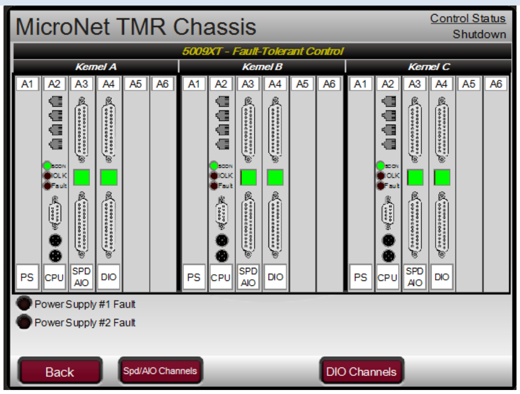
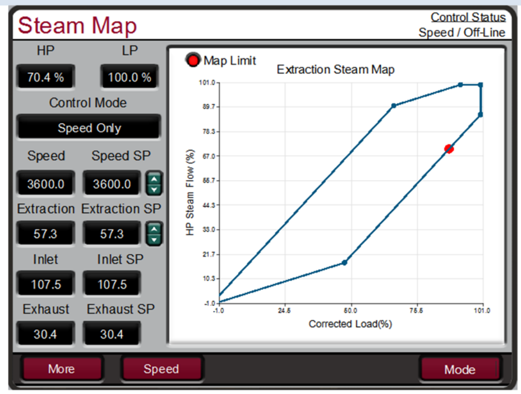
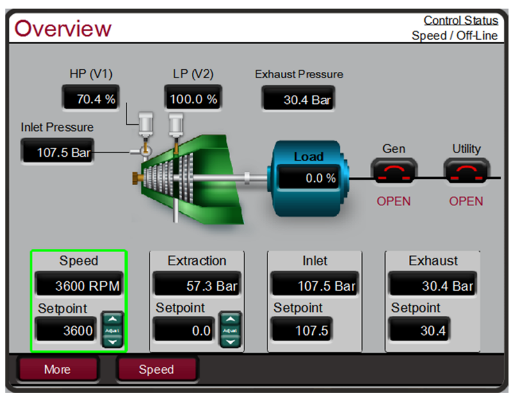
Product Manual 35135V2
(Revision B, 3/2021)
Original Instructions







5009XT Digital Fault Tolerant Control for Steam Turbines (Single Valve, Extraction and/or Admission)

Installation / Hardware Manual Volume 2

Manual 35135 consists of 2 volumes (35135V1, 35135V2)

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.**

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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.

⚠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 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 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.**

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.

Chapter 8.
General Hardware Information

This volume provides hardware description, installation, and troubleshooting information for the Woodward 5009XT Control System. It includes:

- A list of all system hardware
- A description of all hardware
- Mechanical installation instructions
- Electrical installation instructions
- Troubleshooting Guide, including diagnostic tests
- Maintenance procedures (module replacement)

This hardware manual applies to all 5009XT control systems but does not include information that is unique to your system only.

Below are the active 5009XT Control part numbers for this product.

Table 8-1. Part Number Description/ Input Power

8262-1141	5009XT MicroNet TMR Control - 120VAC/DC (88-132 Vac or 100-150 Vdc)
8262-1142	5009XT MicroNet TMR Control - 220 VAC (180–264 Vac)
8262-1143	5009XT MicroNet TMR Control - 24VDC (18–36 Vdc)

These products are defined as 'Controls' or 'Kits' from Woodward and contain only the minimum required hardware & software components. It is required that these component parts be packaged in a suitable electrical enclosure.

Part Number Options

Below are optional kits that can be purchased and added to the system. The application software can then be configured to use these options. Refer to Appendix E – Control Wiring diagram 9971-2025 for the chassis layout, cable and FTM connections and labeling identifications for these options.

Table 8-2. Part Number Options

8928-7574	2 Chan Actuator Controller Kit (module, FTM and cable – quantity of 2 each)
8928-7575	AIO (24/8) Module Kit for slot A5 (3 modules, 6 cables and 2 FTM's)
8928-7577	5009XT Optional CAN cable kit for Digital Driver or Distributed I/O Network

Note: The above CAN cable kit is designed to be used for either the Digital Driver CAN Network or the LinkNet Distributed I/O CAN network. If both options, are added to the 5009XT system, then 2 kits will need to be purchased.

The Appendix G of this volume provide detailed steps that must be followed for initial configuration of each of the three CPU modules in this control. This must be done either by Woodward or the packager initially and must also be followed for the replacement of any CPU module on a running system.

General

The 5009XT Fault-Tolerant Control System is designed to control single valve, split- range valve, single controlled-extraction, single controlled-admission, or single controlled-extraction/admission steam turbines. The 5009XTControl System 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 Windows-based computer program graphical user interface (GUI) to allow a user to configure the control, perform on-line program changes, perform on-line hardware tests, and alternatively operate the turbine. This control can be used as a standalone unit or in conjunction with a plant's Distributed Control System (DCS).

Control Fault Tolerance

The basis of this control's fault tolerance architecture is to detect control related faults, annunciate these faults, and allow on-line service/replacement of modules and/or transducers to correct these faults. This control's architecture allows it to operate with any single point of failure, without shutting down the turbine. A CPU fault tolerance logic of 3-2-0 allows the control to function normally with any CPU module failed or removed. An analog I/O fault tolerance logic of 3-2-1-0 allows the control to function normally with any one or two analog modules failed or removed. A discrete I/O fault tolerance logic of 3-2-0 allows the control to function normally with any one discrete module failed or removed. A power supply fault tolerance logic of 2-1-0 allows the control to function normally with any one power supply failed or removed.

Three isolated kernel sections (A, B & C) each house a Kernel Power Supply module, CPU module, Analog Combo I/O module, and a Discrete I/O module. Optionally an Analog I/O module can be added to each kernel, and also an Actuator Controller module can be added to Kernels A and B. A single motherboard supplies nine electrically isolated data paths. Each CPU has a data path to its VME modules and two separate data paths, one to each of the other CPU modules. There is a total of six paths between CPUs allowing for redundancy and error checking.

All control inputs and outputs are Triple Modular Redundant (TMR); meaning that each individual analog and speed input is monitored by all three 5009XT Control System kernels, then voted upon to ensure that the correct input value is used for control. Each input is split at one of the control's field termination module, and routed to the three kernels (A, B, C) via separate I/O cables; this allows on-line module replacement. Each control output signal is the sum of the three kernels outputs. Because the control monitors the health of each kernel's output signal, it can detect, alarm, and react to any system output fault.

The 5009XT Control System allows redundancy to be extended beyond the control, by allowing multiple transducers to be used for any critical control parameter. Optionally the control can be configured to accept up to four speed sensor inputs, and three analog input signals (from separate transducers) for any single critical control parameter.

8262-1141 8262-1142 8262-1143	Woodward 5009XT MicroNet+ TMR Control System – Project 148215			
5453-279	Main Chassis – MicroNet+ TMR			
Chass/Kernel/Slot	**Module P/N**	**Module Description**	**Cable / Length in**	**FTM P/N (Qty)**
1/A/1	**5466-1049**	MicroNet Kernel Power Supply – 24 VDC Input	-	-
1/A/2	**5466-1347**	CPU - PowerPC5200 400MHz w/ CANOpen	-	-
1/A/3	5466-1115	TMR Speed AIO (4 spd / 12AI / 4AO)	5417-026 / 6 5417-172 / 8	5501-502 5501-372
1/A/4	5466-1051	TMR HD Discrete I/O (24 in / 12 out)	5417-172 / 8 (2)	5453-276 (4)
1/A/5	3799-301	Blank	-	-
1/A/6	5501-1432	2 Chan ACT Controller (200mA)	5417-039	5437-672
1/B/1	**5466-1049**	MicroNet Kernel Power Supply – 24 VDC Input	-	-
1/B/2	**5466-1347**	CPU - PowerPC5200 400MHz w/ CANOpen	5417-393 / 7	-
1/B/3	5466-1115	TMR Speed AIO (4 spd / 12AI / 4AO)	5417-026 / 6 5417-172 / 8	5501-502 5501-372
1/B/4	5466-1051	TMR HD Discrete I/O (24 in / 12 out)	5417-172 / 8 (2)	5453-276 (x)
1/B/5	3799-301	Blank	-	-
1/B/6	5501-1432	2 Chan ACT Controller (200mA)	5417-039	5437-672
1/C/1	**5466-1049**	MicroNet Kernel Power Supply – 24 VDC Input	-	-
1/C/2	**5466-1347**	CPU - PowerPC5200 400MHz w/ CANOpen	5417-393 / 7	-
1/C/3	5466-1115	TMR Speed AIO (4 spd / 12AI / 4AO)	5417-026 / 6 5417-172 / 8	5501-502 5501-372
1/C/4	5466-1051	TMR HD Discrete I/O (24 in / 12 out)	5417-172 / 8 (2)	5453-276 (x)
1/C/5	3799-301	Blank	-	-
1/C/6	3799-301	Blank	-	-

5453-277	Chassis – MicroNet+ TMR Power Supply			
Chass/Slot	**Module P/N**	**Module Description**	**PS Inter. Cable**	**Ribbon Cable**
PSM/1	5501-380	Power Supply to Main Chassis – 120 VAC/DC Input	5417-293	5416-977 / 6"
	or 5501-381	Power Supply to Main Chassis – 220 VAC Input	-	-
	or 5501-370	Power Supply to Main Chassis – 24 VDC Input	-	-
PSM/2	same as PS1	Power Supply to Main Chassis – 120 VAC/DC Input	-	-
	-	-	-	-

Figure 8-1. Chassis Layout with component part numbers

Each CPU module runs the identical software application as the other two. All inputs from each kernel are distributed to the other two kernels. Each CPU then compares the value it read, with the value the other two CPUs read, before outputting a signal to the application software. Depending on the configuration, a total of nine values for the same input parameter could be used in the voting logic to provide the best signal to the application software. Even if a data value has been corrupted along any one of the data paths shown in Figure 2-1, all CPUs use the same correct data for their application calculations. All CPUs use the same voted input signals in the same application calculations to generate the same outputs. All output values are exchanged between kernels, the results are voted and the appropriate value is output from each kernel. Since the system can handle significant single errors, even multiple errors may not shutdown a kernel section. In the event of consistent errors from one of the kernel section, an alarm will be annunciated and that particular kernel will be shut down. Figure 2-1 shows the input to output structure of the MicroNet TMR®.

The 5009XTControl System's redundancy architecture allows all control modules to be replaced one at a time while the turbine is on-line and operating at full power (sometimes referred to a Hot Replacement).

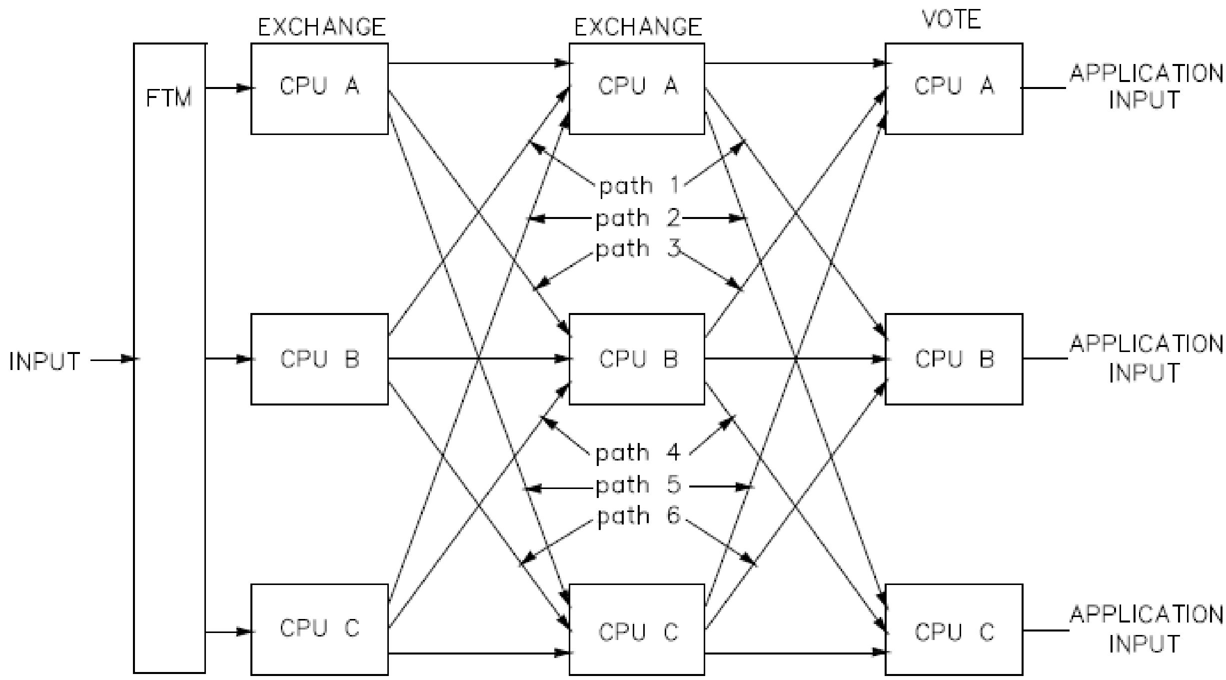


Figure 8-2. Double Exchange and Vote Structure

Speed Inputs

The control can accept one, two, or three speed inputs for the speed controller. Each speed input is monitored by all three kernels. With twelve possible speed signals from which to control with, the control can withstand multiple speed input failures with no loss of control functionality. Only one of the possible twelve inputs is required for speed control. The control can accept a 'slow speed' detect probe on channel 4 which can be unique or different from the other speed signals.

All speed inputs are connected to the control, via field termination modules (FTMs). An input's termination module is used to terminate customer control wiring and distribute each input signal to all three kernels. After the control's kernels double exchange their input values, and vote out any erroneous values, the Application Software Redundancy Manager then compares each kernel's voted result to select a value to be used within the application logic. Figure 8-2 is a graphical view of a control input's architecture. A speed input signal is determined to be faulty and is taken out of the input voting logic when it is below its "Speed Failure Level" setting.

An input deviation alarm is also used to annunciate if any of the four possible speed input channels is sensing a value that is different than the voted-good value used by the application. If an input channel's sensed value deviates from the voted-good signal value, by a greater margin than the speed control's "Max Deviation" setting, an input channel alarm will be issued. This type of annunciation can be used to indicate when an input channel or magnetic pickup unit is intermittently failing high or low. Max Deviation input settings are tunable via the GUI program's Service mode, and are defaulted to 1% (deviation range = .01 to 20%) of the "Overspeed Limit" setting. If a deviation alarm condition occurs, the alarmed input is not removed from the control's voting logic and still can be used to control with, in case all other channels fail.

The voting logic when more than one speed input (MPU or Prox. Probe) is used is as follows:

- With 3 good sensors, use the median value
- With 2 good sensors, use the higher value
- With 1 good sensor, use the good sensor's value

Analog Inputs

The control can accept one, two, or three transducer inputs for all critical parameters (ext/adm, aux, casc inputs). Only one input signal is accepted for non-critical functions (remote setpoint inputs). Each analog input can withstand up to two failures with no loss of control functionality. If any two of an analog input's three "legs" are failed, the control uses the third healthy leg's sensed input signal from which to control.

All analog inputs are connected to the control, via field termination modules (FTMs). An input's termination module is used to terminate customer control wiring and distribute each input signal to all three kernels. After the control's kernels double exchange their input values, and vote out any erroneous values, the Application Software Redundancy Manager then compares each kernel's voted result to select a value to be used within the application logic. Figure 2-2 is a graphical view of a control's input architecture. Table 2-2 displays the redundancy manager's input selection logic, for each possible input condition.

Optionally, each leg of an input channel can be tested and its calibration verified through the GUI program's Service mode, by individually removing the other two input legs. Refer to Volume 3 for all GUI program mode procedures.

An analog input signal is determined to be faulty when it is below its "Fail Low Value" setting, or above its "Fail High Value" setting. These failure level settings can be adjusted via the GUIprogram's Service mode and are defaulted to values in engineering units which correspond to 2 mA and 22 mA respectively. If an input is determined to be failed, that input is removed from the control's voting logic.

Input deviation alarms are used to annunciate if any of the input channels or input legs are sensing a value that is different than the voted-good value used by the application. If an input channel's sensed value deviates from the voted-good value, by a greater margin than its "Max Deviation" setting, an input channel alarm will be issued. This type of annunciation can be used to indicate when an input channel or system transducer is going out of calibration. Max Deviation settings are tunable via the GUI program's Service mode, and are defaulted to 1% (deviation range = .1 to 10%) of the configured input range. If a deviation alarm condition occurs the alarmed input is not removed from the control's voting logic, and still can be used to control with, in case all other channels fail.

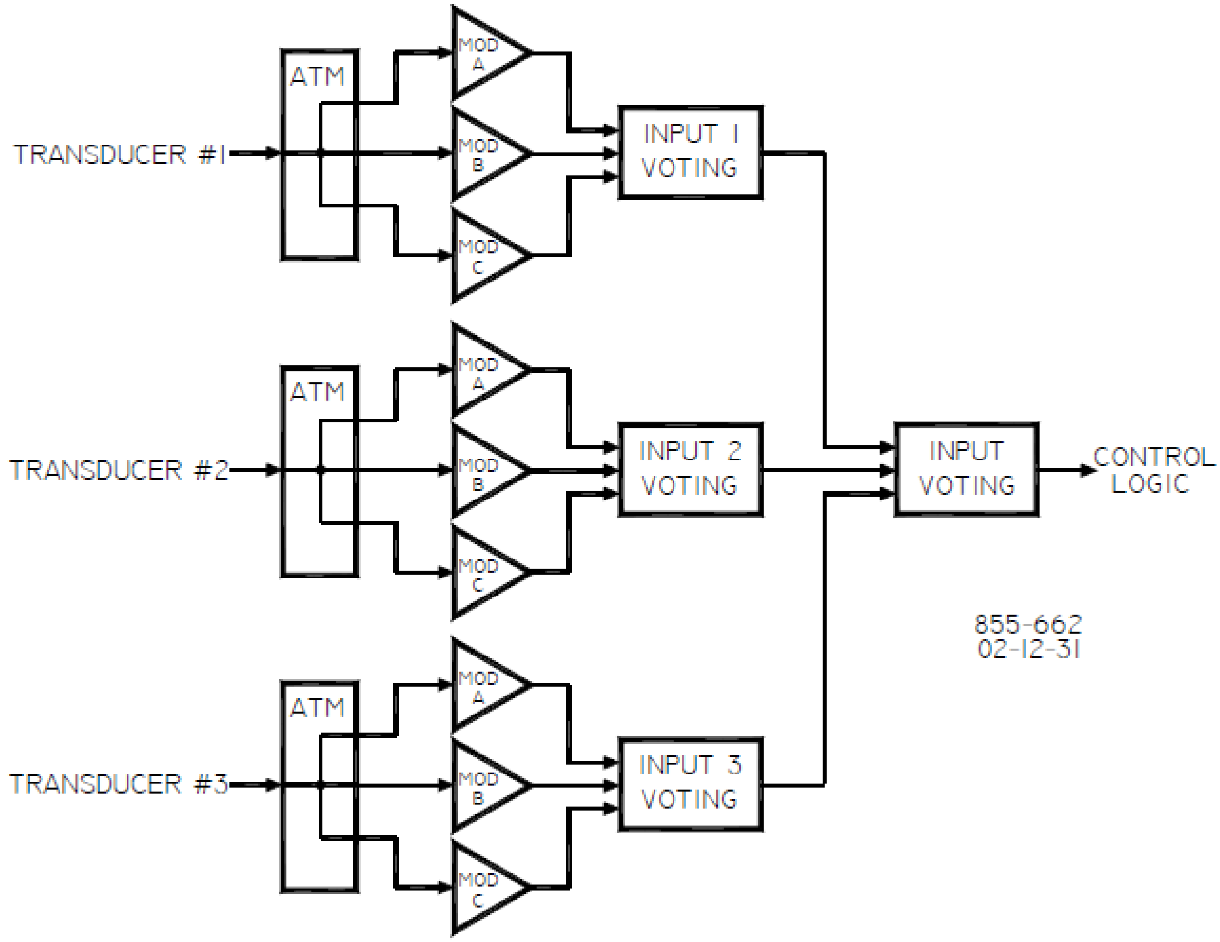


Figure 8-3. Fault Tolerant Analog Input

Table 8-1. Analog Redundancy Manager Truth

A-FAULT	B-FAULT	C-FAULT	OUTPUT OF BLOCH (APPLICATION INPUT)
FALSE	FALSE	FALSE	MEDIAN OF A, B, & C-INPUT
FALSE	FALSE	TRUE	HSS* OF A & B-INPUT
FALSE	TRUE	FALSE	HSS* OF A & C-INPUT
FALSE	TRUE	TRUE	A-INPUT
TRUE	FALSE	FALSE	HSS* OF B & C-INPUT
TRUE	FALSE	TRUE	B-INPUT
TRUE	TRUE	FALSE	C-INPUT
TRUE	TRUE	TRUE	APPL. INPUT SET TO ZERO/FAULT SET TRUE

Discrete Inputs

Each discrete input can withstand up to two failures with no loss of control functionality. If any two of a discrete input's three "legs" fail, the control uses the third healthy leg's sensed input signal from which to control.

All discrete inputs are connected to the control via field termination modules (FTMs). A FTM is used to terminate customer control wiring and distribute each input signal to all three kernels. After the control's kernels double exchange their input values and vote out any erroneous inputs, the Application Software Redundancy Manager then compares each kernel's voted result to select a value to be used within the application logic. Figure 8-5 is a graphical view of the control's discrete input architecture.

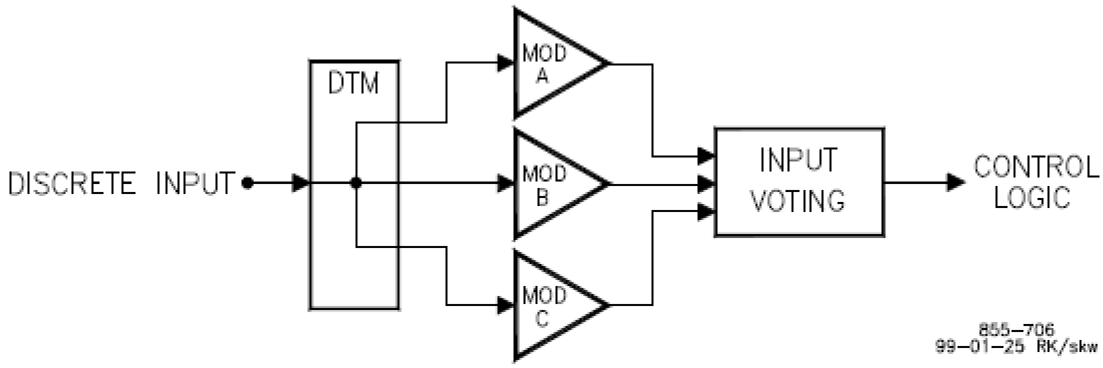


Figure 8-5. Fault Tolerant Discrete Input

Discrete input signal is determined to be faulty when it is determined to be different than the voted-good value used by the application. If an input is determined to be faulty, the input is removed from the control's voting logic and an input channel alarm is issued. Once the input fault is corrected the alarm condition can be reset by issuing a control "Reset" command.

Analog Outputs

Each control readout can withstand up to two failures with no loss of output functionality. Any leg of an output channel can drive a readout's full 4–20 mA current signal. After each CPU generates an analog output signal, the signals are exchanged between CPUs, voted on, and sent to the Redundancy Manager for output. The Redundancy Manager divides the output signal based on the number of known good output channels and distributes each portion of the signal to the respective output channel.

Precision resistors are used in each channel's readback circuitry to measure and verify the health of each output "leg". If a fault condition is detected, the faulty output leg is disabled, and the Redundancy Manager redistributes the output signal to the remaining legs. In a case where two failures are experienced at the same time within different legs, the single good channel (leg) will drive the entire output. Figure 2-4 shows a Fault Tolerant Analog Output's architecture. The Field Termination Module (FTM) combines each analog output signal from all three kernels into one signal at the FTM's terminal blocks.

An output is considered failed, and an alarm issued, if a channel's combined output or any leg of the output measures a difference of more than 10% from the output demand. Optionally, each leg of a readout channel can be tested and its calibration verified through the GUI program's Service mode, by individually removing the other two output legs. Refer to Volume 3 for all GUI program functionality.

With this output architecture, any single output driver failure results in the output signal only stepping to 66.66% of its original value. The time between when a failure is sensed and when the control corrects for it by redistributing current through the other drivers can be as long as 50 milliseconds.

Upon the correction of an output failure, and a "Control Reset" command, each failed output performs a continuity check though the its external load before current is again redistributed evenly between all output drivers. This continuity check entails, the failed driver to output a small amount of current through its output load, and compare that value with what is readback. The time between when a continuity check is performed and when the control redistributes current through the all drivers can be as long as 50 milliseconds.

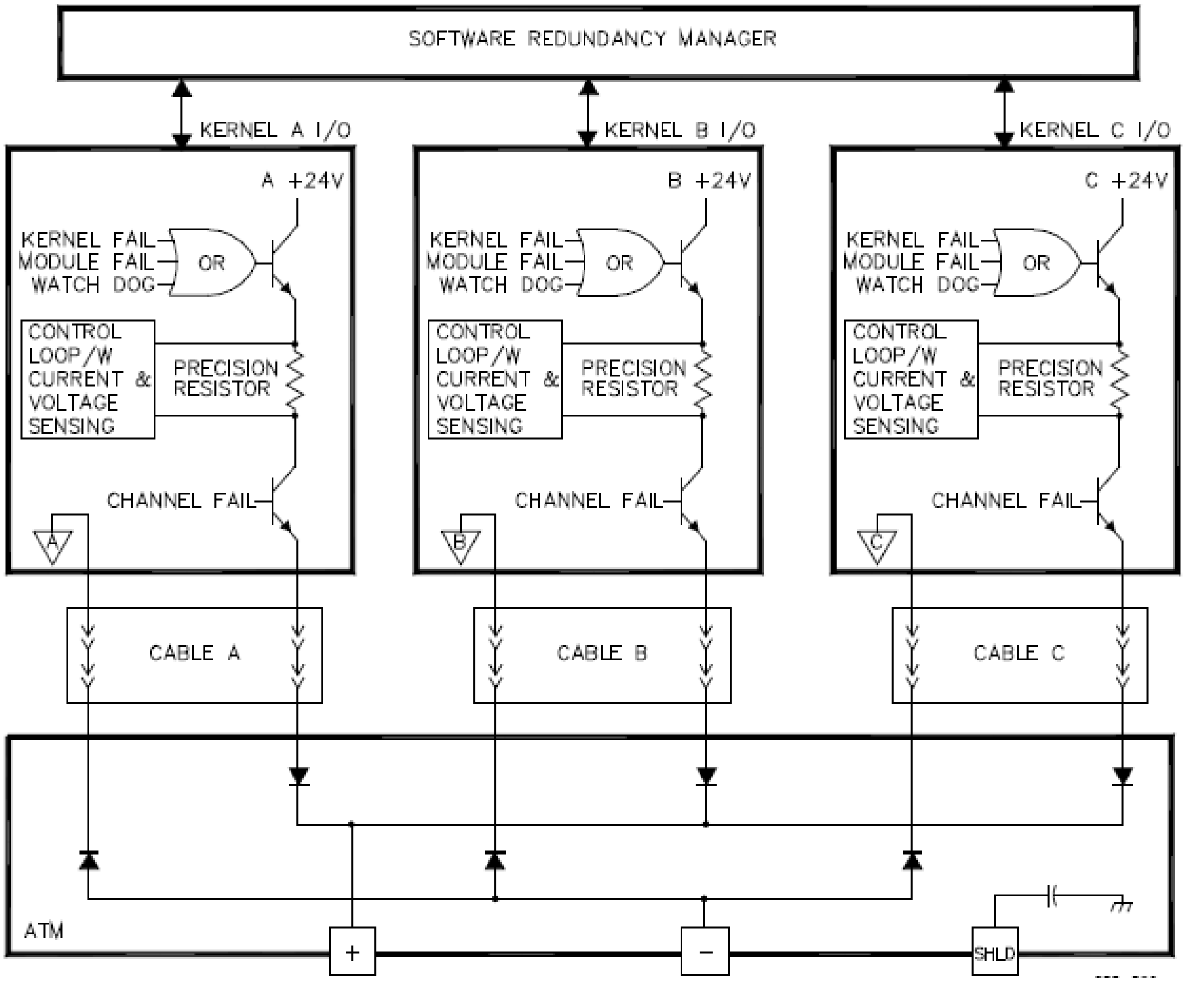


Figure 8-6. Fault Tolerant Analog Output

Relay Outputs

Twelve fault tolerant relay outputs are provided with this control. With this control's architecture, a six relay configuration is used to form each fault tolerant relay output. When a relay output is closed, the contacts of all six relays are closed. Because of the series-parallel configuration that the relays are in, the failure of any individual relay will not cause the output to be open. This series- parallel configuration also allows any single relay of the six relay configuration to be removed and replaced "on-line" with no effect on the state of the fault tolerant relay output.

When a relay output is open, the contacts of all six relays are open. Because of the series-parallel configuration that the relays are in, the failure or removal of any one relay will not cause the output to be closed. The relay output would continue to be open.

Since this control's fault tolerant architecture can tolerate a single fault, it is possible for this fault to go undetected. This is called a latent fault. If a second fault occurs while a latent fault exists, the state of the fault tolerant relay output may be affected, possibly resulting in a shutdown condition. This is why it is important to detect and annunciate latent faults in a fault tolerant system.

Latent fault detection is provided with this control to detect any relay related failure without affecting the state of the overall relay output. Each individual relay output can be configured to use or not use latent fault detection. A latent fault detection test is performed periodically or on command through the GUI. The period of time between tests can be set from 1 to 3000 hours and is defaulted for every 48 hours.

A relay output is tested by cycling the output's individual relays closed then open (or vice-versa depending on the output state), to ensure that they are in the correct state, and that they can change state. Position readback circuitry allows the state of each relay contact to be detected. Any failures are annunciated, and further testing is disabled without affecting the state of the relay output contact or control operation

Each fault tolerant relay configuration consists of 6 relays, driven by two discrete outputs from each kernel (as shown in Figure 8-7). The relays are configured in three legs of two relays each. Customer circuit power is connected to one side of the resulting configuration, and customer load to the other side. Field selectable jumpers, located on system FTMs, are provided to allow each output's latent fault detection logic to be compatible with the circuit being interfaced to. Latent fault detection is used to monitor the actual contact positions of each of the six relays, and to momentarily change states of each relay one at a time. This verifies each relay's "normally open" or "normally closed" contacts.

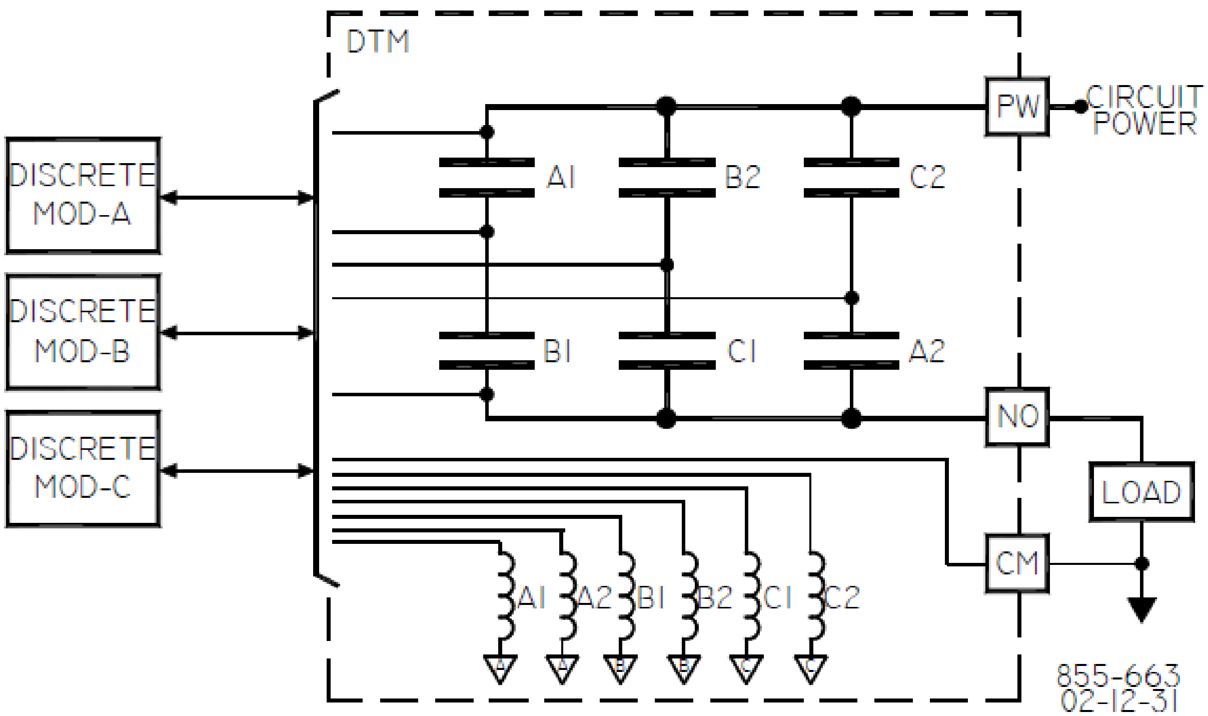


Figure 8-7. Fault Tolerant Discrete (Relay) Output

Latent fault detection (LFD) is not usable with all applications or circuits. The control's LFD logic can only work with circuits using voltages between 18–32 Vdc, 100–150 Vdc, or 88–132 Vac. For latent fault detection to work, a small leakage current is passed through the circuit's load. Depending on the size of the load, the leakage current may be enough to cause a load to be on or active, when a relay contact is open. In this case, the individual relay's latent fault detection logic may be disabled, eliminating the leakage current, or a shunt resister can be used across the load to reduce the leakage current. Refer to the TMR hardware manual to determine if Latent Fault Detection can be used with a circuit.

Servlink Communications

Each of the three CPU's supports Woodward's Servlink protocol to our service tools and provides a direct Woodward Servlink connection to the GUI through the provided network switch. All of the Woodward service tools are able to communicate via Ethernet. The RemoteView GUI can be configured to support redundant links, for example to Kernel A CPU and Kernel B CPU (a different TCP/IP address). Refer to Appendices for information on all RemoteView program functionality options.

Modbus Communication Ports

The 5009XT can be configured for Modbus Communications with a Woodward provided HMI offering, a distributed control system (DCS) or other operator control panel. The control can communicate via TCP, UDP, or serial to these other devices. To support various types of operator interface redundancy there are four communication links that are fully configurable on the Modbus block.

The user can select the ability to enable or disable write commands from each link in the following manners:
Modbus View Only - NO Writes
Modbus Writes Always Enabled
Modbus Writes when Selected

All communication input values and commands from each port are double exchanged between all three CPUs and voted on to vote out any erroneous input values or commands before the application software is given the value or command. All communication output values or indications are also double exchanged between all three CPUs and voted on to vote out any erroneous output values or indications before the value or indication is output to the communications port.

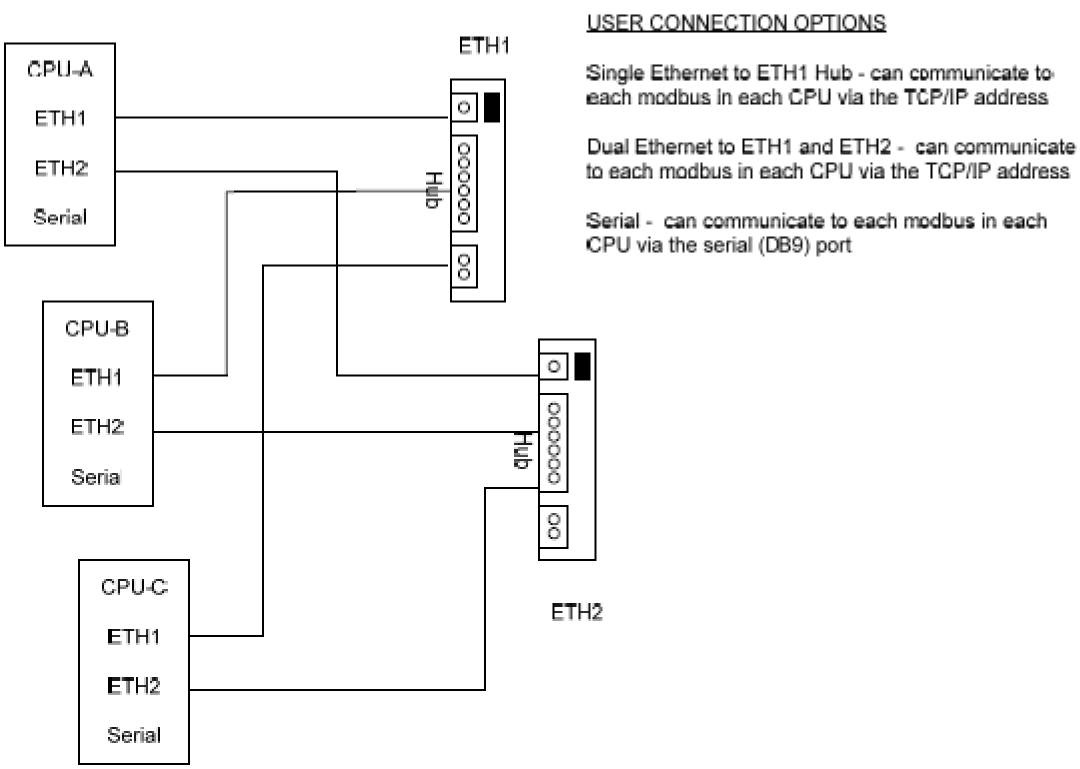


Figure 8-8. Fault Tolerant Modbus Communication Ports

Chapter 9.
Hardware Description

Introduction

The 5009XT digital control is available in 3 options based upon the type of input power supply required. The control components are supplied as 'Kits' and require the user to provide a cabinet and accessory equipment. The control is shipped disassembled and must be installed in a suitable cabinet enclosure. After a control is received, each item must be located and installed via this manual's instructions and the control wiring diagrams in Appendix E. Precautions to eliminate Electrostatic Discharge must be followed any time parts are handled or entering the cabinet containing the MicroNet TMR system.

Woodward also provides this control in custom cabinets as a complete system when required. Other optional add-on kits may also be created for common options requested by customers, after the initial product release

This manual will reference the Woodward MicroNet TMR manual 26167 Volumes 1 and 2. The 5009XT is a derivative of the MicroNet TMR, and the only difference is that the 5009XT is a pre-configured MicroNet TMR System that include control application software (GAP) and a graphical user interface (GUI) program to configure, troubleshoot and operate the turbine. The designation indicators are detailed in the control wiring found in Appendix E.

Table 9-1. Control Components

Designation	Description	Qty	Remarks
U1	Main chassis	1	Standard
U2	Power Chassis	1	Standard
PSM1, PSM2	Main Power Supply Module	2	Standard
A1	Kernel Power Supply Module	3	Standard
A2	CPU Module	3	Standard
A3	MPU & Analog I/O Module	3	Standard
A4	Discrete I/O Module (24 In/12 Out)	3	Standard
A5	Analog HD I/O Module	3	Optional
A6	Actuator Controller Module	2	Optional
FTM103-1, 2	Analog Termination Module	2	Standard
FTM104.1A, 1B, 2A, 2B	Discrete Termination Module (F/T Relay–Discrete In)	4	Standard
FTM105-1, -2	Analog HD I/O Termination Module	2	Optional
FTM106-1, -2	Actuator Controller Termination Module	2	Optional
W101-1	Power Chassis to Main Chassis Cable (1 ft/30 cm)	1	Standard
W101-2	Power Chassis to Main Chassis Cable	1	Standard
W103-A, -B, -C	Analog I/O Cable	6	Standard
W104-A, -B, -C	Discrete I/O Cable	6	Standard
W104-1AB, -2AB	FT Relay to FT Relay box Cable (6”/15 cm)	6	Standard
W105-A, -B, -C	Analog Cable	6	Optional
W106-A, -B	Actuator Controller Cable	2	Optional

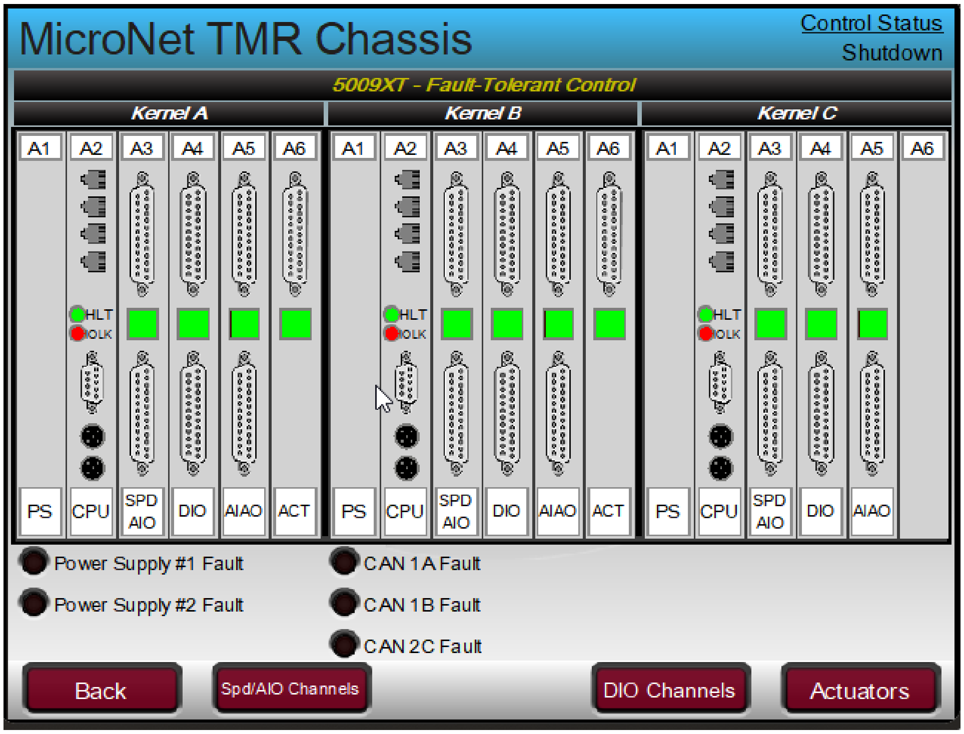


Figure 9-1. GUI View of Chassis, Configured Using All Optional I/O

Main Control Chassis

The main chassis of the 5009XT consists of three six-slot kernel sections. Each kernel section is isolated from the other two. With this configuration the failure of any one section will not cause a shutdown.

Each kernel section includes a kernel power supply, a CPU, a speed/analog combo I/O module, and a discrete I/O module. Optionally other I/O module may be included in the system. Slot-to-slot logic and power connections are made through an etched-circuit motherboard located on the back of the chassis. The motherboard and modules are all VERSA module Eurocard (VME) type. I/O connections are made through cables from the front of the modules to termination modules in the cabinet. See Appendix E for an overview of the main chassis, control modules, and termination modules.

From a module connector standpoint, any I/O module can be installed in any of the chassis slots designated for I/O modules. However, when the application software is designed, each module is assigned to a specific slot, thus the software expects each specific I/O module to always be in its designated slot.

The 5009XT control chassis is cooled by forced air. In order not to starve modules of air flow, either a module or a blank module must be installed and secured in each slot. Cooling fans are located on the top of the main chassis; with one fan per 6-slot card rack. The power supply chassis contains two cooling fans: one on top and one on the bottom of the chassis. These fans run any time the 5009XT chassis is powered up.

See Woodward MicroNet TMR manual 26167 Volume 1, Chapter 3, and Section 1 for more details on the Main Chassis.

System Power Supplies (PSM1 and PSM2)

The 5009XT main control power supply chassis uses redundant power supplies. A motherboard located on the back of the power supply chassis allows the two power supplies to form a redundant power system providing six separately regulated 24 Vdc, 6 A outputs to the control. Power output regulation, including line, load, and temperature effects, is less than +5%.

When redundant power supplies are running, current-sharing circuitry balances the load to reduce heat and improve the reliability of the power supplies. In the event that one supply needs replacement, this feature also ensures hot replacement of the power supplies without disrupting the operation of the control.

⚠WARNING **When hot swapping a Power Supply, avoid reaching into the chassis opening, as the top and bottom fan blades will be exposed.**

Input power connections are made to the main power supply through terminals on the front of the power supplies. For convenience, the user input power connections are made through panel mounted Phoenix type terminal blocks. See Appendix F. A standard 50-pin ribbon cable is used for connecting the power supply chassis to the 5009XT control chassis. As redundancy to this, a wire harness cable connects power from the back of the power supply chassis to the back of the main chassis.

A set of two main power supplies are provided with each system. Different models of power supplies allow the control to interface with different input source voltages.

Main power supplies are available in the following models:
AC/DC – 88–132 Vac or 100–150 Vdc
HVAC/DC – 180–264 Vac or 200–300 Vdc

See Woodward MicroNet TMR manual 26167 Volume 1, Chapter 4, and Sections 1–3 for more details on the Main Power Supplies.

Module Descriptions

Physical Description

All chassis mounted control modules are VME-type (VERSA module Eurocard) modules.

Modules slide into card guides in the 5009XT control's chassis and plug into the motherboard. All modules have their circuitry on a single printed-circuit board. Each module has a front panel extending from the bottom to the top of the cabinet.

The modules are held in place by two screws: one at the top and one at the bottom. Also at the top and bottom are two handles which, when toggled, move the modules out just far enough for the boards to disengage the motherboard connectors. Each module is protected with a molded plastic cover to prevent accidental component damage.

Kernel Power Supply Module (Kernel A/B/C: A1)

The 5009XT contains three kernel power supply modules. Each kernel section (A, B, and C) will contain one kernel power supply module. The kernel power supply will be located in the first slot of each kernel section. This module receives 24 Vdc from the MicroNet main power supplies and regulates it to 5 Vdc, 10 A for the rest of the kernel section and also creates a 5 Vdc precharge voltage.

See Woodward MicroNet TMR manual 26167 Volume 1, Chapter 4, and Sections 4–6 for more details on the Kernel Power Supplies.

Central Processor Unit (CPU) Module (Kernel A/B/C: A2)

The MicroNet TMR 5200 CPU module contains an MPC5200 processor,
128 Mbyte DDR RAM, 64 MB of flash memory, a Real Time clock, and various communication peripherals. These peripherals include (2) general use Ethernet ports, (1) Real Time Network port, (1) serial port, (1) one service port, and (2) CAN ports. This module includes an FPGA to provide VMEbus master/slave capability as well as other functions necessary for redundant systems.

This module, following the instructions of the application program, controls the circuits of the 5009XT control so that they perform all the required control and sequencing functions. There are three CPU modules provided with each system. Each CPU utilizes a PowerPC Motorola 5200 microprocessor to perform its data processing. The VME bus arbitrator block controls the VME bus and determines what device may use the bus when there is a conflict.

See Woodward MicroNet TMR manual 26167 Volume 1, Chapter 5, Section 1 for more details on the TMR 5200 CPU Module.

Speed/Analog IO Combo Module (Kernel A/B/C: A3)

Each Speed/Analog Combo module supplied with the 5009XT contains circuitry for four-speed sensor inputs which can be configured as MPU's (magnetic pickups) or proximity probes (active probes), twelve analog inputs, and four analog driver outputs.

Each analog input must be 4–20 mA, and each analog driver output must be a 4–20 mA.

See Woodward MicroNet TMR manual 26167 Volume 1 for more details on the TMR Analog Combo Module.

Speed/Analog IO Combo Termination Modules (FTM103-1, FTM103-2)

The FTM's for the TMR Speed/Analog Combo are two different part numbers. One is used to connect to the speed sensor inputs, and the other is used to connect to the 12 analog inputs, and four analog driver outputs. Three Analog cables are used to connect the FTM with each of the three TMR Speed/Analog Combo Modules.

There are several connections for power on the FTM's, each for a dedicated purpose. There are twelve +24 Vdc connections available for sourcing 4–20 mA inputs if the channel is configured for loop power from the control. Each connection is protected with a 0.1 A fuse (F1-F4).
On the Speed FTM, there is a +24 Vdc output connection available for powering proximity sensors.

Two FTMs are provided and used with each 5009XT control (FTM103-1 and FTM103-2). Refer to Appendix E for an overview of modules and FTMs used.

See Woodward MicroNet TMR manual 26167 Volume 2, Chapter 12, and Section 2 for more details on the TMR Speed Analog Combo FTM.

Discrete I/O Module (Kernel A/B/C: A4)

Each 24/12 TMR Discrete I/O module (TMR High Density Discrete module) contains circuitry for twenty-four (24) discrete inputs and twelve (12) TMR discrete outputs, and provides latent fault detection for each relay output. Each discrete input may be 24 V, or 125 Vdc. Each relay output provides the option of using a normally open contact, or a normally closed contact.

See Woodward MicroNet TMR manual **26167** Volume 1, Chapter 7, and Section 2 for more details on the TMR 24/12 TMR Discrete I/O Module.

Discrete Termination Modules (F/T Relay Module)

(FTM104-1A, FTM104-1B, FTM104-2A, FTM104-2B)

The Fault Tolerant Relay modules are used to connect discrete field wiring to the 5009XT control. Four FT Relays (FTM104-1A, FTM104-1B, FTM104-2A, and FTM104-2B) are provided and used with each 5009XT control. Refer to Appendix F for an overview of FTMs. Each FTM connects to the control's three independent Discrete I/O modules through individual cables, and provides a common cage-clamp terminal connection for customer field wiring. Each FT Relay box contains circuitry for six contact inputs, three relay outputs and houses circuitry to:

- route each contact input signal to the system's three independent (rack mounted) discrete modules
- provide an open / closed contact output based on associated discrete module commands
- indicate the health of all relays (latent fault detection)

Discrete input power (contact wetting voltage) can be supplied by the 5009XT control or from an external source. The 5009XT control provides an isolated 24 Vdc power source for contact wetting. The external source may be 24 Vdc or 125 Vdc (North American installations only). Separate discrete input terminals are provided based on the level of contact wetting voltage used. See Appendix F.

NOTICE

To comply with CE Marking under the European Low Voltage Directive (LVD) and CSA requirements, the maximum external circuit voltage for both the Discrete Inputs and Relay Output circuit are limited to 18–32 Vdc maximum.

The discrete output relays are mounted on sockets, with 18 relays per FTM. Six relays are used to create each relay output (normally open and normally closed contacts) and allow latent fault detection. See Appendix F. This configuration allows independent testing of each relay output (latent fault detection) without concern of relay position. Customer power is connected to one side of the configuration and load to the other.

Discrete outputs can be configured to use latent fault detection to identify output relay failures without affecting operation. When the contacts are closed, they are periodically opened in pairs, to ensure that they are in the correct state, and that they change state. When they are open, they are periodically closed individually, to ensure that they close. Any failures are annunciated, and further testing is disabled.

NOTICE

It is highly recommended to design the field wiring such that the latent fault detection can be utilized on critical relays (Trips). Without this feature, a single component fault might not be annunciated – leading to a potential unwanted turbine trip.

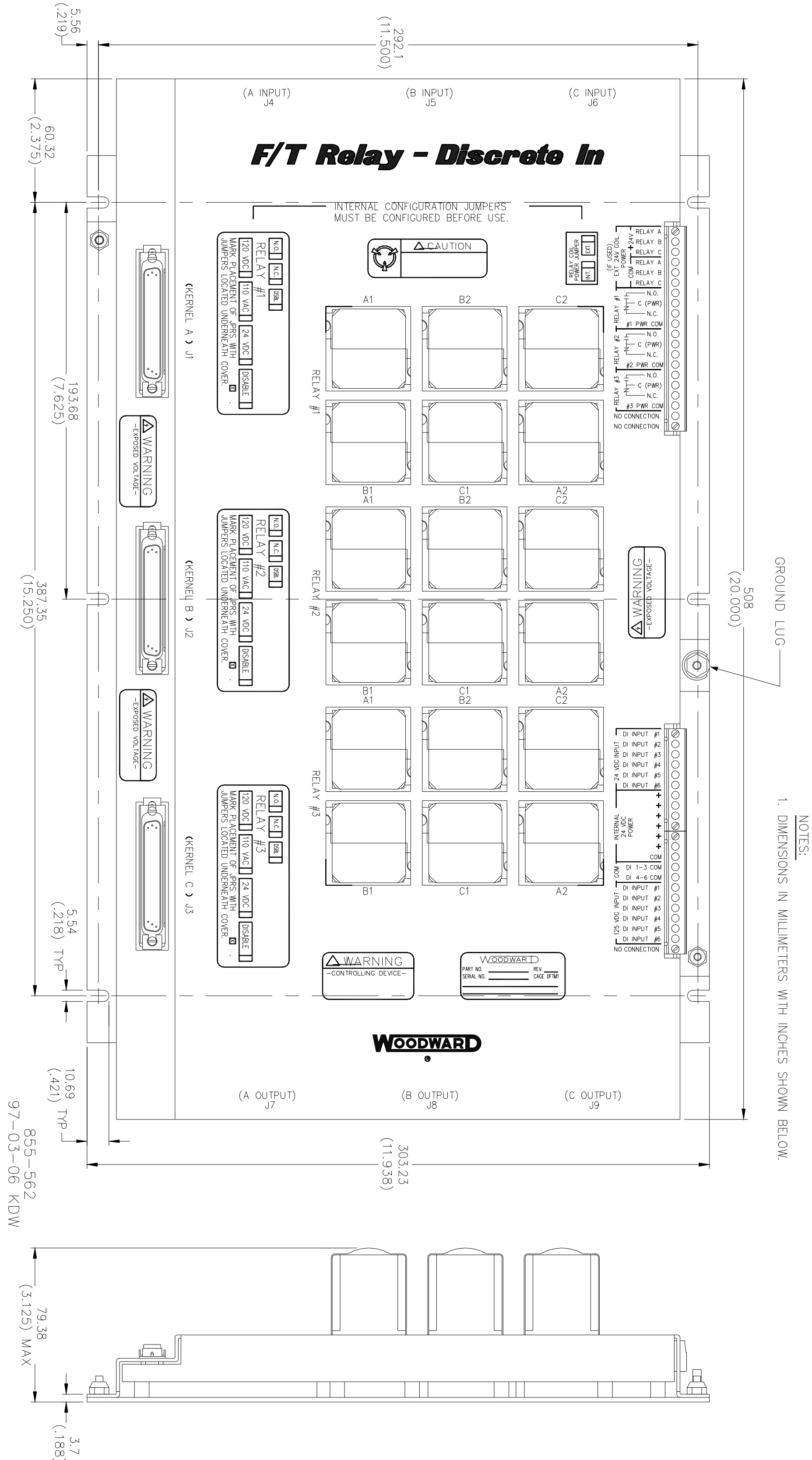


Figure 9-2. Fault Tolerant Relay Outline Drawing

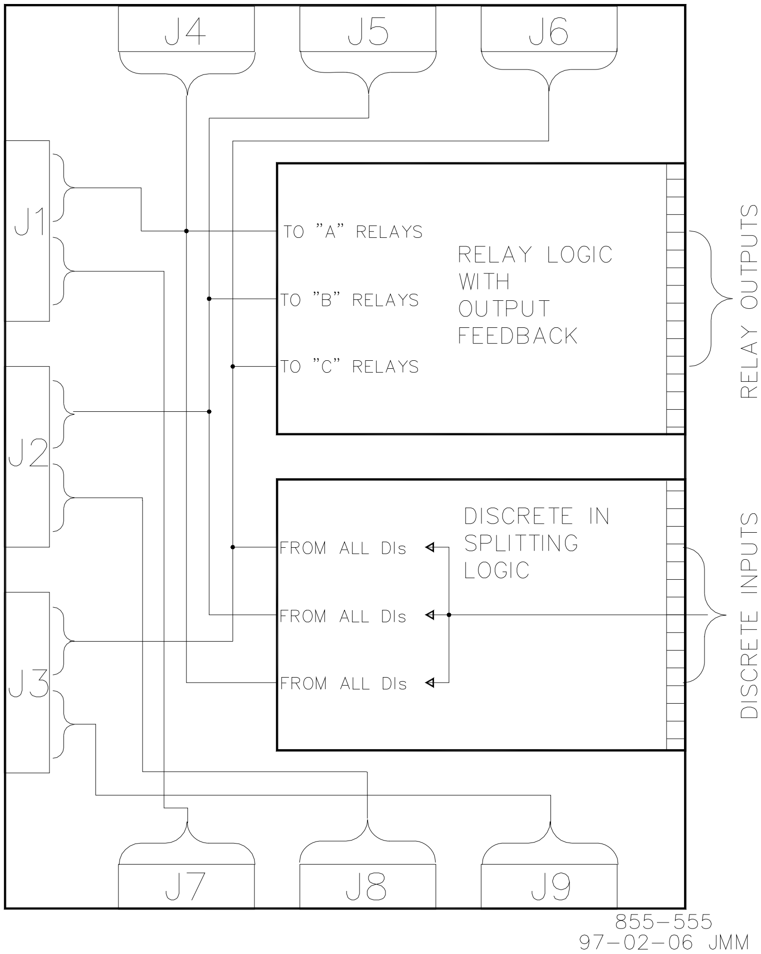


Figure 9-3. FT Relay Block Diagram

Field wiring constraints are detailed in the standard TMR manual—follow all shielding and wiring constraints listed. See Woodward MicroNet TMR manual **26167** Volume 1, Chapter 7, and Section 2 for more details on the FT Relay Module.

Optional TMR 24/8 Analog Module (Kernel A/B/C: A5)

The 24/8 Analog module contains circuitry for twenty-four analog inputs and eight 4–20 mA outputs. These modules have no potentiometers and require no calibration. A module may be replaced with another module of the same part number without any adjustment.

The TMR 24/8 Analog module comes in the following configuration: 24 channels of 4–20 mA inputs with 8 channels of 4–20 mA outputs (2-pole 10 ms filter on all input channels, except channels 23 and 24, which have 2-pole 5 ms filter).

See Woodward MicroNet TMR manual **26167** Volume 1, Chapter 8, Section 1 for more details on the TMR 24/8 Analog Module.

Optional TMR 24/8 Field Termination Module (FTM105-1, FTM105-2)

The TMR 24/8 Analog FTM is used with the TMR 24/8 Analog Modules. Three MicroNet High Density Analog/Discrete cables are used to connect the FTM with the three TMR 24/8 Analog Modules. There are twelve +24 Vdc connections available for sourcing 4–20 mA inputs. Each connection is protected with a 0.1 A fuse.

See Woodward MicroNet TMR manual **26167** Volume 2, Chapter 12, Section 2 for more details on the TMR 24/8 Analog FTM.

Optional 2 Channel Actuator Controller Module (Kernel A/B: A6)

This Kit includes modules, cables and FTM (2 of each) and is designed to be installed in slot A6 of Kernels A & B. See the control wiring in the appendices of this manual to see location and recommended designations for these cables and FTMs, and wiring examples for actuator connections.

> **NOTICE**
>
> **The standard Kit comes with Actuator Controller modules p/n 5501-1432 that are calibrated for a range of +/- 200 mA. If your actuation system requires a lower range, consult Woodward for the correct module part numbers for you system. While the +/- 200 mA range can be setup with a reduced span, the resolution will be affected. Modules with the following ranges are available, +/- 10 mA, 25mA, 50 mA and 100 mA.**

This kit provides 2 redundant channels that will support valve/actuators of the following types:

- Proportional Actuators of range up to 0-200 mA
  - with or without LVDT position feedback
  - single coil (shared) or dual coil
- Integration Actuators of range +/- 200 mA
  - single coil (shared) or dual coil
  - \- single or dual LVDT position feedback

See the appendices of this manual and Woodward MicroNet TMR manual 26167 Volume 1 for more details on the 2 channel Actuator Controller Module.

CAN Open networks for digital drivers and distributed IO

The 5009XT now supports CAN Open connectivity of 2 networks. One for interfacing to Woodward's family of digital driver products and another which allows the addition of distributed LinkNet HT modules for expanding the total system I/O. Details of these features can be found in the Appendices of this manual.

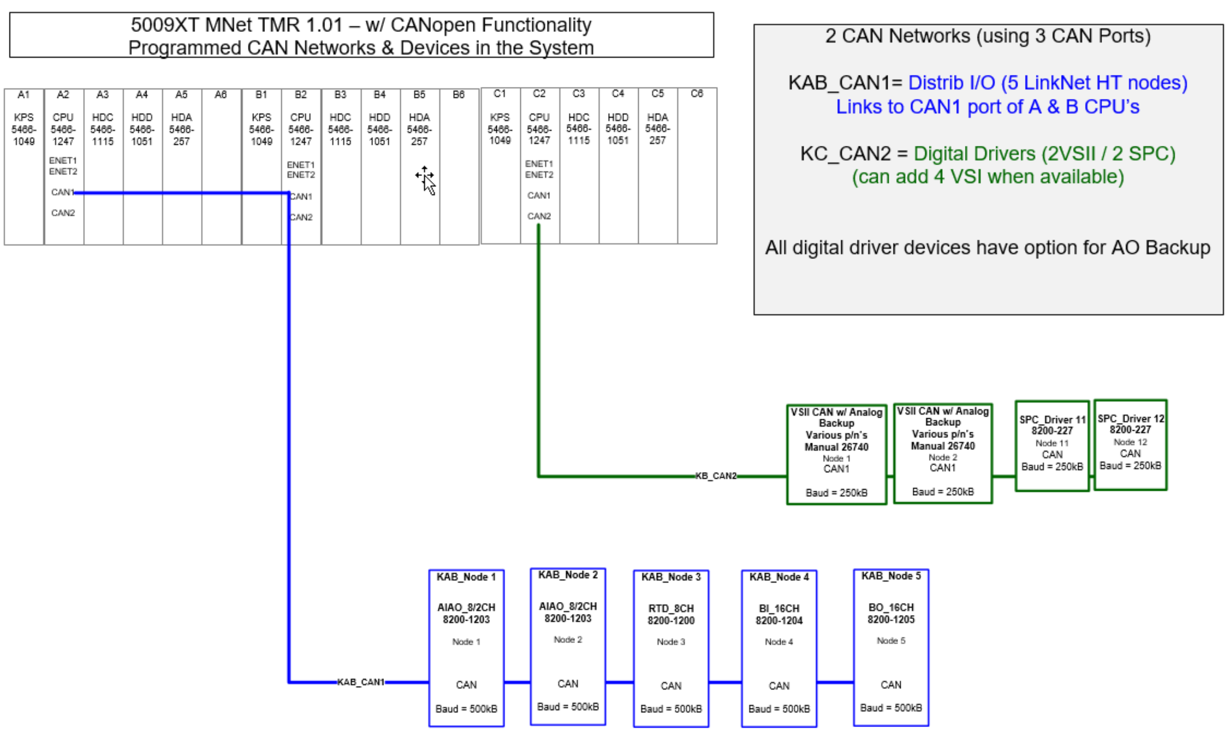


Figure 9-4. CAN links to Digital Drivers

Hardware Specifications

General I/O Specifications

For details on all I/O specifications consult MicroNet TMR manual 26167.

5009XT Control Package— Heat and Load limits include Optional Hardware

Environmental

Humidity
0 to 90%, non-condensing

Shock
US MIL-STD-810C, Method 516.2-1 procedure 1b (15 g 11 ms Half Sine pulse)

Vibration
Lloyd's type ENV2 Vibration test #1; 13–150 Hz @ 1.0 G Ten sweeps at one octave per minute. Unless otherwise reduced by options as shown in the Environmental Classifications for Options Table below, the following classifications apply.

Table 9-2. Environmental Classifications for Options

EN 50178 Humidity Class	EN 50178 Air Pressure Class
3K3 5% to 85%	3K3 86 to 106 kPa

Air Quality
Pollution Degree #2

Altitude (max)
2000 m

Storage Temperature
–20 to +70 °C (-4 to +158 °F)
Component life is adversely affected by high temperature, high humidity environments. Room temperature storage is recommended for long life.

Sound Level
Less than 70 dBA

MicroNet TMR/5009XT I/O Chassis Weight:
22 kg (48 lb)

MicroNet TMR/5009XT Main Power Supply Weight:
8 kg (17 lb)

Power Supply Specifications

Input Power Ratings (see Appendix E for P.S. Options)

DC (18–36 Vdc)

- Nominal Voltage Rating (24 Vdc), (as on Power Supply Label)
- Rated Maximum Current = 33 A
- Input Power Fuse/Breaker Rating = 50 A slow blow
- Wire Size = 5.5 mm² (10 AWG) or larger
- Holdup Time = 5 ms @ 24 Vdc

DC (100–150 Vdc)
- Nominal Voltage Rating (111–136 Vdc), (as on Power Supply Label)
- Rated Maximum Current = 6.0 A
- Input Power Fuse/Breaker Rating = 10 A slow blow
- Wire Size = 2.5 mm² (14 AWG) or larger
- Holdup Time = 7 ms @ 120 Vdc

AC (88–132 Vac, 47–63 Hz)
- Nominal Voltage Rating (98–120 Vac), (as on Power Supply Label)
- Rated Maximum Current = 10.0 A
- Input Power Fuse/Breaker Rating = 20 A slow blow
- Wire Size = 4.0 mm² (12 AWG) or larger
- Holdup Time = 1 cycle @ 120 Vac

High Voltage AC (180–264 Vac, 47–63 Hz)
- Nominal Voltage Rating (200–240 Vac), (as on Power Supply Label)
- Rated Maximum Current = 5.0 A
- Input Power Fuse/Breaker Rating = 10 A slow blow
- Wire Size = 2.5 mm² (14 AWG) or larger
- Holdup Time = 1 cycle @ 220 Vac
-

High Voltage DC (200–300 Vdc)
- Nominal Voltage Rating (223–272 Vdc), (as on Power Supply Label)
- Rated Maximum Current = 3.0 A
- Input Power Fuse/Breaker Rating = 10 A slow blow
- Wire Size = 2.5 mm² (14 AWG) or larger
- Holdup Time = 7 ms @ 200 Vdc

Installation Overvoltage Rating
Category II

Dielectric Withstand
AC/DC and HVAC version: 2200 Vdc from power input to chassis

Power Output Ratings
- 24 Vdc Analog power (prox and analog input power)
  - Acceptable Output Range 20.4—25.2 Vdc (at FTM terminals)
  - Fused to 100 mA on each terminal output
- 24 Vdc Discrete Input power (Contact Wetting Voltage)
  - Acceptable Output Range 20.4—25.2 Vdc (at FTM terminals)
  - Current Limited to 400 mA on each FTM output

CPU Batteries for Real Time Clock Back-Up
NiCad (Not User Replaceable); Charge Time: 72 hours @ 25 °C.
CPU Storage Temperature with battery operating specifications: –20 to +45 °C.

⚠WARNING	**ELECTROCUTION HAZARD—Ground leakage exceeds 3.5 mA. Protective earth grounding is required.**

Chapter 10. Mechanical Installation

Storage

Store 5009XT control and associated parts between –20 and +70 °C (–4 and +158 °F) at a maximum relative humidity of 90% non-condensing. If power supplies are to be stored for a long time, apply operating power to them at least once every 18 months. For more detail, see MicroNet TMR manual 26167.

Unpacking

Unpack each part of the system carefully. Check the units for signs of damage, such as bent or dented panels, scratches, or loose or broken parts. If any damage is found, notify the shipper immediately.

After a control system is received each item must be located and installed via this manual's instructions. The following items should be removed from the packing carton (s) and checked to make sure you have all the necessary components before attempting to assemble and install the system. Refer to Appendix E of this manual.

Unit Location

Consider the following when selecting a location for mounting the 5009XT unit(s):

- Make sure the 5009XT unit(s) is mounted in a dry location, protected from water and condensation (Pollution Degree 2 environment).
- The 5009XT control must be used in a power installation environment rated at Overvoltage II.
- Make sure the ambient temperature of the system location is not lower than 0 °C (32 °F) or higher than 40 °C (104 °F) and that the relative humidity is not over 90%, non-condensing.
- Provide adequate ventilation for cooling the units. If the units must be mounted near heat-producing devices, shield them from the heat.
- Do not install the units or their connecting wires near high-voltage/high- current devices or inductive devices. If this is not possible, shield both the system connecting wires and the interfering devices or wires. If the selected location does not already have a conductor to a good earth ground, provide one.
- Unless otherwise stated, this equipment is suitable for non-hazardous locations only.

IMPORTANT — **Equipment is suitable for use in non-hazardous locations only.**

Manual 26167 provides complete details on installing the 5009XT components into an electrical enclosure. Appendix F of this manual shows an example of a typical Woodward designed cabinet system.

System Maintenance

Cables and Connections
Periodically, check the cables to make sure they are still in good condition, and check the connectors to make sure they are plugged in all the way.

Fans
Power must be removed prior to replacing chassis fans. Only qualified personnel should replace chassis fans. As a preventive maintenance, it is recommended that the main chassis and power chassis cooling fans be replaced every 50 000 hours. For replacement, use fans of like design and specification, or purchase replacement fans from Woodward.

⚠WARNING **Substitution of components may impair suitability of the equipment and is not recommended.**

Chapter 11.
Electrical Installation

Introduction

⚠WARNING	**Before installation read all information and warnings on pages iv and v of this volume.**

Electrical ratings, wiring requirements, and options are provided to allow a customer to fully install the 5009XT control into a new or existing application. Field wiring must be rated at least 25 °C above ambient temperature.

Wiring for installations must be in accordance with Ordinary (non-hazardous) wiring methods and in accordance with the authority having jurisdiction.

After the system has been mechanically installed read this chapter thoroughly before proceeding. Perform system electrical installation by stepping through this chapter's instructions in sequence. Start with system cables instruction, then step to the next set of instructions, etc.

> **Note:** The installer should create a 5009XT I/O configuration wiring list to assist in electrical installation using the information provided in Appendix E of this manual The wiring list will determine what inputs are hooked up to what terminal blocks and how the accessories are wired into the control

Follow the appendix titled 'Control Wiring Diagram' for information on chassis module layout, cable interconnects and signal wiring guidance in addition to the detailed information in this chapter.

Shields and Grounding

An individual shield termination is provided at the terminal block for each of the speed sensor inputs, actuator outputs, analog inputs, analog outputs, and communications ports. All of these inputs and outputs should be wired using shielded, twisted-pair wiring. See options below for correct shield terminations for your installation. The exposed wire length, beyond the shield, should be limited to one inch. Relay outputs, contact inputs, and power supply wiring do not normally require shielding, but can be shielded if desired.

For compliance with EMC standards, it is required that all analog and discrete input/output wiring be separated from all power wiring. It is also required to follow shielding and grounding practices as called out in the manual 26167 Volume 1 & Volume 2.

Signal Wiring

Option 1 (Typical to most industrial sites)—Analog signal shields floating at device end and hard grounded at Control end.

> **Note:** Ensure the FTM Ground Terminals are grounded to Earth (terminal 26 on FTM103-1 and terminal 74 on FTM103 -2).

In this case, the device shield needs to be grounded at the Woodward FTMs. Grounding bars are installed in the FTMs to support this configuration since it is the most common. If the device shields are grounded (to Chassis ground) at the device end, then REMOVE these shorting bars and follow option two or the individual tabs from the Grounding bar can be cut off.

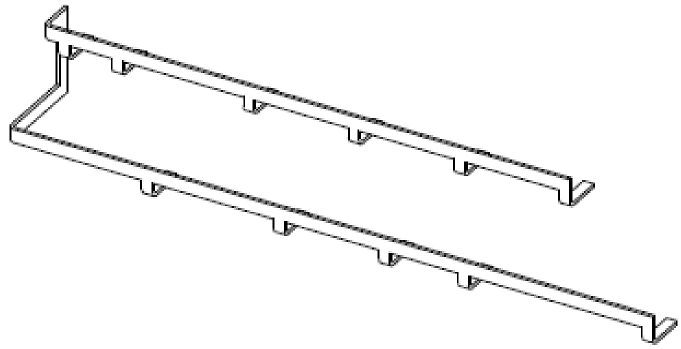


Figure 11-1. FTM103-1 and FTM103-2 Grounding Bars

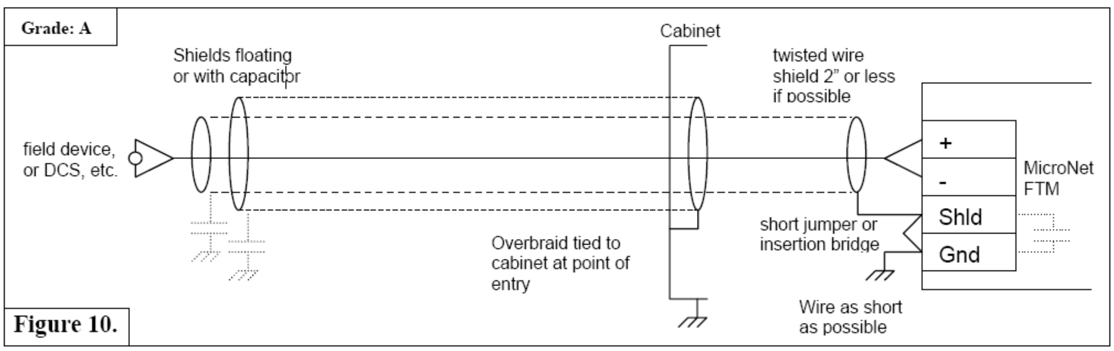


Figure 11-2. Shield Termination Diagram 1

Option 2—Analog signal shields grounded at device end.
The shields should be connected to earth ground at all intermediate terminal blocks, as well as terminated at the control terminal block (AC Coupled).

In this case the shorting bar is removed to provide a capacitive connection to ground (in addition to the 'hard' ground) at the device end.

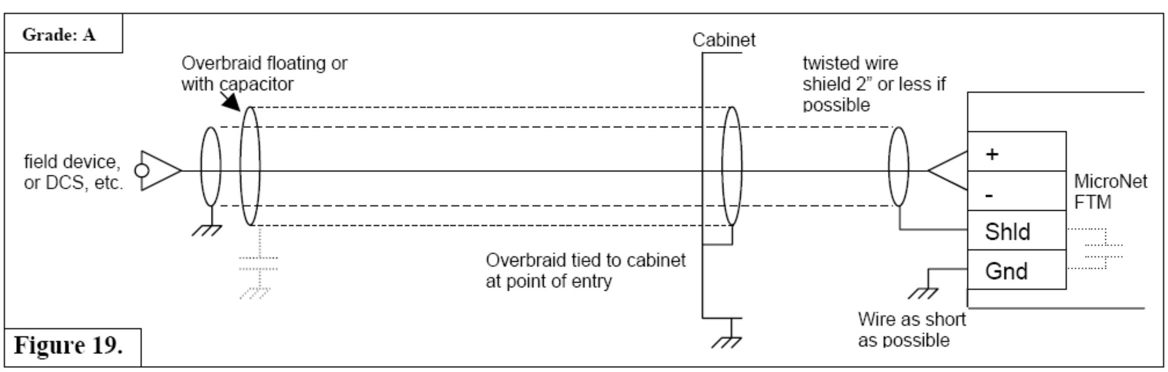


Figure 11-3. Shield Termination Diagram 2

Input Power

Branch circuit fuses, breakers, and wiring must have applicable safety approval and be selected according to applicable codes and area classifications. The system disconnect (not provided) MUST be in easy reach of the operator and marked as a disconnect device. Each main power supply must have its own branch circuit rated fuse, or circuit breaker with a rating no more than 250% of the maximum rated current of the power supply. See Appendix E. Do not connect more than one main power supply to any one fuse or circuit breaker. Use only the wire sizes specified, for the power required, which meet local code requirements.

Each 5009XT control requires a power source capable of a certain output voltage and current. For AC sources, this power rating is stated in volt-amps (VA). The maximum VA of a source can be calculated by taking the rated output voltage times the maximum output current at that voltage. This value should be greater than or equal to the 5009XT control VA requirement.

Note: the control's main power supplies are not equipped with input power switches.

Table 11-1 provides each power supply's holdup time specification, which is the time the supply will continue to operate within specification after its input power is interrupted. This information may be useful in specifying Uninterruptible Power Supply (UPS) systems.

Table 11-1. Fuse/Breaker Requirements

Input Voltage and Frequency Range	Rated Maximum Current	Maximum Fuse/C.B. Rating	Minimum Wire Size mm²/AWG	Wire Temp. Rating (°C)*	Hold Up Time (Minimum)
18–36 Vdc	33 A	50 A	5.5 / 10	90	5 ms @ 24 V
100–150 Vdc	6.0 A	20 A	4.0 / 12	90	7 ms @ 120 V
88–132 Vac 47–63 Hz	10.0 A	20 A	4.0 / 12	90	1 cycle @ 120 V
180–264 Vac 47–63 Hz	5.0 A	10 A	2.5 / 14	90	1 cycle @ 220 V
200–300 Vdc	3.0 A	10 A	2.5 / 14	90	7 ms @ 200 V

*Wire Temp ratings specified are for 55 °C cabinet ambient.
All fuses listed above are "slow blow".

Significant inrush currents are possible when current is applied to the main power supply. The magnitude of the inrush current depends on the power source impedance, so Woodward cannot specify the maximum inrush current. Time- delay fuses or circuit breakers must be used to avoid nuisance trips.

The 5009XT control includes a set of two main power supplies. Input power ratings are identified in Table 4-1 and on each power supply's front panel. Refer to MicroNet TMR manual 26167 for all power supply specifications.

IMPORTANT

Each main power supply provides three separate 24 Vdc outputs rated for 0–6 A each. To preserve system integrity, it is recommended that the control's three isolated 24 Vdc outputs be kept isolated from each other at all times. If the control's 24 V power is used to power external devices, the system's three 24 V outputs must not be tied together. If these outputs are tied together, and a short circuit occurs, it will shut down the entire 5009XT control. External devices requiring 24 Vdc power must be connected to only one of the power supplies.

Externally powered analog inputs or outputs and external relay coil power must be supplied by and IEC rated or NFPA 70 (NEC) Class 2 power supply as required by local authority having jurisdiction.

Communications

Each Kernel CPU has two User-available Ethernet ports, 2 CAN ports and one serial communication port. The primary communication interface to the control is using Ethernet. Each CPU has a primary (ENET1) and secondary port (ENET2) which must be on separate networks. Typically the first ENET port on each control configured with a unique IP address so they can all be connected to a common LAN and accessed by an Ethernet switch.

IMPORTANT	**If both Ethernet ports (1 & 2 on same CPU's) are to be used they must be configured with IP addresses that are on different domains. Refer to Appendix C to see they default IP settings from Woodward as an example.**

Serial Port configurations

The serial port on each CPU is configurable to be used only as a Modbus communication link.

- CPU-A (RS-232/422/485) can function as a port on Modbus as Link 3 or Link 4
- CPU-B (RS-232/422/485) can function as a port on Modbus as Link 3 or Link 4
- CPU-C (RS-232/422/485) can function as a port on Modbus as Link 3 or Link 4

All of these communication ports can interface with other devices via RS-232 communication. RS-232 communication is limited to a distance of 15 m (50 ft). In cases where a device which is being interfaced to is located a distance of greater than 15 m (50 ft) from the control, it is recommended to use RS-422 or RS-485. RS-422 and RS-485 communication support multi-dropping (multiple slaves on a single communication line); RS-232 communication does not.

CAN Port configurations – (planned for release at Revision A)

This control application has pre-programmed CAN communication links on Ports 2 of Kernel B and Kernel C to allow users to easily interface to Woodward's Servo Position Controller (SPC) digital driver product. Four SPC's are supported and allow for various configurations of system redundancy. Refer to section later in this chapter for more information on using CAN connections to SPC digital drivers.

Communication to RemoteView –

RemoteView is the primary GUI interface to the control software and communicates via Woodward's Servlink protocol over Ethernet to any of the 6 ENET port on the control. Appendix H gives detailed instructions on installing this software and establishing a connection to the control.

Communications via Modbus

The 5009XT control can simultaneously communicate with up to four Modbus based devices using ASCII or RTU Modbus transmission protocols. These 4 links can be independent or used as redundant links to other devices.

The Ethernet Modbus links can be configured for TCP or UDP protocol and all 3 of the serial port are available for use as Modbus links. Refer to Volume 3 of this manual for a list of all the Modbus commands and parameters available.

Control System Input/Output Signals

Speed Sensor Inputs—TMR Speed/Analog Combo Module

The 5009XT control uses speed sensing probes mounted off of a gear connected or coupled to the turbine's rotor to sense turbine rotor speed. The first three channels of the control accept passive magnetic pickup units (MPUs), 12 Vdc proximity probes or 24 Vdc proximity probes. These three channels are used to determine the turbine operating speed for control purposes. In this standard software application, Channel 4 is dedicated to be used for slow speed detection only and thus is typically a proximity type probe. The control will display this sensed speed as the turbine speed when the actual speed is below the low speed setting for the first 3 channels.
It is not recommended that gears mounted on an auxiliary shaft coupled to the turbine rotor be used to sense turbine speed. Auxiliary shafts tend to turn more slowly than the turbine rotor (reducing speed sensing resolution) and have coupling gear backlash, which results in less than optimum speed control. For safety purposes it is also not recommend that the speed sensing device sense speed from a gear coupled to a generator or mechanical drive side of a system's rotor coupling.

All speed sensing inputs have the option of using the same programmed gear ratio and number of teeth to calculate speed, thus the speed probes used should sense speed from the same gear. If they are different, that configuration is possible, but not typically recommended. The 5009XT control can sense and control turbine speed from a single speed probe, however, it is recommended that all applications use multiple speed probes to increase system reliability.

A passive MPU provides a frequency output signal corresponding to turbine speed by sensing the movement of a gear's teeth past the MPU's pole piece. The closer the MPU's pole piece is to a gear's teeth and the faster the gear turns the higher a passive MPU's output amplitude will be. The 5009XT control must sense an MPU voltage of 1 to 25 Vrms for proper operation.

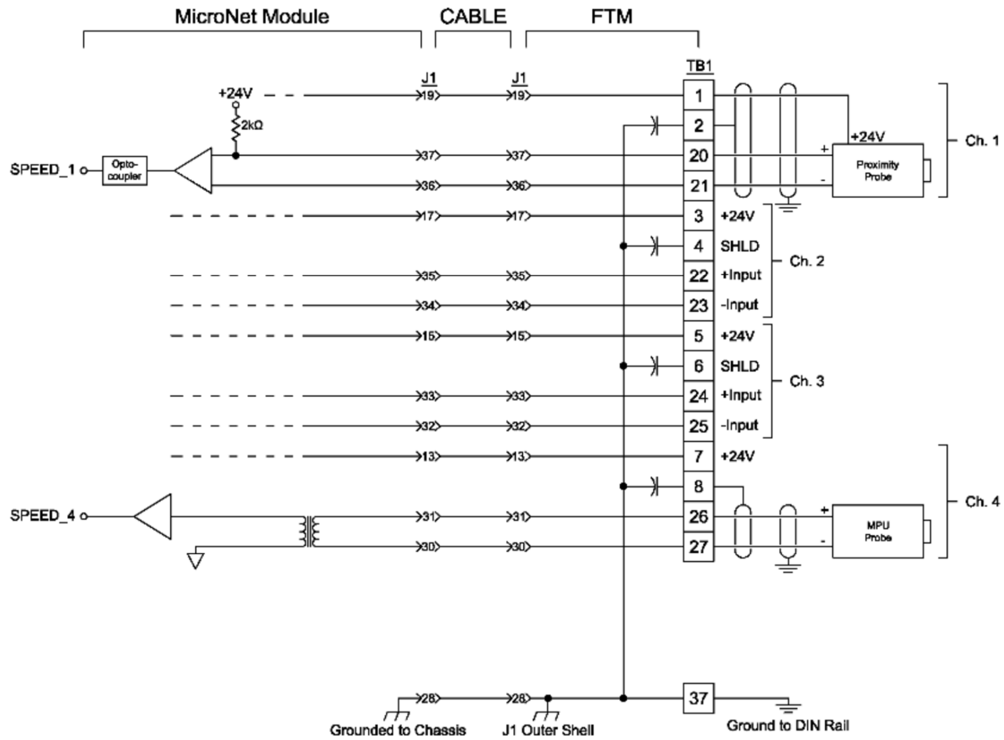
Depending on an MPU's limitations, each input channel can be jumper configured to allow an MPU to drive either two or three inputs (some MPUs cannot drive three inputs). Wire jumpers must be installed to allow an MPU to drive into all three inputs. When the jumpers are not installed, only two input modules are driven by a MPU. With proper MPU, gear size, and MPU-to-gear clearance, speed measurement should be capable down to 100 Hz. Standard MPU clearance is recommended to be 0.25 to 1.02 mm (0.010 to 0.040 inch) from tooth face to pole piece. For information on selecting the correct MPU or gear size, please refer to Woodward manual 82510. See Figure 4-4 for wiring schematic.

Because of differences between the sensing circuits required to interface with passive (MPUs) and active (proximity) probes, separate terminals are provided for each type. This allows a simple method of field selecting the type of speed input based on the type of probe used. Short-circuit protected 12 Vdc and 24 Vdc sources, with isolation diodes on the power, common, and output source lines, are provided with each speed input to power system proximity probes.

Speed channel 4, if used, should be configured to receive a proximity probe. A proximity probe may be used to sense very low speeds. With a proximity probe, speed can be sensed down to 0.5 Hz. The 5009XT control can be programmed to turn on or off a turbine turning gear using a relay output programmed as a slow speed switch. See Figure 4-5 for proximity probe wiring schematic.

Channel 4 prox return input accepts 5–28 Vdc. Alternatively with either 12 Vdc or 24 Vdc open collector probes. When interfacing to open collector type probes a pull-up resistor between the four-voltage terminal and the proximity return terminal is required.

SPEED SECTION 01



GROUNDING

Figure 11-3. Example MPU and Proximity Probe Interface Wiring Diagram

Each FTM connects to the control's MPU & Analog I/O modules through individual cables, and provides a common cage-clamp terminal connection for customer field wiring. Figures 4-4 and 4-5 illustrate the different input wiring configurations based on the type of speed sensing probes used.

Wiring Notes:
- Refer to Figures 11-3 and Appendix E for Speed Sensor wiring connections on the FTMs.
- Each Speed input channel can only accept one MPU or one Proximity probe at a time.
- Proximity Probes only—Individual 12 Vdc and 24 Vdc sources, with isolation diodes on the power, common, and output source lines, are provided with each speed input to power system proximity probes (100 mA fuses are used on the 24 V output, the 12 V is current limited to 100 mA and located on the FTMs).
- Proximity Probes only—External pull-up resistors are required when interfacing with an open collector type of proximity probe.
- Proximity Probes only—Jumpers must be installed from 'A&B IN' and to 'C IN' as shown in Figure 4-5 to avoid noise issues.
- Proximity Probes only—If using external power for these inputs, the power supply should be isolated and must be located within 30 m of the MicroNet+ TMR chassis.
- It is required that twisted shielded wiring be used between each probe and FTM.
- Shields should be connected together at all intermediate terminal blocks and terminated to earth ground at the FTM terminal block through the Grounding Bar. The exposed wire length, beyond the shield, should be limited to 25 mm (1").
- FTM terminals accept wires from 0.08–2.5 mm² (27–12 AWG).

IMPORTANT	If the speed signals are not within the following limits, the 5009XT control will respond with a speed sensor frequency error during the program checking procedure.

