WOODWARD

Installation and Operation Manual

Peak® 150 Digital Control for Steam Turbines

8200-008/009/010/011/012/013/014/015/016/017/018/019
9905-857/858/860/861/863/864/866/867

Manual 85565 (Revision C)

WARNING—DANGER OF DEATH OR PERSONAL INJURY

WARNING—FOLLOW INSTRUCTIONS

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.

WARNING—OUT-OF-DATE PUBLICATION

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, be sure to check the Woodward website:

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WARNING—OVERSPEED PROTECTION

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—PROPER USE

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

CAUTION—POSSIBLE DAMAGE TO EQUIPMENT OR PROPERTY

CAUTION—BATTERY CHARGING

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

CAUTION—ELECTROSTATIC DISCHARGE

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.**

IMPORTANT DEFINITIONS

- **A WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.**
- **A CAUTION indicates a potentially hazardous situation which, if not avoided, could result in damage to equipment or property.**
- **A NOTE provides other helpful information that does not fall under the warning or caution categories.**

Revisions—Text changes are indicated by a black line alongside the text.

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Electrostatic Discharge Awareness

All electronic equipment is static-sensitive, some components more than others. To protect these components from static damage, you must take special precautions to minimize or eliminate electrostatic discharges.

Follow these precautions when working with or near the control.

1. Before doing maintenance on the electronic control, discharge the static electricity on your body to ground by touching and holding a grounded metal object (pipes, cabinets, equipment, etc.).

2. 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.

3. Keep plastic, vinyl, and Styrofoam materials (such as plastic or Styrofoam cups, cup holders, cigarette packages, cellophane wrappers, vinyl books or folders, plastic bottles, and plastic ash trays) away from the control, the modules, and the work area as much as possible.

4. 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.

CAUTION—ELECTROSTATIC DISCHARGE

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*.

Chapter 1.
General Information

This manual describes the Woodward Peak® 150 digital control for steam turbines and the hand-held programmer (9905-292) for the Peak 150 control.

The Peak 150 control is UL Listed for the US and Canada (cUL) for use in Class I, Division 2, Groups A, B, C, and D or non-hazardous locations only.

WARNING—EXPLOSION HAZARD

The Peak 150 control box should not be opened when a hazardous atmosphere is present. Wiring connections which could cause sparks are exposed inside the cabinet.

CAUTION—DO NOT START TURBINE

Do NOT attempt to operate the turbine until the Peak 150 control has been programmed. To do so could cause equipment damage.

The scope of this manual is to provide information on programming, operation and troubleshooting of the Peak 150 control. This manual was written for the program and specifications of the 5-digit display version of the Peak 150 control. This manual can also be used for the 4-digit display version of the Peak 150 control. For the 4-digit version there may be slight differences in the program. However, all aspects of the 4-digit version are covered by this manual.

Chapter 2.
Installation

Packaging

Figure 2-1 is an outline drawing of the Peak® 150 control. All Peak 150 control components are contained in a single, NEMA 4X enclosure. The enclosure can be mounted indoors or out. Access to internal components is through a right-hand-hinged door which is held closed by six captive screws. The approximate size of the enclosure is 19 x 12 x 4 inches (approximately 483 x 305 x 102 mm).

The enclosure has two openings in the bottom for wiring access. One hole is approximately 25 mm (1 inch) diameter, and the other is approximately 38 mm (1.5 inch) diameter. These holes accept either English or metric standard conduit hubs.

NOTE
If it is necessary to meet NEMA 4X requirements, you must use the appropriate conduit hubs and conduit when installing this control.

NOTE
When using the stainless steel hubs to meet the NEMA 4X requirements, ensure the ground post on the conduit hubs is positioned down to allow the front door to fully and properly close.

All internal components are industrial grade. The components include the CPU (central processing unit), its memory, the switching power supply, all relays, all input/output circuitry, and all communications circuitry for the front door display, touch keypad, remote RS-232, RS-422, and RS-485 Modbus® * communications.

* Modbus is a trademark of Modicon, Inc.

Mounting

The standard Peak 150 control enclosure must be vertically mounted on a wall or 19" (483 mm) rack, allowing sufficient room for lid opening and wiring access. Two welded flanges, one on the right side and one on the left side, permit secure mounting.

