WOODWARD

Product Manual 35072V1
(Revision D, 1/2026)
Original Instructions

Vertex Digital Control for Performance and Compressor Control

Volume 1
Installation, Operation, and Configuration Manual

Manual 35072 consists of 3 volumes (35072V1, 35072V2, & 35072V3).

General Precautions	**Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.** **Practice all plant and safety instructions and precautions.** **Failure to follow instructions can cause personal injury and/or property damage.**

Revisions	**This publication may have been revised or updated since this copy was produced. The latest version of most publications is available on the Woodward website.** **Woodward Industrial Support: Get Help** **If your publication is not there, please contact your customer service representative to get the latest copy.**

Proper Use	**Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.**

Translated Publications	**If the cover of this publication states "Translation of the Original Instructions" please note:** **The original source of this publication may have been updated since this translation was made. The latest version of most publications is available on the Woodward website.** **Woodward Industrial Support: Get Help** **Always compare to the original for technical specifications for proper and safe installation and operation procedures.** **If your publication is not on the Woodward website, please contact your customer service representative to get the latest copy.**

Revisions— A bold, black line alongside the text identifies changes in this publication since the last revision.

Contents

Illustrations and Tables

Warnings and Notices

Important Definitions

This is the safety alert symbol used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

- **DANGER** - Indicates a hazardous situation, which if not avoided, will result in death or serious injury.
- **WARNING** - Indicates a hazardous situation, which if not avoided, could result in death or serious injury.
- **CAUTION** - Indicates a hazardous situation, which if not avoided, could result in minor or moderate injury.
- **NOTICE** - Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT** - Designates an operating tip or maintenance suggestion.

NOTICE

To prevent damage to a control system that uses an alternator or battery-charging device, make sure to turn off the charging device before disconnecting the battery from the system.

NOTICE

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual *82715*, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

WARNING

Overspeed / Overtemperature / Overpressure

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

WARNING

Start-up

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

⚠WARNING

Personal Protective Equipment

The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:

- **Eye Protection**
- **Hearing Protection**
- **Hard Hat**
- **Gloves**
- **Safety Boots**
- **Respirator**

Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.

⚠WARNING

IOLOCK. When a CPU or I/O module fails, watchdog logic drives it into an IOLOCK condition where all output circuits and signals are driven to a known de-energized state as described below. Design the System such that IOLOCK and power OFF states will result in a SAFE condition of the controlled device.

- **CPU and I/O module failures will drive the module into an IOLOCK state**
- **CPU failure will assert an IOLOCK signal to all modules and expansion racks to drive them into an IOLOCK state.**
- **Discrete outputs / relay drivers will be non-active and de-energized**
- **Analog and Actuator outputs will be non-active and de-energized with zero voltage or zero current.**

The IOLOCK state is asserted under various conditions including

- **CPU and I/O module watchdog failures**
- **Power Up and Power Down conditions.**
- **System reset and hardware/software initialization**
- **Entering configuration mode**

NOTE: Specify additional watchdog details and any exceptions to these failure states in the related CPU or I/O module section of the manual.

⚠CAUTION

Emergency Disconnecting Device

An emergency switch or circuit breaker shall be included in the building installation that is in close proximity to the equipment and within easy reach of the operator. The switch or circuit breaker shall be clearly marked as the disconnecting device for the equipment. The switch or circuit breaker shall not interrupt the Protective Earth (PE) conductor.

⚠CAUTION

Risk of Calibration and Checkout

Authorized personnel knowledgeable of the risks posed by live electrical equipment should only perform the calibration and checkout procedure.

⚠CAUTION **Fuse Power Supply Mains**	**Properly fuse the Power Supply MAINS according to the NEC/CEC or Authority Having Final Jurisdiction per the Input Power Specifications.**

Electrostatic Discharge Awareness

NOTICE **Electrostatic Precautions**	**Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:** • **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).** • **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.** • **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.** **To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual *82715*, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.**

Follow these precautions when working with or near the control.

1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
2. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

NOTICE	**To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.**

⚠WARNING **SOFTWARE**	**An unsafe condition could occur with improper use of the software tools used with the Vertex control. Only trained personnel should have access to these tools.**

Regulatory Compliance

European Compliance for CE Marking:
These listings are limited only to those units bearing the CE Marking. Refer to DoC for applicability by part number.

EMC Directive: Declared to Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility. (EMC)

ATEX – Potentially Explosive Atmospheres Directive: Declared to Directive 2014/34/EU on the harmonization of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres.
Zone 2, Category 3, Group II G, Ex ic nA IIC T4 X Gc IP20

Low Voltage Directive: Declared to Directive 2014/35/EU on the harmonization of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits.

Other European and International Compliance:

IECEx: Ex ic nA IIC T4 Gc T4 Certificate: IECEx CSA 15.0020X
IEC 60079-0: 2017 – Explosive Atmospheres – Part 0 Equipment General Requirements
IEC 60079-11: 2011 – Explosive Atmospheres – Part 11 Equipment Protection by Intrinsic Safety “i”
IEC 60079-15: 2010 – Explosive Atmospheres – Part 15: Equipment protection by type of protection “n”

North American Compliance:
These listings are limited only to those units bearing the CSA identification.

Units bearing only the CSA identification are restricted for use only in Ordinary Locations in North America.

Units bearing the CSA identification in addition to the marking indicating Class I, Div 2, Groups A, B, C and D are acceptable for use in North American Hazardous Locations.

CSA: CSA Certified for Class I, Division 2, Groups A, B, C, & D, T4 at 70 °C surrounding air temperature. For use in Canada and the United States.
CSA Certificate 70006135

This product is certified as a component for use in other equipment. The final combination is subject to acceptance by the authority having jurisdiction or local inspection.

Special Conditions for Safe Use

The Vertex Compressor Control shall not be installed in areas exceeding Pollution Degree 2 as defined in IEC 60664-1 and Overvoltage Category II.

The controls containing a LCD and Keypad must be mounted in a vertical position with air vents located at the top and bottom of the unit. The Bulkhead mount control can be mounted in a vertical or horizontal position. Regardless of the mounting orientation, the air temperature surrounding the control cannot exceed 70˚C.

A fixed wiring installation is required. Field wiring must be in accordance with North American Class I, Division 2 (CEC and NEC), or European Zone 2, Category 3 wiring methods as applicable, and in accordance with the Local Inspection Authority having jurisdiction. On high voltage versions of the control the interior of the enclosure shall not be accessible in normal operation without the use of a tool.

A switch or circuit breaker shall be included in the building installation that is in close proximity to the equipment and within easy reach of the operator. The switch or circuit breaker shall be clearly marked as the disconnecting device for the equipment. The switch or circuit breaker shall not interrupt the Protective Earth (PE) conductor.

Field wiring must be suitable for the following temperatures:
- Power Input rated minimum of +95˚C.
- All remaining connections; +10˚C above highest ambient temperature.

Protective Earth Grounding of the Vertex Compressor Control connection to the PE terminal is required.

Hazardous Locations

The Low Voltage ATEX Vertex Compressor Control is suitable for use in Class I, Div 2, Gas, Groups A, B, C, and D & European Zone 2, Group IIC environments

The risk of electrostatic discharge is reduced by permanent installation of the Vertex, proper connection of the equipotential ground lugs, and care when cleaning. Verify that the area is non-hazardous prior to the device being cleaned or wiped off.

The Real Time Clock Battery located on the CPU board is not to be recharged and is not user replaceable. Contact a Woodward Authorized Service Center if replacement service is needed.

The controls with an LCD and Keypad must be installed in an area or enclosure providing adequate protection against high impact. (4 Joules and 7 Joules) The control is rated for 2 Joules impact.

The Vertex Bulkhead control must be installed in an area or enclosure that protects the control from any impact.

ATEX/IECEx locations require that the Vertex Control with a keypad and display be installed in a cabinet or enclosure coded Ex nA or Ex e that provides a minimum IP54 ingress protection per IEC 60529 for the rear of the control. The front bezel, keypad and display have been tested and are rated IP54 while the rear of the control is rated IP20 due to the ventilation slots required for heat dissipation. The installer shall ensure that the maximum surrounding air temperature in the enclosure does not exceed the rated temperature of +70˚C.

The Vertex Bulkhead Control without the front panel display or keyboard must be installed in a cabinet or enclosure coded Ex nA or Ex e that provides a minimum IP54 ingress protection per IEC 60529. The installer shall ensure that the maximum surrounding air temperature in the enclosure does not exceed the rated temperature of +70˚C.

Transient Protection for the Vertex is to be provided externally by the end user at the supply terminals of the control. The transient protection device is to be set at a level not exceeding 140% of the maximum rated peak voltage of 36Vdc.

⚠WARNING **Explosion Hazard**	**For ATEX/IECEx installation compliance, the input voltage shall be limited to 36 Vdc. When selecting an external power supply to supply the Control, it shall be ATEX/IECEx approved for Zone 2 Group IIC, Category 3G Applications.**

⚠WARNING **Explosion Hazard**	**Due to the Hazardous Location Listings associated with this product, proper wire type and wiring practices are critical to the operation.**

⚠WARNING

Electric Shock

To reduce the risk of Electrical Shock the Protective Earth (PE) must be connected to the PE ⏚ terminal on the enclosure. The conductor providing the connection must have a properly sized ring lug and wire gauge equal to or larger than 4mm² (12AWG).

⚠WARNING

Explosion Hazard

ENCLOSURE REQUIREMENT—
ATEX/IECEx Zone 2, Category 3G applications require the final installation location provide a minimum IP-54 ingress protection enclosure against dust and water per IEC 60529. The enclosure must be coded Ex nA or Ex e.

⚠WARNING

Explosion Hazard

Do Not Remove Covers or Connect/Disconnect electrical connectors unless power has been switched off or the area is known to be non-hazardous

⚠WARNING

Explosion Hazard

Substitution of components may impair suitability for Class 1, Division 2, or Zone 2.

⚠WARNING

Explosion Hazard

Properly connect the external ground lugs shown on the installation drawing to ensure equipotential bonding. This will reduce the risk of electrostatic discharge in an explosive atmosphere. Perform cleaning by hand or water spray while the area is non-hazardous to prevent an electrostatic discharge in an explosive atmosphere.

⚠WARNING

Explosion Hazard

MOUNTING
Controls containing a LCD and Keypad must be mounted in a vertical position. The installer shall ensure the maximum surrounding air temperature of the control does not exceed 70˚C at the final location.

⚠WARNING

Explosion Hazard

Class I, Div 2 Groups A, B, C, D and Zone 2, Group IIC applications require the input voltage to the relay contacts not exceed 32Vac rms or 32Vdc.

⚠AVERTISSEMENT

Risque d'explosion

Ne pas enlever les couvercles, ni raccorder / débrancher les prises électriques, sans vous en assurez auparavant que le système a bien été mis hors tension; ou que vous situez bien dans une zone non-explosive.

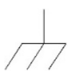
⚠AVERTISSEMENT

Risque d'explosion

La substitution de composants peut rendre ce matériel inacceptable pour les emplacements de Classe I, Division 2 et/ou Zone 2.

> **⚠ AVERTISSEMENT**
>
> **Risque d'explosion**
>
> **Ne pas utiliser les bornes d'essai du block d'alimentation ou des cartes de commande à moins de se trouver dans un emplacement non dangereux.**

Safety Symbols

	Direct current
	Alternating current
	Both alternating and direct current
	Caution, risk of electrical shock
	Caution, refer to accompanying documents
	Protective conductor terminal
	Frame or chassis terminal

Abbreviations

AS	Anti-surge
ASC	Anti-surge Control
GAP	Graphical Application Programmer
OP	Operating Point
PFC	Performance Controller
SCL	Surge Control Line
SLL	Surge Limit Line

Chapter 1.
General Information

Introduction

This manual describes the Woodward Vertex and VertexDR Digital Compressor Control for use with one or two section compressors (axial and centrifugal). The option charts below show the part numbers and the differences between the models. Volume 1 of this manual describes the control, provides installation instructions, defines hardware specifications, and explains the configuration (programming) and operating procedures. Volume 2 includes notes on applying the control to specific applications and Service mode information. Volume 3 includes a detailed commissioning procedure. This manual does not contain instructions for the operation of the complete compressor system. For compressor or plant operating instructions, contact the plant-equipment manufacturer.

VertexDR refers to the latest, preferred models which support either simplex or redundant system architectures. Throughout this manual, all descriptions of functionality using the term Vertex also apply to the VertexDR

Part Number Options

Table 1-1 lists models with an integrated display. Models with display are panel mounted and include a color graphical display that has the capability of customization to unique compressor, OEM, and customer requirements.

Table 1-1. Vertex (with display) Part Number Options

Simplex Only Units

Part Number	Power
8200-1370	LVDC (18-36 Vdc) Ordinary Location Compliance
8200-1371	AC/DC (88-264 Vac or 90-150 Vdc) Ordinary Locations Compliance
8200-2372	ATEX Compliance LVDC (18-36 Vdc)

VertexDR Units – Preferred Models
(Support Simplex or Redundant Configurations)

Part Number	Power
8200-1373	LVDC (18-36 Vdc) Ordinary Location Compliance
8200-1374	AC/DC (88-264 Vac or 90-150 Vdc) Ordinary Locations Compliance
8200-2375	ATEX Compliance LVDC (18-36 Vdc)

Figure 1-1. Vertex Compressor Control (with display)

Table 1-2 lists models without an integrated display. These models are a bulkhead-mounted version of the Vertex. Configured without a display, the Vertex without a display is ideal for remote environments.

Table 1-2. Vertex (without display) Part Number Options

Simplex Only Units

Part Number	Power
8200-1380	LVDC (18-36 Vdc) Ordinary Location Compliance
8200-1381	AC/DC (88-264 Vac or 90-150 Vdc) Ordinary Locations Compliance
8200-2382	ATEX Compliance LVDC (18-36 Vdc)

VertexDR units – Preferred Models
(Support Simplex or Redundant Configurations)

Part Number	Power
8200-1383	LVDC (18-36 Vdc) Ordinary Location Compliance
8200-1384	AC/DC (88-264 Vac or 90-150 Vdc) Ordinary Locations Compliance
8200-2385	ATEX Compliance LVDC (18-36 Vdc)

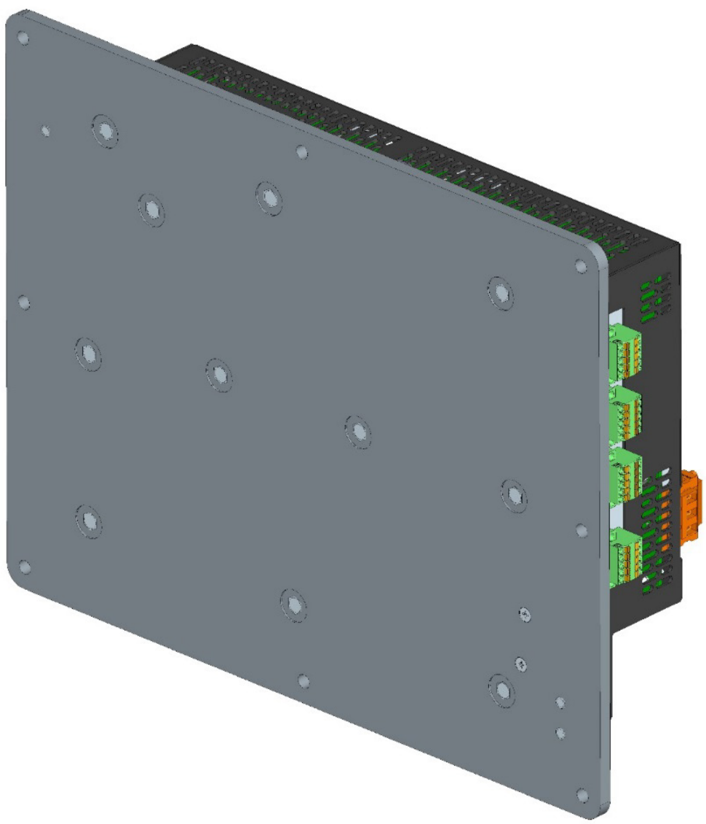


Figure 1-2. Vertex Compressor Control (without display)

Redundant or Simplex Operation

The VertexDR application is designed as a redundant application that also allows a simplex configuration. This is a configuration setting that cannot be changed with the compressor in operation. Configuration as a simplex control will mask out all functions and events related to the backup unit. At any time in the future another unit can be added to the system and this unit can be reconfigured for redundancy. To run as simplex these are the requirements:

1. Chassis is set to Primary
2. Simplex mode is selected in Train Configuration
3. The DR-FTM cannot be used

When configuring the unit for simplex operation, the chassis designation DIP switches are required to be set in the Primary chassis positions. This is the factory default setting of these switches for all VertexDR part numbers, so typically the switches should not need any adjustments for operation as a simplex unit.

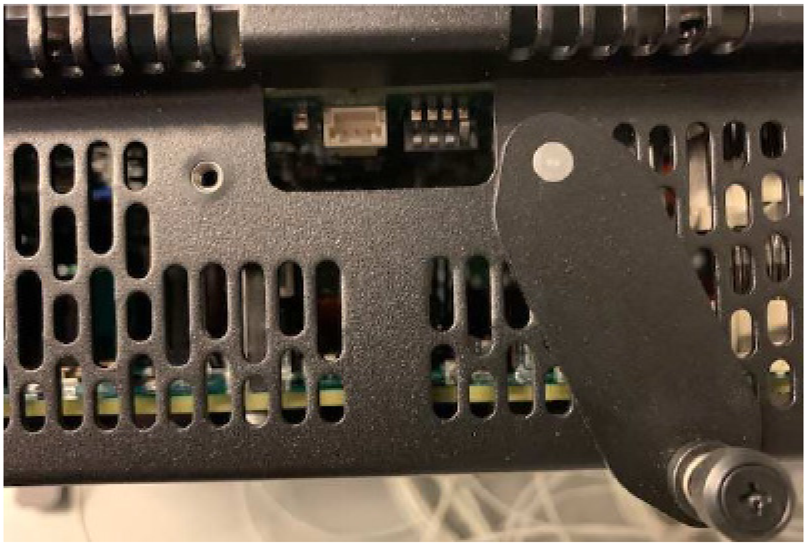


Figure 1-3. Switch Settings for Primary (correct setting for Simplex configuration)

In the **Train Configuration** section of the **Configuration** screens, simplex mode is enabled by unchecking the **Redundant Vertex Control** checkbox. The application default setting of this parameter is to be checked which enables redundant operation.

For redundant system architectures using 2 units, refer to the chapter titled “Dual Redundant Configurations” for complete details on configuration settings and chassis interlock connections. Either unit in a redundant pair can operate the compressor indefinitely in ‘Run Alone’ mode, however persistent alarms will sound in response to the backup unit being unavailable.

General Installation and Operating Notes and Warnings

The Standard Low Voltage and High Voltage Controls are suitable for use in ordinary locations only. The Low Voltage ATEX Control is suitable for use in Class I, Division 2, Groups A, B, C, and D or Class I, European Zone 2, Group IIC environments or non-hazardous locations.

These listings are limited only to those units bearing the certification identification.

Field wiring must be stranded copper wire rated at least 75 °C for operating ambient temperatures expected to exceed 50 °C.

Peripheral equipment must be suitable for the location in which it is used.

Wiring must be in accordance with North American Class I, Division 2, or European Zone 2 wiring methods as applicable, and in accordance with the authority having jurisdiction.

Controller Overview

General Description

The Vertex Compressor Control is field programmable which allows a single design to be used in many different control applications and reduces both cost and delivery time. It uses a built in graphical user interface (GUI) with multi-lingual menu driven screens to instruct site engineers on configuring the control to a specific compressor application. The Vertex can be configured to operate as a stand-alone unit or in conjunction with a plant’s Distributed Control System.

The Vertex control has 12 PID controllers that can affect the controlled operation of the compressor.

1. Anti-Surge PID Stage 1
2. Suction Pressure Override Stage 1
3. Discharge Pressure Override Stage 1
4. Rate Control PID Stage 1
5. Anti-Surge PID Stage 2
6. Suction Pressure Override Stage 2
7. Discharge Pressure Override Stage 2
8. Rate Control PID Stage 2
9. Performance Control PID
10. Performance Limiter 1 PID
11. Performance Limiter 2 PID
12. Load Sharing PID

Depending on the configuration of the Vertex, these PIDs may be used or not used. Please refer to the Block diagrams listed later in this chapter to fully understand PID relationships.

Anti-Surge Control

The Vertex can be applied to protect one or two section compressor trains from surge. The control is configured with the OEM provided compressor performance map which describes the Surge Limit Line. A Surge Control Line with a configured margin away from the Surge Limit Line is generated. The controller continuously monitors the current operating point of the compressor and compares it with the Surge Control Line to determine if opening of the Anti-surge valve is necessary. The Vertex control protects against surge by modulating one or two Anti-Surge Valves (or blow-off valve) while keeping process conditions within acceptable limits.

Performance Control

The Vertex has a Performance Controller (PFC) which is commonly configured to drive suction/discharge throttle valves, Inlet Guide Vane position, or speed control setpoint. When configured, this control function is used to control compressor suction pressure, compressor discharge pressure, compressor flow, or any process variable related to compressor flow or load. This control function compares an analog input signal to an internal setpoint and, depending on the programmed configuration, positions the compressor throttle valve, inlet guide vanes, torque converter, and/or motor speed (VFD) to accomplish the desired control.

Figure 1-1 shows an example of a compressor application with a typical 1-section, 1-valve compressor train. Figure 1-2 shows an example of a compressor application with a typical 2-section, 2-valve compressor train.

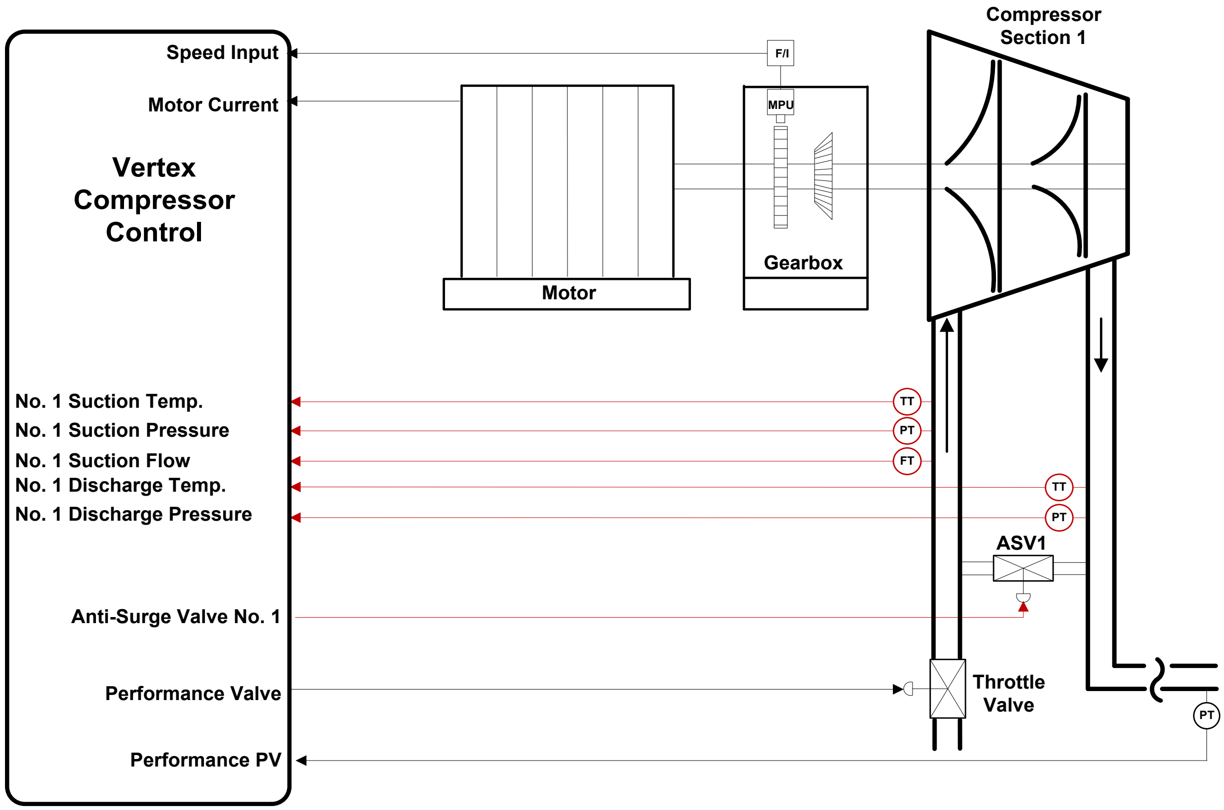


Figure 1-4. Typical One Section Compressor Application

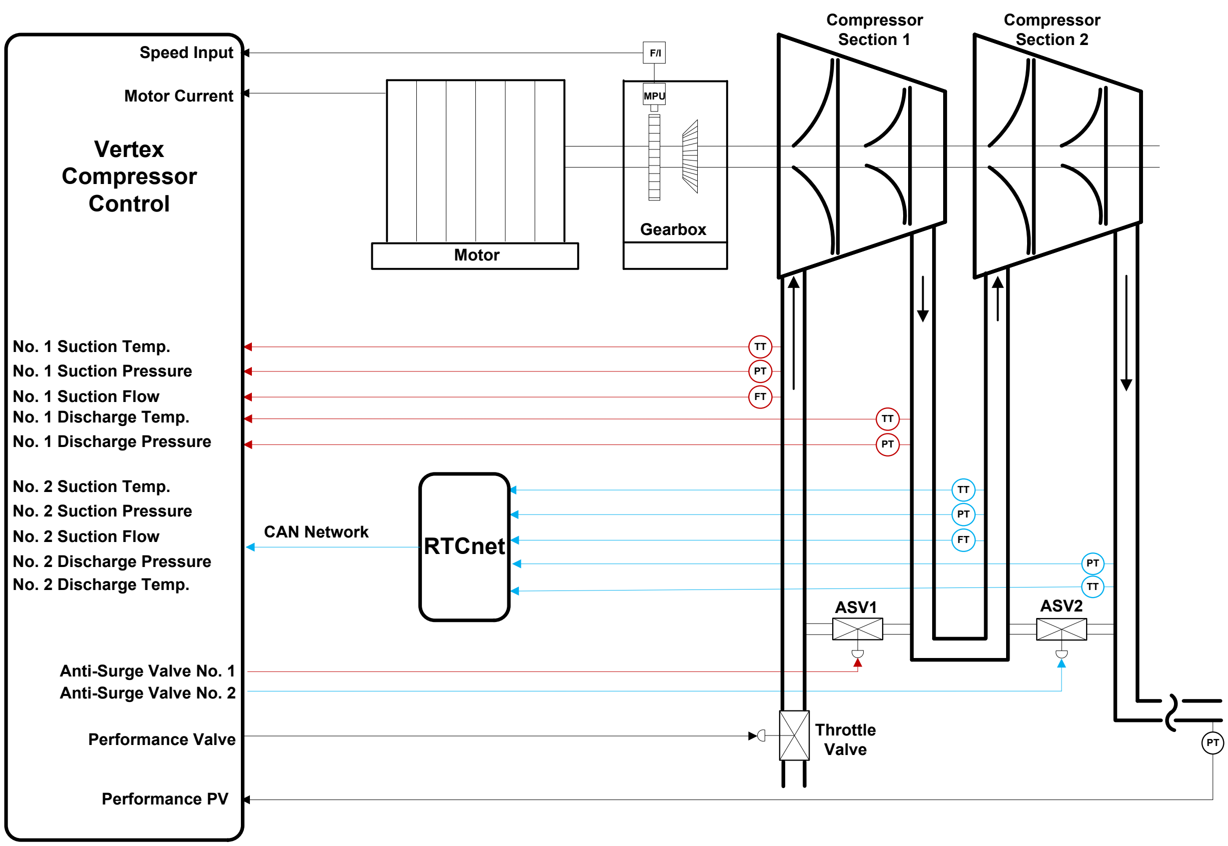


Figure 1-5. Typical Two Section Compressor Application

Load Sharing Control

When multiple compressor trains are given the task of controlling a common process variable, such as suction header pressure or discharge header pressure, multiple Vertex control units can be connected together to equally share the load across multiple compressor trains. The Vertex can load share between two, three, four, or five compressor trains. The load sharing algorithm works with the performance controller outputs to maintain the common process variable (suction or discharge header pressure) and to balance the load between the compressors.

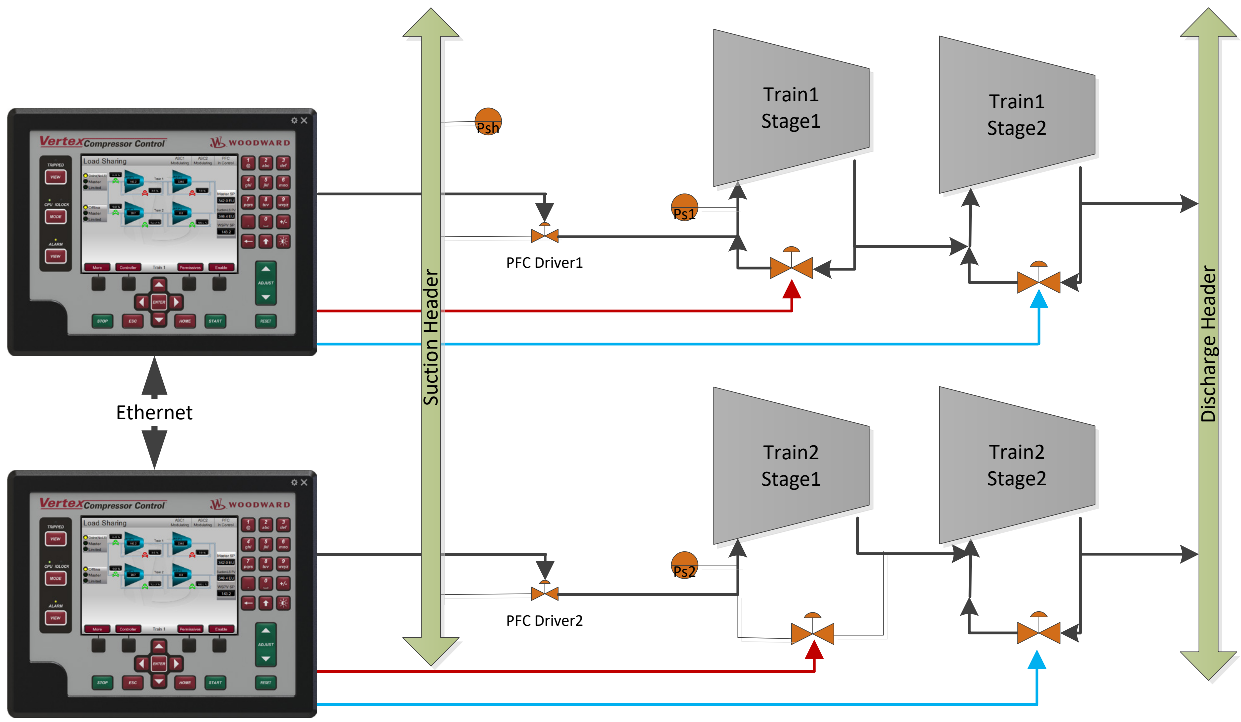


Figure 1-6. Load Sharing Compressor Application

Quench Definition

Quench is a process used in closed-loop refrigeration applications. Hot recycled gas is cooled by injecting liquid in the recycle line. The liquid used for quenching is produced as part of the refrigeration process. The liquid phase is converted to gas phase when it is injected in the hot recycle line. The phase conversion absorbs heat from the hot recycled gas, which lowers its temperature. Quench prevents the compressor suction temperature from exceeding operational limits. A typical piping schematic for a system with quench is shown in Figure 1-7.

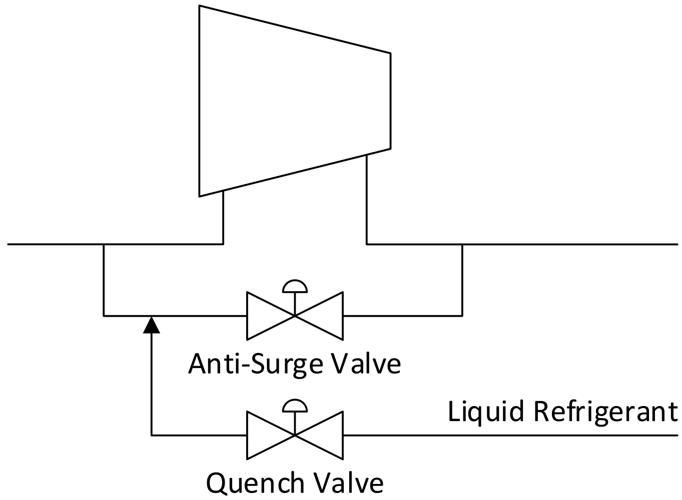


Figure 1-7. Anti-Surge and Quench Valves

Quench Control

The quench valve regulates the amount of liquid injected in the recycle line. If too much liquid is injected, a trip may be triggered as the liquid level in the suction knockout drum exceeds safe limits. If too little liquid is injected, the suction temperature may exceed safe limits. In its simplest form, a quench controller is a standard PID loop that maintains the suction temperature at a setpoint by positioning the quench valve.

Functional Block Diagrams

An overview of the anti-surge and capacity control functions is shown in Figure 1-5. Use this diagram to match the ASC's control features to the site-specific application. Many of the features of the ASC are configurable or optional. Later in this manual, more detailed functional block descriptions will be given for each control feature. The functional diagram in Figure 1-4 is identical for additional sections of anti-surge control.

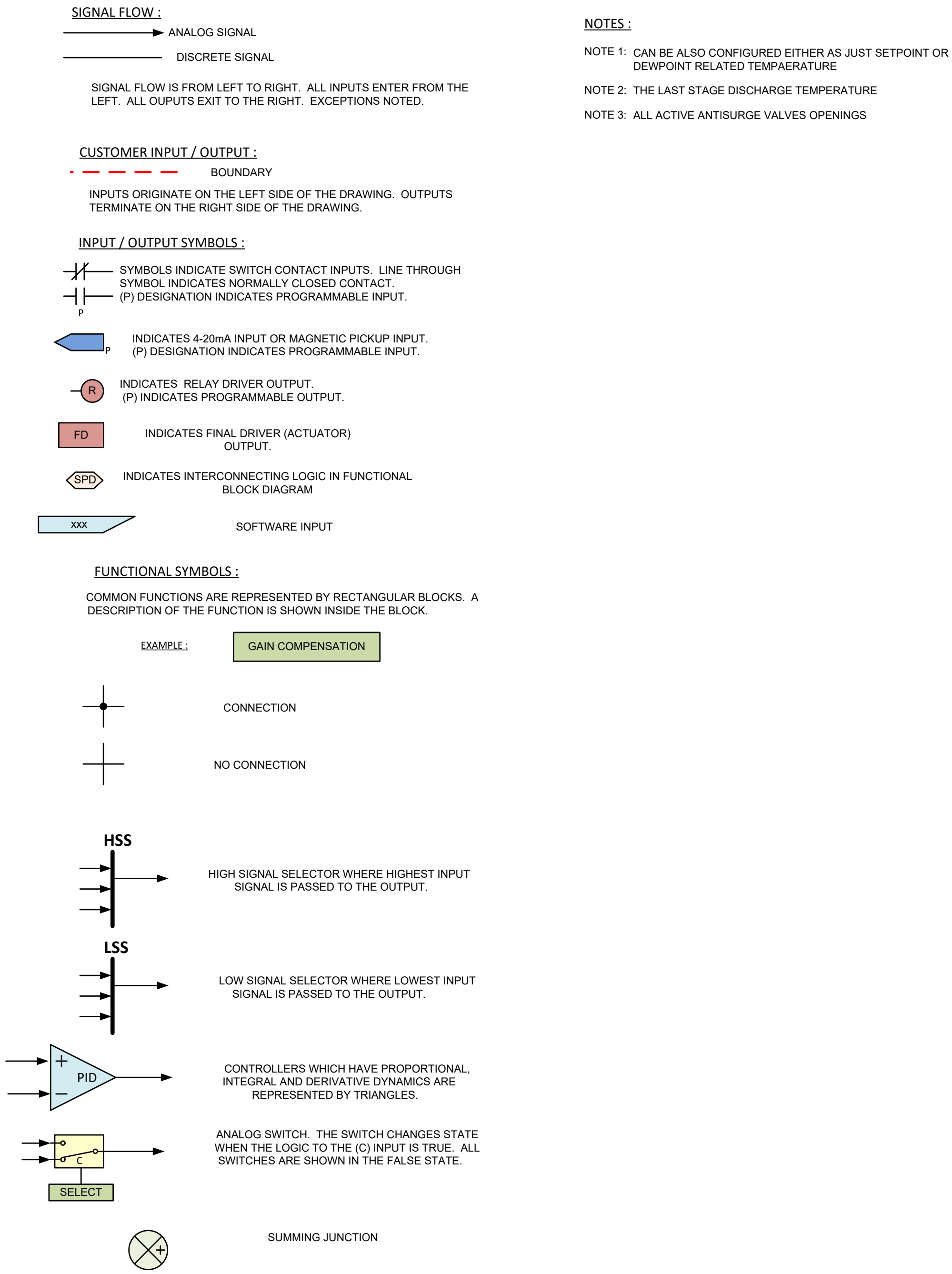


Figure 1-8. Overview of ASC Functionality Notes

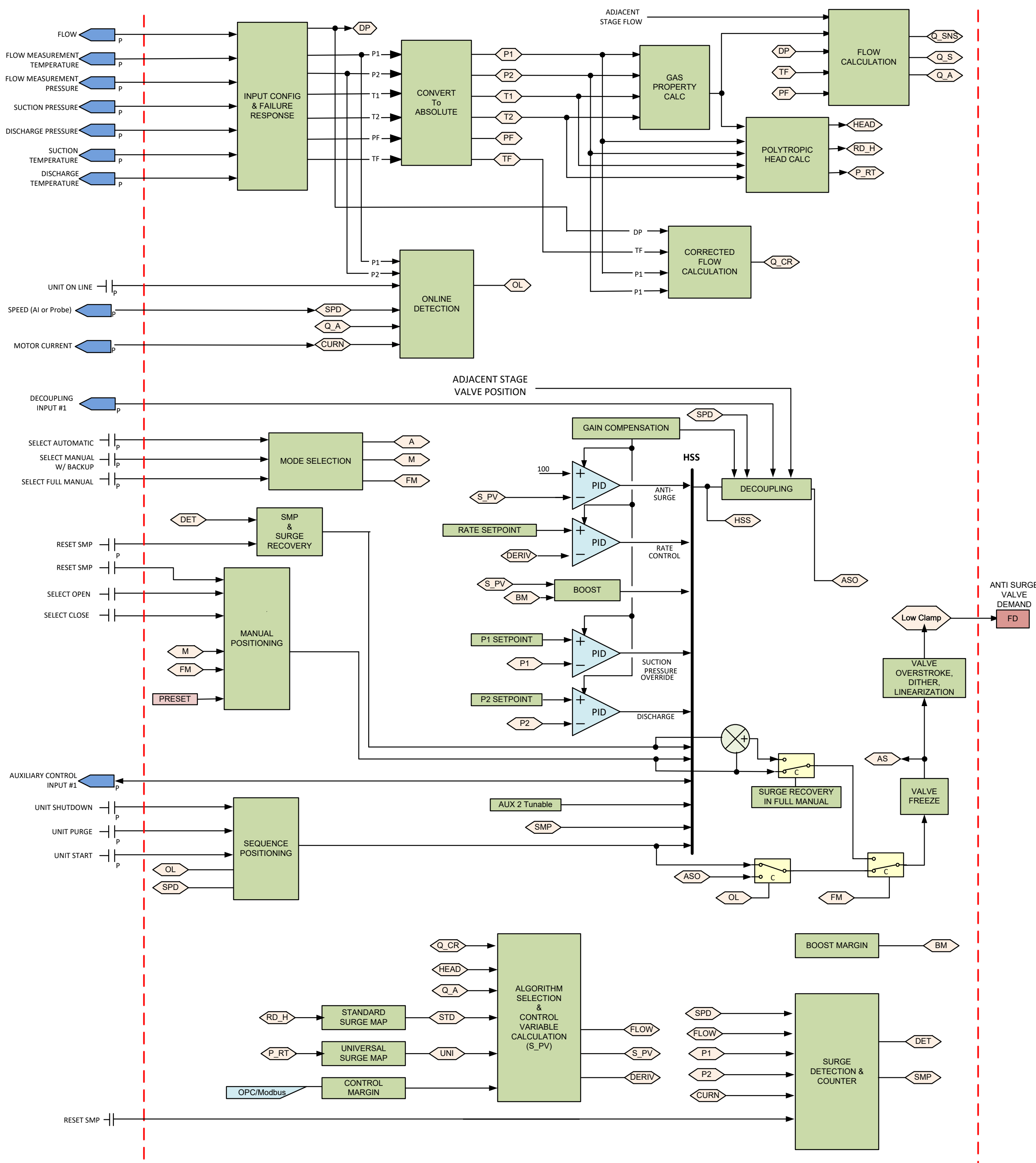


Figure 1-9. Overview of ASC Functional Block Diagram

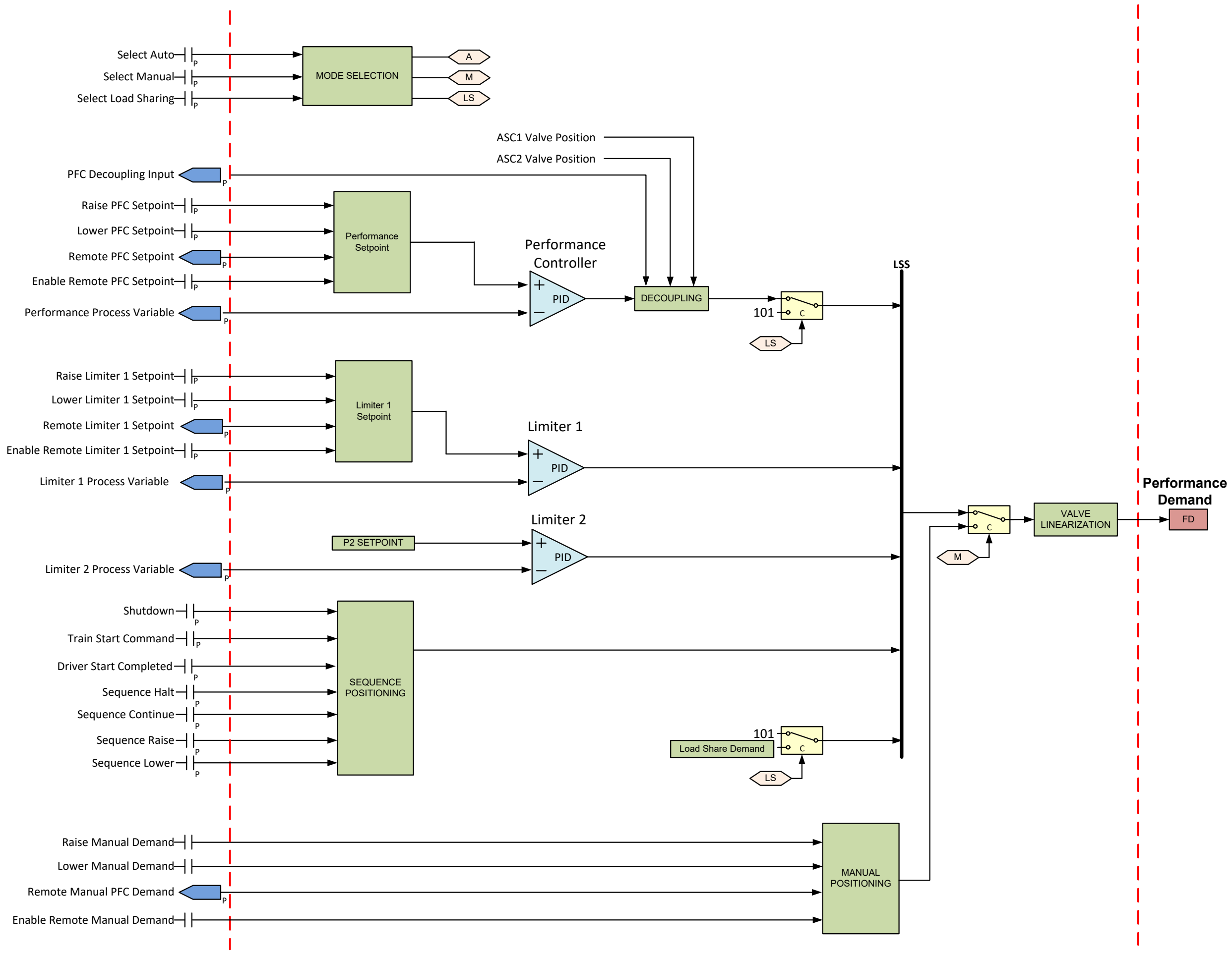


Figure 1-10. Overview of Performance Control Block Diagram

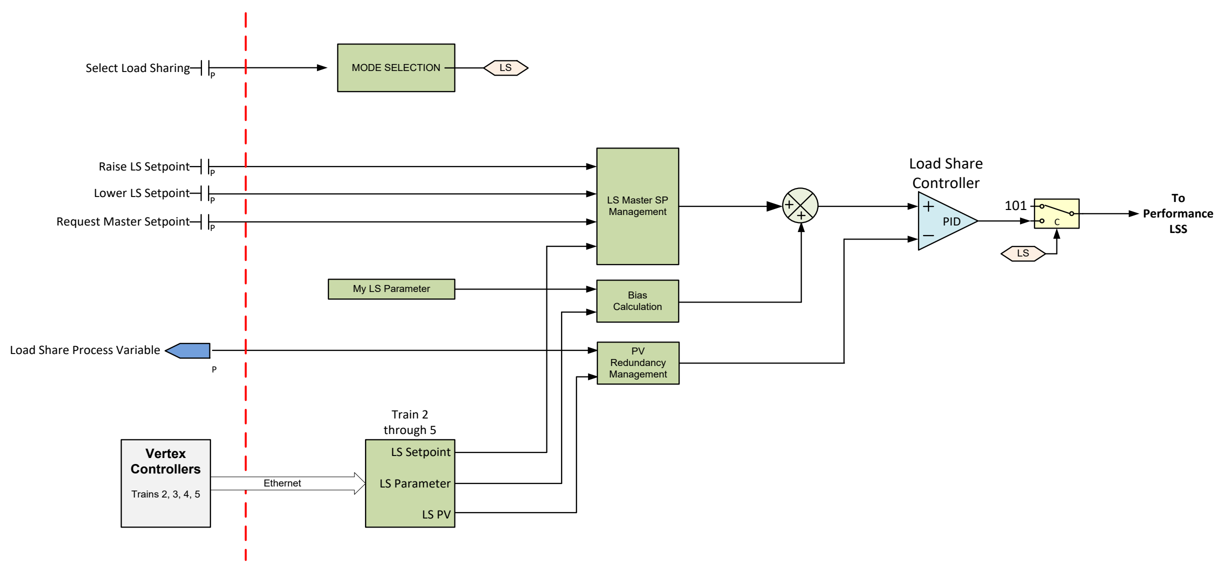


Figure 1-11. Overview of Load Share Control Block Diagram

Additional Features

In addition to the control loops mentioned, the Vertex also provides the following features:

- Internal Compressor Simulator for test and training
- First-Out Trip indication of Alarm and Trip events with time stamp
- Event Log History Viewer with 10ms timestamp resolution (1ms for DIs)
- External DI trip inputs and External Alarm DI inputs
- Zero Speed Detection and Peak Speed Indication
- Variable sample rate (10ms to >1s) datalog capture files
- SNTP time synchronization via an Ethernet IP
- Ability to expand system I/O with Woodward RTCnet Distributed I/O nodes
- Configurable analog inputs may be used for redundant flow transmitters
- Bumpless transfer between three control modes is provided:
    - Automatic
    - Manual with Backup
    - Full Manual

  The controller can fully automate the process, allow manual anti-surge valve control with backup protection override, or provide full manual control for maintenance purposes.
- Suction and Discharge Pressure override PIDs
- Start-up and shutdown sequencing of the anti-surge valve, including an optional purge position, provide complete compressor control from zero speed to full loading
- Input signals are filtered and monitored for failures that trigger fallback routines
- The Surge Control Margin may be automatically increased, to provide more conservative control, when surges are detected
- Freeze, over-stroke, dither, and characterization functions provide customization of the anti-surge valve output signal.
- When system response time (loop period) is excessive, Pre-Pack may be used to decrease system reaction time.
- Deactivation logic provides bumpless transfer between the various control routines.
- Gas properties are calculated for greater accuracy.
- Seven robust surge detection routines detect a surge within 50 milliseconds. These user-configurable surge detection routines are:
    - Flow derivative (rate of change)
    - Minimum Flow level,
    - Speed derivative (rate of change)
    - Suction pressure derivative (rate of change)
    - Discharge pressure derivative (rate of change)
    - Motor Current derivative (rate of change)
    - Surge Cross Line
- To stabilize interrelated processes, Decoupling routines are provided between the anti-surge valve and speed (fast and slow), as well as from a second valve. Two additional decoupling routines can be configured from external sources.
- Performance demand sequencing
- Configurable Load Sharing Auto Rejoin
- Control Redundancy (VertexDR only)
- Support for signal redundancy (VertexDR only)
- Anti-Surge Valve online partial stroke testing (VertexDR only)
- AI maintenance bypass function for signal troubleshooting (VertexDR only)
- Isolated controller (AI to PID to AO) for ancillary process control (VertexDR only)

Operator Control Panel

The Vertex is a field configurable compressor train control and operator control panel (OCP) integrated into one package. A comprehensive graphical operator control panel display and keypad is located on the Vertex's front panel. This display can be used to configure the Vertex, make On-Line program adjustments, and operate the compressor/system. Easy to follow instructions allow operators to view actual process and set point values at any time during turbine operation. Upon power-up from the factory, the default HOME screen has a tutorial that will quickly give first-time users an overview of navigation and operation. Once the unit is configured, this tutorial is always available under the Service Menu.

Using the Vertex

The Vertex control has three normal operating modes, Configuration Mode, Service Mode, and the Run Mode. See chapter 4 for more information about the User Levels required to enter each of these modes.

Configuration Mode

This mode is used to select the options needed to configure the control to your specific compressor application. While in this mode, the control will force the hardware into IO LOCK, meaning that no outputs will be active, all Relays will be de-energized, and all Analog output signals will be at zero current. Once the control has been configured, the Configuration mode is typically not needed again, unless compressor options or operation changes. It is available to be viewed at any time.
A password is required to log into this mode.

⚠WARNING **Anytime the control is in IOLOCK all Relays will be de-energized and all Analog outputs will be at 0 current. Ensure that the devices receiving these commands are fail-safe at these states.**

Calibration Mode

This mode is used to calibrate, tune, and adjust certain parameters while the unit is shutdown. Output forcing is available in this mode. A password is required to log into this mode.

Operation Mode

This mode is the typical state for normal operations of the control and the turbine. The Run Mode is used to operate the turbine from start-up through shutdown.

⚠WARNING
Software

An improperly calibrated control could cause an over-speed or other damage to the prime mover. To prevent possible serious injury read and follow this entire procedure before starting the prime mover.

Vertex Inputs and Outputs

Control Inputs

Speed Input Signals

Two redundant speed inputs are configurable to accept MPUs (magnetic pickup units), or active proximity probes.

Analog 4-20 mA Input Signals

There are eight configurable analog inputs available on the Vertex hardware, each of which can be configured as one of the input functions in the table below. An additional eight analog input channels (up to 16) are available for each RTCnet AIO node configured.

Below is the list of menu functions available—many of the critical input signals have a redundant input option such as the Flow, Suction Pressure and Temperature, and Discharge Pressure and Temperature. Redundant input signals can be used on both simplex or redundant control configurations. When redundant inputs are configured, a pop-up box will be available to select options related to handling these signals.

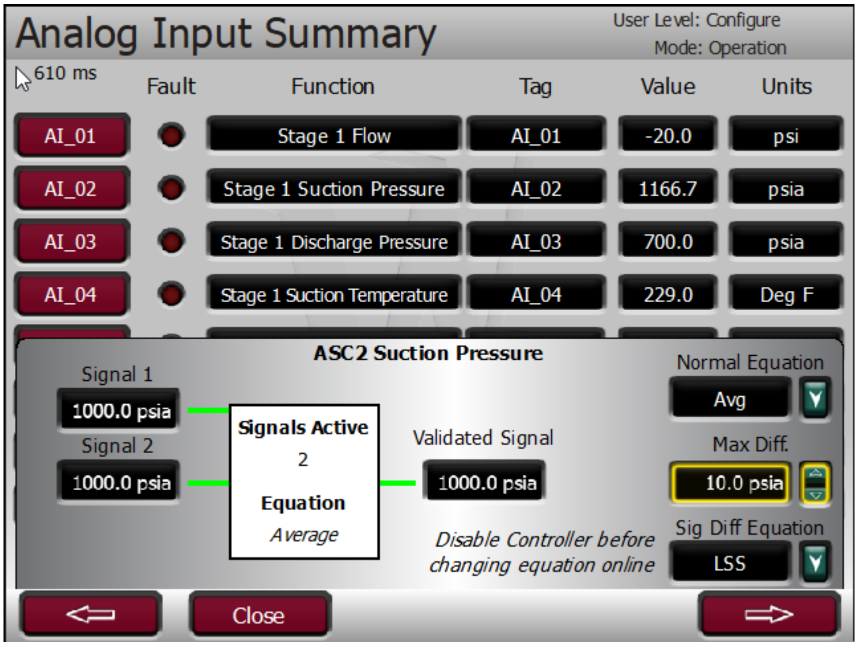


Figure 1-12. Redundant Signal Pop-up Screen From Analog Input Page

Table 1-3. Selectable Functions for 4-20mA Analog Inputs

Function	Signal Name	Description
1	--- Not Used ---	Channel is disabled.
2	Stage 1 Flow	Delta-pressure from the compressor flow element at suction or discharge
3	Stage 1 Suction Pressure	Compressor inlet pressure for ASC1
4	Stage 1 Discharge Pressure	Compressor outlet pressure for ASC1
5	Stage 1 Suction Temperature	Compressor inlet temperature for ASC1
6	Stage 1 Discharge Temperature	Compressor outlet temperature for ASC1
7	Stage 1 AS Valve Feedback Position	This is provided for anti-surge valve position feedback (0% = Closed, 100% = Open)
8	Stage 1 Redundant Flow	Accommodates a second flow transmitter for redundancy
9	Stage 1 AS Valve HSS Demand	Remote demand for anti-surge valve HSS demand selection.
10	Stage 2 Flow	Delta-pressure from the compressor flow element at suction or discharge
11	Stage 2 Suction Pressure	Compressor inlet pressure for ASC2
12	Stage 2 Discharge Pressure	Compressor outlet pressure for ASC2
13	Stage 2 Suction Temperature	Compressor inlet temperature for ASC2
14	Stage 2 Discharge Temperature	Compressor outlet temperature for ASC2
15	Stage 2 AS Valve Feedback Position	This is provided for anti-surge valve position feedback (0% = Closed, 100% = Open)
16	Stage 2 Redundant Flow	Accommodates a second flow transmitter for redundancy
17	Stage 2 AS Valve HSS Demand	Remote demand for anti-surge valve HSS demand selection.

Function	Signal Name	Description
18	External Speed Signal (4-20 mA)	Compressor shaft speed signal.
19	Process/Performance Input	Process variable for Performance Dedicated Input
20	Remote Process/Perf Setpoint	Remote setpoint for the Performance Control
21	Performance Limiter PV	Process variable for Performance Limiter 1
22	Remote Performance Limiter SP	Remote setpoint for the Performance Limiter 1 control
23	Remote Performance Valve Demand	Remote Performance demand positioning (0% = Closed, 100% = Open) in Manual Mode
24	Performance Controller Feedback	This is provided for Performance valve position feedback (0% = Closed, 100% = Open)
25	Performance External Decoupling	Separate process signal to provide feed-forward biasing of the Performance Demand
26	Vibration Input #1	Train vibration signal monitoring input 1
27	Vibration Input #2	Train vibration signal monitoring input 2
28	Vibration Input #3	Train vibration signal monitoring input 3
29	Vibration Input #4	Train vibration signal monitoring input 4
30	Motor Curr/Power 4-20 mA	Prime mover current or power signal
31	Load Share Input	Analog input load share signal
32	Stage 1 Suction Pressure #2	Redundant Suction Pressure input for Stage 1
33	Stage 1 Discharge Pressure #2	Redundant Discharge Pressure input for Stage 1
34	Stage 2 Suction Pressure #2	Redundant Suction Pressure input for Stage 2
35	Stage 2 Discharge Pressure #2	Redundant Discharge Pressure input for Stage 2
36	Process/Performance Input #2	Redundant Performance Process Input
37	Isolated PID PV	Process input for isolated controller function
38	Remote SP for Isolated PV	Remote setpoint for isolated controller function
39	Spare 39	
40	Spare 40	
41	Stage 1 IGV Pos F/B	Inlet Guide Valve Position Feedback for Stage 1
42	Stage 1 Remote ASV DMD PV	Remote AS Valve Demand for Stage 1
43	Stage 1 Decoupling I/P A PV	Decoupling Signal A for Stage 1
44	Stage 1 Decoupling I/P B PV	Decoupling Signal B for Stage 1
45	Stage 1 HSS I/P A PV	External HSS Signal A for Stage 1
46	Stage 1 HSS I/P B PV	External HSS Signal B for Stage 1
47	Stage 1 Press. at Flow Meter PV	Pressure at Flow Meter Signal for Stage 1
48	Stage 1 Press. at Temp Meter PV	Temperature at Flow Meter Signal for Stage 1
49	Stage 1 P1 Override Press. PV	P1 Override Pressure Signal for Stage 1
50	Stage 1 P2 Override Press. PV	P2 Override Pressure Signal for Stage 1
51	Stage 1 ASV Upstream Press. PV	Anti-Surge Valve 1 Upstream Pressure
52	Stage 1 ASV Downstream Press. PV	Anti-Surge Valve 1 Downstream Pressure
53	Stage 1 Temp. at ASV PV	Temperature at Anti-Surge Valve for Stage 1
54	Stage 1 Side-stream Temp. PV	Side Stream Temperature for Stage 1
55	Stage 2 IGV Pos F/B	Inlet Guide Valve Position Feedback for Stage 2

Function	Signal Name	Description
56	Stage 2 Remote ASV DMD PV	Remote AS Valve Demand for Stage 2
57	Stage 2 Decoupling I/P A PV	Decoupling Signal A for Stage 2
58	Stage 2 Decoupling I/P B PV	Decoupling Signal B for Stage 2
59	Stage 2 HSS I/P A PV	External HSS Signal A for Stage 2
60	Stage 2 HSS I/P B PV	External HSS Signal B for Stage 2
61	Stage 2 Press. at Flow Meter PV	Pressure at Flow Meter Signal for Stage 2
62	Stage 2 Temp at Flow Meter PV	Temperature at Flow Meter Signal for Stage 2
63	Stage 2 P1 Override Press. PV	P1 Override Pressure Signal for Stage 2
64	Stage 2 P2 Override Press. PV	P2 Override Pressure Signal for Stage 2
65	Stage 2 ASV Upstream Press. PV	Anti-Surge Valve 2 Upstream Pressure
66	Stage 2 ASV Downstream Press. PV	Anti-Surge Valve 2 Downstream Pressure
67	Stage 2 Temp. at ASV PV	Temperature at Anti-Surge Valve for Stage 2
68	Stage 2 Side-stream Temp. PV	Side Stream Temperature for Stage 2
69	Stage 1 Suction Temperature #2	Redundant Suction Temperature input for Stage 1
70	Stage 1 Discharge Temperature #2	Redundant Discharge Temp input for Stage 1
71	Stage 2 Suction Temperature #2	Redundant Suction Temperature input for Stage 2
72	Stage 2 Discharge Temperature #2	Redundant Discharge Temp input for Stage 2
73	Stage 1 Quench Temperature	Quench Temperature Signal for Stage 1
74	Stage 2 Quench Temperature	Quench Temperature Signal for Stage 2
75	spare_75	

Discrete Contact Input Signals

Vertex has 20 available contact inputs. VertexDR has 19 available contact inputs. One input is dedicated as an Emergency Shutdown Trip from the plant. This must be in a TRUE state to be healthy (fail safe) to be able to be cleared from the Trip list. On the VertexDR, if the DR-FTM is used this dedicated input is channel 13, otherwise it is channel 1 (for both the Vertex and the VertexDR). The rest of the additional contact inputs are available for configuration to function as various controller discrete input functions as listed in Table 1-4. On the front panel display there are four additional keys that are always available for operational functions (GREEN keys) – Start/Stop/Reset and Adjust Up/Down for raising or lowering a highlighted value.

Table 1-4. Selectable Functions for Discrete Inputs

1	---Not Used---	56	ASC1 External Surge Detected
2	Alarm/Reset Command	57	ASC1 External Excessive Surge Detected
3	Train Start Command	58	ASC1 Enable P1 Override Command
4	Train Start Inhibit	59	ASC1 Disable P1 Override Command
5	Train Normal SD Req		
6	Train Quit Normal SD Req	60	ASC1 Enable P2 Override Command
7	PFC Continue Sequence	61	ASC1 Disable P2 Override Command
8	PFC Halt Sequence	62	ASC1 Request Purge Command
9	Spare 09	63	ASC1 Quit Purge Position Command
10	Spare 10	64	ASC1 On-Line Command
11	Spare 11	65	ASC1 Off-Line Command
12	PFC Auto Mode Req	66	ASC1 Valve Open Feedback

13	PFC Full Man Mode Req	67	ASC1 Valve Close Feedback
14	PFC SP Raise	68	ASC1 Valve Fault Feedback
15	PFC SP Lower	69	ASC2 Select Automatic Mode
16	PFC Remote SP Enable	70	ASC2 Select Manual with Backup Mode
17	PFC Remote SP Disable	71	ASC2 Select Full Manual Mode
18	PFC Enable Remote Demand	72	ASC2 Start Position Command
19	PFC Disable Remote Demand	73	ASC2 Manually Open ASV
20	Raise Sequence Limiter Ramp	74	ASC2 Manually Close ASV
21	Lower Sequence Limiter Ramp	75	Spare 75
22	PFC Raise Demand	76	ASC2 Reset SMP
23	PFC Lower Demand	77	ASC2 Increase Control Margin
24	PFC Enable Decoupling	78	ASC2 Decrease Control Margin
25	PFC Disable Decoupling	79	ASC2 Reset Surge Counter
26	Driver Startup Complete Feedback	80	Spare 80
27	PFC Control Driver Fault	81	Spare 81
28	PFC Control Device Opened	82	Spare 82
29	PFC Control Device Closed	83	Spare 83
30	PFC Limiter PID Enable	84	ASC2 External Surge Detected
31	PFC Limiter PID Disable	85	ASC2 External Excessive Surge Detected
32	PFC Limiter PID SP Raise	86	ASC2 Enable P1 Override Command
33	PFC Limiter PID SP Lower	87	ASC2 Disable P1 Override Command
34	PFC Limiter PID Enable Remote SP	88	ASC2 Enable P2 Override Command
35	PFC Limiter PID Disable Remote SP	89	ASC2 Disable P2 Override Command
36	Spare 36	90	ASC2 Request Purge Command
37	Spare 37	91	ASC2 Quit Purge Position Command
38	Spare 38	92	ASC2 On-Line Command
39	Spare 39	93	ASC2 Off-Line Command
40	Spare 40	94	ASC2 Valve Open Feedback
41	ASC1 Select Manual with Backup Mode	95	ASC2 Valve Close Feedback
42	ASC1 Select Automatic Mode	96	ASC2 Valve Fault Feedback
43	ASC1 Select Full Manual Mode	97	Clock SYNC Pulse Contact
44	ASC1 Start Position Command	98	External Alarm 1
45	ASC1 Manually Open ASV	99	External Alarm 2
46	ASC1 Manually Close ASV	100	External Alarm 3
47	Spare 47	101	External Trip 2
48	ASC1 Reset SMP	102	External Trip 3
49	ASC1 Increase Control Margin	103	Enable Load Sharing
50	ASC1 Decrease Control Margin	104	Disable Load Sharing
51	ASC1 Reset Surge Counter	105	Enable Rem SP for Isolated PID
52	Spare 52	106	Isolated Controller Raise
53	Spare 53	107	Isolated Controller Lower
54	Spare 54	108	Spare 108

55	Spare 55	109	Spare 109
		110	Spare 110
		111	ASC1 Close Quench Valve Command
		112	ASC1 Open Quench Valve Command
		113	ASC1 Quench Auto Command
		114	ASC1 Quench Manual Command
		115	ASC1 Lower Quench SP Command
		116	ASC1 Raise Quench SP Command
		117	ASC1 Enable Quench RMT SP Command
		118	ASC1 Disable Quench RMT SP Command
		119	ASC1 Enable RMT DMD Command
		120	ASC1 Disable RMT DMD Command
		121	ASC2 Close Quench Valve Command
		122	ASC2 Open Quench Valve Command
		123	ASC2 Quench Auto Command
		124	ASC2 Quench Manual Command
		125	ASC2 Lower Quench SP Command
		126	ASC2 Raise Quench SP Command
		127	ASC2 Enable Quench RMT SP Command
		128	ASC2 Disable Quench RMT SP Command
		129	ASC2 Enable RMT DMD Command
		130	ASC2 Disable RMT DMD Command

Control Outputs

Actuator Outputs

Two 4–20 mA or 20–160 mA configurable actuator outputs with linearization curves are available for use. The front panel ESTOP button will shutdown the actuator circuit and remove actuator power, ensuring that the actuator goes to the fail-safe position.

The Actuator Outputs use the same function list as the Analog 4-20mA Outputs listed below.

Analog 4-20 mA Outputs

Six 4–20 mA analog outputs are available for use and each can be configured as one of the following output functions. An additional two analog output channels (up to four) are available for each RTCnet AIO node configured.

Table 1-5. Selectable Functions for 4-20mA Analog Outputs

Function	Signal Name	Description
1	--- Not Used ---	Channel disabled
2	Actual Shaft Speed	Speed signal readout
3	Stage 1 AS Valve Demand	ASV 1 Demand Signal
4	Stage 2 AS Valve Demand	ASV 2 Demand Signal
5	Stage 1 Operating Point	ASC 1 WSPV Readout
6	Stage 2 Operating Point	ASC 2 WSPV Readout
7	Process/Perf Input Signal	Performance PV Readout

8	Process/Perf Setpoint	Performance Setpoint Readout
9	Performance Valve Output Demand	Performance Demand Signal
10	Isolated PID Dmd Output	Valve demand output for isolated controller
11	Stage 1 Quench Valve Demand	Output Demand for Quench Valve Stage 1
12	Stage 2 Quench Valve Demand	Output Demand for Quench Valve Stage 2

Relay Outputs

Eight Form-C relay contact outputs are available on the Vertex while the VertexDR has seven. One channel is dedicated as a Trip output and can be configured for use as a complete Summary Trip or a TRIP relay output (where the External Trip inputs are not included). On the VertexDR, if the DR-FTM is used this dedicated output reply is channel 7, otherwise it is channel 1 (for both the Vertex and the VertexDR). The other relays are all are configurable. An additional 16 relay drivers are available when an RTCnet DO node is configured.

Each relay can be programmed to provide a contact related to a conditional state as listed in the first list, or it can be triggered as a level-active switch as per the second list

Conditional States

Table 1-6. Selectable Functions for Relay Output States

1	--- Not Used ---	16	ASC1 Surge Detected
2	Summary Shutdown	17	ASC1 Consecutive Surge Detected
3	Trip Relay	18	ASC2 is Online
4	Summary Alarm	19	ASC2 AS Valve Auto
5	Reset Pulse (2 sec)	20	ASC2 AS Valve Manual
6	Ready to Start	21	ASC2 AS Valve Full Manual
7	Unit Startup Completed	22	ASC2 Surge Detected
8	Performance Control Configured	23	ASC2 Consecutive Surge Detected
9	Performance PID in Control	24	Load Share Ready
10	Remote Performance Setpoint Enabled	25	Load Share Enabled
11	Performance Controller Limited	26	Performance Manual Enabled
12	ASC1 is Online	27	Healthy Redundant Mode
13	ASC1 AS Valve Auto	28	Primary Unit is the SYSCON
14	ASC1 AS Valve Manual	29	Secondary Unit is the SYSCON
15	ASC1 AS Valve Full Manual	30	ASC1 Consecutive Surge Detected ALM
		31	ASC2 Consecutive Surge Detected ALM

Level Activated Switch Using This Value:

Table 1-7. Selectable Functions for Relay Output Level Switches

1	--- Not Used ---	19	LN1 AI Channel 03
2	Actual Speed	20	LN1 AI Channel 04
3	Performance Input	21	LN1 AI Channel 05
4	Stage 1 AS Valve Demand Output	22	LN1 AI Channel 06
5	Stage 2 AS Valve Demand Output	23	LN1 AI Channel 07

6	Performance Controller Output	24	LN1 AI Channel 08
7	ASC1 WSPV	25	LN2 AI Channel 01
8	ASC2 WSPV	26	LN2 AI Channel 02
9	AI Channel 01	27	LN2 AI Channel 03
10	AI Channel 02	28	LN2 AI Channel 04
11	AI Channel 03	29	LN2 AI Channel 05
12	AI Channel 04	30	LN2 AI Channel 06
13	AI Channel 05	31	LN2 AI Channel 07
14	AI Channel 06	32	LN2 AI Channel 08
15	AI Channel 07	33	SPARE 33
16	AI Channel 08	34	SPARE 34
17	LN1 AI Channel 01	35	SPARE 35
18	LN1 AI Channel 02		

Optional Distributed I/O

Additional I/O capacity has been pre-programmed using Woodward's RTCnet distributed I/O nodes. These are available via the Configuration Menu (under RTCnet) and the user is free to select any or all of the nodes listed below. All distributed I/O channels have the same menu of functional choices as the lists above for the Vertex hardware I/O allow for the control I/O capacity to be expanded for specific application needs.

These nodes are

Table 1-8. Available (Programmed) Distributed I/O Nodes

Node Device ID	Part Number	Description	I/O Type/Quantity
1	8200-1103*	Analog 4-20 mA I/O	8 AI and 2 AO
2	8200-1103*	Analog 4-20 mA I/O	8 AI and 2 AO
3	8200-1100	RTD Temperature Inputs	8 RTD
4	8200-1104	Discrete Input	16 DI
5	8200-1105	Discrete Output	16 DO

*8200-1103 for loop powered channels can be replaced by 8200-1102 for self-powered channels.

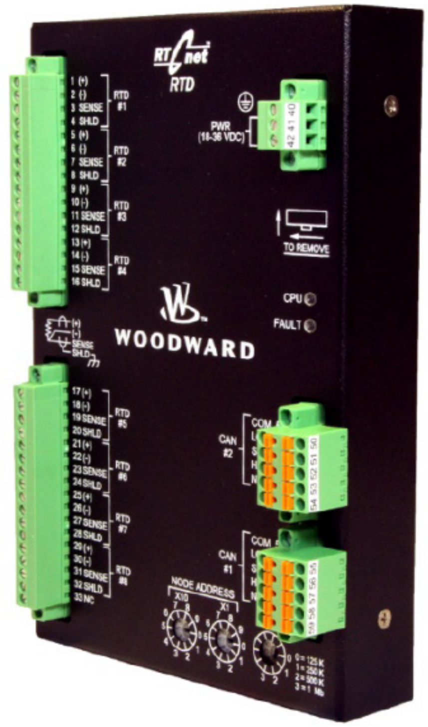


Figure 1-13. RTCnet Distributed I/O Node

Control Communication Interfaces

Modbus

A complete Modbus list of information is available for HMI, plant DCS or other control interfaces. Three physical ports are available for this communication method, 2 Ethernet (RJ45) ports and 1 serial port. The serial port protocol can be either ASCII or RTU and the communications can be RS-232 or RS-485. The Ethernet links can be configured as TCP or UDP on either ENET ports 1 or 2.

Ethernet port 3 is dedicated for use between Vertex controls for Load Sharing functionality. Do not configure port 3 onto any network except for Vertex-to-Vertex communications.

Ethernet port 4 is dedicated for use between Vertex controls for redundancy. There is no application access to this dedicated network. For redundant controls a direct Ethernet link is required between port 4 of the 2 units. Refer to the chapter titled “Dual Redundant Configurations” for complete details.

The control also communicates Servlink protocol (Woodward proprietary) via the Ethernet ports. Using Woodward’s Servlink to OPC Server tool any PC can use this connection to communicate to the control and relay OPC data to the various service tools that support the product.

CAN

The CAN communication ports are available for interfacing the control application with other products. The Vertex has been programmed these to be used for the following:

CAN #1 Reserved
CAN #2 Link to RTCnet distributed I/O nodes
CAN #3 Reserved
CAN #4 Reserved

Keypad and Display

Graphical Display Key Inputs

The front panel display is designed to provide the user with multiple levels of access for configuring, calibrating, tuning, operating, and monitoring the turbine operation. No additional control panels are required to operate the turbine, every turbine control function can be performed from the Vertex's front panel.

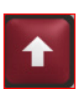
Figure 1-14. Vertex Keypad and Display

A description of each key's function follows.

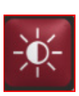
Hard Key Commands

NUMERIC KEYPAD = These are available for entering numeric values or text strings directly into the control when a configurable or programmable edit field has been selected. The bottom row of keys have some special features.

This is a backspace and delete (used when entering text)



In text mode, this functions as a Shift key. When making analog adjustments with the ADJUST key – pressing this key at the same time as the ADJUST will invoke a 'Fast' rate of adjustment



Brightness key – hold this down and then use the ADJUST key to increase/decrease the screen brightness

EMERGENCY TRIP KEY = If configured, this will Trip the compressor train and remove all current from the Actuator outputs (zero current).

LED = Four LED's are found on the left side – a Summary Trip, Summary Alarm, IO Lock and CPU Health. The first two are controlled solely by the GAP program and relate to the status of the control. The IOLOCK and CPU LED's relate to the H/W status and are identical to these same indications on the back of the Vertex

VIEW buttons will jump to the Trip or Alarm Summary screen to show these events in sequence with time stamp.

MODE button will jump to a Login screen that allows the user to view current permissions and allow access to changing the user login level

ESC Key – this will always step the user 'back' one page from the current page displayed

HOME Key = brings the user to the Home menu for Run, Service, or Configure. Pressing the key a second time will return to the Run (Operate) Menu Home Screen

NAVIGATION CROSS KEYS = These are the primary keys for navigating from page to page, or for navigation of the FOCUS on any page.

Soft Key Commands – Dependent on the screen currently in view – the user must use the navigation cross keys to move the "Focus" to the desired component

GREEN KEYS = Generally perform Operational Actions – such as Enabling, Disabling, Starting, Stopping, Tuning or Adjusting values

MAROON KEYS = Generally perform Navigational actions that escort the user through the screen menus

BLACK KEYS = Are soft-key functions that relate to the display indication above them. They can be navigational or operational. These items do not require "Focus", they are always available on that particular screen.

NOTICE **Screen Tutorial**	**The Vertex has a detailed Tutorial that is always accessible through the Service Menu. It provides 'On-Screen' help on topics such as Navigation, User Levels, Operating Modes, how to adjust parameters, and more. The User should familiarize themselves with these screens**

Watchdog Timer/CPU Fault Control

The IO Lock and CPU Health LED's on the front left side of the display – are always in an identical state as the LED's on the backside of the control. In the Vertex, they are completely controlled by the control hardware and are not controlled by the GAP application.

In the VertexDR – these LED's are initially controlled by the hardware OS, but are also utilized by the control application software. Once redundant units have initialized the CPU LED is used to indicate if the unit is operating as the SYSCON (solid green), a healthy Backup (flashing green) or an unavailable Backup (flashing amber). These are further described in the Dual Redundant Configuration chapter of this manual.

Chapter 2.
Installation

Introduction

This chapter provides the basic installation guidance for mounting location selection, installation, and wiring of the controller, including hardware dimensions, ratings, and requirements for mounting and wiring the control in a specific application.

Shipping Carton

Before unpacking the Vertex, refer to the inside front cover and page VI of this manual for WARNINGS and CAUTIONS. Be careful when unpacking the Control. Check for signs of damage such as bent or dented panels, scratches, and loose or broken parts. If you detect any damage, immediately notify the shipper.

The Control ships from the factory in an anti-static foam lined carton. Use this carton for transportation or storage when the Controller is separate from the system.

General Installation

When selecting a location for mounting the Control, consider the following:

- Protect the unit from direct exposure to water or to a condensation-prone environment.
- The control design is ideal for installation in a protective metal enclosure such as a standard cabinet with ingress protection rating of IP54 or greater for Hazardous locations.
- For best airflow, mount the Vertex in a vertical orientation with ventilation slots at the top and bottom of the control.
- Provide an ESD strap or other methods to discharge personnel as ESD mitigation inside any installation cabinet used. The ESD strap must be used for handling the equipment and plugging/unplugging the connectors.
- Provide adequate ventilation for cooling. Mount in a location that is able to maintain an ambient operating temperature within the range of rated maximum and minimum ambient temperatures. Shield the unit from radiant heat sources as needed to maintain ambient temperature within the rated range.
- Do not install the unit or its connecting wires near inductive, high-voltage, or high-current devices. If this is not possible, shield both the system connecting wires and the interfering devices and/or its wires.
- Allow adequate space around the unit for airflow, servicing, and wiring.
- Do not install where damage may occur from objects dropped on the terminals or inside the unit.
- Use the chassis ground lugs with a large a gage wire to Earth Ground the unit for proper safety and shielding effectiveness. Recommend use of the power input ground wire, especially when installed in noisy, high corrosion, or high vibration environments.

General Wiring Guidance

IMPORTANT **Terminal block wiring must use multi-stranded wires to provide best results.**

IMPORTANT **Do not tin (solder) the wires that terminate at the node terminal blocks. The spring-loaded Cage Clamp or screw down terminal blocks is designed to flatten stranded wire, and if those strands are tinned together, the connection loses surface area and is degraded. The solder tinned wire end will also cold flow over time potentially further degrading or break the connection.**

⚠WARNING **CAN NETWORKS. It is possible to disrupt an existing CAN network by attaching an improperly configured device.**

Shielded Wire, Shield Termination Lead Preparation

Where shielded cable is required, cut the cable to the desired length, and prepare the cable as instructed below.

1. Strip outer insulation from both ends, exposing the braided or spiral wrapped shield. Do not cut the shield or nick the wire inside the shield.
2. Using a sharply pointed tool carefully spread the strands of the braided shield to form a hole.
3. Take hold of the inner conductor(s) wire's insulation and pull the wires out of the shield one at a time.
   a. If the shield is the braided type, twist the braid it to prevent fraying; twist it with the drain wire if one is present. Use as much of the shield braid and drain combined as possible to terminate the shield.
   b. Foil shields or shields of foil combined with braid require the drain to be brought out and excess foil may be removed.
4. Remove 6 mm (1/4 inch) of insulation from the inner insulated signal conductors.
5. Connect wiring and shield as shown in plant wiring diagram.
6. If a shield connection is not required or desired, fold back and secure or remove the excess shield as needed. (If there is a landing/connection point for the shield, it should be used to get optimal signal performance.)

General Wiring Installation

All signal lines except power supply, Discrete Input and Discrete Output, wiring should be shielded to prevent picking up stray signals from adjacent equipment. Power supply, Discrete Input and Discrete Output may also be shielded if desired.

For noise suppression reasons, it is recommended that all low current and low voltage wires be separated from all high current and/or high-voltage wiring.

Recommend strain relief for cables as strain relief of cables is a wise practice.

Input power ground terminal, chassis not power return, should also be wired/bonded to earth ground. Using the chassis, ground is critical in environments that lead to corrosion or hazardous atmosphere environments

All shielded cable must be twisted conductor pairs, triples, or multiple twisted pairs. The IO nodes for shielded cable are designed with AC (Capacitor) and direct shield terminations to earth ground at the cable landing points to facilitate shield termination. Cable shields must be terminated at least at one end.

Installations with severe electromagnetic interference (EMI) and maintaining electromagnetic compatibility (EMC) may require additional shielding precautions, such as wire run in metal conduit or double shielding. In general, the devices are designed with a sufficient level of EMC and immunity to EMI for the typical installation environment and added EMC precautions are not needed. Contact Woodward for more information

In general, terminate shields to their landing point, on the IO node terminal block or cage clamp. Shield may also be required to be landed/terminated at the opposite end of the cable. Devices at each end of the shielded cable may have conflicting shield termination requirements, termination should be direct only at one end unless the cable is shorter than 10m. Shields on cables less than 10 m in length may be terminated directly to earth/chassis at both ends.

If both shield ends on a cable longer than 10m must be terminated, a capacitor should be used at one end to terminate the shield to earth/chassis. The preferred point for the capacitor is at the output end. Using a 0.1µF to 0.01 µF, 1000 V, capacitor is typically sufficient.

Shields on cables greater than 30 m in length cannot be terminated directly to earth/chassis at both ends: one end must be AC coupled with a capacitor or floated (unterminated). Directly terminating shields on cables >30 m long may form ground loops with noise current flowing in the shield.

Shield terminations on cables between 10 m and 30 m are deterministic based on the noise in the system. Generally, if shield termination is required for both ends of a cable, the end to an input node should be direct chassis/earth termination and the end to an output should be a capacitor from shield to chassis/earth pin. If the cable is between 10 m & 30 m but within the same cabinet or less than 30 m straight line between shield termination points direct coupling at both ends is permissible. Example: cables that stay in the same cabinet where the shortest straight-line distance between chassis/earth connection points is no further than 30 m apart may be terminated at both ends.

If intervening terminal blocks (TB) are used in routing a shielded signal cable, the shield should be continued through the terminal block. Limit the number of TB break points along the cabling between the field device end and wiring node end to a minimum, zero is best. In general, at least 39 inches (1 m) of cable with an intact shield should present between breaks in the shield. Daisy chained CAN drop cabling on multiple close IO nodes is an exception.

Avoid multiple, spread out, direct or high capacitance connections of a shield to earth. Multiple connections of shielding to earth runs the risk of high levels of low frequency ground current, like 50/60 Hz, flowing within the shield. If there are multiple terminal block shield connections made: the impedance of them must be much greater than safety grounds impedance required by local laws. If shield grounding is desired at the terminal block, it should be AC coupled (capacitor coupled) to earth.

Shielding and Enclosure Installations: If the device is installed in a metal enclosure, as expected and intended, shielded I/O should be AC or DC terminated directly to the enclosure (earth ground) at the entry to the enclosure, as well as at the intended shield pins on the IO nodes inside the enclosure. Marine & Hazardous location installations may require a metal enclosure and shield termination at the entry to the enclosure.

As noted, shield termination can be a deterministic process. AC shield connections (capacitors) on shield I/O may be dictated at the IO node, instead of the typical direct earth connection provided. Typically, shields at signal inputs are connected directly to earth, and shields at signal outputs are AC-coupled to earth or floating. All shields from the nodes, except CAN are designed directly terminated to earth / chassis. See Woodward application notes 50532, *Interference Control in Electronic Governing Systems*, and 51204, *Grounding and Shield Termination,* for more information.

Specifics are in each individual installation section.

Chapter 3.
Hardware Specifications

Vertex Description and Features

The Vertex Compressor Control is a real-time, deterministic compressor controller that is available with or without an integrated HMI display. Enhanced communication options for Serial, Ethernet, and CAN are key features for improved networking and I/O expansion. To expand Controller I/O use into rugged environments use CAN and Woodward RTCnet nodes.

Power Input
- (LV) input power: 18-36 Vdc input, isolated
- (HV) input power: 88-264 Vac / 90-150 Vdc, isolated

Communications
- (4) Ethernet 10/100 communication ports, isolated
- (4) CAN communication ports (1 Mbit), isolated
- RS-232/RS-485 port, isolated
- RS-232 Service port, isolated

I/O Circuits
- GAP configurable update rates of 5 ms to 160 ms
- (2) Speed Sensor inputs (MPU/Prox) (each with Prox Power)
- (8) Analog input 4-20 mA channels (with Loop Power)
- (6) Analog output 4-20 mA channels
- (2) Actuator output channels (configurable 4-20 mA/20-200 mA)
- (20) Discrete input channels (with Contact Power)
- (8) Relay outputs (form-c)

I/O Expansion options using RTCnet
- Refer to RTCnet manual # 26640
- Analog Inputs (4-20mA), RTD inputs, Thermocouple inputs
- +24V Discrete Inputs, Discrete Outputs, Analog Outputs (4-20mA)

HMI
- 8.4” LCD Display (800x600) and Keypad

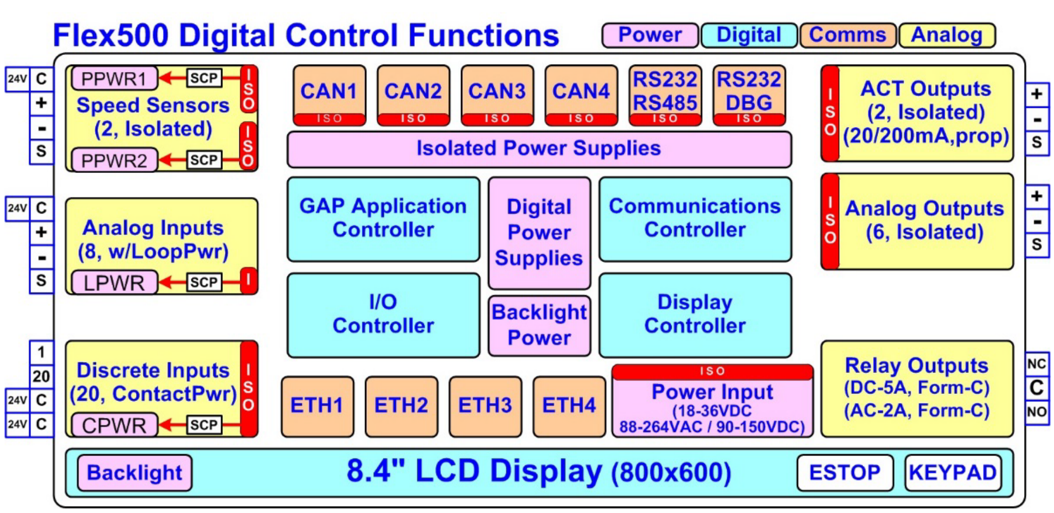


Figure 3-1. Functional Block Diagram (Vertex Control)

Environmental Specifications

Table 3-1. Environmental Specifications

Operating Temperature[1]	Operating range of –30 °C to +70 °C (-22°F to +158°F) [with display] Operating range of –40 °C to +70 °C (-40°F to +158°F) [without display]
Storage Temperature	Recommended 10 °C to 40 °C (50˚F to 104˚F)
Vibration	8.2 Grms, industrial skid mount, per Woodward RV1 (STD version with display) 1.04 Grms, control room, per Woodward RV5 (ATX versions with display) 1.04 Grms, control room, per Woodward RV5 (without display)
Shock[2]	10 G, 3x each axis, 11 ms Half Sine Pulse per Mil-STD 202F method 213B basic test J
Humidity[3,4]	5 % to 95 %, non-condensing
Altitude	3000m (9842 ft.) Maximum
Installation Rating	Pollution Degree 2, Overvoltage Category II
Conformal Coating	Polyacrylate, sulfur resistant (see AppNote #51530)
EMC Emissions	EN 61000-6-4 (Heavy Industrial) & EMI of IACS UR E10
EMC Immunity	EN 61000-6-2 (Heavy Industrial) & EMC of IACS UR E10
Ingress Rating	As shipped: IP-20 IP-56 when installed in an appropriate IP-56 or higher rated enclosure. (Non ATEX/IECEx Applications) IP-54 for ATEX/IECEx Applications when installed in an enclosure coded Ex nA and providing a minimum ingress protection rating of IP-54 as defined in IEC 60529.

[1]Limited by LCD display
[2]Limited by internal relay specification
[3]Relative humidity levels of < 55% will prolong LCD life
[4]Cyclic condensing humidity is supported with an appropriate enclosure

Maintenance Info and Recommendations

The Vertex Compressor Control design allows for continuous operation in a typical industrial environment and includes no components that require periodic service. However, to take advantage of related product software and hardware improvements, we recommend that you send your product to a Woodward Authorized Service Facility after every five to ten years of continuous service for inspection and component upgrades.

Clock Battery

The Real Time Clock (RTC) battery is designed to last approximately 10 years during normal turbine operation. When powered, the RTC automatically disables the battery usage to preserve it. During power-off the battery is enabled and only used to maintain date and time. For long-term storage, the battery is specified to last > 5 years.

The RTC battery is a replaceable lithium coin cell Woodward PN 1743-1017. Contact a Woodward Authorized Service Center if a replacement service is needed.

Calibration and Functional Verification

Recommend calibration verification and functional operation every 24-36 months. This is especially important for spare units that need to be ready for immediate use. Contact a Woodward Authorized Service Center for assistance.

Aluminum Electrolytic Capacitors

Recommend to apply power to spare units every 24-36 months for 3 hours to reform the electrolytic capacitors used in the power module.

Display LCD with Backlight

The Vertex display version uses a low power LED backlight display with a life expectancy of 60K hours to half brightness, at maximum operating temperature. If the display appears dim, use the “SCREEN SETTINGS” menu to verify the brightness setting and adjust as needed with the ADJ ARROW-BRIGHTNESS keypad combination. When display damage or quality is unacceptable, contact a Woodward Authorize Service Center for a replacement display.

Electromagnetic Compatibility (EMC)

The Vertex Compressor Control family complies with Heavy Industrial EMC requirements per EN 61000-6-4 & EN 61000-6-2 specifications as tested at the hardware level. The unit was also tested at the hardware level to the EMC & EMI requirements of IACS UR E10 (Marine).

Emissions EN 61000-6-4 & IACS UR E10

- Radiated RF Emissions Limits 30 to 5000 MHz per IEC 61000-6-4 & 150 kHz to 2000 MHz per IACS UR E10 Class A General Distribution Zone.
- Power Line Conducted RF Emissions Limits 150 kHz to 30 MHz per IEC 61000-6-4 & 10 kHz to 30 MHz per IACS UR E10 Class A General Distribution Zone.

Immunity EN 61000-6-2 & IACS UR E10

- Electrostatic Discharge (ESD) immunity to ±6 kV contact / ±8 kV air per IEC 61000-4-2.
- Radiated RF Immunity to 10 V/m from 80 MHz to 3000 MHz per IEC 61000-4-3.
- Electrical Fast Transients (EFT) Immunity to ±2.0 kV on I/O and Power Supply inputs per IEC 61000-4-4.
- Surge Immunity on DC Power Supply inputs to ±1.0 kV line to earth and ±0.5 kV line to line per IEC 61000-4-5.
- Surge Immunity on AC Power Supply inputs to ±2.0 kV line to earth and ±1.0 kV line to line per IEC 61000-4-5.
- Surge Immunity on I/O to ±1.0 kV line to earth per IEC 61000-4-5.
- Conducted RF Immunity to 10 V (rms) from 150 kHz to 80 MHz per IEC 61000-4-6.
- Conducted Low Frequency Injection Immunity at 10% of the nominal supply level from 50 Hz to 12 kHz on Power Inputs per IACS UR E10.

Outline Drawing for Installation

See figures below for the physical outline dimensions for the Vertex Compressor Control. See Woodward Reference drawing 9989-3210 for additional details if necessary.

NOTICE

This Vertex Compressor Control has the identical mounting hole pattern as the older 505 and Atlas controls, however the holes do not come through the front of this unit; therefore, mounting screws of correct length must be used.

Vertex (with display) Panel Mounting Information:

- There are 8 x 10-32 UNF-2B tapped holes to mount the Vertex.
- The holes are tapped to 0.312” min Depth. Choose the proper length screw to not exceed this depth into the Bezel.
- Use screw 1069-949 (.375 Long, 10-32) for panel thickness (including washers) .065” - .100"
- Use screw 1069-948 (.438 Long, 10-32) for panel thickness (including washers) .101”- .125”
- Use screw 1069-946 (.500 Long, 10-32) For panel thickness (including washers) .126” - .187”

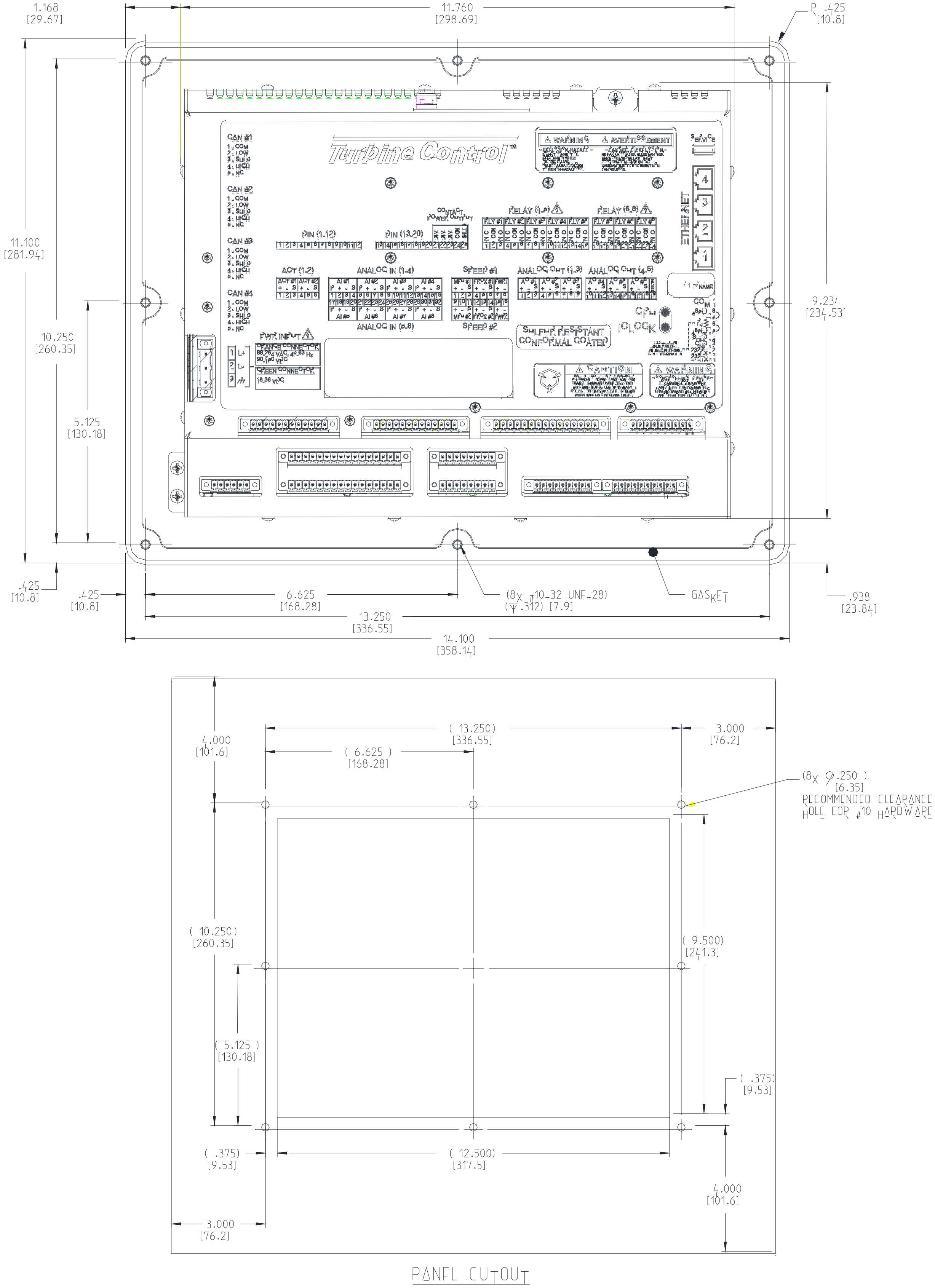
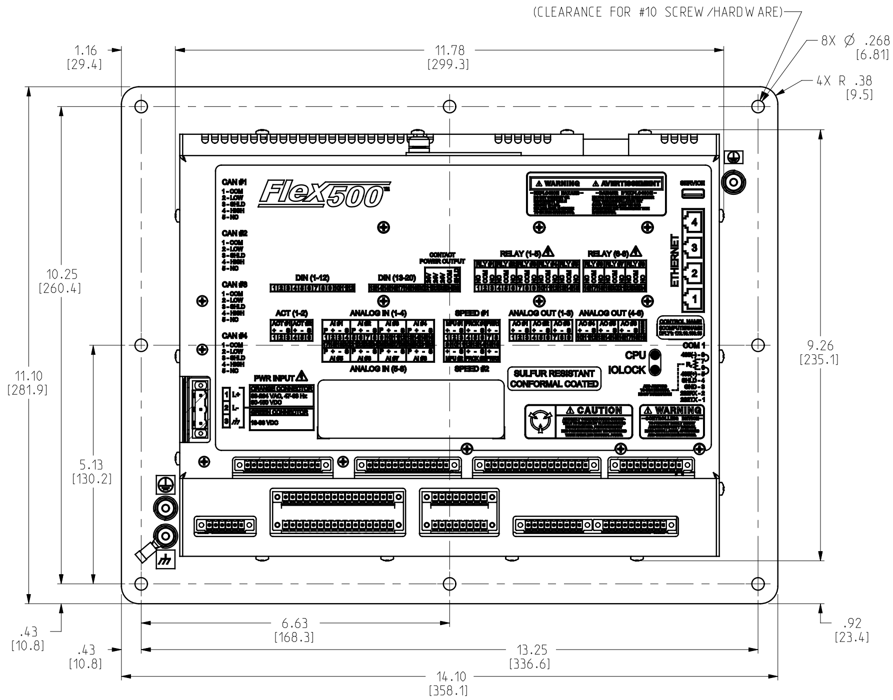


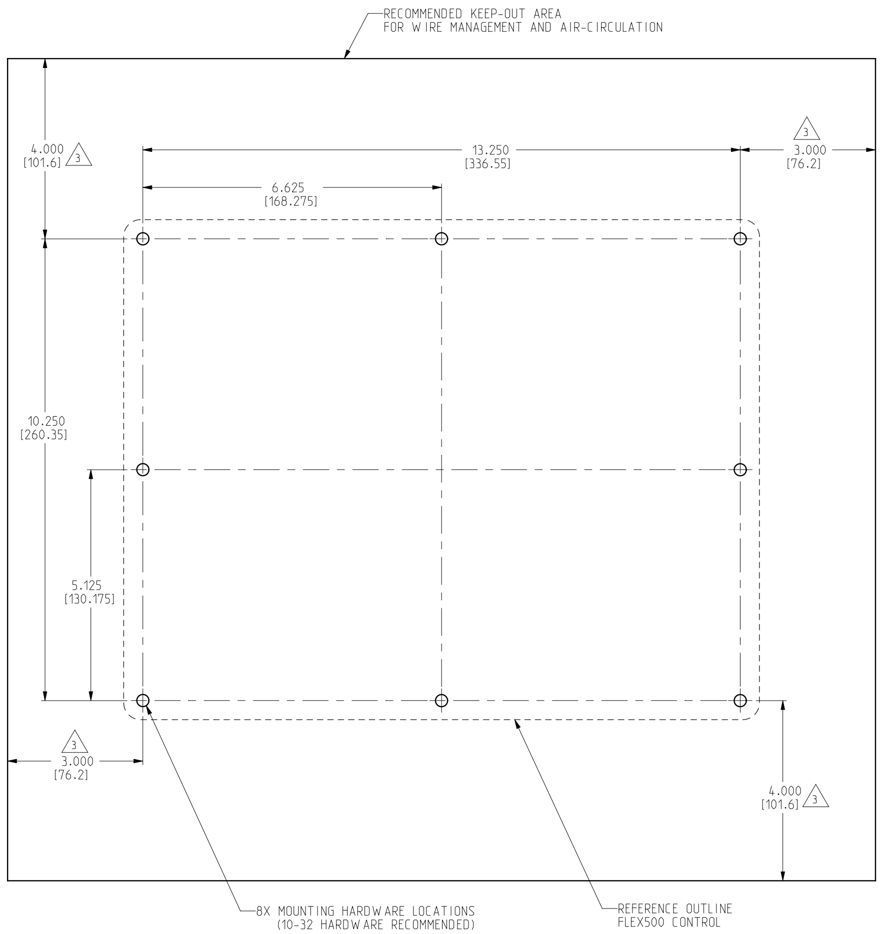
Figure 3-2. Vertex Outline Drawing

Vertex (without display) Panel Mounting Information:

- There are 8x.268" diameter clearance holes for mounting the Vertex. The holes are for 8 x 10-32 bolts with a nut and washer to mount the unit.
- Use screw length 1069-955 (.750 Long, 10-32) for panel thicknesses .100" or less. This assumes using a .25" thick nut and two .062" thick washers to mount the unit.
- Use screw length 1031-1216 (.875 Long, 10-32) for panel thicknesses .101" i - .187". This assumes using a .25" thick nut and two .062" thick washers to mount the unit.