(TxMxR)/60 must be < 25 000 Hz

T = Gear Teeth

M = (Overspeed Test Limit Setting x 1.02)

R = Gear Ratio

IMPORTANT **If the MPU device is not providing a voltage greater than 1.5 Vrms, the MPU device should be moved closer to the gear where speed is being monitored. The following graph shows the minimum voltage necessary to detect speed at the various frequencies.**

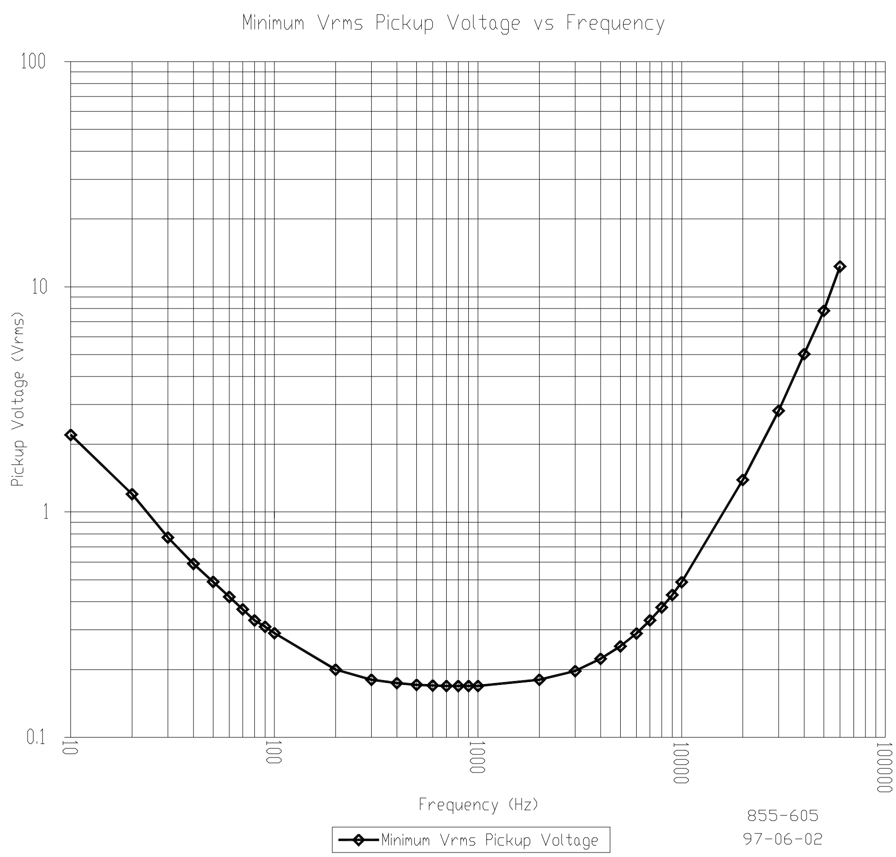


Figure 11-5. MPU Pickup Voltage vs Frequency

Analog Inputs—TMR Analog Combo Module

The base offering control accepts 12 4–20 mA current inputs. All analog inputs may be used with two-wire ungrounded (loop powered) transducers or isolated (self-powered) transducers. Because inputs are not fully isolated, care must be taken in their application and maintenance to avoid “ground-loop” type problems. All analog inputs have 200 Vdc common mode rejection isolation. If interfacing to a non-isolated device which may have the potential of reaching over 200 Vdc with respect to the control’s common, the use of a loop isolator is recommended to break any return current paths, which could result in erroneous readings.

All twelve analog inputs are programmable. When an analog input is used, the chosen input must be wired to and configured within the control’s program to function. Refer to Volume 3 of this manual for a complete list of programmable analog input options.

A 24 Vdc power supply is available from the 5009XT control to power external transducers or other auxiliary devices. Isolation is provided through diodes on the power and common lines. This 24 Vdc output is capable of providing 24 Vdc with +10% regulation. Power connections are be made through terminals located on system FTMs.

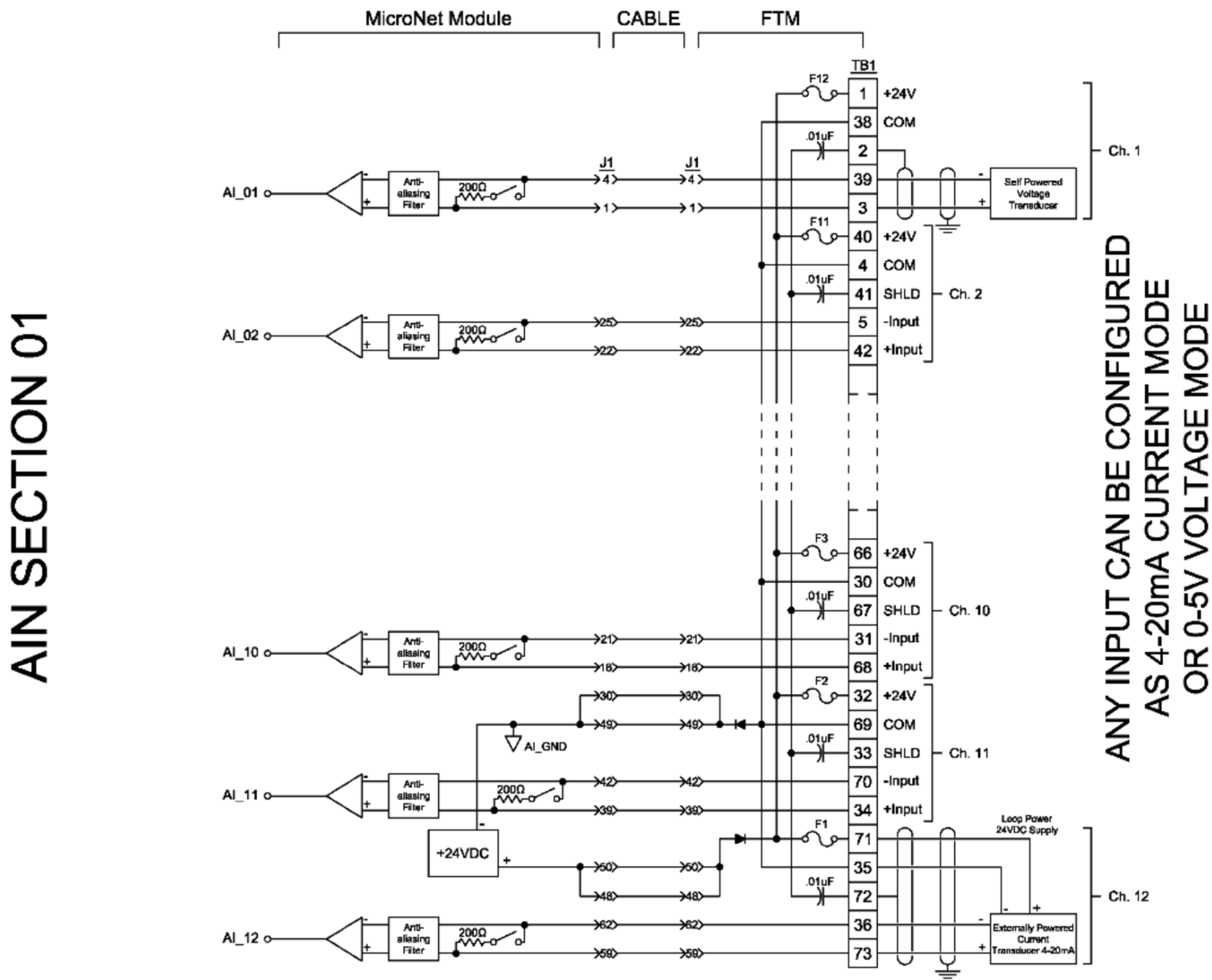


Figure 11-6. Example Analog Input Wiring Diagrams

Analog Outputs—TMR Speed/Analog Combo Module

The control has four 4–20 mA current output drivers. Applications using analog outputs must, within the control's program, have the desired analog value assigned or configured to a specific output. Refer to Volume 1 of this manual for a complete list of programmable analog output options.

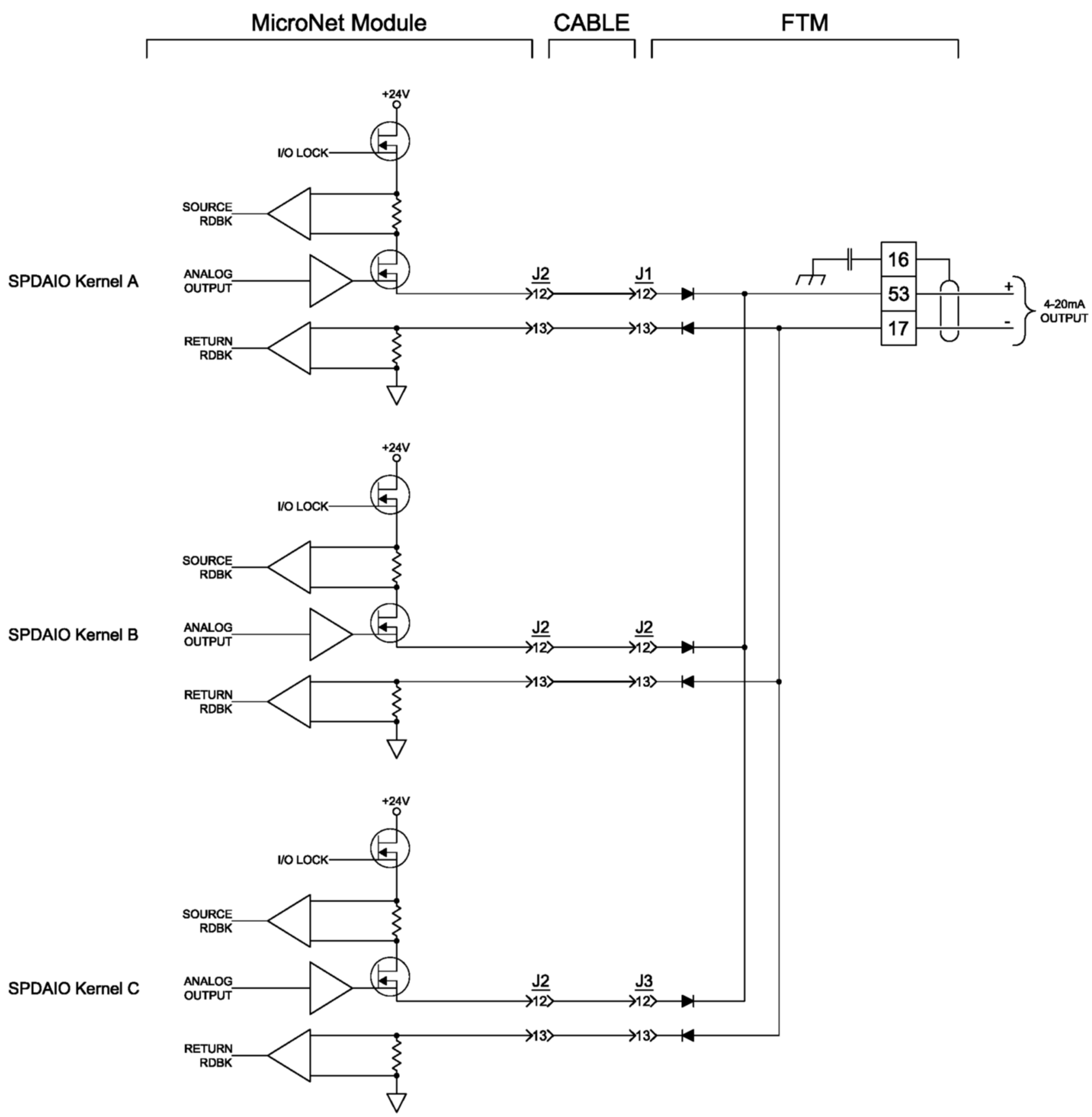


Figure 11-7. Example Analog Output Wiring Diagram

FTM Contact Inputs (F/T Relay–Discrete In)

The 5009XT control accepts 24 contact inputs. Each of the control's four Discrete Termination Modules accepts six contact inputs. Twenty three of the 24 contact inputs are configurable, but the first 4 have been defaulted to functions required by most all systems and should not be changed.
The Preset Contact Inputs are:

- External Emergency Shutdown #1 (fixed)
- External Reset
- Raise Speed Setpoint
- Lower Speed Setpoint

The control will initiate an emergency shutdown any time the External Emergency Shutdown contact input is opened. This input is typically tied into the system's trip string. Before starting, the External Emergency Shutdown input must have an external contact or switch wired to it and it must be closed. The external reset contact can be used to remotely clear latched alarms and trip conditions. The raise and lower speed setpoint inputs can be used to remotely raise and lower speed or load.

Applications requiring external contact inputs must have the desired function assigned or configured to a specific input. Refer to I/O Function Menu lists in Volume 1 of this manual for a complete list of programmable contact input options.

Normal Contacts must change state for a maximum of 160 milliseconds and a minimum of 80 milliseconds for the control to sense and register a change in state.

The ESD contact (#1) must change state for a maximum of 20 milliseconds and a minimum of 10 milliseconds for the control to sense and register a change in state.

Contact wetting voltage can be supplied by the control or from an external source. 24 Vdc contact wetting voltage is available on each FTM (with isolation diodes on the power and common lines). Optionally, an external 18–32 Vdc power source or an external 100–150 Vdc power source can be used to source the circuit wetting voltage. (The FTM's CE and CSA markings only apply to the 24 V option.) Because all discrete inputs are fully isolated, a common reference point must be established between the input opto-isolators and the contact wetting power source. If the 24 Vdc internal power source is used as for contact wetting, jumpers are required between FTM terminals 33 & 34, and terminals 33 & 35. If an external power source is used for contact wetting, the external source's common must be connected to the FTM's discrete input commons (terminals 34 & 35).

⚠WARNING

HIGH VOLTAGE—If high voltage discrete inputs are used, and there is 125 Vdc on the FTM terminal blocks, there will be 125 Vdc on the FTM cables and cable connectors. All modules should be installed and cables connected before wiring the FTM.

Wiring Notes:

- Refer to Figure 11-8 and Appendix E for Contact Input wiring connections to the FTMs. Section 7.2 of manual 26167V1 provides details of using external power or high voltage contacts.
- The wiring information on DI's in section 7.2 of 26167V1 must be followed.
- All contact inputs accept dry contacts.
- The internal 24 Vdc power source, an external 18–36 Vdc power source or an external 100–150 Vdc power source can be used for circuit wetting. (The FTM's European CE Compliance and CSA requirements only apply to the 24 V option.)
- If the 24 Vdc internal power source is used as for contact wetting, jumpers are required between FTM terminals 33 & 34 and terminals 33 & 35.
- If an external power source is used for contact wetting, the external source's common must be connected to the FTM's discrete input commons (terminals 34 & 35). To meet CE or CSA ratings, power for sensors and contacts must be supplied either by the 5009XT power supplies, or the external power supply outputs must be rated for 30 Vdc or less and have its outputs fused with appropriate sized fuses (a maximum current rating of 100/V, where V is the supply's rated voltage or 5 A, whichever is less).

- Each contact input pulls 13 mA @ 24 Vdc (13 mA @ 120 Vdc) when closed, and requires at least 4 mA @ 14 Vdc (4 mA @ 70 Vdc) to recognize a closure command.
- Verify that the correct input terminals are wired to with respect to the level of contact wetting voltage used.
- The combined current draw through terminals 27, 28, 29, 30, 31, and 32 cannot exceed 400 mA or the Discrete I/O module's on-board power converter will current limit.
- It is recommended that 0.75 mm² (20 AWG) or larger wire be used between each discrete input and the FTM.
- FTM terminals accept wires from 0.08–2.5 mm² (27–12 AWG) wire.
- If 125 Vdc Contact Power is used, the Power Supply must meet IEC 6164-1, Overvoltage Category II.
- With the use of 125 Vdc contact power, it is recommended that the contact power be removed before connecting or disconnecting any 5009-to-FTM cable.

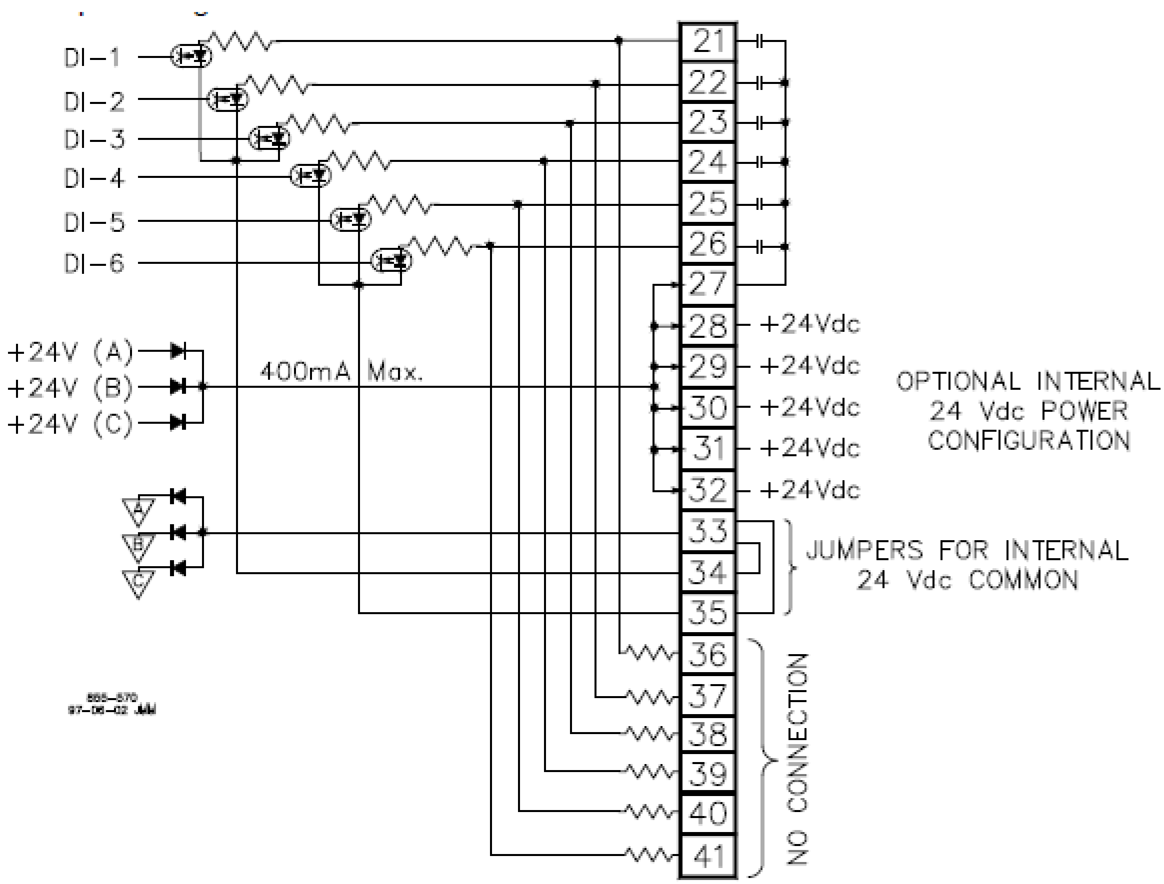


Figure 11-8. Example Discrete Input Wiring using Internal 24 Vdc

FTM Relay Outputs (F/T Relay Outputs)

There are twelve relay outputs available from the 5009XT control, with three outputs per FTM. With the exception of Relay #1 – all of the relays are user-configurable. The defaulted outputs are:

- Shutdown relay #1 (fixed)
- Alarm relay
- Shutdown relay #2

The relay outputs can be programmed to energize upon a function change of state or an analog value level. Applications requiring programmable relay outputs must have the desired switch condition or specific analog value assigned to them within the control's program. Refer to Volume 1 of this manual for a complete list of programmable relay output options.

The 5009XT control system does not have the capability to provide circuit power to external circuits interfacing with a relay output. All external circuits interfacing with control relay outputs must have circuit power provided externally. All relays are dust-tight, magnetic blow-out type relays with Form-C type contacts.

Refer to MicroNet TMR manual 26167 for all relay ratings.

Latent Fault Detection

Because a fault tolerant system can tolerate a single fault, it is possible for this fault to go undetected. This is called a latent fault. If another fault occurs when a latent fault exists, it could cause a shutdown. This is why it is important to detect latent faults in a fault tolerant system.

Each relay output can be individually configured to use latent fault detection to identify relay failures without affecting a relay output's state. A fault tolerant relay configuration consists of 6 relays, driven by two discrete outputs from each kernel. The relays are configured in three legs of two relays each. See Figure 11-8. Customer circuit power is connected to one side of the resulting configuration, and customer load to the other side. Field selectable jumpers, located on system FTMs, are provided to allow each output's latent fault detection logic to be compatible with the circuit being interfaced to.

Six individual relays make up one relay output. When a relay output is closed, the contacts of all six relays are closed. Because of the series-parallel configuration that the relays are in, the failure of any two individual relays will not cause the output to be open. The relay output would continue to be closed. Once a relay output is closed, the output's individual relays are periodically opened and re-closed, to ensure that they were in the correct state, and that they change state.

When a relay output is open, the contacts of all six relays are open. Because of the series-parallel configuration that the relays are in, the failure of any one relay will not cause the output to be closed. The relay output would continue to be open. Once a relay output is open, the output's individual relays are periodically closed and re-opened one by one, to ensure that they were in the correct state, and that they change state. Position readback circuitry allows the state of each relay contact to be detected. Any failures are annunciated, and further testing is disabled without affecting the state of the relay output contact or control operation.

Latent fault detection (LFD) is not usable with all applications or circuits. The control's LFD logic can only work with circuits using voltages between 18–32 Vdc, 100–150 Vdc, or 88–132 Vac. For LFD to work, a small leakage current is passed through the circuit's load. See Figures 11-7, 11-8, and 11-9. Depending on the size of the load, the leakage current may be enough to cause a load to be on or active, when a relay contact is open. In this case, the individual relay's LFD logic may be disabled, eliminating the leakage current.

If LFD is desired, but the leakage current is too great for the load, an external resistor may be connected in parallel with the circuit's load to shunt some of the leakage current away from the load. To prevent failure of a load to de-energize, careful consideration should be given, to ensure that the voltage developed across the load due to leakage current is below the load's drop-out voltage.

With LFD, when a relay contact is closed, no difference in operation is experienced; the relay output appears as a closed contact. However, when a relay contact is open, it appears to the interfaced circuit as a large resistor instead of an open contact. Thus a small amount of current is leaked to the load, resulting in a developed voltage across the load. In most cases this has no bearing on the customer's circuitry, because such a small amount of voltage is developed across its load. However, when a relay output is used with a very high resistance load (low current load), enough voltage may be developed across the load to prevent it from de-energizing.

To verify if Latent Fault Detection can be used with a relay output:

1. Verify that circuit the relay output is used with has a voltage level of 18–32 Vdc, 100–150 Vdc, or 88–132 Vac. If circuit voltage is not within these ranges, disable the relay output's latent fault detection by placing the relay jumpers in their disable state. See Figure 11-11.

2. Use the graph below (Figures 11-7, 11-8, and 11-9) which corresponds to the circuit's voltage level to determine if the voltage developed across the load (due to the leakage current) is lower than the load's drop-out voltage level.
   - Acquire the resistance of the load (relay, motor, solenoid, etc.) to be driven by the relay.
   - Acquire the load's minimum drop-out voltage.
   - From the bottom of the graph, follow the line corresponding to the load's resistance, up until it intersects the circuit power line. At this point the corresponding voltage level (on the left of the graph) is the level of voltage that will be developed across the load due to leakage current.
3. If the developed load voltage (from the graph) is less than the load's drop-out voltage, latent fault detection can be used with the circuit.

4. If the developed load voltage is greater than the load's drop-out voltage, it is recommended that latent fault detection be disabled, or that a resistor be connected in parallel (shunt) with the load. A correctly sized resistor connected in parallel with the circuit load will decrease the developed load voltage below the load's drop-out voltage level. Using the corresponding LFD graph and the load's minimum drop-out voltage, perform the above procedure in reverse (See step #2) to determine an acceptable shunt resistance. When selecting a shunt resistor also verify that its voltage and wattage ratings meet that of the circuit.

LFD Verification Example:
Circuit Power = 110 Vac
Load Resistance = 200 Ω
Load drop-out voltage = 25 Vac

Using the graph in Figure 11-9, the intersection point between the 200 Ω load resistance line and the 110 Vac line was found. From this intersection point it was determined that the voltage developed across the load due to leakage current (when the relay is open) is approximately 7.5 Vac. This voltage level is lower than the load's 25 Vac drop-out voltage, thus Latent Fault detection can be used with this example circuit.

If, however, the load resistance was 1200 Ω, the intersection would be approximately 29.5 Vac too high for LFD. By following the graph along the 25 Vac line to the 110 V line, a total load resistance of 900 Ω is needed. By placing a properly rated 3600 Ω resistor in shunt with the load, (1200//3600⇨900) LFD can be used.

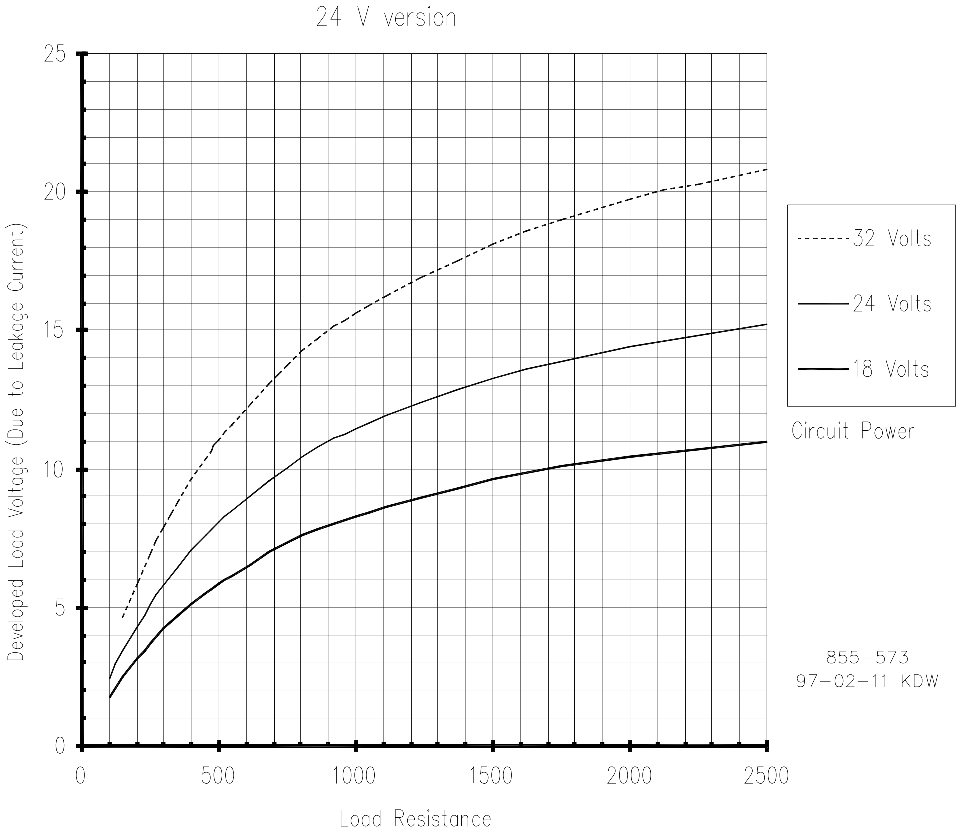


Figure 11-9. Latent Fault Detection Verification Graph—18–32 Vdc Circuitry

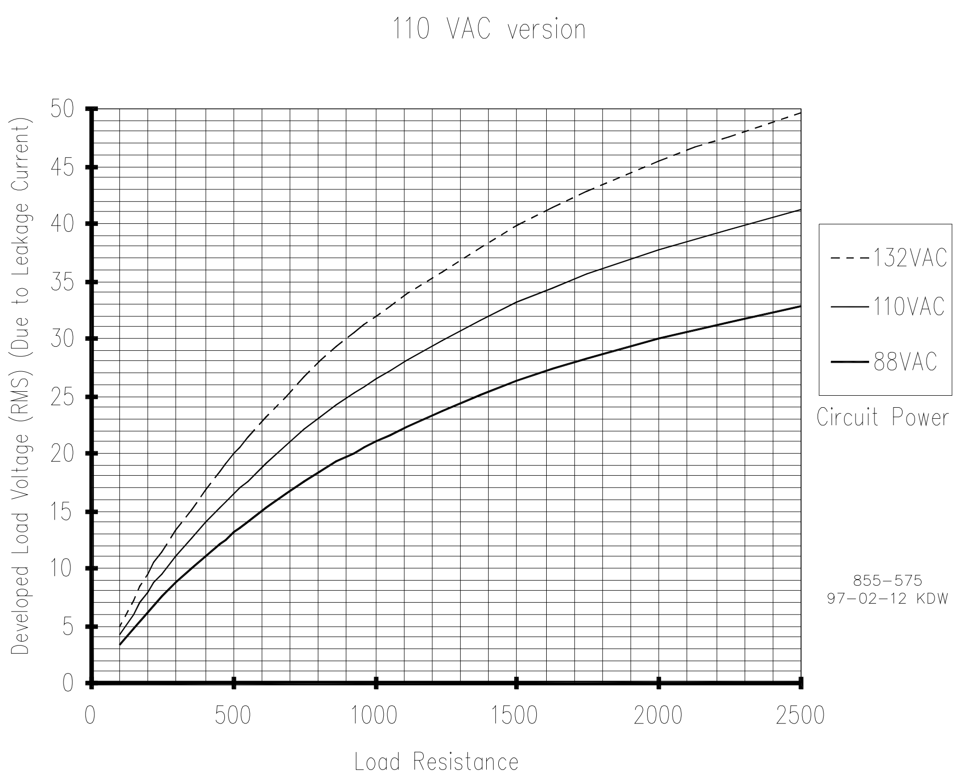


Figure 11-10. Latent Fault Detection Verification Graph—88–132 Vac Circuitry

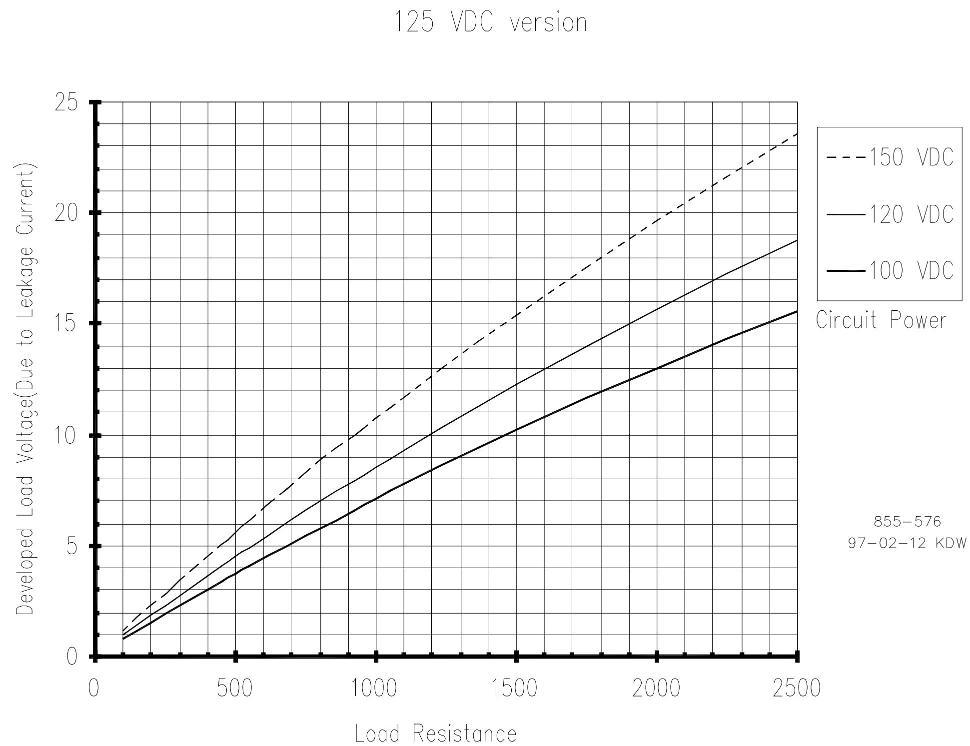


Figure 11-11. Latent Fault Detection Verification Graph—100–150 Vdc Circuitry

Relay Jumper Configurations

Relay coil power should be supplied by the control. Three independent isolated sources are diode selected (High Signal Selected) to power each FTM's relay coil. Jumper banks (four jumpers in one package) are provided on each FTM to allow field selection of internal or external relay coil power. See Figures 11-9 and 11-11. If external relay coil power is supplied, the relay coil power jumper bank must be moved from its defaulted INT. position to the EXT. position.

An FTM includes terminals and internal jumpers to allow its relay coils to be powered by an external power source. This relay coil power configuration was designed for systems which may not have the power sourcing capability to power all system modules and relays (custom designed systems). The 5009XT however, has sufficient power to supply all unit modules and relays.

IMPORTANT	**To retain circuit integrity if an external power supply is used for relay coil power, it must be an isolated 24 Vdc source, with ±5% regulation. When using an external power source for relay coil power, it is recommended that a start-up routine be utilized to remove the source during system power-up and power down. This routine will guarantee that no relay is inadvertently energized due to system power-up surges. (By using the FTM's internal relay coil power this start-up routine is automatically performed.)**

With this system's power configuration, recommend the control's internal power be used to supply the FTM's relay coils at all times.

Field configurable jumpers are used on FTMs to allow a relay's latent fault detection logic to be compatible with different levels of circuit power and to choose which set of relay contacts to test (normally open or normally closed). Each relay output has two banks of jumpers (multiple jumpers in one package).

One jumper-bank (a set of nine jumpers) is used to match the latent fault detection (LFD) circuit with the circuit voltage being interfaced with. The second jumper bank (a set of four jumpers) is used to select which set of relay contacts (N.O. of N.C.) is tested by the LFD logic. During operation, only one set of relay contacts (normally open or normally closed) can be tested. The set of relay contacts tested should be same set of relay contacts used by the circuit interfaced to. Refer to Figure 11-11. LFD can be jumper configured to be compatible with the following circuit voltages:

- 18–32 Vdc circuit power (meets CE & CSA ratings)
- 88–132 Vac circuit power (not listed)
- 100–150 Vdc circuit power (not listed)

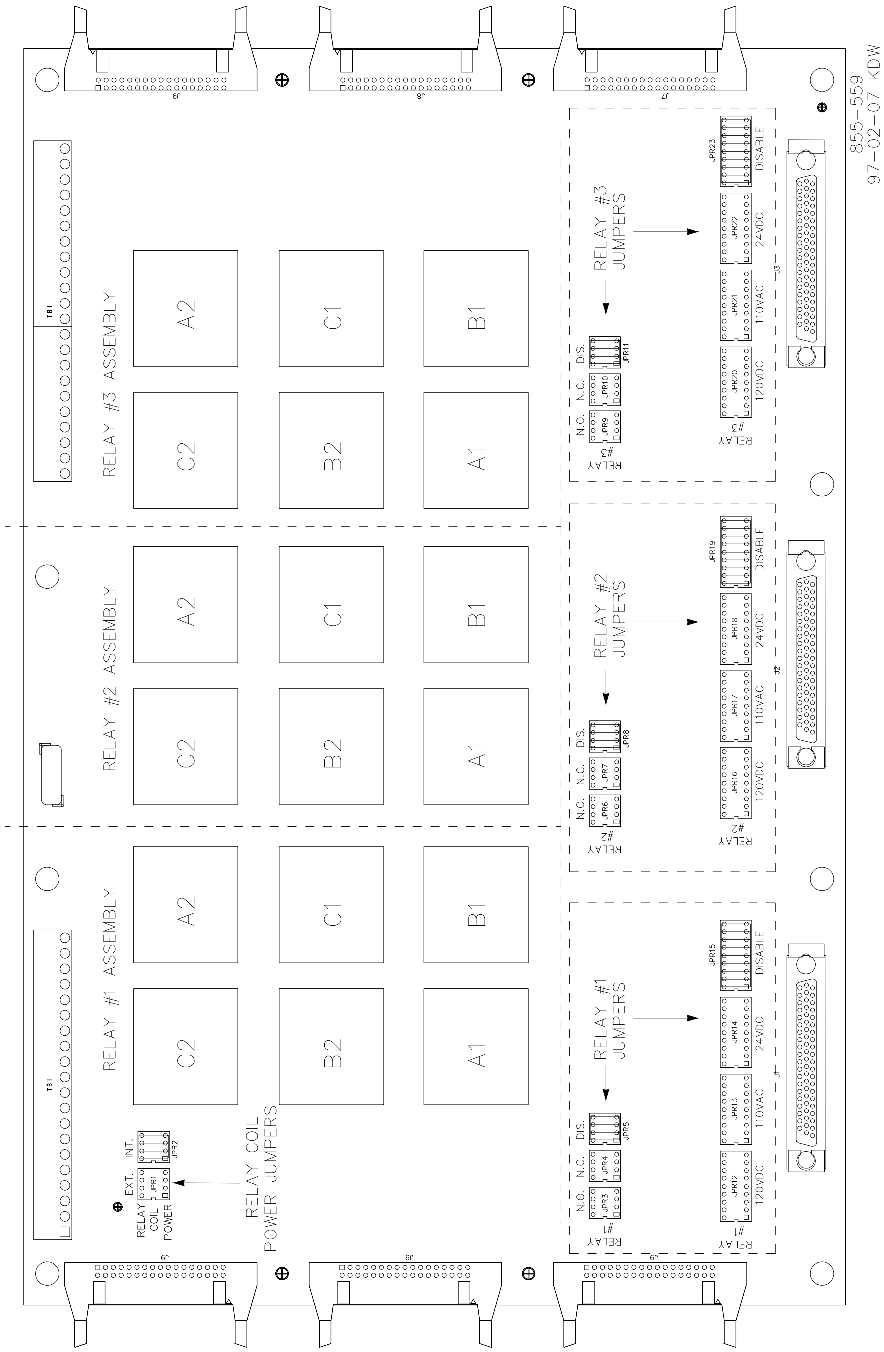


Figure 11-12. Jumper and Relay Location Diagram

After all jumper-banks have been correctly positioned, mark the placement of each jumper-bank on the FTM cover labels, located on each FTM's outer cover. See Figure 11-12.

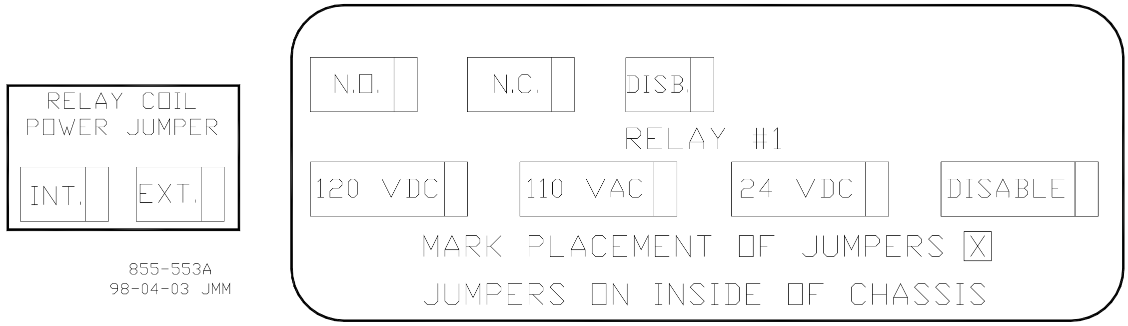


Figure 11-13. FTM Labels

Wiring Notes:

- Refer to Figure 11-14 and Appendix E for relay output wiring connections to the FTMs.
- The wiring information on DO's in section 7.1 of manual 26167V1 must be followed.
- Verify that each set of relay contacts meet the power requirements of the circuit which it is being used with. Interposing relays are required in cases where the interfaced circuit demands relay contacts with a higher power rating. If interposing relays are required, it is recommended that interposing relays with surge (inductive kick-back) protection be used. Improper connection could cause serious equipment damage.
- Verify system power is off before removing or installing any FTM jumper. All jumpers are fragile, use caution when removing and installing FTM jumper-banks.
- Select internal or external relay coil power. If the control's internal power is used verify that the FTM's "Relay Coil Power Jumper" bank is in the INT. position. If external relay coil power is supplied, move the FTM's "Relay Coil Power Jumper" bank to the EXT. position and verify that the external source is fully isolated. (Mark the FTM's label to indicate jumper position.)
- Verify if Latent Fault Detection (LFD) can be used with each relay output.
- If LFD cannot be used with the relay output, verify that the relay's LFD jumper-banks are in their Disable positions. (Mark the FTM's label to indicate jumper position.) Alternatively an external resistor can be wired in parallel with the load to allow LFD to be used with the relay output. In this case it is the customer's responsibility to calculate the required resistor ratings and install it.
- If LFD can be used with the relay output, move the relay's LFD jumper- bank to the correct circuit power position. Also select which set of relay contacts (NO or NC) are to be tested by the LFD logic. Mark the FTM labels to indicate jumper positions.

⚠WARNING	**HIGH VOLTAGE—Relay circuit power is also present on an FTM's relay and cable connectors. When using high voltage relay circuit power, it is recommended that care be taken not to touch exposed connectors when replacing relays or cables. If possible remove relay circuit power from all FTM relays before replacing any FTM relay or cable.**

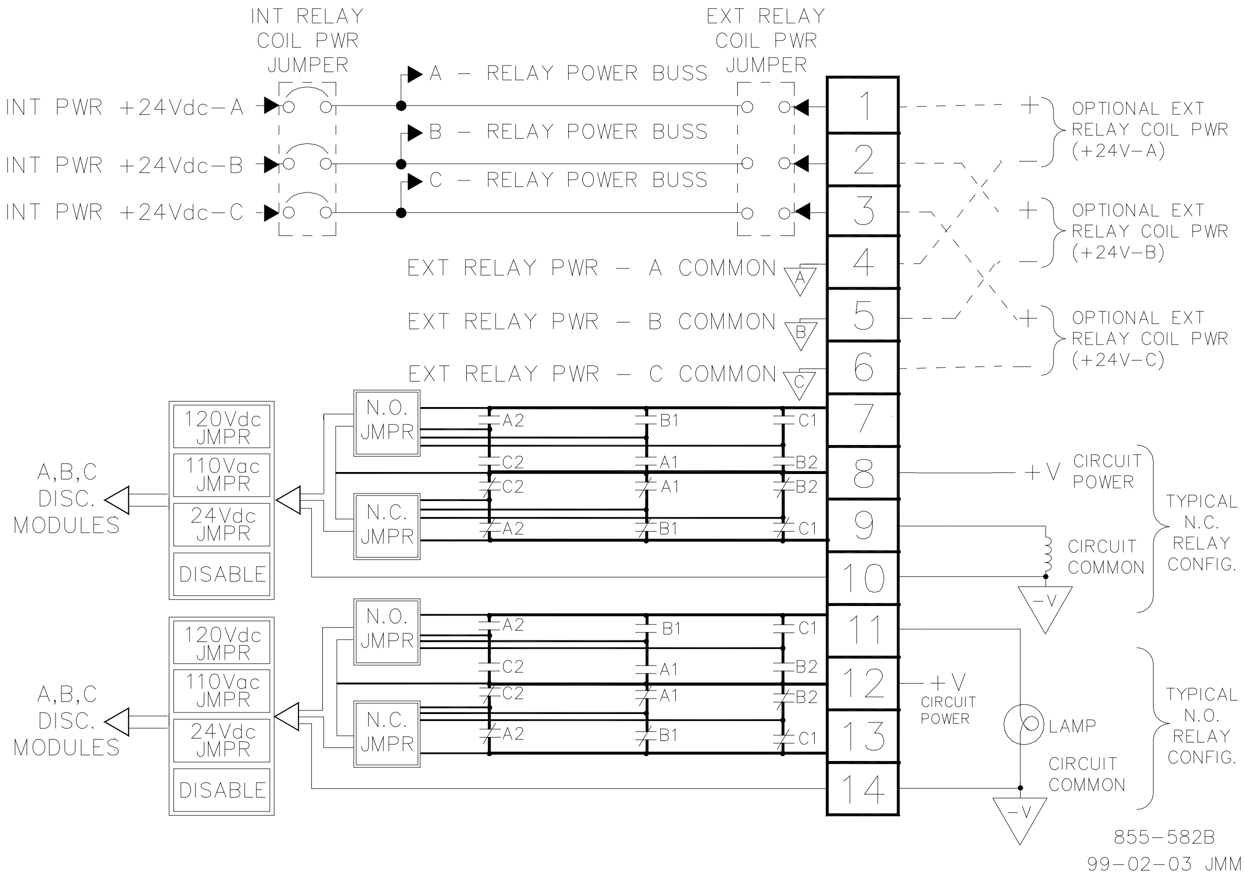


Figure 11-14. Example Relay Output Wiring Diagram

Communications (CAN)

CAN Port Connections to Digital Drivers (If using Optional SPC's)

(Planned for release at Revision A)

The base I/O modules in the system only provide 4 analog outputs each with a range of 4-20mA. For actuator/valve assemblies that require other drive signal ranges or require position feedback, this standard control application supports up to four Servo Position Controllers (SPC / p/n 8200-227). The Kernel B CPU CAN2 port provides a digital link to two drivers, with CAN ID's 11 and 12. The Kernel C CPU CAN2 port provides a digital link to two drivers, with CAN ID's 21 and 22.

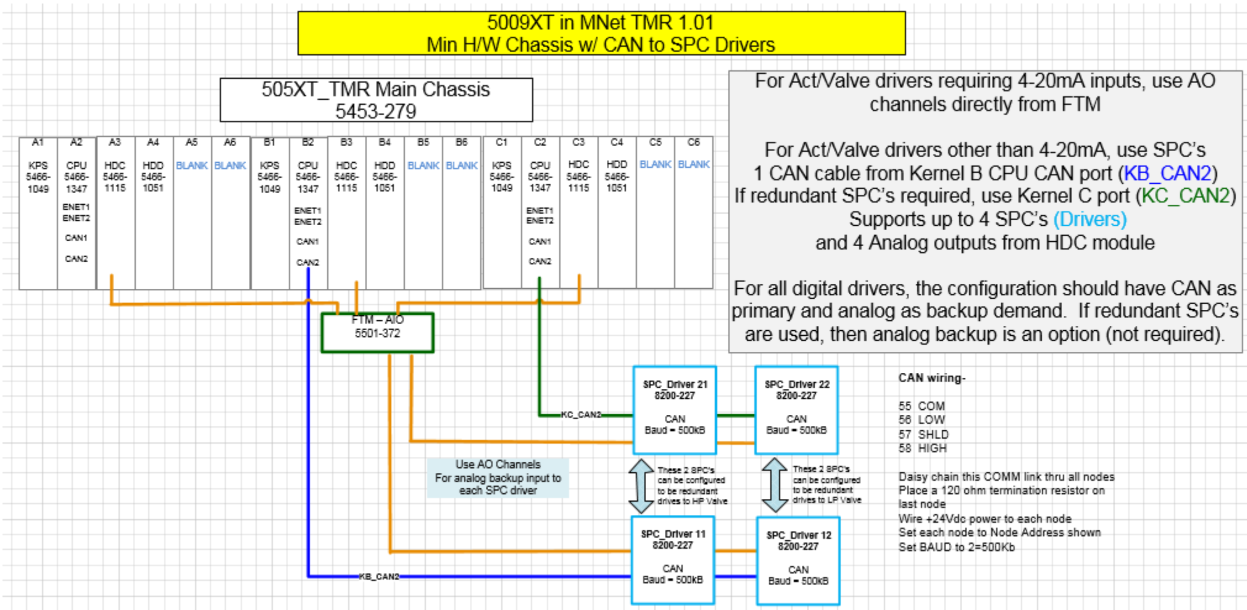
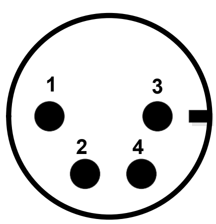


Figure 11-15. Example Control-to-SPC Wiring Diagram

CAN Communication Ports

Five CAN ports (M8 male connectors) are available for communication with Woodward Valves and other CAN devices. A maximum of 15 Woodward valves configured for operation in the 10 ms rate group may be used. When using redundant CPU modules and a failover occurs, each CAN port automatically performs a failover from the SYSCON to the STANDBY CPU module.



Pin 1 – CAN Shield (AC coupled)
Pin 2 – CAN Low (blue)
Pin 3 – CAN Signal Ground (black)
Pin 4 – CAN High (white)

Figure 11-16. CAN Communication Ports (M8 male)

CAN networks must include 120 Ω terminations at each end of the trunk line. Drop cables connecting a device to the trunk line should be as short as possible and less than 6 meters. It is recommended to design the network to be less than 100 meters with a max cumulative drop length of less than 39 meters.

Table 11-2- CAN Network Trunk Line Specifications

Network Speed	Max Trunk Length (Thick cable)	Max Trunk Length (Thin cable)	Max Drop Length	Max Cumulative Drop Length
1 Mbps	30 m	30 m	1 m	6 m
500 Kbps	100 m	100 m	6 m	39 m
250 Kbps	250 m	100 m	6 m	78 m
125 Kbps	500 m	100 m	6 m	156 m

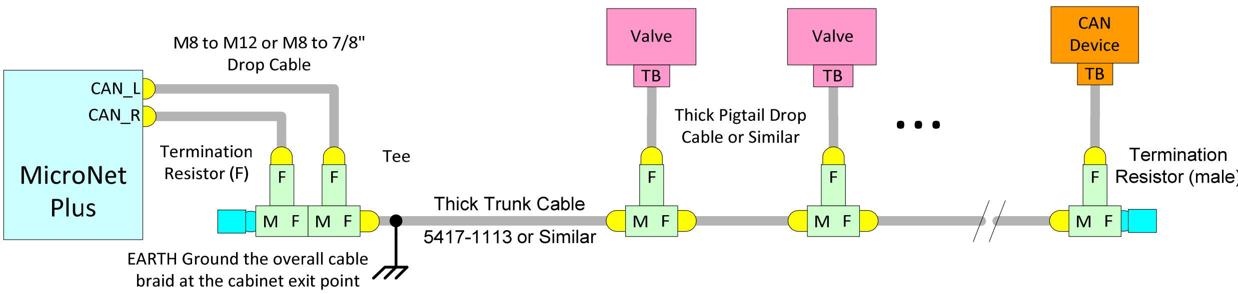
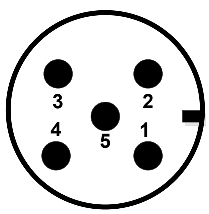


Figure 11-17. MicroNet to Valve CAN Interface

Woodward supplies M8 to M12 (5 pin standard) cables.



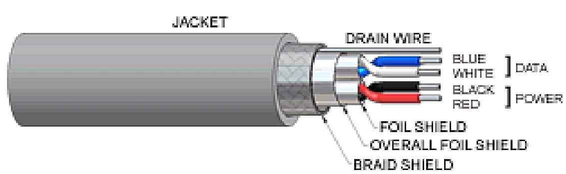
P1 – CAN Shield
P2 – not used
P3 – CAN Signal Ground (black)
P4 - CAN High (White)
P5 – CAN Low (Blue)

Figure 11-18. Example of Woodward supplied 5 Pin Standard Cable

CAN Cable Specification

Thick trunk cable is preferred and recommended. Most CAN / DeviceNet (trademark of ODVA, Inc.) cable is not rated for temperatures above 80 °C so be careful during installation to avoid hot routing areas. Always use shielded cables for improved communications in industrial environments.

Table 11-3. CAN Cable Specification



Impedance:	120 Ω ±10% at 1 MHz
DC resistance:	< 7 Ω per 1000 ft.
Cable capacitance:	12 pF/ft. at 1 kHz
Propagation delay	1.36 ns/ft. (maximum)
Data Pair:	19 strands, 1.0 mm² corresponds to 18 AWG, individually tinned, 3 twists/foot
Power Pair:	19 strands, 1.5 mm² corresponds to 15 AWG, individually tinned, 3 twists/foot
Drain / Shield Wire:	19 strands Tinned Copper shielding braid or shielding braid and foil
Cable type:	Twisted pair cable. 2x2 lines
Bend Radius:	20x diameter during installation or 7x diameter fixed position
Signal attenuation:	0.13 dB/100 ft. @ 125 kHz (maximum) 0.25 dB/100 ft. @ 500 kHz (maximum) 0.40 dB/100 ft. @ 1000 kHz (maximum)

Optional and Custom Modules

Slots A5 in each of the three kernels have been left empty in the base 5009XT offering to provide some flexibility in final configurations. In many cases, the base hardware offering will provide a complete standard control system for typical steam turbine systems. However some systems need specialized interfaces for their actuation, so the intent is that software and hardware module options can be implemented by the OEM or system packager.

Woodward also may provide optional hardware & software modules that can be implemented in similar fashion to support future enhancements. Consult your Woodward sales representative if interested in these options or desire the 5009XT control to be packaged into a system by Woodward.

Control Wiring Diagrams

When installing a system, follow all I/O specific wiring notes (covered earlier in this chapter) and general wiring notes below. For ease of identification system notes are displayed within a triangle on each wiring diagram. The number that appears in a triangle pertains to a wiring note. Appendix E provides all necessary information to wire to the system.

Wiring Notes

1. Refer to Appendix E.
2. Refer to MicroNet TMR manual 26167 for input power ratings.
3. Consult the Customer supplied wiring.
4. Optional Wiring (dependent upon system options).
5. Read and follow all Wiring notes, instructions, and recommendations within this chapter when electrically installing a system.
6. Confirm each connection before operating unit.
7. All analog inputs must be isolated from earth ground.
8. Follow authorized standards for conduit loading and sealing.
9. All wires to terminal blocks shall have wire markers, marked with associated terminal number.

System Power-Up

If at any time during this procedure the defined or expected result is not achieved, step to Chapter 5 of this volume and begin system troubleshooting.

1. Turn the power for one power supply on and verify that the power supply’s green LED is the only power supply LED on.
2. Turn the power for second power supply on and verify that the power supply’s green LED is the only power supply LED on.

At this point, the system will perform off-line diagnostics, this diagnostics testing will typically take about two minutes. When all CPUs have synchronized and completed their diagnostic tests, no red LEDs should be on, and the control will begin running the application program.

IMPORTANT	**When the momentary RESET button is pressed the CPU’s red Fault and Watchdog LEDs should go out and the green RUN LED should go on. At this time, the CPU is performing the self-diagnostics and boot-up processes. If only one CPU has been reset, (other CPUs still failed) the 5009XT will wait for another CPU to boot-up before both CPUs will go to a running state.**

⚠WARNING	**Improperly calibrated devices can cause turbine damage and possible personnel injury or death. Before starting the turbine for the first time, and periodically thereafter, verify the calibration of all external input and output devices.**

Chapter 12. Troubleshooting and Module Replacement

Introduction

This chapter provides detailed information on system hardware, gives tips to assist in solving hardware related issues, and includes module replacement instructions. Once a system problem is annunciated, this chapter can be utilized as a troubleshooting guide to assist problem finding and if necessary module replacement.

Because testing all functions of an individual module is beyond the scope of this manual, when the results of the procedures indicate that a module may be faulty, replace the suspected module with a module known to be good. This will help verify that the cause of the problem actually is in the suspected module.

If after following this chapter's guidance the cause of a problem cannot be found, contact the Woodward technical assistance group.

NOTICE	**Only qualified service personnel should perform the following module replacement procedures.**

Main Power Supply (PSM1 and PSM2)

System diagnostic routines continuously monitor each main power supply for proper operation. If a fault condition is detected, the fault is annunciated, and the supply's output disabled. If necessary, use the power supply's front panel LEDs to assist in diagnosing a related problem. If all supply LEDs are turned off (not illuminated), it is probable that input power is not present and verification should be made.

Main Power Supply LED descriptions:

OK LED—This green LED turns on to indicate that the power supply is operating and no faults are present.

INPUT FAULT LED—This red LED turns on to indicate that the input voltage is either above or below the specified input range. If this LED is on, check the input voltage and correct the problem. Long-term operation with incorrect input voltages may permanently damage the power supply. Once the input voltage is within the supply's input specifications, this LED will turn off. Refer to Table 4-1 for power supply input specifications.

OVERTEMPERATURE LED—This red LED gives an early warning of a thermal shutdown. The LED turns on to indicate when the internal power supply temperature reaches approximately 80 °C. If the internal supply temperature rises further to approximately 90 °C the supply will shutdown. Because of the many variables involved (ambient temperature, load, thermal conductivity variations) there is no accurate way of predicting the time between the indication of Overtemperature (LED illuminated) and power supply shutdown. If this LED is turned on, verify that the fan in the power supply chassis is turning, and is free of dust or other obstructions and that the temperature around the power supply is less than 55 °C. If the power supply is cooled down without delay, it can recover from this situation without shutting down. This LED will turn off once the internal supply temperature decreases below approximately 75 °C.

POWER SUPPLY FAULT—This red LED turns on when one of the supply's three power converters has shut down. If this LED is on, check for a short circuit on external devices connected to the control's power supply. Once the short circuit is removed, the supply may resume normal operation. If no short circuit is found, try resetting the supply by removing input power for one minute. Once input power has been restored, if the power supply is still not functioning, verify that the supply is properly seated to the motherboard connector, if still not functioning, and replace the supply.

Each main power supply must have its own branch circuit rated fuse or circuit breaker. A main power supply module has internal fuses; however these fuses do not protect the supply's input circuitry, and will only open in the event of a component failure internal to the power supply. If any of the supply's internal fuses are open, replace the supply.

To replace a main power supply (PSM1, PSM2):

1. Read all warnings at the beginning of this volume before replacing any module.
2. Remove input power from the power supply being replaced (CB3 or CB4).
3. Unscrew front panel mounting screws, and release the module from the motherboard connectors by pressing the top handles up and the bottom handles down.
4. Remove module by pulling straight out.
5. Install a new power supply by aligning the circuit board edges in the card guides and push the unit into the slots until the connectors on the modules and the connectors on the motherboard make contact.
6. With even pressure exerted at the top and bottom of the supply's front panel, firmly push the unit into place.
7. Tighten the screws that secure the module in place (two at the top and two at the bottom).
8. Re-apply power to the input of the power supply.

Kernel Power Supply (Kernel A/B/C: A1)

Each kernel section of the MicroNet TMR control contains one kernel power supply module located in the first slot of the kernel. This module receives 24 Vdc from the main TMR supply and regulates it to 5 Vdc, 10 A for the rest of the kernel section. The kernel power supply also creates a 5 V pre-charge voltage. There are no switches on this module. A Fault LED is on the front panel of the power supply. It will illuminate if a problem occurs with the 5 V or 5 V precharge.

The kernel power supply module also assists in CPU to CPU communications. If the control reports a CPU to CPU communication fault, the affected kernel power supply module may need to be replaced.

⚠WARNING	**With this control the removal of any single kernel will not cause a shutdown. However, if other faults are present within other kernels, those faults combined with any faults created by the removal of this kernel power supply may cause a system shutdown.**

To Replace a Kernel power supply module:

1. If the control is running and on-line, use RemoteView to verify the other CPUs are running without faults. Correct all other CPU & I/O module faults within the other kernel sections before replacing a kernel's power supply.
2. Unscrew the Kernel Power Supply module's captive screw fasteners and release the module from the motherboard connectors.
3. Press the momentary reset button on the respective kernel's CPU to place the kernel in 'Reset' mode.
4. Remove the Kernel Power Supply by pressing the top handle up and the bottom handle down.
5. Remove the module by pulling straight out and place it into a conductive plastic bag (Woodward P/N 4951-041).
6. Install the replacement supply module by aligning the circuit board edge in the card guides and push the module into the slots until the connector on the module and the connector on the motherboard make contact.
7. With even pressure exerted at the top and bottom of the supply's front panel, firmly push the supply module into place. Tighten the two screws that secure the module in place (one at the top and one at the bottom).
8. At this point, the kernel CPU will automatically begin a reboot procedure and perform off-line diagnostic tests for approximately 60 seconds then re-synchronize with the other control CPUs.
9. At this point – return to RemoteView (re-connect if Kernel A was the area affect by the above procedure), go to the Alarm Summary page, and enter a RESET.

10. All kernel and module alarms should clear, restoring complete fault tolerance to the system.

Replacing a 5009XT CPU while Unit is Running

The 5009XT system from Woodward is initially setup with the following default IP Addresses, unless unique site network IP addresses are provided. If the control is on a LAN network at a site, then use those IP addresses in place of the Woodward default IP's in the table below.

Table 12-1. Default IP Addresses

	KERNEL A	KERNEL B	KERNEL C
ENET1	IP = 172.16.100.11 Subnet = 255.255.0.0	IP = 172.16.100.12 Subnet = 255.255.0.0	IP = 172.16.100.13 Subnet = 255.255.0.0
ENET2	IP = 192.168.128.21 Sub = 255.255.255.0	IP = 192.168.128.22 Sub = 255.255.255.0	IP = 192.168.128.23 Sub = 255.255.255.0

For **Woodward 'Spare' CPU default from factory**
Ethernet 1 =
    Enter the IP address **172.16.100.1**
    Enter the Subnet mask 255.255.0.0
Ethernet 2 =
    Enter the IP address **192.168.128.20**
    Enter the Subnet mask 255.255.255.0

CPU Module (Kernel A/B/C: A2)

System diagnostic routines continuously monitor each CPU for proper operation. If a fault condition is detected, the fault is annunciated and the CPU is locked out of all voting. If necessary, use the CPU module's front panel LEDs to assist in diagnosing a related problem. If all CPU LEDs are turned off (not illuminated), it is probable that input power is not present and verification should be made. If only one CPU module has all of its LEDs off, it is probable that the kernel power supply is not functioning.

The CPU module has the following indicators and switch:

RESET (Recessed)—This momentary push-button resets the CPU and I/O modules (Kernel) when pressed. The CPU performs a boot-up sequence, and then synchronizes to the other Kernels and functions normally.

RUN LED—This turns GREEN when the CPU is operating and no faults are present. If this is RED, the CPU is in Reset mode.
ETH G/Y (Link & TX/RX) LEDs—Link Active GREEN indicates a valid Ethernet connection to another device exists. Tx/Rx Active YELLOW when data is transmitted or received.

SYSCON LED—System Controller GREEN LED –on when the CPU is active and in control of the Kernel IO

LOW VCC LED—This red LED turns on when the Kernel power supply's +5 Vdc output is out of its specified limits. If this LED is on and remains on after a CPU reset, replace the Kernel power supply.

FAULT LED—This RED LED actively flashes CPU fault codes as necessary.

STANDBY LED—NOT USED FOR TMR SYSTEMS

I/OLOCK LED—This red LED turns on when a major CPU or I/O module hardware fault has been detected. When a major fault is detected, the fault is annunciated, all discrete outputs are locked in a de-energized state, and all analog output signals locked to zero current. The reason for a hardware fault can be viewed through the engineering workstation. After the problem has been corrected, perform a CPU reset to unlatch the I/O lock logic.

WDOG LED—This RED LED turns on if the CPU stops executing the application program. After the problem has been corrected, perform a CPU reset to unlatch the Watchdog LED logic.

CAN LEDs—CAN communication ports – if used disconnect this cable after powering down the CPU

To Replace a CPU module:

1. Read all warnings on pages v and vi of this Volume before replacing any module.
   Note: Replacing a CPU will disable all IO from this kernel.
2. If the control is running and on-line, use RemoteView tool to verify that the other CPUs are running without faults. Review the Alarm Annunciation page to ensure that no IO channels in the selected Kernel are needed to operate.
3. Unscrew the Kernel Power Supply and the CPU module's captive-screw fasteners
4. Press the CPU's reset button to place CPU in reset mode.
5. Disengage the Kernel Power Supply by pressing the top handle up and the bottom handle down, slide it out about an inch, but leave it placed in the chassis.
6. Disconnect any communication cables from the CPU.
7. Remove the CPU module from the motherboard connectors by pressing the top handles up and the bottom handles down.
8. Remove the CPU module by pulling straight out and place it into a conductive plastic bag (Woodward P/N 4951-041).
9. Install the replacement CPU module by aligning the circuit board edge in the card guides and push the module into the slot until the connector on the module and the connector on the motherboard make contact.
10. *With even pressure exerted at the top and bottom of the CPU module's front* panel, firmly push the module into place.
11. Tighten the two screws that secure the CPU module in place (one at the top and one at the bottom).
12. Re-connect any communication cables to the CPU.
13. Re-engage the Kernel Power Supply module by pushing the module into the slot until the connector on the module and the connector on the motherboard make contact, use *even pressure exerted at the top and bottom of the Kernel Power Supply module's front panel*
14. Tighten the two screws that secure the Kernel Power Supply module in place (one at the top and one at the bottom).
15. Launch AppManager from a user PC and follow the detailed steps in Appendix G of this manual to load the correct software and prepare the network addresses before attempting to synchronize this CPU with the 2 running CPU's. Be sure to set the CPU's IP addresses to the correct settings above depending on which Kernel CPU is being replaced.
16. Click on this application file and click on the 'Start Application' (pull-down or tool bar icon).
17. The CPU will Start the application and synchronize with the other kernels. It will obtain all current states and tunable values during synchronization with the other Kernels.
18. At this point – use RemoteView and go to the Alarm Summary page and enter a RESET.
19. All kernel and module alarms should clear, restoring complete fault tolerance to the system.

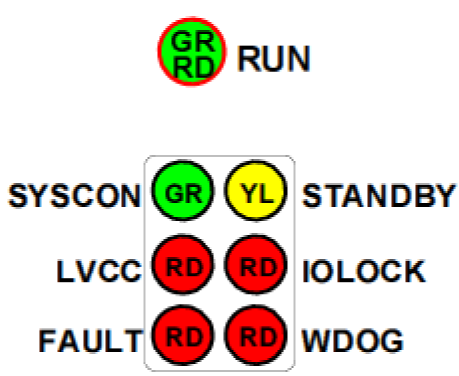


Figure 12-1. CPU Status LED's

For a CPU that already has the correct application loaded and set to Auto-Start, the following is the correct/normal sequence of CPU LED indications above through the boot-up initialization routine (times are approximate):

Table 12-2. CPU LED Boot-Up Initialization Routine with Approximate Times

		Time
1.	Fully inserting CPU into kernel rack with KPS on **LEDs ON—RUN, SYSCON, LVCC, IOLOCK, WDOG**	0:00
2.	**RUN LED** goes OFF	0:05
3.	**RUN LED** goes back ON	0:40
4.	**FAULT LED** goes ON for 2 sec pulse then back OFF	1:05
5.	**LVCC LED** goes OFF	1:20
6.	**WDOG LED** goes OFF	1:30
7.	**IOLOCK LED** goes OFF, hear relay click, sync complete	1:40

Note: If you just press the CPU Reset button on the CPU—sequence and time are the same—the only difference is that the LVCC LED will be OFF the whole time.

Analog and Discrete I/O Modules (Kernel A/B/C: A3-A4)

Each I/O Module has a red Fault LED, controlled by the CPU that is turned on when the system is reset. During initialization of an I/O module, which occurs after every CPU reset, the CPU turns the Fault LEDs on. The CPU then tests each I/O module using diagnostic routines built into software. If the diagnostic test is not passed, the LED remains on. If the test is successful, the LED goes off. If the Fault LED on a module is illuminated after the diagnostics and initialization have been run, the module may be faulty or in the wrong slot.

If during normal control operation all Kernel I/O modules have their Fault LEDs on, check the Kernel CPU for a failure. If during normal control operation, only one module's Fault LED is turned on or flashing, replace this module. A flashing LED indicates that a certain module failure has occurred, and is used by factory technicians to locate module faults. When a module fault is detected, its outputs are disabled or de-energized.

Each Analog I/O Module has a fuse in it.
This fuse is visible and can be changed through the bottom of the plastic cover of the module. If this fuse is blown, replace it with a fuse of the same type and size (24 Vdc/0.1 A).

To Replace an Analog or Discrete I/O module:

1. Read all warnings on pages iv and v of this volume before replacing any module.
2. If the control is running and on-line, use the system engineering workstation to verify that the other CPUs are running without faults.
3. Unscrew the Analog or Discrete I/O module's captive screw fasteners.
4. Disengage the Analog or Discrete I/O by pressing the top handle up and the bottom handle down, slide it out about halfway, but leave it placed in the chassis.

IMPORTANT	**To eliminate the possibility of causing a system trip when replacing a module always un-seat the module before disconnecting the I/O cables. (A system trip is possible if a number of the cable connector pins are shorted to chassis ground.)**

5. Disconnect the module I/O cable or cables. The I/O cables use a slide latch (to disengage slide the latch up).
6. Remove the module by pulling straight out and place it into conductive plastic bag (Woodward P/N 4951-041).

7. Verify that the replacement module is the same Part number as the module that has been removed. It may have a different Revision letter (A, B, C…..) but it must have the same 7 or 8 digit part number (for example the Discrete I/O module is 5466-1051).

⚠WARNING	**Dependent on the field connections and options, connecting the wrong module part number to an FTM or FT Relay Module may cause a system shutdown.**

8. Install the replacement module by aligning the circuit board edge in the card guides and pushing the module into its slot. Slide it in approximately halfway, take care not to allow the module to become in contact with the motherboard connector.
9. Re-connect both module I/O cables. The I/O cables use a slide latch (to secure the cable, slide the latch down). To eliminate the possibility of causing a system trip when replacing a module always connect the I/O cables before seating the module to the motherboard. (A system trip is possible if a number of the cable connector pins are shorted to chassis ground.)
10. With even pressure exerted at the top and bottom of the module's front panel, push the module into place until the module connector is firmly within the motherboard's module receptacle.
11. Tighten the two screws that secure the module in place (one at the top and one at the bottom).
12. At this point the modules LED light should have gone out. If Latent Fault Detection of the FT Relays is used in the system you may hear the clicking of each relay as the system verifies all discrete output functions, this is normal.
13. At this point – return to RemoteView and go to the Alarm Summary page and enter a RESET.
14. All module and channel alarms should clear, restoring complete fault tolerance to the system.

IMPORTANT	**If the module's Fault LED does not turn off after the module has been installed for at least one minute, it may be necessary to re-seat the module more firmly. To re-seat a module follow step #3 of the above procedure to release the module from the motherboard, then re-install the module by following procedure steps #8 and #9. Details of the LED fault codes can be found in manual 26167V1.**

Termination Modules

The replacement of termination modules can be performed on-line (while the unit is operational) or off-line (while the unit is shut down).

IMPORTANT	**If on-line replacement of the FTMs is required/desired, the user must consider this in the assignment of redundant input signals. For example, it may be necessary to add an additional module(s) into the blank slots A05 and/or A06 to meet this requirement. This will require that customized GAP & GUI application software be used.**

Caution must be taken whenever replacing a termination module on-line, or a unit trip could result. The procedure used in the replacement of termination modules on-line varies based on the control's configuration and system wiring configuration. Contact a Woodward representative to establish the correct termination procedure to use based on your configuration. See note above in regard to verifying that upon initial commissioning your system it was designed to allow entire FTM replacement while running, this is not normally a requirement.

Prior to replacement – refer to manual 26167V1 for illustrations on location of fuses on the Analog FTM that should be checked prior to attempting to replace the entire FTM.

To replace an Analog or Discrete Termination Module while the unit is off-line:
1. Read all warnings at the beginning of this Volume before replacing any module.
2. Shut down the control.

3. Remove all power from the system. Do not attempt to replace a termination module with the system powered.
4. Disconnect all FTM and field wiring.
5. Disconnect all FTM cables. The I/O cables use a slide latch (to disengage, slide the latch toward the cable end).
6. Remove the termination module from its panel and install its replacement.
7. Re-connect all cables. The I/O cables use a slide latch; to secure cable, slide the latch away from the cable end.
8. Re-connect all field wiring.
9. Re-apply all power to the system.
10. Reset all CPUs.

To replace FTM Fuses:
1. Read all warnings on pages v and vi of this volume before replacing any fuse. If the control is running and on-line, take care not to come in contact with any FTM circuitry.
2. Remove FTM cover.
3. Verify that the circuit problem has been corrected.
4. Locate and replace fuse (See Figure 5-1) with one of the same size and rating (24 Vdc/0.1 A).
5. Replace FTM Cover.

To replace FT Relays:

⚠WARNING	**HIGH VOLTAGE—Relay circuit power is also present on an FTM's relay and cable connectors. When using high voltage relay circuit power, it is recommended that care be taken not to touch exposed connectors when replacing relays or cables. If possible remove relay circuit power from all FTM relays before replacing any FTM relay or cable.**

1. Read all warnings at the beginning of this volume before replacing any Relay.
2. Locate and replace faulty relay (See Figure 4-18). See MicroNet TMR manual **26167** for recommended replacement relays.
3. Perform a system Reset to clear Alarm.

Diagnostics

The MicroNet CPU module runs off-line and on-line diagnostics that display troubleshooting messages through the debug Service Port and AppManager. Offline diagnostics run automatically on power-up and when the Reset switch is asserted. On-line diagnostics run during normal Control System operation when the GAP application is active. More information on diagnostics tests, subsequent LED flash codes, and serial port messages is contained in the VxWorks® * manual.

*—VxWorks is a trademark of Wind River Systems, Inc.

Table 12-2.CPU Fault LED Flash Codes

Failure	Flash Code
RAM Test Failure	1, 4
Real Time Clock Test Failure	2, 2
Floating Point Unit Test Failure	2, 3
Flash Test Failure	2, 4
HD1 Flash Test Failure	2, 5
I2C Bus Test Failure	2, 6
Module Installed in wrong slot	2, 7
Main Chassis CPU switch must be set to 0	3, 5
Remote RTN Rate Group 5 Slip	3, 7
Remote RTN Rate Group 10 Slip	3, 8
Remote RTN Rate Group 20 Slip	3, 9
Remote RTN Rate Group 40 Slip	3, 10
Remote RTN Rate Group 80 Slip	3, 11
Remote RTN Rate Group 160 Slip	3, 12
Remote RTN Chassis Switch Invalid	4, 5
Backup Remote RTN Chassis Switch different from Primary Remote RTN	4, 6
This module does not support the CAN port(s)	4, 7
This module needs a “footprint” update	4, 9

Table 12-3. Message ID Values as Displayed in AppManager:

Description of ID	ID Number
Created by the Coder (Evaluate specific Application)	1-99
“sysinit” – Problem in system initialization	184,185,186
VerifyCpuMem -- Problem in verify CPU memory	103
VerifyNVLog -- Problem in verify NV_LOG functions	104,143,145
ExecuteTMRMessageTask -- Freerun task error	101,102
TMRDportDiagnostics -- Problem running DualPort test	105,106,112,113,114
WaitRTNBuffer -- Problem waiting for RTN messages	146,147
ioRead -- Problem in the ioRead function	142,183
Run_ll_int -- Problem in the Ladder Logic executive	180
SynCmdBuffer – Problem sending messages to RTN chassis	181
CheckSyncCmdBuffer - Problem sending message to RTN	182
Clk_xvstat -- TMR CPU missing in interrupt service routine	604,605
PresInt -- TMR CPU unable to reach previous target	660
CopyToPickup – Problem syncing lost CPU	130,131,132
Re-sync -- Problem syncing lost CPU	133,134,135,136,137,138
Re-sync -- Lost CPU failed to sync properly	139

Each CPU performs both off-Line and on-line diagnostics. Off-Line diagnostics are performed at power-up or when the CPU’s Reset button is pushed. On-Line diagnostics are performed when the CPU is in its normal operational mode, under application-program control.

System Troubleshooting Guide

The following is a troubleshooting guide for areas to check which may present potential difficulties. By making these checks prior to contacting Woodward for technical assistance your system problems can be more quickly and accurately assessed.

Mechanical System

Actuators

- Is the oil clean?
- Does the actuator have the correct hydraulic pressure (if required)?
- Does the actuator have the correct pneumatic pressure (if required)?
- Does the drive shaft rotate (if required)?
- Is the actuator wiring correct?
- Is the direction of the stroke correct?
- Has the compensation (if so equipped) been adjusted correctly?
- Is the hydraulic return line free and not clogged?
- Is there backpressure on the hydraulic return line?
- Is the feedback (if any) adjusted correctly and sending the correct signal?

Linkage

- Is there slop or lost motion?
- Is there misalignment, binding, or side loading?
- Is there visible wear or scarring?
- Does the linkage move smoothly?

Valves

- Does the valve move through its proper stroke smoothly?
- Does the valve travel its full stroke?
- Can mid-stroke be obtained and held?
- Does the valve fully seat (close) before the governor reaches full minimum stroke?
- Does the valve fully open before the governor reaches maximum stroke?
- Is the bypass valve(s) (if any) in the proper position?
- Are there nicks or contamination which allow steam to pass when the valve is closed?

Oil/Hydraulic System

- Is the oil at the proper operating pressure?
- Is the oil temperature too high for the type of oil being used?
- Is the oil contaminated?
- Does the actuator have sufficient flow of oil?
- Are the accumulators (if any) charged to the correct pressure?
- Are the filters plugged?
- Is the oil pump operating properly?

Steam Conditions

- Is the turbine inlet pressure at design specification?
- Is the steam pressure in the proper operating range?
- Are pressure transducers (if any) located close to the turbine?
- Are there any pressure regulating devices or valves which may interfere with governor operation or proper steam flow?

Control, Alarm, and Fault Indications

- Does the governor indicate it is in the correct control mode?
- Is the governor issuing any alarms?
- Are any of the components of the governor indicating hardware faults?
- Does the actuator demand agree with the actual valve position?
- Are any shutdown conditions present?
- Have the control dynamics been tuned to match the system response?

Communications

- Are the LAN switches powered and operable?
- Are the Ethernet (or Serial) cables all securely connected at both ends?
- Are the IP addresses on the same network domain (within subnet mask)?
- Are any IP addresses duplicated? (LAN will prevent second one from joining)
- Is the 5009XT configured correctly for desired port/protocol/slave #?
- Are there status LEDs that can be checked for activity (on Ethernet)?

Input Signals

- Are all input signals properly scaled?
- Are the inputs free of electrical noise and properly shielded?
- Is the wiring correct?
- Have all field input signals to the control been verified?
- Is the polarity of the signals correct?

Output Signals

- Are the outputs calibrated?
- Have the actuator drivers been calibrated to the stroke of the turbine valves?
- Are the output signals free of noise and properly shielded?
- Is the wiring correct?

Transducers

- Is the transducer calibrated for the proper range?
- Has it been tested by simulating its input and measuring its output signal?
- Does the transducer have power?
- Are the sensing lines feeding the transducer clear of obstructions?

Magnetic Pickups and Other Speed Sensing Devices

- Is the wiring between the speed sensing pickup and the control correct?
- Are there any grounding problems or worn shields?
- Is the signal sufficient (at least 1.5 Vrms)?
- Is the signal a clean sine wave or square wave with no spikes or distortions?
- Is the MPU head clean and free of oil or metallic particles?
- Is the MPU head free of any nicks or chips?
- Is the MPU or proximity probe correctly aligned with the gear?
- Is the speed sensing probe adjusted to the correct gap?
- Is the speed sensing probe head the correct size for the toothed wheel it is being used with?
- Are the proper jumpers installed on the FTM?

Input Voltage/Power Supplies

- Is the input power within the range of the control's power supply input?
- Is the input power free of switching noise or transient spikes?
- Is the power circuit dedicated to the governor only?
- Are the control's supplies indicating that they are OK?
- Are the control's supplies outputting the correct voltage?

Electrical Connections

- Are all electrical connections tight and clean?
- Are all signal wires shielded?
- Are shields continuous from the device to the control?
- Are the shields terminated according to Woodward specifications?
- Are there low voltage signal wires running in the same wiring trays as high voltage wiring?
- Are the governor's signal common or grounds not tied to any other devices?
- Have the signals been checked for electrical noise?

Voltage Regulator

- Is the voltage regulator working properly?

External Devices

- Are there external devices the control is dependent on for input signals?
- Are these devices providing the correct signal to the control?
- Is the external device configured or programmed to be compatible with the control?

Chapter 13.
Software Interface Tools

Overview

This chapter provides an overview of the service tool interfaces to the 5009XT. Instructions for installing and using each these tools are in the Appendices of this volume of the manual. All service tool interfaces to the 5009XT are Ethernet connections and can be used on any of the Ethernet ports. The only requirement is that the PC connecting to the control has an IP address on the same domain (as with any typical network).

Service personnel should become familiar with each of these tools as the each provide different access for troubleshooting and maintenance work. Operations personnel need only be concerned with the RemoteView product, as it can be the primary or secondary tool for operation of the turbine.

Default settings for the Ethernet TCP/IP addresses are in Appendix C of this manual

RemoteView

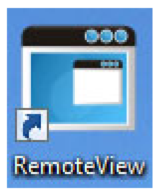


Figure 13-1. RemoteView Icon

The RemoteView program is a common tool for the 5009XT and all of the Woodward's newest generation of 505 products (as well as our standard compressor control offerings. This tool provides GUI access to the control via an Ethernet link with multiple user access levels for Configuration, Service and Operation of the control system.

Users of the popular 505 family of products will find this interface very familiar – as the turbine operational functionality of the 5009XT is identical that of the 505XT. It will allow the user to log into the control from a PC on the same network and provides full access to the control.

Users can log in at any User Level with this tool. It will run for up to 2 hours without a license. For continuous operation of this tool, purchase a runtime license.

Control Assistant (CA)

Figure 13-2. Control Assistant Icon

This tool is the primary service tool that will provide the following features:

- Uploading and Downloading Tunables (your complete configuration settings)
- Live trending of any I/O signal or control parameter
- Troubleshooting any system problem by viewing software variables in the system
- Analyzing any Datalog files that are collected from the control

Servlink-to-OPC-Server (SOS)

Figure 13-3. SOS Icon

Integrated with control assistant is the Woodward Servlink-to-OPC-Server (SOS) program that provides the communication data link between the 5009XT and a user PC or system HMI. The SOS program will run on the PC as a service and convert the Woodward proprietary Servlink data to OPC data. The Control Assistant tool will connect as a client to the SOS server. Customers desiring to link to OPC data from the 5009XT will need to also connect to SOS.

AppManager (AppMan)

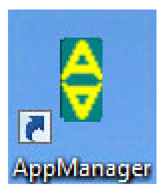


Figure 13-4. AppManager Icon

This program is the primary tool for transferring files to and from the control. It will provide the user with the following services:

- Transferring files to and from the control (executable control software, GUI software, datalog files, system log files, control backup information)
- Setting the control Ethernet port IP addresses and the SNTP time synchronization IP address for network time protocol synchronizing
- Installing a software service pack program
- Starting / Stopping the control program or GUI program

Chapter 14.
5009XT MicroNet TMR® Compatible Products

The following is a list of compatible Woodward products that may be used with the MicroNet TMR 5009XT System. Some of these products include digital communication links that provide simplified interfaces to the control application.

Servo Position Controller (SPC)

(Planned for release at Revision A)
Four SPC's (p/n 8200-227) are pre-programmed in the control application to have CAN interfaces to this product. These digital drivers (manual 26236) support a variety of actuator interfaces including proportional or integrating valves, single coil drives of up to +/- 250 mA, with single or redundant position feedback. They must be configured with a Service Tool from a user PC.

Figure 14-1. Servo Position Controller

DSLC-2™ Digital Synchronizer & Load Control

This device is used with generator applications only. The DSLC-2 is a microprocessor-based generator load sharing control designed for use on three phase ac generators with Woodward speed controls and automatic voltage regulators. The DSLC-2 is a synchronizer, an isochronous load sharing control, a dead bus closing system, a VAR/PF control, and a process control, integrated into one package. The DSLC-2 provides either phase match or slip frequency synchronizing, and ties into the unit automatic voltage regulator to match voltages before paralleling. It interfaces with the control via a speed bias signal to control generator frequency and phase.

To complete an interface with the 5009XT control system, the DSLC-2 must be hardwired to the control and the control's program configured to accept the interface (contact I/O and analog inputs programmed). The 5009XT control can be programmed to use the DSLC-2 as a synchronizer only, or as a synchronizer and load sharing control. Refer to the DSLC-2 Manual (37443) for device-specific information.

Figure 14-2. DSLC-2

Chapter 15.
Application Examples

Overview

This chapter is provided to give users an idea of the 5009XT Control System's capabilities and how to apply them to a system. Typical example applications are schematically shown and their functionality explained.

In addition, programming and run mode notes are given for each example to assist programmers in configuring the 5009XT Control System for their application. Basic peripheral device connections are shown in each application drawing to allow an understanding of how these devices interface to the 5009XT Control

System and expand system capabilities. Refer to Table 15-1.

Speed/Load PID

The Speed PID can control and limit:
- Unit Speed/Frequency
- Unit Load

The 5009XT Control System's Speed PID can be used to control unit speed/ frequency when isolated and unit load when paralleled to an infinite bus (utility). The Speed PID can be programmed to sense unit load via its actuator output signal or a 4–20 mA analog input signal from a generator power sensor. When programmed to sense and control generator load via an analog input, true unit load is sensed and controlled. By using the generator load signal to control from, any turbine inlet or exhaust pressure variation is sensed and compensated for, thus providing true load control.

A combination of the Speed PID and its setpoint limits allow this PID to limit unit load. When used as a unit load limiter, it is recommended that the 5009XT Control System be configured to sense and control only true generator load. If applying the 5009XT System to a soft grid, where the utility frequency varies greatly, it is recommended that unit load limiting be performed by the Auxiliary PID - not the Speed PID. If the 5009XT Control System is controlling an extraction turbine the extraction PID's output is connected directly to the 5009XT Control System ratio/limiter. Therefore, this PID directly positions one or both turbine throttle valves, depending on configuration, to control the above listed parameters.

EXTR/ADM PID (Extraction/ Admission Turbines Only)

The 5009XT Control System's Extr/Adm PID can be programmed to control:
- Extraction and/or Admission Steam Pressure
- Extraction and/or Admission Steam Flow
- Turbine Exhaust Steam Pressure
- Turbine Exhaust Steam Flow

The 5009XT Control System's Extr/Adm PID can be used to control any of the listed parameters. This PID can be enabled and disabled by commands given through the 5009XT Control System's GUI Interface, contact inputs, or Modbus commands.

Since this PID's output is connected directly to the 5009XT Control System's ratio/ limiter, it directly positions one or both turbine throttle valves, depending on configuration, to control the above listed parameters.

Only when the 5009XT Control System is configured for the "Decoupled HP & LP" mode, can the Extr/ Adm PID control turbine exhaust pressure or flow.

Auxiliary PID

The 5009XT Control System's Auxiliary PID can be programmed to control (enabled/disabled on command) or limit:

- Turbine Inlet Steam Pressure
- Turbine Inlet Steam Flow
- Turbine Exhaust Steam Pressure
- Turbine Exhaust Steam Flow
- Generator Power Output
- Plant or Tie line Import/Export Power
- Process Temperature
- Compressor Suction Pressure
- Compressor Suction Flow
- Compressor Discharge Pressure
- Compressor Discharge Flow

Any process parameter related to unit load, inlet pressure, or exhaust pressure (depending on configuration). When programmed as a limiter, this PID's output is low signal selected with the Speed PID's output. This configuration allows the Auxiliary PID to limit unit load based on the parameter being sensed.

When the Auxiliary PID is configured as a controller, it must be enabled and disabled by commands given through the 5009XT Control System's GUI Interface, contact input, or Modbus commands. In this configuration, the Speed PID is disabled and tracks the Auxiliary PID's output when the Auxiliary PID is enabled.

To control or limit any of the listed parameters, the 5009XT Control System must be programmed to accept an auxiliary analog input signal representing that parameter's level. The exception to this rule is when controlling or limiting generator load. The Auxiliary PID can be programmed to use and share the KW/Unit load input with the Speed PID.

Cascade PID

The 5009XT Control System's Cascade PID can be programmed to control:

- Turbine Inlet Steam Pressure
- Turbine Inlet Steam Flow
- Turbine Exhaust Steam Pressure
- Turbine Exhaust Steam Flow
- Generator Power output
- Plant or Tie Line Import/Export Power
- Process Temperature
- Compressor Suction Pressure
- Compressor Suction Flow
- Compressor Discharge Pressure
- Compressor Discharge Flow
- Any process parameter related to unit load, inlet pressure, or exhaust pressure (depending on the configuration)

This PID must be enabled and disabled by commands given through the 5009XT Control's GUI Interface, contact input, or Modbus commands.

The Cascade PID is cascaded with the Speed PID to vary unit speed/load. By directly positioning the Speed PID's setpoint, the Cascade PID can vary unit speed/load to control its input parameter. This configuration allows for bumpless transfers between the two control modes (speed/load and cascade).

Example Applications

The example applications in this chapter do not show every possible control configuration or combination. These examples are provided as a reference to follow when applying any of the controlling combinations or parameters. To apply a desired control parameter, refer to one or more of the typical application configurations that are shown and resemble the control configuration desired, then substitute the shown control parameters with the required control parameters.

Example—To configure the 5009XT Control System to perform a turbine exhaust pressure limiting function use the “Pump or Compressor Discharge Pressure Control with Turbine Inlet Pressure Limiting” application for reference. With this example substitute exhaust pressure for inlet pressure and disregard any program settings specified to control pump or compressor discharge pressure.

The examples shown in this section are summarized as follows:
Example 1—Pump or Compressor Discharge Pressure Control with Inlet Pressure Limiting
Example 2—Pump or Compressor Suction Pressure Control with Dual Coil Actuator.
Example 3—Exhaust Pressure Control with Generator Power Limiting and Plant Import/Export Limiting
Example 4—Plant Import/Export Power Control with DRFD Servo Interface and Dual Coil Actuator
Example 5—Plant Import/Export Power Control with DRFD Servo Interface
Example 6—Inlet Pressure Control with Isochronous Load Share Control in Island Mode
Example 7—Plant Import/Export Power Control with Isochronous Load Share Control in Island Mode
Example 8—Inlet Pressure Control and Exhaust Pressure Control with Generator Power Limiting
Example 9—Admission Steam Control with Bootstrap Start-up Capability
Example 10—Plant Load and Steam Pressure Control
Example 11—Induction Generator Control
The features and functionality shown in each example are summarized in Table 15- 1.

