Figure 5, below)
* Points List
* Controls List
* Alarm List
* Alarm Instructions
* Event Log
* Site Notes
* Site Info Page
* Function to Trend points selected on the schematic or in the points list.
* Navigation links to:
  + Peer Sites
  + Related Sites
  + Zone Schematics

Note: SCADA points tables throughout this document list points to be shown in UUTS SCADA.

## Points Database

Points are configured in the MOSAIC points database to allow visibility/modification of RTU tag values from SCADA. These points include:

* Digital Alarms and Events (Boolean)
* Analog Status (Integer and Real)
* Control Points (Boolean, Real and Integer)

The points list for a particular site will also include “system” points, internally calculated in SCADA.

The digital and analog status points can be viewed (along with their current status) in the Points List, accessible by selecting “Points” from the menu displayed when right clicking the “Functions” button on the schematic page. These points are used to drive the status indication on the site schematic and control popup.

Many control points are written to via controls on the relevant control or equipment popup (dialog). These and the remainder of the site control points can be modified directly in the Controls List, accessible by selecting “Controls” from the menu displayed when right clicking the “Functions” button on the schematic page.

## SCADA Pages

### Site Schematic

The site schematic provides the landing page and overview for the booster site.

The following points from the RTU are shown on the schematic:

* MPC system health status (healthy, alarm, warning, comms fault)
* MPC Mode and On/Off statuses
* Pump status (unavailable, running, speed)
* Suction pressure and pressure transmitter elevation in metres AHD
* Main Delivery pressure and pressure transmitter elevation in metres AHD
* Backup Delivery pressure and pressure transmitter elevation in metres AHD
* Delivery flow (l/s) and (Ml/d)
* Low Zone/Bypass flow (l/s) and (Ml/d)
* Totalised delivery and low zone/bypass flow volumes today (ML)
* Actual station control mode
* Current operator-selected station control mode
* Actual control mode discharge pressure or performance setpoint (as applicable)
* Site power status
* Generator Status (on site, running, online)
* Where Option Q – Pressure Vessel is selected, an accumulator will be displayed on the pump discharge line.

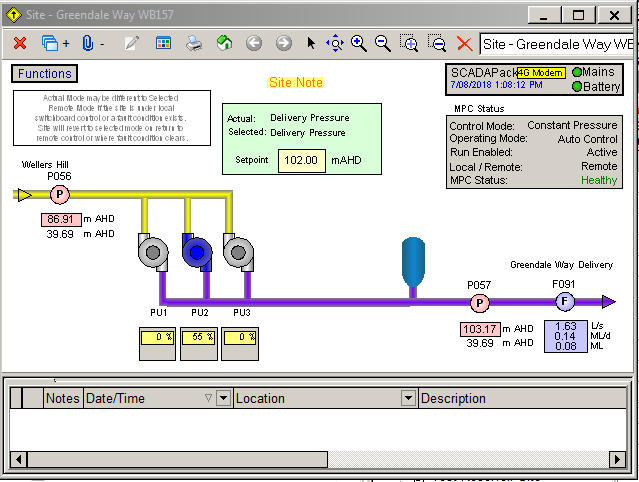


Figure 4 - Typical MPC Water Booster Site Schematic

Also provided on the site schematic is the time of the last communication with the RTU, and in the case of failure of communications with the RTU, a “No Telemetry” message is displayed.

The field at the bottom of the schematic displays active site alarms. The Alarm List window is accessible by selecting “Alarms” from the menu displayed when right clicking the “Functions” button on the schematic page.

#### Standard Schematic Template

The site schematics for all sites created under this standard are to be based on a new standard MPC water booster site schematic template.

The schematic is populated at runtime using site values. Schematic elements are made visible according to values of site option variables or whether the related points are defined for the specific site. Data such as pipe size, pipe colour, and labels for display of neighbouring sites and Zones are provided via equipment parameter records.

### Control Dialog

Clicking on any pump icon or the green station mode box on the site schematic opens the site control dialog (popup), shown below.

The top part of the dialog displays the actual mode and current operator-selected mode, and allows the operator to change mode via a drop-down box. It also provides buttons for the operator to reset MPC alarms and the Setpoint Clamped Alarm

The bottom part of the dialog displays tabs with current settings for each enabled mode, (tabs for modes which are not enabled via a site option are hidden) and allows modification of mode setpoints. In manual mode, the operator can also start and stop the MPC pump set via start/stop buttons.