FLEX500 BULKHEAD
CONTROL REFERENCE



PANEL MOUNTING REFERENCE

Figure 3-3. Vertex Outline Drawing

NOTICE

If using the DR-FTM kit (5541-705) refer to Manual 26838 - Appendix A for mounting information. The FTM is DIN rail mountable and the cable wiring harnesses included in this kit that connect from the FTM to each of the 2 controllers are 2m long.

Input Power Specification

Table 3-2. Specifications (LV)

LV Input Voltage Range:	18-36 Vdc
Input Power (max):	< 77 W, 4.3 A max (Vertex)
	< 71 W, (Vertex)
Output Voltage Holdup Time:	> 14 ms with 24 Vdc input voltage
Isolation to Other Circuits:	> 500 Vrms to all other circuits
Isolation to EARTH:	> 500 Vrms to EARTH
Input Overvoltage Protection:	±60 Vdc @ 25 °C
Reverse Polarity Protection:	60 Vdc @ 25 °C
Input Undervoltage Shutdown:	~11 Vdc, non-latching

Note: Recommend breaker or power-line fusing of 8 A min to protect the power-wiring network from possible wiring shorts.

Table 3-3. Specifications (HV)

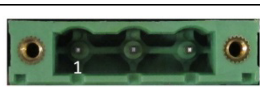
HV Input Voltage Range:	88-264 Vac / 90-150 Vdc
HV Input Frequency Range:	47-63 Hz
Input Power (AC max):	< 73 W, 1.6 A max (Vertex)
	< 67 W, 1.5 A max (Vertex)
Input Power (DC max):	< 73 W, 0.8 A max (Vertex)
	< 67 W, .75 A Max (Vertex)
Output Voltage Holdup Time:	> 30 ms with 110 Vac input voltage
Output Voltage Holdup Time:	> 120 ms with 220 Vac input voltage
Isolation to Other Circuits:	> 3000 Vrms to all other circuits
Isolation to EARTH:	> 1500 Vrms to EARTH
Input Overvoltage Protection:	±375 Vdc @ 25 °C
Reverse Polarity Protection:	375 Vdc
Input Undervoltage Shutdown:	~65 Vdc, non-latching

Note: Recommend breaker or power-line fusing of 3.5 A min to protect the power-wiring network from possible wiring shorts.

Power Connector

Input Power is provided through a three-position, latching terminal block with removable plug. Green connectors are used for low voltage DC units. Orange connectors are used for high voltage AC/DC units.

Table 3-4. Input Power Connector Pinout

Board Connection	PIN	Name	Description
	1	L+	Input Power (+)
	2	L-	Input Power (–)
	3	EARTH	Earth / shield connection
Plug Type: Side entry 7.62 mm, 12 A, pluggable with latching screw down			

WARNING	
Electric Shock	**To reduce the risk of Electrical Shock the Protective Earth (PE) must be connected to the PE ⏚ terminal on the enclosure. The conductor providing the connection must have a properly sized ring lug and wire gauge equal to or larger than 4mm² (12AWG).**

Visual Indicators (LED's) & CPU Configuration

Visual indicators are located on the Front Panel keypad, the controller board, back cover, and related communications ports for diagnostic use.

CPU OK indicator (green/red):
This bi-color LED indicates the CPU status is operational (green) or faulty (red). The CPU will flash fault codes (red) if they exist. This LED exists on both the Front Panel and back cover.

IOLOCK indicator (red):
Indicate the controller is shutdown and held in an IOLOCK state. This LED exists on both the Front Panel and back cover.

ALARM indicator (yellow):
Viewable from the front panel and controlled by GAP software.

TRIPPED indicator (red):
Viewable from the front panel and controlled by GAP software.

Ethernet LED's:
(Green=link, Yellow=traffic) on each RJ45 connector indicate port status and operation.

CPU Hardware Configuration
The CPU Configuration Switch (S1) is reserved for future use and is not active at this time.

Communications (Ethernet)

There are three isolated RJ45 Ethernet Ports (10/100 Mbit/sec) available to the application software for system use. These ports are full duplex with auto crossover detection.

Features
- Interface standard: IEEE 802.3 (Ethernet)
- Port Isolation: 1500 Vrms to PS, EARTH, and all other circuits
- Control configuration using Woodward AppManager
- Control monitoring, trending, and datalog collection
- Control configuration of Ethernet IP addresses
- General communications such as Modbus master/slave
- Manage Configuration data and tunables with Control Assistant
- Network time setup and control (SNTP)

Network Configuration
Ethernet ports (ETH1-2) can be configured for the customer network as desired. See the on-site Network Administrator to define an appropriate I/P address configuration.

IMPORTANT	**ETHERNET CABLES—Max cable length is 100 meters. To ensure signal integrity and robust operation, double shielded (SSTP) Cat5 Ethernet cables are required for customer installations (Woodward PN 5417-394, 10 feet).**

IMPORTANT

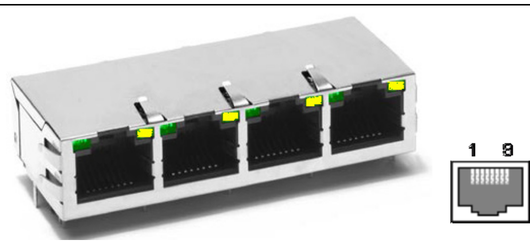
This module has been factory configured with fixed Ethernet IP addresses of
- **Ethernet #1 (ETH1) = 172.16.100.15, Subnet Mask = 255.255.0.0**
- **Ethernet #2 (ETH2) = 192.168.128.20, Subnet Mask = 255.255.255.0**
- **Ethernet #3 (ETH3) = 192.168.129.20, Subnet Mask = 255.255.255.0**
- **Ethernet #4 (ETH4) = 192.168.130.20, Subnet Mask = 255.255.255.0**

IMPORTANT

Each of the ETHERNET ports is required to be configured for a unique subnet (domain) (view default settings as an example).

Ethernet Connector (RJ45)

Table 3-5. Ethernet Ports #1-4 (10/100)

Board Connection	Description
	Pin 1 – TX+ Pin 2 – TX- Pin 3 – RX+ Pin 4 – not used Pin 5 – not used Pin 6 – RX- Pin 7 – not used Pin 8 – not used SHIELD = Chassis GND

Network Configuration Utility (AppManager)

Use Woodward's ***AppManager*** software to configure network setting and load Control software (GAP), HMI display software (QT), and operating system service packs. Download the *AppManager* utility from www.woodward.com/software.

A PC connection must be made to Ethernet #1 (ETH1) using a RJ45 Ethernet cable.

Note: Use AppManager to “discover/view” the current CPU IP Address, however, to modify settings or load applications, when the PC running. Reconfigure AppManager on the same “network” as the CPU.

- Locate the ControlName on the module faceplate and highlight it in *AppManager*.
- To VIEW the IP address configuration, select menu option CONTROL - CONTROL INFORMATION. Look for the Ethernet adapter addresses under the Footprint Description.
- To CHANGE the IP address configuration, select menu option CONTROL - CHANGE NETWORK SETTINGS.

Communications (CAN)

Four Isolated CAN ports are available for general communications as well as simplex distributed control. Compatible devices include Woodward RTCnet nodes products. Removable latching connector plugs are provided for field wiring.

Network Termination:

CAN networks must include a **120 Ω** termination resistor at each end of the trunk line.

Network Topology:

Recommend Daisy chain connections between multiple devices. Any drop cable connection of a device to the trunk line should be as short as possible and much less than six meters.
Recommend the network trunk design be less than 100 meters with a max cumulative drop length of less than 39 meters.

Important:

For one Mbit/sec communication it is required that each drop cable be less than one meter and as short as possible.

Table 3-6. CAN Specifications

Interface Standard	CAN 2.0B, CANopen
Network Connections	(4) CAN ports, separate connectors
Network Isolation	500 Vrms to EARTH, other CAN ports, all other I/O
Network Speed/Length	1 Mbit @ 30 m 500 Kbit @ 100 m 250 Kbit @ 250 m (thick cable only, otherwise limited to 100 m) 125 Kbit @ 500 m (thick cable only, otherwise limited to 100 m)
Network Termination:	(120 ± 10) Ω is required at each end of the network trunk line. **The termination resistor is NOT built into the hardware.
CAN Address	Software configurable
CAN Baud Rate	Software configurable for 125 K, 500 K, 250 K, and 1 Mbit
Cable / Part Number	2008-1512 (120 Ω, 3-wire, shielded twisted pair) —Belden YR58684 or similar
Cable Drops (1 Mbit)	CAN Cable drops shall be < 1 m and as short as possible
Cable Drops (500K, etc.)	CAN Cable drops shall be < 6 m and as short as possible

**If needed, an isolated CAN to USB converter is IXXAT, HW221245

Table 3-7. CAN Connector Pinout

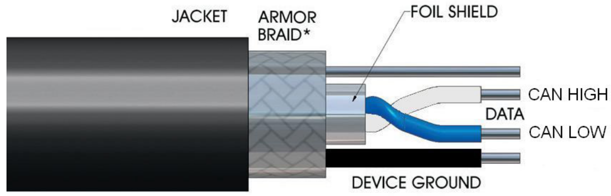
Board Connection	PIN	Color	Description
	1	BLACK	CAN Signal Ground
	2	BLUE	CAN Low
	3	Shield	CAN Shield (30 Meg + AC coupled to EARTH)
	4	WHITE	CAN High
	5	n/a	Not used, no internal connection

Plug Type: Side entry 3.5 mm, 8 A, pluggable with latching screw down
Max wire size: 1.3 mm² / 16 AWG for single wires, 0.5 mm² / 20 AWG for two wires

CAN Cable Specifications

Belden YR58684 (Woodward PN 2008-1512) communications / CAN cable is approved and recommended. This is a smaller and more flexible 0.3 mm² / 22 AWG, low capacitance cable suitable for tight routing in industrial environments.

Table 3-8. Belden YR58684, Bulk Cable (Woodward PN 2008-1512)



Impedance:	120 Ω ±10 % at 1 MHz
DC resistance:	17.5 Ω per 1000 ft.
Cable capacitance:	11 pF/ft. at 1 kHz
Data Pair:	0.3 mm² / 22 AWG, 7 strands, individually tinned, FEP insulation (BLUE, WHITE twisted pair)
Ground:	0.3 mm² / 22 AWG, 7 strands, individually tinned, FEP insulation (BLACK)
Drain / Shield Wire:	0.3 mm² / 22 AWG, 7 strands, individually tinned
Shielding:	Foil 100 % with outer Braid 65 %
Jacket:	FEP Insulation, BLACK
Cable type:	1.5 pair, twisted shielded
Outer Diameter:	0.244 inch
Bend Radius:	2.5 inches
Temperature:	–70 °C to +125 °C
Similar Cable:	Belden 3106A (has different colors & lower temperature specs)

CAN Wiring / Shield Terminations & Limitations

For robust communications performance, the CAN cabling needs to minimize the exposed, non-shielded cable section that occurs at terminal blocks. The exposed length of CAN wiring must be limited to less than 3.8 cm / 1.5 inches from the end of the shield to the terminal block.

CAN shields are terminated to chassis (EARTH) through a capacitor-resistor network. This is designed into the Vertex hardware products. However, the shield must also be directly terminated to chassis (Earth) at one point in the network. In the case of Woodward equipment, the direct ground is meant to be located at the master device end, as it exits the master device's enclosure.

IMPORTANT	**Always use shielded cables for improved communications in industrial environments. Wire terminations should expose as little un-shielded cable as possible (less than 3.8 cm / 1.5 inches).**

Communications (RS-232/RS-485)

An isolated, configurable RS-232/485 serial port is available for customer use, as configured by the GAP software application. RS-422 communications is NOT supported.

Specifications
- Interface Standard: RS-232C and RS-485
- Isolation: 500 Vrms to EARTH and all other I/O
- Baud Rates: 19.2K, 38.4K, 57.6K, and 115.2 K
- Max Distance (RS-232): 15 m (50 feet) max
- Max Distance (RS-485): 1220 m (4000 feet) max
- A shielded cable is required when using this port.
- RS-485 networks require termination at both ends with approximately 90–120 Ω impedance that matches the characteristic impedance of the cable used.

Cable Note: Woodward cable 2008-1512 (3-wire) is a shielded, low capacitance 120-ohm cable that is designed for communications. This cable is also used for CAN communications.

Table 3-9. COM1 Serial Port Connector

Board Connection	Description
 **(8 pins)**	Pin 1 – RS-232 Transmit Pin 2 – RS-232 Receive Pin 3 – Signal Common Pin 4 – Shield (AC) Pin 5 – RS-485 (+) Pin 6 – Termination Resistor (+) Pin 7 – Termination Resistor (-) Pin 8 – RS-485 (-)

Plug Type: Side entry 3.5 mm, 8 A, pluggable with latching screw down
Max wire size: 1.3 mm² / 16 AWG for single wires, 0.5 mm² / 20 AWG for two wires

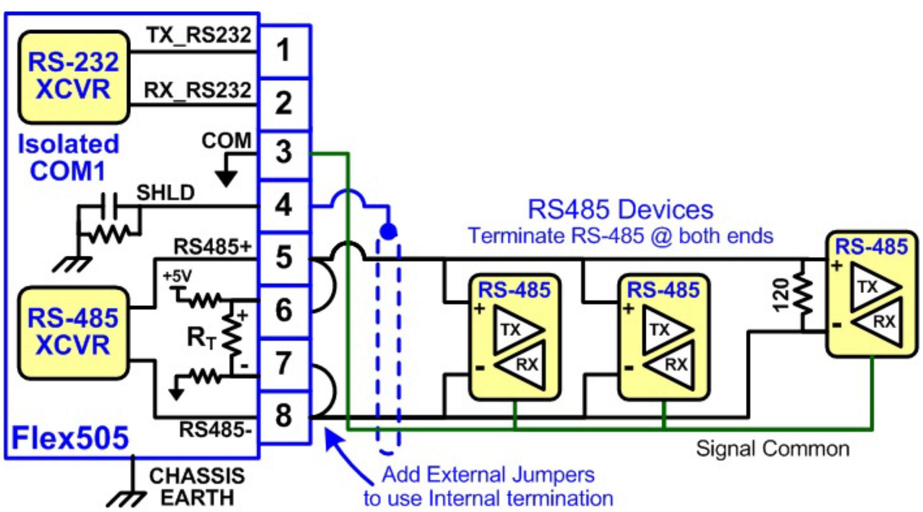


Figure 3-4. COM1 Example RS-485 Wiring

Communications (Service Ports)

RS-232 Service Port

An isolated RS-232 service port is located on the CPU board. Isolation is specified at 500 Vrms and baud rate is fixed at **115.2K** baud, 8 data bits, no parity, 1 stop-bit, and no flow control. This port is for VxWorks operating system use only and cannot be configured for application software use.

For debug use, a **Woodward PN 5417-1344**, USB to serial debug cable is required to attach this port to a PC. Trained Field Service personnel use this port only!

Dura-Clik connector (male)
Pin 1 – RS-232 Transmit
Pin 2 – RS-232 Receive
Pin 3 – Signal Ground

Figure 3-5. CPU Service Port (3 pin, 2 mm)

USB Service Port

Note: This USB service port is currently disabled.

Hardware - Terminal Blocks & Wiring

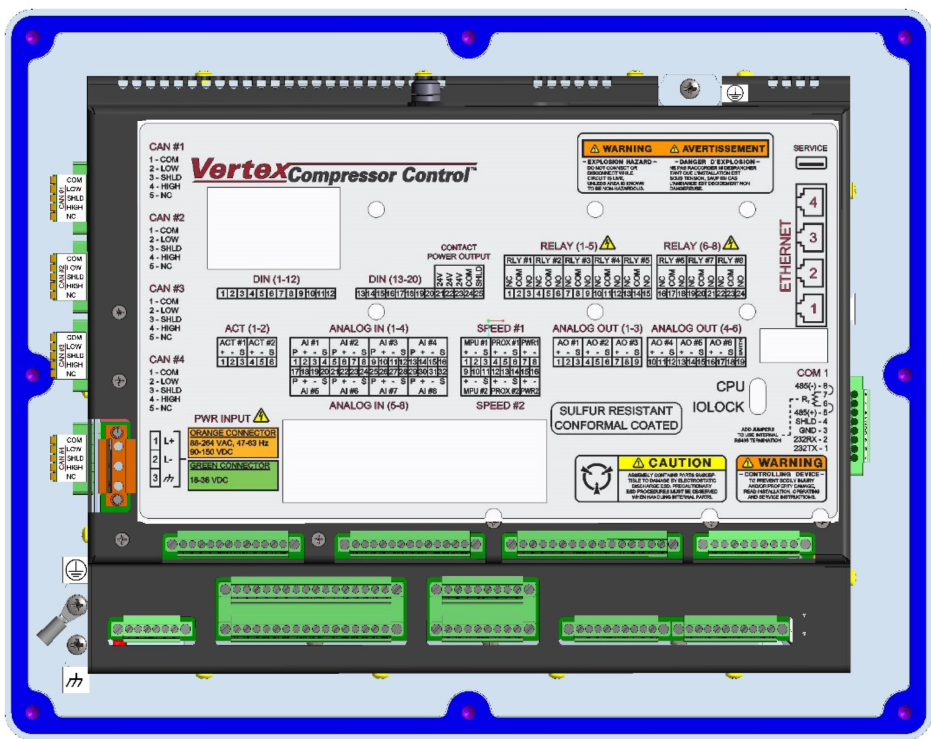


Figure 3-6. Vertex Back Cover Label

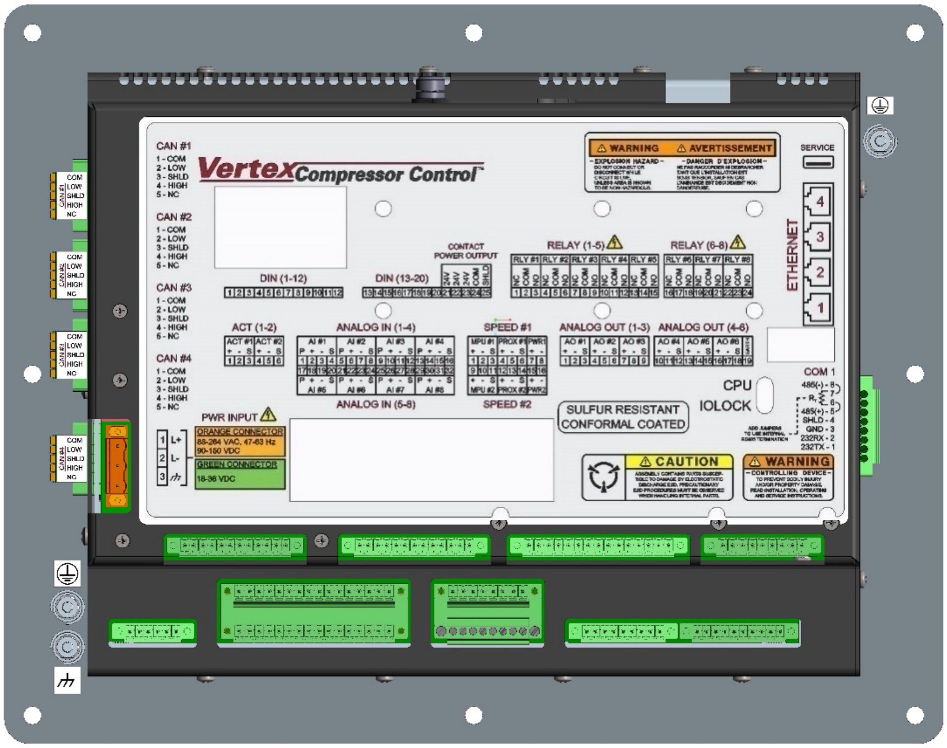


Figure 3-7. Vertex Back Cover Label

Terminal Block Connectors

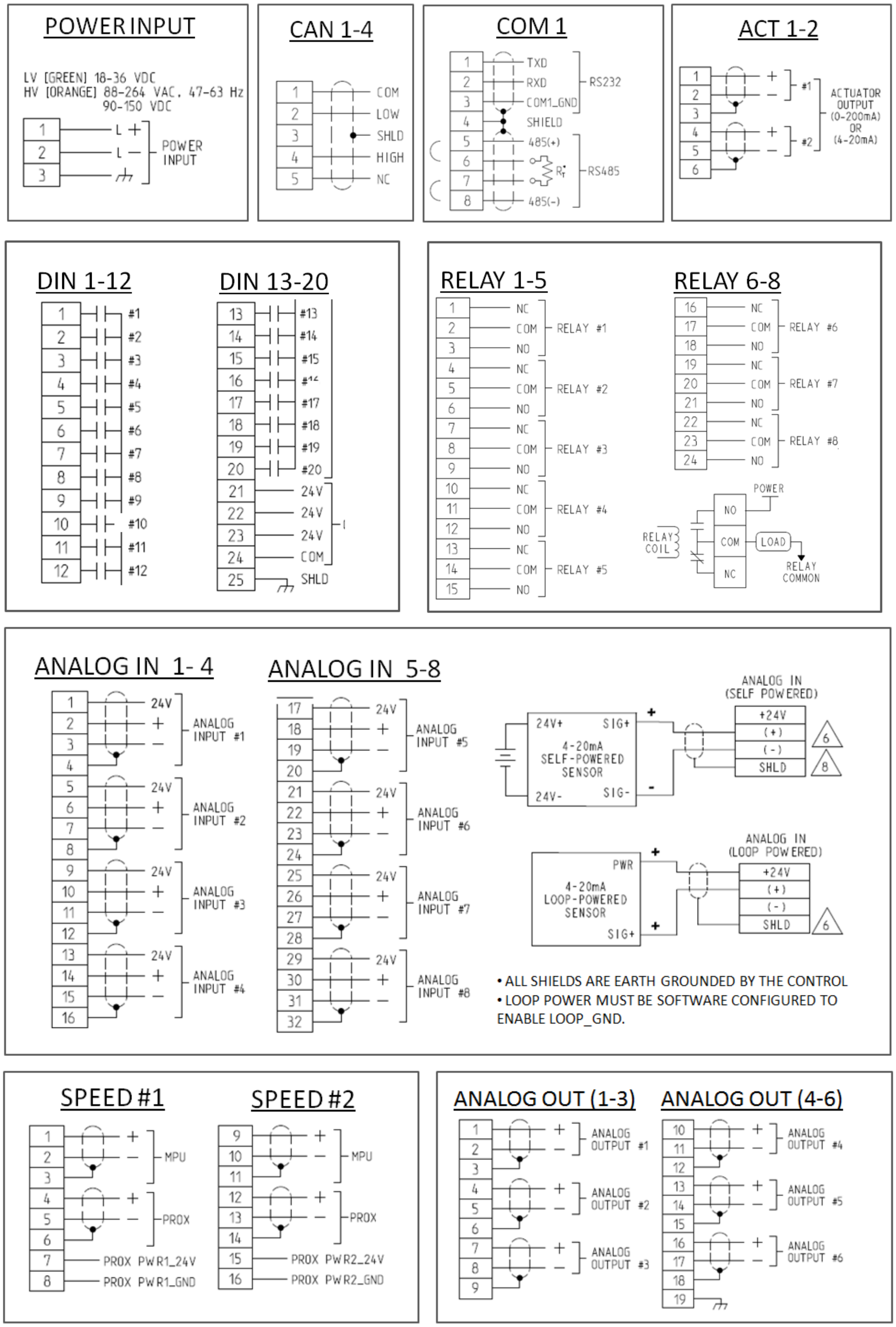


Figure 3-8. Vertex Terminal Block Connectors

Hardware - Speed Sensor Inputs

This controller includes two Digital Speed Sensor circuits that are capable of interfacing to MPU and Proximity speed probe sensors. Each channel is isolated from each other and may be configured for either MPU or PROX sensors. A dedicated and isolated, PROX power (+24 V) is provided on each channel for proximity sensor use.

Note: Do not use the Proximity Power outputs to power any other type devices.

Features

- Two Digital Speed Sensor circuits, isolated individually
- GAP configurable for MPU sensors or Proximity sensor operation
- Separate terminals provided for MPU and Proximity sensors
- Isolated Prox Power (+24 Vdc) is provided with short-circuit protection
- Woodward GAP block, diagnostics, and configuration support
- GAP configurable update rates of 5 ms to 160 ms

Table 3-10. Specifications (MPU/PROX)

MPU Input Voltage:	1 to 35 Vrms
MPU Input Frequency:	10 Hz to 35 KHz
MPU Input Impedance:	2000 Ω, DC
MPU Input Isolation:	500 Vrms to EARTH and all other I/O 500 Vrms to other MPU and PROX channels
Prox Input Voltage:	0-32 VDC
Prox Input Frequency:	0.04 Hz to 35 KHz (low limit depends on range)
Prox Input Impedance:	2000 Ω, DC
Prox Threshold:	Low is < 8 VDC High is > 16VDC
Prox Input Isolation:	500 Vrms to EARTH and all other I/O 500 Vrms to other MPU and PROX channels.
Prox Power1+2 out:	24 VDC ± 14%, 0-200 mA, short circuit & diode protected
Prox Power Isolation:	500 Vrms to EARTH, all other I/O, & other Prox Power
Max Speed Range:	Software selectable from 5 kHz to 35 kHz
Accuracy (-40,70c):	< ±0.01% of full scale range selected
Resolution:	> 22 bits
Speed Filter (ms):	5-10,000 ms (2 poles)
Derivative Filter (ms):	5-10,000 ms (speed filter + 1 pole)
Derivative Accuracy:	0.1% of full scale range, over full temperature range
Acceleration Limit:	1-10,000 %/sec

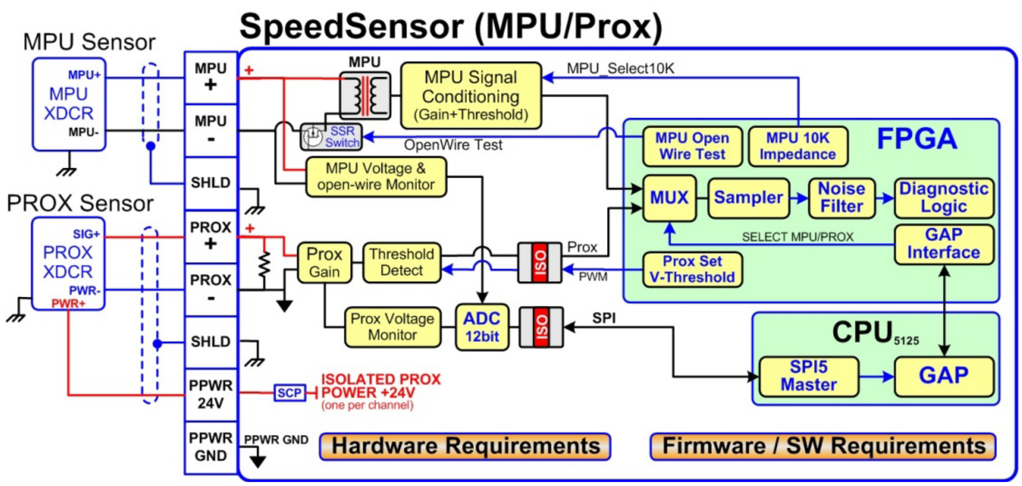


Figure 3-9. Speed Sensor Block Diagram

Hardware - Analog Inputs (4-20 mA)

AI Description and Features

The Vertex Compressor Controller includes eight 4–20 mA input channels for I/O monitoring and control. Each channel is differential (self-powered) but can be software configured for Loop Power mode. An Isolated Loop Power (+24 Vdc) is provided for analog input transducers and includes short-circuit/over-voltage protection.

Note: Do not use the Loop Power output to power any other type devices.

Features

- Eight 4–20 mA Analog Input Channels, 16 bit resolution
- Differential inputs with high common-mode voltage capability
- Isolated Loop Power +24 V is provided with short-circuit protection
- Fast AI channel #8 for special control functions
- Woodward GAP block, diagnostics, and configuration support
- GAP configurable update rates of 5 ms to 160 ms
- GAP configurable for Loop power operation

Table 3-11. Specifications (AI)

Number of Channels:	8
AI Input Range:	0 to 24 mA
AI Input Isolation:	0 V channel to channel. 500 Vrms to EARTH and all other I/O (except USB)
AI Accuracy (@ 25 °C):	≤ 0.024 mA (0.1% of FS=24 mA)
AI Accuracy (–40, +70 °C):	≤ 0.06 mA (0.25% of FS=24 mA)
AI Resolution:	~16 bits of full scale
AI Hardware Filter:	2 poles @ ~10 ms **Fast channel (Ch. 8) has 2 poles @ ~5 ms
AI Input Impedance:	200 ohms (Rsense = 162 ohms)
AI Loop Power Output:	24 V ±14% (0-250 mA) short circuit & diode protected
AI Loop Power Isolation:	500 Vrms to EARTH and all other I/O
AI CMRR Over Temp:	> 70 dB @ 50/60 Hz (typical 86 db)
AI CMVR:	> 200 V (dc) to EARTH
AI Overvoltage:	±36 V (dc) continuous at room temperature

Released

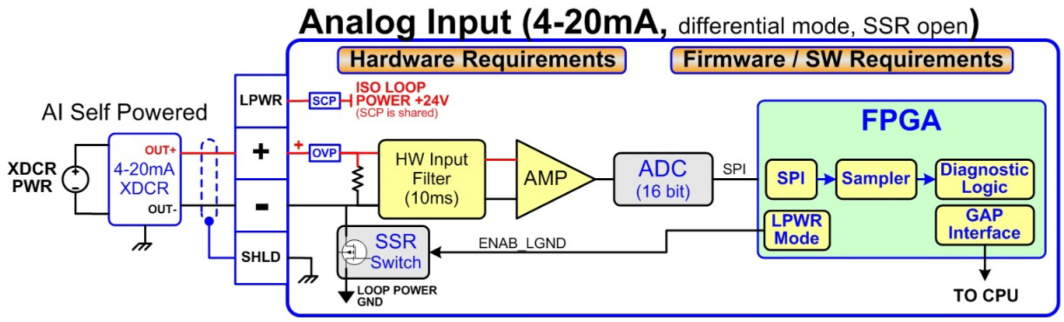


Figure 3-10. Analog Input – Self-Powered Block Diagram

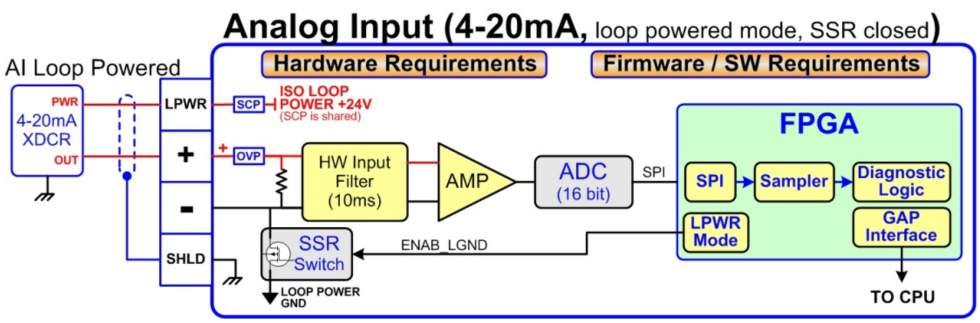


Figure 3-11. Analog Input – Loop-Powered Block Diagram

Hardware - Analog Outputs (4-20 mA)

This control provides an isolated group of six 4-20 mA outputs for customer use. Each output can drive up to 600-ohm loads and provides fault monitoring of individual source and return currents.

Features

- Six Analog Output channels (4-20 mA)
- Source and return current monitors
- Group isolated from other circuits
- Capable of driving higher impedance loads up to 600 ohms
- Woodward GAP block, diagnostics, and configuration support
- GAP configurable update rates of 5 ms to 160 ms

Table 3-12. Specifications (AO)

Number of Channels:	6 (each with readback)
AO Output Range:	0 to 24 mA, 0 mA during shutdown
AO Output Isolation:	0 V channel to channel 500 Vrms to EARTH and all other I/O
AO Accuracy (@ 25 °C):	≤ 0.024 mA (0.1% of FS=24 mA)
AO Accuracy (–40, +70 °C):	≤ 0.120 mA (0.5% of FS=24 mA)
AO Resolution:	~14 bits of full scale
AO Hardware Filter (max):	3 poles @ 250 µs
AO Load Capability:	600 Ω at 20 mA
AO Output Readbacks:	(0 to 24) mA, source and return
AO Readback Accuracy:	< 1% at 25°C, < 3% over full temperature range
AO Readback HW Filter:	~0.5 ms nominal
IOLOCK State:	AO circuits are driven to 0 mA during power-up, power-down, core voltage failures, and watchdog failures

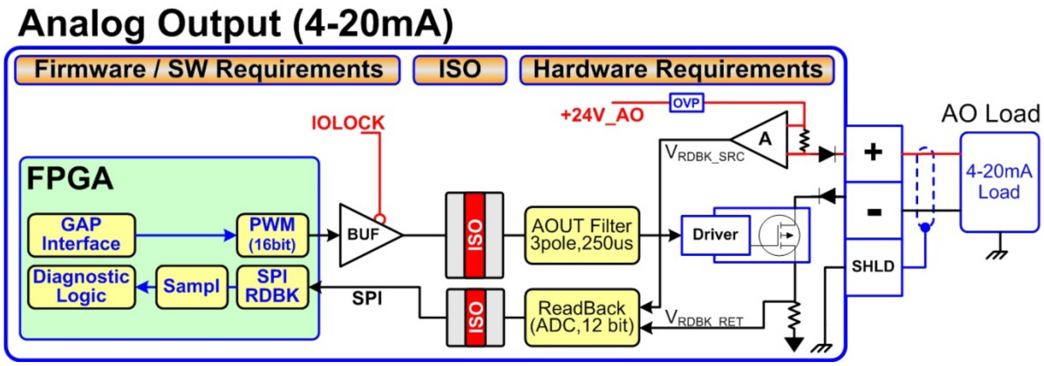


Figure 3-12. Analog Output Block Diagram

Hardware - Actuator Outputs

This control provides an isolated group of two Actuator outputs for customer use. Each driver can be configured for low-range (20 mA) or high-range (200 mA) operation. Fault monitoring of individual source and return currents is included.

Features

- Two Actuator Output channels (4-20 mA, 20-200 mA)
- Source and return current monitoring
- Group isolated from other circuits
- Capable of driving higher impedance loads
- Woodward GAP block, diagnostics, and configuration support
- GAP configurable update rates of 5 ms to 160 ms

Table 3-13. Specifications (ACT)

Number of Channels	2 proportional drivers with source & return readbacks	
ACT Output Range	Configurable for 24 mA or 200 mA range	
ACT Output Range (low)	0-24 mA, 0 mA during shutdown (FS = 24 mA)	
ACT Output Range (high)	0-200 mA, 0 mA during shutdown (FS = 210 mA)	
ACT Output Isolation	0 V channel to channel 500 Vrms to EARTH and all other I/O	
ACT Accuracy (25 °C)	Low Range ≤ 0.024 mA (0.1%)	High Range ≤ 0.21 mA (0.1%)
ACT Accuracy (–40, +70 °C)	Low Range ≤ 0.120 mA (0.5%)	High Range ≤ 1.00 mA (0.5%)
ACT Resolution	~14 bits of full scale	
ACT Hardware Filter (max)	3 poles @ 500 µs	
ACT Load Capability (low)	600 Ω at 20 mA	
ACT Load Capability (high)	65 Ω at 200 mA	
ACT Output Readbacks	(0 to 24) mA, source and return	
ACT Readback Accuracy	< 1% at 25°C, < 3% over full temperature range, (source & return)	
ACT Readback HW Filter	~0.5 ms nominal	
ESTOP Action	Front panel ESTOP button will shut down the actuator circuit, remove actuator power, and set an alarm in GAP software.	
IOLOCK Action	During IOLOCK, ACT power is shutdown and ACT circuits are driven to 0 mA during power-up, power-down, core voltage failures, and watchdog failures.	

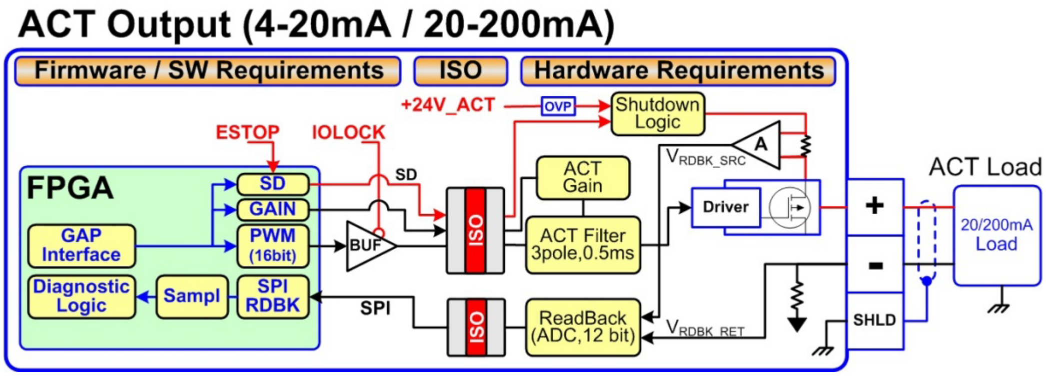


Figure 3-13. Actuator Output Block Diagram

Hardware - Discrete Inputs

This control provides an isolated group of 20 discrete input channels for use with +24 V (dc) signals. An isolated Contact Power voltage supply of +24 V (dc) is provided for use with the discrete inputs. This supply includes short-circuit and over-voltage protection.

Note: Do not use the Contact Power output to power any other devices.

Features

- 20 Discrete Input Channels for +24 V (dc) signals
- +24 V Contact Power with short-circuit and diode protection
- Isolated power and discrete input group
- Woodward GAP block, diagnostics, and configuration support
- GAP configurable update rates of 5 ms to 160 ms
- Time-stamping capability (1 ms)

Table 3-14. Specifications (DI)

Number of Channels	20
DI Input Low State	(0 to 8) V (dc)
DI Input High State	(16 to 32) V (dc)
DI Input Current	< 5 mA per channel
DI Input Impedance	25K approximate
DI Hardware Filter	1.0 ms approximate at room temp
DI Channel Isolation	0 V channel to channel 500 Vrms to EARTH and all other I/O
DI Overvoltage	Overvoltage to 36 V (dc) for inputs
Contact Power Output	24 V ±14 %, 150 mA (max), short circuit & diode protected
Contact Power Isolation	500 Vrms to EARTH and all other I/O

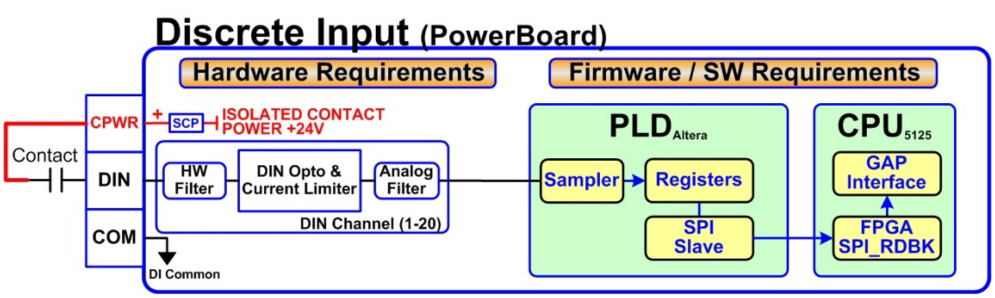


Figure 3-14. Discrete Input Block Diagram

Hardware - Relay Outputs

This control provides eight Isolated, Form-C Relay outputs with NO, COM, NC contacts available at the terminal block.

Features

- Eight Relay Output Channels
- Each Relay Output provides NO, COM, and NC contacts
- Each Relay Output channel provides a coil voltage readback fault
- Woodward GAP block, diagnostics, and configuration support
- Contact isolation maintained at terminal blocks
- ATEX approved version available using hermetically sealed relays
- GAP configurable update rates of 5 ms to 160 ms

Table 3-15. Specifications (relay outputs)

Number of Channels	8 relays
Contact Type	Form-C with NO, COM, and NC terminals
STD Relay, Contacts (DC)	5 A, 5-30 Vdc (resistive)
STD Relay, Contacts (AC)	2 A, 115 Vac (resistive)
STD Relay, Operate time	< 15 ms typical
RELAY Coil Readback	Coil voltage readback status is available
RELAY Coil Rdbk Filter	1 ms approximate at room temp
RELAY Output Isolation	500 Vrms minimum to EARTH and all other I/O
RELAY Contact Isolation	500 Vrms minimum between open contacts
RELAY to RELAY Isolation	500 Vrms minimum between relays
IOLOCK State	Relay outputs are de-energized during power-up, power-down, core voltage failures and watchdog failures
ATEX Version:	The ATEX approved control uses a Hermetically sealed relay
ATX Relay, contacts (DC)	5 A, 5-30 Vdc (resistive), 0.2-0.5 A (inductive)
ATX Relay, contacts (AC)**	2 A, 115 Vac (resistive), 0.1-0.2 A (inductive), non-hazardous area

⚠WARNING

EXPLOSION HAZARD

****ATEX/IECEx and North American Hazardous Locations Compliance requires relay contact loads be limited to ≤ 32 Vac rms / ≤ 32 Vdc.**

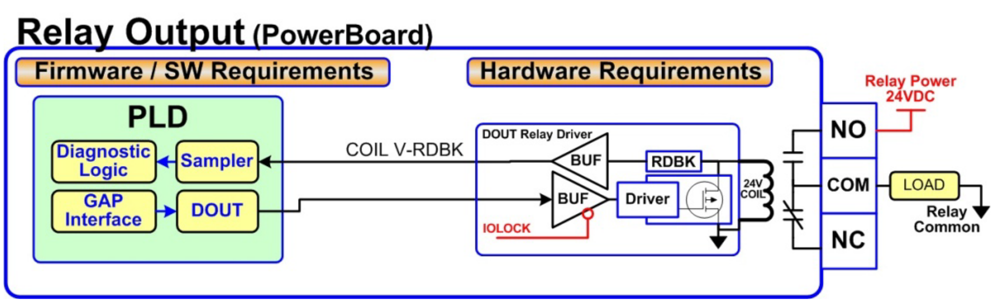


Figure 3-15. Relay Output Block Diagram

Troubleshooting Fault Codes

The CPU board runs diagnostics that display troubleshooting messages through the debug Service Port and AppManager. Additional information on diagnostics tests, subsequent LED flash codes, and serial port messages is contained in the VxWorks manual.

Table 3-16. CPU Fault LED Flash Codes

Failure	Flash Code
CPU not operational, IOLOCK state	Solid Red
RAM Test Failure	2, 1
FPGA Test Failure	2, 9
Watchdog not enabled	2, 10
RAM drive error	2, 11
Flash drive error	2, 12

Troubleshooting & Commissioning Checks

Power Checks

- Verify proper polarity on power connections
- Verify power source and wire size is sufficient for all loads
- Verify input power voltage is correct (i.e.: low voltage unit is 18 V to 36 Vdc)
- Verify PS(+) and PS(–) impedance to EARTH is > 10 MΩ

Ethernet Checks

- Verify cabling meets CAT-5 or better performance specs
- Verify cables are shielded properly per Woodward spec (using inner foil and outer braid)
- Verify each port is connected to the desired port & cable is labeled with correct port number
- Verify the cable installation has a bend radius is > 3 inches to prevent cable stress/breakage
- Verify that any tie-wraps used for cable installation are not overly tight to prevent cable stress
- **Verify IP Address** of each port is set correctly according to your plant network & administrator
- A list of the default IP address for all ports is in the Hardware/Ethernet section of this manual.
- The Woodward AppManager tool can be used to review & change IP Address settings
- Verify that Woodward Tools use Ethernet #1 (AppManager, OPC Server, & Control Assistant)
- Consider using color coded tie wraps for ports (i.e.: ETH1 = blue, ETH2=red, ETH3=yellow)
- For best performance, verify that Ethernet traffic is < 70% and GAP rate group loading is < 80%

RS-232 Wiring Checks

- Verify the RS-232 wiring uses a high quality shielded communication cable. For example, Woodward 2008-1512 (Belden YR58684) or equivalent low capacitance, shielded communications wire.
- Verify the RS-232 wiring uses the signal common (COM1_GND)
- Verify RS-232 network length is within specifications (typically < 50 feet)
- Verify Signal wires (TX+,RX-) are not shorted to each other
- Verify Signal wires (TX+,RX-) are not shorted to COM1_GND
- Verify Signal wires (TX+,RX-) are not shorted to COM1_SHLD
- Verify Signal wires (TX+,RX-) are not connected to PS(+), PS(–), EARTH
- Verify COM1_GND is not connected to PS(+), PS(–), EARTH
- Verify the overall cable shield is terminated to EARTH at only (1) location.

RS-485 Wiring Checks

- Verify the RS-485 wiring uses a high quality shielded communication cable. For example, Woodward 2008-1512 (Belden YR58684) or equivalent low capacitance, shielded communications wire.
- Verify RS-485 network length is within spec for the baud-rate (typically < 4000 feet)
- Verify the network is terminated properly at both ends with approx. 90–120 Ω
- Verify the RS-485 wiring uses the signal common (COM1_GND)
- Verify Signal wires (RS-485+, RS-485–) are not shorted to each other

- Verify Signal wires (RS-485+, RS-485–) are not shorted to COM1_GND
- Verify Signal wires (RS-485+, RS-485–) are not shorted to COM1_SHLD
- Verify Signal wires (RS-485+, RS-485–) are not connected to PS(+), PS(–), EARTH
- Verify COM1_GND is not connected to PS(+), PS(–), EARTH
- Verify the overall cable shield is terminated to EARTH at only (1) location.

CAN Wiring Checks

- Verify the CAN wiring uses a high quality, 3-wire, shielded communication cable. For example, Woodward 2008-1512 (Belden YR58684) or equivalent low capacitance, shielded communications wire.
- Verify CAN network length is < max length spec for the baud rate being used
- Verify network is terminated properly at both ends with 120 Ω, ±10%
- Verify the CAN wiring uses the signal common (CAN_GND)
- Verify CAN drop cables to each device are as short as possible and meets spec.
- Verify CANH is not connected to PS(+), PS(–), EARTH
- Verify CANL is not connected to PS(+), PS(–), EARTH
- Verify CAN_COM is not connected to PS(+), PS(–), EARTH
- Verify CAN_SHLD shield wire is not shorted to PS(+), PS(–)
- Verify the CAN overall cable shield is terminated to EARTH at only (1) location for each network.

Speed Sensor MPU/PROX Wiring Checks

- Verify MPU sensors are wired to MPU terminal block location
- Verify PROX sensors are wired to PROX terminal block location
- Verify that each sensor is wired to the correct channel (i.e.: MPU1 to channel1)
- Verify that MPU+, PROX+ is not connected to PS(+), PS(–), EARTH
- Verify that MPU-, PROX- is not connected to PS(+), PS(–), EARTH
- Verify shield wires are not shorted to signals (MPU+, MPU-, PROX+, PROX-)
- Verify shield wires are not shorted to input power PS(+), PS(–)
- Verify MPU voltage amplitude meets spec (i.e.: > 1Vrms)
- Verify PROX voltage amplitude meets spec (i.e.: < 8V for low, >16V for high)
- If Prox Power#1 output is used, make sure it is ONLY used for sensor power1
- If Prox Power#2 output is used, make sure it is ONLY used for sensor power2
- If using Prox Power, verify that wiring is correct and isolation between sensors is maintained
- If using Prox Power, verify PPWR1+,PPWR2+ are not connected to PS(+), PS(-), EARTH
- If using Prox Power, verify PPWR1-,PPWR2- are not connected to PS(+), PS(-), EARTH
- If using Prox Power, verify PPWR1+,PPWR2+ are not connected to each other
- If using Prox Power, verify PPWR1-,PPWR2- are not connected to each other

AI (non-loop), Analog Input Wiring Checks

- Verify that external XDCR's are NOT used with these self-powered channels.
- Verify each AI (+,–) is not shorted to another input channel.
- Verify each AI (+) terminal is not shorted to PS (+), PS (–), EARTH.
- Verify each AI (–) terminal is not shorted to PS (+), PS (–), EARTH.
- Verify each AI shield wire is not shorted to PS (+), PS (–).
- Verify each AI shield wire is terminated at the node properly.
- Functionally verify the wiring for each AI channel using a simulator source.

AI (Loop power), Analog Input Wiring Checks

- Verify that external XDCR's are connected to these channels.
- Verify the LPWR voltage level (+24 V dc) is correct for the XDCR.
- Verify each LPWR (+) terminal is wired to the XDCR POWER (+).
- Verify each LPWR (+) terminal is not shorted to PS (+), PS (–), EARTH.
- Verify each AI (–) terminal is not shorted to PS (+), PS (–), EARTH.
- Verify each AI shield wire is not shorted to PS (+), PS (–).
- Verify each AI shield wire is terminated at the node properly.
- Verify that all XDCR's channels use less than 250 mA of LPWR.

- Functionally verify the wiring for each AI channel using a simulator source.

AO, Analog Output Wiring Checks

- Verify each AO (+,–) is not shorted to another output channel.
- Verify each AO (+,–) is not shorted to another Analog Input channel.
- Verify each AO (+) terminal is not shorted to PS (+), PS (–), EARTH.
- Verify each AO (–) terminal is not shorted to PS (+), PS (–), EARTH.
- Verify each AO shield wire is not shorted to PS (+), PS (–).
- Verify each AO shield wire is terminated at the node properly.
- Functionally verify the wiring for each AOUT by driving 4 mA and 20 mA to the load from the GAP application. Verify correct output current with a meter. Verify the correct SRC_RDBK & RET_RDBK values in GAP.

DI, Discrete Input Wiring Checks

- Verify each DI (+) is not shorted to another input.
- Verify each DI (+) is not shorted to CPWR (+), CPWR (–), PS (+), PS (–), EARTH.
- Verify each DI (+) wiring is functional by setting each input HIGH (>16 V DC) and then LOW (<8 V DC). Verify GAP software detects the state change.
- When possible, consider using a shielded DIN cable.

DI, Contact Power (CPWR) Wiring Checks

- CPWR (+) is an output voltage, it should never be connected to any other supply.
- To maintain node isolation, verify CPWR (–) is not shorted to PS (–).
- Using the internal isolated Contact Power output (CPWR,COM) is highly recommended to maintain discrete input isolation for other plant devices / controls
- Verify CPWR (+) is not connected to CPWR (–), PS (–), EARTH.
- Verify CPWR (–) is not connected to CPWR (+), PS (+), EARTH.
- Verify CPWR voltage meets spec at the terminal block (18 to 32 V dc).

DO Relays, Relay Wiring Checks

- Verify each Relay output (NO, C, NC) contact is connected to the load properly
- Verify each Relay output (NO, C, NC) is not shorted to another output channel.
- Verify the function of each Relay output (NC, NO) wiring by driving each output ON then OFF. Verify the GAP software detects the readback state change.
- When possible, consider using shielded wiring for relay cables.

Additional Wiring Checks When Using RTCnet Nodes

TC, Thermocouple Input Wiring Checks

- Verify each TC (+,–) is not shorted to another input channel.
- Verify each TC (+) terminal is not shorted to PS (+), PS (–), EARTH.
- Verify each TC (–) terminal is not shorted to PS (+), PS (–), EARTH.
- Verify each TC shield wire is not shorted to PS (+), PS (–).
- Verify no wires are landed accidentally on the NC, no-connect terminals.
- Verify each TC shield wire is terminated at the node properly.
- Functionally verify the wiring for each TC channel using a simulator source.
- TC OPENS: A TC input will read MAX Deg C if the (+) or (–) wire is broken / open.
- TC SHORTS: A TC input will read zero Deg C if the (+) and (–) wires are shorted.

NOTICE	**GROUND FAULTS: Input channels accidentally shorted to EARTH will be more susceptible to spurious noise events related to the installation and environment.**

RTD, Input Wiring Checks

- Verify each RTD (+,–) is not shorted to another input channel.
- Verify each RTD (+) terminal is not shorted to PS (+), PS (–), EARTH.
- Verify each RTD (–) terminal is not shorted to PS (+), PS (–), EARTH.
- Verify each RTD (sense) terminal is not shorted to PS (+), PS (–), EARTH.
- Verify each RTD (sense) terminal is connected properly for 3-wire sensors.
- Verify each RTD (sense) terminal is jumpered to RTD (–) for 2-wire sensors.
- Verify each RTD shield wire is not shorted to PS (+), PS (–).
- Verify each RTD shield wire is terminated at the node properly.
- Functionally verify the wiring for each RTD channel using a simulator source.
- RTD OPENS: RTD channels will read MAX DegC if the (+) or (–) wire is broken.

Chapter 4.
Manual Network Setup

Factory Set IP Addresses for the Control

Table 4-1. Factory-set IP Addresses for the Vertex CPU

Port Name	IP Address	Subnet Mask
Ethernet #1	172.16.100.15	255.255.0.0
Ethernet #2	192.168.128.20	255.255.255.0
Ethernet #3	192.168.129.20	255.255.255.0
Ethernet #4	192.168.130.20	255.255.255.0
Default Gateway	<none>	

Factory Set Network Passwords

Note: See AppManager Help for more information.

The control Operating System enforces security by requiring the user to login with valid permissions before accessing privileged control services. A login is required in order to connect the AppManager tool to the control.

Note: All account names and passwords are case sensitive!

Table 4-2. Factory-set Account Names and Passwords for Newer Controls

Account Name	Password
Configure	wg1113
Service	wg1112
Operator	wg1111

Network Setup Instructions for the Control

Here is a simple flowchart, which shows the steps for configuring the control's network settings to work on your network. The listing of factory set IP addresses are in Table 4-1 and detailed instructions for the steps in the flowchart are below:

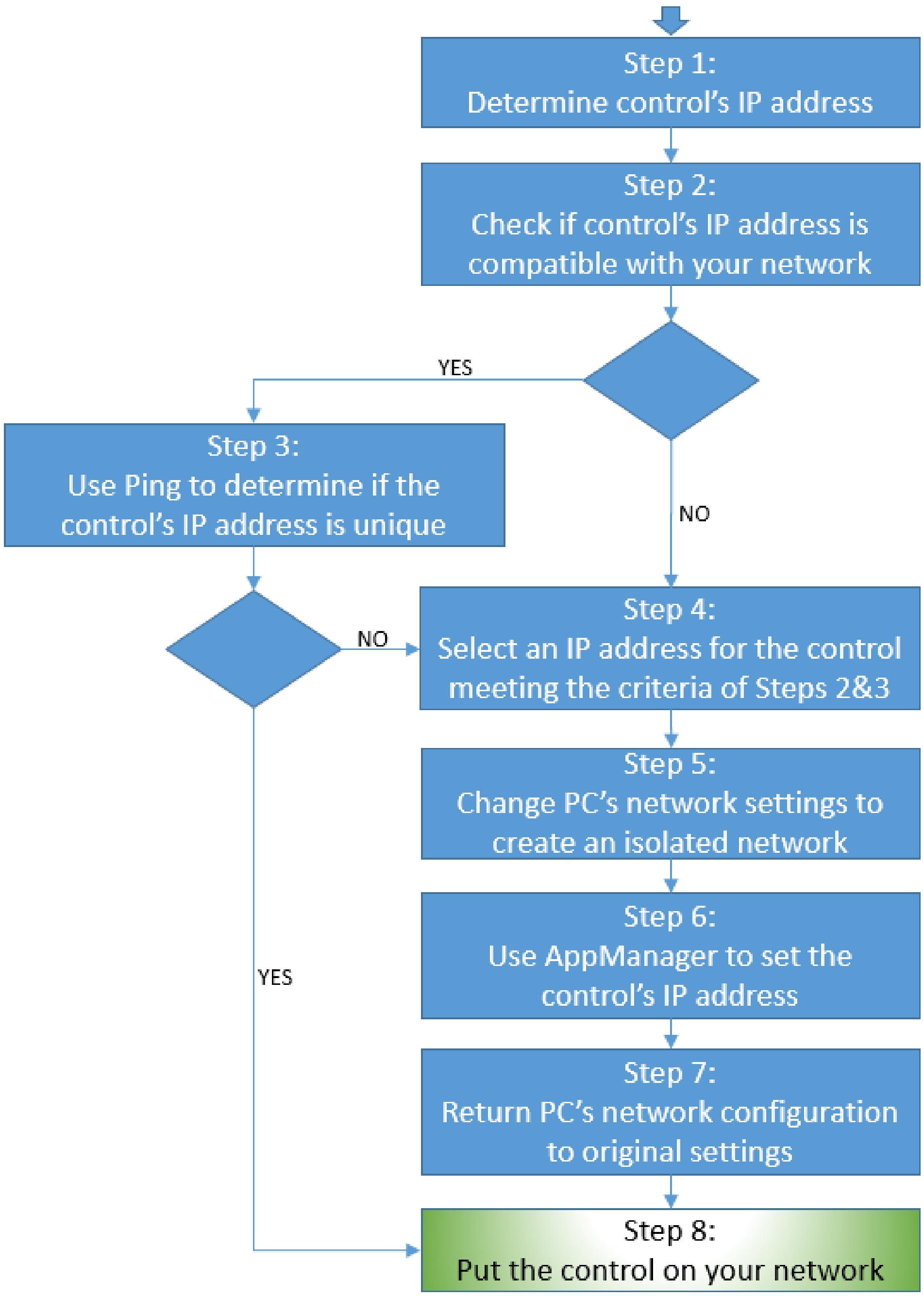


Figure 4-1. Network Setup Flowchart

Detailed network setup instructions for the control

Execute the following steps (up to 8) to configure your control to work with your network. The control's primary IP address must be compatible with your network, but cannot collide with an existing device's address.

1. Get control's current IP address:

Determine the current IP address of your control. The current address listed under "Ethernet #1" in table 4-1, 4-2, or 4-3 at the beginning of this chapter.

2. Check control's IP address for network compatibility:

Determine if the control's primary IP address is compatible with your network. This compatibility can be determined by looking at the IP address and subnet mask on your PC. These are viewed by running "ipconfig" from a cmd window on your PC (to open a cmd window, click on "Run…" in the Start menu and type in "cmd"). You are likely to be interested in the values for the Local Area Connection.

If you translate the Subnet Mask of your PC to binary, you can see which values of the control IP address must match the PC's IP address. For example, if the subnet address is "255.255.0.0", then the first two octets must match:

- **172**.**16**.99.4 *matches* **172**.**16**.100.1
- **172**.**18**.100.1 *does not match* **172**.**16**.100.2

For example, if the subnet address is "255.255.240.0", then the first two octets must match and the first 4 bits of the third octet must match (240 is 11110000 in binary and "1"s indicate a required bit position match):

- **172**.**16**.**107.4** *matches* **172**.**16**.**100**.1 because 110 is "**0110**0100" in binary and 107 is "**0110**1011" in binary
- **172**.**16**.**116.4** *does not match* **172**.**16**.**100**.1 because 100 is "**0110**0100" in binary and 116 is "**0111**0100" in binary

If you are not sure what the PC's IP address or subnet mask are or if your network has some other complexity, consult with your IT department for help in determining or establishing a compatible IP address for the control.

Is the control's primary IP address compatible with the PC's network?

If NO, or if you need to change the network settings for another reason, go to Step 4 below.
If YES, continue to STEP 3 below.

3. Check control's IP address for uniqueness:

Determine if the current IP address of your control (from Step 1) is in use in your network. To see if it is already used, Ping the IP address from a PC on the network. The description of the Ping command is in Chapter 8 *Ethernet Networking*. If it does not respond with "Destination host unreachable." the IP address is already used and is not available for the new control. If this is the case, skip to Step 4 where you will change the control's primary IP address.

Is the control's IP address already in use?

If YES, or if you need to change the network settings for another reason, go to Step 4 below.
If NO, jump to STEP 8.

4. Select a new IP address for the control's Ethernet #1 port:

If your network contains many devices, you should consult with your network administrator to find an available IP address for you to claim and use. If your network is simple or you do not have an administrator, you could try guessing a suitable IP address by taking your PC's IP address and changing the final octet to a different number until you find an available IP address (see STEP 3). For example, if your PC's IP address is "10.14.129.37", you could try "10.14.129.38", "10.14.129.39", etc. Keep trying different values until you find one that works.

> **Note:** Any IP address you choose must still match the subnet mask of the PC, as described in Step 2.

5. Create an isolated network between the PC and the control:

To avoid IP address conflicts on your network, isolate the control and the PC that you will be using for setting up the control from the network. Two examples of recommended methods appear in Figure 4-2.

1. On your PC, shut down your network applications but do not log off.
2. Temporarily change your PC's IP address to be compatible with the current IP address of the control (from Step 1). A simple compatible IP address would be to take the control's address and add 1 to the final octet (e.g. use "172.16.100.2" to connect with a control at "172.16.100.1". Keep a record of your PC's current IP address.
3. Connect as shown in Figure 2-2 and power up the Woodward control.

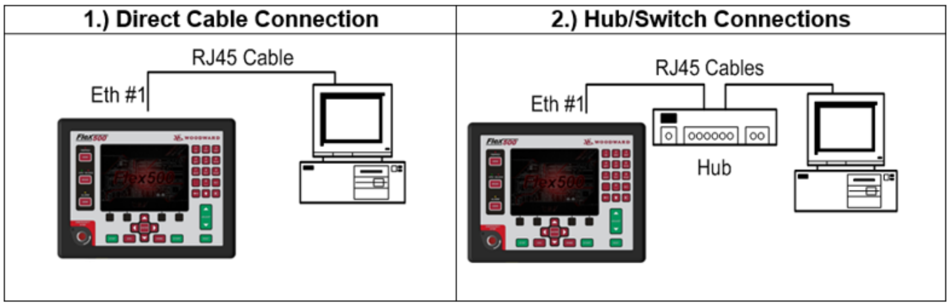


Figure 4-2. Network Cable Connections

When you have the proper connection between the Woodward control's Ethernet Port #1 and your PC, you will see the green "Link" LED remain on (solid) on your PC *and* on the control.

IMPORTANT	**A Hub/Switch will cause your PC's Link light to be on even when a control is not connected. The Vertex has two LEDs for each connector.**

Chapter 5. Distributed I/O Expansion

The Vertex Compressor Control can be expanded to higher I/O counts by using the Woodward RTCnet distributed I/O nodes. GAP3.04 and Coder 6.0 or later software tools are required. Contact Woodward Marketing and Sales for compatibility with other Woodward products.

> **IMPORTANT**
> **Reference Information:**
> **Manual 35072—For Vertex Compressor Control manual.**

Network Wiring Considerations

The CAN network may be routed using either a simple daisy chain wiring strategy (preferred) or a Trunk and daisy chain wiring strategy. The primary requirement is that the CAN network is terminated with 120 Ω ±10 Ω resistors at each end of the “trunk” cable.

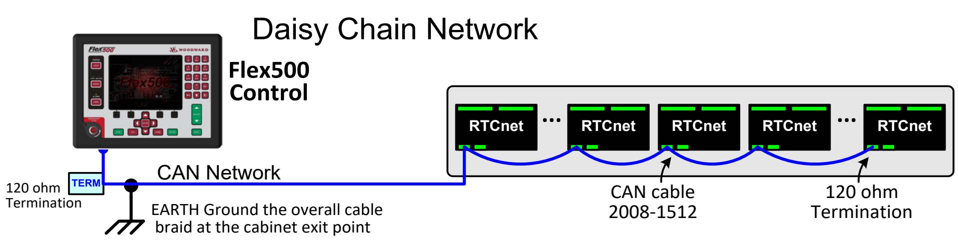


Figure 5-1. Daisy Chain Network (preferred)

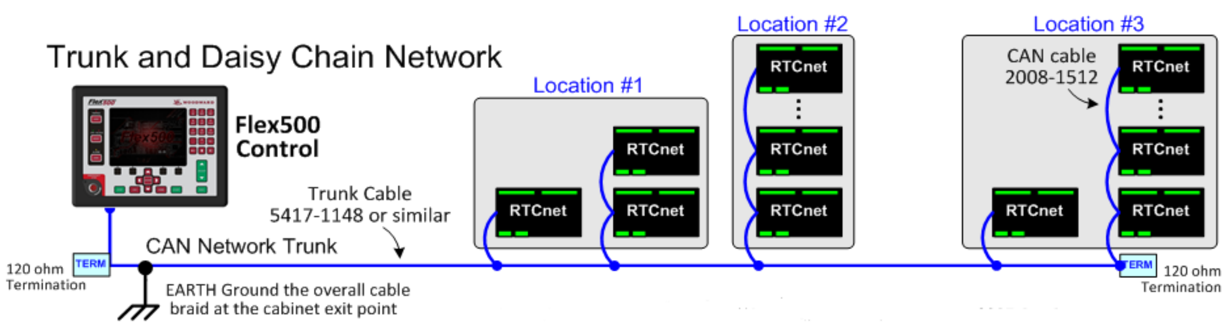


Figure 5-2. Trunk and Daisy Chain Network

> **IMPORTANT**
> **Recommended shielded CAN cable is 2008-1512. Thicker trunk CAN cable and connector options can be found on Woodward Reference drawing 9097-2097.**

Table 5-1. Useful Woodward Part Numbers at the Time of Publication

CAN Cables (reference drawing 9097-2097)	
5417-1127	Cable - CAN MicroNet drop, 7/8 inch male to M12 female (1 m)
5417-1142	Cable - CAN drop, 7/8 inch male to pigtail (1 m, mid gauge)
5417-1148	Cable - CAN mid trunk cable (3 m, mid gauge)
1635-1463	Connector - CAN network tee, 7/8 inch M/F with F drop
1635-1464	Connector - CAN terminator 7/8 inch, male 121 Ω
1635-1465	Connector - CAN terminator 7/8 inch, female 121 Ω
2008-1512	Cable - CAN RTCnet High Temp (1.5 pair, 0.3 mm^2 / 22 AWG, 125 °C)
8923-1889	KIT - RTCnet CAN termination resistor (121 Ω, qty 20)

Ethernet Switches and Cables	
5417-394	Cable - Double Shielded CAT-5 Ethernet (SSTP), 10 foot
1711-1350	SWITCH - MODULE ETHERNET (PHOENIX FL SWITCH SFNT 8TX)

Chapter 6.
Control Description

Introduction

The Vertex is designed to protect compressors from surge and establish optimal operation. The controller continuously monitors the current operating point of the compressor and compares it with the Surge Control Line to determine if opening of the anti-surge valve (recycle or blow-off) is necessary. Regardless of the number of compressor anti-surge control loops, a performance controller (PFC) can also be configured. The performance control is commonly configured to drive suction/discharge throttle valves, Inlet Guide Vane position, or speed control setpoint. When configured, this control function is used to control compressor suction pressure, compressor discharge pressure, compressor flow, or any process variable related to compressor flow or load. When the performance controller is configured, the Load Sharing option can also be configured in order to use the performance output in order to control a common process variable while equally distributing the load across multiple compressor trains.

The configurations support the following compressor train control types:

Table 6-1. Compressor Train Control Types

	Compressor Anti-surge Protection Loops	Performance Used	Load Sharing Used
Type 0	One	No	No
Type 1	One	Yes	No
Type 2	One	Yes	Yes
Type 3	Two	No	No
Type 4	Two	Yes	No
Type 5	Two	Yes	Yes

The Vertex control loops are independent of the type of compressor prime mover. Certain functions within the control are designed to work with specific prime mover types, such as the motor current limit protection in the Performance control.

This chapter will detail the anti-surge, performance, and load sharing control algorithms used in the Vertex Control.

Anti-Surge Control

The ASC (Anti-Surge Control) is Woodward standard control software application function module designed for preventing surge in dynamic (axial and centrifugal) compressors and for providing additional control functions aimed at keeping compressor operation within safe limits and for maximizing compressor and process efficiency. Figure 6-1 shows an example of a compressor application with a typical 2-section, 2-valve compressor train with discharge header pressure control via inlet throttle valve.

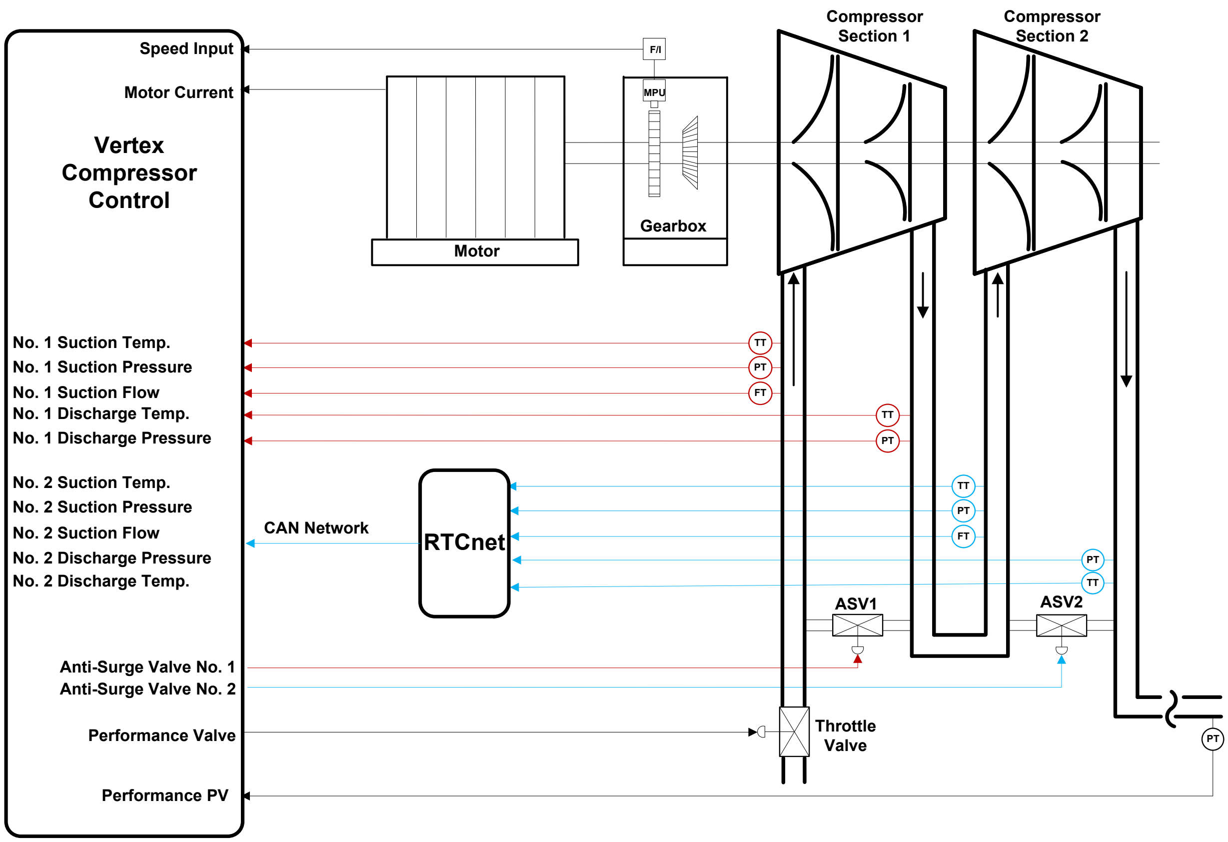


Figure 6-1. Typical Compressor Application

What is Surge?

Surge in a dynamic compressor is one of the most dangerous operating phenomena and must be avoided. Surge occurs at a low flow rate below which compressor cannot further increase its head (pressure ratio) to overcome resistance of the system. Compressor stable operation cannot be sustained at flows below the surge flow. Surge is characterized by a migration of gas from compressor discharge into suction through the compressor flow path (flow reversal). A developed surge is a cyclical process of reverse and forward flow patterns. Surge can be observed in rapid oscillations of flow and pressure, rising discharge and sometimes suction temperature and is usually evident by an audible boom or piping vibration. Violent surging may result in serious damage to the compressor equipment:

- Increased clearances of the impeller seals leading to higher internal recycling and reduced capacity
- Damage to balance piston seals
- Damage to compressor shaft end seals
- Damage to compressor thrust bearings
- Damage to compressor radial bearings
- Damage to impellers and stationary possible shaft coupling failure
- Possible shearing of drive shaft

Along with possible compressor damage, the process flow and pressure become very unstable doing surge contributing to upstream and downstream process upsets.

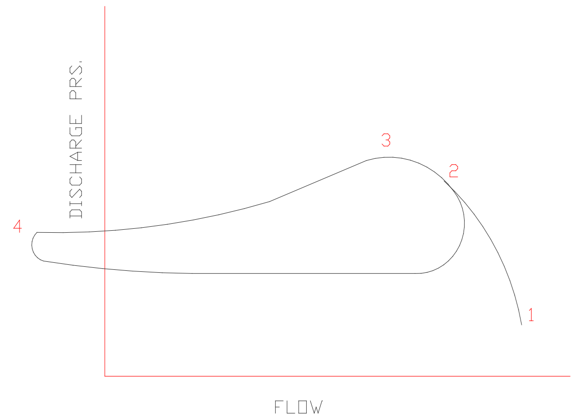


Figure 6-2. Surge Cycle

Figure 6-2 shows a typical surge cycle at a constant speed and constant suction density. The compressor, operating at point 1, has low discharge pressure and the output flow is at its maximum value. As the system resistance increases (e.g. discharge valve closes, downstream processes shutdown or decrease load, series units drop off-line, or parallel units come on-line), the compressor flow decreases, and discharge pressure increases. At operating point two, the compressor is near the surge limit. As the system resistance increases further, the flow continues to decrease, and discharge pressure continues to increase. Eventually, a limit is reached where the compressor can no longer increase discharge pressure, such as at operating point 3. If the system resistance increases further, the discharge pressure becomes greater than the machine's capability. This initiates a surge that spans between points three and four. Flow may actually reverse through the compressor, as shown at point four. A now reduced system resistance will allow increased flow back through the compressor that brings the operation back to point 2. This surge cycle will continue until broken by some control or operator action.

Maintaining flow above the compressor's surge limit prevents these surge conditions. The controller must continually monitor the operating point and compare it to the surge limit of the compressor. If the operating point reaches a minimum flow value, the controller responds by opening the anti-surge valve(s). This simultaneously causes the flow to increase and discharge pressure and polytropic head to decrease, moving the operating point away from the surge limit.

Anti-Surge Control Theory

By modulating the anti-surge valve, the anti-surge controller maintains certain process conditions to:

- Prevent the compressor from operating in an unstable condition (surge or near surge), thereby preventing any surge related compressor damage.
- Reduce process upsets.
- Maximize the compressor and total train efficiency.

In order to perform these tasks, the controller must monitor the parameters of current operating point, and compare it to the known parameters on the Surge Control Line (SCL), and determine if opening of the anti-surge valve is necessary.

The compressor performance map describes the relationship between speed, pressures, temperatures, gas properties, and inlet flow. This map also describes the operating limits of the compressor in terms of a Surge Limit Line (SLL) or surge region. Several variations are possible on how this information is presented, each describing the compressor with a different set of variables.

Compressor Choke (Stonewall)

Compressor choke or stonewall is an undesired operating condition for centrifugal compressor. Choking of centrifugal compressor occurs when velocity of gas in the compressor reaches sonic velocity and further reduction of compressor discharge pressure can no longer increase flow through the compressor.

Stonewall or choke point for a centrifugal compressor occurs when the resistance to flow in the compressor discharge line drops significantly below the normal levels. Due to low resistance, compressor overall compressor ratio across the compressor is significantly low. As suggested by the compressor maps for a fixed RPM value, compressor output increases as the backpressure at compressor discharge drops down. This leads to increased gas velocity in the centrifugal compressor. The increase in gas velocity can occur up to sonic condition. When the gas velocity in any of the compressor parts is about sonic velocity (MACH=1), no further gas speed increase is possible, hence resulting in stonewall (choke) conditions for compressor operation. On the compressor manufacturer performance curves the condition can be represented by a nearly vertical drop of compressor curves, catching the idea that once choke conditions are achieved any further drop in compressor ratio will not result in further increase of compressor flow rate.

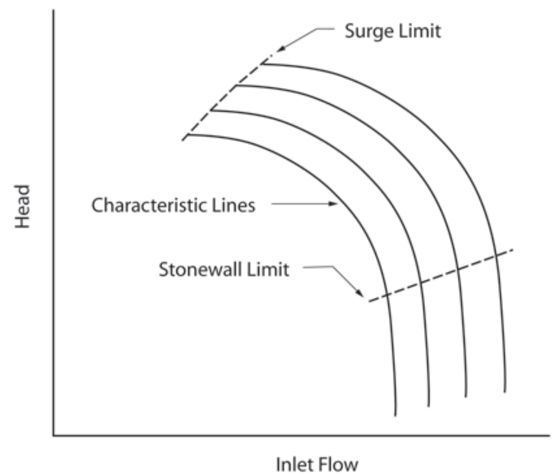


Figure 6-3. Stonewall

Prolonged operation of a compressor at its choke limit can lead to damaging the compressor parts. Compressor choking is not particularly damaging to single-stage centrifugal compressors but can cause serious damage to the rotors and blades of multistage centrifugal and axial compressors.

Currently, the Vertex provides visualization of the choke limit and the option of triggering an alarm related to prolonged operation at this limit. The option to provide Choke control with a dedicated valve output may be implemented as a future enhancement. This is implemented on some custom compressor control applications done by Woodward, thus you may see references to this in the modbus interface lists, as it is part of our Anti-Surge Loop CORE logic which is used in both standard and custom controls.

Standard Compressor Performance Map

The Standard Compressor Map is described by polytropic head, Hp, versus actual volumetric suction flow, Qa, and compressor speed, N, see Figure 6-4. Depending upon the compressor configuration and instrumentation, changes in molecular weight, temperature, and compressibility are compensated for accurate representation of the compressor operation.

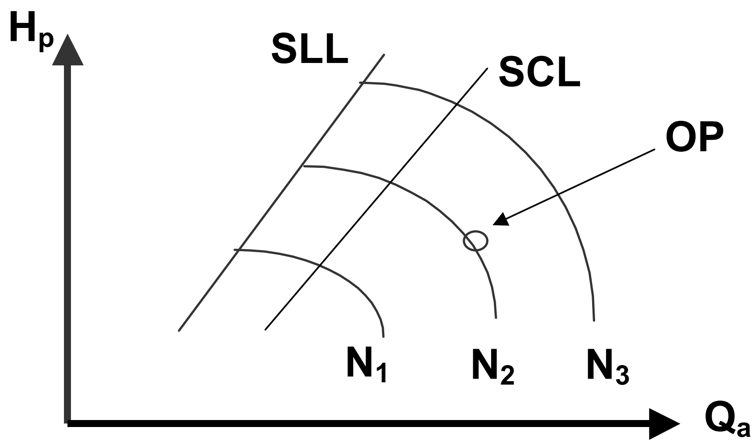


Figure 6-4. Standard Compressor Map

Standard Operating Point

The definition of an operating point is necessary for any digital controller. It is easy for a person to identify the current operating parameters and relate these parameters to a surge control line on a compressor map. However, this is a difficult task for a controller to perform in varying process applications. Therefore, it is necessary to define an operating point as a single number that can be handled easily. A further enhancement is to normalize this calculation for ease of understanding.

The Standard compressor map is presented in terms of polytropic head, Hp, versus volumetric inlet flow, Qa, see Figure 6-5. The operating point is also defined using these parameters. Simply, the operating point is defined as volumetric inlet flow squared divided by polytropic head.

$$\text{Operating Point} = \frac{(Q_a)^2}{H_p}$$

Figure 6-5. Operating Point Calculation

The result is a single number that identifies the operating point that can easily be manipulated by the controller and signifies the distance of corresponding point on the Surge Control Line.

This calculation can be expanded to show that the operating point is invariant of the gas composition. All of the critical parameters in this equation can be measured, and the others can be estimated or assumed constant. A detailed explanation of the necessary equations can be found in the Operating Point Calculations section later in this chapter. For a simplified view of the measurements necessary to determine the operating point, refer to the process control diagram in Figure 6-5.

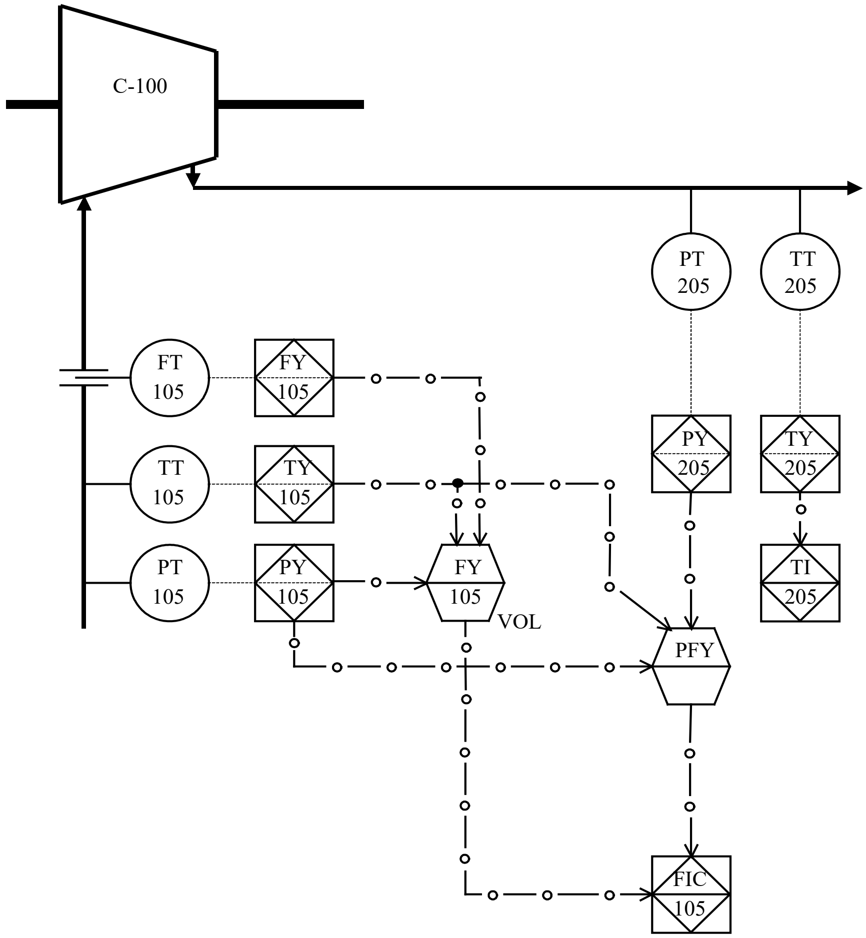


Figure 6-6. Process Control Diagram

Here it can be seen that the volumetric flow calculation is carried out using three measurements.

- PT-105, compressor suction pressure
- TT-105, compressor suction temperature
- FT-105, differential pressure across the flow element

The polytropic head calculation also requires three measurements.

- PT-105, compressor suction pressure
- PT-205, compressor discharge pressure
- TT-105, compressor suction temperature

If the gas composition through the compressor changes, the discharge temperature measurement, TT-205, would be necessary to calculate gas properties. This example assumes a suction flow element. Discharge flow elements are handled similarly.

Standard Surge Control Line

Only a portion of the compressor map must be programmed into the anti-surge controller. Data points from the surge limit line are collected from the compressor map, Figure 6-4. , and entered into the controller. Combining the surge line and a safety margin (user configured as a percentage of flow from surge) defines the Surge Control Line (SCL). This is the point at which the controller will limit operation by modulating the anti-surge valve.

The Boost Line, or Backup Line, provides additional anti-surge protection. When the operating point (OP) reaches this line, a fixed response is triggered to prevent a surge. The Boost Line is defined as a percentage of flow behind (to the left of) the Surge Control Line.

The Surge Limit Line is programmed into the controller as a series of operating X-Y points (with a maximum of twelve). Compressor maps can be defined in different units. The ASC supports the following compressor map unit entries:

- Discharge pressure versus actual flow, P2=F(flow)
- Pressure ratio versus actual flow, P2/P1=F(flow)
- Polytropic head versus actual flow, H=F(flow)

Occasionally the given compressor map is described in a different unit and will need to be converted.

Additionally, surge limits might be unproven or unknown, so it is sometimes desirable to determine the values used for the surge points by field mapping the compressor.

Recommend entering that at least six points. Enter points in ascending order, meaning that entering the lowest flow at point 1. Compressors typically have higher flow requirements with higher head values.

S_PV (Surge Process Variable)

The anti-surge controller generates a single variable, S_PV (Surge Process Variable), to describe the relationship between the current operating point and the corresponding point on the surge control line. This is done to provide the user and the control one number that reflects the current operating condition.

Once the actual operating point and its corresponding surge control line point are calculated, the ratio of these two parameter is calculated and then normalized to the value of 100 as shown below.

$$\mathrm{S\_PV} = \frac{\mathrm{operating\_point}}{\mathrm{corresponding\_point\_on\_SCL}} \cdot 100$$

By normalizing the process variable, each compressor section that is protected will control to the same number, 100. Notice that this is independent of the control margin that is programmed. In all cases, if S_PV is equal to 100, the compressor is operating on the Surge Control Line.

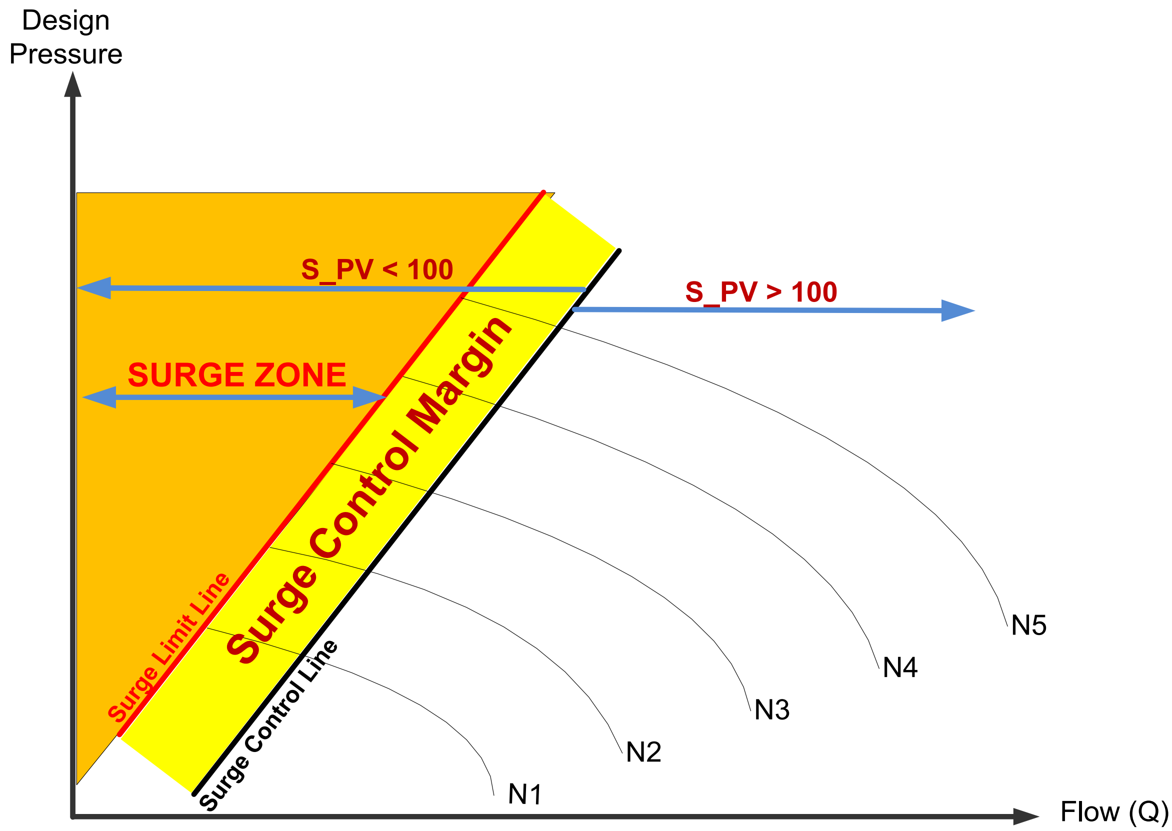


Figure 6-7. Compressor Map S_PV Regions

A surge control margin is programmed by adding a correction factor percentage (%) to the flow values for the actual surge points, establishing a Surge Control Line. A typical surge control margin of 10% is attainable on most applications with proper anti-surge valve sizing, stroking speed, etc. However, if the anti-surge valve stroking speed or sizing is not optimal, the surge margin may need to be increased to insure protection of the compressor.

If S_PV is greater than 100, the compressor is operating in a safe region of the compressor map. During this condition, the anti-surge controller is able to close the anti-surge valve. When the S_PV value is equal to or less than 100, the anti-surge control will modulate the anti-surge valve to limit the operation of the compressor to be no further left than the Surge Control Line. To an operator, S_PV is an indication of how far away the compressor is operating from the surge control line. Since the control setpoint is always 100, regardless of the control margin, the operator can judge if the anti-surge valve will open when performing a process function. For example, a value of 180 indicates that the compressor is 80% of flow beyond the surge control line--The compressor is operating far from surge and the anti-surge system should close the anti-surge valve.

ASC Anti-Surge Control Description

The anti-surge software provides all necessary functions from manual control to sequencing to closed loop PID control.

When the anti-surge control is in the Automatic mode or Manual with Backup mode, there are several controllers that can position the anti-surge valve. Each routine is an input into a high signal selector (HSS). The input with the highest value will control the anti-surge valve. These routines can be broken down into anti-surge control and process control routines.

In addition to compressor protection, other supporting functions of the anti-surge control reduce upsets, increase accuracy, and simplify programming.

Control Modes

While on-line, the anti-surge controller is designed to operate in one of three control modes, Automatic, Manual with Backup, and Full Manual. These modes are provided to give the operator any level of control that is desired. These modes can be configured to operate in compressor off-line state as well.

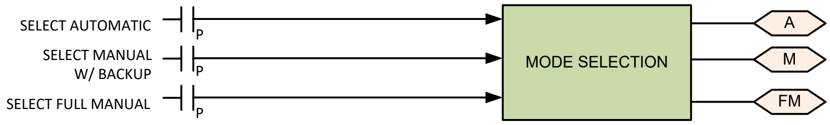


Figure 6-8. Mode Select

Automatic Mode

The anti-surge valve position demand is modulated automatically based on compressor proximity to surge control line. Valve position cannot be controlled manually in this mode.

The surge controller determines the operation of the anti-surge valve. The control monitors S_PV and then determines the position of the anti-surge valve. While the control is in Automatic, the Manual mode will track the current valve position demand for a bump-less transfer to Manual.

Manual with Backup Mode

In this mode, the operator is allowed to open the anti-surge valve, but the valve may not be closed below the automatic demand. Effectively, the output to the anti-surge valve is the higher of the manual signal or the automatic signal.

Full Manual Mode

In this mode, the operator manually moves the anti-surge valve. The automatic controllers are bypassed and cannot operate the anti-surge valve, no matter where the operating point is on the compressor map. Decoupling is not active while in this mode. If enabled (recommended), “Surge Recovery in Full Manual” will allow the open-loop surge recovery routine to activate if a surge is detected when in Full Manual control. The valve will automatically step open according to the surge recovery demand configured. After surge detection, the operator has full control of the anti-surge valve demand.

In Full Manual mode Surge Minimum Position is inactive (see Chapter 1, Surge Minimum Position).

Manual Valve Positioning

There are binary commands available for opening and closing the anti-surge valve when in Manual Mode. These inputs should be momentary, not sustained (toggles). When the input is closed, the valve is ramped at the configured “Manual Valve Rate.” If the input is held for five seconds, the ramp speed will increase to three times that rate. A maintained contact will result in continuous change of valve position until the valve reaches its limits (fully open or fully closed).

Additionally, if an exact position is desired, a target value can be entered and the valve will ramp to that position at the configured rate.

Each of these positioning commands is disabled if Remote Positioning, described below, is active.