Table 15-1. Example Extraction Summary

APPLICATION		EXAMPLES 1	2	3	4	5	6	7	8	9	10	11
Turbine Type	Mechanical Drive	X	X									
	Synchronous Gen. Drive			X	X	X	X	X	X	X	X	
	Induction Gen. Drive											X
	Dual Inlet			X								
	Extraction Control						X	X	X		X	
	Ext./Admission Control					X						
	Admission Control									X		
Control Channels	Auxiliary Limiting	X	X	X			X					
	Auxiliary Control				X	X						
	Cascade Control	X	X	X			X	X				
	Synchronizing			X	X	X	X	X	X	X		
	Loadsharing						X	X				
	Frequency Control				X	X	X					
	Extr/Adm Control					X	X	X		X		
Control Modes	Inlet Pressure Control		X				X		X			
	Min Inlet Pres. Limiting	X										
	KW / Load Control							X		X	X	
	KW / Load Limiting		X				X		X			
	Import/Export Load Cntrl				X	X		X			X	
	Import/Export Load Limtg			X								
	Ext/Adm Pressure Control					X	X	X			X	
	Adm Flow Control									X		
	Exhaust Pressure Control			X				X	X			
	Suction Pressure Control		X									
Map Coupling Mode	Coupled HP & LP					X				X		
	Decoupled Inlet (HP)						X					
	Decoupled Exhaust (LP)							X				
	Decoupled HP & LP								X			
Devices	Dig. Sync Ld Share (DSLC)			X	X	X	X	X	X	X	X	
	Mstr Sync Ld Share (MSLC)							X			X	
	Real Power Sensor (RPS)			X	X	X	X		X	X		
	Dig. Rmt Final Dvr (DRFD)				X	X						
	Redundant Sensors		X									
	Dual-Coil Actuator		X									

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Example 1—Pump or Compressor Discharge Pressure Control with Turbine Inlet Pressure Limiting

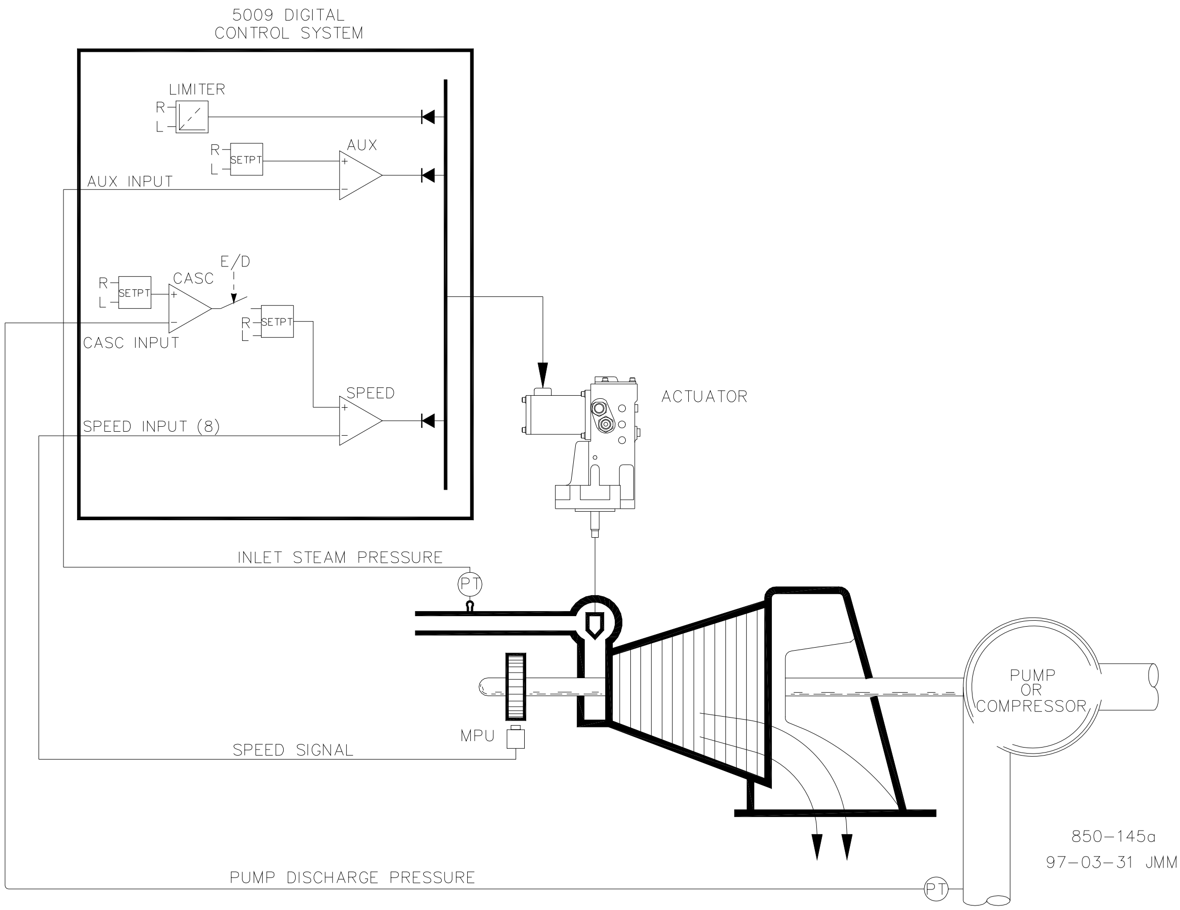


Figure 15-1. Pump or Compressor Discharge Pressure Control with Turbine Inlet Pressure Limiting

This is an example of a typical pump or compressor application. In this application the 5009XT Control System is configured to normally control pump/ compressor discharge pressure and limit governor valve position based on low turbine inlet steam pressure. Both the auxiliary and cascade modes were used for this example application. Other applications may or may not use all the functionality shown in Figure 15-1 and described below.

With this application pump/compressor discharge pressure control is performed within the 5009XT Control System through the Cascade Controller. Because the discharge pressure being controlled typically affects many other plant processes, a plant Distributed Control System (DCS) may be used to monitor plant process conditions and set the cascade setpoint. This can be performed through Modbus commands, discrete raise and lower commands, an analog setpoint signal or through the GUI.

For this application a limiting type of control function was required to help preserve inlet header pressure in case of system header problems. Because the Auxiliary PID is the only controller that has this capability, it is used to sense turbine inlet pressure and limit governor valve position based on a low inlet pressure setting.
If a DCS is used to sense and control a process by positioning the load of multiple pumps or compressors (load sharing), the DCS may interface directly to the 5009XT Control's Speed PID setpoint through a remote speed setpoint analog input. This allows a DCS to monitor and compensate for plant and system conditions by directly changing the speed of multiple pumps or compressors simultaneously.

All 5009XT PID controller setpoints may be adjusted through programmed raise and lower contacts, 4–20 mA inputs, Modbus commands or the GUI.

The following list of notes is provided as a reference for application programmers to follow when configuring the 5009XT Control to achieve any of the control and limiting actions shown in Figure 15-1.

Starting & Run Mode Notes for Example 1—Starting and ramping to an idle or minimum speed position can be performed automatically, semiautomatically, or manually. From this position, the Idle/Rated or Auto Start Sequence functions, if programmed, can be used to assist in ramping the control to a rated speed position or an operator can give a raise command to manually increase turbine speed.

After the unit has been started and is controlling at a minimum/desired speed position, cascade control (pump/compressor discharge pressure) can be enabled through contacts, Modbus commands, or the GUI. When cascade control is enabled, if actual discharge pressure does not match the setpoint, the control will automatically ramp turbine speed at the 'SPEED SETPOINT SLOW RATE' setting until the pump/compressor discharge pressure matches the setpoint.

With this application the auxiliary control is used as a limiter, thus it does not need to be enabled. If turbine inlet pressure decreases below the auxiliary setpoint at any time the Auxiliary PID will take control of the governor valve and lower it to help preserve inlet header pressure.

See the Service Mode section of this manual for information on related tunable values and rates.

Example 2— Pump or Compressor Suction Pressure Control with Turbine Inlet Pressure Limiting and Dual Coil Actuator

This is an example of a typical pump or compressor application. With this application the 5009XT Control System is configured to normally control pump/ compressor suction pressure, and limit governor valve position based on low turbine inlet steam pressure. Both the auxiliary and cascade modes were used for this example application. Redundant signals are used for the MPUs and the cascade input. Other applications may or may not use all the functionality shown in Figure 15-2 and described below.

With this application pump/compressor suction pressure control is performed within the 5009XT Control System through the Cascade Controller. The cascade inputs are from redundant pressure transducers. The I/O handling for redundant sensors is explained in Volume 1 of this manual.

Because the discharge pressure being controlled typically affects many other plant processes, a plant Distributed Control System (DCS) may be used to monitor plant process conditions and set the cascade setpoint position. This can be performed through Modbus commands, discrete raise and lower commands, with an analog setpoint signal or through the GUI

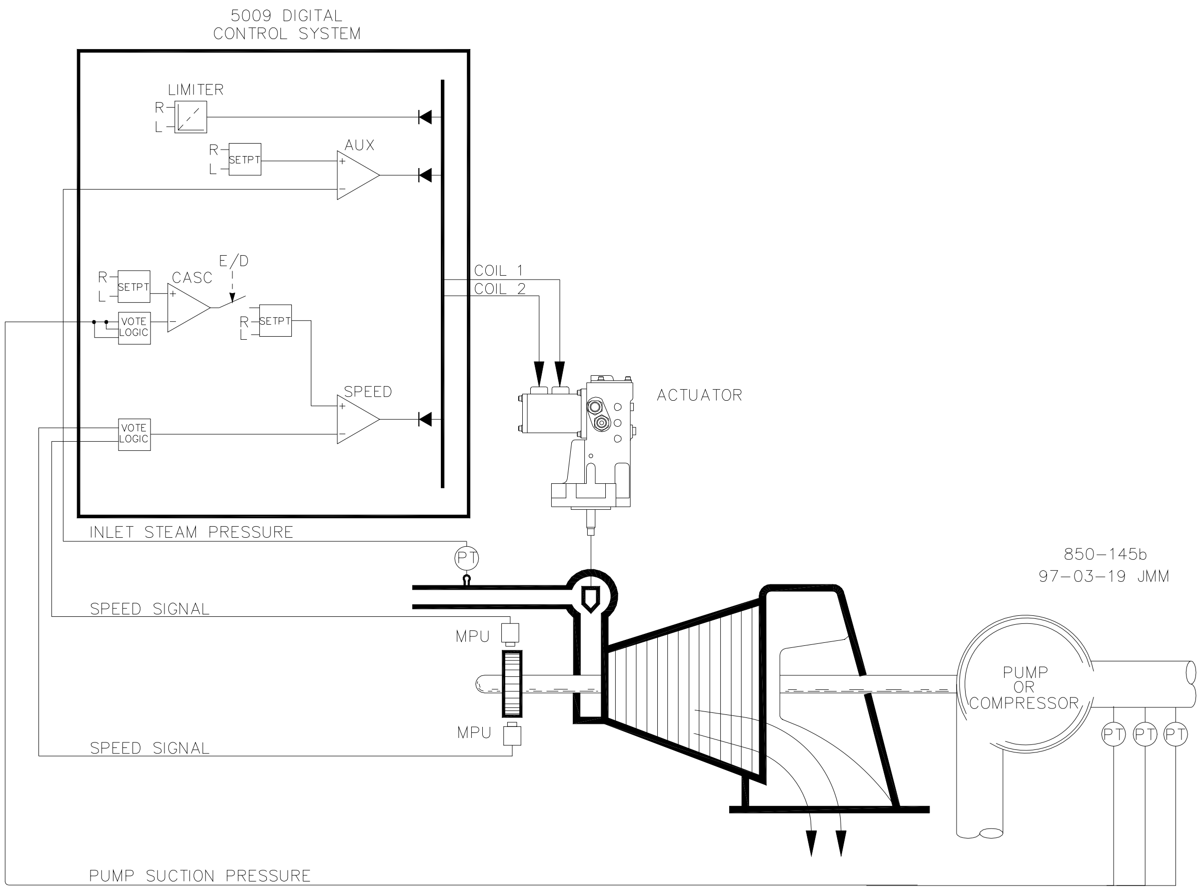


Figure 15-2. Pump or Compressor Suction Pressure Control with
Turbine Inlet Pressure Limiting and Dual Coil Actuator

For this application a limiting type of control function was required to help preserve inlet header pressure in case of system header problems. Because the Auxiliary PID is the only controller that has this capability, it is used to sense turbine inlet pressure and limit governor valve position, based on a low inlet pressure setting.

If a DCS is used to sense and control a process by positioning the load of multiple pumps or compressors (load sharing), the DCS may interface directly to the 5009XT Control's Speed PID setpoint through a programmed remote speed setpoint analog input. This allows a DCS to monitor and compensate for plant and system conditions by directly changing the speed of multiple pumps or compressors simultaneously.

All 5009XT PID controller setpoints may be changed through programmed raise and lower contacts, 4–20 mA inputs, Modbus commands, or the GUI.

The following list of notes is provided as a reference for application programmers to follow when configuring the 5009XT Control System to achieve any of the control and limiting actions shown in Figure 15-2.

Starting & Run Mode Notes for Example 2—Starting and ramping to an idle or minimum speed position can be performed automatically, semiautomatically, or manually. From this position, the Idle/Rated or Auto Start Sequence functions, if programmed, can be used to assist in ramping the control to a rated speed position or an operator can give a raise command to manually increase turbine speed.

After the unit has been started and is controlling at a minimum/desired speed position, cascade control (pump/compressor discharge pressure) can be enabled through contacts, Modbus commands, or the GUI. When cascade control is enabled, if actual discharge pressure does not match the setpoint, the control will automatically ramp turbine speed at the 'SPEED SETPOINT SLOW RATE' setting until the pump/compressor discharge pressure matches the setpoint.

With this application the auxiliary control is used as a limiter, thus it does not need to be enabled. If turbine inlet pressure decreases below the auxiliary setpoint at any time the Auxiliary PID will take control of the governor valve and lower it to help preserve inlet header pressure.

See the service mode section of this manual, for information on related tunable values and rates.

Example 3—Exhaust Pressure Control with Generator Power Limiting and Plant Import/Export Limiting

This is an example of a typical turbine generator application where plant process steam (turbine exhaust pressure) is desired to be controlled at a single pressure level. With this type of application, turbine load varies based on the plant process steam demand. Both the auxiliary and cascade modes were used for this example application. Other applications may or may not utilize all the functionality shown in Figure 4-3 and described below.

With this application turbine exhaust pressure control is performed within the 5009XT Control through the Cascade PID controller. This is an ideal controller for this type of function because it can be enabled and disabled as desired by a system operator. This gives a system operator full authority of when to transfer process pressure control to or from a letdown station or turbine bypass valve.

Because turbine load may vary greatly with this application, a limiter is used to protect the generator from being over powered. In order to limit generator load, the 5009XT Control must be able to sense generator load. As shown in Figure 15-3 generator load is being sensed with a Woodward Real Power Sensor (RPS) and supplied to the 5009XT Control's KW droop input. Generator over-load protection is performed by a combination of the Speed PID and the speed setpoint maximum limit. By programming the speed setpoint maximum limit to that of rated speed plus the % droop value at 100% load, the speed setpoint cannot be taken over 100% load.

A limiting type of control function was required to limit the plant export power to zero. The plant does not get reimbursed for any power exported, and it is more economical to make power than purchase it from the utility, thus a zero plant import/export power level is desired. Because the Auxiliary PID is the only 5009XT controller that has this limiting capability, it was used to sense tie line power and limit turbine/generator output based on a zero export limit setting.

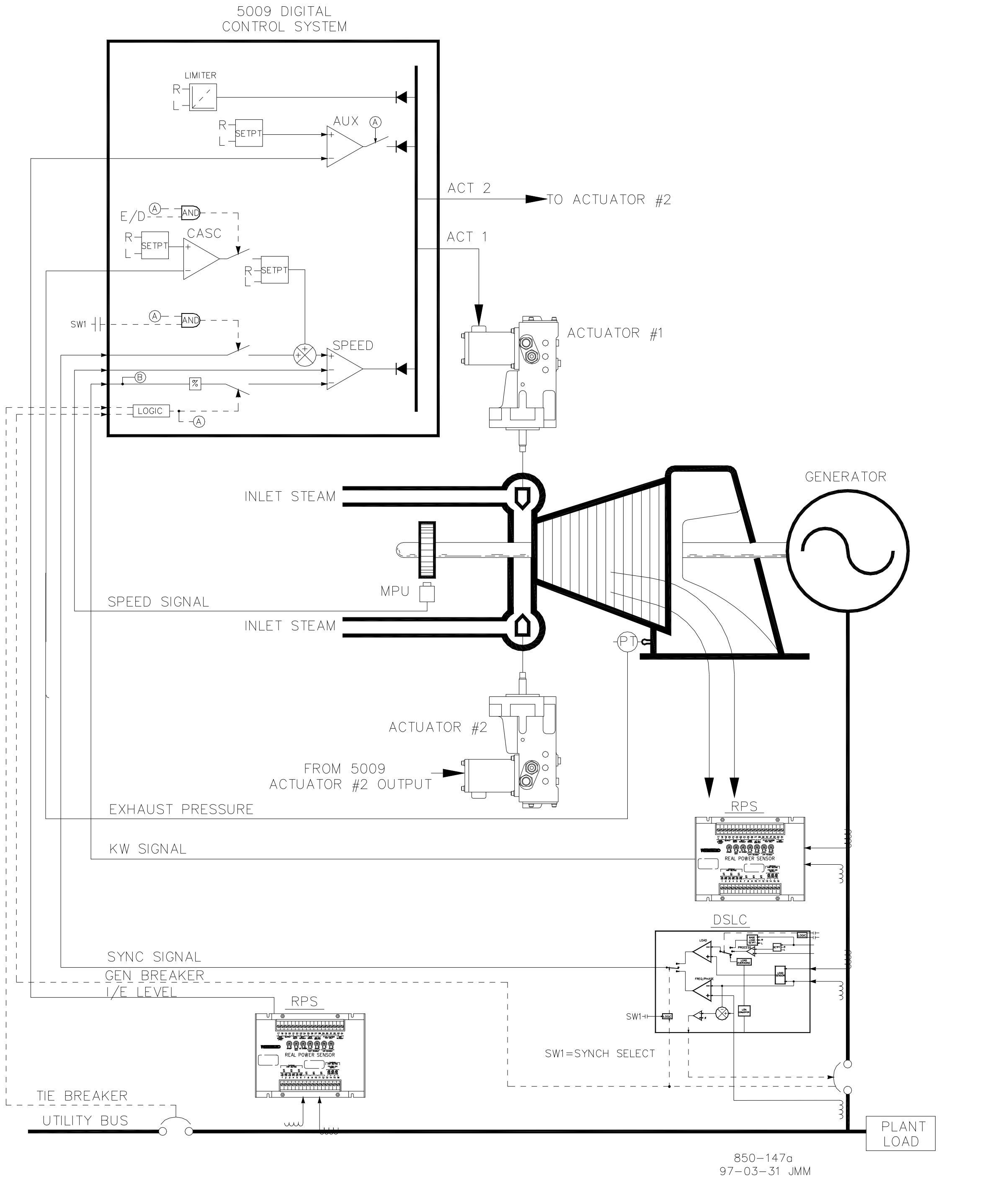


Figure 15-3. Exhaust Pressure Control with Generator Power Limiting and Plant Import/Export Limiting

A second RPS #8272-726 was used with this application to sense utility tie line power. This RPS senses –5 to +5 A CT current to allow its output to represent power flow in both the import and export directions. With this RPS 12 mA represents zero power flow. Because of this feature the RPS #8272-726 cannot be used with the 5009XT Control to sense generator load/power. Please check with a Woodward certified distributor or factory for the correct RPS to use as a generator load sensor.

This application uses a DSLC™ control for synchronization only. Because the DSLC interfaces to the 5009XT Control through an analog signal, a 5009XT Control analog input must be programmed. When a synchronizing input/function is programmed, the input can be enabled, through a contact input, Modbus command, or the GUI. As shown in Figure 15-3 a panel mounted (DPST) switch is used with this application to select automatic synchronization in both the DSLC and 5009XT Control.

This example uses split range valves. Both valves are driven from the same Low Signal Select (LSS) bus, however, actuator #2 does not begin to open until actuator #1 reaches the programmed offset %. After this point both actuators move proportionally. See Figure 15-3b.

All 5009XT Control PID controller setpoints may be changed through programmed raise and lower contacts, 4–20 mA inputs, Modbus commands, or the GUI.

The following list of notes are provided as a reference for application programmers to follow when programming the 5009XT Control to achieve the control and limiting actions shown in Figure 15-3.

Starting & Run Mode Notes for Example 3—Starting and ramping to an idle or minimum speed position can be performed automatically, semiautomatically, or manually. From an idle or minimum speed position, the Idle/Rated or Auto Start Sequence functions, if programmed, can be used to assist in ramping the control to a rated speed position. Alternatively, an operator can give a manual raise command to increase turbine speed as desired.

After the unit has been started and is controlling at a rated speed position, the turbine generator can be synchronized manually, or automatically. The system operator can select automatic synchronization through the auto-synch select switch (SW1 in Figure 15-3). When this switch is closed, the 5009XT Control's synchronizing input is enabled and the DSLC control's automatic synchronizing function selected.

When the plant to utility tie line/breaker is closed, and the unit generator breaker closes, the 5009XT Control steps the speed/load setpoint up to a minimum load level to reduce the chance of reverse powering or motoring the generator. This minimum load level is based on the speed/load setpoint and is defaulted to a "3%" step change of the speed/load setpoint. The defaulted value is adjustable through the 5009XT Control's GUI (**BREAKER LOGIC - MIN LOAD BIAS = 5 RPM**).

After synchronization the 5009XT Control's load setpoint can be positioned through raise and lower speed/load setpoint contacts, a programmed 4–20 mA input, Modbus commands, or the GUI.

Cascade control (turbine exhaust pressure) can be enabled at any time after the utility tie breaker and generator breaker input contacts are closed. Cascade control can be enabled through a programmed contact, Modbus command, or the GUI. Exhaust pressure control can be transferred from a letdown station or turbine bypass valve in one of the following ways; enabling cascade control and backing down the letdown station's setpoint, or slowly increasing turbine load with the Speed PID's setpoint to allow the letdown station to close, then enable cascade control.

After exhaust pressure control has been transferred to the 5009XT Control's Cascade PID, the letdown station or turbine bypass valve must be closed or in a manual control mode. This will stop the two controllers (5009XT Control Cascade PID and system letdown station) from fighting for control of one parameter and causing system instability.

With this application the auxiliary control is programmed to be used as a limiter and be automatically enabled when both the utility tie and generator breakers are closed. When paralleled to the utility this 5009XT and RPS combination allows the plant to import power from the utility, but not export power. If the utility-to-plant tie line power reaches a zero import/export level the Auxiliary PID will begin limiting generator output until plant conditions require power to be imported again.

Optionally the Auxiliary PID's setpoint can be varied to limit plant power to a different import or export power level.

Example 4—Plant Import/Export Control with SPC Interface

This is an example of a typical turbine generator application where plant import/ export control is desired when paralleled with the utility, and frequency control when isolated from the utility. When paralleled to the utility, turbine load varies based on the plant power demand. Other applications may or may not use all the functionality shown in Figure 15-4 and described below.

With this application plant import/export control is performed within the 5009XT Control through the Auxiliary PID controller. Optionally the Cascade PID controller could have been used instead. For this application the Auxiliary PID is configured to be enabled and disabled on command instead of performing a limiting action. This gives a system operator full authority of when to enable or disable plant import/export control.

When programmed for this type of control action, the Speed PID is disabled when the Auxiliary PID is enabled and can only limit the 5009XT Control's valve output signal if unit load reaches 100%. Also, the auxiliary setpoint automatically tracks the PID's input value when not in control.

A Real Power Sensor (RPS) #8272-726 was used with this application to sense utility tie line power flow. This RPS senses –5 to +5 A CT current to allow its output to represent power flow in both the import and export directions. With this RPS 12 mA represents zero power flow. Because of this feature the RPS #8272-726 cannot be used with the 5009XT Control to sense generator load/power.

To save buying a second RPS for this application, unit load is sensed through turbine inlet valve position (5009XT Control LSS bus), not a generator load signal. When the generator is paralleled to the utility, the Speed PID controls governor valve position instead of generator power. Thus 100% governor valve position is considered 100% unit load regardless of system conditions.

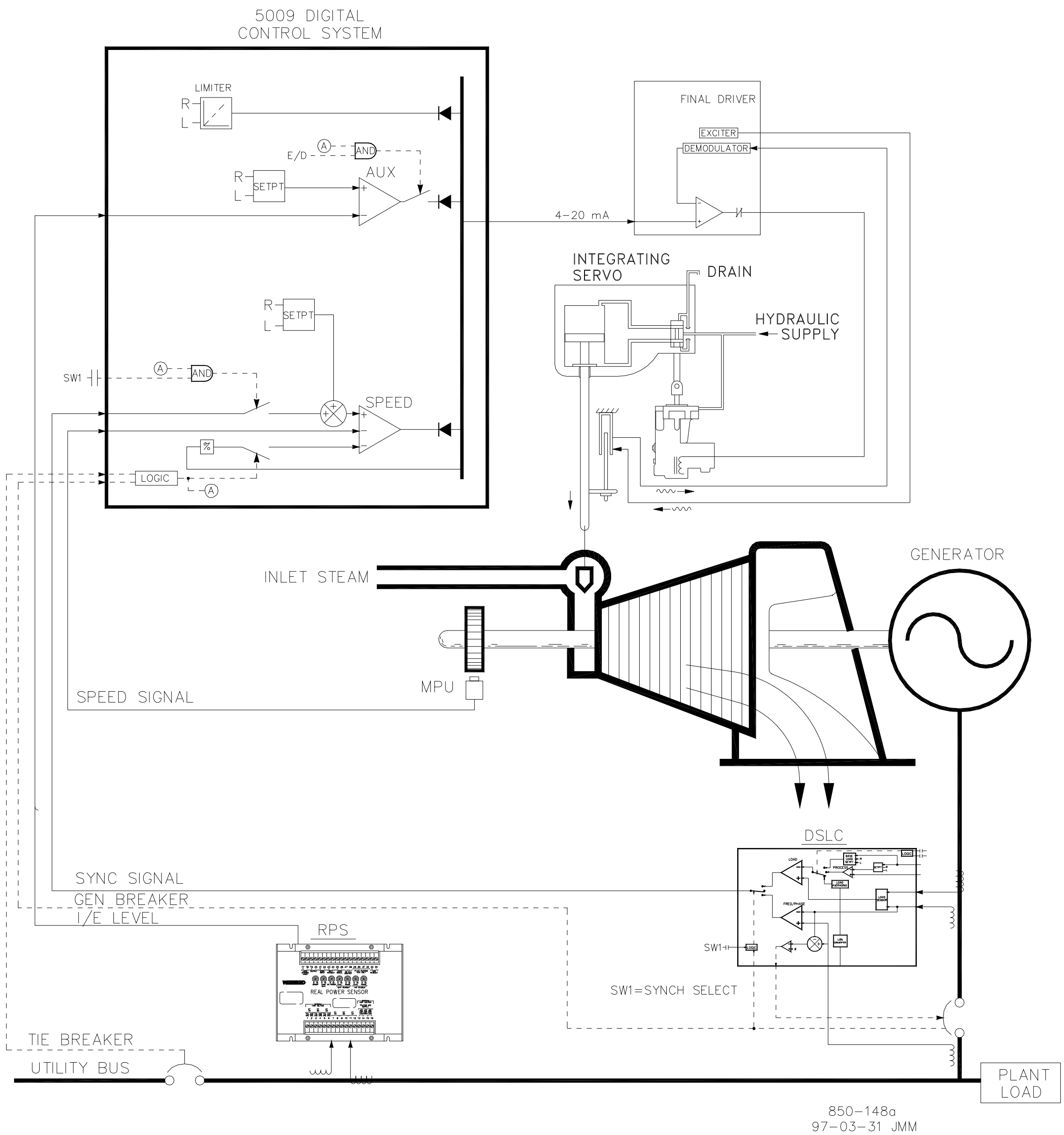


Figure 15-4. Plant Import/Export Control with DRFD Servo Interface

The DSLC is used for synchronization only. Because the DSLC interfaces to the 5009XT Control through an analog signal, a 5009XT Control analog input must be programmed. When a synchronizing input/function is programmed, the input can be enabled through a contact input, Modbus command, or the GUI. As shown in Figure 15-4 a panel mounted (DPST) switch is used with this application to select automatic synchronization in both the DSLC and 5009XT Control.

With this application the existing servo assembly had an actuator which required ±50 mA for pilot valve positioning and a LVDT mounted to the valve rack to feedback actual rack position. Because the 5009XT Control does not have a bipolar drive circuit and cannot perform closed loop servo position control, a Woodward Servo Position Controller (SPC) was used to interface with the existing servo actuator. The integrating type of SPC used accepts a 4–20 mA valve demand signal from the 5009XT Control, monitors actual valve position (through, LVDTs, MLDTs, or other DC position feedback devices), compares the two signals, and outputs a drive signal to the servo assembly's actuator accordingly. The SPC interfaces directly with an LVDT, (providing excitation and demodulation) thus no external converter was required.

Older 5009XT installations utilize the Digital Remote Final Driver (DRFD), which is still a valid control solution. However, for new installations, the Servo Position Controller (SPC) should be used. Also, with the new 5009XT system, the option exists to interface the actuator and its feedback mechanisms directly to the 5009XT Actuator Controller card.

All 5009XT Control PID controller setpoints may be changed through programmed raise and lower contacts, 4–20 mA inputs, Modbus commands, or the GUI.

The following list of notes are provided as a reference for application programmers to follow when programming the 5009XT Control to achieve any control and limiting actions shown in Figure 15-4.

Starting & Run Mode Notes for Example 4—Starting and ramping to an idle or minimum speed position can be performed automatically, semiautomatically, or manually. From an idle or minimum speed position, the Idle/Rated or Auto Start sequence functions, if programmed, can be used to assist in ramping the control to a rated speed position. Alternatively, an operator can give a manual raise command to increase turbine speed as desired.

After the unit has been started and is controlling at a rated speed position, the turbine generator can be synchronized manually or automatically. The system operator can select automatic synchronization through the auto-synch select switch (SW1 in Figure 15-4). When this switch is closed the 5009XT Control's synchronizing input is enabled and the DSLC control's automatic synchronizing function selected.

The DSLC provides either phase matching or slip frequency synchronizing, and ties into the unit automatic voltage regulator to match voltages before paralleling. It communicates over a LAN, using an Echelon network, with other plant DSLC controls to perform safe dead bus closing.

When the plant-to-utility tie line/breaker is closed and the unit generator breaker closes, the 5009XT Control steps the speed/load setpoint up to a minimum load level to reduce the chance of reverse powering or motoring the generator. This minimum load level is based on the speed/load setpoint and is defaulted to a "3%" step change of the speed/load setpoint. The defaulted value is adjustable through the 5009XT Control's Service mode (BREAKER LOGIC - MIN LOAD BIAS = 5 RPM).

After synchronization the 5009XT Control's load setpoint can be positioned through raise and lower speed/load setpoint contacts, a programmed 4–20 mA input, Modbus commands, or the GUI.

With this configuration, Import/Export control (Auxiliary PID) can be enabled at any time after the utility tie breaker and generator breaker input contacts are closed. Auxiliary control can be enabled through the programmed contact, a Modbus command, or the GUI. Because the auxiliary setpoint tracks plant import/export power before being enabled, the transfer to auxiliary control is bumpless. Once enabled, the Auxiliary PID's setpoint can then be positioned to the desired import or export level.

Because of the 5009XT Control's configuration, this unit will automatically switch to frequency control the plant-to-utility tie breaker is opened.

Example 5—Plant Import/Export Control with SPC Interface

(Adm or Extr/Adm Turbine, Coupled HP & LP mode)

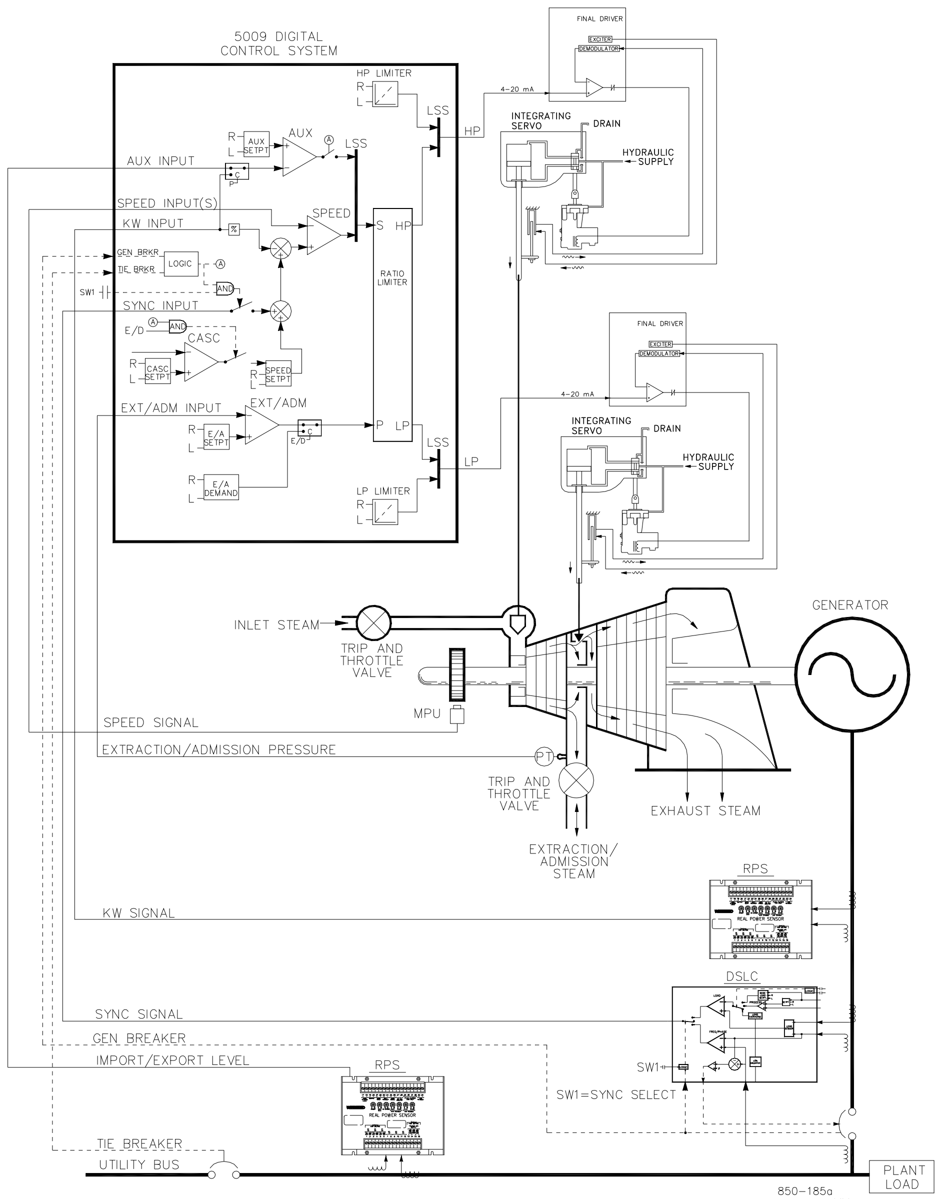


Figure 15-5. Plant Import/Export Control with DRFD Servo Interface

This is an example of a typical turbine generator application where plant import/ export control is desired when paralleled with the utility, and frequency control when isolated from the utility. When paralleled to the utility, turbine load varies based on the plant power demand. Other applications may or may not use all the functionality shown in Figure 15-5 and described below.

With this application, plant import/export control is performed within the 5009XT Control through the Auxiliary PID controller. The Cascade PID controller could have been used instead. Also, the Auxiliary PID is configured to be enabled and disabled on command instead of performing a limiting action. This gives a system operator full authority of when to enable or disable plant import/export control. When programmed for this type of control action, the Speed PID is disabled when the Auxiliary PID is enabled and can only limit the 5009XT Control's valve output signal if unit load reaches 100%. The auxiliary setpoint automatically tracks the Auxiliary PID's input value when not in control.

Two Real Power Sensors (RPS) were used with this application; one for sensing generator load to allow the 5009XT Control Speed/load PID to control generator output, and one for sensing plant import/export tie line power to allow the 5009XT Control Auxiliary PID to control plant import/export power.

A RPS #8272-726 was used with this application to sense utility tie line power flow. This RPS senses –5 to +5 A CT current to allow its output to represent power flow in both the import and export directions. With this RPS 12 mA represents zero power flow. Because of this feature, the RPS #8272-726 cannot be used with the 5009XT Control to sense generator load/power.

Because of the similarities between the operation of admission (Adm) and extraction/admission (Extr/Adm) turbines, this example application will cover both types of turbines. In either case it is assumed that an external trip valve or trip-and-throttle valve is used to completely stop any admission steam from entering the turbine upon a system shutdown condition.

Adm or Extr/Adm pressure is controlled by the Extr/Adm PID. This PID must be manually enabled once the pressures on both sides of the admission trip-and - throttle (T&T) valve have been matched. A manual demand signal is available in the 5009XT Control to allow an operator to match the pressures across the admission T&T valve before enabling the control loop. With this application the Extr/Adm setpoint is varied through the 5009XT Control's GUI or Modbus commands.

This application uses a DSLC for synchronization only. Because the DSLC interfaces to the 5009XT Control through an analog signal, an analog input must be programmed. When a synchronizing input/function is programmed, the input can be enabled through a contact input, Modbus command, or the GUI. As shown in Figure 15-5, a panel mounted (DPST) switch is used with this application to select automatic synchronization in both the DSLC and the 5009XT Control.

With this application the existing servo assembly had an actuator which required ±50 mA for pilot valve positioning and a LVDT mounted to the valve rack to feedback actual rack position. Because the 5009XT Control does not have a bipolar drive circuit and cannot perform closed loop servo position control, a Woodward Servo Position Controller (SPC) was used to interface with the existing servo actuator. The integrating type of SPC used accepts a 4–20 mA valve demand signal from the 5009XT Control, monitors actual valve position (through, LVDTs, MLDTs, or other DC position feedback devices), compares the two signals, and outputs a drive signal to the servo assemblies actuator accordingly. The SPC interfaces directly with an LVDT, (providing excitation and demodulation) thus no external converter was required.

Older 5009XT installations utilize the Digital Remote Final Driver (DRFD), which is still a valid control solution. However, for new installations, the Servo Position Controller (SPC) should be used. Also, with the new 5009XT system, the option exists to interface the actuator and its feedback mechanisms directly to the 5009XT Actuator Controller card.

All 5009XT Control PID controller setpoints may be changed through programmed raise and lower contacts, 4–20 mA inputs, Modbus commands, or the GUI.

The following list of notes are provided as a reference for application programmers to follow when programming the 5009XT Control to achieve any control and limiting actions shown in Figure 15-5.

Starting & Run Mode Notes for Example 5—Starting and ramping to an idle or minimum speed position can be performed automatically, semiautomatically, or manually. From an idle or minimum speed position, the Idle/ Rated or Auto Start sequence functions can be used to assist in ramping the control to a rated speed position. Alternatively, an operator can give a manual raise command to increase turbine speed as desired.

After the unit has been started and is controlling at a rated speed position, the turbine generator can be synchronized. This can be done manually or automatically. The system operator can select automatic synchronization through the Auto-Sync select switch (SW1 in Figure 15-5). When this switch is closed the 5009XT Control's Synchronizing input is enabled and the DSLC control's automatic synchronizing function selected.

The DSLC provides either phase matching or slip frequency synchronizing and ties into the unit automatic voltage regulator to match voltages before paralleling. It communicates over a LAN, using an Echelon network, with other plant DSLC controls to perform safe dead bus closing.

When the plant-to-utility tie line/breaker is closed and the unit generator breaker closes, the 5009XT Control steps the speed/load setpoint up to a minimum load level to reduce the chance of reverse powering or motoring the generator. This minimum load level is based on the speed/load setpoint and is defaulted to a "3%" step change of the speed/load setpoint. The defaulted value is adjustable through the 5009XT Control's GUI (**BREAKER LOGIC, MIN LOAD BIAS = xxx RPM**).

After synchronization the 5009XT Control's load setpoint can be positioned through raise and lower speed/load setpoint contacts, a programmed 4–20 mA input, Modbus commands, or the GUI.

Admission or Extr/Adm control can be enabled any time after the generator breaker is closed. To perform a bumpless transfer into Adm or Extr/Adm control the pressures on each side of the Adm Trip-&-Throttle (T&T) valve should be matched. The 5009XT Control has a manual demand signal to allow operators to manually vary the pressure on the turbine side of the Adm T&T valve. Once these pressures are matched an operator can open the T&T valve and then issue an Extr/ Adm control enable command. The manual demand signal's raise and lower and the Extr/Adm enable/disable commands can all be issued through the 5009XT Control's GUI, contact inputs, or Modbus commands.

When a letdown station is used as a backup to the turbine extraction pressure controller, it is required that the letdown station's setpoint be lower than that of the 5009XT Extraction Control's setpoint to prevent fighting and potential instability between the controllers.

With this configuration, import/export control (Auxiliary PID) can be enabled at any time after the utility tie breaker and generator breaker input contacts are closed. Auxiliary control can be enabled through the programmed contact, a Modbus command, or the GUI. Because the auxiliary setpoint tracks plant import/export power before being enabled, the transfer to auxiliary control is bumpless. Once enabled, the Auxiliary PID's setpoint can then be positioned to the desired import or export level.

Because of the 5009XT Control's configuration this unit will automatically switch to frequency control upon the opening of the plant-to-utility tie breaker.

Example 6—Inlet Pressure Control with Isochronous Load Sharing Control in Island Mode

(Extraction Turbine, Decoupled Inlet mode, Coupled HP & LP mode)

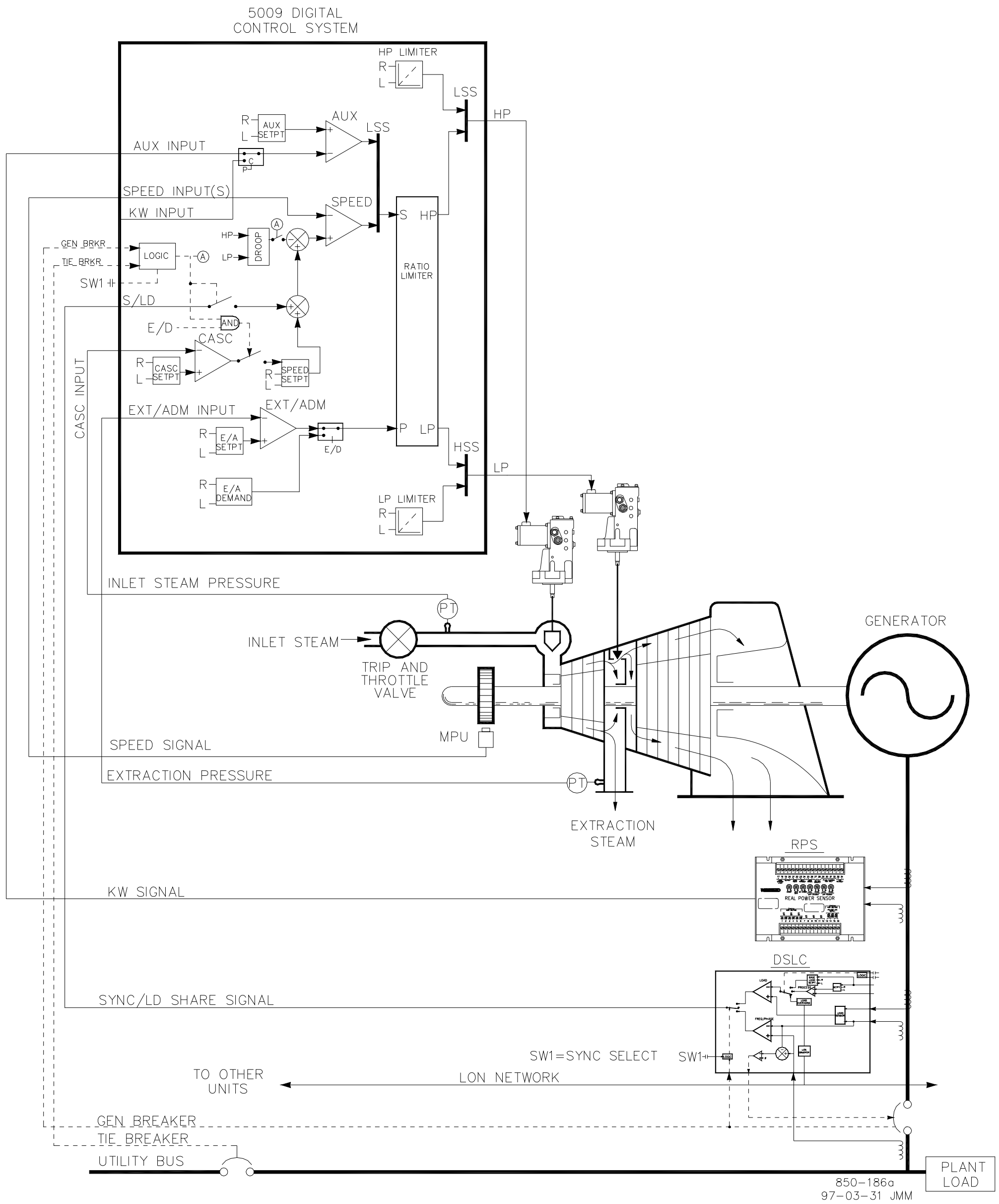


Figure 15-6. Inlet Pressure Control with Isochronous Load Sharing Control in Island Mode

For this application it is desired to control inlet pressure when paralleled to the utility, and plant frequency when isolated from the utility. With this type of application load varies based on plant process steam demand when paralleled to the utility. When isolated from the utility, unit load varies based on plant power demand. Other applications may or may not utilize all the functionality shown in Figure 15-6 and described below.

Turbine inlet header pressure control is performed within the 5009XT Control through the Cascade PID controller. This is an ideal controller for this type of function because it can be enabled and disabled as desired by a system operator. This gives a system operator full authority of when to transfer process pressure control to or from a letdown station or turbine bypass valve.

Extraction pressure is controlled by the extraction PID. This PID controller can be enabled automatically or manually depending on configuration. In all cases the 5009XT Control starts up with the extraction PID disabled and the LP valve at its maximum open position. This allows a turbine to warm-up in a uniform manner. The extraction setpoint can be varied through the 5009XT Control's GUI, discrete inputs, a 4–20 mA signal, or Modbus commands.

During normal operation, unit load is determined by the Cascade PID which is controlling inlet header pressure. Because turbine load may vary greatly, a limiter is used to protect the generator from being over powered. This protection is performed by the Auxiliary PID configured as a limiter.

This application uses a DSLC for synchronization and isochronous load sharing. When the unit is paralleled to the utility, the DSLC is disabled and the 5009XT Control's internal load setpoint or Cascade PID (inlet header pressure) is used to control/set unit load. When the plant becomes isolated from the utility (utility tie breaker opens), the DSLC is enabled, cascade control is disabled, and the 5009XT Control is switched to a frequency control / load sharing mode.

The DSLC sends an analog input signal to the 5009XT Control to set the Sync/Ld Share level. When a Sync/Ld Share analog input is programmed, the input is automatically enabled if the generator breaker input is closed and the utility tie breaker input is open.

Before the generator breaker is closed, the Sync/Ld Share input can be enabled to allow automatic synchronization by the DSLC. This synchronizing function/input can be enabled through a contact input, Modbus command, or the GUI. As shown in Figure 15-6 a panel mounted (DPST) switch is used with this application to select automatic synchronization in both the DSLC and 5009XT Control. Alternatively, this switch could come from a 5009XT Control relay programmed to energize for a Modbus Command, GUI Command, Sync Enabled, or a Speed Switch Level Reached condition.

All 5009XT Control PID controller setpoints may be changed through programmed raise and lower contacts, 4–20 mA inputs, Modbus commands, or the GUI.

The following list of notes are provided as a reference for application programmers to follow when programming the 5009XT Control to achieve any control and limiting actions shown in Figure 15-6.

Starting & Run Mode Notes for Example 6—Starting and ramping to an idle or minimum speed position can be performed automatically, semiautomatically, or manually. From an idle or minimum speed position, the Idle/ Rated or Auto Start Sequence functions, if programmed, can be used to assist in ramping the control to a rated speed position. Alternatively, an operator can give a manual raise command to increase turbine speed as desired.

When the unit has been started and is controlling at a rated speed position, the turbine generator can be synchronized. This can be done manually or automatically. The system operator can select automatic synchronization through the Auto-Sync select switch (SW1 in Figure 15-6). When this switch is closed the 5009XT Control's Sync/Load Sharing input is enabled and the DSLC control's automatic synchronizing function is selected.

After synchronization, generator load is determined by the state of the utility tie breaker contact input. If the utility tie breaker contact is closed, generator load is determined by the 5009XT Control's internal load setpoint or, when enabled, inlet header pressure control (cascade control). If the utility tie breaker contact is open, generator load is determined by the DSLC. The DSLC can be configured to operate in several different load control modes. For this application the DSLC is only used for isochronous load sharing, when the plant is isolated from the utility.

In this plant four generating units use DSLC controls and, upon the plant-to-utility tie breaker opening, they all switch to frequency control and communicate over a LAN, using an Echelon network, to share load. Thus plant frequency is controlled by all units and plant load is shared proportionally by all four units. With this configuration, plant frequency will be the average frequency of all units. The 5009XT Control has a feature that resets its frequency setpoint to the 'RATED SPEED SETPOINT' setting upon the utility tie breaker opening, thus assuring that all units will be at synchronous speed. The DSLC control's frequency trimmer function may also be programmed to trim system frequency to a desired frequency.

Cascade control (turbine inlet header pressure) can be enabled at any time after the utility tie breaker and generator breakers are closed through a contact input, Modbus command or the GUI. If the actual inlet header pressure does not match the cascade setpoint when cascade control is enabled, the control will automatically ramp turbine load at the “Speed Setpoint Slow Rate” setting until the inlet header pressure does match the setpoint. Once in control, the Cascade PID will no longer be limited by the “Speed Setpoint Slow Rate” setting. The 5009XT Control’s ratio/limiter uses the coupled HP & LP mode when cascade control is disabled, and the decoupled Inlet mode when cascade control is enabled.

Because the 5009XT Control was programmed for the capability to automatically enable Extraction Control, the operator may choose to automatically or manually enable Extraction Control. To manually enable Extraction Control, the operator must issue a LP valve limiter lower command from the 5009XT Control GUI, a contact input, or through Modbus commands. The LP valve limiter must be taken to its minimum position to fully enable Extraction Control.

The enabling routine, which automatically lowers the LP valve limiter, may be issued from the 5009XT Control’s GUI, contact input, or through Modbus commands. This routine automatically ramps the LP valve to its minimum position and may be stopped at any time by momentarily issuing a LP valve limiter raise or lower command. Once the automatic enabling routine has been stopped it may be restarted/enabled at any time by issuing a disable command followed by an Extr/Adm control enable command or, once stopped, the operator may continue the routine manually. (Disabling of Exhaust control can also be performed manually or automatically.)

When a letdown station is used as a backup to the turbine extraction pressure controller, it is required that the letdown station’s setpoint be lower than that of the 5009XT Control extraction control’s setpoint to prevent fighting and potential instability between the controllers.

With this application the Auxiliary Control is programmed to be used as a limiter and to be automatically enabled when both the utility tie and generator breakers are closed. When paralleled to the utility, if inlet header pressure demand and/or other system conditions try to force the generator to operate above its load limit setting, the Auxiliary PID will take control of the governor valve to limit generator load. Once system conditions demand unit load below that of the auxiliary setpoint, the Cascade/Speed PIDs will again take control of generator load.

Example 7—Import/Export Control or Exhaust Pressure Control with Isochronous Load Sharing in Island Mode

(Extraction Turbine, Decoupled Exhaust Mode, Coupled HP & LP Mode)

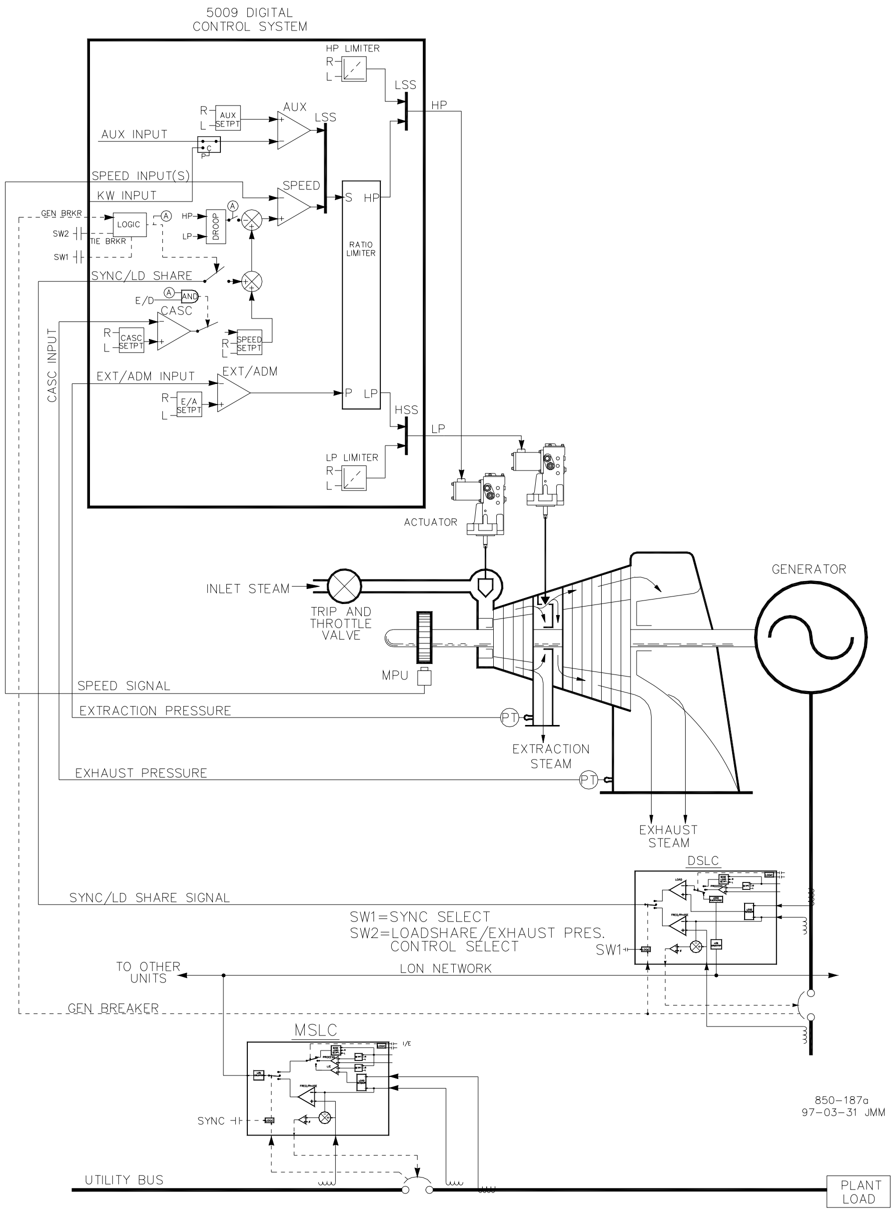


Figure 15-7. Import/Export Control or Exhaust Pressure Control with Isochronous Load Sharing in Island Mode

This example utilizes multiple turbine generators and requires that all units have the capability to control different plant parameters depending on the status of each unit. Normal operation is to have one unit control plant process steam (turbine exhaust pressure) and the other units be controlled based on plant import/export demand. Other applications may or may not utilize all the functionality shown in Figure 15-7 and described below.

Based on system health, only one unit at any time is used to control plant process steam. The other units are used to control a plant export power level of 5 MW.

Each unit control panel has a mode selection switch which allows an operator to place a unit in one of three different modes of operation. The three modes of operation are: manual load (used to manually load and unload a unit), plant process steam control (turbine exhaust pressure), and load sharing (used for plant import/export control or unit load sharing).

When a unit is switched to manual load control mode, its internal load setpoint determines unit load. This allows an operator to manually load or unload a unit to a set level if desired.

When a unit is switched to the plant process control mode, turbine exhaust pressure control is performed within the 5009XT Control through the Cascade PID controller. This is an ideal controller for this type of function because it can be enabled and disabled as desired by a system operator. This gives a system operator full authority of when to transfer process pressure control to or from a letdown station or turbine bypass valve.

This application uses Woodward DSLC controls and an MSLC to allow all units to communicate, share plant load, and control plant export power. The DSLC is used on each unit for synchronization and load sharing. One Master Synchronizer & Load Control (MSLC) is used for plant synchronization and import/export power control. The MSLC, when enabled, sets the load setpoint of each unit DSLC (in the load sharing mode) to control a plant export level. When the plant- to-utility tie breaker is open, the MSLC is disabled, and each unit communicates with the other units in the load sharing mode via the DSLC control's LON network to share plant load.

Extraction pressure is controlled by the Extr/Adm PID. This PID controller can be enabled automatically or manually depending on configuration. In all cases the 5009XT Control starts up with the Extr/Adm PID disabled and the LP valve at its maximum open position. This allows a turbine to warm-up in a uniform manner. With this application the Extr/Adm setpoint is only varied through the 5009XT Control's GUI or Modbus Commands. Optionally the 5009XT Control could be programmed to have the Extr/Adm setpoint varied through discrete inputs or a 4–20 mA signal.

A DSLC control's speed bias signal interfaces to a 5009XT Control through an analog input signal. When a Sync/Ld Share analog input is programmed, the input is automatically enabled if the generator breaker input is closed and the utility tie breaker input is open.

Before the generator breaker is closed, the 5009XT Control's Sync/Ld Share analog input can be enabled to allow automatic synchronization by the DSLC. This synchronizing function/input can be enabled through a contact input, Modbus command, or the GUI. As shown in Figure 15-7, a panel mounted (DPST) switch is used to select automatic synchronization in both the DSLC and 5009XT Control. Alternatively, this switch could come from a 5009XT Control relay programmed to energize for a Modbus command selected, sync enabled, or a speed switch level reached.

All 5009XT Control PID controller setpoints may be changed through programmed raise and lower contacts, 4–20 mA inputs, Modbus commands, or the GUI.

The following list of notes are provided as a reference for application programmers to follow when programming the 5009XT Control to achieve any control and limiting actions shown in Figure 15-7.

Starting & Run Mode Notes for Example 7—Starting and ramping to an idle or minimum speed position can be performed automatically, semiautomatically, or manually. From an idle or minimum speed position, the Idle/ Rated or Auto Start sequence functions can be used to assist in ramping the control to a rated speed position. Alternatively, an operator can give a manual raise command to increase turbine speed as desired.

After the unit has been started and is controlling at a rated speed position, the turbine generator can be synchronized. This can be done manually or automatically. The system operator can select automatic synchronization through the Auto-Sync select switch (SW1 in Figure 15-7). When this switch is closed the 5009XT Control's Synchronizing input is enabled and the DSLC control's automatic synchronizing function selected.

In this mode, the operation of the system is dependent on SW2's position. When SW2 is not selecting the load sharing mode and the generator breaker is closed, unit load is set by the 5009XT Control's internal speed/load setpoint, or the Cascade PID if enabled. Upon the generator breaker closing, the 5009XT Control steps the speed/load setpoint up to a minimum load level to reduce the chance of reverse powering or motoring the generator. This minimum load level is based on the speed/load setpoint and is defaulted to a speed setpoint rpm value equal to "3%" turbine/generator load. The defaulted value is adjustable through the 5009XT Control's GUI or Modbus commands.

After synchronization the 5009XT Control's load setpoint can be positioned through raise and lower speed/load setpoint contacts, a programmed 4–20 mA input, Modbus commands, or the GUI.

Since decoupled exhaust was the ratio/limiter action programmed with this application, it is recommended that Extraction Control be enabled (the LP limiter lowered to min) before exhaust control (which uses the LP valve to control). It is also recommended that cascade control be disabled before Extraction Control is disabled (the LP limiter raised). By following these recommended procedures, each control mode can be bumplessly taken into and out of control. The 5009XT Control's ratio/limiter uses the coupled HP & LP mode when cascade control is disabled, and the decoupled exhaust mode when cascade control is enabled.

Because the 5009XT Control was programmed for the capability to automatically enable Extraction Control, the operator may choose to automatically or manually enable Extraction Control. To manually enable Extraction Control the operator must issue a LP valve limiter lower command from the GUI, a contact input, or through Modbus commands. The LP valve limiter must be taken to its minimum position to fully enable Extraction Control.

The enabling routine, which automatically lowers the LP valve limiter, may be issued from the 5009XT Control's GUI, contact input, or through Modbus commands. This routine automatically ramps the LP valve to its minimum position and may be stopped at any time by momentarily issuing a LP valve limiter raise or lower command. Once the automatic enabling routine has been stopped it may be restarted/enabled at any time by issuing a disable command followed by an Extr/Adm control enable command or, once stopped, the operator may continue the routine manually. (Disabling of Exhaust control can also be performed manually or automatically.)

Cascade control (turbine exhaust pressure) can be enabled at any time after the utility tie breaker and generator breaker input contacts are closed. Cascade control can be enabled through a programmed contact, Modbus command, or the GUI. Exhaust pressure control can be transferred from a letdown station to 5009XT Control Cascade Control in one of the following ways; enabling cascade control, and backing down the letdown station' s setpoint, or enabling cascade control and raising the cascade's setpoint. When a letdown station is used as a backup to the turbine pressure controller, it is required that the letdown station's setpoint be lower than that of the 5009XT Control's setpoint to prevent fighting and potential instability between the controllers.

After exhaust pressure control has been transferred to the 5009XT's Cascade PID, the letdown station or turbine bypass valve must be closed or in a manual control mode. This will stop the two controllers (5009XT Control Cascade PID and system letdown station) from fighting for control of one parameter and causing system instability. If both a turbine bypass valve and the turbine's flow are required to satisfy the header flow requirements, droop is required in one of the control loops for stability.

When SW2 is switched to select load sharing, the DSLC bumplessly ramps load to match the MSLC's load setpoint, or to a load setting determined by the DSLC control's load sharing circuitry, depending on utility-to-tie breaker position. The MSLC can be used to set all the units in the load sharing mode to a base load setting or to vary their load based on a plant import/export demand setting.

During normal operation, one unit is controlling plant process steam and the other units are in load sharing control mode. The units sharing load are loaded based on the MSLC plant load demand. If the plant should become isolated from the utility, the MSLC is disabled and the load sharing units will share plant load. When desired, the MSLC can be enabled to re-synchronize the plant bus to the utility bus and close the plant-to-utility tie breaker. After synchronization the MSLC will either ramp plant power to the desired export power level or ramp plant load to a base load setting, depending on the mode of operation selected.

Woodward DSLC controls can interface directly with a unit's automatic voltage regulator. This allows units with DSLC controls to share reactive power as well as real power. This configuration also allows the MSLC to control plant power factor when the utility-to-tie breaker is closed.

Example 8—Inlet Pressure Control & Exhaust Pressure Control with Generator Power Limiting
(Extraction Only Turbine, Decoupled HP & LP Mode)

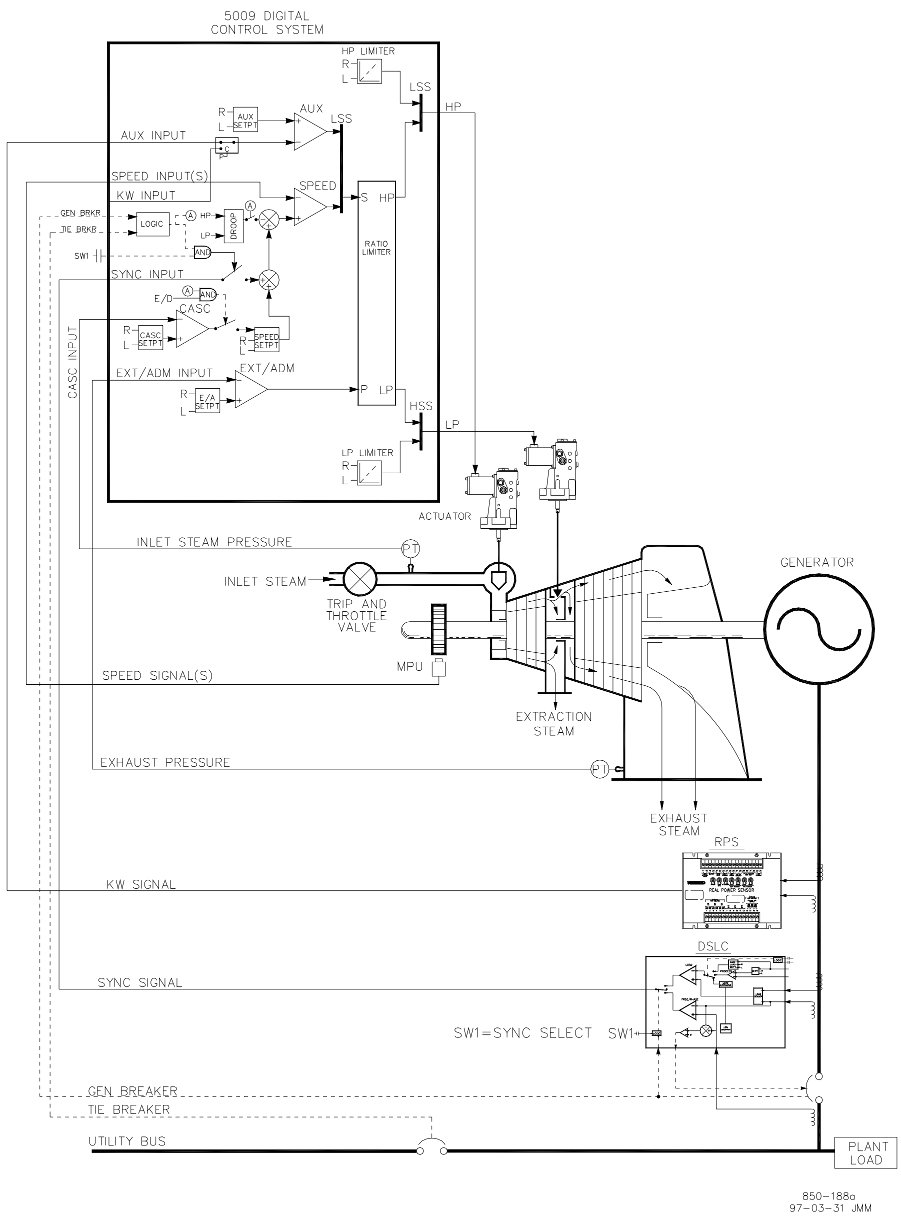


Figure 15-8. Inlet Pressure Control, Exhaust Pressure Control with Generator Power Limiting

This is an example of a typical turbine generator application where the turbine inlet and exhaust header pressures are desired to be controlled and the turbine's extraction header pressure is controlled by a system letdown station. With this type of application, turbine load varies based on the plant process steam demand. Both the auxiliary and cascade modes were used for this example application. Other applications may or may not utilize all the functionality shown in Figure 15- 8 and described below.

With this application, turbine inlet header pressure control is performed within the 5009XT Control through the Cascade PID controller. This is an ideal controller for this type of function because it can be enabled and disabled as desired by a system operator. This gives a system operator full authority of when to transfer process pressure control to or from a letdown station or turbine bypass valve.

During normal operation unit load is determined by the Cascade PID controlling inlet header pressure. Because turbine load may vary greatly with this application, a limiter is used to protect the generator from being over powered. This protection is performed by the Auxiliary PID configured as a limiter. By configuring the Auxiliary PID as a limiter and using a Real Power Sensor's (RPS) output signal as the PID's controlling parameter, the maximum load the generator can operate at can be limited.

Turbine exhaust pressure is controlled by the Extraction PID. This PID controller can be enabled automatically or manually depending on configuration. In all cases the 5009XT Control starts up with the Extraction PID disabled and the LP valve at its maximum open position. This allows a turbine to warm-up in a uniform manner. With this example the extraction setpoint is only varied through the 5009XT Control's GUI or Modbus commands. Optionally the 5009XT Control could be programmed to have the Extr/Adm setpoint varied through discrete inputs, a 4- 20 mA signal.

This application uses a DSLC for synchronization only. Because the DSLC interfaces to the 5009XT Control through an analog signal, a 5009XT Control analog input must be programmed to receive the DSLC control's Speed Bias signal. When a synchronizing input/function is programmed, the input can be enabled through a contact input, Modbus command, or the GUI. As shown in Figure 15-8 a panel mounted (DPST) switch is used with this application to select automatic synchronization in both the DSLC and 5009XT Control. Alternatively, this switch could come from a 5009XT Control relay programmed to energize for a Modbus Command Selected, Sync Enabled, or a Speed Switch Level Reached.

All 5009XT Control PID controller setpoints may be changed through programmed raise and lower contacts, programmed 4–20 mA inputs, Modbus commands, or the GUI.

The following list of notes are provided as a reference for application programmers to follow when programming the 5009XT Control to achieve any of the control and limiting actions shown in Figure 15-8.

Starting & Run Mode Notes for Example 8—Starting and ramping to an idle or minimum speed position can be performed automatically, semiautomatically, or manually. From an idle or minimum speed position, the Idle/ Rated or Auto Start sequence functions, if programmed, can be used to assist in ramping the control to a rated speed position. Alternatively an operator can give a manual raise command to increase turbine speed as desired.

After the unit has been started and is controlling at a rated speed position, the turbine generator can be synchronized. This can be done manually or automatically. The system operator can select automatic synchronization through the Auto-Sync select switch (switch SW1 in Figure 15-8). When this switch is closed, the 5009XT Control's Synchronizing input is enabled and the DSLC control's automatic synchronizing function is selected.

When the plant-to-utility tie-line breaker is closed and the unit generator breaker closes, the 5009XT Control steps the speed/load setpoint up to a minimum load level to reduce the chance of reverse powering or motoring the generator. This minimum load level is based on the speed/load setpoint and is defaulted to a "3%" step change of the speed/load setpoint. The defaulted 3% minimum load value (stored as a setpoint "rpm" change) is adjustable through the 5009XT Control's GUI or Modbus commands. (Breaker Logic, Min Load Bias = X rpm).

After synchronization the 5009XT Control's load setpoint can be positioned through raise and lower speed/load setpoint contacts, a programmed 4–20 mA input, Modbus commands, or the GUI. This load control mode may be used to slowly increase turbine load, and take control away from a letdown station or turbine bypass valve.

Cascade control (turbine inlet header pressure) can be enabled at any time after the utility tie breaker and generator breakers are closed, through a contact input, Modbus command or the GUI. When cascade control is enabled the cascade setpoint will match the inlet header pressure level at that time, thus a bumpless transfer to inlet header pressure control is accomplished. After the Cascade Controller has been enabled, the operator can increase or decrease the control setpoint as desired.

Because the 5009XT Control was programmed for the capability to automatically enable Extraction Control, the operator may choose to automatically or manually enable Extraction Control. To manually enable Extraction Control, the operator must issue a LP valve limiter lower command from the GUI, a contact input, or through Modbus commands. The LP valve limiter must be taken to its minimum position to fully enable Extraction (exhaust) Control.

The enable routine command may be issued from the 5009XT Control's GUI, contact input, or through Modbus commands. This routine automatically ramps the LP valve to its minimum position and may be stopped at any time by momentarily issuing a LP valve limiter raise or lower command. Once the automatic enabling routine has been stopped it may be restarted/enabled at any time by issuing a disable command followed by an Extr/Adm control enable command or, once stopped, the operator may continue the routine manually (disabling of exhaust control can also be performed manually or automatically).

When a letdown station is used as a backup to the turbine extraction pressure controller, it is required that the letdown station's setpoint be lower than that of the 5009XT Extraction Control's setpoint to prevent fighting and potential instability between the controllers.

With this application the auxiliary control is programmed to be used as a limiter and to be automatically enabled when both the utility tie and generator breakers are closed. When paralleled to the utility, if inlet header pressure demand and/or other system conditions try to force the generator to operate above its load limit setting, the Auxiliary PID will take control of the HP governor valve to limit generator load. Once system conditions demand unit load below that of the auxiliary setpoint, the cascade/Speed PIDs will again take control of generator load.

Example 9—Admission Steam Turbine Control with Bootstrap Start-up

(Admission Turbine, Coupled HP & LP Mode)

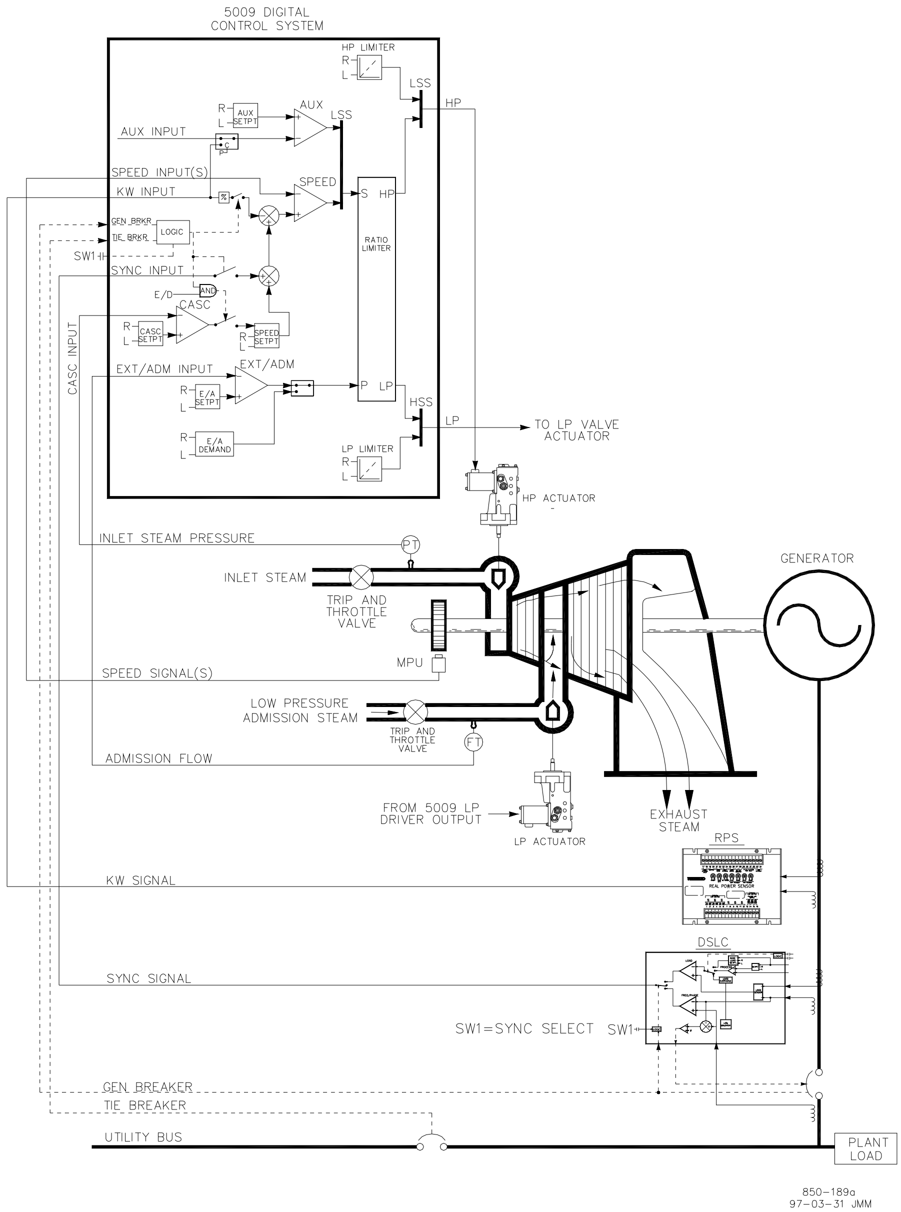


Figure 15-9. Admission Steam Turbine Control with Bootstrap Start-up

This is an example of a typical turbine generator application where turbine load and admission flow are controlled. However, this application requires that the turbine be started with low pressure admission steam until the refinery can be bootstrapped up to begin producing high pressure inlet steam. Other applications may or may not use all the functionality shown in Figure 15-9 and described below.

With this application, a Real Power Sensor (RPS) is used to sense generator load and allow the 5009XT speed/load PID to control and limit generator load.

In this example, it is assumed that an external trip valve or trip-and-throttle valve is used to completely stop any admission steam from entering the turbine upon a system shutdown condition.

Admission pressure is controlled by the Admission PID. An operator uses a manual demand signal to match the pressures on both sides of the admission trip & throttle valve. After the pressures have been matched, the operator can enable admission. At this point the operator can vary the admission setpoint through the 5009XT Control's GUI or Modbus commands.

This application uses a DSLC for synchronization only. Because the DSLC interfaces to the 5009XT Control through an analog signal, a 5009XT Control analog input must be programmed to receive the DSLC control's speed bias signal. When a synchronizing input/function is programmed, the input can be enabled through a contact input, Modbus command, or the GUI. As shown in Figure 15-9 a panel mounted (DPST) switch is used with this application to select automatic synchronization in both the DSLC and the 5009XT Control.

All 5009XT PID controller setpoints may be changed through programmed raise and lower contacts, programmed 4–20 mA inputs, Modbus commands, or the GUI.

The following list of notes are provided as a reference for application programmers to follow when programming the 5009XT Control to achieve any control and limiting actions shown in Figure 15-9.

Starting & Run Mode Notes for Example 9—Starting and ramping to an idle or minimum speed position can be performed automatically, semiautomatically, or manually. With this type of configuration, a semiautomatic start requires that the LP valve limiter be manually lowered to 0% before the admission Trip-and-Throttle (T&T) valve is opened.

From an idle or minimum speed position, the Idle/Rated or Auto Start sequence functions, if programmed, can be used to assist in ramping the control to a rated speed position. Alternatively, an operator can give a manual raise command to increase turbine speed as desired.

After the unit has been started and is controlling at a rated speed position, the turbine generator can be synchronized. This can be done manually or automatically. The system operator can select automatic synchronization through the Auto-Sync select switch (SW1 in Figure 15-9). When this switch is closed the 5009XT Control's synchronizing input is enabled and the DSLC control's automatic synchronizing function selected.

The DSLC provides phase matching or slip frequency synchronizing, and ties into the unit automatic voltage regulator to match voltages before paralleling. It communicates over a LAN, using an Echelon network, with other plant DSLC controls to perform safe dead bus closing.

When the plant-to-utility tie line/breaker is closed and the unit generator breaker closes, the 5009XT Control steps the speed/load setpoint up to a minimum load level to reduce the chance of reverse powering or motoring the generator. This minimum load level is based on the speed/load setpoint and is defaulted to a "3%" load. The defaulted value is adjustable through the 5009XT Control's GUI or Modbus commands. (Breaker Logic, Min Load Bias = xxx).

After synchronization, the 5009XT Control's load setpoint can be positioned through raise and lower speed/load setpoint contacts, a 4–20 mA input, Modbus commands, or the GUI.

Once the inlet steam pressure is near rated levels, the HP T&T valve can be opened. As inlet steam capacity increases, the 5009XT Control will reposition the control valves to hold a constant load level (true load control is capable only if KW droop is used).

Admission control can be enabled any time after the generator breaker is closed, the HP trip-&-throttle valve has been opened, and the inlet steam source has the capacity to provide the steam required to hold the turbine at its current load level.

To perform a bumpless transfer into admission control, the 5009XT's manual demand signal must be manually adjusted to match the signal to the admission's steam flow (in %). Once the manual demand signal matches the current percent admission steam flow, admission control can be enabled. The manual demand signal's raise/lower and the admission enable/disable commands can be issued through the 5009XT Control's GUI, contact inputs, or Modbus commands.

Example 10—Typical Plant Load and Steam Pressure Control Application

With this application a combination of 5009XT Control System, DSLC controls, MSLCs, and a Single Loop PID controller allow the following plant parameters to be controlled:

- Plant Import and/or Export Power (Utility Tie breaker closed)
- Plant Inlet Header Pressure (Utility Tie breaker closed)
- Plant Power Factor or VARs (Utility Tie breaker closed)
- Plant Frequency with proportional load sharing (Utility Tie breaker open)
- Plant Power Factor Sharing (Utility Tie breaker open)
- Plant to Utility Frequency Automatic Synchronizing (Utility Tie breaker open)
- Plant to Utility Phase Automatic Synchronizing (Utility Tie breaker open)
- Plant to Utility Voltage Automatic Synchronizing (Utility Tie breaker open)
- Plant Extraction Header Pressure (Utility Tie breaker open or closed)

This is an example of a typical plant application where multiple turbine generators are load and flow shared to control plant functions like import/export power or turbine inlet header pressure and extraction header pressure. When the plant is disconnected from a utility, this configuration allows all units to control plant frequency, load share, and continue flow sharing into the extraction header. Other applications may or may not use all the functionality shown in Figure 15-10 and described below.

With this application, each 5009XT Control is paired with a Digital Synchronizer and Load Control (DSLC). When enabled each DSLC interfaces with its respective 5009XT Control to determine the unit's load. Each DSLC, when in the isochronous load sharing mode, interfaces with all other plant DSLC controls and MSLCs via an Echelon Network. This digital network allows units to share load with each other or be controlled by a Master Synchronizer and Load Control (MSLC). Only one MSLC at a time can be active on the Echelon network.

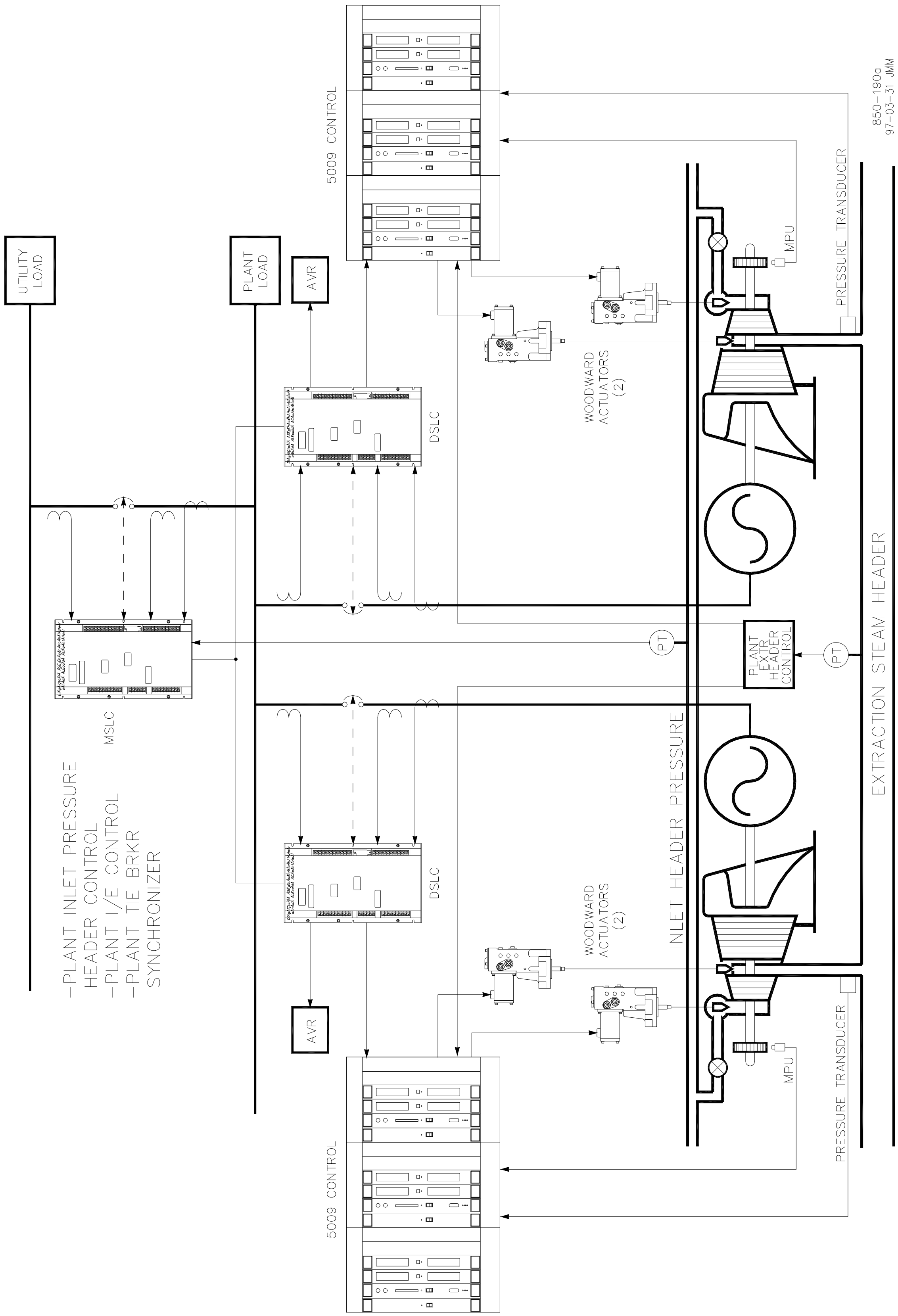


Figure 15-10. Plant Load and Steam Pressure Control Application

An MSLC, when enabled, can control the load of all units (via DSLC controls and 5009XTs) on the Echelon network to control a common parameter. To have its load level set by the MSLC, a DSLC must be in the isochronous load sharing mode. This allows an operator to determine which units will function together to control a common parameter (inlet header pressure, import/export power) and which units will function separately to control other parameters (exhaust pressure, unit load).

The MSLC senses plant import/export power and uses a “PI” controller to command any or all units on the Echelon network to control plant import/export power. The MSLC can also accept and control (with a “PI” controller) any process signal which is directly related to each unit’s load and which the units enabled all have in common (inlet header pressure, exhaust header pressure). All units share equally in the load because the MSLC sends the same demand signal to each DSLC.

When the utility tie breaker is open, the MSLC can be used to automatically synchronize the plant bus to the utility grid. The MSLC varies the frequency setting of all units, through the DSLC controls, which are on-line and enabled for synchronization. By connecting each DSLC to its respective generator’s automatic voltage regulator (AVR), the MSLC can also communicate with all the enabled DSLC controls to match plant voltage to that of the utility.

With each DSLC connected to its unit AVR, the MSLC can be used to control the plant power factor or reactive power level (VARs). This configuration also allows power factor sharing between units when the plant is disconnected from the utility.

The plant extraction header pressure controller used with this application is a stand-alone “PI” controller. This controller senses extraction header pressure and outputs identical signals to all unit extraction pressure controllers thus forcing allow all units to equally flow share. The controller’s output signal is used to drive each unit’s extraction pressure setpoint. Unlike the MSLC, this controller does not communicate over an Echelon network, thus the plant extraction header controller is required to have multiple outputs.

Because turbine extraction pressure is not a function of turbine load, the MSLC cannot be used to control this parameter. A “PI” controller was used with this application to allow all units to flow share. Alternatively, one unit could have been used to control any changes in plant demand and the other units could have been set to output a constant flow. The latter configuration, however, limits the amount of plant demand change the system can handle without an upset or an operator driven change.

Another benefit of this MSLC - DSLC configuration is that any prime mover that has a DSLC installed can be used to load share. Because each DSLC has an individual load sharing gain setting, the response differences between units can be compensated for.

Example 11—Induction Generator Applications

When the 5009XT Control is configured for induction generator applications, there are typically only two differences in the programming of the 5009XT Control versus programming for synchronous generator applications.

The induction generator’s slip frequency must be taken into account. This is achieved by compensating for the slip frequency with the 5009XT Control’s maximum speed setpoint setting. The maximum speed setpoint must be equal to synchronous speed plus the droop percentage plus the full load slip frequency percentage.

1. **MAX CONTROL SETPOINT**= Sync Speed + (Sync Speed * Droop) + Max Slip RPM

2. In the Configuration menu, under Operating Parameters, the selection of “Use Generator Breaker Open Trip?” should be checked.

Chapter 16.
Understanding PID Settings

Overview

The Speed, Cascade, Auxiliary (1 & 2), and Acceleration controls utilize PID controllers. The response of each control loop can be adjusted for optimum response, however it is important to understand what a PID controller is and the effect each controller adjustment has on the controller response. Proportional gain, integral gain (stability), and DR (speed 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 5009XT as follows:

- P = Proportional gain (%)
- I = Integral gain (%)
- D = Derivative (determined by DR and I)

Proportional Control

Proportional response is directly proportional to a process change.

Analogy: Setting hand throttle to keep constant speed on straight and level.

Proportional control (using the same analogy) results in a certain speed as long as the car is not subjected to any load change such as a hill. If a throttle is set to any particular setting, the speed of the car will remain constant as long as the car remains straight and level. If the car goes up a hill, it will slow down. Of course, going down a hill the car would gain speed.

Integral Control

Integral compensates for process and setpoint load changes.

Analogy: Cruise control maintains constant speed regardless of hills.