The Control popup is defined as part of the schematic template.

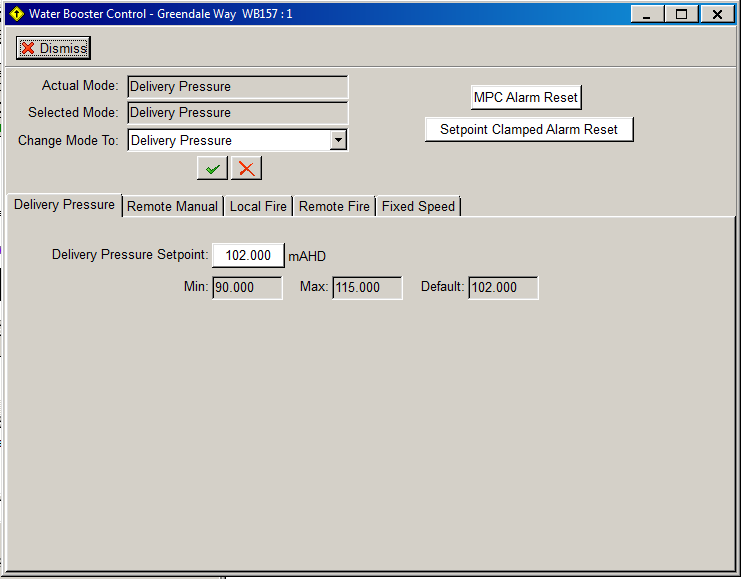


Figure 5 - Water Booster Control DIalog

### Zone Schematic

The water booster site is shown on the relevant zone schematic, which also allows navigation to the water booster’s schematic page.

Note: These Zone schematics were created as a proof of concept some years ago and are not maintained.