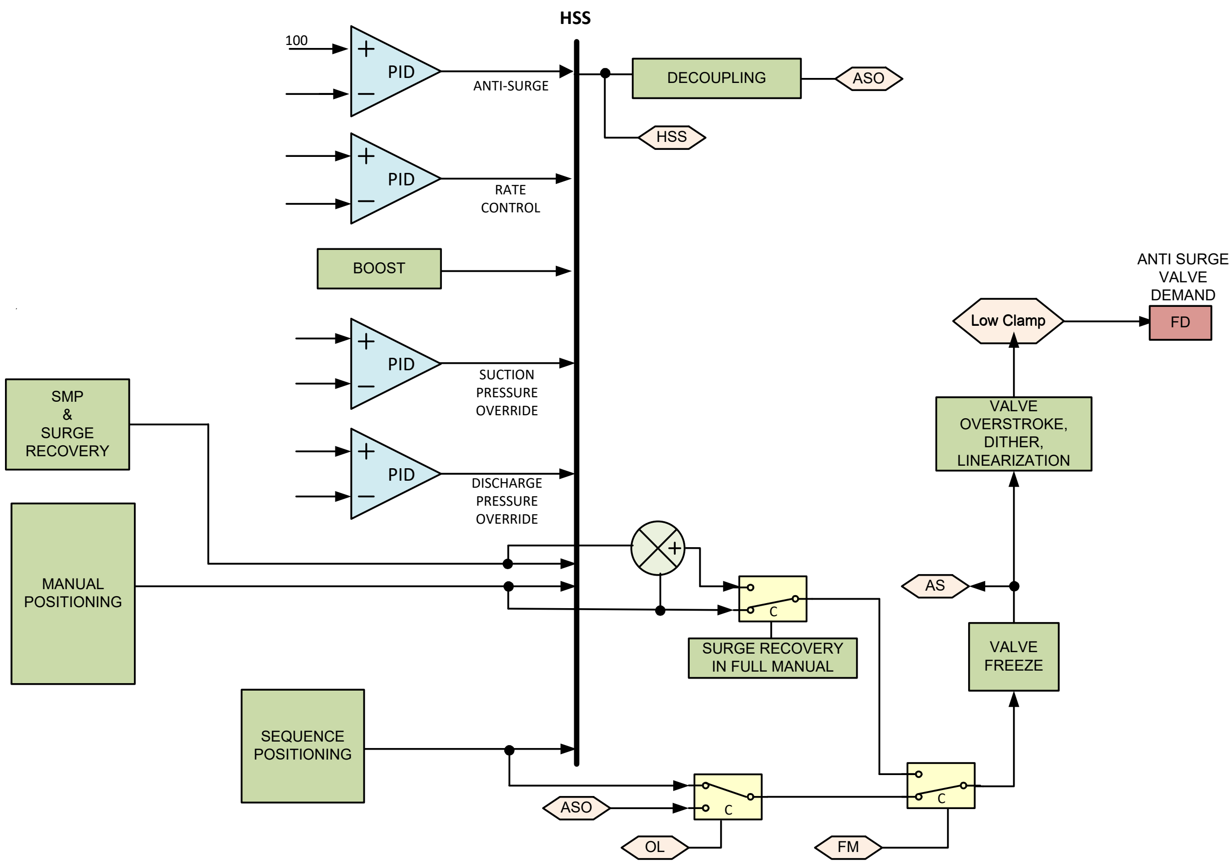


Figure 6-9. Manual Setting of Anti-Surge Valve

Sequencing Functions

During start-up and shutdown of the compressor, the compressor flow is fluctuating, and the process is unstable. This time between a start and stable automatic control is termed “off-line.” A separate routine is focused on detecting when automatic, or “on-line,” operation is allowable.

To prevent the anti-surge controller from attempting any control function during the off-line period, sequencing provides fixed valve positioning. There are four programmable positions:

- Purge Position
- Start Position
- Shutdown Position
- Zero Speed Position

Speed setpoint, binary inputs, or combinations of both determine when to select the start, shutdown, and zero speed positions. The purge position can be selected with a dedicated binary command.

Using speed can simplify sequencing by allowing software speed switches to determine what state of start-up/shutdown the prime mover is in. Alternatively, binary inputs or Modbus commands can signal a start or shutdown.

Purge Position

A purge sequence is required during the start-up of some processes to close the anti-surge valve, partly or fully, and send forward the process gas. Every time after a trip and before or during start-up, and before an “on-line” condition is triggered, a positive edge and sustained binary input or Modbus command will position the anti-surge valve in the configured “Purge Position.” The valve will remain in that position as long as the input is held and the unit remains off-line, no ESD. At least one Online Detection method must be configured, but not yet satisfied, to allow a Purge cycle.

Start Position
If purge position is not set and no shutdown command received, a start command or “Zero Speed Level” triggered or “Zero Current level” triggered will ramp the anti-surge valve to the “Position During Startup” at “Valve Start Rate”. It will maintain this fixed position until the compressor is determined to be on-line. This start sequence is also reinitiated if any on-line trigger is deactivated while in normal operation.

Online
Once all on-line triggers are satisfied (see below), the control will slowly close the anti-surge valve until the automatic anti-surge routines take control. If any on-line trigger is deactivated while in normal operation, the control returns to the start sequence.

Shutdown Position
At any time, the compressor can be shut down from an ESD (Emergency Shutdown) or by a dedicated trip input. In any case, the anti-surge valve is immediately positioned and held at the configured “Shutdown Position.” If the shutdown condition is cleared, the unit can be restarted as described above.

Zero Speed (or Current) Position
The anti-surge valve will remain in the shutdown position until the unit is re-started or the speed drops below the “Zero Speed Set point” for a configured “Shutdown Delay Time.” Once this delay timer expires, the anti-surge valve will be moved to the “Zero Speed Position.” This position can be useful in applications requiring the anti-surge valve be closed for process isolation after the compressor is shutdown. If the application does not require this final sequencing step, configure the Zero Speed Position to the same value as the Shutdown Position and the Zero Speed Delay Time to 0 seconds.

If Motor Current analog signal is configured, then the logic for Zero Current Position will be the same as described above.

IMPORTANT	The zero speed sequencing described above is active only if a valid speed signal is available. If not, the unit will sequence to and from the shutdown position only. In this case, a “start” signal (binary input, Modbus, HMI/DCS command) must be used to sequence the compressor online. If the unit is configured for compressor-only Mode, speed inputs are optional.

On-Line Detection
Once any one of the on-line triggers are satisfied (see below), then after configurable delay timer lapses, the control will slowly close the anti-surge valve until the automatic anti-surge routines take control. If any on-line trigger is deactivated while in normal operation, the control returns to the start sequence.

On-line detection is an important determination made by the anti-surge controller. Once the compressor is determined to be on-line, the surge detection and automatic control routines are activated. Suction pressure, discharge pressure, flow, speed, motor current, and an auxiliary input may be used together or independently to determine when the compressor is on-line.

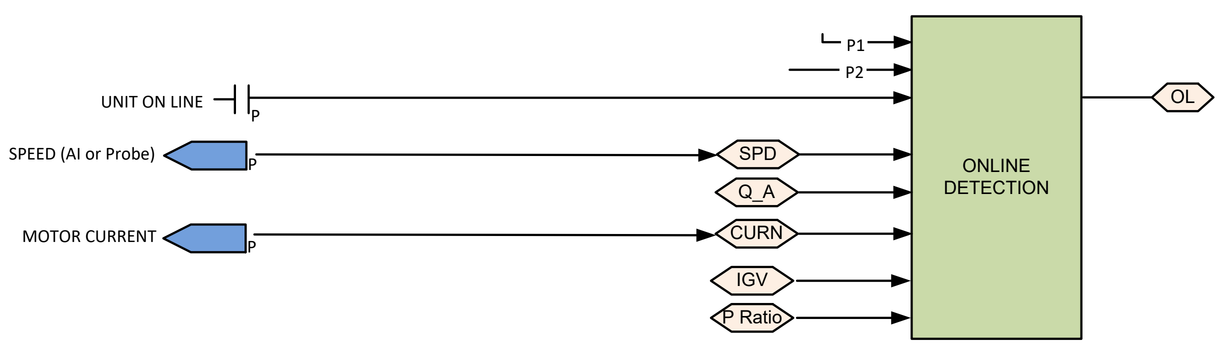


Figure 6-10. On-Line Detection

Each on-line detection method may be enabled or disabled and setpoints configured in the Compressor Configuration section of the software. The Auxiliary Input (configurable discrete input or Modbus command), if enabled, must be a sustained input (toggle). This input is most often driven by a compressor safety system or sequencer. Speed, discharge pressure, motor current, and flow must exceed their respective online setpoints. Conversely, suction pressure must drop below its setpoint (suction pressure of a second compressor section must exceed its set point, if enabled). If more than one method is enabled, all must be satisfied before the compressor is considered on-line. If none are enabled, the unit will transfer directly to automatic, online control during start-up, i.e. the anti-surge valve will not be held at its Start Position. This is usually undesirable as most compressors will be susceptible to surge during start-up. A Purge cycle, if requested, is not possible unless in a Start Sequence and prior to on-line control.

IMPORTANT

If utilized, the on-line contact input must be maintained closed the entire time the compressor is operating. If the contact is opened, the ASC will assume the compressor is off-line and revert to the start sequence and position the anti-surge valve at its start position.

When speed or the binary inputs are the recommended, usually the primary, on-line detection methods are recommended. If other parameters are to be used, exercise care in selecting their setpoints so as not to interfere with normal start-up procedures. Some start-up valve sequencing may inadvertently trigger the on-line status if setpoints are configured too low (flow, discharge pressure). There is off delay time for online detection to avoid frequent on-off condition. If more than one on-line detection methods are chosen, than the logical AND of all conditions are required to go online.

IMPORTANT

The speed-based online detection described above is active only if a valid speed signal is available. If the unit is configured for compressor-only mode, speed inputs are optional.

Anti-Surge Control Routines

Each anti-surge routine is designed to operate in a certain region of the compressor map. In total, these routines encompass the entire operating region, see Figure 6-11.

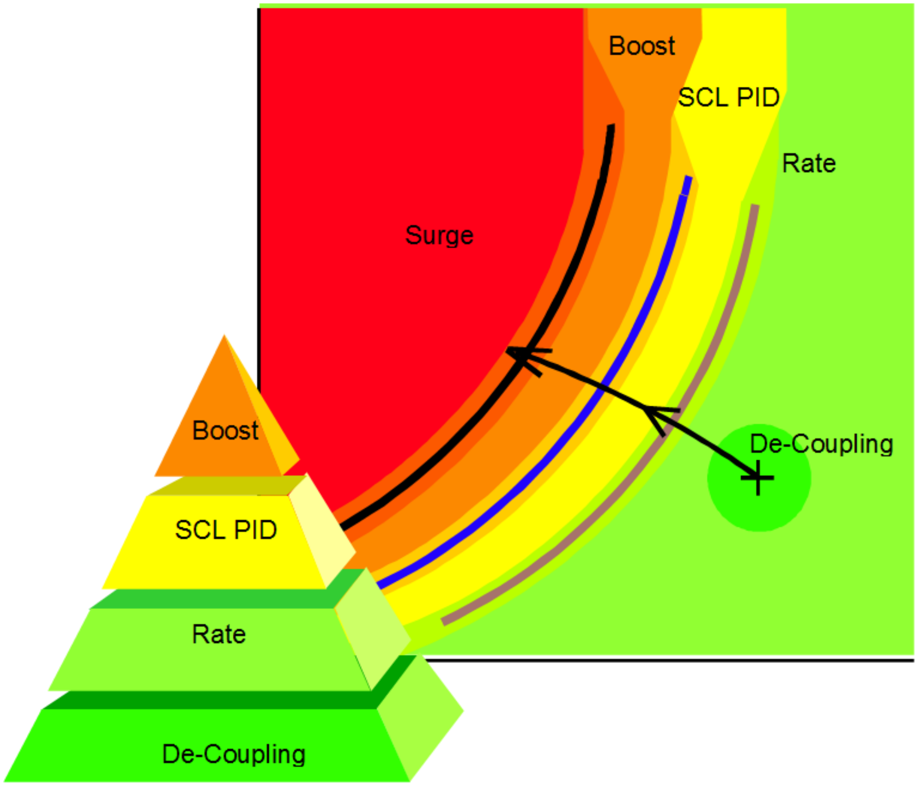


Figure 6-11. Anti-Surge Functions

Starting in the surge, or unstable operating region, there are three routines dedicated to preventing or responding to a surge. Surge Recovery and Surge Minimum Position (SMP) are the routines that react to a surge with a fixed (open loop) valve action. The amount of corrective action taken by these routines is not dynamic; it is pre-configured in the controller.

The next open loop function is Boost, or Valve Step Opening. This routine monitors the operating point with respect to the Boost Line, or Backup Line. If the operating point crosses the line, it initiates a momentary small step increase in the anti-surge valve to prevent further movement toward the Surge Limit Line.

The two PID controllers are the main anti-surge protection routines. They monitor process conditions and provide a corrective action until the process returns to an acceptable operating point. These routines provide a continuous modulated output for the anti-surge valve. When the operating point is at the Surge Control Line (SCL), the Anti-Surge main PID loop is active. If the operating point is away from the control line but approaching the SCL rapidly, the Rate Controller PID loop anticipates the need for action, opening the anti-surge valve earlier in order to bring the velocity of approaching SCL down to zero.

Even when the operating point is not on the SCL, decoupling acts to stabilize the process by minimizing the interaction of controllers.

Surge Detection

The Surge Detection routines are configured to determine when a surge event has occurred, capture the surge signature, and maintain a surge counter. Refer to Section "What is Surge?" earlier in this chapter for further details of the actual surge event. The surge signature is a collection of values indicating how parameters change when a surge occurs. The routines available for surge detection are:

- Flow Derivative
- Suction Pressure Derivative
- Discharge Pressure Derivative
- Speed Derivative
- Minimum Flow
- Surge Limit Line Crossing
- Motor Current Derivative
- External Surge Detection contact

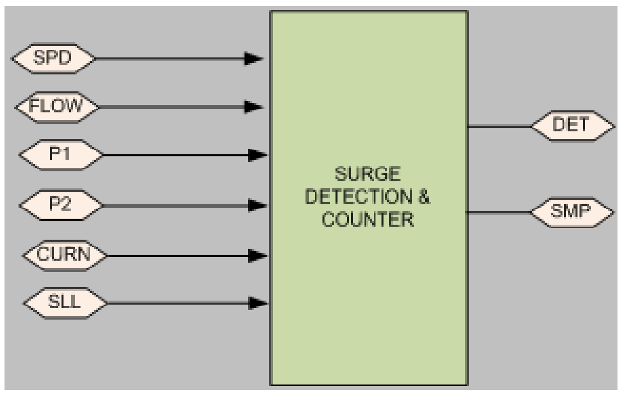


Figure 6-12. Surge Detection and Counter

IMPORTANT	**The speed-based surge detection described above is active only if a valid speed signal is available. If the unit is configured for compressor-only mode, speed inputs are optional.**

Note: Two routines, Minimum Flow and Surge Limit Line Crossing, do not actually detect a surge. They merely initiate a surge response if the calculated flow reaches the respective setpoint.

These surge detection routines may be enabled as deemed appropriate and adjusted after the surge signature has been established (usually by recording data from a surge test of the compressor). One of the most reliable detection routine is flow derivative. This routine is typically enabled before any surge data is available. The remaining routines are enabled as setpoints are found during system tests. A detection routine should be enabled only if it is possible to discriminate a surge event from typical process upsets and signal noise.

The compressor must be on-line and the field sensors need to be operating to arm the detection routines. This prevents the surge control from falsely sensing a surge event during start up or when an input signal fails.

When the anti-surge control detects a surge, assuming surge detection and recovery functions have been configured, the following events will occur:

1. The surge counter will count the number of surges that were detected.
2. The anti-surge valve will open to the surge recovery amount.
3. The individual surge detection routines will capture the surge signature.
4. The individual surge detection routines will indicate which ones detected the surge.
5. An alarm will indicate surge detection.
6. The Surge Minimum Position (SMP) is enabled.

Total Surge Counter
The Surge Counter records the number of surges detected by the anti-surge controller. The counter increments one for each detection and is triggered by the surge signature data. The Total Surges counter is also incremented, but it cannot be reset without special software maintenance tools.

Surge Recovery
Under certain process conditions, the anti-surge control may not be able to prevent a surge from occurring. Woodward employs patented Surge Recovery control response to break surge cycling and prevent repeated surging.

Whenever surge is detected, the Surge Recovery response immediately opens the anti-surge valve by a fixed amount above the current position demand (see Figure 6-13). The minimum amount that the valve must be opened during Surge Recovery can also be configured. The resulting Surge Recovery response will be the greater of the two values. Following the Surge Recovery response, the valve demand will remain constant for the loop period time (see the Loop Period section) and then begin decaying in a closing direction.

Woodward Surge Recovery response is more effective in breaking surge cycles as it warrants additional opening of the anti-surge valve during surge event regardless on which method of detecting surge was used and what pattern the surge variable followed thereafter.

Surge Minimum Position
During the closing phase of the Surge Recovery response the anti-surge valve cannot be allowed to close back father than its position at surge event to prevent reentering surge zone (repeated surge). The anti-surge valve position demand is then limited by the Surge Minimum Position (SMP).

This SMP routine captures the valve position demand when the compressor at onset of the first surge cycle and then adds a configurable bias to that. Thus, the anti-surge valve cannot be closed by more than the total SMP amount. Once process conditions are stabilized, the operator can reset SMP function and the valve will close normally until either surge control line is reached or fully closed.

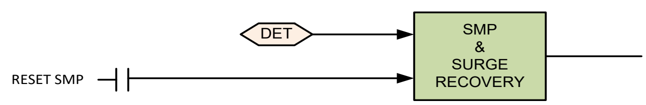


Figure 6-13. Surge Recovery and Surge Minimum Position (SMP)

For example, in Figure 6-14, the Anti-Surge PID, and a single 3% Boost response were not sufficient to prevent a surge, and the anti-surge valve was 34% open when a surge was detected. The SMP Amount was configured for 5%, generating an SMP value of 39%. If the Surge Recovery Amount was configured for 14%, it will stroke the valve to 48% open position to break the surge cycle. After the Loop Period duration, the Surge Recovery response ramped out. The anti-surge routines regained control but could not close the valve below 39%. The operator determined that a valve had inadvertently closed in the process and the problem was bypassed. Now, the operator can reset the SMP function that allows the anti-surge routines to close the valve further and move the operating point to the surge control line. As in any surge event, the cause of the surge needs to be investigated before resetting SMP. Resetting SMP may cause the compressor to surge again if the conditions that created the surge have not been corrected.

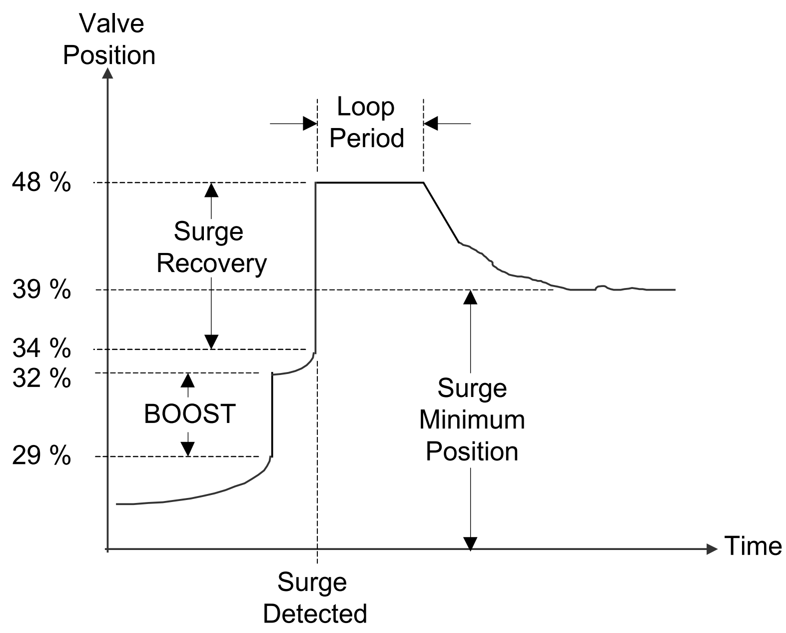


Figure 6-14. Anti-Surge Valve Response to a Surge

Consecutive Surge
As additional protection, it is possible to generate an alarm, or a shutdown based on the number of detected surges within a configured time. Also, external hardwired multi surge detection option available. If enabled, the anti-surge valve will go to the 100% open position if a consecutive surge alarm is detected.

Boost / Valve Step Opening

The Boost, line is established between the Surge Limit Line and the Surge Control Line for a backup surge prevention in case the main PID loop and rate PID loop actions do not produce strong enough effect so to keep compressor operating to the right of surge control line. When the compressor operating point crossed the Boost Line, the Boost response immediately steps the valve open from its current position by a preconfigured amount.

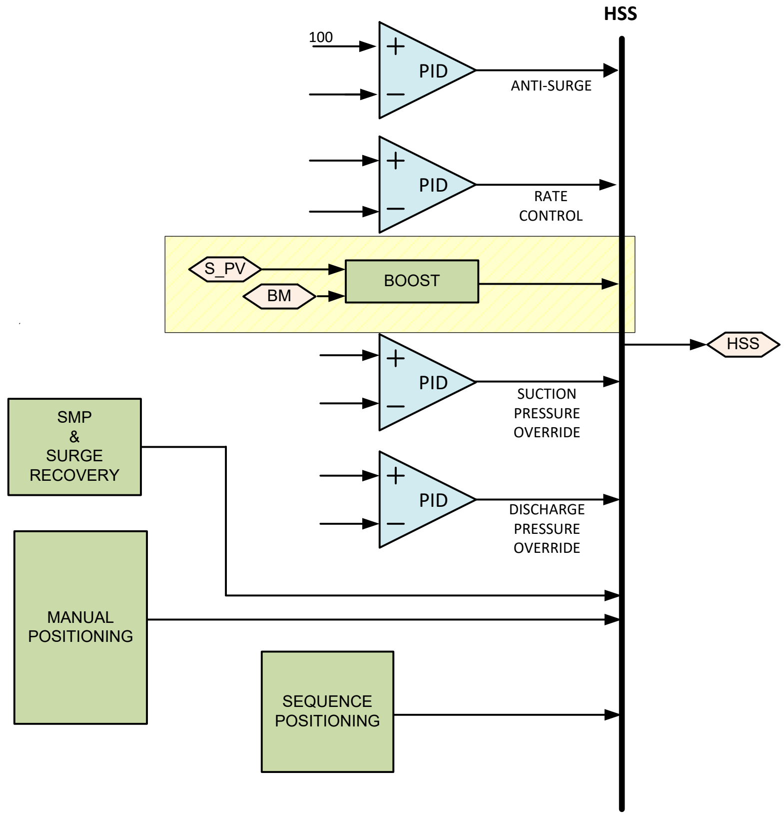


Figure 6-15. Boost

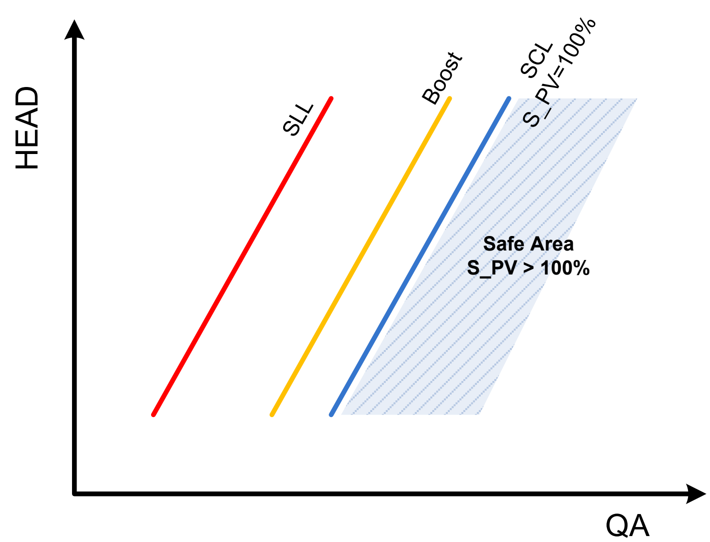


Figure 6-16. Compressor Map Margin and Region

The valve position demand will remain constant for a fixed amount of time (the loop period) waiting for the compressor operating point to return to the right of the Boost Line. If the operating point is in the safe region (above the Boost Line), the Boost action will begin to decrease and allow the anti-surge controllers to regain control. However, if the operating point is still below the Boost Line, this sequence will repeat until the operating point is in a safe operating region of the compressor.

Functioning as a safety net to the closed loop controls, this routine assists the Anti-Surge PID. The Boost action is only a temporary event that is at zero output during steady state operation. It is inhibited when the unit is not on-line.

The Boost Margin, a percentage to the left of the Surge Control Line, determines the location of the Boost Line.

If the SCL margin is 15% and the Boost Margin is 5%, then the SCL is 15% from the SLL and the Boost Line is 9.25% from the SLL (or, 5% from the SCL = 1.15 * 0.95). The Boost Line is always left of the SCL by the amount of the Boost Margin. Hence, as the SCL moves so does the Boost Line.

Anti-Surge PID
This is the main anti-surge control routine. The Anti-Surge PID compares the process variable, S_PV, to 100 in order to determine the proper position of the anti-surge valve. If S_PV is greater than 100, the PID will move toward zero percent (closing the anti-surge valve). When the value is equal to or less than 100, the PID output will increase until the flow through the anti-surge valve restores S_PV to the setpoint of 100.

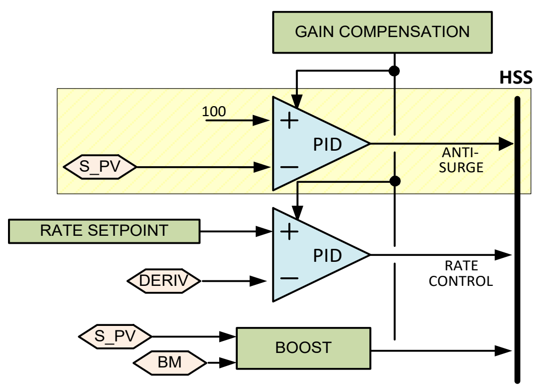


Figure 6-17. Anti-Surge PID

Rate Controller PID

If the flow through the compressor reduces too rapidly, the Anti-Surge PID may not react fast enough to prevent a surge. The rate controller monitors the time derivative of S_PV and acts to open the anti-surge valve if this rate is too fast for the system to respond. This action will take place before the operating point reaches the Surge Control Line. This proactive routine takes the place of derivative action in the Anti-Surge PID. The Rate PID is automatically disabled if any input signal is failed.

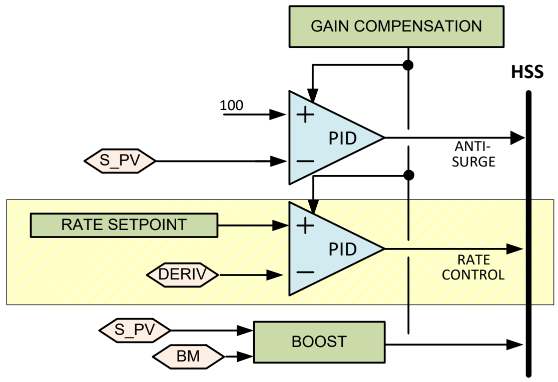


Figure 6-18. Rate Controller PID

The setpoint for the Rate Controller PID is a percentage of the maximum safe rate of approach to the Surge Control Line. The allowable rate of approach to the SCL is dynamically calculated from the proximity to the SCL and the system response time (loop period), as shown below.

$$\text{Allowable\_rate} = \frac{\text{S\_PV} - 100}{\text{LoopPeriod}}$$

The further the operating point is from the SCL (S_PV > 100), the greater the allowable rate. Likewise, the faster the system can respond to changes (shorter Loop Period), the greater the allowable rate. As the operating point moves closer to the SCL, the rate setpoint is reduced. This ensures that operation is not limited under normal conditions with the compressor loaded. As the operating point approaches, the SCL it becomes more critical to limit the velocity of the operating point to maintain stability.

To ensure the controller has time to react, the actual rate setpoint is a percentage, typically 60-80%, of this maximum allowed rate. Therefore, if the system dynamics require that the controller act sooner when the anti-surge valve is closing prior to reaching the SCL, reduce this Rate setpoint. As this value approaches 100%, the Rate Controller setpoint approaches the calculated maximum allowable rate.

IMPORTANT	**As Loop Period decreases, the maximum allowable S_PV rate increases, effectively “detuning” the Rate PID—It may not act fast enough for rapid operating point moves. For short Loop Periods, it may be necessary to decrease the Rate PID setpoint. Obviously, system dynamics and tuning affect these values, so ample testing is the key to determining the best settings.**

Gain Compensation

The Anti-Surge, Rate Controller, and Pressure Override PID dynamics include proportional, integral, and derivative action. These dynamics can be compensated by the Automatic Gain Compensation (AGC) routine as the compressor operating conditions change. This means that the PIDs can be tuned once during commissioning of the unit, and as the process conditions change, the PIDs will remain stable over the entire operating region.

The gain compensation routine scales the proportional gains of all PID loops (Anti-Surge, Rate Control, Suction Pressure Override, and Discharge Pressure Override) as well as Fast Speed Decoupling, discussed later in this chapter. Gain compensation is calculated differently depending upon the choice of Algorithm.

If Standard Algorithm is utilized

If the Standard Algorithm is utilized, the gain compensation routine constantly calculates full-open anti-surge valve flow under the current process conditions. The same calculation generates a "Normal Value" at the chosen operating point during initial commissioning and PID tuning. The resulting gain compensation value is the ratio of this fixed normal value to the current value that is constantly calculated. Hence, as compressor loading increases for a constant speed (higher flow, lower head), the calculated anti-surge valve flow will decrease. This increases the gain compensation value and results in more aggressive proportional gains, where gain compensation is applied. Without compensation, the overall control loop gain has been reduced since opening the anti-surge valve would divert relatively lower flow. Conversely, as compressor-loading decreases (lower flow, higher head), the anti-surge valve flow calculation will lower the gain compensation value, detuning those proportional gains, since the valve gain has been increased by the process conditions.

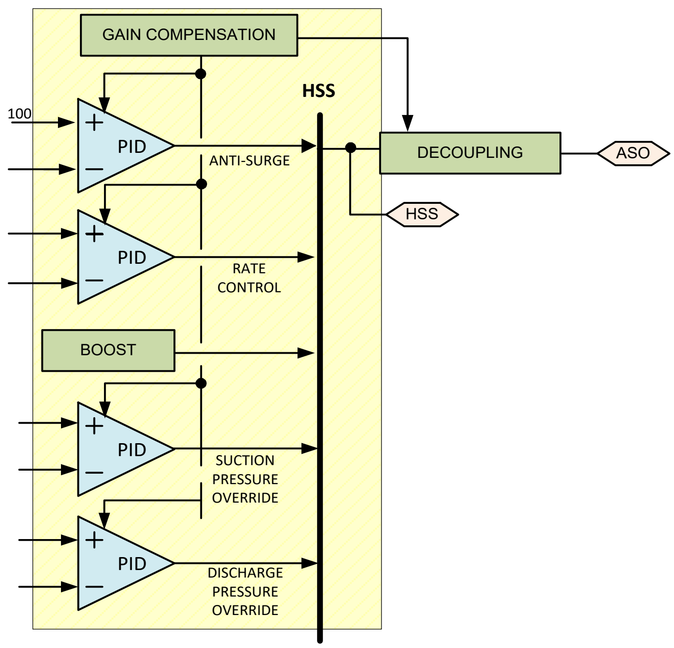


Figure 6-19. Automatic Gain Compensation

AGC must be configured if it is enabled on any of the four PID controls or if Decoupling is enabled and the "Fast Speed Amount" is not 0.0. That is, for Decoupling, Gain Compensation applies only to the Fast Speed routine. Therefore, if that particular routine is disabled by tuning its amount to 0.0, AGC configuration is not necessary. The gain factor is automatically limited to a range of 0.2 to 5.0 within the control so as not to cause instability when applied to the PID gains. Gain Compensation is inhibited when any input signal is failed and when the unit is not on-line.

To configure AGC, first place the compressor in an operating condition where the operating point is above minimum head/flow conditions and below maximum head/flow conditions. Ideally, this would be exactly in the middle of the compressor's map or near the normal operating point, although AGC can be tuned at any operating condition. The compressor must be on-line, and it is preferable to have the unit in Manual to prevent instability during this procedure. Configure the anti-surge valve's full-open Cv value, which is required to calculate flow through the valve. The "Normal Value" is anti-surge valve flow (Am^3/hr)—Tune this value until the "Gain Factor" equals 1.00. At this point, the "Normal Value" equals the flow through the anti-surge valve if it were 100% open at the current conditions.

Released

AGC is now configured at the current operating point. The gain factor will move above and below 1.0 as the compressor moves from this operating point.

IMPORTANT	**AGC may be configured before or after PID tuning, but in either case, PID loops should be tuned with AGC disabled. Both PID tuning and AGC configuration should be done with the compressor at the same, or similar, operating conditions.**

Decoupling

In order to maintain a stable system, Decoupling may be necessary to provide action before an upset occurs. Upsets are anticipated from knowledge of the operating parameters and their relation to the operation of the anti-surge valve. For instance, a pressure set-point change will usually require a speed change, and this usually results in a compressor operating point change, in percent from the surge line. By the nature of changing speed, S_PV changes and the Anti-Surge PID will respond. The decoupling routines are designed to anticipate the PID change and preset the anti-surge system to the final position without any PID action. Decoupling drives the system to stable operation much quicker than waiting for the PID output to settle. Additionally, the dynamics of the anti-surge control may be too close in response time to the pressure control/speed control and the two systems may fight. Decoupling will also drive this situation to a stable point.

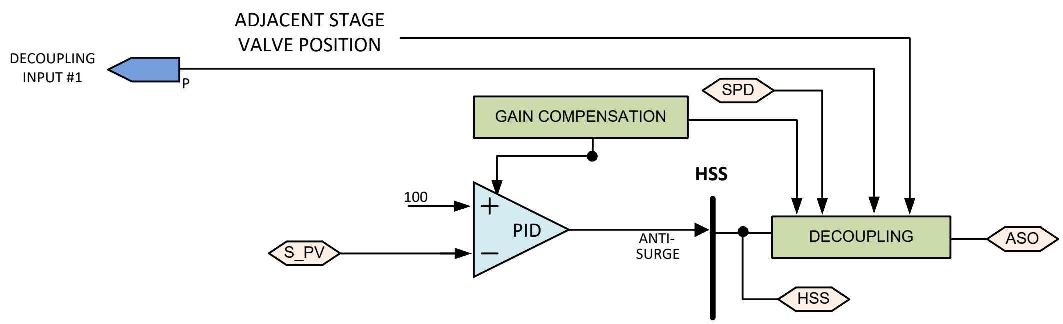


Figure 6-20. Anti-Surge Decoupling

There are four separate Decoupling routines: two based on speed, one configurable inputs from separate processes, and one based upon an adjacent compressor section's anti-surge valve. Decoupling is enabled as a whole. Disabling any of the four routines individually is done by configuring their respective "Amounts" to 0.0. In addition, the action is not allowed to influence the anti-surge valve until the compressor is on-line and in Automatic Mode. Also, since there is no need to manipulate the anti-surge valve if the compressor is operating far from the Surge Control Line, Decoupling is inhibited if the current S_PV value is greater than the configured "S_PV Range" value. Moreover, since Decoupling is a supplemental function, the configured "Decoupling Output Limit" limits not a primary control, its output. The sum of all five decoupling responses may not open the valve more than this amount.

As mentioned previously, speed decoupling can be performed in two cases, one to prevent a surge and the other to stabilize the process. Once the compressor is stable at an operating point, a decrease in speed would move the operating point towards surge. The first form of speed decoupling uses a direct relationship from change in speed to generate the appropriate valve movement. This form is called "dynamic" and is fast acting and momentary. It is configured as the "Fast Speed Amount" in percent per rpm. Usually, the relationship of speed to S_PV is direct so this value is set greater than zero. The time constant is configured as "Fast Speed Delay Time" and represents the total length of time that the decoupling action will last. Gain Compensation impacts fast Speed Decoupling, so the decoupling should not be configured until after gain compensation has been configured.

The second form of speed decoupling uses knowledge of the relationship between speed and flow to anticipate the necessary movement of the anti-surge valve. The change in speed is related to a change in flow, and the anti-surge valve moves to maintain the previous flow. This type of decoupling is also quick to initiate, however, it lasts for a much longer period and is removed slowly. It is most helpful in load-sharing applications where there are several units piped in parallel or series. This slower acting decoupling is configured as “Slow Speed Amount” and is usually greater than zero. The time constant is set at “Slow Speed Delay Time.”

Field-testing is the only method to determine the relationship between a change in speed and a necessary change in valve position or flow. Both speed-decoupling routines are disabled in the event of a speed signal failure.

IMPORTANT **The speed-based decoupling detection described above is active only if a valid speed signal is available. If the unit is configured for compressor-only mode, speed inputs are optional.**

Decoupling from an adjacent section anti-surge valve uses a direct relationship from a change in one valve position to generate the appropriate movement in another valve. Like all Decoupling routines, there is a filter component and an amount. However, piping arrangement (how one compressor’s recycling affects flow through the other) must be considered when configuring the decoupling amount. Consider a two-section machine for which decoupling is configured for the first stage. If the second stage begins to recycle to the inter-stage piping, the system resistance to the first stage is increased, moving it towards surge. In this case, the “Another Stage Amount” would be a positive value. If, however, the second compressor section recycles to the first stage suction piping, the first stage flow would increase, moving away from surge. This situation would require a negative “Amount.” Similar relationships exist relative to decoupling the second compressor section from the first stage anti-surge valve. See Figure 6-21. and Figure 6-22. for examples of Another Stage Decoupling values based upon piping arrangement.

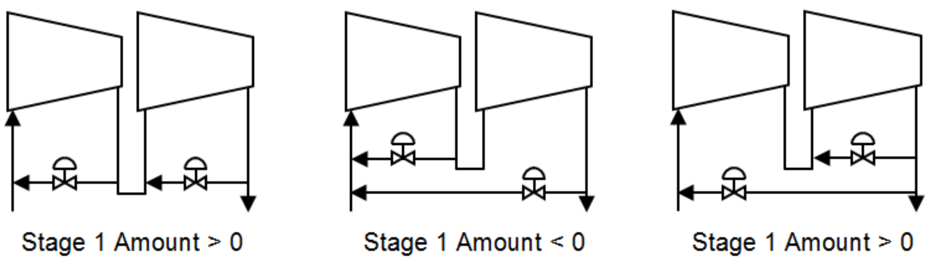


Figure 6-21. Effect of Valve Layout on Adjacent Stage Decoupling Amounts

Lastly, there are two configurable inputs of Decoupling. These inputs can be any other process variables that directly affect the flow through the anti-surge valve or the compressor. This form of decoupling relates a unit change in the process variable to a necessary change in the anti-surge valve position. Each decoupling input has a “Delay Time” and an “Amount” to configure (as with speed decoupling). As before, the larger the filter time constant, the longer the decoupling lasts before it is removed. The “Amount” value is the relationship of input change to decoupling output; a larger amount value translates into a higher impact of anti-surge valve movement to input change. In addition, as the Adjacent Stage Decoupling described above, the amount should be positive if the process variable is inversely proportional to compressor flow and negative if the relationship is directly proportional. These decoupling routines are disabled if their respective input signals fail.

Decoupling mode is deactivated in Full Manual mode and temporary deactivated in Manual with Backup mode if the manual demand is controlling the anti-surge valve.

Process Control Routines

The following routines can operate the anti-surge valve to control a process condition other than anti-surge control. Contained within the ASC software are suction and discharge pressure controllers. When the prime mover's speed is varied to maintain suction or discharge pressure, two problems can occur. First, the response to a change in speed and a change in pressure may be too slow. Second, if the prime mover's minimum speed is reached, suction or discharge pressure cannot be maintained at their respective setpoints. In these cases, this controller will modulate the anti-surge valve to control pressure and assist the primary controller. Both Suction Pressure Override and Discharge Pressure Override may be simultaneously activated. Both may also utilize Automatic Gain Compensation, described previously. Each is automatically disabled if its respective input signal fails.

In the case of 2-loop compressors, the recycle piping arrangement can affect the implementation of these override controllers. Consider a dual stage, 2-valve compressor with a common suction configuration. In this scenario opening the Stage 1 valve will relieve interstage pressure; and will increase first stage suction pressure; opening the Stage 2 valve will relieve unit discharge pressure and will increase stage 2 suction. The Stage 2 Suction Pressure Override controller acts on the unit suction pressure, not the interstage pressure. Since first stage discharge override and second stage suction override both will Overrides act on the same process variable, only one should be enabled, or their set points staggered to prevent interaction if both are enabled. Similar caution should be applied to common discharge piping arrangements.

Since the pressure override controllers are high signal selected with all other anti-surge control routines, their effect may be negated if normal compressor operation is on the control line. In this case, the Anti-Surge controller will already be modulating the valve at some open position. If an override controller begins to act, it must exceed the demand of the Anti-Surge PID in order to increase the current valve position. This probably will not occur unless the override controller tuning is very aggressive (undesirable) or the valve is open only a small amount. As such, enabling and tuning the override controllers may be helpful only when the compressor is loaded sufficiently for the Anti-Surge PID to keep the valve closed, or nearly closed.

To allow external control of the anti-surge valve, two auxiliary inputs to the HSS are also available. These inputs will position the compressor anti-surge valve based upon demands from external devices, but all automatic routines within the ASC are still active. The HSS will select the highest valve position regardless of its control source.

Suction Pressure Override

The Suction Pressure Override routine monitors the difference between the suction pressure setpoint and the compressor suction pressure. If enabled, the override controller will open the valve to help boost the suction pressure as needed. Obviously, the anti-surge valve cannot be used to reduce suction pressure, in which case the prime mover's speed controller, or other control loop, acts alone.

The suction pressure override can be configured to use the actual suction pressure or an external signal.

Discharge Pressure Override

The Discharge Pressure Override routine monitors the difference between the compressor discharge pressure and the discharge pressure setpoint. The override controller will open the valve to help reduce the discharge pressure. Obviously, the anti-surge valve cannot be used to increase discharge pressure, in which case the prime mover's speed controller, or other control loop, acts alone.

The discharge pressure override can be configured to use the actual discharge pressure or an external signal.

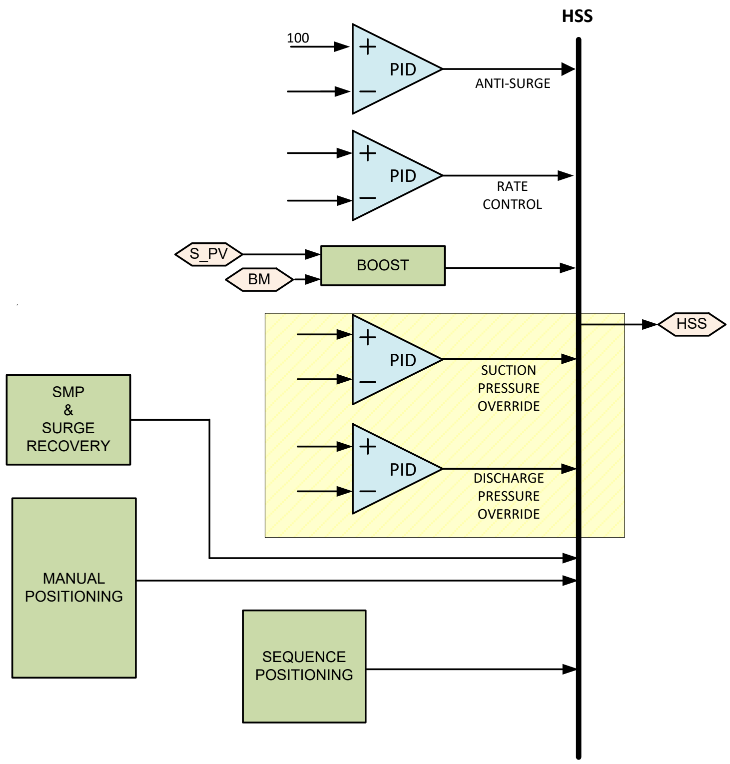


Figure 6-22. Pressure Override Control

Auxiliary Control

Up to two custom controllers may be added to the High Signal Select (HSS) bus within the ASC. One of these inputs is a configurable analog input that must be calibrated for 0–100% open on the anti-surge valve. If necessary, a first-order lag filter delay time may also be configured for the analog input. If the input signal fails, it is ignored by the HSS. The second auxiliary input to the HSS is a software tunable that is accessible through the Service Menu.

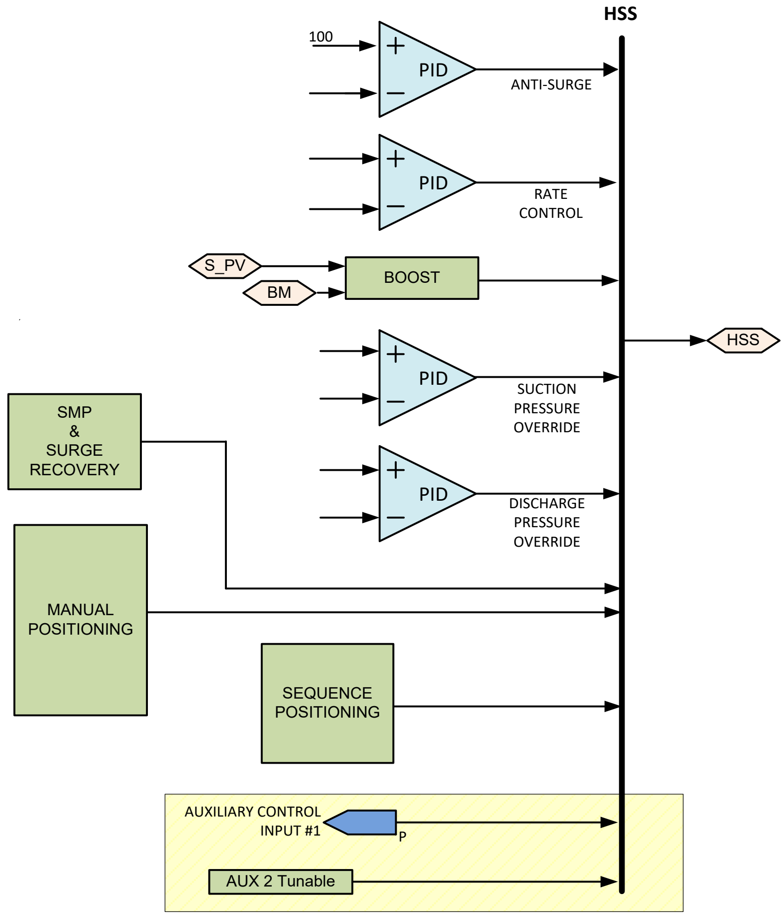


Figure 6-23. Auxiliary Control Variables

Support Functions

In addition to anti-surge control routines, there are support functions that enhance the ASC abilities:

- Configurable analog inputs may be used for redundant flow transmitters.
- Input signals are filtered and monitored for failures that trigger fallback routines.
- The Surge Control Margin may be automatically increased, to provide more conservative control, when surges are detected.
- Freeze, over-stroke, dither, and characterization functions provide customization of the anti-surge valve output signal.
- When system response time (loop period) is excessive, Pre-Pack may be used to decrease system reaction time.
- Deactivation logic provides bumpless transfer between the various control routines.
- Gas properties are calculated for greater accuracy (Standard Algorithm).
- Quench PID control.
- Choke limit alarm and choke line visualization.
- A high-speed datalog function is provided.

Signal Filtering

All of the signals that are input into the anti-surge controller may be filtered for noise. This aids in preventing false surge detections, prevents unnecessary response to noise, and stabilizes the control routines. All input signals are filtered after scaling and redundancy management. If process measurements are clean enough to provide adequate control without filtering, configuring filter time constants of 0 seconds would optimize the controller's speed of response. In any case, if filtering is deemed necessary, it is recommended to enable it in the control, not in the field device—disable or minimize any transmitter filtering.

Temperature and pressure measurements can be filtered with a high level of accuracy due to the expected responsiveness of these process signals. The filter is a simple first-order lag. The lag time constant, in seconds, is configured on the Stage I/O Configuration Screen. Since it is a time constant, a high value is required if the noise is of low frequency or high amplitude. Typical defaults are 3.0 seconds for temperature inputs and 0.2 seconds for pressure signals.

In contrast, the flow sensor requires careful consideration as it is typically noisy but is the primary surge detection signature. As a result, the anti-surge controller employs a more elaborate filtering scheme. A Moving Average filter provides a highly correlated signal without excessive delay times. A lag time constant is configured similarly to the other inputs but is used in a fourth-order filter scheme that weights the lagged signals according to their respective "ages." The most recent value is given the largest weighting, while the "oldest" value has the lowest weighting. Flow signals require much faster filtering than do pressures and temperatures. Lag time constants are typically less than 100 milliseconds.

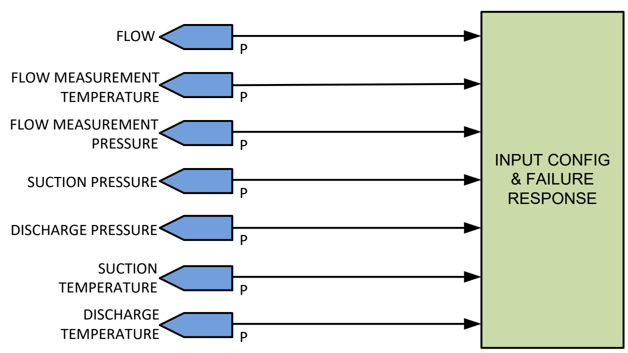


Figure 6-24. Analog 4–20 mA Input Signal Filtering and Failure Monitoring

Control Line Shift

Occasionally, changing process conditions will move a compressor's normal operation toward its surge limit. Consider an aging compressor in a dirty gas service. Internal fouling may reduce the compressor's efficiency, reducing flow output at a given head. These situations may eventually deteriorate into frequent but unnecessary surge events because of compressor mechanical conditions or process conditions changing over time. As a result, it may be necessary to increase the control margin to account for this deteriorating controllability.

The ASC offers automatic biasing of the control margin to shift the Surge Control Line when surges are detected. This feature is a temporary solution to a surge event. If enabled, the control margin will shift to the right a configured amount for each surge detected, as enumerated by the surge counter. For example, if the control margin is at 10% and a surge event records three individual surges, a configured SCL Shift Amount of 1% would bias the control margin to 13% from 10%, or 1% for every surge detected. When the surge counter is reset, the shift amount ramps slowly back to zero, gradually returning the SCL to its original location determined by the configured base control margin. If the process change that initiated the surge event is deemed chronic, as in the fouling example noted above, the base control margin should be increased to permanently move the SCL.

This biasing would normally be used only if the compressor's normal operation is at or near the Surge Control Line and the unit is susceptible to intermittent but significant process disturbances that can lead to surge.

Valve Freeze Mode
Under some operating conditions, the anti-surge valve may be continuously modulated at a partially open position. To eliminate unnecessary movements of the valve caused by process signal noise, the "Valve Freeze Mode" is used. When this mode is enabled, the valve will be held in position until a significant change in the process occurs. This can prevent reaction of the anti-surge valve and help stabilize minor process swings.

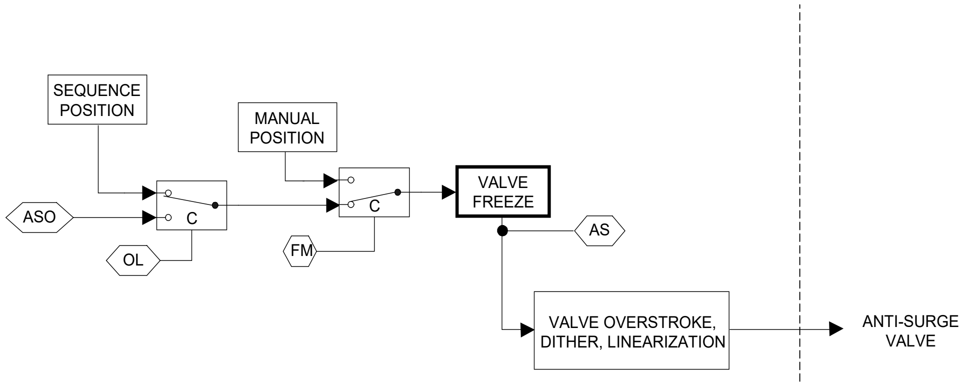


Figure 6-25. Valve Position Freeze Routine

The "Freeze Delay Time" defines the time interval at which the Freeze function is enabled, or sampled. In other words, after that time delay, the Freeze routine is initiated. However, to determine if the valve movement should be stopped, two criteria must be met. First, the valve position must be moving less than two percent (peak-to-peak). Second, S_PV must stay within a window of six percent (peak-to-peak). If both of these conditions are satisfied, the valve demand will remain clamped by the Freeze routine. Conversely, if either of these conditions is exceeded after the valve is held, Freeze mode will be disabled, the valve will move, and the timer will be reset.

Freeze mode is inhibited during start-up and shutdown (sequence positioning), when in Full Manual or Manual with Backup control modes, if the anti-surge valve is closed (<2%), and when the operating point is far from the Surge Control Line (S_PV>115).

Valve Over Stroke
To ensure full seating of the anti-surge valve in the fully open and closed positions Valve Overstroke function is used. This function adds a configured "Overstroke Open Amount" to the valve position once its position demand reaches 99.8% open. If, for example, the over stroke amount is set at 5%, the valve demand will step to 105% once the control output reaches 99.8%. Conversely, the "Overstroke Closed Amount" value is subtracted from the control output once it reaches 0.2% open. If the same 5% over stroke were set for the closed position, a control output of 0.2% would yield a valve demand of –5%, positively seating the valve closed.

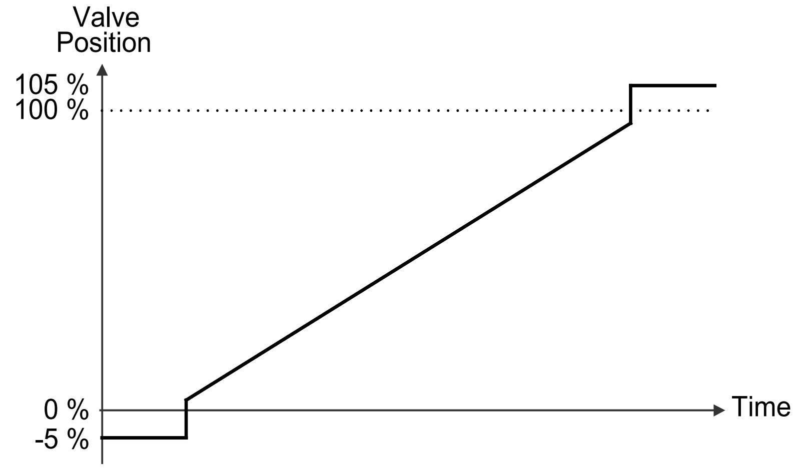


Figure 6-26. Valve Overstroke

Anti-Surge Valve Check Feature

The Vertex DR has an AS Valve Check Routine that allows technicians to partially stroke or verify AS valve operation. This test is intended to be used while the compressor is running. This is a useful test if the ASV has been completely closed for a long time and operators are concerned about its operability. This feature can also be used to measure the flow increase gained by stepping the ASV open a small percentage. That data can then be used to set appropriate boost settings for surge protection.

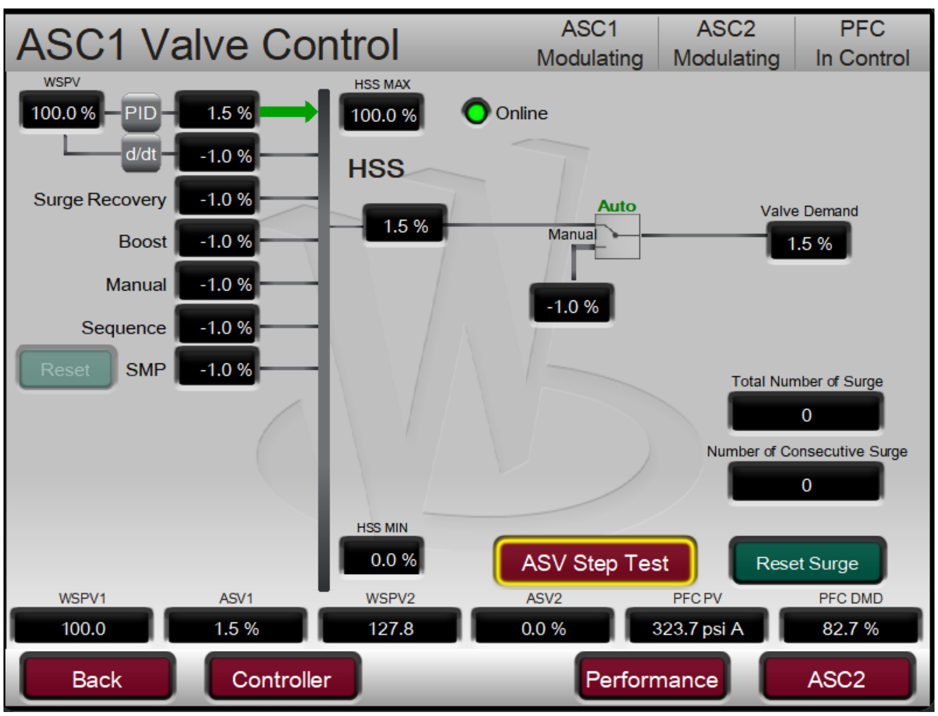


Figure 6-27. ASV Step Test Navigation Button

This function is only available through the GUI (local or RemoteView) on the valve demand screen and provides 2 types of verification on the functionality of the anti-surge valve:

1. Verify the valve operates correctly and is not stuck or sluggish, using the ASV position feedback during the check can verify the valve's response to the step-up in demand.
2. Provide a control calculated metric (FLOWRISE) on the percentage of suction flow rise that was created by this specific demand (%) increase.

To enter the routine, navigate to the ASV Step Test button and press enter. The test pop-up window will appear and with service level login, all of the adjustments and commands will be available.

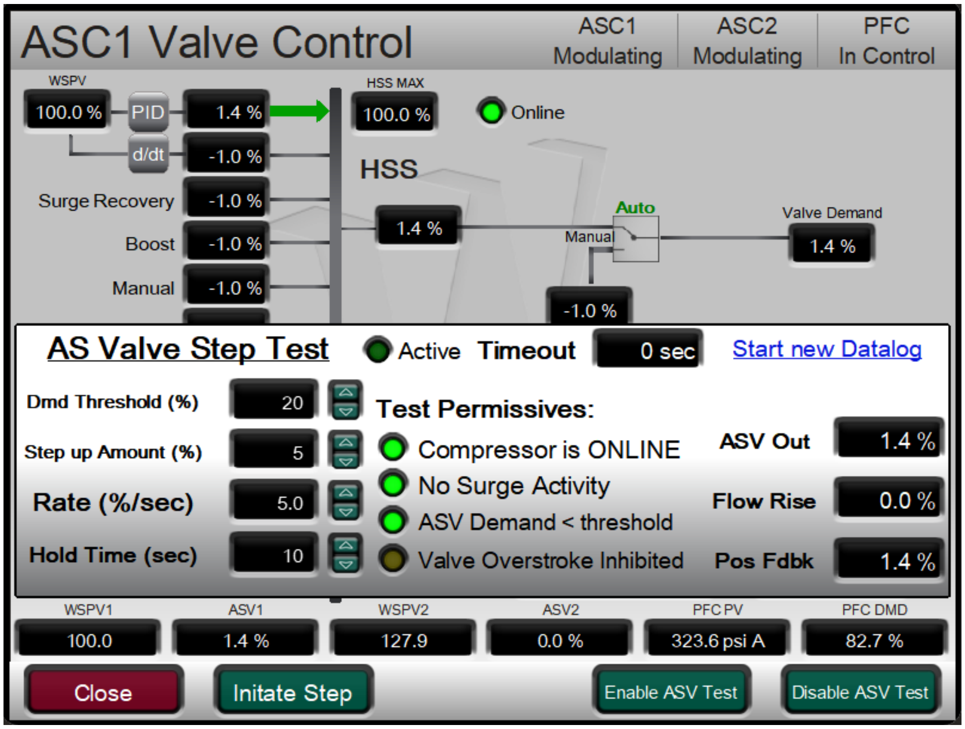


Figure 6-28. Step Test Pop-up Window

User Settings: **Adjustments user can set for this test**

AS Valve Demand Threshold (%) *20 (1, 90)

ASV must be below this % demand to allow the step up test

Step up Amount (%) *5 (1, 50)

Valve percent amount to add to valve demand

Rate (%/sec) *2.5 (0.5, 1000)

Rate the step will be added to demand

Hold Time (duration before ramp out) *10 (1, 60)

Time (sec) it will hold the step amount before ramping it back out

Permissives: Compressor conditions required for this test

LED Compressor Unit is ONLINE

LED No Surge Activity Detected

LED AS Valve is below the user configured threshold

LED (Amber) Warning that Overstroke will be Bypassed

If 'Overstroke' is configured for use – this will appear to indicate it is being bypassed

User Feedback:

- Behind the pop-up, current valve demand information can be monitored
- Below the pop-up, current compressor operational data can be monitored
- Active LED – goes green once the test is enabled
- Timeout – time remaining in the test routine (limited to 2 minutes with no activity)
- ASV Out – shows the current valve demand percentage
- Flow Rise** – upon completion of the test (step up then ramp back down), this will indicate a calculated value of the percentage of flow increase seen by the compressor during the test. This is calculated at the midpoint of the HOLD time
- Position Feedback – if an AI has been configured for ASV position feedback, that value will be shown here

*** Flow thru the compressor must increase when the ASV is opened, regardless of whether the flow element is at the suction (typical) or discharge end of the compressor.*

User Commands:

Enable ASV Test Momentary Button –
This enables the test function and starts the routine timer
Disable ASV Test Momentary Button –
This disables the test function and resets the timer
Initiate Step Momentary Button –
This triggers the test to add the configured % to the valve demand at the configured rate

Procedure:

When the permissives are satisfied (all conditions TRUE), the user:

1. Press the Enable button and the routine will be active and the pop-up will display a countdown timer.
    a. A time limiter for this routine has been implemented to prohibit it from being active for more than 120 seconds with no activity.
    b. Any triggering of a Step will restart the timer. The loss of any of the permissives during the test routine, will also disable the routine.
2. At any time the user can press the Disable button to exit the routine.
    a. The ‘amber’ permissive LED will only appear if the configuration is using the “valve overstroke” feature.
    b. If this feature is enabled, this LED will appear to indicate to the user that during this test routine, this function has been bypassed.
3. If desired, verify that the datalog block is collecting data, upon completion of the test this file can be captured (Stop Trendlog) to provide full details of the operation during this valve test.
4. When the user triggers a Step, the control will add the user configured step up amount to the AS valve demand output at the rate (%/sec) set by the user.
    a. After the Hold time expires the control will ramp the step up amount back to zero at 1%/sec (or the manual valve rate, whichever is slower).
5. The user can repeat step test if desired.
    a. When complete they can disable the test mode.
    b. If they do not disable the test mode, it will automatically be disabled after 120 seconds of no user actions.

Example 1 – Step test on ASV 1 while it is actively controlling (open a small %)

The figures below show this test being performed on ASV1. In this example, the valve is being actively controlled by the ASC PID, since the stage 1 WSPV is at 100% and the unit is operating on the surge control line. In this case, when the 5% step demand was added to the valve which was at 1.2%, the WSPV was raised to 120%, thus the PID demand quickly went to 0%. This is why during the test the valve demand was only at 5% and not at 6.2%. If the ASV1 would have been in manual w/ backup mode, the valve would have been at 6.2% during the test. From the valve position feedback we can see that the valve did respond correctly to the step test.

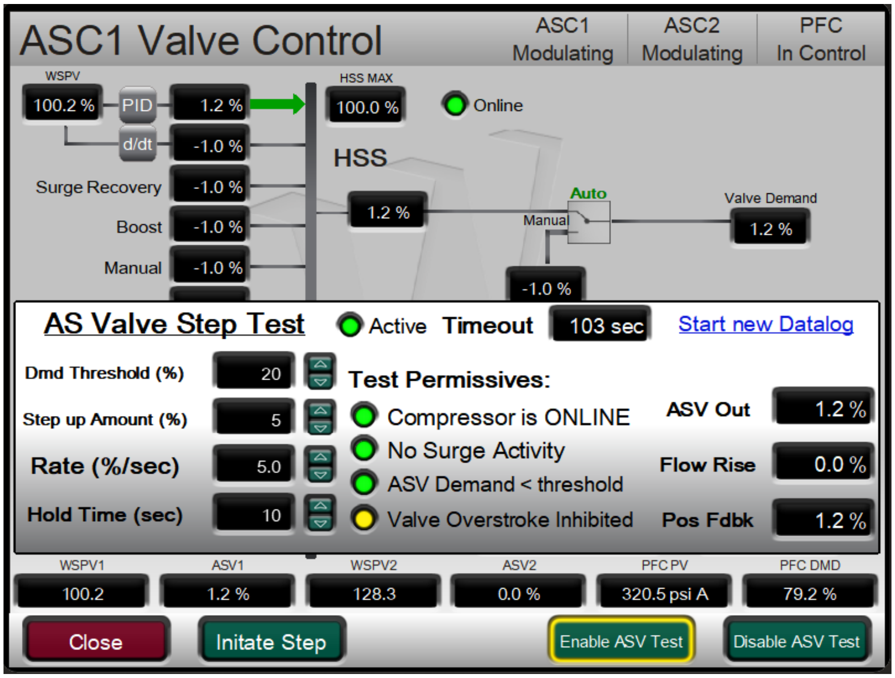


Figure 6-29. Step Test Enabled, Prior to Initiate Step

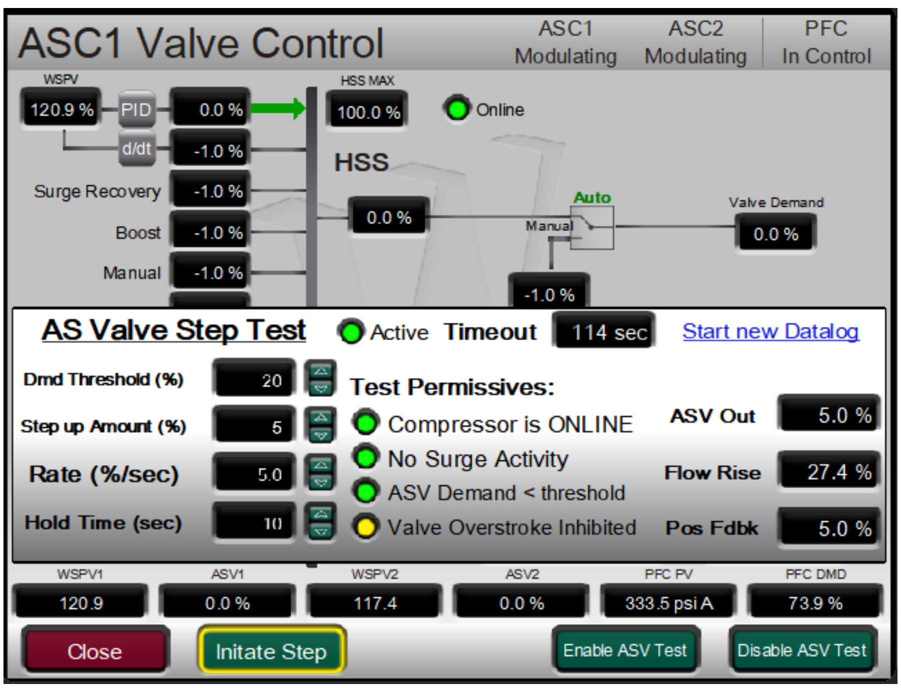


Figure 6-30. During Step Test

At the completion of the test the Flow Rise shows a 24% increase in inlet flow from this 5% step. This metric should be used in terms of a relative number and not an absolute measure. Any repeated tests over time of the same settings and compressor operating conditions should result in similar values

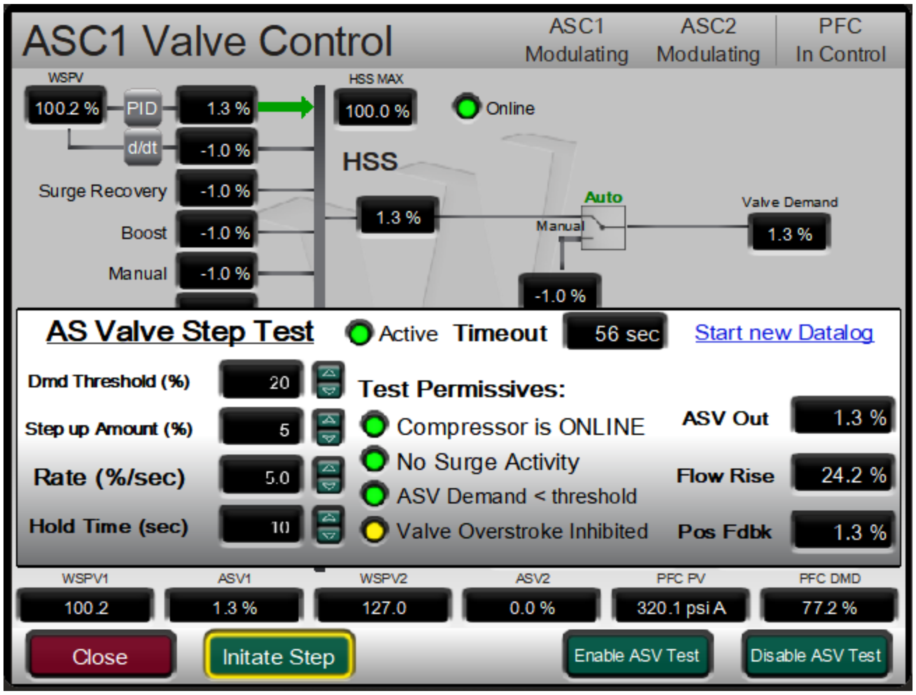


Figure 6-31. Step Test complete, After Ramp Out of Step Amount

Example 2 – Step test on ASV 2 while it is fully closed (demand = 0.0 %)
The figures below show this test being performed on ASV2. In this example, the valve is fully closed, since the stage 2 WSPV is at 130% and the unit is operating far to the right of the surge control line. In this case, when the 5% step demand was added to the valve which was at 0.0%, the WSPV was only raised to 133%. From the valve position feedback we can see that the valve did respond correctly to the step test.

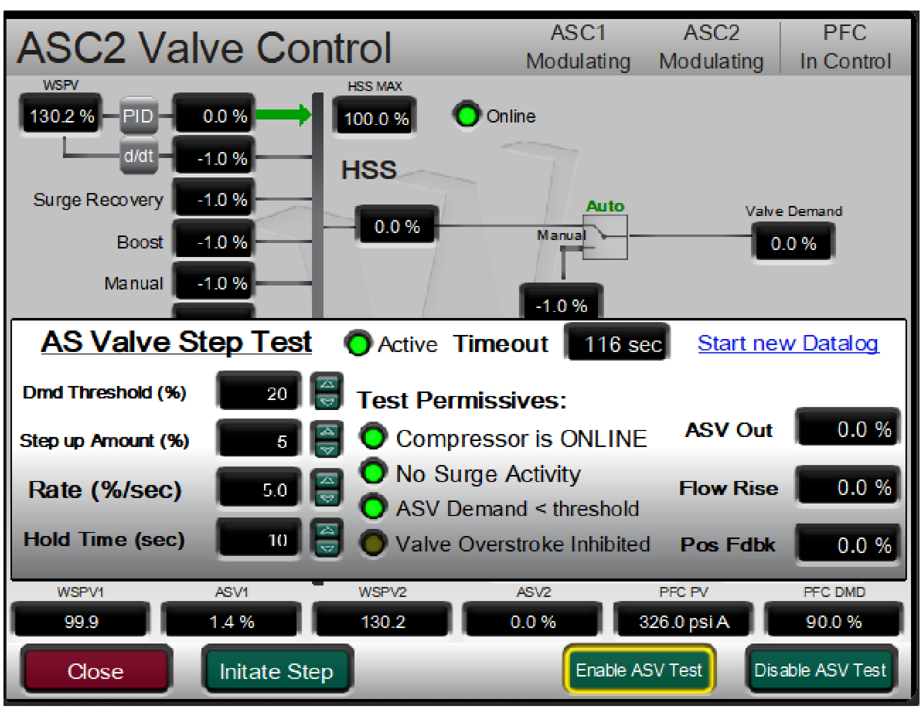


Figure 6-32. Step Test Enabled, Prior to Initiate Step

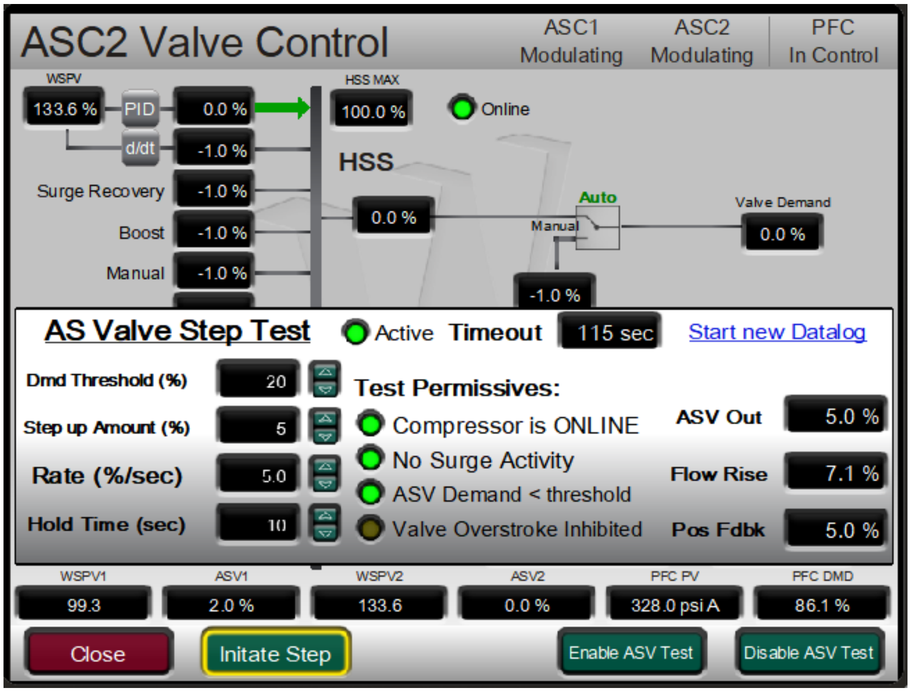


Figure 6-33. During Step Test

At the completion of the test the Flow Rise shows a 7.1% increase in inlet flow from this 5% step. This metric should be used in terms of a relative number and not an absolute measure. Any repeated tests over time of the same settings and compressor operating conditions should result in similar values

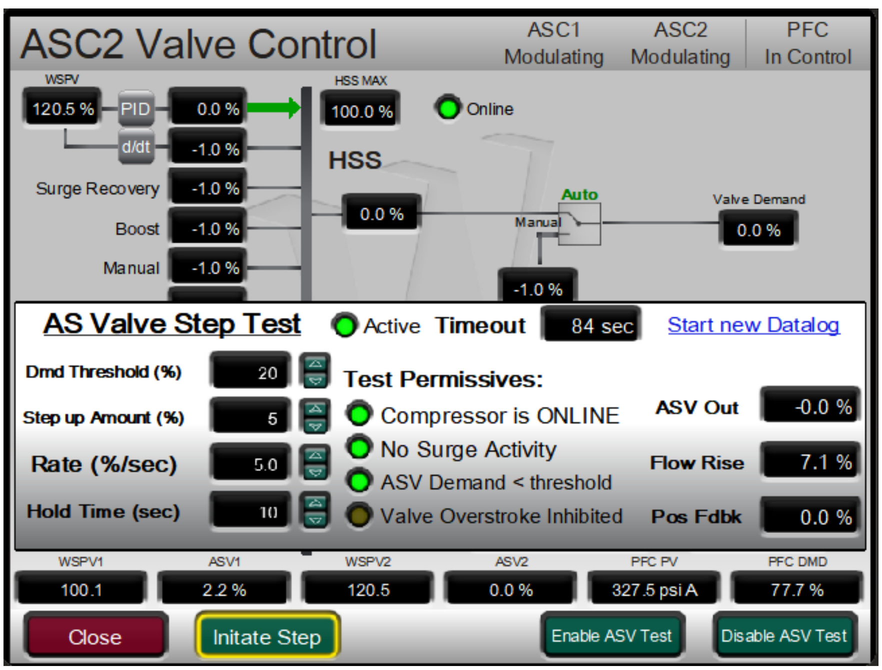


Figure 6-34. Step Test Complete, After Ramp Out of Step Amount

Valve Dither

Many valve designs can develop memory if their positions remain constant for long periods. Other mechanical, electrical, or electro-mechanical devices in the anti-surge valve's 4–20 mA loop, such as current to pneumatic transducers (I/Ps), can also suffer from this phenomenon. Mechanical inertia also plays a role, particularly in large anti-surge valves with tight seals. The combination of these factors is often referred to as "sticky", a contraction of static and friction, and can be detrimental to good control, especially in high gain systems requiring fine valve control. For applications susceptible to this condition, the ASC offers a dither function added to the valve demand output. Dither applies a 12.5 Hz signal of configurable amplitude onto the valve demand. Figure 6-41 shows a 0.5% dither applied to a constant 39.5% valve output. Dither, if applied, should not be visible as movement in the valve. The dither function is always active. Configure the "Amount" to 0.0% for no dither.

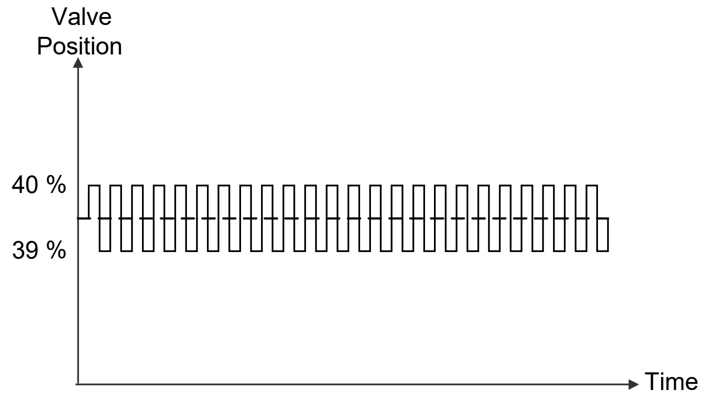


Figure 6-35. Valve Dither

Valve Linearization

Valve linearization plays an important role in compressor control applications. To ensure adequate tuning of valve control within wide position range, linear anti-surge valve characteristic is generally preferred. However, valves with quick opening, equal-percentage, and modified equal percentage characteristic are also used in some applications. Woodward controls incorporates valve-linearizing function that converts control output to flow demand. An eleven-point linearization table is provided to characterize the demand output to the anti-surge valve's flow characteristics.

See Figure 6-37 for a sample equal percentage valve characteristic and the corresponding linearization curve that results in a linear flow characteristic.

Table 6-2. Valve Characterization Percentages

Valve Flow Demand (Valve % Stroke)	Equal Percentage Valve Characteristic (% of Max Flow)	Linearized Output (Y-values) (Valve % Stroke)
0	0	0
10	5	30
20	7	52
30	10	64
40	14	72
50	19	77
60	25	81
70	37	86
80	57	91
90	78	95
100	100	100

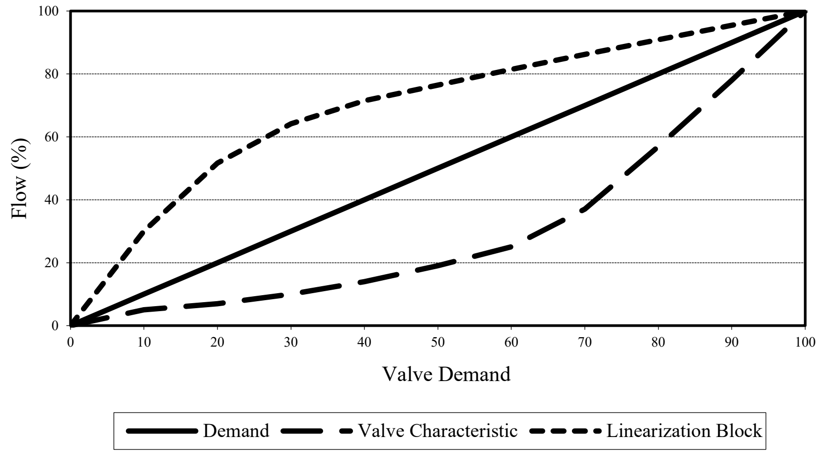


Figure 6-36. Valve Characterization

Pre-Pack
Pre-pack feature is used on applications where long piping runs and/or large volumes create a significant system lag. The ASC can compensate for this time lag if the system is lag limited, but not if it is rate limited. Rate limited means that the system will only react at a set rate, regardless of how quickly the valve acts. Lag limited means the system has no measurable response for a set time, and then at some point, a response is measured.

To help overcome this control lag, the Pre-Pack routine will over-stroke the anti-surge valve momentarily at the beginning of the Boost and Surge Recovery responses. This temporary overreaction can reduce the total response time of the system. See Figure 6-38 for a sample valve output illustrating a Boost response with Pre-Pack enabled.

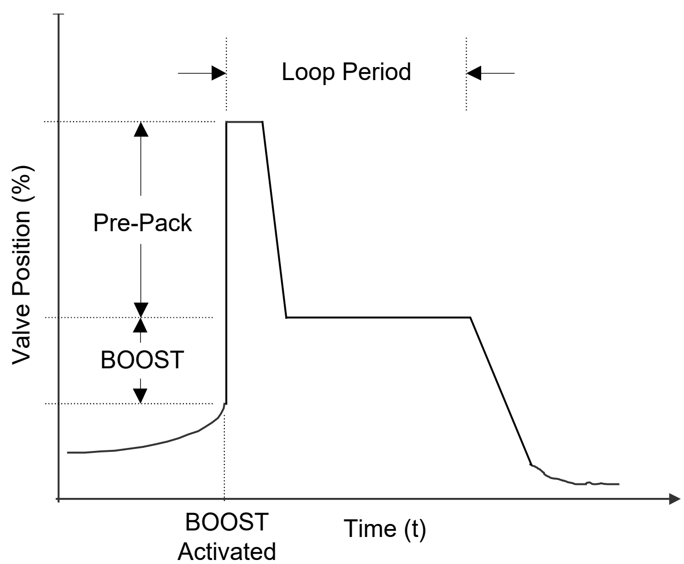


Figure 6-37. Boost Response with Pre-Pack

This routine should be enabled only if it is determined that the response time of the system is excessive (greater than 10 seconds) and if the system will respond to this action as described. In some cases, the anti-surge valve or other components in the system are the limiting factors, which will not be affected by this routine. A pre-pack value between 10% and 40% is tunable, depending on the system's ability to react and process stability required.

Deactivation
If a routine is abruptly disabled while in control of the anti-surge valve or control is transferred from one routine to another, the deactivation function provides for a smooth transition of the valve demand output. Deactivation is an internal function and not accessible by a user, that only occasionally has control of the valve--It is mentioned here merely for explanation

Compressibility Calculation (Woodward Standard Operating Point Calculation Algorithm)
Since Woodward Standard Algorithm uses calculated flow and polytropic head, such calculations require knowing gas compressibility factor Z. To input gas compressibility at suction (Z1), discharge (Z2), and flow meter (Zf) conditions:

- Input constant values provided by the OEM compressor map or API datasheet

If the constant Z values are used, compressibility at the flow sensor (Zf) is selected based upon the configured flow element location, i.e. suction or discharge. In either case, the calculated average compressibility (Zavg = (Z1+Z2)/2) is used for polytropic head calculations.

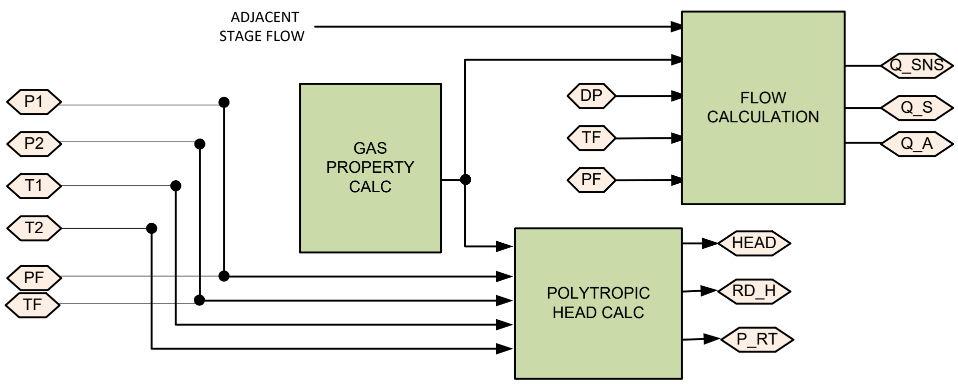


Figure 6-38. Gas Properties Calculations

Specific Heat Ratio Calculation (Woodward Standard Algorithm)
If the Standard Algorithm is selected, the specific heat ratio, or isentropic exponent, for the process gas must be known for polytropic head calculation. Default values for specific heat ratio and efficiency are configured into the control and used in the polytropic head calculation. However, the control will automatically calculate the specific heat ratio from on-line temperature and pressure measurements if the original "Gas Component" configuration is "Variable." This automatic calculation is disabled until the unit is online, when operation is not steady state, and if the calculated value exceeds the configured default ± 0.25.

Signal Failure Routines
When a field sensor (or both sensors, if redundant) used for surge protection fails, four actions are possible to be used:
- Default Value
- Last Good Value
- Variable Default
- Smart Value
- Manual operation
- Minimum recycling flow

The first action, if enabled, verifies steady state operation and uses the last good process value (LGV) for that signal before the sensor failed. This action is inhibited if the compressor operation was not stable prior to the failure, rendering the validity of "last good value" questionable. LGV can be enabled or disabled for individual inputs. Even when Last Good Value has been selected, proper Default values should be entered.

Operational stability is determined by monitoring speed, flow, suction pressure, and discharge pressure. If each input is stable for approximately one minute, the compressor is in a steady state condition, and the last good value selections, 30 seconds previous, would be valid. If the compressor were to move from this operating point, at least two of these four inputs will change, indicating an unstable operating condition and inhibiting last good value selection. Movement of the compressor operating point requires that at least two inputs are changing. Therefore, if only one input moves from the stable condition, it may be an indication of a failing signal while the actual compressor operation remains stable. In this case, last good value remains enabled.

IMPORTANT	**Last Good Value monitors for approximately one minute of stable operation and selects the value from 30 seconds prior to the failure. Failure is defined as an input signal that moves outside of the normal 2–22 mA (or other) operating range. If a transmitter is failing slowly, or drifting, and the signal takes longer than 30 seconds to reach the milliamp limits, the LGV routine may select an inappropriate value.**

IMPORTANT	**The speed-based stability monitoring described above is active only if a valid speed signal is available. If the unit is configured for Compressor-Only Mode, speed inputs are optional.**

The second action is taken if the system steady state condition changes or a second signal failure occurs while using the last good value for any input. In this case, or if LGV is not enabled, the control value for that input is transferred to a configured fail-safe default. At the moment any signal failure occurs, the values of speed, flow, suction pressure, and discharge pressure are captured. If the current values of these sensors change (one percent for pressure, three percent for flow, one percent of minimum governor for speed), or if a second sensor fails, the system can no longer be considered steady state. At that point, the last good value, if it is being used, is discarded and the control will transfer to the constant fail-safe value. These default values should be chosen to generate a conservative S_PV.

ASC provides a variable value setting as a fallback strategy, if enabled, that will replace the Last Good Value or Default Value method when either the flow sensor or pressure sensor fails. The Variable Q Default will take place when the flow sensor fails. The Variable Default Ratio (P2 to P1 ratio) will take place when either the suction pressure sensor or discharge pressure sensor fails. Figure 6-30 explains the Variable-Q Default method; the same concept applies for the Variable-Default Ratio.

If Variable Q or Variable Ratio method are selected, the control will automatically disable the automatic mode, and switch to Manual with backup mode.

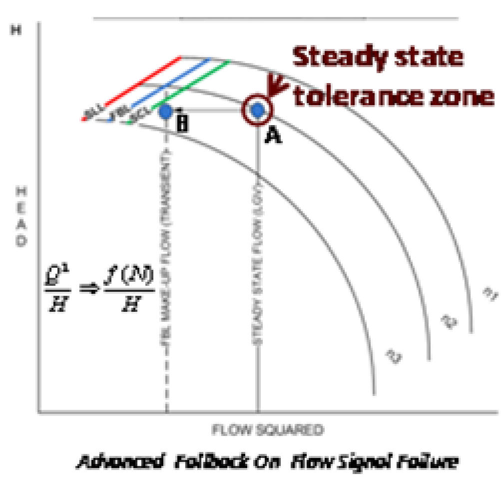


Figure 6-39. Input Signal Configure and Failure Response

The method will assume the flow (or pressure ratio) on the Surge control Line for a given speed. As result, the surge detection and prevention algorithms are still active, while a conservative, with respect to the surge, head-flow relation is put in place. This method is not recommended for where inlet temperature and gas composition may be changing by more than few percent.

The third signal failure routine is to calculate the value of one failed sensor (either suction temperature or discharge temperature sensor) from the available actual value of the other sensors (suction and discharge pressure sensors, and suction/discharge temperature sensor). In ASC, this method is called Smart-method.

Polytropic exponent relationships can be exploited to calculate any of the failed values P1, P2, T1, T2 as far as at least three out of four are available, Equations are explained in detail in Section "Universal Algorithm" below. This approach suits applications where efficiency and gas property variations are limited.

The fourth signal failure routine is to switch to Full Manual control and step open the anti-surge valve on flow signal failure by a predefined amount. This is a single strategy that is enabled or disabled for all inputs or for the solely flow.

The Last Good Value and Default Value routines will allow the compressor to run uninterrupted, thereby eliminating unnecessary recycling because of a transmitter failure. However, predicting the actual compressor operating point is somewhat compromised. Fail to Manual is the most conservative reaction, opening the anti-surge valve a configured amount beyond the current position to ultimately protect the machine when important process data is unavailable.

Minimum Valve Position if selected, in addition to any of the fallback strategies, the anti-surge valve will ramp toward a specified value, when flow sensor or pressure @ flow fails. As long as the sensor is lost, the anti-surge position cannot be lower than this value, unless full manual is selected.
When Minimum Valve Position is activated, the automatic mode cannot be selected. Only full manual or manual with backup mode are available.

This minimum position will automatically ramp back to zero when the sensor is detected healthy.

During this de-activation, the anti-surge valve control will not move the valve.

While a flow signal failure has but one backup routine, there are several possible response sequences to other signal failures, depending upon compressor operational stability and the configuration of Last Good Value and Fail to Manual. See the following tables for the order of events after an initial signal failure and subsequent operational instability.

Table 6-3. Temperature Fallback Strategy

Last Good Value	Smart Settings	Values in Stable Operation	Value if not stable	Value on multiple failures
NO	NO	Default	Default	Default
YES	NO	Last Good	Default	Default
YES	YES	Last Good	Calculated Value	Last good calculated value
NO	YES	Calculated Value	Calculated Value	Last good calculated value

The above table is only valid when temperature sensor is available

Table 6-4. Discharge Pressure Fallback Strategy

Last Good Value	Use Ratio for P2	Use Variable Ratio	Values in Stable Operation	Value if not stable	Value on Multiple Failure or P1 Fault
NO	NO	Indifferent	Default P2	Default P2	Default P2
YES	NO	Indifferent	Last Good P2	Default P2	Default P2
YES	YES	NO	Last Good P2	‘Default Ratio” *P1	Default Ratio*P1_DFLT
NO	YES	NO	Default Ratio *P1	“Default Ratio” *P1	“Default Ratio” *P1_DFLT
NO	YES with “Use Ratio LGV”	NO	LGV Ratio*P1	Default Ratio *P1	“Default Ratio” *P1_DFLT
NO	YES with “Use ratio LGV”	YES	LGV Ratio*P1	“Variable Default Ratio” *P1	“Variable Default Ratio” *P1_DFLT
NO	YES	YES	“Variable Default Ratio” *P1	“Variable Default Ratio” *P1	“Variable Default Ratio” *P1_DFLT
YES	YES	YES	Last Good P2	“Variable Default Ratio”*P1	“Variable Default Ratio”*P1_DFLT

Table 6-5. Suction Pressure Fallback Strategy

Last Good Value	Use Ratio for P2	Use Variable Ratio	Values in Stable Operation	Value if not stable	Value on multiple failure or P2 Fault
NO	NO	Indifferent	Default P1	Default P1	Default P1
YES	NO	Indifferent	Last Good P1	Default P1	Default P1
YES	YES	NO	Last Good P1	‘P2/”Default Ratio”	P2_DFLT / Default Ratio
NO	YES	NO	P2 / “Default Ratio”	P2/”Default Ratio”	P2_DFLT / “Default Ratio”
NO	YES with “Use Ratio LGV”	NO	P2 / “LGV Ratio”	P2/”Default Ratio”	*P2_DFLT / “Default Ratio “
NO	YES with “Use ratio LGV”	YES	P2 / “LGV Ratio”	P2 / “Variable Default Ratio”	P2_DFLT /”Variable Default Ratio”
NO	YES	YES	P2 / “Variable Default Ratio”	P2 / “Variable Default Ratio”	P2_DFLT / “Variable Default Ratio”
YES	YES	YES	Last Good P1	P2 / “Variable Default Ratio”	P2_DFLT / “Variable Default Ratio”

Table 6-6. Fallback Strategy on Flow Failure

Last Good Value	Variable Q_ Default	Values in Stable Operation	Value if not stable	Value on multiple failures
NO	NO	Default	Default	Default
YES	NO	Last Good Value	Default	Default
YES	YES	Last Good Value	Variable Default Q	Variable Default Q
NO	YES	Variable Default Q	Variable Default Q	Variable Default Q

Table 6-7. Action on Flow Failure

Full manual	Min flow	Transition on failure	Operation modes available	Valve demand
YES	NO	Full Manual mode	Full Manual mode	Last good position+ added Man Amount
YES	YES	Full Manual mode	Full Manual mode	Last good position+ added Man Amount (No Min Setting)
NO	NO	Manual with backup	Full Manual or Manual with backup	Last good position+ added Man Amount
NO	YES	Manual with backup	Full Manual or Manual with backup	Last good position+ added Man Amount +Min Valve lift (Man with backup)

Operating Point Calculations

Standard Algorithm

The Standard Algorithm operating point for a compressor is simply the volumetric inlet flow squared divided by the polytropic head, shown below. This equation can be expanded to show that it reduces to a form that only contains measurable quantities and constants. This is critical for applications where the gas composition changes. First, the flow term will be explored, then, the polytropic head calculation is detailed, and the combination of the two is expanded to produce the operating point.

$$\text{Operating Point} = \frac{(Q_A)^2}{H_P}$$

Flow can be input to the control in various unit calibrations: flow element differential pressure with or without square-root extraction, normal or standard volumetric flow, or mass flow. The latter two require an external flow computer or transmitter calibration using fixed process data. While these are suitable for simple flow measurement and display, they are not ideal for surge control because of accuracy limitations and response time delays. For these reasons, the preferred flow measurement for surge prevention and control is raw flow element differential pressure without square-root extraction. The calculations described below assume this configuration.

Volumetric inlet flow is calculated in two steps. First the standard/normal volumetric (N·m³/hr) or mass (kg/hr) flow through the flow element is calculated using the measurements of flow element differential pressure, pressure at the flow sensor, and temperature at the flow sensor. The selection of standard / normal condition volumetric flow or mass flow is made during initial configuration and will dictate what flow units are displayed on the ASC operating screens. The mass flow equation, with flowing process parameters substituted for density, is:

$$Q_M = N \cdot C \cdot Y \cdot d^2 \cdot \sqrt{\frac{h_f \cdot P_f \cdot MW}{R_g \cdot T_f \cdot Z_f \cdot (1-\beta^4)}}$$

Where:
QM is mass flow
N is a unit-sizing factor
C is the flow element Discharge Coefficient
Y is the flow element Gas Expansion Factor
d is the flow element bore
hf is the differential pressure across the flow element
Pf is the gas pressure at the flow element
MW is the gas molecular weight
Rg is the Universal Gas Constant
Tf is the gas temperature at the flow element
Zf is the gas compressibility at the flow element
β is the flow element Beta ratio (bore divided by pipe internal diameter)

Combining constant parameters, the equation is rewritten as:

$$Q_M = \frac{N \cdot C \cdot Y \cdot d^2}{\sqrt{R_g \cdot (1-\beta^4)}} \cdot \sqrt{\frac{h_f \cdot P_f \cdot MW}{T_f \cdot Z_f \cdot}}$$

$$Q_M = K_M \cdot \sqrt{\frac{h_f \cdot P_f \cdot MW}{T_f \cdot Z_f \cdot}}$$

Where:
KM is a mass flow constant, combining other constant values

The flow constant (K_M) and Molecular Weight (MW) are input to the control during initial configuration. Flow element differential (h_f), pressure (P_f), and temperature (T_f) are measured. As discussed previously, compressibility (Z_f) is either configured as a constant or calculated on-line.
If, instead of mass flow, normal volumetric flow is selected during configuration, the calculation is similar:

$$Q_{nor} = \frac{Q_M}{\rho_{nor}} = \frac{N \cdot C \cdot Y \cdot d^2 \cdot \sqrt{\frac{h_f \cdot P_f \cdot MW}{R_g \cdot T_f \cdot Z_f \cdot (1-\beta^4)}}}{\frac{P_{nor} \cdot MW}{R_g \cdot T_{nor} \cdot Z_{nor}}}$$

Where:
Qnor is normal volumetric flow
ρnor is the normal condition gas density
Pnor is the normal condition gas pressure
Tnor is the normal condition gas temperature
Znor is the normal condition gas compressibility

Combining constant parameters, the equation is rewritten as:

$$Q_{nor} = N \cdot C \cdot Y \cdot d^2 \cdot \sqrt{\frac{h_f}{1-\beta^4} \cdot \frac{P_f \cdot MW}{R_g \cdot T_f \cdot Z_f}} \cdot \frac{R_g \cdot T_{nor} \cdot Z_{nor}}{P_{nor} \cdot MW}$$

$$Q_{nor} = \frac{N \cdot C \cdot Y \cdot d^2 \cdot T_{nor} \cdot Z_{nor} \cdot \sqrt{R_g}}{P_{nor} \cdot \sqrt{1-\beta^4}} \cdot \sqrt{\frac{h_f \cdot P_f}{T_f \cdot Z_f \cdot MW}}$$

$$Q_{nor} = K_{nor} \cdot \sqrt{\frac{h_f \cdot P_f}{T_f \cdot Z_f \cdot MW}}$$

Where:
Knor is a normal volumetric flow constant, combining other constant values

As seen in these equations, the selection of mass or normal volumetric flow will affect the calculation of the flow constant (K_M or K_{nor}), which is input to the control during initial configuration. While this calculation is performed automatically by the ASC, the equations are provided here for verification:

If Mass Flow is selected:

$$K_M = 0.0438521 \cdot \frac{C \cdot Y \cdot d^2}{\sqrt{(1-\beta^4)}}$$

If Normal Volumetric Flow is selected:

$$K_{nor} = 0.9829 \cdot \frac{C \cdot Y \cdot d^2}{\sqrt{(1-\beta^4)}}$$

IMPORTANT

These formulas for calculating flow constants assume SI engineering units of kPa, °C, kg/hr, m³/hr, and mm. This matches the required inputs of the ASC. These constants will be different when compared to other flow measurements in different engineering units.