Integral, (sometimes called reset) provides additional action to the original proportional response as long as the process variable remains away from the setpoint. Integral is a function of the magnitude and duration of the deviation. In this analogy, the reset response would keep the car speed constant regardless of the terrain.

Derivative

Derivative provides a temporary over-correction to compensate for long transfer lags and reduce stabilization time on process upsets (momentary disturbances).

Analogy: Accelerating into high-speed lane with merging traffic.

Derivative, sometimes called “preact” or “rate”, is very difficult to draw an accurate analogy to, because the action takes place only when the process changes and is directly related to the speed at which the process changes. Merging into high-speed traffic of a freeway from an “on” ramp is no easy task and requires accelerated correction (temporary overcorrection) in both increasing and decreasing directions. The application of brakes to fall behind the car in the first continuous lane or passing gear to get ahead of the car in the first continuous lane is derivative action.

Proportional Response

The amount of controller change is directly related to the process change and the Proportional gain setting on the controller; Controller output change is Proportional to the process change. If there is no process change, there is no change in output from the controller (or valve change) regardless of the deviation. This results in an undesired offset between the original desired Setpoint and the resulting drop in the Control Point.

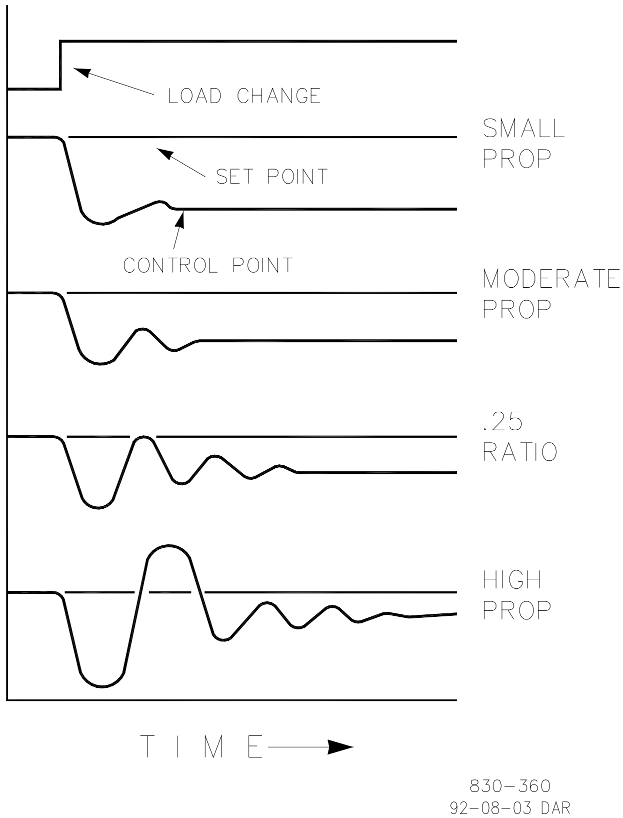


Figure 16-1. Proportional Gain Setting Effects

Proportional Gain (effect of settings)

Figure 13-1 shows the effect of Proportional gain settings on control. Starting at the top of the graph a load change is introduced. With a small Proportional gain (meaning a large process change is required to produce full valve travel), stability is good but offset is very high. With a moderate gain setting (higher number setting) stability is still good–offset is still fairly high. With a high setting, offset is considerably smaller but the stability is poor. The 0.25 ratio effects a minimum area whereby the offset is reduced to a minimum while stability is in a decaying manner at 0.25% ratio. The decay ratio used (0.25%) means that if the second cycle is 1/4 of the first cycle, then each succeeding cycle will be 1/4 of the preceding cycle until the cycle is not visible.

Since Proportional gain is adjusted to produce (only) the proper stability of a process, do not continue increasing its effect to correct offset conditions. The amount of stability and offset is directly related to the setting of the Proportional setting. Stability is of course also affected by the stability of the process. In essence, the amount of output from the controller due to the Proportional setting is from the error. If there is no error, then there is no Proportional effect.

Integral Response

Integral Gain as stated in the Woodward controls is repeats per minute (or Reset Rate). Therefore, a high amount of Integral gain (high number) would result in a large amount of Reset action. Conversely, a low Integral gain (low number) would result in a slower reset action.

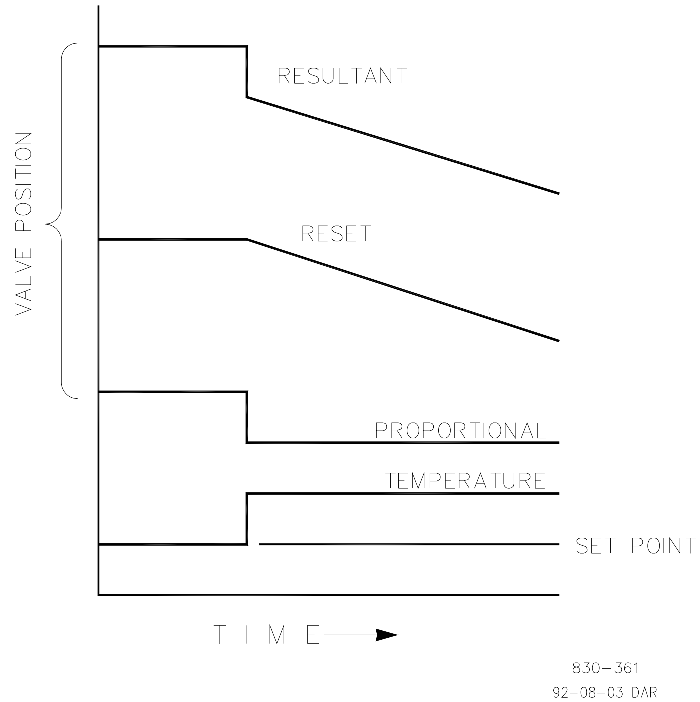


Figure 16-2. Open Loop Proportional and Integral Response

Integral response is provided to eliminate the offset that resulted from straight Proportional control. Figure 16-2 shows how the controller action is Proportional to the measurement change, but as we saw earlier, this results in offset. The Integral (or Reset) action is a function of both time and magnitude of the deviation. As long as an offset condition (due to load changes) exists, Integral action is taking place.

The amount of Integral action is a function of four things:

- The magnitude of the deviation
- The duration of the deviation
- The Proportional gain setting
- The Integral setting

In this Open Loop figure (16-2), the Integral response is shown increasing due to the offset condition existing between the temperature and the setpoint. The resultant action is the top curve showing the step Proportional response that ends as soon as the measurement stops changing. Then the Integral (or reset) action is added to the Proportional action in an amount equal to the Integral of the deviation. In other words, Reset action continues (in either or both directions) as long as there is a difference (deviation) between the setpoint and the process measurement.

In this case, the deviation will never be eliminated (or even reduced) because the system is in Open Loop.

Proportional + Integral = (closed loop)

Figure 16-3 shows the closed loop effects of integral action. The bottom curve displays the load change. The next curve up shows the setpoint and the measured variable, temperature. With the load change the temperature drops or deviates from the setpoint.

The next highest curve is the Proportional action and follows the measured variable proportionately. The Integral curve adds to the Proportional curve resulting in a different valve position, thereby returning the process to the Setpoint.

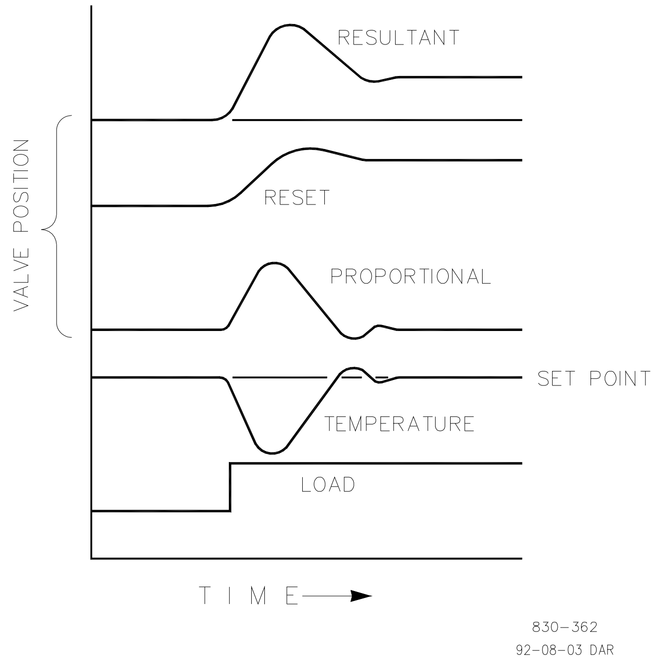


Figure 16-3. Closed Loop Proportional and Integral Response

In Closed Loop, however (as opposed to Open Loop), as the measurement decays toward the Setpoint the Proportional action is taking place Proportionally to the measurement change, and the Integral action is decaying proportionately to the magnitud16e and duration of the deviation until the measurement reaches the setpoint at which time the Integral action is zero.

Integral (effects of settings)

Figure 16-4 shows the effect of fast or slow Integral action. For a given load change an offset results with Proportional response only. Since recovery time (for a given load change) is important, the Integral setting should remove the offset in minimum time without adding additional cycling. If two cycles are added, then too much Integral Gain has been added. Of course, Proportional only must first establish the 1/4 decay ratio. If increased cycling occurs, the Integral must be turned off or the controller switched to “manual” if allowed to go too far. Ideally, the process should not continue to cycle after the setpoint has been reached as in the second curve from the bottom.

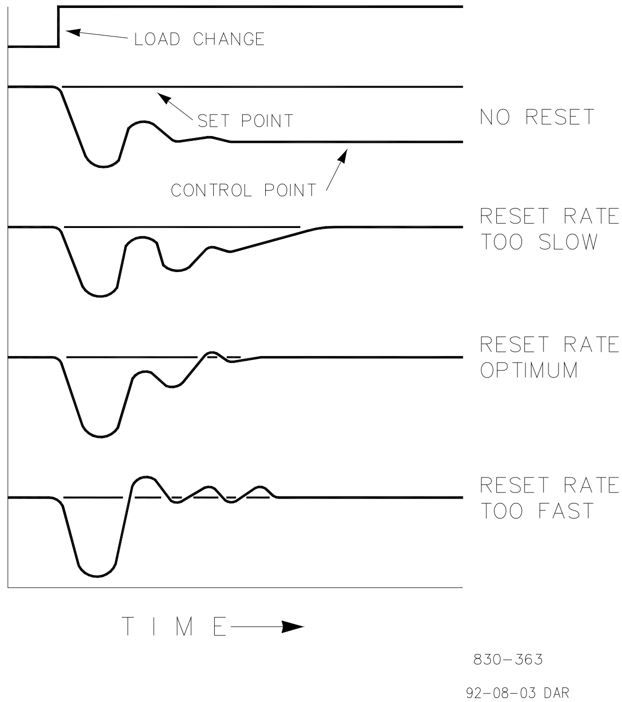


Figure 16-4. Integral Gain (Reset) Setting Responses

Derivative Response

In a process control loop the Derivative action is directly related to how fast the process changes (rate of change). If the process change is slow then the Derivative action is proportional to that rate of change. Derivative acts by advancing the Proportional action. Derivative acts at the start of the process change, when the process changes its rate and when the process stops its change.

Derivative action takes place at only three times:

- When the process starts to change
- When the rate of change takes place in the process
- When the process stops changing

The net result of Derivative action is to oppose any process change and combined with Proportional action to reduce stabilization time in returning the process to the setpoint after an upset. Derivative will not remove offset.

Woodward Derivative is split into two working domains, Input dominant and Feedback dominant. The allowed values for DR range from 0.01 to 100. The most common derivative is Feedback dominant; it is automatically selected with a Derivative Ratio (DR) from one to 100. The Input dominant domain is selected with DR values between 0.01 and 1.

Feedback dominant applies the derivative action to the integrator feedback term of the PID equation and is more stable than input dominant derivative. This will not take corrective action as early and it will be less noise sensitive. When tuning the derivative, the DR will be established in the 1 to 100 range because it is easier to tune and more forgiving of excessive values. Most PIDs will employ feedback dominant derivative.

Input dominant derivative applies the DR term before the integrator term of the PID equation. When the DR is less than one, the derivative is input dominant and reacts very quickly to process upsets. This function is very adapted for PIDs that control the load parameter, such as load shaft turbine speed. Since the input dominant derivative is so sensitive, it should be reserved only for applications without high frequency noise.

Except for input dominant and feedback dominant features, the reciprocal of one domain will appear identical in the other domain. As an example, consider a DR of 5.0, the reciprocal being 1/5. That means that a DR of 5.0 will appear the same as DR of 0.200. The difference in response between these values of 5.0 and 0.2 is in the dominance feature.

If in doubt about the type of derivative to use, then set up for feedback dominant, 1 < DR < 100.

Proportional + Derivative (closed loop)

Figure 16-5 shows how Derivative acts to oppose a change in process in either direction. The dashed line shows the Derivative action going through zero to oppose the process deviation traveling toward zero. Notice offset still exists between the desired setpoint and the drooped control point that resulted from the load change. The top curve is the resultant controller output, Proportional plus Derivative.

If an upset (momentary) had occurred rather than a load change, there would be no offset.

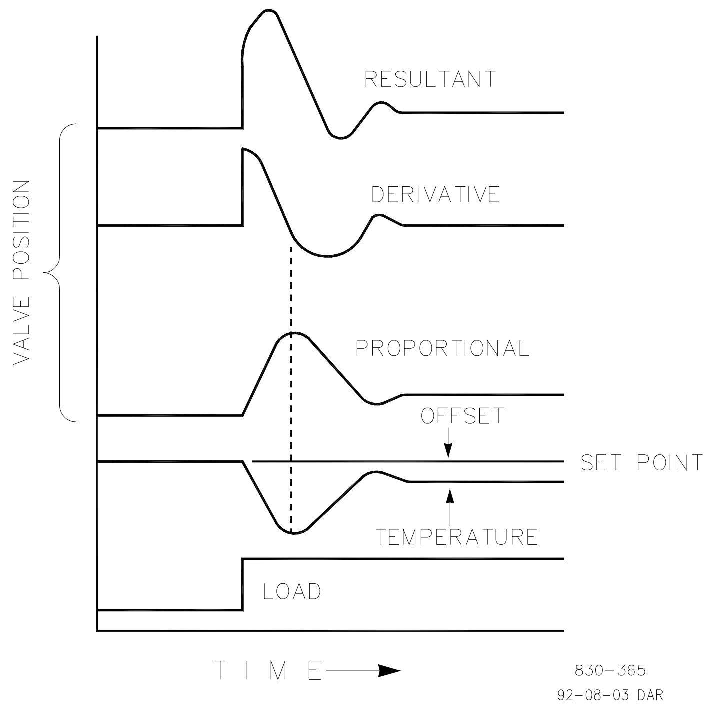


Figure 16-5. Closed Loop Proportional and Derivative Action

Derivative (effects of settings)

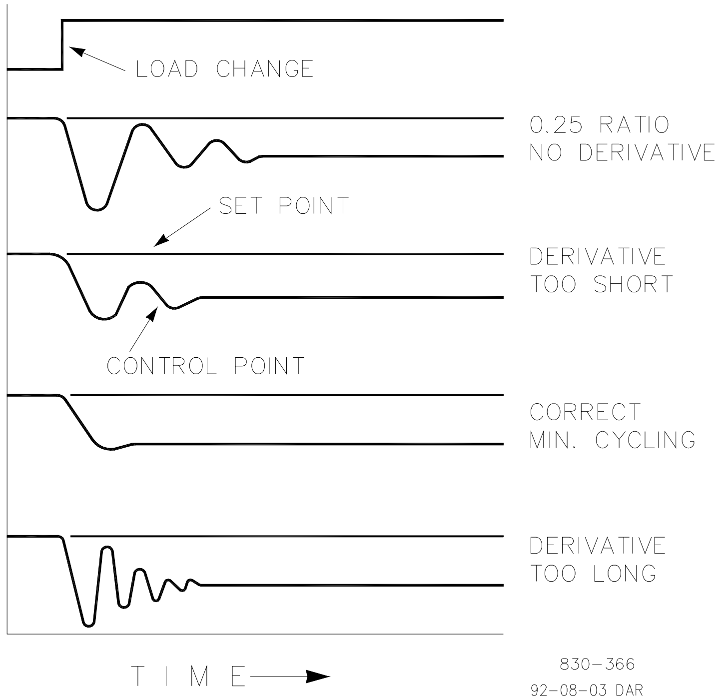


Figure 16-6. Derivative Setting Effects

Figure 16-6 shows the effect of different Derivative settings. The curves are relative since it depends on what type of control is desired in order to properly adjust Derivative time. For example, if minimum cycling is desired (as is shown here) then Derivative is added to the 1/4 decay cycle provided by Proportional until more than one cycle is removed and of course the 1/4 decay is destroyed. However, in most cases it is desirable to retain the 1/4 decay cycle, in which case Derivative is added to the point of removing only one cycle from the 1/4 decay ratio then the gain is increased until the 1/4 decay ratio is restored.

In all the above curves, you will note offset exists since offset is only eliminated by the addition of Integral (or Reset).

Proportional + Integral + Derivative = (closed loop)

Figure 16-7 shows the relationship of valve position to the interaction of the PID modes of control whenever a load change takes place in closed loop. As the temperature drops due to the load change, the proportional action moves the control valve proportionately to the measurement (temperature) change. The integral gain/reset adds to the proportional action because of the magnitude and time (duration) of the deviation. In addition, the derivative temporarily over-corrects based on the speed at which the measurement moves in any direction. The resultant curve (at the top) shows a similar over-correction (in this case), but in addition, the valve will stay at the new position required to keep the measurement at the setpoint.

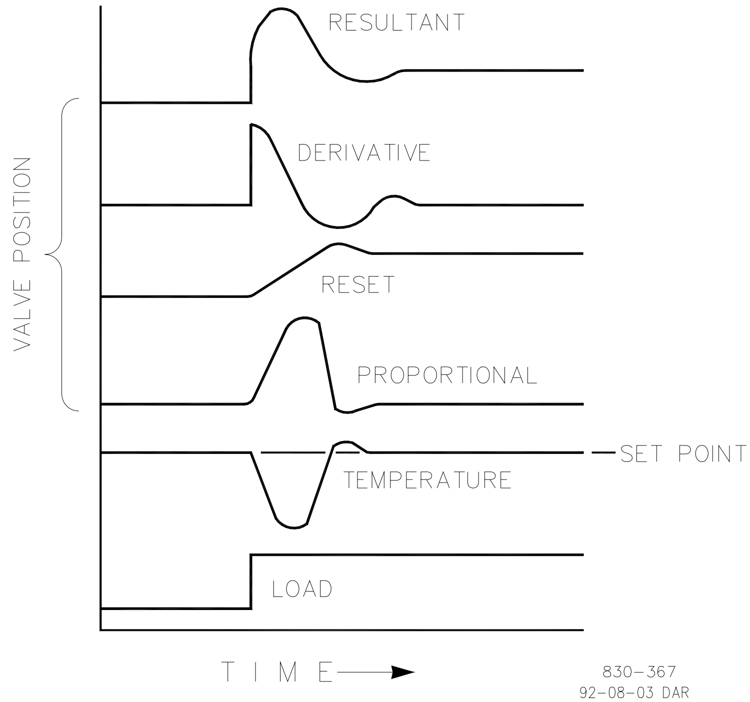


Figure 16-7. Closed Loop Proportional, Integral and Derivative Action

In summary, Derivative provides a temporary over-correction to compensate for long transfer lags and reduce stabilization time on process upsets (momentary disturbances).

NOTICE

Do not use if high frequency noise is normally in the measured variable or the main lag is dead time. After Proportional is set to 1/4 decay ratio and Derivative is adjusted to remove one cycle as well as decreasing the 1/4 decay ratio, then the Proportional gain can be increased to restore the 1/4 decay ratio.

Adding Derivative

The value of the Derivative Ratio (DR) term can range from 0.01 to 100. In order to simplify adjustment of the dynamics of the 5009XT, adjusting the integral gain value sets both the "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

The change from one of these configurations to the other may have no effect during normal operation; however, it can cause great differences in response when the governor is coming into control. (i.e. at startup, during a full load change, or during transfer of control from another channel).

An input dominant controller is more sensitive to the change-of-rate of its input (i.e. Speed, Cascade in or Auxiliary in), and can therefore prevent overshoot of the setpoint better than a feedback dominant controller. Although this response is desirable during a startup or full load rejections, 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 setpoint 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.

Controller Field Tuning General

The quality of regulation obtained from an automatic control system depends upon the adjustments that are made to the various controller modes. Best results are obtained when the adjustment (tuning) is done systematically. Prior training and experience in controller tuning are desirable for effective application of this procedure.

This procedure will lead to controller settings, which will provide after a load change:

- Process control without sustained cycling
- Process recovery in a minimum time

Controller settings derived for given operating conditions are valid over a narrow range of load change. The settings made for one operating set of conditions may result in excessive cycling or highly damped response at some other operating condition. This procedure should be applied under the most difficult operating conditions to assure conservative settings over the normal operating range. It is good practice to keep the average of the setpoint changes near the normal setpoint of the process to avoid excessive departure from normal operating level.

After each setpoint change, allow sufficient time to observe the effect of the last adjustment (see Figure 16-8). It is wise to wait until approximately 90% of the change has been completed.

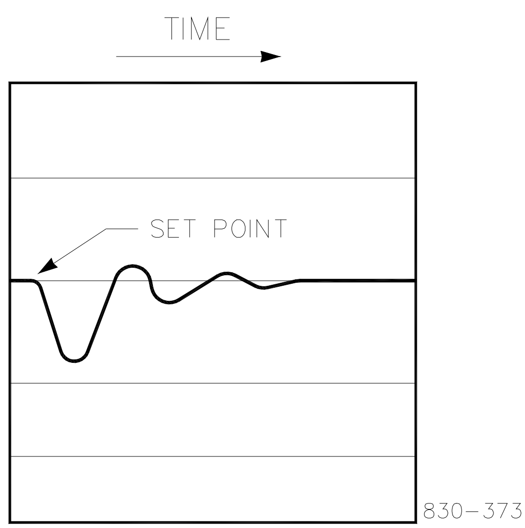


Figure 16-8. Typical Response to Load Change

Tuning Example

If the system is unstable, make sure the governor is the cause. This can be checked by closing the valve limiter until it has control of the actuator output. If the governor is causing the oscillation, time the oscillation cycle time. A rule-of–thumb is, if the system's oscillation cycle time is less than 1 second reduce the Proportional gain term. A rule-of-thumb is, if the system's oscillation cycle time is greater the one-second reduce the Integral gain term (proportional gain may need to increase).

On an initial startup with the 5009XT, all PID dynamic gain terms will require adjustment to match the respective PID's response to that of its control loop. There are multiple dynamic tuning methods available that can be used with the 5009XT's PIDs to assist in determining the gain terms that provide optimum control loop response times.

The following method can be used to achieve PID gain values that are close to optimum:

1. Increase Derivative Ratio (SDR) to 100 (Service Mode adjustment)
2. Reduce integral gain to 0.01 (Run Mode adjustment)
3. Increase proportional gain until system just starts to oscillate (Run Mode).The optimum gain for this step is when the system just starts to oscillate and maintains a self-sustaining oscillation that does not increase or decrease in magnitude.
4. Record the critical gain (Kc) and oscillation period (T) in seconds.
5. Set the dynamics as follows:
    a. For PI control: G=P(I/s + 1)
        i. Set:Proportional gain = 0.45*Kc
        ii. Integral gain = 1.2/T
        iii. Derivative ratio = 100
    b. For PID control: G=P(I/s + 1 + Ds)
        i. Set:Proportional gain = 0.35*Kc
        ii. Integral gain = 0.76/T
        iii. Deriv ratio = (5.2*T)/Integral Gain for fdbk dominant
        = (0.19*Integral Gain)/T for input dominant

This method of tuning will get the gain settings close; they can be fine-tuned from this point.

OPTI_PID Automatic Dynamic Optimizer

Use of the PID_OPTI features

- User can tune the Manual settings for OFFLINE and ONLINE (same as old 5009)
- Can select to use OPTI_Tune – this will automatically populate the OPTI values with the manual values
- For OPTI_Tune there is 1 set of dynamics for OFFLINE and a Curve of 1, 2 or 3 points for ONLINE
- Recommend to use the 3-pt curve for ONLINE settings using 20%, 50% and 80% load setpoints

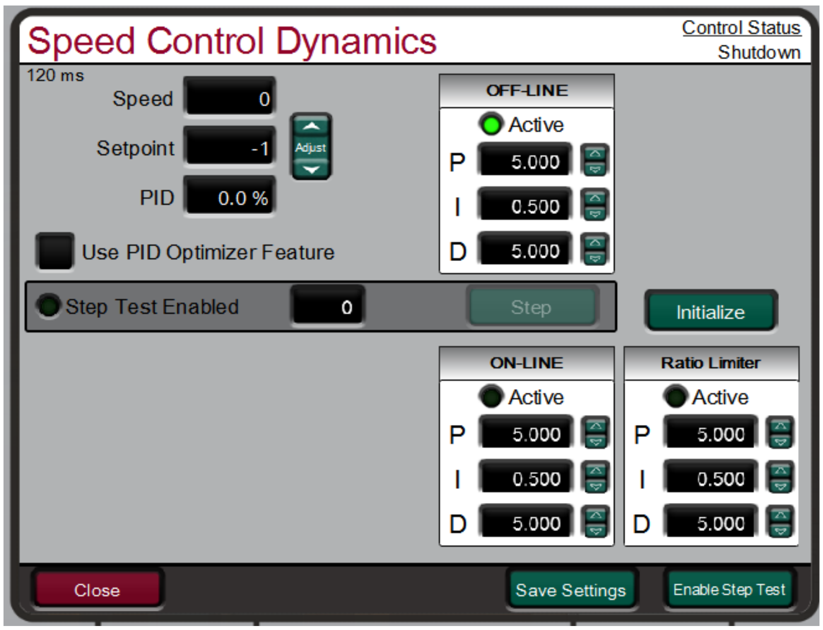


Figure 16-9. Speed Dynamics for Extraction/Admission type turbine

Multiple Speed Dynamic Settings Features

Recommend the user tune the Manual settings for OFFLINE and ONLINE to settings that provide reasonably stable running conditions (same as old 5009). Speed and setpoint are normalized (0-100%) into the speed PID on the 5009XT, same as old 5009's. This insures that gain settings from the installed units will work nearly identical to the new unit.

For the 5009XT – view tables below for available dynamic settings and descriptions of when used

Table 16-1. Speed Control Dynamic Settings Options

Turbine Type	Available Dynamic Settings
Single Valve – mechanical drive	OFFLINE ONLINE
Single Valve – generator drive A Curve of 1, 2 or 3 points for ONLINE is available. if desired, we recommend to use the 3 curve points at 10%, 50% and 80% load setpoints	OFFLINE ONLINE (Curve Point 1) ONLINE (Curve Point 2) - optional ONLINE (Curve Point 3) - optional
Extraction/Admission – mechanical or GEN drive	OFFLINE ONLINE ON Ratio Limiter

Table 16-2. On-Line/Off-Line Dynamics Selection

Mechanical Drive	OFFLINE	=	DI OPEN or Speed < Min Gov
	ONLINE	=	DI CLOSED or Speed > Min Gov
	ONLINE Ratio Limiter	=	ONLINE and Extraction Enabled
Generator Drive	OFFLINE	=	DI OPEN or Either Breaker Open
	ONLINE (1, 2 or 3 pts)	=	DI CLOSED or Both Breakers Closed
	ONLINE Ratio Limiter	=	ONLINE and Extraction Enabled

*The contact input option has priority, when programmed.

For the generator applications – selecting to use the Gain Curve will allow access to the page below which will allow the operator to run the OPTI_Tune process at multiple load points and create a gain curve that will adjust the Speed PID gains through the load range of the turbine.

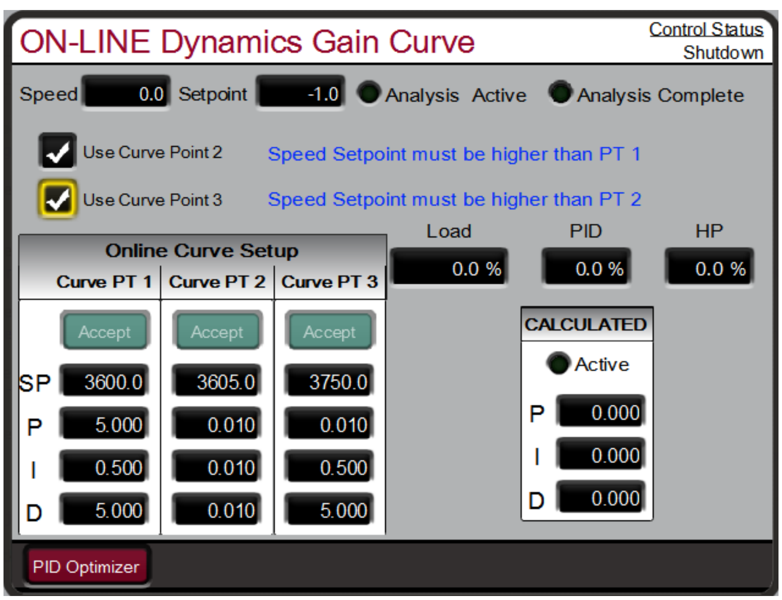


Figure 16-10. Speed Dynamics Generator On-Line Gain Curve

Using the OPTI-Tune feature –

Use of the PID_OPTI Automated Tune process –

- The OPTI_Tune can be performed for any of the available dynamic settings
- OPTI_Tune is operator initiated and will abort if any abnormal
- OPTI_Tune will calculate new settings – but the user decides to use them or keep previous
- OPTI_Tune can be adjusted to calculate different response profiles
- Adjustment of the OPTI_Tune settings are available – but default values typically will work

By checking the option to use the PID Optimizer Feature – a navigation button will appear that will allow you to open the following screen:

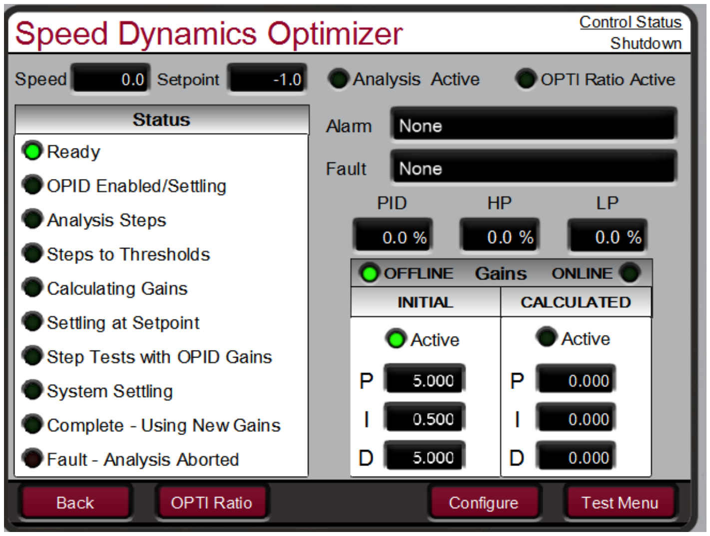


Figure 16-11. Speed Dynamics Optimizer

OPTI_Tune will step through the process of analyzing the system dynamics, calculate gain values, run a test step, and indicate that it is complete. Once OPTI_Tune has calculated gains, it will use those gains until they are Accepted or OPTI_Tune process is Aborted.

CAUTION – if the values are not desired to be used – Abort will cause a 'step' back to manual settings. There is a 6 minute TIMEOUT from when OPID test starts, if not ACCEPTED it will Abort after this time

Configuring the OPTI-Tune test limits –

The configuration of the OPTI_Tune should work with the default values, but if needed, there is a Configure button, which allows the operator to adjust the settings used during the test. The Process and Actuator Limit values are used such that the OPTI_Tune cannot exceed these values during the test – if they are exceeded the Test will abort, dynamic values will return to the initial values and a Fault status message will be displayed.

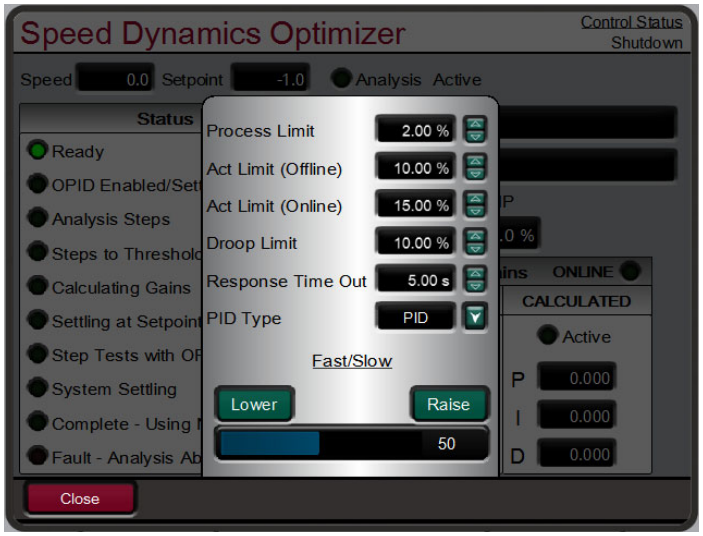


Figure 16-12. Configuring settings for OPTI_Tune

Chapter 17. Application enhancements in GAP Revision "C"

This new chapter details the GAP and GUI application enhancements that have been added to this product. The software part number of 5418-7830 has been advanced to revision "C" and all 5009XT controls that ship after March/2021 will contain this version. Any current 5009XT controls in the field that utilize this application software part number can be upgraded to this version. Currently those control part numbers, described in chapter 8, are 8262-1141, 8262-1142 and 8262-1143.

Addition of optional AIO Module in slot 5 of each kernel

For systems requiring more analog input or output signals, the application now supports the addition of an AIO (24/8 channel) module in slot 5. A 'kit' of the required components is listed in chapter 8, which includes – 3 AIO (24/8) Modules, 6 cables and 2 FTM's.

In the Configuration menus, under the Woodward Links screens, there is a checkbox that enables the use of these modules. Once checked, all these additional I/O channels will be added to the available analog input and output channel selection screens. The channel number assignments for these will be continuous from the channels present in the Speed/AIO combo module (slot A3) which is standard on the 5009XT. Thus, in the GAP/GUI applications, the first AI of the slot 5 module will be assigned channel #13 and the first AO will be channel #5.

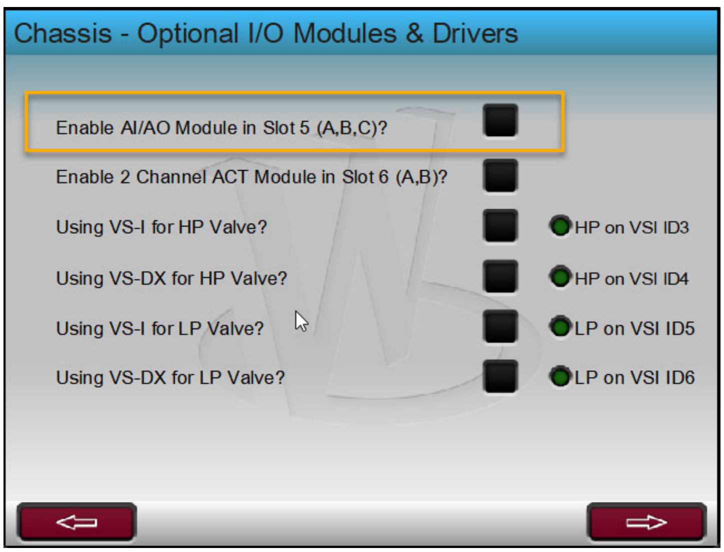


Figure 17-1. Configuration Screen to Enable Use of Slot 5 AIO Module

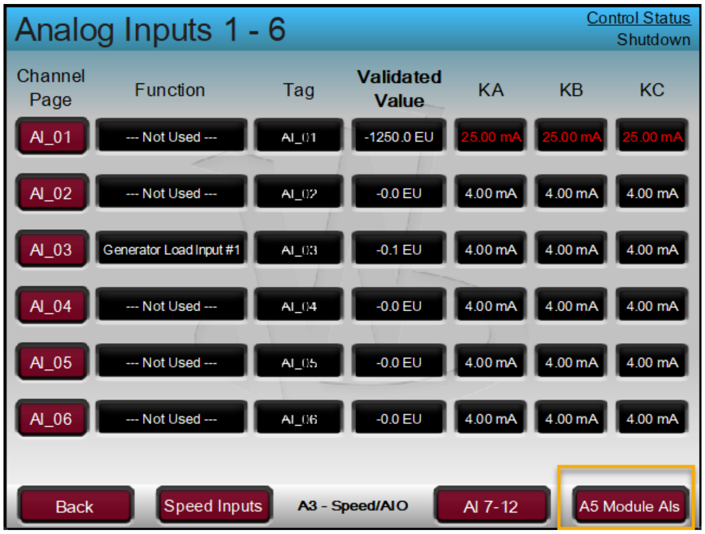


Figure 17-2. Screen to access analog input channels on slot 5 AIO Module

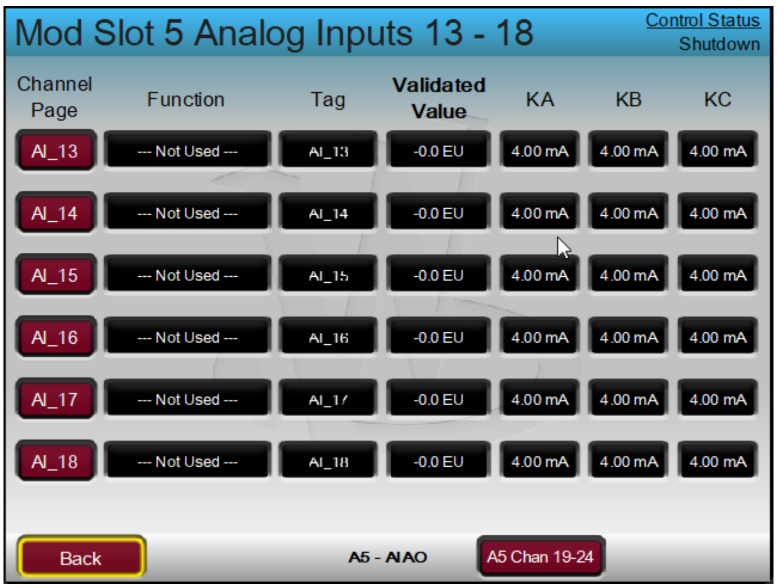


Figure 17-3. First analog input channel of slot 5 AIO Module is assigned AI_13

Distributed (Remote) I/O Network – (KAB_CAN1 in figure)

Support for adding distributed I/O has been added using 2 CAN ports (1 each from kernel A & B) to connect to Woodward LinkNet HT modules. All distributed I/O channels have the same menu of functional choices as the lists for all the other 5009XT hardware I/O selections, however, these are intended to support operation, monitoring and setpoint types of signals, not control process variables (PV). The PV control signals, and valve demand output signals should be assigned to local I/O in the main chassis.

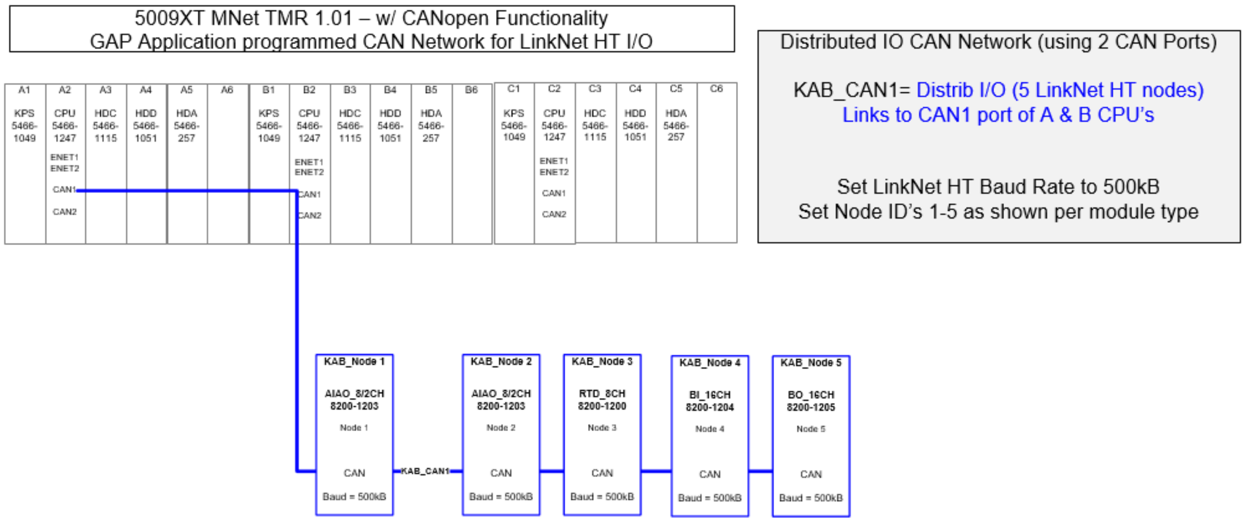


Figure 17-4. CAN Links to Digital Drivers

This is a single CAN network cable connection from the CAN port 1 on the Kernel A CPU to CAN port 1 on the Kernel B CPU, then to the LinkNet HT I/O nodes. This network runs an 500KBaud and the I/O modules placed on it must be configured for the same rate. The modules will also need to have their node ID set to the correct Node ID designations (Nodes 1-5). More details can be found in this manual about configuring the control to use these products, in the Configuration menus, under Woodward Links screens.

The application supports up to 5 nodes as follows – 2 AIO modules (Nodes ID 1 & 2), 1 RTD module (ID=3), 1 DI module (ID=4) and 1 DO module (ID=5). As delivered all these are disabled in the control, the user can then configure the unit to activate any combination of these nodes.

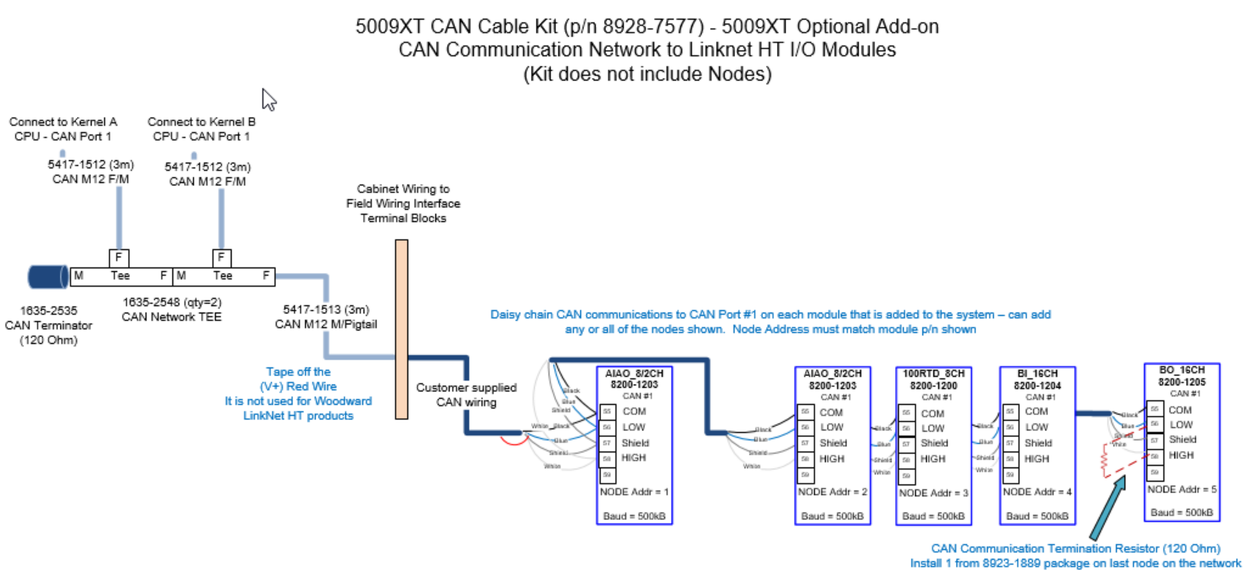


Figure 17-5. CAN wiring of Distributed I/O Network

The 8928-7577 kit containing the CAN cabling components is required to connect the CPU's to the cabinet field wiring interface. This kit can also be used to directly wire the nodes to the control if the nodes are located locally in the control cabinet.

For customer CAN wiring Woodward recommends Belden YR58684 (Woodward p/n 2008-1512), for other options and complete information on CAN wire specification requirements refer to Woodward's MicroNet TMR hardware manual 26167 V1 & V2.

The I/O modules are purchased separately as per the part number table below. The configuration of the nodes to be activated are available via the Configuration Menu (under Woodward Links) and the user is free to select any or all of the nodes listed below.

Table 17-1. Available (Programmed) Distributed I/O Nodes

Node Device ID	Part Number	Description	I/O type/quantity
1	8200-1203	Analog 4-20 mA I/O	8 AI and 2 AO
2	8200-1203	Analog 4-20 mA I/O	8 AI and 2 AO
3	8200-1200	RTD Temperature Inputs	8 RTD
4	8200-1204	Discrete Input	16 DI
5	8200-1205	Discrete Output	16 DO

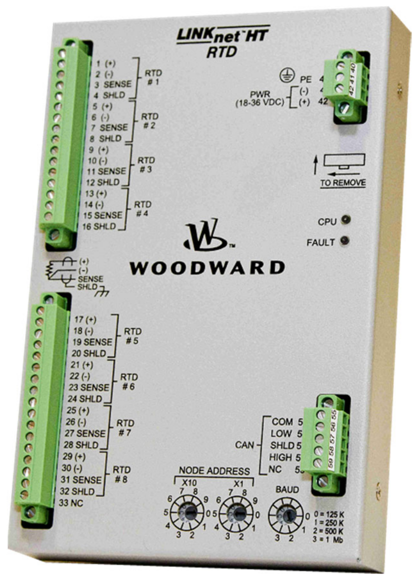


Figure 17-6. LinkNet Distributed I/O Node

Below are the screens related to configuration and the operational status of each node as well as the communication status of the entire CAN network. The Service menu screen has access to buttons to initialize the entire LinkNet network (will fault all nodes and re-initialize them) or to reinitialize just a single node. If a single node is power cycled (like to be replaced) – it will need to be initialized from this screen to synchronize with the rest of the nodes on the running CAN network.

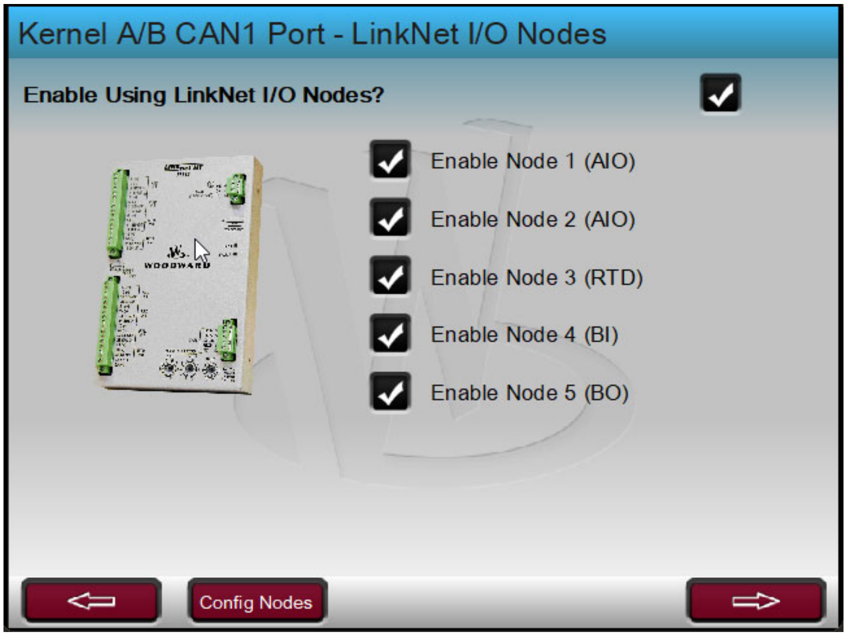


Figure 17-7. Configuration Screen to Enable Use of LinkNet I/O Nodes

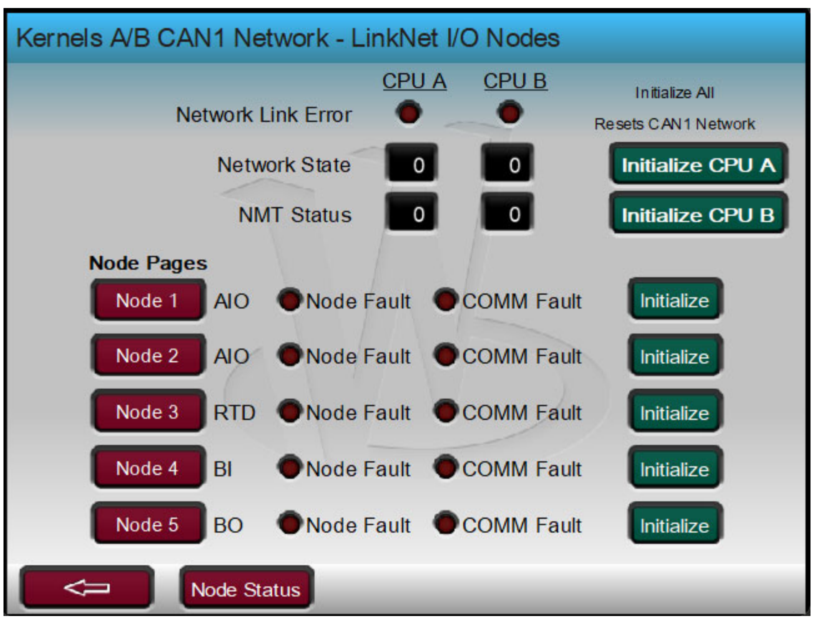


Figure 17-8. Distributed I/O CAN Network and Node Status

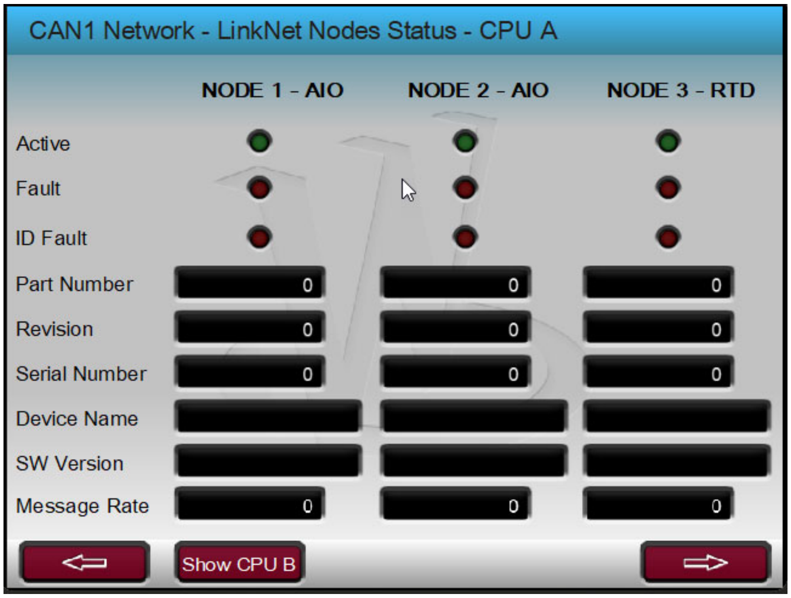


Figure 17-9. Detailed Node Status Information

Once the control has been configured to use these nodes, access to the signals connected to these modules will be on the Home screen under the LinkNet I/O navigation screen.

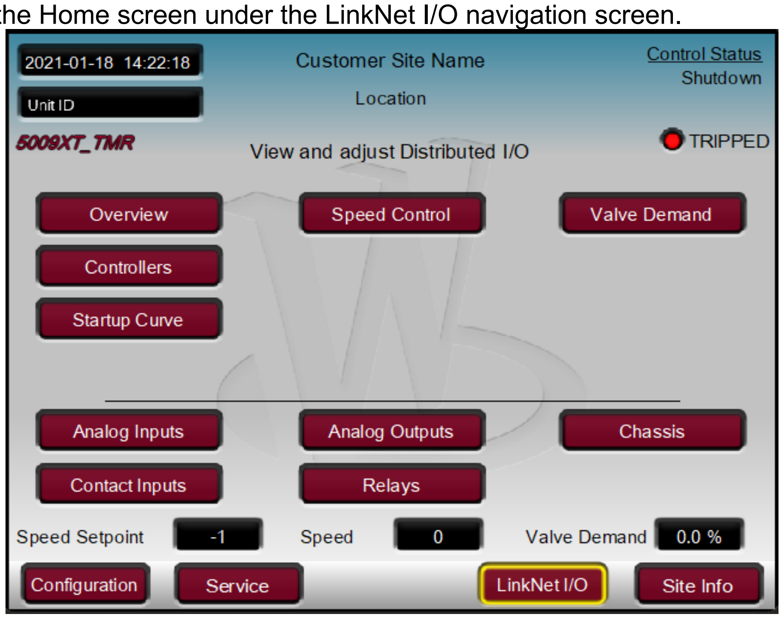


Figure 17-10. Access to LinkNet Channels

All alarms related to distributed I/O will trigger an Event #222 “LinkNet IO Summary Alarm”. From the alarm summary screen an additional page navigation will be available to annunciate the specific node and channel details. A similar page is available for any Trips that are initiated related to the LinkNet I/O.

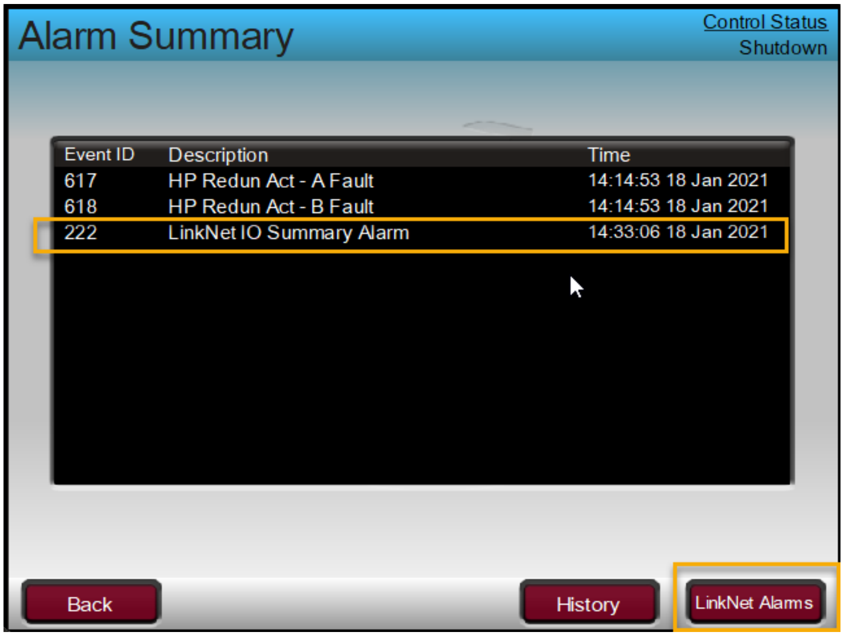


Figure 17-11. Access to LinkNet related alarms

Using External Trips on LinkNet Discrete Input Module

When External Trip signals are used on the LinkNet modules, the signal is automatically inverted. When the signal goes FALSE, the contact is open, and then the Trip signal will be sent to the control. Unlike External Trips wired into the chassis DI channels on the 5009XT unit, 1ms time stamping resolution is not available on the LinkNet External Trip signals.

Configuring devices on the CAN Digital Driver network

The 5009XT application supports a CAN digital communication network that has been designed to support eight device nodes. It currently supports two VSII and two SPC devices and will support four VSI units in the future.

Eight dedicated inputs have been allocated, 2 for VariStroke II, 2 for SPC's and 4 for VariStroke I devices as per the table below. It is important that the appropriate device and ID number be configured for the same CAN node ID as the device being used.

Table 17- . VSII and VSI Dedicated Inputs

VSII ID 1 is Healthy (DVP1)	(example = HP)
VSII ID 2 is Healthy (DVP2)	(example = LP)
VSI ID 3 is Healthy (DVP3)	(example = HP - solo or Unit A on DX)
VSI ID 4 is Healthy (DVP4)	(example = HP - Unit B on DX)
VSI ID 5 is Healthy (DVP5)	(example = LP - solo or Unit A on DX)
VSI ID 6 is Healthy (DVP6)	(example = LP - Unit B on DX)
SPC11 is Healthy (RemDrvr1)	(example = HP)
SPC12 is Healthy (RemDrvr2)	(example = LP)

Configuration to use the VariStroke II (VSII) –

The 5009XT application digital driver network supports Two VariStroke II electro-hydraulic actuators. The VariStroke-II is a linear electro-hydraulic actuator designed to provide the linear actuation force to operate steam turbine control valves or valve racks. This connection will provide a demand signal from the control to the VS-II and permit the control to receive and annunciated detailed product information and signal status. It is recommended that the VSII be configured to use this link as the primary demand with the analog demand as the backup.

Refer to Chapter 1 of this manual for optional cable kits that can be purchased and wiring details on CAN wiring to the VS-II. For more information consult manuals 26167 (MicroNet TMR Hardware) and 26740 (VS-II).

Figure 17-12. Configuration Screen for VS-II (1 or 2 Nodes)

Two additional items must be configured –

- An AO assigned with the function the same as the VS-II function above (in this example DVP1 = HP Demand and DVP2 = LP Demand)
- A DI assigned as a health indication from the VS-II – "VSII ID 1 is Healthy (DVP1)"

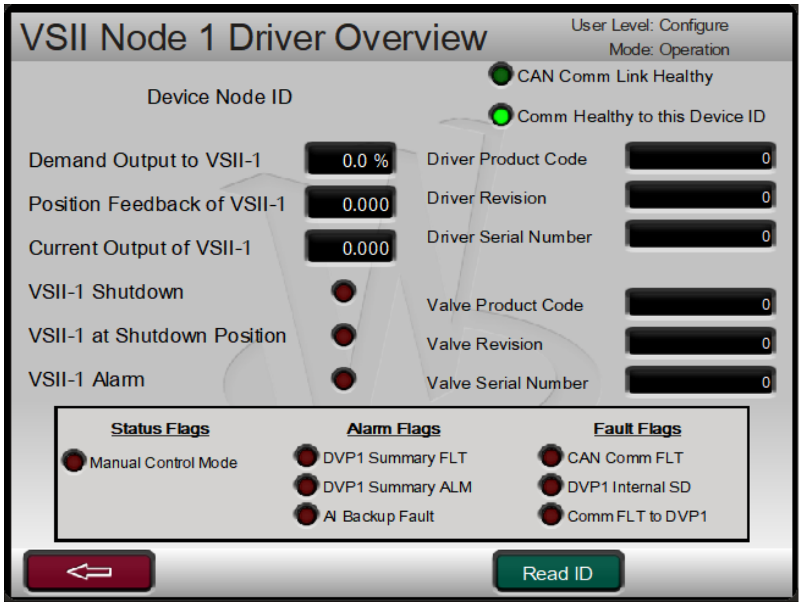


Figure 17-13. Service Screen Access for VS-II-Unit Status Information

Configuration for Using the VariStroke I (VSI) or VariStroke-DX Skid (VS-DX) –

Figure 17-14 VariStroke-DX (Redundant VSI skid)

When using a VS-DX skid for either the HP or LP valve, the appropriate configuration checkboxes must be enabled in the Configuration Menu under the Woodward Links screen. This will ensure that the correct actions are taken (alarm or trip) based upon faults of the configured I/O signals below. There are unique discrete input (DI) selections that correspond to the unit identifiers (ID) for each VariStroke unit (device). In the example screen below, using a VS-DX for HP demand, the LED's indicate that the control configuration will require DI channels to be assigned for the health of VS-I ID3 (unit A on skid) and VS-I ID4 (unit B on the skid).

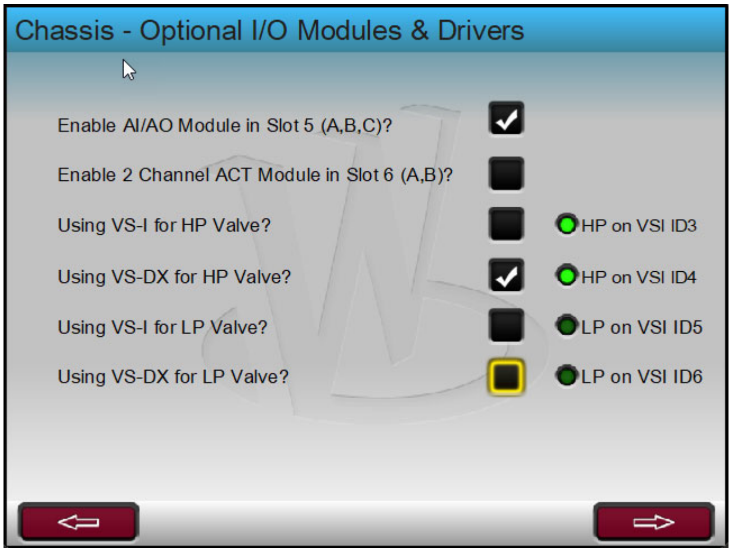


Figure 17-15. Example of VS-DX for HP and single VS1 for LP

Note on support of the VariStroke DX – the GAP application currently only supports 1 single AO driver to each VS-I on the VS-DX skid. This is being done because the current VS-DX does not support a CAN interface. Once that enhancement is completed on the VS-DX, the control will be updated to support the CAN link to each of the 2 VS-I units on the skid and support CAN with analog backup configurations. When a VS-DX selection has been checked, the service screens will make visible a user selection box so that the assignment of the 'Master' unit can be done from the control.

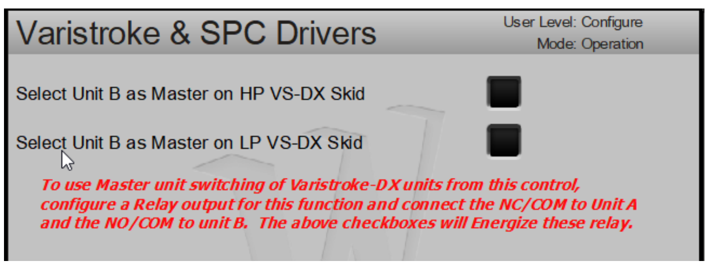


Figure 17-16. Service Screen Access for VS-DX Master Unit Switching

Control I/O Configurations

Configure 2 AO channels

- HP Redund Act A Vlv Dmd Connect to VS-DX Unit A (ID3) – Demand Input 1
- HP Redund Act B Vlv Dmd Connect to VS-DX Unit B (ID4) – Demand Input 1

Or

- LP Redund Act A Vlv Dmd Connect to VS-DX Unit A (ID5) – Demand Input 1
- LP Redund Act B Vlv Dmd Connect to VS-DX Unit B (ID6) – Demand Input 1

Configure 2 DI channels

- VSI ID 3 is Healthy (DVP3) Unit A – Shutdown Output
- VSI ID 4 is Healthy (DVP4) Unit B – Shutdown Output

(if VS-DX is used on LP then use ID's 5 and 6)

Configure 1 Relay output (Optional, not Required)
"Select B on VS-DX for HP" Relay NC terminal to Unit A Master Unit Designation
Relay NO terminal to Unit B Master Unit Designation
Relay COM terminal to Unit A/B DI GND

Or if using VS-DX on LP - "Select B on VS-DX for LP"

Example 1 – Configuration for a VariStroke (VSI) on the HP Valve (with single 1 AO demand)

Driver Configuration: HP Actuator Type Single Coil (1xAO/ACT)

Configure an Analog Output channel as: HP Valve Demand

Configure a DI channel as: "VSI ID 3 is Healthy (DVP3)"

If either the AO channel faults, or the DI signal is lost this will cause an “HP Actuator Fault” and TRIP the turbine.

If it is desired to provide 2 Analog Output channels to a single VSI, then refer to the next example in how to configure the Driver and the Analog Output functions. The DI configuration will still apply.

Example 2 – Configuration for a VariStroke-I (VSI), using redundant Analog demands or a VariStroke-DX (VSI) on the HP Valve (with single 1 AO demand to each unit)

Driver Configuration: HP Actuator Type Redundant Actuators (2xAO/ACT)

Configure an Analog Output channel as HP Redund Act A Vlv Dmd
Configure a second Analog Output channel as HP Redund Act B Vlv Dmd

Configure a DI channel as "VSI ID 3 is Healthy (DVP3)"
(For DX only) Configure a second DI as "VSI ID 4 is Healthy (DVP4)"

If either AO channel faults or the DI signal is lost this will cause an “HP Redund Act A (or B) Fault” ALARM will be annunciated. If both AO channels fault or both DI signals are lost, this will cause an “HP Actuator Fault” and TRIP the turbine.

On a simple VSI with redundant AO’s – there is only 1 status DI returned to the control so for this case the loss of the DI will cause a TRIP.

Example 3 – Configuration for a VariStroke (VSI) on the LP Valve (no CAN, just 1 AO demand)

Driver Configuration: LP Actuator Type Single Coil (1xAO/ACT)

Configure an Analog Output channel as: LP Valve Demand

Configure a DI channel as: "VSI ID 5 is Healthy (DVP3)"

If either the AO channel faults, or the DI signal is lost this will cause an “LP Actuator Fault” and TRIP the turbine.

Example 4 – Configuration for a VariStroke-DX (VSI) on the LP Valve (no CAN, just an AO demand)

Driver Configuration: LP Actuator Type Redundant Actuators (2xAO/ACT)

Configure an Analog Output channel as: LP Redund Act A Vlv Dmd
Configure a second Analog Output channel as: LP Redund Act B Vlv Dmd

Configure a DI channel as: "VSI ID 5 is Healthy (DVP3)"
Configure a second DI channel as: "VSI ID 6 is Healthy (DVP3)"

If either AO channel faults or the DI signal is lost this will cause an “LP Redund Act A (or B) Fault” ALARM will be annunciated. If both AO channels fault or both DI signals are lost, this will cause an “LP Actuator Fault” and TRIP the turbine.

Configuration to use Servo Position Controllers (SPC) –

The 5009XT application CAN digital driver network has been programmed to support up to two Servo Position Controllers (SPC’s) that can be used to interface to actuators that do not directly accept a 4-20mA demand signals. For example, an integrating valve/actuator assembly or a proportional valve (with or without feedback) that requires a larger current output. The SPC positions hydraulic or pneumatic actuators base on a position demand signal received from the control.

There are two SPC’s available on the CAN driver network on CAN port 2 of the CPU in Kernel C. The list of the functional options available for demand signals to these SPC devices is identical to the first 15 function options for the Analog Output menus listed above. These drivers are available to interface to single coil or redundant actuator type of valve/actuator assembly, in the 5009XT application they do not support dual coil devices. They do support redundant input demands from the control are intended to be configured with a primary CAN link and an analog (4-20mA) as backup.

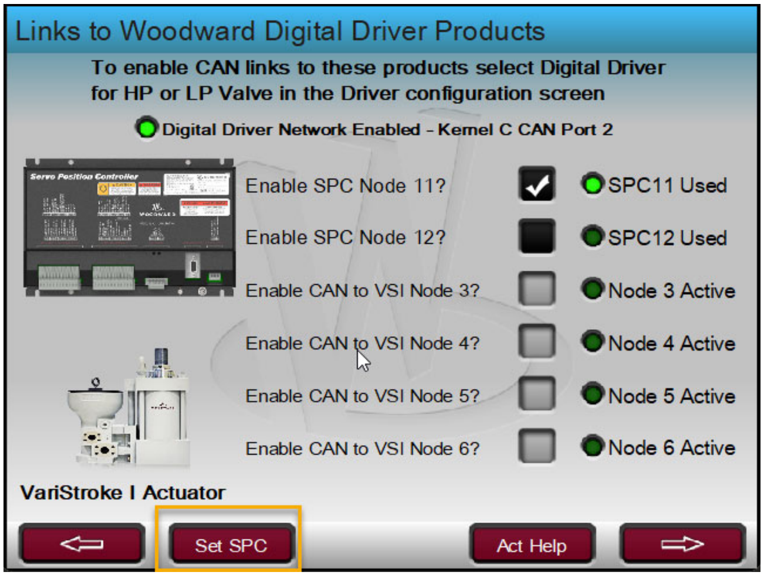


Figure 17-17. Configuration for SPC Controllers

Refer to Chapter 1 of this manual for optional cable kits that can be purchased and wiring details on CAN wiring to the VS-II. For more information consult manuals 26167 (MicroNet TMR Hardware) and 26236 (SPC).

Configuration of the SPC –

The SPC must be configured and calibrated using the dedicated service tool. The 5009XT control will support manually stroking the demand to exercise and verify valve stroke, but it will not provide support for calibration. When configuring the SPC’s the following configuration parameters are required.

CANopen Baud Rate: 250 Kbaud
CANopen Node ID: 11 or 12
CANopen timeout: 40ms
No Calibration via CAN (leave this box unchecked)

Driver Fault Delay: 0.20 sec
Driver Fault Response: Shutdown

Position Demand Source CANopen Primary

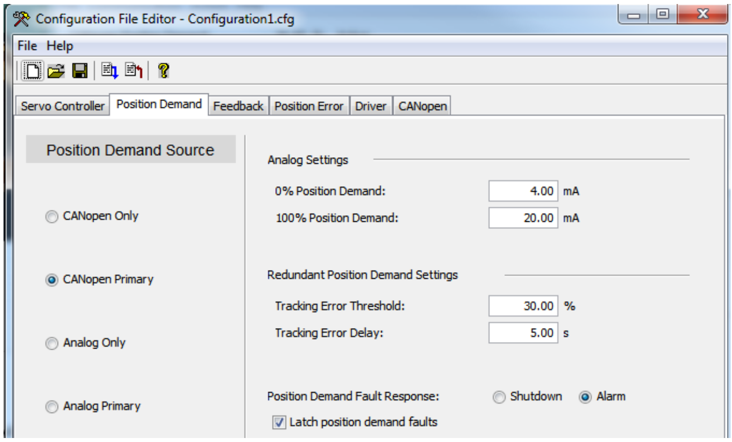


Figure 17-18. Configuration for Position Demand Source

Once configured for use, the GUI will make visible an overview screen for each SPC device that will show all the important status information from the unit (obtained via the CAN link).

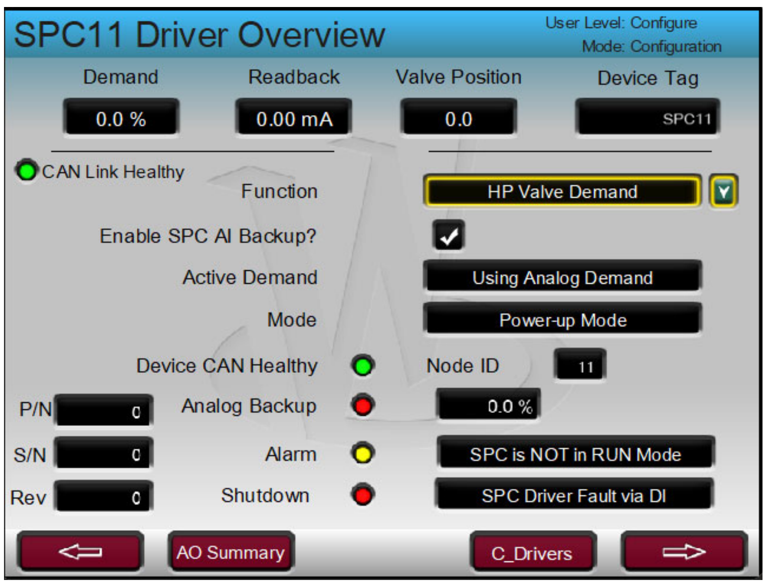


Fig 17-19. Operational overview of SPC

When the unit is in Calibration mode, this overview screen will make visible a page navigation button labeled “Stroke” to allow for manual stroking of the 0-100% demand. From this pop-up screen the control will allow the user to enable forcing mode which will allow the demand to the SPC and its feedback to can be verified.

Figure 17-20. Access to Stroking of SPC Demand (Calibration Mode)

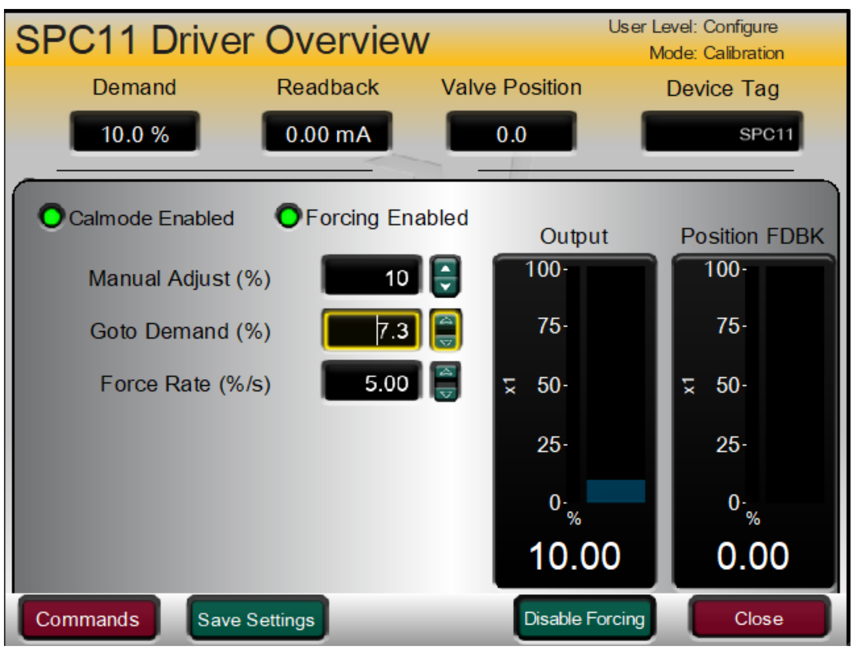


Figure 17-21. Manual Stroking of SPC demand (Forcing)

Idle/Rated Sequence

A new feature was added to the discrete input (DI) functional menu selection **"Idle Rated Permissive".** If the control is configured to use this function and Idle/Rated is the start sequence that is used, then this DI channel will come into effect when the turbine has started and reached Idle warmup speed. This DI which will act as a 'Hold unit at Idle' and not allow the operator command to proceed to Rated until this DI is TRUE.

When configured for use, an LED will show up on the Start Curve screen, once the DI channel is TRUE the LED will turn ON and allow the turbine to proceed to Rated. The state of this DI channel will have no effect at any other time during turbine operation.

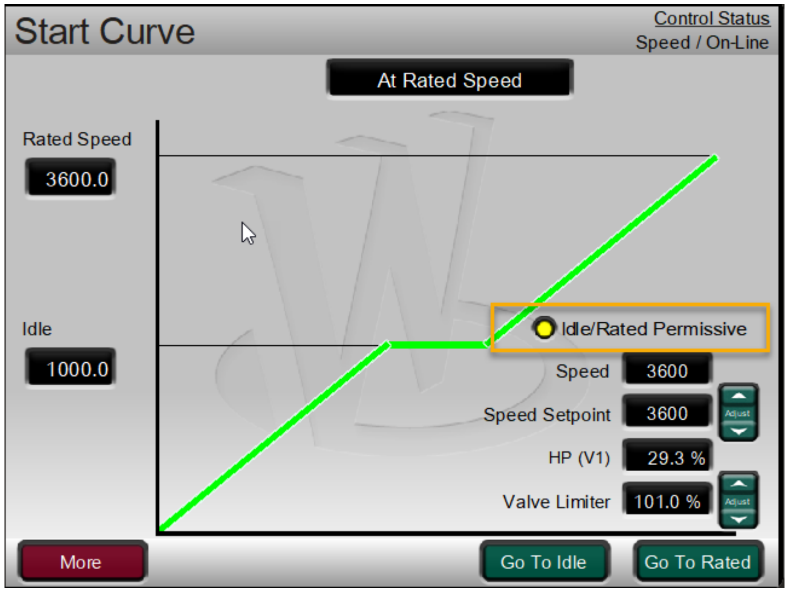


Figure 17-22. Start Curve Screen with Idle/Rated Permissive Used

Load Limiter function

A Load Limiter Function has been added to the control application that provides logic to limit the load output of the turbine without having to use the AUX controller as a limiter to do this. On units configured for generator applications, this feature can provide load limiting, while allowing the AUX controller to be used as an additional control or limiter based on another input parameter.

If the unit is configured for GEN operation and has a Load process variable defined then this function will be available in Service, no additional configuration items are required. In the Service menus, under the Breaker Logic screens, the user can set a Load Limit value and Enable the Load Limiter function. These values are active and available during operation.

The following are the configuration requirements for Load Limiting to be available:

- Configured for GEN operation
- Must have an input defined for GEN Load (AI or digital comm)

The following are the permissives for Load Limiting to be available during operation:

- Must have a healthy active KW input (not faulted)
- Load Limiter is Enabled (Available at any time in Service menus (Breaker Logic)
- GEN breaker is closed

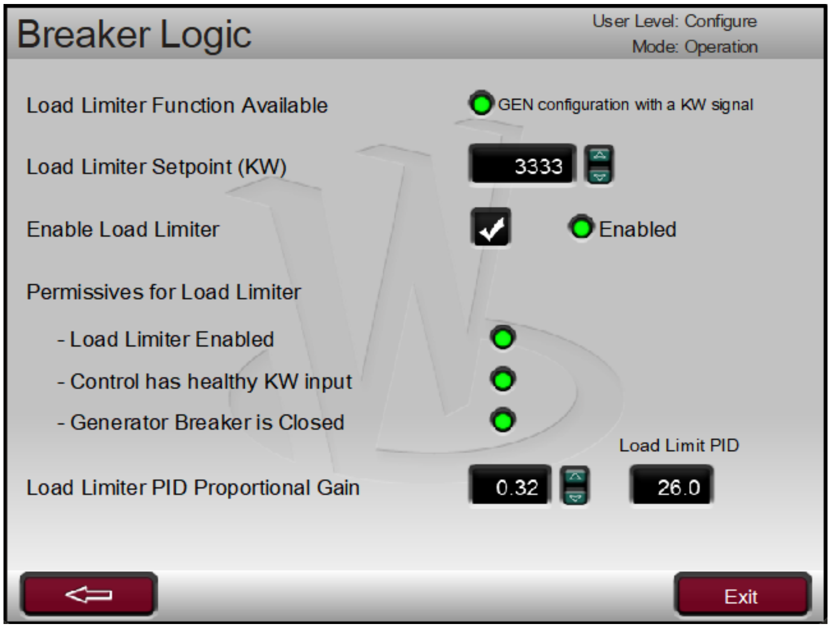


Figure 17-23. Service/Breaker Logic – Load Limiter Function Settings

Notes on User settings:

Load Limit Setpoint (KW) Integer value entered by user (always in KW)

Enable Load Limiter (checkbox) Checking the box enables the Load Limiter PID

Load Limiter PID Proportional Gain Simple dynamic gain adjustment factor (if needed)

Load Limiter Functional Operation:

When the Load Limiter is enabled and the permissives are met, the Load Limit Setpoint & the Load Limiter ACTIVE LED will be visible on the Speed Control and Overview Operation screens, but the LED will be in the OFF state. When the turbine load reaches the setpoint, the Load Limiter is ACTIVE, the LED will be ON (green) and the HP Valve demand will not be allowed to go any higher. The operational status of the control will stay in the presently operating control modes during this time, but the Load Limiter LED will be lit.

If the unit is currently in Load Sharing mode when the load limiter becomes active, this unit will be removed from the load sharing group (load sharing will be disabled on this unit).

The load limiter enables a PID that will actively limit the Speed/Load demand (LSS Bus which is the S term on Extraction units) once the load reaches the load limit setpoint, it will stay active as long as the load is within 3% of the setpoint. Once the load is reduced below this threshold the load limiter PID will be disabled from the LSS bus. The service screen has access to the proportional gain term of the load limiting PID, if adjust is required. Operational feedback of this is available on the Valve Demand screen.

This function requires a configured and healthy generator load input signal. If this signal is failed, the load limiter will not go active. If this signal fails while the load limiter is active, this function will be disabled and the unit will ramp to the speed/load setpoint, which will be at or above the current load limit setpoint. The user entered load limit setpoint will be always be in the units of KW. Internal logic will switch this value to MW if that is required.

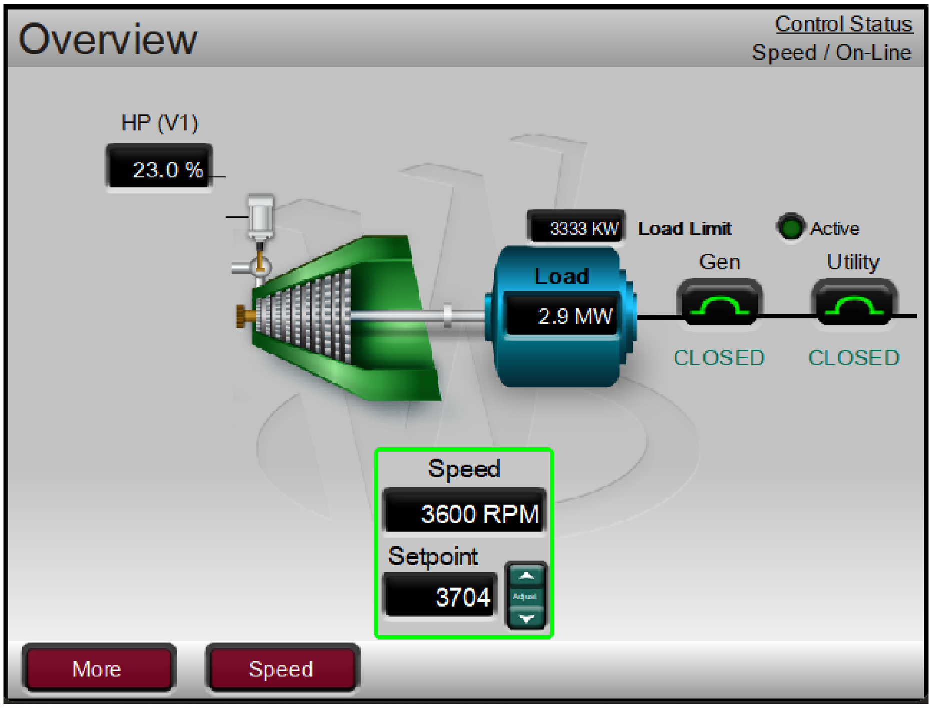


Figure 17-24. Overview of Load Limiter Enabled (Not Active)

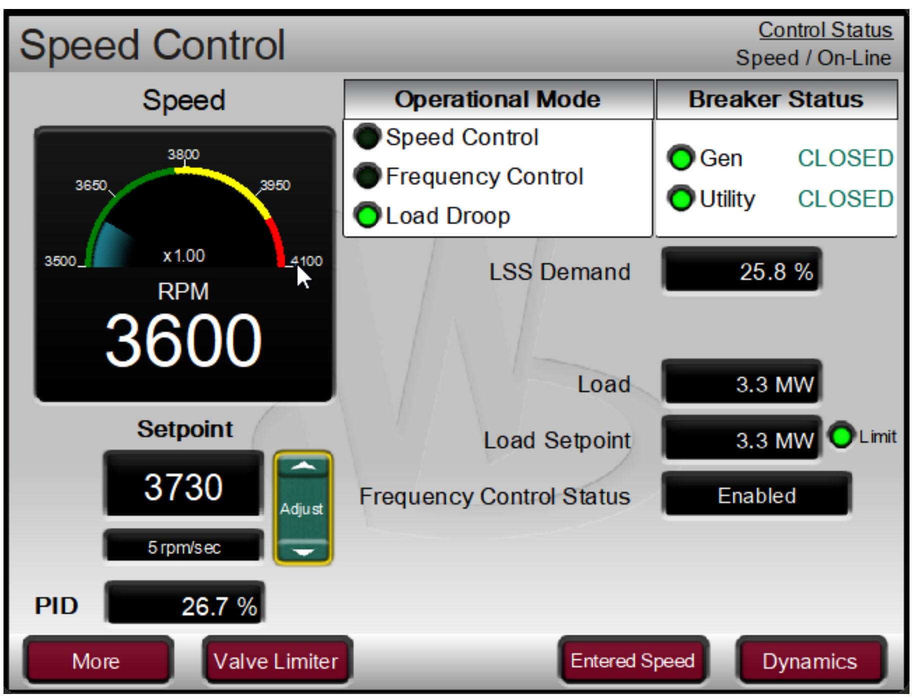


Figure 17-25. Speed Control with Load Limiter enabled and Active

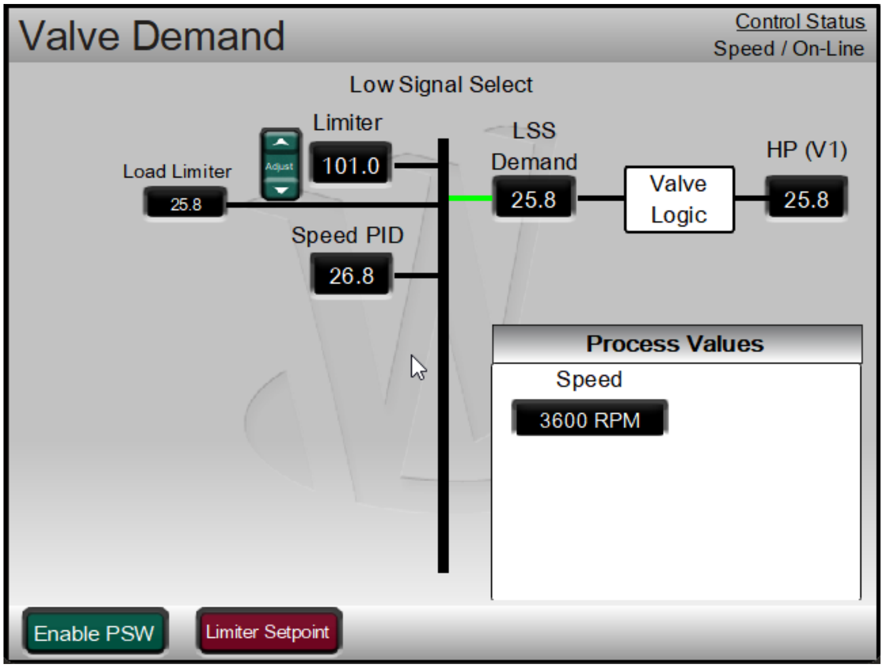


Figure 17-26. Valve Demand with Load Limiter is Active

Pre-Start Warm-up Function

This logic allows operators to 'Pre-warmup' the turbine before a Start command is given. Allows users to access the valve ramp functions for both the HP and the LP valves to OPEN them while the turbine is shutdown. There is an option in the Configuration/Turbine Start screen to allow this function to be available. If the control is configured to allow this option, and the operator desires to enable this function, it will require that the control is in a Shutdown state and that no speed is detected.

- Any speed detected above Speed Failed setting will immediately deactivate this function and step the valve demands to 0%
- If a Reset is issued that clears the Shutdown/TRIP latch – that will immediately deactivate this function and step the valve demands to 0%
- When the function is enabled, user will be allowed to ramp open the HP and/or LP valves to any desired setting at the valve limiter rate available in Service

Configuration requirements for Pre-Start Warm-up

(Located in Configure menus on the 'Turbine Start' page)

Allow Pre-Start Warm-up? Checkbox {CNFG_START.QT_USE_PRESTARTWARM}

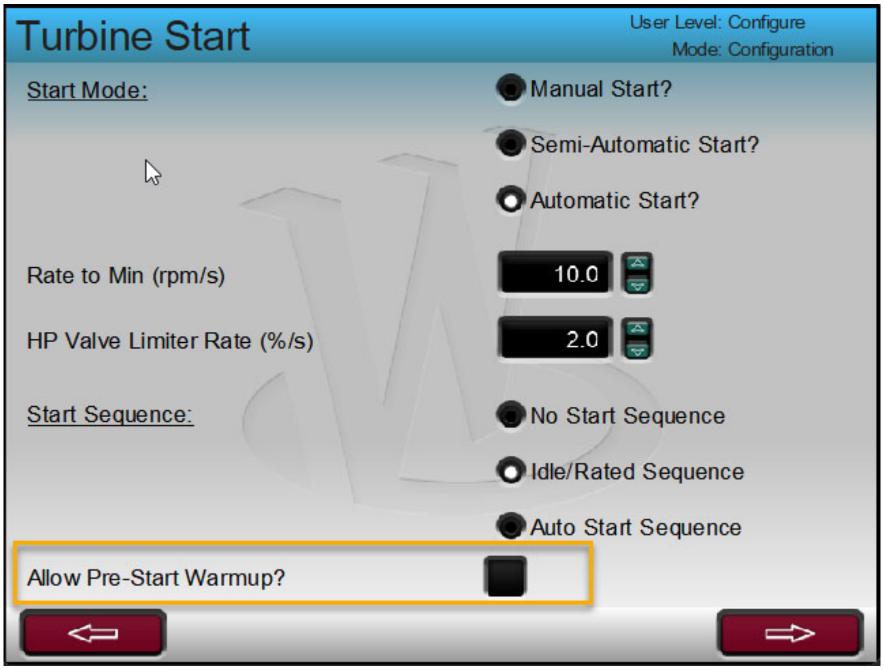


Figure 17-27. Configuration Turbine Start Screen – Option for Pre-Start Warmup

Operation Screen: **(Start Curve, Valve Demand, and Overview)**

Permissives for Pre-Start Warm-up (LED) to be ACTIVE/ON:

- Unit is configured for this option
- Unit is in a SHUTDOWN state
- Speed is below the Failed Speed Level configured in Speed inputs screen
- Operator has Enabled warm-up

To enable the Pre-Start Warmup, press the Enable PSW command button from the Valve Demand screen.