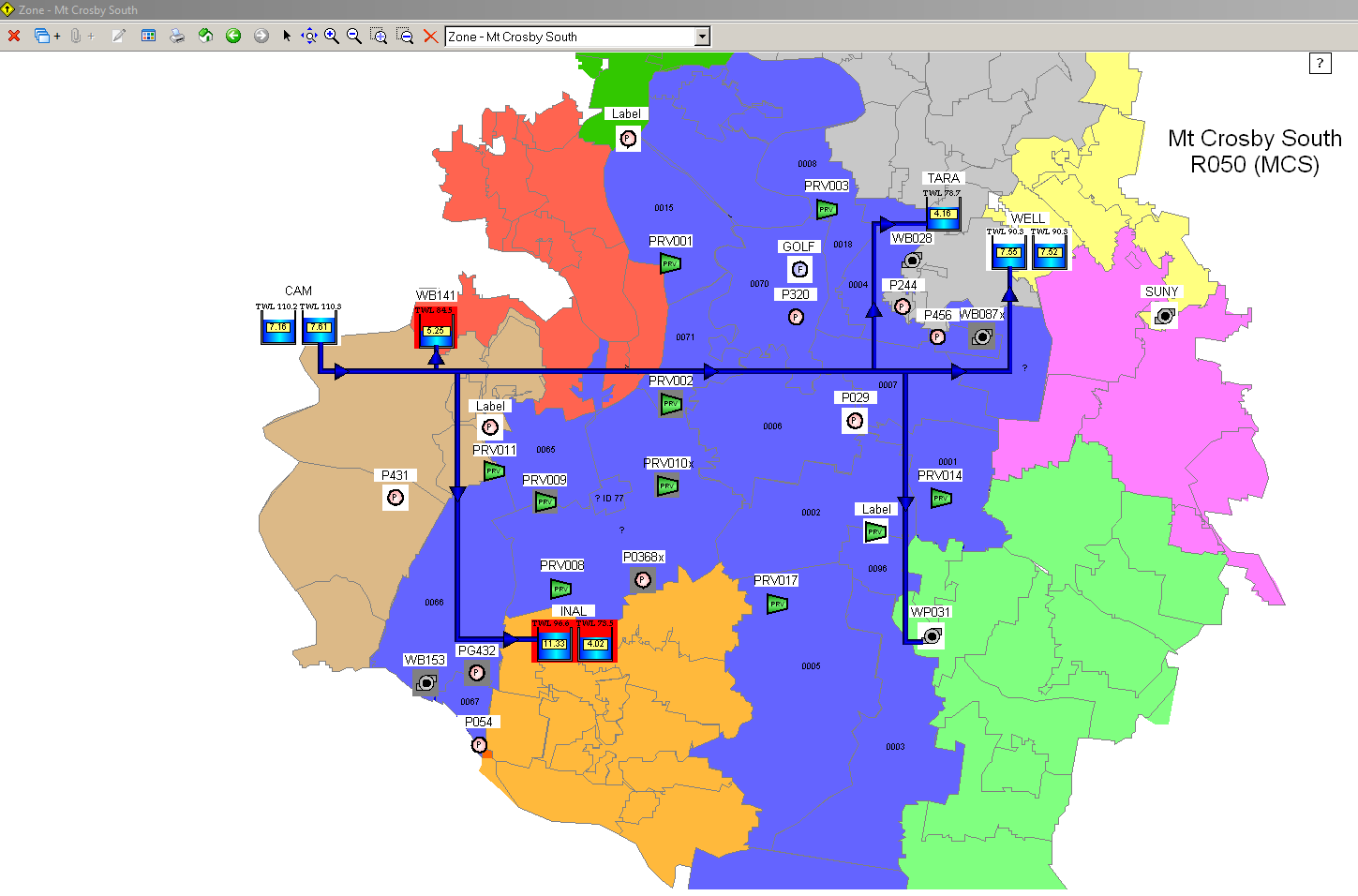


Figure 6 - Typical Zone Schematic

## Communications

The UUTS SCADA master station site communicates with the site RTU using DNP3 protocol via Trio data radio.

The site is polled periodically by the SCADA Master Station to bring back point statuses and download logged data. This period is site-specific based on site criticality.

The RTU can request an out-of-sequence update if a critical event occurs or an internal buffer reaches capacity. This is an implementation of a standard DNP3 protocol feature. Operator SCADA commands will immediately be sent to the RTU and will not wait for the next polling time.

### Polling

RTU points are read by the SCADA Master station using full scans and COS (change of state) scans. On a Full scan, the master station requests all values of all SCADA points. On COS scans, the master station requests only the points that have changed since the last COS or full scan.

Times between full and COS scans are site-specific depending on site criticality. An example site, WB032 Seventeen Mile Rocks Rd has Full Scan Rate set to 1800s (30min), and COS Scan Rate set to 480s (8 min).

A COS scan is also requested following sending of a control by an operator, so that the results of the control can be viewed. (This is a configurable option.)

### Communications Monitoring

Monitoring of the status of the communications link is provided to the operator by way of the ”DACUnit” and “RTU” equipment items, which are linked to elements on the site schematic.

The “RTU & Poll” schematic element shows the time of the last communication with the RTU. In the case of failure of communications with the RTU, a “No Telemetry” message is displayed in bold red text at the top of the site schematic via the “Telemetry Status” schematic element, which is linked to the “DACUnit” equipment item.

Figure 7 – RTU & Poll Schematic Element

Site communications status and settings can be viewed via the RTU/Module Telemetry popup. This is a system popup which includes entries for all sites.