If an annubar is used as the flow element, substitute pipe internal diameter (D) for bore diameter (d) and zero for beta ratio (β) in these equations.

Beta ratio (β), flow element bore (d, millimeters), Discharge Coefficient (C), and Gas Expansion Factor (Y) are all taken from the Flow Element Calculation or Data Sheets. The latter value, but to some degree all four, will vary with process conditions and flow rate. In addition, flow element calculations are often made at a maximum flow condition for calibration of the flow (differential pressure) transmitter. As such, the flow element calculation sheet's data may not be relevant to normal compressor operation. If possible, maximum accuracy is achieved by selecting the "constants" that correspond to the compressor's normal operating conditions and flow rate. The numerical constants are calculated from the Universal Gas Constant (Rg), N-factor (N), and normal condition process parameters in SI units.

Table 6-8. Typical Discharge Coefficients

ISA 1932 Nozzles	$C = 0.999 - 0.2262\beta^{4.1} - (0.00175\beta^2 - 0.0033\beta^{4.15})(\frac{10^6}{Red})^{1.15}$
Long Radius Nozzles	$C = 0.9965 - 0.00653\sqrt{\frac{10^6\beta}{Re_D}}$
Venturi Nozzles	$C = 0.9858 - 0.196\beta^{4.5}$
Classical Venturi tubes with an "as cast" convergent section	C=0.984
Classical Venturi tubes with a machined convergent section	C=0.995
Classical Venturi tube with a rough-welded sheet-iron convergent section	C=0.985

The calculated normal/standard volumetric or mass flow through the flow element can then be combined with any side-stream or adjacent stage flows resulting in the total flow through the compressor stage, Qs. However, actual volumetric suction flow is necessary to plot on the chosen compressor map, so the conversion is made with the one of the following equations:
If Mass Flow is selected:

$$Q_A = \frac{Q_S}{\rho_1} = \frac{Q_S \cdot R_g \cdot T_1 \cdot Z_1}{P_1 \cdot MW}$$

If Normal Volumetric Flow is selected:

$$Q_A = Q_S \cdot \frac{P_{nor}}{P_1} \cdot \frac{T_1}{T_{nor}} \cdot \frac{Z_1}{Z_{nor}}$$

Where:
QA is actual volumetric suction flow
QS is total compressor stage flow (normal or mass)
ρ1 is the gas density at suction conditions
T1 is the gas temperature at suction conditions
Z1 is the gas compressibility at suction conditions
P1 is the gas pressure at suction conditions
Tnor is the normal condition gas temperature
Znor is the normal condition gas compressibility
Pnor is the normal condition gas pressure

By substituting the flow sensor calculation (Qs), the result is:

$$Q_A = K\sqrt{\frac{T_1^2 \cdot Z_1^2}{P_1^2} \cdot \frac{h_f \cdot P_f}{T_f \cdot Z_f \cdot MW}}$$

Where:
K is a combination of those flow constants calculated previously, for mass or normal volumetric flow (KM or Knor), and the Universal Gas Constant (Rg) or normal condition process parameters (Tnor, Pnor, Znor).

Assume, for example, that the flow element is located in the compressor suction line (f=1). The equation can be simplified as:

$$Q_A = K\sqrt{\frac{T_1 \cdot Z_1 \cdot h}{P_1 \cdot MW}}$$

In order to determine the second half of the operating point, the following equation is used to calculate the polytropic head for the compressor:

$$H_P = \frac{R_g \cdot T_1 \cdot Z_{avg}}{MW} \cdot \frac{\left(\frac{P_2}{P_1}\right)^{\sigma} - 1}{\sigma}$$

Where:
HP is polytropic head
Zavg is the average gas compressibility for the compressor
P2 is the gas pressure at discharge conditions
σ is the polytropic exponent which can be defined as:

$$\sigma = \frac{k-1}{k \cdot \eta_P} = \frac{\ln\left(\frac{T_2}{T_1} \cdot \frac{Z_2}{Z_1}\right)}{\ln\left(\frac{P_2}{P_1}\right)} \cong \frac{\ln\left(\frac{T_2}{T_1}\right)}{\ln\left(\frac{P_2}{P_1}\right)}$$

Where:
k is the specific heat ratio, or isentropic exponent, of the gas
ηp is the polytropic efficiency of the compressor
T2 is the gas temperature at discharge conditions
Z2 is the gas compressibility at discharge conditions

After volumetric flow and polytropic head have been calculated, the controller can now combine these two values and calculate a single value representing the operating point of the compressor. If this is continued in equation form, we have the following:

$$\text{Operating Point} = \frac{(Q_A)^2}{H_P} = \frac{K^2 \cdot \frac{T_1^2 \cdot Z_1^2}{P_1^2} \cdot \frac{h_f \cdot P_f}{T_f \cdot Z_f \cdot MW}}{\frac{R_g \cdot T_1 \cdot Z_{avg}}{MW} \cdot \frac{\left(\frac{P_2}{P_1}\right)^{\sigma} - 1}{\sigma}}$$

Now it can be seen that several of the terms on the top and bottom of the ratio can be canceled out. The gas molecular weight (MW) cancels out of the numerator and denominator. In most cases, the gas compressibility does not change much between the suction and discharge, so the compressibility terms may be canceled with little or no error introduced. This leaves the following equation:

$$\text{OperatingPoint} = \frac{K^2 \cdot T_1 \cdot P_f \cdot h_f \cdot \sigma}{R_g \cdot T_f \cdot P_1^2 \cdot \left(\left(\frac{P_2}{P_1}\right)^{\sigma} - 1\right)}$$

K and Rg are constants that do not change, and all that remain are measured variables.

As for sigma, this requires another calculation but it is still found from measured values. The following equation is the relationship between pressures and temperatures for an isentropic process such as compression:

$$\sigma = \frac{\ln\left(\frac{T_2}{T_1}\right)}{\ln\left(\frac{P_2}{P_1}\right)}$$

The only additional parameter not mentioned previously is discharge temperature. Therefore, this measurement is necessary if the gas composition passed through the compressor is expected to change. That is, if the “Gas Component” configuration is “Variable,” then temperature measurements are required in the suction and discharge. Conversely, if the “Gas Component” configuration is “Constant,” then, at a minimum, a temperature measurement is required in the location of the flow element (suction or discharge). If only one temperature measurement is available, the control will automatically calculate the other temperature using the relationship of sigma (σ), described above, or from a mass balance flow equation. Then all of the necessary parameters for calculating an accurate operating point are measured and variances compensated.

Anti-Surge Control Recommendations

Compressor control systems are but one element in the entire anti-surge control loop. Particularly, field instrumentation and final control elements (anti-surge valves) often do not receive an appropriate level of attention during the design phase of the compressor system. Speed of response and sophisticated software routines are the primary differentiators that set compressor controls apart from typical process controls. However, users often rely on “typical” process equipment for transmitters and valves, while spending significant time and resources to select the control system. The speed and accuracy of the entire control loop, including instruments and valves, is critical—the system is only as good as its weakest link.

With this in mind, recommend looking at the entire control loop when designing a fast, accurate, and reliable anti-surge control system. These recommendations are not intended to replace good engineering analysis but do provide typical, industry accepted guidelines.

Instrumentation

Speed is the primary factor in selecting transmitters. Most compressor systems will utilize analog electronic transmitters with time constants from about 250 milliseconds. As a comparison, pneumatic transmitters can have time constants of several seconds, which obviously eliminates their use in surge protection. As digital transmitters have become more prominent, it is becoming increasingly more difficult to procure their analog predecessors. The extra signal processing in these transmitters adds time, albeit small amounts, to the loop response. For the fastest response, some diffused silicon sensors can have time constants as short as 10 milliseconds. Keep impulse lines as short as possible, and mount transmitters above the process line to promote liquid drainage. Follow proper application of the flow element. Upstream pipe run recommendations or the use of flow conditioners not only improve accuracy but also reduce signal noise.

Anti-surge Valves

Size anti-surge valves properly, capable of the full capacity flow of the compressor at reduced pressure. A typical valve-sizing coefficient (Cv) is roughly double the highest surge limit line flow. Stroking speeds are typically two seconds or less from closed to fully open. This often requires the use of volume boosters, particularly on larger valve sizes, for normal operation. Linear valves are preferred, but non-linear valves can be characterized within the compressor control application. Positioners can be problematic in anti-surge applications, but their use is sometimes required because of the type of valve being used. Consult with the valve manufacturer carefully. Noise abatement may be required in some applications.

Anti-Surge Control 2

The ASC2 control loop for a second compressor section can be configured. Except for the decoupling signal (if used), the ASC1 and ASC2 control loops calculate the section operating points and modulate their respective valves independently. The compressor control and protection routines described in the previous section also apply for the ASC2 control loop. All IO, Alarms, and Shutdowns are annunciated with ASC1 or ASC2 in the descriptions to specify which compressor section they apply to.

When ASC2 is used, the Vertex IO can be expanded using RTCNet modules in order to accommodate the required IO counts. The same IO functions can be selected on an RTCNet Node as the Vertex control. Please see chapter 5 for details on RTCNet IO Expansion.

In some applications, the compressor contains two sections, each with individual operating point calculations, but only one ASV for surge protection. In this case, the Vertex can be configured with two ASC sections with the required IO points, and the “ASV1 For Both Sections” option can be selected in the ASC1 Compressor Layout configuration menu. This will allow the “Stage 1 AS Valve Demand” output to be driven by the High Signal Select (HSS) of the ASC1 and ASC2 control demand outputs.

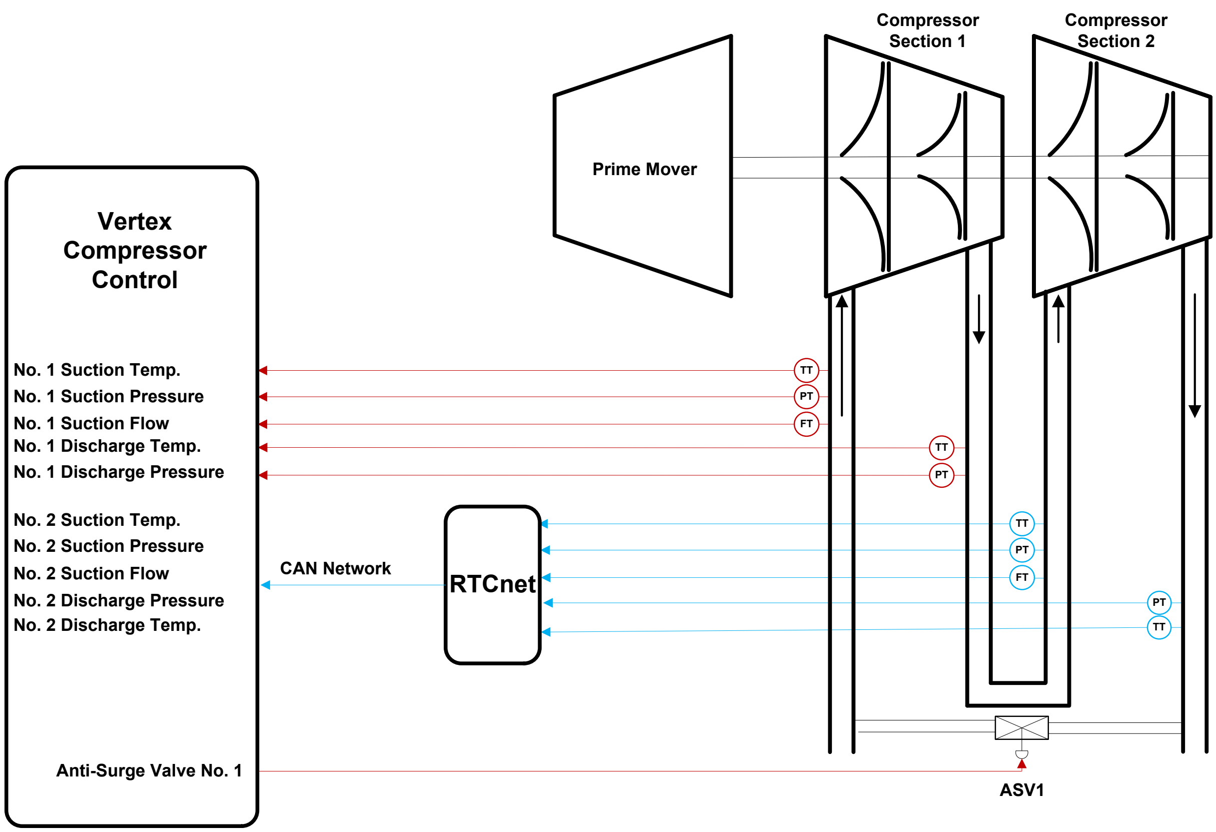


Figure 6-40. Two Section Compressor with One ASV

Commands - Train Commands

The control algorithms are sequenced using inputs from the prime mover system. These commands are:

- Train Start Command
- Train Start Inhibit
- Driver Startup Complete
- Train Normal Shutdown Request
- Train Quit Normal Shutdown Request

Train Start Command
When this command is received, it indicates to the Vertex control that the train prime mover has been started. The Performance demand will ramp to the “Startup Position” setting. The control will then wait for the “Driver Startup Complete” command.

This command is positive edge triggered.
Make this command through the Vertex front keypad, contact input, or Modbus/OPC.

Train Start Inhibit
When this command is received, the “Train Start Command” is inhibited. If a “Train Start Command” is received while the “Train Start Inhibit” command is active, it will be ignored. The “Train Start Command” must then go from TRUE-FALSE-TRUE again to trigger the start command.

This command is maintained, not edge triggered.
Make this command through a contact input or Modbus/OPC.

Driver Startup Complete
When this command is received, it indicates to the Vertex control that the train prime mover startup had been completed and is running within the normal operating speed range. The anti-surge valve(s) will ramp to the “Position During Startup” and wait for the Online Detection permissive to be met. The Performance control will ramp its demand towards 100% until the Performance PID takes control of the process variable at the setpoint.

This command is positive edge triggered.
Make this command through a contact input or Modbus/OPC.

Train Normal Shutdown Request
When this command is received, it indicates to the Vertex control that the unit is to be brought offline in a controlled fashion. The anti-surge controller(s) will begin ramping the valve(s) to the “Shutdown Position” at the configured rate. Once the anti-surge valve(s) have reached the “Position at Start”, the Performance control will begin ramping its demand toward the “Reset Position” setting at the configured rate.

This command is positive edge triggered.
Make this command through the Vertex front keypad, contact input, or Modbus/OPC.

Train Quit Normal Shutdown Request
When this command is received, the Normal Shutdown is aborted. The anti-surge valve(s) will ramp to the “Position During Startup” and wait for the Online Detection permissive to be met. If the Performance startup sequence is in the ‘Continue’ state, it will return to Auto control when the Normal Shutdown is aborted. If the Performance startup sequence is in the ‘Halt’ state, it will go to Manual and hold the last demand when the Normal Shutdown is aborted.

This command is positive edge triggered.
Make this command through the Vertex front keypad, contact input, or Modbus/OPC.

Performance Control

The Performance Control (PFC) is commonly configured to drive suction/discharge throttle valves, Inlet Guide Vane position, or speed control setpoint. When configured, this control function is used to control compressor suction pressure, compressor discharge pressure, compressor flow, or any process variable related to compressor flow or load. This control function compares an analog input signal to an internal setpoint and, depending on the programmed configuration, positions the compressor throttle valve, inlet guide vanes, torque converter, and/or motor speed (VFD) to accomplish the desired control.

The Performance control consists of the Performance PID, Limiter 1 PID (if configured), Limiter 2 PID (if configured), and Sequence Ramp. The outputs from each of these functions are Low Signal Selected (LSS) to determine the final Performance demand. When Load Sharing is used and enabled, the Performance PID is switched off the LSS and the Load Share PID is switched on to the LSS. The Manual positioning ramp allows an operator to take direct control of the final Performance demand by bumpless switching between the LSS demand and the Manual demand ramp.

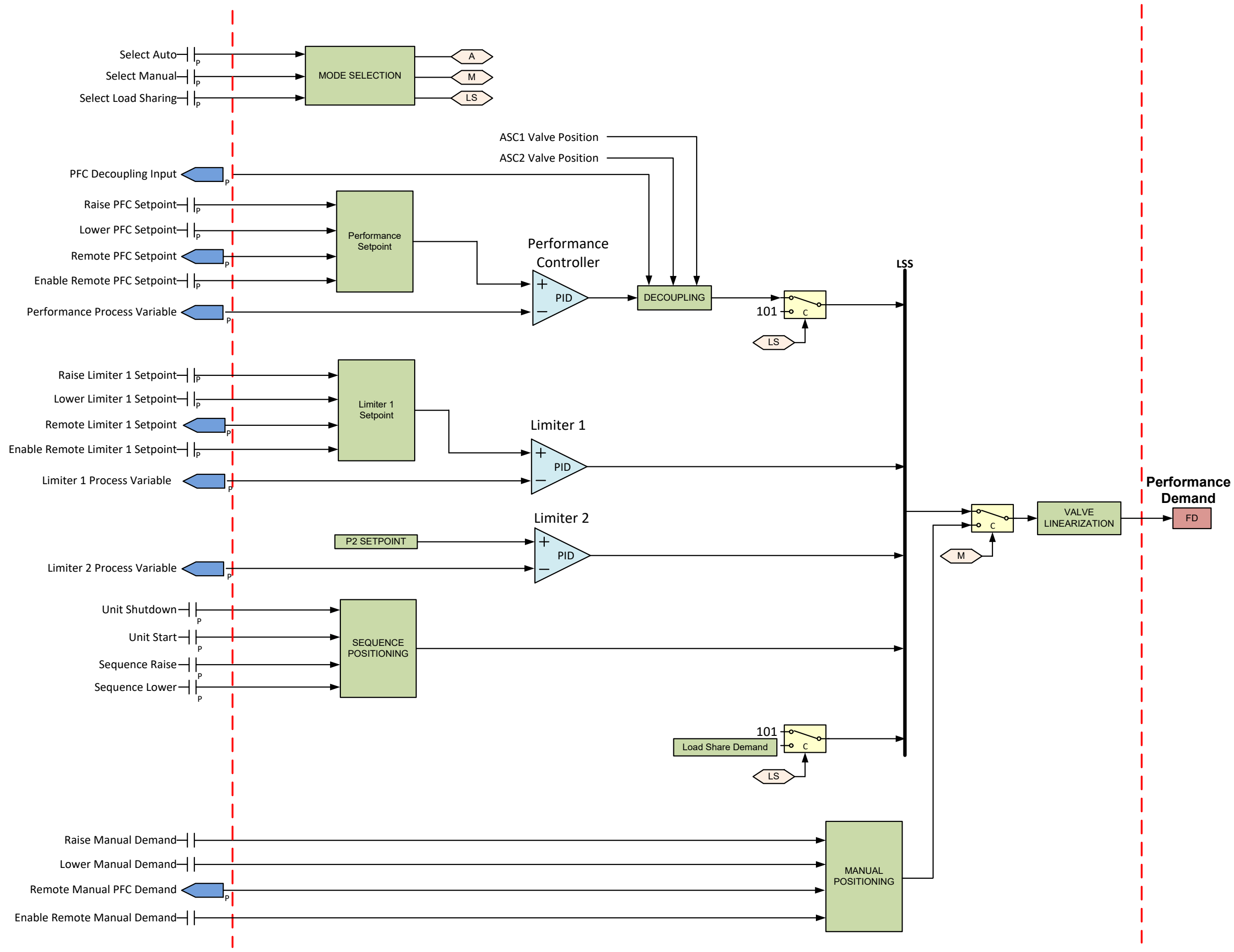


Figure 6-41. Performance Control Overview

Sequence Ramp

The Sequence Ramp is always active on the LSS bus and sets the Performance demand during the train startup and shutdown. There are two programmable demand settings:

- Reset Position
- Startup Position

Reset Position
When the Vertex is tripped, the Sequence Ramp is forced to 0% demand. When all trips are cleared, the Sequence Ramp ramps to the "Reset Position" at the "Sequence Ramp Rate". The "Reset Position" setting can be used in the case that the Performance demand output is driving a suction or discharge throttle valve to allow process gas to pressurize vessels and the compressor prior to starting the prime mover.

Startup Position
When the "Train Start Command" is received, the Sequence Ramp will ramp from the "Reset Position" to the "Startup Position" at the "Sequence Ramp Rate". The Sequence Ramp will hold at the "Startup Position" until the "Driver Start Completed" command is received or the Sequence Ramp is manually positioned above the "Startup Position".

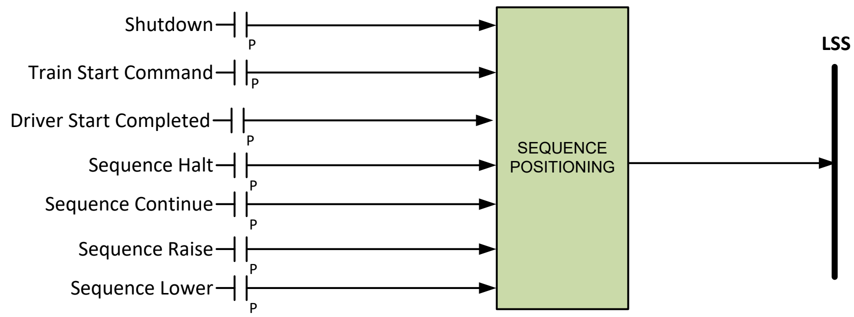


Figure 6-42. Sequence Ramp Overview

The Performance Halt/Continue commands allow the sequence ramp to be paused and resumed prior to the "Driver Start Completed" command. If halted, the Sequence Ramp will remain at its last position and can be manually positioned. The Sequence Ramp will remain in the halted state until a Continue command is received, at which point it will continue to ramp towards the "Startup Position". If halted and a "Driver Start Completed" command is received, the Sequence Ramp will remain at the halted position and can be manually positioned. When a Continue command is received and the "Driver Start Completed" signal has been received, the Sequence Ramp will begin ramping to 100% at the "Sequence Ramp Rate" until the Performance PID takes over the demand on the LSS.

Prior to the "Driver Start Command" being received, the Performance PID is in a tracking mode and not able to control the process variable to the setpoint. Prior to the "Driver Start Command" being received, the Limiter 1 and Limiter 2 PIDs (if configured) must be enabled to be active on the LSS bus, allowing the protections to take over the Sequence Ramp demand if needed.

The Sequence Ramp can be manually positioned at any time. Manually positioning the Sequence Ramp halts the startup ramp and requires a Continue command reinitiate the startup sequencing. If the Sequence Ramp is manually positioned above the "Startup Position" prior to the "Driver Start Completed" signal being received, the Vertex considers the prime mover started, allowing the Performance PID to take over on the LSS bus. The Sequence Ramp can be opened manually to its maximum position to finish the start process. The Sequence Ramp can be positioned manually from the front panel, contact inputs, or Modbus/OPC.

If "Use Remote Start?" is selected, the Sequence Ramp does not use the "Train Start Command" or "Driver Start Completed" signals. When all trips are cleared, the Vertex considers the prime mover started and the Sequence Ramp begins ramping to 100% at the "Sequence Ramp Rate" until the Performance PID takes over the demand on the LSS.

If "Use Manual Start?" is selected, the then the Performance control will be placed in Manual mode as soon as the Vertex moves to the Start Completed state (either the "Driver Start Completed" signal or manually driving the Sequence Ramp), and will hold the last demand set by the Sequence Ramp. If the Sequence Ramp is in a Continue state, it will ramp to the maximum once the Performance manual demand has taken control of the output.

The Sequence Ramp is always active on the LSS so it can be lowered at any time to take over the current Performance demand. This is useful for troubleshooting control stability issues or for specific operating conditions.

Performance Control Modes

When the Start Completed state is reached, the Performance controller is designed to operate in one of three control modes, Automatic, Manual, and Load Sharing (if configured). These modes can be selected from the Performance Control page on the front panel display, through contact inputs, or through Modbus/OPC communications.

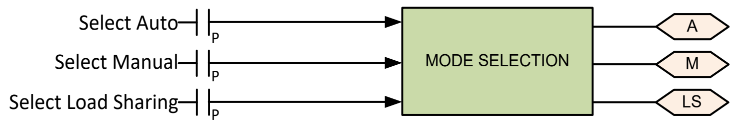


Figure 6-43. Mode Select

Automatic Mode

While in Automatic Mode, the LSS bus has control of the final Performance output demand and is determined by one of the PID or Sequence Ramp outputs. Operation of each of the PID controllers is described in detail below.

Manual Mode

While in this mode, the operator manually moves the Performance output demand. The internal process controllers/limiters are bypassed and cannot operate the Performance output.

The Manual Performance demand is adjustable with raise or lower commands through the Vertex front keypad, through remote contact inputs or through Modbus. In addition, the Manual demand can be set directly by entering the new set point from the keypad or through Modbus communications. In addition, program an analog input to remotely position the Manual demand.

When a raise or lower Manual demand command is issued, the set point moves at the programmed “Manual Demand Rate” setting.

The shortest length of time a set point will move for an accepted raise or lower command is 40 milliseconds (120 milliseconds for a Modbus command).

Optionally, program one of the Vertex’s analog inputs to position the Manual demand. This allows the Performance demand output to be positioned remotely by a process control or distributed plant control system.

The Remote Manual Demand input may be enabled from the Vertex keypad, contact input, Analog input 4-20 mA, and Modbus/OPC communications. The last command given from any of these three sources dictates the state of the remote input. A contact input can be programmed to enable and disable the Remote Performance Demand input/function. When this contact is open, the remote set point is disabled, and when it is closed, the remote setpoint is enabled. The contact can be either open or closed when a trip condition is cleared. If the contact is open, it must be closed to enable the remote set point input. If the contact is closed, it must be opened and re-closed to enable the remote set point input.

Load Sharing Mode

When Load Sharing is configured and active, the Performance PID is switched off the LSS and the Load Share PID is switched onto the LSS. This allows the Load Share setpoint and process variable to determine the Performance demand output with the protections of the Limiter 1 and Limiter 2 PIDs. If Limiter 1 or Limiter 2 PIDs come into control of LSS bus, the train is removed from Load Sharing, and the Performance PID is switched back on the LSS. While Load Sharing is active, the Performance PID is tracking the LSS output such that it can come bumpless back into control when switched back onto the LSS bus. See the Load Sharing section in this chapter for complete details on Load Sharing functionality.

Performance PID

The selection of the Process Variable to use for control is:

- ASC 1 Suction Pressure
- ASC 1 Discharge Pressure
- ASC 2 Suction Pressure
- ASC 2 Discharge Pressure
- Dedicated Signal

Each of these inputs is a 4 to 20mA current signal. When an ASC signal is selected, the performance controller also uses the same analog input used by the ASC. The Dedicated Signal can be selected as a generic process variable. When Dedicated Signal is selected, an analog input channel must be configured as "Process/Performance Input".

The PID control amplifier compares this input signal with the Performance set point to produce a control output to the digital LSS (low-signal select) bus. The LSS bus sends the lowest signal to the analog output circuitry.

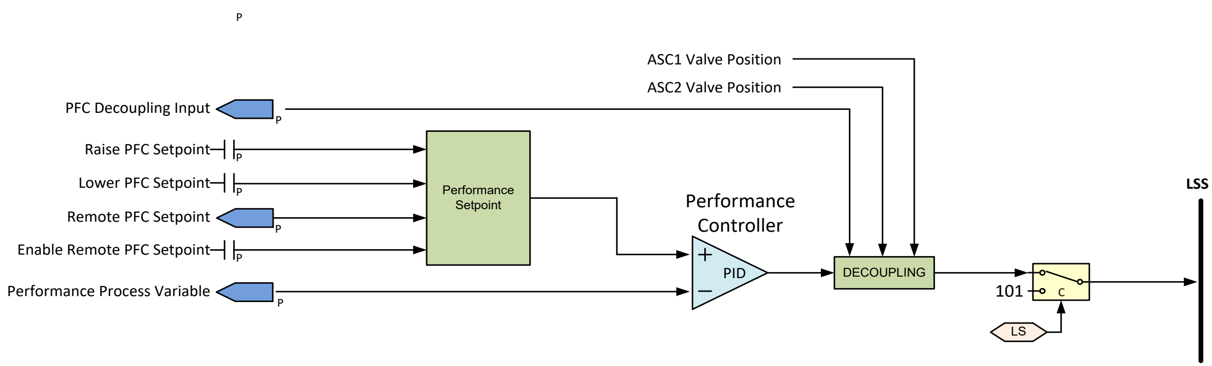


Figure 6-44. Performance PID Overview

Prior to Start Completed, the Performance PID output is switched off the LSS and is in a tracking mode of the LSS demand set by the Sequence Ramp. Once in Start Completed, the PID switched onto the LSS and will take over from the Sequence Ramp only once the process variable is approaching the setpoint. If "Use Setpoint Tracking?" is selected, the Performance Setpoint will track the process variable until the Start Completed state is reached. Once Start Completed is reached, the setpoint will hold at the value of the process variable and the PID will take over on the LSS as the Sequence Ramp ramps to the maximum, allowing for a bumpless transition into Performance PID control. If "Use Setpoint Tracking?" is not selected, then the PID will attempt to control to the "Initial Setpoint" setting. If the process variable is less than the "Initial Setpoint" when Start Completed is reached, the Sequence Ramp will increase the demand until the process variable reaches the "Initial Setpoint" and the Performance PID comes bumpless into control.

Performance PID Dynamics

The Performance PID control uses its own set of dynamic settings. These values are programmable and may be tuned at any time. Refer to the PID Dynamic Adjustments section in this manual.

Invert Performance Input

Depending on the control action required, the Performance PID's input signal can be inverted. If a decrease control position is required to increase the Performance process signal, select the "Inverted?" setting. An example of this control action is when configuring the Performance PID to control compressor discharge throttle valve position to control compressor suction pressure. To increase compressor suction pressure, the discharge throttle valve position must be decreased.

Performance Set Point

The Performance set point is adjustable with raise or lower commands through the Vertex front keypad, through remote contact inputs or through Modbus. In addition, the setpoint can be set directly by entering the new set point from the keypad or through Modbus communications. In addition, an analog input can be programmed to remotely position the Performance set point.

The Performance set point range must be defined in the Configuration mode. Program settings "Minimum Setpoint" and "Maximum Setpoint" define the range of the Performance set point and control.

When a raise or lower Performance Set Point command is issued, the set point moves at the programmed "Setpoint Rate" setting. If a Performance raise or lower command is selected for longer than three seconds, the Performance set point will move at three times at the fast rate which is three times the Performance set point rate. The Performance set point rate, fast rate delay, and fast rate can all be adjusted in the Service mode.

The shortest length of time a set point will move for an accepted raise or lower command is 40 milliseconds (120 milliseconds for a Modbus command).

A specific set point may also be directly entered from the Vertex keypad or through Modbus/OPC communications. When this is performed, the set point will ramp at the "Setpoint Rate" (as defaulted in Service mode).

To "enter" a specific set point from the Vertex Display use the following steps:

1. From the HOME page go to the Performance Control page
2. Press the Commands button until 'Setpoint' appears
3. Select 'Setpoint' and a pop-up will appear
4. Press Enter from the Navigation cross and the pop-up value will highlight
5. Adjust the value with the Adjust keys or enter a value from the keypad
6. Press Enter again when desired value has been entered
7. The value in the pop-up will be accepted, if it is invalid a message will appear
8. Select the GO button to ramp the setpoint to this entered value

Refer to Volume 2 of this manual for further information on Service mode and on-line tunables. All pertinent Performance control parameters are available through the Modbus links. See Chapter 9 for a complete listing of Modbus parameters.

Remote Performance Set Point

Optionally, one of the Vertex's analog inputs can be programmed to position the Performance PID set point. This allows the Performance set point to be positioned remotely by a process control or distributed plant control system.

The programmed Analog input's 4 mA and 20 mA settings determine the Remote Performance Setpoint range. The Remote Performance Set Point range is tunable in the Service mode, but cannot be set outside of the min and max Performance Set Point settings.

When enabled, the Remote Performance Set Point may not match the Performance set point. In this case, the Performance set point will ramp to the Remote Performance Set Point at the programmed "Not Matched Rate" setting (as defaulted in the Service mode). Once in control, the set point will follow the analog input value at the 'Remote Setpoint Maximum Rate' setting.

If the milliamp signal to the Remote Performance Set Point input is out of range, (below 2 mA or above 22 mA) an alarm will occur and the Remote Performance Set Point will be inhibited until the input signal is corrected and the alarm is cleared. Depending on configuration and system conditions, the Remote Performance Set Point may be in one of the following states (Vertex display screen messages):

- Disabled—The Remote Set Point function is disabled and will have no effect on the Performance set point.
- Enabled—The Remote Set Point has been enabled, but permissive are not met.

- Active—The Remote Set Point has been enabled, permissive are met, but Performance PID is not in control of the LSS bus.
- In Control—The Remote Set Point is in control of the Performance set point, and the Performance PID is in control of the LSS bus.
- Inhibited—Remote Set Point cannot be enabled; Remote Set Point input signal is failed, Performance control is Inhibited, or Remote Performance Set Point is not programmed.

The Remote Performance Set Point input may be enabled from the Vertex keypad, contact input, or Modbus/OPC communications. The last command given from any of these three sources dictates the state of the remote input. A contact input can be programmed to enable and disable the Remote Performance Set Point input/function. When this contact is open, the remote set point is disabled, and when it is closed the remote setpoint is enabled. The contact can be either open or closed when a trip condition is cleared. If the contact is open, close the contact to enable the remote set point input. If the contact is closed, open and then re-close the contact to enable the remote setpoint input.

Performance Process Variable/Driver Failure
If the milliamp signal to the Performance process variable input is out of range (below 2 mA or above 22 mA) an alarm will occur and is considered faulted. Similarly, if the analog output being driven by the Performance demand senses a readback current discrepancy or source current failure, an alarm will occur and is considered failed. If a process variable or driver fault occurs, the Performance demand will follow the “PV or Demand Failure Mode” setting in the Service Menu.

- Fail to Manual – If selected, the Performance control will switch to manual mode and hold the last demand.
- Fail to Max – If selected, the Performance control will switch to manual mode and ramp to the maximum demand setting.
- Fail to Min - If selected, the Performance control will switch to manual mode and ramp to the minimum demand setting.

The Performance demand will remain at the configured fallback demand until the input signal or driver circuit is repaired and the alarm is cleared. Once cleared, the Performance control will remain in Manual mode until an operator issues an Auto command.

Performance Decoupling
In order to maintain a stable system, Performance Decoupling may be necessary to provide action before an upset occurs. Upsets are anticipated from knowledge of the operating parameters and their relation to the operation of the anti-surge valve. For instance, a pressure set-point change will usually require a speed change, and this usually results in a compressor operating point change, in percent from the surge line. By the nature of changing speed, S_PV changes and the Anti-Surge PID will respond. The decoupling routines are designed to anticipate the PID change, or change in an external process, and preset the Performance control to the final position without any PID action. Decoupling drives the system to stable operation much quicker than waiting for the PID output to settle. Decoupling will also drive this situation to a stable point.

There are two separate Performance Decoupling routines; one based upon compressor section anti-surge valves, and one based on a configurable input from a separate process. Only one routine can be used. Performance Decoupling must be configured to be used, but can be enabled and disabled from the Service menu. The Performance Decoupling routine only affects the demand when the Start Completed state has been reached.

Limiter 1 PID

The Limiter 1 PID can be used to limit any parameter directly related to the Performance demand output. For example, if Performance demand is driving a throttle valve to control a header pressure, the Limiter 1 PID can be used to limit the output to the maximum motor current allowed.

The selection of the Process Variable to use for control is:

- Motor Current/Power Input
- ASC 1 Suction Pressure
- ASC 1 Discharge Pressure
- ASC 2 Suction Pressure
- ASC 2 Discharge Pressure
- Limiter Analog Input

Each of these inputs is a 4 to 20mA current signal. When an ASC signal is selected, the Limiter 1 controller also uses the same analog input used by the ASC. The Limiter Analog Input can be selected as a generic process variable. When Limiter Analog Input is selected, an analog input channel must be configured as “Performance Limiter PV”.

The PID control amplifier compares this input signal with the Limiter 1 set point to produce a control output to the digital LSS (low-signal select) bus. The LSS bus sends the lowest signal to the analog output circuitry.

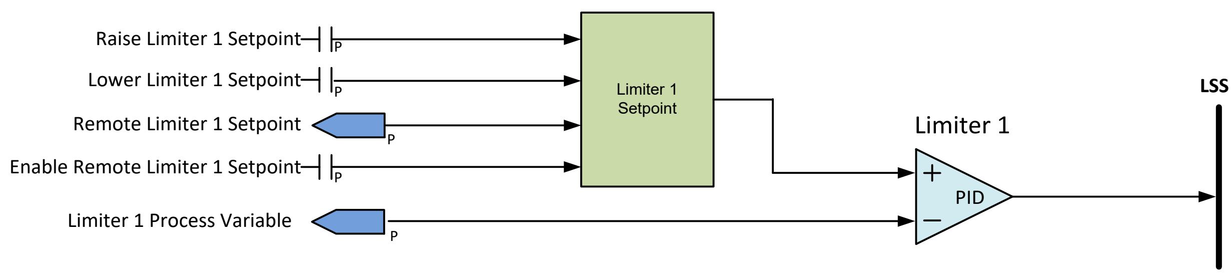


Figure 6-45. Limiter 1 PID Overview

The Limiter 1 PID must configured in order to be used, but it can be enabled and disabled through the Service menu while the compressor is online.

Limiter 1 PID Dynamics

The Limiter 1 PID control uses its own set of dynamic settings. These values are programmable and may be tuned at any time. Refer to the PID Dynamic Adjustments section in this manual.

Invert Limiter 1 Input

Depending on the control action required, the Limiter 1 PID’s input signal can be inverted. If a decrease control position is required to increase the Limiter 1 process signal, select the “Inverted?” setting. An example of this control action would be when the Limiter 1 PID is configured to control compressor discharge throttle valve position to control compressor suction pressure. To increase compressor suction pressure, the discharge throttle valve position must be decreased.

Limiter 1 Set Point

The Limiter 1 set point is adjustable with raise or lower commands through the Vertex front keypad, through remote contact inputs or through Modbus. In addition, the setpoint can be set directly by entering the new set point from the keypad or through Modbus communications. In addition, an analog input can be programmed to remotely position the Limiter 1 set point.

The Limiter 1 set point range must be defined in the Configuration mode. Program settings “Minimum Setpoint” and “Maximum Setpoint” define the range of the Limiter 1 set point and control.

When a raise or lower Limiter 1 Set Point command is issued, the set point moves at the programmed "Setpoint Rate" setting. If a Limiter 1 raise or lower command is selected for longer than three seconds, the Limiter 1 set point will move at three times at the fast rate which is three times the Limiter 1 set point rate. The Limiter 1 set point rate, fast rate delay, and fast rate can all be adjusted in the Service mode.

The shortest length of time a set point will move for an accepted raise or lower command is 40 milliseconds (120 milliseconds for a Modbus command).

A specific set point may also be directly entered from the Vertex keypad or through Modbus/OPC communications. When this is performed, the set point will ramp at the "Setpoint Rate" (as defaulted in Service mode).

To "enter" specific set points from the Vertex Display use the following steps:

1. From the HOME page go to the Performance Control page
2. Press the "Limiter 1" soft-key
3. Press the Commands button until 'Setpoint' appears
4. Select 'Setpoint' and a pop-up will appear
5. Press Enter from the Navigation cross and the pop-up value will highlight
6. Adjust the value with the Adjust keys or enter a value from the keypad
7. Press Enter again when desired value has been entered
8. The value in the pop-up will be accepted, if it is invalid a message will appear
9. Select the GO button to ramp the setpoint to this entered value

Refer to Volume 2 of this manual for further information on Service mode and on-line tunables. All pertinent Limiter 1 control parameters are available through the Modbus links. See Chapter 9 for a complete listing of Modbus parameters.

Remote Limiter 1 Set Point

Optionally, one of the Vertex's analog inputs can be programmed to position the Limiter 1 PID set point. This allows the Limiter 1 set point to be positioned remotely by a process control or distributed plant control system.

The programmed Analog input's 4 mA and 20 mA settings determine the Remote Limiter 1 Set Point range. The Remote Limiter 1 Set Point range is tunable in the Service mode, but cannot be set outside of the min and max Limiter 1 Set Point settings.

When enabled, the Remote Limiter 1 Set Point may not match the Limiter 1 set point. In this case, the Limiter 1 set point will ramp to the Remote Limiter 1 Set Point at the programmed "Not Matched Rate" setting (as defaulted in the Service mode). Once in control, the set point will follow the analog input value at the 'Remote Setpoint Maximum Rate' setting.

If the milliamp signal to the Remote Limiter 1 Set Point input is out of range, (below 2 mA or above 22 mA) an alarm will occur and the Remote Limiter 1 Setpoint will be inhibited until the input signal is corrected and the alarm is cleared. Depending on configuration and system conditions, the Remote Limiter 1 Set Point may be in one of the following states (Vertex display screen messages):

- Disabled—The Remote Set Point function is disabled and will have no effect on the Limiter 1 set point.
- Enabled—The Remote Setpoint has been enabled, but permissives are not met.
- Active—The Remote Setpoint has been enabled, permissives are met, but Limiter 1 PID is not in control of the LSS bus.
- In Control—The Remote Setpoint is in control of the Limiter 1 setpoint, and the Limiter 1 PID is in control of the LSS bus.
- Inhibited—Remote Setpoint cannot be enabled; Remote Setpoint input signal is failed, Limiter 1 control is Inhibited, or Remote Limiter 1 Set Point is not programmed.

The Remote Limiter 1 Set Point input may be enabled from the Vertex keypad, contact input, or Modbus/OPC communications. The last command given from any of these three sources dictates the state of the remote input. A contact input can be programmed to enable and disable the Remote Limiter 1 Set Point input/function. When this contact is open, the remote set point is disabled, and when it is closed, the remote setpoint is enabled. The contact can be either open or closed when a trip condition is cleared. If the contact is open, it must be closed to enable the remote set point input. If the contact is closed, open and then re-close the contact to enable the remote set point input.

Limiter 1 Process Variable Failure
If the milliamp signal to the Limiter 1 process variable input is out of range (below 2 mA or above 22 mA) an alarm will occur and is considered faulted. If the process variable fails while the Limiter 1 PID has control of the LSS, the Performance control will switch to Manual Mode and hold at the last demand. Auto Mode can be enabled to reactivate the Performance PID control on the process, but the Limiter 1 protection is inhibited until the input signal is repaired and the alarm cleared. Once cleared, the Limiter 1 PID will be active on the LSS.

Limiter 2 PID
The Limiter 2 PID can be used to limit any parameter directly related to the Performance demand output.

The selection of the Process Variable to use for control is:
- Motor Current/Power Input
- ASC 1 Suction Pressure
- ASC 1 Discharge Pressure
- ASC 2 Suction Pressure
- ASC 2 Discharge Pressure

Each of these inputs is a 4 to 20mA current signal. When an ASC signal is selected, the same analog input used by the ASC is also used by the Limiter 2 controller.

The PID control amplifier compares this input signal with the Limiter 2 set point to produce a control output to the digital LSS (low-signal select) bus. The LSS bus sends the lowest signal to the analog output circuitry.

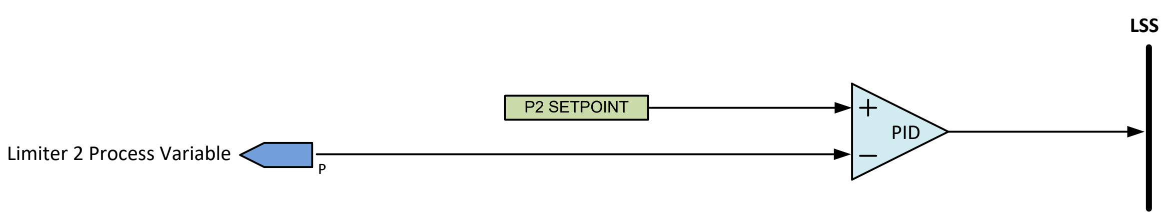


Figure 6-46. Limiter 2 PID Overview

The Limiter 2 PID must configured in order to be used, but it can be enabled and disabled through the Service menu while the compressor is online.

Limiter 2 PID Dynamics
The Limiter 2 PID control uses its own set of dynamic settings. These values are programmable and may be tuned at any time. Refer to the PID Dynamic Adjustments section in this manual.

Invert Limiter 2 Input
Depending on the control action required, the Limiter 2 PID’s input signal can be inverted. If a decrease control position is required to increase the Limiter 2 process signal, select the “Inverted?” setting. An example of this control action is when configuring the Limiter 2 PID to control compressor discharge throttle valve position to control compressor suction pressure. To increase compressor suction pressure, the discharge throttle valve position must be decreased.

Limiter 2 Set Point

The Limiter 2 set point is adjustable with raise or lower commands through the Vertex front keypad or through Modbus. In addition, the set point can be directly set by entering the new set point from the keypad or through Modbus communications.

The Limiter 2 set point range must be defined in the Configuration mode. Program settings "Minimum Setpoint" and "Maximum Setpoint" define the range of the Limiter 2 set point and control.

When a raise or lower Limiter 2 Set Point command is issued, the set point moves at the programmed "Setpoint Rate" setting. If a Limiter 2 raise or lower command is selected for longer than three seconds, the Limiter 2 set point will move at three times at the fast rate which is three times the Limiter 2 set point rate. The Limiter 2 set point rate, fast rate delay, and fast rate can all be adjusted in the Service mode.

The shortest length of time a set point will move for an accepted raise or lower command is 40 milliseconds (120 milliseconds for a Modbus command).

A specific set point may also be directly entered from the Vertex keypad or through Modbus/OPC communications. When this is performed, the set point will ramp at the "Setpoint Rate" (as defaulted in Service mode).

To "enter" a specific set point from the Vertex Display use the following steps:

1. From the HOME page go to the Performance Control page
2. Press the "Limiter 2" soft-key
3. Press the Commands button until 'Setpoint' appears
4. Select 'Setpoint' and a pop-up will appear
5. Press Enter from the Navigation cross and the pop-up value will highlight
6. Adjust the value with the Adjust keys or enter a value from the keypad
7. Press Enter again when desired value has been entered
8. The value in the pop-up will be accepted, if it is invalid a message will appear
9. Select the GO button to ramp the setpoint to this entered value

Refer to Volume 2 of this manual for further information on Service mode and on-line tunables. All pertinent Limiter 2 control parameters are available through the Modbus links. See Chapter 9 for a complete listing of Modbus parameters.

Limiter 2 Process Variable Failure

If the milliamp signal to the Limiter 2 process variable input is out of range (below 2 mA or above 22 mA) an alarm will occur and is considered faulted. If the process variable fails while the Limiter 2 PID has control of the LSS, the Performance control will switch to Manual Mode and hold at the last demand. Auto Mode can be enabled to reactivate the Performance PID control on the process, but the Limiter 2 protection is inhibited until the input signal is repaired and the alarm cleared. Once cleared, the Limiter 2 PID will be active on the LSS.

Load Sharing Control

When giving multiple compressor trains the task of controlling a common process variable, such as suction header pressure or discharge header pressure, multiple Vertex control units can be connected together to equally share the load across multiple compressor trains. The Vertex can load share between two, three, four, or five compressor trains. The Load Sharing (LS) algorithm works with the Performance controller output to maintain the common process variable (suction or discharge header pressure) and to balance the load between the compressors.

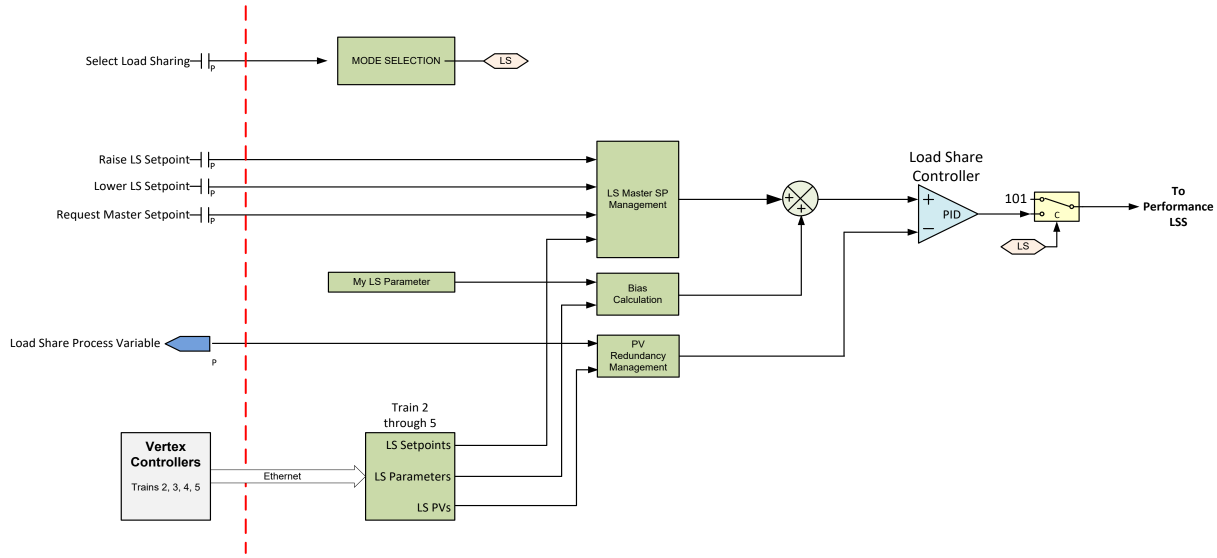


Figure 6-47. Load Sharing Functional Block Overview

Control Theory

In many industrial processes, multiple controllers are given the task of controlling a common process variable. Consider the example of multiple compressors connected in parallel to a common suction header and a common discharge header, as shown in Figure 6-41.

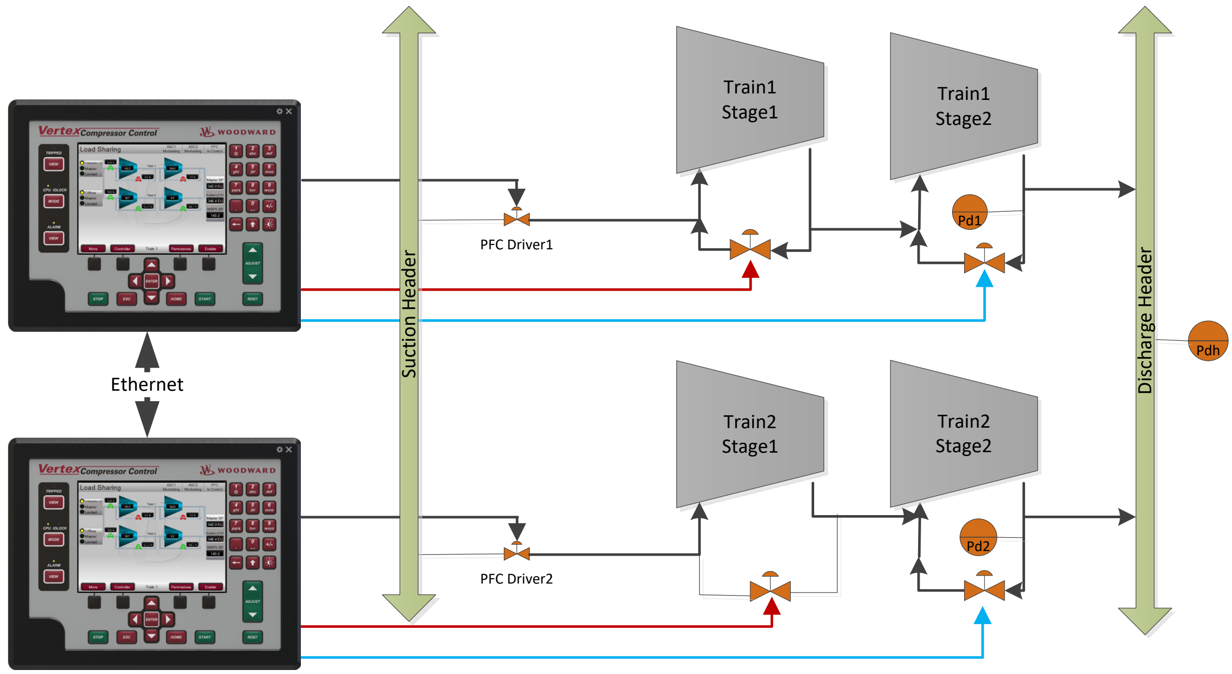


Figure 6-48. Two Compressors Supplied by a Common Suction Header

The Performance controller for each compressor controls the compressor discharge pressure (Pd1 and Pd2) with a suction throttle valve (PFC Driver 1 and PFC Driver 2). If load sharing is not used, it is possible for one controller to drive its throttle valve fully open, while the other controller drives its throttle valve fully closed. While the discharge pressure might be maintained at the setpoint, the load is not shared between the two compressors. The parallel load sharing algorithm works with the Performance control output to maintain the common process variable (Pdh) and to balance the load between the compressors. There are multiple process variables that can be designated as the load to be shared between compressors.

Load Share Bias

The LS PID is provided the validated process variable and the process set point to produce a demand that controls the process variable to the set point. The primary function of the parallel load-sharing algorithm is to generate a bias signal for the LS PID. A typical implementation is shown in Figure 6-47.

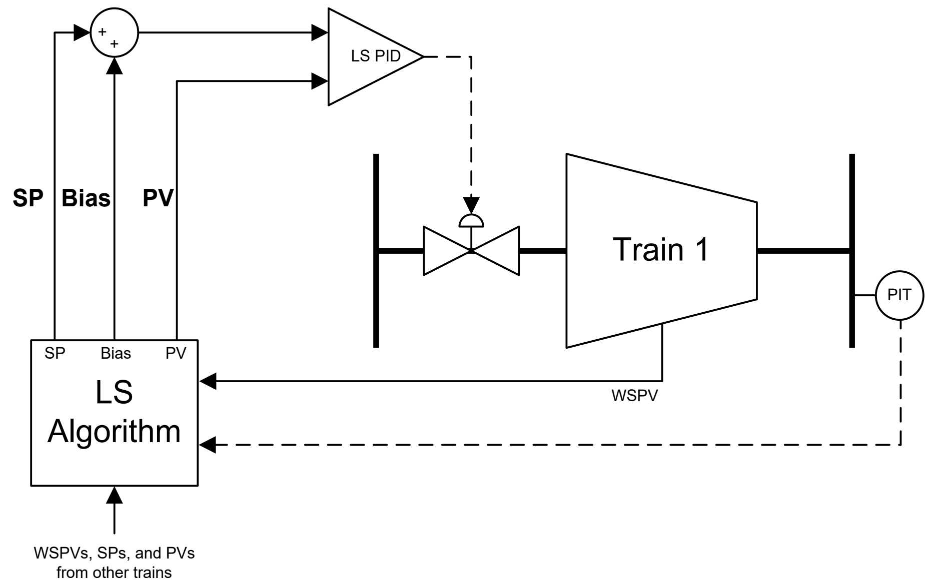


Figure 6-49. Load Share (LS) Implementation

In this example, a set of parallel trains (only the first train is shown) is controlling the common discharge header pressure. The shared parameter is the WSPV of the compressors. The Vertex control compares the WSPV of the first train with the WSPVs of the other trains. The difference between the first trains' WSPV and the average WSPV of all trains is used to generate the bias signal. The bias signal is added to the Load Share setpoint (SP). The PID controller will respond to the bias such that the WSPV of the first train moves toward the average WSPV of all trains.

The LS bias can be configured as one of the following common parameters to balance across all trains:

- WSPV
- Speed
- Q - Actual Flow through Train

If multiple ASC stages exist for each train and WSPV or flow is configured as the LS parameter, the LS parameter is Low Signal Select of the signal from each stage.

Process Variable

Configure each train in load sharing with a unique Train ID. It is required to configure Train ID 1 with the "Load Share Input" analog input. Configure only Train ID 1 with an analog input. This input is shared with the other trains over the Ethernet communication link between the controllers. However, it is common to wire additional "Load Share Input" signals to each of the trains in load sharing. This can be done with multiple transmitters on the process being controlled, or with a signal splitter, or a combination of both. In order for a train controller to share its PV signal with the other controls, the unit must be powered on and the communication links healthy. Wiring multiple PV signals to multiple controllers allows operation of the train system with a limited number of trains available.

When multiple trains receive an analog input, the signals from each train are shared with the other trains and the LS redundancy management validates a common signal to be used by each train controller. When greater than two signals are healthy, the median value of the signals is used for control. If the number of signals in the median equation is odd, the middle value is used. If the number of signals in the median equation is even, the average of the two middle values is used. When only two signals are healthy, the control will use either the Low Signal Select, High Signal Select, or average of the two healthy values. The equation used for two healthy signals is selected in the Service Menu.

IMPORTANT **If a unit is sending a PV signal to an active load-sharing group is powered down, it is possible to affect the validated PV value in the active load-sharing group as it gets removed from the PV redundancy management logic.**

If the milliamp signal to the LS process variable input is out of range (below 2 mA or above 22 mA) an alarm will occur and is considered faulted. When faulted, the signal from that train is removed from the redundancy management in all trains. Only one healthy signal to one unit is required to be able to run all trains in Load Sharing. If all signals fail, all trains will be kicked out of LS.

If the communication link from a train controller is failed, the PV signal from that train is considered faulted and is removed from the redundancy management in each of the other trains.

Setpoint Master

The train that is controlling the setpoint is referred to as the Setpoint Master. The Setpoint Master determines the setpoint for each of the other trains. The LS control logic manages the selection of the Setpoint Master and the routing of the correct setpoint value to the LS controller.

The first train to join the active load-sharing group will become the Setpoint Master. The trains that subsequently join the active load-sharing group will use the setpoint that the operator specifies in the Setpoint Master train. If the current Setpoint Master leaves the active load sharing group for any reason, the train in the active load sharing group with the lowest train ID number will become the Setpoint Master. Any non-Master unit in the active load-sharing group can become the Setpoint Master by requesting the Setpoint Master status. The request is made by sending a Request Master command from the Vertex front panel or Modbus/OPC. Requesting the Setpoint Master is a bumpless transition and can be performed without affecting the process control. This allows operators to change the Master Setpoint from any of the Vertex units.

The Master Setpoint is adjustable with raise or lower commands through the Vertex front keypad or through Modbus. In addition, the set point can be directly set by entering the new set point from the keypad or through Modbus communications.

Define the Master Setpoint range in the Configuration mode. Program settings “Minimum Setpoint” and “Maximum Setpoint” define the range of the Master Setpoint set point and control.

When a raise or lower Master Setpoint command is issued, the set point moves at the programmed “Setpoint Rate” setting. A specific set point may also be directly entered from the Vertex keypad or through Modbus/OPC communications. When this is performed, the set point will ramp at the “Setpoint Rate” (as defaulted in Service mode).

Us the following steps to “enter” a specific setpoint from the Vertex Display:

1. From the HOME page go to the Load Sharing page
2. Press the “Controller” soft-key to launch the LS Controller pop-up
3. If the unit is not the Setpoint Master, navigate to the “Request Master” button and press enter using the navigation cross
4. Once the unit is the Setpoint Master, navigate to the “Setpoint” button in the pop-up
5. Select ‘Setpoint’ and a pop-up will appear
6. Press Enter from the Navigation cross and the pop-up value will highlight
7. Adjust the value with the Adjust keys or enter a value from the keypad
8. Press Enter again when desired value has been entered
9. The value in the pop-up will be accepted, if it is invalid a message will appear
10. Select the GO button to ramp the setpoint to this entered value

Refer to Volume 2 of this manual for further information on Service mode and on-line tunables. All pertinent Master Setpoint control parameters are available through the Modbus links. See Chapter 9 for a complete listing of Modbus parameters.

The Master Setpoint will initialize to the “Initial Setpoint” setting when the unit is powered up or upon exiting Configuration Mode. The “Initial Setpoint” is available in the Service Menu. Prior to enabling load sharing on any units in the load-sharing group, the setpoint may be modified to allow pre-positioning of the setpoint. Once a Setpoint Master is active, the set point for all other trains follow the Setpoint Master value, even if load sharing is disabled.

Enabling and Disabling Load Sharing

An Enable Load Sharing command will initiate the process of joining the active load-sharing group. The following permissives must be met to enable load sharing:

- All PV Inputs Not Failed
- Communication Link Healthy
- Performance Control Ready for LS
    - In Auto and PID control of the Performance LSS
    - Performance PV and Driver Not Failed
- Communication Link Healthy
- Anti-surge Control 1 Ready
    - In Auto (Service Mode option)
    - Online
    - Driver Not Faulted
    - No Surge Active
- Anti-surge Control 2 Ready (if configured)
    - In Auto (Service Menu option)
    - Online
    - Driver Not Faulted
    - No Surge Active

Prior to load sharing being enabled, the LS PID is in tracking mode and switched to 101 to the Performance LSS bus. If load sharing is permissible when the enable command is received, the train will transition from the disabled state to the joining state. Once load sharing is enabled, the LS PID is switched bumpless onto the Performance LSS and simultaneously the Performance PID is switched off the LSS bus and goes into tracking mode.

If the train is the first to join the active load-sharing group, it will immediately transition from the joining state to the enabled state. If the train is not the first to join the active load-sharing group, it will remain in the joining state for at least three seconds. After three seconds have elapsed, the Vertex will check the deviation between the train’s shared parameter and the shared parameter target. If the deviation is within the configured window, the train will transition from the joining state to the enabled state. Otherwise, the train will remain in the joining state until the deviation is within the configured window. The joining window should be less than the deviation window. The joining and deviation windows can be set in the Service Menu.

The shared parameter and anti-surge valve position kickout conditions are overridden while the train is in the joining state. The kickout conditions will cause the train to transition from the enabled state to the disabled state.

While the train is in the disabled state, the bias signal calculated from the shared parameter will be zero. The train can be transitioned to the disabled state at any time by a sending a Disable Load Sharing command. The LS enable and disable commands can be made from the Vertex front panel, contact inputs, or Modbus/OPC.

When Load Sharing is disabled, the Performance control takes over the output controlling its local train PV. For example, if the load sharing PV is the common discharge header and the Performance PV is the local discharge pressure of the train, the Performance control will try to maintain the last discharge pressure at the time LS was disabled.

Kick-outs

The following kickout conditions will cause load sharing to be disabled:

- User Disable command
- Shutdown
- Communication to all trains failed
- All LS PVs failed
- Performance Manual Demand enabled
- ASC 1 offline
- ASC 2 offline (if configured)
- PFC Limiter 1 In-control (if configured, Service Menu option)
- PFC Limiter 2 In-control (if configured, Service Menu option)
- Excessive anti-surge valve position deviation (Service Menu option)
- Excessive LS parameter deviation (Service Menu option)
- ASC 1 Surge (Service Menu option)
- ASC 1 Full Manual enabled (Service Menu option)
- ASC 1 Driver failure (Service Menu option)
- ASC 2 Surge (Service Menu option)
- ASC 2 Full Manual enabled (Service Menu option)
- ASC 2 Driver failure (Service Menu option)

The Kickout conditions above only affect the train for which they are detected on. When a Kickout occurs, load sharing is disabled and the train is removed from the active load-sharing group. When load sharing is disabled, the control automatically transfers bumpless back to Performance control of the local process variable configured for Performance.

User Disable command

A train can be removed from the load-sharing group by issuing a load share disable command from the front panel, discrete input, or Modbus.

Shutdown

A shutdown will disable load sharing requiring load sharing to be re-enabled the next time the unit is started.

Communication to all trains failed

If a train detects that communications to all other trains in the load sharing group (i.e. Ethernet cable is unplugged or cut), it is removed from load sharing. The other units in the load share group will detect a communication error to that train and remove it from the load share bias calculations.

All LS PVs failed

The process variable signal for load sharing is only required to be healthy for one train in the load sharing group. If the signal fails, the All LS PVs failed alarm is generated for all units and load sharing is disabled for all units.

Performance Manual Demand enabled
If Performance is placed into Manual Mode, load sharing is kicked out as the load sharing PID cannot modulate the Performance demand output.

ASC 1 (or 2) offline
When an ASC is not online, the ability of the Performance demand output to control the load sharing PV is adversely affected and load sharing is kicked out.

PFC Limiter 1 (or 2) In-control (if configured, Service Menu option)
If the load sharing PID demand to the Performance output is limited, the load sharing logic will be adversely affected. For this reason, it is recommend to remove a train from load-sharing when its performance output is limited by either of the Performance Limiter PIDs. In order for the limit conditions to generate a kickout, the kickout must be enabled in the Service Menu. Before a kickout is generated, the limit condition must be continuously active for the time specified by the delay configuration.

Excessive anti-surge valve position deviation (Service Menu option)
The ASV deviation is the difference between the train's ASV position and the average ASV positions of all trains in the load sharing group. If the magnitude of the deviation is greater than the value specified in the Service Menu, a kickout condition is generated. To disable load sharing, this kickout condition must be continuously active for the time specified by the delay configuration, and the kickout must be enabled in the Service Menu. By default, the Vertex does not perform ASV balancing across trains in the load sharing group and therefore the ASV deviation kickout is disabled by default.

Excessive LS parameter deviation (Service Menu option)
The shared parameter deviation is the difference between the train's shared parameter value and the target shared parameter value. If the magnitude of the deviation is greater than the value specified in the configuration, a kickout condition is generated. To disable load sharing, this kickout condition must be continuously active for the time specified by the delay configuration, and the kickout must be enabled in the Service Menu. This kickout condition is overridden while any train is joining the active load-sharing group. The Joining Window must be set lower than the shared parameter deviation kickout window to ensure the deviation kickout condition is not met when the unit joining condition is met.

ASC 1 (or 2) Surge (Service Menu option)
A surge event will result in a load sharing kickout. After a surge event, the surge alarms must be cleared by issuing a reset to the Vertex in order to re-enable load sharing.

ASC 1 (or 2) Full Manual enabled (Service Menu option)
If Full Manual Mode is enabled in the ASC, the compressor protections are removed and will kickout load sharing.

ASC 1 (or 2) Driver failure (Service Menu option)
If the ASC driver to the ASV is failed, the compressor protections are limited and will kickout load sharing.

The default settings of the kickout conditions in the Service Menu are the recommended settings.

If Auto Rejoin is enabled in the Service Menu, load-sharing control will be automatically re-enabled after a kickout condition once the kickout condition is no longer active and the permissives to enable load sharing are met for the Auto Rejoin Delay time.

Communications Setup

When Load Sharing is configured, each Vertex unit communicates to all other Vertex units in the loadsharing group over an isolated Ethernet network. In the Vertex simple models the dedicated Load Sharing port is Ethernet Port 4, in the VertexDR model the Load Sharing port is Ethernet Port 3.

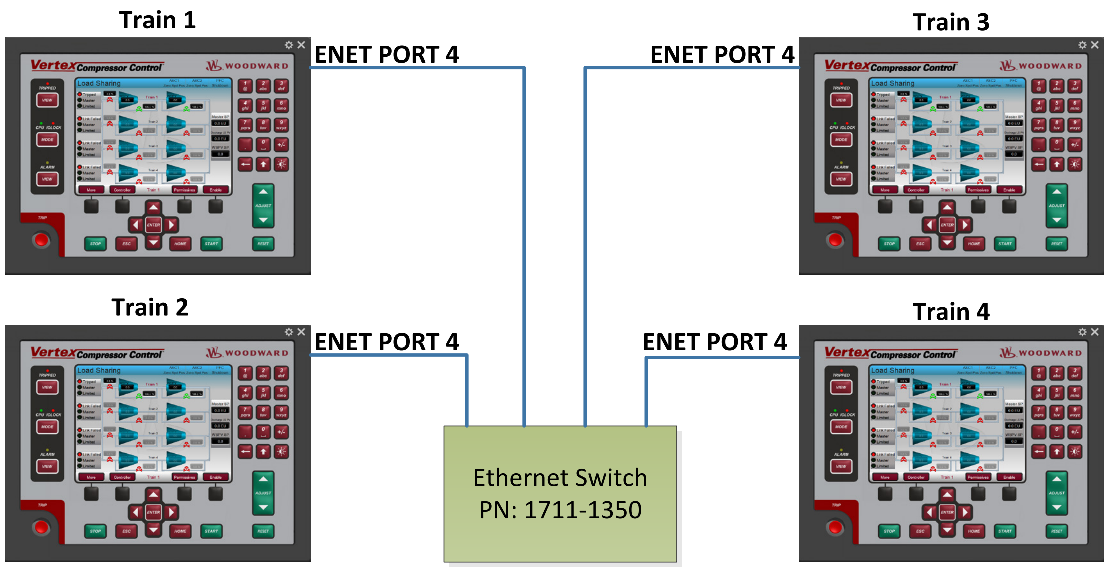


Figure 6-50. Load Share Communication Overview in Vertex (Simplex Only Versions)

The load sharing communications are designed to be 'plug-and-play'. There are only two steps for establishing communications between the units:

1) On the Configuration Menu > Load Sharing GUI screen, configure a unique Train ID for each Vertex in the load sharing group.
2) Connect the correct Load Sharing Ethernet Port of each control to the common Ethernet switch.

The IP addresses are within the same network of the factory assigned IP address for Port 4 or Port 3. On the VertexDR units, IP addresses for both the Primary and Secondary chassis will be automatically assigned. The auto-assigned IP addresses are set automatically when the unit exits IO LOCK or by pressing the "Initialize Link" button in the Load Sharing page of the Configuration or Service Menu. The IP addresses are within the same network of the factory assigned IP address for Port 4. When the IP address is assigned and connected to the network, it will automatically begin communicating with any other Vertex on the network. Each Vertex in the load sharing group should be assigned a unique train ID prior to placing the units on the load sharing network in order to avoid IP address conflicts. Once unique train IDs are assigned to each unit, the IP address can be reset by pressing the "Initialize Link" soft key in the Configuration or Service Menu.

The current state of the network communications is shown in the Service Menu > Load Sharing menu.

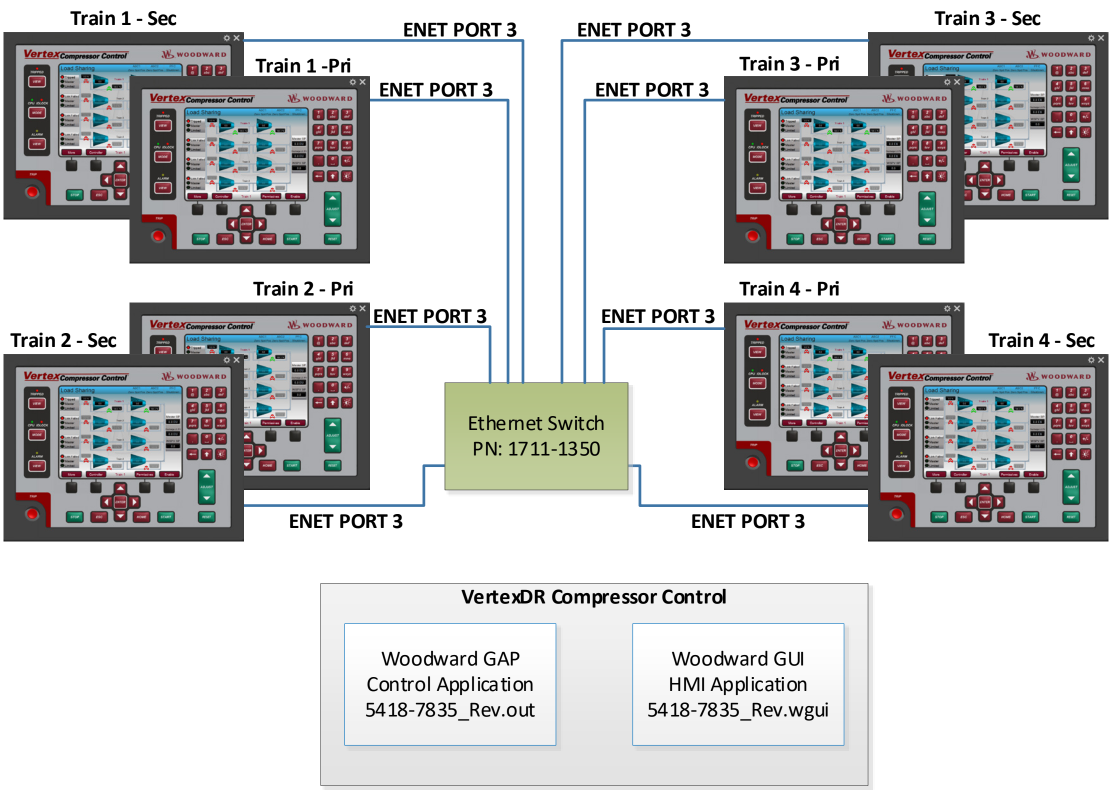


Figure 6-51. Load Share Communication Overview in VertexDR

When a communication link to one of the other Vertex units is failed, an alarm is annunciated. If train links are not healthy, verify the following:

1) Each Vertex in the load sharing group has a unique train ID.
   a. Once verified, press “Initialize Link” on each unit to reinitialize the IP addresses.
2) Verify each of the Ethernet connections on the load sharing network ports and the Ethernet switch have LED transmit and receive indications.

The Ethernet Port 4 of the Vertex control is reserved specifically for load sharing communications. On the VertexDR models, load sharing communications is done on Ethernet Port 3. The load sharing network must remain isolated from the plant network (used for DCS communications etc.). By keeping the load sharing network isolated, the data being used for control of the compressor trains is not interfered with or delayed by plant network traffic or network devices. In addition, the Vertex units broadcast the load sharing data to each of the other Vertex units on the network; using an isolated network for load sharing ensures that the network traffic from the load sharing units does not affect the plant network.

It is not recommended to put any other devices or PCs on the load sharing network. The Vertex control should be interfaced to the plant network or service tools using Ethernet Ports 1 or 2.

The recommended Ethernet switch is Woodard Part Number 1711-1350.

Isolated PID Control

The Isolated PID Controller can be configured to control any system process. Typically this controller is configured and used to control seal gas or gland seal pressure, but it can also be used for any type of PID loop.

The Isolated PID compares a 4–20 mA process signal with an internal setpoint to directly position an analog output configured as Isolated PID output.

The Isolated PID loop can be put in manual and automatic mode via dedicated contact input, Modbus commands or display. It also has an Enable/Disable control function so that operations can choose to take it on or offline.

If a contact input is programmed to function as an Isolated PID manual contact, Isolated PID Control is in automatic when the contact is opened and in manual mode when it is closed. If a command is send via Modbus to put this PID in automatic, then the contact input must be closed/opened to bring back the manual mode.

Isolated Manual Mode

When the Isolated PID is in manual mode, it is possible to manipulate its output directly using Raise/Lower demand commands. These commands are available via Modbus, display, or contact inputs configured as Isolated PID raise/lower demand.

Should a Process value be lost, it is also possible to configure the 505XT to hold the last value, ramp the PID output up or down automatically.

Isolated PID Dynamics

The Isolated PID control uses its own set of dynamic settings. These values are programmable and may be tuned at any time from display Interface only.

Isolated Set Point

The Isolated setpoint can be adjusted from the display Interface, external contacts, or Modbus.

When a raise or lower Isolated PID setpoint command is issued, the setpoint moves at the Isolated PID setpoint rate. If an Isolated PID Set Point raise or lower command is selected for longer than three seconds, the setpoint will move at the fast rate, which is three times the cascade setpoint rate. The Isolated setpoint rate, fast rate delay, and fast rate can all be adjusted in the Service Mode.

Invert Isolated PID

Depending on the control action required, the Isolated PV input signal can be inverted. If a decrease of PID output is required to increase the cascade process signal, program the input to be inverted.

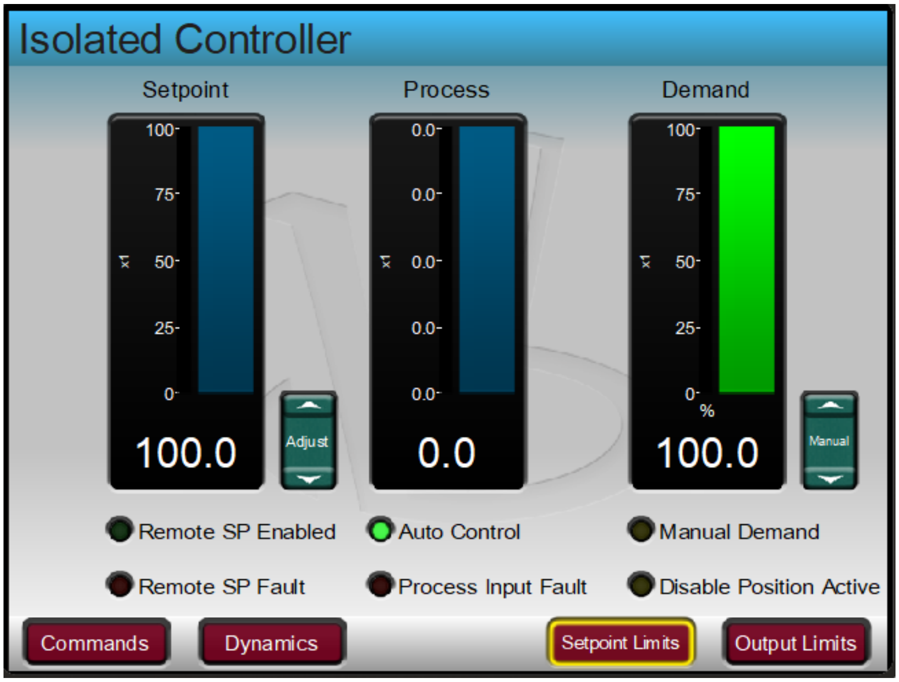


Figure 6-52. Isolated Controller Operation Screen in Service Menu

Quench Control

Quench temperature control is employed in refrigeration compressors to provide cooling of the anti-surge recycle line. Temperature control is achieved by injecting liquid process fluid in the recycle line. Fluid from the main condenser flashes from liquid to gas when it enters the recycle line. The recycle line temperature is reduced as the phase change process absorbs heat from the hot recycle gas.

The quench temperature control valve is driven by the Quench PID, an exhaust temperature limiter PID, or an external signal. These three signals are high signal selected to determine which signal controls the quench valve. By default, the quench valve is held closed while the anti-surge valve is closed, but this feature can be overridden. Manual operation of the quench valve is allowed.

The temperature measurement for the Quench PID can come from one of three sources:

- Suction temperature
- Temperature at the flow meter
- Dedicated quench temperature measurement

Three options are available for the Quench PID setpoint:

- Fixed Setpoint – A setpoint adjusted by the operator.
- Variable Setpoint from Dew Point Curve – A setpoint calculated from the dew point temperature. The dew point temperature is constantly updated as suction pressure changes. The setpoint includes a configurable offset from the dew point temperature.
- Limited Fixed Setpoint – The setpoint is a combination of the first two options. The operator chooses the setpoint, but the setpoint is limited by the dew point temperature to prevent over-quenching.

An example of a typical dew point curve and offset setpoint is shown in Figure 6-53.

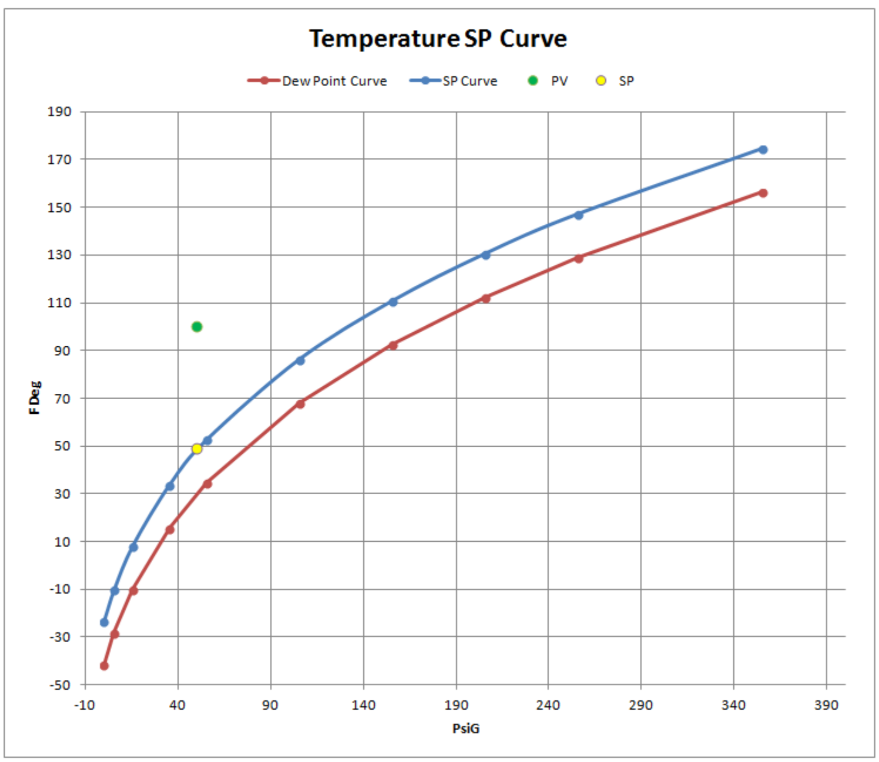


Figure 6-53. Dew Point Curve for Propane

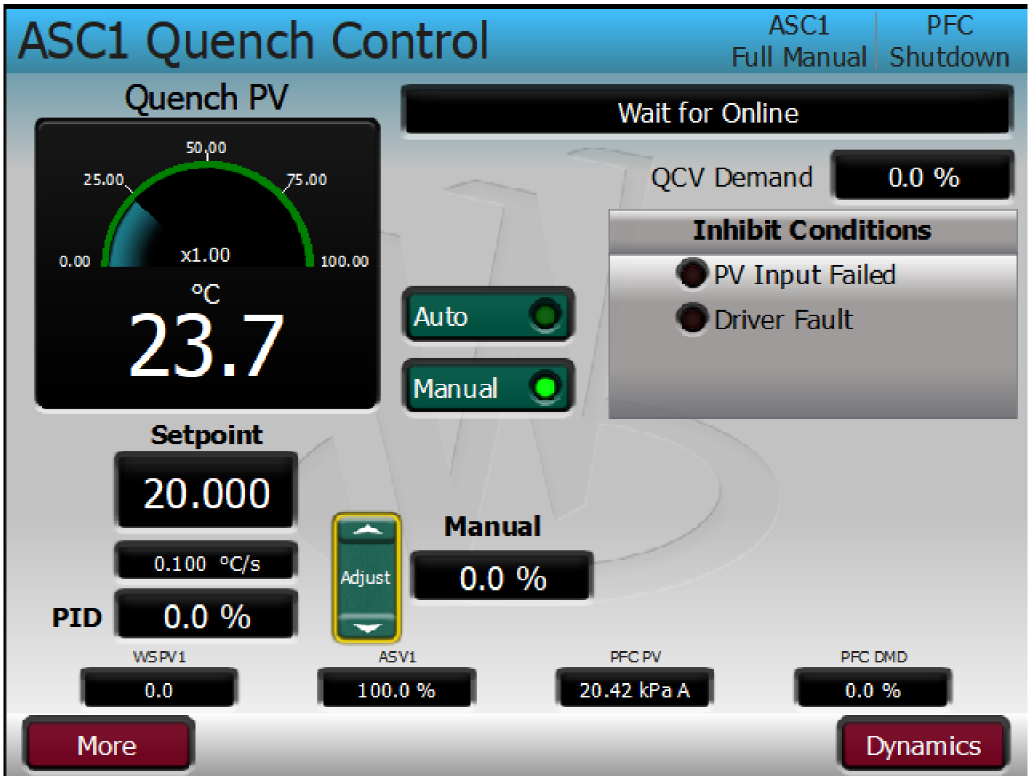


Figure 6-54. Quench Control Screen

Chapter 7. Configuration Procedures

Program Architecture

The Vertex is easy to configure from the built-in graphical user interface (GUI). After the CPU self-test is completed and when powering up the control, the control displays the home screen and the CPU LED on the left side of the front panel should be green. At this point the configuration can be done locally on the display or remotely using the RemoteView tool on a user PC. Using the remote tool may be more convenient as you can use a mouse to navigate and the full keyboard to enter data. Refer to the appropriate appendix in Volume 2 for installing and using RemoteView.

The operating procedures are divided into two sections: the Configuration Mode, discussed in this chapter, and the Run Modes (Operation and Calibration) (refer to Chapter 8 for RUN Mode information). The Configure Mode is used to configure the Vertex for the specific application and set all operating parameters. The Run Mode is the normal turbine operation mode and is used to view operating parameters and run the turbine.

The configuration cannot be changed or altered while the turbine is running, however, it can be accessed and all programmed values monitored. This minimizes the possibility of introducing step disturbances into the system. To monitor or review the program while in the run mode, enter the Configuration menu from the first (leftmost) soft key on the Home screen.

Display Modes and User Levels

The Vertex Display operates in several modes and access user levels, each of which has a different purpose. The modes are: OPERATION, CALIBRATION, and CONFIGURATION. In order to enter and exit a particular mode, the user must be logged in with an appropriate user level. These user levels are: MONITOR, OPERATOR, SERVICE, and CONFIGURE. In addition to granting authority to enter and exit modes, user levels also determine what parameters the user is authorized to adjust. See Table 7-1, Mode Access by User Level.

Table 7-1. Mode Access by User Level

		Mode		
		Operation	Calibration	Configuration
User Level	Monitor			
	Operator	X		
	Service	X	X	
	Configure	X	X	X

Mode Descriptions

The OPERATION mode is the only mode that can be used to run the turbine. This is the default mode. Exiting CALIBRATION or CONFIGURATION mode will return to OPERATION mode. User levels: Operator, Service, or Configure.

The CALIBRATION mode is used to force signal outputs in order to calibrate signals and field devices. In this mode, the actuator, analog, and relay outputs can be manually controlled. To enter this mode the turbine speed must be shutdown with no speed detected. User levels: Service or Configure.

The CONFIGURE mode is used to set up the parameters for a specific application prior to operation of the unit. To enter this mode the turbine speed must be shutdown with no speed detected. When the unit enters CONFIGURE mode the control is placed in IOLOCK which will disable all Output I/O channels. If the control is not shutdown, navigating through the configuration pages will allow viewing of CONFIGURE, but will not permit any changes to be made.

User Level Descriptions

The Monitor user level is view-only access. All commands from the front panel are inhibited. All values displayed on each screen are continuously updated.

The Operator user level allows for control of the turbine. Front panel commands to start, change setpoints, enable/disable functions, and stop the turbine are accepted.

The Service user level allows the same commands as the Operator user level plus tuning of Service menu parameters and issuing of additional commands.

The Configure user level allows the same commands and access as the Service user level plus tuning of Configuration menu parameters.

Configuring the Vertex

Before the Vertex can operate any compressor train, configure the Vertex with a valid configuration. See Appendix A of this manual for a Vertex Configure Mode Worksheet. This chapter contains additional information related to completing this worksheet and configuring the specific application. Recommend this worksheet be completed and used to document your specific configuration.

It is also possible to configure a unit by loading the configuration (tunable) file from another unit. This is the recommended method for configuring a spare unit. Refer to the appropriate appendix in Volume 2 for installing and using the Control Assistant service tool. It will describe how to retrieve and send these file to and from the control.

Figure 7-1 illustrates the Vertex screen displayed when power is first applied and before unit configuration. This is the HOME screen. It includes tips on how to enter the Configure Mode from this point. A password is required to protect against both intentional and inadvertent configuration changes. To change the password, refer to Volume 2 for information on changing passwords. This screen will become the main menu after unit configuration. Operational screens as well as the Service and Configure menus are accessed from the HOME screen.

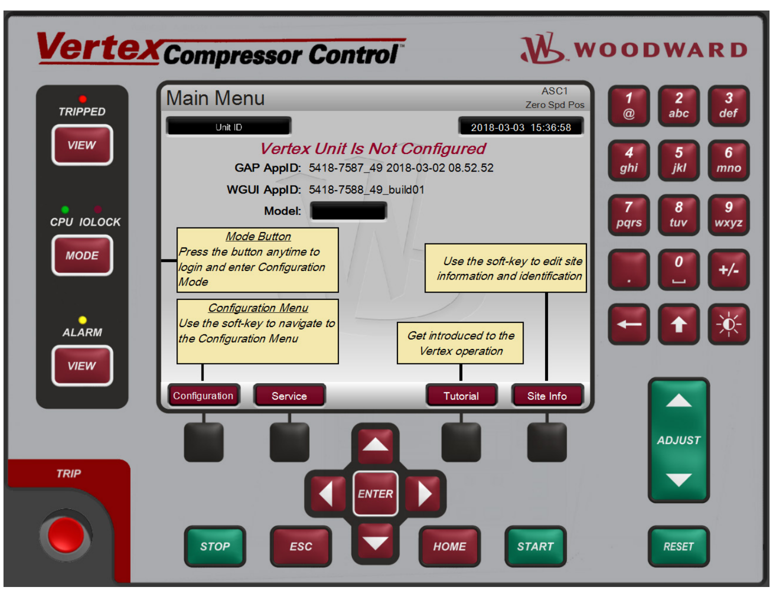


Figure 7-1. Initial HOME Screen (unit not configured)

Use the following procedure to begin configuring the Vertex:
1. Press the MODE key.
2. Press the LOGIN softkey to open the User Login popup.
3. Login to the ‘Configure’ user level.
4. Close the User Login popup screen.
5. Press the Configuration softkey to enter configuration mode. Verify that the following Calibration and Configuration Mode Permissives are met:
   a. Unit Shutdown
   b. No Speed Detected
   c. “Configure” User Level or greater is logged in
6. Press MODE or HOME to return to the HOME screen.
7. Press the Configuration softkey to access the configuration menus.
8. Use the navigation cross to navigate up/down/left/right and use ENTER to select a menu or item.

The Vertex configure mode may be accessed if the unit is in a Shutdown state, no speed or flow is detected, and the correct user level is logged in (Configure or higher). For safety reasons the configuration may be monitored only and no changes will be accepted if the turbine is running. By pressing the MODE key, pressing the soft key for LOGIN, and logging in as the “Configure” user level by entering the password (wg1113). Select a field using the navigation cross arrows and then press ENTER to enter text. When finished, press ENTER again.

All configuration values and saved service mode changes are stored as a file on the Vertex control. To ensure that values are saved, exit Configure mode or select ‘Save Settings’ from the MODE screen. If power is removed from the Vertex all saved values will return once power is restored. No batteries or back up power is required.

NOTICE **The field-configured portion of the configuration settings will be zeroed out after factory repair. You must reconfigure these values before the unit is put back into service.**

Using Configure Menus

Once the Configure Mode has been entered with the password, the specific application information must be entered into the Vertex. To access the configure menu, select the ‘Configuration’ softkey from the HOME screen.

The navigation arrow keys (red navigation cross keypad; up, down, left and right) navigate the Configure menus. Press ENTER to go into a menu. Then use the navigation cross to move up or down (left/right, if needed) in the menu. In the Configuration mode, the control will generate an error message shown on the Configuration menu home screen as well as the MODE screen if an invalid configuration exits. A configuration error will cause the control to remain tripped. It is possible to exit Configuration mode with such an error but the control will trip until the Configuration mode is entered again and the Configuration error is corrected.

See the Tutorial to learn how to adjust a value. Access the tutorial from the HOME screen by pressing the Tutorial softkey before the unit is configured or from the Service menu any time.

To return to the previous screen, press the ESC key. While in a Configure menu, to return to the main Configure menu screen, press the HOME key. To return to the main Home screen, press the HOME key again. To exit the Configure mode, go to the MODE screen and select the ‘Exit Configuration’ soft key. This will save values, exit I/O Lock, and reboots the Vertex.

Configure Menus

To program the control, navigate through the menus and configure the control features for the desired application. Every installation requires programming of the first four configure menus listed below, as well as drivers and other I/O. The remaining menus contain optional features which can be selected if desired. The configure menus and their basic functions are described below.

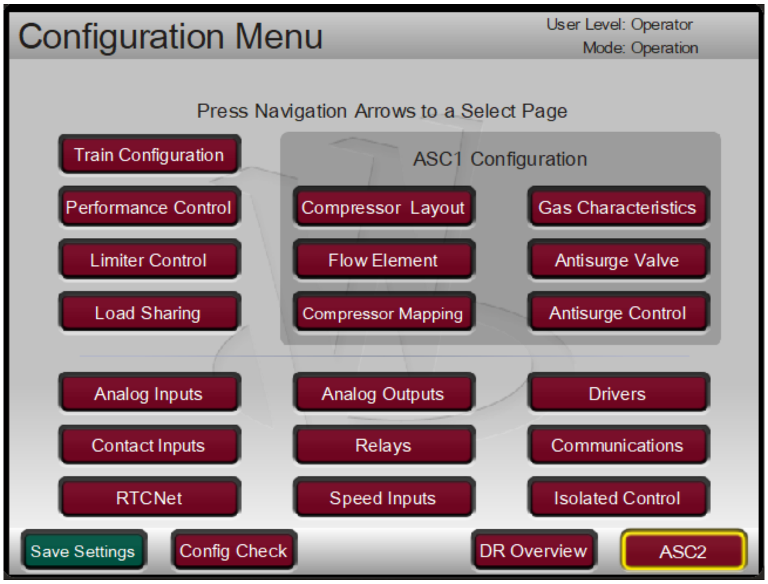


Figure 7-2. Configuration Menu – Configuration Mode (Edit)

Table 7-2. Configuration Modes and Descriptions

Configuration Mode	**Description**
Train Configuration:	Configure overall train layout, units used in the control, and train functionality
Performance Control:	Configure Performance controller and sequencing
Limiter Control:	Configure Performance Limiter 1 and Limiter 2
Load Sharing:	Configure Load Share control
Compressor Layout:	Configure compressor section layout
Gas Characteristics:	Configure process gas properties (MW, Heat Ratio, Compressibility)
Flow Element:	Configure and Calibrate the flow element type and properties. Validate flow coefficient used.
Anti-surge Valve:	Configure the anti-surge driver output
Compressor Mapping:	Configure the compressor section Surge Limit Line from and rated conditions
Anti-surge Control:	Configure anti-surge valve sequencing, surge detection, surge protection, and fall back strategies
Analog Inputs:	Configure analog input options
Analog Outputs:	Configure analog output options
Drivers:	Configure actuator driver output options
Contact Inputs:	Configure contact input options
Relays:	Configure relay options
Communications:	Configure Ethernet IP addresses and Modbus communication options

RTCNet:	Configure Woodward Expanded IO Nodes
Speed Inputs:	Configure speed pickup options

The configure menus are described in detail below and contain information detailing each question and/or Vertex configuration option. Each question/option shows the default (dflt) value and the adjustable range of that parameter (shown in parentheses). In addition, any additional configuration constraints appear in italics following the description. There is a Configuration mode worksheet in Appendix A of this manual that should be completed/filled-in and used as a guide for your particular application. This worksheet then becomes a reference to document your application program.