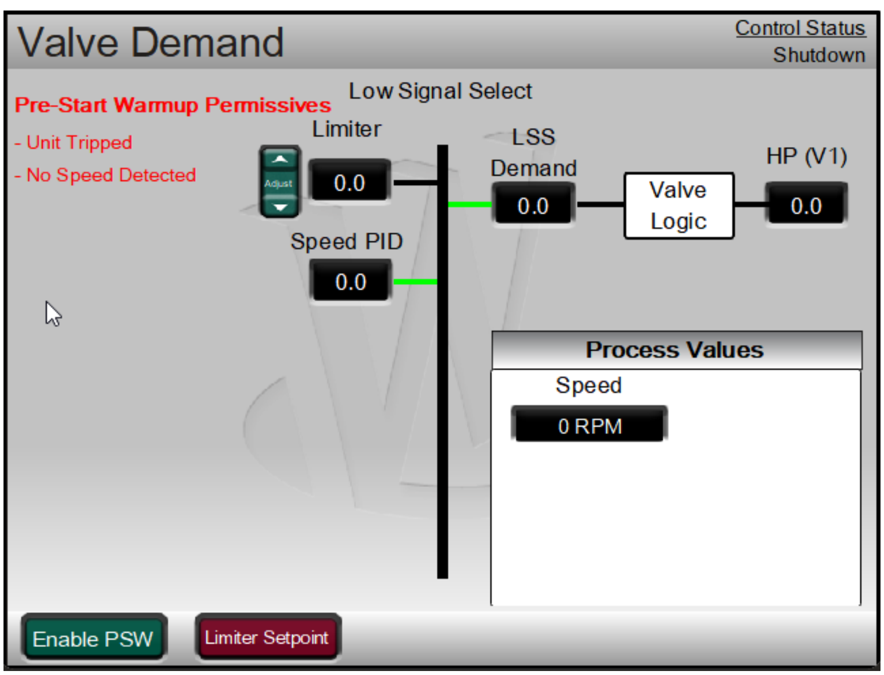


Figure 17-28. Valve Demand Page with PSW Configured but Not Enabled

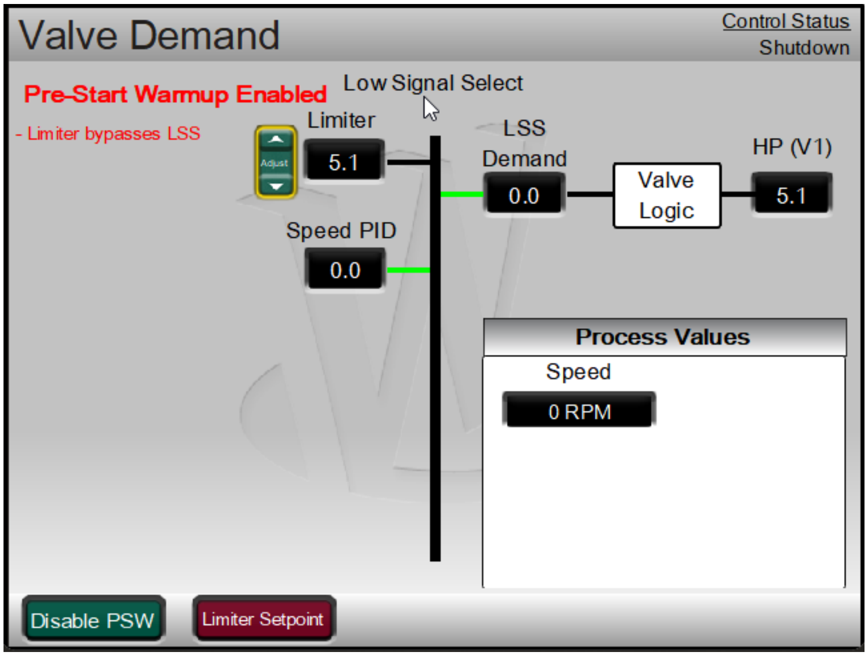


Figure 17-29. Valve Demand Page with Pre-Start Warmup (PSW) Enabled

Once the PSW is enabled the message “Pre-Start Warmup Enabled” will appear on the Valve Demand and Overview screens. In this state the operator can manually use the valve limiter functions on both the HP and LP (if configured for use) valves to ramp the valves open to any desired position. The valves will ramp at the valve limiter rate found in Service settings for each valve. When the PSW function is disabled by the user, if the Shutdown/Trip condition is cleared, or if speed is detected while this function is active the valves will step closed to 0% demand.

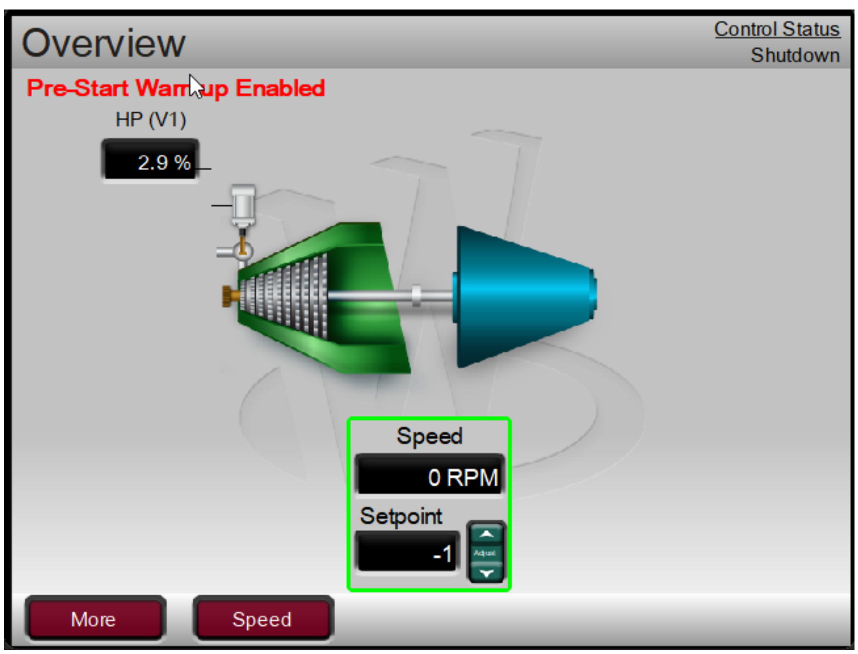


Figure 17-30. Overview Page with Caution Message when PSW is Enabled

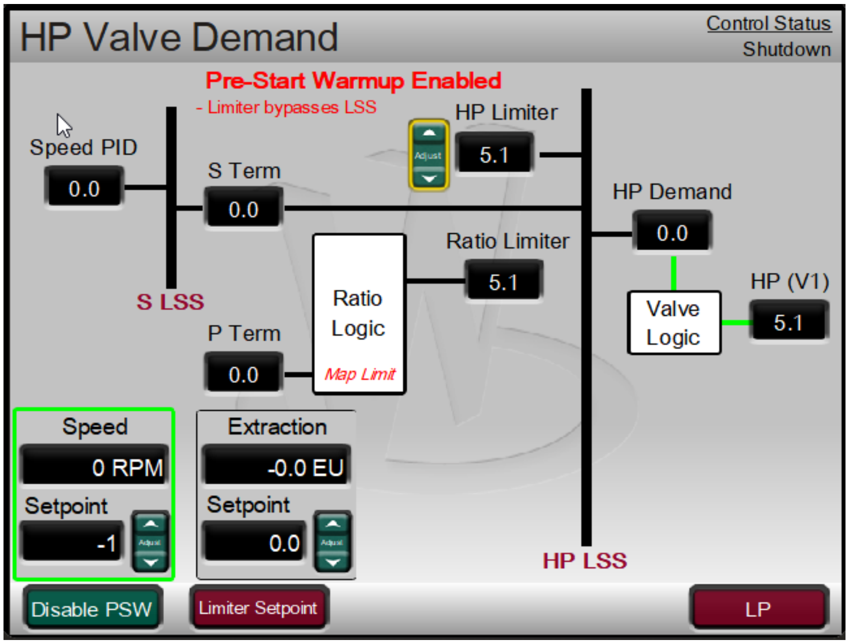


Figure 17-31. HP Valve Demand Page with Pre-Start Warmup Enabled

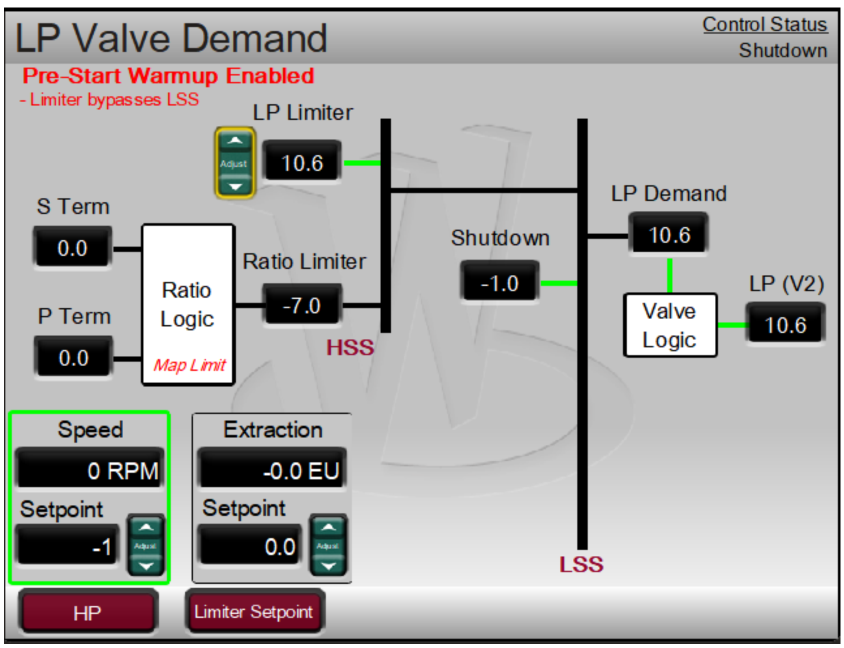


Figure 17-32. LP Valve Demand Page with Pre-Start Warmup Enabled

Appendix A. Configuration Mode Worksheets

Control Part Number ______________________

Serial Number ______________________

Application ______________________________ Date ___________

For details on individual settings, refer to Chapter 4.

TURBINE START	Default	Site Value	
Manual Start			YES/NO
Automatic Start			YES/NO
Semiautomatic Start			YES/NO
Rate to Min (rpm/s)	10		rpm/s
Valve Lmtr Rate (%/s)	2		%/s
Allow Pre-Start Warmup	NO		YES/NO
Use Idle/Rated?	NO		YES/NO
Idle Setpt (rpm)	1000		rpm
Rated Setpt (rpm)	3600		rpm
Cold Idle/Rated Rate (rpm/s)	20		rpm/s
Hot Idle/Rated Rate (rpm/s)	20		rpm/s
Use Temp Input for Hot/Cold	NO		YES/NO
Use Temp Input 2?	NO		YES/NO
Hot Min Temp on Temp 1	1400		Temp deg
Hot Min Temp on Temp 2	1400		Temp deg
Use Warm Condition	NO		YES/NO
Warm Min Temp on Temp 1	1200		Temp deg
Warm Min Temp on Temp 2	1200		Temp deg
Use Temperature Difference (1/2)	NO		YES/NO
Hot Temp Diff (between 1 & 2)	10		value
Warm Temp Diff (between 1 & 2)	10		value
Use Auto Start Sequence	NO		YES/NO
Cold Start = (> xx Hrs)	0		HRS
Hot Start = (< xx Hrs)	0		HRS
Low Idle Setpt (rpm)	1000		rpm
Low Idle Delay (Cold)	0		MIN
Low Idle Delay (Hot)	0		MIN
Use Idle 2	NO		YES/NO
Rate to Idle 2 (Cold)	5		rpm/s
Rate to Idle 2 (Hot)	5		rpm/s
Idle 2 Setpt (rpm)	1500		rpm
Idle 2 Delay (Cold)	0		MIN
Idle 2 Delay (Hot)	0		MIN
Use Idle 3	NO		YES/NO
Rate to Idle 3 (Cold)	5		rpm/s
Rate to Idle 3 (Hot)	5		rpm/s

TURBINE START	Default	Site Value	
Idle 3 Setpt (rpm)	2000		rpm
Idle 3 Delay (Cold)	0		MIN
Idle 3 Delay (Hot)	0		MIN
Use Temp for Idle	NO		YES/NO
Use Temp Input 2?	NO		YES/NO
Use Temp Difference	NO		YES/NO
Idle 1 Temp 1 Setpoint	1500		Temp deg
Idle 1 Temp 2 Setpoint	1500		Temp deg
Idle 1 Max Temp Difference	10		Value
Idle 2 Temp 1 Setpoint	1500		Temp deg
Idle 2 Temp 2 Setpoint	1500		Temp deg
Idle 2 Max Temp Difference	10		Value
Idle 3 Temp 1 Setpoint	1500		Temp deg
Idle 3 Temp 2 Setpoint	1500		Temp deg
Idle 3 Max Temp Difference	10		Value
Rate to Rated (Cold)	5		rpm/s
Rate to Rated (Hot)	5		rpm/s
RST Timer Level (rpm)	1		rpm
Hot RST Timer (min)	0		min
Auto Halt at Idle Setpts	NO		YES/NO

SPEED SETPOINT VALUES	Default	Site Value	
Overspeed Test Lmt (rpm)	1100		rpm
Overspeed Trip (rpm)	1000		rpm
Max Governor Speed (rpm)	1		rpm
Nominal Speed (rpm)	3600		
Min Governor Speed (rpm)	1		rpm
Off-line Slow Rate (rpm/s)	5		rpm/s
On-line Slow Rate (rpm/s)	5		rpm/s
Use Remote Speed Setpt ?	NO		YES/NO
Remote Speed Setpt Max Rate	50		rpm/s
Use Critical Speeds?	NO		YES/NO
Critical Speed Rate	50		rpm/s
Critical Speed 1 Max	1		rpm
Critical Speed 1 Min	1		rpm
Use Critical Band 2 ?	NO		YES/NO
Critical Speed 2 Max	1		rpm
Critical Speed 2 Min	1		rpm
Use Critical Band 3 ?	NO		YES/NO
Critical Speed 3 Max	1		rpm
Critical Speed 3 Min	1		rpm

SPEED CONTROL	Default	Site Value	
Probe Type Speed Sig 1	MPU		MPU/Active
Device Tag ID			User text
Teeth Seen by MPU	60		
Gear Ratio 1 :	1.000		
Max Speed Level (rpm)	1000		rpm
Failed Speed Level (rpm)	250		rpm
Use Speed Input #2?			YES/NO
Probe Type Speed Sig 2	MPU		MPU/Active
Device Tag ID			User text
Teeth Seen by MPU	60		
Gear Ratio 1 :	1.000		
Max Speed Level (rpm)	1000		rpm
Failed Speed Level (rpm)			rpm
Off-Line Prop Gain	5.000		%
Off-Line Int Gain	0.500		rps
Off-Line Deriv Ratio	5.000		%
On-Line Prop Gain	5.000		%
On-Line Int Gain	0.500		rps
On-Line Deriv Ratio	5.000		%

OPERATING PARAMETERS	Default	Site Value	
Generator Application?	NO		YES/NO
Use Gen Brkr Open Trip ?	NO		YES/NO
Use Tie Brkr Open Trip ?	NO		YES/NO
Nominal Frequency	60		50/60
Droop (%)	5.0		%
Use MW as Load Units	NO		YES/NO
Use Load Droop?	NO		YES/NO
Maximum Load	5000		KW/MW
Primary Gen Load Signal	none		AI/DSLC-2
Secondary Gen Load Signal	none		AI/DSLC-2
Primary Sync/LS Signal	none		AI/DSLC-2
Secondary Sync/LS Signal	none		AI/DSLC-2
Primary Sync Signal	none		AI/DSLC-2
Secondary Sync Signal	none		AI/DSLC-2
Use Freq Arm/Disarm ?	NO		YES/NO
Tie Open activates Load Rejection	YES		YES/NO
Controlled Stop & Trip?	NO		YES/NO
Ext Trips in Trip Relay	YES		YES/NO
Reset Clears Trip Output	NO		YES/NO
Trip = Zero Current to Actuators	YES		YES/NO
Use Pressure Compensation	NO		YES/NO

AUXILIARY CONTROL	Default	Site Value	
Use Auxiliary Control?	NO		YES/NO
Lost Aux Input Shutdown?	NO		YES/NO
Select Process Signal			
Invert Aux?	NO		YES/NO
Min Aux Setpt	0		Units
Max Aux Setpt	100		Units
Aux Setpt Rate units/s	5		Units/s
Use Aux as a Controller?	NO		YES/NO
Setpt Initial Value	0		Units
Aux Droop	0		%
Aux PID Prop Gain	1.00		%
Aux PID Integral Gain	0.300		rps
Aux Derivative Ratio	100		%
Tiebrkr Open Aux Disable	NO		YES/NO
Genbrkr Open Aux Disable	NO		YES/NO
Use Remote Aux Setpoint	NO		YES/NO
Remote Aux Max Rate	5		Units/s
Aux Units of Measure			User text
Decimals Displayed	1		value

CASCADE CONTROL	Default	Site Value	
Use Cascade Control ?	NO		YES/NO
Lost Casc Input Shutdown?	NO		YES/NO
Select Process Signal			YES/NO
Invert Casc?	NO		YES/NO
Min Casc Setpt	0		Units
Max Casc Setpt	100		Units
Casc Setpt Rate units/s	5		Units/s
Use Casc as a Controller?	NO		YES/NO
Setpt Initial Value	0		Units
Speed Setpoint Lower Limit	0		Rpm
Speed Setpoint Upper Limit	0		Rpm
Max Speed Setpoint Rate	20		Rpm/s
Casc Droop	0		%
Casc PID Prop Gain	1.00		%
Casc PID Integral Gain	0.300		rps
Casc Derivative Ratio	100		%
Tiebrkr Open Casc Disable	NO		YES/NO
Genbrkr Open Casc Disable	NO		YES/NO
Use Remote Casc Setpoint	NO		YES/NO
Remote Casc Max Rate	5		Units/s
Casc Units of Measure			User text
Decimals Displayed	1		value

INLET PRESSURE CONTROL	Default	Site Value	
Use Inlet Pressure Control?	NO		YES/NO
Lost Inlet Input Shutdown?	NO		YES/NO
Invert Inlet ?	NO		YES/NO
Min Inlet Setpt	0		Units
Max Inlet Setpt	100		Units
Inlet Setpt Rate units/s	5		Units/s
Use Inlet as a Controller?	NO		YES/NO
Setpt Initial Value	0		Units
Use Droop?	NO		YES/NO
Inlet Droop	0		%
Inlet PID Prop Gain	1.00		%
Inlet PID Integral Gain	0.300		rps
Inlet Derivative Ratio	100		%
Use Remote Inlet Setpoint	NO		YES/NO
Remote Inlet Max Rate	5		Units/s
Inlet Units of Measure			User text
Decimals Displayed	1		value

EXHAUST PRESSURE CONTROL	Default	Site Value	
Use Exhaust Pressure Control ?	NO		YES/NO
Lost Exhaust Input Shutdown?	NO		YES/NO
Invert Exhaust ?	NO		YES/NO
Min Exhaust Setpt	0		Units
Max Exhaust Setpt	100		Units
Exhaust Setpt Rate units/s	5		Units/s
Use Exhaust as a Controller?	NO		YES/NO
Setpt Initial Value	0		Units
Use Droop?	NO		YES/NO
Exhaust Droop	0		%
Exhaust PID Prop Gain	1.00		%
Exhaust PID Integral Gain	0.300		rps
Exhaust Derivative Ratio	100		%
Use Remote Exhaust Setpoint	NO		YES/NO
Remote Exhaust Max Rate	5		Units/s
Exhaust Units of Measure			User text
Decimals Displayed	1		value

EXTR / ADM CONTROL	Default	Site Value	
Use Extraction /Admission Control ?	NO		YES/NO
Lost E/A Input = Trip ?	NO		YES/NO
Min Extr/Adm Setpt Units	0		Units
Max Extr/Adm Setpt Units	100		Units
Setpoint Rate (units/sec) Units	5		Units/s
Use Setpoint Tracking?	NO		YES/NO
Setpoint Initial Value Units	0		Units
Use Droop?	NO		YES/NO
Extr/Adm Droop %	0		%
PID Proportional Gain %	1		%
PID Integral Gain rps	0.30		rps
PID Derivative Ratio %	100		%
Tiebrkr Open E/A Disable	YES		YES/NO
Genbrkr Open E/A Disable	YES		YES/NO
Generator Breaker Open Extr/Adm Inhibit?	YES		YES/NO
Use Remote Setting?	NO		YES/NO
Remote Setpt Max Rate Units	5		Units/s
Ext/Adm Units Of Measure			Units
Decimals Displayed	1		
Allow use of Full Decoupled Mode?	NO		YES/NO

STEAM PERFORMANCE MAP	Default	Site Value	
Turbine Type	single		menu
Maximum Power	20000		YES/NO
Maximum HP Flow	100		Units
Use Alternate Modes?	NO		YES/NO
Maximum Extraction Flow	20000		Units
Maximum Admission Flow	20000		Units
Use Automatic Enable?	YES		YES/NO
LP Valve Limiter Rate	1		Units/s
Use Min Flow Line?	0		%
Load when HP=0 (Min Flow Line)	2000		%
Load when HP=100 (Min Flow Line)	8000		%
Extraction Priority on LP Max Limit?	NO		YES/NO
Max Power at Min Extract/Adm (Pt A)	84		Units
Max HP Flow at Min Extract/Adm (Pt A)	43.6		Units
Min Power at Max Extract/Adm (Pt B)	44		Units
Min HP Flow at Max Extract/Adm (Pt B)	87.6		Units
Min Power at Min Extract/Adm (Pt C)	4		Units
Min HP Flow at Min Extract/Adm (Pt C)	11.6		Units
Min LP Lift	0		%
Min HP Lift (if Adm)	0		%
Mode 0 Speed/Extraction	Speed		Spd/Ext
Mode 1 Speed/Inlet	Speed		Spd/Inlet
Mode 2 Extraction/Inlet	Inlet		Inlet/Ext
Mode 3 Speed/Exhaust	Speed		Spd/Exhaust
Mode 4 Extraction/Exhaust	Exhaust		Exhaust/Ext
Mode 5 Inlet/Exhaust	Inlet		Inlet/Exhaust
Mode 6 Inlet/Exhaust	Inlet		Inlet/Exhaust
K1 Gain Map calculated value shown			
K2 Gain Map calculated value shown			
K3 Gain Map calculated value shown			
K4 Gain Map calculated value shown			
K5 Gain Map calculated value shown			
K6 Gain Map calculated value shown			
Retain Service Values			

ISOLATED CONTROL	Default	Site Value	
Use Isolated PID Control ?	NO		YES/NO
Use Remote Setpoint			
Valve Action upon PV Fault?	NO		YES/NO
Inverted ?	NO		YES/NO
Allow Manual Valve Control			
Maximum Setpt	100		Units
Minimum Setpt	0		Units
Setpt Initial Value	0		Units

COMMUNICATIONS	Default	Site Value	
Ethernet IP Configuration			
ENET 1 Address	172.16.100.15		
ENET 1 Subnet Mask	255.255.0.0		
ENET 2 Address	192.168.128.20		
ENET 2 Subnet Mask	255.255.255.0		
ENET 3 Address	192.168.129.20		
ENET 3 Subnet Mask	255.255.255.0		
ENET 4 Address	192.168.128.20		
ENET 4 Subnet Mask	255.255.255.0		
Modbus Configuration			
Use Modbus	NO		YES/NO
Use Serial Link 1	NO		YES/NO
Use Ethernet Link 2	NO		YES/NO
Use Ethernet Link 3	NO		YES/NO
Device Address (1-247)	1		
Enable Write Commands	NO		YES/NO
Protocol	Ascii		Asci/rtu
Baud Rate	115200		110-115K
Bits	8		7/8
Stop Bits	1		1/1.5/2
Parity	OFF		Off/odd/even
Driver	RS-232		232/485
Modbus Ethernet Link 2			
Ethernet Protocol	Ethernet TCP		TCP/UDP
Device Address (1-247)	2		
Enable Write Commands	NO		YES/NO
Modbus Ethernet Link 3			
Ethernet Protocol	Ethernet TCP		TCP/UDP
Device Address (1-247)	3		
Enable Write Commands	NO		YES/NO

DRIVER CONFIGURATION

HP Actuator Type	Not Used		List
Use HP Fault SD?	YES		YES/NO
Invert HP Driver Output?	NO		YES/NO
Use HP2 Demand (for Split Range)?	NO		YES/NO
HP2 Offset	0.0%		0-100
Use HP2 Fault SD?	NO		YES/NO
LP Actuator Type	Not Used		List
Use LP Fault SD?	NO		YES/NO
Invert LP Driver Output?	NO		YES/NO
IF 2 CH Actuator Module (A6) is used ->			
Actuator Channel 1 Function	Not Used		List
Control Type	PROP		List
Position Feedback Type	NONE		List

Forward/Reverse Acting	Forward		Forward/Rev
Feedback Fail High/Low	Use High		High/Low
Use External Excitation?	NO		YES/NO
Actuator Channel 2 Function	Not Used		List
Control Type	PROP		List
Position Feedback Type	NONE		List
Forward/Reverse Acting	Forward		Forward/Rev
Feedback Fail High/Low	Use High		High/Low
Use External Excitation?	NO		YES/NO

WOODWARD LINKS

Enable AI/AO Module in Slot 5 (A,B,C)?	NO		YES/NO
Enable 2 Channel ACT Module in Slot 6 (A,B)?	NO		YES/NO
Using VS-I for HP Valve?	NO		YES/NO
Using VS-DX for HP Valve?	NO		YES/NO
Using VS-I for LP Valve?	NO		YES/NO
Using VS-DX for LP Valve?	NO		YES/NO
Enable Using LinkNet I/O Nodes?	NO		YES/NO
Enable Node 1 (AIO)?	NO		YES/NO
Enable Node 2 (AIO)?	NO		YES/NO
Enable Node 3 (RTD)?	NO		YES/NO
Enable Node 4 (BI)?	NO		YES/NO
Enable Node 5 (BO)?	NO		YES/NO
Using VSII Node 1?	NO		YES/NO
Enable VSII AI Backup?	YES		YES/NO
Use AI as Primary Demand?	NO		YES/NO
Node 1 Function	Not Used		List
Using VSII Node 2?	PROP		List
Node 2 Function	Not Used		List
Enable VSII AI Backup?	YES		YES/NO
Use AI as Primary Demand?	NO		YES/NO
Enable SPC Node 11?	NO		YES/NO
Enable SPC Node 12?	NO		YES/NO
Using a DSLC-2 (Digital Synchronizer/Load Control)?	NO		YES/NO
Select one: Synch Only, Sync/LS, KW Only	SYNC/LS		3 options
Device Slave Address (1-255)	247		1-255
Device IP Address	192.168.1.3		IP setting

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						

When Actuator Outputs have been (In Service) Calibrated and Stroked, record values here.

	Default	**Value in 5009XT**
Actuator # 1 mA at Minimum Position	*4.00	
Actuator # 1 mA at Maximum Position	*20.00	
Actuator # 1 Dither (mA)	*0.00	
Actuator # 2 mA at Minimum Position	*4.00	
Actuator # 2 mA at Maximum Position	*20.00	
Actuator # 2 Dither (mA)	*0.00	

Appendix A1. Service Mode Worksheets

SPEED CONTROL	Default	Site Value	
Rate to Minimum	10		rpm/s
Slow Rate Offline (RPM/sec)	5		rpm/s
Slow Rate Online (RPM/sec)	5		rpm/s
Fast Rate Delay	3		rpm/s
Fast Rate Offline	15		rpm/s
Fast Rate Online	15		rpm/s
Entered Rate Offline	5		rpm/s
Entered Rate Offline	5		rpm/s
Underspeed Setting	0		rpm
Online Speed Deadband (Hz)	0		value
Instant Minimum Load Rate	50		rpm/s
Display Gauge Multiplier	x1		value
Hold Speed Changes	NO		YES/NO
Overspeed Rate	5		rpm/s
Use Reduced Overspeed SP	NO		YES/NO
Reduced Overspeed Setpoint	1000		rpm
If Remote Speed Setpoint (config > speed setpoints)			
Not Matched Rate	5		rpm/s
Speed Setpoint Maximum Rate	5		rpm/s
Minimum Speed Setpoint	1		rpm
Maximum Speed Setpoint	1		rpm
Remote Deadband Value	0		rpm
Lag-Tau Value	1		value
Use Minimum Load	YES		YES/NO
Hold Remote Speed Changes	NO		YES/NO
Generator Breaker Open Disable?	NO		YES/NO
Utility Breaker Open Disable?	NO		YES/NO

VALVE LIMITER	Default	Site Value	
HP Limiter Rate	5		rpm/s
HP Entered Rate	5		rpm/s
HP Limiter Maximum	101		%
HP Maximum at Startup	101		%
Shutdown at Maximum	NO		YES/NO
HP Minimum Lift (Admission Only)	0		

Hold Limiter Changes	NO		YES/NO
If Ext/Adm			
LP Limiter Rate	1		rpm/s
LP Entered Rate	1		rpm/s
LP Auto Rate	10		
LP Maximum Lift	100		%
LP Limiter Minimum	0		%
Hold Limiter Changes	NO		YES/NO

MPU SIGNALS	Default	Site Value	
Use MPU Override Timer	NO		YES/NO
Override Time (s)	600		
Override Timer Remaining (s)	0		status
MPU 1 Override On	ON		status
MPU 2 Override On	ON		status

IDLE RATED RAMP	Default	Site Value	
Hours Since Trip	200		status
Hot Reset Timer (Min)	0		min
Idle/Rated Cold Rate	20		rpm/s
Idle/Rated Warm Rate	20		rpm/s
Idle/Rated Hot Rate	20		rpm/s
Use Ramp to Idle	YES		YES/NO
Idle Priority	NO		YES/NO
Rated Priority	YES		YES/NO
If Temp Start used			
Temperature 1 Input	0		Status (deg)
Override Temperature 1	NO		YES/NO
Temperature 2 Input	0		Status (deg)
Override Temp 2	NO		YES/NO

AUTOMATIC START SEQUENCE	Default	Site Value	
Hours Since Trip	200		status
Hot Reset Timer (minutes)	0		min
Hot Reset Time Remaining (minutes)	0		status
Hot Time Remaining (Hour)	20		status
Time until Cold Start	20		status
Rate to Rated	5		rpm/s
Low Idle Delay	0		min
Rate to Idle 2	5		rpm/s

Idle 2 Delay	0		min
Rate to Idle 3	5		rpm/s
Idle 3 Delay	0		min
If Temp Start used			
Temperature 1 Input	0		Status (deg)
Override Temperature 1	NO		YES/NO
Temperature 1 Input	0		Status (deg)
Override Temp 1	NO		YES/NO

PRESSURE COMPENSATION	Default	Site Value	
Current Gain	1		status
Pressure of Point 1	1		pressure
Gain of Point 1	1		value
Pressure of Point 2	2		pressure
Gain of Point 2	1		value
Pressure of Point 3	3		pressure
Gain of Point 3	1		value
Pressure of Point 4	4		pressure
Gain of Point 4	1		value
Pressure of Point 5	5		pressure
Gain of Point 5	1		value

Note: *Each pressure point MUST be higher than the previous point (points 1-5)*

BREAKER LOGIC	Default	Site Value	
Frequency Control Armed	On		status
Sync Window RPM	10		rpm
Sync Window Rate	2		rpm/s
Tie Breaker Open Ramp	YES		YES/NO
Tie Open Rate	1		rpm/s
Generator Open Setpoint	3600		rpm
Zero Load Value (HP valve %)	0		%
Use Minimum Load	YES		YES/NO
Reverse Power Protection?	YES		YES/NO
Min Load Bias (rpm above Rated)	5.4		rpm
Frequency Offset (Hz)	0		hz
Frequency Deadband (Hz)	0		hz
Tie Open Load Rejection?	YES		YES/NO
Hold Breaker Logic Changes	NO		YES/NO
Frequency Excursion Test Visible?	NO		YES/NO
Load Limiter Function Available	Display LED		
Load Limiter Setpoint (KW)	10000		100-100K

Enable Load Limiter	NO		YES/NO
Permissives for Load Limiter	Status LED's		
Load Limiter PID Proportional Gain	0.25		0.0 - 10.0

SYNC/LOAD SHARE	Default	Site Value	
Input Bias Gain	5		value
Input Bias Deadband	0		rpm
Lag-Tau Value	0		filter
Hold Bias Change	NO		YES/NO

SPEED CONTROL DROOP	Default	Site Value	
Actual Droop	5		value
Minimum Droop	1		rpm
Maximum Droop	12		filter
Use MW as Load Units?	NO		YES/NO
Use Load Droop?	NO		YES/NO
Entered Droop Setpoint	5		value

AUXILIARY CONTROL	Default	Site Value	
Slow Rate	5		Units/s
Fast Rate Delay	3		s
Fast Rate	15		Units/s
Entered Rate	5		Units/s
Droop (%)	0		%
Rated Auxiliary Setpoint	100		Units
Threshold (Limiter)	10		%
Threshold (Controller)	100		%
PID Minimum Output	0		%
Display Gauge Multiplier	x1		Value
Hold Auxiliary Changes	NO		YES/NO
If Remote Auxiliary Setpoint			
Not Matched Rate	5		Units/s
Remote Auxiliary Maximum Rate	5		Units/s
Minimum Remote Auxiliary Setpoint	0		Units
Maximum Remote Auxiliary Setpoint	0		Units
Remote Deadband Value	0		Units
Lag-Tau Value	0		value
Hold Remote Auxiliary Changes	NO		YES/NO

EXT/ADM CONTROL	Default	Site Value	
Setpoint Adjustment Slow Rate (units/sec)	5		Units/s
Setpoint Adjustment Fast Rate Delay	3		s
Setpoint Adjustment Fast Rate	15		Units/s
Rate to Entered Setpoint	5		Units/s
Use Droop?	NO		YES/NO
Droop (%)	0		%
Rated Setpoint (if Droop is used)	100		Units
Action On PV Failure	Manual P Demand		Manual P LP Limiter Max LP Limiter Min
PID Threshold	100		%
PID Minimum Output	0		%
Startup Demand Setting (for E/A or Adm)	50		%
Speed Enable Setting	1000		RPM
Generator Breaker Open Extr/Adm Inhibit?	YES		YES/NO
Deadband	0		Units
Display Gauge Multiplier	x1		Value
Manual P Demand Rate (%/s)	0.5		
Hold Ext/Adm Changes	NO		YES/NO
Go to Full Decoupled Mode?	NO		YES/NO
If Remote Ext/Adm Setpoint			
Not Matched Rate	5		Units/s
Remote Maximum Rate	5		Units/s
Minimum Remote Setpoint	0		Units
Maximum Remote Setpoint	0		Units
Remote Deadband Value	0		Units
Lag-Tau Value	0		value
Hold Remote Changes	NO		YES/NO

CASCADE CONTROL	Default	Site Value	
Slow Rate (units/sec)	5		Units/s
Fast Rate Delay (sec)	3		s
Fast Rate (units/sec)	15		Units/s
Entered Rate (units/sec)	5		Units/s
Droop (%)	0		%
Rated Cascade Setpoint (units)	100		Units
Cascade Not Matched Rate (units/sec)	5		Units/s
Maximum Speed Rate (RPM/sec)	20		RPM/s

Minimum Speed Setpoint	1		RPM
Maximum Speed Setpoint	1		RPM
Cascade Deadband	0.1		Units
Raise/Lower Cascade Only	NO		YES/NO
Use Minimum Load	YES		YES/NO
Breaker Enables Control	NO		YES/NO
Display Gauge Multiplier	X1		value
Hold Cascade Changes	NO		YES/NO
If Remote Cascade Setpoint			
Not Matched Rate	5		Units/s
Remote Cascade Maximum Rate	5		Units/s
Minimum Remote Cascade Setpoint	0		Units
Maximum Remote Cascade Setpoint	0		Units
Remote Deadband Value	0		Units
Lag-Tau Value	0		value
Hold Remote Cascade Changes	NO		YES/NO

COMMUNICATIONS	Default	Site Value	
Use Modbus Trip	Yes		Yes/No
Use 2-Step Trip	No		Yes/No
Enable Port 1 Writes?	No		Yes/No
Enable Port 2 Writes?	No		Yes/No
Enable Port 3 Writes?	No		Yes/No
Enable Port 4 Writes?	No		Yes/No
Port 1			
Link Status			Status
Exception Error			Status
Time-out Delay	10		s
Error Code			Status
Port 2			
Link Status			Status
Exception Error			Status
Time-out Delay	10		s
Error Code			Status
Port 3			
Link Status			Status
Exception Error			Status
Time-out Delay	10		s
Error Code			Status
Port 4			

Link Status			Status
Exception Error			Status
Time-out Delay			s
Error Code			Status

ACTUATORS	Default	Site Value	
Act Channel 1			
Dither (mA)	0.0		YES/NO
Excitation Amplitude (Vrms)	7.07		Vrms
Command Trim Enable	NO		YES/NO
Enable Feedback Alarms	NO		YES/NO
Feedback Voltage Tolerance (Vrms)	0.5		Vrms
Feedback Max Difference (%)	10.0		%
Feedback Difference Delay (ms)	1000.0		ms
Position Out of Range (%)	5.0		%
Position Error Threshold (%)	10.0		%
Position Error Delay (ms)	2000		ms
Act Channel 2			
Dither (mA)	0.0		YES/NO
Excitation Amplitude (Vrms)	7.07		Vrms
Command Trim Enable	NO		YES/NO
Enable Feedback Alarms	NO		YES/NO
Feedback Voltage Tolerance (Vrms)	0.5		Vrms
Feedback Max Difference (%)	10.0		%
Feedback Difference Delay (ms)	1000.0		ms
Position Out of Range (%)	5.0		%
Position Error Threshold (%)	10.0		%
Position Error Delay (ms)	2000		ms

ALARMS	Default	Site Value	
Trip is an Alarm	NO		YES/NO
Blink upon new Alarm	NO		YES/NO
Jump to Alarm Screen	NO		YES/NO
Shutdown on Power Up	YES		YES/NO
Test Alarm (Tunable) – Event ID 82	NO		YES/NO
Configurable Alarm 1			
Analog Input Signal	Not Used		
Use Alarm Setpoint 1	NO		YES/NO
Use Alarm Setpoint 2	NO		YES/NO
Level 1 Setpoint	60		Units
Invert Action on Level 1?	NO		YES/NO

ALARMS	Default	Site Value	
Level 2 Setpoint	70		Units
Invert Action on Level 2?	NO		YES/NO
Use Level 2 As a Trip?	NO		YES/NO
Setpoint Hysteresis	-3		Units
Delay for Event Action (sec)	2		s
Enable Speed Setpoint (RPM)	100		RPM
Enable Speed Setpoint Hysteresis (RPM)	10		RPM
Configurable Alarm 2			
Analog Input Signal	Not Used		
Use Alarm Setpoint 1?	NO		YES/NO
Use Alarm Setpoint 2?	NO		YES/NO
Level 1 Setpoint	60		Units
Invert Action on Level 1?	NO		YES/NO
Level 2 Setpoint	70		Units
Invert Action on Level 2?	NO		YES/NO
Use Level 2 As a Trip?	NO		YES/NO
Setpoint Hysteresis	-3		Units
Delay for Event Action (sec)	2		s
Enable Speed Setpoint (RPM)	100		RPM
Enable Speed Setpoint Hysteresis (RPM)	10		RPM
Configurable Alarm 3			
Analog Input Signal	Not Used		
Use Alarm Setpoint 1?	NO		YES/NO
Use Alarm Setpoint 2?	NO		YES/NO
Level 1 Setpoint	60		Units
Invert Action on Level 1?	NO		YES/NO
Level 2 Setpoint	70		Units
Invert Action on Level 2?	NO		YES/NO
Use Level 2 As a Trip?	NO		YES/NO
Setpoint Hysteresis	-3		Units
Delay for Event Action (sec)	2		s
Enable Speed Setpoint (RPM)	100		RPM
Enable Speed Setpoint Hysteresis (RPM)	10		RPM
Inlet Pressure Alarm			
Analog Input Signal	Not Used		
Use Alarm Setpoint 1?	NO		YES/NO
Use Alarm Setpoint 2?	NO		YES/NO
Level 1 Setpoint	60		Units
Invert Action on Level 1?	NO		YES/NO

ALARMS	Default	Site Value	
Level 2 Setpoint	70		Units
Invert Action on Level 2?	NO		YES/NO
Use Level 2 As a Trip?	NO		YES/NO
Setpoint Hysteresis	-3		Units
Delay for Event Action (sec)	2		s
Enable Speed Setpoint (RPM)	100		RPM
Enable Speed Setpoint Hysteresis (RPM)	10		RPM
Exhaust Pressure Alarm			
Analog Input Signal	Not Used		
Use Alarm Setpoint 1	NO		YES/NO
Use Alarm Setpoint 2	NO		YES/NO
Level 1 Setpoint	60		Units
Invert Action on Level 1?	NO		YES/NO
Level 2 Setpoint	70		Units
Invert Action on Level 2?	NO		YES/NO
Use Level 2 As a Trip?	NO		YES/NO
Setpoint Hysteresis	-3		Units
Delay for Event Action (sec)	2		s
Enable Speed Setpoint (RPM)	100		RPM
Enable Speed Setpoint Hysteresis (RPM)	10		RPM
Valve Position Feedback Alarm			
Enable HP Difference Alarm?	NO		YES/NO
Position Error Tolerance (%)	5		%
Position Error Duration (sec)	5		s

ACTUATOR LINEARIZATION	Default	Site Value	
HP (V1) Linearization			
X-1 Value	0		%
Y-1 Value	0		%
X-2 Value	10		%
Y-2 Value	10		%
X-3 Value	20		%
Y-3 Value	20		%
X-4 Value	30		%
Y-4 Value	30		%
X-5 Value	40		%
Y-5 Value	40		%
X-6 Value	50		%
Y-6 Value	50		%

ACTUATOR LINEARIZATION	Default	Site Value	
X-7 Value	60		%
Y-7 Value	60		%
X-8 Value	70		%
Y-8 Value	70		%
X-9 Value	80		%
Y-9 Value	80		%
X-10 Value	90		%
Y-10 Value	90		%
X-11 Value	100		%
Y-11 Value	100		%
HP2 (V1B) Linearization			
X-1 Value	0		%
Y-1 Value	0		%
X-2 Value	10		%
Y-2 Value	10		%
X-3 Value	20		%
Y-3 Value	20		%
X-4 Value	30		%
Y-4 Value	30		%
X-5 Value	40		%
Y-5 Value	40		%
X-6 Value	50		%
Y-6 Value	50		%
X-7 Value	60		%
Y-7 Value	60		%
X-8 Value	70		%
Y-8 Value	70		%
X-9 Value	80		%
Y-9 Value	80		%
X-10 Value	90		%
Y-10 Value	90		%
X-11 Value	100		%
Y-11 Value	100		%
LP (V2) Linearization			
X-1 Value	0		%
Y-1 Value	0		%
X-2 Value	10		%
Y-2 Value	10		%
X-3 Value	20		%

ACTUATOR LINEARIZATION	Default	Site Value	
Y-3 Value	20		%
X-4 Value	30		%
Y-4 Value	30		%
X-5 Value	40		%
Y-5 Value	40		%
X-6 Value	50		%
Y-6 Value	50		%
X-7 Value	60		%
Y-7 Value	60		%
X-8 Value	70		%
Y-8 Value	70		%
X-9 Value	80		%
Y-9 Value	80		%
X-10 Value	90		%
Y-10 Value	90		%
X-11 Value	100		%
Y-11 Value	100		%

REAL TIME CLOCK	Default	Site Value	
Use SNTP Synchronization (in AppManager)	NO		YES/NO
Time Zone	0		Integer
Year	15		Integer
Month	1		Integer
Day	1		Integer
Hour	0		Integer
Minutes	0		Integer
Seconds	0		Integer

DATALOG	Default	Site Value	
TrendLog Status			
Collecting Data			YES/NO
Collection Time (sec)			Seconds
Next Log File Index			Index Number
Printing File to Hard Drive			YES/NO
Data Sample Rate	1000		ms
Continuous Mode Active			YES/NO

ISOLATED CONTROL	Default	Site Value	
Setpoint	100		Units
Process			Status
Demand			Status
Remote Setpoint Enabled			Status
Remote Setpoint Fault			Status
Auto Control			Status
Process Input Fault			Status
Manual Demand			Status
Setpoint Limits			
MAX	100		Units
MIN	0		Units
Initial	100		Units
Normal Rate	1		Units/s
Fast Rate	3		Units/s
Output Limits			
MAX	100		Units
MIN	0		Units
Initial	100		Units
Normal Rate	1		Units/s
Fast Rate	3		Units/s
PID Dynamics			
P Term	0.55		Value
I Term	0.75		Value
D Term	100		Value

SCREEN/KEY OPTIONS	Default	Site Value	
Auto Login as Operator?	YES		YES/NO
Operator Password	wg1111		string
Use STOP Command	YES		YES/NO
Use RemoteView Trip?	YES		YES/NO
CPU Idle Time (%)			Status (%)

CUSTOM TREND	Default	Site Value	
Settings			
Time Window	60		s
Variable 1 (Red)	Not Used		Selection
Y Max	100		Units
Y Min	0		Units

CUSTOM TREND	Default	Site Value	
Width	1		Value
Axis	YES		YES/NO
Variable 1 (Green)	Not Used		Selection
Y Max	100		Units
Y Min	0		Units
Width	1		Value
Axis	YES		YES/NO
Variable 3 (Blue)	Not Used		Selection
Y Max	100		Units
Y Min	0		Units
Width	1		Value
Axis	YES		YES/NO
Variable 4 (Purple)	Not Used		Selection
Y Max	100		Units
Y Min	0		Units
Width	1		Value
Axis	YES		YES/NO
Variable 5 (Orange)	Not Used		Selection
Y Max	100		Units
Y Min	0		Units
Width	1		Value
Axis	YES		YES/NO

FEEDFORWARD	Default	Site Value	
Feed Forward Speed Deadband	0.1		Value
Use Direct Feed Forward?	NO		Status
Speed Offset at 4mA	-100		RPM
Speed Offset at 20mA	100		RPM
Action Delay (s)	179		s
Min Forward Rate (%/s)	-100		%/s
Speed Offset at Min Rate	-100		
Max Forward Rate (%/s)	100		%/s
Speed Offset at Max Rate	100		
Use only when in Cascade?	YES		Status
Cascade Deadband when Forward active	0.1		
Use Emergency Feed Forward?	NO		Status
Emergency Action Delay (s)	10		s
Forward Rate to Activate (%/s)	10		%/s
Emergency Max Forward Rate (%/s)	100		%/s

Emergency Max Speed Offset	300		RPM
Emergency Max Speed Rate (rpm/s)	500		RPM/s

MANUAL DEMAND	Default	Site Value	
Enable Use of Manual Demand	NO		YES/NO
Manual Demand Rate (%/sec)	0.25		%/s
Timeout When Inactive (sec)	300		s

ACCELERATION LIMITER	Default	Site Value	
Use Acceleration Limiter	NO		YES/NO
Proportional Gain	0.5		Value
Integral Gain	0.5		Value
Derivative Gain	5		Value

Varistroke/SPC			
Select Unit B as Master on HP VS-DX Skid	NO		YES/NO
Select Unit B as Master on LP VS-DX Skid	NO		YES/NO

INLET CONTROL	Default	Site Value	
Slow Rate (units/sec)	5		Units/s
Fast Rate Delay	3		s
Fast Rate	15		Units/s
Entered Rate	5		Units/s
Use Droop?	NO		YES/NO
Droop (%)	0		%
Rated Setpoint	100		Units
Deadband	0		
Threshold (Limiter)	10		%
Threshold (Controller)	100		%
PID Minimum Output	0		%
Display Gauge Multiplier	x1		Value
Hold Inlet Changes	NO		YES/NO
If Remote Inlet Setpoint			
Not Matched Rate	5		Units/s
Remote Maximum Rate	5		Units/s
Minimum Remote Setpoint	0		Units
Maximum Remote Setpoint	0		Units
Remote Deadband Value	0		Units
Lag-Tau Value	0		value

Hold Remote Changes	NO		YES/NO

EXHAUST CONTROL	Default	Site Value	
Slow Rate (units/sec)	5		Units/s
Fast Rate Delay	3		s
Fast Rate	15		Units/s
Entered Rate	5		Units/s
Use Droop?	NO		
Droop (%)	0		%
Rated Setpoint (if droop is used)	100		Units
Deadband	0		
Threshold (Limiter)	10		%
Threshold (Controller)	100		%
PID Minimum Output	0		%
Display Gauge Multiplier	x1		Value
Hold Auxiliary Changes	NO		YES/NO
If Remote Inlet Setpoint			
Not Matched Rate	5		Units/s
Remote Maximum Rate	5		Units/s
Minimum Remote Setpoint	0		Units
Maximum Remote Setpoint	0		Units
Remote Deadband Value	0		Units
Lag-Tau Value	0		value
Hold Remote Changes	NO		YES/NO

STEAM MAP	Default	Site Value	
Steam Performance Map			
K1 Map Value	0.36		Value
K1 Service Value	0.36		Value
K2 Map Value	0.59		Value
K2 Service Value	0.59		Value
K3 Map Value	13.05		Value
K3 Service Value	13.05		Value
K4 Map Value	1.14		Value
K4 Service Value	1.14		Value
K5 Map Value	-0.55		Value
K5 Service Value	-0.55		Value
K6 Map Value	4.55		Value
K6 Service Value	4.55		Value
S0 Value			

STEAM MAP	Default	Site Value	
Retain Service Values	NO		YES/NO
Steam Map Priority Selection			
Mode 0	Speed		Speed/Extraction
Mode 1	Speed		Speed/Inlet
Mode 2	Inlet		Extraction/Inlet
Mode 3	Speed		Speed/Exhaust
Mode 4	Exhaust		Extraction/Exhaust
Mode 5	Inlet		Inlet/Exhaust
Mode 6	Inlet		Inlet/Exhaust

Appendix B
5009XT I/O Function Menus

Table B-1. Analog Input Function Menu Options

Menu #	Function Selection
1	--- Not Used ---
2	Remote Speed Setpoint #1
3	Remote Speed Setpoint #2
4	Remote Speed Setpoint #3
5	Generator Load Input #1
6	Generator Load Input #2
7	Generator Load Input #3
8	Cascade Input #1
9	Cascade Input #2
10	Cascade Input #3
11	Auxiliary Input #1
12	Auxiliary Input #2
13	Auxiliary Input #3
14	Inlet Pressure Input #1
15	Inlet Pressure Input #2
16	Inlet Pressure Input #3
17	Exhaust Pressure Input #1
18	Exhaust Pressure Input #2
19	Exhaust Pressure Input #3
20	Extraction/Admission Input #1
21	Extraction/Admission Input #2
22	Extraction/Admission Input #3
23	Synchronizing Input
24	Sync / Load Share
25	Remote Cascade Setpoint
26	Remote Auxiliary Setpoint
27	Remote Droop
28	Remote Load Setpoint
29	Remote Extr/Adm Setpoint
30	Remote Manual Extr/Adm (P) Demand
31	Remote Exhaust Pressure Setpoint
32	Remote Inlet Pressure Setpoint
33	HP Valve Feedback Position
34	HP2 Valve Feedback Position
35	LP Valve Position Feedback
36	I/H Actuator 1 Feedback
37	I/H Actuator 2 Feedback

Menu #	Function Selection
38	Speed Feed-Forward
39	Isolated PID PV
40	Remote SP for Isolated PV
41	Start Temperature 1
42	Start Temperature 2
43	Customer Signal 1 (Monitor)
44	Customer Signal 2 (Monitor)
45	Customer Signal 3 (Monitor)
46	Customer Signal 4 (Monitor)
47	Customer Signal 5 (Monitor)
48	Spare_48
49	Spare_49
50	Spare_50

Table B-2. Analog Output Function Menu Options

1	--- Not Used ---
2	HP Valve Demand
3	HP Dual Coil A Vlv Dmd
4	HP Dual Coil B Vlv Dmd
5	HP Redund Act A Vlv Dmd
6	HP Redund Act B Vlv Dmd
7	LP Valve Demand
8	LP Dual Coil A Vlv Dmd
9	LP Dual Coil B Vlv Dmd
10	LP Redund Act A Vlv Dmd
11	LP Redund Act B Vlv Dmd
12	HP2 Valve Demand
13	LP2 Valve Demand
14	Isolated PID Dmd Output
15	spare_15
16	Actual Shaft Speed
17	Speed Reference Setpoint
18	Remote Speed Setpoint
19	Load Share Input
20	Synchronizing Input
21	Generator Load
22	Cascade Input Signal
23	Cascade Setpoint
24	Remote Cascade Setpoint
25	Auxiliary Input Signal
26	Auxiliary Setpoint
27	Remote Auxiliary Setpoint

28	I/H Actuator 1 Feedback Readout
29	I/H Actuator 2 Feedback Readout
30	Isolated PID PV Input Signal
31	Isolated PID Setpoint
32	Remote Isolated PID Setpoint
33	Spare_33
34	Inlet Pressure Input
35	Exhaust Pressure Input
36	Extraction/Admission Input
37	Extraction/Admission Setpoint
38	Exhaust Pressure Setpoint
39	Inlet Pressure Setpoint
40	Remote KW Setpoint
41	HP Valve Limiter Setpoint
42	LP Valve Limiter Setpoint
43	LSS Value
44	HP Valve Feedback Position
45	HP2 Valve Feedback Position
46	Speed/Load Demand (S Demand)
47	Extraction/Admission Demand (P Demand)
48	Inlet Pressure Demand (Q Demand)
49	Exhaust Pressure Demand (R Demand)
50	Signal Monitoring #1
51	Signal Monitoring #2
52	Signal Monitoring #3
53	Start Temperature 1
54	Start Temperature 2
55	HP Valve Demand Readout
56	HP2 Valve Demand Readout
57	LP Valve Demand Readout
58	LP2 Valve Demand Readout
59	Spare_59
60	Spare_60

Table B-3. Discrete Input Function Menu Options

Menu #	Function Selection
1	---Not Used---
2	Reset Command
3	Speed Raise Command
4	Speed Lower Command
5	Generator Breaker
6	Utility Tie Breaker
7	Overspeed Test
8	External Run
9	Idle / Rated Command
10	Halt/Continue Auto Start
11	Override MPU Fault
12	Select On-Line Dynamics
13	I/H Actuator 1 Fault
14	I/H Actuator 2 Fault
15	Rmt Spd Setpt Enable
16	Sync Enable
17	Freq Control Arm/Disarm
18	Casc Setpt Raise
19	Casc Setpt Lower
20	Casc Control Enable
21	Rmt Casc Setpt Enable
22	Aux Setpt Raise
23	Aux Setpt Lower
24	Aux Control Enable
25	Rmt Aux Setpt Enable
26	Start Permissive 1
27	Start Permissive 2
28	Start Permissive 3
29	Redundant ESTOP (Use w/ DI01)
30	HP Valve Limiter Open
31	HP Valve Limiter Close
32	Controlled Shutdown(STOP)
33	External Trip 2
34	External Trip 3
35	External Trip 4
36	External Trip 5
37	External Trip 6
38	External Trip 7
39	External Trip 8
40	External Trip 9
41	External Trip 10

Menu #	Function Selection
42	External Trip 11
43	External Trip 12
44	External Trip 13
45	External Trip 14
46	External Trip 15
47	SPC11 is Healthy (RemDrvr1)
48	SPC12 is Healthy (RemDrvr2)
49	VSII ID 1 is Healthy (DVP1)
50	VSII ID 2 is Healthy (DVP2)
51	Spare 51
52	ISO PID Ext2 Control Enable
53	Idle Rated Permissive
54	Speed Forward Enable
55	Instant Min Gov/Load Speed
56	Select Hot Start
57	Remote KW Setpoint Enable
58	Clock SYNC Pulse Contact
59	Enable Rem SP for Isolated PID
60	Isolated Controller Raise
61	Isolated Controller Lower
62	LP Valve Limiter Open
63	LP Valve Limiter Close
64	Extr/Adm Setpoint Raise
65	Extr/Adm Setpoint Lower
66	Extr/Adm Control Enable
67	Extr/Adm Remote Setpoint Enable
68	Enable Manual Extr/Adm (P) Demand
69	Inlet Pressure Setpoint Raise
70	Inlet Pressure Setpoint Lower
71	Inlet Pressure Control Enable
72	Inlet Pressure Remote Setpoint Enable
73	Exhaust Pressure Setpoint Raise
74	Exhaust Pressure Setpoint Lower
75	Exhaust Pressure Control Enable
76	Exhaust Pressure Remote SP Enable
77	Select Priority
78	Enable Decoupling
79	Manual P Demand Raise
80	Manual P Demand Lower
81	VSI ID 3 is Healthy (DVP3)
82	VSI ID 4 is Healthy (DVP4)
83	VSI ID 5 is Healthy (DVP5)

Menu #	Function Selection
84	VSI ID 6 is Healthy (DVP6)
85	External Alarm 1
86	External Alarm 2
87	External Alarm 3
88	External Alarm 4
89	External Alarm 5
90	External Alarm 6
91	External Alarm 7
92	External Alarm 8
93	External Alarm 9
94	External Alarm 10
95	External Alarm 11
96	External Alarm 12
97	External Alarm 13
98	External Alarm 14
99	External Alarm 15
100	Spare_100

There are two menu tables for selecting Relay output functions – the first is related to a state or condition selection. The second table is if the relay is configured to act as a level switch based upon an analog value. The menu selects the analog value to use and the relay then will support ON/OFF levels related to this analog signal.

Conditional States

Table B-4. Selectable functions for Relay Output States

1	--- Not Used ---
2	Summary Shutdown
3	Summary Shutdown (Trip Relay)
4	Summary Alarm
5	All Alarms Clear
6	Control Status OK
7	Overspeed Trip
8	Overspeed Test Enabled
9	Speed PID in Control
10	Remote Speed Setpoint Enabled
11	Remote Speed Setpoint Active
12	Underspeed Switch
13	Auto Start Sequence Halted
14	On-Line Speed PID Dynamics Mode
15	Spare
16	Frequency Control Armed
17	Frequency Control
18	Sync Input Enabled

19	Sync / Loadshare Input Enabled
20	Loadshare Mode Active
21	Cascade Control Enabled
22	Cascade Control Active
23	Remote Cascade Setpoint Enabled
24	Remote Cascade Setpoint Active
25	Auxiliary Control Enabled
26	Auxiliary Control Active
27	Auxiliary PID in Control
28	Remote Auxiliary Setpoint Enabled
29	Remote Auxiliary Setpoint Active
30	Unit Started
31	SD/Reset VSII Driver #1 (DVP1)
32	SD/Reset VSII Driver #2 (DVP2)
33	SD/Reset VSI Driver #3 (DVP3)
34	SD/Reset VSI Driver #4 (DVP4)
35	HP Valve Limiter in Control
36	Command from Modbus BW addresse
37	Reset Pulse (2 sec)
38	Open GEN Breaker Cmd
39	Feed-Forward Enabled
40	Feed-Forward Active
41	Cascade PID in Control
42	Ready to Start
43	SD/Reset Remote Driver #1 (SPC11)
44	SD/Reset Remote Driver #2 (SPC12)
45	Unit OK (No SD)
46	Remote KW SP Enabled
47	Remote KW Setpoint Active
48	Manual Relay Control
49	Isolated Controller in Auto
50	LP Valve Limiter in Control
51	Extr/Adm Control Enabled
52	Extr/Adm Control Active
53	Extr/Adm PID In Control
54	Remote Extr/Adm Setpoint Enabled
55	Remote Extr/Adm Setpoint Active
56	Inlet Pressure Control Enabled
57	Inlet Pressure Control Active
58	Inlet Pressure PID In Control
59	Remote Inlet Pressure Setpoint Enabled
60	Remote Inlet Pressure Setpoint Active
61	Exhaust Pressure Control Enabled
62	Exhaust Pressure Control Active

63	Exhaust Pressure PID In Control
64	Remote Exhaust Pressure SP Enabled
65	Remote Exhaust Pressure SP Active
66	Priority Selected
67	Alternate Mode Enabled
68	Controlling on Steam Map Limiter
69	Priority Active
70	Extr/Adm Input Failed
71	Inlet Pressure Input Failed
72	Exhaust Pressure Input Failed
73	Zero Speed Detected
74	Select Unit B - HP on VS-DX
75	Select Unit B - LP on VS-DX
76	SD/Reset VSI Driver #5 (DVP5)
77	SD/Reset VSI Driver #6 (DVP6)
78	Spare_78
79	Spare_79
80	Spare_80

Level activated switch using this value:

Table B-5. Selectable functions for Relay Output Level switches

1	--- Not Used ---
2	Actual Speed
3	Speed Setpoint
4	KW Input
5	Sync/Load Share Input
6	Cascade Input
7	Cascade Setpoint
8	Auxiliary Input
9	Auxiliary Setpoint
10	LSS Value
11	HP Valve Demand
12	HP2 Valve Demand
13	HP Valve Limiter Setpoint
14	LP Valve Demand
15	LP Valve Limiter Setpoint
16	Inlet Pressure
17	Exhaust Pressure
18	Customer Signal 1 (Monitor)
19	Customer Signal 2 (Monitor)
20	Customer Signal 3 (Monitor)
21	Speed/Load Demand (S Demand)
22	Extr/Adm Input
23	Extr/Adm Setpoint
24	Ext/Adm Demand (P Demand)
25	Inlet Pressure Setpoint
26	Inlet Pressure Demand (Q Demand)
27	Exhaust Pressure Setpoint
28	Exhaust Pressure Demand (R Demand)
29	Spare_29
30	Spare_30
31	Spare_31
32	Spare_32
33	Spare_33
34	Spare_34
35	Spare_35

Appendix C.
Summary Alarm and Shutdown Lists

The following is a complete list of all possible Shutdown events in the system. The event ID of SD_xx that shows up in RemoteView equals the Event ID in this list.

Table C-1. SD_xx Event ID

Event ID	DESCRIPTION	MEANING
1	Power Up Trip	Control just powered-up or the Configuration mode was exited
2	Trip Cmd from RemoteView	Trip command received from RemoteView
3	Trip Command from Modbus	Modbus communication link trip was commanded
4	Normal Shutdown Complete	Controlled shutdown was performed and completed
5	Unit in Calibration Mode	Control is in Calibration Mode
6	Configuration Error	Control has a configuration error
7	Configuration Mode (IO Lock)	Control is in Configuration Mode (in IOLOCK)
8	SPARE_8	N/A
9	HP Ramp at Max/No Speed	HP Valve Limiter ramp is at Max but no speed is detected
10	spare_10	N/A
11	Overspeed	Turbine overspeed was sensed
12	All Speed Probes Failed	Loss of all speed probes was sensed
13	Overspeed Test Limit Reached	Speed Setpoint has reached Max Overspeed Test Limit
14	spare_14	N/A
15	spare_15	N/A
16	Tie Breaker Opened	Utility tie breaker was opened after it was closed
17	GEN Breaker Opened	Generator breaker was opened after it was closed
18	Aux Input Failed	Aux analog input failure detected (> 22 mA or < 2 mA)
19	Inlet Input Signal Failed	Inlet Pressure Input Signal failure detected (> 22 mA or < 2 mA)
20	Ext/Adm Input Signal Failed	Ext/Adm Pressure Input Signal failure detected (> 22 mA or < 2 mA)
21	Exhaust Input Signal Failed	Exhaust Pressure Input Signal failure detected (> 22 mA or < 2 mA)
22	spare_22	N/A
23	Inlet Stm Pressure Level2 TRIP	Inlet Steam Pressure passed trip level limit
24	EXH Stm Pressure Level2 TRIP	Exhaust Steam Pressure passed trip level limit
25	Selected PV 1 Level 2 TRIP	Customer Monitor Signal 1 passed trip level limit
26	Selected PV 2 Level 2 TRIP	Customer Monitor Signal 2 passed trip level limit

Event ID	DESCRIPTION	MEANING
27	Selected PV 3 Level 2 TRIP	Customer Monitor Signal 3 passed trip level limit
28	spare_28	N/A
29	spare_29	N/A
30	HP Actuator Fault	HP Actuator fault detected (an open or short circuit was sensed)
31	HP2 Actuator Fault	HP2 Actuator fault detected (an open or short circuit was sensed)
32	LP Actuator Fault	LP Actuator fault detected (an open or short circuit was sensed)
33	LP2 Actuator Fault	LP2 Actuator fault detected (an open or short circuit was sensed)
34	Tunable Trip	reserved for simulation use
35	Open Wire on MPUs (Flex only)	Open wires detected on all MPUs
36	spare_36	N/A
37	spare_37	N/A
38	spare_38	N/A
39	spare_39	N/A
40	spare_40	N/A
41	Reserved for Vertex SDs	N/A
42	spare_42	N/A
43	spare_43	N/A
44	spare_44	N/A
45	spare_45	N/A
46	spare_46	N/A
47	spare_47	N/A
48	spare_48	N/A
49	spare_49	N/A
50	spare_50	N/A
51	Main Chassis / OS Fault	Power lost or Main Chassis/OS Fault
52	All Speed/AIO Modules (slot 3) Failed	All Speed/AIO modules (slot A3) failed
53	All DIO Modules (slot 4) Failed	All DIO modules (slot A4) failed
54	All HDAIO Modules (slot 5) Failed	All HDAIO modules (slot A5) failed (option)
55	External Trip #1	External Trip (DI #1) contact input was opened
56	External Trip #2	External Trip #2 contact input was opened
57	External Trip #3	External Trip #3 contact input was opened
58	External Trip #4	External Trip #4 contact input was opened
59	External Trip #5	External Trip #5 contact input was opened
60	External Trip #6	External Trip #6 contact input was opened
61	External Trip #7	External Trip #7 contact input was opened
62	External Trip #8	External Trip #8 contact input was opened

Event ID	DESCRIPTION	MEANING
63	External Trip #9	External Trip #9 contact input was opened
64	External Trip #10	External Trip #10 contact input was opened
65	External Trip #11	External Trip #11 contact input was opened
66	External Trip #12	External Trip #12 contact input was opened
67	External Trip #13	External Trip #13 contact input was opened
68	External Trip #14	External Trip #14 contact input was opened
69	External Trip #15	External Trip #15 contact input was opened
70-80	Spare	

The following is a complete list of all possible Alarm events in the system. The event ID of ALM_xxx that shows up in RemoteView equals the Event ID in this list.

Table C-2. ALM_xxx Event ID

Event ID	Description
1	Internal HW Simulation Enabled
2	Mod Comm Link #1 Failed
3	Mod Comm Link #2 Failed
4	Mod Comm Link #3 Failed
5	Mod Comm Link #4 Failed
6	Start Perm Not Closed
7	Stuck In Critical Band
8	Start Temperature #1 Override Active
9	Start Temperature #2 Override Active
10	spare_10
11	Turbine Tripped
12	Overspeed ALM
13	Overspeed Test Enabled
14	Turbine Maintenance Interval Alm
15	spare_15
16	HP Valve Pos Fdbk Diff ALM
17	HP2 Valve Pos Fdbk Diff ALM
18	LP Valve Pos Fdbk Diff ALM
19	LP2 Valve Pos Fdbk Diff ALM
20	HP Valve Feedback Failed
21	HP2 Valve Feedback Failed
22	LP Valve Feedback Failed
23	LP2 Valve Feedback Failed
24	spare_24
25	Tunable Alarm
26	TIE Breaker Opened
27	GEN Breaker Opened
28	Tie Open / No Auxiliary
29	Gen Open / No Auxiliary

Event ID	Description
30	Tie Open / No Cascade
31	Gen Open / No Cascade
32	Tie Open / No Remote
33	Gen Open / No Remote
34	Tie Open / No Inlet
35	Gen Open / No Inlet
36	Tie Open / No Extraction
37	Gen Open / No Extraction
38	Tie Open / No Exhaust
39	Gen Open / No Exhaust
40	Limiter in Control
41	Pressure Compensation Curve Error
42	Actuator Linearization Curve Error
43	Alternate Mode Map Error
44	Speed Below Min - No Extraction
45	LP Lmtr->No Spd Cntl->Ratio Lmtr Dsbl
46	LP Actuator Linear Curve Error
47	Backup Gen Load AI Failed
48	spare_48
49	Comm Link to DSLC2 Failed
50	Comm Link to HiProtec Failed
51	Cascade Control Disabled AI Failed
52	AUX Control Disabled AI Failed
53	KW Load Droop Disabled AI Failed
54	Sync Input Failed
55	Remote Speed Input Failed
56	Remote Cascade Input Failed
57	Remote AUX Input Failed
58	Inlet Press Control Disabled AI Failed
59	Inlet Steam Pressure Lvl1 ALM
60	Inlet Steam Pressure Lvl2 ALM
61	Exh Steam Pressure Lvl1 ALM
62	Exh Steam Pressure Lvl2 ALM
63	Selected PV 1 Level 1 ALM
64	Selected PV 1 Level 2 ALM
65	Selected PV 2 Level 1 ALM
66	Selected PV 2 Level 2 ALM
67	Selected PV 3 Level 1 ALM
68	Selected PV 3 Level 2 ALM
69	spare_69
70	spare_70
71	spare_71
72	spare_72

Event ID	Description
73	Sync/LS Input Failed
74	Remote Droop Fault
75	Remote KW Setpoint Failed
76	Exhaust Press Control Disabled AI Fail
77	Feed-forward input failed
78	IH-A Input press AI FLT
79	IH-B Input press AI FLT
80	Ext/Adm Control Disabled AI Failed
81	Remote Extr/Adm SP Disabled AI Failed
82	Remote Manual P Disabled AI Failed
83	Remote Exhaust SP Disabled AI Failed
84	Remote Inlet SP Disabled AI Failed
85	spare_85
86	spare_86
87	Isolated PID Control Disabled AI Fail
88	Rem SP Isolated PID Failed
89	Temp for Hot/Cold Starts Failed
90	spare_90
91	spare_91
92	spare_92
93	spare_93
94	spare_94
95	spare_95
96	spare_96
97	spare_97
98	spare_98
99	spare_99
100	spare_100
101 - 199	Reserved for Vertex ALMs
200	Spare
201	Kernel A CPU Faulted
202	Kernel B CPU Faulted
203	Kernel C CPU Faulted
204	Kernel A High Temp Alarm
205	Kernel B High Temp Alarm
206	Kernel C High Temp Alarm
207	Power Supply #1 Fault
208	Power Supply #2 Fault
209	TMR CPU Voting Error
210	Kern A Module A03 Failed
211	Kern A Module A04 Failed
212	Kern A Module A05 Failed
213	Kern A Module A06 Failed

Event ID	Description
214	Kern B Module A03 Failed
215	Kern B Module A04 Failed
216	Kern B Module A05 Failed
217	Kern B Module A06 Failed
218	Kern C Module A03 Failed
219	Kern C Module A04 Failed
220	Kern C Module A05 Failed
221	Kern C Module A06 Failed
222	Spare
223	Spare
224	Redundant DI ESTOP Alarm
225	AI #01 Chan Fail Kern A Mod A03
226	AI #01 Chan Fail Kern B Mod A03
227	AI #01 Chan Fail Kern C Mod A03
228	AI #01 Chan Diff between Kernels
229	AI #01 Input Signal Failure
230	AI #02 Chan Fail Kern A Mod A03
231	AI #02 Chan Fail Kern B Mod A03
232	AI #02 Chan Fail Kern C Mod A03
233	AI #02 Chan Diff between Kernels
234	AI #02 Input Signal Failure
235	AI #03 Chan Fail Kern A Mod A03
236	AI #03 Chan Fail Kern B Mod A03
237	AI #03 Chan Fail Kern C Mod A03
238	AI #03 Chan Diff between Kernels
239	AI #03 Input Signal Failure
240	AI #04 Chan Fail Kern A Mod A03
241	AI #04 Chan Fail Kern B Mod A03
242	AI #04 Chan Fail Kern C Mod A03
243	AI #04 Chan Diff between Kernels
244	AI #04 Input Signal Failure
245	AI #05 Chan Fail Kern A Mod A03
246	AI #05 Chan Fail Kern B Mod A03
247	AI #05 Chan Fail Kern C Mod A03
248	AI #05 Chan Diff between Kernels
249	AI #05 Input Signal Failure
250	AI #06 Chan Fail Kern A Mod A03
251	AI #06 Chan Fail Kern B Mod A03
252	AI #06 Chan Fail Kern C Mod A03
253	AI #06 Chan Diff between Kernels
254	AI #06 Input Signal Failure
255	AI #07 Chan Fail Kern A Mod A03
256	AI #07 Chan Fail Kern B Mod A03

Event ID	Description
257	AI #07 Chan Fail Kern C Mod A03
258	AI #07 Chan Diff between Kernels
259	AI #07 Input Signal Failure
260	AI #08 Chan Fail Kern A Mod A03
261	AI #08 Chan Fail Kern B Mod A03
262	AI #08 Chan Fail Kern C Mod A03
263	AI #08 Chan Diff between Kernels
264	AI #08 Input Signal Failure
265	AI #09 Chan Fail Kern A Mod A03
266	AI #09 Chan Fail Kern B Mod A03
267	AI #09 Chan Fail Kern C Mod A03
268	AI #09 Chan Diff between Kernels
269	AI #09 Input Signal Failure
270	AI #10 Chan Fail Kern A Mod A03
271	AI #10 Chan Fail Kern B Mod A03
272	AI #10 Chan Fail Kern C Mod A03
273	AI #10 Chan Diff between Kernels
274	AI #10 Input Signal Failure
275	AI #11 Chan Fail Kern A Mod A03
276	AI #11 Chan Fail Kern B Mod A03
277	AI #11 Chan Fail Kern C Mod A03
278	AI #11 Chan Diff between Kernels
279	AI #11 Input Signal Failure
280	AI #12 Chan Fail Kern A Mod A03
281	AI #12 Chan Fail Kern B Mod A03
282	AI #12 Chan Fail Kern C Mod A03
283	AI #12 Chan Diff between Kernels
284	AI #12 Input Signal Failure
285	AI #13 Chan Fail Kern A Mod A05
286	AI #13 Chan Fail Kern B Mod A05
287	AI #13 Chan Fail Kern C Mod A05
288	AI #13 Chan Diff between Kernels
289	AI #13 Input Signal Failure
290	AI #14 Chan Fail Kern A Mod A05
291	AI #14 Chan Fail Kern B Mod A05
292	AI #14 Chan Fail Kern C Mod A05
293	AI #14 Chan Diff between Kernels
294	AI #14 Input Signal Failure
295	AI #15 Chan Fail Kern A Mod A05
296	AI #15 Chan Fail Kern B Mod A05
297	AI #15 Chan Fail Kern C Mod A05
298	AI #15 Chan Diff between Kernels
299	AI #15 Input Signal Failure

Event ID	Description
300	AI #16 Chan Fail Kern A Mod A05
301	AI #16 Chan Fail Kern B Mod A05
302	AI #16 Chan Fail Kern C Mod A05
303	AI #16 Chan Diff between Kernels
304	AI #16 Input Signal Failure
305	AI #17 Chan Fail Kern A Mod A05
306	AI #17 Chan Fail Kern B Mod A05
307	AI #17 Chan Fail Kern C Mod A05
308	AI #17 Chan Diff between Kernels
309	AI #17 Input Signal Failure
310	AI #18 Chan Fail Kern A Mod A05
311	AI #18 Chan Fail Kern B Mod A05
312	AI #18 Chan Fail Kern C Mod A05
313	AI #18 Chan Diff between Kernels
314	AI #18 Input Signal Failure
315	AI #19 Chan Fail Kern A Mod A05
316	AI #19 Chan Fail Kern B Mod A05
317	AI #19 Chan Fail Kern C Mod A05
318	AI #19 Chan Diff between Kernels
319	AI #19 Input Signal Failure
320	AI #20 Chan Fail Kern A Mod A05
321	AI #20 Chan Fail Kern B Mod A05
322	AI #20 Chan Fail Kern C Mod A05
323	AI #20 Chan Diff between Kernels
324	AI #20 Input Signal Failure
325	AI #21 Chan Fail Kern A Mod A05
326	AI #21 Chan Fail Kern B Mod A05
327	AI #21 Chan Fail Kern C Mod A05
328	AI #21 Chan Diff between Kernels
329	AI #21 Input Signal Failure
330	AI #22 Chan Fail Kern A Mod A05
331	AI #22 Chan Fail Kern B Mod A05
332	AI #22 Chan Fail Kern C Mod A05
333	AI #22 Chan Diff between Kernels
334	AI #22 Input Signal Failure
335	AI #23 Chan Fail Kern A Mod A05
336	AI #23 Chan Fail Kern B Mod A05
337	AI #23 Chan Fail Kern C Mod A05
338	AI #23 Chan Diff between Kernels
339	AI #23 Input Signal Failure
340	AI #24 Chan Fail Kern A Mod A05
341	AI #24 Chan Fail Kern B Mod A05
342	AI #24 Chan Fail Kern C Mod A05

Event ID	Description
343	AI #24 Chan Diff between Kernels
344	AI #24 Input Signal Failure
345	AI #25 Chan Fail Kern A Mod A05
346	AI #25 Chan Fail Kern B Mod A05
347	AI #25 Chan Fail Kern C Mod A05
348	AI #25 Chan Diff between Kernels
349	AI #25 Input Signal Failure
350	AI #26 Chan Fail Kern A Mod A05
351	AI #26 Chan Fail Kern B Mod A05
352	AI #26 Chan Fail Kern C Mod A05
353	AI #26 Chan Diff between Kernels
354	AI #26 Input Signal Failure
355	AI #27 Chan Fail Kern A Mod A05
356	AI #27 Chan Fail Kern B Mod A05
357	AI #27 Chan Fail Kern C Mod A05
358	AI #27 Chan Diff between Kernels
359	AI #27 Input Signal Failure
360	AI #28 Chan Fail Kern A Mod A05
361	AI #28 Chan Fail Kern B Mod A05
362	AI #28 Chan Fail Kern C Mod A05
363	AI #28 Chan Diff between Kernels
364	AI #28 Input Signal Failure
365	AI #29 Chan Fail Kern A Mod A05
366	AI #29 Chan Fail Kern B Mod A05
367	AI #29 Chan Fail Kern C Mod A05
368	AI #29 Chan Diff between Kernels
369	AI #29 Input Signal Failure
370	AI #30 Chan Fail Kern A Mod A05
371	AI #30 Chan Fail Kern B Mod A05
372	AI #30 Chan Fail Kern C Mod A05
373	AI #30 Chan Diff between Kernels
374	AI #30 Input Signal Failure
375	AI #31 Chan Fail Kern A Mod A05
376	AI #31 Chan Fail Kern B Mod A05
377	AI #31 Chan Fail Kern C Mod A05
378	AI #31 Chan Diff between Kernels
379	AI #31 Input Signal Failure
380	AI #32 Chan Fail Kern A Mod A05
381	AI #32 Chan Fail Kern B Mod A05
382	AI #32 Chan Fail Kern C Mod A05
383	AI #32 Chan Diff between Kernels
384	AI #32 Input Signal Failure
385	AI #33 Chan Fail Kern A Mod A05

Event ID	Description
386	AI #33 Chan Fail Kern B Mod A05
387	AI #33 Chan Fail Kern C Mod A05
388	AI #33 Chan Diff between Kernels
389	AI #33 Input Signal Failure
390	AI #34 Chan Fail Kern A Mod A05
391	AI #34 Chan Fail Kern B Mod A05
392	AI #34 Chan Fail Kern C Mod A05
393	AI #34 Chan Diff between Kernels
394	AI #34 Input Signal Failure
395	AI #35 Chan Fail Kern A Mod A05
396	AI #35 Chan Fail Kern B Mod A05
397	AI #35 Chan Fail Kern C Mod A05
398	AI #35 Chan Diff between Kernels
399	AI #35 Input Signal Failure
400	AI #36 Chan Fail Kern A Mod A05
401	AI #36 Chan Fail Kern B Mod A05
402	AI #36 Chan Fail Kern C Mod A05
403	AI #36 Chan Diff between Kernels
404	AI #36 Input Signal Failure
405	AO #1 Chan Fail Kern A
406	AO #1 Chan Fail Kern B
407	AO #1 Chan Fail Kern C
408	AO #1 No Load Detected
409	AO #1 Chan Fail All Kernels
410	AO #2 Chan Fail Kern A
411	AO #2 Chan Fail Kern B
412	AO #2 Chan Fail Kern C
413	AO #2 No Load Detected
414	AO #2 Chan Fail All Kernels
415	AO #3 Chan Fail Kern A
416	AO #3 Chan Fail Kern B
417	AO #3 Chan Fail Kern C
418	AO #3 No Load Detected
419	AO #3 Chan Fail All Kernels
420	AO #4 Chan Fail Kern A
421	AO #4 Chan Fail Kern B
422	AO #4 Chan Fail Kern C
423	AO #4 No Load Detected
424	AO #4 Chan Fail All Kernels
425	AO #5 Chan Fail Kern A
426	AO #5 Chan Fail Kern B
427	AO #5 Chan Fail Kern C
428	AO #5 No Load Detected

Event ID	Description
429	AO #5 Chan Fail All Kernels
430	AO #6 Chan Fail Kern A
431	AO #6 Chan Fail Kern B
432	AO #6 Chan Fail Kern C
433	AO #6 No Load Detected
434	AO #6 Chan Fail All Kernels
435	AO #7 Chan Fail Kern A
436	AO #7 Chan Fail Kern B
437	AO #7 Chan Fail Kern C
438	AO #7 No Load Detected
439	AO #7 Chan Fail All Kernels
440	AO #8 Chan Fail Kern A
441	AO #8 Chan Fail Kern B
442	AO #8 Chan Fail Kern C
443	AO #8 No Load Detected
444	AO #8 Chan Fail All Kernels
445	AO #9 Chan Fail Kern A
446	AO #9 Chan Fail Kern B
447	AO #9 Chan Fail Kern C
448	AO #9 No Load Detected
449	AO #9 Chan Fail All Kernels
450	AO #10 Chan Fail Kern A
451	AO #10 Chan Fail Kern B
452	AO #10 Chan Fail Kern C
453	AO #10 No Load Detected
454	AO #10 Chan Fail All Kernels
455	AO #11 Chan Fail Kern A
456	AO #11 Chan Fail Kern B
457	AO #11 Chan Fail Kern C
458	AO #11 No Load Detected
459	AO #11 Chan Fail All Kernels
460	AO #12 Chan Fail Kern A
461	AO #12 Chan Fail Kern B
462	AO #12 Chan Fail Kern C
463	AO #12 No Load Detected
464	AO #12 Chan Fail All Kernels
425	AO #5 Chan Fail Kern A
426	AO #5 Chan Fail Kern B
427	AO #5 Chan Fail Kern C
428	AO #5 No Load Detected
429	AO #5 Chan Fail All Kernels
430	AO #6 Chan Fail Kern A
431	AO #6 Chan Fail Kern B

Event ID	Description
432	AO #6 Chan Fail Kern C
433	AO #6 No Load Detected
434	AO #6 Chan Fail All Kernels
435	AO #7 Chan Fail Kern A
436	AO #7 Chan Fail Kern B
437	AO #7 Chan Fail Kern C
438	AO #7 No Load Detected
439	AO #7 Chan Fail All Kernels
440	AO #8 Chan Fail Kern A
441	AO #8 Chan Fail Kern B
442	AO #8 Chan Fail Kern C
443	AO #8 No Load Detected
444	AO #8 Chan Fail All Kernels
445	AO #9 Chan Fail Kern A
446	AO #9 Chan Fail Kern B
447	AO #9 Chan Fail Kern C
448	AO #9 No Load Detected
448	AO #9 No Load Detected
449	AO #9 Chan Fail All Kernels
450	AO #10 Chan Fail Kern A
451	AO #10 Chan Fail Kern B
452	AO #10 Chan Fail Kern C
453	AO #10 No Load Detected
454	AO #10 Chan Fail All Kernels
455	AO #11 Chan Fail Kern A
456	AO #11 Chan Fail Kern B
457	AO #11 Chan Fail Kern C
458	AO #11 No Load Detected
459	AO #11 Chan Fail All Kernels
460	AO #12 Chan Fail Kern A
461	AO #12 Chan Fail Kern B
462	AO #12 Chan Fail Kern C
463	AO #12 No Load Detected
464	AO #12 Chan Fail All Kernels
465	Spare
466	DI #1 Chan Fail Kern A
467	DI #1 Chan Fail Kern B
468	DI #1 Chan Fail Kern C
469	DI #2 Chan Fail Kern A
470	DI #2 Chan Fail Kern B
471	DI #2 Chan Fail Kern C
472	DI #3 Chan Fail Kern A
473	DI #3 Chan Fail Kern B

Event ID	Description
474	DI #3 Chan Fail Kern C
475	DI #4 Chan Fail Kern A
476	DI #4 Chan Fail Kern B
477	DI #4 Chan Fail Kern C
478	DI #5 Chan Fail Kern A
479	DI #5 Chan Fail Kern B
480	DI #5 Chan Fail Kern C
481	DI #6 Chan Fail Kern A
482	DI #6 Chan Fail Kern B
483	DI #6 Chan Fail Kern C
484	DI #7 Chan Fail Kern A
485	DI #7 Chan Fail Kern B
486	DI #7 Chan Fail Kern C
487	DI #8 Chan Fail Kern A
488	DI #8 Chan Fail Kern B
489	DI #8 Chan Fail Kern C
490	DI #9 Chan Fail Kern A
491	DI #9 Chan Fail Kern B
492	DI #9 Chan Fail Kern C
493	DI #10 Chan Fail Kern A
494	DI #10 Chan Fail Kern B
495	DI #10 Chan Fail Kern C
496	DI #11 Chan Fail Kern A
497	DI #11 Chan Fail Kern B
498	DI #11 Chan Fail Kern C
499	DI #12 Chan Fail Kern A
500	DI #12 Chan Fail Kern B
501	DI #12 Chan Fail Kern C
502	DI #13 Chan Fail Kern A
503	DI #13 Chan Fail Kern B
504	DI #13 Chan Fail Kern C
505	DI #14 Chan Fail Kern A
506	DI #14 Chan Fail Kern B
507	DI #14 Chan Fail Kern C
508	DI #15 Chan Fail Kern A
509	DI #15 Chan Fail Kern B
510	DI #15 Chan Fail Kern C
511	DI #16 Chan Fail Kern A
512	DI #16 Chan Fail Kern B
513	DI #16 Chan Fail Kern C
514	DI #17 Chan Fail Kern A
515	DI #17 Chan Fail Kern B
516	DI #17 Chan Fail Kern C

Event ID	Description
517	DI #18 Chan Fail Kern A
518	DI #18 Chan Fail Kern B
519	DI #18 Chan Fail Kern C
520	DI #19 Chan Fail Kern A
521	DI #19 Chan Fail Kern B
522	DI #19 Chan Fail Kern C
523	DI #20 Chan Fail Kern A
524	DI #20 Chan Fail Kern B
525	DI #20 Chan Fail Kern C
526	DI #21 Chan Fail Kern A
527	DI #21 Chan Fail Kern B
528	DI #21 Chan Fail Kern C
529	DI #22 Chan Fail Kern A
530	DI #22 Chan Fail Kern B
531	DI #22 Chan Fail Kern C
532	DI #23 Chan Fail Kern A
533	DI #23 Chan Fail Kern B
534	DI #23 Chan Fail Kern C
535	DI #24 Chan Fail Kern A
536	DI #24 Chan Fail Kern B
537	DI #24 Chan Fail Kern C
538	Speed Chan #1 Fail Kern A
539	Speed Chan #1 Fail Kern B
540	Speed Chan #1 Fail Kern C
541	Speed Signal Input Chan #1 Failed
542	Speed Chan #2 Fail Kern A
543	Speed Chan #2 Fail Kern B
544	Speed Chan #2 Fail Kern C
545	Speed Signal Input Chan #2 Failed
546	Speed Chan #3 Fail Kern A
547	Speed Chan #3 Fail Kern B
548	Speed Chan #3 Fail Kern C
549	Speed Signal Input Chan #3 Failed
550	Speed Chan #4 Fail Kern A
551	Speed Chan #4 Fail Kern B
552	Speed Chan #4 Fail Kern C
553	Speed Signal Input Chan #4 Failed
554	Speed Signal #1 Difference ALM
555	Speed Signal #2 Difference ALM
556	Speed Signal #3 Difference ALM
557	FT Relay #1 Summary Fault
558	FT Relay #2 Summary Fault
559	FT Relay #3 Summary Fault

Event ID	Description
560	FT Relay #4 Summary Fault
561	FT Relay #5 Summary Fault
562	FT Relay #6 Summary Fault
563	FT Relay #7 Summary Fault
564	FT Relay #8 Summary Fault
565	FT Relay #9 Summary Fault
566	FT Relay #10 Summary Fault
567	FT Relay #11 Summary Fault
568	FT Relay #12 Summary Fault
569	External Alarm #1
570	External Alarm #2
571	External Alarm #3
572	External Alarm #4
573	External Alarm #5
574	External Alarm #6
575	External Alarm #7
576	External Alarm #8
577	External Alarm #9
578	External Alarm #10
579	External Alarm #11
580	External Alarm #12
581	External Alarm #13
582	External Alarm #14
583	External Alarm #15
584	Kernel B CAN Port 2 Fault
585	Kernel C CAN Port 2 Fault
586	Kern A Mod5 Chan1 Fault
587	Kern A Mod5 Chan2 Fault
588	Kern A Mod6 Chan1 Fault
589	Kern A Mod6 Chan2 Fault
590	Kern B Mod5 Chan1 Fault
591	Kern B Mod5 Chan2 Fault
592	Kern B Mod6 Chan1 Fault
593	Kern B Mod6 Chan2 Fault
594	Kern C Mod5 Chan1 Fault
595	Kern C Mod5 Chan2 Fault
596	Kern C Mod6 Chan1 Fault
597	Kern C Mod6 Chan2 Fault
598	Spare
599	Diff ALM on Redun RmtSpd Setpt inputs
600	Spare
601	Diff ALM on Redun GEN Load inputs
602	Spare

Event ID	Description
603	Diff ALM on Redun Cascade inputs
604	Spare
605	Diff ALM on Redun Auxiliary inputs
606	Spare
607	Diff ALM on Redun Inlet Press inputs
608	Spare
609	Diff ALM on Redun Exhaust Press inputs
610	Spare
611	Diff ALM on Redun Ext/Adm Press inputs
612	Spare
613	Spare
614	Spare
615	HP Valve - Dual Coil A Fault
616	HP Valve - Dual Coil B Fault
617	HP Redun Act - A Fault
618	HP Redun Act - B Fault
619	HP Dmd - SPC11 Fault
620	HP Dmd - AO Backup to SPC11 Fault
621	HP Dmd - SPC21 Fault
622	HP Dmd - AO Backup to SPC12 Fault
623	LP Valve - Dual Coil A Fault
624	LP Valve - Dual Coil B Fault
625	LP Redun Act - A Fault
626	LP Redun Act - B Fault
627	LP Dmd - SPC12 Fault
628	LP Dmd - AO Backup to SPC12 Fault
629	LP Dmd - SPC11 Fault
630	LP Dmd - AO Backup to SPC11 Fault
631	SPC11 Summary Alarm
632	SPC12 Summary Alarm
633	VSII ID 1 Summary Alarm
634	VSII ID 2 Summary Alarm
635	HP2 Valve Fault – Alarm
636	LP Valve Fault – Alarm
637	LP2 Valve Fault - Alarm
638	HP Valve Fault - Alarm
639 - 650	Spare

Appendix D
Modbus Address List

Below is the complete list of all programmed Modbus addresses in the base product. It is possible that additional addresses may be added to these lists on certain systems.