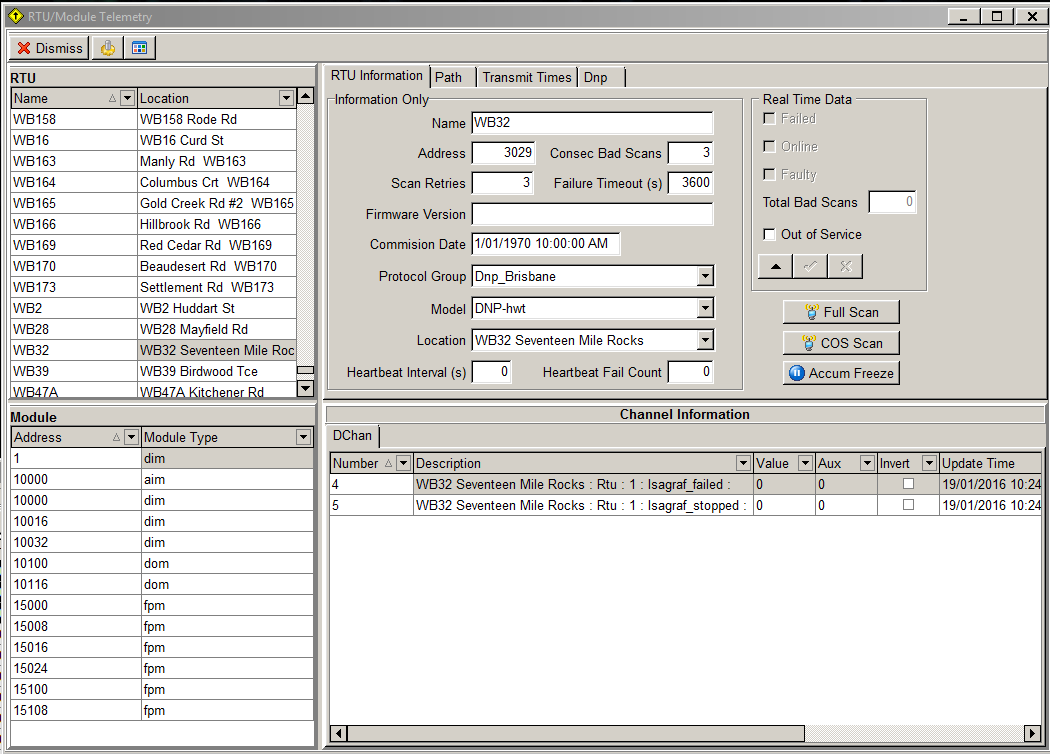


Figure 8 - RTU/Module Telemetry Popup

## Alarms

### Displays

Alarms for a site are displayed in the pane at the bottom of the site schematic page, and in a more accessible form, in the site’s alarm list window.

An alarm appears in the alarm list on activation of its alarm state. It remains in the alarm list until it has been acknowledged by an operator and it returns to its healthy state.

### Priorities

Alarms are classified with a High (1), Medium (2) or Low (3) priority, colour coded red, blue and green respectively in the alarm pane and alarm list. (Note: Events are priority 4)

|  |  |
| --- | --- |
| **Alarm Priority** | **Colour** |
| High | Red |
| Medium | Blue |
| Low | Green |

### Logging

While the alarm list only shows currently active and/or unacknowledged alarms, a record of all alarms (alarm state on, alarm state off and operator acknowledge action) is logged in the event log.

Note: For events, state is recorded in the event log on change of state.

### Alarm Resets

A number of alarms are latched by the RTU and require a reset from SCADA to return them to healthy state.

#### Abnormal Operation Reset

The Abnormal Operation Alarm indicates that the site RTU has restarted, and must be reset by the operator individually to ensure the operator is aware that the RTU has restarted.

Historically, for sites with non-retentive memory, the requirement to reset this alarm served as a reminder to the operator to check the current mode of the site and all setpoint feedback points, and resend setpoints and controls if necessary. The SCADAPack RTUs used by this standard have retentive memory, but this alarm is still useful as a reminder to check the site has restarted correctly.

#### Setpoint Clamped Alarm Reset

The setpoint clamped alarm is reset using the setpoint clamped alarm reset digital command. The requirement to reset this alarm serves as a reminder to the operator to check any recently changed setpoints.

#### MPC Alarm Reset

In any mode except Local Mode, an operator can send an alarm reset request to the MPC controller via the “MPC Alarm Reset” button in SCADA.

This control also resets (in any mode) any latched alarms derived in the RTU from the MPC’s Alarm or Warning registers.

#### Generator Alarm Reset

The generator alarm reset is used to reset generator fail to start/stop alarms, ATS fail to transfer alarms, and alarms related to the generator test sequence.

#### RTU Fault Reset

The RTU Fault Reset control is used to clear the System Error Code Register and hence reset the RTU System Error Alarm.

### Alarm Instructions

(To be updated following development of Standard MPC Water Booster Alarm Instructions)

Each alarm has a corresponding alarm instruction, which provides the control room operator with the actions required to be carried out if that alarm occurs. Below is an example of an alarm instruction file for the “Water\_Booster : Mains\_fail alarm”.