Table 7-3. Configure Menu Descriptions

Train Configuration

Train Configuration - (Train Configuration)

Compressor 1 Selection	**dflt= Standard Algorithm Used [ASC1 Not Used, Standard Algorithm Used, Universal Algorithm Used]**
Selecting Standard Algorithm Used enables the first compressor protection loop and defines the operating point calculation.	
Compressor 2 Selection	**dflt= ASC2 Not Used [ASC2 Not Used, Standard Algorithm Used, Universal Algorithm Used]**
Selecting Standard Algorithm Used enables the second compressor protection loop and defines the operating point calculation.	
Compressor Driver	**dflt= Motor Driven [Not Used, Turbine Driven, Motor Driven]**
Select the prime mover type to show the correct image in the GUI.	
Speed Sensor Selection	**dflt= NO (YES/NO)**
Select YES if speed sensor is enabled for use in the anti-surge control online detection and sequencing.	
Current Sensor Selection	**dflt= NO (YES/NO)**
Select YES if current sensor is enabled for use in the anti-surge control online detection and sequencing.	
Use Redundant Vertex Control?	**Dflt=YES (YES/NO) Unchecked = Simplex Mode Only**
Unchecking this box will configure the unit to operate only as a simple control, mask all information related to redundant control configurations.	
Use VertexDR FTM?	**Dflt=YES (YES/NO)**
Select this box if configured for redundant controls and the Woodward DR-FTM will be used to interconnect the units. When this is used the dedicated Emergency Shutdown contact input will be channel 13 and the Trip Output Relay will be Relay 7. When this is not used DI channel 1 and Relay 1 are used for this functions	

Train Configuration - (Units Defined in the Controller)

Metric – Imperial	**dflt= Metric Units for All Signals [Metric Units for All Signals, Imperial Units for All Signals]**
Select the units system to be used. This selection of units is used to configure the compressor control. The units system is also used to define the Analog Input unit system for signals related to the compressor operating point calculation.	

Pressure Unit Used	**dflt= kPa (Abs) Metric: [kPa (Absolute), MPa (Absolute), Bar (Absolute), kg/cm^2 (Absolute), kPa (Gauge), MPa (Gauge), Bar (Gauge), kg/cm^2 (Gauge)] Imperial: [psia, Ft of H2O (Absolute), Atm (Absolute), Torr (Absolute), Tons-force/ft^2 (Absolute), In of Hg (Absolute), psi (Gauge), Ft of H2O (Gauge), Atm (Gauge), Torr (Gauge), Tons-force/ft^2 (Gauge), in. Hg (Gauge)]**
Select the pressure unit used for all pressure transmitters with the exception of the flow element.	
Temperature Unit Used	**dflt= Deg C Metric: [Deg C, Deg K] Imperial: [Deg F, Deg R]**
Select the temperature unit used for all temperature transmitters.	
Flow Unit for Mapping Used	**dflt= Actual m^3/hr Metric: [Actual m^3/hr, Actual m^3/min] Imperial: [Actual ft^3/hr, Actual ft^3/min]**
Select the flow unit used to define the compressor Surge Limit Line points.	
Polytropic Head Unit Used	**dflt= N-m/kg Metric: [N-m/kg, kg-m/kg, kJ/kg] Imperial: [ft-lbf/lbm]**
The polytropic head unit used can only be selected with metric units. A fixed unit is applicable for imperial units.	
Flow Element Delta P Unit Used	**dflt= kPa Metric: [kPa, mbar, mm H2O, mm Hg] Imperial: [psi, in. H2O, in. Hg]**
Select the unit used for delta-pressure transmitter on the flow element.	
Load Unit	**dflt= MW Metric: [MW, kW] Imperial: [MW, kW]**
Select the load unit used for configuration and display.	

Train Configuration - (Altitude and Standard Conditions)

Altitude Compensation, Average Atmospheric Pressure at Site	**dflt (Metric)= 101.3 (70.0, 105.0) dflt (Imperial)= 14.73 (10.0, 17.0)**
Set the average atmospheric pressure at site in metric kPa or imperial psia, both absolute.	
Standard Conditions, Temperature	**dflt (Metric)= 15.66 (0.0, 25.0) dflt (Imperial)= 60.0 (30.0, 75.0)**
This value sets the Standard Temperature for mass flow calculations. If not known, leave at default.	
Standard Conditions, Pressure	**dflt (Metric)= 101.3 (70.0, 105.0) dflt (Imperial)= 14.73 (10.0, 17.0)**
This value sets the Standard Pressure for mass flow calculations. If not known, leave at default.	

Train Configuration - (Train Parameters)

External Trips in Trip Relay?	**dflt= YES (YES/NO)**
Select YES to allow external trips to trigger the trip relay. Select NO to not allow external trips to trigger the trip relay.	
Reset Clears Trip Relay	**dflt= NO (YES/NO)**
Select YES to allow a reset to clear the trip relay. Select NO to not allow a reset to clear the trip relay.	
Trip on Normal Shutdown Complete?	**dflt= YES (YES/NO)**
Select YES to allow a trip to be issued after a normal shutdown is complete. Select NO to not allow a trip to be issued after a normal shutdown is complete.	
Use Trip Emergency Push Button	**dflt= YES (YES/NO)**
Select YES if emergency push button is used. Select NO if emergency push button is not used.	

ASC Compressor Layout

Compressor Layout - (ASC Layout)

Layout	**dflt= Stand Alone Compressor [Stand Alone Compressor, ASV1 for Both Stages]**
Select the configuration of the compressor train. Select *Stand Alone Compressor* if the compressor section has an anit-surge valve dedicated for the section. Select *ASV1 for Both Stages* if the compressor has multiple stages with a single anti-surge valve to protect both sections. If *ASV1 for Both Stages* is selected, the HSS of the valve demand from ASC1 and ASC2 will drive the valve.	
Flow Meter Location	**dflt= Flow Meter at Suction Side [Flow Meter at Suction Side, Flow Meter at Discharge Side, Upstream Stage Flow + Sensor Flow, Upstream Stage Flow - Sensor Flow, Downstream Stage Flow + Sensor Flow, Downstream Stage Flow - Sensor Flow]**
Select the location of the flow meter used, i.e. at the suction or discharge of the compressor. This selection determines which pressure and temperature sensors are used for the flow calculation.	
Suction Temperature Configuration	**dflt= Measured by Temperature Sensor [Measured by Temperature Sensor, Calculated from T2 and Pressure Ratio, Calc from Upstream/Sidestream mixed, Default Value Used]**
Select the location of the temperature sensor(s) when used. Further selections can be made to use a default or calculated value of the temperature measurement instead of a measured value. A temperature sensor at the flow element is needed when using the standard algorithm.	
Discharge Temperature Configuration	**dflt= Measured by Temperature Sensor [Measured by Temperature Sensor, Calculated from T2 and Pressure Ratio, Calc from Upstream/Sidestream mixed, Default Value Used]**
Select the location of the temperature sensor(s) when used. Further selections can be made to use a default or calculated value of the temperature measurement instead of a measured value. A temperature sensor at the flow element is needed when using the standard algorithm.	
Temperature Sensor at Flowmeter	**dflt= T at flow not Used [T at flow not Used, T at flow Used]**
Select as per the location of flow meter, if the flow meter is located at significant distance from the compressor, then its corresponding temperature sensor shall be used for temperature compensation of flow.	
Pressure Sensor at Flowmeter	**dflt= P at flow not Used [P at flow not Used, P at flow Used]**
Select as per the location of flow meter, if the flow meter is located at significant distance from the compressor, then its corresponding pressure sensor shall be used for pressure compensation of flow.	
Intercoolers	**dflt= No Intercooler [No Intercooler, One Intercooler, Two Intercoolers, Three Intercoolers]**
If used, select how many intercoolers are used for this compressor train. Inter coolers can be used for one stage or between multiple stages. This will introduce an error in the polytropic exponent. The ASC uses an advanced algorithm to correct for this. Selection needs to be made on the number of inter coolers in the installation to enable the correction regardless of the ASC considering it to be one loop, i.e. no information available before or after the coolers.	
Air Case	**dflt= No Air Compressor [No Air Compressor, Air compressor with Suction Press, Air Compressor without Suction Press]**

Select whether or not the machine is an air compressor. If the unit is an air compressor – this setting can help simplify the configuration, as a P1 Suction Pressure signal is optional, but is not required If configured as Air Compressor using option 3 – the configuration check for a P1 (Suction Pressure) sensor will be bypassed in the configuration checks If configured as Air Compressor (option 2 or 3) - these fixed values will be used: Molecular Weight (g/mol) = 28.95 Specific Heat Ratio = 1.4028	
Tag Name	**dflt= ASC1 (32 Characters)**
This is a user entered field. It allows entry of a tag name for the compressor section.	
Description	**dflt= ASC1 Surge Controller (32 Characters)**
This is a user entered field. It allows entry of a short description for the compressor section.	
Use Start Position Command	**dflt= NO (YES/NO)**
If YES, this option requires a dedicated ASC Start Command, independent of the Train Start Command.	

ASC Gas Characteristics

Gas Characteristics - (ASC Gas Characteristic)

Gas Molecular Weight	**dflt= 30.0 (2.0, 200.0)**
Enter the molecular weight of the compressor gas. The molecular weight is expressed in g/mol. The value entered should be identical to the value provided by the compressor manufacturer as shown on the surge map. It will be used to calculate the surge map and to display the mass flow. Deviations (from the entered value) smaller than 15 % will not affect the accuracy of the anti-surge controller, but for optimization it is necessary to set the value.	
Gas Specific Heat Ratio	**dflt= 1.4 (1.0, 2.5)**
Enter the specific heat ratio (for perfect gas) of the compressor gas. The specific heat ratio for perfect gas (Cp0/Cv0), sometimes known as the Isentropic Exponent, should be invariant of the process conditions. It is used for the calculation of the polytropic exponent.	
Compressibility at Suction (Z1)	**dflt= 1.0 (0.6, 1.2)**
Enter the gas compressibility expected at suction conditions of the compressor. Although the compressor control can calculate this compressibility factor while running, it is mandatory to set this value according to the design specification to be used for definition of the surge map.	
Compressibility at Discharge (Z2)	**dflt= 1.0 (0.6, 1.2)**
Enter the gas compressibility expected at discharge conditions of the compressor. Although the compressor control can calculate this compressibility factor while running, it is mandatory to set this value according to the design specification to be used for definition of the surge map.	
Compressibility at Standard Conditions (Zstd)	**dflt= 1.0 (0.6, 1.2)**
Enter the gas compressibility expected at standard conditions. The ASC uses the following standard flow conditions: Metric: Temperature 15.66 Deg C Pressure 101.3 kPa, values are tunable. Imperial: Temperature 60 Deg F, Pressure 14.73 psia, values are tunable.	

ASC Flow Element

Flow Element - (ASC Flow Element)

Flow Element	**dflt= Throat [Orifice Plate, Throat, Long Radius Nozzle, Venturi Nozzle, Venturi Tube, Annubar, V-Cone, Other]**
Select the type of flow element used for compressor flow measurement. This information can be found on the Flow Metering Device (FMD) data sheet. Please see V3 of this manual for a detailed example on how to configure the Flow Element. NOTE: The selection of Annubar or V-Cone do not support the 'Flow Data from Geometry, it must be entered from a calibration sheet. These two flow elements are also the only two that support variable expansion factors. There are configuration checks to verify that these choices are correctly set.	
Type of Transmitter	**dflt= Raw Flow at Sensor [Raw Flow at Sensor, Square Root at Sensor, Square Root & Compensation at Sensor]**
Select the method with which the flow element provides flow data. For raw flow, the flow element will provide a raw value only, i.e. a delta pressure. For square root, the flow element will provide the square root of the delta pressure; therefore, the compressor control will not perform this calculation. For square root and pressure compensated, the flow element will provide the square root of the delta pressure, and compensate the value based on the actual pressure at the sensor. **It is strongly recommended to configure the flow transmitter to send the "Raw Flow at Sensor". The Vertex can perform the square and compensation calculations much faster than typical flow transmitters, allowing for more precise measurements of the flow and faster response to surge events.**	
Expansion Factor	**dflt= Fixed Expansion Factor [Fixed Expansion Factor, Variable Expansion Factor]**
When "Fixed expansion factor" is selected, the flow coefficient will only use the data sheet parameters. When "Variable expansion factor" is selected, the flow coefficient will be updated online based on actual pressure at the flow meter and actual delta pressure.	
Method Used	**dflt= Flow Data from Calibration Sheet [Flow Data from Calibration Sheet, Flow**

	Data from Geometry, Manual Setting of Flow Coefficient]
Select the method used to calculate the flow element coefficient. The "Flow data from calibration sheet" method can be used when the calibration sheet of the flow element is available. The "Flow data from geometry" can be used when the geometry of the flow element is known. The compressor control can calculate the coefficient based on this data. The flow element coefficient can be entered directly and sent to the control using the "Manual setting of flow coefficient" option. This is only recommended for users that have the expertise in determining this value. Otherwise, the other methods should be used.	
Flow Element Delta P Unit Used	**dflt= kPa [kPa, mbar, mmH2O, mmHg]**
Select the delta pressure units used that were used when the flow meter was calibrated.	
Mass/Standard Flow Unit	**dflt= Nm^3/hr [Nm^3/hr, kg/hr]**
Select the mass/standard flow units that were used when the flow meter was calibrated.	
Flow Coefficient Used	**dflt= Display Only Calculated from Calibration**
This field displays the generated flow coefficient value that will be used by the compressor control. This value is confirmed and accepted during calibration of the flow element.	
Status	**dflt= Display Only**
This field displays whether or not the generated flow coefficient has been configured and accepted. If the configuration is invalid, an error message will appear. If the configuration is accepted, the status will change to "Configuration OK". The configuration must be valid in order to start the Vertex.	

Flow Element - (ASC Flow Element) - Calibration - (ASC Flow Meter Calibration)

Flow	**dflt= 20000.0 (0.0, 1.0e+11)**
Enter the flow of the gas used during the calibration in the units shown from the FMD data sheet.	
Delta Pressure at Flow	**dflt= 20.0 (0.0, 10000.0)**
Enter the delta pressure at the given flow of the gas used during the calibration in the units shown from the FMD data sheet.	
Molecular Weight	**dflt= 20.0 (0.0, 100.0)**
Enter the molecular weight of the gas used during the calibration in the units shown from the FMD data sheet... This gas may be different from the gas running through the compressor.	
Pressure at Flow Meter	**dflt= 20.0 (0.0, 1000000.0)**
Enter the pressure of the gas at the flow meter during calibration in the units shown from the FMD data sheet.	
Temperature at Flow Meter	**dflt= 20.0 (-600.0, 10000.0)**
Enter the temperature of the gas at the flow meter during calibration in the units shown from the FMD data sheet.	
Compressibility at Flow (Z)	**dflt= 1.0 (0.5, 1.2)**
Enter the compressibility factor of the gas during calibration from the FMD data sheet.	
Percentage lost	**dflt= 0.0 (0.0, 15.0)**
Diameter (d)	**dflt= 0.349 (0.0, 10000.0)**
Enter the diameter of the flow element from the FMD data sheet in mm or inches, depends on the unit configuration.	
Beta Ratio (d/D)	**dflt= 0.349 (0.0, 100.0)**
Enter the beta ratio of the flow element from the FMD data sheet.	
Y-Factor	**dflt= 1.0 (0.0, 100.0)**
Enter the Y-factor (expansibility factor) of the flow element from the FMD data sheet.	
C-Coefficient	**dflt= 1.0 (0.0, 100.0)**
Enter the C-coefficient of the flow element from the FMD data sheet.	
Manual Coefficient	**dflt= 20.0 (0.0, 10000000.0)**
Enter the flow coefficient to be used by the control. This option is only recommended for users that have the expertise to determine this value.	
Intermediate Result	**dflt= Display Only Calculated Flow Coefficient**
This field displays the generated flow coefficient value that will be used by the compressor control. The "Send Calculated Value to Control" button will set this value and the status will change to "Configuration OK".	
Status	**dflt= Display Only**

This field displays whether or not the generated flow coefficient has been configured and accepted. If the configuration is invalid, an error message will appear. If the configuration is accepted, the status will change to "Configuration OK". The configuration must be valid in order to start the Vertex.	
Send Calculated Value to Control	**dflt= NO**
This button sets and applies the generated flow coefficient value to the compressor control and triggers the Status above to update.	

ASC Antisurge Valve

Antisurge Valve - (ASC Antisurge Valve)

Gain Compensation	**dflt= Not Used [Not Used, Linearization Curve Used, Compensation Based on CV]**
Select the type of gain compensation to be used. "Linearization Curve Used" enables curve data to be entered while "Compensation Based on CV" enables entry of the CV of the valve as well as the normal (standard) flow through the valve expected when fully opened in normal conditions.	
Normal Flow Value	**dflt= 0.0 (0.0, 2500000.0)**
AS Valve CV	**dflt= 0.0 (0.0, 2500000.0)**
Valve min position	**dflt= 10.0 (-1.0, 50.0)**
Enter the minimum stroke of the antisurge valve.	
Dither	**dflt= 0.0 (0.0, 3.0)**
Enter the amount of dither to generate a pulsation signal at high frequency.	
Inhibit Full Manual	**dflt= YES (YES/NO)**
Select YES to inhibit full manual mode. Select NO to allow full manual mode . Full manual mode will allow the operator to manually stroke the antisurge valve. The automatic controllers are bypassed and cannot operate the antisurge valve, no matter where the operating point is on the compressor map.	
Use Overstroke	**dflt= NO (YES/NO)**
Select YES to provide a surplus on the open or close demand to ensure the position is mechanically seated. Select NO to not provide overstroke.	
Overstroke Open	**dflt= 10.0 (0.0, 30.0)**
Enter the amount of overstroke for the open demand.	
Overstroke Close	**dflt= -10.0 (-30.0, 0.0)**
Enter the amount of overstroke for the close demand.	

ASC Compressor Mapping

Compressor Mapping - (ASC Map Type)

Status of Actual Map	**dflt= Display Only**
This field displays whether or not the surge/choke map has been configured and accepted. If the configuration is invalid, an error message will appear. If the configuration is accepted, the status will change to "All Data OK and Used".	
Type of Map Entered	**dflt= [P2 = F (flow)] [P2 = F (flow), P2/P1 = F (flow), H = F (flow), IH = F(flow), IH = F(IP)]**
Select the type of surge map to be configured from the compressor performance map.	
Type of Flow for Mapping	**dflt= Actual Flow [Actual Flow, Mass Flow, Standard Flow]**
Select the type of flow (x-axis) to be configured and displayed on the surge map.	
Flow Unit Used for Configuration	**dflt= Display Only Configured in Train Configuration**
Flow Unit Used for Configuration can only be modified in Train Configuration.	
Pressure Unit Used for Mapping	**dflt= Pressure Unit in Gauge for Mapping [Pressure Unit in Gauge for Mapping, Pressure Unit in Abs for Mapping]**
Select the type of pressure unit configured for transmitters. This selection determines if a conversion factor needs to be applied. If transmitters are gauge, select gauge. If transmitters are Abs, select Abs.	
Y Axis Unit Used for Configuration	**dflt= Display Only Configured in Train Configuration**
Y Axis Unit Used for Configuration can only be modified in Train Configuration.	
Number of Points Used	**dflt= 3 Point Used [1 Point Used,**

	2 Points Used, 3 Points Used, 4 Points Used, 5 Points Used, 6 Points Used, 7 Points Used, 8 Points Used, 9 Points Used, 10 Points Used]
Select the number of surge map points to be entered.	
Choke Map	**dflt= Choke map Not Used [Choke map Not Used, Choke Map Used]**
Select whether or not a choke map will be configured and displayed.	
Choke Alarm Used	**dflt= NO (YES/NO)**
Select YES if an alarm should annunciate if the operating point crosses the choke line. Select NO if a choke alarm should not be used.	

Compressor Mapping - (ASC Units and Multipliers)

Status of Actual Map	**dflt= Display Only**
This field displays whether or not the surge/choke map has been configured and accepted. If the configuration is invalid, an error message will appear. If the configuration is accepted, the status will change to "All Data OK and Used". The configuration must be valid in order to start the Vertex.	
Actual Flow Unit	**dflt= Display Only Configured in Train Configuration**
Actual Flow Unit can only be modified in Train Configuration.	
Actual Flow Multiplier	**dflt= X 1 [X 1, X 10, X 100, E+03, E+04, E+05, E+06, E+07, E+08]**
Select a multiplier for actual flow in order to avoid entering large flow values into the surge/choke map. The value should be identical to the one used for the surge map provided.	
Mass Flow Unit	**dflt= Display Only Configured in Train Configuration**
Mass flow only has one available selection for metric and imperial unit selections (one option each). Metric/Imperial unit selection can only be modified in Train Configuration.	
Mass Flow Multiplier	**dflt= X 1 [X 1, X 10, X 100, E+03, E+04, E+05, E+06, E+07, E+08]**
Select a multiplier for mass flow in order to avoid entering large flow values into the surge/choke map. The value should be identical to the one used for the surge map provided.	
Standard Flow Unit	**dflt= Display Only Configured in Train Configuration**
Standard flow only has one available selection for metric and imperial unit selections (one option each). Metric/Imperial unit selection can only be modified in Train Configuration.	
Standard Flow Multiplier	**dflt= X 1 [X 1, X 10, X 100, E+03, E+04, E+05, E+06, E+07, E+08, MMSCFD or MMSCMD]**
Select a multiplier for standard flow in order to avoid entering large flow values into the surge/choke map. The value should be identical to the one used for the surge map provided.	
Head Unit	**dflt= Display Only Configured in Train Configuration**
Head Unit can only be modified in Train Configuration.	
Head Multiplier	**dflt= X 1 [X 1, X 10, X 100, E+03, E+04, E+05, E+06, E+07, E+08]**
Select a multiplier for head in order to avoid entering large head values into the surge/choke map. The value should be identical to the one used for the surge map provided.	

Compressor Mapping - (ASC Rated for Mapping)

Status of Actual Map	**dflt= Display Only**
This field displays whether or not the surge/choke map has been configured and accepted. If the configuration is invalid, an error message will appear. If the configuration is accepted, the status will change to "All Data OK and Used". The configuration must be valid in order to start the Vertex.	
Suction Temperature	**dflt= 0.0 (-500.0, 1000.0)**
Enter the rated suction temperature of the medium as shown on the surge map provided.	
Suction Pressure	**dflt= 103.0 (-500000.0, 1000000.0)**
Enter the rated suction pressure of the medium as shown on the surge map provided.	

Discharge Temp (estimated)	**dflt= Display Only Calculated based on Rated Mapping Parameters**
This field displays an approximation of discharge pressure based on other rated mapping parameters.	
Discharge Pressure	**dflt= 103.0 (-500000.0, 1000000.0)**
Enter the rated discharge pressure of the medium as shown on the surge map provided.	
Actual Flow at Rated	**dflt= 10000.0 (0.1, 1000000.0)**
Enter the actual flow at rated conditions as shown on the surge map provided.	
Rated Speed	**dflt= 103.0 (-500000.0, 1000000.0)**
Enter the speed at rated conditions as shown on the surge map provided. This value is considered less critical and is used for indication.	
Percent Speed at Rated	**dflt= 103.0 (0.0, 120.0)**
Enter the percent of speed at rated conditions as shown on the surge map provided.	
Polytropic Efficiency	**dflt= 83.0 (10.0, 100.0)**
Enter the average value of the polytropic efficiency of the compressor.	

Compressor Mapping - (ASC Estimated Conditions)

Status of Actual Map	**dflt= Display Only**
This field displays whether or not the surge/choke map has been configured and accepted. If the configuration is invalid, an error message will appear. If the configuration is accepted, the status will change to "All Data OK and Used". The configuration must be valid in order to start the Vertex.	
Mass Flow at Rated	**dflt= Display Only Calculated based on Rated Mapping Parameters**
This field displays the calculated mass flow approximation according to the data provided for the rated mapping conditions.	
Standard Flow at Rated	**dflt= Display Only Calculated based on Rated Mapping Parameters**
This field displays the calculated standard flow approximation according to the data provided for the rated mapping conditions.	
Polytropic Head at Rated	**dflt= Display Only Calculated based on Rated Mapping Parameters**
This field displays the calculated polytrpic head approximation according to the data provided for the rated mapping conditions.	
Power at Rated	**dflt= Display Only Calculated based on Rated Mapping Parameters**
This field displays the calculated power approximation according to the data provided for the rated mapping conditions.	
Confirm Rated Conditions	**dflt= NO**
This button confirms the calculated rated conditions for mass flow, standard flow, polytropic head, and power.	

Compressor Mapping - (ASC Surge Map Configuration)

NOTE: The interpolation of map point values in the graphic visualization was greatly improved in the GAP & GUI Revision "A" update. In all cases it is recommended to provide at least three X-Y points to expect a reasonable surge map and accurate WSPV operating point graphical display.

Status of Actual Map	**dflt= Display Only**
This field displays whether or not the surge/choke map has been configured and accepted. If the configuration is invalid, an error message will appear. If the configuration is accepted, the status will change to "All Data OK and Used". The configuration must be valid in order to start the Vertex. NOTE: the indication below of 'rated condition' applies to map types P2, P2/P1, or Head. When entering points for these types of surge maps, all points must be related to one suction condition.	
X1 Value	**dflt= 1.01 (0.0, 1000000.0)**
Enter a value to represent the x position of the 1st surge map point (rated condition).	
Y1 Value	**dflt= 1.11 (-1000000.0, 1000000.0)**
Enter a value to represent the y position of the 1st surge map point (rated condition).	
X2 Value	**dflt= 1.02 (0.0, 1000000.0)**
Enter a value to represent the x position of the 2nd surge map point (rated condition).	

Y2 Value	**dflt= 1.12 (-1000000.0, 1000000.0)**
Enter a value to represent the y position of the 2nd surge map point (rated condition).	
X3 Value	**dflt= 1.03 (0.0, 1000000.0)**
Enter a value to represent the x position of the 3rd surge map point (rated condition).	
Y3 Value	**dflt= 1.13 (-1000000.0, 1000000.0)**
Enter a value to represent the y position of the 3rd surge map point (rated condition).	
X4 Value	**dflt= 1.04 (0.0, 1000000.0)**
Enter a value to represent the x position of the 4th surge map point (rated condition).	
Y4 Value	**dflt= 1.14 (-1000000.0, 1000000.0)**
Enter a value to represent the y position of the 4th surge map point (rated condition).	
X5 Value	**dflt= 1.05 (0.0, 1000000.0)**
Enter a value to represent the x position of the 5th surge map point (rated condition).	
Y5 Value	**dflt= 1.15 (-1000000.0, 1000000.0)**
Enter a value to represent the y position of the 5th surge map point (rated condition).	
X6 Value	**dflt= 1.06 (0.0, 1000000.0)**
Enter a value to represent the x position of the 6th surge map point (rated condition).	
Y6 Value	**dflt= 1.16 (-1000000.0, 1000000.0)**
Enter a value to represent the y position of the 6th surge map point (rated condition).	
X7 Value	**dflt= 1.07 (0.0, 1000000.0)**
Enter a value to represent the x position of the 7th surge map point (rated condition).	
Y7 Value	**dflt= 1.17 (-1000000.0, 1000000.0)**
Enter a value to represent the y position of the 7th surge map point (rated condition).	
X8 Value	**dflt= 1.08 (0.0, 1000000.0)**
Enter a value to represent the x position of the 8th surge map point (rated condition).	
Y8 Value	**dflt= 1.18 (-1000000.0, 1000000.0)**
Enter a value to represent the y position of the 8th surge map point (rated condition).	
X9 Value	**dflt= 1.09 (0.0, 1000000.0)**
Enter a value to represent the x position of the 9th surge map point (rated condition).	
Y9 Value	**dflt= 1.19 (-1000000.0, 1000000.0)**
Enter a value to represent the y position of the 9th surge map point (rated condition).	
X10 Value	**dflt= 1.1 (0.0, 1000000.0)**
Enter a value to represent the x position of the 10th surge map point (rated condition).	
Y10 Value	**dflt= 1.2 (-1000000.0, 1000000.0)**
Enter a value to represent the y position of the 10th surge map point (rated condition).	
Speed 1	**dflt= 70.0 (0.0, 150.0)**
Enter the percent of speed at rated conditions of the 1st surge map point.	
Speed 2	**dflt= 70.0 (0.0, 150.0)**
Enter the percent of speed at rated conditions of the 2nd surge map point.	
Speed 3	**dflt= 70.0 (0.0, 150.0)**
Enter the percent of speed at rated conditions of the 3rd surge map point.	
Speed 4	**dflt= 70.0 (0.0, 150.0)**
Enter the percent of speed at rated conditions of the 4th surge map point.	
Speed 5	**dflt= 70.0 (0.0, 150.0)**
Enter the percent of speed at rated conditions of the 5th surge map point.	
Speed 6	**dflt= 70.0 (0.0, 150.0)**
Enter the percent of speed at rated conditions of the 6th surge map point.	
Speed 7	**dflt= 70.0 (0.0, 150.0)**
Enter the percent of speed at rated conditions of the 7th surge map point.	
Speed 8	**dflt= 70.0 (0.0, 150.0)**
Enter the percent of speed at rated conditions of the 8th surge map point.	
Speed 9	**dflt= 70.0 (0.0, 150.0)**
Enter the percent of speed at rated conditions of the 9th surge map point.	
Speed 10	**dflt= 70.0 (0.0, 150.0)**
Enter the percent of speed at rated conditions of the 10th surge map point.	
Forced OFF	**dflt= Display Only Status**

Error	**dflt= Display Only Status**
Error is detected when an entered value is considered invalid. It will not be possible to proceed to the next point until the error is corrected.	
Active	**dflt= Display Only Status**
This status shows whether or not a surge map point is currently being used and displayed.	
Save Point	**dflt= NO**
This button confirms and sets the data entered on the surge map for one specific point. Save Point will not be issued or clear until all previous point errors have been resolved.	
Save All	**dflt= NO**
This button confirms and sets the data entered on the surge map for all points. Save All will not be issued or clear until all errors have been resolved.	

Compressor Mapping - (ASC Choke Map Configuration)

Status of Actual Map	**dflt= Display Only**
This field displays whether or not the surge/choke map has been configured and accepted. If the configuration is invalid, an error message will appear. If the configuration is accepted, the status will change to "All Data OK and Used".	
X1 Value	**dflt= 1.0 (0.0, 1000000.0)**
Enter a value to represent the x position of the 1st choke point on the surge map (rated condition).	
Y1 Value	**dflt= 1.1 (-1000000.0, 1000000.0)**
Enter a value to represent the y position of the 1st choke point on the surge map (rated condition).	
X2 Value	**dflt= 1.0 (0.0, 1000000.0)**
Enter a value to represent the x position of the 2nd choke point on the surge map (rated condition).	
Y2 Value	**dflt= 2.0 (-1000000.0, 1000000.0)**
Enter a value to represent the y position of the 2nd choke point on the surge map (rated condition).	
X3 Value	**dflt= 1.0 (0.0, 1000000.0)**
Enter a value to represent the x position of the 3rd choke point on the surge map (rated condition).	
Y3 Value	**dflt= 3.0 (-1000000.0, 1000000.0)**
Enter a value to represent the y position of the 3rd choke point on the surge map (rated condition).	
X4 Value	**dflt= 1.0 (0.0, 1000000.0)**
Enter a value to represent the x position of the 4th choke point on the surge map (rated condition).	
Y4 Value	**dflt= 4.0 (-1000000.0, 1000000.0)**
Enter a value to represent the y position of the 4th choke point on the surge map (rated condition).	
X5 Value	**dflt= 1.0 (0.0, 1000000.0)**
Enter a value to represent the x position of the 5th choke point on the surge map (rated condition).	
Y5 Value	**dflt= 5.0 (-1000000.0, 1000000.0)**
Enter a value to represent the y position of the 5th choke point on the surge map (rated condition).	
X6 Value	**dflt= 1.0 (0.0, 1000000.0)**
Enter a value to represent the x position of the 6th choke point on the surge map (rated condition).	
Y6 Value	**dflt= 6.0 (-1000000.0, 1000000.0)**
Enter a value to represent the y position of the 6th choke point on the surge map (rated condition).	
Speed 1	**dflt= 70.0 (0.0, 150.0)**
Enter the percent of speed at rated conditions of the 1st choke point on the surge map.	
Speed 2	**dflt= 80.0 (0.0, 150.0)**
Enter the percent of speed at rated conditions of the 2nd choke point on the surge map.	
Speed 3	**dflt= 85.0 (0.0, 150.0)**
Enter the percent of speed at rated conditions of the 3rd choke point on the surge map.	
Speed 4	**dflt= 90.0 (0.0, 150.0)**
Enter the percent of speed at rated conditions of the 4th choke point on the surge map.	
Speed 5	**dflt= 100.0 (0.0, 150.0)**
Enter the percent of speed at rated conditions of the 5th choke point on the surge map.	
Speed 6	**dflt= 105.0 (0.0, 150.0)**
Enter the percent of speed at rated conditions of the 6th choke point on the surge map.	
Forced OFF	**dflt= Display Only Status**

Error	**dflt= Display Only Status**
An error is detected when an entered value is considered invalid. It will not be possible to proceed to the next point until the error is corrected.	
Save Point	**dflt= NO**
This button confirms and sets the data entered on the surge map for one specific point. Save Point will not be issued or clear until all previous point errors have been resolved.	
Save All	**dflt= NO**
This button confirms and sets the data entered on the surge map for all points. Save All will not be issued or clear until all errors have been resolved.	

Compressor Mapping - (ASC Map Display Configuration)

Type of Map to be Displayed	**dflt= [P2 = F (flow)] [P2 = F (flow), P2/P1 = F (flow), H = F (flow)]**
Select the type of map preferred to visualize the surge map. Options include discharge pressure (P2) vs flow (F), pressure ratio (P2/P1) vs flow (F), and polytropic head (H) vs flow (F). For each map, the scaling for flow (x axis) is the same. For each map, the scaling for Y min and Y max can be set.	
Type of Flow to be Displayed	**dflt= Actual Flow (Qa) [Actual Flow (Qa), Mass Flow (Qm), Standard Flow (Qs)]**
Select the type of flow to be displayed on the surge map.	
Y maximum to display	**dflt= 100.0 (0.0, 50000000000.0)**
Enter a value to limit the maximum allowable (y axis) value to be displayed on the surge map.	
Y minimum to display	**dflt= 100.0 (0.0, 50000000000.0)**
Enter a value to limit the minimum allowable (y axis) value to be displayed on the surge map.	
Y Display Multiplier	**dflt= Display Only Configured in Compressor Mapping**
Y Display Multiplier can only be configured in Compressor Mapping.	
Y Modbus Multiplier	**dflt= X 1 [• X 0.001 • X 0.01 • X 0.1 • X 1 • X 10 • X 100]**
Select a multiplier to manipulate the y axis value sent through modbus.	
X maximum to display	**dflt= 100.0 (0.0, 50000000000.0)**
Enter a value to limit the maximum allowable (x axis) value to be displayed on the surge map.	
X minimum to display	**dflt= 100.0 (0.0, 50000000000.0)**
Enter a value to limit the minimum allowable (x axis) value to be displayed on the surge map.	
X Display Multiplier	**dflt= Display Only Configured in Compressor Mapping**
X Display Multiplier can only be configured in Compressor Mapping.	
X Modbus Multiplier	**dflt= X 1 [• X 0.001 • X 0.01 • X 0.1 • X 1 • X 10 • X 100]**
Select a multiplier to manipulate the x axis value sent through modbus.	
AutoScale (On/Off)	**dflt= ON (ON/OFF)**
Select On to allow the Vertex to automatically scale the surge map. Select NO to manually configure the surge map display.	

ASC Antisurge Control

Antisurge Control - Sequencing - (ASC Sequencing Start and Shutdown)

Shutdown Manual Position Enabled	**dflt= YES (YES/NO)**
Select YES to force the antisurge valve to a certain position upon shutdown conditions. Select NO to allow the antisurge valve to remain at the same position prior to shutdown conditions.	
Position just After Shutdown	**dflt= 100.0 (0.0, 100.0)**
Enter the required position (in percent) of the antisurge valve upon shutdown conditions, where 100% represents a full recycle position of the antisurge valve.	
Zero Speed Level	**dflt= 10.0 (0.0, 10000.0)**
Enter the speed level (in RPM) at which the compressor is considered started. This is the speed at which the antisurge valve transitions from its configured zero speed position to the configured start position. This is also the speed at which the unit is considered zero-speed after a shutdown. The zero speed level switching will only come in to effect when other start conditions have been fulfilled.	
Zero Current Level	**dflt= 1.0 (-1.0, 10000.0)**
Enter the current level (in Amps) at which the compressor is considered started. This is the current at which the antisurge valve transitions from its configured zero current position to the configured start position. This is also the current at which the unit is considered zero speed after a shutdown. The zero current level switching will only come into effect when other start conditions have been fulfilled.	
Position if Zero Speed/Curr and SD Delay Passed	**dflt= 100.0 (0.0, 100.0)**
Enter the required position (in percent) of the antisurge valve when zero speed conditions are not met and the time after shutdown has passed, where 100% represents a full recycle position of the antisurge valve. This shutdown sequence could be used to close the antisurge valve after a shutdown to provide process isolation instead of leaving the valve open. Configure the position identical to the shutdown position and set the delay time to 0 when this function is not required.	
Position During Startup	**dflt= 100.0 (0.0, 100.0)**
Enter the required startup position (in percent) of antisurge valve, where 100% represents a full recycle position of the antisurge valve. The valve will transition to this position on startup and remain there until the configured online conditions are met. At least one online trigger must be enabled to enable this start sequence. The control will skip the start sequence and transition immediately to automatic online control if no online triggers are configured, which is not recommended.	

Antisurge Control - Sequencing - (ASC Sequencing Online Detection)

NOTE: At least 1 Online Detection method must be selected	
Use Minimum Speed Level	**dflt (Trigger)= NO (YES/NO)** **dflt (Level)= 0.0 (0.0, 25000.0)**
Check to enable the speed detection method for the online condition. Uncheck to not use this feature. Enter the required speed setpoint (in RPM) for the online condition. The online trigger is satisfied during startup once speed increases beyond this setpoint.	
Use Maximum Suction Pressure Level	**dflt (Trigger)= NO (YES/NO)** **dflt (Level)= 0.0 (-14.0, 25000.0)**
Check to enable the suction pressure detection method for the online condition. Uncheck to not use this feature. Enter the required suction pressure setpoint in the unit shown for the online condition. On startup, once suction pressure decreases beyond this setpoint, the online detection trigger is satisfied.	
Use Minimum Discharge Pressure Level	**dflt (Trigger)= NO (YES/NO)** **dflt (Level)= 0.0 (0.0, 25000.0)**
Check to enable the discharge pressure detection method for the online condition. Uncheck to not use this feature. Enter the required discharge pressure setpoint in the unit shown for the online condition. On startup, once discharge pressure increases beyond this setpoint, the online detection trigger is satisfied.	
Use Minimum Flow Level	**dflt (Trigger)= NO (YES/NO)** **dflt (Level)= 0.0 (0.0, 1000000.0)**
Check to enable the flow detection method for the online condition. Uncheck to not use this feature. Enter the required flow setpoint at suction in the unit shown for the online condition. On startup, once flow increases beyond this setpoint, the online detection trigger is satisfied.	
Use Minimum Current Level	**dflt (Trigger)= NO (YES/NO)** **dflt (Level)= 0.0 (0.0, 25000.0)**

Check to enable the actual motor current input detection method for the online condition. Uncheck to not use this feature. Enter the required online current level for the online condition. On startup, once the actual motor current input increases beyond this setpoint, the online detection trigger is satisfied.	
Use Minimum Pressure Ratio	**dflt (Trigger)= NO (YES/NO)** **dflt (Level)= 1.0 (1.0, 100.0)**
Check to enable the pressure ratio detection method for the online condition. Uncheck to not use this feature. Enter the required pressure ratio for the online condition. On startup, once the ratio of discharge pressure (P2) to suction pressure (P1) increases beyond this setpoint, the online detection trigger is satisfied.	
Use Minimum IGV Level	**dflt (Trigger)= NO (YES/NO)** **dflt (Level)= 10.0 (0.0, 100.0)**
Check to enable the IGV detection method for the online condition. Uncheck to not use this feature. Enter the required pressure ratio for the online condition. On startup, once the IGV value increases beyond this setpoint, the online detection trigger is satisfied.	
Use External Contact	**dflt (Trigger)= NO (YES/NO)**
Check to enable the auxiliary binary input for online condition. Uncheck to not use this feature. This auxiliary input can be through Modbus or hardwired.	
Delay Timer for Online Detection	**dflt (Level)= 10.0 (0.0, 300.0)**
Enter a delay time (in seconds) for online detection to complete once any one of the online triggers is satisfied. After the delay time has passed, the control will slowly close the anti-surge valve until the automatic antisurge routines take control.	

Antisurge Control - Sequencing - (ASC Sequencing Valve Rates)

Automatic Close Rate	**dflt (Level)= 1.0 (0.0, 10.0)**
Enter the ramp rate value, in percent per second, to be used by the automatic open-loop routines when ramping down the anti-surge valve.	
Offline/Start Rate	**dflt (Level)= 1.0 (0.1, 100.0)**
Enter the ramp rate value, in percent per second, to be used during start or when the compressor is offline.	
NSD Rate	**dflt (Level)= 1.0 (0.1, 100.0)**
Enter the ramp rate value, in percent per second, to be used during controlled shutdown. The compressor must be Online for this rate to be used during a controlled shutdown, otherwise, the Offline/Start Rate is used.	
Manual Raise/Lower Slow Rate	**dflt (Level)= 0.5 (0.0, 100.0)**
Enter the slow ramp rate value, in percent per second, to be used when the raise or lower valve command is requested in the manual or manual with backup mode.	
Delay for Fast Rate	**dflt (Level)= 3.0 (0.0, 30.0)**
Enter the value, in seconds, to activate the fast rate when the raise or lower valve command is requested in the manual or manual with backup mode.	
Manual Raise/Lower Fast Rate	**dflt (Level)= 1.0 (0.0, 100.0)**
Enter the fast ramp rate value, in percent per second, to be used after the delay time when the raise or lower valve command is requested in the manual or manual with backup mode.	
Allow use of Remote AS Valve Demand (0-100%)	**dflt=NO (YES/NO)**
Check this box to allow an external AI (4-20mA) signal to be used for direct AS valve demand. If checked, the configuration checks will verify that an AI is configured for this function. Once programmed, this remote anti-surge valve demand can be enabled/disabled from the GUI (compressor control page) modbus or discrete inputs.	

Antisurge Control - Sequencing - (ASC Sequencing NSD/Purge)

Normal SD State	**dflt= NSD on Train NSD Request** **[NSD on Train NSD Request,** **NSD with Compressor 2 Offline]**
NSD on Train NSD Request:Normal shutdown trigger from Train NSD command. NSD with Compressor 2 Offline: Normal shutdown trigger when ASC2 goes offline.	
Manual w/ Backup on NSD Complete	**dflt=YES (YES/NO)**
If YES is selected, the ASC will transfer to Manual with Backup Mode once the Normal Shutdown is complete. This option allows the valve to remain at	

the Start Position if the Online Detection conditions are still TRUE. If NO is selected, the control will remain in AUTO control once the NSD is complete. Important: If NO is selected and the control is in AUTO and the compressor online conditions are met, the ASC will begin to ramp the ASV back to zero demand.	
Purge Command	**dflt= Purge Never Used [Purge Never Used, Purge Disabled at Start, Purge Disabled at Online, Purge Disabled on Speed Level, Purge Disabled on Motor Current Level, Purge on Request Only]**
Purge Never Used: Purge command is not available. *Purge Disabled at Start:* Purge option is disabled if start sequence initiated or ESD is active. *Purge Disabled at Online:* Purge option is disabled if compressor state is online or ESD is active. *Purge Disabled On Speed Level:* Purge option is disabled if actual speed is higher than trigger off Level or ESD is active. *Purge Disabled On Motor Current Level:* Purge option is disabled if actual motor current is higher than trigger off Level or ESD is active. *Purge on Request Only:* Purge option is always available except ESD status.	
Purge Position	**dflt= 0.0 (0.0, 100.0)**
Enter the required anti-surge valve position for a purge cycle during startup, i.e. 0 to 100% open.	
Actual Speed Trigger Off Level	**dflt= 200.0 (10.0, 25000.0)**
Enter the Speed in RPM that will disable the Purge sequence if speed is sensed above this level.	
Actual Motor Trigger Off Level	**dflt= 200.0 (10.0, 25000.0)**
Enter the Motor Current in Engineering Units that will disable the Purge sequence if Motor Current is sensed above this level.	

Antisurge Control - Surge Detection - (ASC Surge Detection Method Used)

Flow Derivative Detection	**dflt (Use)= NO (YES/NO) dflt (Trigger Setpoint)= 80.0 (1.0, 300.0) dflt (Captured Values)= Display Only**
Check to enable the flow derivative surge detection routine. This routine detects surge by monitoring the rate of change of calculated compressor flow. Enter the flow derivative value, in percent of suction volumetric flow units per second, above which the Surge Recovery and Surge Minimum Position routines, if enabled, are to be triggered. The set point is configured in percent to account for the wide range of most compression processes and to eliminate false triggers on noise at low flow levels. For example, if the current operating flow is 10,000 m3/hr and this set point is configured as 50%, a surge will be detected if the rate of flow change exceeds 5,000 m3/hr. However, the same derivative at a nominal flow rate of 50,000 m3/hr is only 10%, and could be caused by a noisy signal, not surge. Data from an actual surge event is helpful (recorded in the Caputured Values column) in establishing an appropriate set point to exclude normal signal noise and process fluctuations.	
Minimum Flow Detection	**dflt (Use)= NO (YES/NO) dflt (Trigger Setpoint)= 1.0 (0.01, 100000000.0)**
Check to enable the minimum flow surge detection routine. This routine, though included as a surge detection method, does not actually detect surge. It merely initiates the same open-loop Surge Recovery and Surge Minimum Position responses when the compressor operating point falls below the configured minimum flow set point. Enter the minimum flow value, in engineering units, of suction volumetric flow below which the Surge Recovery and Surge Minimum Position routines, if enabled, are to be triggered.	
Disch. P. Derivative Detection	**dflt (Use)= NO (YES/NO) dflt (Trigger Setpoint)= -100.0 (-**

	1000000.0, 0.0) **dflt (Captured Values)= Display Only**
Check to enable the discharge pressure derivative surge detection routine. This routine detects surge by monitoring the rate of change of measured compressor discharge pressure. Enter the discharge pressure derivative value, in engineering units per second, above which the Surge Recovery and Surge Minimum Position routines, if enabled, are to be triggered. Data from an actual surge event is helpful in establishing an appropriate set point to exclude normal process fluctuations.	
Suction P. Derivative Detection	**dflt (Use)= NO (YES/NO)** **dflt (Trigger Setpoint)= 1.0 (0.0, 100000.0)** **dflt (Captured Values)= Display Only**
Check to enable the suction pressure derivative surge detection routine. This routine detects surge by monitoring the rate of change of measured compressor suction pressure. Enter the suction pressure derivative value, in engineering units per second, above which the Surge Recovery and Surge Minimum Position routines, if enabled, are to be triggered. Data from an actual surge event is helpful in establishing an appropriate set point to exclude normal process fluctuations.	
Speed Derivative Detection	**dflt (Use)= NO (YES/NO)** **dflt (Trigger Setpoint)= 1.0 (1.0, 30000.0)** **dflt (Captured Values)= Display Only**
Check to enable the speed derivative surge detection routine. This routine detects surge by monitoring the rate of change of measured compressor speed. Enter the speed derivative value, in engineering units per second, above which the Surge Recovery and Surge Minimum Position routines, if enabled, are to be triggered. Data from an actual surge event is helpful in establishing an appropriate set point to exclude normal process fluctuations.	
Motor Curr. Derivative Detection	**dflt (Use)= NO (YES/NO)** **dflt (Trigger Setpoint)= -1.0 (-30000.0, 0.0)** **dflt (Captured Values)= Display Only**
Check to enable the motor current derivative surge detection routine. This routine detects surge by monitoring the rate of change of measured compressor motor current. Enter the motor current derivative value, in engineering units per second, above which the Surge Recovery and Surge Minimum Position routines, if enabled, are to be triggered.	
Surge Detection on Cross Line	**dflt (Use)= YES (YES/NO)**
Check to enable the surge limit line crossing surge detection routine. This routine, though included as a surge detection method, does not actually detect surge. It merely initiates the same open-loop Surge Recovery and Surge Minimum Position responses when the compressor operating point falls below the configured Surge Limit Line.	
Operating SP Limit To Detect Surge	**dflt (Trigger Setpoint)= 150.0 (104.0, 200.0)** **dflt (Captured Values)= Display Only**
Enter the limit for operating set point in percent to detect surge. When operating set point is less than the entered value, surge can be detected and counted, and anti-surge action can be activated.	

Antisurge Control - Surge Detection - (ASC Actions Taken when Surge Detected)

Loop Period	**dflt= 10.0 (1.0, 300.0**
Enter the appropriate system loop delay time in seconds. This is the time required for a step change in anti-surge valve position to be realized in the flow measurement once the flow measurement reaches 70~90% of its final steady-state value. This value is depending on piping volumes.	

Use External Surge Detection Contact	**dflt (Use)= NO (YES/NO)**
Check to enable the surge detection on external hardwired signal. This routine, initiates the surge detection as well as multi surge detection response when external Boolean hardwired command is detected. This is required when surge detection is also done by third party control system.	
Enable Surge Recovery?	**dflt= YES (YES/NO)** **dflt (Amount)= 1.0 (0.5, 50.0)**
Check to enable the open-loop step response triggered when surge is detected by any of the configured surge detection methods. Enter the value in valve percent, typically 3~5%, that will be added to the anti-surge valve demand when surge was detected to establish the SMP valve limit. After the open-loop Surge Recovery response ramps out, the valve will not be allowed to close to the demand at surge plus this amount, so as not to drive the unit into surge again.	
Enable Surge Recovery in Full Manual	**dflt= YES (YES/NO)** **dflt (Minimum Amount)= 1.0 (1.0, 100.0)**
Check to enable the Surge Recovery open-loop step response even when in full manual mode. This protection is the only automatic routine that will override manual anti-surge valve control in the full manual mode.	
Enable Surge Minimum Position?	**dflt= YES (YES/NO)** **dflt (Amount)= 1.0 (0.5, 50.0)**
Check to enable the Surge Minimum Position function, which will, after the surge cycle has been broken, prevent the anti-surge valve from closing to the point at which surge was detected.	
SMP Reset	**dflt= Dedicated Reset Used to clear SMP** **[Dedicated Reset Used to clear SMP,** **Normal Reset Used to clear SMP]**
Select *Dedicated Reset Used to Clear SMP* to require an independent signal to be used to reset the SMP level (recommended). If *Normal Reset Used to Clear SMP* is selected, the Alarm Reset command will also trigger the SMP to ramp back to 0.	
Use Auto Shift Function	**dflt= YES (YES/NO)** **dflt (Amount)= 1.0 (1.0, 10.0)**
Check to enable Surge Control Line auto-shifting based upon the surge counter. The Surge Control Line will be shifted a given amount of percentage for each detected surge, i.e. % per surge.	
Control Line Shift Reset	**dflt= Consec SRG RST used for Shift Reset** **[Consec SRG RST used for Shift Reset,** **SMP RST used for Shift Reset,** **Total SRG RST used for Shift Reset,** **Dedicated RST used for Shift Reset]**
When the surge counter is reset, the shifted amount will slowly ramp back to 0, returning the SCL to its original position. Available Reset possibilities are given below: • Consecutive Surge Reset used for Shift reset • SMP Reset used for Shift Reset • Total Surge Reset used for Shift Reset • Dedicated Reset used for Shift Reset	

Antisurge Control - Surge Protection - (ASC Surge Control and Boost Line)

Surge Control Line Margin	**dflt= 30.0 (-30.0, 50.0)**
Enter the margin, used to calculate the setpoint or Surge Control Line (SCL) when the standard algorithm is used. This margin is expressed as a percentage of additional flow, shown on the map to the right of the configured Surge Limit Line (SLL).	
Surge Control Line Margin Minimum	**dflt= 15.0 (-30.0, 50.0)**
Enter the minimum margin allowed during compressor operation.	
Enable Boost	**dflt= YES (YES/NO)**
Check the box to enable the boost or backup line open-loop step response.	
Boost Margin	**dflt= 5.0 (0.0, 50.0)**

Enter the margin in percent flow, typically 3~5%, to locate the boost or backup line to the left of the configured Surge Control Line.	
Amount	**dflt= 10.0 (0.0, 50.0)**
Enter the amount in valve percent that will be added to the current anti-surge valve position when the compressor operating point reaches the boost or backup line. This new valve position remains active for the configured loop period time and then slowly ramps out at the configured valve decay rate. Typically, this value will be what will increase compressor flow by the percent configured as the boost margin. In other words, this amount of valve opening should move the compressor from the boost or back-up line to the Surge Control Line.	
Enable Pre-pack	**dflt= NO (YES/NO)**
Check to enable the Pre-Pack function. This function will briefly over-stroke the anti-surge valve at the beginning of the boost and surge recovery open-loop steps to help decrease system response time. It is typically used on processes with excessive loop periods due to large piping volumes.	
Pre-pack Amount	**dflt= 0.0 (0.0, 50.0)**
Enter the value in valve percent that will be added to the anti-surge valve demand at the beginning of the boost and surge recovery steps.	

Antisurge Control - Surge Protection - (ASC Consecutive Surges Alarm Counter)

Maximum Number of Surges (Consecutive Surges Alarm Counter)	**dflt= 3 (1, 5)**
Enter the number of Surges within the *Time for Maximum Number of Surges* to trigger the Alarm on consecutive surges detected.	
Time for Maximum Number of Surges (Consecutive Surges Alarm Counter)	**dflt= 20 (0, 3600)**
The amount of time that the *Maximum Number of Surges* must be detected within in order to trigger the Alarm on consecutive surges detected.	
Alarm if Consecutive Surges	**dflt= YES (YES/NO)**
Enable this option to generate an alarm in case alarm consecutive surge detection is set.	
Full Opening if Consecutive Surges Alarm Detected	**dflt= YES (YES/NO)**
Enable this option to fully open the anti-surge valve in case alarm consecutive surge detection is set.	
Maximum Number of Surges (Consecutive Surges Shutdown Counter)	**dflt= 3 (1, 5)**
Enter the number of Surges within the *Time for Maximum Number of Surges* to trigger the Shutdown on consecutive surges detected.	
Time for Maximum Number of Surges (Consecutive Surges Shutdown Counter)	**dflt= 20 (0, 3600)**
The amount of time that the *Maximum Number of Surges* must be detected within in order to trigger the Shutdown on consecutive surges detected.	
Trip if Consecutive Surges SD Detected	**dflt= NO (YES/NO)**
Enable this option to issue a shutdown in case the set trip consecutive surge detection activates. This is defaulted to NO to not interfere with the Solo run during commissioning, however, it is recommended that this option is checked for normal operation.	

Antisurge Control - Surge Protection - (ASC AS Valve Feedback Action)

Action Based on AS Valve Feedbacks or Trip Solenoids Status	**dflt= No Action on Valve Feedback/Solenoids [No Action on Valve Feedback/Solenoids, FRC Open if Dev Dmd/AS Opened Contact, FRC Open: AS Contact is Trip Sol, FRC Open if Dev Dmd/AS Analog Feedback]**
There are actions that can be configured: • No action on Valve Feedback /Solenoids • Force Open if Deviation Demand / Anti Surge valve open contact • AS Valve will be forced to open when AS valve set point is lower than a specific configured value (90%-Tunable), and the AS valve hardware binary feedback from field is open. This indicated that regardless of the controller demand, the valve remains opened. Therefore, the controller should not try to close them. • Force Open: Anti Surge contact is trip solenoid.	

• AS Valve will be forced to open when the AS valve hardware binary feedback from field is open. These solenoids are forcing the AS valve to open. Therefore the controller must not try to close them. • Anti-Surge valve Open: Analog feedback • AS Valve will be forced to open when AS valve position feedback input is higher than a specific configured value. • When the AS valve demand is less than 90% (tunable) and the analog signal indicates that the valve is 100% opened then the controller is not in control of the valve and should not try to close it. • When the AS valve demand is different than AS valve feedback, with configurable threshold, an alarm is activated.	
AS Opened Contact Inverted	**dflt= NO (YES/NO)**
It is possible to configure the state of anti-surge opened contact: inverted or not-inverted.	
Full Manual Mode Request Inhibited	**dflt= YES (YES/NO)**
Check to inhibit full manual mode operator selection.	

Antisurge Control - Signal Conditioning - (ASC Last Good Values)

This screen is used for setting up the control actions associated with failures of field instruments used by ASC core. Description can be found in Chapter 2, section 'Signal Failure Routines'. The options for configuration are:

- Last good values
- Smart Settings
- Default value settings
- Field signal filtering
- Field signal fault action on control

Use Suction Pressure Last Good Value	**dflt= NO (YES/NO)**
Check to enable the last good value failure response for the compressor suction pressure signal. If the signal fails, and compressor operation has been stable for approximately one minute, the stable suction pressure value will be retained for control, even though the input has failed.	
Use Discharge Pressure Last Good Value	**dflt= NO (YES/NO)**
Check to enable the last good value failure response for the compressor discharge pressure signal. If the signal fails, and compressor operation has been stable for approximately one minute, the stable discharge pressure value will be retained for control, even though the input has failed.	
Use Suction Temperature Last Good Value	**dflt= NO (YES/NO)**
When checked, the last good value failure response for the compressor suction temperature signal is enabled. If the signal fails, and compressor operation has been stable for approximately one minute, the stable suction temperature value will be retained for control, even though the input has failed.	
Use Discharge Temperature Last Good Value	**dflt= NO (YES/NO)**
When checked, the last good value failure response for the compressor discharge temperature signal is enabled. If the signal fails, and compressor operation has been stable for approximately one minute, the stable discharge temperature value will be retained for control, even though the input has failed.	
Use Actual Flow Last Good Value	**dflt= NO (YES/NO)**
Check to enable the last good value failure response for the compressor actual flow. If the signal fails, and compressor operation has been stable for approximately one minute, the stable actual flow value will be retained for control, even though the input has failed.	
Use Pressure Ratio Last Good Value	**dflt= NO (YES/NO)**
Check to enable the last good value failure response for the compressor pressure ratio. If the signal fails, and compressor operation has been stable for approximately one minute, the stable pressure ratio will be retained for control, even though the input has failed.	

Antisurge Control - Signal Conditioning - (ASC Smart Calculation Settings)

Use Smart Suction Temperature	**dflt= NO (YES/NO)**
Check to enable the smart setting failure response for the compressor suction temperature. This option will be active in the online condition when P1, P2 and T2 sensors are healthy. If any of the other sensors are failed, Default Value for suction temperature will be used.	
Use Smart Discharge Temperature	**dflt= NO (YES/NO)**
Check to enable the smart setting failure response for the compressor discharge temperature. This option will be active in the online condition when P1 and P2 sensors are healthy. If any of the other sensors are failed, Default Value for discharge temperature will be used.	

Antisurge Control - Signal Conditioning - (ASC Default Value Settings)

Default Pressure At Suction	**dflt= 1.0 (-10000.0, 10000.0)**
Enter a conservative default value for the compressor suction pressure. This value will be used for control after a signal failure if last good value is not enabled or not suitable because of unstable operation, or if compressor operation becomes unstable while the last good value is in use. Generally, this default value should be chosen to generate a conservative calculation of compressor operation in the case of a signal failure. A typical value is 10% less than the rated suction pressure.	
Default Temperature At Suction	**dflt= 1.0 (-273.0, 3000.0)**
Enter a conservative default value for compressor suction temperature. This value will be used for control after a signal failure if last good value is not enabled or not suitable because of unstable operation, or if compressor operation becomes unstable while the last good value is in use. Generally, this default value should be chosen to generate a conservative calculation of compressor operation in the case of a signal failure. A typical value is 10% more than the rated suction temperature.	
Default Pressure At Discharge	**dflt= 1.0 (-10000.0, 10000.0)**
Enter a conservative default value for compressor discharge pressure. This value will be used for control after a signal failure if last good value is not enabled or not suitable because of unstable operation, or if compressor operation becomes unstable while the last good value is in use. Generally, this default value should be chosen to generate a conservative calculation of compressor operation in the case of a signal failure. A typical value is 10% more than the rated discharge pressure.	
Default Temperature At Discharge	**dflt= 1.0 (-273.0, 3000.0)**
Enter a conservative default value for compressor discharge temperature. This value will be used for control after a signal failure if last good value is not enabled or not suitable because of unstable operation, or if compressor operation becomes unstable while the last good value is in use. Generally, this default value should be chosen to generate a conservative calculation of compressor operation in the case of a signal failure. A typical value is 10% more than the rated discharge temperature.	
Default Pressure At Flow Element	**dflt= 1.0 (-10000.0, 10000.0)**
If an alternate pressure signal is used for the flow measurement, enter a conservative default value to be used in the event that the alternate pressure signal fails This value will be used for control after a signal failure if last good value is not enabled or not suitable because of unstable operation, or if compressor operation becomes unstable while the last good value is in use. Generally, this default value should be chosen to generate a conservative calculation of compressor operation in the case of a signal failure. A typical value is 10% more than the rated flow pressure. **The default pressure at flow element should always be set to the value at flow meter location regardless of a dedicated sensor being used.**	
Default Temperature At Flow Element	**dflt= 1.0 (-273.0, 3000.0)**
If an alternate temperature signal is used for the flow measurement, enter a conservative default value to be used in the event that the alternate temperature signal fails. This value will be used for control after a signal failure if last good value is not enabled or not suitable because of unstable operation, or if compressor operation becomes unstable while the last good value is in use. Generally, this default value should be chosen to generate a conservative calculation of compressor operation in the case of a signal failure. A typical value is 10% less than the rated flow temperature. **The default temperature at flow element should always be set to the value at flow meter location regardless of a dedicated sensor being used.**	
Default Actual Flow	**dflt= 1.0 (0.0, 300000000000.0)**
Enter a conservative default value default actual flow generally, this default value should be chosen to generate a conservative calculation of compressor operation in the case of a signal failure.	
Default Pressure Ratio	**dflt= 1.5 (1.0, 50.0)**

Enter a conservative default pressure ratio for flow measurement on both suction pressure and discharge pressure sensors failures. Generally, this default value should be chosen to generate a conservative calculation of compressor operation in the case of a signal failure.	
Use Pressure Ratio as Ref. when P1 Fail	**dflt= NO (YES/NO)**
When checked, the default or variable default pressure ratio will be used as calculation reference in case P1 sensor fails.	
Use Pressure Ratio as Ref. when P2 Fail	**dflt= NO (YES/NO)**
When checked, the pressure ratio will be used as calculation reference in case P2 sensor fails.	

Antisurge Control - Signal Conditioning - (ASC Field Signal Filtering)

Flow Filter (ARMA)	**dflt= 0.0 (0.0, 30.0)**
Enter the appropriate filter time constant, in seconds, to be used with the flow signal filter within the ASC. Filtering should be minimized if at all possible, but this value can be adjusted as necessary to provide a clean, noise-free flow signal. Because the flow signal is the fastest and most important anti-surge process variable, filter times should usually be restricted to 100 milliseconds or less.	
Pressure Filter	**dflt= 0.0 (0.0, 30.0)**
Enter the appropriate filter time constant, in seconds, to be used with the pressure signal filters within the ASC. Filtering should be minimized if at all possible, but this value can be adjusted as necessary to provide clean, noise-free pressure signals. Because pressure processes are generally moderate in speed and signals clean, filter times, if necessary at all, are usually in the hundreds of milliseconds.	
Temperature Filter	**dflt= 0.0 (0.0, 30.0)**
Enter the appropriate filter time constant, in seconds, to be used with the temperature signal filters within the core control software. Filtering should be minimized if at all possible, but this value can be adjusted as necessary to provide clean, noise-free temperature signals. Because temperature processes are generally slow and signals clean, filter times, if necessary at all, can be extended to seconds.	

Antisurge Control - Signal Conditioning - (ASC Field Signal Fault Action on Control)

Added Man Amount on Flow Fail	**dflt= 10.0 (0.0, 100.0)**
Specify the amount of anti-surge valve demand to add on the flow signal failure. Minimum anti-surge valve demand if Flow or Pressure at flow fail.	
Full Manual on Flow sensor Fault	**dflt= NO (YES/NO)**
Check to enable the fail to manual strategy on flow sensor input failures.	
Full Manual Mode Selected on Any Fault	**dflt= NO (YES/NO)**
Check to enable the fail to manual strategy on all input failures, not only flow, but also pressures and temperatures. This is the most conservative strategy for handling input signal failures, but last good value, if enabled, takes priority.	
Min. AS Valve Demand if Flow or Press @ Flow Fail	**dflt= NO (YES/NO)**
Check to enable the minimum anti surge valve demand on flow or pressures input failure.	
Min. AS Valve Demand on Fault	**dflt= 10.0 (0.0, 100.0)**
Specify the amount of anti-surge valve demand to add on the flow or pressure signal failure.	
Flow Fail Position Delay	**dflt= 2.0 (0.0, 10.0)**
Specify the delay time of anti-surge valve demand to add on the flow or pressure signal failure.	

Antisurge Control - PIDs - (ASC Normal Surge Controller Settings)

Use Compensation on Normal PID	**dflt= NO (YES/NO)**
Check this checkbox to enable automatic gain compensation of the anti-surge PID's proportional gain (see Chapter 6 for a complete description of this function). If enabled, gain compensation will scale the proportional gain relative to the compressor's current operating conditions. This feature is only possible when anti-surge valve Cv gain compensation is configured.	
Proportional Gain	**dflt= 0.3 (0.0, 50.0)**
Enter the appropriate proportional gain (in percent) of the anti-surge PID.	
Integral Gain	**dflt= 0.3 (0.0, 50.0)**
Enter the appropriate integral gain (in repeats per second) of the anti-surge PID.	
Speed Derivative Ratio	**dflt= 100.0 (0.0, 100.0)**
Enter the appropriate speed derivative ratio (in percent) of the anti-surge PID. Leave this value at 100% for proportional and integral control (recommended).	

Antisurge Control - PIDs - (ASC Rate PID Controller Settings)

Use Rate Controller	**dflt= NO (YES/NO)**

Check to enable the Rate Controller, which limits the rate of movement of the compressor operating point toward its Surge Control Line. As the operating point moves closer to the Surge Control Line, its speed of approach becomes more critical. If the control deems the rate of approach excessive, it will open the anti-surge valve to slow the operating point before it reaches the Surge Control Line, thereby lessening overshoot and instability during a severe transient condition.	
Use Compensation on Normal Rate PID	**dflt= NO (YES/NO)**
Check to enable automatic gain compensation of the rate PID's proportional gain. If enabled, gain compensation will scale the proportional gain relative to the compressor's current operating conditions.	
Proportional Gain	**dflt= 0.3 (0.0, 50.0)**
Enter the appropriate proportional gain (in percent) of the rate PID.	
Integral Gain	**dflt= 0.3 (0.0, 50.0)**
Enter the appropriate integral gain (in repeats per second) of the rate PID.	
Speed Derivative Ratio	**dflt= 100.0 (0.0, 100.0)**
Enter the appropriate speed derivative ratio (in percent) of the rate PID. Leave this value at 100% for proportional and integral control.	
Rate Setpoint (% of Max Rate)	**dflt= 33.0 (1.0, 100.0)**
Enter the appropriate rate controller setpoint, in percent of maximum allowable rate.	

Antisurge Control - PIDs - (ASC Valve Freeze Option)

Use Valve Freeze Option	**dflt= NO (YES/NO)**
Check to enable the anti-surge valve freeze function. This routine will clamp the valve demand at a fixed output if unit operation varies within confined windows of anti-surge valve demand and S_PV. This may aid in settling an unnecessarily swinging process.	
Delay Before Freezing the Valve	**dflt= 30.0 (0.0, 300.0)**
Enter the time delay, in seconds, at which the freeze function is enabled or sampled. In other words, after this time delay the freeze routine is initiated provided that the valve demand and S_PV criteria are satisfied.	
Window on Valve Demand	**dflt= 3.0 (0.1, 10.0)**
Enter the value of internal valve demand, in %, at which the freeze function remains active.	
Window on Surge Operation Point	**dflt= 3.0 (0.0, 10.0)**
Enter the value of internal S_PV, in %, at which the Freeze function remains active.	

Antisurge Control - PIDs - (ASC Suction Pressure Override Controller)

Tag Name	**dflt= PICXXX (32 Characters)**
User entry for control tag.	
Description	**dflt= Suction pressure override (32 Characters)**
User entry for control description.	
Controller Function Selection	**dflt= Not Used [Not Used, Used With Actual P1]**
Select "Used with Actual P1" to enable suction pressure override control. This auxiliary controller will modulate the anti-surge valve when suction pressure falls below an established limiting setpoint. This control loop is usually used to help maintain suction pressure within the it process limits. One example of activating this control loop would be, in a situation when the motor or turbine speed reaches its minimum value and suction pressure continues to fall. The actual P1 or another dedicated channel can be selected to be used for suction pressure override controller.	
Use Pressure Compensation	**dflt= NO (YES/NO)**
Check to enable automatic gain compensation of the suction pressure PID's proportional gain. If enabled, gain compensation will scale the proportional gain relative to the compressor's current operating conditions.	
Proportional Gain	**dflt= 0.3 (0.0, 50.0)**
Enter the appropriate proportional gain (in percent) of the suction pressure PID.	
Integral Gain	**dflt= 0.3 (0.0, 50.0)**
Enter the appropriate integral gain (in repeats per second) of the suction pressure PID.	
Speed Derivative Ratio	**dflt= 100.0 (0.0, 100.0)**
Enter the appropriate speed derivative ratio (in percent) of the suction pressure PID. Leave this value at 100% for proportional and integral control.	

Initial Setpoint	**dflt= () see AI_03**
Enter an appropriate pressure override setpoint value, such as compressor suction pressure setpoint. This setpoint should be chosen carefully if other devices or logic will be controlling the same process parameter.	
SP Rate of Change	**dflt= 0.1 (0.001, 10000.0)**
This defines the rate of change when the setpoint is raised or lowered during running.	
Auto Enable on Power-up	**dflt= NO (YES/NO)**
Check to automatically enable P1 Override Controller of the suction pressure at power-up and initialization of the system	

Antisurge Control - PIDs - (ASC Discharge Pressure Override Controller)

Tag Name	**dflt= PICXXX (32 Characters)**
User entry for control tag.	
Description	**dflt= Discharge pressure override (32 Characters)**
User entry for control description.	
Controller Function Selection	**dflt= Not Used [Not Used, Used With Actual P2]**
Select "Used with Actual P2" to enable discharge pressure override control. This auxiliary controller will modulate the anti-surge valve to relieve compressor discharge pressure and is usually used as a backup to other primary controllers such as when the motor speed which is controlling suction pressure reaches minimum governor. The actual P2 or another dedicated channel can be selected to be used for discharge pressure override controller.	
Use Pressure Compensation	**dflt= NO (YES/NO)**
Check to enable automatic gain compensation of the suction pressure PID's proportional gain. If enabled, gain compensation will scale the proportional gain relative to the compressor's current operating conditions.	
Proportional Gain	**dflt= 0.3 (0.0, 50.0)**
Enter the appropriate proportional gain (in percent) of the discharge pressure PID.	
Integral Gain	**dflt= 0.3 (0.0, 50.0)**
Enter the appropriate integral gain (in repeats per second) of the discharge pressure PID.	
Speed Derivative Ratio	**dflt= 100.0 (0.0, 100.0)**
Enter the appropriate speed derivative ratio (in percent) of the discharge pressure PID. Leave this value at 100% for proportional and integral control.	
Initial Setpoint	**dflt= ()**
Enter an appropriate pressure override setpoint value, such as compressor discharge pressure setpoint. This setpoint should be chosen carefully if other devices or logic will be controlling the same process parameter.	
SP Rate of Change	**dflt= 0.1 (0.001, 10000.0)**
This defines the rate of change when the setpoint is raised or lowered during running.	
Auto Enable on Power-up	**dflt= NO (YES/NO)**
Check to automatically enable P2 Override Controller of the discharge pressure at power-up and initialization of the system	

Antisurge Control - Decoupling - (ASC Decoupling - Main Settings)

Decoupling may be necessary to provide action before an upset occurs. Upsets are anticipated from knowledge of the operating parameters and their relation to the operation of the anti-surge valve.

Decoupling Selection	**dflt= No compressor decoupling used [No compressor decoupling used, Compressor Decoupling used]**
The following selections can be made to activate decoupling: • No compressor decoupling used • Compressor decoupling used (Enables Decoupling Action)	
Min Decoupling Level	**dflt= 0.0 (0.0, 1.0)**
Minimum values added/subtracted to the valve as demand by the decoupling action.	
Max Decoupling Level	**dflt= 0.0 (0.0, 20.0)**
Maximum values added/subtracted to the valve as demand by the decoupling action.	

Surge Process Value Range (to Act)	**dflt= 110.0 (100.0, 140.0)**
This is the minimum value of the surge operating point to activate decoupling.	
Rate Limit on Enable/Disable Decoupling	**dflt= YES (YES/NO)**
Limit the rate when bringing Decoupling in and out of control.	

Antisurge Control - Decoupling - (ASC Decoupling on Speed)

Slow Speed Delay Time	**dflt= 110.0 (0.0, 500.0)**
Enter the appropriate delay time (in seconds) that the steady-state speed decoupling routine will remain in effect.	
Slow Speed Amount	**dflt= 0.0 (0.0, 300.0)**
Enter the appropriate gain, or scalar, (in percent valve demand per rpm) applied to a change in prime mover speed to generate a feed-forward bias of the anti-surge valve demand. Decoupling is enabled by setting the amount separately for all routines. Set the amount to 0.0 to disable a particular decoupling routine.	
Fast Speed Delay Time	**dflt= 30.0 (0.0, 5000.0)**
Enter the appropriate delay time (in seconds) that the emergency speed decoupling routine will remain in effect. After this time delay, the bias will be removed from the valve demand.	
Fast Speed Amount	**dflt= 0.0 (0.0, 200.0)**
Enter the appropriate gain or scalar (in percent valve demand per rpm), applied to a change in prime mover speed, to generate a feed-forward bias of the anti-surge valve demand. Decoupling is enabled by setting the amount separately for all routines. Set the amount to 0.0 to disable a particular decoupling routine. **Automatic Gain Compensation (AGC) is applied to Fast Speed Decoupling, so AGC should be configured prior to Decoupling.** **Decoupling on speed as described above is only active when a valid speed signal is available.**	

Antisurge Control - Decoupling - (ASC Decoupling Selection)

Decoupling Selection 1	**dflt= Decoupling 1 Not Used [Decoupling 1 Not Used, Decoupling 1 on ASC2 Demand, Decoupling 1 on Performance Demand, Decoupling 1 on External Signal 1]**
Decoupling signal source can be configured as: *Decoupling on ASC Demand*: The valve demand signal from the other ASC section. *Decoupling on Performance Demand:* The demand from the performance control *Decoupling on External Signal 1*: An analog input from another plant process	
Selection 1 Delay Time	**dflt= 0.0 (0.0, 500.0)**
This is the delay time in seconds that decoupling from the selected decoupling signal will remain in effect. After this time delay, the bias will be removed from the valve demand.	
Selection 1 Amount	**dflt= 0.0 (-100.0, 300.0)**
This is the gain in percent per percent of the decoupling signal to modulate the anti-surge valve.	
Decoupling Selection 2	**dflt= Decoupling 2 Not Used [Decoupling 2 Not Used, Decoupling 2 on ASC2 Demand, Decoupling 2 on Performance Demand, Decoupling 2 on External Signal 1]**
Decoupling signal source can be configured as: *Decoupling on ASC Demand*: The valve demand signal from the other ASC section. *Decoupling on Performance Demand:* The demand from the performance control *Decoupling on External Signal 1*: An analog input from another plant process	
Selection 2 Delay Time	**dflt= 110.0 (1.0, 140.0)**
This is the delay time in seconds that decoupling from the selected decoupling signal will remain in effect. After this time delay, the bias will be removed from the valve demand.	
Selection 2 Amount	**dflt= 0.0 (-100.0, 300.0)**
This is the gain in percent per percent of the decoupling signal to modulate the anti-surge valve.	
Decoupling Selection 3	**dflt= Decoupling 3 Not Used [Decoupling 3 Not Used,**

	Decoupling 3 on ASC2 Demand, Decoupling 3 on Performance Demand, Decoupling 3 on External Signal 1]
Decoupling signal source can be configured as: *Decoupling on ASC Demand*: The valve demand signal from the other ASC section. *Decoupling on Performance Demand:* The demand from the performance control *Decoupling on External Signal 1*: An analog input from another plant process	
Selection 3 Delay Time	**dflt= 110.0 (1.0, 140.0)**
This is the delay time in seconds that decoupling from the selected decoupling signal will remain in effect. After this time delay, the bias will be removed from the valve demand.	
Selection 3 Amount	**dflt= 0.0 (-100.0, 300.0)**
This is the gain in percent per percent of the decoupling signal to modulate the anti-surge valve.	

Antisurge Control - Decoupling - (ASC Auxiliary Controls)

Use Auxiliary HSS1	**dflt= NO (YES/NO)**
Check to enable the High Signal Select (HSS) bus for auxiliary input #1. The auxiliary input has to come from a 4–20 mA input, but should be configured 0-100% open. It is routed through the HSS bus, so all other anti-surge functions are still active.	
Signal Filter (HSS1)	**dflt= 0.5 (0.0, 300.0)**
Filter applied to the signal by the compressor control.	
Use Auxiliary HSS2	**dflt= NO (YES/NO)**
Check to enable the High Signal Select (HSS) bus for auxiliary input #2. The auxiliary input has to come from tunable Signal Value and has a range of 0-100%. It is routed through the HSS bus, so all other anti-surge functions are still active.	
Signal Filter (HSS2)	**dflt= 0.5 (0.0, 300.0)**
Filter applied to the signal by the compressor control.	
Signal Value	**dflt= -1.0 (-1.0, 101.0)**
Value from 0-100% that is routed to the HSS.	

Antisurge Control - Display Settings - (ASC Display Settings)

WSPV Gauge Max	**dflt= 200.0 (0.0, 300.0)**
This adjusts the high end of the gauge range (in WSPV) on runtime screens. This value does not affect control.	
WSPV Gauge Min	**dflt= 50.0 (0.0, 90.0)**
This adjusts the low end of the gauge range (in WSPV) on runtime screens. This value does not affect control.	
Overview Flow Indication	**dflt= Actual Flow Display [No Flow Display, Actual Flow Display, Standard Flow Display, Mass Flow Display]**
This selection determines the units of the flow indicator on the Overview and Compressor Map pages. This is for display only.	

Performance Control

Performance Control - (Performance Configuration)

Performance Configuration	**dflt= Not Used [Not Used, ASC 1 Suction Pressure, ASC 1 Discharge Pressure, ASC 2 Suction Pressure, ASC 2 Discharge Pressure, Dedicated Signal]**
Select which input the control should use. The input selected here should be configured as an analog input, which is used as the process value for this controller. If Dedicated Signal is used, then an analog input with "Process/Performance Input" must be configured.	
Minimum Setpoint	**dflt= 0.0 (-10000.0, 100000.0)**
Set the minimum Performance set point. This value is the minimum set point value that the Performance set point can be decreased/lowered to (lower limit of Performance set point).	
Maximum Setpoint	**dflt= 100.0 (-100000.0, 100000.0)**
Set the maximum Performance set point. This value is the maximum set point value that the Performance set point can be increased/raised to (upper limit of Performance set point). (Must be greater than the 'Min Performance Setpoint' Setting)	
Inverted?	**dflt= NO (YES/NO)**
Select YES if the Performance control will be reverse acting. If NO is selected, the control will be forward acting. Set to YES if the valve needs to open when the input exceeds the set point. An example where the invert would be YES is for inlet pressure control.	
Setpoint Rate	**dflt= 1.0 (0.0, 100000.0)**
Set the performance set point rate. This value is the rate (in units per second) at which performance set point moves when adjusted	
Use Setpoint Tracking?	**dflt= YES (YES/NO)**
Select YES or NO. If YES, the Performance set point tracks the process variable to provide bumpless transfer to Performance control when it is enabled. If NO, the Performance set point remains at the last position except on power-up or exiting the Configuration mode.	
Initial Setpoint	**dflt= 0.0 (-100000.0, 100000.0)**
Set the set point initialization value. When not using the Set Point Tracking function, this is the value that the Performance set point initializes to upon power-up or exiting the program mode. (Must be less than or equal to the 'Max Performance Setpoint' Setting)	

Performance Control - (Performance Configuration)

Use Remote Setpoint?	**dflt= NO (YES/NO)**
Set to YES to allow the Performance set point to be adjusted from an analog input. (Must program a 'Remote Performance Setpoint' analog input)	
Remote Setpoint Rate	**dflt= 5.0 (0.1, 100000.0)**
Enter the maximum rate at which the remote input will move the Performance set point.	
Use Driver Limit Tracking?	**dflt= NO (YES/NO)**
Select YES to enable Tracking Mode when a signal from the Speed Control indicates that the driver is limited.	
Minimum Governor Speed	**dflt= 100.0 (0.0, 100000.0)**
When Performance sets the Speed Setpoint, this is the Minimum of the normal operating speed range. This value alows the Performance to track the speed value and output an appropriate demand while Driver Tracking is active.	
Maximum Governor Speed	**dflt= 200.0 (0.0, 100000.0)**
When Performance sets the Speed Setpoint, this is the Maximum of the normal operating speed range. This value alows the Performance to track the speed value and output an appropriate demand while Driver Tracking is active.	
Use Remote Manual Demand?	**dflt= NO (YES/NO)**
Select YES to allow an analog input to directly set the Performance output demand. (Must program a "Remote Performance Valve Demand" analog input).	
Performance Drive Type	**dflt= Suction Throttle Valve [Suction Throttle Valve Discharge Throttle Valve Speed Control Setpoint IGV Position ASC 2 Discharge Pressure Dedicated Signal]**

Select the component which will receive the Performance demand signal. This selection is used for Displaying the correct driver in the GUI, and enables IGV Positioning for ASC Online detection, if IGV Position is selected.

Performance Control - (Performance Sequencing)

Reset Position	**dflt= 0.0 (0.0, 100.0)**
Enter the demand in percent the Performance control will demand when in the "Reset Position" (all trips cleared, but not started).	
Startup Position	**dflt= 0.0 (0.0, 101.0)**
Enter the demand in percent the Performance control will demand when the Start Command is given.	
Startup Delay	**dflt= 0.0 (0.0, 600.0)**
Enter the delay in seconds the control will wait after receiving the Start Command before ramping to the "Startup Position".	
Sequence Ramp Rate	**dflt= 1.0 (0.099, 25.0)**
Enter the rate in percent per second that the Performance sequencing routines will ramp the demand at.	
Use Remote Start?	**dflt= NO (YES/NO)**
If YES, when all trips are cleared, the Vertex considers the prime mover started and the Sequence Ramp begins ramping to 100% at the “Sequence Ramp Rate” until the Performance PID takes over the demand on the LSS.	
Use Manual Start?	**dflt= NO (YES/NO)**
If YES, Manual Start is selected, and the Performance control will be placed in Manual mode as soon as the Vertex moves to the Start Completed state, and will hold the last demand set by the Sequence Ramp. If NO, Auto Start is selected, and the Performance control will be placed in Automatic mode as soon as the Vertex moves to the Start Completed state.	
Force Full Open upon a SD?	**dflt= NO (YES/NO**
If YES, when a Trip occurs the PFC valve will step to 100% open position. Upon a 'Reset' of the TRIP condition, the PFC valve will 'step' to 0% demand and then ramp to the PFC sequence 'Reset Position' demand (use with caution – this only applies to certain valve arrangements).	

Performance Control - (Performance Configuration - Decoupling)

Decoupling Signal Selection	**dflt= Not Used [Not Used, External AI Signal, ASV1 Demand, ASV2 Demand, HSS of ASV1 and ASV2]**
Select the decoupling signal to be used in biasing the Performance demand.	
Gain	**dflt= 0.0 (-10.0, 10.0)**
This is the gain in percent per percent of the decoupling signal to modulate the Performance demand.	
Lag	**dflt= 0.0 (0.0, 10.0)**
This is the delay time in seconds that decoupling from the selected decoupling signal will remain in effect. After this time delay, the bias will be removed from the Performance demand.	
On Rate	**dflt= 1.0 (0.0, 20.0)**
When decoupling is enabled, this rate, in percent per second that the decoupling bias can modulate the Performance demand.	
Off Rate	**dflt= 1.0 (0.0, 20.0)**
When decoupling is disabled, this is the rate to deactivate the decoupling bias to zero.	
Range	**dflt= 0.0 (0.0, 20.0)**
Set the authority level in percent of the decoupling bias. This is the max bias +/- from the current Performance demand.	

Limiter Control

Limiter Control - (Performance Limiter 1)

Limiter Configuration	**dflt= Not Used [Not Used, Motor Current/Power Input, ASC 1 Suction Pressure, ASC 1 Discharge Pressure, ASC 2 Suction Pressure, ASC 2 Discharge Pressure, Limiter Analog Input]**
Select which input the control should use. The input selected here should be configured as an analog input, which is used as the process value for this controller. If Limiter Analog Input is used, then an analog input with "Limiter 1 Input" must be configured.	

Minimum Setpoint	**dflt= 0.0 (-1.0e+38, 1.0e+38)**
Set the minimum Limiter set point. This value is the minimum set point value that the Limiter set point can be decreased/lowered to (lower limit of Limiter set point).	
Maximum Setpoint	**dflt= 100.0 (-1.0e+38, 1.0e+38)**
Set the maximum Limiter set point. This value is the maximum set point value that the Limiter set point can be increased/raised to (upper limit of Limiter set point). (Must be greater than the 'Min Limiter Setpoint' Setting)	
Initial Setpoint	**dflt= 0.0 (0.0, 1.0e+20)**
Set the set point initialization value. When not using the Set Point Tracking function, this is the value that the Limiter set point initializes to upon power-up or exiting the program mode. (Must be less than or equal to the 'Max Limiter Setpoint' Setting)	
Inverted?	**dflt= NO (YES/NO)**
Select YES if the Limiter control will be reverse acting. If NO is selected, the control will be forward acting. Set to YES if the valve needs to open when the input exceeds the set point. An example where the invert would be YES is for inlet pressure control.	
Setpoint Rate	**dflt= 5.0 (0.01, 1000.0)**
Set the Limiter set point rate. This value is the rate (in units per second) at which Limiter set point moves when adjusted	
Use Remote Setpoint?	**dflt= NO (YES/NO)**
Set to YES to allow the Limiter set point to be adjusted from an analog input. (Must program a 'Remote Limiter 1 Setpoint' analog input)	
Remote Setpoint Rate	**dflt= 5.0 (0.01, 1000.0)**
Enter the maximum rate at which the remote input will move the Limiter set point.	

Limiter Control - (Performance Limiter 2)

Limiter Configuration	**dflt= Not Used [Not Used, Motor Current/Power Input, ASC 1 Suction Pressure, ASC 1 Discharge Pressure, ASC 2 Suction Pressure, ASC 2 Discharge Pressure]**
Select which input the control should use. The input selected here should be configured as an analog input, which is used as the process value for this controller.	
Minimum Setpoint	**dflt= 0.0 (-1.0e+38, 1.0e+38)**
Set the minimum Limiter set point. This value is the minimum set point value that the Limiter set point can be decreased/lowered to (lower limit of Limiter set point).	
Maximum Setpoint	**dflt= 100.0 (-1.0e+38, 1.0e+38)**
Set the maximum Limiter set point. This value is the maximum set point value that the Limiter set point can be increased/raised to (upper limit of Limiter set point). (Must be greater than the 'Min Limiter Setpoint' Setting)	
Initial Setpoint	**dflt= 0.0 (0.0, 1.0e+20)**
Set the set point initialization value. When not using the Set Point Tracking function, this is the value that the Limiter set point initializes to upon power-up or exiting the program mode. (Must be less than or equal to the 'Max Limiter Setpoint' Setting)	
Inverted?	**dflt= NO (YES/NO)**
Select YES if the Limiter control will be reverse acting. If NO is selected, the control will be forward acting. Set to YES if the valve needs to open when the input exceeds the set point. An example where the invert would be YES is for inlet pressure control.	
Setpoint Rate	**dflt= 5.0 (0.01, 1000.0)**
Set the Limiter set point rate. This value is the rate (in units per second) at which Limiter set point moves when adjusted	

Load Sharing

Load Sharing - (Load Sharing)

Use Load Sharing?	**dflt= NO (YES/NO)**
Select YES to enable the load sharing functionality. When enabled, the Ethernet communications and fault annunciations are activated.	
Number of Trains in Load Sharing	**dflt= 2 (2,5)**
Select the total number of trains in the load-sharing group.	
Train ID	**dflt= 1 (1,5)**
Each train in the load sharing group must be assigned a unique ID. The train ID is used for signal routing.	
Load Sharing Parameter	**dflt= WSPV [WSPV, Speed, Flow Through Stage]**
This selection determines which signal is used to balance the load across each train in the load-sharing group. WSPV: If the surge process variable is chosen, the Performance demand for each train will be biased to the average of all the trains such that each train in the load-sharing group has the same operating point. If WSPV is selected, the ASVs from all trains will begin opening at the same time (WSPV = 100) Speed: If speed is chosen, the Performance demand for each train will be biased to the average speed of all the trains such that each train in the load sharing group will operate at the same speed. Flow Through Stage: IIf flow is chosen, the Performance demand for each train will be biased to the average flow of all the trains such that each train in the load sharing group will operate at the same flow rate.	
Inverted Control?	**dflt= NO (YES/NO)**
Select YES if the Load Share control will be reverse acting. If NO is selected, the control will be forward acting. Set to YES if the valve needs to open when the input exceeds the set point. An example where the invert would be YES is for inlet pressure control.	
Inverted Bias?	**dflt= NO (YES/NO)**
Select YES to invert the load share bias to the load sharing setpoint. Each train calculates the average load share parameter (i.e. WSPV) from all trains as the target value. The load share parameter bias is calculated as average value minus the local train value. This bias is added to the load sharing master setpoint. Inverting the bias will calculate the bias as the train value minus the average value (i.e. WSPV). For example, if a common suction header pressure is to be controlled by the load sharing group via Performance suction throttle valves and the *Load Sharing Parameter* is configured as WSPV, then *Invert Control* is YES. As a result, the *Invert Bias* should be YES. In this case, if the local train WSPV is greater than the average WSPV, the throttle valve needs to close in order to reduce the compressor WSPV. To achieve this, the load share setpoint must be increased (because *Invert Control* is YES). When *Invert Bias* is YES, the bias is calculated as local train WSPV minus the average WSPV. This results in an increase to the Master setpoint and the control responds by closing the throttle valve, bringing the local compressor WSPV back to the target.	
Load Sharing Parameter Location	**dflt= Suction Header [Suction Header, Discharge Header]**
Select Inlet Header if the common process variable for all trains is the Inlet Header. Select Discharge Header if the common process variable for all trains is the Discharge Header. This parameter is used for display purposes only.	
Minimum Setpoint	**dflt= 0.0 (-1.0e+38, 1.0e+38)**
Set the minimum Load Share set point. This value is the minimum set point value that the Load Share set point can be decreased/lowered to (lower limit of Limiter set point).	
Maximum Setpoint	**dflt= 100.0 (-1.0e+38, 1.0e+38)**
Set the maximum Load Share set point. This value is the maximum set point value that the Load Share set point can be increased/raised to (upper limit of Load Share set point). (Must be greater than the 'Min Load Share Setpoint' Setting)	
Initial Setpoint	**dflt= 0.0 (-100000.0, 100000.0)**
Set the set point initialization value. When not using the Set Point Tracking function, this is the value that the Load Share set point initializes to upon power-up or exiting the program mode. (Must be less than or equal to the 'Max Load Share Setpoint' Setting)	

Units	dflt= EU (8 Characters)
User entry field to set the units for the Load Share controller to be displayed in the run-time screens.	

Analog Inputs

Analog Input Configuration Menu

Signal	dflt= Display Only
Displays the mA signal reading.	
Value	**dflt= Display Only**
Displays the current scaled mA value.	
4 mA Value	**dflt= 0.0 (-1.0e+38, 1.0e+38)**
Set the value (in engineering units) that corresponds to 4 milliamps (mA) on the analog input.	
20 mA Value	**dflt= 100.0 (-1.0e+38, 1.0e+38)**
Set the value (in engineering units) that corresponds to 20 milliamps (mA) on the analog input. (Must be greater than the 'Input 4 mA Value' Setting)	
Fault	**dflt= Display Only**
Displays the fault status of the analog input. The channel is considered faulted if the mA reading is less than 2mA or greater than 22mA.	
Input Function	
Scroll through the menu by navigating the focus highlighter to the desired item, pressing ENTER, using the Adjust Up/Down Arrows, and then pressing the ENTER key again to select the option/function. Press the ESC key to cancel the selection. See tables in chapter 1 for the list of functional options.	
Gain	**dflt= 1.0 (-2.0, 10.0)**
Gain is used in calibration to bias the signal at its maximum value in order to match the signal being transmitted from the source device. Control Signal = Signal*Gain + Offset	
Offset	**dflt= 0.0 (-100.0, 100.0)**
Offset is used in calibration to bias the signal at its minimum value in order to match the signal being transmitted from the source device. Control Signal = Signal*Gain + Offset	
Loop Powered	**dflt= NO (YES/NO)**
Check this box if the Vertex should provide loop power for the transmitter.	
Device Tag	**dflt= AI_01 (25 Characters)**
This is a user entered field. It allows entry of a short description or tag name for this channel.	
Units	**dflt= Display Only Configured in Train Configuration**
This is a user entered field. It allows entry of a unit label for this channel.	
Modbus Multiplier	**dflt= 1 [0.01, 0.1, 1, 10, 100]**
This is the multiplier that will be used for this parameter address on the Vertex slave Modbus communication link.	
Decimals Displayed	**dflt= 1 [0, 1, 2, 3]**
This is the number of decimals to be displayed on the Vertex screens for this parameter.	
Use as Generic Input?	**dflt= NO (YES/NO)**
Select YES if the analog input channel function is not used by the Vertex control, but is used for Alarm/Trip monitoring in the Channel Events.	
Inhibit Backup on Fault?	**Dflt=NO (YES/NO)**
Selecting this box will inhibit a transfer to the Backup unit from occurring if this input signal is faulted. The default setting of NO, means that if this input channel is faulted on the backup unit, it will still be available for application triggered transfers of SYSCON control. With either selection, the control will annunciate an alarm indicating this signal is failed on the backup unit. This setting only applies to the 8 AI channels on the main chassis, it does not apply to any AI's from the RTCNet nodes. {This setting is ignored if a simplex configuration is used}	

Analog Inputs - Channel Events

Analog Input 01 Signal	dflt= Display Only Configured in Analog Inputs - AI_01

Displays the Function the channel is configured for.	
Use Alarm Setpoint 1?	**dflt= NO (YES/NO)**
Set to YES to enable Level 1 Setpoint. Once enabled, if the signal is greater than the Level 1 Setpoint, an Alarm will be generated.	
Use Alarm Setpoint 2?	**dflt= NO (YES/NO)**
Set to YES to enable Level 2 Setpoint. Once enabled, if the signal is greater than the Level 2 Setpoint, an Alarm (or trip) will be generated.	
Use Level 2 As a Trip?	**dflt= NO (YES/NO)**
Set to YES to enable the Level 2 Setpoint will generate a trip, shutting down the turbine.	
Level 1 Setpoint	**dflt= 60.0 (-90000.0, 90000.0)**
Value for the Level 1 Setpoint Alarm in engineering Units.	
Invert Alarm 1	**dflt= NO (YES/NO)**
Set to YES to change alarm to a falling level trigger. If the Signal falls below the Level 1 Setpoint, an Alarm will be generated.	
Level 2 Setpoint	**dflt= 70.0 (-90000.0, 90000.0)**
Value for the Level 2 Setpoint Alarm/Trip in engineering Units.	
Invert Alarm 2	**dflt= NO (YES/NO)**
Set to YES to change alarm to a falling level trigger. If the Signal falls below the Level 2 Setpoint, an Alarm/Trip will be generated.	
Setpoint Hysteresis	**dflt= -3.0 (-100.0, 100.0)**
The hysteresis value determines when the Alarm will be triggered and when it will be cleared again. For non-inverted action: If hysteresis is zero, an alarm is triggered when the Input Signal becomes greater than or equal to the Level Setpoint and the alarm condition is cleared when the input signal goes less than the Level Setpoint. If hysteresis is positive, an alarm is triggered when the Input Signal becomes greater than or equal to the Level Setpoint plus Hysteresis and the alarm condition is cleared when the input signal goes less than the Level Setpoint. If hysteresis is negative, an alarm is triggered when the Input Signal becomes greater than or equal to the Level Setpoint and the alarm condition is cleared when the input signal goes less than the Level Setpoint minus Hysteresis (absolute value). For inverted action: If hysteresis is zero, an alarm is triggered when the Input Signal becomes less than or equal to the Level Setpoint and the alarm condition is cleared when the input signal goes greater than the Level Setpoint. If hysteresis is positive, an alarm is triggered when the Input Signal becomes less than or equal to the Level Setpoint minus Hysteresis and the alarm condition is cleared when the input signal goes greater than the Level Setpoint. If hysteresis is negative, an alarm is triggered when the Input Signal becomes less than or equal to the Level Setpoint plus Hysteresis (absolute value) and the alarm condition is cleared when the input signal goes greater than the Level Setpoint.	
Delay for Event Action (sec)	**dflt= 2.0 (0.0, 300.0)**
This value sets the delay in seconds from the time an Alarm condition is met to the time an alarm is generated. The alarm condition must be present for at least this delay time for an alarm to be generated.	
Enable Speed Setpoint (RPM)	**dflt= -1 (-1, 10000)**
This value is used as a permissive for the alarm condition. If drive speed is below this value, an alarm is not generated even if the alarm condition is met.	
Enable Speed Hysteresis (RPM)	**dflt= 0.0 (-100.0, 100.0)**
The hysteresis value determines when the Alarm speed permissive will be met and when it will be cleared again.	