Table D-1. Boolean Write Addresses

Addr	Description	Addr	Description
0:0001	Emergency Shutdown	0:0071	* Disable Droop Setpoint change
0:0002	Emergency Shutdown Acknowledge	0:0072	* Enable Speed Fowarding
0:0003	Controlled Shutdown	0:0073	* Disable Speed Fowarding
0:0004	Abort Controlled Shutdown	0:0074	Spare 74
0:0005	System Reset	0:0075	Spare 75
0:0006	Start / Run	0:0076	Spare 76
0:0007	Manual Open VLV Limiter	0:0077	Spare 77
0:0008	Manual Close VLV Limiter	0:0078	Spare 78
0:0009	Lower Speed Setpoint	0:0079	Spare 79
0:0010	Raise Speed Setpoint	0:0080	Spare 80
0:0011	Go To Rated (Idle / Rated)	0:0081	Enable Inlet Control
0:0012	Go To Idle (Idle / Rated)	0:0082	Disable Inlet Control
0:0013	Halt Auto Start Seq	0:0083	Lower Inlet Setpoint
0:0014	Continue Auto Start Seq	0:0084	Raise Inlet Setpoint
0:0015	Enable Remote Speed Setpoint Control	0:0085	Enable Remote Inlet Setpoint Control
0:0016	Disable Remote Speed Setpoint Control	0:0086	Disable Remote Inlet Setpoint Control
0:0017	Go To Modbus Entered Speed Setpt	0:0087	Go To Modbus Entered Inlet Setpt
0:0018	Spare_18	0:0088	Enable Remote KW Setpoint Control
0:0019	Arm Frequency Control	0:0089	Disable Remote KW Setpoint Control
0:0020	Disarm Frequency Control	0:0090	Isolated Controller SP Raise
0:0021	Sync Enable	0:0091	Isolated Controller SP Lower
0:0022	Sync Disable	0:0092	Select Hot Start
0:0023	Enable Cascade Control	0:0093	Select Cold Start
0:0024	Disable Cascade Control	0:0094	Spare 94
0:0025	Lower Cascade Setpoint	0:0095	Spare 95
0:0026	Raise Cascade Setpoint	0:0096	Spare 96
0:0027	Enable Remote Cascade Setpoint Control	0:0097	Enable Exhaust Control
0:0028	Disable Remote Cascade Setpoint Control	0:0098	Disable Exhaust Control
0:0029	Go To Modbus Entered Cascade Setpt	0:0099	Lower Exhaust Setpoint
0:0030	Spare_30	0:0100	Raise Exhaust Setpoint
0:0031	Enable Aux Control	0:0101	Enable Remote Exhaust Setpoint Control
0:0032	Disable Aux Control	0:0102	Disable Remote Exhaust Setpoint Control
0:0033	Lower Aux Setpoint	0:0103	Go To Modbus Entered Exhaust Setpt
0:0034	Raise Aux Setpoint	0:0104	Request Alternate Mode Transfer
0:0035	Enable Remote Aux Setpoint Control	0:0105	Mode 0 Request
0:0036	Disable Remote Aux Setpoint Control	0:0106	Enable Manual P Demand
0:0037	Go To Modbus Entered Auxiliary Setpt	0:0107	Disable Manual P Control
0:0038	Spare_38	0:0108	Spare 108
0:0039	Spare_39	0:0109	Lower Manual P Setpoint
0:0040	Spare_40	0:0110	Raise Manual P Setpoint
0:0041	Spare_41	0:0111	Enable Remote Manual P Setpoint Control

Addr	Description	Addr	Description
0:0042	Modbus Alarm/SD Acknowledge	0:0112	Disable Remote Manual P Setpoint Control
0:0043	Momentarily Energize Relay 2	0:0113	Go To Modbus Entered Manual P Setpt
0:0044	Momentarily Energize Relay 3	0:0114	Energize Relay 2
0:0045	Momentarily Energize Relay 4	0:0115	De-Energize Relay 2
0:0046	Momentarily Energize Relay 5	0:0116	Energize Relay 3
0:0047	Momentarily Energize Relay 6	0:0117	De-Energize Relay 3
0:0048	Momentarily Energize Relay 7	0:0118	Energize Relay 4
0:0049	Momentarily Energize Relay 8	0:0119	De-Energize Relay 4
0:0050	Momentarily Energize Relay 9	0:0120	Energize Relay 5
0:0051	Momentarily Energize Relay 10	0:0121	De-Energize Relay 5
0:0052	Momentarily Energize Relay 11	0:0122	Energize Relay 6
0:0053	Momentarily Energize Relay 12	0:0123	De-Energize Relay 6
0:0054	Spare_54	0:0124	Energize Relay 7
0:0055	Spare_55	0:0125	De-Energize Relay 7
0:0056	Synchronize TOD Clock	0:0126	Energize Relay 8
0:0057	Enable Extraction Control	0:0127	De-Energize Relay 8
0:0058	Disable Extraction Control	0:0128	Energize Relay 9
0:0059	Lower Extraction Setpoint	0:0129	De-Energize Relay 9
0:0060	Raise Extraction Setpoint	0:0130	Energize Relay 10
0:0061	Enable Remote Extr Setpoint Control	0:0131	De-Energize Relay 10
0:0062	Disable Remote Extr Setpoint Control	0:0132	Energize Relay 11
0:0063	Go To Modbus Entered Extraction Setpt	0:0133	De-Energize Relay 11
0:0064	Open LP Valve Limiter	0:0134	Energize Relay 12
0:0065	Close LP Valve Limiter	0:0135	De-Energize Relay 12
0:0066	Decrease Extr/Adm Demand	0:0136	Isolated Control 2nd Ext Cntrl Enable
0:0067	Increase Extr/Adm Demand	0:0137	Isolated Control 2nd Ext Cntrl Disable
0:0068	Enable Extr/Adm Priority	0:0138	Isolated Control Limiter Raise
0:0069	Disable Extr/Adm Priority	0:0139	Isolated Control Limiter Lower
0:0070	* Enable Droop Setpoint change	0:0140	Isolated Control Manual Enable
		0:0141	Isolated Control Auto Enable
		0:0142	Isolated Control Manual Raise
		0:0143	Isolated Control Manual Lower

Table D-2. Boolean Read Addresses

Addr	Description	Addr	Description
1:0001	Shutdown Exists (Trip Indication)	1:0444	Kern C Module A06 Failed
1:0002	Summary Alarm Exists	1:0445	LinkNet IO Summary Alarm
1:0003	Modbus ESD Acknowledge Enable	1:0446	spare_223
1:0004	Moving to Min Setpoint	1:0447	Redundant DI ESTOP Alarm
1:0005	Ramping to Idle (Idle / Rated)	1:0448	AI #01 Chan Fail Kern A Mod A03
1:0006	Idle / Rated at Idle	1:0449	AI #01 Chan Fail Kern B Mod A03
1:0007	Ramping to Rated (Idle / Rated)	1:0450	AI #01 Chan Fail Kern C Mod A03
1:0008	At Rated	1:0451	AI #01 Chan Diff between Kernels
1:0009	Auto Seq - Setpt at Idle 1	1:0452	AI #01 Input Signal Failure
1:0010	Auto Seq - Ramp to Idle 2	1:0453	AI #02 Chan Fail Kern A Mod A03
1:0011	Auto Seq - Setpt at Idle 2	1:0454	AI #02 Chan Fail Kern B Mod A03
1:0012	Auto Seq - Ramp to rated	1:0455	AI #02 Chan Fail Kern C Mod A03
1:0013	Auto Seq - At Rated	1:0456	AI #02 Chan Diff between Kernels
1:0014	Speed PID In Control	1:0457	AI #02 Input Signal Failure

Addr	Description	Addr	Description
1:0015	Speed Sensor 1 Failed Overide ON	1:0458	AI #03 Chan Fail Kern A Mod A03
1:0016	Speed Sensor 2 Failed Overide ON	1:0459	AI #03 Chan Fail Kern B Mod A03
1:0017	Overspeed Test Permissive	1:0460	AI #03 Chan Fail Kern C Mod A03
1:0018	Overspeed Test In progress	1:0461	AI #03 Chan Diff between Kernels
1:0019	Speed At or above Min Gov	1:0462	AI #03 Input Signal Failure
1:0020	Turbine In Critical Speed Band	1:0463	AI #04 Chan Fail Kern A Mod A03
1:0021	Remote Speed Setpt Is Enabled	1:0464	AI #04 Chan Fail Kern B Mod A03
1:0022	Remote Speed Setpt Is Active	1:0465	AI #04 Chan Fail Kern C Mod A03
1:0023	Remote Speed Setpt Is In Control	1:0466	AI #04 Chan Diff between Kernels
1:0024	Remote Speed Setpt Is Inhibited	1:0467	AI #04 Input Signal Failure
1:0025	Speed PID In Control (not being Imted)	1:0468	AI #05 Chan Fail Kern A Mod A03
1:0026	Auto Seq - at idle 3	1:0469	AI #05 Chan Fail Kern B Mod A03
1:0027	Spare	1:0470	AI #05 Chan Fail Kern C Mod A03
1:0028	Generator Breaker Closed	1:0471	AI #05 Chan Diff between Kernels
1:0029	Utility Tie Breaker Closed	1:0472	AI #05 Input Signal Failure
1:0030	Synchronizing Rate Selected	1:0473	AI #06 Chan Fail Kern A Mod A03
1:0031	Synchronizing Is Enabled	1:0474	AI #06 Chan Fail Kern B Mod A03
1:0032	Sync or Load Share Is In Control	1:0475	AI #06 Chan Fail Kern C Mod A03
1:0033	Sync / Load Share Is Inhibitied	1:0476	AI #06 Chan Diff between Kernels
1:0034	Spare	1:0477	AI #06 Input Signal Failure
1:0035	Frequency Control Armed	1:0478	AI #07 Chan Fail Kern A Mod A03
1:0036	Frequency Control	1:0479	AI #07 Chan Fail Kern B Mod A03
1:0037	Reset	1:0480	AI #07 Chan Fail Kern C Mod A03
1:0038	Cascade Is Enabled	1:0481	AI #07 Chan Diff between Kernels
1:0039	Cascade Is Active	1:0482	AI #07 Input Signal Failure
1:0040	Cascade Is In Control	1:0483	AI #08 Chan Fail Kern A Mod A03
1:0041	Cascade Is Inhibited	1:0484	AI #08 Chan Fail Kern B Mod A03
1:0042	Rmt Cascade Is Enabled	1:0485	AI #08 Chan Fail Kern C Mod A03
1:0043	Rmt Cascade Is Active	1:0486	AI #08 Chan Diff between Kernels
1:0044	Rmt Cascade Is In Control	1:0487	AI #08 Input Signal Failure
1:0045	Rmt Cascade Is Inhibited	1:0488	AI #09 Chan Fail Kern A Mod A03
1:0046	IH Configured	1:0489	AI #09 Chan Fail Kern B Mod A03
1:0047	Auxiliary Is Enabled	1:0490	AI #09 Chan Fail Kern C Mod A03
1:0048	Auxiliary Is Active	1:0491	AI #09 Chan Diff between Kernels
1:0049	Auxiliary Is In Control	1:0492	AI #09 Input Signal Failure
1:0050	Aux Active / Not Limiting	1:0493	AI #10 Chan Fail Kern A Mod A03
1:0051	Aux Active / Not In Control	1:0494	AI #10 Chan Fail Kern B Mod A03
1:0052	Auxiliary is Inhibited	1:0495	AI #10 Chan Fail Kern C Mod A03
1:0053	Remote Aux Is Enabled	1:0496	AI #10 Chan Diff between Kernels
1:0054	Remote Aux Is Active	1:0497	AI #10 Input Signal Failure
1:0055	Rmt Aux Is In Control	1:0498	AI #11 Chan Fail Kern A Mod A03
1:0056	Rmt Aux Is Inhibited	1:0499	AI #11 Chan Fail Kern B Mod A03

Addr	Description	Addr	Description
1:0057	Startup Complete	1:0500	AI #11 Chan Fail Kern C Mod A03
1:0058	Extraction Is Enabled	1:0501	AI #11 Chan Diff between Kernels
1:0059	Extraction Is Active	1:0502	AI #11 Input Signal Failure
1:0060	Extraction Is In Control	1:0503	AI #12 Chan Fail Kern A Mod A03
1:0061	Extraction is Inhibited	1:0504	AI #12 Chan Fail Kern B Mod A03
1:0062	Remote Extraction Is Enabled	1:05009XT	AI #12 Chan Fail Kern C Mod A03
1:0063	Remote Extraction Is Active	1:0506	AI #12 Chan Diff between Kernels
1:0064	Rmt Extraction Is In Control	1:0507	AI #12 Input Signal Failure
1:0065	Rmt Extraction Is Inhibited	1:0508	AI #13 Chan Fail Kern A Mod A05
1:0066	Pressure Priority Enabled	1:0509	AI #13 Chan Fail Kern B Mod A05
1:0067	Pressure Priority Active	1:0510	AI #13 Chan Fail Kern C Mod A05
1:0068	Speed Priority Active	1:0511	AI #13 Chan Diff between Kernels
1:0069	Priority Transfer Permissible	1:0512	AI #13 Input Signal Failure
1:0070	* Auto seq:ramp to Idle3	1:0513	AI #14 Chan Fail Kern A Mod A05
1:0071	Controlled Stop In Progress	1:0514	AI #14 Chan Fail Kern B Mod A05
1:0072	LP Valve Limiter Is Open	1:0515	AI #14 Chan Fail Kern C Mod A05
1:0073	LP Valve Limiter Is Closed	1:0516	AI #14 Chan Diff between Kernels
1:0074	LP Valve Limiter In Control	1:0517	AI #14 Input Signal Failure
1:0075	HP Valve Limiter Is Open	1:0518	AI #15 Chan Fail Kern A Mod A05
1:0076	HP Valve Limiter Is Closed	1:0519	AI #15 Chan Fail Kern B Mod A05
1:0077	HP Valve Limiter In Control	1:0520	AI #15 Chan Fail Kern C Mod A05
1:0078		1:0521	AI #15 Chan Diff between Kernels
1:0079	MODBUS Active	1:0522	AI #15 Input Signal Failure
1:0080	Start Permissive	1:0523	AI #16 Chan Fail Kern A Mod A05
1:0081	At Steam Map Limit	1:0524	AI #16 Chan Fail Kern B Mod A05
1:0082	At Min Press Limit	1:0525	AI #16 Chan Fail Kern C Mod A05
1:0083	At HP MAX Limit	1:0526	AI #16 Chan Diff between Kernels
1:0084	At HP MIN Limit	1:0527	AI #16 Input Signal Failure
1:0085	At LP MAX Limit	1:0528	AI #17 Chan Fail Kern A Mod A05
1:0086	At LP MIN Limit	1:0529	AI #17 Chan Fail Kern B Mod A05
1:0087	At Max Power Limit	1:0530	AI #17 Chan Fail Kern C Mod A05
1:0088	At Max Press Limit	1:0531	AI #17 Chan Diff between Kernels
1:0089	Ready to Start	1:0532	AI #17 Input Signal Failure
1:0090	Start Initiated	1:0533	AI #18 Chan Fail Kern A Mod A05
1:0091	Unit Started / Above Idle	1:0534	AI #18 Chan Fail Kern B Mod A05
1:0092	Aux Controller Configured	1:0535	AI #18 Chan Fail Kern C Mod A05
1:0093	Sync Function Configured	1:0536	AI #18 Chan Diff between Kernels
1:0094	Modbus- ESD Control Configured	1:0537	AI #18 Input Signal Failure
1:0095	Manual Start Configured	1:0538	AI #19 Chan Fail Kern A Mod A05
1:0096	Auto Start Configured	1:0539	AI #19 Chan Fail Kern B Mod A05
1:0097	Semi-Auto Start Configured	1:0540	AI #19 Chan Fail Kern C Mod A05
1:0098	Idle/Rated Start Configured	1:0541	AI #19 Chan Diff between Kernels
1:0099	Auto Start Sequence Configured	1:0542	AI #19 Input Signal Failure

Addr	Description	Addr	Description
1:0100	Inlet Pressure Configured	1:0543	AI #20 Chan Fail Kern A Mod A05
1:0101	Remote Control Configured	1:0544	AI #20 Chan Fail Kern B Mod A05
1:0102	Loadsharing Configured	1:0545	AI #20 Chan Fail Kern C Mod A05
1:0103	HP2 Configured	1:0546	AI #20 Chan Diff between Kernels
1:0104	Gen Set Configured	1:0547	AI #20 Input Signal Failure
1:0105	Cascade Control Configured	1:0548	AI #21 Chan Fail Kern A Mod A05
1:0106	Remote Cascade Configured	1:0549	AI #21 Chan Fail Kern B Mod A05
1:0107	Aux Control Configured	1:0550	AI #21 Chan Fail Kern C Mod A05
1:0108	Remote Aux Configured	1:0551	AI #21 Chan Diff between Kernels
1:0109	Enables Mod Port1 In Local	1:0552	AI #21 Input Signal Failure
1:0110	Start Permissive Configured	1:0553	AI #22 Chan Fail Kern A Mod A05
1:0111	Frequency Arm/Disarm Configured	1:0554	AI #22 Chan Fail Kern B Mod A05
1:0112	Frequency Control Configured	1:0555	AI #22 Chan Fail Kern C Mod A05
1:0113	MPU 2 Configured	1:0556	AI #22 Chan Diff between Kernels
1:0114	Local/Remote Configured	1:0557	AI #22 Input Signal Failure
1:0115	Local Trip Enabled	1:0558	AI #23 Chan Fail Kern A Mod A05
1:0116	Casc Tracking Configured	1:0559	AI #23 Chan Fail Kern B Mod A05
1:0117	KW Signal OK	1:0560	AI #23 Chan Fail Kern C Mod A05
1:0118	Extr/Adm Configured	1:0561	AI #23 Chan Diff between Kernels
1:0119	Admission-only Configured	1:0562	AI #23 Input Signal Failure
1:0120	Extr Enable/Disable Configured	1:0563	AI #24 Chan Fail Kern A Mod A05
1:0121	Priority Selection Configured	1:0564	AI #24 Chan Fail Kern B Mod A05
1:0122	Remote Extr/Adm Setpt Configured	1:0565	AI #24 Chan Fail Kern C Mod A05
1:0123	E/A Setpt Tracking Config'd	1:0566	AI #24 Chan Diff between Kernels
1:0124	Controlled Stop In Progress	1:0567	AI #24 Input Signal Failure
1:0125	Inlet Is Enabled	1:0568	AI #25 Chan Fail Kern A Mod A05
1:0126	Inlet Is Active	1:0569	AI #25 Chan Fail Kern B Mod A05
1:0127	Inlet Is In Control	1:0570	AI #25 Chan Fail Kern C Mod A05
1:0128	Inlet Active / Not Limiting	1:0571	AI #25 Chan Diff between Kernels
1:0129	Inlet Active / Not In Control	1:0572	AI #25 Input Signal Failure
1:0130	Inlet is Inhibited	1:0573	AI #26 Chan Fail Kern A Mod A05
1:0131	Remote Inlet Is Enabled	1:0574	AI #26 Chan Fail Kern B Mod A05
1:0132	Remote Inlet Is Active	1:0575	AI #26 Chan Fail Kern C Mod A05
1:0133	Rmt Inlet Is In Control	1:0576	AI #26 Chan Diff between Kernels
1:0134	Rmt Inlet Is Inhibited	1:0577	AI #26 Input Signal Failure
1:0135	Inlet Limiter Configured	1:0578	AI #27 Chan Fail Kern A Mod A05
1:0136	Inlet Control Configured	1:0579	AI #27 Chan Fail Kern B Mod A05
1:0137	Remote Inlet Configured	1:0580	AI #27 Chan Fail Kern C Mod A05
1:0138	Remote KW Setpt Is Enabled	1:0581	AI #27 Chan Diff between Kernels
1:0139	Remote KW Setpt Is Active	1:0582	AI #27 Input Signal Failure
1:0140	Remote KW Setpt Is In Control	1:0583	AI #28 Chan Fail Kern A Mod A05
1:0141	Remote KW Setpt Is Inhibited	1:0584	AI #28 Chan Fail Kern B Mod A05
1:0142	Remote KW Control Configured	1:0585	AI #28 Chan Fail Kern C Mod A05

Addr	Description	Addr	Description
1:0143	* IHB Configured	1:0586	AI #28 Chan Diff between Kernels
1:0144	Enables Mod Port2 In Local	1:0587	AI #28 Input Signal Failure
1:0145	Enables Mod Port3 In Local	1:0588	AI #29 Chan Fail Kern A Mod A05
1:0146	Isolated Control Auto	1:0589	AI #29 Chan Fail Kern B Mod A05
1:0147	Isolated Control Manual	1:0590	AI #29 Chan Fail Kern C Mod A05
1:0148	Isoloated Control Remote Enabled	1:0591	AI #29 Chan Diff between Kernels
1:0149	Isoloated Control EXT2 Enabled	1:0592	AI #29 Input Signal Failure
1:0150	Isolated Control EXT2 PID In Control	1:0593	AI #30 Chan Fail Kern A Mod A05
1:0151	Isolated Control EXT2 Limiter In Control	1:0594	AI #30 Chan Fail Kern B Mod A05
1:0152	Spare	1:0595	AI #30 Chan Fail Kern C Mod A05
1:0153	Extraction Active / Not Limiting	1:0596	AI #30 Chan Diff between Kernels
1:0154	Extraction Active / Not In Control	1:0597	AI #30 Input Signal Failure
1:0155	Extraction Limiter Configured	1:0598	AI #31 Chan Fail Kern A Mod A05
1:0156	Extraction Control Configured	1:0599	AI #31 Chan Fail Kern B Mod A05
1:0157	Remote Extraction Configured	1:0600	AI #31 Chan Fail Kern C Mod A05
1:0158	Exhaust Is Enabled	1:0601	AI #31 Chan Diff between Kernels
1:0159	Exhaust Is Active	1:0602	AI #31 Input Signal Failure
1:0160	Exhaust Is In Control	1:0603	AI #32 Chan Fail Kern A Mod A05
1:0161	Exhaust Active / Not Limiting	1:0604	AI #32 Chan Fail Kern B Mod A05
1:0162	Exhaust Active / Not In Control	1:0605	AI #32 Chan Fail Kern C Mod A05
1:0163	Exhaust is Inhibited	1:0606	AI #32 Chan Diff between Kernels
1:0164	Remote Exhaust Is Enabled	1:0607	AI #32 Input Signal Failure
1:0165	Remote Exhaust Is Active	1:0608	AI #33 Chan Fail Kern A Mod A05
1:0166	Rmt Exhaust Is In Control	1:0609	AI #33 Chan Fail Kern B Mod A05
1:0167	Rmt Exhaust Is Inhibited	1:0610	AI #33 Chan Fail Kern C Mod A05
1:0168	Exhaust Limiter Configured	1:0611	AI #33 Chan Diff between Kernels
1:0169	Exhaust Control Configured	1:0612	AI #33 Input Signal Failure
1:0170	Remote Exhaust Configured	1:0613	AI #34 Chan Fail Kern A Mod A05
1:0171	At MIN Flow Limit	1:0614	AI #34 Chan Fail Kern B Mod A05
1:0172	Mode Transfer Inhibited	1:0615	AI #34 Chan Fail Kern C Mod A05
1:0173	Alternate Mode Active	1:0616	AI #34 Chan Diff between Kernels
1:0174	Spare	1:0617	AI #34 Input Signal Failure
1:0175	Illegal Steam Map	1:0618	AI #35 Chan Fail Kern A Mod A05
1:0176	Ratio Limiter Active	1:0619	AI #35 Chan Fail Kern B Mod A05
1:0177	Spare	1:0620	AI #35 Chan Fail Kern C Mod A05
1:0178	Relay 2 is Level Switch	1:0621	AI #35 Chan Diff between Kernels
1:0179	Relay 3 is Level Switch	1:0622	AI #35 Input Signal Failure
1:0180	Relay 4 is Level Switch	1:0623	AI #36 Chan Fail Kern A Mod A05
1:0181	Relay 5 is Level Switch	1:0624	AI #36 Chan Fail Kern B Mod A05
1:0182	Relay 6 is Level Switch	1:0625	AI #36 Chan Fail Kern C Mod A05
1:0183	Relay 7 is Level Switch	1:0626	AI #36 Chan Diff between Kernels
1:0184	Relay 8 is Level Switch	1:0627	AI #36 Input Signal Failure

Addr	Description	Addr	Description
1:0185	Relay 9 is Level Switch	1:0628	AO #1 Chan Fail Kern A
1:0186	Relay 10 is Level Switch	1:0629	AO #1 Chan Fail Kern B
1:0187	Relay 11 is Level Switch	1:0630	AO #1 Chan Fail Kern C
1:0188	Relay 12 is Level Switch	1:0631	AO #1 No Load Detected
1:0189		1:0632	AO #1 Chan Fail All Kernels
1:0190		1:0633	AO #2 Chan Fail Kern A
1:0191		1:0634	AO #2 Chan Fail Kern B
1:0192		1:0635	AO #2 Chan Fail Kern C
1:0193		1:0636	AO #2 No Load Detected
1:0194		1:0637	AO #2 Chan Fail All Kernels
1:0195		1:0638	AO #3 Chan Fail Kern A
1:0196		1:0639	AO #3 Chan Fail Kern B
1:0197		1:0640	AO #3 Chan Fail Kern C
1:0198		1:0641	AO #3 No Load Detected
1:0199	Shutdown Relay Energized(Relay 1)	1:0642	AO #3 Chan Fail All Kernels
1:0200	Relay 2 Energized	1:0643	AO #4 Chan Fail Kern A
1:0201	Relay 3 Energized	1:0644	AO #4 Chan Fail Kern B
1:0202	Relay 4 Energized	1:0645	AO #4 Chan Fail Kern C
1:0203	Relay 5 Energized	1:0646	AO #4 No Load Detected
1:0204	Relay 6 Energized	1:0647	AO #4 Chan Fail All Kernels
1:0205	Relay 7 Energized	1:0648	AO #5 Chan Fail Kern A
1:0206	Relay 8 Energized	1:0649	AO #5 Chan Fail Kern B
1:0207	Relay 9 Energized	1:0650	AO #5 Chan Fail Kern C
1:0208	Relay 10 Energized	1:0651	AO #5 No Load Detected
1:0209	Relay 11 Energized	1:0652	AO #5 Chan Fail All Kernels
1:0210	Relay 12 Energized	1:0653	AO #6 Chan Fail Kern A
1:0211	ESD Contact Input Closed	1:0654	AO #6 Chan Fail Kern B
1:0212	Contact In 2 Closed	1:0655	AO #6 Chan Fail Kern C
1:0213	Contact In 3 Closed	1:0656	AO #6 No Load Detected
1:0214	Contact In 4 Closed	1:0657	AO #6 Chan Fail All Kernels
1:0215	Contact In 5 Closed	1:0658	AO #7 Chan Fail Kern A
1:0216	Contact In 6 Closed	1:0659	AO #7 Chan Fail Kern B
1:0217	Contact In 7 Closed	1:0660	AO #7 Chan Fail Kern C
1:0218	Contact In 8 Closed	1:0661	AO #7 No Load Detected
1:0219	Contact In 9 Closed	1:0662	AO #7 Chan Fail All Kernels
1:0220	Contact In 10 Closed	1:0663	AO #8 Chan Fail Kern A
1:0221	Contact In 11 Closed	1:0664	AO #8 Chan Fail Kern B
1:0222	Contact In 12 Closed	1:0665	AO #8 Chan Fail Kern C
1:0223	Contact In 13 Closed	1:0666	AO #8 No Load Detected
1:0224	Contact In 14 Closed	1:0667	AO #8 Chan Fail All Kernels
1:0225	Contact In 15 Closed	1:0668	AO #9 Chan Fail Kern A
1:0226	Contact In 16 Closed	1:0669	AO #9 Chan Fail Kern B
1:0227	Contact In 17 Closed	1:0670	AO #9 Chan Fail Kern C

Addr	Description	Addr	Description
1:0228	Contact In 18 Closed	1:0671	AO #9 No Load Detected
1:0229	Contact In 19 Closed	1:0672	AO #9 Chan Fail All Kernels
1:0230	Contact In 20 Closed	1:0673	AO #10 Chan Fail Kern A
1:0231	Contact In 21 Closed	1:0674	AO #10 Chan Fail Kern B
1:0232	Contact In 22 Closed	1:0675	AO #10 Chan Fail Kern C
1:0233	Contact In 23 Closed	1:0676	AO #10 No Load Detected
1:0234	Contact In 24 Closed	1:0677	AO #10 Chan Fail All Kernels
1:0235		1:0678	AO #11 Chan Fail Kern A
1:0236		1:0679	AO #11 Chan Fail Kern B
1:0237		1:0680	AO #11 Chan Fail Kern C
1:0238		1:0681	AO #11 No Load Detected
1:0239	Power Up Trip	1:0682	AO #11 Chan Fail All Kernels
1:0240	Trip Cmd from RemoteView	1:0683	AO #12 Chan Fail Kern A
1:0241	Trip Command from Modbus	1:0684	AO #12 Chan Fail Kern B
1:0242	Normal Shutdown Complete	1:0685	AO #12 Chan Fail Kern C
1:0243	Unit in Calibration Mode	1:0686	AO #12 No Load Detected
1:0244	Configuration Error	1:0687	AO #12 Chan Fail All Kernels
1:0245	Configuration Mode (IO Lock)	1:0688	Spare
1:0246	spare_8	1:0689	DI #1 Chan Fail Kern A
1:0247	HP Ramp at Max/No Speed	1:0690	DI #1 Chan Fail Kern B
1:0248	spare_10	1:0691	DI #1 Chan Fail Kern C
1:0249	Overspeed	1:0692	DI #2 Chan Fail Kern A
1:0250	All Speed Probes Failed	1:0693	DI #2 Chan Fail Kern B
1:0251	Overspeed Test Limit Reached	1:0694	DI #2 Chan Fail Kern C
1:0252	spare_14	1:0695	DI #3 Chan Fail Kern A
1:0253	spare_15	1:0696	DI #3 Chan Fail Kern B
1:0254	Tie Breaker Opened	1:0697	DI #3 Chan Fail Kern C
1:0255	GEN Breaker Opened	1:0698	DI #4 Chan Fail Kern A
1:0256	Aux Input Failed	1:0699	DI #4 Chan Fail Kern B
1:0257	Inlet Input Signal Failed	1:0700	DI #4 Chan Fail Kern C
1:0258	Ext/Adm Input Signal Failed	1:0701	DI #5 Chan Fail Kern A
1:0259	Exhaust Input Signal Failed	1:0702	DI #5 Chan Fail Kern B
1:0260	spare_22	1:0703	DI #5 Chan Fail Kern C
1:0261	Inlet Stm Pressure Level2 TRIP	1:0704	DI #6 Chan Fail Kern A
1:0262	EXH Stm Pressure Level2 TRIP	1:0705	DI #6 Chan Fail Kern B
1:0263	Selected PV 1 Level 2 TRIP	1:0706	DI #6 Chan Fail Kern C
1:0264	Selected PV 2 Level 2 TRIP	1:0707	DI #7 Chan Fail Kern A
1:0265	Selected PV 3 Level 2 TRIP	1:0708	DI #7 Chan Fail Kern B
1:0266	spare_28	1:0709	DI #7 Chan Fail Kern C
1:0267	spare_29	1:0710	DI #8 Chan Fail Kern A
1:0268	HP Actuator Fault	1:0711	DI #8 Chan Fail Kern B
1:0269	HP2 Actuator Fault	1:0712	DI #8 Chan Fail Kern C
1:0270	LP Actuator Fault	1:0713	DI #9 Chan Fail Kern A

Addr	Description	Addr	Description
1:0271	LP2 Actuator Fault	1:0714	DI #9 Chan Fail Kern B
1:0272	Tunable Trip	1:0715	DI #9 Chan Fail Kern C
1:0273	Open Wire on MPUs (Flex only)	1:0716	DI #10 Chan Fail Kern A
1:0274	spare_36	1:0717	DI #10 Chan Fail Kern B
1:0275	spare_37	1:0718	DI #10 Chan Fail Kern C
1:0276	spare_38	1:0719	DI #11 Chan Fail Kern A
1:0277	spare_39	1:0720	DI #11 Chan Fail Kern B
1:0278	spare_40	1:0721	DI #11 Chan Fail Kern C
1:0279		1:0722	DI #12 Chan Fail Kern A
1:0280		1:0723	DI #12 Chan Fail Kern B
1:0281		1:0724	DI #12 Chan Fail Kern C
1:0282		1:0725	DI #13 Chan Fail Kern A
1:0283		1:0726	DI #13 Chan Fail Kern B
1:0284		1:0727	DI #13 Chan Fail Kern C
1:0285		1:0728	DI #14 Chan Fail Kern A
1:0286		1:0729	DI #14 Chan Fail Kern B
1:0287		1:0730	DI #14 Chan Fail Kern C
1:0288		1:0731	DI #15 Chan Fail Kern A
1:0289	Main Chassis / OS Fault	1:0732	DI #15 Chan Fail Kern B
1:0290	All Speed/AIO Modules (slot 3) Failed	1:0733	DI #15 Chan Fail Kern C
1:0291	All DIO Modules (slot 4) Failed	1:0734	DI #16 Chan Fail Kern A
1:0292	All HDAIO Modules (slot 5) Failed	1:0735	DI #16 Chan Fail Kern B
1:0293	External Trip #1	1:0736	DI #16 Chan Fail Kern C
1:0294	External Trip #2	1:0737	DI #17 Chan Fail Kern A
1:0295	External Trip #3	1:0738	DI #17 Chan Fail Kern B
1:0296	External Trip #4	1:0739	DI #17 Chan Fail Kern C
1:0297	External Trip #5	1:0740	DI #18 Chan Fail Kern A
1:0298	External Trip #6	1:0741	DI #18 Chan Fail Kern B
1:0299	External Trip #7	1:0742	DI #18 Chan Fail Kern C
1:0300	External Trip #8	1:0743	DI #19 Chan Fail Kern A
1:0301	External Trip #9	1:0744	DI #19 Chan Fail Kern B
1:0302	External Trip #10	1:0745	DI #19 Chan Fail Kern C
1:0303	External Trip #11	1:0746	DI #20 Chan Fail Kern A
1:0304	External Trip #12	1:0747	DI #20 Chan Fail Kern B
1:0305	External Trip #13	1:0748	DI #20 Chan Fail Kern C
1:0306	External Trip #14	1:0749	DI #21 Chan Fail Kern A
1:0307	External Trip #15	1:0750	DI #21 Chan Fail Kern B
1:0308	LinkNet IO Summary Trip	1:0751	DI #21 Chan Fail Kern C
1:0309		1:0752	DI #22 Chan Fail Kern A
1:0310		1:0753	DI #22 Chan Fail Kern B
1:0311		1:0754	DI #22 Chan Fail Kern C
1:0312		1:0755	DI #23 Chan Fail Kern A
1:0313		1:0756	DI #23 Chan Fail Kern B
1:0314		1:0757	DI #23 Chan Fail Kern C
1:0315		1:0758	DI #24 Chan Fail Kern A
1:0316		1:0759	DI #24 Chan Fail Kern B
1:0317		1:0760	DI #24 Chan Fail Kern C
1:0318		1:0761	Speed Chan #1 Fail Kern A
1:0319		1:0762	Speed Chan #1 Fail Kern B
1:0320		1:0763	Speed Chan #1 Fail Kern C
1:0321		1:0764	Speed Signal Input Chan #1 Failed
1:0322		1:0765	Speed Chan #2 Fail Kern A
1:0323		1:0766	Speed Chan #2 Fail Kern B
1:0324	Internal HW Simulation Enabled	1:0767	Speed Chan #2 Fail Kern C

Addr	Description	Addr	Description
1:0325	Mod Comm Link #1 Failed	1:0768	Speed Signal Input Chan #2 Failed
1:0326	Mod Comm Link #2 Failed	1:0769	Speed Chan #3 Fail Kern A
1:0327	Mod Comm Link #3 Failed	1:0770	Speed Chan #3 Fail Kern B
1:0328	spare_5	1:0771	Speed Chan #3 Fail Kern C
1:0329	Start Perm Not Closed	1:0772	Speed Signal Input Chan #3 Failed
1:0330	Stuck In Critical Band	1:0773	Speed Chan #4 Fail Kern A
1:0331	Start Temperature #1 Override Active	1:0774	Speed Chan #4 Fail Kern B
1:0332	Start Temperature #2 Override Active	1:0775	Speed Chan #4 Fail Kern C
1:0333	spare_100	1:0776	Speed Signal Input Chan #4 Failed
1:0334	Turbine Tripped	1:0777	Speed Signal #1 Difference ALM
1:0335	Overspeed ALM	1:0778	Speed Signal #2 Difference ALM
1:0336	Overspeed Test Enabled	1:0779	Speed Signal #3 Difference ALM
1:0337	Turbine Maintenance Interval Alm	1:0780	FT Relay #1 Summary Fault
1:0338	spare_15	1:0781	FT Relay #2 Summary Fault
1:0339	HP Valve Pos Fdbk Diff ALM	1:0782	FT Relay #3 Summary Fault
1:0340	HP2 Valve Pos Fdbk Diff ALM	1:0783	FT Relay #4 Summary Fault
1:0341	LP Valve Pos Fdbk Diff ALM	1:0784	FT Relay #5 Summary Fault
1:0342	LP2 Valve Pos Fdbk Diff ALM	1:0785	FT Relay #6 Summary Fault
1:0343	HP Valve Feedback Failed	1:0786	FT Relay #7 Summary Fault
1:0344	HP2 Valve Feedback Failed	1:0787	FT Relay #8 Summary Fault
1:0345	LP Valve Feedback Failed	1:0788	FT Relay #9 Summary Fault
1:0346	LP2 Valve Feedback Failed	1:0789	FT Relay #10 Summary Fault
1:0347	spare_24	1:0790	FT Relay #11 Summary Fault
1:0348	Tunable Alarm	1:0791	FT Relay #12 Summary Fault
1:0349	TIE Breaker Opened	1:0792	External Alarm #1
1:0350	GEN Breaker Opened	1:0793	External Alarm #2
1:0351	Tie Open / No Auxiliary	1:0794	External Alarm #3
1:0352	Gen Open / No Auxiliary	1:0795	External Alarm #4
1:0353	Tie Open / No Cascade	1:0796	External Alarm #5
1:0354	Gen Open / No Cascade	1:0797	External Alarm #6
1:0355	Tie Open / No Remote	1:0798	External Alarm #7
1:0356	Gen Open / No Remote	1:0799	External Alarm #8
1:0357	Tie Open / No Inlet	1:0800	External Alarm #9
1:0358	Gen Open / No Inlet	1:0801	External Alarm #10
1:0359	Tie Open / No Extraction	1:0802	External Alarm #11
1:0360	Gen Open / No Extraction	1:0803	External Alarm #12
1:0361	Tie Open / No Exhuast	1:0804	External Alarm #13
1:0362	Gen Open / No Exhaust	1:0805	External Alarm #14
1:0363	Limiter in Control	1:0806	External Alarm #15
1:0364	Pressure Compensation Curve Error	1:0807	Kernel B CAN Port 2 Fault
1:0365	Actuator Linearization Curve Error	1:0808	Kernel C CAN Port 2 Fault
1:0366	Alternate Mode Map Error	1:0809	Kern A Mod5 Chan1 Fault
1:0367	Speed Below Min - No Extraction	1:0810	Kern A Mod5 Chan2 Fault
1:0368	LP Lmtr->No Spd Cntl->Ratio Lmtr Dsbl	1:0811	Kern A Mod6 Chan1 Fault
1:0369	LP Actuator Linear Curve Error	1:0812	Kern A Mod6 Chan2 Fault
1:0370	Backup Gen Load AI Failed	1:0813	Kern B Mod5 Chan1 Fault
1:0371	spare_48	1:0814	Kern B Mod5 Chan2 Fault
1:0372	Comm Link to DSLC2 Failed	1:0815	Kern B Mod6 Chan1 Fault
1:0373	Comm Link to HiProtec Failed	1:0816	Kern B Mod6 Chan2 Fault
1:0374	Cascade Input Failed	1:0817	Kern C Mod5 Chan1 Fault
1:0375	AUX Input Failed	1:0818	Kern C Mod5 Chan2 Fault
1:0376	KW Load Input Failed	1:0819	Kern C Mod6 Chan1 Fault
1:0377	Sync Input Failed	1:0820	Kern C Mod6 Chan2 Fault

Addr	Description	Addr	Description
1:0378	Remote Spd Input Failed	1:0821	Spare
1:0379	Remote Casc Input Failed	1:0822	Diff ALM on Redun RmtSpd Setpt inputs
1:0380	Remote AUX Input Failed	1:0823	All Remote Spd Setpoint Sigs Failed
1:0381	Inlet Press Input Failed	1:0824	Diff ALM on Redun GEN Load inputs
1:0382	Inlet Steam Pressure Lvl1 ALM	1:0825	All GEN Load Sigs Failed
1:0383	Inlet Steam Pressure Lvl2 ALM	1:0826	Diff ALM on Redun Cascade inputs
1:0384	Exh Steam Pressure Lvl1 ALM	1:0827	All Cascade Sigs Failed
1:0385	Exh Steam Pressure Lvl2 ALM	1:0828	Diff ALM on Redun Auxiliary inputs
1:0386	Selected PV 1 Level 1 ALM	1:0829	All Auxiliary Sigs Failed
1:0387	Selected PV 1 Level 2 ALM	1:0830	Diff ALM on Redun Inlet Press inputs
1:0388	Selected PV 2 Level 1 ALM	1:0831	All Inlet Pressure Sigs Failed
1:0389	Selected PV 2 Level 2 ALM	1:0832	Diff ALM on Redun Exhaust Press inputs
1:0390	Selected PV 3 Level 1 ALM	1:0833	All Exhaust Pressure Sigs Failed
1:0391	Selected PV 3 Level 2 ALM	1:0834	Diff ALM on Redun Ext/Adm Press inputs
1:0392	spare_69	1:0835	All Ext/Adm Pressure Sigs Failed
1:0393	spare_70	1:0836	Spare
1:0394	spare_71	1:0837	Spare
1:0395	spare_72	1:0838	HP Valve - Dual Coil A Fault
1:0396	Sync/LS Input Failed	1:0839	HP Valve - Dual Coil B Fault
1:0397	Remote Droop Fault	1:0840	HP Redun Act - A Fault
1:0398	Remote KW Setpoint Failed	1:0841	HP Redun Act - B Fault
1:0399	Exhaust Press Input Failed	1:0842	HP Dmd - SPC11 Fault
1:0400	Feed-forward input failed	1:0843	HP Dmd - AO Backup to SPC11 Fault
1:0401	IH-A Input press AI FLT	1:0844	HP Dmd - SPC12 Fault
1:0402	IH-B Input press AI FLT	1:0845	HP Dmd - AO Backup to SPC12 Fault
1:0403	Extraction/Admission Input Failed	1:0846	LP Valve - Dual Coil A Fault
1:0404	Remote Extr/Adm SP Input Failed	1:0847	LP Valve - Dual Coil B Fault
1:0405	Remote Manual P Demand Input Failed	1:0848	LP Redun Act - A Fault
1:0406	Remote Exhaust SP Input Failed	1:0849	LP Redun Act - B Fault
1:0407	Remote Inlet Pressure SP Input Failed	1:0850	LP Dmd - SPC12 Fault
1:0408	spare_85	1:0851	LP Dmd - AO Backup to SPC12 Fault
1:0409	spare_86	1:0852	LP Dmd - SPC11 Fault
1:0410	Isolated PID PV Failed	1:0853	LP Dmd - AO Backup to SPC11 Fault
1:0411	Rem SP Isolated PID Failed	1:0854	SPC11 Summary Alarm
1:0412	Temp for Hot/Cold Starts Failed	1:0855	SPC12 Summary Alarm
1:0413	spare_90	1:0856	DVP ID 1 Summary Alarm
1:0414	spare_91	1:0857	DVP ID 2 Summary Alarm
1:0415	spare_92	1:0858	HP2 Valve Fault - Alarm
1:0416	spare_93	1:0859	LP Valve Fault - Alarm
1:0417	spare_94	1:0860	LP2 Valve Fault - Alarm
1:0418	spare_95	1:0861	Spare
1:0419	spare_96	1:0862	Spare
1:0420	spare_97	1:0863	Spare
1:0421	spare_98	1:0864	Spare
1:0422	spare_99	1:0865	Spare
1:0423	spare_100	1:0866	Spare
1:0424	Kernel A CPU Faulted	1:0867	Spare
1:0425	Kernel B CPU Faulted	1:0868	Spare
1:0426	Kernel C CPU Faulted	1:0869	Spare
1:0427	Kernel A High Temp Alarm	1:0870	Spare
1:0428	Kernel B High Temp Alarm	1:0871	Spare
1:0429	Kernel C High Temp Alarm	1:0872	Spare
1:0430	Power Supply #1 Fault	1:0873	Spare

Addr	Description	Addr	Description
1:0431	Power Supply #2 Fault	1:0874	Spare
1:0432	TMR CPU Voting Error	1:0875	Spare
1:0433	Kern A Module A03 Failed	1:0876	Spare
1:0434	Kern A Module A04 Failed	1:0877	Spare
1:0435	Kern A Module A05 Failed	1:0878	Spare
1:0436	Kern A Module A06 Failed	1:0879	Spare
1:0437	Kern B Module A03 Failed	1:0880	Spare
1:0438	Kern B Module A04 Failed	1:0881	Spare
1:0439	Kern B Module A05 Failed	1:0882	Spare
1:0440	Kern B Module A06 Failed	1:0883	Spare
1:0441	Kern C Module A03 Failed	1:0884	Spare
1:0442	Kern C Module A04 Failed	1:0885	Spare
1:0443	Kern C Module A05 Failed		

Table D-3. Analog Read Addresses

Addr	Description	Units	Multiplier
3:0001	Control Parameter		1
3:0002	Spare2		1
3:0003	Spare3		1
3:0004	Actual Turbine Speed (RPM)	rpm	1
3:0005	Actual Speed (%) x 100	%	100
3:0006	Speed Setpoint (%) x 100	%	100
3:0007	Speed Setpoint (RPM)	rpm	1
3:0008	Speed Droop Setpoint (RPM)	rpm	1
3:0009	Speed Droop (%) x 100	%	100
3:0010	Speed PID Output (%)	%	100
3:0011	Min Governor Speed Setpoint (RPM)	rpm	1
3:0012	Highest Speed reached	rpm	1
3:0013	Idle / Rated - Idle Speed (RPM)	rpm	1
3:0014	Idle / Rated - Rated Speed (RPM)	rpm	1
3:0015	Auto Seq - Idle 1 Speed Setpt (RPM)	rpm	1
3:0016	Auto Seq- Idle 1 Dly Time (MIN) X 100	min	100
3:0017	Auto Seq-Time Left Idle 1 (MIN) X 100	min	100
3:0018	Auto Seq- Idle1 to Idle2 Rate RPM/SEC	rpm/s	1
3:0019	Auto Seq - Idle 2 Speed Setpt (RPM)	rpm	1
3:0020	Auto Seq- Idle 2 Dly Time (MIN) X 100	min	100
3:0021	Auto Seq-Time Left Idle 2(MIN) X 100	min	100
3:0022	Auto Seq-Time ramp to Rated (RPM/S)	rpm/s	1
3:0023	Auto Seq- Rated speed stpt (RPM)	rpm	1
3:0024	Auto Seq - Run Time Hours	hrs	1
3:0025	Auto Seq-Hours Since trip	hrs	1
3:0026	Cascade Setpoint (Scaled)	Casc units	AI_SCALE
3:0027	Cascade PID Output (%) x 100	%	100
3:0028	Cascade Input (%)	%	100
3:0029	Cascade Setpoint (%)	%	100
3:0030	Cascade Scale Factor		1
3:0031	Cascade Input (Scaled)	Casc units	AI_SCALE
3:0032	Remote Cascade Input (Scaled)	Casc units	AI_SCALE
3:0033	Aux Setpoint (Scaled)	aux units	AI_SCALE
3:0034	Aux PID Output (%) x 100	%	100
3:0035	Aux Input (%)	%	100
3:0036	Aux Setpoint (%)	%	100

Addr	Description	Units	Multiplier
3:0037	Aux Scale Factor		1
3:0038	Aux Input (Scaled)	aux units	AI_SCALE
3:0039	Remote Aux Input (Scaled)	aux units	AI_SCALE
3:0040	Remote Speed Setpoint Input	rpm	1
3:0041	Inlet Pressure Scale Factor		1
3:0042	Inlet Pressure Input (Scaled)	IP units	AI_SCALE
3:0043	Loadshare Scale Factor		1
3:0044	Sync / Loadshare Input (Scaled)	rpm	AI_SCALE
3:0045	KW Scale Factor		1
3:0046	KW Input (Scaled)	kW units	AI_SCALE
3:0047	HP VLV Limiter Output x 100	%	100
3:0048	LSS Demand (%) x100	%	100
3:0049	HP Actuator Demand (%) x100	%	100
3:0050	HP2 Actuator Demand (%) x100	%	100
3:0051	Extr/Adm Manual Demand x 100	%	100
3:0052	Extraction Setpoint (Scaled)	ext units	AI_SCALE
3:0053	Extraction PID Output (%) x 100	%	100
3:0054	Extraction Input (%)	%	100
3:0055	Extraction Setpoint (%)	%	100
3:0056	Extraction Scale Factor		1
3:0057	Extraction Input (Scaled)	ext units	AI_SCALE
3:0058	Remote Extr Input (Scaled)	ext units	AI_SCALE
3:0059	Spare59		
3:0060	Modbus Entered Speed Setpoint (fdbk)	rpm	1
3:0061	Modbus Entered Cascade Setpoint (fdbk)	Casc units	AI_SCALE
3:0062	Modbus Entered Aux Setpoint (fdbk)	Aux units	AI_SCALE
3:0063	Modbus Entered Extr Setpoint (fdbk)	Ext	AI_SCALE
3:0064	S-demand Limited (from ratio/lmtr)	%	100
3:0065	P-demand Limited (from ratio/lmtr)	%	100
3:0066	HP Map Demand (from ratio/lmtr)	%	100
3:0067	LP Map Demand (from ratio/lmtr)	%	100
3:0068	S-term (from LSS to ratio/lmtr)	%	100
3:0069	P-term (from E/A dmd to ratio/lmtr)	%	100
3:0070	Controling Parameter 1 (5009XTE)		
3:0071	Controling Parameter 2 (5009XTE)		
3:0072	Compressor Load (% of Spd Range)		100
3:0073	* Auto Seq-Time ramp to idle 3(RPM/S)		100
3:0074	* Auto Seq Idle 3 speed RPM		100
3:0075	* Auto Seq-HH Idle Dly Time (MIN)X 100		100
3:0076	* Auto Seq-Time Left Idle 3(MIN) X100		100
3:0077	* Max Governor Speed		100
3:0078	Spare78		100
3:0079	* IH-A Scale Factor	mA	100
3:0080	* IH-A Press Units Configured	mA	100
3:0081	Start Temperature 1 Scale Factor	mA	100
3:0082	Start Temperature 1 Input	mA	100
3:0083	Start Temperature 2 Scale Factor	mA	100
3:0084	Start Temperature 2 Input	mA	100
3:0085	Spare85		100
3:0086	Configuration Error First Out		1
3:0087	Alarm First Out		1
3:0088	Shutdown First Out		1

Addr	Description	Units	Multiplier
3:0089	Last Trip		1
3:0090	KW Units (3=MW 4=KW)		1
3:0091	* Feed Forward Bias		1
3:0092	Spare92		1
3:0093	* Droop Setting		1
3:0094	* Autostart seq rate to Idle 1		1
3:0095	* Autostart seq CF Cold rte to Idle 2		1
3:0096	* Autostart seq CF Hot rate to Idle 2		1
3:0097	* Autostart seq CF Cold rte to Idle 3		1
3:0098	* Autostart seq CF Hot rate to Idle 3		1
3:0099	* Autostart seq CF Cold rate to rated		1
3:0100	* Autostart seq CF Hot rate to rated		1
3:0101	Speed Derivative signal		1
3:0102	Speed Accel Rate		1
3:0103	Spare103		1
3:0104	Spare104		1
3:0105	Spare105		1
3:0106	Spare106		1
3:0107	Inlet Setpoint (Scaled)		1
3:0108	Inlet PID Output (%) x 100		100
3:0109	Inlet Input (%)		100
3:0110	Inlet Setpoint (%)		100
3:0111	Inlet Scale Factor		1
3:0112	Inlet Input (Scaled)		1
3:0113	Remote Inlet Input (Scaled)		1
3:0114	Modbus Entered Inlet Setpoint (fdbk)		1
3:0115	Exhaust Setpoint (Scaled)		1
3:0116	Exhaust PID Output (%) x 100		100
3:0117	Exhaust Input (%)		100
3:0118	Exhaust Setpoint (%)		100
3:0119	Exhaust Scale Factor		1
3:0120	Exhaust Input (Scaled)		1
3:0121	Remote Exhaust Input (Scaled)		1
3:0122	Modbus Entered Exhaust Setpoint (fdbk)		1
3:0123	Exhaust-demand Limited (from ratio/lmtr)	rpm/s	1
3:0124	Spare124	rpm	1
3:0125	* IH-B Scale Factor	min	100
3:0126	* IH-B Press Units Configured	min	100
3:0127	* Autostart seq CF Warm rte to Idle 2	rpm	1
3:0128	* Autostart seq CF Warm rte to Idle 3		1
3:0129	* Autostart seq CF Warm rate to rated		1
3:0130	Idle / Rated Cold Rate		1
3:0131	Idle / Rated Warm Rate		1
3:0132	Idle / Rated Hot Rate		1
3:0133	Remote KW Setpoint Scale Factor		1
3:0134	Remote KW Setpoint Input		1
3:0135	Spare135		1
3:0136	Spare136		100
3:0137	Active Speed Setpoint Rate	rpm/s	1
3:0138	Active Cascade Setpoint Rate	rpm/s	1
3:0139	Active AUX Setpoint Rate	rpm/s	1
3:0140	Active Extraction/Admission Setpoint Rate	rpm/s	1

Addr	Description	Units	Multiplier
3:0141	Active Inlet Setpoint Rate	rpm/s	1
3:0142	Active Exhaust Setpoint Rate	rpm/s	1
3:0143	5009XT Control Parameter	rpm/s	1
3:0144	5009XT Ratio Limiter Contol Parameter	rpm/s	1
3:0145	5009XT Map Limit Parameter	%/s	1
3:0146	LP Actuator Demand (%) x100	%	100
3:0147	Turbine Starts Counter		1
3:0148	HOT Turbine Starts Counter		1
3:0149	Total Trips Counter		1
3:0150	Trips with Load >25% Counter		1
3:0151	Trips with Load >75% Counter		1
3:0152	Total Run Time Hours Counter		1
3:0153	Run Time Hours with Load >25% Counter		1
3:0154	Run Time Hours with Load >75% Counter		1
3:0155	Peak Speed Reached		1
3:0156	Maximum Acceleration Reached		1
3:0157	Number of Overspeed Trips		1
3:0158	LP Valve Limiter x100		1
3:0159	HP Valve FDBK Position Scale Factor		AI_SCALE
3:0160	HP Valve FDBK Position Input	%	100
3:0161	HP2 Valve FDBK Position Scale Factor	%	100
3:0162	HP2 Valve FDBK Position Input	%	100
3:0163	Validated Remote Speed PV		
3:0164	Validated Cascade PV		
3:0165	Validated AUX PV		
3:0166	Validated Inlet Pressure PV		
3:0167	Validated Ext/Adm Pressure PV		
3:0168	Validated Exhaust Pressure PV		
3:0169	Validated GEN Load PV		
3:0170	Spare170		
3:0171	Spare171		
3:0172	Spare172		
3:0173	Spare173		
3:0174	Hardware Parameters Start Here		1
3:0175	Speed Sensor #1 Input (RPM)	RPM	1
3:0176	Speed Sensor #2 Input (RPM)	RPM	1
3:0177	Speed Sensor #3 Input (RPM)	RPM	1
3:0178	Speed Sensor #4 Input (RPM)	RPM	1
3:0179	Analog Input 1 (percent x 100)		100
3:0180	Analog Input 2 (percent x 100)		100
3:0181	Analog Input 3 (percent x 100)		100
3:0182	Analog Input 4 (percent x 100)		100
3:0183	Analog Input 5 (percent x 100)		100
3:0184	Analog Input 6 (percent x 100)		100
3:0185	Analog Input 7 (percent x 100)		100
3:0186	Analog Input 8 (percent x 100)		100
3:0187	Analog Input 9 (percent x 100)		100
3:0188	Analog Input 10 (percent x 100)		100
3:0189	Analog Input 11 (percent x 100)		100
3:0190	Analog Input 12 (percent x 100)		100
3:0191	Analog Output 1 (mA x 100)		100
3:0192	Analog Output 2 (mA x 100)		100

Addr	Description	Units	Multiplier
3:0193	Analog Output 3 (mA x 100)		100
3:0194	Analog Output 4 (mA x 100)		100
3:0195	SPC ID 11 (percent x 100)	%	100
3:0196	SPC ID 12 (percent x 100)	%	100
3:0197	DVP ID 1 (percent x 100)	%	100
3:0198	DVP ID 2 (percent x 100)	%	100
3:0199	DVP ID 3 (percent x 100)	%	100
3:0200	DVP ID 4 (percent x 100)	%	100
3:0201	DVP ID 5 (percent x 100)	%	100
3:0202	DVP ID 6 (percent x 100)	%	100
3:0203	Spare203	%	100
3:0204	Spare204		AI_SCALE
3:0205	Spare205		AI_SCALE
3:0206	Spare206		AI_SCALE
3:0207	Analog Input 1 Configuration		AI_SCALE
3:0208	Analog Input 2 Configuration		AI_SCALE
3:0209	Analog Input 3 Configuration		AI_SCALE
3:0210	Analog Input 4 Configuration		AI_SCALE
3:0211	Analog Input 5 Configuration		AI_SCALE
3:0212	Analog Input 6 Configuration		AI_SCALE
3:0213	Analog Input 7 Configuration		AI_SCALE
3:0214	Analog Input 8 Configuration		AI_SCALE
3:0215	Analog Input 9 Configuration		AI_SCALE
3:0216	Analog Input 10 Configuration		AI_SCALE
3:0217	Analog Input 11 Configuration		AI_SCALE
3:0218	Analog Input 12 Configuration		AI_SCALE
3:0219	Analog Output 1 Configuration		AI_SCALE
3:0220	Analog Output 2 Configuration		RTD_SCALE
3:0221	Analog Output 3 Configuration		RTD_SCALE
3:0222	Analog Output 4 Configuration		RTD_SCALE
3:0223	Relay 1 Configuration		RTD_SCALE
3:0224	Relay 2 Configuration		RTD_SCALE
3:0225	Relay 3 Configuration		RTD_SCALE
3:0226	Relay 4 Configuration		RTD_SCALE
3:0227	Relay 5 Configuration		RTD_SCALE
3:0228	Relay 6 Configuration	rpm	1
3:0229	Relay 7 Configuration	Casc units	1
3:0230	Relay 8 Configuration	aux units	1
3:0231	Relay 9 Configuration	ext/adm units	1
3:0232	Relay 10 Configuration	inlet units	1
3:0233	Relay11 Configuration		1
3:0234	Relay 12 Configuration		1
3:0235	Contact 2 Configuration		1
3:0236	Contact 3 Configuration		1
3:0237	Contact 4 Configuration		1
3:0238	Contact 5 Configuration		1
3:0239	Contact 6 Configuration		1
3:0240	Contact 7 Configuration		1
3:0241	Contact 8 Configuration		1
3:0242	Contact 9 Configuration		1
3:0243	Contact 10 Configuration		1
3:0244	Contact 11 Configuration		1

Addr	Description	Units	Multiplier
3:0245	Contact 12 Configuration		1
3:0246	Contact 13 Configuration		1
3:0247	Contact 14 Configuration		1
3:0248	Contact 15 Configuration		1
3:0249	Contact 16 Configuration		1
3:0250	Contact 17 Configuration		
3:0251	Contact 18 Configuration		
3:0252	Contact 19 Configuration		
3:0253	Contact 20 Configuration		
3:0254	Contact 21 Configuration		
3:0255	Contact 22 Configuration		
3:0256	Contact 23 Configuration		
3:0257	Contact 24 Configuration		
3:0258	Spare258		
3:0259	Spare259		
3:0260	Spare260		
3:0261	Kern A A5 Chan 1 (mA x 100)		100
3:0262	Kern A A5 Chan 2 (mA x 100)		100
3:0263	Kern A A6 Chan 1 (mA x 100)		100
3:0264	Kern A A6 Chan 2 (mA x 100)		100
3:0265	Kern B A5 Chan 1 (mA x 100)		100
3:0266	Kern B A5 Chan 2 (mA x 100)		100
3:0267	Kern B A6 Chan 1 (mA x 100)		100
3:0268	Kern B A6 Chan 2 (mA x 100)		100
3:0269	Kern C A5 Chan 1 (mA x 100)		100
3:0270	Kern C A5 Chan 2 (mA x 100)		100
3:0271	Kern C A6 Chan 1 (mA x 100)		100
3:0272	Kern C A6 Chan 2 (mA x 100)		100
3:0273	Spare273		
3:0274	Spare274		
3:0275	Spare275		
3:0276	Spare276		
3:0277	Spare277		
3:0278	Spare278		
3:0279	Spare279		
3:0280	Spare280		
3:0281	LinkNet Alarm First Out		
3:0282	LinkNet TRIP First Out		100
3:0283	A5 Analog Input 1 (percent x 100)		100
3:0284	A5 Analog Input 2 (percent x 100)		100
3:0285	A5 Analog Input 3 (percent x 100)		100
3:0286	A5 Analog Input 4 (percent x 100)		100
3:0287	A5 Analog Input 5 (percent x 100)		100
3:0288	A5 Analog Input 6 (percent x 100)		100
3:0289	A5 Analog Input 7 (percent x 100)		100
3:0290	A5 Analog Input 8 (percent x 100)		100
3:0291	A5 Analog Input 9 (percent x 100)		100
3:0292	A5 Analog Input 10 (percent x 100)		100
3:0293	A5 Analog Input 11 (percent x 100)		100
3:0294	A5 Analog Input 12 (percent x 100)		100
3:0295	A5 Analog Input 13 (percent x 100)		100
3:0296	A5 Analog Input 14 (percent x 100)		100

Addr	Description	Units	Multiplier
3:0297	A5 Analog Input 15 (percent x 100)		100
3:0298	A5 Analog Input 16 (percent x 100)		100
3:0299	A5 Analog Input 17 (percent x 100)		100
3:0300	A5 Analog Input 18 (percent x 100)		100
3:0301	A5 Analog Input 19 (percent x 100)		100
3:0302	A5 Analog Input 20 (percent x 100)		100
3:0303	A5 Analog Input 21 (percent x 100)		100
3:0304	A5 Analog Input 22 (percent x 100)		100
3:0305	A5 Analog Input 23 (percent x 100)		100
3:0306	A5 Analog Input 24 (percent x 100)		100
3:0307	A5 Analog Output 1 (mA x 100)		100
3:0308	A5 Analog Output 2 (mA x 100)		100
3:0309	A5 Analog Output 3 (mA x 100)		100
3:0310	A5 Analog Output 4 (mA x 100)		100
3:0311	A5 Analog Output 5 (mA x 100)		100
3:0312	A5 Analog Output 6 (mA x 100)		100
3:0313	A5 Analog Output 7 (mA x 100)		100
3:0314	A5 Analog Output 8 (mA x 100)		100

Table D-4. Analog Write Addresses

Addr	Description	Units	Multiplier
4:0001	Modbus Entered Speed Setpoint	rpm	none
4:0002	Modbus Entered Casc Setpoint	Casc units	Casc scale factor
4:0003	Modbus Entered Aux Setpoint	Aux units	Aux scale factor
4:0004	Modbus Entered Extraction Setpoint	Ext/Adm units	Ext/Adm scale factor
4:0005	Modbus Droop demand	%	x0.01
4:0006	Modbus Entered Inlet Setpoint	Inlet Units	Inlet scale factor
4:0007	Modbus Entered Exhaust Setpoint	Exhaust Units	Exhaust scale factor
4:0008	SPARE_8		
4:0009	Modbus Entered Manual P Setpoint	Ext/Adm Units	Exhaust scale factor
4:0010	SPARE_10		

Released

Appendix E.
Control Wiring Diagram

REVISION HISTORY			
REV	DESCRIPTION	DATE	APPROVED
-	CN049243 DPENNI	MAY-2019	SOCEAN

Control Wiring Diagram

5009XT-FAULT-TOLERANT CONTROL

ITEM NUMBER	DESCRIPTION	MICRONET+ TMR W/120VDC/AC PS	MICRONET+ TMR W/220VAC PS	MICRONET+ TMR W/24VDC PS
8262-1141	CONTROL - 5009XT MICRONET+W/2 120VAC/DC TMR PS	X		
8262-1142	CONTROL - 5009XT MICRONET+W/2 220VAC TMR PS		X	
8262-1143	CONTROL - 5009XT MICRONET+W/2 24VDC TMR PS			X
8928-7574	KIT - 5009XT - OPTIONAL ACTUATOR MODULE/FTM/CABLE KIT			
8928-7577	KIT - SPC CAN DRIVERS			

MATERIALS:

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES.

THIRD ANGLE PROJECTION

APPROVED	DATE
TANAKA	MAR-2017
CHECKED	DATE
W4536	MAR-2017
DRAWN	DATE
W4536	MAR-2017

WOODWARD FT. COLLINS COLORADO USA

TITLE: CONTROL WIRING DIAGRAM 5009XT TMR

SIZE	CAGE CODE	DWG NO	REV
D	7LLB9	9971-2025	-

SCALE NTS SHEET 1 OF 17

AUTOCAD

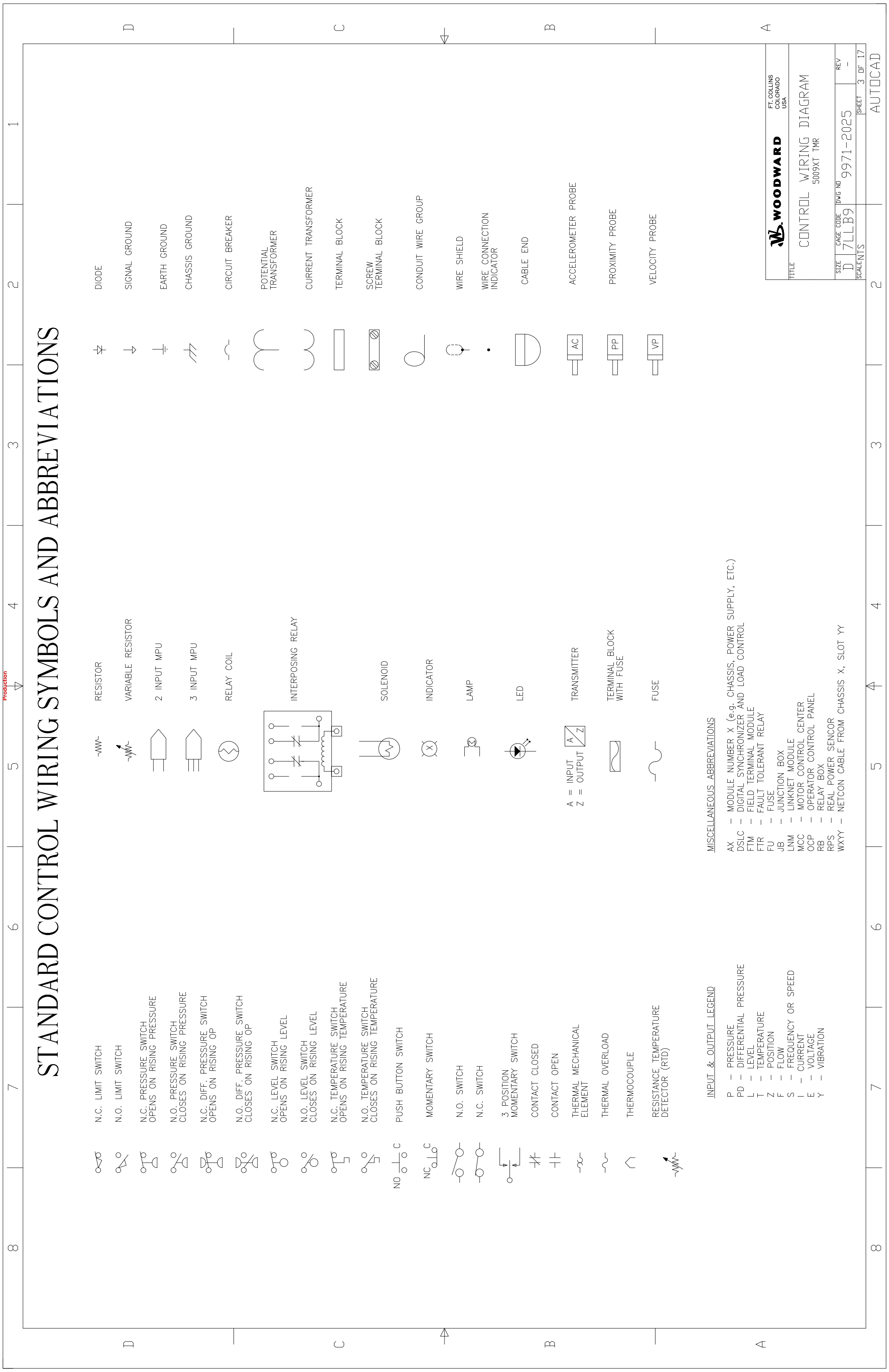
STANDARD CONTROL WIRING NOTES

1. SHIELDS MUST BE GROUNDED AS SHOWN.
2. ALL SHIELDS MUST BE CARRIED CONTINUOUSLY THROUGH ALL TERMINAL BLOCKS AND MUST NOT BE TIED TO OTHER SHIELDS. UNLESS OTHERWISE SHOWN.
3. INPUT SIGNAL FROM OTHER SYSTEMS MUST BE ISOLATED FROM EARTH EITHER BY DESIGN OR EMPLOYMENT OF ISOLATION AMPLIFIERS.
4. UNLESS OTHERWISE SPECIFIED:
   A. RELAYS SHOWN DE-ENERGIZED.
   B. RELAYS ENERGIZE FOR FUNCTION.
   C. RELAY CONTACT RATINGS:

   12/24 CHANNEL RELAY FTM
   - RESISTIVE - 10A AT 28VDC
     3A AT 150VDC
     10A AT 115VAC 50/60HZ
   - INDUCTIVE - 3A AT 28VDC
     1.2A AT 150VDC
     6A AT 115VAC 50/60HZ
     3A AT 240VAC 50/60HZ
5. CONFIRM EACH CONNECTION BEFORE OPERATING UNIT.
6. ALL ANALOG INPUTS MUST BE ISOLATED FROM EARTH GROUND.
7. CABLE WIRES ARE MARKED WITH COLORS DESIGNATED.
8. LETTERS IN PARENTHESES INDICATE LOWER CASE LETTERS 0N CONNECTORS.
9. UNLESS OTHERWISE SPECIFIED, ALL WIRE IS (WHT) 20GA. 600V CRC WIRE (9097-274) WITH THE EXCEPTION OF EARTH GROUND, WHICH IS GREEN. 16 GA, UNLESS OTHER WISE NOTED.
10. UNLESS OTHERWISE SPECIFIED, FOR SHIELDED WIRE USE:
    2008-053 20 GA 1 CONDUCTOR SHIELDED WIRE
    2008-055 20 GA 2 CONDUCTOR SHIELDED WIRE
    2008-057 20 GA 3 CONDUCTOR SHIELDED WIRE
    2008-089 20 GA 4 CONDUCTOR SHIELDED WIRE
11. MEASURE INDIVIDUAL WIRES TO LENGTH AND INSTALL ON CORRESPONDING TB POSITION PER THIS DOCUMENT.
12. SECURE CABLE ASSYS TO TIE POINTS AND SIDE MTG ANGLES USING 1609-569 TIE STRAPS.
13. USE CABLE INDEX OF THIS DOCUMENT FOR CABLE IDENTIFICATION.
14. ALL WIRES TO TERMINAL BLOCKS SHALL HAVE WIRE MARKERS; MARKED WITH IDENTIFYING TB NUMBER.
15. CUSTOMER SUPPLIED EQUIPMENT.
16. ALL UNUSED INDIVIDUAL WIRE ENDS (INCLUDING THOSE IN SHIELDED CABLES) TO BE FOLDED BACK AND COVERED WITH SHRINK TUBING.
17. DASHED WIRES ARE INSTALLED BY THE CUSTOMER — — —
18. UNUSED WIRES MAY BE PRESENT IN PREFABRICATED CABLE ASSEMBLIES AND SHOULD BE PROPERLY INSULATED IF NOT USED
19. ALL FIELD TERMINAL MODULES ARE TO BE GROUNDED USING WOODWARD ITEM NUMBER 1604-813 GROUND BLOCK AND GRN/YEL 16 AWG WIRE (2007-731).
20. FOR ALL WIRE CONNECTIONS, WIRE END TERMINALS (FERULES) ARE SUGGESTED.
    24 GA. WIRE, USE 0.25 MM2
    22 GA. WIRE, USE 0.34 MM2
    20 GA. WIRE, USE 0.50 MM2
    18 GA. WIRE, USE 0.75 MM2
    16 GA. WIRE, USE 1.50 MM2
21. SECURE ID LABELS TO MOUNTING PLATE, AND COMPONENTS.
22. DRILL AND TAP PANEL FOR A M6 SCREW. USE SHORT 2007-727 12AWG WIRE, 1602-249 (2X) LUG, 1023-200 FLAT WASHER, 1023-319 SPLITLOCK WASHER AND 1029-431 SCREW. USE EXISTING MOUNTING HARDWARE ON DEVICE END.
23. ATTACH GROUND BAR TO FTM TERMINALS:
    1751-4012 TO 5437-672 FTM
    1751-4014 TO 5501-372 FTM
24. TWIST WIRE TOGETHER (BLK/WHT) AND GND WIRE IF APPLICABLE FROM EACH CB TO DEVICE
25. REFER TO BOM FOR OPTIONAL COMPONENTS.
26. ITEM NOT INCLUDED WHEN ONLY A 8262-____ KIT IS PROVIDED.
27. 20A CIRCUIT BREAKER USED FOR 120VDC/VAC
    10A CIRCUIT BREAKER USED FOR 220VAC
    50A CIRCUIT BREAKER USED FOR 24VDC (USE ALL 8 GA WIRE)
28. THE 5417-293 CABLE SHOULD BE ROUTED BEHIND THE CHASSIS PANEL WITH CONNECTORS ROUTING THROUGH THE PANEL HOLES TO CHASSIS POSTS.
29. POWER AND ETHERNET WIRING TO CCT SHOULD ROUTE UP TO THE TOP OF BACK PANEL,ALONG TOP OF LEFT PANEL, DOWN FRONT OF LEFT PANEL APPROX. 24", THEN ACROSS DOOR TO CCT CONNECTIONS. SECURE WITH WIRE TIES AND TIE WRAP ANCORS AS NEEDED.