Electrical Connections

All electrical connections must be made through the two openings in the bottom of the enclosure to the terminal blocks inside the enclosure. Route all low-current lines through the large wiring port. Route all high-current lines through the small wiring port.

Wiring for each MPU and for each actuator must be separately shielded. We also recommend separate shielding for each mA input. Contact inputs may be bundled together within a single multiconductor cable with one overall shield. Shields should be connected only at the Peak 150 control. Relay and power supply wiring do not normally require shielding.

Make sure that all inputs and outputs, including all shields, are NOT grounded outside the Peak 150 control box. Terminal block 1 (ground) is the only connection that should be wired to external ground.

See Figure 2-2 for the control wiring diagram and terminal block numbers.

WARNING—EXPLOSION HAZARD
Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.

Substitution of components may impair suitability for Class I, Division or Zone applications.

AVERTISSEMENT—RISQUE D'EXPLOSION
Ne pas raccorder ni débrancher tant que l'installation est sous tension, sauf en cas l'ambiance est décidément non dangereuse.

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

NOTE
All peripheral equipment must be suitable for the location in which used.

Shielded Wiring

All shielded cable must be twisted-conductor pairs. Do not attempt to tin the braided shield. All signal lines should be shielded to prevent picking up stray signals from adjacent equipment. Connect the shields to the indicated shield terminals. Wire exposed beyond the shield should be as short as possible, not exceeding 50 mm (2 inches). The other end of the shields must be left open and insulated from any other conductor. DO NOT run shielded signal wires along side or in the same conduit with other wires carrying large currents. See Woodward publication 50532, *EMI Control for Electronic Governing Systems*, for more information.

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

1. Strip outer insulation from BOTH ENDS, exposing the braided or spiral wrapped shield. DO NOT CUT THE SHIELD.
2. Using a sharp, pointed tool, carefully spread the strands of the shield.
3. Pull inner conductor(s) out of the shield. If the shield is the braided type, twist it to prevent fraying.
4. Remove 6 mm (1/4 inch) of insulation from the inner conductors.

Installations with severe electromagnetic interference (EMI) may require additional shielding precautions. Contact Woodward for more information.