If hysteresis is zero, the alarm speed permissive is met when the Speed Signal becomes greater than or equal to the Enable Speed Setpoint and the alarm speed permissive is not met when the speed signal goes less than the Enable Speed Setpoint. If hysteresis is zero, the alarm speed permissive is met when the Speed Signal becomes greater than or equal to the Enable Speed Setpoint plus Hysteresis and the alarm speed permissive is not met when the speed signal goes less than the Enable Speed Setpoint. If hysteresis is zero, the alarm speed permissive is met when the Speed Signal becomes greater than or equal to the Enable Speed Setpoint plus Hysteresis and the alarm speed permissive is not met when the speed signal goes less than the Enable Speed Setpoint minus Hysteresis (absolute value).

Analog Inputs # 2 through # 8 are configured following the same rules as described for Analog Input # 1.

Analog Outputs

Analog Outputs Configuration Menu

Readback	**dflt= Display Only**
Displays the current mA readback current sensed at the negative terminal.	
Value	**dflt= Display Only**
Displays the current value, in engineering units, being sent.	
Min Range	**dflt= 0.0 (-1.0e+38, 1.0e+38)**
Set the value (in engineering units) that corresponds to 4 milliamps (mA) on the analog output.	
Max Range	**dflt= 100.0 (-1.0e+38, 1.0e+38)**
Set the value (in engineering units) that corresponds to 20 milliamps (mA) on the analog output. (Must be greater than the 'Readout 4 mA Value' Setting)	
Fault	**dflt= Display Only**
Indicates if a fault has been detected for the channel. See 'Enable Readback Fault' for more details.	
Output Function	
Scroll through the menu by navigating the focus highlighter to the desired item, pressing ENTER, using the Adjust Up/Down Arrows, and then pressing the ENTER key again to select the option/function. Press the ESC key to cancel the selection. See tables in chapter 1 for the list of functional options.	
Device Tag	**dflt= AO 01 (30 Characters)**
This is a user entered field. It allows entry of a short description or tag name for this channel.	
Units	**dflt= EU (30 Characters)**
This is a user entered field. It allows entry of a unit label for this channel.	
Enable Readback Fault?	**dflt= NO (YES/NO)**
Select YES to issue an alarm when an actuator fault is detected. If YES, the Vertex will issue an alarm if the analog channel has a fault. If NO, no fault alarm will be issued. A fault will be determined if the current drops below the failure level or if the difference between the current detected on the source and return wires of the circuit is greater than approximately 5%.	
Use Fault Shutdown?	**dflt= NO (YES/NO)**
When configured as a driver, selecting YES will issue a trip if a Readback Fault is detected. If NO, an alarm is annunciated.	
Fail Open Actuator?	**dflt= YES (YES/NO) for ASV dflt= NO (YES/NO) for PFC**
Select YES to drive 20mA at 0% Demand and 4mA at 100% Demand.	

Analog Outputs # 2 through # 6 are configured following the same rules as described for Analog Output # 1.

Drivers

Driver Configuration Menu

Demand	**dflt= Display Only**
Displays the current demand in percent.	
Readback	**dflt= Display Only**

Displays the current mA readback current sensed at the negative terminal.	
Min Range	**dflt= 0.0 (-1.0e+38, 1.0e+38)**
Set the value (in engineering units) that corresponds to 4 milliamps (mA) on the actuator output.	
Max Range	**dflt= 100.0 (-1.0e+38, 1.0e+38)**
Set the value (in engineering units) that corresponds to 20 milliamps (mA) on the actuator output.	
Fault	**dflt= Display Only**
Indicates if a fault has been detected for the channel. See 'Enable Readback Fault' for more details.	
Actuator Function	
Scroll through the menu by navigating the focus highlighter to the desired item, pressing ENTER, using the Adjust Up/Down Arrows, and then pressing the ENTER key again to select the option/function. Press the ESC key to cancel the selection. See tables in chapter 1 for the list of functional options.	
Actuator Range	**dflt= 4-20 mA [4-20 mA 0-200 mA]**
Select the actuator channel output current range. Select 4–20 mA or 20–160 mA. The range can be adjusted via calibration, for example, for a 20-160 mA actuator select the 0-200 mA range.	
Dither	**dflt= 0.0 (0.0, 10.0)**
Enter the dither percentage for the actuator channel. Enter 0.0 if no dither is required.	
Units	**dflt= EU (14 Characters)**
This is a user entered field. It allows entry of a unit label for this channel.	
Device Tag	**dflt= ACT 01 (30 Characters)**
This is a user entered field. It allows entry of a short description or tag name for this channel.	
Fail Open Actuator?	**dflt= YES (YES/NO) for ASV** **dflt= NO (YES/NO) for PFC**
Select YES to drive 20mA at 0% Demand and 4mA at 100% Demand.	
Use Fault Shutdown?	**dflt= NO (YES/NO)**
When configured as a driver, selecting YES will issue a trip if a Readback Fault is detected. If NO, an alarm is annunciated.	

Actuator 2 is configured following the same rules as Actuator 1.

Contact Inputs

Contact Input Configuration Menu

Status	**dflt= Display Only**
Displays the current signal status of the contact input channel.	
Input Function	
Scroll through the menu by navigating the focus highlighter to the desired item, pressing ENTER, using the Adjust Up/Down Arrows, and then pressing the ENTER key again to select the option/function. Press the ESC key to cancel the selection. See tables in chapter 1 for the list of functional options.	
Device Tag	**dflt= Contact BI02 (30 Characters)**
This is a user entered field. It allows entry of a short description or tag name for this channel.	
Invert Logic?	**dflt= NO (YES/NO)**
Select this to invert this contact input. Inverting means that a function normally activated when CLOSED or TRUE will not be activated when the contact is OPEN or FALSE. Note that this is not required for External Trip inputs because the “Normal” or “Non-Inverted” functionality is already fail-safe (CLOSED/TRUE = healthy, OPEN/FALSE = trip).	

Relays

Relay Configuration Menu	
Status	**dflt= Display Only**
Displays the current signal status of the Relay channel.	
Use as Level Switch?	**dflt= NO (YES/NO)**
Select this to use this relay output as a level switch. Otherwise, the relay output will be a status indication.	
Relay Output Function	

Scroll through the menu by navigating the focus highlighter to the desired item, pressing ENTER, using the Adjust Up/Down Arrows, and then pressing the ENTER key again to select the option/function. Press the ESC key to cancel the selection. See tables in chapter 1 for the list of functional options.	
Level ON	**dflt= 0.0 (-1.0e+38, 1.0e+38)**
Enter the level switch ON setting in engineering units. There is an ON and an OFF setting for each level switch option. This allows the user to program the desired hysteresis for the function selected.	
Level OFF	**dflt= 0.0 (-1.0e+38, 1.0e+38)**
Enter the level switch OFF setting in engineering units. (Must be less than the 'Relay On Level' Setting)	
Device Tag	**dflt= Relay 02 (30 Characters)**
This is a user entered field. It allows entry of a short description or tag name for this channel.	
Invert Logic?	**dflt= NO (YES/NO)**
Use to invert the normal status of the relay. Note that Normally Open and Normally Closed contacts are available when wiring to the relays and that these states will be inverted. In the event of a control power failure, the contact will return to its normal state.	
Delay (s)	**dflt= 0.0 (0.0, 3600.0)**
Enter the delay in seconds from when the relay function signal is met before the output is energized.	

Speed Inputs

Speed Input Configuration Menu

Probe Type	**dflt= Not Used [Not Used, MPU, Active]**
Select the probe type, whether passive or active.	
Device Tag	**dflt= SPD01 Input Signal (25 Characters)**
This is a user entered field. It allows entry of a short description or tag name for this channel.	
Gear Teeth	**dflt= 60 (1, 300)**
Enter the number of teeth on gear that the speed probe is mounted on.	
Gear Ratio	**dflt= 1.0 (0.1, 20.0)**
Enter the speed sensor gear ratio. This value is the ratio of the speed sensor gear to the turbine shaft. This gear ratio is the result of dividing the speed of the speed sensor gear by the speed of the turbine shaft.	
Failed Speed Level	**dflt= 250.0 (10.0, 25000.0)**
Enter the Failed Speed Level (in rpm) to set the speed probe input failure level. If speed drops below this level, the control will determine the speed input device is failed and issue an alarm. (Must be greater than or equal to 0.0204 x Maximum Speed Level) Note: The MPU override level is this value + 50 RPM. When speed increases above this level the speed input override is removed and the failure detection is armed.	
Max Speed Level	**dflt= 10000.0 (10.0, 32000.0)**
Enter the Maximum Speed Level (in rpm) to set the speed probe input maximum detectable level. If speed goes above this level, it will not be read in the control.	
Prox Signal Max (Volts)	**dflt= Display Only**
Displays the max voltage being sensed from the Proximity probe.	
Prox Signal Min (Volts)	**dflt= Display Only**
Displays the max voltage being sensed from the Proximity probe.	
Trigger Level (Volts)	**dflt= 12.0 (4.0, 20.0)**
Set the Trigger Level between the Prox Signal Max and Prox Signal Min in order to detect speed.	

RTCNet

RTCNet Expandable I/O Nodes

Enable Using RTCNet I/O Nodes?	**dflt= NO (YES/NO)**
Select YES to enable CAN Port 1 to interface to WWD RTCNet nodes.	
Enable Node 1 (AIO)	**dflt= NO (YES/NO)**
If Yes - Set the Node address on this device to 1	
Enable Node 2 (AIO)	**dflt= NO (YES/NO)**
If Yes - Set the Node address on this device to 2	
Enable Node 3 (RTD)	**dflt= NO (YES/NO)**
If Yes - Set the Node address on this device to 3	

Enable Node 4 (BI)	**dflt= NO (YES/NO)**
If Yes - Set the Node address on this device to 4	
Enable Node 5 (BO)	**dflt= NO (YES/NO)**
If Yes - Set the Node address on this device to 5	

General comments about using RTCNet distributed I/O –
• Once configured a RTCNet I/O button will appear on the HOME run screen to provide quick access to the channel and node status info
• • There is no 'Loop Powered' configuration selection for AI's – this is determined by the p/n of the AIO node that is purchased
• It is not recommended to program External Trips on these channels, since a loss of a node or the CAN communication link will result in a Trip
• RTCNet I/O specific alarms and/or trips, relating to channels or nodes will produce a summary event on the VIEW screens. From the VIEW screen a button will be available to display these specific events
See the above configuration parameter descriptions for configuring RTCNet IO channels.

RTCNet - (CAN Network - RTCNet I/O Nodes)

Network Link Error	**dflt= Display Only**
The Vertex detects and error on the overall CAN network. Ensure that the each node has the correct, unique ID and that the baud rate is set to 500k.	
NMT Status	**dflt= Display Only**
0 = Bootup 4 = Stopped 5 = Operational 127 = Pre-Operational	
Initialize All	**dflt= NO**
Selecting this button will initialize ALL RTC Nodes on the network. During initialization, all IO communciations with the nodes will be lost.	
Node 1 = Node 21	**dflt (Node Fault)= Display Only** **dflt (COMM Fault)= Display Only** **dflt (Initialize)= NO (YES/NO)**
Displays the current status of Node1.	
Node 2 = Node 22	**dflt (Node Fault)= Display Only** **dflt (COMM Fault)= Display Only** **dflt (Initialize)= NO (YES/NO)**
Displays the current status of Node2.	
Node 3 = Node 23	**dflt (Node Fault)= Display Only** **dflt (COMM Fault)= Display Only** **dflt (Initialize)= NO (YES/NO)**
Displays the current status of Node3.	
Node 4 = Node 24	**dflt (Node Fault)= Display Only** **dflt (COMM Fault)= Display Only** **dflt (Initialize)= NO (YES/NO)**
Displays the current status of Node4.	
Node 5 = Node 25	**dflt (Node Fault)= Display Only** **dflt (COMM Fault)= Display Only** **dflt (Initialize)= NO (YES/NO)**
Displays the current status of Node5.	

RTCNet - RTD Configuration Menu

Value	**dflt= Display Only**
Displays the current temperature value.	
Units	**dflt= Display Only Configured below**
Displays the unit C or F.	
Minimum Value	**dflt= 0.0 (-10000.0, 10000.0)**
Set the minimum value for a valid temperature reading in engineering units. If below this value, a sensor fault is given.	
Maximum Value	**dflt= 1500.0 (-10000.0, 10000.0)**

Set the maximum value for a valid temperature reading in engineering units. If above this value, a sensor fault is given.	
Fault	**dflt= Display Only**
Sensor reading is outside of the Minimum and Maximum values.	
Input Function	**dflt= ---Not Used--- [---Not Used---, Bearing Temperature 1, Bearing Temperature 2, Bearing Temperature 3, Bearing Temperature 4, Lube Oil Temperature, Temperature Monitoring #1, Temperature Monitoring #2, Temperature Monitoring #3, Temperature Monitoring #4, Temperature Monitoring #5, Temperature Monitoring #6, Temperature Monitoring #7, Temperature Monitoring #8]**
Scroll through the menu by navigating the focus highlighter to the desired item, pressing ENTER, using the Adjust Up/Down Arrows, and then pressing the ENTER key again to select the option/function. Press the ESC key to cancel the selection.	
Gain	**dflt= 1.0 (0.8, 1.2)**
Gain is used in calibration to bias the signal at its maximum value in order to match the signal being transmitted from the source device. Control Signal = Signal*Gain + Offset	
Offset	**dflt= 0.0 (-100.0, 100.0)**
Offset is used in calibration to bias the signal at its minimum value in order to match the signal being transmitted from the source device. Control Signal = Signal*Gain + Offset	
Device Tag	**dflt= RTD_1 (25 Characters)**
This is a user entered field. It allows entry of a short description or tag name for this channel.	
Units - Use Deg F for all RTD's	**dflt= YES (YES/NO)**
Select YES for Deg F. Select NO for Deg C.	
Modbus Multiplier	**dflt= 1 [0.01, 0.1, 1, 10, 100]**
This is the multiplier that will be used for this parameter address on the Vertex slave Modbus communication link.	
Curve Type	**dflt= European [European, American]**
The Curve Input determines what temperature coefficient the RTD sensor is calibrated. To use a RTD that is calibrated with an alpha = 0.00385, the input should be 'European'. To use a RTD that is calibrated with an alpha = 0.00392, the input should be 'American'.	
Decimals Displayed	**dflt= 1 [0, 1, 2, 3]**
This is the number of decimals to be displayed on the Vertex screens for this parameter.	
Ohm Value	**dflt= 100 Ohm [100 Ohm, 200 Ohm]**
This input determines what type of the RTD sensor is being used. To use a 100 Ohm RTD , the select 100 Ohm. To use a 200 Ohm RTD, the select 200 Ohm.	

RTCNet - RTD Channel Events

RTD Input 01 Signal	**dflt= Display Only Configured in RTCNet - Config Nodes - Node 3 - RTD_1**
Displays the Function the channel is configured for.	
Use Alarm Setpoint 1?	**dflt= NO (YES/NO)**
Set to YES to enable Level 1 Setpoint. Once enabled, if the signal is greater than the Level 1 Setpoint, an Alarm will be generated.	
Trip on Signal Failure?	**dflt= NO (YES/NO)**
Select YES to issue a shutdown on a failed sensor.	
Use Alarm Setpoint 2?	**dflt= NO (YES/NO)**

Set to YES to enable Level 2 Setpoint. Once enabled, if the signal is greater than the Level 2 Setpoint, an Alarm (or trip) will be generated.	
Use Level 2 As a Trip?	**dflt= NO (YES/NO)**
Set to YES to enable the Level 2 Setpoint will generate a trip, shutting down the turbine.	
Level 1 Setpoint	**dflt= 60.0 (-90000.0, 90000.0)**
Value for the Level 1 Setpoint Alarm in engineering Units.	
Invert Alarm 1	**dflt= NO (YES/NO)**
Set to YES to change alarm to a falling level trigger. If the Signal falls below the Level 1 Setpoint, an Alarm will be generated.	
Level 2 Setpoint	**dflt= 70.0 (-90000.0, 90000.0)**
Value for the Level 2 Setpoint Alarm/Trip in engineering Units.	
Invert Alarm 2	**dflt= NO (YES/NO)**
Set to YES to change alarm to a falling level trigger. If the Signal falls below the Level 2 Setpoint, an Alarm/Trip will be generated.	
Setpoint Hysteresis	**dflt= -3.0 (-100.0, 100.0)**
The hysteresis value determines when the Alarm will be triggered and when it will be cleared again. For non-inverted action: If hysteresis is zero, an alarm is triggered when the Input Signal becomes greater than or equal to the Level Setpoint and the alarm condition is cleared when the input signal goes less than the Level Setpoint. If hysteresis is positive, an alarm is triggered when the Input Signal becomes greater than or equal to the Level Setpoint plus Hysteresis and the alarm condition is cleared when the input signal goes less than the Level Setpoint. If hysteresis is negative, an alarm is triggered when the Input Signal becomes greater than or equal to the Level Setpoint and the alarm condition is cleared when the input signal goes less than the Level Setpoint minus Hysteresis (absolute value). For inverted action: If hysteresis is zero, an alarm is triggered when the Input Signal becomes less than or equal to the Level Setpoint and the alarm condition is cleared when the input signal goes greater than the Level Setpoint. If hysteresis is positive, an alarm is triggered when the Input Signal becomes less than or equal to the Level Setpoint minus Hysteresis and the alarm condition is cleared when the input signal goes greater than the Level Setpoint. If hysteresis is negative, an alarm is triggered when the Input Signal becomes less than or equal to the Level Setpoint plus Hysteresis (absolute value) and the alarm condition is cleared when the input signal goes greater than the Level Setpoint.	
Delay for Event Action (sec)	**dflt= 2.0 (0.0, 300.0)**
This value sets the delay in seconds from the time an Alarm condition is met to the time an alarm is generated. The alarm condition must be present for at least this delay time for an alarm to be generated.	
Enable Speed Setpoint (RPM)	**dflt= -1 (-1, 10000)**
This value is used as a permissive for the alarm condition. If drive speed is below this value, an alarm is not generated even if the alarm condition is met.	
Enable Speed Hysteresis (RPM)	**dflt= 0.0 (-100.0, 100.0)**
The hysteresis value determines when the Alarm speed permissive will be met and when it will be cleared again. If hysteresis is zero, the alarm speed permissive is met when the Speed Signal becomes greater than or equal to the Enable Speed Setpoint and the alarm speed permissive is not met when the speed signal goes less than the Enable Speed Setpoint. If hysteresis is zero, the alarm speed permissive is met when the Speed Signal becomes greater than	

or equal to the Enable Speed Setpoint plus Hysteresis and the alarm speed permissive is not met when the speed signal goes less than the Enable Speed Setpoint. If hysteresis is zero, the alarm speed permissive is met when the Speed Signal becomes greater than or equal to the Enable Speed Setpoint plus Hysteresis and the alarm speed permissive is not met when the speed signal goes less than the Enable Speed Setpoint minus Hysteresis (absolute value).

Communications

Communications - (Ethernet IP Configuration)

ENET 1 Address	**dflt (Octet 1)= 172 (0, 255)** **dflt (Octet 2)= 16 (0, 255)** **dflt (Octet 3)= 100 (0, 255)** **dflt (Octet 4)= 15 (0, 255)**
Enter the integers corresponding to the network TCP/IP address	
ENET 1 Subnet Mask	**dflt (Octet 1)= 255 (0, 255)** **dflt (Octet 2)= 255 (0, 255)** **dflt (Octet 3)= 0 (0, 255)** **dflt (Octet 4)= 0 (0, 255)**
Enter the integer corresponding to the network subnet mask.	
Set IP1	**dflt= NO**
Press this button to trigger resetting the IP of ENET 1 to the entered value	
ENET 2 Address	**dflt (Octet 1)= 192 (0, 255)** **dflt (Octet 2)= 168 (0, 255)** **dflt (Octet 3)= 128 (0, 255)** **dflt (Octet 4)= 20 (0, 255)**
Enter the integers corresponding to the network TCP/IP address	
ENET 2 Subnet Mask	**dflt (Octet 1)= 255 (0, 255)** **dflt (Octet 2)= 255 (0, 255)** **dflt (Octet 3)= 0 (0, 255)** **dflt (Octet 4)= 0 (0, 255)**
Enter the integer corresponding to the network subnet mask.	
Set IP2	**dflt= NO**
Press this button to trigger resetting the IP of ENET 1 to the entered value	
Gateway	**dflt= NO**
Enter the integers corresponding to the network gateway.	

Communications - (Modbus)

Use Modbus	**dflt= NO (YES/NO)**
Set to YES to use the Modbus communications feature of the Vertex. There are 3 identical Modbus ports available; 1 via the Serial port and 2 available via Ethernet. Select NO if Modbus communications will not be used.	
Use Link 1 (Serial Port)?	**dflt= NO (YES/NO)**
Set to YES to use the serial Modbus port.	
Use Link 2 (ENET1)?	**dflt= NO (YES/NO)**
Select a protocol to use the Modbus Link 2 via Ethernet. This will be available on an RJ45 connection to Ethernet Port 1. Selecting UDP will use port 5001.	
Use Link 3 (ENET2)?	**dflt= NO (YES/NO)**
Select a protocol to use the Modbus Link 3 via Ethernet. This will be available on an RJ45 connection to Ethernet Port 2. Selecting UDP will use port 5002.	
Use Modbus Trip	**dflt= YES (YES/NO)**
Select YES to enable a trip signal to be sent via Modbus.	

Modbus – Link 1 - Serial

DEVICE ADDRESS	**dflt= 1 (1, 247)**
Enter the integer corresponding to the Modbus device number/address required.	
ENABLE WRITE COMMANDS	**dflt= NO (Yes/No)**
Select YES to allow this Modbus link to write values to the control. If NO, it will be read only.	
PROTOCOL	**dflt= ASCII (ASCII, RTU)**
Select ASCII or RTU to determine the format of the Modbus communications.	

BAUD RATE	**dflt= 115,200**
Select the communications baud rate.	
BITS	**dflt= 7 (7, 8)**
Select the integer corresponding to the bits required.	
STOP BITS	**dflt= 1 (1, 2, 1.5)**
Select the stop bits required.	
PARITY	**dflt= NONE (NONE, ODD, EVEN)**
Select the parity required.	
DRIVER	**dflt= RS-232 (RS-232, RS-422, RS-485)**
Select the serial communications mode required. Enter RS-232, RS-422, or RS-485 communications.	

Modbus Link 2

ETHERNET Port 1 – IP Address =	**<display only>**
ETHERNET PROTOCOL	**Port = <menu selection>**
This can be Primary Ethernet TCP, Primary Ethernet UDP, Secondary Ethernet TCP, Secondary Ethernet UDP, or Secondary Serial	
DEVICE ADDRESS	**dflt= 2 (1, 247)**
Enter the integer corresponding to the Modbus device number/address required.	
ENABLE WRITE COMMANDS	**dflt= NO (Yes/No)**
Select YES to allow this Modbus link to write values to the control. If NO, it will be read only.	

Modbus Link 3

ETHERNET Port 2 – IP Address =	**<display only>**
ETHERNET PROTOCOL	**Port = <menu selection>**
This can be Primary Ethernet TCP, Primary Ethernet UDP, Secondary Ethernet TCP, Secondary Ethernet UDP, or Secondary Serial	
DEVICE ADDRESS	**dflt= 2 (1, 247)**
Enter the integer corresponding to the Modbus device number/address required.	
ENABLE WRITE COMMANDS	**dflt= NO (Yes/No)**
Select YES to allow this Modbus link to write values to the control. If NO, it will be read only.	

Isolated Control Menu

USE ISOLATED PID	**dflt= NO (Yes/No)**
Select YES to configure the Isolated PID function. Select NO if this function is not used. When using the Isolated PID Control, it is recommended to select the “Enable Readback Fault” option for the Analog Output channel configured as the Isolated PID Demand. This will trigger an alarm in the 505 if a fault of the output circuit is detected. By default, Analog Output channels are not configured to produce an alarm when the output circuit has a fault.	
USE REMOTE SETPOINT	**dflt= NO (Yes/No)**
Set to YES to allow the Isolated PID set point to be adjusted from an analog input.	
OUTPUT VALVE DEMAND ACTION ON INPUT FAULT	**dflt= HOLD DEMAND**
Set to “HOLD Demand” maintain the demand at the time of failure. Set to “Go to Maximum Demand” to move the demand to 100% output. Set to “Go to Minimum Demand” to move the demand to 0% output.	
INVERT CONTROLLER?	**dflt= NO (Yes/No)**
Select YES if the control will be reverse acting. If NO is selected, the control will be forward acting. Typically this will be set to NO, the only time the input would be inverted is if the valve needs to open when the input exceeds the set point.	
ALLOW MANUAL CONTROL?	**dflt= NO (Yes/No)**
Set to YES to allow the Isolated PID output to be manipulated by the operator. Set to NO to keep this controller in automatic, controlled by the PID, at all times except in the event of an input failure.	
MAXIMUM SETPOINT	**dflt= 100.0 (-100000.0, 100000.0)**
This is the maximum limit for the Isolated Control setpoint in engineering units.	
MINIMUM SETPOINT	**dflt= 0.0 (-100000.0, 100000.0)**
This is the minimum limit for the Isolated Control setpoint in engineering units	
INITIAL SETPOINT	**dflt= 100.0 (-100000.0, 100000.0)**
This is the value in engineering units at which the Isolated Control setpoint ramp will initialize.	

Antisurge Control – Quench Control

Configure Quench Control Check to use the quench controller	**dflt= NO (YES/NO)**
Setpoint Selection Select the method used for determining the quench PID temperature setpoint. The Fixed Setpoint is controlled by the operator (raise / lower commands) or by a remote setpoint analog input. The Fixed Setpoint with Dew Point Limiter is the same as the Fixed Setpoint, but the setpoint cannot be lowered below the setpoint calculated from the dew point curve. The Setpoint Based On Dew Point Curve uses a setpoint calculated from the dew point with a configurable offset. Because the dew point varies with pressure, this setpoint will change as the suction pressure changes.	**dflt= Fixed Setpoint Fixed SP w/ Dew Pt Limiter, SP based on Dew Pt Curve**
Field Signal selection Select the source for the temperature process value controlled by the quench PID	**dflt= Not Used, External Signal, T@Flowmeter,T@ Suction**
Enable Liquid Phase Alarm Check the box to enable the liquid phase alarm. The liquid phase alarm indicates that the temperature controlled by the quench PID has dropped below the level at which liquid phase fluid can form. The dew point curve must be configured correctly if the alarm is enabled. **Alarm – Temp Offset (deg)** **Alarm – Delay (sec)**	**dflt= Not Used [Not Used,** **dflt = 5.0 (-10, 200)** **dflt = 5.0 (1, 100)**
Tag Name	**Dflt = TICxxxx**
Description	**Dflt = Quench Controller**
Track in Manual	**dflt= No (Yes/No)**
Min Setpoint Minimum value for the quench setpoint.	**dflt = 0 (-10000, 10000)**
Max Setpoint Maximum value for the quench setpoint.	**dflt = 1 (-10000, 10000)**
Delay for activating fast setpoint rate If a raise / lower command is maintained for longer than this delay time, the Setpoint Fast Multiplier will be active.	**dflt = 10 (0.1, 1000)**
Multiplier for fast setpoint rate Setpoint Rate of Change will be multiplied by Setpoint Fast Multiplier to cause the setpoint to change more quickly when raise / lower commands are maintained for longer than the Setpoint Fast Delay.	**dflt = 1 (1,10)**
Manual demand rate Rate of change of the quench valve manual demand in %/sec.	**dflt = 1.0 (0.01, 10.0)**
Quench PID Settings	
Trip Position (%)	**dflt = 0.0 (0.0, 100.0)**

When the quench actuator fails, or when the compressor is shutdown, the quench valve will go to the trip position with a rate of 50 percent per second.	
Droop (%) Droop logic may be needed if multiple quench valves are controlling the same suction temperature. If droop logic is not needed, set this value to 0.0.	**dflt = 0.0** **(0.0, 100.0)**
Invert the PID? Check to invert the response of the quench controller	**dflt= NO (YES/NO)**
Droop base Reference The droop logic will attempt to hold the quench valve at this reference position. When the suction temperature deviates from the setpoint, the quench valve demand will deviate from this reference position to restore the suction temperature to the setpoint value.	**dflt = 25.0** **(0.0, 100.0)**
Proportional Gain Enter the proportional gain of the quench PID.	**dflt = 1.0** **(0.001, 30.0)**
Integral Gain Enter the integral gain of the quench PID.	**dflt = 0.10** **(0.0001, 10.0)**
Speed Derivative Ratio Enter the derivative (SDR) gain of the quench PID. Leave at 100 for Proportional and PI control	**dflt = 100.0** **(0.1, 100.0)**
Enabling Mode Select the sequence logic used to enable the quench controller. When the controller is enabled, it will modulate the quench valve to control the suction temperature. Level to Enable	**dflt = Enabled @ Online, Enabled@ Start, Enabled at Speed Level, Enabled at Current Level, Always Enabled** **dflt = 200.0** **(10, 25000.0)**
If Dew Point Curve is used: The dew point curve is defined with 10 points (pressure vs. temperature). The dew point curve must be entered correctly if the setpoint setting is Fixed Setpoint with Dew Point Limiter or Setpoint Based On Dew Point Curve. The curve is also required if the liquid phase alarm is enabled. Enter the points in the same units that were selected for the pressure and temperature inputs.	**X1 = 0 Y1 = 0** **X1 = 1 Y1 = 0** **X1 = 2 Y1 = 0** **X1 = 3 Y1 = 0** **X1 = 4 Y1 = 0** **X1 = 5 Y1 = 0** **X1 = 6 Y1 = 0** **X1 = 7 Y1 = 0** **X1 = 8 Y1 = 0** **X1 = 9 Y1 = 0** **X range (0, 100000)** **Y range (0,2000)**
Max Low ASV Clamp	**dflt = 0.0** **(0.0, 25.0)**
Quench vs. Anti-Surge Demand Gain	**dflt = 5.0** **(1.0, 100.0)**
Override High Quench clamp	**dflt= NO (YES/NO)**
Decoupling Signal	**Dflt = No decoupling** **(Decoupling on AS Demand, Decoupling on External Signal)**
Quench Exhaust Temp Limiter (QETL)	**Dflt = Exhaust Temp Lmtr Not used, Exhaust Temp with Droop Logic**
Droop (%)	

Exiting the Configure Mode

Once completing the programming steps, the Configuration mode can be exited. To exit the Configure mode the User Level must still be logged in with Configure privileges. Then the ‘Exit Configuration’ softkey will be available on the MODE screen. Pressing this initiates the Vertex to save the configuration and exit IO Lock. If there are no errors in the configuration, the Vertex will be in the Shutdown state. At this point it may be ready to reset and run but, if this is the first time the Vertex has been configured with the unit’s actuator/linkage/valve, then it is recommended to run the valve stroking procedure in calibration mode and adjust current limits as needed. However, if there is an error in the program, the Vertex will be in a shutdown state and unable to reset. Configuration errors can be viewed by going to the Configuration Menu (softkey on the HOME/main menu screen) and pressing the ‘Config Check’ softkey. The next section identifies the various configuration error messages and explains the meaning of the error.

There is a procedure in the Appendix on how to restore a unit to the original factory defaults, using a service tool.

Configuration Error Messages

The control automatically performs a check on the configured values to assure that required program blocks have values loaded into them. This check cannot determine if the values entered are realistic but it makes sure that values have been loaded into required parameters. If any errors are found in the program, the Vertex will remain in a shutdown state and a banner message will appear on the Configuration Menu and MODE screens. They can be displayed by pressing the ‘Config Check’ softkey on the Configuration Menu screen.

The configuration error message alerts you that a configuration change is required before the Vertex can operate the compressor. Correct all errors before in order to be able to reset the Vertex to the “Ready to Start” condition.

The figure below identifies the various configuration error messages that may appear and explains the meaning of the error.

Table 7-4. Configuration Error Messages

Event ID	Description	Error Meaning
1	Wrong Product Model Detected	The Hardware model number does not match the Application.
2	Maximum Speed > Probe 1 Freq Range	The maximum speed input is 35000 hertz. This is a limitation of the Vertex hardware/speed sensing circuitry. The frequency input of the speed sensor must be less than this value. The gear the speed sensor is mounted on may need to be changed to one with less teeth, this will decrease the frequency seen by the speed probes. The Maximum Speed Level for Speed Input Channel 1, converted to frequency (Hz), is greater than 35000 Hz.
3	Maximum Speed > Probe 2 Freq Range	The maximum speed input is 35000 hertz. This is a limitation of the Vertex hardware/speed sensing circuitry. The frequency input of the speed sensor must be less than this value. The gear the speed sensor is mounted on may need to be changed to one with less teeth, this will decrease the frequency seen by the speed probes. The Maximum Speed Level for Speed Input Channel 2, converted to frequency (Hz), is greater than 35000 Hz.
4	Duplicate PFC Driver	There is more than 1 selection for the Performance valve demand output
5	spare	
6	spare	
7	Speed Sensor #1 Failed < Freq Range	The failed speed setting for speed input #1 is below the minimum allowed setting. The minimum allowed setting is calculated as follows: (Maximum Speed Level) * (0.0204).
8	Speed Sensor #2 Failed < Freq Range	The failed speed setting for speed input #2 is below the minimum allowed setting. The minimum allowed setting is calculated as follows: (Maximum Speed Level) * (0.0204).
9	Duplicate ASV1 Configured	There is more than 1 selection for the anti-surge 1 valve demand output
10	Duplicate ASV2 Configured	There is more than 1 selection for the anti-surge 2 valve demand output
11	Duplicate Analog Inputs Configured	Two analog inputs were programmed for the same function.
12	Duplicate Boolean Inputs Configured	Two contact inputs were programmed for the same function.
13	PFC PV Not Configured	The Performance control function was programmed but the selected process variable analog input was not configured.
14	PFC Configured, no Driver	The Performance control function was programmed but an analog output for the Performance demand signal was not configured.

Event ID	Description	Error Meaning
15	Rmt PFC SP Configured, No Rmt AI	The Remote Performance set point control function was configured but no Remote Performance set point analog input was configured.
16	PFC Limiter 1 Configured, no AI	The Performance Limiter 1 function was programmed but the selected process variable analog input was not configured.
17	Rmt PFC Limiter 1 SP Cnfg, no Rmt AI	The Remote Limiter 1 set point control function was configured but no Remote Limiter 1 set point analog input was configured.
18	PFC Limiter 2 Configured, no AI	The Performance Limiter 2 function was programmed but the selected process variable analog input was not configured.
19	Rmt PFC Sequence DMD Configured, no AI	The Remote Performance Demand was configured but no Remote Performance Demand analog input was configured.
20	ASC1 Purge on SPD configured, No SPD	Purge on Speed condition configured but a speed signal has not been configured.
21	ASC1 Purge on Curr configured, No Curr	Purge on Current condition configured but a motor current signal has not been configured.
22	ASC2 Purge on SPD configured, No SPD	Purge on Speed condition configured but a speed signal has not been configured.
23	ASC2 Purge on Curr configured, No Curr	Purge on Current condition configured but a motor current signal has not been configured.
24	ASC1 Major Change :MAP Dsbld	The compressor map configuration has been modified and must be reconfirmed in the Configuration Menu > Compressor Mapping page
25	ASC1 MAP Error-Wait for Correction	The configured compressor map contains an error. Verify that X and Y values are increasing from X1 and Y1 to X1 and Y2 etc.
26	ASC1 MAP Error P2 Rated<P1 Rated	Rated Discharge pressure is configured less than Rated Suction pressure in the Compressor Mapping menu.
27	ASC1 MAP Rated Cond Chngd-Re Confirm	The compressor rated conditions have been modified and must be reconfirmed in the Configuration Menu > Compressor Mapping page
28	ASC1 Surge Map Update Needed	A compressor surge map point has been modified and must be reconfirmed in the Configuration Menu > Compressor Mapping page
29	ASC1 Surge Map Never Fully Configured	The compressor map configuration has never been changed and confirmed from the default values. Enter the compressor surge map and confirm the values in the Compressor Mapping menu.
30	ASC1 Choke Map not Fully Configured	The compressor surge map has been configured but the configuration has never been changed and confirmed from the default values. Enter the compressor surge map and confirm the values in the Compressor Mapping menu.

Event ID	Description	Error Meaning
31	ASC1 Un-Auth New Setting Detected	An authorized change to the compressor map, gas properties, rated conditions, or flow metering device settings has been made. Please confirm the settings.
32	ASC2 Major Change Det MAP Dsbld	The compressor map configuration has been modified and must be reconfirmed in the Configuration Menu > Compressor Mapping page
33	ASC2 MAP Error-Wait for Correction	The configured compressor map contains an error. Verify that X and Y values are increasing from X1 and Y1 to X1 and Y2 etc.
34	ASC2 MAP Error P2 Rated<P1 Rated	Rated Discharge pressure is configured less than Rated Suction pressure in the Compressor Mapping menu.
35	ASC2 MAP Rated Cond Chngd- Re-Confirm	The compressor rated conditions have been modified and must be reconfirmed in the Configuration Menu > Compressor Mapping page
36	ASC2 Surge Map Update Needed	A compressor surge map point has been modified and must be reconfirmed in the Configuration Menu > Compressor Mapping page
37	ASC2 Surge Map Never Fully Configured	The compressor map configuration has never been changed and confirmed from the default values. Enter the compressor surge map and confirm the values in the Compressor Mapping menu.
38	ASC2 Choke Map Not Fully Configured	The compressor surge map has been configured but the configuration has never been changed and confirmed from the default values. Enter the compressor surge map and confirm the values in the Compressor Mapping menu.
39	ASC2 Un-Auth New Setting Detected	An authorized change to the compressor map, gas properties, rated conditions, or flow metering device settings has been made. Please confirm the settings.
40	ASC1 Configured but No ASV	The ASC1 control function was programmed but an analog output for the anti-surge valve demand signal was not configured.
41	ASC2 Configured but No ASV	The ASC2 control function was programmed but an analog output for the anti-surge valve demand signal was not configured.
42	ASC2 Configured but No Flow TX	The ASC1 control function was programmed but an analog input for the flow dP signal was not configured.
43	ASC2 Configured but No P1 TX	The ASC2 control function was programmed but an analog input for the flow dP signal was not configured.
44	ASC2 Configured but No P2 TX	The ASC1 control function was programmed but an analog input for the discharge pressure signal was not configured.
45	ASC1 Configured but No Flow TX	The ASC2 control function was programmed but an analog input for the discharge pressure signal was not configured.

Event ID	Description	Error Meaning
46	ASC1 Configured but No P1 TX	The ASC1 control function was programmed but an analog input for the suction pressure signal was not configured.
47	ASC1 Configured but No P2 TX	The ASC2 control function was programmed but an analog input for the suction pressure signal was not configured.
48	Error Analog Input 1	The specified analog input was configured for a function that is not configured as used. Either the analog input was miss-configured or the function required is miss-configured. For example, analog input #1 is programmed for Remote Performance Set Point but Remote Performance Set Point was not configured under the Performance configuration menu.
49	Error Analog Input 2	See "Analog Input 01 Error".
50	Error Analog Input 3	See "Analog Input 01 Error".
51	Error Analog Input 4	See "Analog Input 01 Error".
52	Error Analog Input 5	See "Analog Input 01 Error".
53	Error Analog Input 6	See "Analog Input 01 Error".
54	Error Analog Input 7	See "Analog Input 01 Error".
55	Error Analog Input 8	See "Analog Input 01 Error".
56	Error RTC Node 1 Analog Input 1	See "Analog Input 01 Error".
57	Error RTC Node 1 Analog Input 2	See "Analog Input 01 Error".
58	Error RTC Node 1 Analog Input 3	See "Analog Input 01 Error".
59	Error RTC Node 1 Analog Input 4	See "Analog Input 01 Error".
60	Error RTC Node 1 Analog Input 5	See "Analog Input 01 Error".
61	Error RTC Node 1 Analog Input 6	See "Analog Input 01 Error".
62	Error RTC Node 1 Analog Input 7	See "Analog Input 01 Error".
63	Error RTC Node 1 Analog Input 8	See "Analog Input 01 Error".
64	Error RTC Node 2 Analog Input 1	See "Analog Input 01 Error".
65	Error RTC Node 2 Analog Input 2	See "Analog Input 01 Error".
66	Error RTC Node 2 Analog Input 3	See "Analog Input 01 Error".
67	Error RTC Node 2 Analog Input 4	See "Analog Input 01 Error".
68	Error RTC Node 2 Analog Input 5	See "Analog Input 01 Error".
69	Error RTC Node 2 Analog Input 6	See "Analog Input 01 Error".
70	Error RTC Node 2 Analog Input 7	See "Analog Input 01 Error".
71	Error RTC Node 2 Analog Input 8	See "Analog Input 01 Error".
72	Error Contact Input 2	The specified contact input was configured for a function that is not configured as used. Either the contact input was miss-configured or the function required is miss-configured. For example, contact input #2 is programmed for Remote Performance Set Point Enable but Remote Performance Set Point was not programmed under the Performance configure menu.
73	Error Contact Input 3	See "Contact Input 02 Error".

Event ID	Description	Error Meaning
74	Error Contact Input 4	See "Contact Input 02 Error".
75	Error Contact Input 5	See "Contact Input 02 Error".
76	Error Contact Input 6	See "Contact Input 02 Error".
77	Error Contact Input 7	See "Contact Input 02 Error".
78	Error Contact Input 8	See "Contact Input 02 Error".
79	Error Contact Input 9	See "Contact Input 02 Error".
80	Error Contact Input 10	See "Contact Input 02 Error".
81	Error Contact Input 11	See "Contact Input 02 Error".
82	Error Contact Input 12	See "Contact Input 02 Error".
83	Error Contact Input 13	See "Contact Input 02 Error".
84	Error Contact Input 14	See "Contact Input 02 Error".
85	Error Contact Input 15	See "Contact Input 02 Error".
86	Error Contact Input 16	See "Contact Input 02 Error".
87	Error Contact Input 17	See "Contact Input 02 Error".
88	Error Contact Input 18	See "Contact Input 02 Error".
89	Error Contact Input 19	See "Contact Input 02 Error".
90	Error Contact Input 20	See "Contact Input 02 Error".
91	Error RTC Node 4 Contact Input 1	See "Contact Input 02 Error".
92	Error RTC Node 4 Contact Input 2	See "Contact Input 02 Error".
93	Error RTC Node 4 Contact Input 3	See "Contact Input 02 Error".
94	Error RTC Node 4 Contact Input 4	See "Contact Input 02 Error".
95	Error RTC Node 4 Contact Input 5	See "Contact Input 02 Error".
96	Error RTC Node 4 Contact Input 6	See "Contact Input 02 Error".
97	Error RTC Node 4 Contact Input 7	See "Contact Input 02 Error".
98	Error RTC Node 4 Contact Input 8	See "Contact Input 02 Error".
99	Error RTC Node 4 Contact Input 9	See "Contact Input 02 Error".
100	Error RTC Node 4 Contact Input 10	See "Contact Input 02 Error".
101	Error RTC Node 4 Contact Input 11	See "Contact Input 02 Error".
102	Error RTC Node 4 Contact Input 12	See "Contact Input 02 Error".
103	Error RTC Node 4 Contact Input 13	See "Contact Input 02 Error".
104	Error RTC Node 4 Contact Input 14	See "Contact Input 02 Error".
105	Error RTC Node 4 Contact Input 15	See "Contact Input 02 Error".
106	Error RTC Node 4 Contact Input 16	See "Contact Input 02 Error".
107	Error Relay Output 2	The specified relay was programmed for a function that is not configured as used. Either the relay was miss-configured or the function required is miss-programmed. For example, relay #2 is configured for Performance PID in Control but Performance Control was not configured under the Performance configure menu.
108	Error Relay Output 3	See "Relay 02 Error".
109	Error Relay Output 4	See "Relay 02 Error".
110	Error Relay Output 5	See "Relay 02 Error".

Event ID	Description	Error Meaning
111	Error Relay Output 6	See "Relay 02 Error".
112	Error Relay Output 7	See "Relay 02 Error".
113	Error Relay Output 8	See "Relay 02 Error".
114	Error RTC Node 5 Relay Output 1	See "Relay 02 Error".
115	Error RTC Node 5 Relay Output 2	See "Relay 02 Error".
116	Error RTC Node 5 Relay Output 3	See "Relay 02 Error".
117	Error RTC Node 5 Relay Output 4	See "Relay 02 Error".
118	Error RTC Node 5 Relay Output 5	See "Relay 02 Error".
119	Error RTC Node 5 Relay Output 6	See "Relay 02 Error".
120	Error RTC Node 5 Relay Output 7	See "Relay 02 Error".
121	Error RTC Node 5 Relay Output 8	See "Relay 02 Error".
122	Error RTC Node 5 Relay Output 9	See "Relay 02 Error".
123	Error RTC Node 5 Relay Output 10	See "Relay 02 Error".
124	Error RTC Node 5 Relay Output 11	See "Relay 02 Error".
125	Error RTC Node 5 Relay Output 12	See "Relay 02 Error".
126	Error RTC Node 5 Relay Output 13	See "Relay 02 Error".
127	Error RTC Node 5 Relay Output 14	See "Relay 02 Error".
128	Error RTC Node 5 Relay Output 15	See "Relay 02 Error".
129	Error RTC Node 5 Relay Output 16	See "Relay 02 Error".
130	Error Analog Output 1	The specified readout was configured for a function that is not configured as used. Either the readout was miss-configured or the function required is miss-configured. For example, readout #1 is configured for Performance Set Point but Performance Control was not configured under the Performance configure menu.
131	Error Analog Output 2	See "Analog Output 01 Error".
132	Error Analog Output 3	See "Analog Output 01 Error".
133	Error Analog Output 4	See "Analog Output 01 Error".
134	Error Analog Output 5	See "Analog Output 01 Error".
135	Error Analog Output 6	See "Analog Output 01 Error".
136	Error RTC Node 1 Analog Output 1	See "Analog Output 01 Error".
137	Error RTC Node 1 Analog Output 2	See "Analog Output 01 Error".
138	Error RTC Node 2 Analog Output 1	See "Analog Output 01 Error".
139	Error RTC Node 2 Analog Output 2	See "Analog Output 01 Error".
140	Error Actuator Output 1	See "Analog Output 01 Error".
141	Error Actuator Output 2	See "Analog Output 01 Error".
142	ASC: Speed used but not configured	The ASC 1 or 2 has been configured to use a speed signal but a speed signal is not configured
143	ASC: Current used but not configured	The ASC 1 or 2 has been configured to use a motor current signal but a speed signal is not configured
144	PFC Driver Tracking - No Speed Signal	Performance Speed Controller Tracking has been configured but a speed signal has not been configured.

Event ID	Description	Error Meaning
145	PFC Tracking - Min Gov GT Max Gov	Performance Speed Controller Tracking has been configured and the configured value for Minimum Governor is greater than Maximum Governor.
146	ASC1 FlowMeter Values Changed: Confirm	The configured values for the flow metering device have been modified. Confirm the values in the Flow Element configuration menu.
147	ASC2 FlowMeter Values Changed: Confirm	The configured values for the flow metering device have been modified. Confirm the values in the Flow Element configuration menu.
148	Load Share Train 1 - No AI	Load Sharing has been configured and the Train ID 1 does not have an analog input for Load Share Input configured.
149	Load Share ID GT Number Trains	The Train ID is greater than the number of trains in the Load Share group.
150	ASV1 Both Stages, ASC2 Not Configured	Compressor Layout is for multistage, but ASC2 stage is not configured
151	Error Contact Input 1	Error on usage configuration of discrete input Channel 1
152	Error Relay Output 1	Error on usage configuration of output relay Channel 1

Calibration/Stroking Procedure

⚠WARNING **Before calibrating or testing, the unit must be tripped and the feed gas supply removed.**

1. The Vertex must be shutdown to enter Calibration Mode.
2. Go to the MODE screen by pressing the MODE key.
3. Enter Calibration Mode by pressing the ‘Calibration’ softkey. The following permissives must be met:
   a. Unit Shutdown
   b. No Speed Detected
   c. Appropriate User Level Login
4. Navigate to the Analog or Actuator Driver Summary page by pressing the ‘Analog Output’ or ‘Drivers’ in either the HOME menu or Configure menu.
5. Select the desired output channel.
6. In the output channel screen, press the ‘Force Output’ softkey to access the calibration options.
7. Verify the green “Calmode Enabled” LED is ON to confirm that the unit is in Calibration Mode.
8. Press the ‘Enable Forcing’ softkey to enable forcing.
9. Verify that the green “Forcing Enabled” LED is now also ON.
10. Use the focus navigation to select and adjust items on the screen (Manual Adjust, Goto Demand, Force Rate, etc.).
11. Analog Output Calibration:
    a. Analog Output current output at min and max can be adjusted by selecting “Offset” and “Gain”. Use the up/down Adjust arrows or numerical keypad and ENTER key to the change the values.
    b. Control Signal = Signal*Gain + Offset
    c. Offset should be used to tune the minimum current level.
    d. Once the Demand is equal to 100%, the Gain should be used to set the maximum current level.

12. Actuator Driver Calibration:
    a. Actuator current output at min and max can be adjusted by selecting “mA at 0% Demand” or “mA at 100% Demand”. Use the up/down Adjust arrows or numerical keypad and ENTER key to the change the values.
13. Press the ‘Commands’ softkey to access other commands such as “Go to Min”, Go to Max”, and “GO”. “GO” can be used with the “Goto Demand” value.
14. When finished, make sure to save the settings by pressing any ‘Save Settings’ softkey. A ‘Save Settings’ softkey can be accessed on the MODE screen.
15. Exit Calibration Mode by pressing the ‘Exit Calmode’ softkey from the MODE page or, if it is desired to stroke another channel, return to the Driver or I/O screen to continue stroking other channels.

If changes are made to the minimum or maximum current values, they can be recorded on the Configure Mode worksheets. Exiting the Calibration Mode or Forcing Mode will not permanently save any calibration changes.

NOTICE

Press the ‘Save Settings’ softkey to permanently save any minimum or maximum actuator settings into the Vertex. If variables are tuned or changed but not saved, then those changes will be lost if power is removed from the control or if the control receives a CPU reset.

Chapter 8.
Vertex Operation

Software Architecture

The Vertex is a field configurable compressor control and graphical user interface (GUI) integrated into one package. The Vertex control has been designed to run 2 separate, independent programs on the same platform. One controls the I/O and therefore controls compressor operation. The other program provides all the visual and command interaction with the user.

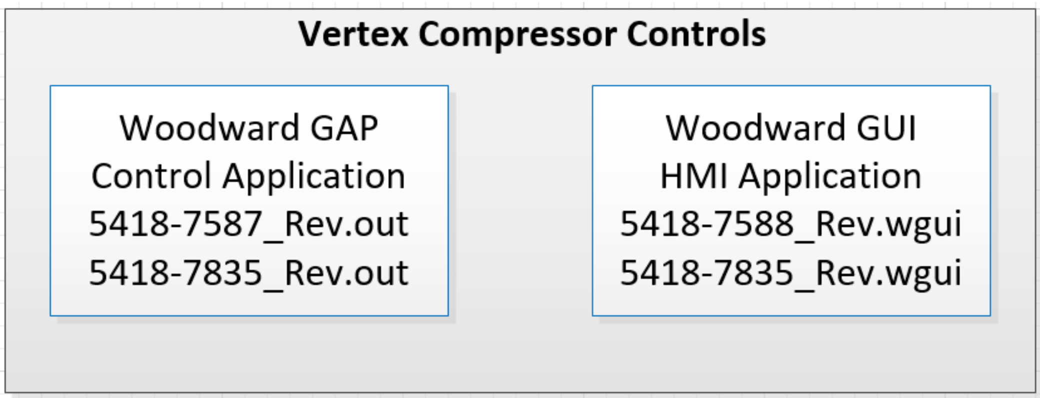


Figure 8-1. Software Architecture

The primary application program is the GAP based control application program. This controls all the system I/O and functional algorithms which control the operation of the compressor train.

The secondary application program is the Digia/Qt based graphical user interface (GUI) program. This controls all the screen information that is displayed to the user. It links to the GAP via an internal communication link to pass all required interface variables to and from the display.

Both of these programs are automatically launched at power-up. The GAP program MUST always be executing to run the compressor control and protections. However, the GUI program may be 'Stopped' using a service tool (AppManager) and restarted at any time without affecting GAP or the compressor operation. This unique and useful feature of the Vertex allows the following operations to be accomplished (if needed or desired) while the Vertex control is operating the compressor train.

- Change the language on the screen
- Update the GUI program (newer build revisions with improvement/enhancements)
- Upgrade the GUI program – load a custom version that may be created for a specific OEM or customer jobsite

Power-Up Screen

Viewed from the front the Vertex – the following is the correct boot-up sequence of a Vertex unit loaded with the standard Vertex GAP and Qt GUI applications. Times are approximant.

At Power-up Screen = BLANK /BLACK
IOLOCK = ON (RED)
After about 1:00 Screen = "Splash Screen"
TRIPPED/CPU/ALARM LED's will flash check
IOLOCK = ON
After about 1:15 TRIPPED=ON (RED)
IOLOCK = OFF
CPU = ON (GREEN)

After about 1:50 ALARM LED (YELLOW) Flashes/Blinks

After about 6:00 Screen = HOME

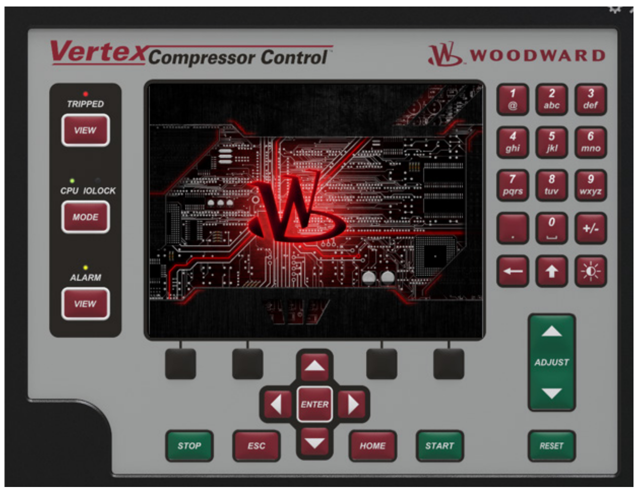


Figure 8-2. Vertex Splash Screen

Any time that a Display application program is not running, the 'Splash Screen' will appear. If at power-up the Alarm LED stops flashing and this screen still appears – then the GUI program has not initialized correctly.

Once the unit has been configured, all following power cycles will result in a screen similar to the following, dependent on what functionality has been configured. The numbers in the top right indicate that there is a quick keypad command to get to that screen. For example pressing 2 will jump to the valve Demands screen, from that screen if you press 7 it will jump to the Trends screen. From any operational screen, pressing HOME will always return to this screen.

Figure 8-3. Boot-up to HOME Screen

Refer to Figure 7-1 for the view of an initial power-up of an unconfigured unit.

In redundant systems the IOLOCK LED will only go out after both the SYSCON and the BACKUP units complete their boot-up and initialize as healthy. If either unit fails to do this, or the required interlock connections are not healthy. The IOLOCK will remain RED and user confirmation will be required to run on a single unit. See the Dual Redundant Configurations chapter for more details.

There is a Screen Saver function that is invoked after a period of inactivity. It is defaulted to 4 hours (adjustable in Service / Screen Settings) – when this comes it a small version of the 'Splash Screen' will bounce around on the screen. Press any key to revive the display (maroon keys are recommended). When awaking from screen saver the user login level will be reduced to Operator. This also is adjustable in Service / Screen Settings if desired, it can be changed to awaken to Monitor.

Control Mode Architecture

Basic control program architecture is illustrated in Figure 8-1. The Vertex's normal operating architecture divides the control into two states.

Run – which includes Operation and Calibration modes
Program - Configuration mode

Pressing the MODE key at any time will open the Login and Mode Screen

The Configuration Mode is used to configure the Vertex for the specific application and set all operating parameters (see Chapter 7). In this mode the control will issue an IOLOCK (LED) and the state of all Outputs from the Vertex are disabled. This means that all Relays are de-energized and all Analog/Driver outputs are at zero current. Initially all Vertex's must be placed in this mode to enter a valid configuration of the I/O and functions desired for the specific compressor application.

The Calibration Mode is used after the configuration of the Vertex is complete. It is used to perform calibration of signals, verification of speed signals and the forcing of outputs of the control in preparation to run the compressor. All I/O is functional in this state. To enter this mode the turbine must be TRIPPED (LED).

The Operation Mode is used to view operating parameters and run the compressor train. This is the typical mode the control uses and is the default mode it enters at Power-up. All I/O is functional in this state. The compressor may be either running or not running in this mode.

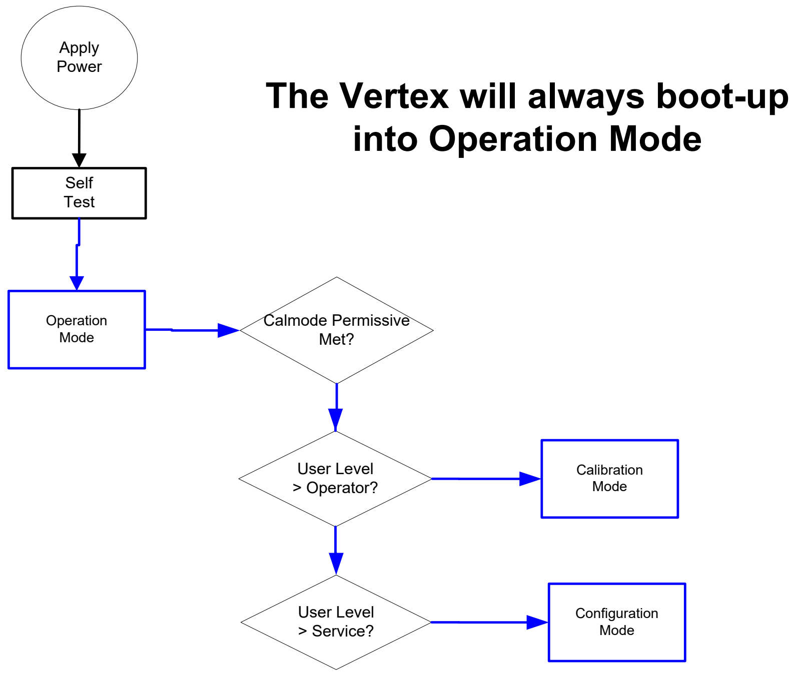


Figure 8-4. Control Mode Architecture

User Login Levels

Pressing the MODE key at any time will open the Login and Mode Screen

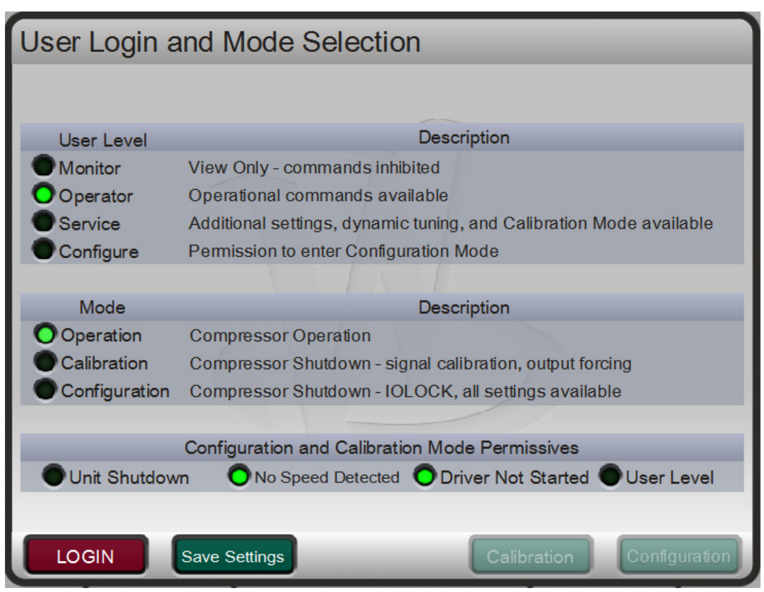


Figure 8-5. Mode Screen

Monitor – (logout to enter this)
Even Keypad Green keys inhibited
Operator – (passwords are provided in Vol 2 Appendix C)
Intended for normal turbine operation – default mode
Screen saver initiates to this level
Service – (passwords are provided in Vol 2 Appendix C)
Allows tuning of parameters, while turbine is running (PID dynamics) and entering of Calibration Mode
Configure – (passwords are provided in Vol 2 Appendix C)
Highest user authority / can enter any Mode

NOTICE	**EMERGENCY STOP is always available in all modes and logins as it has direct H/W action to open the Actuator circuits.**

To Login –

1. **Press the LOGIN button**
2. ** Navigate so the Login or Password field is highlighted (in-focus)
3. Press **Enter** on the Navigation Cross
4. Use the keypad to enter the text field **(hold key down to scroll options)**
5. Press **Enter** on the Navigation Cross – to accept your entry

** Or you can navigate to the Autofill buttons and press Enter – it will auto-populate the Login information so you only need to enter the Password.

Navigation

This is NOT a touchscreen! Due to quality, robustness, screen cleanliness, and long-term reliability concerns Woodward chose not to implement a touchscreen directly on this product. Using the RemoteView tool a user can take advantage of either a mouse device or a touchscreen on an external computer, but for navigation and selection directly on the Vertex display, buttons and an IN-Focus highlighter indication are used.

In general the maroon buttons provide navigation from page-to-page and throughout the components on a page. Most of the navigation is done with the Navigation cross.

Figure 8-6. Navigation Cross

1. Use the “Arrow” buttons to move the IN-Focus highlighter to the desired page
2. Press the “Enter” button to launch the page selected
3. Press the “ESC” (Escape) button to go back 1 page from current page
4. Press the “HOME” button to return to the main menu *Note: If in Service or Configure menu a second press of HOME will return to the Operational Home screen*

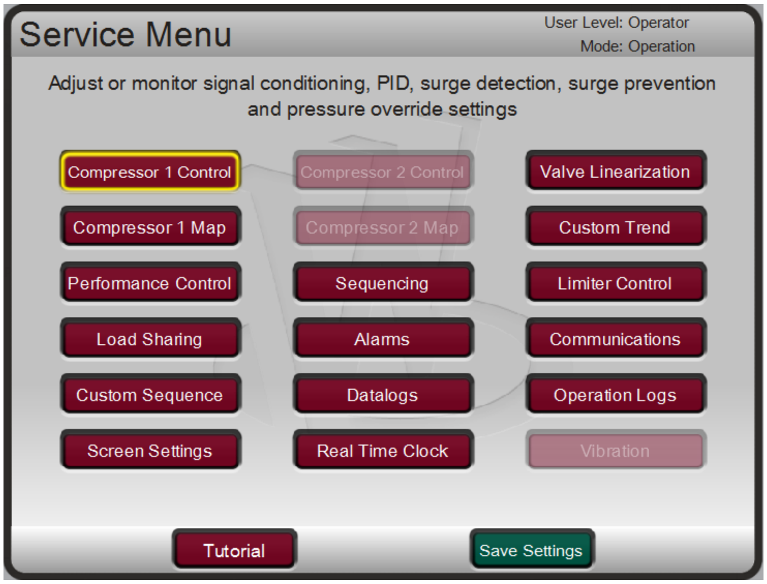


Figure 8-7. Service Menu Showing “Compressor 1 Control” IN-Focus

Page Organization

There are three primary menu lists that organize the access to all of the information that is available on the display. These menu lists are available at all times. The user simply uses the navigation cross to Focus on the desired page and press Enter, or use the Black ‘soft keys’ (no Focus needed).

Run/Operation Menus - The HOME page contains the Run/Operation menus and is automatically updated to match the configuration of the control.

Service Menus - The Service ‘HOME’ page contains navigation buttons to all of the service related parameters and special feature of the control and it too is automatically updated to match the configuration of the control.

Configuration Menus - The Configuration ‘HOME’ page contains navigation buttons to all features and options of the Vertex. When the unit is in Configure Mode (IOLOCK) the background of all pages will be a blue gradient as shown below, in addition to the status in the upper right.

Figure 8-8. Configuration Menu – Operation Mode (view only)

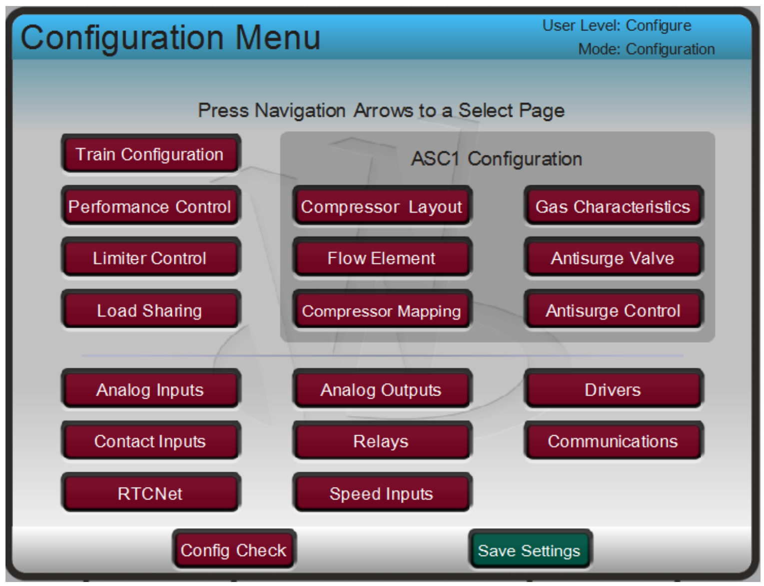


Figure 8-9. Configuration Menu – Configuration Mode (edit)

Refer to Chapter 1 for more details about all of the keys; below are some general reminders about the keypad functions

Green Keys – Initiate operational commands

Red Keys - Navigate or enter values via the alpha numeric keys

Black Keys – Called Softkeys, these are software dependent and may do either, they never require 'IN-Focus' the command shown in above the key is always available

Start and Stop Keys – Always require a Confirmation and user must be logged-in at appropriate User level (Operator or greater)

TRIP is always available in all modes and logins as it has direct H/W action to open the Actuator circuits. For the Vertex, this button may be disabled in the configuration mode, but will always open the Actuator circuits when pressed. Analog outputs are not opened with a direct H/W action and may be preferred for compressor applications.

When entering string text from the keypad, holding down the key will make is slowly cycle through the characters available on that key. Releasing the key will select the character shown at that time.

Overview Screen

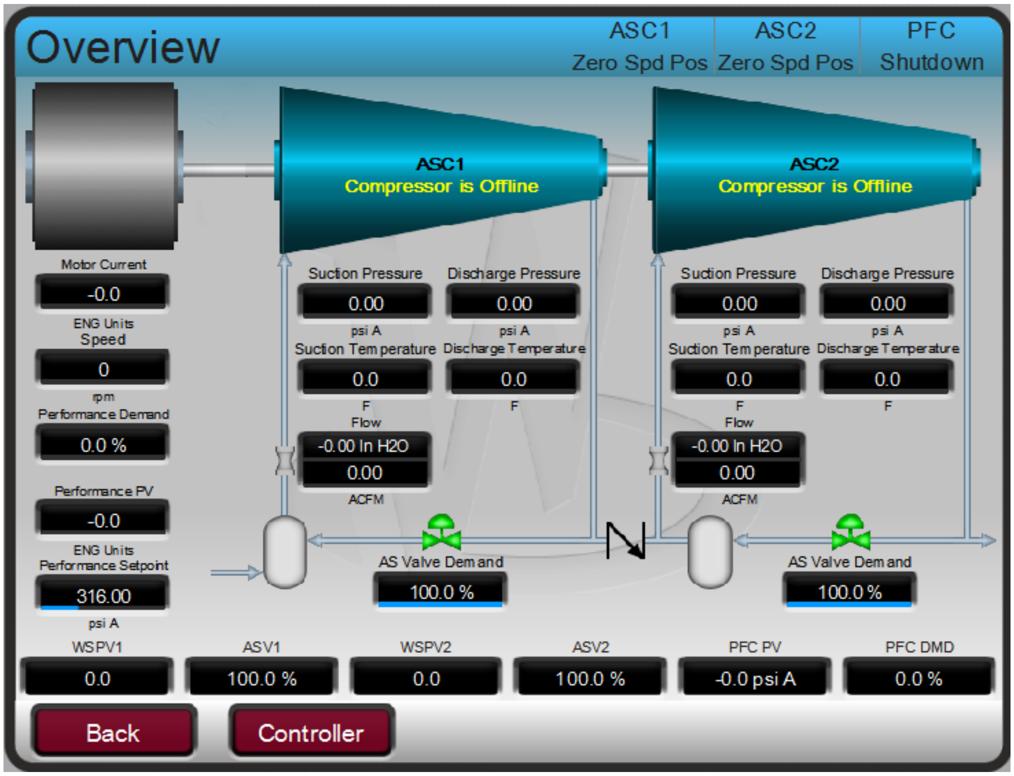


Figure 8-10. Overview Screen

The Overview screen will adapt to the configuration of the Vertex and show all configured options. During normal run operation, this screen should provide the user with all of the primary compressor train parameter values and operational status.

Pressing the “Controller” softkey will cycle through the configured controllers and allow for operation changes to control modes and setpoints.

ASC Controller Popup Screen

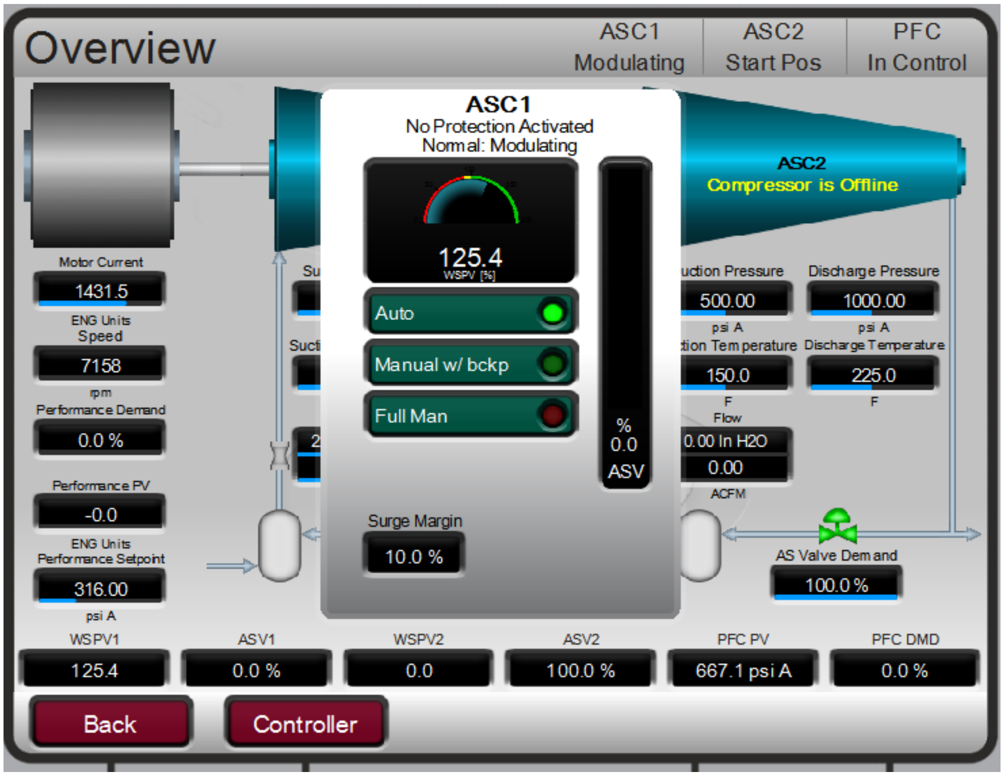


Figure 8-11. ASC Control Popup

ASC Demands Screen

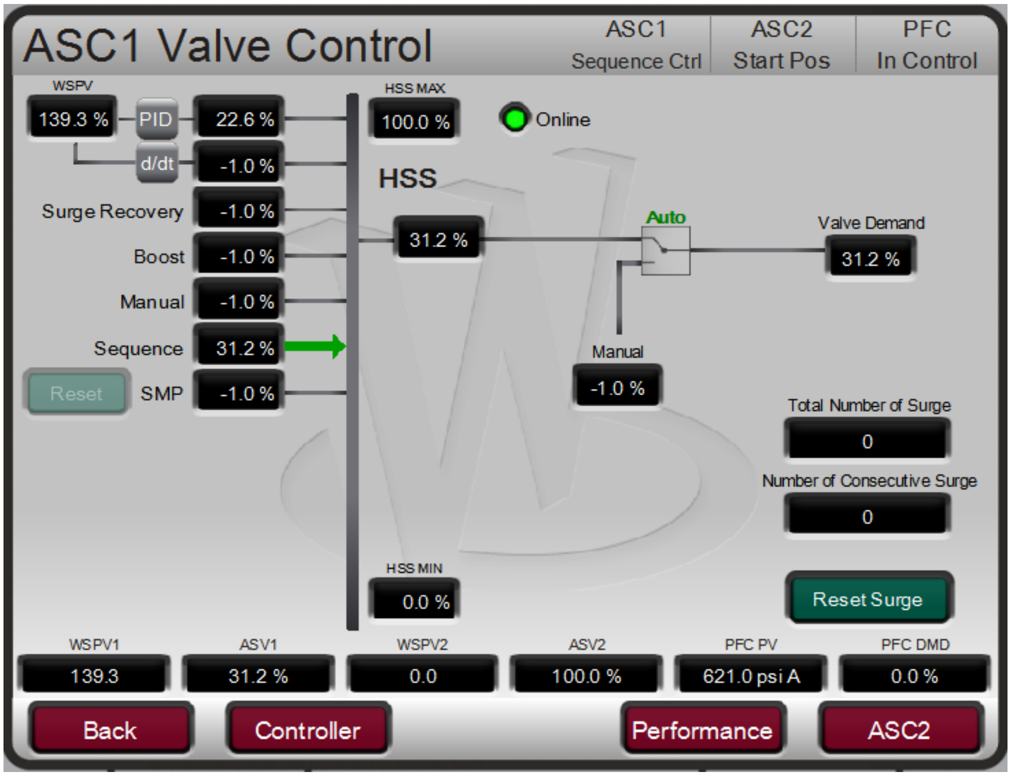


Figure 8-12. ASC Demands Screen

The ASC Demand Valve Control screen will adapt to the configuration of the Vertex and show all configured options that can affect the final output demand to the ASV valve. During normal run operation, this screen provides the user with a clear picture of what control or ramp is controlling the valve demand output. The High Signal Select (HSS) bus will output the highest value seen at its inputs. The valve logic options may be used to adjust this value (such as valve linearization and/or pressure compensation) prior to output to the ASV valve. If these options are not used, the ASV valve demand output will always equal the HSS value.

For two section compressors, the menu bar will have a navigation button to switch to the equivalent ASC2 screen.

ASC Antisurge Control Screen

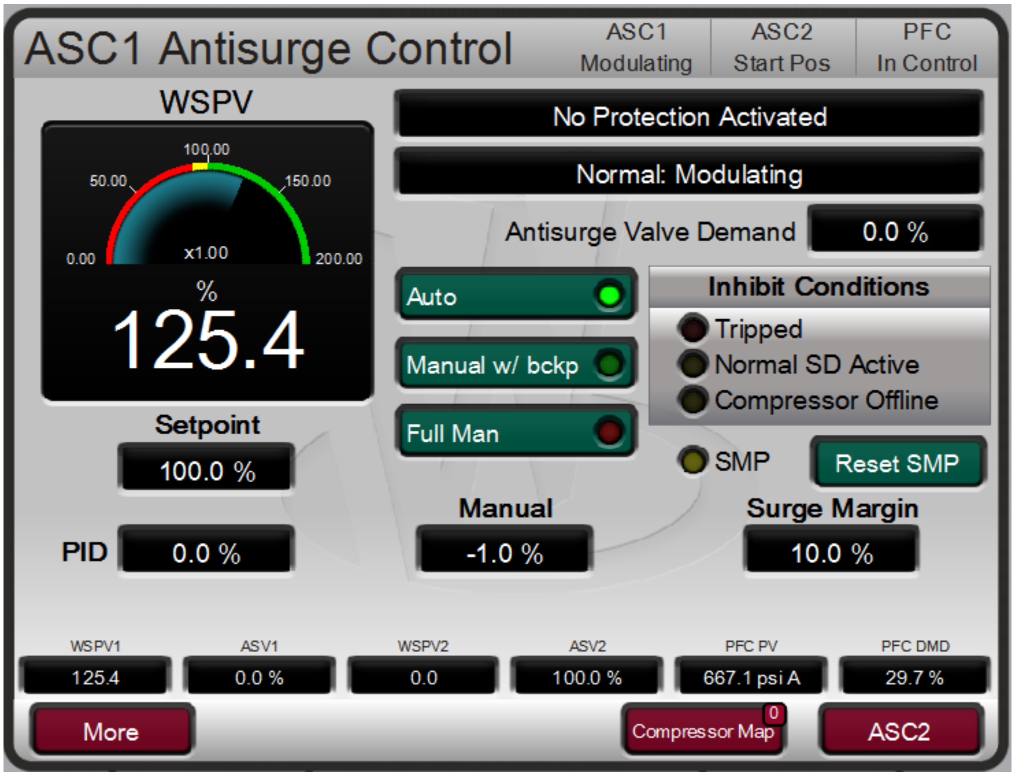


Figure 8-13. ASC Demands Screen

The ASC Antisurge Control screen will adapt to the configuration of the Vertex. During normal run operation, this screen provides the user with all details that are related to the antisurge control loop. The operator can place the control into Auto, Manual with Backup, or Full Manual mode from this screen. If SMP is active, it can be reset from this screen or the Demands page. The antisurge PID control output goes into ASV HSS and can directly affect the ASV valve position demand.

The menu bar functions will allow the user to access a number of other screens that are related to antisurge control, such as directly entering a valve demand (in Manual with backup or Full Manual Mode), access to the Online Conditions, or adjusting antisurge control dynamic settings. In addition, the Compressor Map page can be launched from the menu bar, or by pressing the ‘0’ hotkey.

For two section compressors, the menu bar will have a navigation button to switch to the equivalent ASC2 screen.

ASC Compressor Map Screen

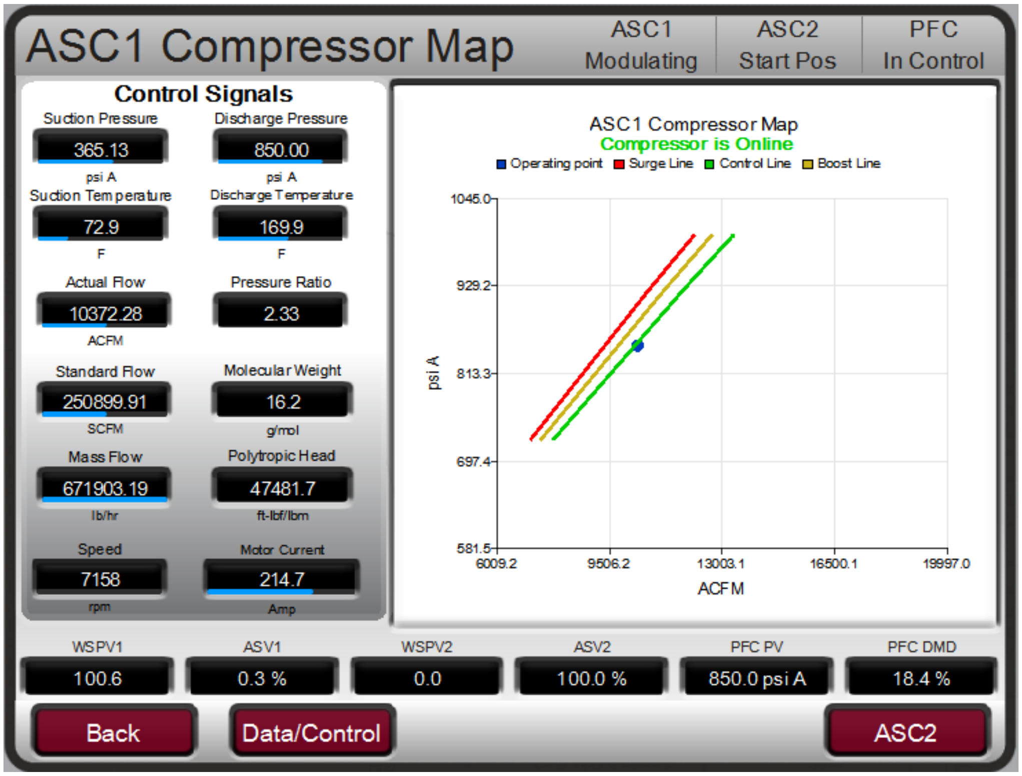


Figure 8-14. ASC Compressor Map Screen

The ASC Compressor Map page can be accessed at any time from the runtime pages by pressing the “0” hotkey. It can also be navigated to from the Antisurge Control page. The screen displays the Surge Limit Line, Boost Line, and Surge Control Line along with the current operating point (blue dot). The surge map adapts to the configured units and ranges. As the operating point moves to the right of the surge map lines the compressor is moving further away from surge.

The Control Signal panel displays all field signals related to the operating point calculation as well as calculated values for flow, pressure ratio, molecular weight, and head. Pressing the Data/Control softkey will alternate between the Control Signal panel and the ASC Control Popup. The ASC Control Popup can be used to change the operating mode of the ASC.

For two section compressors, the menu bar will have a navigation button to switch to the equivalent ASC2 screen.

ASC Control Dynamics

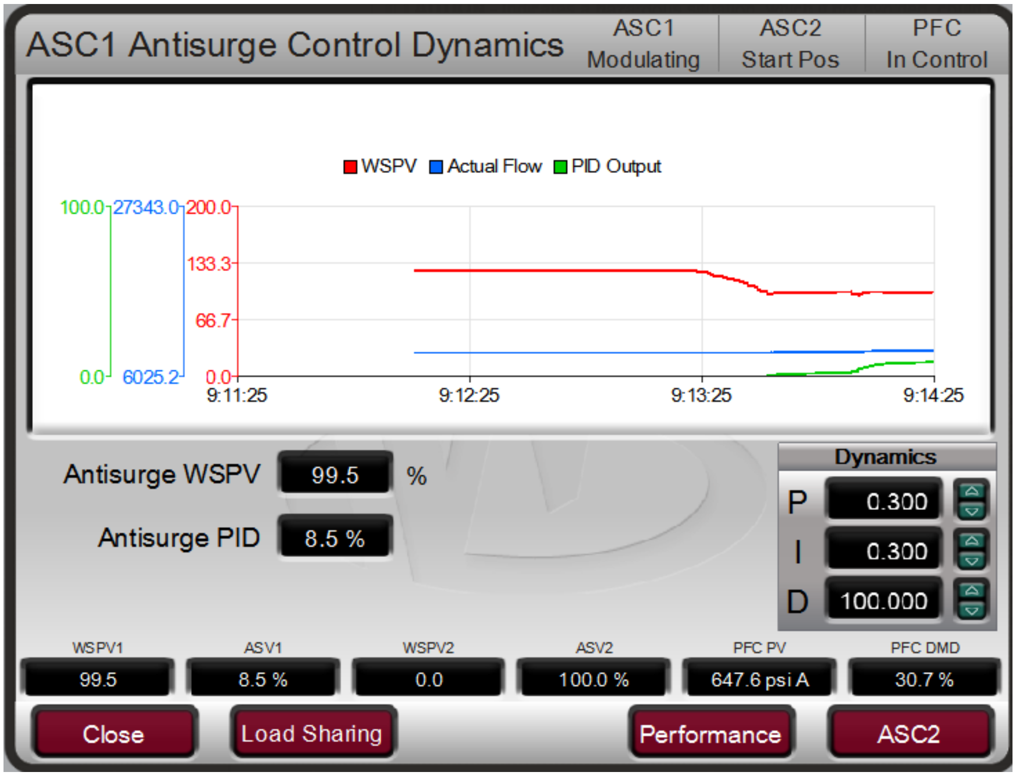


Figure 8-15. ASC Control Dynamics Screen

The ASC Control Dynamics allow the antisugre PID settings to be tune, along with a trend to plot the control and process response. This screen can be navigated to from the Antisurge Control screen or by pressing the '+/-' hotkey.

The menu bar contains links to the other configured controllers in the Vertex.

Performance Control Screen

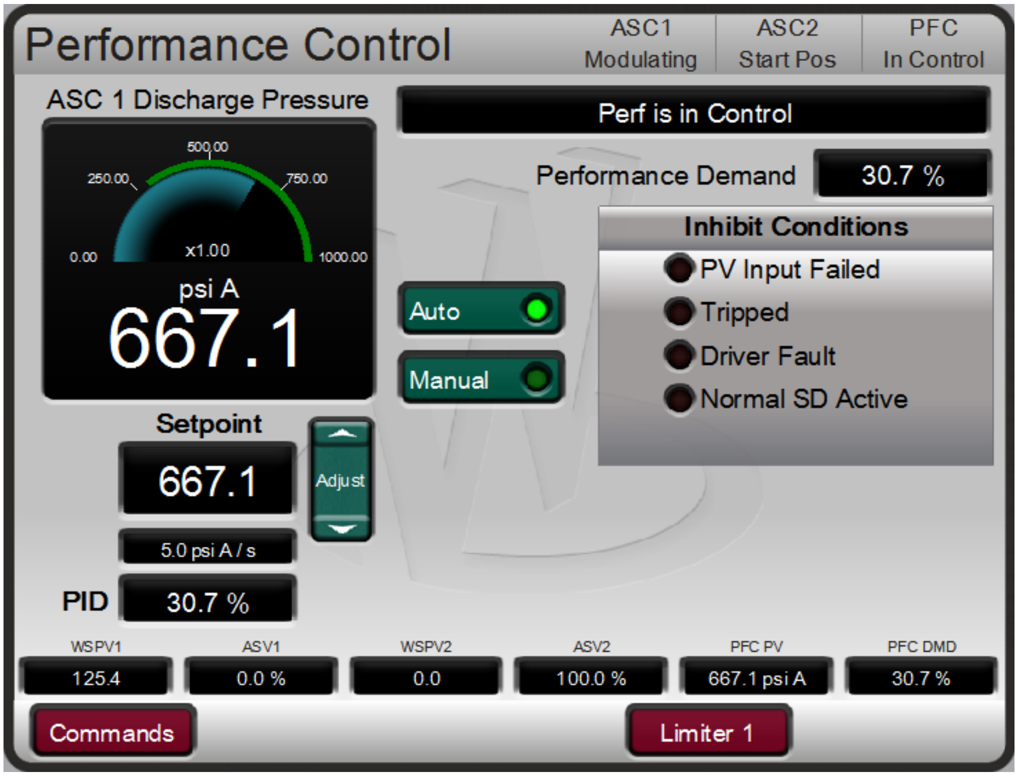


Figure 8-16. Performance Control Screen

The Performance Control screen will adapt to the configuration of the Vertex. During normal run operation, this screen provides the user with all details that are related to the Performance control loop. The operator can place the control into Auto or Manual Mode from this screen. The Performance PID control output goes into Performance LSS and can directly affect the Performance demand.

The menu bar functions will allow the user to access a number of other screens that are related to performance control, such as directly entering a valve demand (in Manual Mode), directly entering a Setpoint, Enabling/Disabling the Remote Setpoint, or adjusting Performance control dynamic settings.

When the Limiter 1 and Limiter 2 PIDs are configured the control pages can be navigated to from the menu bar.

Performance Sequencing Screen

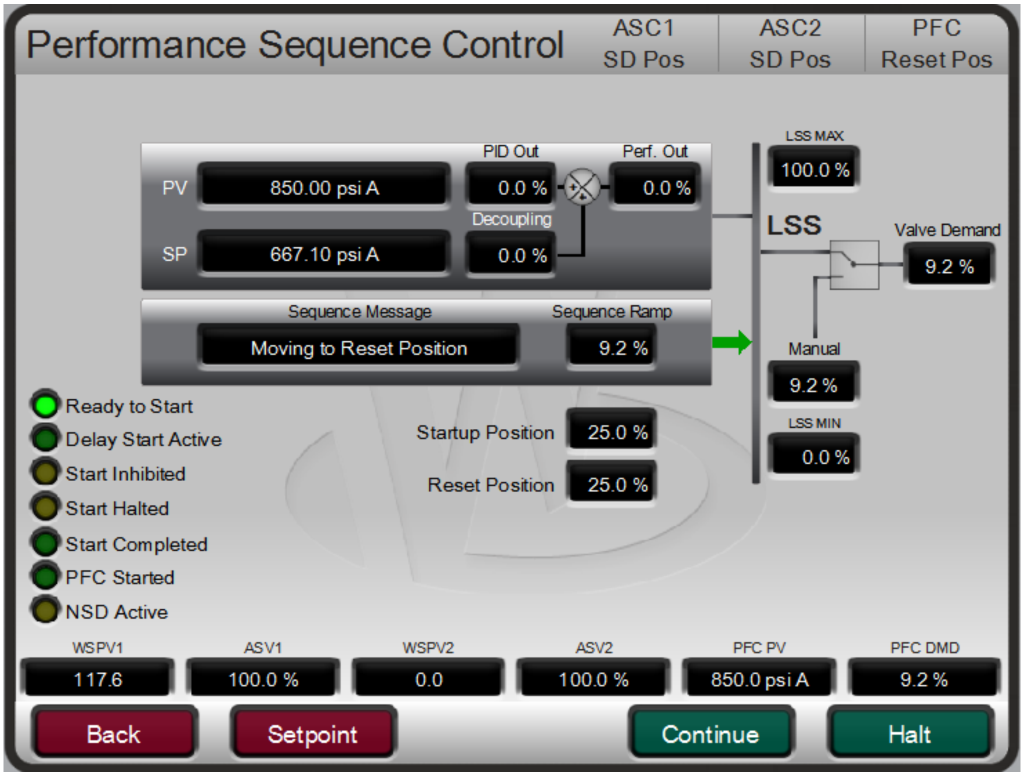


Figure 8-17. Performance Sequencing Screen

The Performance Sequencing screen will adapt to the configuration of the Vertex and show all configured options that can affect the final output demand to the Performance valve. During startup, this screen provides the user with a clear picture the sequencing ramp controlling the valve demand output. The LEDs in the bottom left of the screen provide an overview of the sequence positioning state.

The menu bar functions will allow the user to access pages and commands associated with the startup sequence such as directly entering a sequence position and issuing Halt/Continue commands.

Performance Valve Demand Screen

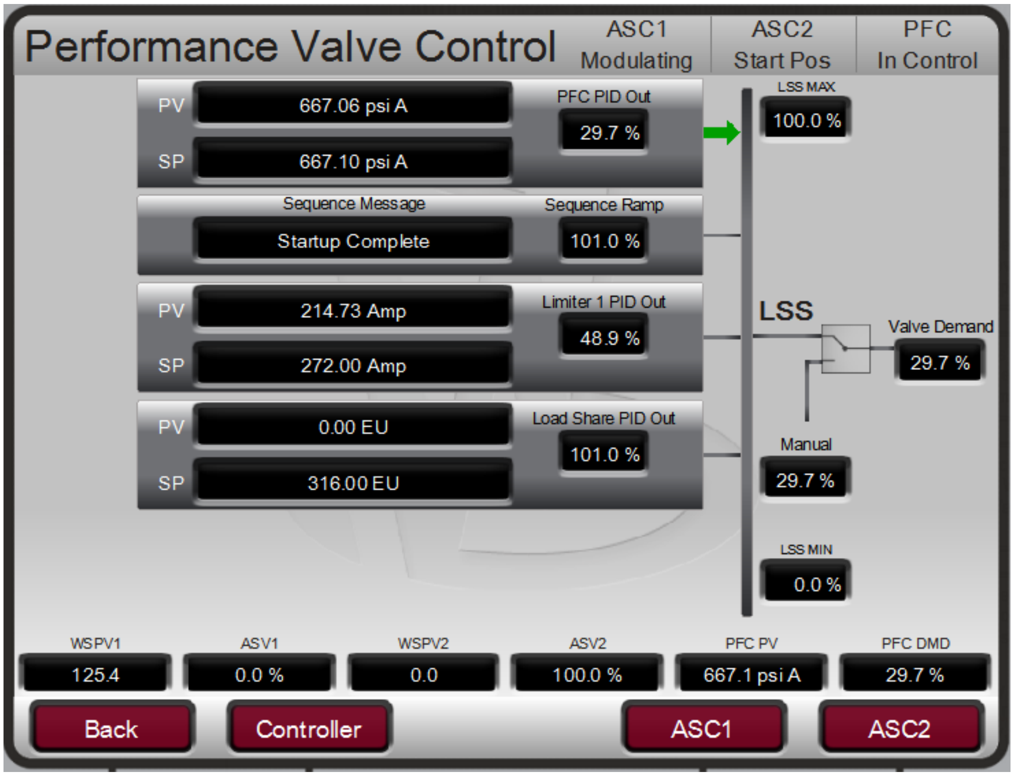


Figure 8-18. Performance Valve Demand Screen

The Performance Demand Valve Control screen will adapt to the configuration of the Vertex and show all configured options that can affect the final output demand to the Performance valve. During normal run operation, this screen provides the user with a clear picture of what control or ramp is controlling the valve demand output. The Low Signal Select (LSS) bus will output the lowest value seen at its inputs. The valve logic options may be used to adjust this value (such as valve linearization and/or pressure compensation) prior to output to the Performance valve. If these options are not used, the Performance valve demand output will always equal the LSS value.

This screen can be navigated to from the ASC Demands menu bar.

Pressing the “Controller” softkey will cycle through the configured controllers and allow for operation changes to control modes and setpoints.

Controllers Screen

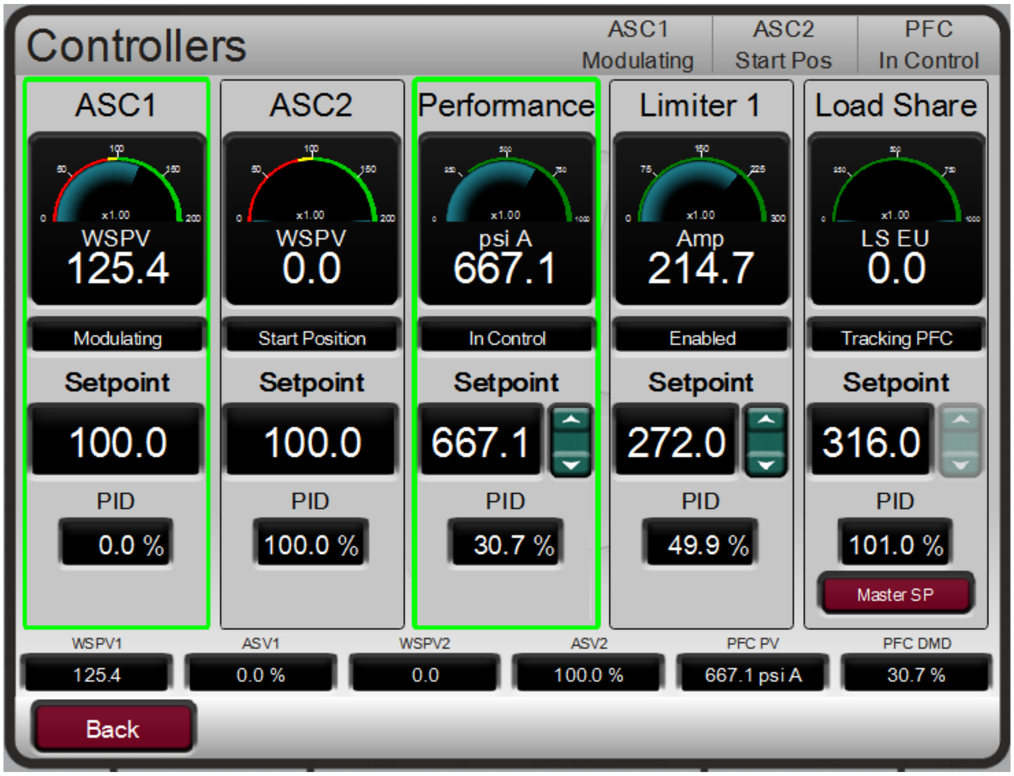


Figure 8-19. Controllers Screen

The Controllers screen will adapt to the configuration of the Vertex and show all configured options. During normal run operation, this screen provides the user with information similar to the Overview, but in a graphical gauge view. It provides larger values for distance viewing and control PID information which is useful for monitoring when the Vertex is near transition points between controllers or limiters.