WOODWARD		FT. COLLINS COLORADO USA	
TITLE: CONTROL WIRING DIAGRAM 5009XT TMR			
SIZE D	CAGE CODE 7LLB9	DWG NO 9971-2025	REV -
SCALE NTS		SHEET 2 OF 17	

AUTOCAD


STANDARD CONTROL WIRING SYMBOLS AND ABBREVIATIONS
N.C. LIMIT SWITCH
N.O. LIMIT SWITCH
N.C. PRESSURE SWITCH OPENS ON RISING PRESSURE
N.O. PRESSURE SWITCH CLOSES ON RISING PRESSURE
N.C. DIFF. PRESSURE SWITCH OPENS ON RISING OP
N.O. DIFF. PRESSURE SWITCH CLOSES ON RISING OP
N.C. LEVEL SWITCH OPENS ON RISING LEVEL
N.O. LEVEL SWITCH CLOSES ON RISING LEVEL
N.C. TEMPERATURE SWITCH OPENS ON RISING TEMPERATURE
N.O. TEMPERATURE SWITCH CLOSES ON RISING TEMPERATURE
NO C
PUSH BUTTON SWITCH
NC C
MOMENTARY SWITCH
N.O. SWITCH
N.C. SWITCH
3 POSITION MOMENTARY SWITCH
CONTACT CLOSED
CONTACT OPEN
THERMAL MECHANICAL ELEMENT
THERMAL OVERLOAD
THERMOCOUPLE
RESISTANCE TEMPERATURE DETECTOR (RTD)
RESISTOR
VARIABLE RESISTOR
2 INPUT MPU
3 INPUT MPU
RELAY COIL
INTERPOSING RELAY
SOLENOID
INDICATOR
LAMP
LED
A = INPUT
Z = OUTPUT
A
Z
TRANSMITTER
TERMINAL BLOCK WITH FUSE
FUSE
DIODE
SIGNAL GROUND
EARTH GROUND
CHASSIS GROUND
CIRCUIT BREAKER
POTENTIAL TRANSFORMER
CURRENT TRANSFORMER
TERMINAL BLOCK
SCREW TERMINAL BLOCK
CONDUIT WIRE GROUP
WIRE SHIELD
WIRE CONNECTION INDICATOR
CABLE END
AC
ACCELEROMETER PROBE
PP
PROXIMITY PROBE
VP
VELOCITY PROBE
INPUT & OUTPUT LEGEND
P – PRESSURE
PD – DIFFERENTIAL PRESSURE
L – LEVEL
T – TEMPERATURE
Z – POSITION
F – FLOW
S – FREQUENCY OR SPEED
I – CURRENT
E – VOLTAGE
Y – VIBRATION
MISCELLANEOUS ABBREVIATIONS
AX – MODULE NUMBER X (e.g. CHASSIS, POWER SUPPLY, ETC.)
DSLC – DIGITAL SYNCHRONIZER AND LOAD CONTROL
FTM – FIELD TERMINAL MODULE
FTR – FAULT TOLERANT RELAY
FU – FUSE
JB – JUNCTION BOX
LNM – LINKNET MODULE
MCC – MOTOR CONTROL CENTER
OCP – OPERATOR CONTROL PANEL
RB – RELAY BOX
RPS – REAL POWER SENCOR
WXYY – NETCON CABLE FROM CHASSIS X, SLOT YY
WOODWARD
FT. COLLINS COLORADO USA
TITLE
CONTROL WIRING DIAGRAM
5009XT TMR
SIZE D
CAGE CODE 7LLB9
DWG NO 9971-2025
REV -
SCALE NTS
SHEET 3 OF 17
AUTOCAD
Production
8 7 6 5 4 3 2 1
D C B A

SHEET NUMBER	DESIGNATION	DESCRIPTION	
SHEET 1		COVER SHEET	MAY-2019
SHEET 2		NOTES SHEET	MAY-2019
SHEET 3		SYMBOL LEGEND SHEET	MAY-2019
SHEET 4		SHEET INDEX SHEET	MAY-2019
SHEET 5		CABLE / FTM SHEET	MAY-2019
SHEET 6		POWER DISTRIBUTION SHEET	MAY-2019
SHEET 7		5009FT CHASSIS LAYOUT	MAY-2019
SHEET 8	FTM103-1	SPEED AIO COMBO SPEED INPUTS	MAY-2019
SHEET 9	FTM103-2	SPEED AIO COMBO INPUTS	MAY-2019
SHEET 10	FTM103-2	SPEED AIO COMBO OUTPUTS	MAY-2019
SHEET 11	FTM104-1A	FT RELAY MODULE DISCRETE INPUTS / OUTPUTS	MAY-2019
SHEET 12	FTM104-1B	FT RELAY MODULE DISCRETE INPUTS / OUTPUTS	MAY-2019
SHEET 13	FTM104-2A	FT RELAY MODULE DISCRETE INPUTS / OUTPUTS	MAY-2019
SHEET 14	FTM104-2B	FT RELAY MODULE DISCRETE INPUTS / OUTPUTS	MAY-2019
SHEET 15	FTM106-1	ANALOG HD TMR ANALOG INPUTS	MAY-2019
SHEET 16	FTM106-2	ANALOG HD TMR ANALOG INPUTS	MAY-2019
SHEET 17			MAY-2019
SHEET 18			
SHEET 19			
SHEET 20			
SHEET 21			
SHEET 22			
SHEET 23			
SHEET 24			
SHEET 25			
SHEET 26			
SHEET 27			
SHEET 28			
SHEET 29			
SHEET 30			
SHEET 31			
SHEET 32			
SHEET 33			
SHEET 34			
SHEET 35			
SHEET 36			
SHEET 37			
SHEET 38			
SHEET 39			

SHEET NUMBER	DESIGNATION	DESCRIPTION	
SHEET 40			
SHEET 41			
SHEET 42			

WOODWARD FT. COLLINS COLORADO USA

TITLE CONTROL WIRING DIAGRAM
5009XT TMR

SIZE	CAGE CODE	DWG NO	REV
D	7LLB9	9971-2025	-
SCALE NTS		SHEET 4 OF 17	

AUTOCAD

Production

		FROM	TO	FIELD
CABLE P/N	CABLE DESIGNATION	MODULE/CONNECTOR	FIELD TERMINATION/CONNECTOR	TERMINATION P/N
5416-977	W101-1	PS1-PS CHASSIS	A1 - TMR CHASSIS	
28 5417-293	W101-2	PS1- POSTS ON BACK	A1 TMR CHASSIS - POSTS ON BACK	
5417-026	W103-A1	KERNEL A-A3/J1	FTM103-1/J1	5501-502
5417-172	W103-A2	KERNEL A-A3/J2	FTM103-2/J1	5501-372
5417-172	W104-A1	KERNEL A-A4/J1	FTM104-1A/J1	5453-276
5417-172	W104-A2	KERNEL A-A4/J2	FTM104-2A/J1	5453-276
	RESERVED			
	RESERVED			
5417-039	W106-A	KERNEL A-A6/J1	FTM106-1/J1	5437-672
5417-1512	W102-B-CAN2	KERNEL B-A2/CAN2	CAN NETWORK TEE	1635-2548
5417-026	W103-B1	KERNEL B-A3/J1	FTM103-1/J2	
5417-172	W103-B2	KERNEL B-A3/J2	FTM103-2/J2	
5417-172	W104-B1	KERNEL B-A4/J1	FTM104-1A/J2	
5417-172	W104-B2	KERNEL B-A4/J2	FTM104-2A/J2	
5417-172	RESERVED		FTM105-1/J2	
5417-173	RESERVED		FTM105-2/J2	
5417-039	W106-B	KERNEL B-A6/J1	FTM106-2/J1	5437-672
5417-1512	W102-C-CAN2	KERNEL C-A2/CAN2	CAN NETWORK TEE	1635-2548
5417-026	W103-C1	KERNEL C-A3/J1	FTM103-1/J3	
5417-172	W103-C2	KERNEL C-A3/J2	FTM103-2/J3	
5417-172	W104-C1	KERNEL C-A4/J1	FTM104-1A/J3	
5417-172	W104-C2	KERNEL C-A4/J2	FTM104-2A/J3	
5417-019	W104-1AB-7	FTM104-1A/J7	FTM104-1B/J4	
5417-019	W104-1AB-8	FTM104-1A/J8	FTM104-1B/J5	
5417-019	W104-1AB-9	FTM104-1A/J9	FTM104-1B/J6	
5417-019	W104-2AB-7	FTM104-2A/J7	FTM104-2B/J4	
5417-019	W104-2AB-8	FTM104-2A/J8	FTM104-2B/J5	
5417-019	W104-2AB-9	FTM104-2A/J9	FTM104-2B/J6	
5417-1513	W102-B-SPC11	KB CAN TEE	SPC11	
5417-1513	W102-C-SPC21	KC CAN TEE	SPC21	

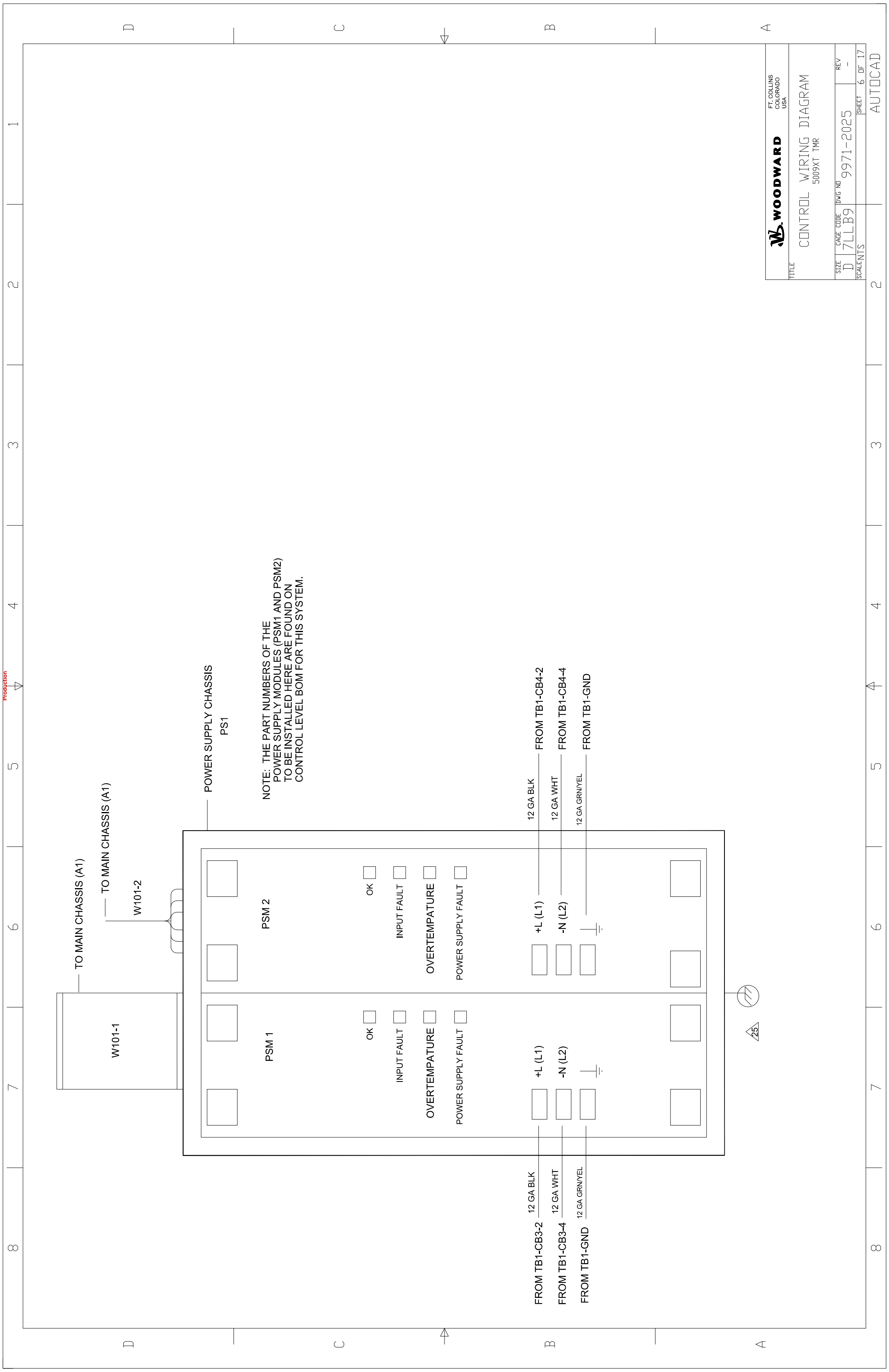
WOODWARD FT. COLLINS COLORADO USA

TITLE CONTROL WIRING DIAGRAM
5009XT TMR

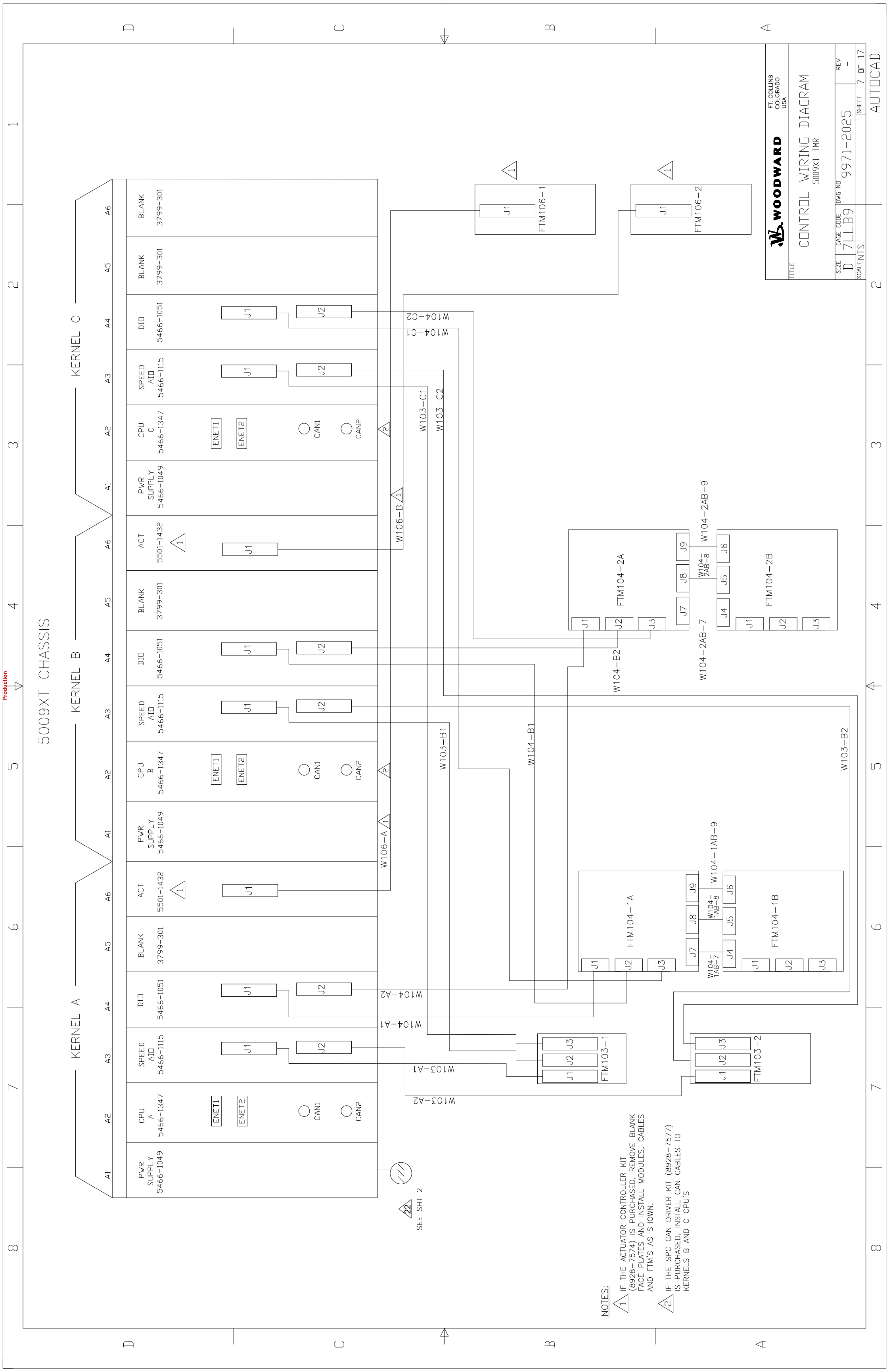
SIZE	CAGE CODE	DWG NO	REV
D	7LLB9	9971-2025	-
SCALE NTS		SHEET 5 OF 17	

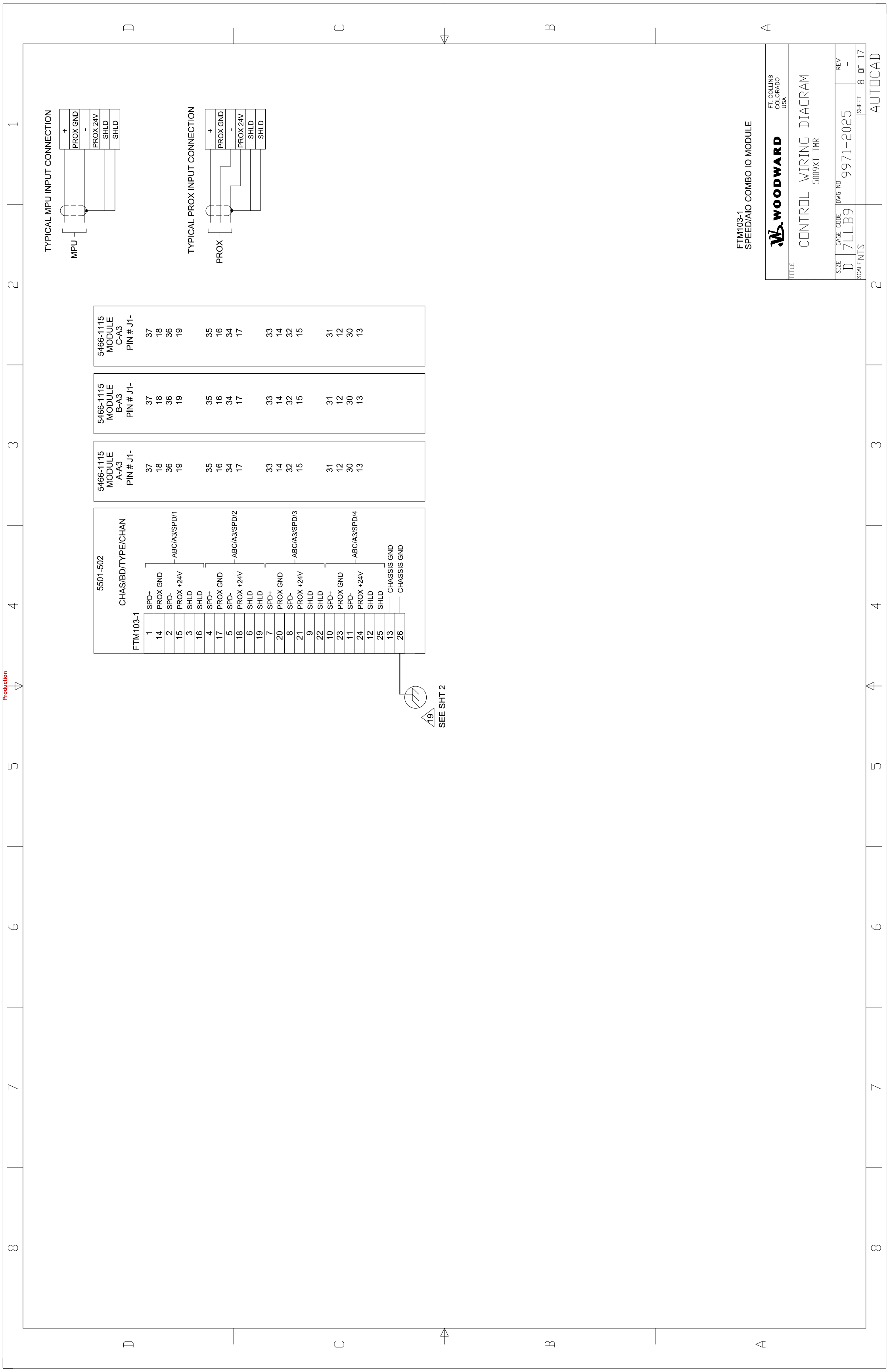
AUTOCAD

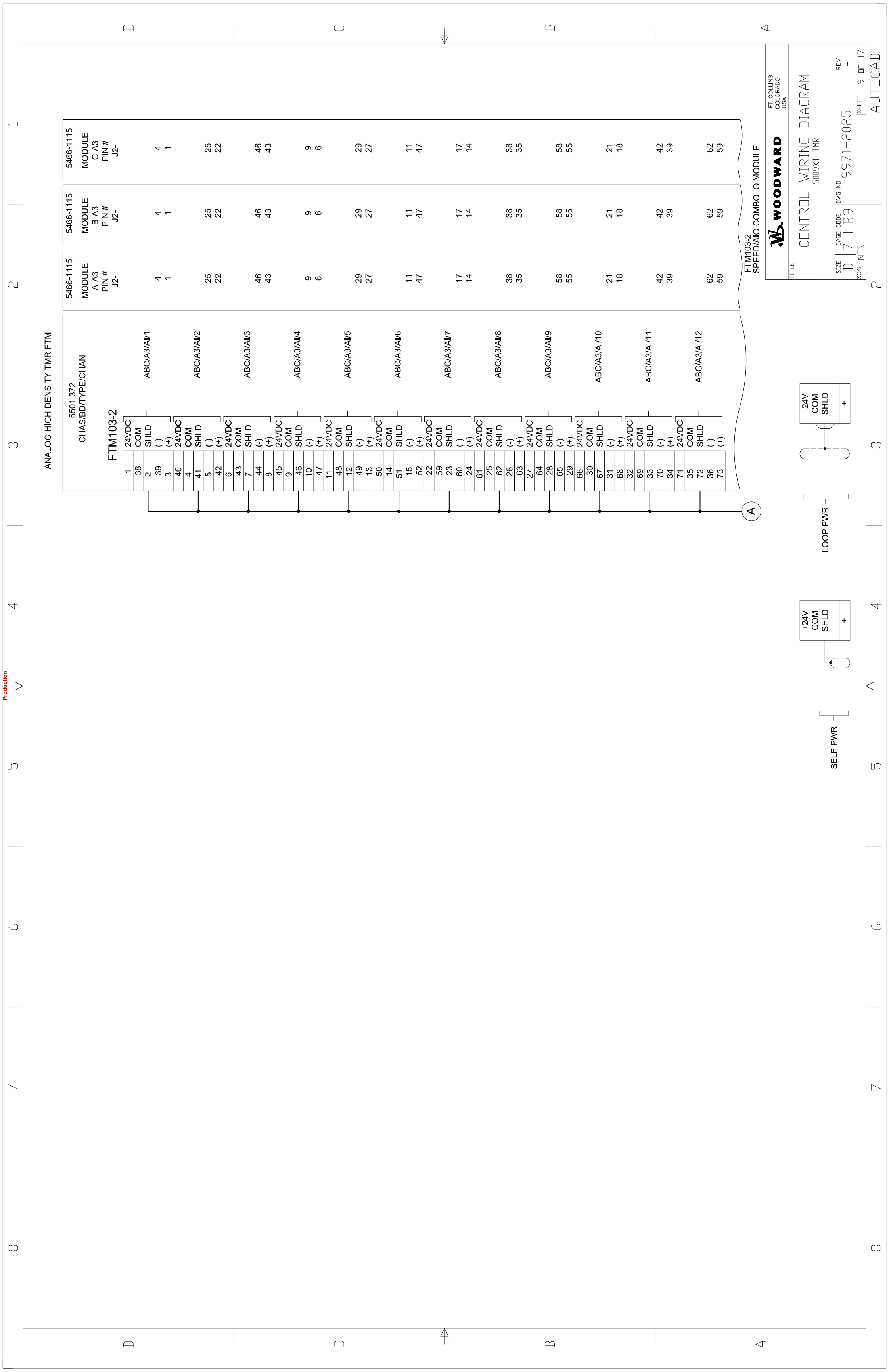
Released



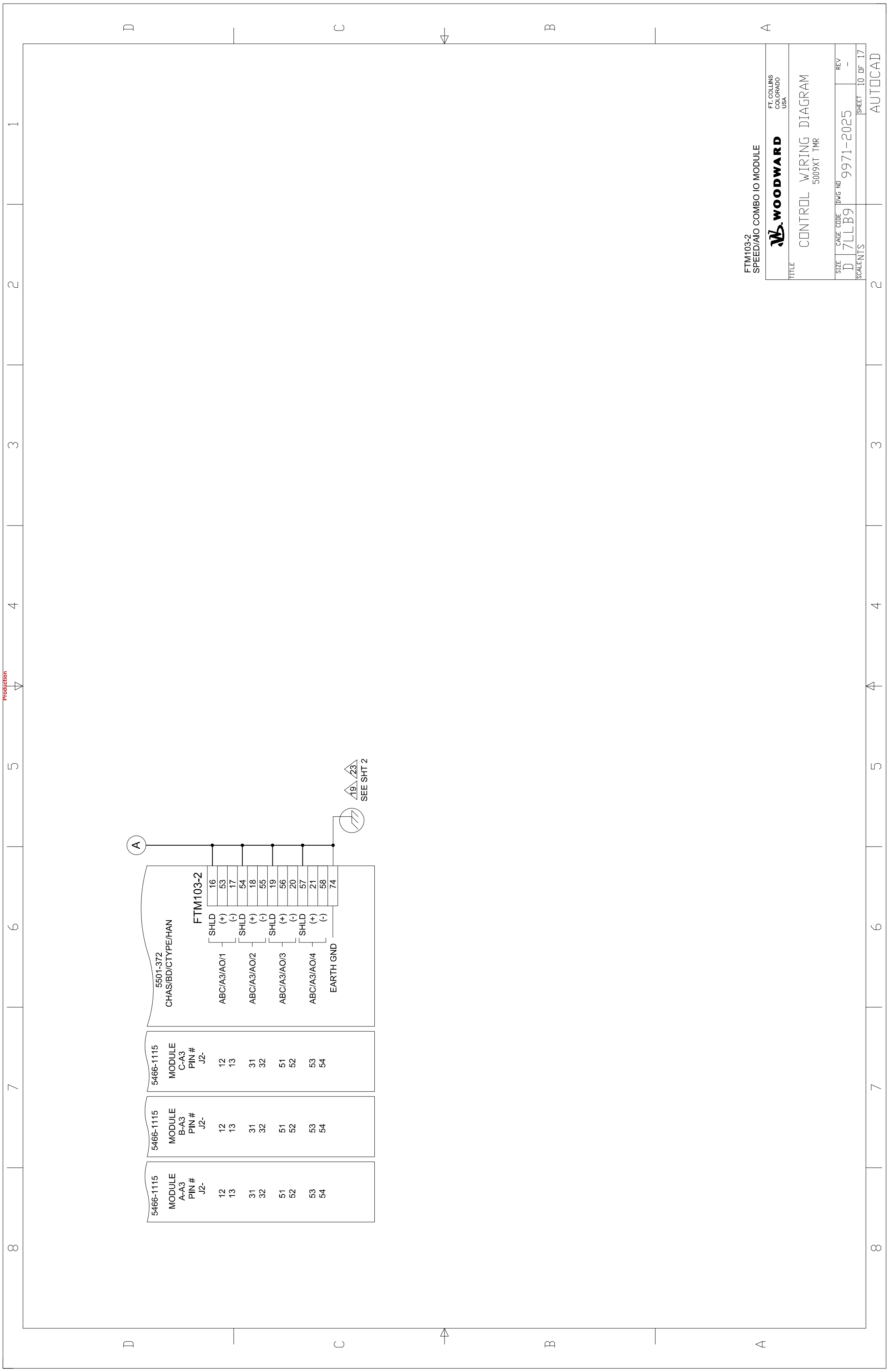
POWER SUPPLY CHASSIS
PS1
NOTE: THE PART NUMBERS OF THE POWER SUPPLY MODULES (PSM1 AND PSM2) TO BE INSTALLED HERE ARE FOUND ON CONTROL LEVEL BOM FOR THIS SYSTEM.
TO MAIN CHASSIS (A1)
TO MAIN CHASSIS (A1)
W101-2
W101-1
PSM 2
PSM 1
OK
INPUT FAULT
OVERTEMPATURE
POWER SUPPLY FAULT
+L (L1)
-N (L2)
12 GA BLK
12 GA WHT
12 GA GRN/YEL
FROM TB1-CB4-2
FROM TB1-CB4-4
FROM TB1-GND
FROM TB1-CB3-2
FROM TB1-CB3-4
FROM TB1-GND
25
Production
WOODWARD
FT. COLLINS COLORADO USA
TITLE
CONTROL WIRING DIAGRAM
5009XT TMR
SIZE D
CAGE CODE 7LLB9
DWG NO 9971-2025
REV -
SCALE NTS
SHEET 6 OF 17
AUTOCAD

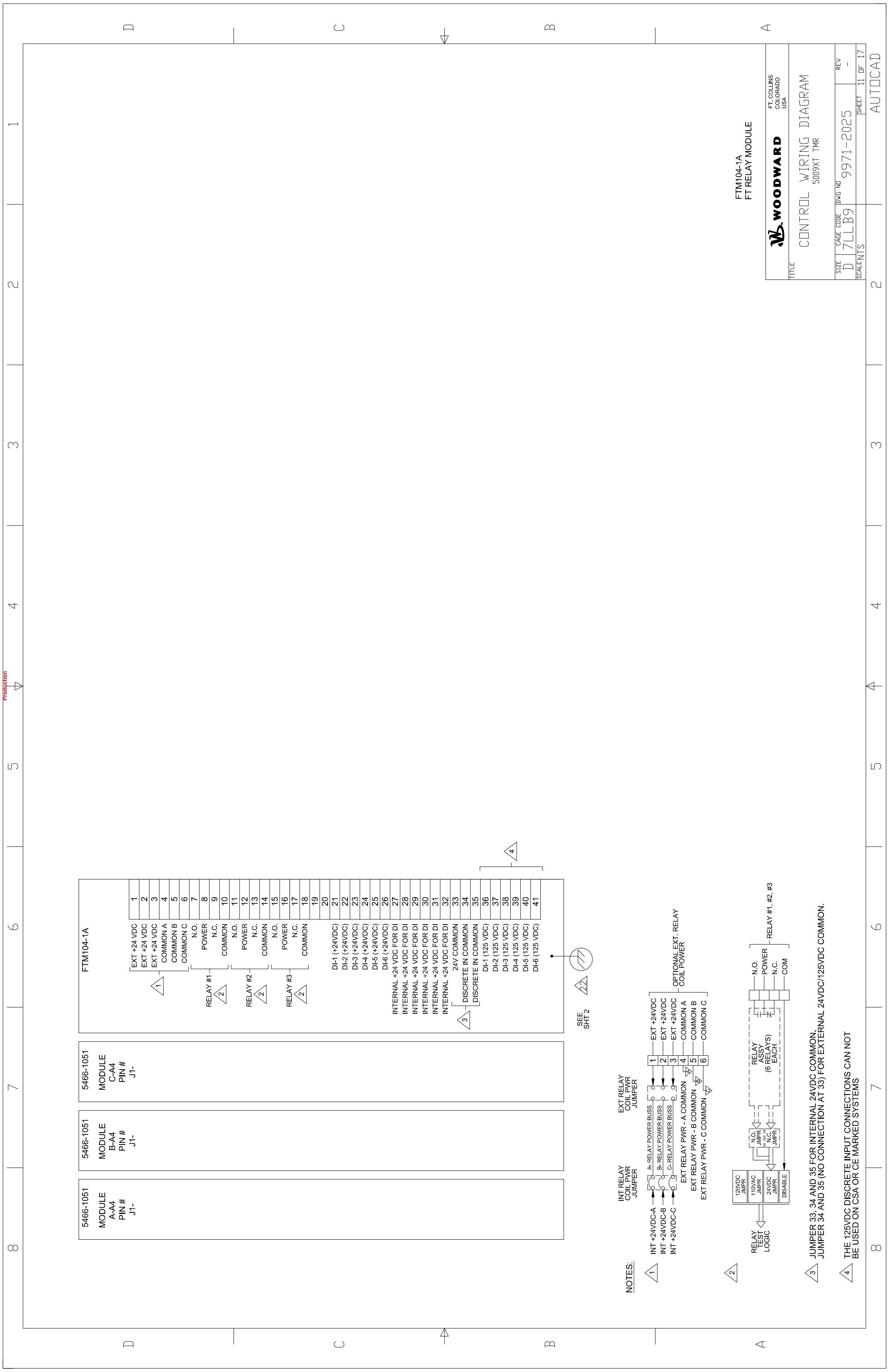

5009XT CHASSIS
KERNEL A
KERNEL B
KERNEL C
PWR SUPPLY 5466-1049
CPU A 5466-1347
CPU B 5466-1347
CPU C 5466-1347
ENET1
ENET2
CAN1
CAN2
SPEED AID 5466-1115
DIO 5466-1051
BLANK 3799-301
ACT 5501-1432
FTM106-1
FTM106-2
FTM104-1A
FTM104-1B
FTM104-2A
FTM104-2B
FTM103-1
FTM103-2
W103-A1
W103-A2
W103-B1
W103-B2
W103-C1
W103-C2
W104-A1
W104-A2
W104-B1
W104-B2
W104-C1
W104-C2
W106-A
W106-B
W104-1AB-7
W104-1AB-8
W104-1AB-9
W104-2AB-7
W104-2AB-8
W104-2AB-9
SEE SHT 2
NOTES:
1 IF THE ACTUATOR CONTROLLER KIT (8928-7574) IS PURCHASED, REMOVE BLANK FACE PLATES AND INSTALL MODULES, CABLES AND FTM'S AS SHOWN.
2 IF THE SPC CAN DRIVER KIT (8928-7577) IS PURCHASED, INSTALL CAN CABLES TO KERNELS B AND C CPU'S
WOODWARD
FT. COLLINS COLORADO USA
TITLE
CONTROL WIRING DIAGRAM
5009XT TMR
SIZE D
CAGE CODE 7LLB9
DWG NO 9971-2025
REV -
SCALE NTS
SHEET 7 OF 17
AUTOCAD

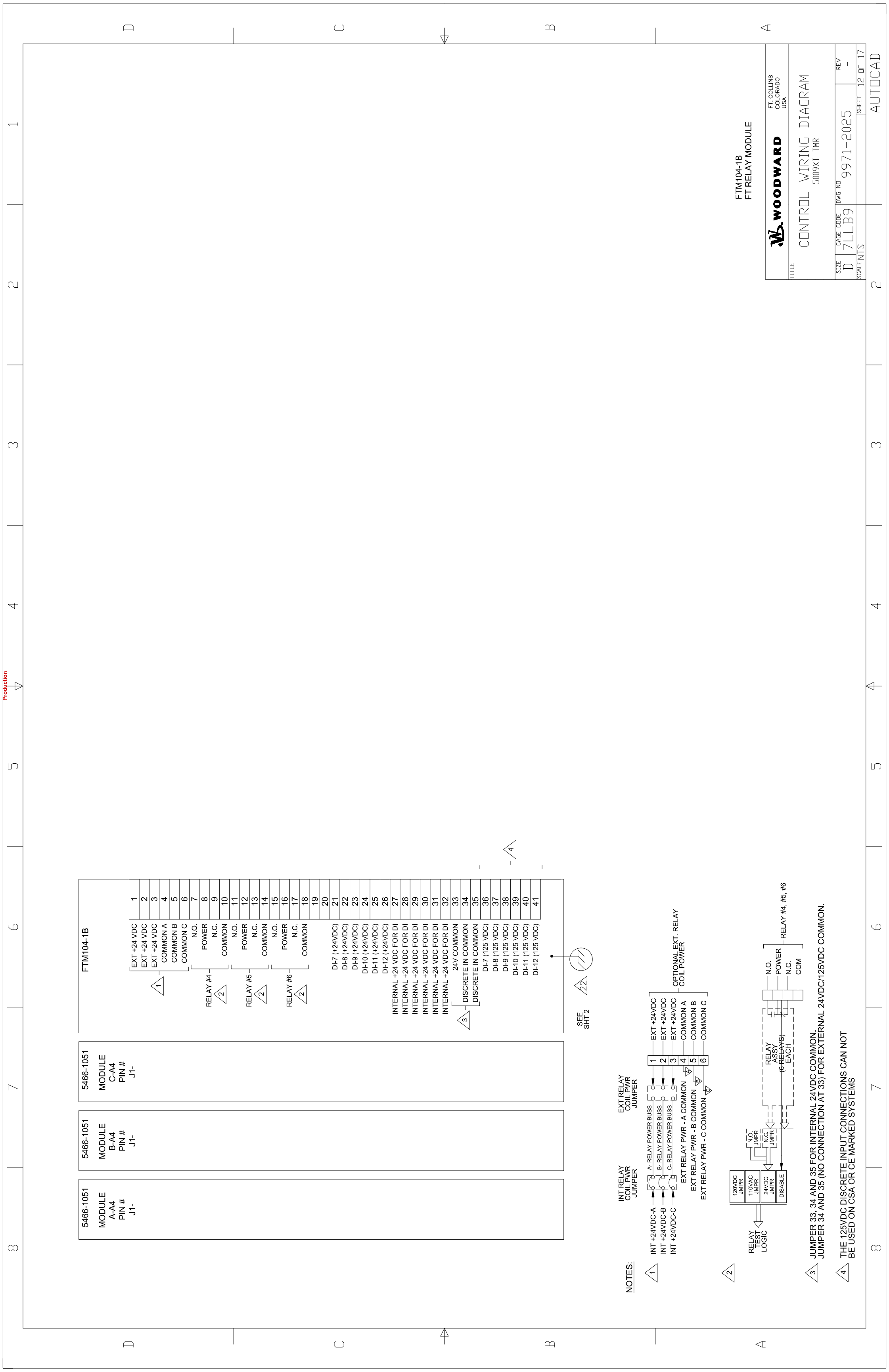

TYPICAL MPU INPUT CONNECTION
MPU
+
PROX GND
-
PROX 24V
SHLD
SHLD
TYPICAL PROX INPUT CONNECTION
PROX
FTM103-1
SPEED/AIO COMBO IO MODULE
WOODWARD
FT. COLLINS COLORADO USA
CONTROL WIRING DIAGRAM
5009XT TMR
D 7LLB9 9971-2025
SHEET 8 OF 17
AUTOCAD
5466-1115 MODULE C-A3 PIN # J1-
5466-1115 MODULE B-A3 PIN # J1-
5466-1115 MODULE A-A3 PIN # J1-
5501-502
CHAS/BD/TYPE/CHAN
FTM103-1
ABC/A3/SPD/1
ABC/A3/SPD/2
ABC/A3/SPD/3
ABC/A3/SPD/4
SPD+
PROX GND
SPD-
PROX +24V
SHLD
CHASSIS GND
SEE SHT 2

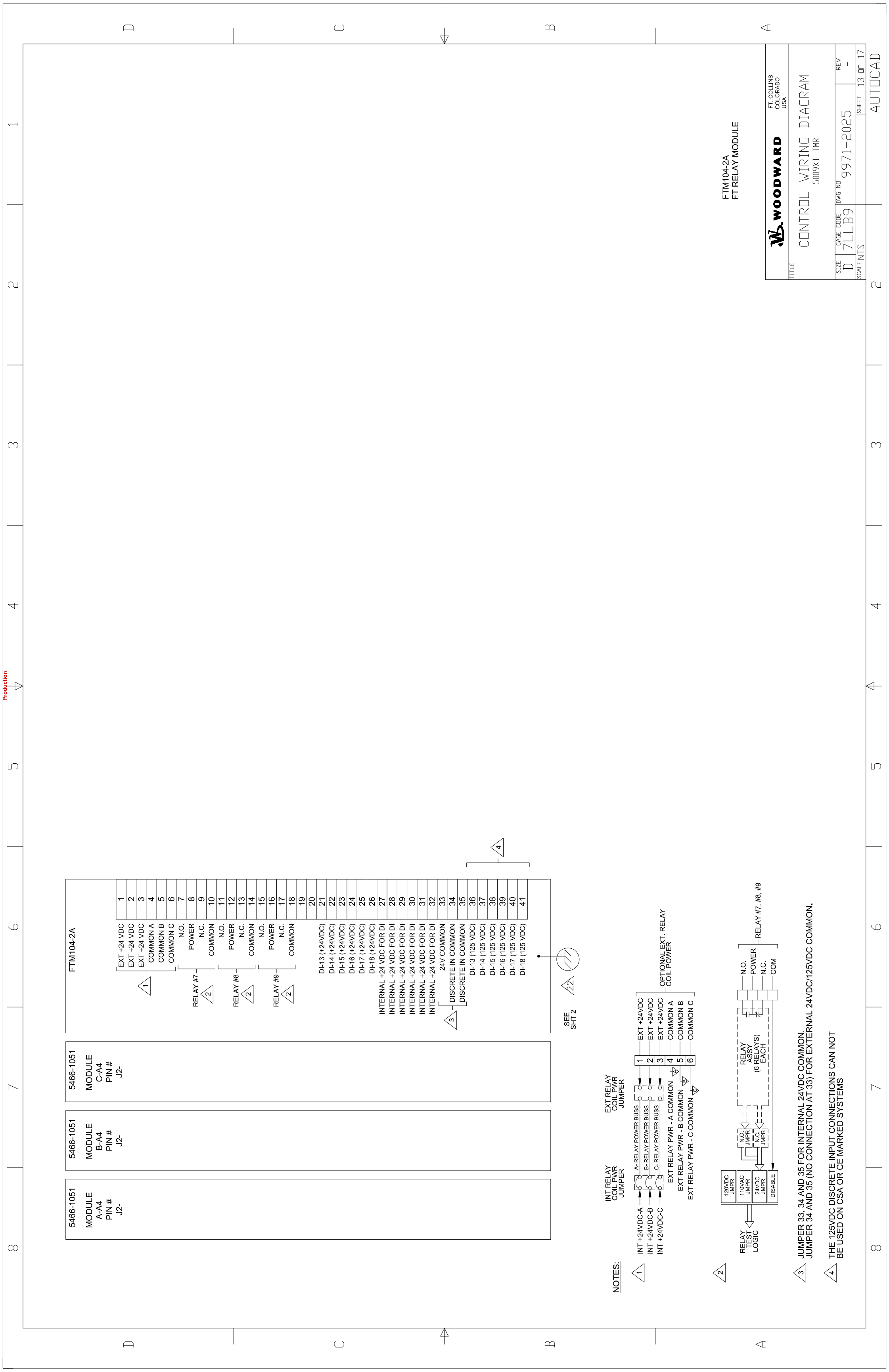

ANALOG HIGH DENSITY TMR FTM
5501-372
CHAS/BD/TYPE/CHAN
FTM103-2
5466-1115 MODULE A-A3 PIN # J2-
5466-1115 MODULE B-A3 PIN # J2-
5466-1115 MODULE C-A3 PIN # J2-
FTM103-2 SPEED/AIO COMBO IO MODULE
ABC/A3/AI/1
ABC/A3/AI/2
ABC/A3/AI/3
ABC/A3/AI/4
ABC/A3/AI/5
ABC/A3/AI/6
ABC/A3/AI/7
ABC/A3/AI/8
ABC/A3/AI/9
ABC/A3/AI/10
ABC/A3/AI/11
ABC/A3/AI/12
LOOP PWR
SELF PWR
+24V COM SHLD - +
WOODWARD
FT. COLLINS COLORADO USA
CONTROL WIRING DIAGRAM
5009XT TMR
D 7LLB9 9971-2025
SHEET 9 OF 17
AUTOCAD

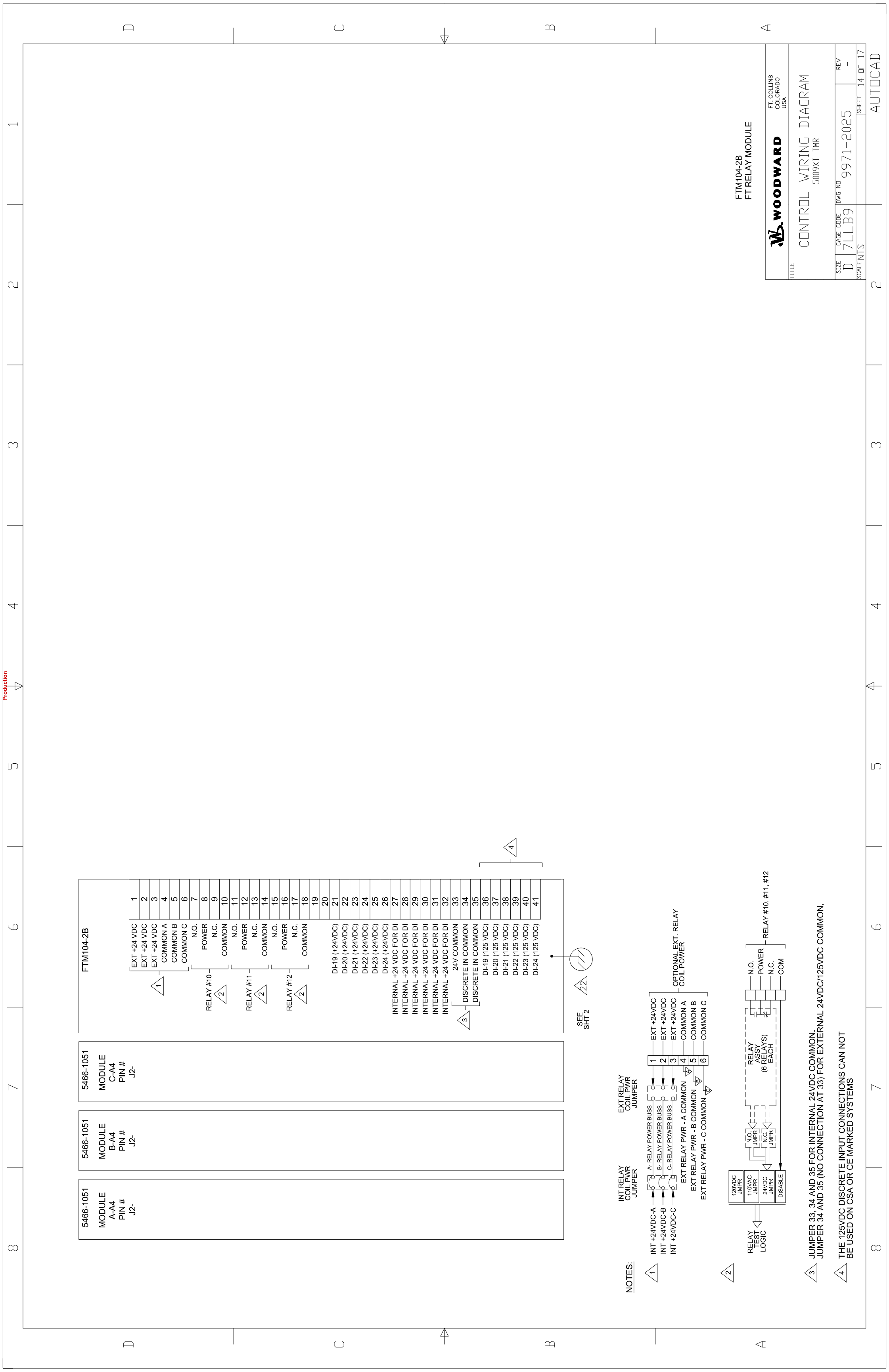
Released

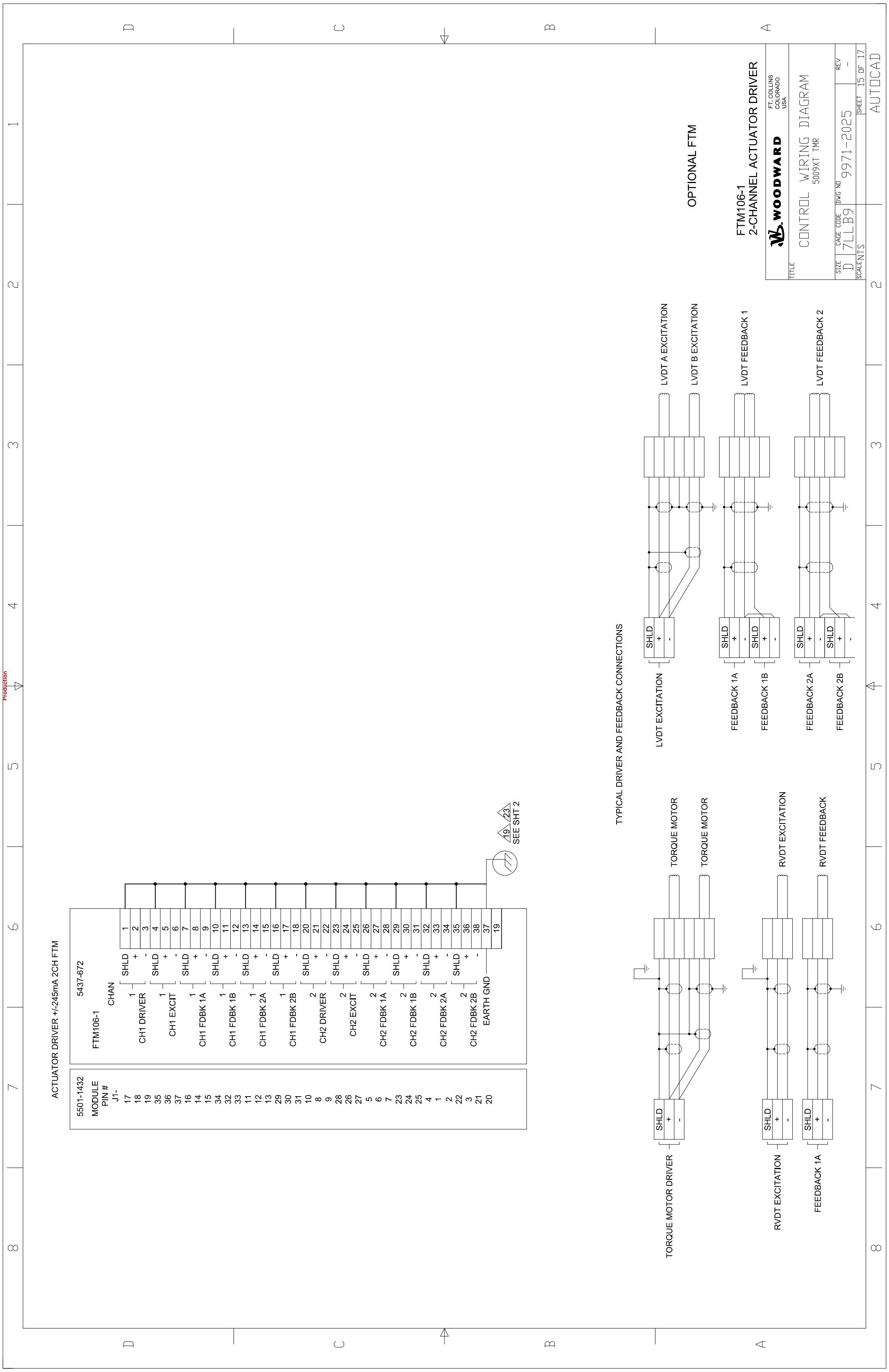

FTM103-2
SPEED/AIO COMBO IO MODULE
WOODWARD
FT. COLLINS COLORADO USA
TITLE
CONTROL WIRING DIAGRAM
5009XT TMR
SIZE D
CAGE CODE 7LLB9
DWG NO 9971-2025
REV -
SCALE NTS
SHEET 10 OF 17
AUTOCAD
5466-1115 MODULE A-A3 PIN # J2-
5466-1115 MODULE B-A3 PIN # J2-
5466-1115 MODULE C-A3 PIN # J2-
12 13 31 32 51 52 53 54
5501-372 CHAS/BD/CTYPE/HAN
FTM103-2
ABC/A3/AO/1
ABC/A3/AO/2
ABC/A3/AO/3
ABC/A3/AO/4
EARTH GND
SHLD (+) (-)
16 53 17 54 18 55 19 56 20 57 21 58 74
A
19 23 SEE SHT 2
Production

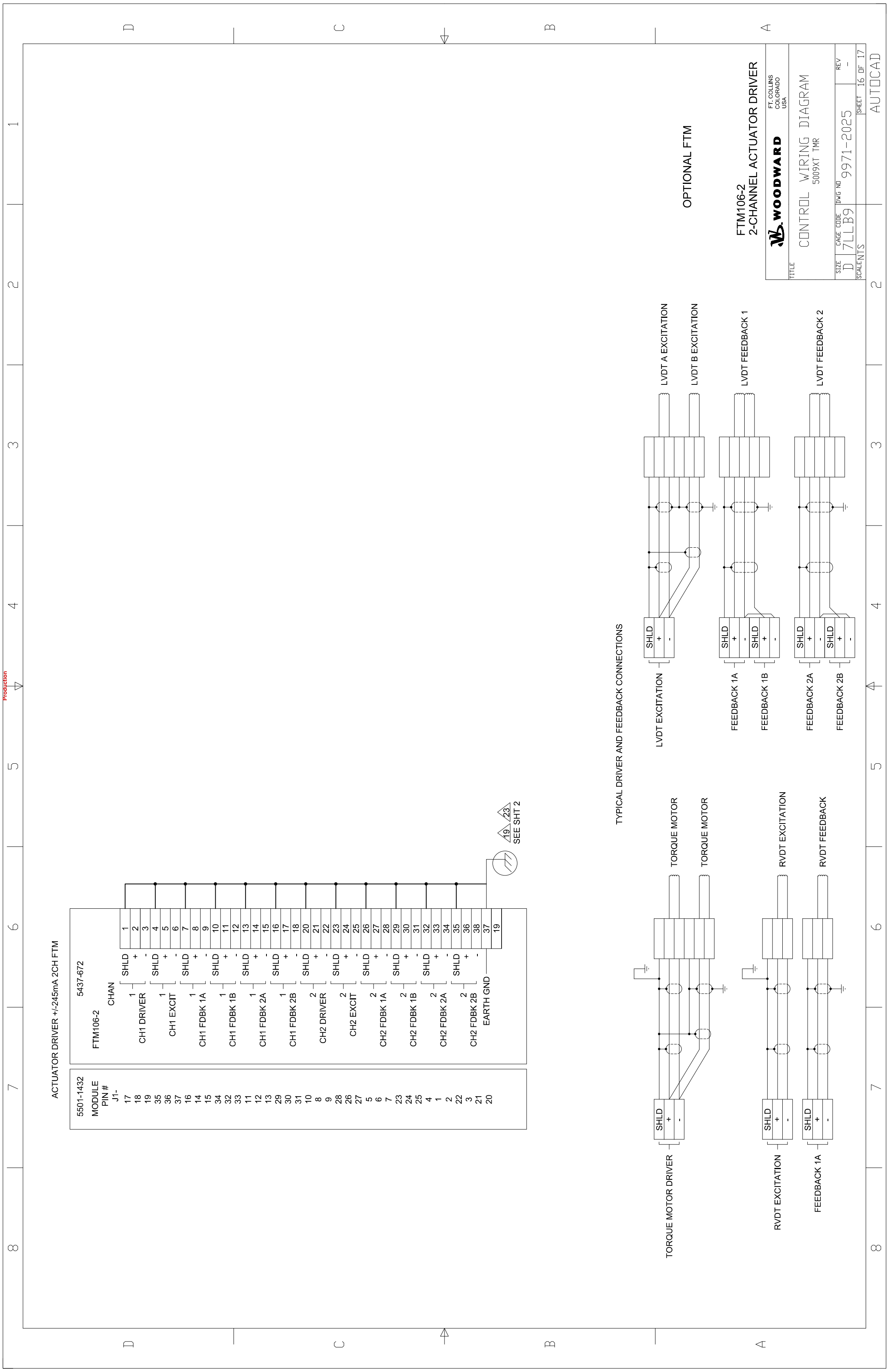

FTM104-1A
FT RELAY MODULE
WOODWARD
FT. COLLINS COLORADO USA
CONTROL WIRING DIAGRAM
5009XT TMR
D
7LLB9
9971-2025
SHEET 11 OF 17
AUTOCAD
FTM104-1A
5466-1051 MODULE C-A4 PIN # J1-
5466-1051 MODULE B-A4 PIN # J1-
5466-1051 MODULE A-A4 PIN # J1-
EXT +24 VDC
COMMON A
COMMON B
COMMON C
N.O.
POWER
N.C.
COMMON
RELAY #1
RELAY #2
RELAY #3
DI-1 (+24VDC)
DI-2 (+24VDC)
DI-3 (+24VDC)
DI-4 (+24VDC)
DI-5 (+24VDC)
DI-6 (+24VDC)
INTERNAL +24 VDC FOR DI
24V COMMON
DISCRETE IN COMMON
DI-1 (125 VDC)
DI-2 (125 VDC)
DI-3 (125 VDC)
DI-4 (125 VDC)
DI-5 (125 VDC)
DI-6 (125 VDC)
SEE SHT 2
NOTES:
INT +24VDC-A
INT +24VDC-B
INT +24VDC-C
INT RELAY COIL PWR JUMPER
EXT RELAY COIL PWR JUMPER
A- RELAY POWER BUSS
B- RELAY POWER BUSS
C- RELAY POWER BUSS
EXT RELAY PWR - A COMMON
EXT RELAY PWR - B COMMON
EXT RELAY PWR - C COMMON
EXT +24VDC
OPTIONAL EXT. RELAY COIL POWER
RELAY TEST LOGIC
120VDC JMPR
110VAC JMPR
24VDC JMPR
DISABLE
RELAY ASSY (6 RELAYS) EACH
N.O. JMPR
N.C. JMPR
COM
RELAY #1, #2, #3
JUMPER 33, 34 AND 35 FOR INTERNAL 24VDC COMMON.
JUMPER 34 AND 35 (NO CONNECTION AT 33) FOR EXTERNAL 24VDC/125VDC COMMON.
THE 125VDC DISCRETE INPUT CONNECTIONS CAN NOT BE USED ON CSA OR CE MARKED SYSTEMS

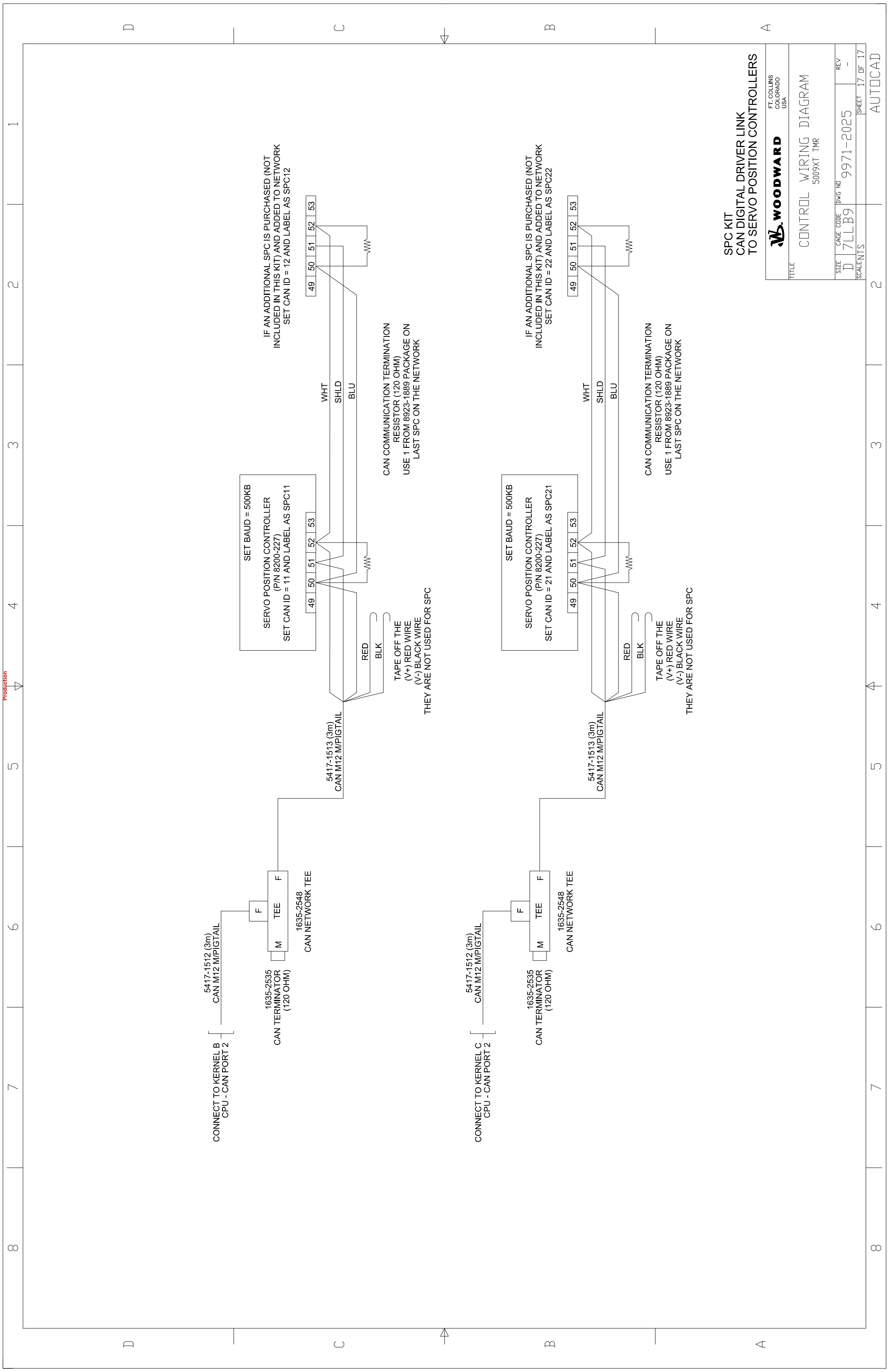

5466-1051
MODULE
A-A4
PIN #
J1-
5466-1051
MODULE
B-A4
PIN #
J1-
5466-1051
MODULE
C-A4
PIN #
J1-
FTM104-1B
EXT +24 VDC 1
EXT +24 VDC 2
EXT +24 VDC 3
COMMON A 4
COMMON B 5
COMMON C 6
RELAY #4
N.O. 7
POWER 8
N.C. 9
COMMON 10
RELAY #5
N.O. 11
POWER 12
N.C. 13
COMMON 14
RELAY #6
N.O. 15
POWER 16
N.C. 17
COMMON 18
19
20
DI-7 (+24VDC) 21
DI-8 (+24VDC) 22
DI-9 (+24VDC) 23
DI-10 (+24VDC) 24
DI-11 (+24VDC) 25
DI-12 (+24VDC) 26
INTERNAL +24 VDC FOR DI 27
INTERNAL +24 VDC FOR DI 28
INTERNAL +24 VDC FOR DI 29
INTERNAL +24 VDC FOR DI 30
INTERNAL +24 VDC FOR DI 31
INTERNAL +24 VDC FOR DI 32
24V COMMON 33
DISCRETE IN COMMON 34
DISCRETE IN COMMON 35
DI-7 (125 VDC) 36
DI-8 (125 VDC) 37
DI-9 (125 VDC) 38
DI-10 (125 VDC) 39
DI-11 (125 VDC) 40
DI-12 (125 VDC) 41
SEE SHT 2
NOTES:
INT RELAY COIL PWR JUMPER
EXT RELAY COIL PWR JUMPER
INT +24VDC-A
INT +24VDC-B
INT +24VDC-C
A- RELAY POWER BUSS
B- RELAY POWER BUSS
C- RELAY POWER BUSS
EXT RELAY PWR - A COMMON
EXT RELAY PWR - B COMMON
EXT RELAY PWR - C COMMON
EXT +24VDC
EXT +24VDC
EXT +24VDC
COMMON A
COMMON B
COMMON C
OPTIONAL EXT. RELAY COIL POWER
RELAY TEST LOGIC
120VDC JMPR
110VAC JMPR
24VDC JMPR
DISABLE
N.O. JMPR
N.C. JMPR
RELAY ASSY (6 RELAYS) EACH
N.O.
POWER
N.C.
COM
RELAY #4, #5, #6
JUMPER 33, 34 AND 35 FOR INTERNAL 24VDC COMMON.
JUMPER 34 AND 35 (NO CONNECTION AT 33) FOR EXTERNAL 24VDC/125VDC COMMON.
THE 125VDC DISCRETE INPUT CONNECTIONS CAN NOT BE USED ON CSA OR CE MARKED SYSTEMS
FTM104-1B
FT RELAY MODULE
WOODWARD
FT. COLLINS COLORADO USA
TITLE
CONTROL WIRING DIAGRAM
5009XT TMR
SIZE D
CAGE CODE 7LLB9
DWG NO 9971-2025
REV -
SCALE NTS
SHEET 12 OF 17
AUTOCAD


FTM104-2A
FT RELAY MODULE
5466-1051 MODULE A-A4 PIN # J2-
5466-1051 MODULE B-A4 PIN # J2-
5466-1051 MODULE C-A4 PIN # J2-
EXT +24 VDC 1
EXT +24 VDC 2
EXT +24 VDC 3
COMMON A 4
COMMON B 5
COMMON C 6
RELAY #7 N.O. 7 POWER 8 N.C. 9 COMMON 10
RELAY #8 N.O. 11 POWER 12 N.C. 13 COMMON 14
RELAY #9 N.O. 15 POWER 16 N.C. 17 COMMON 18
DI-13 (+24VDC) 21
DI-14 (+24VDC) 22
DI-15 (+24VDC) 23
DI-16 (+24VDC) 24
DI-17 (+24VDC) 25
DI-18 (+24VDC) 26
INTERNAL +24 VDC FOR DI 27-32
24V COMMON 33
DISCRETE IN COMMON 34
DISCRETE IN COMMON 35
DI-13 (125 VDC) 36
DI-14 (125 VDC) 37
DI-15 (125 VDC) 38
DI-16 (125 VDC) 39
DI-17 (125 VDC) 40
DI-18 (125 VDC) 41
SEE SHT 2
NOTES:
INT +24VDC-A
INT +24VDC-B
INT +24VDC-C
INT RELAY COIL PWR JUMPER
EXT RELAY COIL PWR JUMPER
A- RELAY POWER BUSS
B- RELAY POWER BUSS
C- RELAY POWER BUSS
EXT RELAY PWR - A COMMON
EXT RELAY PWR - B COMMON
EXT RELAY PWR - C COMMON
OPTIONAL EXT. RELAY COIL POWER
RELAY TEST LOGIC
120VDC JMPR
110VAC JMPR
24VDC JMPR
DISABLE
N.O. JMPR
N.C. JMPR
RELAY ASSY (6 RELAYS) EACH
N.O. POWER N.C. COM
RELAY #7, #8, #9
JUMPER 33, 34 AND 35 FOR INTERNAL 24VDC COMMON.
JUMPER 34 AND 35 (NO CONNECTION AT 33) FOR EXTERNAL 24VDC/125VDC COMMON.
THE 125VDC DISCRETE INPUT CONNECTIONS CAN NOT BE USED ON CSA OR CE MARKED SYSTEMS
WOODWARD
FT. COLLINS COLORADO USA
CONTROL WIRING DIAGRAM
5009XT TMR
SIZE D
CAGE CODE 7LLB9
DWG NO 9971-2025
REV -
SCALE NTS
SHEET 13 OF 17
AUTOCAD


FTM104-2B
FT RELAY MODULE
WOODWARD
FT. COLLINS COLORADO USA
CONTROL WIRING DIAGRAM
5009XT TMR
SIZE D
CAGE CODE 7LLB9
DWG NO 9971-2025
REV -
SCALE NTS
SHEET 14 OF 17
AUTOCAD
FTM104-2B
EXT +24 VDC
EXT +24 VDC
EXT +24 VDC
COMMON A
COMMON B
COMMON C
N.O.
POWER
N.C.
COMMON
RELAY #10
RELAY #11
RELAY #12
DI-19 (+24VDC)
DI-20 (+24VDC)
DI-21 (+24VDC)
DI-22 (+24VDC)
DI-23 (+24VDC)
DI-24 (+24VDC)
INTERNAL +24 VDC FOR DI
24V COMMON
DISCRETE IN COMMON
DI-19 (125 VDC)
DI-20 (125 VDC)
DI-21 (125 VDC)
DI-22 (125 VDC)
DI-23 (125 VDC)
DI-24 (125 VDC)
SEE SHT 2
5466-1051 MODULE C-A4 PIN # J2-
5466-1051 MODULE B-A4 PIN # J2-
5466-1051 MODULE A-A4 PIN # J2-
NOTES:
INT +24VDC-A
INT +24VDC-B
INT +24VDC-C
INT RELAY COIL PWR JUMPER
EXT RELAY COIL PWR JUMPER
A- RELAY POWER BUSS
B- RELAY POWER BUSS
C- RELAY POWER BUSS
EXT RELAY PWR - A COMMON
EXT RELAY PWR - B COMMON
EXT RELAY PWR - C COMMON
OPTIONAL EXT. RELAY COIL POWER
RELAY TEST LOGIC
120VDC JMPR
110VAC JMPR
24VDC JMPR
DISABLE
RELAY ASSY (6 RELAYS) EACH
RELAY #10, #11, #12
COM
JUMPER 33, 34 AND 35 FOR INTERNAL 24VDC COMMON.
JUMPER 34 AND 35 (NO CONNECTION AT 33) FOR EXTERNAL 24VDC/125VDC COMMON.
THE 125VDC DISCRETE INPUT CONNECTIONS CAN NOT BE USED ON CSA OR CE MARKED SYSTEMS

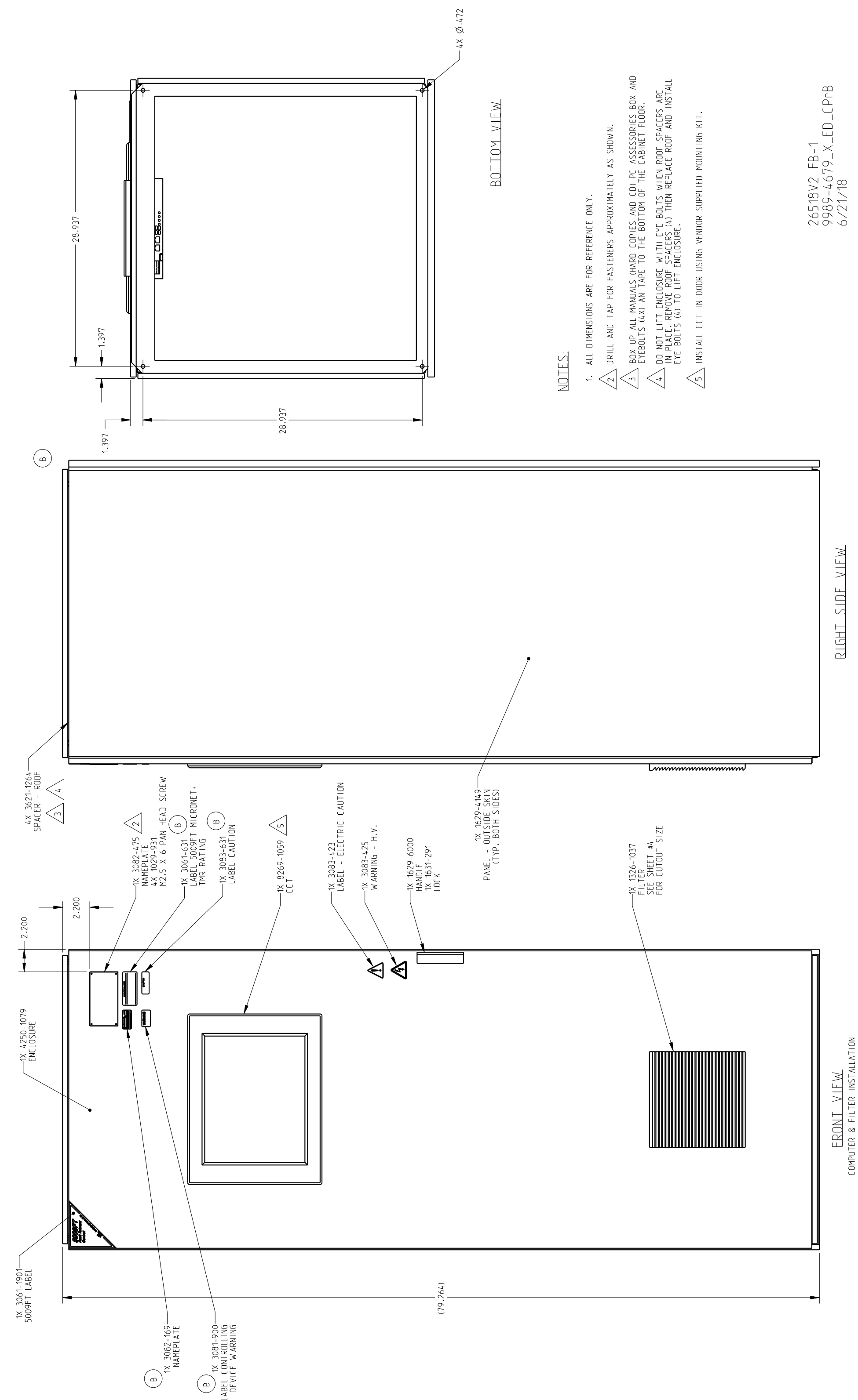

ACTUATOR DRIVER +/-245mA 2CH FTM
5501-1432
MODULE
PIN #
J1-
FTM106-1
5437-672
CHAN
CH1 DRIVER
CH1 EXCIT
CH1 FDBK 1A
CH1 FDBK 1B
CH1 FDBK 2A
CH1 FDBK 2B
CH2 DRIVER
CH2 EXCIT
CH2 FDBK 1A
CH2 FDBK 1B
CH2 FDBK 2A
CH2 FDBK 2B
EARTH GND
SHLD
SEE SHT 2
TYPICAL DRIVER AND FEEDBACK CONNECTIONS
TORQUE MOTOR DRIVER
TORQUE MOTOR
RVDT EXCITATION
RVDT FEEDBACK
FEEDBACK 1A
LVDT EXCITATION
LVDT A EXCITATION
LVDT B EXCITATION
FEEDBACK 1B
LVDT FEEDBACK 1
FEEDBACK 2A
FEEDBACK 2B
LVDT FEEDBACK 2
OPTIONAL FTM
FTM106-1
2-CHANNEL ACTUATOR DRIVER
WOODWARD
FT. COLLINS COLORADO USA
TITLE
CONTROL WIRING DIAGRAM
5009XT TMR
SIZE D
CAGE CODE 7LLB9
DWG NO 9971-2025
REV -
SCALE NTS
SHEET 15 OF 17
AUTOCAD

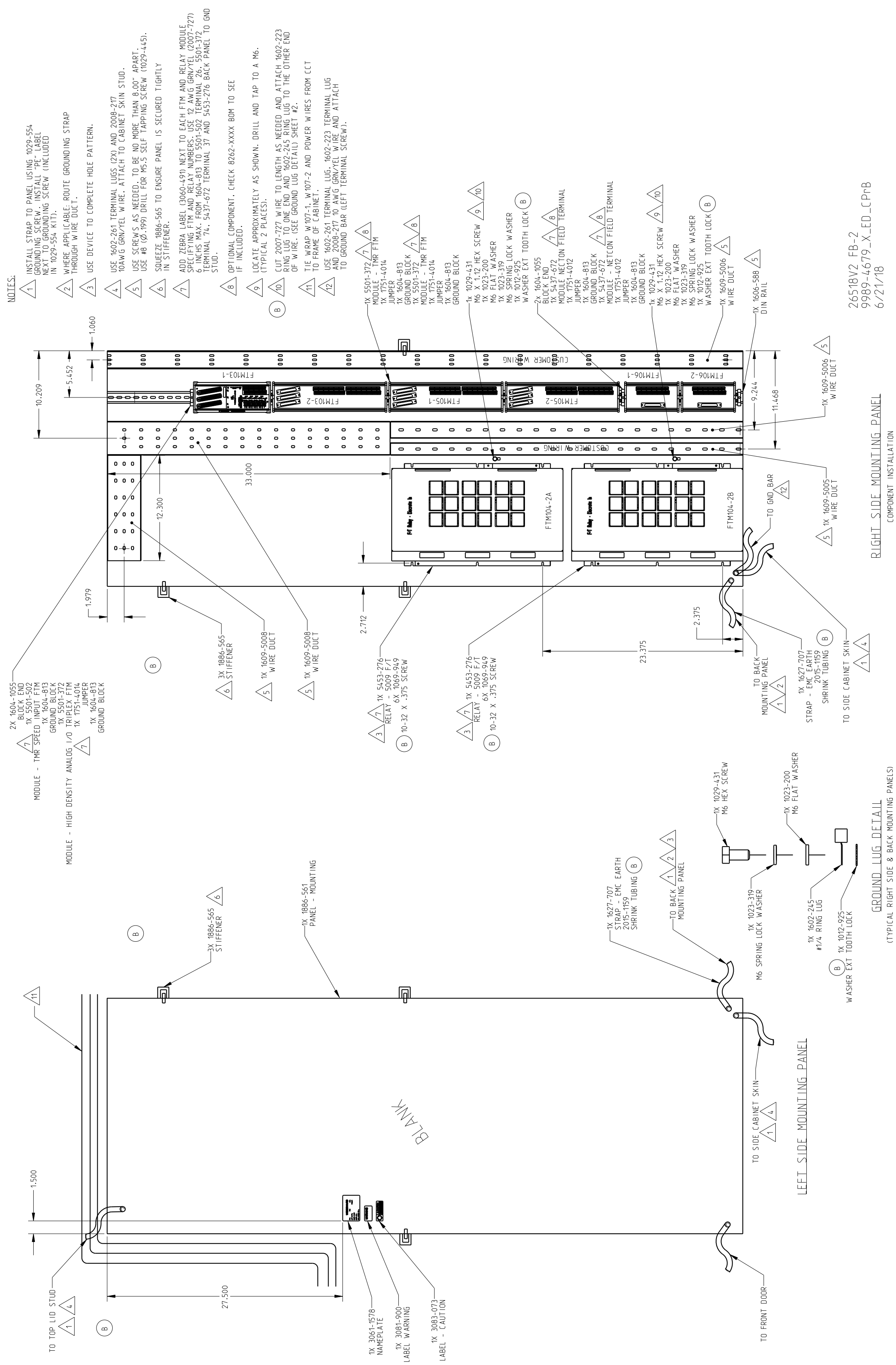

ACTUATOR DRIVER +/-245mA 2CH FTM
5501-1432
MODULE
PIN #
J1-
5437-672
FTM106-2
CHAN
CH1 DRIVER
CH1 EXCIT
CH1 FDBK 1A
CH1 FDBK 1B
CH1 FDBK 2A
CH1 FDBK 2B
CH2 DRIVER
CH2 EXCIT
CH2 FDBK 1A
CH2 FDBK 1B
CH2 FDBK 2A
CH2 FDBK 2B
EARTH GND
SHLD
SEE SHT 2
TYPICAL DRIVER AND FEEDBACK CONNECTIONS
TORQUE MOTOR DRIVER
TORQUE MOTOR
RVDT EXCITATION
FEEDBACK 1A
RVDT FEEDBACK
LVDT EXCITATION
LVDT A EXCITATION
LVDT B EXCITATION
FEEDBACK 1A
FEEDBACK 1B
LVDT FEEDBACK 1
FEEDBACK 2A
FEEDBACK 2B
LVDT FEEDBACK 2
OPTIONAL FTM
FTM106-2
2-CHANNEL ACTUATOR DRIVER
WOODWARD
FT. COLLINS
COLORADO
USA
TITLE
CONTROL WIRING DIAGRAM
5009XT TMR
SIZE D
CAGE CODE 7LLB9
DWG NO 9971-2025
REV -
SCALE NTS
SHEET 16 OF 17
AUTOCAD

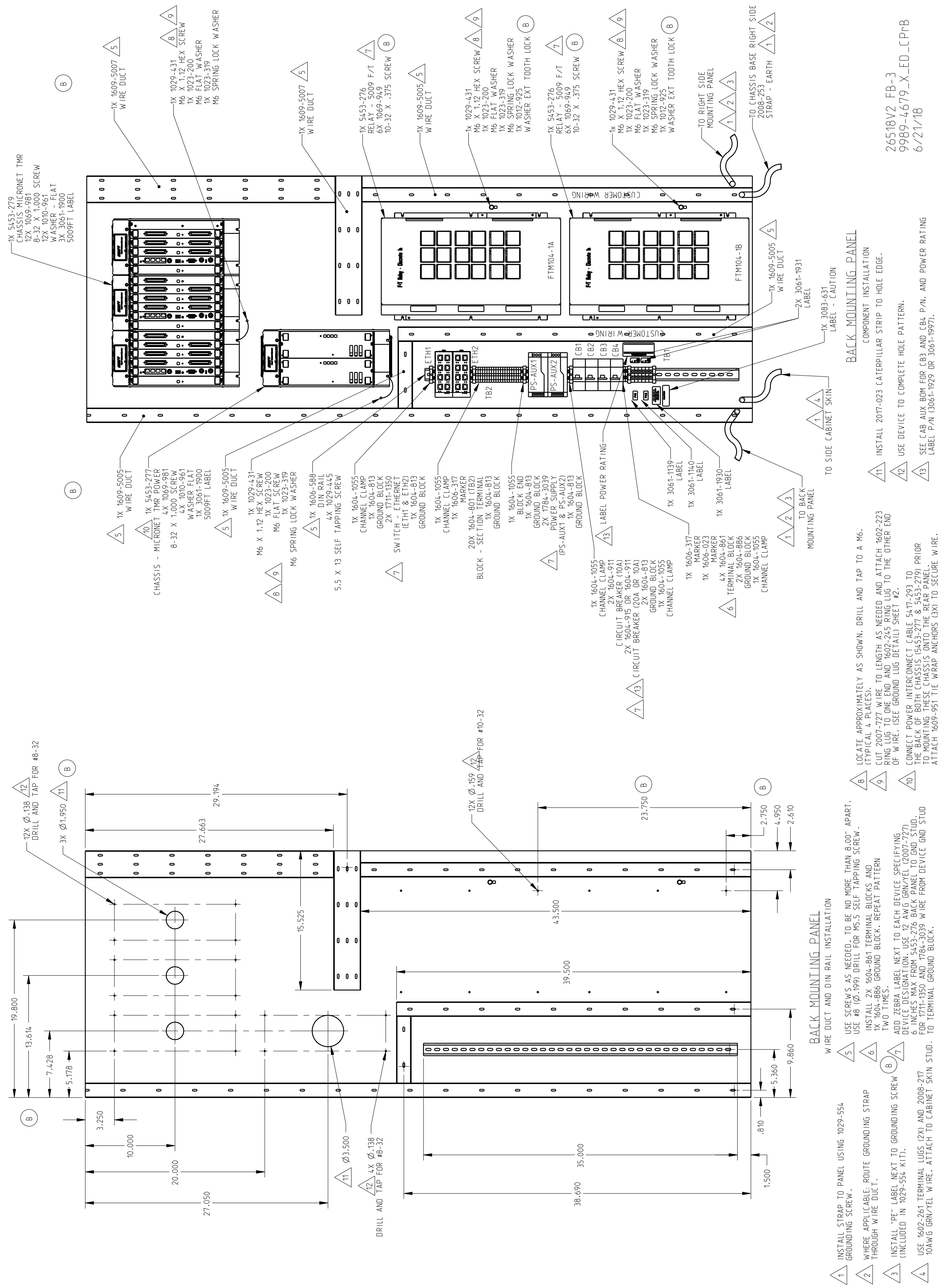

CONNECT TO KERNEL B
CPU - CAN PORT 2
5417-1512 (3m)
CAN M12 M/PIGTAIL
1635-2535
CAN TERMINATOR
(120 OHM)
M TEE F F
1635-2548
CAN NETWORK TEE
5417-1513 (3m)
CAN M12 M/PIGTAIL
SERVO POSITION CONTROLLER
(P/N 8200-227)
SET CAN ID = 11 AND LABEL AS SPC11
SET BAUD = 500KB
49 50 51 52 53
RED
BLK
TAPE OFF THE
(V+) RED WIRE
(V-) BLACK WIRE
THEY ARE NOT USED FOR SPC
WHT
SHLD
BLU
CAN COMMUNICATION TERMINATION
RESISTOR (120 OHM)
USE 1 FROM 8923-1889 PACKAGE ON
LAST SPC ON THE NETWORK
IF AN ADDITIONAL SPC IS PURCHASED (NOT
INCLUDED IN THIS KIT) AND ADDED TO NETWORK
SET CAN ID = 12 AND LABEL AS SPC12
CONNECT TO KERNEL C
CPU - CAN PORT 2
5417-1512 (3m)
CAN M12 M/PIGTAIL
1635-2535
CAN TERMINATOR
(120 OHM)
M TEE F F
1635-2548
CAN NETWORK TEE
5417-1513 (3m)
CAN M12 M/PIGTAIL
SERVO POSITION CONTROLLER
(P/N 8200-227)
SET CAN ID = 21 AND LABEL AS SPC21
SET BAUD = 500KB
RED
BLK
TAPE OFF THE
(V+) RED WIRE
(V-) BLACK WIRE
THEY ARE NOT USED FOR SPC
WHT
SHLD
BLU
CAN COMMUNICATION TERMINATION
RESISTOR (120 OHM)
USE 1 FROM 8923-1889 PACKAGE ON
LAST SPC ON THE NETWORK
IF AN ADDITIONAL SPC IS PURCHASED (NOT
INCLUDED IN THIS KIT) AND ADDED TO NETWORK
SET CAN ID = 22 AND LABEL AS SPC22
SPC KIT
CAN DIGITAL DRIVER LINK
TO SERVO POSITION CONTROLLERS
WOODWARD
FT. COLLINS
COLORADO
USA
TITLE
CONTROL WIRING DIAGRAM
5009XT TMR
SIZE D
CAGE CODE 7LLB9
DWG NO 9971-2025
REV -
SCALE NTS
SHEET 17 OF 17
AUTOCAD

Appendix F. Example Cabinet Layout Diagram

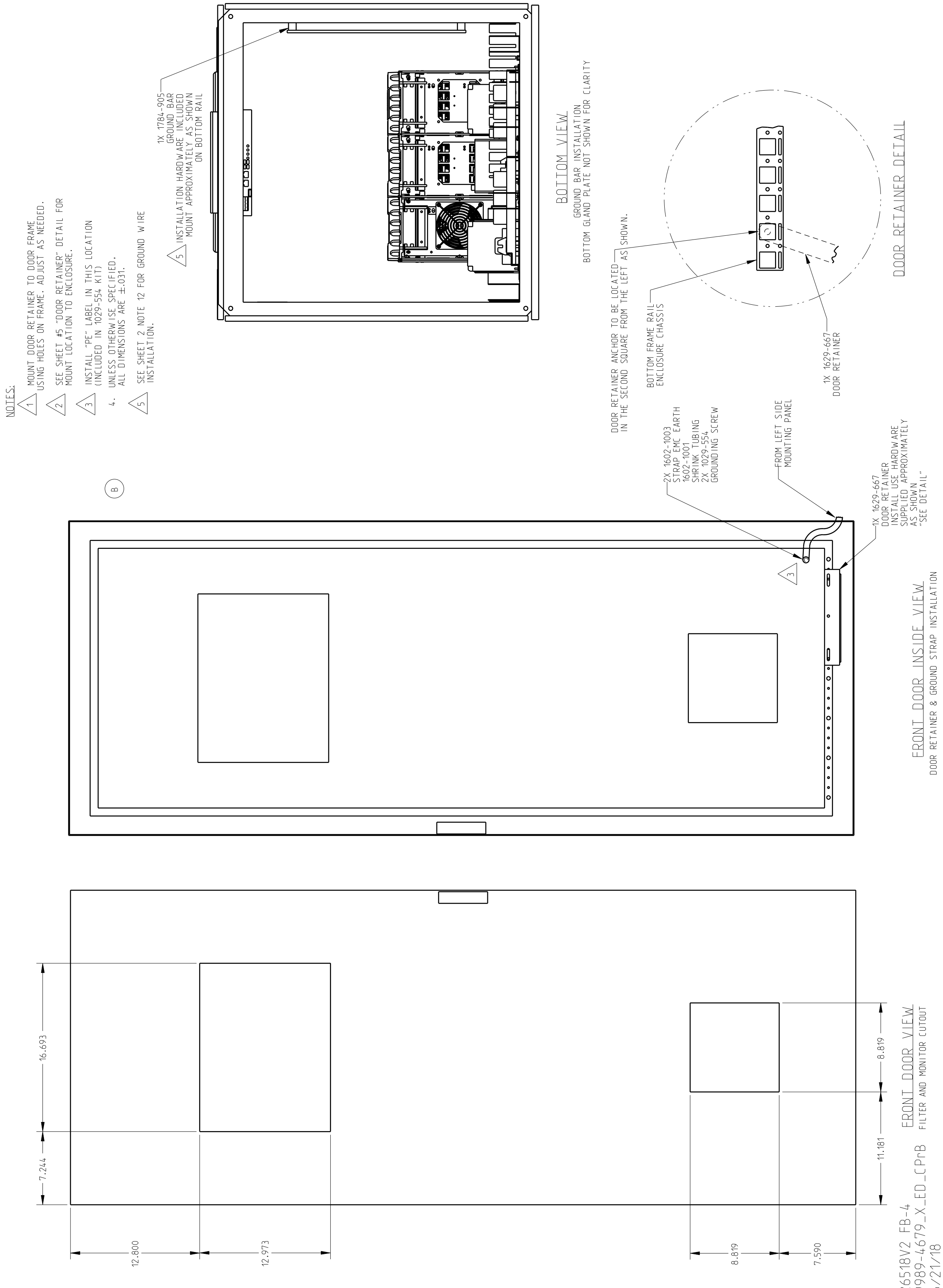
This Appendix provides an example of a typical cabinet design when Woodward is asked to provide a complete system to our customers. We do not offer a 'standard' cabinet, but are often contracted by our steam turbine OEM customers to build complete systems such as the one shown here.


BOTTOM VIEW
RIGHT SIDE VIEW
FRONT VIEW
COMPUTER & FILTER INSTALLATION
NOTES:
1. ALL DIMENSIONS ARE FOR REFERENCE ONLY.
2 DRILL AND TAP FOR FASTENERS APPROXIMATELY AS SHOWN.
3 BOX UP ALL MANUALS (HARD COPIES AND CD) PC ASSESSORIES BOX AND EYEBOLTS (4X) AN TAPE TO THE BOTTOM OF THE CABINET FLOOR.
4 DO NOT LIFT ENCLOSURE WITH EYE BOLTS WHEN ROOF SPACERS ARE IN PLACE. REMOVE ROOF SPACERS (4) THEN REPLACE ROOF AND INSTALL EYE BOLTS (4) TO LIFT ENCLOSURE.
5 INSTALL CCT IN DOOR USING VENDOR SUPPLIED MOUNTING KIT.
26518V2 FB-1
9989-4679_X_ED_CPrB
6/21/18
4X Ø.472
28.937
1.397
(79.264)
2.200
4X 3621-1264 SPACER - ROOF
1X 3082-475 NAMEPLATE
4X 1029-931 M2.5 X 6 PAN HEAD SCREW
1X 3061-631 LABEL 5009FT MICRONET, TMR RATING
1X 3083-631 LABEL CAUTION
1X 8269-1059 CCT
1X 3083-423 LABEL - ELECTRIC CAUTION
1X 3083-425 WARNING - H.V.
1X 1629-6000 HANDLE
1X 1631-291 LOCK
1X 1629-4149 PANEL - OUTSIDE SKIN (TYP. BOTH SIDES)
1X 1326-1037 FILTER SEE SHEET #4 FOR CUTOUT SIZE
1X 4250-1079 ENCLOSURE
1X 3061-1901 5009FT LABEL
1X 3082-169 NAMEPLATE
1X 3081-900 LABEL CONTROLLING DEVICE WARNING


NOTES:
1 INSTALL STRAP TO PANEL USING 1029-554 GROUNDING SCREW. INSTALL "PE" LABEL NEXT TO GROUNDING SCREW (INCLUDED IN 1029-554 KIT).
2 WHERE APPLICABLE: ROUTE GROUNDING STRAP THROUGH WIRE DUCT.
3 USE DEVICE TO COMPLETE HOLE PATTERN.
4 USE 1602-261 TERMINAL LUGS (2X) AND 2008-217 10AWG GRN/YEL WIRE. ATTACH TO CABINET SKIN STUD.
5 USE SCREWS AS NEEDED. TO BE NO MORE THAN 8.00" APART. USE #8 (Ø.199) DRILL FOR M5.5 SELF TAPPING SCREW (1029-445).
6 SQUEEZE 1886-565 TO ENSURE PANEL IS SECURED TIGHTLY IN STIFFENER.
7 ADD ZEBRA LABEL (3060-491) NEXT TO EACH FTM AND RELAY MODULE SPECIFYING FTM AND RELAY NUMBERS. USE 12 AWG GRN/YEL (2007-727) 6 INCHS MAX. FROM 1604-813 TO 5501-502 TERMINAL 26, 5501-372 TERMINAL 74, 5437-672 TERMINAL 37 AND 5453-276 BACK PANEL TO GND STUD.
8 OPTIONAL COMPONENT. CHECK 8262-XXXX BOM TO SEE IF INCLUDED.
9 LOCATE APPROXIMATELY AS SHOWN. DRILL AND TAP TO A M6. (TYPICAL 2 PLACES).
B 10 CUT 2007-727 WIRE TO LENGTH AS NEEDED AND ATTACH 1602-223 RING LUG TO ONE END AND 1602-245 RING LUG TO THE OTHER END OF WIRE. (SEE GROUND LUG DETAIL) SHEET #2.
11 TIE WRAP W107-1, W107-2 AND POWER WIRES FROM CCT TO FRAME OF CABINET.
12 USE 1602-261 TERMINAL LUG, 1602-223 TERMINAL LUG AND 2008-217 10 AWG GRN/YEL WIRE AND ATTACH TO GROUND BAR (LEFT TERMINAL SCREW).
1X 5501-372 7 8 MODULE - TMR FTM 1X 1751-4014 JUMPER 1X 1604-813 GROUND BLOCK
1X 5501-372 7 8 MODULE - TMR FTM 1X 1751-4014 JUMPER 1X 1604-813 GROUND BLOCK
1x 1029-431 M6 X 1.12 HEX SCREW 9 10 1X 1023-200 M6 FLAT WASHER 1X 1023-319 M6 SPRING LOCK WASHER 1X 1012-925 WASHER EXT TOOTH LOCK B
2x 1604-1055 BLOCK END 1X 5437-672 7 8 MODULE NECTON FIELD TERMINAL 1X 1751-4012 JUMPER 1X 1604-813 GROUND BLOCK 1X 5437-672 7 8 MODULE - NETCON FIELD TERMINAL 1X 1751-4012 JUMPER 1X 1604-813 GROUND BLOCK
1x 1029-431 M6 X 1.12 HEX SCREW 9 10 1X 1023-200 M6 FLAT WASHER 1X 1023-319 M6 SPRING LOCK WASHER 1X 1012-925 WASHER EXT TOOTH LOCK B
1X 1609-5006 5 WIRE DUCT
1X 1606-588 5 DIN RAIL
1X 1609-5006 5 WIRE DUCT
1X 1609-5005 5 WIRE DUCT
TO GND BAR 12
TO SIDE CABINET SKIN 1 4
1X 1627-707 STRAP - EMC EARTH 2015-1159 SHRINK TUBING B
TO BACK MOUNTING PANEL 1 2
2X 1604-1055 BLOCK END 1X 5501-502 MODULE - TMR SPEED INPUT FTM 7 1X 1604-813 GROUND BLOCK 1X 5501-372 MODULE - HIGH DENSITY ANALOG I/O TRIPLEX FTM 7 1X 1751-4014 JUMPER 1X 1604-813 GROUND BLOCK
3X 1886-565 STIFFENER 6
1X 1609-5008 WIRE DUCT 5
1X 1609-5008 WIRE DUCT 5
3 7 1X 5453-276 RELAY - 5009 F/T 6X 1069-949 B 10-32 X .375 SCREW
3 7 1X 5453-276 RELAY - 5009 F/T 6X 1069-949 B 10-32 X .375 SCREW
FTM103-1
FTM103-2
FTM105-1
FTM105-2
FTM106-1
FTM106-2
FTM104-2A
FTM104-2B
CUSTOMER WIRING
CUSTOMER WIRING
10.209
5.452
1.060
1.979
12.300
33.000
2.712
23.375
2.375
9.244
11.468
RIGHT SIDE MOUNTING PANEL
COMPONENT INSTALLATION
26518V2 FB-2
9989-4679_X_ED_CPrB
6/21/18
1X 1029-431 M6 HEX SCREW
1X 1023-319 M6 SPRING LOCK WASHER
1X 1023-200 M6 FLAT WASHER
1X 1602-245 #1/4 RING LUG
B 1X 1012-925 WASHER EXT TOOTH LOCK
GROUND LUG DETAIL
(TYPICAL RIGHT SIDE & BACK MOUNTING PANELS)
1X 1627-707 STRAP - EMC EARTH 2015-1159 SHRINK TUBING B
TO BACK MOUNTING PANEL 1 2 3
3X 1886-565 STIFFENER 6
1X 1886-561 PANEL - MOUNTING
11
1.500
TO TOP LID STUD 1 4
27.500
BLANK
1X 3061-1578 NAMEPLATE
1X 3081-900 LABEL WARNING
1X 3083-073 LABEL - CAUTION
TO FRONT DOOR
TO SIDE CABINET SKIN 1 4
LEFT SIDE MOUNTING PANEL


BACK MOUNTING PANEL
WIRE DUCT AND DIN RAIL INSTALLATION
BACK MOUNTING PANEL
COMPONENT INSTALLATION
1 INSTALL STRAP TO PANEL USING 1029-554 GROUNDING SCREW.
2 WHERE APPLICABLE, ROUTE GROUNDING STRAP THROUGH WIRE DUCT.
3 INSTALL "PE" LABEL NEXT TO GROUNDING SCREW (INCLUDED IN 1029-554 KIT).
4 USE 1602-261 TERMINAL LUGS (2X) AND 2008-217 10AWG GRN/YEL WIRE. ATTACH TO CABINET SKIN STUD.
5 USE SCREWS AS NEEDED, TO BE NO MORE THAN 8.00" APART. USE #8 (Ø.199) DRILL FOR M5.5 SELF TAPPING SCREW.
6 INSTALL 2X 1604-861 TERMINAL BLOCKS AND 1X 1604-886 GROUND BLOCK. REPEAT PATTERN TWO TIMES.
7 ADD ZEBRA LABEL NEXT TO EACH DEVICE SPECIFYING DEVICE DESIGNATION. USE 12 AWG GRN/YEL (2007-727) 6 INCHES MAX FROM 5453-276 PANEL TO GND STUD. FOR 1711-1350 AND 1784-3039 WIRE FROM DEVICE GND STUD TO TERMINAL GROUND BLOCK.
8 LOCATE APPROXIMATELY AS SHOWN. DRILL AND TAP TO A M6. (TYPICAL 4 PLACES).
9 CUT 2007-727 WIRE TO LENGTH AS NEEDED AND ATTACH 1602-223 RING LUG TO ONE END AND 1602-245 RING LUG TO THE OTHER END OF WIRE. (SEE GROUND LUG DETAIL) SHEET #2.
10 CONNECT POWER INTERCONNECT CABLE 5417-293 TO THE BACK OF BOTH CHASSIS (5453-277 & 5453-279) PRIOR TO MOUNTING THESE CHASSIS ONTO THE REAR PANEL. ATTACH 1609-951 TIE WRAP ANCHORS (3X) TO SECURE WIRE.
11 INSTALL 2017-023 CATERPILLAR STRIP TO HOLE EDGE.
12 USE DEVICE TO COMPLETE HOLE PATTERN.
13 SEE CAB AUX BOM FOR CB3 AND CB4 P/N. AND POWER RATING LABEL P/N (3061-1929 OR 3061-1997).
26518V2 FB-3
9989-4679_X_ED_CPrB
6/21/18

Released


NOTES:
1 MOUNT DOOR RETAINER TO DOOR FRAME USING HOLES ON FRAME. ADJUST AS NEEDED.
2 SEE SHEET #5 "DOOR RETAINER" DETAIL FOR MOUNT LOCATION TO ENCLOSURE.
3 INSTALL "PE" LABEL IN THIS LOCATION (INCLUDED IN 1029-554 KIT)
4. UNLESS OTHERWISE SPECIFIED. ALL DIMENSIONS ARE ±.031.
5 SEE SHEET 2 NOTE 12 FOR GROUND WIRE INSTALLATION.
B
1X 1784-905 GROUND BAR
5 INSTALLATION HARDWARE INCLUDED MOUNT APPROXIMATELY AS SHOWN ON BOTTOM RAIL
BOTTOM VIEW
GROUND BAR INSTALLATION
BOTTOM GLAND PLATE NOT SHOWN FOR CLARITY
DOOR RETAINER ANCHOR TO BE LOCATED IN THE SECOND SQUARE FROM THE LEFT AS SHOWN.
BOTTOM FRAME RAIL ENCLOSURE CHASSIS
1X 1629-667 DOOR RETAINER
DOOR RETAINER DETAIL
2X 1602-1003 STRAP EMC EARTH 1602-1001 SHRINK TUBING 2X 1029-554 GROUNDING SCREW
FROM LEFT SIDE MOUNTING PANEL
1X 1629-667 DOOR RETAINER INSTALL USE HARDWARE SUPPLIED APPROXIMATELY AS SHOWN "SEE DETAIL"
3
FRONT DOOR INSIDE VIEW
DOOR RETAINER & GROUND STRAP INSTALLATION
7.244
16.693
12.800
12.973
8.819
7.590
11.181
8.819
FRONT DOOR VIEW
FILTER AND MONITOR CUTOUT
26518V2 FB-4
9989-4679_X_ED_CPrB
6/21/18

Appendix G
Initial Setup of 5009XT TMR CPU's

General

The 5009XT control system requires that all of the CPU's be initially setup by the following procedure. If the control is expected to be on a LAN at site and unique site IP addresses are provided by the site network engineers, then use those IP addresses instead of the Woodward defaults.