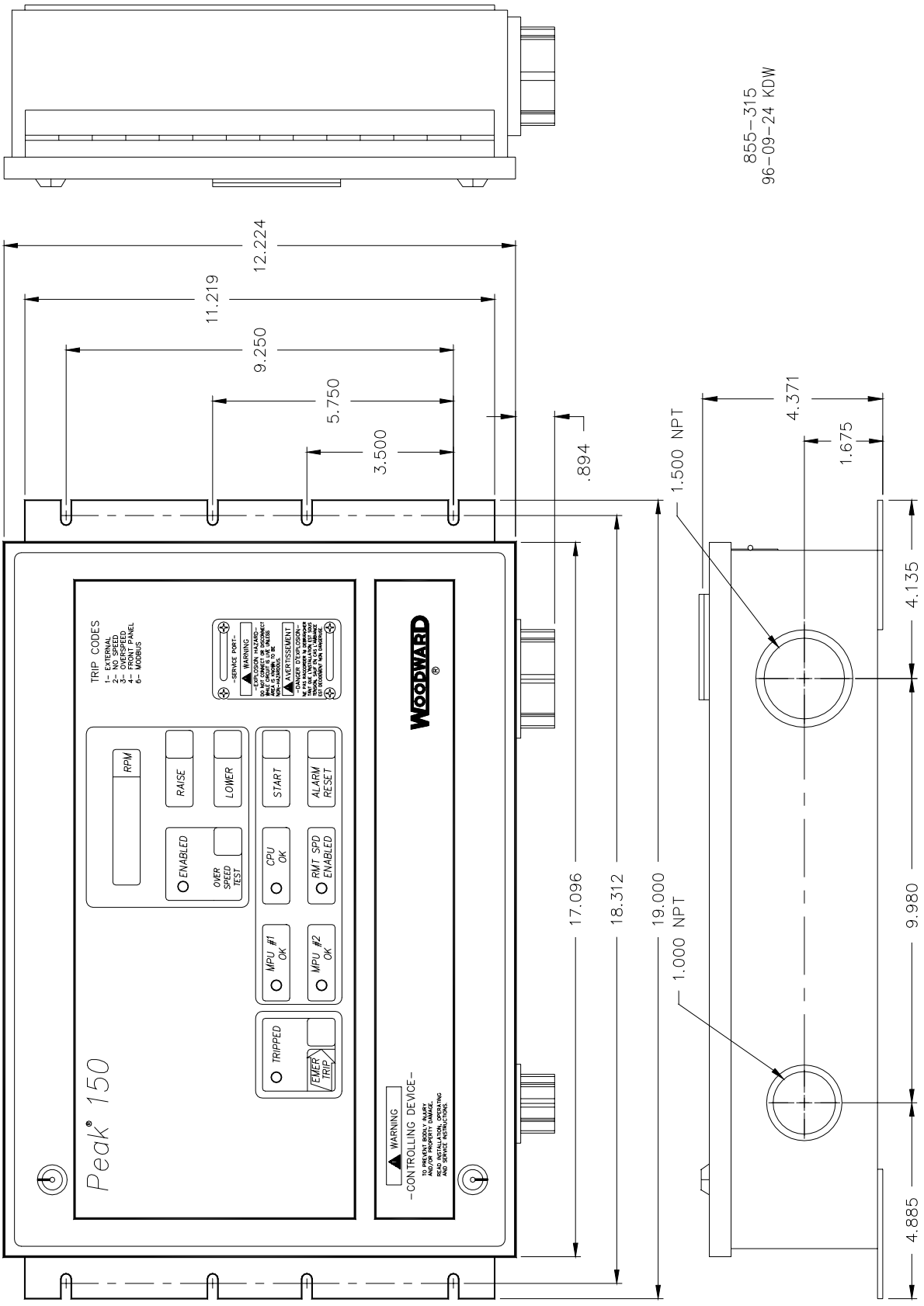
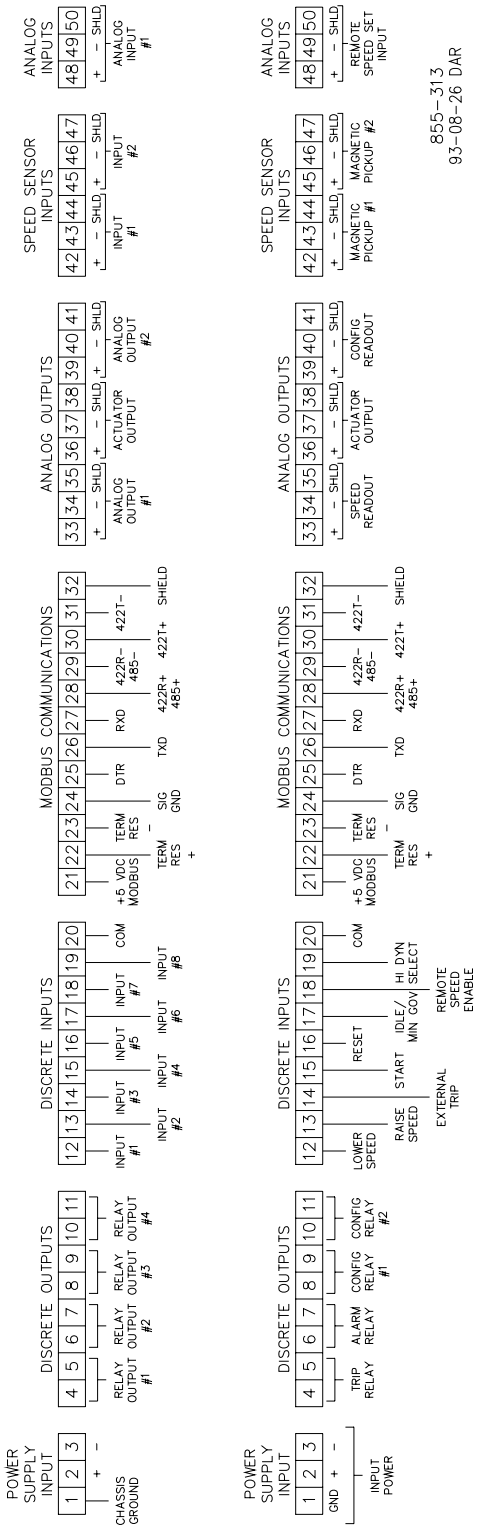


Figure 2-1. Peak 150 Control Outline Drawing



Use this Wiring Diagram with part numbers 8200-004, -020, -021, -022, and -023

Use this Wiring Diagram with all other part numbers referenced in this manual.