**Alarm Instruction – Water\_Booster : Mains\_fail     v0.00**

Alarm Message – “Fault”

The two states for the Water\_booster : Mains\_fail are:

|  |  |
| --- | --- |
| **State** | **Description** |
| Fault | An Supply Authority supply loss is currently being detected for the site. |
| Ok | Supply Authority supply to the site has been restored. |

**Description**

The site has lost Supply Authority supply.

**Possible Causes**

-       The site is experiencing a Supply Authority power failure.

-       The circuit breaker protecting the power fail relay has tripped.

**Consequences**

-       The RTU, flow/pressure transmitters are running on batteries, which may fail at any time.

- The water booster pump has no power and cannot boost the zone pressure.

-       **If the site batteries fail, the site will not communicate, and monitoring and control will not be possible.**

**Required Action**:

-       Contact Supply Authority

o       If Supply Authority are aware of the problem:

         Request an estimate of when power will be restored.

o       If Supply Authority are unaware of any problem:

         An urgent inspection is required.

         Notify Field Services to Attend.

o       Also advise Supply Authority of:

         Pole or pillar box number if available from site info page.

         Urgency of supply restoration.

-       Check Inlet Valve status – manually open valve if required.

- Create Site Note (include Work Order Number).

In general, the alarm instructions are generic across sites for each alarm plant and quantity. The SCADA administrator can generate a site specific instruction file if the site needs a unique instruction.

A listing of all alarm instructions for standard MPC water booster sites is provided in Appendix E.

## Trends

Trend data is captured in the RTU using analog events. Analog events can be triggered using deviation settings as configured in the site E Configurator (.rtu) file, or by RTU logic. (see section 5.3 Analog Trend Data Logging.)

An operator is able to view trends for various points (where they have been configured) by clicking the equipment icon(s) on the schematic page, or clicking the point(s) in the points list, and then selecting “Trend Points” from the menu displayed when right clicking the “Functions” button on the schematic.

## Site Info Page

All water booster sites have a Site Info (Location Instruction) page, which shows information such as UBD and Bimap references, as well as equipment identifiers.

Figure 9 - Example Site Info Page

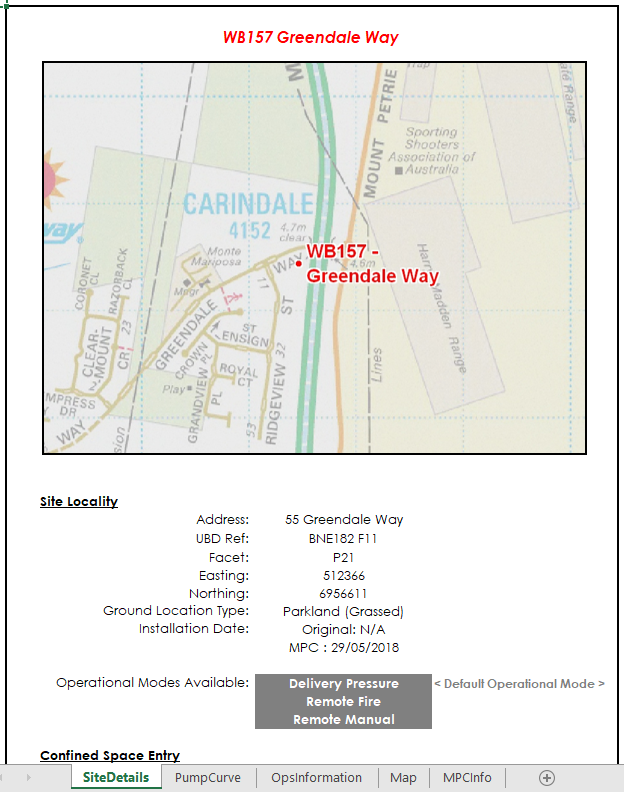


Figure 10 - Site Info Page

## Security

Access to UUTS SCADA is by individual user account. Users are assigned different roles which define their ability to access certain menus and functions and control a site.

The roles are:

1. Admin
2. Support
3. Operator
4. User
5. Visitor

In addition, sites are assigned to areas of authority:

1. Water
2. Sewage
3. Water Quality

Users are also assigned an area of authority, which determines the alarms the user receives by default. e.g. By default, a user with the Water Area of Authority will receive alarms only from sites in the Water Area of Authority.