The green highlighter indicates which controller has active control over a valve or demand output.

Analog Input Summary Screen

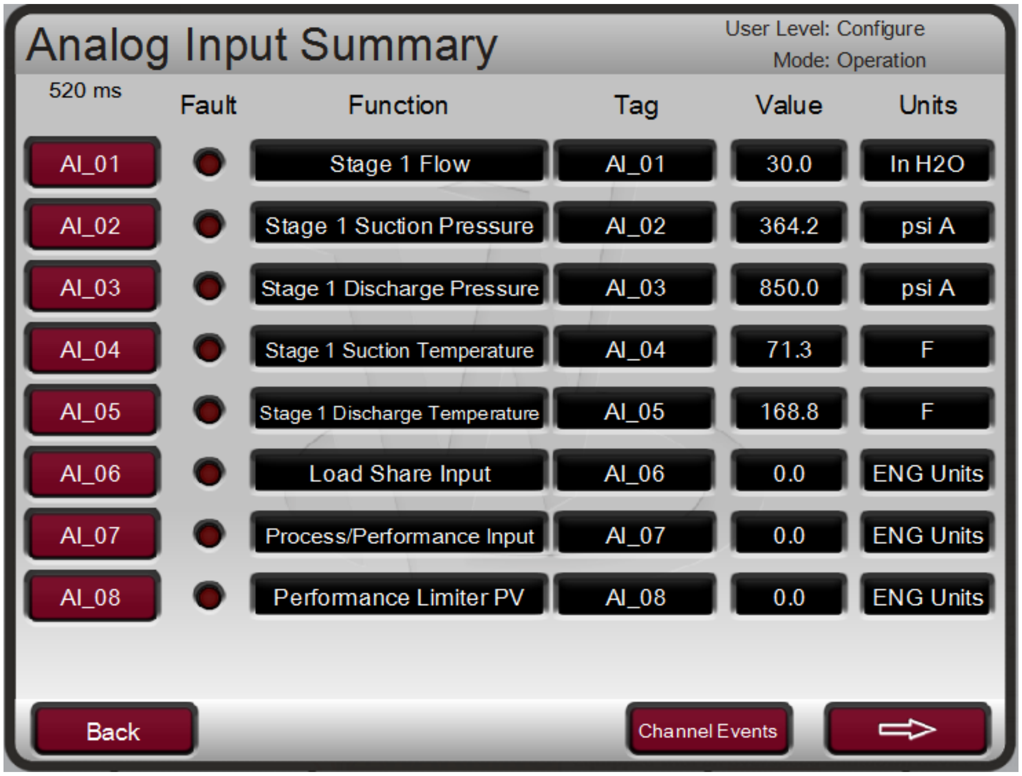


Figure 8-20. Analog Input Summary Screen

The Analog Input Summary screen will display the status of all channels available on the Vertex hardware. The fault status, function, device tag, engineering value and units are shown for each channel as well as navigation buttons for each channel that take the user to a page showing all parameters available for that input.

The menu bar functions will allow the user to access the detailed page of the speed input signals

Contact Input Summary Screen

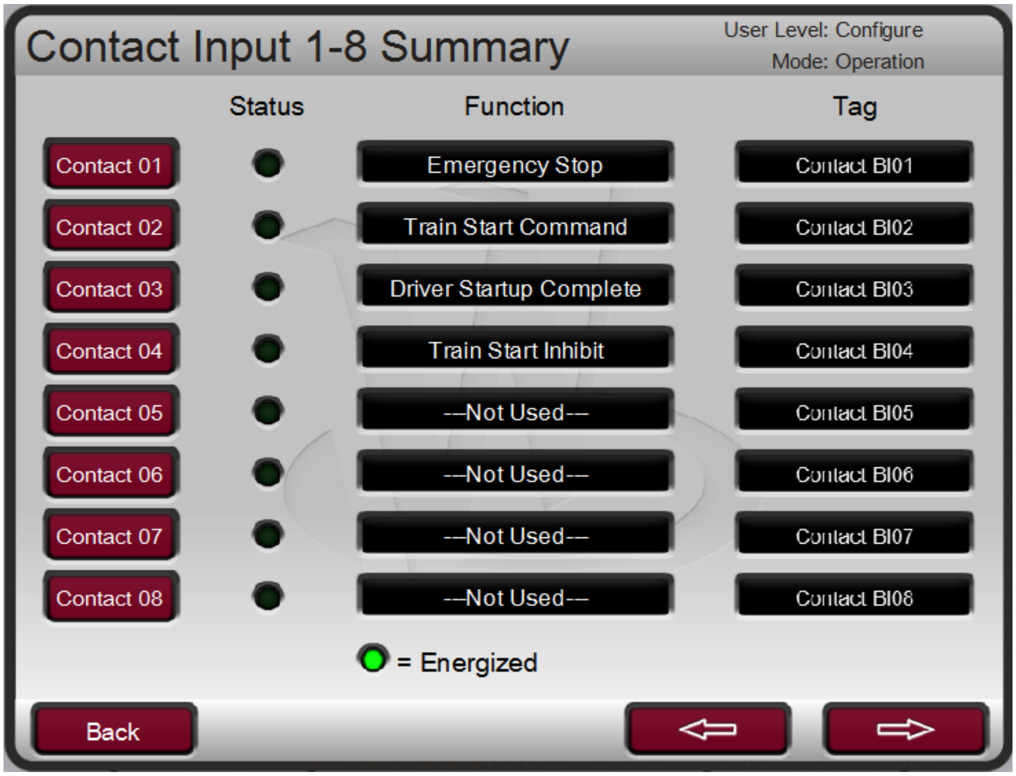


Figure 8-21. Contact Input Summary Screen

The Contact Input Summary screen will display the status of channels available on the Vertex hardware. The fault status, function, and device tags are shown for each channel as well as navigation buttons for each channel that take the user to a page showing all parameters available for that input.

The contact input summary is broken into three pages and the menu bar contains navigation buttons to view all the channels

Analog Output Summary Screen

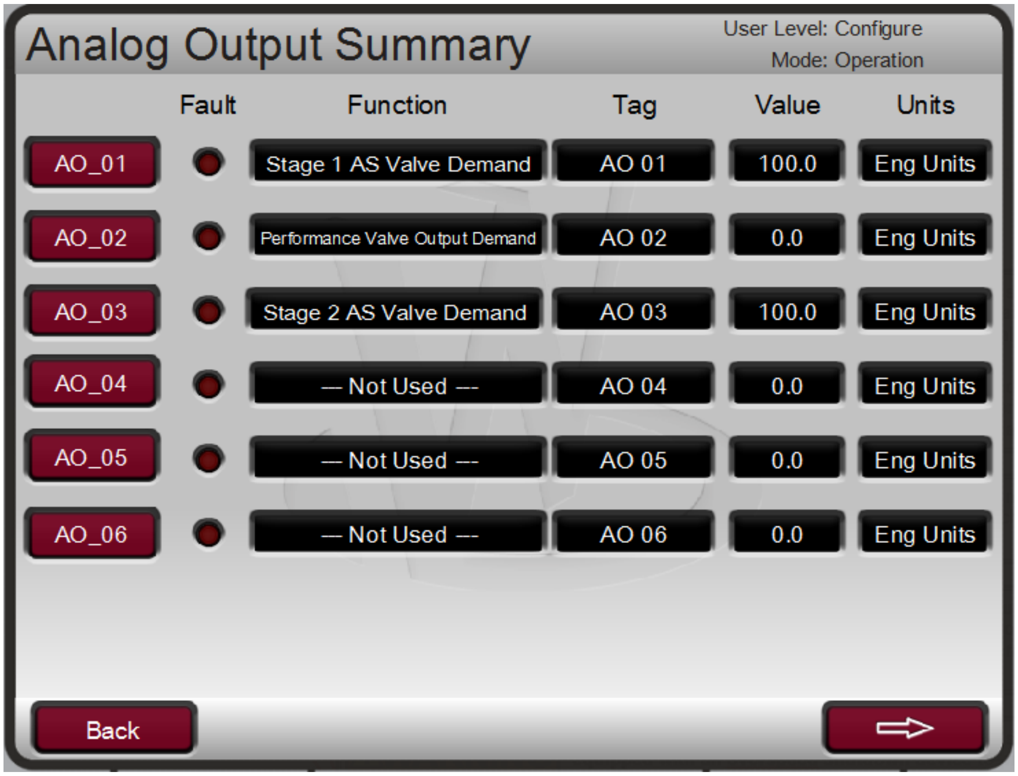


Figure 8-22. Analog Output Summary Screen

The Analog Output Summary screen will display the status of all channels available on the Vertex hardware. The fault status, function, device tag, engineering value and units are shown for each channel as well as navigation buttons for each channel that take the user to a page showing all parameters available for that output.

Relay Output Summary Screen

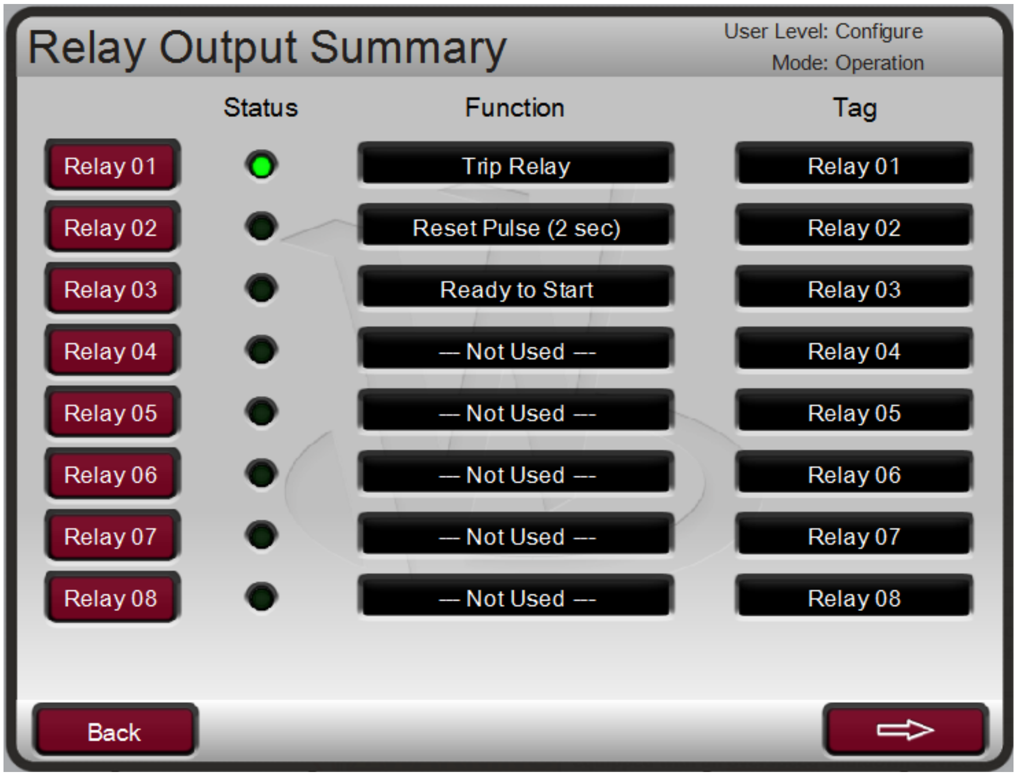


Figure 8-23. Relay Output Summary Screen

The Relay Output Summary screen will display the status of all channels available on the Vertex hardware. The coil status, function, and device tag are shown for each channel as well as navigation buttons for each channel that take the user to a page showing all parameters available for that output.

Actuator Driver Summary Screen

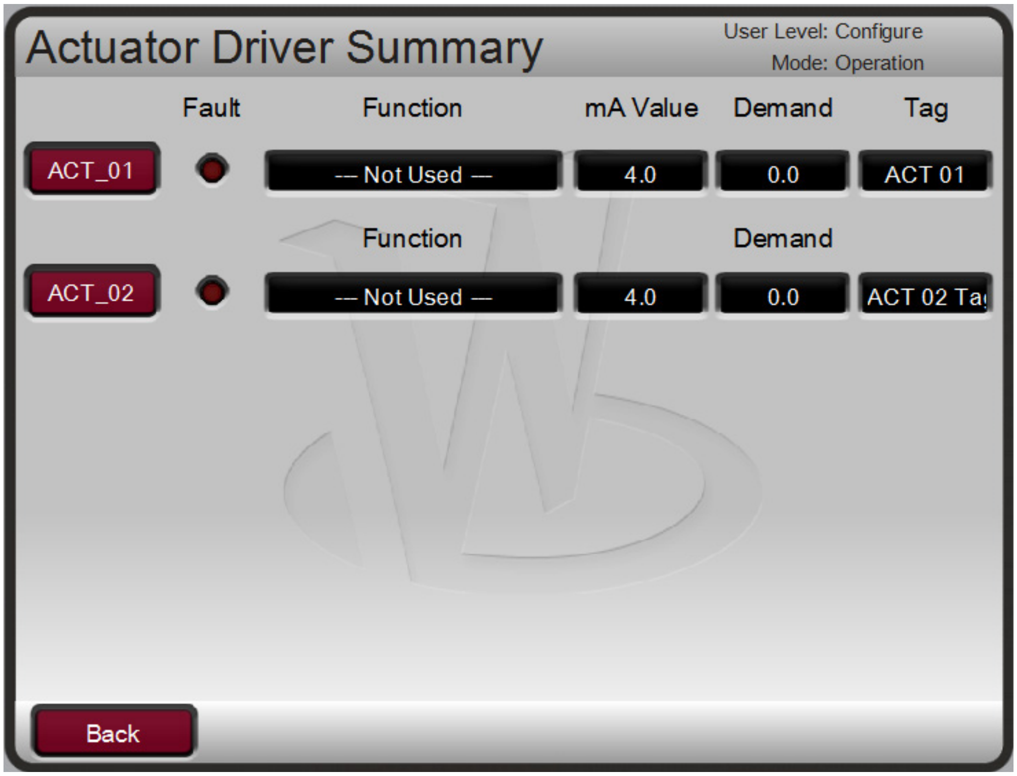


Figure 8-24. Actuator Driver Summary Screen

The Actuator Driver Summary screen will display the status of the two channels available on the Vertex hardware. The fault status, function, current value (in mA), engineering value and units are shown for each channel as well as navigation buttons for each channel that take the user to a page showing all parameters available for that input.

Stop Key

The STOP key is used to perform a controlled/manual compressor train shutdown or stop. To perform a Manual Shutdown, press the STOP key and confirm from the keypad or close the Controlled Shutdown contact input (if programmed) or select Controlled Shutdown from a Modbus communications link. Once initiated, the display dialog box will change to give the user the option to abort the Normal stop sequence. This dialog box will close after 10 seconds, but can be reopened by pressing the STOP key. This function can be also be stopped by opening the contact or selecting Abort Controlled Shutdown from a Modbus communications link.

Alarm Summary

The ALARM screen is always available with the VIEW button under the ALARM LED. When an alarm is detected, it gets latched in the event logic, the Alarm relay is energized, and the ALARM LED illuminates (Yellow). The cause of the event will be indicated with an Event ID, description and time/date stamp on the Alarm Summary page. The list will always place the first event at the top of the list, if more than one alarm condition is present they will all be listed with their corresponding time stamp.

To clear any alarms that are no longer present, press the RESET key, close the Reset contact input, or select Reset from either Modbus communications link. If the cause of the event has been corrected the alarm will clear, it not it will remain and the time-stamp will remain unchanged.

Figure 8-25. ALARM Screen

Each individual alarm condition is available through the Modbus links to monitor the control status. A common alarm indication is also provided.

Relay indications can be programmed to indicate a Vertex Common Alarm, in addition to the dedicated Alarm Relay output.

The table below lists all the potential alarm conditions and their Event ID.

Table 8-1. ALARM Messages

Event ID	Description	Meaning
1	Chassis Summary Alarm	1- Display Backlight Fault 2- CPU OS fault 3- Vertex Internal temp is high (> 70 Deg C) 4- Unit Calibration Fault (Factory Calibration)
2	Internal HW Simulation Enabled	Internal Vertex SIMULATION Mode Active
3	Mod Comm Link #1 (Serial)Failed	Modbus com link #1 was detected as failed—time out error
4	Mod Comm Link #2 (ENET1) Failed	Modbus com link #2 was detected as failed—time out error
5	Mod Comm Link #3 (ENET2) Failed	Modbus com link #3 was detected as failed—time out error
6	GUI Communication Error	GAP to Display communication timeout
7	Spare007	Reserved
8	Spare008	Reserved
9	AO_01 Readback Fault	Analog Output Chan 1 readback failure detected (> 22 mA or < 2 mA)
10	AO_02 Readback Fault	Analog Output Chan 2 readback failure detected (> 22 mA or < 2 mA)

Event ID	Description	Meaning
11	AO_03 Readback Fault	Analog Output Chan 3 readback failure detected (> 22 mA or < 2 mA)
12	AO_04 Readback Fault	Analog Output Chan 4 readback failure detected (> 22 mA or < 2 mA)
13	AO_05 Readback Fault	Analog Output Chan 5 readback failure detected (> 22 mA or < 2 mA)
14	AO_06 Readback Fault	Analog Output Chan 6 readback failure detected (> 22 mA or < 2 mA)
15	Spare015	Reserved
16	Spare016	Reserved
17	AI Chan 1 Level 1 ALM	Analog Input 1 passed alarm level 1 limit
18	AI Chan 1 Level 2 ALM	Analog Input 1 passed alarm level 2 limit
19	AI Chan 2 Level 1 ALM	Analog Input 2 passed alarm level 1 limit
20	AI Chan 2 Level 2 ALM	Analog Input 2 passed alarm level 2 limit
21	AI Chan 3 Level 1 ALM	Analog Input 3 passed alarm level 1 limit
22	AI Chan 3 Level 2 ALM	Analog Input 3 passed alarm level 2 limit
23	AI Chan 4 Level 1 ALM	Analog Input 4 passed alarm level 1 limit
24	AI Chan 4 Level 2 ALM	Analog Input 4 passed alarm level 2 limit
25	AI Chan 5 Level 1 ALM	Analog Input 5 passed alarm level 1 limit
26	AI Chan 5 Level 2 ALM	Analog Input 5 passed alarm level 2 limit
27	AI Chan 6 Level 1 ALM	Analog Input 6 passed alarm level 1 limit
28	AI Chan 6 Level 2 ALM	Analog Input 6 passed alarm level 2 limit
29	AI Chan 7 Level 1 ALM	Analog Input 7 passed alarm level 1 limit
30	AI Chan 7 Level 2 ALM	Analog Input 7 passed alarm level 2 limit
31	AI Chan 8 Level 1 ALM	Analog Input 8 passed alarm level 1 limit
32	AI Chan 8 Level 2 ALM	Analog Input 8 passed alarm level 2 limit
33	Alarm from RTCNet Nodes	An alarm exists on a RTCNet node – check the RTCNet summary screen for details
34	MPU1 Fault	Speed probe #1 failure—(< Failed Speed Level or 1 Vrms)
35	MPU2 Fault	Speed probe #2 failure—(< Failed Speed Level or 1 Vrms)
36	Both MPUs Fault	Loss of all speed probes was sensed
37	Speed 4-20 Signal Fault	Speed Input Signal failure detected (> 22 mA or < 2 mA)
38	External alarm # 1	External Alarm #1 from contact input
39	External alarm # 2	External Alarm #2 from contact input
40	External alarm # 3	External Alarm #3 from contact input
41	Un-Authorized Start Attempted	Start Inhibited and Start Command Received
42	Speed 1 and Speed 2 Deviation	MPU Channel 1 and MPU Channel 2 RPM Value Difference
43	Spare 043	Reserved
44	Spare 044	Reserved
45	Spare 045	Reserved
46	Spare 046	Reserved
47	Spare 047	Reserved
48	Spare 048	Reserved
49	ASC#1: Consecutive surge AL Detected	Number of detected surges exceeds limit within a configured time

Event ID	Description	Meaning
50	ASC#1: HSS#1 Fault	External ASC HSS Analog Input failure (> 22 mA or < 2 mA)
51	ASC#1: Primary Flow PV Failed	Flow dP Analog Input failure (> 22 mA or < 2 mA)
52	ASC#1: Secondary Flow PV Failed	Redundant Flow dP Analog Input failure (> 22 mA or < 2 mA)
53	ASC#1: Suction Pressure PV Failed	Suction Pressure Analog Input failure (> 22 mA or < 2 mA)
54	ASC#1: Discharge Pressure PV Failed	Discharge Pressure Analog Input failure (> 22 mA or < 2 mA)
55	ASC#1: Suction Temp PV Failed	Suction Temperature Analog Input failure (> 22 mA or < 2 mA)
56	ASC#1: Discharge Temp PV Failed	Discharge Temperature Analog Input failure (> 22 mA or < 2 mA)
57	ASC#1: Position feedback fault	ASV Position Analog Input failure (> 22 mA or < 2 mA)
58	ASC#1: Driver Fault	ASV Analog or Driver Output fault detected (open or short circuit was sensed)
59	ASC#1: Full Manual Active	ASC is in Full Manual Mode - Surge protections disabled
60	AS1 Valve Pos Fdbk Diff ALM	ASV demand versus Feedback Difference
61	ASC#1: Surge on Flow Deriv	Surge Detected: Flow Derivative Trigger Setpoint Exceeded
62	ASC#1: Surge on P1 Deriv	Surge Detected: Suction Pressure Derivative Trigger Setpoint Exceeded
63	ASC#1: Surge on P2 Deriv	Surge Detected: Dishcarge Pressure Derivative Trigger Setpoint Exceeded
64	ASC#1: Surge on Speed Deriv	Surge Detected: Speed Derivative Trigger Setpoint Exceeded
65	ASC#1: Surge on Crossed Line	Surge Detected: Operating Point Crossed the Surge Limit Line
66	ASC#1: Surge On Motor current	Surge Detected: Motor Current Derivative Trigger Setpoint Exceeded
67	ASC#1: Choke Map Reached	Operating Point reached the Choke Line
68	ASC#1: Surges- AS valve forced to max	Number of detected surges exceeds limit within a configured time
69	ASC#1: AS VLV Fdbk Error-Force open	ASV demand versus Feedback Difference
70	ASC#1:Linearaization Error	Output valve curve error on X-Y points
71	ASC#1:Surge on Min Flow	Surge Detected: Minimum flow trigger setpoint reached
72	Spare 072	Reserved
73	ASC#1: External Surge Detected	Surge Detected: External contact input
74	ASC#1: External Multi Surge Detected	Surge Detected: External contact input
75	ASC#1 Red Flow TX Dev Active	Flow dP and Redundant signal difference
76	ASC#1: Suction Pressure PV #2Failed	ASC#1 Redundant Suction Pressure PV Analog Input failure (>22 mA or <2 mA)
77	Discharge Pressure PV #2 Failed	ASC#1 Redundant Discharge Pressure PV Analog Input failure (>22 mA or <2 mA)
78	Performance PV Input #2 Failed	Performance PV Analog Input failure (>22 mA or <2 mA)

Event ID	Description	Meaning
79	Started from Remote	Trip cleared - unit started
80	Primary Ctrl POS Feedback Fault	Performance Valve Feedback Analog Input Failure (> 22 mA or < 2 mA)
81	Performance PV Input Failed	Performance PV Analog Input Failure (> 22 mA or < 2 mA)
82	Remote Performance Setpoint Failed	Remote Performance Setpoint Analog Input Failure ((> 22 mA or < 2 mA))
83	Remote Performance Demand Failed	Remote Performance Demand Analog Input Failure (> 22 mA or < 2 mA)
84	Performance Limiter PV Input Failed	Performance Limiter 1 PV Analog Input Failure (> 22 mA or < 2 mA)
85	External Decoupling Signal Fault	Performance External Decoupling Analog Input Failure (> 22 mA or < 2 mA)
86	Motor Current/Power Signal Fault	Motor Current Analog Input Failure (> 22 mA or < 2 mA)
87	Perf Cntrl Reset Pos > Start Pos Err	Performance settings Reset Position greater than Start Position
88	Perf Limiter1 RMT SP Input Failed	Performance Limiter 1 Remote Setpoint Analog Input Failure (> 22 mA or < 2 mA)
89	Performance Controller Driver Fault	PFC Analog or Driver Output fault detected (open or short circuit was sensed)
90	Performance Linearization Error	Output valve curve error on X-Y points
91	ASC#2: Consecutive surge AL Detected	Number of detected surges exceeds limit within a configured time
92	ASC#2: HSS#1 Fault	External ASC HSS Analog Input failure (> 22 mA or < 2 mA)
93	ASC#2: Primary Flow PV Failed	Flow dP Analog Input failure (> 22 mA or < 2 mA)
94	ASC#2: Secondary Flow PV Failed	Redundant Flow dP Analog Input failure (> 22 mA or < 2 mA)
95	ASC#2: Suction Pressure PV Failed	Suction Pressure Analog Input failure (> 22 mA or < 2 mA)
96	ASC#2: Discharge Pressure PV Failed	Discharge Pressure Analog Input failure (> 22 mA or < 2 mA)
97	ASC#2: Suction Temp PV Failed	Suction Temperature Analog Input failure (> 22 mA or < 2 mA)
98	ASC#2: Discharge Temp PV Failed	Discharge Temperature Analog Input failure (> 22 mA or < 2 mA)
99	ASC#2: Position feedback fault	ASV Position Analog Input failure (> 22 mA or < 2 mA)
100	ASC#2: Driver Fault	ASV Analog or Driver Output fault detected (open or short circuit was sensed)
101	ASC#2: Full Manual Active	ASC is in Full Manual Mode - Surge protections disabled
102	ASC#2: AS Valve Pos Fdbk Diff ALM	ASV demand versus Feedback Difference
103	ASC#2: Surge on Flow Deriv	Surge Detected: Flow Derivative Trigger Setpoint Exceeded
104	ASC#2: Surge on P1 Deriv	Surge Detected: Suction Pressure Derivative Trigger Setpoint Exceeded
105	ASC#2: Surge on P2 Deriv	Surge Detected: Discharge Pressure Derivative Trigger Setpoint Exceeded
106	ASC#2: Surge on Speed Derivative	Surge Detected: Speed Derivative Trigger Setpoint Exceeded
107	ASC#2: Surge on Crossed Line	Surge Detected: Operating Point Crossed the Surge Limit Line

Event ID	Description	Meaning
108	ASC#2: Surge On Motor current	Surge Detected: Motor Current Derivative Trigger Setpoint Exceeded
109	ASC#2: Choke Map Reached	Operating Point reached the Choke Line
110	ASC#2: Surges- AS valve forced to max	Number of detected surges exceeds limit within a configured time
111	ASC#2: AS VLV Fdbk Error-Force open	ASV demand versus Feedback Difference
112	ASC#2: Linearization Error	Output valve curve error on X-Y points
113	ASC#2: Surge on Min Flow	Surge Detected: Minimum flow trigger setpoint reached
114	Spare 114	Reserved
115	ASC#2: External Surge Detected	Surge Detected: External contact input
116	ASC#2: External Multi Surge Detected	Surge Detected: External contact input
117	ASC#2 Red Flow TX Dev Active	Flow dP and Redundant signal difference
118	ASC#2: Suction Pressure PV #2 Failed	ASC#2 Redundant Suction Pressure PV Analog Input failure (>22 mA or <2 mA)
119	ASC#2: Discharge Pressure PV #2 Failed	ASC#2 Redundant Discharge Pressure PV Analog Input failure (>22 mA or <2 mA)
120	Spare_120	Reserved
121	Vibration Input #1 Fault	Vibration Analog Input Failure (> 22 mA or < 2 mA)
122	Vibration Input #2Fault	Vibration Analog Input Failure (> 22 mA or < 2 mA)
123	Vibration Input #3Fault	Vibration Analog Input Failure (> 22 mA or < 2 mA)
124	Vibration Input #4 Fault	Vibration Analog Input Failure (> 22 mA or < 2 mA)
125	Signal Fault AI 1	Generic Input Used - Analog Input Failure (> 22 mA or < 2 mA) Channel 1
126	Signal Fault AI 2	Generic Input Used - Analog Input Failure (> 22 mA or < 2 mA) Channel 2
127	Signal Fault AI 3	Generic Input Used - Analog Input Failure (> 22 mA or < 2 mA) Channel 3
128	Signal Fault AI 4	Generic Input Used - Analog Input Failure (> 22 mA or < 2 mA) Channel 4
129	Signal Fault AI 5	Generic Input Used - Analog Input Failure (> 22 mA or < 2 mA) Channel 5
130	Signal Fault AI 6	Generic Input Used - Analog Input Failure (> 22 mA or < 2 mA) Channel 6
131	Signal Fault AI 7	Generic Input Used - Analog Input Failure (> 22 mA or < 2 mA) Channel 7
132	Signal Fault AI 8	Generic Input Used - Analog Input Failure (> 22 mA or < 2 mA) Channel 8
133	Tunable Alarm	Service Menu > Screen Settings Page Checked
134	Maintenance Alarm	Run Hours Reached Maintenance Interval
135	Load Share PV Failed	Load Share PV Analog Input failure (>22 mA or <2 mA)
136	Isolated Controller PV Failed	ISO PID PV Analog Input failure (>22 mA or <2 mA)
137	Iso Cntrl Rem Setpoint Failed	ISO PID Remote SP PV Analog Input failure (>22 mA or <2 mA)
138	T1 Comms Failure Override Active	Communication errors override active to Train 1

Event ID	Description	Meaning
139	T2 Comms Failure Override Active	Communication errors override active to Train 2
140	T3 Comms Failure Override Active	Communication errors override active to Train 3
141	T4 Comms Failure Override Active	Communication errors override active to Train 4
142	T5 Comms Failure Override Active	Communication errors override active to Train 5
143	Kicked Out of Parallel Load Sharing	Generic Load Sharing Kickout Alarm
144	All Load Sharing PVs Failed	Load Sharing Analog Input Failure on All Trains (> 22 mA or < 2 mA)
145	T1 Tripped Out of Load Sharing	Train 1 Tripped and excluded from load sharing group
146	T2 Tripped Out of Load Sharing	Train 2 Tripped and excluded from load sharing group
147	T3 Tripped Out of Load Sharing	Train 3 Tripped and excluded from load sharing group
148	T4 Tripped Out of Load Sharing	Train 4 Tripped and excluded from load sharing group
149	T5 Tripped Out of Load Sharing	Train 5 Tripped and excluded from load sharing group
150	T1 Performance Controller is Limited	Train 1 Driver has been limited - Removed from load sharing group
151	T2 Performance Controller is Limited	Train 2 Driver has been limited - Removed from load sharing group
152	T3 Performance Controller is Limited	Train 3 Driver has been limited - Removed from load sharing group
153	T4 Performance Controller is Limited	Train 4 Driver has been limited - Removed from load sharing group
154	T5 Performance Controller is Limited	Train 5 Driver has been limited - Removed from load sharing group
155	T1 Load Sharing PV Fault	Train 1 Load Sharing PV Analog Input Failure (> 22 mA or < 2 mA)
156	T2 Load Sharing PV Fault	Train 2 Load Sharing PV Analog Input Failure (> 22 mA or < 2 mA)
157	T3 Load Sharing PV Fault	Train 3 Load Sharing PV Analog Input Failure (> 22 mA or < 2 mA)
158	T4 Load Sharing PV Fault	Train 4 Load Sharing PV Analog Input Failure (> 22 mA or < 2 mA)
159	T5 Load Sharing PV Fault	Train 5 Load Sharing PV Analog Input Failure (> 22 mA or < 2 mA)
160	Link 1 from T1 Failed	Communication Link Error from Train 1
161	Link 1 from T2 Failed	Communication Link Error from Train 2
162	Link 1 from T3 Failed	Communication Link Error from Train 3
163	Link 1 from T4 Failed	Communication Link Error from Train 4
164	Link 1 from T5 Failed	Communication Link Error from Train 5
165	Link 2 from T1 Failed	Communication Link Error from Train 1
166	Link 2 from T2 Failed	Communication Link Error from Train 2
167	Link 2 from T3 Failed	Communication Link Error from Train 3
168	Link 2 from T4 Failed	Communication Link Error from Train 4
169	Link 2 from T5 Failed	Communication Link Error from Train 5
170	Shared parameter fault	Speed or Flow Signal Fault

Event ID	Description	Meaning
171	LS KO: All Comm Links Failed	Load Sharing Kicked Out: Communication to all other trains failed
172	LS KO: All Load Share PVs Failed	Load Sharing Kicked Out: All Load Sharing PVs Failed (> 22 mA or < 2 mA)
173	LS KO: Performance Manual Enabled	Load Sharing Kicked Out: Performance Mode in Manual
174	LS KO: ASC1 Offline	Load Sharing Kicked Out: ASC1 has gone Offline
175	LS KO: ASC2 Offline	Load Sharing Kicked Out: ASC2 has gone Offline
176	LS KO: PFC Limiter 1 Active	Load Sharing Kicked Out: Limiter 1 PID has Control of PFC Demand output
177	LS KO: PFC Limiter 2 Active	Load Sharing Kicked Out: Limiter 2 PID has Control of PFC Demand output
178	LS KO: ASC Deviation	Load Sharing Kicked Out: ASV devation from train average exceeded
179	LS KO: Parameter Deviation	Load Sharing Kicked Out: LS Parameter deviation from average exceeded
180	LS KO: ASC1 Surge	Load Sharing Kicked Out: ASC1 surge detected
181	LS KO: ASC2 Surge	Load Sharing Kicked Out: ASC2 surge detected
182	LS KO: ASC1 Full Manual Active	Load Sharing Kicked Out: ASC1 in Full Manual Mode
183	LS KO: ASC2 Full Manual Active	Load Sharing Kicked Out: ASC2 in Full Manual Mode
184	LS KO: ASC1 Driver Failed	Load Sharing Kicked Out: ASC1 ASV Driver fault detected
185	LS KO: ASC2 Driver Failed	Load Sharing Kicked Out: ASC2 ASV Driver fault detected
186	LS KO: PFC Driver Failed	Load Sharing Kicked Out: Performance driver fault detected
187	LS KO: PFC Speed Tracking Enabled	Load Sharing Kicked Out: Performance Speed controller is limited
188	AI Maintenance Override Active	The AI Service maintenance bypass is active on 1 or more channels
189-200	Spare	Alarms below only apply to redundant controls
201	Backup Unavailable	Backup chassis is not available
202	Secondary Chassis Summary Fault	Backup chassis has a chassis h/w or OS fault
203	Backup Speed 1 Fault	Speed chan 1 on backup unit is failed
204	Backup Speed 2 Fault	Speed chan 2 on backup unit is failed
205	Backup AI 1 Fault	Analog input chan 1 on backup unit is failed
206	Backup AI 2 Fault	Analog input chan 2 on backup unit is failed
207	Backup AI 3 Fault	Analog input chan 3 on backup unit is failed
208	Backup AI 4 Fault	Analog input chan 4 on backup unit is failed
209	Backup AI 5 Fault	Analog input chan 5 on backup unit is failed
210	Backup AI 6 Fault	Analog input chan 6 on backup unit is failed
211	Backup AI 7 Fault	Analog input chan 7 on backup unit is failed
212	Backup AI 8 Fault	Analog input chan 8 on backup unit is failed
213	Diff Alarm Redun ASC1 Suction Press	Out of tolerance difference exists in the redundant ASC1 Suction Pressure signals
214	Diff Alarm Redun ASC1 Discharge Press	Out of tolerance difference exists in the redundant ASC1 Discharge Pressure signals
215	Diff Alarm Redun ASC2 Suction Press	Out of tolerance difference exists in the redundant ASC2 Suction Pressure signals

Event ID	Description	Meaning
216	Diff Alarm Redun ASC2 Discharge Press	Out of tolerance difference exists in the redundant ASC2 Discharge Pressure signals
217	Diff Alarm Redun Performance PV	Out of tolerance difference exists in the redundant Performance process signals
218	Analog Output 01 Backup Fault	Analog output chan 1 on backup unit is failed
219	Analog Output 02 Backup Fault	Analog output chan 2 on backup unit is failed
220	Analog Output 03 Backup Fault	Analog output chan 3 on backup unit is failed
221	Analog Output 04 Backup Fault	Analog output chan 4 on backup unit is failed
222	Analog Output 05 Backup Fault	Analog output chan 5 on backup unit is failed
223	Analog Output 06 Backup Fault	Analog output chan 6 on backup unit is failed
224	Actuator Output 01 Backup Fault	Actuator output chan 1 on backup unit is failed
225	Actuator Output 02 Backup Fault	Actuator output chan 2 on backup unit is failed
226	Simplex Config detects Sec Chassis	VertexDR is configured as a simplex unit, but a second unit has been detected
227	Iso Cntrl Driver Fault	A fault has been detected on the driver output channel for the Isolated PID Controller option

Shutdown Summary

The Shutdown Summary screen is always available with the VIEW button under the TRIPPED LED. When a trip is detected, it gets latched in the event logic, the Trip relay is de-energized, all steam valve demand outputs go to zero, and the TRIPPED LED illuminates (Red). The cause of the event will be indicated with an Event ID, description and time/date stamp on the Shutdown Summary page. The list will always place the first event at the top of the list. If more than one trip condition is present, they will all be listed with their corresponding time stamp.

To clear any shutdowns that are no longer present, press the RESET key, close the Reset contact input, or select Reset from either Modbus communications link. If the cause of the event has been corrected the event will clear, it not it will remain and the time-stamp will remain unchanged.

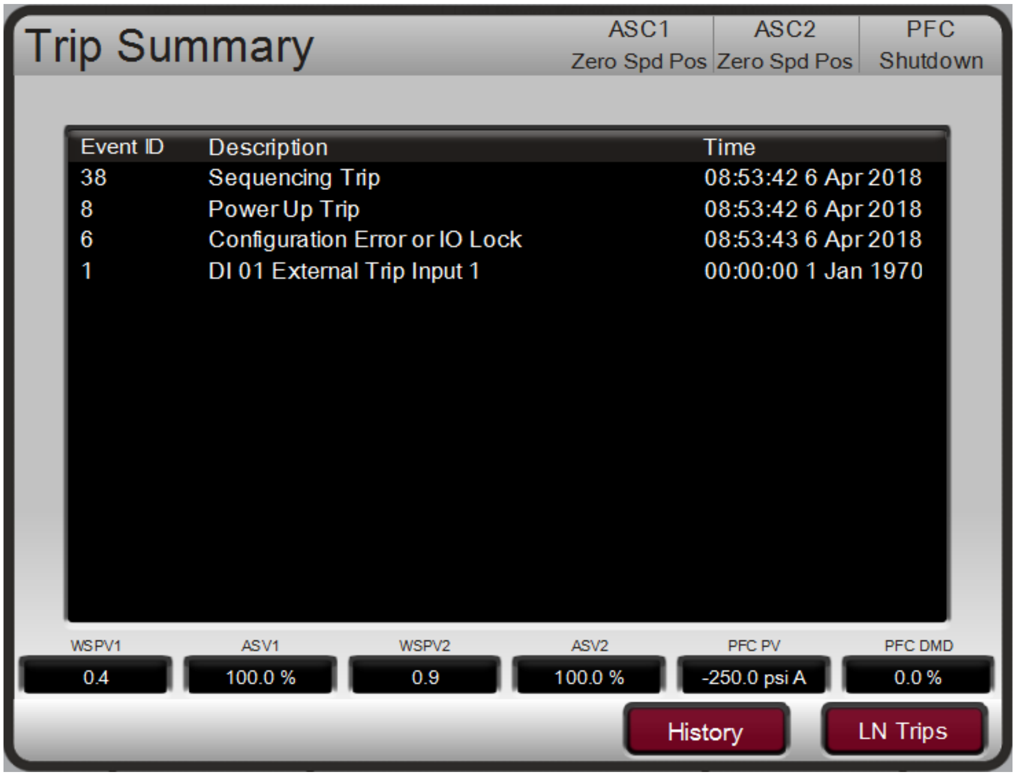


Figure 8-26. Shutdown Summary Screen

The table below lists all the potential shutdown conditions.

Table 8-2. Shutdown Messages

Event ID	Description	Meaning
1	DI 1 or 13 External Trip Input 1	External Trip contact input was opened
2	Front Display Trip Button	Front Panel Display Trip Button was pressed
3	ASC#1 Consecutive Surges	Number of detected surges exceeds limit within a configured time
4	ASC#2 Consecutive Surges	Number of detected surges exceeds limit within a configured time
5	Trip Command from Modbus	Modbus communication link trip was commanded
6	Configuration Error or IO Lock	Vertex has a configuration error
7	Unit in Calibration Mode	Vertex is in Calibration Mode
8	Power Up Trip	Vertex lost power or the Configuration Mode was exited
9	External Trip Input 2	External Trip #2 contact input was opened
10	External Trip Input 3	External Trip #3 contact input was opened
11	TRIP from RTCNet Nodes	Trip from an RTCNet Node - check the RTCNet summary screen for details
12	Actuator Range Scale Trip	For Act 1&2 the Min current setting must be Less than Max current setting (use Invert option to reverse these)
13	Spare	Reserved
14	Tunable TRIP (SIM Mode)	Reserved for simulation use
15	IO Lock Active	Vertex is in Configuration Mode
16	ASV 1 Output Fault	ASV driver fault detected (an open or short circuit was sensed)
17	ASV 2 Output Fault	ASV driver fault detected (an open or short circuit was sensed)

Event ID	Description	Meaning
18	Spare	Reserved
19	Spare	Reserved
20	AI Chan 1 Level 2 Trip	Analog Input 1 passed trip level 2 limit
21	AI Chan 2 Level 2 Trip	Analog Input 2 passed trip level 2 limit
22	AI Chan 3 Level 2 Trip	Analog Input 3 passed trip level 2 limit
23	AI Chan 4 Level 2 Trip	Analog Input 4 passed trip level 2 limit
24	AI Chan 5 Level 2 Trip	Analog Input 5 passed trip level 2 limit
25	AI Chan 6 Level 2 Trip	Analog Input 6 passed trip level 2 limit
26	AI Chan 7 Level 2 Trip	Analog Input 7 passed trip level 2 limit
27	AI Chan 8 Level 2 Trip	Analog Input 8 passed trip level 2 limit
28	Normal Shutdown Complete	Controlled shutdown was performed and completed
29	Signal Fault AI 1	Generic Input Used - Analog Input Failure (> 22 mA or < 2 mA) Channel 1
30	Signal Fault AI 2	Generic Input Used - Analog Input Failure (> 22 mA or < 2 mA) Channel 2
31	Signal Fault AI 3	Generic Input Used - Analog Input Failure (> 22 mA or < 2 mA) Channel 3
32	Signal Fault AI 4	Generic Input Used - Analog Input Failure (> 22 mA or < 2 mA) Channel 4
33	Signal Fault AI 5	Generic Input Used - Analog Input Failure (> 22 mA or < 2 mA) Channel 5
34	Signal Fault AI 6	Generic Input Used - Analog Input Failure (> 22 mA or < 2 mA) Channel 6
35	Signal Fault AI 7	Generic Input Used - Analog Input Failure (> 22 mA or < 2 mA) Channel 7
36	Signal Fault AI 8	Generic Input Used - Analog Input Failure (> 22 mA or < 2 mA) Channel 8
37	Performance Output Driver Fault	PFC driver fault detected (an open or short circuit was sensed)
38	Sequencing Trip	Custom Sequencing Signal Tripped the Vertex. See Service Menu > Custom Sequencing
39	Driver Stopped Trip	The prime mover driving the compressor is stopped
40	SPARE_40	Reserved
41	SPARE_41	Reserved
42	SPARE_42	Reserved

Each individual trip condition is available through the Modbus links to monitor the control status. A common trip indication is also provided.

Relay indications can be programmed to indicate a Vertex Shutdown Condition (energizes for a shutdown condition) or a Trip Relay (de-energizes for a shutdown/trip), in addition to the dedicated Emergency Trip Relay output.

Manual Dynamic Adjustments of Anti-surge, Performance, Limiter 1, Limiter 2, Load Sharing, and Pressure Override PID Controls

This section will cover the basics of the manual tuning of the PID dynamics that need to be performed initially on the unit. Only the ASC1 loop is used on every system, the other controls need not be tuned if they are not configured for use.

Dynamic control values are programmed in the configuration mode and adjusted in the RUN (Operation or Service) mode. The Proportional and Integral Gain and the Derivative Ratio dynamic adjustments are available under found under Dynamics pages for each controller (ASC1, ASC2, Performance, Limiter 1, Limiter 2, P1 Override, P2 Override, and Load Sharing). To adjust the gain settings, the In-Focus highlighter must be on the component value to tune. The In-Focus highlighter is moved using the navigation Cross. The ADJUST UP and DOWN keys can then be used to adjust the function In-Focus.

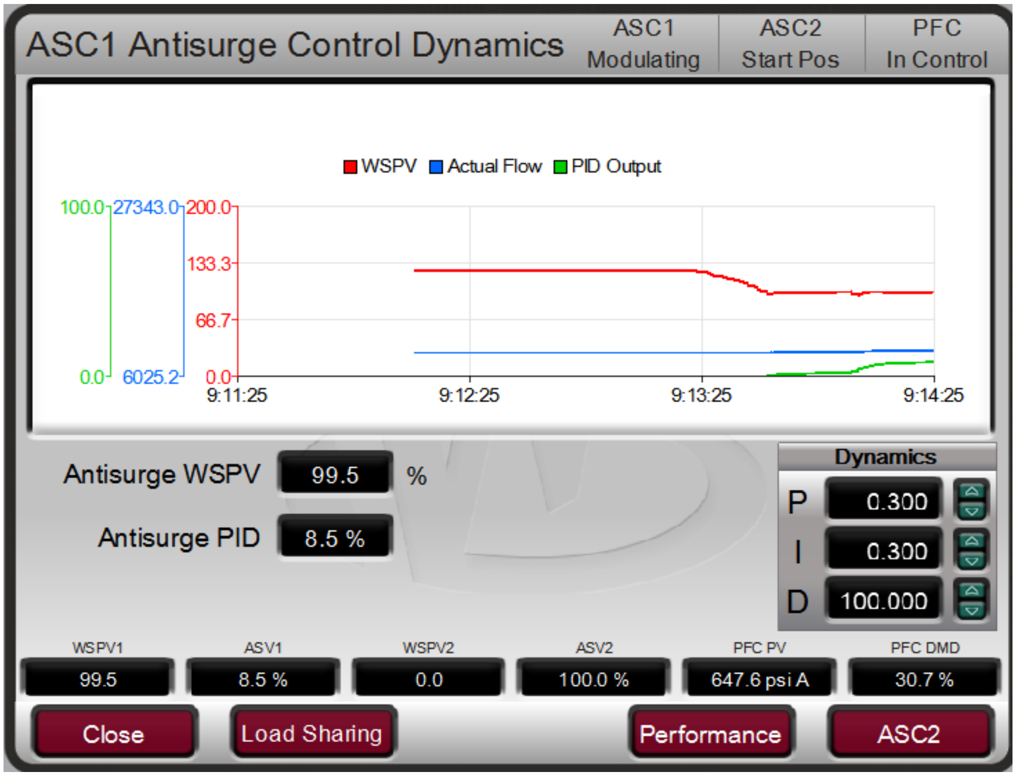


Figure 8-27. ASC Dynamics Adjustment Screen

The ASC1, ASC2, Performance, Limiter 1, Limiter 2, P1 and P2 Overrides, and Load Sharing controls are PID controllers. The response of each control loop can be adjusted by selecting the dynamics mode as described above. Proportional gain, integral gain (stability), and DR (derivative ratio) are the adjustable and interacting parameters used to match the response of the control loop with the response of the system. They correspond to the P (proportional), I (integral), and D (derivative) terms, and are displayed by the Vertex as follows:

P = Proportional gain (%)
I = Integral gain (%)
D = Derivative (determined by DR and I)

Tuning P & I Gains

Proportional gain must be tuned to best respond to a system transient or step change. If system response is not known, a typical starting value is 0.3% to 0.5%. If proportional gain is set too high the control will appear to be overly sensitive, and may oscillate with a cycle time of less than 1 second.

Integral gain must be tuned for best control at steady state. If system response is not known a typical starting value is 0.1% to 0.5%. If the integral gain is set too high the control may hunt or oscillate at cycle times of over 1 second.

To obtain a faster transient response, slowly increase the proportional gain setting until the actuator or final driver output begins to oscillate or waver. Then adjust the integral gain as necessary to stabilize the output. If stability cannot be obtained with the integral gain adjustment, reduce the proportional gain setting.

A well-tuned system, when given a step change, should slightly overshoot the control point then come into control.

A PID control loop's gain is a combination of all the gains in the loop, also known as the system gain. The loop's total gain includes actuator gain and valve gain, transducer gain, internal compressor gains, and the Vertex's adjustable gains. If the accumulated mechanical gain (actuators, valves etc.) is very high, the Vertex's gain must be very low to be added to the system gain required for system stability.

Tuning Derivative

The value of the Derivative Ratio (DR) term can range from 0.01 to 100. If unsure of the correct value, set DR terms to 100%. In order to simplify adjustment of the dynamics, adjusting the integral gain value sets both I and D terms of the PID controller. The DR term establishes the degree of effect the integral gain value has on the "D" term, and changes the configuration of a controller from input rate sensitive (input dominant) to feedback rate sensitive (feedback dominant) and vice versa.

Another possible use of the DR adjustment is to reconfigure the controller from a PID to a PI controller. This is done by adjusting the DR term to its upper or lower limits, depending on whether an input or feedback dominant controller is desired.

- A DR setting of 1 to 100 selects feedback dominant mode.
- A DR setting of .01 to 1 selects input dominant mode.
- A DR setting of .01 or 100 selects a PI only controller, input and feedback dominant respectively.

An input dominant controller is more sensitive to the change-of-rate of its input and can therefore prevent overshoot of the set point better than a feedback dominant controller. Although this response is desirable during a start-up or full load rejections in a speed controller, it can cause excessive control motions in some systems where a smooth transition response is desired.

A controller configured as feedback dominant is more sensitive to the change-of- rate of its feedback (LSS). A feedback dominant controller has the ability to limit the rate of change of the LSS bus when a controller is near its set point but is not yet in control. This limiting of the LSS bus allows a feedback dominant controller to make smoother control transitions than an input dominant controller.

IMPORTANT **For additional information on PID settings, refer to volume 2 of this manual.**

Maintenance Override

The maintenance override function gives technicians a predictable and controlled method for taking sensors out of service. This function is accessible from the Configuration Toolkit. When maintenance override is activated for a sensor, the sensor is treated as failed by the ASCE. All configured failure responses for that sensor will be triggered. However, the standard fallback response is not used. Instead, the sensor value is replaced by a Maintenance Override Value. The Maintenance Override Value is initially set to the current value used in the control, ensuring a bumpless transfer to the Maintenance Override Value. The Maintenance Override Value can then be adjusted as needed by the technician in Toolkit.

Chapter 9.
Communications

Modbus Communications

The Vertex control can communicate with plant distributed control systems and/or CRT based operator control panels through Modbus communication ports. There is one serial port that supports RS-232 and RS-485 communications using ASCII or RTU MODBUS transmission protocols. There are 2 ports available for either Modbus UDP or TCP/IP protocol which can be utilized from Ethernet port 1 or 2. Modbus utilizes a master/slave protocol. This protocol determines how a communication network's master and slave devices establish and break contact, how a sender is identified, how messages are exchanged, and how errors are detected.

IMPORTANT	**Our experience has been that not all serial interfaces on laptops or Desktop PCs work the same. Many USB-to-Serial converters work, but some do not.**

To use a Vertex Modbus port to monitor and/or operate, check the "Use Modbus" checkbox under the Configurations menu / Communications page.

Monitor Only

The three Modbus communication ports are defaulted as read-only. As read-only ports, the Vertex can be monitored but not controlled from an external device. By simply connecting a monitoring device, configured to communicate through Modbus, and to the Vertex's defaulted protocol settings (parity, stop bits, etc.), this device can be used to monitor all the Vertex's controlling parameters, modes, etc. without affecting control.

Configuration of the protocol is found on the Communications page under both the Configuration and Service menus. There are options for the serial settings, slave address number and a checkbox to enable write commands from each individual link.

Monitor and Control

Once a Modbus port is configured within the Vertex's Configuration mode, the Vertex will accept RUN mode commands from an external network master device (DCS, etc.). This allows a Modbus compatible device to monitor and perform all Vertex RUN mode parameters and commands.

Each Modbus port is independent of the other, and can be used simultaneously. Each only must have its own slave device address and each has its own enable write checkbox. The last command given from any of the ports has priority or is the mode or function selected.

Modbus Communication

The Vertex control supports two Modbus transmission modes. A mode defines the individual units of information within a message and the numbering system used to transmit the data. Only one mode per Modbus network is allowed. The supported modes are ASCII (American Standard Code for Information Interchange), and RTU (Remote Terminal Unit). These modes are defined in the following table.

Table 9-1. ASCII vs RTU Modbus

Characteristic	ASCII	RTU
Coding System	Hexadecimal (uses ASCII printable binary characters: 0-9, A-F)	8-bit binary
Start Bits	1	1
Data Bits per Character	7	8
Parity	Even, odd, or none	Even, odd, or none
Stop Bits	1, 1.5, or 2	1, 1.5, or 2
Baud Rate	110, 300, 600, 1200, 1800, 2400, 4800, 9600, 19200, 38400, or 57600	110,300, 600, 1200, 1800, 2400, 4800, 9600, 19200, 38400, or 57600
Error Checking	LRC (Longitudinal Redundancy Check)	CRC (Cyclical Redundancy Check)

In the RTU mode, data is sent in 8-bit binary characters and transmitted in a continuous stream. In the ASCII mode, each binary character is divided into two 4-bit parts (high order and low order), changed to be represented by a hexadecimal equivalent, then transmitted, with breaks of up to 1 second possible. Because of these differences, data transmission with the ASCII mode is typically slower (see Figure 9-1 below).

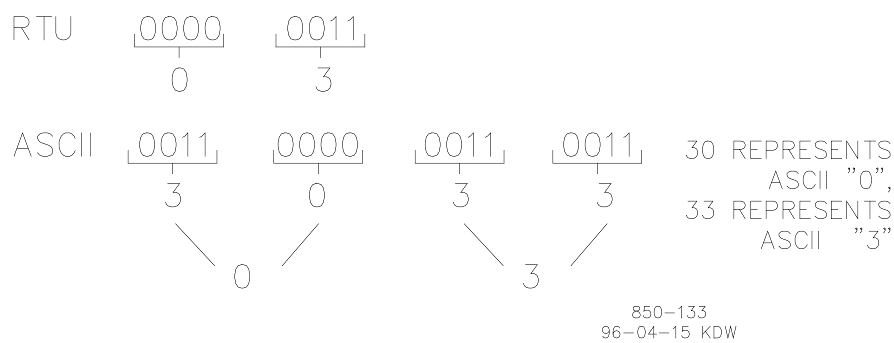


Figure 9-1. ASCII/RTU Representation of Three

The Modbus protocol allows one master and up to 247 slaves on a common network. Each slave is assigned a fixed, unique device address in the range of 1 to 247. With the Modbus protocol, only the network master can initiate a transaction. A transaction consists of a request from the master to a slave unit and the slave's response. The protocol and Modbus device number are set in the Configuration mode and can be adjusted in the Service Mode, if required.

The Vertex control is programmed to function as a slave unit only. As a slave unit, the Vertex will only respond to a transaction request by a master device. The Vertex can directly communicate with a DCS or other Modbus supporting device on a single communications link, or through a multi-dropped network. If multi-dropping is used, up to 246 devices (Vertex or other customer devices) can be connected to one Master device on a single network. The control address is programmed under the Vertex's communications block and can be changed in the service mode, if needed.

Each message to or from a master has a defined structure called the message "frame". A frame consists of the slave device address, a code defining the requested data, and error checking information. See Figure 9-2.

	BEGINNING OF FRAME	SLAVE ADDRESS	FUNCTION CODE	DATA	ERROR CHECK CODE	END OF FRAME
ASCII	:	2 CHARS 8 BITS	2 CHARS 8 BITS	4 BITS DATA PER CHAR	2 CHAR 8 BITS	CR LF
RTU	3-CHAR DEAD TIME	1 CHAR 8 BITS	1 CHAR 8 BITS	8 BITS DATA PER CHAR	2 CHAR 16 BITS	3 CHAR DEAD TIME

855-382
93-09-27 DAR

Figure 9-2. Modbus Frame Definition

The Modbus function code tells the addressed slaves what function to perform. The following table lists the function codes supported by this control.

Table 9-2. Modbus Function Codes

Code	Definition	Reference Address
01	Read Digital Outputs (Raise/Lower and Enable/Disable Commands)	0XXXX
02	Read Digital Inputs (Status Indications/Alarms and Trips)	1XXXX
03	Read Analog Outputs	4XXXX
04	Read Analog Inputs (Speed, Setpt, etc.)	3XXXX
05	Write Single Discrete Output (Raise/Lower and Enable/Disable Commands)	0XXXX
06	Write Single Register (Enter Setpt Directly)	4XXXX
08	Loopback Diagnostic Test (Subfunction 0 only)	N/A
15	Write Digital Outputs	0XXXX
16	Write Analog Outputs	4XXXX

When a Modbus message is received, it is checked for any errors or invalid data. If there is invalid data in the message, an error code is sent back to the master and the control issues an alarm message. The error codes are defined in the following table. The exception error status and respective error codes can be viewed on the Communication pages under the Service Menu.

If the control has not received a message for the configured time-out period, the control will alarm with an error message, but no message is sent to the master. This time-out is defaulted to 2 seconds and only applies to units using both monitor and control (adjustable through the Service Menu).

Table 9-3. Modbus Error Codes

Error Code	Error Message	Code Sent To Master	Description
0	No Error	0	No Error
1	Bad Modbus function	1	The specified function is not supported for this control.
2	Bad Modbus data address	2	The Modbus value addressed is not valid for this control.
3	Bad Modbus data value	3	Too many values requested or the on/off indicator in function code 5 is invalid.
9	Bad Modbus checksum	None	Message checksum did not match
10	Bad Modbus message	None	Message could not be decoded
N/A	Lost Modbus link	None	No messages received for the configured time-out period

Port Adjustments

Before the Vertex will communicate with the master device, the communication parameters must be verified. These values are set in the Configure Mode and can be adjusted, if required, from the Service Mode.

Table 9-4. Modbus Communication Port Adjustments

Parameter	Adjustment Range
Baud Rate	110 TO 57600
Parity	NONE, ODD or EVEN
Stop Bits	1 TO 2
Driver	RS-232, RS-422, or RS-485

Vertex Control Modbus Addresses

The Modbus communication ports in the Vertex control are programmed for unique Modbus addresses. A complete listing of these addresses for your application is located at the end of this section in the manual. The Modbus address listing consists of Boolean Writes, Boolean Reads, Analog Reads, and Analog Writes. The Boolean reads and writes are also referred to as input and holding coils. The analog reads and writes are also referred to as input registers and holding registers.

All values that can be addressed by Modbus are considered to be discrete and numeric. The discrete values are a 1-bit binary, on or off value and the numerics are 16 bit values. Discrete values are sometimes referred to as coils or digitals and numerics are referred to as registers or analogs. All read/write registers are interpreted by the Vertex as signed 16 bit integer values. Since Modbus can only handle integers, values that require a decimal point in the Modbus Master Device are multiplied by a scaling constant before being sent by Vertex. See Tables 9-7 and 9-8 for defaulted communication constants and ranges.

The maximum number of discretes and registers that can be transmitted in one packet is dependent on each implementation of Modbus. The following table defines these limits.

Table 9-5. Maximum Modbus Discrete and Analog Values

Mode Of Transmission	Max Discretes	Max Registers
ASCII	944	59
RTU	1188	118

Boolean Writes (Holding Coils)

Holding coils are logical signals that are both readable from and writable to the Vertex control. An example of a Boolean write value would be raise or lower commands. A logical true denoted by the value 1 will cause the command listed in the description to be executed. For example, if a 1 is written to address 0:0010 and this corresponded to a speed raise command, the manual speed set point will increase until a 0 is written to address 0:0010. The Vertex control supports function codes 1, 5, and 15. These correspond to reading selected holding coils, writing to a single holding coil, and writing to multiple holding coils, respectively. The holding coils available are listed in Table 9-5.

Boolean Reads (Input Coils)

Input coils are logical signals that are readable from, but not writable to, the Vertex control. An example of an Boolean read value would be a Vertex trip status indication. The input coil will have the value 1 if the statement in the description column is true and a 0 if false. The `1:' term in the address identifies an input coil. The Vertex control supports Modbus function code 2, which involves reading selected input coils. The input coils available are listed in Table 9-6.

Analog Reads (Input Registers)

Input registers are analog values that are readable from, but not writable to, the Vertex control. An example of an analog read value would be turbine speed. The values of the input registers are stored internal to the control as floating point numbers representing engineering units (kPa or rpm). The values that are transmitted are integer values ranging from -32767 to +32767. Since Modbus can only handle integers, values that have a decimal point are multiplied by a constant before being sent by Modbus. For example, these input registers may be listed as the Modbus value `x100' or `x10' under the description heading to denote the value is multiplied by a scaling constant. This will allow transmission of decimal parts of a unit if this is necessary for better resolution.

See the Vertex Service mode for defaulted communication constants and ranges. The Vertex control supports Modbus function code 4, which involves reading selected input registers. The input registers available are listed in Table 9-7.

Analog Writes (Holding Registers)

Holding registers are analog values that are writable to the Vertex control. These values can also be read from by a device performing error checking. An example of an analog write value would be a direct speed set point value as opposed to raise and lower commands. The value of the holding registers are also stored in the control as numbers representing engineering units (psi or rpm). The Vertex control supports Modbus function codes 3, 6, and 16. These correspond to reading selected holding registers, writing to a single holding register, and writing to multiple holding registers, respectively. The holding registers available are listed in Table 9-8.

The following tables give the address and description of all Boolean and analog, reads and writes:

Table 9-6. Boolean Write Addresses

Addr	Description
0:0001	System Reset
0:0002	Emergency Shutdown
0:0003	Emergency Shutdown Acknowledge
0:0004	Transfer Syscon from Modbus
0:0005	Spare
0:0006	Spare
0:0007	Spare
0:0008	ASC#1: Close ASV command
0:0009	ASC#1: Open ASV command
0:0010	ASC#1: Reset SMP command
0:0011	ASC#1: Reset Surge Counter command
0:0012	ASC#1: Automatic Mode command
0:0013	Enable Remote Performance SP
0:0014	ASC#1: Manual with Backup command
0:0015	ASC#1: Full Manual Mode command
0:0016	ASC#1: Increase Control Margin
0:0017	ASC#1: Decrease Control Margin
0:0018	ASC#1: Raise Choke Control command
0:0019	ASC#1: Lower Choke Control command
0:0020	ASC#1: Choke Auto mode Request cmd
0:0021	ASC#1: Choke Manual mode Request cmd
0:0022	ASC#1: Enable P1 Override

Addr	Description
0:0023	ASC#1: Disable P1 Override
0:0024	ASC#1: Enable P2 Override
0:0025	ASC#1: Disable P2 Override
0:0026	ASC#1: Purge Request
0:0027	ASC#1: Quit Purge Request
0:0028	ASC#1: Auxiliary Online
0:0029	ASC#1: Auxiliary Offline
0:0030	ASC#1: Goto Valve Target command
0:0031	ASC#1: Goto Suction Pres Ovrd Tg cmd
0:0032	ASC#1: Goto Discharg P Ovrd Tg cmd
0:0033	Spare
0:0034	ASC#1: Start Position
0:0035	ASC#1 Enable Remote Valve Position
0:0036	ASC#1 Disable Remote Valve Position
0:0037	Spare
0:0038	Spare
0:0039	Spare
0:0040	Spare
0:0041	Spare
0:0042	Start Train
0:0043	Start Inhibit
0:0044	Continue Start Sequence
0:0045	Halt Start Sequence
0:0046	Train Normal SD
0:0047	Train Normal SD Quit
0:0048	Startup Complete Feedback
0:0049	Sequence Limiter Raise
0:0050	Sequence Limiter Lower
0:0051	Enable Remote Sequence Demand
0:0052	Disable Remote Sequence Demand
0:0053	Request Auto Performance Control
0:0054	Request Full Manual Demand
0:0055	Performance SP Raise
0:0056	Performance SP Lower
0:0057	Enable Remote Performance SP
0:0058	Disable Remote Performance SP
0:0059	Manual Performance Demand Raise
0:0060	Manual Performance Demand Lower
0:0061	Enable Performance Decoupling
0:0062	Disable Performance Decoupling
0:0063	Limiter1 PID Enable
0:0064	Limiter1 PID Disable
0:0065	Limiter1 PID SP Raise

Addr	Description
0:0066	Limiter1 PID SP Lower
0:0067	Limiter1 PID Remote SP Enable
0:0068	Limiter1 PID Remote SP Disable
0:0069	PFC PID Setpoint GO
0:0070	PFC Limiter PID Setpoint GO
0:0071	PFC Sequence Ramp Position GO
0:0072	Limiter 2 PID Enable
0:0073	Limiter 2 PID Disable
0:0074	Limiter 2 PID SP Raise
0:0075	Limiter 2 PID SP Lower
0:0076	Limiter 2 PID Remote SP Enable
0:0077	Limiter 2 PID Remote SP Disable
0:0078	PFC Limiter 2 PID Setpoint GO
0:0079	Spare
0:0080	Spare
0:0081	Isolated Controller SP Raise
0:0082	Isolated Controller SP Lower
0:0083	Spare
0:0084	ASC#2: Close ASV command
0:0085	ASC#2: Open ASV command
0:0086	ASC#2: Reset SMP command
0:0087	ASC#2: Reset Surge Counter command
0:0088	ASC#2: Automatic Mode command
0:0089	ASC#2: Manual with Backup command
0:0090	ASC#2: Full Manual Mode command
0:0091	ASC#2: Increase Control Margin
0:0092	ASC#2: Decrease Control Margin
0:0093	ASC#2: Raise Choke Control command
0:0094	ASC#2: Lower Choke Control command
0:0095	ASC#2: Choke Auto mode Request cmd
0:0096	ASC#2: Choke Manual mode Request cmd
0:0097	ASC#2: Enable P1 Override
0:0098	ASC#2: Disable P1 Override
0:0099	ASC#2: Enable P2 Override
0:0100	ASC#2: Disable P2 Override
0:0101	ASC#2: Purge Request
0:0102	ASC#2: Quit Purge Request
0:0103	ASC#2: Auxiliary Online
0:0104	ASC#2: Auxiliary Offline
0:0105	ASC#2: Goto Valve Target command
0:0106	ASC#2: Goto Suction Pres Ovrd Tg cmd
0:0107	ASC#2: Goto Discharg P Ovrd Tg cmd
0:0108	Spare

Addr	Description
0:0109	ASC#2: Start Position
0:0110	Enable Load Sharing
0:0111	Disable Load Sharing
0:0112	Request Setpoint Master Status
0:0113	Set T1 Comms Failure Override
0:0114	Reset T1 Comms Failure Override
0:0115	Set T2 Comms Failure Override
0:0116	Reset T2 Comms Failure Override
0:0117	Set T3 Comms Failure Override
0:0118	Reset T3 Comms Failure Override
0:0119	Set T4 Comms Failure Override
0:0120	Reset T4 Comms Failure Override
0:0121	Set T5 Comms Failure Override
0:0122	Reset T5 Comms Failure Override
0:0123	Raise Maser Setpoint
0:0124	Lower Master Setpoint
0:0125	GoTo Master Setpoint
0:0126	Disable ISO PID
0:0127	Enable ISO PID

Table 9-7. Boolean Read Addresses

Addr	Description
1:0001	ASC#1: Automatic Mode Active
1:0002	PFC Auto Active
1:0003	ASC#1: SMP is Active
1:0004	ASC#1: In Control - Boost Active
1:0005	PFC PID Limited
1:0006	SPARE
1:0007	Any Analog Signal Fault
1:0008	Reset Pulse
1:0009	Unit Tripped
1:0010	Stop Command Pulse
1:0011	Start Command Pulse
1:0012	PFC Started
1:0013	PFC Start Complete
1:0014	Discrete Input 1 State
1:0015	Discrete Input 2 State
1:0016	Discrete Input 3 State
1:0017	Discrete Input 4 State
1:0018	Discrete Input 5 State
1:0019	Discrete Input 6 State
1:0020	Discrete Input 7 State
1:0021	SPARE

Addr	Description
1:0022	ALM: Mod Comm Link #1 (Serial)Failed
1:0023	ALM: Mod Comm Link #2 (ENET1) Failed
1:0024	PFC Tracking
1:0025	Relay Output 1 State
1:0026	Relay Output 2 State
1:0027	Relay Output 3 State
1:0028	Relay Output 4 State
1:0029	Relay Output 5 State
1:0030	PFC PID Limited
1:0031	SPARE
1:0032	ASC#1: Override Active
1:0033	PFC Tracking
1:0034	SPARE
1:0035	ASC#1: Override Active
1:0036	ASC#1: On-Line
1:0037	Alarm
1:0038	ALM: Chassis Summary Alarm
1:0039	SPARE
1:0040	Any AO Readback Fault
1:0041	SPARE
1:0042	Delay Start Active
1:0043	TRIP: DI 01 External Trip Input 1
1:0044	ASC#1: Off-Line - Purge
1:0045	SPARE
1:0046	SPARE
1:0047	PFC Limiter PID Enabled
1:0048	All Modbus Writes Disabled
1:0049	SPARE
1:0050	PFC Remote SP Enabled
1:0051	ALM: Mod Comm Link #3 (ENET2) Failed
1:0052	Performance Cntrl Device Open Feedback
1:0053	Performance Cntrl Device Close Feedback
1:0054	SPARE
1:0055	SPARE
1:0056	SPARE
1:0057	Analog Input 01 Failed
1:0058	Analog Input 02 Failed
1:0059	Analog Input 03 Failed
1:0060	Analog Input 04 Failed
1:0061	Analog Input 05 Failed
1:0062	Analog Input 06 Failed
1:0063	Analog Input 07 Failed
1:0064	Analog Input 08 Failed

Addr	Description
1:0065	ASC#1: Control Offline
1:0066	ASC#1: Off-Line - Ctrl SD
1:0067	ASC#1: Off-Line - Start
1:0068	ASC#1: ASV Position Feddback Fault
1:0069	ASC#1: Off-Line - ESD
1:0070	ASC#1: On-Line
1:0071	ASC#1: On-Line - Ctrl SD
1:0072	ASC#1: On-Line - Online
1:0073	ASC#1: In Control - P2 Override
1:0074	ASC#1: In Control - Anti-Surge PID
1:0075	ASC#1: In Control - Aux input #1
1:0076	ASC#1: In Control - Aux input #2
1:0077	ASC#1: In Control - Aux input #3
1:0078	ASC#1: In Control - Boost
1:0079	ASC#1: In Control - Deactivation
1:0080	ASC#1: In Control - P1 Override
1:0081	ASC#1: In Control - Rate Controller
1:0082	ASC#1: In Control - Sequence Pos
1:0083	ASC#1: In Control - Surge Recovery
1:0084	ASC#1: In Control - Manual w/Back
1:0085	SPARE
1:0086	ASC#1: In Control - Surge Recovery Active
1:0087	SPARE
1:0088	ASC#1: Full Manual Mode Active
1:0089	ASC#1: Manual Mode Active
1:0090	ASC#1: SMP is Active
1:0091	ASC#1: Rate Controller Active
1:0092	ASC#1: P1 Ovrd - P1 Ovrd Enabled
1:0093	ASC#1: P1 Ovrd - P1 Ovrd Active
1:0094	ASC#1: P2 Ovrd - P2 Ovrd Enabled
1:0095	ASC#1: P2 Ovrd - P2 Ovrd Active
1:0096	ASC#1: Choke Ctrl in Automatic
1:0097	ASC#1: Choke Ctrl in Control
1:0098	ASC#1: Consecutive Surge Alarm Detected
1:0099	ASC#1: Surge on Flow Deriv
1:0100	ASC#1: Surge on P1 Deriv
1:0101	ASC#1: Surge on P2 Deriv
1:0102	ASC#1: Surge on Speed Deriv
1:0103	ASC#1: Surge on Min flow
1:0104	ASC#1: Surge on Cross Line
1:0105	ASC#1: MAP Configuration Error
1:0106	ASC#1: Flow Difference Detected
1:0107	ASC#1: Primary Flow Sensor Fault

Addr	Description
1:0108	ASC#1: Redundant Flow Sensor Fault
1:0109	ASC#1: All Flow Sensor Fault
1:0110	ASC#1: Suction Press Fault
1:0111	ASC#1: Disch Press Fault
1:0112	ASC#1: Suction Temp Fault
1:0113	ASC#1: Disch Temp Fault
1:0114	ASC#1: HSS#1 Fault
1:0115	ASC#1: Decoupling#1 Fault
1:0116	ASC#1: Decoupling#2 Fault
1:0117	ASC#1: Remote Man vlv fault
1:0118	ASC#1: Consecutive Surge Trip Detected
1:0119	ASC#1: Surge On Motor current
1:0120	ASC#1: Choke Map Reached
1:0121	ASC#1: Feedback CMD difference(5%)
1:0122	ASC#1 External Surge Contact Detected
1:0123	ASC#1 External Multisurge Contact Detected
1:0124	ASC#1: P1 Ovrd Invalid SP Entered
1:0125	ASC#1: P1 Ovrd Invalid SP Entered
1:0126	ASC#1: Decoupling#3 Fault
1:0127	PFC Sequence Ramp In Control
1:0128	PFC Start Inhibited
1:0129	SPARE
1:0130	PFC Halted
1:0131	SPARE
1:0132	Normal SD Active
1:0133	Sequence Ramp GT Start Pos
1:0134	Remote Sequence Demand Enabled
1:0135	Sequence Ramp At Max
1:0136	PFC Limiter PID In Control
1:0137	SPARE
1:0138	PFC Limiter PID Inhibited
1:0139	PFC Limiter PID Active
1:0140	PFC Limiter Remote SP Enabled
1:0141	PFC Limiter Remote SP Active
1:0142	PFC Limiter Remote SP In Control
1:0143	PFC Limiter Remote SP Inhibited
1:0144	PFC Auto Enabled
1:0145	SPARE
1:0146	PFC Manual Enabled
1:0147	PFC PID In Control
1:0148	PFC Remote Manual Dmd in Ctrl
1:0149	PFC Remote SP In Control
1:0150	PFC Low Limited

Addr	Description
1:0151	PFC High Limited
1:0152	PFC Decoupling Enabled
1:0153	PFC Limiter2 PID In Control
1:0154	PFC Limiter2 PID Enabled
1:0155	PFC Limiter2 PID Inhibited
1:0156	PFC Limiter2 PID Active
1:0157	PFC Limiter2 Remote SP Enabled
1:0158	PFC Limiter2 Remote SP Active
1:0159	PFC Limiter2 Remote SP In Control
1:0160	PFC Limiter2 Remote SP Inhibited
1:0161	Sequence MB Goto Value Invalid
1:0162	Limiter 1 MB Goto Value Invalid
1:0163	Limiter 2 MB Goto Value Invalid
1:0164	PFC MB Goto Value Invalid
1:0165	SPARE
1:0166	ASC#2: Control Offline
1:0167	ASC#2: Off-Line - Ctrl SD
1:0168	ASC#2: Off-Line - Start
1:0169	ASC#2: Off-Line - Purge
1:0170	ASC#2: Off-Line - ESD
1:0171	ASC#2: On-Line
1:0172	ASC#2: On-Line - Ctrl SD
1:0173	ASC#2: On-Line
1:0174	ASC#2: In Control - P2 Override
1:0175	ASC#2: In Control - Anti-Surge PID
1:0176	ASC#2: In Control - Aux input #1
1:0177	ASC#2: In Control - Aux input #2
1:0178	ASC#2: In Control - Aux input #3
1:0179	ASC#2: In Control - Boost
1:0180	ASC#2: In Control - Deactivation
1:0181	ASC#2: In Control - P1 Override
1:0182	ASC#2: In Control - Rate Controller
1:0183	ASC#2: In Control - Sequence Pos
1:0184	ASC#2: In Control - Surge Recovery
1:0185	ASC#2: In Control - Manual w/Back
1:0186	ASC#2: In Control - Boost Active
1:0187	ASC#2: In Control - Surge Recovery Active
1:0188	ASC#2: Automatic Mode Active
1:0189	ASC#2: Full Manual Mode Active
1:0190	ASC#2: Manual Mode Active
1:0191	ASC#2: SMP is Active
1:0192	ASC#2: Rate Controller Active
1:0193	ASC#2: P1 Ovrd - P1 Ovrd Enabled

Addr	Description
1:0194	ASC#2: P1 Ovrd - P1 Ovrd Active
1:0195	ASC#2: P2 Ovrd - P2 Ovrd Enabled
1:0196	ASC#2: P2 Ovrd - P2 Ovrd Active
1:0197	ASC#2: Choke Ctrl in Automatic
1:0198	ASC#2: Choke Ctrl in Control
1:0199	ASC#2: Consecutive Surge Alarm Detected
1:0200	ASC#2: Surge on Flow Deriv
1:0201	ASC#2: Surge on P1 Deriv
1:0202	ASC#2: Surge on P2 Deriv
1:0203	ASC#2: Surge on Speed Deriv
1:0204	ASC#2: Surge on Min flow
1:0205	ASC#2: Surge on Cross Line
1:0206	ASC#2: MAP Configuration Error
1:0207	ASC#2: Flow Difference Detected
1:0208	ASC#2: Primary Flow Sensor Fault
1:0209	ASC#2: Redundant Flow Sensor Fault
1:0210	ASC#2: All Flow Sensor Fault
1:0211	ASC#2: Suction Press Fault
1:0212	ASC#2: Disch Press Fault
1:0213	ASC#2: Suction Temp Fault
1:0214	ASC#2: Disch Temp Fault
1:0215	ASC#2: HSS#1 Fault
1:0216	ASC#2: Decoupling#1 Fault
1:0217	ASC#2: Decoupling#2 Fault
1:0218	ASC#2: Remote Man vlv fault
1:0219	ASC#2: Consecutive Surge Trip Detected
1:0220	ASC#2: Surge On Motor current
1:0221	ASC#2: Choke Map Reached
1:0222	ASC#2: Feedback CMD difference(5%)
1:0223	ASC#2 External Surge Contact Detected
1:0224	ASC#2 External Multisurge Contact Detected
1:0225	ASC#2: P1 Ovrd Invalid SP Entry
1:0226	ASC#2: P2 Ovrd Invalid SP Entry
1:0227	ASC#2:ASV Position Feedback Fault
1:0228	ASC#2: Decoupling#3 Fault
1:0229	SPARE
1:0230	SPARE
1:0231	SPARE
1:0232	SPARE
1:0233	SPARE
1:0234	SPARE
1:0235	Discrete Input 8 State
1:0236	Discrete Input 9 State

Addr	Description
1:0237	Discrete Input 10 State
1:0238	Discrete Input 11 State
1:0239	Discrete Input 12 State
1:0240	Discrete Input 13 State
1:0241	Discrete Input 14 State
1:0242	Discrete Input 15 State
1:0243	Discrete Input 16 State
1:0244	Discrete Input 17 State
1:0245	Discrete Input 18 State
1:0246	Discrete Input 19 State
1:0247	Discrete Input 20 State
1:0248	SPARE
1:0249	SPARE
1:0250	SPARE
1:0251	SPARE
1:0252	SPARE
1:0253	Relay Output 6 State
1:0254	Relay Output 7 State
1:0255	Relay Output 8 State
1:0256	LN Node 4 DI 1 State
1:0257	LN Node 4 DI 2 State
1:0258	LN Node 4 DI 3 State
1:0259	LN Node 4 DI 4 State
1:0260	LN Node 4 DI 5 State
1:0261	LN Node 4 DI 6 State
1:0262	LN Node 4 DI 7 State
1:0263	LN Node 4 DI 8 State
1:0264	LN Node 4 DI 9 State
1:0265	LN Node 4 DI 10 State
1:0266	LN Node 4 DI 11 State
1:0267	LN Node 4 DI 12 State
1:0268	LN Node 4 DI 13 State
1:0269	LN Node 4 DI 14 State
1:0270	LN Node 4 DI 15 State
1:0271	LN Node 4 DI 16 State
1:0272	LN Node 5 DO 1 State
1:0273	LN Node 5 DO 2 State
1:0274	LN Node 5 DO 3 State
1:0275	LN Node 5 DO 4 State
1:0276	LN Node 5 DO 5 State
1:0277	LN Node 5 DO 6 State
1:0278	LN Node 5 DO 7 State
1:0279	LN Node 5 DO 8 State

Addr	Description
1:0280	LN Node 5 DO 9 State
1:0281	LN Node 5 DO 10 State
1:0282	LN Node 5 DO 11 State
1:0283	LN Node 5 DO 12 State
1:0284	LN Node 5 DO 13 State
1:0285	LN Node 5 DO 14 State
1:0286	LN Node 5 DO 15 State
1:0287	LN Node 5 DO 16 State
1:0288	ALM_001: Chassis Summary Alarm
1:0289	ALM_002: Internal HW Simulation Enabled
1:0290	ALM_003: Mod Comm Link #1 (Serial)Failed
1:0291	ALM_004: Mod Comm Link #2 (ENET1) Failed
1:0292	ALM_005: Mod Comm Link #3 (ENET2) Failed
1:0293	ALM_006: GUI Communication Error
1:0294	ALM_007: Spare007
1:0295	ALM_008: Spare008
1:0296	ALM_009: AO_01 Readback Fault
1:0297	ALM_010: AO_02 Readback Fault
1:0298	ALM_011: AO_03 Readback Fault
1:0299	ALM_012: AO_04 Readback Fault
1:0300	ALM_013: AO_05 Readback Fault
1:0301	ALM_014: AO_06 Readback Fault
1:0302	ALM_015: Spare015
1:0303	ALM_016: Spare016
1:0304	ALM_017: AI Chan 1 Level 1 ALM
1:0305	ALM_018: AI Chan 1 Level 2 ALM
1:0306	ALM_019: AI Chan 2 Level 1 ALM
1:0307	ALM_020: AI Chan 2 Level 2 ALM
1:0308	ALM_021: AI Chan 3 Level 1 ALM
1:0309	ALM_022: AI Chan 3 Level 2 ALM
1:0310	ALM_023: AI Chan 4 Level 1 ALM
1:0311	ALM_024: AI Chan 4 Level 2 ALM
1:0312	ALM_025: AI Chan 5 Level 1 ALM
1:0313	ALM_026: AI Chan 5 Level 2 ALM
1:0314	ALM_027: AI Chan 6 Level 1 ALM
1:0315	ALM_028: AI Chan 6 Level 2 ALM
1:0316	ALM_029: AI Chan 7 Level 1 ALM
1:0317	ALM_030: AI Chan 7 Level 2 ALM
1:0318	ALM_031: AI Chan 8 Level 1 ALM
1:0319	ALM_032: AI Chan 8 Level 2 ALM
1:0320	ALM_033: Alarm from RTCNet Nodes
1:0321	ALM_034: MPU1 Fault
1:0322	ALM_035: MPU2 Fault

Addr	Description
1:0323	ALM_036: Both MPUs Fault
1:0324	ALM_037: Speed 4-20 Signal Fault
1:0325	ALM_038: External alarm # 1
1:0326	ALM_039: External alarm # 2
1:0327	ALM_040: External alarm # 3
1:0328	ALM_041: Un-Authorized Start Attempted
1:0329	ALM_042: Speed 1 and Speed 2 Deviation
1:0330	ALM_043: Tunable Alarm
1:0331	ALM_044: Maintenance Alarm
1:0332	ALM_045: Spare 045
1:0333	ALM_046: Spare 046
1:0334	ALM_047: Spare 047
1:0335	ALM_048: Performance Controller Driver Fault
1:0336	ALM_049: Performance Linearization Error
1:0337	ALM_050: Performance PV Input #2 Failed
1:0338	ALM_051: Started from Remote
1:0339	ALM_052: Primary Ctrl POS Feedback Fault
1:0340	ALM_053: Performance PV Input Failed
1:0341	ALM_054: Remote Performance Setpoint Failed
1:0342	ALM_055: Remote Performance Demand Failed
1:0343	ALM_056: Performance Limiter PV Input Failed
1:0344	ALM_057: External Decoupling Signal Fault
1:0345	ALM_058: Motor Current/Power Signal Fault
1:0346	ALM_059: Perf Cntrl Reset Pos > Start Pos Err
1:0347	ALM_060: Perf Limiter1 RMT SP Input Failed
1:0348	ALM_061: ASC#1: Surge on Flow Deriv
1:0349	ALM_062: ASC#1: Surge on P1 Deriv
1:0350	ALM_063: ASC#1: Surge on P2 Deriv
1:0351	ALM_064: ASC#1: Surge on Speed Deriv
1:0352	ALM_065: ASC#1: Surge on Crossed Line
1:0353	ALM_066: ASC#1: Surge On Motor current
1:0354	ALM_067: ASC#1: Choke Map Reached
1:0355	ALM_068: ASC#1: Surges- AS valve forced to max
1:0356	ALM_069: ASC#1: AS VLV Fdbk Error-Force open
1:0357	ALM_070: ASC#1:Linearaization Error
1:0358	ALM_071: ASC#1:Surge on Min Flow
1:0359	ALM_072: Spare 072
1:0360	ALM_073: ASC#1: External Surge Detected
1:0361	ALM_074: ASC#1: External Multi Surge Detected
1:0362	ALM_075: ASC#1 Red Flow TX Dev Active
1:0363	ALM_076: ASC#1: Primary Flow Sensor Fault
1:0364	ALM_077: ASC#1: Secondary Flow Sensor Fault
1:0365	ALM_078: ASC#1: Suction Pressure PV #1 Failed

Addr	Description
1:0366	ALM_079: ASC#1: Suction Pressure PV #2 Failed
1:0367	ALM_080: ASC#1: Discharge Pressure PV #1 Failed
1:0368	ALM_081: ASC#1: Discharge Pressure PV #2 Failed
1:0369	ALM_082: ASC#1: Suction Temp PV #1 Failed
1:0370	ALM_083: ASC#1: Suction Temp PV #2 Failed
1:0371	ALM_084: ASC#1: Discharge Temp PV #1 Failed
1:0372	ALM_085: ASC#1: Discharge Temp PV #2 Failed
1:0373	ALM_086: ASC#1: All Flow Sensor Fault
1:0374	ALM_087: ASC#1: All Suction Press Fault
1:0375	ALM_088: ASC#1: All Disch Press Fault
1:0376	ALM_089: ASC#1: All Suction Temp Fault
1:0377	ALM_090: ASC#1: All Discharge Temp Fault
1:0378	ALM_091: ASC#1: Suction Press Difference
1:0379	ALM_092: ASC#1: Discharge Press Difference
1:0380	ALM_093: ASC#1: Suction Temp Difference
1:0381	ALM_094: ASC#1: Discharge Temp Difference
1:0382	ALM_095: ASC#1: Pressure At Flow Fault
1:0383	ALM_096: ASC#1: Temp At Flow Fault
1:0384	ALM_097: ASC#1: HSS#1 Fault
1:0385	ALM_098: ASC#1: HSS#2 Fault
1:0386	ALM_099: ASC#1: Decoupling#1 Fault
1:0387	ALM_100: ASC#1: Decoupling#2 Fault
1:0388	ALM_101: ASC#1: Remote Man vlv fault
1:0389	ALM_102: ASC#1: Upstream Valve Press Flt
1:0390	ALM_103: ASC#1: Downstream Valve Press Flt
1:0391	ALM_104: ASC#1: Temp At Valve Fault
1:0392	ALM_105: ASC#1: Alternate P1 Overrd Fault
1:0393	ALM_106: ASC#1: Alternate P2 Overrd Fault
1:0394	ALM_107: ASC#1: External HSS AS Vlv Dmd Fault
1:0395	ALM_108: ASC#2: External HSS AS Vlv Dmd Fault
1:0396	Spare
1:0397	ALM_110: ASC#1: Gas Liquid phase
1:0398	ALM_111: ASC#1: Quench Temperature Fault
1:0399	ALM_112: ASC#2: Linearization Error
1:0400	ALM_113: ASC#2: Surge on Min Flow
1:0401	ALM_114: ASC#1: IGV position feedback fault
1:0402	ALM_115: ASC#1: ASV FDBK and CMD Mismatch
1:0403	ALM_116: ASC#1: ASV Feedback Fault
1:0404	ALM_117: ASC#1: Side-stream Tempertaure Fault
1:0405	ALM_118: ASC#1: Motor Current Fault
1:0406	ALM_119: ASC#1: Compressor Speed Fault
1:0407	ALM_120: ASC#1: Flow Forcing Enabled
1:0408	ALM_121: ASC#1: Suction Press Forcing Enabled

Addr	Description
1:0409	ALM_122: ASC#1: Discharge Press Forcing Enabled
1:0410	ALM_123: ASC#1: Suction Temp Forcing Enabled
1:0411	ALM_124: ASC#1: Disch Temp Forcing Enabled
1:0412	ALM_125: ASC#1: Press at Flow Forcing Enabled
1:0413	ALM_126: ASC#1: Temp at Flow Forcing Enabled
1:0414	ALM_127: Spare
1:0415	ALM_128: Spare
1:0416	ALM_129: Spare
1:0417	ALM_130: Spare
1:0418	ALM_131: Spare
1:0419	ALM_132: ASC#1: SS Temp Forcing Enabled
1:0420	ALM_133: ASC#1: Motor Current Forcing Enabled
1:0421	ALM_134: ASC#1: Comp Speed Forcing Enabled
1:0422	ALM_135: ASC#1: Surge Minimum Position Active
1:0423	ALM_136: ASC#1: Surge Recovery Active
1:0424	SD001: DI 01 External Trip Input 1
1:0425	SD002: Front Display Trip Button
1:0426	SD003: ASC#1 Consecutive Surges
1:0427	SD004: ASC#2 Consecutive Surges
1:0428	SD005: Trip Command from Modbus
1:0429	SD006: Configuration Error or IO Lock
1:0430	SD007: Unit in Calibration Mode
1:0431	SD008: Power Up Trip
1:0432	SD009: External Trip Input 2
1:0433	SD010: External Trip Input 3
1:0434	SD011: TRIP from RTCNet Nodes
1:0435	SD012: Actuator Range Scale Trip
1:0436	SD013: Trip Cmd from OPC Device
1:0437	SD014: Tunable TRIP (SIM Mode)
1:0438	SD015: IO Lock Active
1:0439	SD016: ASV 1 Output Fault
1:0440	SD017: ASV 2 Output Fault
1:0441	SD018: Spare
1:0442	SD019: Spare
1:0443	SD020: AI Chan 1 Level 2 Trip
1:0444	SD021: AI Chan 2 Level 2 Trip
1:0445	SD022: AI Chan 3 Level 2 Trip
1:0446	SD023: AI Chan 4 Level 2 Trip
1:0447	SD024: AI Chan 5 Level 2 Trip
1:0448	SD025: AI Chan 6 Level 2 Trip
1:0449	SD026: AI Chan 7 Level 2 Trip
1:0450	SD027: AI Chan 8 Level 2 Trip
1:0451	SD028: Normal Shutdown Complete

Addr	Description
1:0452	SD029: Signal Fault AI 1
1:0453	SD030: Signal Fault AI 2
1:0454	SD031: Signal Fault AI 3
1:0455	SD032: Signal Fault AI 4
1:0456	SD033: Signal Fault AI 5
1:0457	SD034: Signal Fault AI 6
1:0458	SD035: Signal Fault AI 7
1:0459	SD036: Signal Fault AI 8
1:0460	SD037: Performance Output Driver Fault
1:0461	SD038: SPARE_38
1:0462	SD039: SPARE_39
1:0463	SD040: SPARE_40
1:0464	SD041: SPARE_41
1:0465	SD042: SPARE_42
1:0466	Load Sharing: T1 comms fault override on
1:0467	Load Sharing: T2 comms fault override on
1:0468	Load Sharing: T3 comms fault override on
1:0469	Load Sharing: T4 comms fault override on
1:0470	Load Sharing: T5 comms fault override on
1:0471	Load Sharing: Disabled pulse
1:0472	Load Sharing: Kicked out pulse
1:0473	Load Sharing: No setpoint master
1:0474	Load Sharing: All PV failed
1:0475	Load Sharing: Inhibited
1:0476	Load Sharing: Joining group
1:0477	Load Sharing: Setpoint master
1:0478	Load Sharing: In load sharing group
1:0479	Load Sharing: Link 1 from T1 enabled
1:0480	Load Sharing: Link 2 from T1 enabled
1:0481	Load Sharing: Link 1 from T1 failed
1:0482	Load Sharing: Link 2 from T1 failed
1:0483	Load Sharing: Link 1 from T2 enabled
1:0484	Load Sharing: Link 2 from T2 enabled
1:0485	Load Sharing: Link 1 from T2 failed
1:0486	Load Sharing: Link 2 from T2 failed
1:0487	Load Sharing: Link 1 from T3 enabled
1:0488	Load Sharing: Link 2 from T3 enabled
1:0489	Load Sharing: Link 1 from T3 failed
1:0490	Load Sharing: Link 2 from T3 failed
1:0491	Load Sharing: Link 1 from T4 enabled
1:0492	Load Sharing: Link 2 from T4 enabled
1:0493	Load Sharing: Link 1 from T4 failed
1:0494	Load Sharing: Link 2 from T4 failed

Addr	Description
1:0495	Load Sharing: Link 1 from T5 enabled
1:0496	Load Sharing: Link 2 from T5 enabled
1:0497	Load Sharing: Link 1 from T5 failed
1:0498	Load Sharing: Link 2 from T5 failed
1:0499	ALM_137: spare
1:0500	ALM_138: Spare
1:0501	ALM_139: Spare
1:0502	ALM_140: Spare
1:0503	ALM_141: Spare
1:0504	ALM_142: Spare
1:0505	ALM_143: Kicked Out of Parallel Load Sharing
1:0506	ALM_144: All Load Sharing PVs Failed
1:0507	ALM_145: T1 Tripped Out of Load Sharing
1:0508	ALM_146: T2 Tripped Out of Load Sharing
1:0509	ALM_147: T3 Tripped Out of Load Sharing
1:0510	ALM_148: T4 Tripped Out of Load Sharing
1:0511	ALM_149: T5 Tripped Out of Load Sharing
1:0512	ALM_150: T1 Performance Controller is Limited
1:0513	ALM_151: T2 Performance Controller is Limited
1:0514	ALM_152: T3 Performance Controller is Limited
1:0515	ALM_153: T4 Performance Controller is Limited
1:0516	ALM_154: T5 Performance Controller is Limited
1:0517	ALM_155: T1 Load Sharing PV Fault
1:0518	ALM_156: T2 Load Sharing PV Fault
1:0519	ALM_157: T3 Load Sharing PV Fault
1:0520	ALM_158: T4 Load Sharing PV Fault
1:0521	ALM_159: T5 Load Sharing PV Fault
1:0522	ALM_160: Link 1 from T1 Failed
1:0523	ALM_161: Link 1 from T2 Failed
1:0524	ALM_162: Link 1 from T3 Failed
1:0525	ALM_163: Link 1 from T4 Failed
1:0526	ALM_164: Link 1 from T5 Failed
1:0527	ALM_165: Link 2 from T1 Failed
1:0528	ALM_166: Link 2 from T2 Failed
1:0529	ALM_167: Link 2 from T3 Failed
1:0530	ALM_168: Link 2 from T4 Failed
1:0531	ALM_169: Link 2 from T5 Failed
1:0532	ALM_170: Shared parameter fault
1:0533	ALM_171: LS KO: All Comm Links Failed
1:0534	ALM_172: LS KO: All Load Share PVs Failed
1:0535	ALM_173: LS KO: Performance Manual Enabled
1:0536	ALM_174: LS KO: ASC1 Offline
1:0537	ALM_175: LS KO: ASC2 Offline