Figure 2-2. Control Wiring Diagram

Power Supply

Run the power leads directly from the power source to the control box. Use 12 AWG or larger wire for the power supply. Shield the power supply wires and connect the shield to an external point. DO NOT POWER OTHER DEVICES WITH LEADS COMMON TO THE CONTROL. Avoid long wire lengths. This wiring must be fully enclosed in conduit to meet Class I, Division 2, Group D requirements.

NOTE

Input and output wiring must be in accordance with Class I, Division 2 wiring methods and in accordance with the authority having jurisdiction.

Chapter 3.
Control Description

Introduction

The Peak® 150 digital control is a microprocessor-based control designed to control single-valve or single-valve rack steam turbines. A microprocessor-based digital control provides flexibility in configuring to your specific control requirements. This ability to configure your system in the field allows a single design to be used in many different control applications, and reduces both cost and delivery time.

Starting Modes

The Peak 150 control has two starting modes: manual start mode and automatic start mode.

Manual Start Mode
With the manual start mode, speed control begins at minimum governor speed (as opposed to idle speed) (see Figure 3-1).

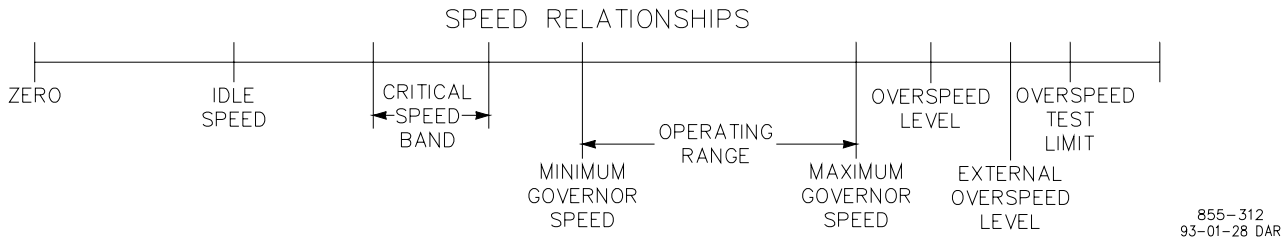


Figure 3-1. Speed Relationships

Minimum governor speed is the lower limit of the normal operating speed range. All speed control during start-up is the responsibility of the operator until minimum governor speed is reached.

Automatic Start Mode
With automatic start mode, speed control begins at idle speed (which is lower than minimum governor speed). A critical speed band can be configured if needed. The speed set point is used to bring the turbine speed up to minimum governor speed, either manually (with the Raise/Lower commands) or automatically (with the front-panel START pushbutton or the Idle/Minimum Ramp contact input).

Operating Modes

The Peak 150 control has three operating modes: manual mode, remote speed set mode, and combination mode.

Manual Mode
If the manual mode is configured, the turbine speed is adjusted solely by the front panel keys and the remote raise and lower discrete inputs. The remote speed setting analog input is ignored in this mode.

Remote Speed Set Mode
When the remote speed set mode is configured, the turbine speed is determined by the remote speed setting analog input. When the remote speed setting enable contact is closed and the turbine is at or above minimum governor speed, turbine speed will ramp from minimum governor speed to the remote value at a user-defined rate. Once the speed set point output matches the setting of the remote speed setting signal, the speed will change at a new user-defined rate for process control. If the remote speed setting signal is disabled for any reason, the speed set point will remain at the last speed and the set point adjustment operates as it does in manual mode.

Combination Mode
The combination mode is similar to the analog remote speed set mode, except that the speed demand generated by the discrete (front panel and remote raise and lower contact inputs) and the analog remote speed setting signal are compared for the highest value. This highest value is passed on as the commanded speed. If the remote speed setting signal is disabled for any reason, control of the speed set point operates as it does in manual mode.

Communication

The Peak 150 control has four methods of communication:
- Control panel
- Hand-held programmer
- Remote inputs for governor commands
- An optional Modbus protocol serial port

Chapter 4.
Wiring

Inputs and Outputs

All inputs and outputs to the Peak® 150 control are made through terminal blocks inside the Peak 150 control enclosure. Wiring passes through two wiring ports on the bottom of the control.