## System Colours and Fonts

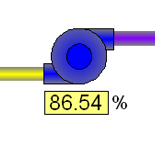
### Alarm Colours

Alarms are classified with a High (1), Medium (2) or Low (3) priority, colour coded red, blue and green respectively in the alarm pane and alarm list. (Note: Events are priority 4)

|  |  |
| --- | --- |
| **Alarm Priority** | **Colour** |
| High | Red |
| Medium | Blue |
| Low | Green |

### Equipment Status Colours

Pump status is shown via the colour of the circle in the centre of the pump icon on the schematic.



|  |  |
| --- | --- |
| **Status** | **Colour** |
| Running | Blue |
| Stopped | Grey |
| Unavailable | Red |

Figure 11 - Pump Status Indication - Running

1. Standard Physical I/O List Template
2. Example CU352 and Pump VSD Settings

To be included following commissioning of first contract C1392 site.

1. Standard SCADA Point List

To be included following update of standard MPC Water Booster SCADA.

1. Standard Alarm Instructions

To be completed following development of Standard MPC Alarm Instructions.

1. Maintenance Mode (UUTS SCADA Only)

Maintenance Mode functionality has been developed for execution by the Master Station, rather than by the PLC/RTU. The following is an overview of maintenance mode functionality; refer to the functional specification “SCADA Maintenance Mode Functional Requirements Specification” [[3]](#endnote-3) for further details.

Maintenance mode will be activated by the Control Room operator by using a popup screen which will have the following control features.

1. On-site personnel check-in or check-out (Visitor or Maintenance mode)

2. Ability to set on-site duration (20 mins to 4 hours)

3. Current Status (Off/On)

4. Warning alarm 10 minutes prior to on-site duration expiring

The main screen of the site will indicate whether the site is in maintenance mode. The operator will initiate maintenance mode when an on-site operator calls in from site. The on-site duration is to be determined in consultation with the on-site operator. When the on-site operator calls in to leave site, the control room operator will deactivate maintenance mode and ensure there are no active alarms for the water booster site.

Maintenance mode will alarm inhibit all alarms for the water booster station with the following exceptions;

* Delivery Pressure Low Alarm
* Site maintenance mode
* Site visitation mode

All points that are not affected by maintenance mode have the Disable Alarm Inhibit (DAI) point attribute.



# REFERENCES

1. [↑](#endnote-ref-1)
2. |  |  |
   | --- | --- |
   | TITLE | *TMS1202 Control System Implementation* |
   | Document ID | TMS1202 |
   | Version | 3 (Jan 2017) |
   | Author | Steve Bourke |
   | Document owner | Ken Vaheesan |

   [↑](#endnote-ref-2)
3. |  |  |
   | --- | --- |
   | TITLE | SCADA Maintenance Mode Functional Requirements Specification |
   | Document ID | N/A |
   | Version | TBC |
   | Author | Logica (now known as CMG) |
   | Document owner | TBA |

   |  |  |
   | --- | --- |
   | TITLE | *TMS1229 PLC Programming and Configuration Standard* |
   | Document ID | TMS1229 |
   | Version | 3.0 (Jan 2016) |
   | Author | Steve Bourke |
   | Document owner | Ken Vaheesan |

   |  |  |
   | --- | --- |
   | TITLE | *ISaGRAF Naming Convention* |
   | Document ID | N/A |
   | Version | N/A |
   | Author | Unknown |
   | Document owner | TBA |

   |  |  |
   | --- | --- |
   | TITLE | Water Booster Pump Station Standard Technical Specification |
   | Document ID | TMS1638 |
   | Version | 0 (06/09/2016) |
   | Author | Harald Kemmetmuller |
   | Document owner | TBA |

   |  |  |
   | --- | --- |
   | TITLE | SCADAPack E Data Processing Technical Reference |
   | Document ID | N/A |
   | Version | 8.12.1, May 2015 |
   | Author | Schneider Electric |
   | Document owner | N/A |

   |  |  |
   | --- | --- |
   | TITLE | Modbus for Grundfos boosters |
   | Document ID | 5153608 |
   | Version | “Modbus for Grundfos Booster – 5153608.pdf” |
   | Author | Grundfos |
   | Document owner | N/A |

   [↑](#endnote-ref-3)