Addr	Description
1:0538	ALM_176: LS KO: PFC Limiter 1 Active
1:0539	ALM_177: LS KO: PFC Limiter 2 Active
1:0540	ALM_178: LS KO: ASC Deviation
1:0541	ALM_179: LS KO: Parameter Deviation
1:0542	ALM_180: LS KO: ASC1 Surge
1:0543	ALM_181: LS KO: ASC2 Surge
1:0544	ALM_182: LS KO: ASC1 Full Manual Active
1:0545	ALM_183: LS KO: ASC2 Full Manual Active
1:0546	ALM_184: LS KO: ASC1 Driver Failed
1:0547	ALM_185: LS KO: ASC2 Driver Failed
1:0548	ALM_186: LS KO: PFC Driver Failed
1:0549	ALM_187: LS KO: PFC Speed Tracking Enabled
1:0550	ALM_188: AI Maintenance Override Active
1:0551	ALM_189: Load Share PV Failed
1:0552	ALM_190: Isolated Controller PV Failed
1:0553	ALM_191: Iso Cntrl Rem Setpoint Failed
1:0554	ALM_192: T1 Comms Failure Override Active
1:0555	ALM_193: T2 Comms Failure Override Active
1:0556	ALM_194: T3 Comms Failure Override Active
1:0557	ALM_195: T4 Comms Failure Override Active
1:0558	ALM_196: T5 Comms Failure Override Active
1:0559	ALM_197: spare
1:0560	ALM_198: spare
1:0561	ALM_199: spare
1:0562	ALM_200: spare
1:0563	ALM_201: Backup Unavailable
1:0564	ALM_202: Secondary Chassis Fault
1:0565	ALM_203: Backup Speed 1 Fault
1:0566	ALM_204: Backup Speed 2 Fault
1:0567	ALM_205: Backup AI 1 Fault
1:0568	ALM_206: Backup AI 2 Fault
1:0569	ALM_207: Backup AI 3 Fault
1:0570	ALM_208: Backup AI 4 Fault
1:0571	ALM_209: Backup AI 5 Fault
1:0572	ALM_210: Backup AI 6 Fault
1:0573	ALM_211: Backup AI 7 Fault
1:0574	ALM_212: Backup AI 8 Fault
1:0575	ALM_213: Diff Alarm Redun ASC1 Suction Press
1:0576	ALM_214: Diff Alarm Redun ASC1 Discharge Press
1:0577	ALM_215: Diff Alarm Redun ASC2 Suction Press
1:0578	ALM_216: Diff Alarm Redun ASC2 Discharge Press
1:0579	ALM_217: Diff Alarm Redun Performance PV
1:0580	ALM_218: Analog Output 01 Backup Fault

Addr	Description
1:0581	ALM_219: Analog Output 02 Backup Fault
1:0582	ALM_220: Analog Output 03 Backup Fault
1:0583	ALM_221: Analog Output 04 Backup Fault
1:0584	ALM_222: Analog Output 05 Backup Fault
1:0585	ALM_223: Analog Output 06 Backup Fault
1:0586	ALM_224: Actuator Output 01 Backup Fault
1:0587	ALM_225: Actuator Output 02 Backup Fault
1:0588	ALM_226: Simplex Config detects Sec Chassis
1:0589	ALM_227: Iso Cntrl Driver Fault
1:0590	ALM_228
1:0591	ALM_229
1:0592	ALM_230
1:0593	ALM_231
1:0594	ALM_232
1:0595	
1:0596	**Start of DR added Parameters**
1:0597	Primary Unit Healthy
1:0598	Primary Unit is SYSCON
1:0599	Secondary Unit Healthy
1:0600	Secondary Unit is SYSCON
1:0601	Backup Unit Faulted
1:0602	Backup Unit Unavailable
1:0603	Backup Contact In 1 Closed
1:0604	Backup Contact In 2 Closed
1:0605	Backup Contact In 3 Closed
1:0606	Backup Contact In 4 Closed
1:0607	Backup Contact In 5 Closed
1:0608	Backup Contact In 6 Closed
1:0609	Backup Contact In 7 Closed
1:0610	Backup Contact In 8 Closed
1:0611	Backup Contact In 9 Closed
1:0612	Backup Contact In 10 Closed
1:0613	Backup Contact In 11 Closed
1:0614	Backup Contact In 12 Closed
1:0615	Backup Contact In 13 Closed
1:0616	Backup Contact In 14 Closed
1:0617	Backup Contact In 15 Closed
1:0618	Backup Contact In 16 Closed
1:0619	Backup Contact In 17 Closed
1:0620	Backup Contact In 18 Closed
1:0621	Backup Contact In 19 Closed
1:0622	Backup Contact In 20 Closed
1:0623	Backup Relay 1 Energized

Addr	Description
1:0624	Backup Relay 2 Energized
1:0625	Backup Relay 3 Energized
1:0626	Backup Relay 4 Energized
1:0627	Backup Relay 5 Energized
1:0628	Backup Relay 6 Energized
1:0629	Backup Relay 7 Energized
1:0630	Backup Relay 8 Energized
1:0631	ALM_251: ASC#2: Surge on Flow Deriv
1:0632	ALM_252: ASC#2: Surge on P1 Deriv
1:0633	ALM_253: ASC#2: Surge on P2 Deriv
1:0634	ALM_254: ASC#2: Surge on Speed Deriv
1:0635	ALM_255:ASC#2: Surge on Min flow
1:0636	ALM_256:ASC#2: Surge on Cross Line
1:0637	ALM_257:ASC#2: Configuration Error
1:0638	ALM_258:ASC#2: Flow Difference Detected
1:0639	ALM_259:ASC#2: Primary Flow Sensor Fault
1:0640	ALM_260:ASC#2: Second Flow Sensor Fault
1:0641	ALM_261: ASC#2: All Flow Sensor Fault
1:0642	ALM_262: ASC#2: Flow Sensor Config Error
1:0643	ALM_263: ASC#2: Flow Sensor Degraded Mode
1:0644	ALM_264: ASC#2: Flow Sensor Transfer Inhibit
1:0645	ALM_265: ASC#2: Suction Press Difference
1:0646	ALM_266: ASC#2: Primary Suction Press Fault
1:0647	ALM_267: ASC#2: Second Suction Press Fault
1:0648	ALM_268: ASC#2: All Suction Press Fault
1:0649	ALM_269: ASC#2: Suction Press Config Error
1:0650	ALM_270: ASC#2: Suction Press Degraded Mode
1:0651	ALM_271: ASC#2: Suction Press Transfer Inhibit
1:0652	ALM_272: ASC#2: Disch Press Difference
1:0653	ALM_273: ASC#2: Primary Disch Press Fault
1:0654	ALM_274: ASC#2: Second Disch Press Fault
1:0655	ALM_275: ASC#2: All Disch Press Fault
1:0656	ALM_276: ASC#2: Disch Press Config Error
1:0657	ALM_277: ASC#2: Disch Press Degraded Mode
1:0658	ALM_278: ASC#2: Disch Press Transfer Inhibit
1:0659	ALM_279: ASC#2: Pressure At Flow Fault
1:0660	ALM_280: ASC#2: Suction Temp Fault
1:0661	ALM_281: ASC#2: Disch Temp Fault
1:0662	ALM_282: ASC#2: Temp At Flow Fault
1:0663	ALM_283: ASC#2: HSS#2 Fault
1:0664	ALM_284: ASC#2: HSS#2 Fault
1:0665	ALM_285: ASC#2: Decoupling#2 Fault
1:0666	ALM_286: ASC#2: Decoupling#2 Fault

Addr	Description
1:0667	ALM_287: ASC#2: Remote Man vlv fault
1:0668	ALM_288: ASC#2: Upstream Valve Press Flt
1:0669	ALM_289: ASC#2: Downstream Valve Press Flt
1:0670	ALM_290: ASC#2: Temp At Valve Fault
1:0671	ALM_291: ASC#2: Alternate P1 Overrd Fault
1:0672	ALM_292: ASC#2: Alternate P2 Overrd Fault
1:0673	ALM_293: ASC#2: Consecutive surge AL Detected
1:0674	ALM_294: ASC#2: Surge On Motor current
1:0675	ALM_295: ASC#2: Choke Map Reached
1:0676	ALM_296: ASC#2: Gas Liquid phase
1:0677	ALM_297: ASC#2: Quench Temperature Fault
1:0678	ALM_298: ASC#2: Surges- AS valve forced to max
1:0679	ALM_299: ASC#2: AS VLV Fdbk Error-Force open
1:0680	ALM_300: ASC#2: IGV position feedback fault
1:0681	ALM_301: ASC#2: ASV FDBK and CMD Mismatch
1:0682	ALM_302: ASC#2: External Surge Detected
1:0683	ALM_303: ASC#2: Excessive Surge Detected
1:0684	ALM_304: ASC#2: ASV Feedback Fault
1:0685	ALM_305: ASC#2: Side-stream Tempertaure Fault
1:0686	ALM_306: ASC#2: Motor Current Fault
1:0687	ALM_307: ASC#2: Compressor Speed Fault
1:0688	ALM_308: ASC#2: Flow Forcing Enabled
1:0689	ALM_309: ASC#2: Suction Press Forcing Enabled
1:0690	ALM_310: ASC#2: Disch Press Forcing Enabled
1:0691	ALM_311: ASC#2: Suction Temp Forcing Enabled
1:0692	ALM_312: ASC#2: Disch Temp Forcing Enabled
1:0693	ALM_313: ASC#2: Discharge Temp PV #1 Failed
1:0694	ALM_314: ASC#2: Discharge Temp PV #2 Failed
1:0695	ALM_315: ASC#2: All Suction Temp Fault
1:0696	ALM_316: ASC#2: All Discharge Temp Fault
1:0697	ALM_317: ASC#2: Suction Temp Difference
1:0698	ALM_318: ASC#2: Discharge Temp Difference
1:0699	Spare
1:0700	Spare
1:0701	ALM_321: ASC#2: Press at Flow Forcing Enabled
1:0702	ALM_322: ASC#2: Temp at Flow Forcing Enabled
1:0703	Spare
1:0704	Spare
1:0705	Spare
1:0706	Spare
1:0707	Spare
1:0708	ALM_328: ASC#2: SS Temp Forcing Enabled
1:0709	ALM_329: ASC#2: Motor Current Forcing Enabled

Addr	Description
1:0710	ALM_330: ASC#2: Comp Speed Forcing Enabled
1:0711	ALM_331: ASC#2: Surge Minimum Position Active
1:0712	ALM_332: ASC#2: Surge Recovery Active
1:0713	Spare
1:0714	Spare
1:0715	Spare

Table 9-8. Analog Read Addresses

Addr	Description	Units	Multiplier
3:0001	Analog Input 1 Value	AI 01 Units	AI 01 Mult
3:0002	Analog Input 2 Value	AI 02 Units	AI 02 Mult
3:0003	Analog Input 3 Value	AI 03 Units	AI 03 Mult
3:0004	Analog Input 4 Value	AI 04 Units	AI 04 Mult
3:0005	Analog Input 5 Value	AI 05 Units	AI 05 Mult
3:0006	Analog Input 6 Value	AI 06 Units	AI 06 Mult
3:0007	Analog Input 7 Value	AI 07 Units	AI 07 Mult
3:0008	Analog Input 8 Value	AI 08 Units	AI 08 Mult
3:0009	ASC#1: Operating Point (S_PV)	%	100
3:0010	ASC#1: HSS Ctrl Dmd (x100%)	%	100
3:0011	PFC Valve Demand	%	100
3:0012	Spare	N/A	1
3:0013	ASC#1 Display Surge Map#1: Surge Margin (%)	%	100
3:0014	WSPV Denominator		
3:0015	WSPV Numerator		
3:0016	ASC#1: Total NB of Surges	N/A	1
3:0017	Spare	N/A	1
3:0018	ASC#1: Actual Press ratio (X10)	N/A	10
3:0019	Speed (RPM)	RPM	1
3:0020	ASC#1: Mass/Normal at Flowmeter (EU)	EU	Configured Mult
3:0021	ASC#1: Actual Flow (EU)	EU	Configured Mult
3:0022	Spare	N/A	1
3:0023	Stage 1 Efficiency	N/A	100
3:0024	Spare	N/A	1
3:0025	PFC PV	Perf Units	Perf AI Mult
3:0026	PFC PID SP	Perf Units	Perf AI Mult
3:0027	Spare	N/A	1
3:0028	Spare	N/A	1
3:0029	PFC Limiter PID PV	Limiter Units	Limiter AI Mult
3:0030	PFC Limiter PID SP	Limiter Units	Limiter AI Mult
3:0031	Spare	N/A	1
3:0032	Spare	N/A	1

Addr	Description	Units	Multiplier
3:0033	Internal Board Temp	N/A	100
3:0034	24VDC	N/A	100
3:0035	Spare	N/A	1
3:0036	Spare	N/A	1
3:0037	Spare	N/A	1
3:0038	Spare	N/A	1
3:0039	ASC1 Readback (0-100%)	%	FDBK AI Mult
3:0040	PFC Readback (0-100%)	%	FDBK AI Mult
3:0041	ASC2 Readback (0-100%)	%	FDBK AI Mult
3:0042	Spare	N/A	1
3:0043	Spare	N/A	1
3:0044	Spare	N/A	1
3:0045	Spare	N/A	1
3:0046	Spare	N/A	1
3:0047	Spare	N/A	1
3:0048	Spare	N/A	1
3:0049	Spare	N/A	1
3:0050	Spare	N/A	1
3:0051	MPU Speed Signal 1	RPM	1
3:0052	MPU Speed Signal 2	RPM	1
3:0053	Actuator 1 Output (mA x100)	mA	100
3:0054	Actuator 2 Output (mA x100)	mA	100
3:0055	Analog Output 1 (mA x100)	mA	100
3:0056	Analog output 2 (mA x100)	mA	100
3:0057	Analog Output 3 (mA x100)	mA	100
3:0058	Analog Output 4 (mA x100)	mA	100
3:0059	Analog Output 5 (mA x100)	mA	100
3:0060	Analog Output 6 (mA x100)	mA	100
3:0061	LN Node 1 Analog Input 1 Val	LN1 AI 01 Units	LN1 AI 01 Mult
3:0062	LN Node 1 Analog Input 2 Val	LN1 AI 02 Units	LN1 AI 02 Mult
3:0063	LN Node 1 Analog Input 3 Val	LN1 AI 03 Units	LN1 AI 03 Mult
3:0064	LN Node 1 Analog Input 4 Val	LN1 AI 04 Units	LN1 AI 04 Mult
3:0065	LN Node 1 Analog Input 5 Val	LN1 AI 05 Units	LN1 AI 05 Mult
3:0066	LN Node 1 Analog Input 6 Val	LN1 AI 06 Units	LN1 AI 06 Mult
3:0067	LN Node 1 Analog Input 7 Val	LN1 AI 07 Units	LN1 AI 07 Mult
3:0068	LN Node 1 Analog Input 8 Val	LN1 AI 08 Units	LN1 AI 08 Mult
3:0069	LN Node 2 Analog Input 1 Val	LN2 AI 01 Units	LN2 AI 01 Mult

Addr	Description	Units	Multiplier
3:0070	LN Node 2 Analog Input 2 Val	LN2 AI 02 Units	LN2 AI 02 Mult
3:0071	LN Node 2 Analog Input 3 Val	LN2 AI 03 Units	LN2 AI 03 Mult
3:0072	LN Node 2 Analog Input 4 Val	LN2 AI 04 Units	LN2 AI 04 Mult
3:0073	LN Node 2 Analog Input 5 Val	LN2 AI 05 Units	LN2 AI 05 Mult
3:0074	LN Node 2 Analog Input 6 Val	LN2 AI 06 Units	LN2 AI 06 Mult
3:0075	LN Node 2 Analog Input 7 Val	LN2 AI 07 Units	LN2 AI 07 Mult
3:0076	LN Node 2 Analog Input 8 Val	LN2 AI 08 Units	LN2 AI 08 Mult
3:0077	LN Node 1 Analog Output 1 (mA x100)	mA	100
3:0078	LN Node 1 Analog Output 2 (mA x100)	mA	100
3:0079	LN Node 2 Analog Output 1 (mA x100)	mA	100
3:0080	LN Node 2 Analog Output 2 (mA x100)	mA	100
3:0081	LN Node 3 RTD Input 1 Temp	RTD 01 Units	RTD 01 Mult
3:0082	LN Node 3 RTD Input 2 Temp	RTD 02 Units	RTD 02 Mult
3:0083	LN Node 3 RTD Input 3 Temp	RTD 03 Units	RTD 03 Mult
3:0084	LN Node 3 RTD Input 4 Temp	RTD 04 Units	RTD 04 Mult
3:0085	LN Node 3 RTD Input 5 Temp	RTD 05 Units	RTD 05 Mult
3:0086	LN Node 3 RTD Input 6 Temp	RTD 06 Units	RTD 06 Mult
3:0087	LN Node 3 RTD Input 7 Temp	RTD 07 Units	RTD 07 Mult
3:0088	LN Node 3 RTD Input 8 Temp	RTD 08 Units	RTD 08 Mult
3:0089	First Out Alarm	N/A	1
3:0090	First Out Trip	N/A	1
3:0091	Isolated Control Process Value	Eng Units	*1.0 (0.001, 100)
3:0092	Isolated Control Setpoint	Eng Units	*1.0 (0.001, 100)
3:0093	Isolated Valve Demand (%x10)	%	*10.0 (0.001, 100)
3:0094	Spare	N/A	1
3:0095	Spare	N/A	1
3:0096	ASC#1 Valve 1 Position FDBK	%	100
3:0097	Spare	N/A	1
3:0098	Spare	N/A	1
3:0099	ASC#1: Min HSS Ctrl-SMP (x100%)	%	100
3:0100	ASC#1: Max HSS Ctrl (x100%)	%	100
3:0101	ASC#1: AS PID Output(X100%)	%	100
3:0102	ASC#1: Surge Recovery Dmd (X100%)	%	100
3:0103	ASC#1: Boost Dmd (X100%)	%	100
3:0104	ASC#1: Man Dmd (X100%)	%	100
3:0105	ASC#1: P1 override PID (X100%)	%	100
3:0106	ASC#1: P2 override PID (X100%)	%	100
3:0107	ASC#1: Rate PID Output (X100%)	%	100
3:0108	ASC#1: Seq Demand (X100%)	%	100
3:0109	ASC#1: Ext HSS1 Demand (X100%)	%	100
3:0110	ASC#1: Ext HSS2 Demand (X100%)	%	100
3:0111	ASC#1: Decoupling 1 Dmd (X100%)	%	100
3:0112	ASC#1: Decoupling 2 Dmd (X100%)	%	100

Addr	Description	Units	Multiplier
3:0113	ASC#1: Decoupling 3 Dmd (X100%)	%	100
3:0114	ASC#1: Speed Decp Dmd (X100%)	%	100
3:0115	ASC#1: Final Dcpl Demand (X100%)	%	100
3:0116	ASC#1: Final Valve Demand (X100%)	%	100
3:0117	Spare	N/A	1
3:0118	Spare	N/A	1
3:0119	ASC#1: ST Flow at Flowmeter (EU)	EU	Configured Mult
3:0120	ASC#1: Corrected Flow (EU)	EU	Configured Mult
3:0121	Spare	N/A	1
3:0122	ASC#1: Polytropic Head	Config Units	1
3:0123	ASC#1: Reduced Head	Config Units	1
3:0124	ASC#1: Delta P Flow PV (EU)	Flow 1 AI Units	Flow 1 AI Mult
3:0125	ASC#1: Prim Flows PV (EU)	Flow 1 AI Units	Flow 1 AI Mult
3:0126	ASC#1: Second Flow PV (EU)	Flow 2 AI Units	Flow 2 AI Mult
3:0127	ASC#1: Suction Press Used (EU)	PSUC Units	PSUC AI Mult
3:0128	ASC#1: Prim Disch Press PV (EU)	PDIS Units	PDIS AI Mult
3:0129	ASC#1: Suction T PV Used (EU)	TSUC Units	TSUC AI Mult
3:0130	ASC#1: Disch T PV (EU)	TDIS Units	TDIS AI Mult
3:0131	ASC#1 Display Surge Map#1: Map	N/A	1
3:0132	Asc#1 Display Surge Map#1: OP ptX (EU)	EU	Configured Mult
3:0133	Asc#1 Display Surge Map#1: OP ptY (EU)	EU	Configured Mult
3:0134	Asc#1 Display Surge Map#1: Point X1 (EU)	EU	Configured Mult
3:0135	ASC#1 Display Surge Map#1: Point Y1 (EU)	EU	Configured Mult
3:0136	ASC#1 Display Surge Map#1: Point X2 (EU)	EU	Configured Mult
3:0137	Asc#1 Display Surge Map#1: Point Y2 (EU)	EU	Configured Mult
3:0138	ASC#1 Display Surge Map#1: Point X3 (EU)	EU	Configured Mult
3:0139	ASC#1 Display Surge Map#1: Point Y3 (EU)	EU	Configured Mult
3:0140	ASC#1 Display Surge Map#1: Point X4 (EU)	EU	Configured Mult
3:0141	ASC#1 Display Surge Map#1: Point Y4 (EU)	EU	Configured Mult
3:0142	ASC#1 Display Surge Map#1: Point X5 (EU)	EU	Configured Mult
3:0143	ASC#1 Display Surge Map#1: Point Y5 (EU)	EU	Configured Mult
3:0144	ASC#1 Display Surge Map#1: Point X6 (EU)	EU	Configured Mult
3:0145	ASC#1 Display Surge Map#1: Point Y6 (EU)	EU	Configured Mult
3:0146	ASC#1 Display Surge Map#1: Point X7 (EU)	EU	Configured Mult
3:0147	ASC#1 Display Surge Map#1: Point Y7 (EU)	EU	Configured Mult
3:0148	ASC#1 Display Surge Map#1: Point X8 (EU)	EU	Configured Mult
3:0149	ASC#1 Display Surge Map#1: Point Y8 (EU)	EU	Configured Mult
3:0150	ASC#1 Display Surge Map#1: Point X9 (EU)	EU	Configured Mult
3:0151	ASC#1 Display Surge Map#1: Point Y9 (EU)	EU	Configured Mult
3:0152	ASC#1 Display Surge Map#1: Point X10 (EU)	EU	Configured Mult
3:0153	ASC#1 Display Surge Map#1: Point Y10 (EU)	EU	Configured Mult
3:0154	ASC#1 Display Surge Map#1: Point X11 (EU)	EU	Configured Mult
3:0155	ASC#1 Display Surge Map#1: Point Y11 (EU)	EU	Configured Mult

Addr	Description	Units	Multiplier
3:0156	ASC#1 Display Surge Map#1: Point X12 (EU)	EU	Configured Mult
3:0157	ASC#1 Display Surge Map#1: Point Y12 (EU)	EU	Configured Mult
3:0158	ASC#1 Display Surge Map#1: Max X (EU)	EU	Configured Mult
3:0159	ASC#1 Display Surge Map#1: Min X (EU)	EU	Configured Mult
3:0160	ASC#1 Display Surge Map#1: Max Y (EU)	EU	Configured Mult
3:0161	ASC#1 Display Surge Map#1: Min Y (EU)	EU	Configured Mult
3:0162	ASC#1: Choke Operating Point	%	100
3:0163	ASC#1: Choke PID Controller Demand	%	100
3:0164	ASC#1 Display Choke Map#1: Point X1 (EU)	EU	Configured Mult
3:0165	ASC#1 Display Choke Map#1: Point Y1 (EU)	EU	Configured Mult
3:0166	ASC#1 Display Choke Map#1: Point X2 (EU)	EU	Configured Mult
3:0167	ASC#1 Display Choke Map#1: Point Y2 (EU)	EU	Configured Mult
3:0168	ASC#1 Display Choke Map#1: Point X3 (EU)	EU	Configured Mult
3:0169	ASC#1 Display Choke Map#1: Point Y3 (EU)	EU	Configured Mult
3:0170	ASC#1 Display Choke Map#1: Point X4 (EU)	EU	Configured Mult
3:0171	ASC#1 Display Choke Map#1: Point Y4 (EU)	EU	Configured Mult
3:0172	ASC#1 Display Choke Map#1: Point X5 (EU)	EU	Configured Mult
3:0173	ASC#1 Display Choke Map#1: Point Y5 (EU)	EU	Configured Mult
3:0174	ASC#1 Display Choke Map#1: Point X6 (EU)	EU	Configured Mult
3:0175	ASC#1 Display Choke Map#1: Point Y6 (EU)	EU	Configured Mult
3:0176	ASC#1 Display Surge Map#1: Max X Exposant	EU	Configured Mult
3:0177	ASC#1 Display Surge Map#1: Max Y Exposant	EU	Configured Mult
3:0178	ASC#1 Display Surge Map#1: Surge Base Margin (%)	%	100
3:0179	Spare	N/A	1
3:0180	ASC#1 Display Surge Map#1: Boost Margin (%)	%	100
3:0181	ASC#1 Multiply Factor OP ptX (X100)	%	100
3:0182	ASC#1 Multiply Factor OP ptY (X100)	%	100
3:0183	ASC#1 Minimum MAP X Displayed	EU	1
3:0184	ASC#1 Minimum MAP Y Displayed	EU	1
3:0185	ASC#1 Message 1	N/A	1
3:0186	ASC#1 Message 2	N/A	1
3:0187	Spare	N/A	1
3:0188	ASC#1: Consecutive NB of Surges	N/A	1
3:0189	ASC#1 Flow Derivative Surge Detected(%/sec)	%/sec	Flow 1 AI Mult
3:0190	ASC#1 P1 Derivative Surge Detected(unit/sec)	EU/Sec	PSUC AI Mult
3:0191	ASC#1 P2 Derivative Surge Detected(unit/sec)	EU/sec	PDIS AI Mult
3:0192	ASC#1 Spd Derivative Surge Detected(rpm/sec)	RPM/sec	1
3:0193	ASC#1 Current/Power Derivative Surge Detected(Amp/sec)	Amp/sec	Current AI Mult
3:0194	ASC#1 WSPV Denominator	N/A	1
3:0195	ASC#1 WSPV Numerator	N/A	1
3:0196	ASC#1 Polytropic Efficiency	N/A	1

Addr	Description	Units	Multiplier
3:0197	Spare	N/A	1
3:0198	Spare	N/A	1
3:0199	Spare	N/A	1
3:0200	Spare	N/A	1
3:0201	PFC Startup Position	%	100
3:0202	PFC Sequence Ramp	%	100
3:0203	PFC Remote Sequence Demand	%	100
3:0204	PFC Limiter PID Demand	%	100
3:0205	PFC Limiter PID Remote SP	RMT Limiter Units	RMT Limiter AI Mult
3:0206	Spare	N/A	1
3:0207	Spare	N/A	1
3:0208	PFC PID Demand	%	100
3:0209	Spare	N/A	1
3:0210	Spare	N/A	1
3:0211	PFC Remote SP	RMT Perf Units	RMT Perf AI Mult
3:0212	PFC LSS	%	100
3:0213	Spare	N/A	1
3:0214	PFC Decoupling Bias	%	100
3:0215	PFC Limiter 2 PID Demand	%	100
3:0216	PFC Limiter 2 PID Remote SP	RMT Limiter 2 Units	RMT Limiter 2 AI Mult
3:0217	PFC Limiter 2 PID SP	Limiter 2 Units	Limiter 2 AI Mult
3:0218	PFC Limiter 2 PID PV	Limiter 2 Units	Limiter 2 AI Mult
3:0219	Spare	N/A	1
3:0220	Spare	N/A	1
3:0221	Spare	N/A	1
3:0222	Spare	N/A	1
3:0223	Spare	N/A	1
3:0224	ASC#2 Valve 1 Position FDBK	%	100
3:0225	ASC#2: Operating Point (S_PV)	%	100
3:0226	ASC#2: HSS Ctrl Dmd (x100%)	%	100
3:0227	ASC#2: Min HSS Ctrl-SMP (x100%)	%	100
3:0228	ASC#2: Max HSS Ctrl (x100%)	%	100
3:0229	ASC#2: AS PID Output(X100%)	%	100
3:0230	ASC#2: Surge Recovery Dmd (X100%)	%	100
3:0231	ASC#2: Boost Dmd (X100%)	%	100
3:0232	ASC#2: Man Dmd (X100%)	%	100
3:0233	ASC#2: P1 override PID (X100%)	%	100
3:0234	ASC#2: P2 override PID (X100%)	%	100
3:0235	ASC#2: Rate PID Output (X100%)	%	100
3:0236	ASC#2: Seq Demand (X100%)	%	100
3:0237	ASC#2: Ext HSS1 Demand (X100%)	%	100
3:0238	ASC#2: Ext HSS2 Demand (X100%)	%	100

Addr	Description	Units	Multiplier
3:0239	ASC#2: Decoupling 1 Dmd (X100%)	%	100
3:0240	ASC#2: Decoupling 2 Dmd (X100%)	%	100
3:0241	ASC#2: Decoupling 3 Dmd (X100%)	%	100
3:0242	ASC#2: Speed Decp Dmd (X100%)	%	100
3:0243	ASC#2: Final Dcpl Demand (X100%)	%	100
3:0244	ASC#2: Final Valve Demand (X100%)	%	100
3:0245	ASC#2: Actual Flow (EU)	EU	Configured Mult
3:0246	ASC#2: Mass/Normal at Flowmeter (EU)	EU	Configured Mult
3:0247	ASC#2: ST Flow at Flowmeter (EU)	EU	Configured Mult
3:0248	ASC#2: Corrected Flow (EU)	EU	Configured Mult
3:0249	ASC#2: Actual Press ratio (X10)	N/A	10
3:0250	ASC#2: Polytropic Head	Config Units	1
3:0251	ASC#2: Reduced Head	Config Units	1
3:0252	ASC#2: Delta P Flow PV (EU)	Flow 1 AI Units	Flow 1 AI Mult
3:0253	ASC#2: Prim Flows PV (EU)	Flow 1 AI Units	Flow 1 AI Mult
3:0254	ASC#2: Second Flow PV (EU)	Flow 2 AI Units	Flow 2 AI Mult
3:0255	ASC#2: Suction Press Used (EU)	PSUC Units	PSUC AI Mult
3:0256	ASC#2: Prim Disch Press PV (EU)	PDIS Units	PDIS AI Mult
3:0257	ASC#2: Suction T PV Used (EU)	TSUC Units	TSUC AI Mult
3:0258	ASC#2: Disch T PV (EU)	TDIS Units	TDIS AI Mult
3:0259	ASC#2 Display Surge Map#1: Map	N/A	1
3:0260	ASC#2 Display Surge Map#1: OP ptX (EU)	EU	Configured Mult
3:0261	ASC#2 Display Surge Map#1: OP ptY (EU)	EU	Configured Mult
3:0262	ASC#2 Display Surge Map#1: Point X1 (EU)	EU	Configured Mult
3:0263	ASC#2 Display Surge Map#1: Point Y1 (EU)	EU	Configured Mult
3:0264	ASC#2 Display Surge Map#1: Point X2 (EU)	EU	Configured Mult
3:0265	ASC#2 Display Surge Map#1: Point Y2 (EU)	EU	Configured Mult
3:0266	ASC#2 Display Surge Map#1: Point X3 (EU)	EU	Configured Mult
3:0267	ASC#2 Display Surge Map#1: Point Y3 (EU)	EU	Configured Mult
3:0268	ASC#2 Display Surge Map#1: Point X4 (EU)	EU	Configured Mult
3:0269	ASC#2 Display Surge Map#1: Point Y4 (EU)	EU	Configured Mult
3:0270	ASC#2 Display Surge Map#1: Point X5 (EU)	EU	Configured Mult
3:0271	ASC#2 Display Surge Map#1: Point Y5 (EU)	EU	Configured Mult
3:0272	ASC#2 Display Surge Map#1: Point X6 (EU)	EU	Configured Mult
3:0273	ASC#2 Display Surge Map#1: Point Y6 (EU)	EU	Configured Mult
3:0274	ASC#2 Display Surge Map#1: Point X7 (EU)	EU	Configured Mult
3:0275	ASC#2 Display Surge Map#1: Point Y7 (EU)	EU	Configured Mult
3:0276	ASC#2 Display Surge Map#1: Point X8 (EU)	EU	Configured Mult
3:0277	ASC#2 Display Surge Map#1: Point Y8 (EU)	EU	Configured Mult
3:0278	ASC#2 Display Surge Map#1: Point X9 (EU)	EU	Configured Mult
3:0279	ASC#2 Display Surge Map#1: Point Y9 (EU)	EU	Configured Mult
3:0280	ASC#2 Display Surge Map#1: Point X10 (EU)	EU	Configured Mult
3:0281	ASC#2 Display Surge Map#1: Point Y10 (EU)	EU	Configured Mult

Addr	Description	Units	Multiplier
3:0282	ASC#2 Display Surge Map#1: Point X11 (EU)	EU	Configured Mult
3:0283	ASC#2 Display Surge Map#1: Point Y11 (EU)	EU	Configured Mult
3:0284	ASC#2 Display Surge Map#1: Point X12 (EU)	EU	Configured Mult
3:0285	ASC#2 Display Surge Map#1: Point Y12 (EU)	EU	Configured Mult
3:0286	ASC#2 Display Surge Map#1: Max X (EU)	EU	Configured Mult
3:0287	ASC#2 Display Surge Map#1: Min X (EU)	EU	Configured Mult
3:0288	ASC#2 Display Surge Map#1: Max Y (EU)	EU	Configured Mult
3:0289	ASC#2 Display Surge Map#1: Min Y (EU)	EU	Configured Mult
3:0290	ASC#2: Choke Operating Point	%	100
3:0291	ASC#2: Choke PID Controller Demand	%	100
3:0292	ASC#2 Display Choke Map#1: Point X1 (EU)	EU	Configured Mult
3:0293	ASC#2 Display Choke Map#1: Point Y1 (EU)	EU	Configured Mult
3:0294	ASC#2 Display Choke Map#1: Point X2 (EU)	EU	Configured Mult
3:0295	ASC#2 Display Choke Map#1: Point Y2 (EU)	EU	Configured Mult
3:0296	ASC#2 Display Choke Map#1: Point X3 (EU)	EU	Configured Mult
3:0297	ASC#2 Display Choke Map#1: Point Y3 (EU)	EU	Configured Mult
3:0298	ASC#2 Display Choke Map#1: Point X4 (EU)	EU	Configured Mult
3:0299	ASC#2 Display Choke Map#1: Point Y4 (EU)	EU	Configured Mult
3:0300	ASC#2 Display Choke Map#1: Point X5 (EU)	EU	Configured Mult
3:0301	ASC#2 Display Choke Map#1: Point Y5 (EU)	EU	Configured Mult
3:0302	ASC#2 Display Choke Map#1: Point X6 (EU)	EU	Configured Mult
3:0303	ASC#2 Display Choke Map#1: Point Y6 (EU)	EU	Configured Mult
3:0304	ASC#2 Display Surge Map#1: Max X Exposant	EU	Configured Mult
3:0305	ASC#2 Display Surge Map#1: Max Y Exposant	EU	Configured Mult
3:0306	ASC#2 Display Surge Map#1: Surge Base Margin (%)	%	100
3:0307	ASC#2 Display Surge Map#1: Surge Margin (%)	%	100
3:0308	ASC#2 Display Surge Map#1: Boost Margin (%)	%	100
3:0309	ASC#2 Multiply Factor OP ptX (X100)	%	100
3:0310	ASC#2 Multiply Factor OP ptY (X100)	%	100
3:0311	ASC#2 Minimum MAP X Displayed	EU	1
3:0312	ASC#2 Minimum MAP Y Displayed	EU	1
3:0313	ASC#2 Message 1	N/A	1
3:0314	ASC#2 Message 2	N/A	1
3:0315	ASC#2: Total NB of Surges	N/A	1
3:0316	ASC#2: Consecutive NB of Surges	N/A	1
3:0317	ASC#2 Flow Derivative Surge Detected(%/sec)	%/sec	Flow 1 AI Mult
3:0318	ASC#2 P1 Derivative Surge Detected(unit/sec)	EU/Sec	PSUC AI Mult
3:0319	ASC#2 P2 Derivative Surge Detected(unit/sec)	EU/sec	PDIS AI Mult
3:0320	ASC#2 Spd Derivative Surge Detected(rpm/sec)	RPM/sec	1
3:0321	ASC#2 Current/Power Derivative Surge Detected(Amp/sec)	Amp/sec	Current AI Mult
3:0322	ASC#2: WSPV Denominator	N/A	1

Addr	Description	Units	Multiplier
3:0323	ASC#2: WSPV Numerator	N/A	1
3:0324	ASC#2: Polytropic Efficiency	N/A	1
3:0325	Load Sharing: Voted PV	EU	100
3:0326	Load Sharing: Master SP	EU	100
3:0327	Load Sharing: Bias Signal	EU	100
3:0328	Load Sharing: Shared Parameter Error	EU	100
3:0329	Load Sharing: Bias from Shared Parameter	EU	100
3:0330	Load Sharing: Shared Parameter Target	EU	100
3:0331	Load Sharing: ASV Position Error	%	100
3:0332	Load Sharing: Bias from ASV Position	EU	100
3:0333	**Start of DR added Parameters**		
3:0334	Backup Speed Sensor #1 Input (RPM)	RPM	1
3:0335	Backup Speed Sensor #2 Input (RPM)	RPM	1
3:0336	Backup Analog Input 1 (mA x 100)	mA	100
3:0337	Backup Analog Input 2 (mA x 100)	mA	100
3:0338	Backup Analog Input 3 (mA x 100)	mA	100
3:0339	Backup Analog Input 4 (mA x 100)	mA	100
3:0340	Backup Analog Input 5 (mA x 100)	mA	100
3:0341	Backup Analog Input 6 (mA x 100)	mA	100
3:0342	Backup Analog Input 7 (mA x 100)	mA	100
3:0343	Backup Analog Input 8 (mA x 100)	mA	100
3:0344	Backup Analog Output 1 (mA x 100)	mA	100
3:0345	Backup Analog Output 2 (mA x 100)	mA	100
3:0346	Backup Analog Output 3 (mA x 100)	mA	100
3:0347	Backup Analog Output 4 (mA x 100)	mA	100
3:0348	Backup Analog Output 5 (mA x 100)	mA	100
3:0349	Backup Analog Output 6 (mA x 100)	mA	100
3:0350	Backup Actuator #1 Output (mA x 100)	mA	100
3:0351	Backup Actuator #2 Output (mA x 100)	mA	100

Multipliers listed as “Configured Mult” are configured with the Analog Input channel associated with the signal.

Table 9-9. Analog Write Addresses

Addr	Description	Units	Multiplier
4:0001	Performance Controller SP	Perf Units	Perf AI Mult
4:0002	ASC#1 Manual Demand	%	100
4:0003	Performance Controller Manual Demand	%	100
4:0004	Performance Controller Limiter1 Loop SP	Limiter Units	Limiter AI Mult
4:0005	ASC#1 Suction Pressure Over SP	PSUC Units	PSUC AI Mult
4:0006	ASC#1 Discharge Pressure Over SP	PDIS Units	PDIS AI Mult
4:0007	ASC#1 External Decoupling Signal		1
4:0008	ASC#2 Manual Demand	%	100
4:0009	ASC#2 Suction Pressure Over SP	PSUC Units	PSUC AI Mult
4:0010	ASC#2 Discharge Pressure Over SP	PDIS Units	PDIS AI Mult
4:0011	ASC#2 External Decoupling Signal		1
4:0012	Performance Controller Limiter2 Loop SP	Limiter Units	Limiter AI Mult
4:0013	Load Sharing Setpoint	EU	100

Modbus Scale Factors

Modbus has two limitations:

- Only integers can be sent across
- The value is limited between -32767 and 32767

These limitations can be overcome by scaling the value before it is sent across the Modbus. The default scale factor for the analog values is one. The scale factor can be changed in the service mode between 1 and 100. Values that require a decimal point must be multiplied by the scale factor (10 or 100) prior to being sent across the Modbus. The value sent must then be divided by the scale factor in the Master.

The Scale Factor adjusts all associated analog reads and writes accordingly. For example, the Performance Process Variable Scale Factor adjusts the Performance input and set point analog read values as well as the Entered Setpt analog write value.

For example, if the Performance set point of 60.15 needs to be sent across the Modbus and have two decimal places, the Performance PV Analog Input Modbus Multiplier would be set to 100. This will change the value so that the decimal places can be sent across the Modbus communications link (60.15 * 100 = 6015). After the value is sent across the Modbus, it must be rescaled in the Master to the original value (6015/100 = 60.15). A Directly Entered Performance Set Point (4:0001) of 61.5 would be sent across the link as 6150 and the Vertex automatically divides the value by the Performance Scale Factor and uses the value of 61.5 as the set point desired.

Modbus Percentage

Some of the analog read addresses have percentages sent across. The formula used in the percentage calculation is (actual/max) * 100). The percentage is multiplied by 100 before being sent across the Modbus to provide up to 2 decimal places, if desired.

Modbus Emergency Shutdown

Two different types of shutdown commands (emergency and controlled) can be issued through Modbus. The Emergency Shutdown command instantly takes the outputs to the safe positions. Optionally the Vertex can be configured to ignore this Emergency Shutdown command if it is desired to not allow the unit to be tripped through Modbus.

To avoid an inadvertent trip, the emergency shutdown command from Modbus can be configured to require a two-step process before a shutdown command is issued. When the shutdown is a two-step process Boolean write address 0002 starts the shutdown process. An acknowledgement on address 0003 has to be given within five seconds for the control to issue a shutdown command.

For More Modbus Information

Detailed information on the Modbus protocol is presented in “Reference Guide PI-MBUS-300” published by AEC Corp./Modicon Inc., formerly Gould Inc. To implement your own source code, you must register with Modicon. Registration includes purchasing document PI-MBUS-303 and signing a non-disclosure agreement. You can register to use Modbus at your nearest Modicon field office. To find the office nearest you, contact Modicon Technical Support at 1-800-468- 5342.

Chapter 10.
Product Support and Service Options

Product Support Options

If you are experiencing problems with the installation, or unsatisfactory performance of a Woodward product, the following options are available:

- Consult the troubleshooting guide in the manual.
- Contact the manufacturer or packager of your system.
- Contact the Woodward Full Service Distributor serving your area.
- Contact Woodward technical assistance (see "How to Contact Woodward" later in this chapter) and discuss your problem. In many cases, your problem can be resolved over the phone. If not, you can select which course of action to pursue based on the available services listed in this chapter.

OEM or Packager Support: Many Woodward controls and control devices are installed into the equipment system and programmed by an Original Equipment Manufacturer (OEM) or Equipment Packager at their factory. In some cases, the programming is password-protected by the OEM or packager, and they are the best source for product service and support. Warranty service for Woodward products shipped with an equipment system should also be handled through the OEM or Packager. Please review your equipment system documentation for details.

Woodward Business Partner Support: Woodward works with and supports a global network of independent business partners whose mission is to serve the users of Woodward controls, as described here:

- A **Full Service Distributor** has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.
- An **Authorized Independent Service Facility (AISF)** provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.

A current list of Woodward Business Partners is available at:
https://www.woodward.com/en/support/industrial/service-and-spare-parts/find-a-local-partner

Product Service Options

The following factory options for servicing Woodward products are available through your local Full-Service Distributor or the OEM or Packager of the equipment system, based on the standard Woodward Product and Service Warranty (Woodward North American Terms and Conditions of Sale 5-09-0690) that is in effect at the time the product is originally shipped from Woodward or a service is performed:

- Replacement/Exchange (24-hour service)
- Flat Rate Repair
- Flat Rate Remanufacture

Replacement/Exchange: Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime. This is a flat-rate program and includes the full standard Woodward product warranty (Woodward North American Terms and Conditions of Sale 5-09-0690).

This option allows you to call your Full-Service Distributor in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Full-Service Distributor.

Charges for the Replacement/Exchange service are based on a flat rate plus shipping expenses. You are invoiced the flat rate replacement/exchange charge plus a core charge at the time the replacement unit is shipped. If the core (field unit) is returned within 60 days, a credit for the core charge will be issued.

Flat Rate Repair: Flat Rate Repair is available for the majority of standard products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be. All repair work carries the standard Woodward service warranty (Woodward North American Terms and Conditions of Sale 5-09-0690) on replaced parts and labor.

Flat Rate Remanufacture: Flat Rate Remanufacture is very similar to the Flat Rate Repair option with the exception that the unit will be returned to you in "like-new" condition and carry with it the full standard Woodward product warranty (Woodward North American Terms and Conditions of Sale 5-09-0690). This option is applicable to mechanical products only.

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned for repair, please contact your Full-Service Distributor in advance to obtain Return Authorization and shipping instructions.

When shipping the item(s), attach a tag with the following information:
- Return authorization number
- Name and location where the control is installed
- Name and phone number of contact person
- Complete Woodward part number(s) and serial number(s)
- Description of the problem
- Instructions describing the desired type of repair

Packing a Control

Use the following materials when returning a complete control:
- Protective caps on any connectors
- Antistatic protective bags on all electronic modules
- Packing materials that will not damage the surface of the unit
- At least 100 mm (4 inches) of tightly packed, industry-approved packing material
- A packing carton with double walls
- A strong tape around the outside of the carton for increased strength

NOTICE

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Replacement Parts

When ordering replacement parts for controls, include the following information:

- The part number(s) (XXXX-XXXX) that is on the enclosure nameplate
- The unit serial number, which is also on the nameplate

Engineering Services

Woodward offers various Engineering Services for our products. For these services, you can contact us by telephone, by email, or through the Woodward website.

- Technical Support
- Product Training
- Field Service

Technical Support is available from your equipment system supplier, your local Full-Service Distributor, or from many of Woodward's worldwide locations, depending upon the product and application. This service can assist you with technical questions or problem solving during the normal business hours of the Woodward location you contact. Emergency assistance is also available during non-business hours by phoning Woodward and stating the urgency of your problem.

Product Training is available as standard classes at many of our worldwide locations. We also offer customized classes, which can be tailored to your needs and can be held at one of our locations or at your site. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability.

Field Service engineering on-site support is available, depending on the product and location, from many of our worldwide locations or from one of our Full-Service Distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface.

For information on these services, please contact one of the Full-Service Distributors listed at:
https://www.woodward.com/en/support/industrial/service-and-spare-parts/find-a-local-partner

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory at https://www.woodward.com/support, which also contains the most current product support and contact information.

You can also contact the Woodward Customer Service Department at one of the following Woodward facilities to obtain the address and phone number of the nearest facility at which you can obtain information and service.

Products Used in Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 8818 5515
Germany	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
Poland	+48 (12) 295 13 00
United States	+1 (970) 482-5811

Products Used in Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 8818 5515
Germany	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
United States	+1 (970) 482-5811

Products Used in Industrial Turbomachinery Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 8818 5515
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+ 82 (51) 636-7080
Poland	+48 (12) 295 13 00
United States	+1 (970) 482-5811

Technical Assistance

If you need to contact technical assistance, you will need to provide the following information. Please write it down here before contacting the Engine OEM, the Packager, a Woodward Business Partner, or the Woodward factory:

General

Your Name

Site Location

Phone Number

Fax Number

Prime Mover Information

Manufacturer

Turbine Model Number

Type of Fuel (gas, steam, etc.)

Power Output Rating

Application (power generation, marine, etc.)

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter

Control Description or Governor Type

Serial Number

Control/Governor #2

Woodward Part Number & Rev. Letter

Control Description or Governor Type

Serial Number

Control/Governor #3

Woodward Part Number & Rev. Letter

Control Description or Governor Type

Serial Number

Symptoms

Description

If you have an electronic or programmable control, please have the adjustment setting positions or the menu settings written down and with you at the time of the call.

Appendix A.
Vertex Configuration Mode Worksheets

Control Part Number ____________________

Serial Number ____________________

Application ______________________________ Date __________

For details on individual settings, refer to Chapter 7.

Train Configuration

Train Configuration - (Train Configuration)	Default	Site Value
Compressor 1 Selection	dflt= Standard Algorithm Used [ASC1 Not Used, Standard Algorithm Used]	
Compressor 2 Selection	dflt= ASC2 Not Used [ASC2 Not Used, Standard Algorithm Used]	
Compressor Driver	dflt= Motor Driven [Not Used, Turbine Driven, Motor Driven]	
Speed Sensor Selection	dflt= NO (YES/NO)	
Use Redundant Vertex Control?	dflt= YES (YES/NO)	
Use VertexDR FTM?	Dflt=YES (YES/NO)	
Current Sensor Selection	dflt= NO (YES/NO)	

Train Configuration - (Units Defined in the Controller)	Default	Site Value
Metric – Imperial	dflt= Metric Units for All Signals	
Pressure Unit Used	dflt= kPa (Abs)	
Temperature Unit Used	dflt= Deg C	
Flow Unit for Mapping Used	dflt= Actual m^3/hr	
Polytropic Head Unit Used	dflt= N-m/kg	
Flow Element Delta P Unit Used	dflt= kPa	
Load Unit	dflt= MW	

Train Configuration - (Altitude and Standard Conditions)	Default	Site Value
Altitude Compensation, Average Atmospheric Pressure at Site	dflt (Metric)= 101.3 (70.0, 105.0) dflt (Imperial)= 14.73 (10.0, 17.0)	
Standard Conditions, Temperature	dflt (Metric)= 15.66 (0.0, 25.0) dflt (Imperial)= 60.0 (30.0, 75.0)	
Standard Conditions, Pressure	dflt (Metric)= 101.3 (70.0, 105.0) dflt (Imperial)= 14.73 (10.0, 17.0)	

Train Configuration - (Train Parameters)	Default	Site Value
External Trips in Trip Relay?	dflt= YES (YES/NO)	
Reset Clears Trip Relay	dflt= NO (YES/NO)	
Trip on Normal Shutdown Complete?	dflt= YES (YES/NO)	
Use Trip Emergency Push Button	dflt= YES (YES/NO)	

ASC Compressor Layout

Configuration parameter descriptions listed in this section apply to both ASC 1 and ASC 2.

Compressor Layout - (ASC Layout)	Default	Site Value
Layout	dflt= Stand Alone Compressor	
Flow Meter Location	dflt= Flow Meter at Suction Side	
Temperature Usage	dflt= Suction & Discharge Used	
Intercoolers	dflt= No Intercooler	
Air Case	dflt= No Air Compressor	
Tag Name	dflt= ASC1 (32 Characters)	
Description	dflt= ASC1 Surge Controller (32 Characters)	
Use Start Position Command	dflt= NO (YES/NO)	

ASC Gas Characteristics

Gas Characteristics - (ASC Gas Characteristic)	Default	Site Value
Gas Molecular Weight	dflt= 30.0 (2.0, 200.0)	
Gas Specific Heat Ratio	dflt= 1.4 (1.0, 2.5)	
Compressibility at Suction (Z1)	dflt= 1.0 (0.6, 1.2)	
Compressibility at Discharge (Z2)	dflt= 1.0 (0.6, 1.2)	
Compressibility at Standard Conditions (Zstd)	dflt= 1.0 (0.6, 1.2)	

ASC Flow Element

Flow Element - (ASC Flow Element)	Default	ASC1 Value	ASC2 Value
Flow Element	dflt= Throat		
Type of Transmitter	dflt= Raw Flow at Sensor		
Expansion Factor	dflt= Fixed Expansion Factor		
Method Used	dflt= Flow Data from Calibration Sheet		
Flow Element Delta P Unit Used	dflt= kPa		
Mass/Standard Flow Unit	dflt= Nm^3/hr		
Flow Coefficient Used	dflt= Display Only		
Status	dflt= Display Only		

Flow Element - (ASC Flow Element) - Calibration - (ASC Flow Meter Calibration)	Default	ASC1 Value	ASC2 Value
Flow	dflt= 20000.0 (0.0, 1.0e+11)		
Delta Pressure at Flow	dflt= 20.0 (0.0, 10000.0)		
Molecular Weight	dflt= 20.0 (0.0, 100.0)		
Pressure at Flow Meter	dflt= 20.0 (0.0, 1000000.0)		
Temperature at Flow Meter	dflt= 20.0 (-600.0, 10000.0)		
Compressibility at Flow (Z)	dflt= 1.0 (0.5, 1.2)		
Percentage lost	dflt= 0.0 (0.0, 15.0)		
Diameter (d)	dflt= 0.349 (0.0, 10000.0)		
Beta Ratio (d/D)	dflt= 0.349 (0.0, 100.0)		
Y-Factor	dflt= 1.0 (0.0, 100.0)		
C-Coefficient	dflt= 1.0 (0.0, 100.0)		
Manual Coefficient	dflt= 20.0 (0.0, 10000000.0)		
Intermediate Result	dflt= Display Only Calculated Flow Coefficient		
Status	dflt= Display Only		
Send Calculated Value to Control	dflt= NO		

ASC Antisurge Valve

Antisurge Valve - (ASC Antisurge Valve)	Default	ASC1 Value	ASC2 Value
Gain Compensation	dflt= Not Used		
Normal Flow Value	dflt= 0.0 (0.0, 2500000.0)		
AS Valve CV	dflt= 0.0 (0.0, 2500000.0)		
Valve min position	dflt= 10.0 (-1.0, 50.0)		
Dither	dflt= 0.0 (0.0, 3.0)		
Inhibit Full Manual	dflt= YES (YES/NO)		
Use Overstroke	dflt= NO (YES/NO)		
Overstroke Open	dflt= 10.0 (0.0, 30.0)		
Overstroke Close	dflt= -10.0 (-30.0, 0.0)		

ASC Compressor Mapping

Compressor Mapping - (ASC Map Type)	Default	ASC1 Value	ASC2 Value
Status of Actual Map	dflt= Display Only		
Type of Map Entered	dflt= [P2 = F (flow)]		
Type of Flow for Mapping	dflt= Actual Flow		
Flow Unit Used for Configuration	dflt= Display Only Configured in Train Configuration		
Pressure Unit Used for Mapping	dflt= Pressure Unit in Gauge for Mapping		
Y Axis Unit Used for Configuration	dflt= Display Only Configured in Train Configuration		
Number of points Used	dflt= 3 Point Used		
Choke Map	dflt= Choke map Not Used		
Choke Alarm Used	dflt= NO (YES/NO)		

Compressor Mapping - (ASC Units and Multipliers)	Default	ASC1 Value	ASC2 Value
Status of Actual Map	dflt= Display Only		
Actual Flow Unit	dflt= Display Only Configured in Train Configuration		
Actual Flow Multiplier	dflt= X 1		
Mass Flow Unit	dflt= Display Only Configured in Train Configuration		
Mass Flow Multiplier	dflt= X 1		
Standard Flow Unit	dflt= Display Only Configured in Train Configuration		
Standard Flow Multiplier	dflt= X 1 [X 1, X 10, X 100, E+03, E+04, E+05, E+06, E+07, E+08, MMSCFD or MMSCMD]		
Head Unit	dflt= Display Only Configured in Train Configuration		
Head Multiplier	dflt= X 1		

Compressor Mapping - (ASC Rated for Mapping)	Default	ASC1 Value	ASC2 Value
Status of Actual Map	dflt= Display Only		
Suction Temperature	dflt= 0.0 (-500.0, 1000.0)		
Suction Pressure	dflt= 103.0 (-500000.0, 1000000.0)		
Discharge Temp (estimated)	dflt= Display Only Calculated based on Rated Mapping Parameters		
Discharge Pressure	dflt= 103.0 (-500000.0, 1000000.0)		
Actual Flow at Rated	dflt= 10000.0 (0.1, 1000000.0)		
Rated Speed	dflt= 103.0 (-500000.0, 1000000.0)		
Percent Speed at Rated	dflt= 103.0 (0.0, 120.0)		
Polytropic Efficiency	dflt= 83.0 (10.0, 100.0)		

Compressor Mapping - (ASC Estimated Conditions)	Default	ASC1 Value	ASC2 Value
Status of Actual Map	dflt= Display Only		
Mass Flow at Rated	dflt= Display Only Calculated based on Rated Mapping Parameters		
Standard Flow at Rated	dflt= Display Only Calculated based on Rated Mapping Parameters		
Polytropic Head at Rated	dflt= Display Only Calculated based on Rated Mapping Parameters		

Power at Rated	dflt= Display Only Calculated based on Rated Mapping Parameters		
Confirm Rated Conditions	dflt= NO		

Compressor Mapping - (ASC Surge Map Configuration)	Default	ASC1 Value	ASC2 Value
Status of Actual Map	dflt= Display Only		
X1 Value	dflt= 1.01 (0.0, 1000000.0)		
Y1 Value	dflt= 1.11 (-1000000.0, 1000000.0)		
X2 Value	dflt= 1.02 (0.0, 1000000.0)		
Y2 Value	dflt= 1.12 (-1000000.0, 1000000.0)		
X3 Value	dflt= 1.03 (0.0, 1000000.0)		
Y3 Value	dflt= 1.13 (-1000000.0, 1000000.0)		
X4 Value	dflt= 1.04 (0.0, 1000000.0)		
Y4 Value	dflt= 1.14 (-1000000.0, 1000000.0)		
X5 Value	dflt= 1.05 (0.0, 1000000.0)		
Y5 Value	dflt= 1.15 (-1000000.0, 1000000.0)		
X6 Value	dflt= 1.06 (0.0, 1000000.0)		
Y6 Value	dflt= 1.16 (-1000000.0, 1000000.0)		
X7 Value	dflt= 1.07 (0.0, 1000000.0)		
Y7 Value	dflt= 1.17 (-1000000.0, 1000000.0)		
X8 Value	dflt= 1.08 (0.0, 1000000.0)		
Y8 Value	dflt= 1.18 (-1000000.0, 1000000.0)		
X9 Value	dflt= 1.09 (0.0, 1000000.0)		
Y9 Value	dflt= 1.19 (-1000000.0, 1000000.0)		
X10 Value	dflt= 1.1 (0.0, 1000000.0)		
Y10 Value	dflt= 1.2 (-1000000.0, 1000000.0)		
Speed 1	dflt= 70.0 (0.0, 150.0)		
Speed 2	dflt= 70.0 (0.0, 150.0)		
Speed 3	dflt= 70.0 (0.0, 150.0)		
Speed 4	dflt= 70.0 (0.0, 150.0)		
Speed 5	dflt= 70.0 (0.0, 150.0)		
Speed 6	dflt= 70.0 (0.0, 150.0)		
Speed 7	dflt= 70.0 (0.0, 150.0)		
Speed 8	dflt= 70.0 (0.0, 150.0)		
Speed 9	dflt= 70.0 (0.0, 150.0)		
Speed 10	dflt= 70.0 (0.0, 150.0)		
Forced OFF	dflt= Display Only Status		
Error	dflt= Display Only Status		
Active	dflt= Display Only Status		
Save Point	dflt= NO		
Save All	dflt= NO		

Compressor Mapping - (ASC Choke Map Configuration)	Default	ASC1 Value	ASC2 Value
Status of Actual Map	dflt= Display Only		
X1 Value	dflt= 1.0 (0.0, 1000000.0)		
Y1 Value	dflt= 1.1 (-1000000.0, 1000000.0)		

X2 Value	dflt= 1.0 (0.0, 1000000.0)		
Y2 Value	dflt= 2.0 (-1000000.0, 1000000.0)		
X3 Value	dflt= 1.0 (0.0, 1000000.0)		
Y3 Value	dflt= 3.0 (-1000000.0, 1000000.0)		
X4 Value	dflt= 1.0 (0.0, 1000000.0)		
Y4 Value	dflt= 4.0 (-1000000.0, 1000000.0)		
X5 Value	dflt= 1.0 (0.0, 1000000.0)		
Y5 Value	dflt= 5.0 (-1000000.0, 1000000.0)		
X6 Value	dflt= 1.0 (0.0, 1000000.0)		
Y6 Value	dflt= 6.0 (-1000000.0, 1000000.0)		
Speed 1	dflt= 70.0 (0.0, 150.0)		
Speed 2	dflt= 80.0 (0.0, 150.0)		
Speed 3	dflt= 85.0 (0.0, 150.0)		
Speed 4	dflt= 90.0 (0.0, 150.0)		
Speed 5	dflt= 100.0 (0.0, 150.0)		
Speed 6	dflt= 105.0 (0.0, 150.0)		
Forced OFF	dflt= Display Only Status		
Error	dflt= Display Only Status		
Save Point	dflt= NO		
Save All	dflt= NO		

Compressor Mapping - (ASC Map Display Configuration)	**Default**	**ASC1 Value**	**ASC2 Value**
Type of Map to be Displayed	dflt= [P2 = F (flow)]		
Type of Flow to be Displayed	dflt= Actual Flow (Qa)		
Y maximum to display	dflt= 100.0 (0.0, 50000000000.0)		
Y minimum to display	dflt= 100.0 (0.0, 50000000000.0)		
Y Display Multiplier	dflt= Display Only Configured in Compressor Mapping		
Y Modbus Multiplier	dflt= X 1		
X maximum to display	dflt= 100.0 (0.0, 50000000000.0)		
X minimum to display	dflt= 100.0 (0.0, 50000000000.0)		
X Display Multiplier	dflt= Display Only Configured in Compressor Mapping		
X Modbus Multiplier	dflt= X 1		
AutoScale (On/Off)	dflt= ON (ON/OFF)		

ASC Antisurge Control

Antisurge Control - Sequencing - (ASC Sequencing Start and Shutdown)	**Default**	**ASC1 Value**	**ASC2 Value**
Shutdown Manual Position Enabled	dflt= YES (YES/NO)		
Position just After Shutdown	dflt= 100.0 (0.0, 100.0)		
Zero Speed Level	dflt= 10.0 (0.0, 10000.0)		
Zero Current Level	dflt= 1.0 (-1.0, 10000.0)		
Position if Zero Speed/Curr and SD Delay Passed	dflt= 100.0 (0.0, 100.0)		

Position During Startup	dflt= 100.0 (0.0, 100.0)		

Antisurge Control - Sequencing - (ASC Sequencing Online Detection)	Default	ASC1 Value	ASC2 Value
Use Minimum Speed Level	dflt (Trigger)= NO (YES/NO) dflt (Level)= 0.0 (0.0, 25000.0)		
Use Maximum Suction Pressure Level	dflt (Trigger)= NO (YES/NO) dflt (Level)= 0.0 (-14.0, 25000.0)		
Use Minimum Discharge Pressure Level	dflt (Trigger)= NO (YES/NO) dflt (Level)= 0.0 (0.0, 25000.0)		
Use Minimum Flow Level	dflt (Trigger)= NO (YES/NO) dflt (Level)= 0.0 (0.0, 1000000.0)		
Use Minimum Current Level	dflt (Trigger)= NO (YES/NO) dflt (Level)= 0.0 (0.0, 25000.0)		
Use Minimum Pressure Ratio	dflt (Trigger)= NO (YES/NO) dflt (Level)= 1.0 (1.0, 100.0)		
Use Minimum IGV Level	dflt (Trigger)= NO (YES/NO) dflt (Level)= 10.0 (0.0, 100.0)		
Use External Contact	dflt (Trigger)= NO (YES/NO)		
Delay Timer for Online Detection	dflt (Level)= 10.0 (0.0, 300.0)		

Antisurge Control - Sequencing - (ASC Sequencing Valve Rates)	Default	ASC1 Value	ASC2 Value
Automatic Close Rate	dflt (Level)= 1.0 (0.0, 10.0)		
Offline/Start Rate	dflt (Level)= 1.0 (0.1, 100.0)		
NSD Rate	dflt (Level)= 1.0 (0.1, 100.0)		
Manual Raise/Lower Slow Rate	dflt (Level)= 0.5 (0.0, 100.0)		
Delay for Fast Rate	dflt (Level)= 3.0 (0.0, 30.0)		
Manual Raise/Lower Fast Rate	dflt (Level)= 1.0 (0.0, 100.0)		
Allow use of Remote ASV Valve Dmd	dflt (Trigger)= NO (YES/NO		

Antisurge Control - Sequencing - (ASC Sequencing NSD/Purge)	Default	ASC1 Value	ASC2 Value
Normal SD State	dflt= NSD on Train NSD Request [NSD on Train NSD Request, NSD with Compressor 2 Offline, Not Used]		
Purge Command	dflt= Purge Never Used [Purge Never Used, Purge Disabled at Start, Purge Disabled at Online, Purge Disabled on Speed Level, Purge Disabled on Motor Current Level, Purge on Request Only]		
Purge Position	dflt= 0.0 (0.0, 100.0)		
Actual Speed Trigger Off Level	dflt= 200.0 (10.0, 25000.0)		
Actual Motor Trigger Off Level	dflt= 200.0 (10.0, 25000.0)		

Antisurge Control - Surge Detection - (ASC Surge Detection Method Used)	Default	ASC1 Value	ASC2 Value
Flow Derivative Detection	dflt (Use)= NO (YES/NO) dflt (Trigger Setpoint)= 80.0 (1.0, 300.0) dflt (Captured Values)= Display Only		
Minimum Flow Detection	dflt (Use)= NO (YES/NO) dflt (Trigger Setpoint)= 1.0 (0.01, 100000000.0)		
Disch. P. Derivative Detection	dflt (Use)= NO (YES/NO) dflt (Trigger Setpoint)= -100.0 (-1000000.0, 0.0) dflt (Captured Values)= Display Only		
Suction P. Derivative Detection	dflt (Use)= NO (YES/NO) dflt (Trigger Setpoint)= 1.0 (0.0, 100000.0) dflt (Captured Values)= Display Only		
Speed Derivative Detection	dflt (Use)= NO (YES/NO) dflt (Trigger Setpoint)= 1.0 (1.0, 30000.0) dflt (Captured Values)= Display Only		
Motor Curr. Derivative Detection	dflt (Use)= NO (YES/NO) dflt (Trigger Setpoint)= -1.0 (-30000.0, 0.0) dflt (Captured Values)= Display Only		
Surge Detection on Cross Line	dflt (Use)= YES (YES/NO)		
Operating SP Limit To Detect Surge	dflt (Trigger Setpoint)= 150.0 (104.0, 200.0) dflt (Captured Values)= Display Only		

Antisurge Control - Surge Detection - (ASC Actions Taken when Surge Detected)	Default	ASC1 Value	ASC2 Value
Loop Period	dflt= 10.0 (1.0, 300.0		
Use External Surge Detection Contact	dflt (Use)= NO (YES/NO)		
Enable Surge Recovery?	dflt= YES (YES/NO) dflt (Amount)= 1.0 (0.5, 50.0)		
Enable Surge Recovery in Full Manual	dflt= YES (YES/NO) dflt (Minimum Amount)= 1.0 (1.0, 100.0)		
Enable Surge Minimum Position?	dflt= YES (YES/NO) dflt (Amount)= 1.0 (0.5, 50.0)		
SMP Reset	dflt= Dedicated Reset Used to clear SMP [Dedicated Reset Used to clear SMP, Normal Reset Used to clear SMP]		
Use Auto Shift Function	dflt= YES (YES/NO) dflt (Amount)= 1.0 (1.0, 10.0)		

Control Line Shift Reset	dflt= Consec SRG RST used for Shift Reset [Consec SRG RST used for Shift Reset, SMP RST used for Shift Reset, Total SRG RST used for Shift Reset, Dedicated RST used for Shift Reset]		

Antisurge Control - Surge Protection - (ASC Surge Control and Boost Line)	**Default**	**ASC1 Value**	**ASC2 Value**
Surge Control Line Margin	dflt= 30.0 (-30.0, 50.0)		
Surge Control Line Margin Minimum	dflt= 15.0 (-30.0, 50.0)		
Enable Boost	dflt= YES (YES/NO)		
Boost Margin	dflt= 5.0 (0.0, 50.0)		
Amount	dflt= 10.0 (0.0, 50.0)		
Enable Pre-pack	dflt= NO (YES/NO)		
Pre-pack Amount	dflt= 0.0 (0.0, 50.0)		

Antisurge Control - Surge Protection - (ASC Consecutive Surges Alarm Counter)	**Default**	**ASC1 Value**	**ASC2 Value**
Maximum Number of Surges (Consecutive Surges Alarm Counter)	dflt= 3 (1, 5)		
Time for Maximum Number of Surges (Consecutive Surges Alarm Counter)	dflt= 20 (0, 3600)		
Alarm if Consecutive Surges	dflt= YES (YES/NO)		
Full Opening if Consecutive Surges Alarm Detected	dflt= YES (YES/NO)		
Maximum Number of Surges (Consecutive Surges Shutdown Counter)	dflt= 3 (1, 5)		
Time for Maximum Number of Surges (Consecutive Surges Shutdown Counter)	dflt= 20 (0, 3600)		
Trip if Consecutive Surges SD Detected	dflt= NO (YES/NO)		

Antisurge Control - Surge Protection - (ASC AS Valve Feedback Action)	**Default**	**ASC1 Value**	**ASC2 Value**
Action Based on AS Valve Feedbacks or Trip Solenoids Status	dflt= No Action on Valve Feedback/Solenoids [No Action on Valve Feedback/Solenoids, FRC Open if Dev Dmd/AS Opened Contact, FRC Open: AS Contact is Trip Sol, FRC Open if Dev Dmd/AS Analog Feedback]		
AS Opened Contact Inverted	dflt= NO (YES/NO)		
Full Manual Mode Request Inhibited	dflt= YES (YES/NO)		

Antisurge Control - Signal Conditioning - (ASC Last Good Values)	Default	ASC1 Value	ASC2 Value
Use Suction Pressure Last Good Value	dflt= NO (YES/NO)		
Use Discharge Pressure Last Good Value	dflt= NO (YES/NO)		
Use Suction Temperature Last Good Value	dflt= NO (YES/NO)		
Use Discharge Temperature Last Good Value	dflt= NO (YES/NO)		
Use Actual Flow Last Good Value	dflt= NO (YES/NO)		
Use Pressure Ratio Last Good Value	dflt= NO (YES/NO)		

Antisurge Control - Signal Conditioning - (ASC Smart Calculation Settings)	Default	ASC1 Value	ASC2 Value
Use Smart Suction Temperature	dflt= NO (YES/NO)		
Use Smart Discharge Temperature	dflt= NO (YES/NO)		

Antisurge Control - Signal Conditioning - (ASC Default Value Settings)	Default	ASC1 Value	ASC2 Value
Default Pressure At Suction	dflt= 1.0 (-10000.0, 10000.0)		
Default Temperature At Suction	dflt= 1.0 (-273.0, 3000.0)		
Default Pressure At Discharge	dflt= 1.0 (-10000.0, 10000.0)		
Default Temperature At Discharge	dflt= 1.0 (-273.0, 3000.0)		
Default Pressure At Flow Element	dflt= 1.0 (-10000.0, 10000.0)		
Default Temperature At Flow Element	dflt= 1.0 (-273.0, 3000.0)		
Default Actual Flow	dflt= 1.0 (0.0, 300000000000.0)		
Default Pressure Ratio	dflt= 1.5 (1.0, 50.0)		
Use Pressure Ratio as Ref. when P1 Fail	dflt= NO (YES/NO)		
Use Pressure Ratio as Ref. when P2 Fail	dflt= NO (YES/NO)		

Antisurge Control - Signal Conditioning - (ASC Field Signal Filtering)	Default	ASC1 Value	ASC2 Value
Flow Filter (ARMA)	dflt= 0.0 (0.0, 30.0)		
Pressure Filter	dflt= 0.0 (0.0, 30.0)		
Temperature Filter	dflt= 0.0 (0.0, 30.0)		

Antisurge Control - Signal Conditioning - (ASC Field Signal Fault Action on Control)	Default	ASC1 Value	ASC2 Value
Added Man Amount on Flow Fail	dflt= 10.0 (0.0, 100.0)		
Full Manual on Flow sensor Fault	dflt= NO (YES/NO)		
Full Manual Mode Selected on Any Fault	dflt= NO (YES/NO)		
Min. AS Valve Demand if Flow or Press @ Flow Fail	dflt= NO (YES/NO)		
Min. AS Valve Demand on Fault	dflt= 10.0 (0.0, 100.0)		
Flow Fail Position Delay	dflt= 2.0 (0.0, 10.0)		

Antisurge Control - PIDs - (ASC Normal Surge Controller Settings)	Default	ASC1 Value	ASC2 Value
Use Compensation on Normal PID	dflt= NO (YES/NO)		
Proportional Gain	dflt= 0.3 (0.0, 50.0)		
Integral Gain	dflt= 0.3 (0.0, 50.0)		
Speed Derivative Ratio	dflt= 100.0 (0.0, 100.0)		

Antisurge Control - PIDs - (ASC Rate PID Controller Settings)	Default	ASC1 Value	ASC2 Value
Use Rate Controller	dflt= NO (YES/NO)		
Use Compensation on Normal Rate PID	dflt= NO (YES/NO)		
Proportional Gain	dflt= 0.3 (0.0, 50.0)		
Integral Gain	dflt= 0.3 (0.0, 50.0)		
Speed Derivative Ratio	dflt= 100.0 (0.0, 100.0)		
Rate Setpoint (% of Max Rate)	dflt= 33.0 (1.0, 100.0)		

Antisurge Control - PIDs - (ASC Valve Freeze Option)	Default	ASC1 Value	ASC2 Value
Use Valve Freeze Option	dflt= NO (YES/NO)		
Delay Before Freezing the Valve	dflt= 30.0 (0.0, 300.0)		
Window on Valve Demand	dflt= 3.0 (0.1, 10.0)		
Window on Surge Operation Point	dflt= 3.0 (0.0, 10.0)		

Antisurge Control - PIDs - (ASC Suction Pressure Override Controller)	Default	ASC1 Value	ASC2 Value
Tag Name	dflt= PICXXX (32 Characters)		
Description	dflt= Suction pressure override (32 Characters)		
Controller Function Selection	dflt= Not Used [Not Used, Used With Actual P1]		
Use Pressure Compensation	dflt= NO (YES/NO)		
Proportional Gain	dflt= 0.3 (0.0, 50.0)		
Integral Gain	dflt= 0.3 (0.0, 50.0)		
Speed Derivative Ratio	dflt= 100.0 (0.0, 100.0)		
Initial Setpoint	dflt= () see AI_03		
SP Rate of Change	dflt= 0.1 (0.001, 10000.0)		

Antisurge Control - PIDs - (ASC Discharge Pressure Override Controller)	Default	ASC1 Value	ASC2 Value
Tag Name	dflt= PICXXX (32 Characters)		
Description	dflt= Discharge pressure override (32 Characters)		
Controller Function Selection	dflt= Not Used [Not Used, Used With Actual P2]		
Use Pressure Compensation	dflt= NO (YES/NO)		
Proportional Gain	dflt= 0.3 (0.0, 50.0)		

Integral Gain	dflt= 0.3 (0.0, 50.0)		
Speed Derivative Ratio	dflt= 100.0 (0.0, 100.0)		
Initial Setpoint	dflt= ()		
SP Rate of Change	dflt= 0.1 (0.001, 10000.0)		

Antisurge Control - Decoupling - (ASC Decoupling - Main Settings)	**Default**	**ASC1 Value**	**ASC2 Value**
Decoupling may be necessary to provide action before an upset occurs. Upsets are anticipated from knowledge of the operating parameters and their relation to the operation of the anti-surge valve.			
Decoupling Selection	dflt= No compressor decoupling used [No compressor decoupling used, Compressor Decoupling used]		
Min Decoupling Level	dflt= 0.0 (0.0, 1.0)		
Max Decoupling Level	dflt= 0.0 (0.0, 20.0)		
Surge Process Value Range (to Act)	dflt= 110.0 (100.0, 140.0)		
Rate Limit on Enable/Disable Decoupling	dflt= YES (YES/NO)		

Antisurge Control - Decoupling - (ASC Decoupling on Speed)	**Default**	**ASC1 Value**	**ASC2 Value**
Slow Speed Delay Time	dflt= 110.0 (0.0, 500.0)		
Slow Speed Amount	dflt= 0.0 (0.0, 300.0)		
Fast Speed Delay Time	dflt= 30.0 (0.0, 5000.0)		
Fast Speed Amount	dflt= 0.0 (0.0, 200.0)		

Antisurge Control - Decoupling - (ASC Decoupling Selection)	**Default**	**ASC1 Value**	**ASC2 Value**
Decoupling Selection 1	dflt= Decoupling 1 Not Used [Decoupling 1 Not Used, Decoupling 1 on ASC2 Demand, Decoupling 1 on Performance Demand, Decoupling 1 on External Signal 1]		
Selection 1 Delay Time	dflt= 0.0 (0.0, 500.0)		
Selection 1 Amount	dflt= 0.0 (-100.0, 300.0)		
Decoupling Selection 2	dflt= Decoupling 2 Not Used [Decoupling 2 Not Used, Decoupling 2 on ASC2 Demand, Decoupling 2 on Performance Demand, Decoupling 2 on External Signal 1]		
Selection 2 Delay Time	dflt= 110.0 (1.0, 140.0)		
Selection 2 Amount	dflt= 0.0 (-100.0, 300.0)		
Decoupling Selection 3	dflt= Decoupling 3 Not Used [Decoupling 3 Not Used, Decoupling 3 on ASC2 Demand, Decoupling 3 on Performance Demand, Decoupling 3 on External Signal 1]		
Selection 3 Delay Time	dflt= 110.0 (1.0, 140.0)		
Selection 3 Amount	dflt= 0.0 (-100.0, 300.0)		

Antisurge Control - Decoupling - (ASC Auxiliary Controls)	Default	ASC1 Value	ASC2 Value
Use Auxiliary HSS1	dflt= NO (YES/NO)		
Signal Filter (HSS1)	dflt= 0.5 (0.0, 300.0)		
Use Auxiliary HSS2	dflt= NO (YES/NO)		
Signal Filter (HSS2)	dflt= 0.5 (0.0, 300.0)		
Signal Value	dflt= -1.0 (-1.0, 101.0)		

Antisurge Control - Display Settings - (ASC Display Settings)	Default	ASC1 Value	ASC2 Value
WSPV Gauge Max	dflt= 200.0 (0.0, 300.0)		
WSPV Gauge Min	dflt= 50.0 (0.0, 90.0)		
Overview Flow Indication	dflt= Actual Flow Display		

Performance Control

Performance Control - (Performance Configuration)	**Default**	**Site Value**
Performance Configuration	dflt= Not Used [Not Used, ASC 1 Suction Pressure, ASC 1 Discharge Pressure, ASC 2 Suction Pressure, ASC 2 Discharge Pressure, Dedicated Signal]	
Minimum Setpoint	dflt= 0.0 (-10000.0, 100000.0)	
Maximum Setpoint	dflt= 100.0 (-100000.0, 100000.0)	
Inverted?	dflt= NO (YES/NO)	
Setpoint Rate	dflt= 1.0 (0.0, 100000.0)	
Use Setpoint Tracking?	dflt= YES (YES/NO)	
Initial Setpoint	dflt= 0.0 (-100000.0, 100000.0)	

Performance Control - (Performance Configuration)	**Default**	**Site Value**
Use Remote Setpoint?	dflt= NO (YES/NO)	
Remote Setpoint Rate	dflt= 5.0 (0.1, 100000.0)	
Use Driver Limit Tracking?	dflt= NO (YES/NO)	
Minimum Governor Speed	dflt= 100.0 (0.0, 100000.0)	
Maximum Governor Speed	dflt= 200.0 (0.0, 100000.0)	
Use Remote Manual Demand?	dflt= NO (YES/NO)	
Performance Drive Type	dflt= Suction Throttle Valve	

Performance Control - (Performance Sequencing)	**Default**	**Site Value**
Reset Position	dflt= 0.0 (0.0, 100.0)	
Startup Position	dflt= 0.0 (0.0, 101.0)	
Startup Delay	dflt= 0.0 (0.0, 600.0)	
Sequence Ramp Rate	dflt= 1.0 (0.099, 25.0)	
Use Remote Start?	dflt= NO (YES/NO)	
Use Manual Start?	dflt= NO (YES/NO)	

Performance Control - (Performance Configuration - Decoupling)	Default	Site Value
Decoupling Signal Selection	dflt= Not Used [Not Used, External AI Signal, ASV1 Demand, ASV2 Demand, HSS of ASV1 and ASV2]	
Gain	dflt= 0.0 (-10.0, 10.0)	
Lag	dflt= 0.0 (0.0, 10.0)	
On Rate	dflt= 1.0 (0.0, 20.0)	
Off Rate	dflt= 1.0 (0.0, 20.0)	
Range	dflt= 0.0 (0.0, 20.0)	

Limiter Control

Limiter Control - (Performance Limiter 1)	Default	Site Value
Limiter Configuration	dflt= Not Used [Not Used, Motor Current/Power Input, ASC 1 Suction Pressure, ASC 1 Discharge Pressure, ASC 2 Suction Pressure, ASC 2 Discharge Pressure, Limiter Analog Input]	
Minimum Setpoint	dflt= 0.0 (-1.0e+38, 1.0e+38)	
Maximum Setpoint	dflt= 100.0 (-1.0e+38, 1.0e+38)	
Initial Setpoint	dflt= 0.0 (0.0, 1.0e+20)	
Inverted?	dflt= NO (YES/NO)	
Setpoint Rate	dflt= 5.0 (0.01, 1000.0)	
Use Remote Setpoint?	dflt= NO (YES/NO)	
Remote Setpoint Rate	dflt= 5.0 (0.01, 1000.0)	

Limiter Control - (Performance Limiter 2)	Default	Site Value
Limiter Configuration	dflt= Not Used [Not Used, Motor Current/Power Input, ASC 1 Suction Pressure, ASC 1 Discharge Pressure, ASC 2 Suction Pressure, ASC 2 Discharge Pressure]	
Minimum Setpoint	dflt= 0.0 (-1.0e+38, 1.0e+38)	
Maximum Setpoint	dflt= 100.0 (-1.0e+38, 1.0e+38)	
Initial Setpoint	dflt= 0.0 (0.0, 1.0e+20)	
Inverted?	dflt= NO (YES/NO)	
Setpoint Rate	dflt= 5.0 (0.01, 1000.0)	

Load Sharing

Load Sharing - (Load Sharing)	Default	Site Value
Use Load Sharing?	dflt= NO (YES/NO)	
Number of Trains in Load Sharing	dflt= 2 (2,5)	
Train ID	dflt= 1 (1,5)	
Load Sharing Parameter	dflt= WSPV [WSPV, Speed, Flow Through Stage]	
Inverted Control?	dflt= NO (YES/NO)	
Inverted Bias?	dflt= NO (YES/NO)	
Load Sharing Parameter Location	dflt= Suction Header [Suction Header, Discharge Header]	
Minimum Setpoint	dflt= 0.0 (-1.0e+38, 1.0e+38)	
Maximum Setpoint	dflt= 100.0 (-1.0e+38, 1.0e+38)	
Initial Setpoint	dflt= 0.0 (-100000.0, 100000.0)	
Units	dflt= EU (8 Characters)	

Communications - (Modbus)	Default	Site Value
Use Modbus	dflt= NO (YES/NO)	
Use Link 1 (Serial Port)?	dflt= NO (YES/NO)	
Use Link 2 (ENET1)?	dflt= NO (YES/NO)	
Use Link 3 (ENET2)?	dflt= NO (YES/NO)	
Use Modbus Trip	dflt= YES (YES/NO)	

Modbus – Link 1 - Serial	Default	Site Value
DEVICE ADDRESS	dflt= 1 (1, 247)	
ENABLE WRITE COMMANDS	dflt= NO (Yes/No)	
PROTOCOL	dflt= ASCII (ASCII, RTU)	
BAUD RATE	dflt= 115,200	
BITS	dflt= 7 (7, 8)	
STOP BITS	dflt= 1 (1, 2, 1.5)	
PARITY	dflt= NONE (NONE, ODD, EVEN)	
DRIVER	dflt= RS-232 (RS-232, RS-422, RS-485)	

Modbus Ethernet Link 2	Default	Site Value
ETHERNET PROTOCOL	dflt= TCP (TCP, UDP port 5001)	
DEVICE ADDRESS	dflt= 2 (1, 247)	
ENABLE WRITE COMMANDS	dflt= NO (Yes/No)	

Modbus Ethernet Link 3	Default	Site Value
ETHERNET PROTOCOL	dflt= TCP (TCP, UDP port 5001)	
DEVICE ADDRESS	dflt= 2 (1, 247)	
ENABLE WRITE COMMANDS	dflt= NO (Yes/No)	

Communications

Communications - (Ethernet IP Configuration)	Default	Site Value
ENET 1 Address	dflt (Octet 1)= 172 (0, 255) dflt (Octet 2)= 16 (0, 255) dflt (Octet 3)= 100 (0, 255) dflt (Octet 4)= 15 (0, 255)	
ENET 1 Subnet Mask	dflt (Octet 1)= 255 (0, 255) dflt (Octet 2)= 255 (0, 255) dflt (Octet 3)= 0 (0, 255) dflt (Octet 4)= 0 (0, 255)	
ENET 2 Address	dflt (Octet 1)= 192 (0, 255) dflt (Octet 2)= 168 (0, 255) dflt (Octet 3)= 128 (0, 255) dflt (Octet 4)= 20 (0, 255)	
ENET 2 Subnet Mask	dflt (Octet 1)= 255 (0, 255) dflt (Octet 2)= 255 (0, 255) dflt (Octet 3)= 0 (0, 255) dflt (Octet 4)= 0 (0, 255)	
ENET 3 Address	dflt (Octet 1)= 192 (0, 255) dflt (Octet 2)= 168 (0, 255) dflt (Octet 3)= 129 (0, 255) dflt (Octet 4)= 20 (0, 255)	
ENET 3 Subnet Mask	dflt (Octet 1)= 255 (0, 255) dflt (Octet 2)= 255 (0, 255) dflt (Octet 3)= 255 (0, 255) dflt (Octet 4)= 0 (0, 255)	

Isolated Control Menu		Site Value
USE ISOLATED PID	dflt= NO (Yes/No)	
USE REMOTE SETPOINT	dflt= NO (Yes/No)	
OUTPUT VALVE DEMAND ACTION ON INPUT FAULT	dflt= HOLD DEMAND	
INVERT CONTROLLER?	dflt= NO (Yes/No)	
ALLOW MANUAL CONTROL?	dflt= NO (Yes/No)	
MAXIMUM SETPOINT	dflt= 100.0 (-100000.0, 100000.0)	
MINIMUM SETPOINT	dflt= 0 (-100000.0, 100000.0)	
INITIAL SETPOINT	dflt= 100.0 (-100000.0, 100000.0)	

CORE H/W I/O – Channel Configuration Tables

Speed Channels – These inputs are configured in Configuration Menu – Speed Control section

Analog Input Channels -

Ch	Function	Val@4	Val@20	Loop Pwrd	TAG	Units	Modbus Mult.	Dec Disp
1								
2								
3								
4								
5								
6								

7								
8								

Discrete Input Channels -

Ch	Function	Invert Logic	TAG
1	Emergency Stop	Yes	
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Analog Output Channels -

Ch	Function	Val@4	Val@20	Ena Rdbk Flt	TAG	Units
1						
2						
3						
4						
5						
6						

Actuator Output Channels -

Ch	Function	Range	mA@0	mA@100	Dither	Act Flt = SD	Inv	TAG
1								
2								

Discrete Output Relays

Ch	Level or State	Function	Invert Logic	Level ON	Level OFF	TAG
1						
2						
3						
4						
5						
6						
7						
8						

RTCNet I/O Modes – Channel Configuration Tables (OPTIONAL)

Node 1 – 8 Channels Analog Input 4-20mA & 2 channels Analog Output 4-20mA

Ch	Function	Val@4	Val@20	Units	Modbus Mult.	Dec Disp	TAG
1							
2							
3							
4							
5							
6							
7							
8							
1							
2							

Node 2 – 8 Channels Analog Input 4-20mA & 2 channels Analog Output 4-20mA

Ch	Function	Val@4	Val@20	Units	Modbus Mult.	Dec Disp	TAG
1							
2							
3							
4							
5							
6							
7							
8							
1							
2							

Node 3 – 8 Channels RTD Input (100 or 200 ohm)

	Function	Min Val	Max Val	Deg F/C	Mod Mult	Dec Disp	Crv E/A	ohm val	TAG
1									
2									
3									
4									
5									
6									
7									
8									

For each of the Analog Input Node channels above, events can be configured if desired.

NODE 1 Events

Ch	Use Alm1	Use Alm2	Use Trip	Level 1 SP	Inv	Level 2 SP	Inv	Setpoint Hysteresis	Delay	Ena Spd	Spd Hys
1											
2											
3											
4											
5											
6											
7											
8											

NODE 2 Events

Ch	Use Alm1	Use Alm2	Use Trip	Level 1 SP	Inv	Level 2 SP	Inv	Setpoint Hysteresis	Delay	Ena Spd	Spd Hys
1											
2											
3											
4											
5											
6											
7											
8											

NODE 3 Events

Ch	Use Alm1	Use Alm2	Use Trip	Level 1 SP	Inv	Level 2 SP	Inv	Setpoint Hysteresis	Delay	Ena Spd	Spd Hys
1											
2											
3											
4											
5											
6											
7											
8											

Node 4 – 16 Channel Discrete Input (24Vdc)

Ch	Function	Invert Logic	TAG
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			

Node 5 – 16 Channel Discrete Output (24Vdc)

Ch	Level or State	Function	Invert Logic	Level ON	Level OFF	TAG
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						

When Actuator Outputs have been (In Service) Calibrated and Stroked, record values here.

	Default	Vertex Unit #1	Value in Vertex
Actuator # 1 mA at Minimum Position	*4.00		
Actuator # 1 mA at Maximum Position	*20.00		
Actuator # 1 Dither (%)	*0.00		
Actuator # 2 mA at Minimum Position	*4.00		
Actuator # 2 mA at Maximum Position	*20.00		
Actuator # 2 Dither (%)	*0.00		

Revision History

Revision D
- Revised content in Chapter 7 tables: ASC Compressor Layout and ASC Compressor Mapping

Revision C
- Added content about quench to Chapter 1
- Added new Figures 1-7 and 1-12
- Added additional content to Analog 4-20 mA Input Signals
- Added new entries to Tables 1-3, 1-4, 1-5, and 1-6
- Added new content to Compressor Choke (Stonewall) in Chapter 6
- Added content on quench control to Chapter 6
- New Figures 6-53 and 6-54
- Revised various sections in Table 7-3
- Added Antisurge Control- Quench Control to Table 7-3
- Added Maintenance Override content to Chapter 8
- Revised Tables 9-6 and 9-7

Revision B
- Revised Table 1-1 and 1-2
- Revised Table 3-1 Vibration section

Revision A
- Added VertexDR information to the Introduction section of Chapter 1
- Added VertexDR information to Tables 1-1 and 1-2
- Added Redundant or Simplex Operation section to Chapter 1
- Added VertexDR to the Additional Features section of Chapter 1
- Added VertexDR to Tables 1-3, 1-4, and 1-5
- Added content to the Watchdog Timer/CPU Fault Control section of Chapter 1
- Added content in the Modbus section of Chapter 1
- Added NOTICE box after Figure 3-3
- Revised content to the Communications (Ethernet) and Network Configuration sections in Chapter 3
- Changed figure callout in second paragraph of Standard Operating Point in Chapter 6
- Replaced Figure 6-44
- Revised content below new figure and renumbered figures in Chapter 6
- Added Isolated PID Control section to the end of Chapter 6
- Changed description in Pressure Unit Used for Mapping in ASC Compressor Mapping table on pg. 135
- Replaced Figure 7-2
- Revised the following sections in Table 7-3:
    - Use Redundant Vertex Control?
    - Use VertexDR FTM?
    - Inhibit Backup on Fault?
    - RTCNet - (CAN Network - RTCNet I/O Nodes)
    - Communications - (Ethernet IP Configuration)
    - Modbus Ethernet Link 2
    - Isolated Control Menu
- Added lines 150, 151, and 152 to Table 7-4
- Replaced Figures 8-1 and 8-3
- Added paragraph below Figure 8-3
- Added rows to bottom of Table 8-1
- Replaced antisurge control with performance control in second paragraph beneath Fig. 8-16
- Added the following new alarms to Table 8-1:
    - Speed 1 and Speed 2 Deviation
    - ASC#1: Suction Pressure PV #2Failed

- Discharge Pressure PV #2 Failed
- Performance PV Input #2 Failed
- ASC#2: Suction Pressure PV #2 Failed
- ASC#2: Discharge Pressure PV #2 Failed
- Load Share PV Failed
- Isolated Controller PV Failed
- Iso Cntrl Rem Setpoint Failed
- Iso Cntrl Rem Setpoint Failed

- Revised Event IDs 1 and 39 in Table 8-2
- Made the following changes to Table 9-7:
  - ALM_042: Speed 1 and Speed 2 Deviation
  - ALM_076: ASC#1: Suction Pressure PV #2Failed
  - ALM_077: ASC#1: Discharge Pressure PV #2 Failed
  - ALM_078: Performance PV Input #2 Failed
  - ALM_118: ASC#2: Suction Pressure PV #2 Failed
  - ALM_119: ASC#2: Discharge Pressure PV #2 Failed
  - ALM_135: Load Share PV Failed
  - ALM_136: Isolated Controller PV Failed
  - ALM_137: Iso Cntrl Rem Setpoint Failed
  - ALM_226: Simplex Config detects Sec Chassis
  - ALM_227: Iso Cntrl Driver Faulto
- Revised the bottom of Table 9-7
- Added Dual Redundant addresses and rows to the bottom of Table 9-8
- Added content to rows 3:0091, 3:0092, and 3:0093 in Table 9-8
- Added two new rows to the Train Configuration table in Appendix A
- Added Isolated PID table to Appendix A

Declarations

EU DECLARATION OF CONFORMITY

EU DoC No.:	00466-04-EU-02-02
Manufacturer's Name:	WOODWARD INC.
Manufacturer's Contact Address:	1041 Woodward Way Fort Collins, CO 80524 USA
Model Name(s)/Number(s):	505D (LV-ATEX/MARINE) 18-36Vdc P.N. 8200-1302 505XT (LV-ATEX/MARINE) 18-36Vdc P.N. 8200-1312 Flex500 (LV-ATEX/MARINE) 18-36Vdc P.N. 8200-1342 and 8200-1345 Flex500 Bulkhead (LV-ATEX/MARINE) 18-36Vdc P.N. 8200-1352 and 8200-1355 Vertex (LV-ATEX) 18-36Vdc P.N. 8200-1372 and 8200-1375 Vertex Bulkhead (LV-ATEX) 18-36Vdc P.N. 8200-1382 and 8200-1385
The object of the declaration described above is in conformity with the following relevant Union harmonization legislation:	Directive 2014/34/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility (EMC)
Markings in addition to CE marking:	Ex Category 3 Group II G, Ex ic nA nC IIC T4X Gc IP20
Applicable Standards:	EN 61000-6-4, 2011: EMC Part 6-4: Generic Standards - Emissions for Industrial Environments EN 61000-6-2, 2005: EMC Part 6-2: Generic Standards - Immunity for Industrial Environments EN60079-0, 2017 : Explosive Atmospheres - Part 0: Equipment – General requirements EN60079-11, 2012 :Explosive Atmospheres – Part 11 : Equipment protection by intrinsic safety "i" EN60079-15, 2010 : Explosive Atmospheres - Part 15: Equipment protection by type of protection "n

This declaration of conformity is issued under the sole responsibility of the manufacturer
We, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s).

MANUFACTURER

[signature]
Signature

Mike Row
Full Name

Engineering Manager
Position

Woodward, Fort Collins, CO, USA
Place

22 - July - 2020
Date

5-09-1183 Rev 34

Page 1 of 1

EU DECLARATION OF CONFORMITY

EU DoC No.: 00466-04-EU-02-01
Manufacturer's Name: WOODWARD INC.

Manufacturer's Contact Address: 1041 Woodward Way
Fort Collins, CO 80524 USA

Model Name(s)/Number(s): 505D, 505XT, 505DR, Flex500, Flex500 Bulkhead, Vertex, Vertex Bulkhead and 505-HT (HV-STD) 88-264Vac, 90-150Vdc
505D, 505XT, 505DR, Flex500, Flex500 Bulkhead, Vertex, Vertex Bulkhead and 505-HT (LV-STD) 18-36Vdc
FTM MODULE, FLEX500/505/VERTEX REDUNDANT

The object of the declaration described above is in conformity with the following relevant Union harmonization legislation: Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility (EMC)

Directive 2014/35/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits

Applicable Standards: EN 61000-6-4, 2011: EMC Part 6-4: Generic Standards - Emissions for Industrial Environments
EN 61000-6-2, 2005: EMC Part 6-2: Generic Standards - Immunity for Industrial Environments
EN61010-1, 2010 : Safety Requirements for Electrical Equipment for measurement, control and laboratory use – Part 1 : General Requirements

Conformity Assessment: Woodward EMC Conformity Assessment 00466-04-EU-EMC-03-05

This declaration of conformity is issued under the sole responsibility of the manufacturer
We, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s).

MANUFACTURER

Signature

Mike Row
Full Name

Engineering Supervisor
Position

Woodward, Fort Collins, CO, USA
Place

11-December-2019
Date

Page 1 of 1

5-09-1183 Rev 33

We appreciate your comments about the content of our publications.

Send comments to: industrial.support@woodward.com

Please reference publication 35072V1.

B35072V1 : D

PO Box 1519, Fort Collins CO 80522-1519, USA
1041 Woodward Way, Fort Collins CO 80524, USA
Phone +1 (970) 482-5811

Email and Website—www.woodward.com

Woodward has company-owned plants, subsidiaries, and branches, as well as authorized distributors and other authorized service and sales facilities throughout the world.

Complete address / phone / fax / email information for all locations is available on our website.