Inputs and outputs to the control are:

- Power supply input
- Discrete outputs
- Discrete inputs
- Modbus communications (optional)
- Analog outputs
- Speed sensor (magnetic pickup) inputs
- One analog input (remote speed set)
- A service port for the hand-held programmer

WARNING—EXPLOSION HAZARD

The Peak 150 control box should not be opened when a hazardous atmosphere is present. Wiring connections which could cause sparks are available inside the cabinet.

NOTE

For part numbers 8200-004, -020, -021, -022, and -023, the wiring information in this chapter does not apply. To wire these controls refer to Control Wiring Diagram Figure 2-2.

Power Supply

Figure 4-1 shows the power-supply connections. The following tables show the Input voltages and frequencies for the different versions of the Peak 150 control. Maximum power consumption is 38 W.

cUL Version	NEMA 4 Part Number	NEMA 4X Part Number
24 Vdc	9905-857	9905-863
24 Vdc w/Modbus	9905-860	9905-866
ac/dc	9905-858	9905-864
ac/dc/ w/Modbus	9905-861	9905-867

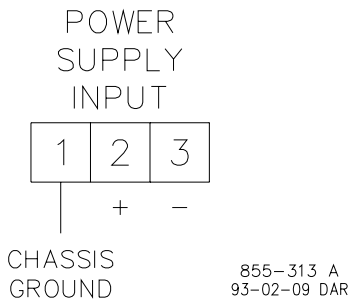


Figure 4-1. Power Supply Input

Version	Input Voltage	Frequency
1 (24 Vdc)	18–32 Vdc	NA
2 (ac/dc)	90–150 Vdc	NA
	88–132 Vac	47–63 Hz

No power switch is provided, the unit operates whenever power is applied. Input over-or under-voltage shutdown is not provided; if the +5 Vdc supply in the unit goes below 4.7 volts, the microprocessor will be reset.

Discrete Outputs

There are four hermetically-sealed relays: two dedicated, two user-configurable:
- Relay output #1 = TRIP
- Relay output #2 = ALARM (de-energizes for alarm)
- Relay output #3 = USER-CONFIGURE (energizes for function)
- Relay output #4 = USER-CONFIGURE (energizes for function)

The Trip Relay can be configured to either de-energize or energize for shutdown (see Figure 4-9 jumper option chart).

If required the configurable relays can be programmed as an additional Trip (using Option 2) or Alarm (Option 1) function. See Functional Block Diagram (Chapter 10) or Relays section of Configuration Menu (Chapter 9) for options.

Figure 4-2 shows the relay terminals.

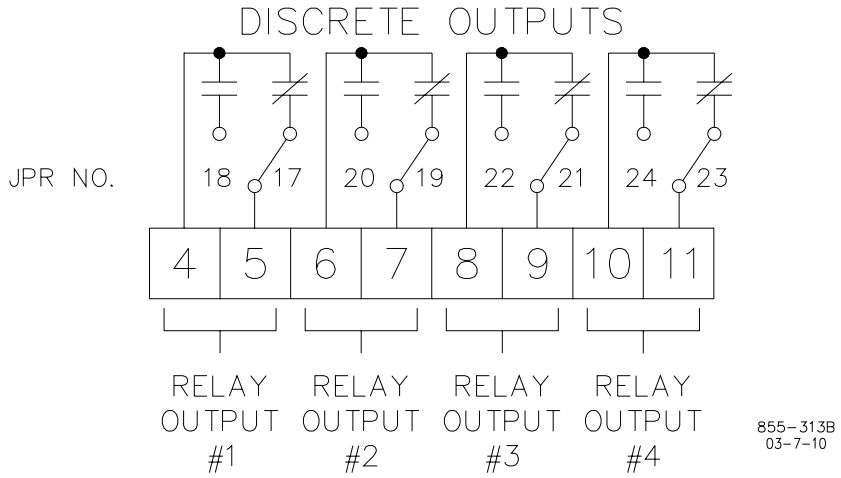


Figure 4-2. Relay Outputs

Internal jumpers provide a choice of normally open or normally closed contacts (see Figure 4-9 for jumper option chart).

Relay Contact Output Ratings
- 2 A Resistive @ 28 Vdc
- 0.3 A Resistive @ 115 Vac

NOTE
An interposing relay is required if more current is needed.