EQUIPMENT REQUIRED:

Computer with RJ45 Ethernet cable and AppManager installed
MicroNet TMR chassis with KPS and CPU's installed & TMR Power Supply chassis powered up
APPMANAGER
BCDxxxxx or the 5009XT_Install_Kit

PURPOSE: The purpose of this procedure is to prepare the three MicroNet TMR CPU's (p/n 5466-1347) for use in a 5009XT system, which require -

Setup the correct default IP addresses for the CPU's
Setup the correct default user accounts on the CPU's
Install 5009XT software applications (GAP and GUI)

1. Using the BCD or Install_Kit file, install the 5009XT software onto the target PC.
2. Install the AppManager software tool (if not already available on PC).
3. Give your PC a fixed IP of 172.16.100.20 then directly connect the Ethernet cable from the PC into the ENET1 port on the CPU in Kernel A
4. Launch AppManager and the CPU should appear on the left window with the control name and the IP address of 172.16.100.1
5. Follow the steps below:

<table>
<tr><td></td><td>6.0</td><td>Set the IP Addresses for Kernel A CPU
Click on the Control Name and login with the following credentials
Connect As: ServiceUser
Password: ServiceUser@1

Select Control> Change Network Settings.

With Ethernet 1 selected in the top list –
Enter the New IP address of 172.16.100.11
Enter the Subnet mask of 255.255.0.0.
The Gateway address can be cleared out (delete each octet)

With Ethernet 2 selected in the top list –
Enter the New IP address of 192.168.128.21
Enter the Subnet mask of 255.255.255.0.

Select the OK box.
A dialog box will appear to warn that the CPU will need to reboot – click on OK

Verify that after the reboot the IP addresses for each Ethernet Port on this CPU now match the above addresses</td></tr>
</table>

7.0

Setting the User Level Accounts

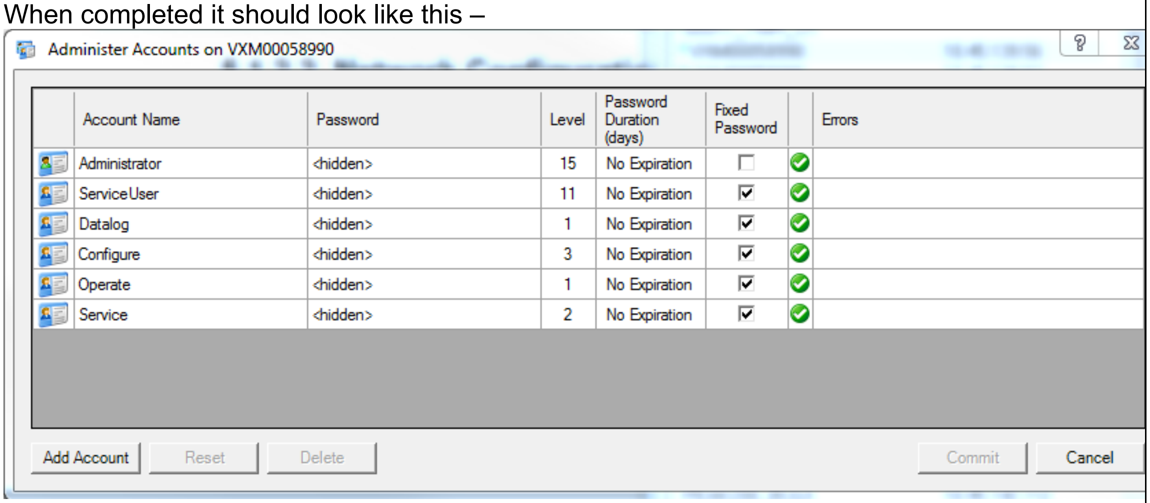
Select Security/Login with different credentials and login as the following:
Connect As: Administrator
Password: Admin@1

Select Security/Administer Accounts and a dialog box will appear – use the Add Account button to add the following:

Account Name	Password	Level	Duration	Fixed
Operate	wg1111	1	0 (=No Expiration)	Yes
Service	wg1112	2	0 (=No Expiration)	Yes
Configure	wg1113	3	0 (=No Expiration)	Yes

Click on the Commit button when complete

When completed it should look like this –



8.0

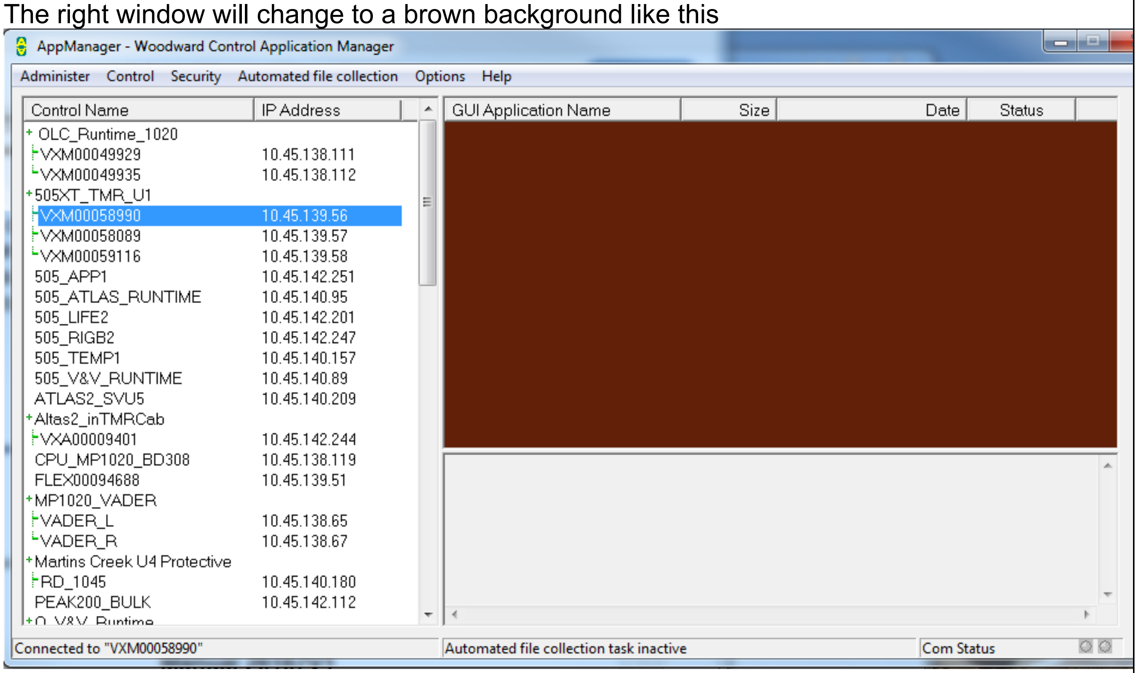
Loading the Application Files

GAP Application -
Select Control/Transfer Application Files
A browser window will open – find and select the .out file that was obtained from EFMS earlier in this procedure –
5418-7830-.out (with the last digit in the file name being the revision of the item number)

Once transferred this file should appear in the right window

GUI Application -
Select Control/Show GUI Applications View

The right window will change to a brown background like this



Select Control/Transfer GUI Application
A browser window will open – find and select the .wgui file that was obtained from EFMS earlier in this procedure –
5418-7830-.wgui (with the last digit in the file name being the revision of the item number)

Once transferred this file should appear in the right window

9.0

CPU in Kernel B –

Disconnect from the CPU in Kernel A
Directly connect the PC via Ethernet to the ENET 1 port of the CPU in Kernel B and launch AppManager. It should appear on the left window with the control name and the IP address of 172.16.100.1

10.0	**Set the IP Addresses for Kernel B CPU** Click on the Control Name and login with the following credentials Connect As: ServiceUser Password: ServiceUser@1 Select Control> Change Network Settings. With **Ethernet 1** selected in the top list – Enter the New IP address of **172.16.100.12** Enter the Subnet mask of **255.255.0.0**. The Gateway address can be cleared out (delete each octet) With **Ethernet 2** selected in the top list – Enter the New IP address of **192.168.128.22** Enter the Subnet mask of 255.255.255.0. Select the OK box. A dialog box will appear to warn that the CPU will need to reboot – click on OK Verify that after the reboot the IP addresses for each Ethernet Port on this CPU now match the above addresses
11.0	**For CPU in Kernel B –** Repeat the steps 7 and 8 above (exactly) for this CPU **7.0 Setting the User Level Accounts** **8.0 Loading the Application Files**
12.0	**CPU in Kernel C –** Disconnect from the CPU in Kernel B Directly connect the PC via Ethernet cable to the ENET 1 port of the CPU in Kernel C and launch AppManager. It should appear on the left window with the control name and the IP address of 172.16.100.1
13.0	**Set the IP Addresses for Kernel C CPU** Click on the Control Name and login with the following credentials Connect As: ServiceUser Password: ServiceUser@1 Select Control> Change Network Settings. With **Ethernet 1** selected in the top list – Enter the New IP address of **172.16.100.13** Enter the Subnet mask of **255.255.0.0**. The Gateway address can be cleared out (delete each octet) With **Ethernet 2** selected in the top list – Enter the New IP address of **192.168.128.23** Enter the Subnet mask of 255.255.255.0. Select the OK box. A dialog box will appear to warn that the CPU will need to reboot – click on OK Verify that after the reboot the IP addresses for each Ethernet Port on this CPU now match the above addresses

14.0	**For CPU in Kernel C –** Repeat the steps 7 and 8 above (exactly) for this CPU **7.0 Setting the User Level Accounts** **8.0 Loading the Application Files**
15.0	**For CPU in Kernel C –** While connected to Kernel C – CPU From the Control Applications View – Select the .out file Then Select Control/Start Application The status on right should change to Initializing Disconnect from this CPU and connect to Kernel B CPU Repeat these steps – This time verify that after Initializing – the status changes to Running (the message box in bottom right will have a message that TMR Kernel A just failed – that it fine Disconnect from this CPU and connect to Kernel A CPU Repeat these steps – Verify that after Initializing – the status changes to Running Verify that on all 3 CPU's the SYSCON LED is GREEN and ON and that all other LED's are Off
16.0	**VERIFY CORRECT BOOTUP OPERATION** Power down the entire TMR chassis then after 15 seconds re-power the chassis. After bootup (of approx. 90 seconds) Verify that on all 3 CPU's the SYSCON LED is GREEN (ON) and that all other LED's are Off

Appendix H. Password Information

General

The 5009XT control system requires a password to be entered before access can be given to the OPERATOR, SERVICE, CONFIGURE, or ServiceUser modes. These passwords help prevent unauthorized or untrained personnel from accessing these modes and possibly making changes that could cause damage to the turbine or associated process. If only selected people are to know these passwords, remove this appendix and keep it in a separate place, apart from the manual.

To enter the login or password on the front panel display:

Navigate so the Login or Password field is highlighted (in-focus)
Press **Enter** on the Navigation Cross
Use the keypad to enter the text field **(hold key down to scroll options)**
Press **Enter** on the Navigation Cross – to accept your entry

Monitor User Level

There is no password required to monitor values – all navigational commands and display information is available on all screens but no operational commands can be entered from the display. The Emergency Stop button is always available.

"Operator" User Level Password

Login as Operator:
Login: Operator
Password: wg1111

"Service" User Level Password

Login as Service:
Login: Service
Password: wg1112

"Configure" User Level Password

Login as Configure:
Login: Configure
Password: wg1113

"ServiceUser" User Level Password

Login as ServiceUser (no autofill key available, must be entered manually):
Login: ServiceUser
Password: ServiceUser@1

Modifying User level Passwords

If it is desired or required to modify the default credentials to access the control logic, do so using AppManager and follow the instructions in appendix G step 7. The operating system supports security levels from 0 (lowest authority) to 15 (highest authority). The control application uses levels 1, 2 and 3 for the escalating levels of Operator, Service and Configuration levels. Any user account set to a level of 3 or higher will have access to all adjustable parameters, in the control software.

Access the Help/Accounts information inside of AppManager for more information.

If this is being done, be aware of the following items.

- To do this, the turbine must be shutdown and the application stopped in AppManager to gain access to the Security/Administer Accounts modification page
- This will need to be done to each of the 3 CPU's (they do not share this information)
- Changing just the passwords is recommended as the first step, this will keep all parameter access of the existing levels intact and the MODE login screen will function the exactly the same
- If the user accounts are changed, or the existing ones deleted, both the user account and password will need to be entered on the MODE screen to gain access to the control
- Monitor mode is level 0
- If the Administrator account password is changed and lost, there is no way to recover, the CPU will need to be returned to the factory

Appendix I.
Servlink-to OPC Server (SOS) Tool

SOS Communication Link

The Woodward SOS Servlink OPC server ("SOS") provides an OPC interface for Woodward controls. It runs on a Windows PC that accesses data on controls using the Woodward proprietary Servlink protocol through an Ethernet connection. Woodward OPC client applications, such as Monitor GAP and Control Assistant connect to SOS by selecting a 'Servlink OPC server' connection. SOS implements the OPC Data Access 2.0 standard, so other OPC client applications may also function with it.

The install for this program is included on the system documentation CD, the latest releases and updates are always available on the Woodward.com website.

For this control be sure to install SOS version 4.15 or newer.

Features of SOS

- Establishes communication link between control and a PC
- Can support redundant Ethernet links to a single control
- Can support links to many controls at the same time
- Can create a .CSV file of all alarm and trip events

Prior to installing SOS, you must install the Microsoft .net framework program, which is available on the Woodward website (**www.woodward.com**). This will install some operating system library files that are used by Control Assistant.

Installing SOS

License agreement & Setup

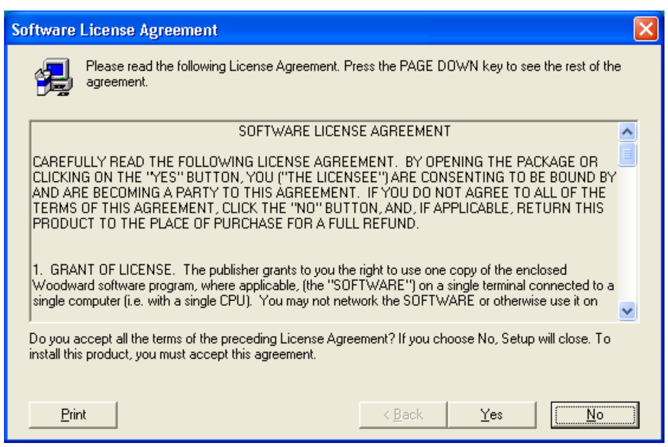


Figure I-1. SOS

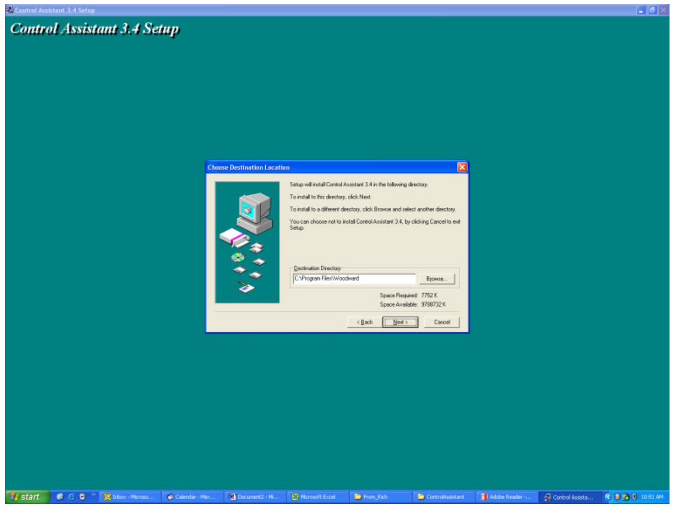


Figure I-2. SOS Install Window

Define the desired directory to save

Connecting a PC/Laptop to the Control

You will need to connect to the 5009XT with an RJ45 Ethernet cable. Any Ethernet port can be used, however it is most convenient to use the same network port that handles all LAN communications (if the 5009XT is connected to a plant network). You will need to know the IP address of the Ethernet port.

The Default IP for Ethernet 1 = 172.16.100.15 (subnet = 255.255.0.0)

All information in the communication link between the 5009XT and the PC is done via a Woodward Servlink connection (using the SOS tool). It is recommended to initially launch this tool independently to establish a healthy communication link. Once this is done, the PC will cache this information so that future launches will remember 5009XT controls.

Servlink-to-OPC Server (SOS) 

The Woodward SOS tool is a sub-component of Control Assistant that handles all of the communications between one or many 5009XT's on a network and the PC. It can be run independently, which is a useful way to clearly establish a connection prior to using the Control Assistant or other programs.

To launch SOS on independently:
Under Start / All Programs / Woodward / SOS Servlink OPC Server

Click on 

SOS Servlink OPC Server
You should see the following dialog box appear –

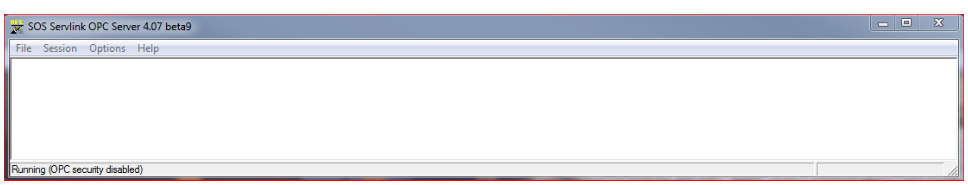


Figure I-3. SOS Server status dialog box

Under Session – scroll down and select New Session and a dialog box similar to the one below will appear. In the top entry box, enter the IP address of the 5009XT.

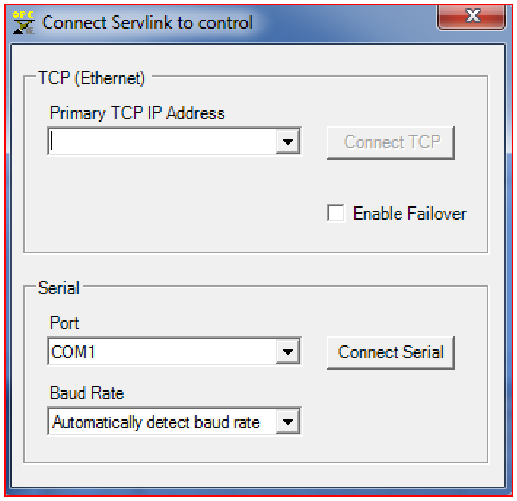


Figure I-4. SOS – New Session box

If you are connected to Ethernet Port 1 of the 5009XT, enter the IP address of this port. The 5009XT default is shown below or enter the IP for your plant LAN network.
Then click on the Connect TCP button

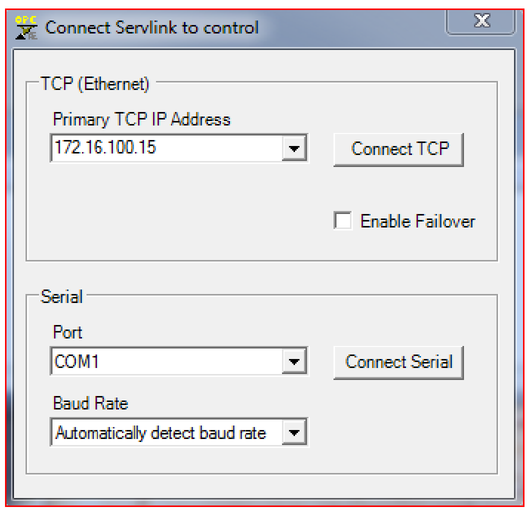


Figure I-5. SOS - Enter 5009XT TCP/IP address

The SOS program will locate the control and establish a Woodward Servlink connection between the control and your PC. This will take a few seconds to establish, the dialog box should now look like this (with the IP address being equal to what you typed in above).

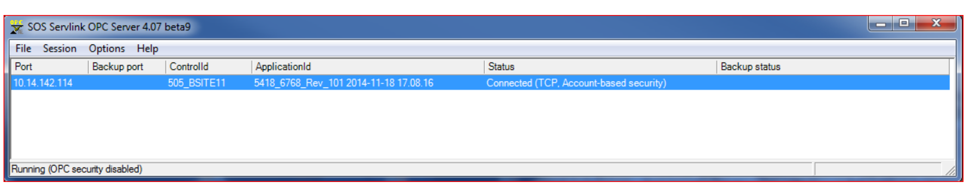


Figure I-6. SOS – Active Links dialog box

Control Name and Control ID

The default Control Name of production CPU's can be found on the front label. For example:

ControlName VXM00058990

The Control ID is setup in the control application as a tunable string value. This ID will be used by AppManager to 'group' the 3 CPU's of the TMR control and by the SOS interface tool to identify the session.

The default Control ID is 5009XT_U1

Changing the Control ID

If it is desired to change this ID, for example, perhaps there are multiple 5009XT units at the same location, then the following procedure should be used. The turbine must be shutdown to perform this procedure.

1. Connect to a single CPU of the control with SOS (Enable Failover is NOT checked)
2. Launch Control Assistant, open a WinPanel session and download the current tunable settings file (xxxx.tc)
3. Search the file (ctrl F) for APP_STRING
4. In the column label "Current" change the 5009XT_U1 string to the desired ID string
5. Save this file with a new name
6. From Control Assistant place control in Lock IO
7. Send tunable list to the control and click on 'Store' in the dialog box
8. When this is done it will show an error – this is ok (because the Control ID for the session has changed.it will terminate the session and show this error).
9. Relaunch the WinPanel session and it should now appear with the new Control ID
10. Issue a Reset from Control Assistant to bring the unit out of IO Lock
11. If AppManager is running, it will need to be shutdown and relaunched for the tool to obtain this new name for the 3 CPU's in the control 'Group'

Appendix J. Control Assistant—Software Interface Tool

Features of Control Assistant

Control Assistant is an optional software interface tool designed to help experienced users maintain setup and configuration settings and troubleshoot system problems. It provides a flexible window into the application software with multiple features for the user.

The install for this program is included on the system documentation CD, the latest releases and updates are always available on the Woodward.com website.

For this control be sure to install Control Assistant version 4.14 or newer.

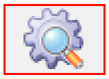
Features

- Using WinPanel (similar to the previous Watch Window products)
- Receiving Control Tunables (Download/Receive Tunables from control)
- Sending Control Tunables (Upload/Send a Tunable File to the control)
- Trending Control Parameters

Viewing Datalog files

Prior to installing Control Assistant, you must install the Microsoft .net framework program, which is available on the Woodward website (www.woodward.com). This will install some operating system library files that are used by Control Assistant.

Installing Control Assistant



License Agreement & Setup

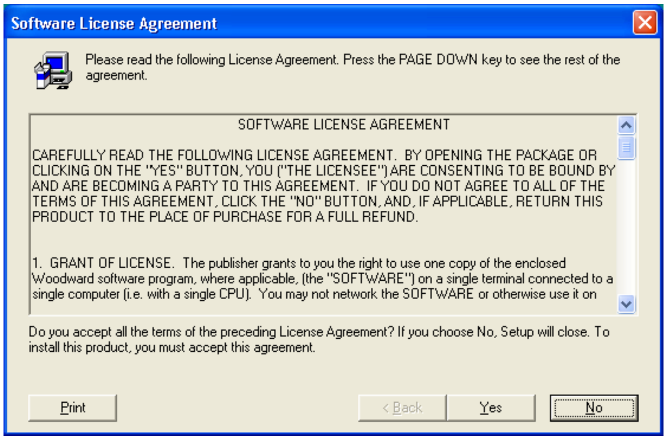


Figure J-1. Control Assistant License Agreement

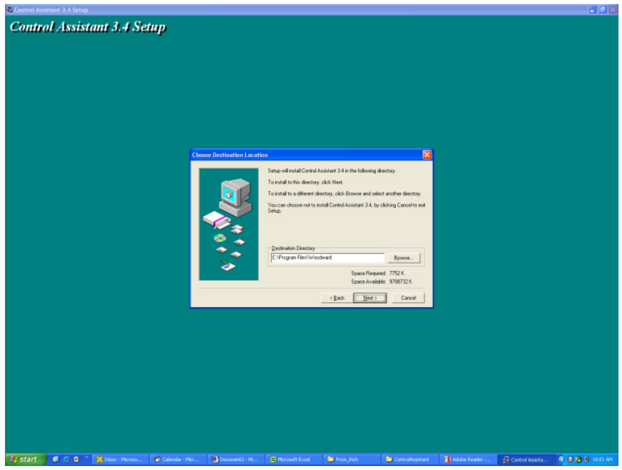


Figure J-2. Control Assistant Install Window

Define the desired directory to save Control Assistant and press ‘Next’. It is preferable to use the default, as it will keep all Woodward Software in a common folder. If the program folder field is blank, type in “Woodward” and the install will create a program folder named Woodward.

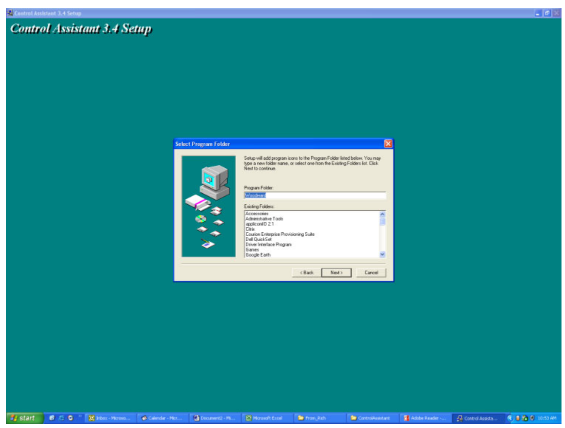


Figure J-3. Control Assistant Folder Selection

Choose the desired folder in the ‘Start Menu’ to save the shortcuts.

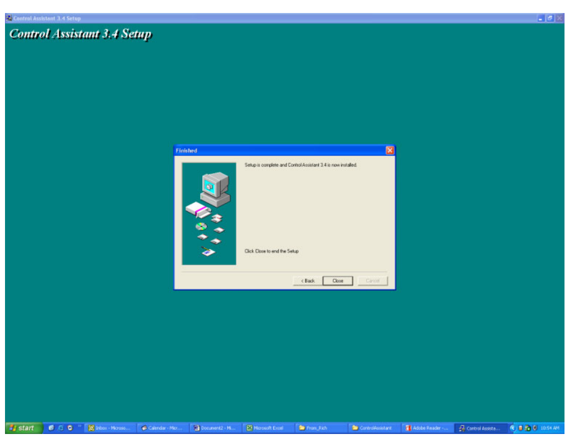


Figure J-4. Control Assistant Install Complete

After Control assistant is installed press ‘Close’. You may or may not have to restart your computer depending on whether or not you had a previous version installed.

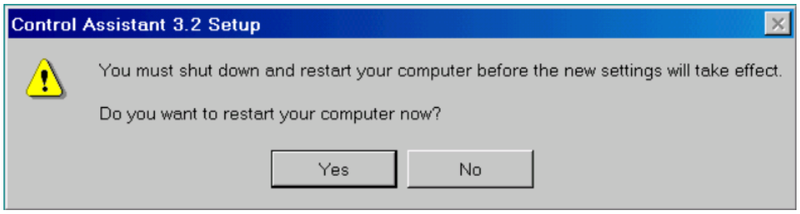


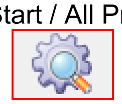
Figure J-5. Install Restart Window

Press ‘Yes’ to restart your computer now, or press ‘No’ to restart your computer later. Control Assistant will NOT function properly until the PC is restarted.

Using Control Assistant

To launch Control Assistant:

Under Start / All Programs / Woodward / Control Assistant 4

Click on  Control Assistant 4

NOTICE

Use the Control Assistant HELP in the menu list to get familiar with all features of this product, or for additional information about using the features discussed in this chapter.

You should see the following dialog box appear –

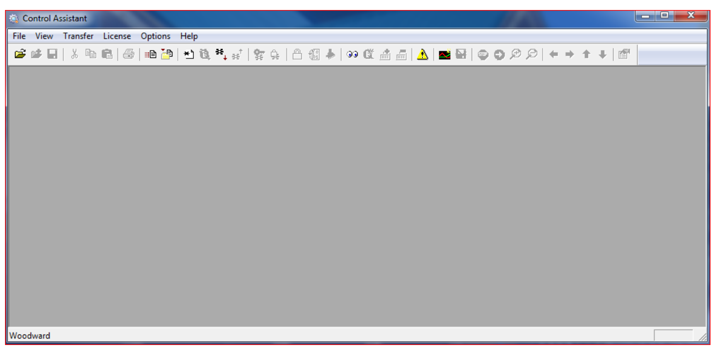
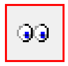


Figure J-6. Control Assistant Window

Next click on the New WinPanel icon  in the toolbar- and the following dialog box will appear.

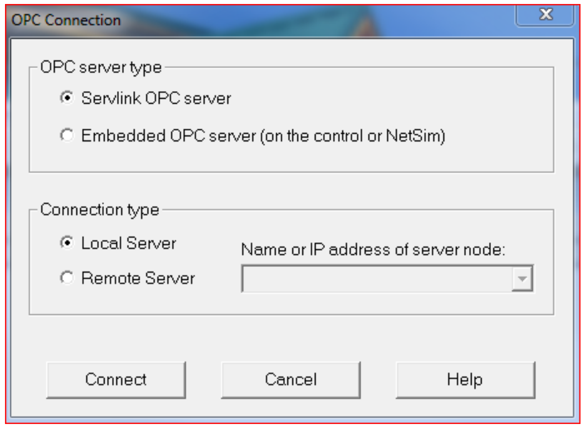


Figure J-7. Dialog for Servlink OPC connection

Clicking on Connect will open a WinPanel window that will look like the figure below.

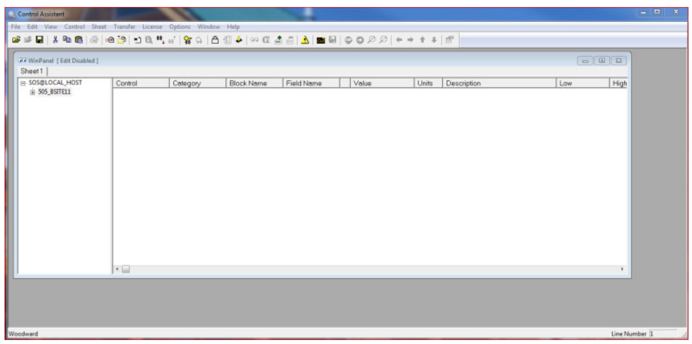


Figure J-8. WinPanel Session

Using WinPanel (.ws files)

Control Assistant includes a feature called WinPanel that provides a text listing of all the GAP blocks in the application. The WinPanel window allows viewing of any software variable in the system, and is therefore intended to be used by users familiar with the architecture of the control software. WinPanel is a typical Windows application that provides a powerful and intuitive interface. The menu structures are familiar to Windows users. Variable navigation is provided through the Explorer window similar to the Explorer in Windows. This tool will look very familiar to users with experience using Woodward's Watch Windows products.

The WinPanel window acts as an OPC client and establishes the data link with SOS. For this reason, the WinPanel window must be opened and a control selected to enable uploading or downloading the tunables or trending data from the control (next sections). If multiple controls are available in SOS, they will all appear in the WinPanel window.

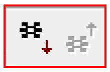
Typical users are not familiar with the GAP and therefore it is not expected to normally need to create new WinPanel views.

What is valuable for users is the ability to Open WinPanel View files that have been created by Woodward or by commissioning engineers. These files are identified as *<filename>.ws* files. This is a handy way to be able to gather system information, support tasks such as valve stroking, tuning or system checkout.

Retrieving Control Tunables (Tunables from 5009XT to a PC)

NOTICE	**Tunables can be RETRIEVED from the control at any time with no effect on turbine operation.**

Once the control is configured and the signals are calibrated, it is recommended that the user save a file containing this information. This is useful for setting up a spare unit, as a replacement or for initially configuring other units of the same type.

1. The first step is to follow the above steps up to the point of having a WinPanel open and the correct control selected
2. Select Transfer/Receive Debug Tunable List from the menus or the Retrieve Icon from the tool bar  (Note the send icon is not available)

The following box should appear

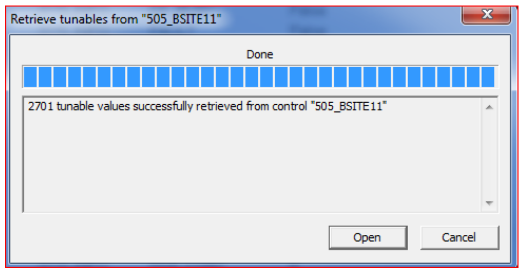


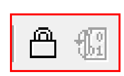
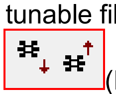
Figure J-9. Control Assistant – Retrieve Tunable Dialog box

3. Click on the Open button and the file will be automatically created with the control ID, time and date in the filename and the extension .tc. Save this file.

Sending Control Tunables (Tunables from PC to 5009XT Control)

⚠WARNING	**To send tunable settings to the control it must be in the IO Lock condition, therefore, the turbine must be shut down and the control must be in a TRIPPED state. Entering into I/O Lock mode while the turbine is running will cause an automatic shutdown of the turbine with resulting process stoppage. Do not enter the I/O Lock to upload tunables into the control while the turbine is running.**

To load a previously created tunable file (.tc) into the control, the turbine must be shut down since the control will need to enter configuration mode to complete this process. Once the turbine is shutdown, follow these steps:

1. From within Control Assistant Open the tunable (.tc) file
2. Follow the steps in the previous section up to the point of having a WinPanel open and the correct control selected
3. From the menu select Control/Lock IO or select the Lock IO icon from the tool bar 
4. Once selected a dialog box will appear asking for the Debug password – Enter 1112
5. If the 5009XT TRIPPED LED was ON (Trip is present) a confirmation box will appear that Lock IO was issued. If the 5009XT TRIPPED LED was OFF (no trips present) then the confirmation box will state it was not allowed
6. Click on the tunable file and select Transfer/Send Tunable List from the menus or the Send Icon from the tool bar (Note in this state both retrieve and send are available)

7. The following box should appear

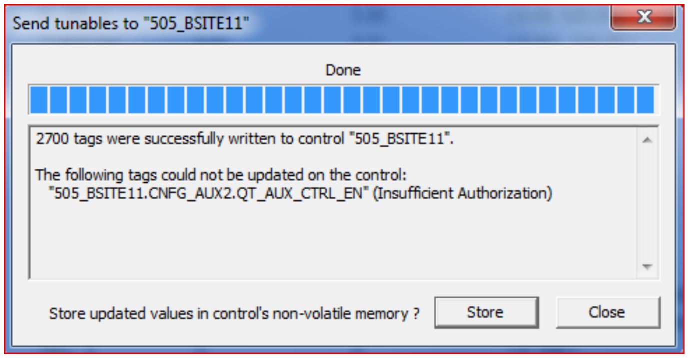
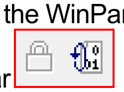


Figure J-10. Control Assistant – Send Tunable Dialog box

8. Click on Store and the control will save these values.
9. Next click back onto the WinPanel window and then select Control/Reset from the menus or the Reset Icon from the tool bar 
10. A dialog confirmation box will appear with some warnings and requires a confirmation check that these have been consider. There is also an option to Save Values again if desired. Checking the warning acknowledge box will allow the Reset button to be selected.
11. Selecting Reset will issue a 'soft' reset to the control and it will perform a soft reboot – similar to when the user exits the Configuration mode. The procedure is now complete.

IMPORTANT	**It is highly recommended that the user keep a current tunable list file available at site. This will make the configuration and setup of a spare unit very simple and assist in troubleshooting system problems.**

Trending Control Parameters

This can be done at any time and will not interfere with any control functions.

The first step is to follow the previous steps that were listed up to the point of having a WinPanel open and the correct control selected

Use File/Open to open a previously saved trend script file (if you have one). To create new trends, the user will need some understanding of how Woodward's GAP software is constructed as well as some specific knowledge of the control application software. If the user is not familiar with GAP, they should limit their use to existing trend script files.

Opening existing Trend Script Files

When you open an existing trend script, the graph will automatically begin trending the control data. The graph will auto scale or the scale can be adjusted to fixed values by the user. There are 2 vertical curser lines that the user can slide along the X axis – the Y1 and Y2 values below the graph relate to these values and the Total Difference (lower right corner) will show the time difference between the 2 cursers lines at all times.

The control assistant tool bar has Stop/Start/Zoom button and options to save the data buffer of values into a file for later viewing or analysis. Use the Help menu item to learn more.

Below is an example of the Speed Control Trend Script.

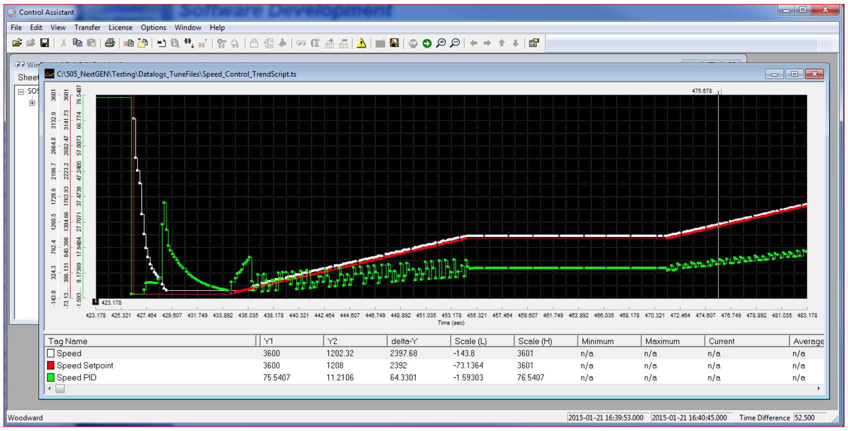


Figure J-11. Control Assistant – Speed Control Trend Script

Creating a Trend Script File

Click on the New Trend icon  if you want to create a new trend of parameters. A dialog box will appear and the user will be able to build a trend script file for view system parameters by expanding the explorer window on the left and 'drag & drop' GAP block field parameters into the window on the right.

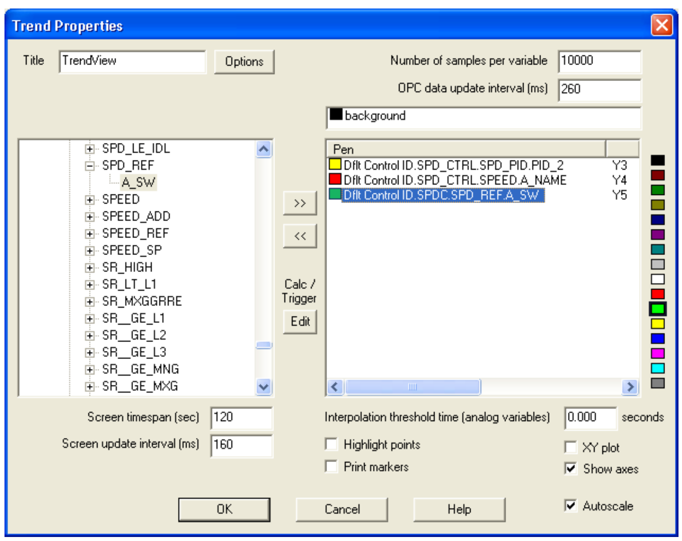


Figure J-12. Control Assistant – Create Trend Script File

Once the script file is complete, clicking on OK will launch the trend file so that live control data can be viewed. For additional information on the trending capabilities, refer to the Control Assistant Help menu.

Opening a Trend Script File as a Template

Opening a trend script file that was saved for a different control can be opened for a different control (with a different control ID) by opening the trend scrip as a template.

Click File > Open script as a template… > Select the Trend Script

Control Assistant will then pull up a list of all the controls available in SOS. Select the control to which you would like to apply the Trend Script.

Appendix K
AppManger Service Tool

File Management with App. Manager

AppManager is a Windows based remote access tool for Woodward controls. The control is loaded with a service that allows it to interface with AppManager. AppManager is used to manage the applications on the control and provide access to operating system information.

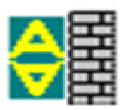
The install for this program is included on the system documentation CD, the latest releases and updates are always available on the Woodward.com website.

For this control be sure to install AppManager version 3.12 or newer.

Features of App. Manager

- Send/Retrieve files from the control
- Retrieve datalogs from the control
- Change Ethernet Network addresses
- Start/Stop the GAP or WGUI application that is running on the control
- Load Service Packs

Installing App Manager



License agreement & Setup

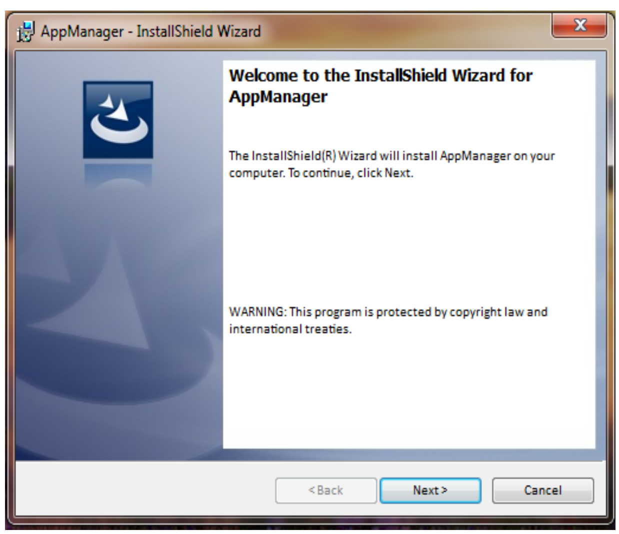


Figure K-1. App Manager Install Window

To continue with App Manager installation, select Next.

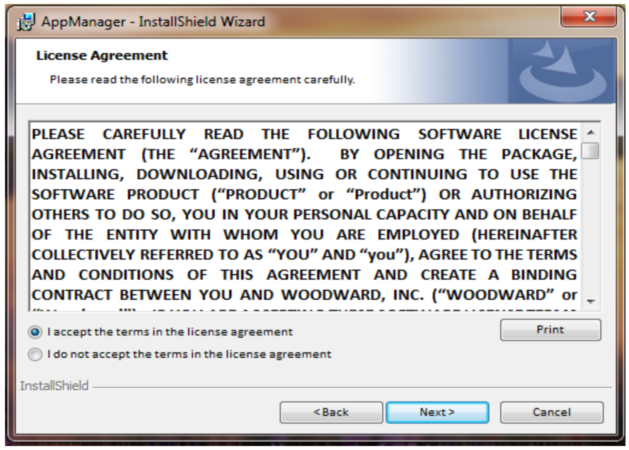


Figure K-2. App Manager License Agreement Window

To install App Manager, select "I accept the terms in the license agreement". Once this has been selected, select "Next" to continue the installation.

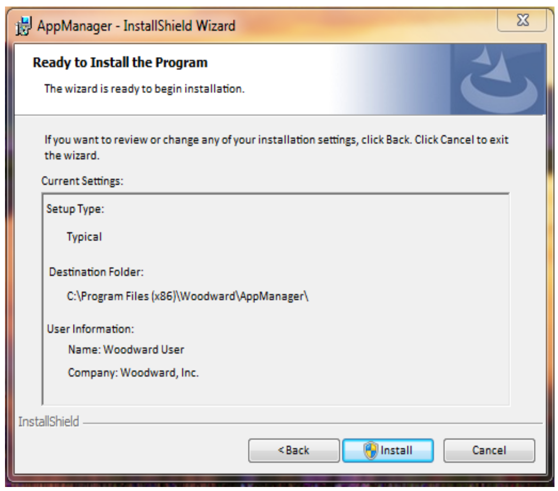


Figure K-3. App Manager Installation

Choose the desired folder in the 'Start Menu' to save the shortcuts.

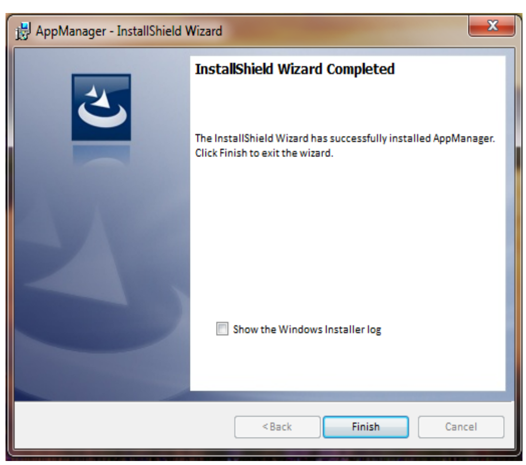


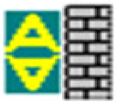
Figure K-4. App Manager Install Complete

After App Manager is installed press ‘Finish’. You may to restart your computer depending on whether or not you had a previous version installed.

The topics covered below will highlight the main functions that a 5009XT user may want to do using this tool. For user already familiar with this tool the only new feature is the ability to access the GUI files. For complete information on this tool, use the help menu

To launch App Manager:

Under Start / All Programs / Woodward / AppManager

Click on  AppManager

You should see the following dialog box appear –

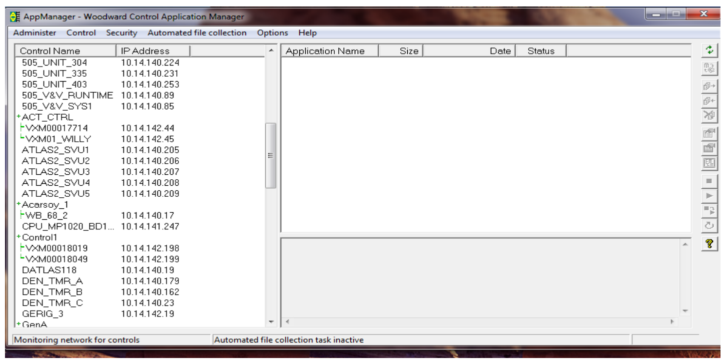


Figure K-5. AppManager Window

AppManager will display three panels; the left side panel will show the Control Name and IP Address for each control available on the network. The right side panels will not show information until you are logged into a specific control. When that is done, the right upper panel will show the list of applications available and the right bottom panel will show control status information.

Next click on the “Control Name” of the control you want to connect to. The following dialog box will appear.

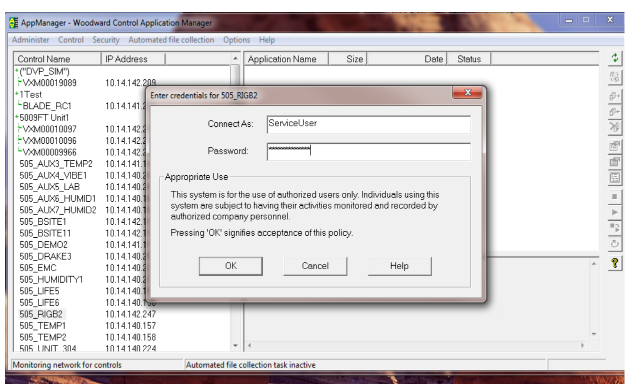


Figure K-6. Dialog for App Manager Connection

To connect to the control use the following

Connect As: ServiceUser
Password: ServiceUser@1

Click OK and the window should look something like this.

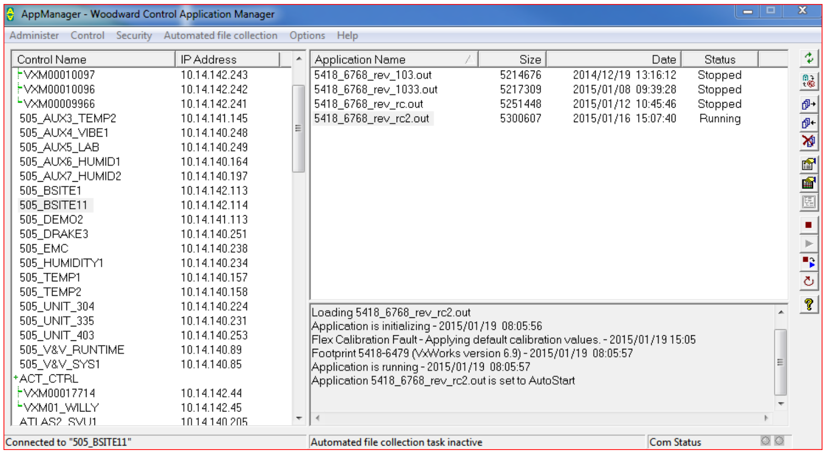


Figure K-7. App Manager Connected to a Control

Control Information Parameters

From the main screen – click on the Control Name and then from the Control menu pull-down select Control Information. The figure below shows an example of the all the information available here. This is a useful place to obtain embedded software part numbers, memory usage, Ethernet IP assignments, and total hardware run hours (power up time).

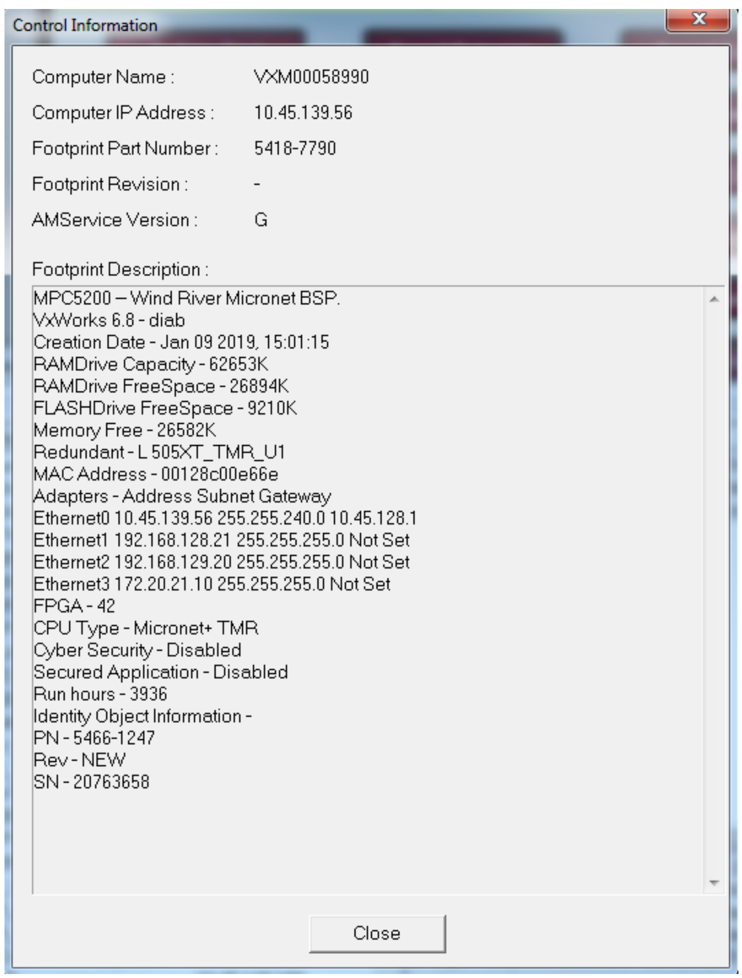
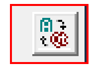


Figure K-8. AppManager Control Info Window

Switching Application Panel Views

The application panel has two views - the control application panel has a white background while the GUI application window has a maroon background. To toggle between the panels use the swap  button on the far right side (the second button down from the top).

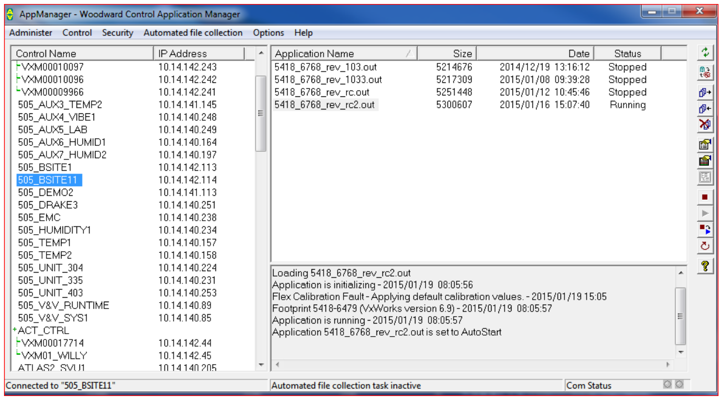


Figure K-9. AppManager Control (GAP) Application Panel

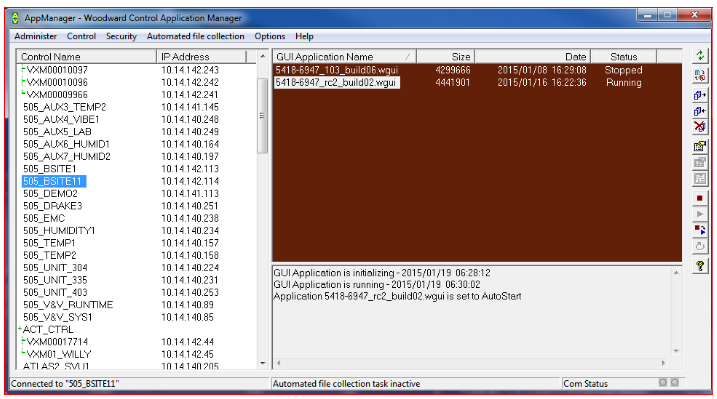


Figure K-10. AppManager GUI Application Panel

Retrieving Files

The most common use of AppManager is to retrieve data files from the control, specifically Data log and Trend log files. Do this by using the menus and selecting Control/Retrieve Files. A dialog box will open and show the files that are available in that particular application directory.

All Data and Trend log files are located in the control application folder.

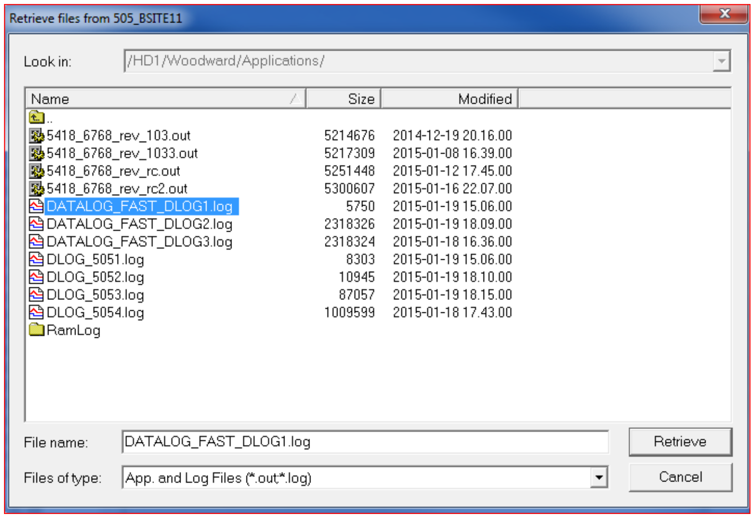


Figure K-11. Retrieving Files

Transferring Files

AppManager is the primary tool for transferring files to the control. To transfer files to the control, first be sure you are in the correct application window. For example to transfer a customized or updated GUI file – switch to the GUI application file panel before transferring the new file.

Use the menu and select Control/Transfer Application Files. A dialog box will open so that you can browse your PC to find the correct file needing to transfer.

The control will allow any file to be transferred, unless it says an existing file on the control with the same name. If this occurs, the user must first delete the file on the control before the new one can be transferred. Woodward typically adds a revision or a build number to the end of the file name so that any updates can be added to the control and the previous revisions will still be available. All user tunable settings are associated with a specific program revision.

Changing the Ethernet IP addresses

It is recommended that the user configure the IP addresses and through the GUI in configuration mode at the same time the control is setup. It is possible to set them up with AppManager – but stop the control applications first. It is best to only have experienced users do this via AppManager. In either method, the turbine must be shutdown to change the IP addresses.

Start/Stop Applications

AppManager is the tool that is used to Start or Stop the execution of the GAP (control and IO) program and/or the GUI (display) program. The GAP and the GUI are handled very differently and will be explained below.

GAP applications – Control logic and I/O

The GAP program (*filename.out*) has logic checks to insure that it is never stopped while the turbine is in operation. Stopping the GAP program puts the control in IOLOCK. There is typically no need for the user to stop the GAP program unless an OS service pack is being loaded or the unit is being updated to a newer GAP revision.

GUI applications – Display Graphics

The GUI program (*filename.wgui*) contains all the pages of information that appear on the front screen.

On the MicroNet and MicroNet TMR platforms the GUI file is stored here only. Since there is no local display, it never executes on the control, it is only accessed by RemoteView. The buttons to start/stop this file will not be available.

On Flex Platform controls the GUI is executed to drive the local display. It may be stopped and restarted without any interruption of turbine operation (does not affect the GAP execution).

The typical use of stopping and restarting the GUI program is:

1. Change the program (to a different build revision)
2. Change the default language of the screen

To change the language, go to the MODE Screen, navigate to the Globe Icon, and press Enter. A list of language options will appear – after selecting the desired language the GUI must be restarted. If the turbine is shutdown, you could just power cycle the control. If the turbine is in operation – or it is not desired to stop the GAP application, then the GUI can be selected, stopped, and started from the screen shown in Figure G-10.

Install a Woodward Service Pack

AppManager is the tool that is used if a service pack needs to be installed to update the OS or the real-time process that executes the GUI application.

Typically, only Woodward representatives do this or via a service bulletin, that directs the user through the process.
In general, these are the steps:

1. Shutdown the turbine to a complete stop
2. Stop the GAP and GUI applications that are running
3. Under the Control menu click on Install Service Pack
4. Locate and launch the Woodward service pack (may take minutes)
5. At the end there will be a dialog box asking to Reset the control click yes
6. After the control reboots – log into the control again
7. Start the GAP and GUI applications

Appendix L. RemoteView Tool

The RemoteView tool is used to connect to the 5009XT controller via Ethernet and provides a user friendly graphical interface into the control application software. The Remote View tool connects to the control, downloads the GUI application, and launches it on a PC. The Remote View tool also includes the same front panel physical buttons, except for the ESTOP button. All operation and configuration tasks can be performed remotely using this tool.

The login User Level determines the access capabilities of the Remote View. Different levels of access allow Operation, Service and Configuration of the control.

The Remote View tool is disconnected after two hours and must be launched again to reconnect if it is not licensed. The software license part number 8928-5311 is available that will allow the software to run continuously and is highly recommended for this product. The following window will be displayed when the time limit has expired.

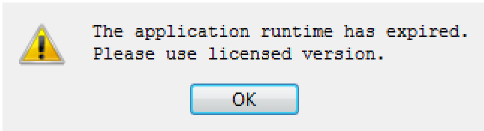


Figure L-1. Window Shown when the Time Limit is Exceeded

Installation

The installation file is included on the system documentation CD. The name of the installation file will include the revision and be similar to 9927-2344_F_RemoteView.exe. The file name may vary slightly as future revisions are released. Execute this file to begin the installation process.

When the installation file is executed, the following welcome window will appear:

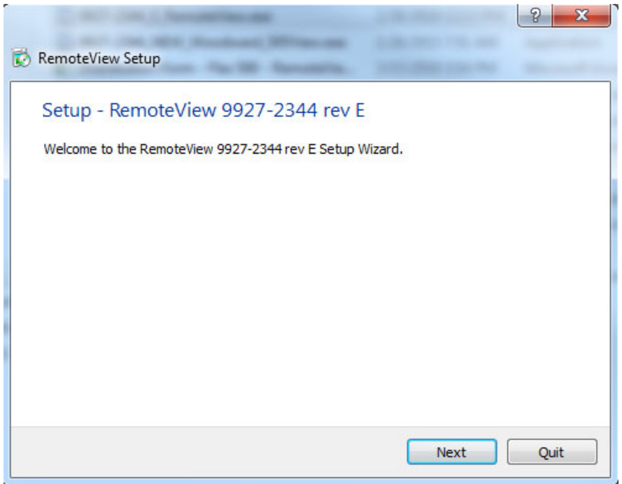


Figure L-2. Installation Welcome Window

Select “Next” to continue.

The Installation Folder window will open. A default installation folder will be shown. If a different installation folder is needed, click the “Browse…” button to select the new folder.

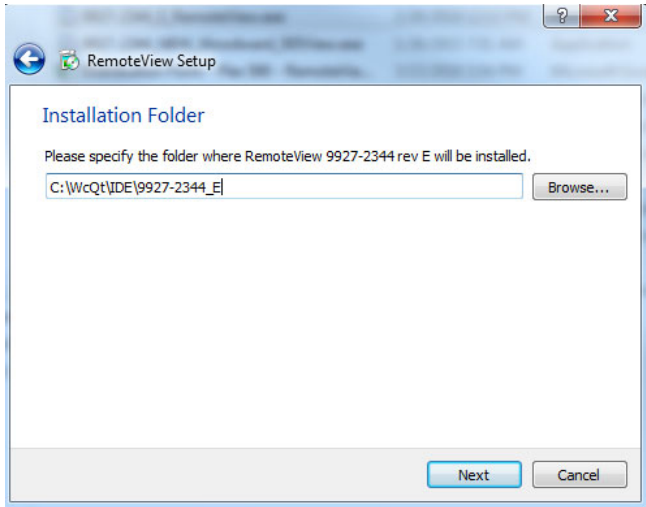


Figure L-3. Installation Folder Window

Select “Next” to continue.

The License Agreement window will open. Review the terms of each license associated with the tool. Installation can only continue if the licenses are accepted. To accept the licenses, select the “I accept the licenses” option.

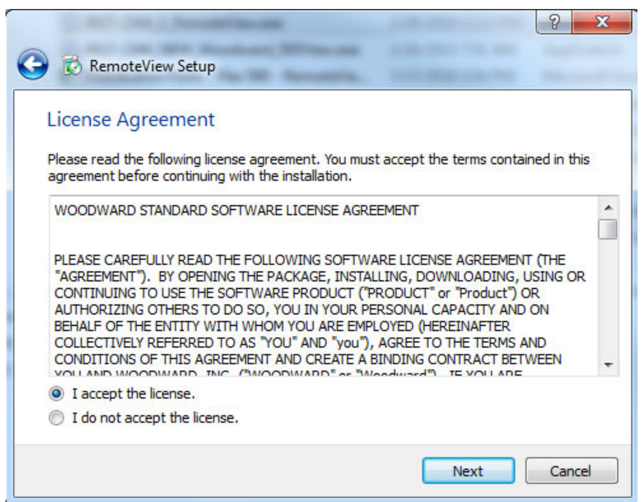


Figure L-4. Installation License Agreement Window

Select “Next” to continue.

The Start Menu shortcuts window will open. A default location in the Woodward program folder will be shown. If a different Start Menu location is needed, type the new location in the window or select one of the locations presented in the list.

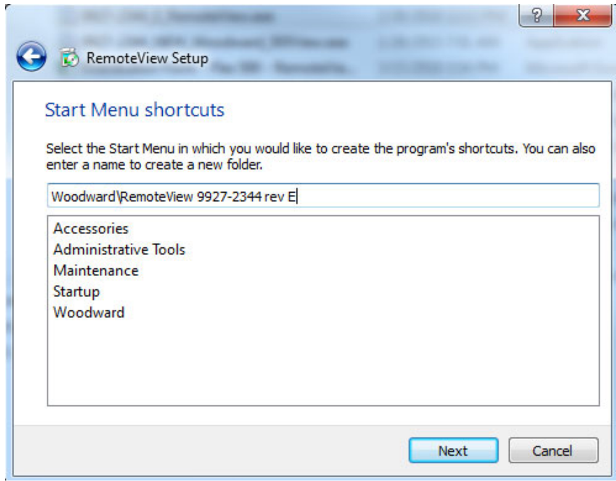


Figure L-5. Installation Start Menu Shortcuts Window

Select “Next” to continue.

The “Ready to Install” window will open.

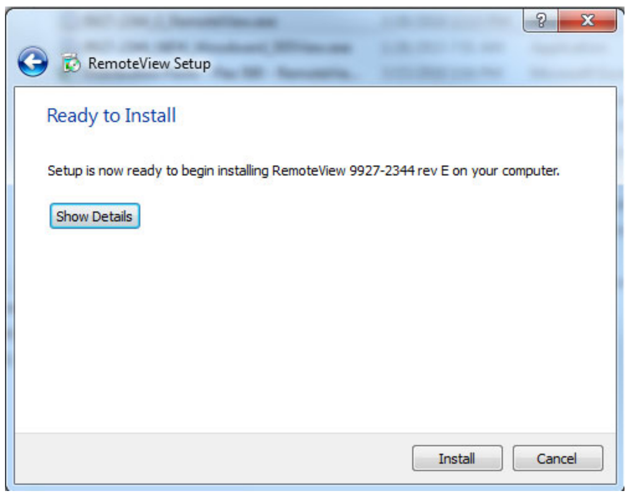


Figure L-6. Installation Ready to Install Window

Select “Install” to continue.

Configuration of the installation is complete and the actual installation process will begin. A window will open showing the progress of the installation. If prompted to do so, give the installation file permission to make changes to the PC. The following window will open when installation is complete.

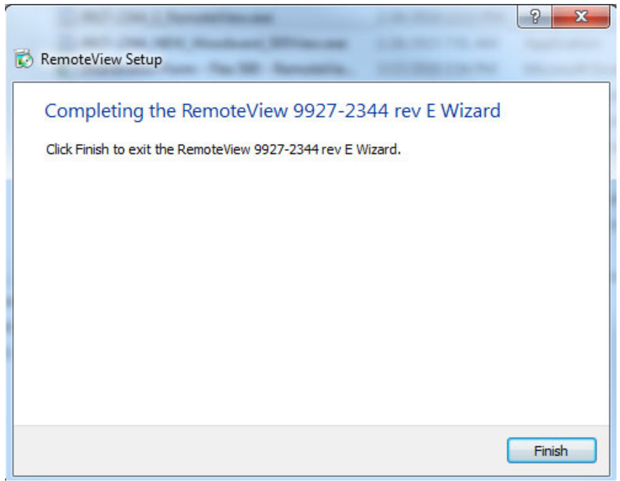


Figure L-7. Installation Complete Window

Click “Finish” to close the window. The Remote View tool is now ready for use.

Remote View Configuration

To start the RemoteView tool, go to the Start Menu and select RemoteView from the Woodward folder (or in the alternate folder specified at installation). The configuration window will open. This window has the following sections:

- Control list
- Application list
- Display properties
- Predefined settings
- Log

Control List

The Control list shows each control that can be connected to the Remote View tool. Identify Controls by their IP address, and manually add each control must to the list. To add a control, put the cursor in the IP address field and type in the address, as shown in the following figure. Enter the IP address of any kernel CPU, if they have not been changed from the defaults, kernel A CPU Ethernet port 1 will be 172.16.100.11 as shown below – then click Connect

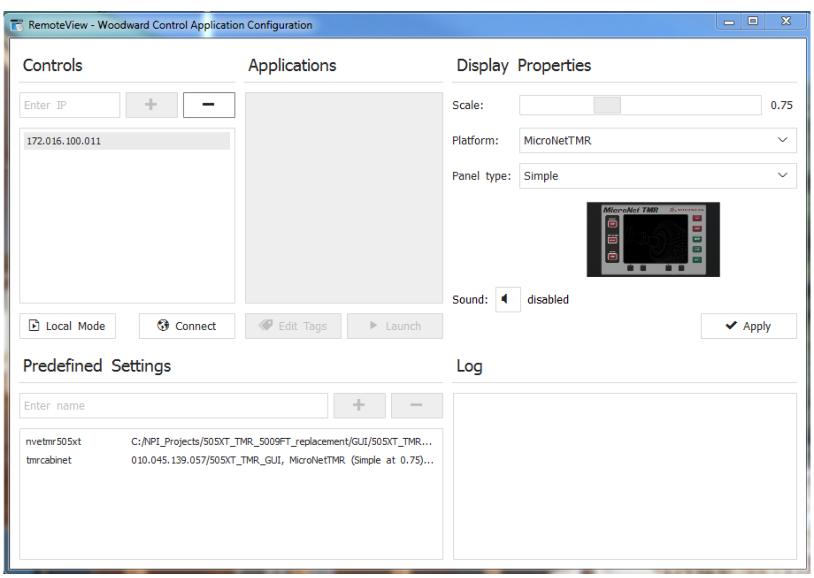


Figure L-8. Entering an IP Address to be Added to the Control List

When the address has been entered, click the "+" button to add the control to the list. When a control is selected in the Control list, the "Connect" button becomes as available, click on this to get the Login pop-up as shown in the following figure.

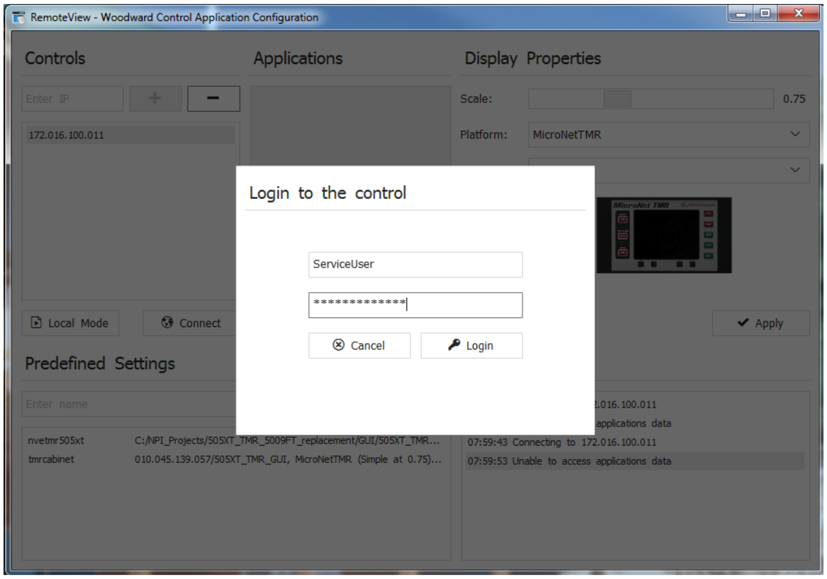


Figure L-9. Login Window with Fields for User Name and Password

The first line in the login window is the user name. The default user name is ServiceUser. The second line is the password. The default password is ServiceUser@1. After entering the login credentials, click "Login". The screen below will then appear showing the available GUI files in the applications box.

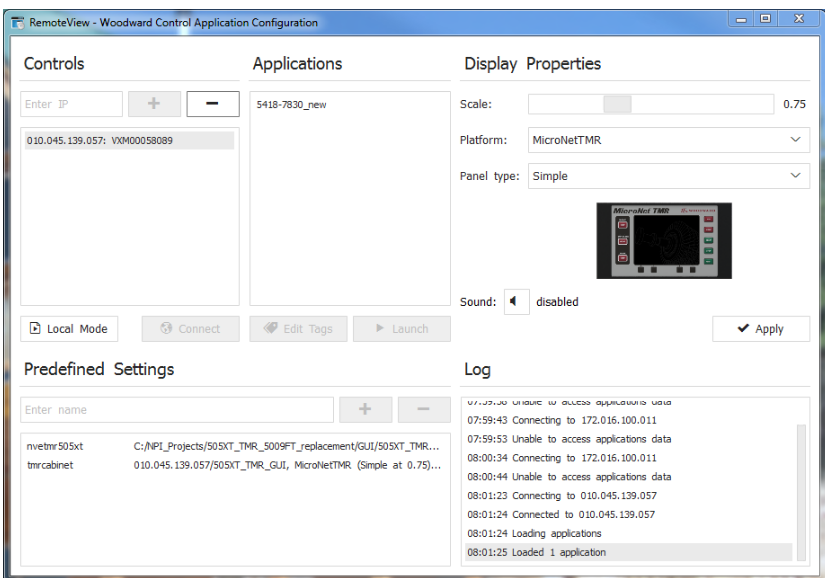


Figure L-10. Control Selected in the Control List

Application list

After a successful login, the application list will show the applications that are loaded on the control. In most cases, the 5009XT control will have a single application loaded. After selecting an application, the "Launch" button will be available. Befoe clicking the "Launch" button to open the Remote View tool, review the settings in the Display Properties section.

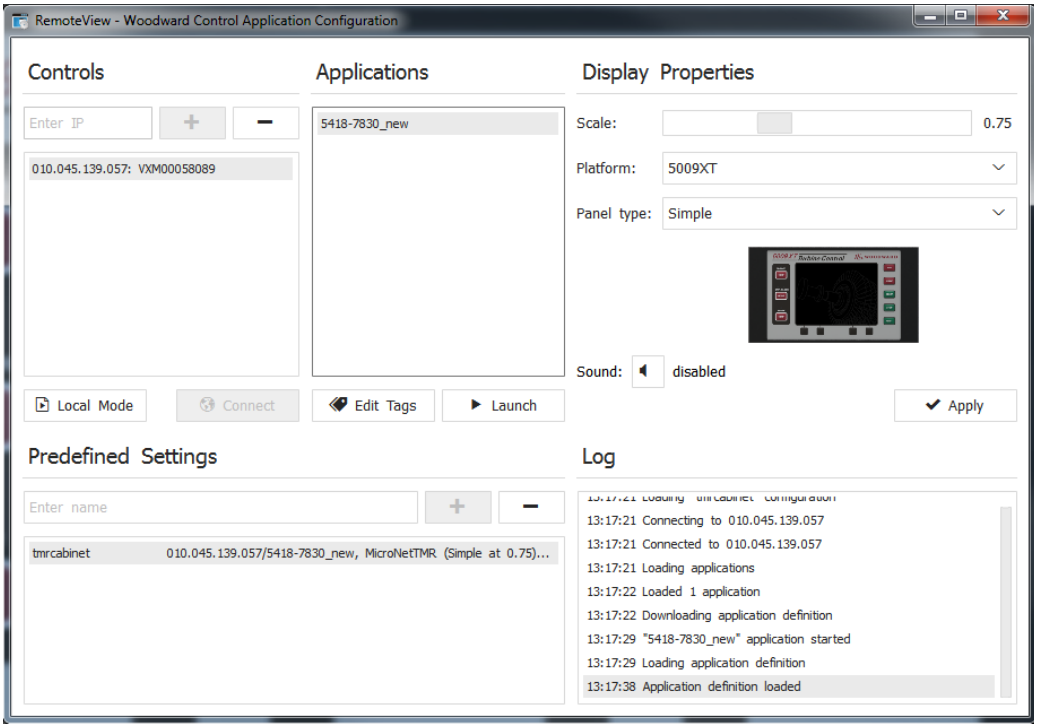


Figure L-11. Control Connected with Application List Populated

Display properties

This section has four options that will affect the appearance of the GUI when the Launch button is pressed, the Scale, Platform, Panel type and Sound.

The scale sets the size of the RemoteView tool window, where 1.00 is full size. If the Remote View tool is too large for the PC monitor, use the slider to reduce the scale.

NOTICE	**RemoteView has a "Scale" factor in the display properties that adjusts the display window size. This scaling is based on 1.0 being equal to a resolution of 800 x 600. As this scale is adjusted from this native resolution the text can become 'fuzzy'. If this scale factor is adjusted from 1.0, it should be 'tuned' to find a good balance between window size and text clarity.**

The Platform allows the user to select the control platform or a specific standard control to which RemoteView will connect. For this control select the 5009XT.

The Panel type option allows different views for framing the screens. These options vary depending on the platform that was selected. For the 5009XT select the Simple panel type.

The Sound button allows the user to Enable or Disable audible alarms from activating when an alarm or trip event occurs in the control. For this to function the control configuration will also need to have audible alarms enabled. This is typically used if the RemoteView is going to be used as the primary operational interface to the control.

Click the "Apply" button to confirm these selections and RemoteView will cache them to be the defaults for future use. After this is done click the Launch button

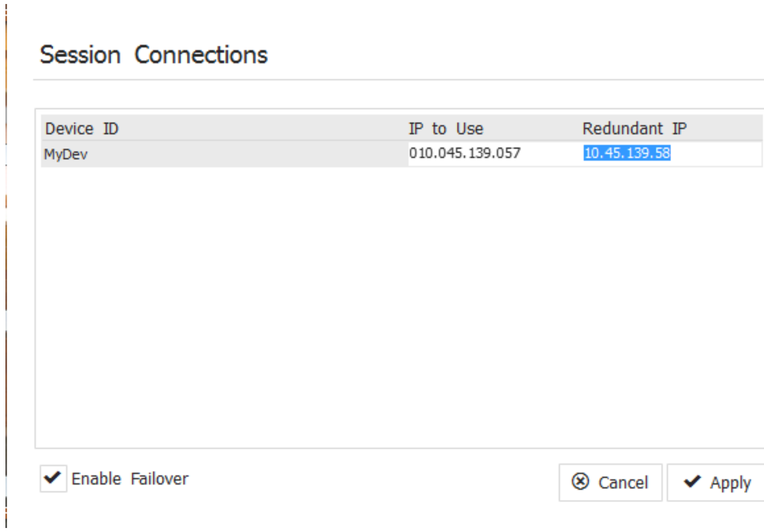


Figure L-12. Session connections dialog box

This dialog will appear and give the user an option to modify the IP for the active connection, enter the control IP and if a redundant connection is desired, click the Enable Failover checkbox and add a redundant IP to use. In the case of the 5009XT, use any 2 kernel CPU IP addresses, then click apply.

Figure L-13. Simple View of the 5009XT Tool

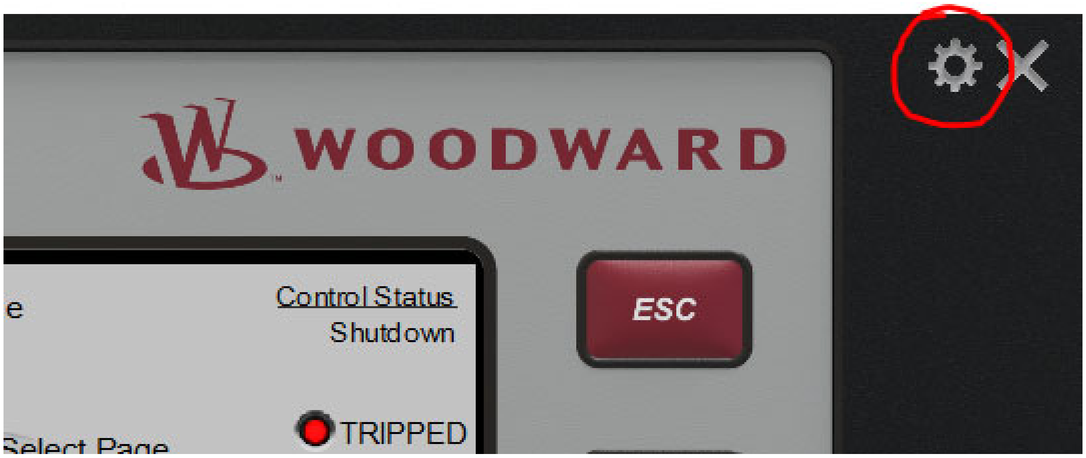


Figure L-14. RemoteView Settings (gear icon)

To adjust the settings use the ‘Gear icon’ in the upper right corner to return to the tool settings options.

Predefined settings
This dialog is used to save the settings of the Remote View tool for a specific connection. To save the current Remote View settings for the control list and the display properties, enter a name for the settings and the click “+” button. The following figure shows “tmrcabinet” entered as the name for the current settings.

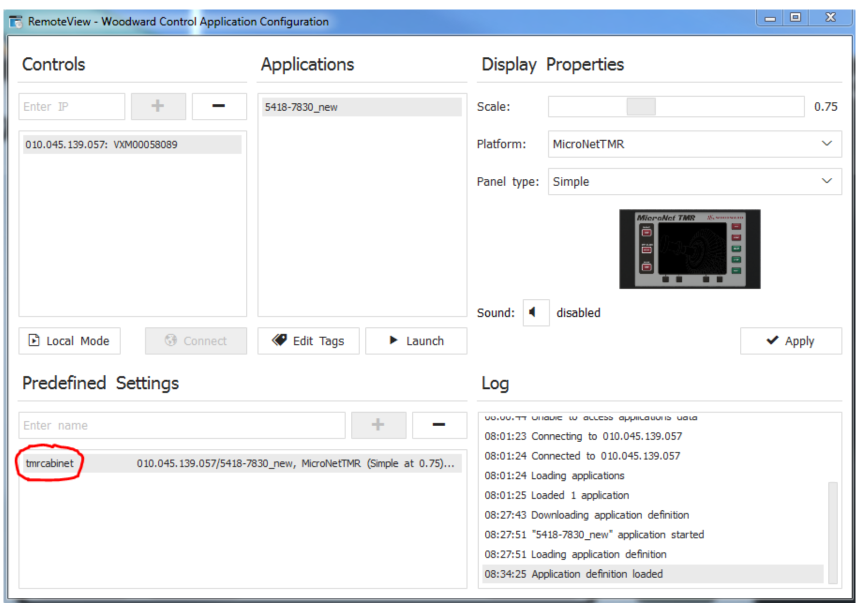


Figure L-15. Entering a Name for the Current Settings

To delete a settings file, select the file from the list and click "-" button. To load a settings file, double-click on the name of the file. The login window will open. After a success login, the Remote View tool will open.

Log
The log shows a record of the actions taken by the tool, such as GUI file retrieval from the control and login to the control. The user will generally not need to check the log, but it is useful for troubleshooting.

Using Remote View

Future launching of the Remote View tool, will cache previous selections to simplfy making connects to the control.

- Double click on the predefined settings
- Confirm the IP in the sessions connnections box

The Remote View tool is opened by selecting an application in the configuration window and clicking "Launch". Alternately, open the Remote View tool by selecting a properly configured settings file from the configuration window.

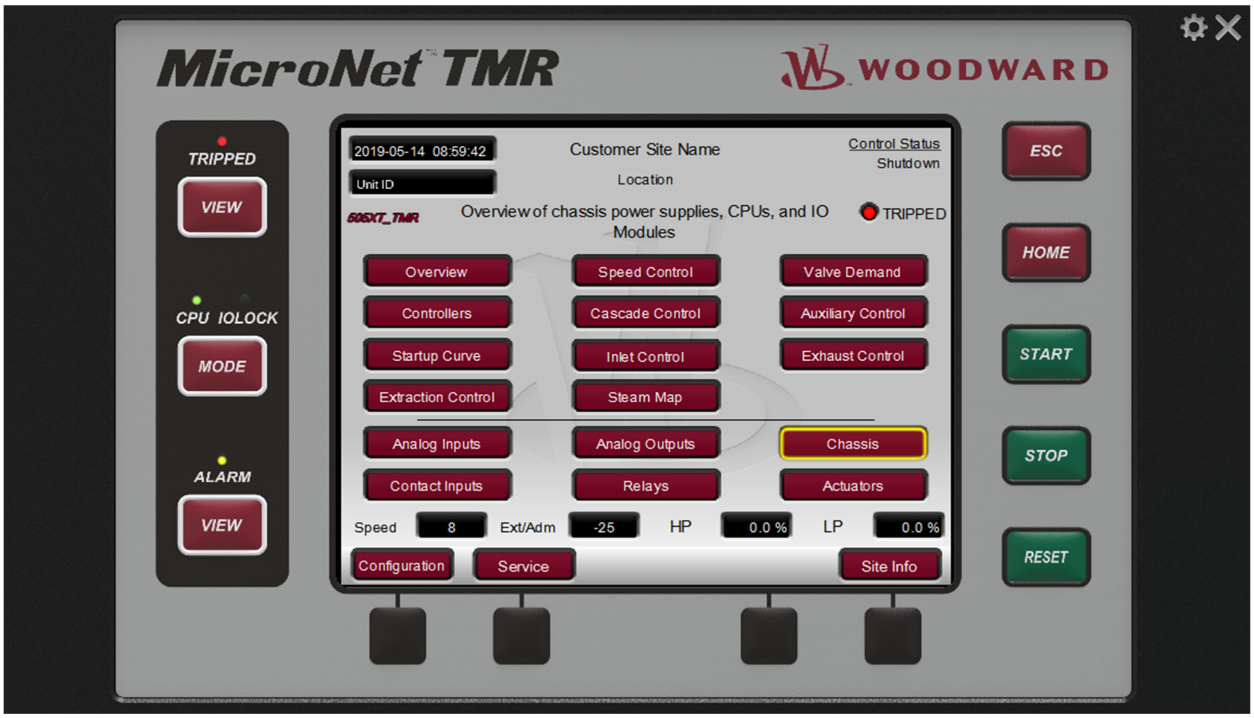


Figure L-16. Remote View Tool after
Opening Predefined settings file using MicroNet TMR platform

The Remote View tool serves as the primary interface to the 5009XT, enabling operation and configuration from a PC.

⚠WARNING	**If multiple controls are available on a network – they can all be accessed through this tool. Be sure that you are connected to the correct unit prior to making operational adjustments.**

The configuration window can be opened at any time by clicking the gear button at the top right corner of the tool. The Remote View tool can be closed by clicking the X button at the top right corner of the tool.

Revision History

Revision B —

- Revised the content in the Part Number Options section of Chapter 8
- Added Table 9-1 and Figure 9-1 then renumbered the remaining tables and figures
- Added Optional TMR sections below Figure 9-2
- Added Can Open section and Figure 9-3 to Chapter 9
- Added Chapter 17
- Revised Valve Lmtr Rate in Turbine Start Configuration Mode Worksheets
- Revised Use HP2 entry in Driver Configuration Mode Worksheets
- Revised Woodward Links table
- Added five rows to Breaker Logic table
- Added Varistroke/SPC
- Revised several rows in Table B3
- Revised several rows in Table B4
- Revised several rows in Table C2
- Revised several rows in Tables D1, D2, and D3

Revision A —

- Replaced and added the content in Table D-2

Released

Declarations

EU DECLARATION OF CONFORMITY

EU DoC No.:	00421-04-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):	5009FT, 5009XT
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 harmonisation 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, 2007 A1, 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

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

15-Jul-2019

Date

5-09-1183 Rev 31

Released

We appreciate your comments about the content of our publications.

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B35135V2 : B

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

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