Discrete Inputs

There are eight discrete inputs (shown in Figure 4-3), powered either by an internal 24 Vdc supply or by an external 5–28 Vdc supply:

- Input #1 = Lower Speed
- Input #2 = Raise Speed
- Input #3 = External Trip
- Input #4 = Start
- Input #5 = Reset
- Input #6 = Idle/Minimum Governor
- Input #7 = Remote Speed Enable
- Input #8 = Select High Dynamics or Overspeed Test

Input #3 (External Trip) opens for a trip condition. Input #6 (Idle/Minimum Governor) closes to select minimum governor and opens to select idle. All other inputs close for the function listed.

NOTE
A jumper or external shutdown switch must be installed across Input #3.

As shown in Figure 4-4, internally powered contact inputs (dry contacts) use Jumper 15 and +24 Vdc from analog Outputs Terminal 33 or 39). Externally powered contact inputs use Jumper 16 and an external + 24 Vdc supply.

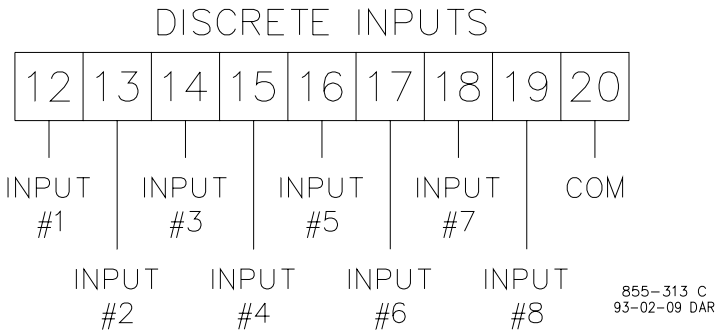


Figure 4-3. Discrete Input Connections

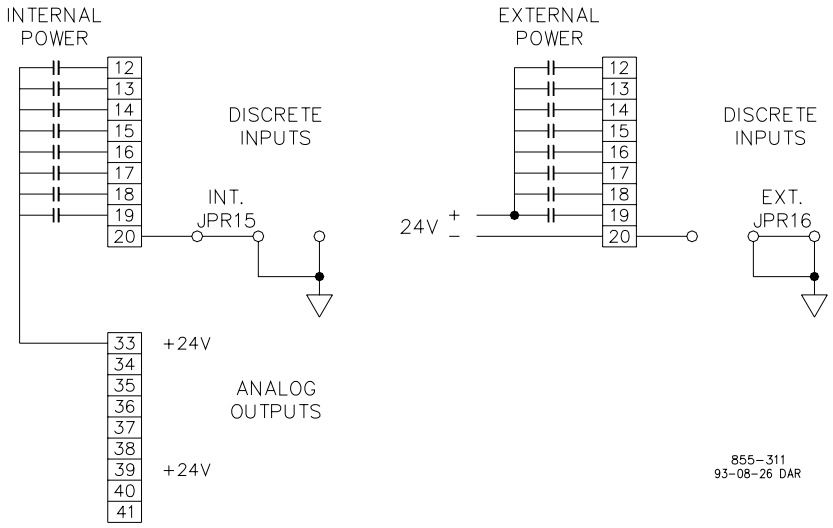


Figure 4-4. Powering Discrete Inputs

Modbus Communications

Figure 4-5 shows the connections for Modbus communications. Refer to Chapter 11 for additional Modbus information.

If terminals 21–34 are not installed, your unit is not capable of Modbus communications.

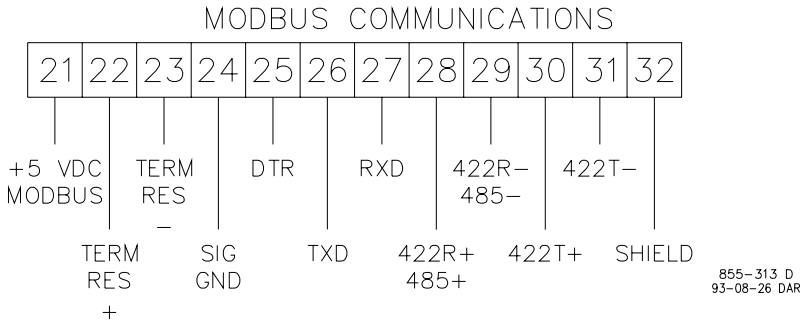


Figure 4-5. Modbus Connections

Analog Outputs

- Analog output #1 = Speed Readout
- Analog output #2 = User Configurable
- Actuator output = Signal to Actuator

Figure 4-6 shows the Analog Output connections. Analog outputs #1 and #2 are 4–20 mA or 0–1 mA, internal jumper selectable (see Figure 4-9 for jumper option chart).

Actuator output is 0–20 mA or 0–200 mA, internal jumper selectable (see Figure 4-9 for jumper option chart).

The fuel-valve actuator wires will carry a 0–200 mA or 4–20 mA signal and must be fully enclosed in conduit to meet hazardous-environment requirements.

The speed readout output is included in the control connections to drive a tachometer installed at the turbine site or in the turbine control room.

The control may be tailored to give accurate readings on the tachometer by making adjustments on the set point programmer (see Service Menus and Configure Menus Chapters).

See Readouts section of Configuration Menus for Configurable Readout options.

Figure 4-6 shows the connections for analog outputs.

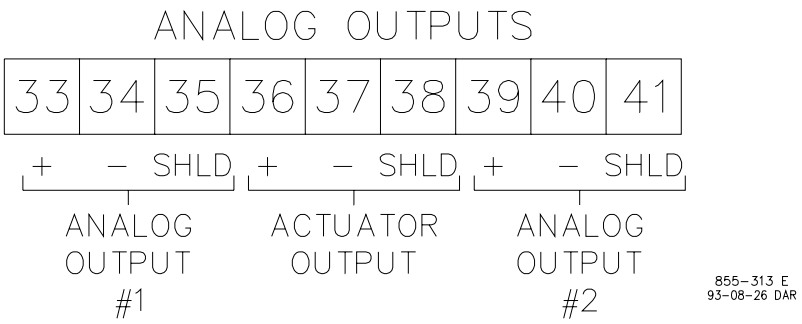


Figure 4-6. Connections for Analog Outputs

Speed Sensor Inputs

Figure 4-7 shows the connections for the two speed sensor inputs. The minimum signal amplitude required for speed sensing is 1 Vrms. The minimum detectable frequency is 200 Hz @ 1 Vrms. The maximum detectable frequency is 15 kHz.

- Input #1 = Magnetic Pickup Unit 1
- Input #2 = Magnetic Pickup Unit 2

Maximum control speed = 15000 rpm.

The MPU cable must have two wires from the MPU plus a shield. The shield is grounded at the control only: it must not be grounded at the MPU. The integrity of the shield must be maintained between the MPU and the control. Polarity of the signal wires from the MPU to the control is not important.

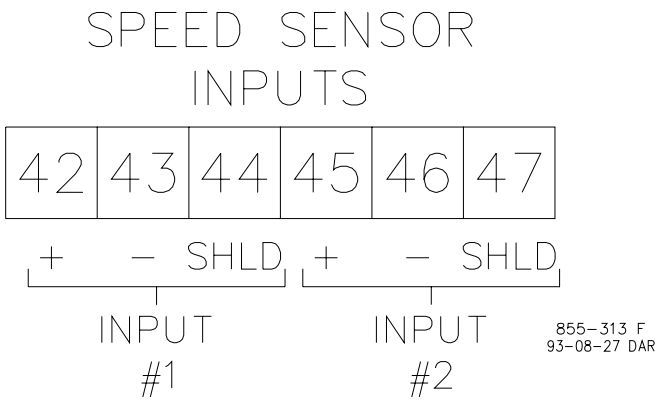


Figure 4-7. Connections for Speed Sensing

Analog Input

There is one analog input: the remote speed setting input. Figure 4-8 shows the connections for the analog input.

- Analog input #1 = Remote Speed Set
- 4–20 mA or 1–5 Vdc internal jumper selectable, (see Figure 4-9 for jumper option chart)

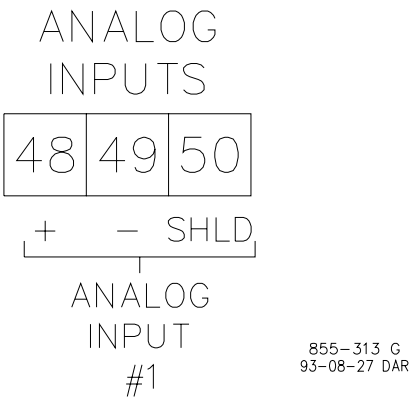


Figure 4-8. Connections for Analog Input

Jumpers and Test Points

Figure 4-9 shows the location and functions of the Peak 150 control's jumpers and test points.

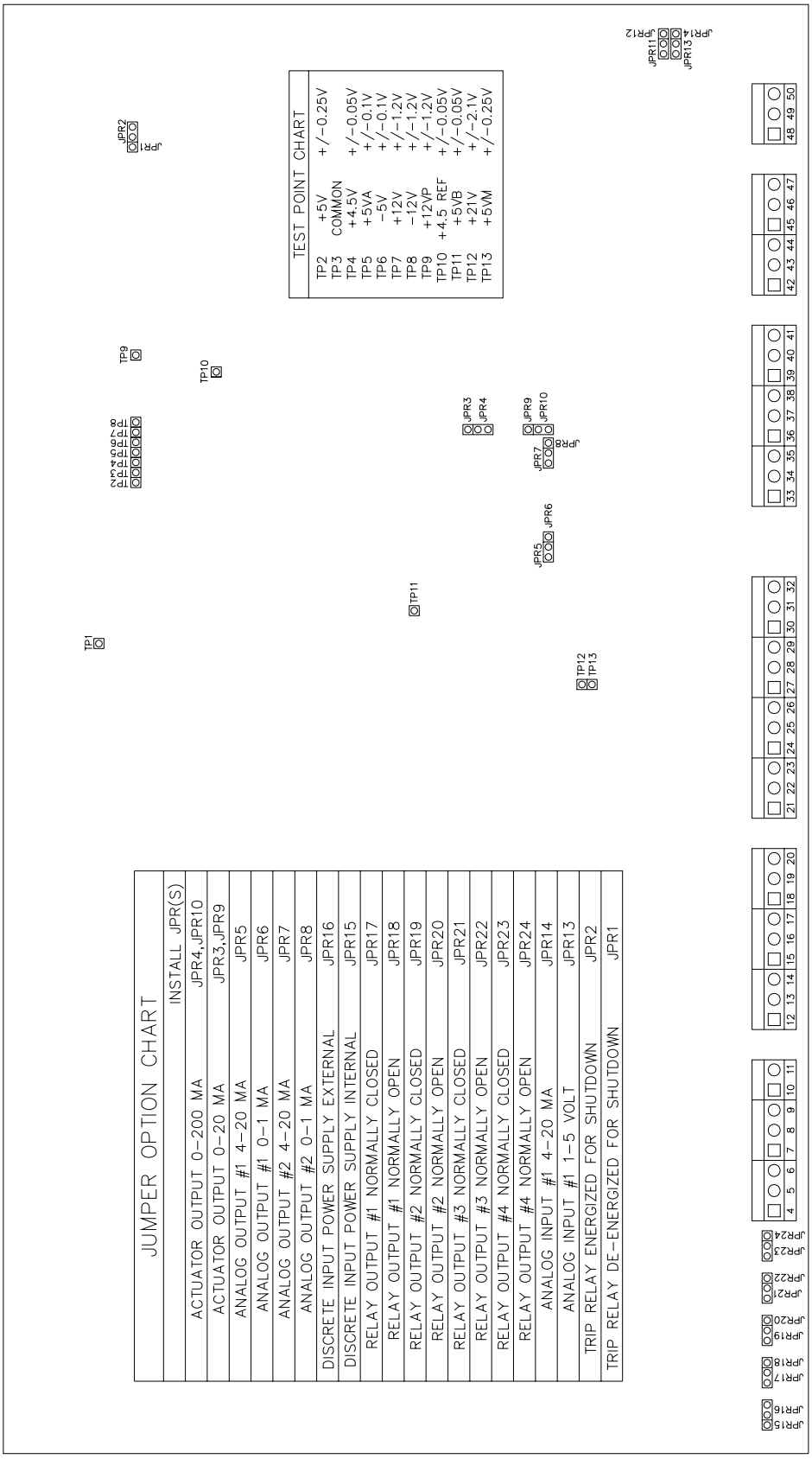


Figure 4-9. Jumper and Test Point Locations and Functions

Chapter 5.
Functional Description

Introduction

A system overview in block form is shown in Figure 5-1. Chapter 10 contains the detailed functional block diagram for the Peak® 150 control.

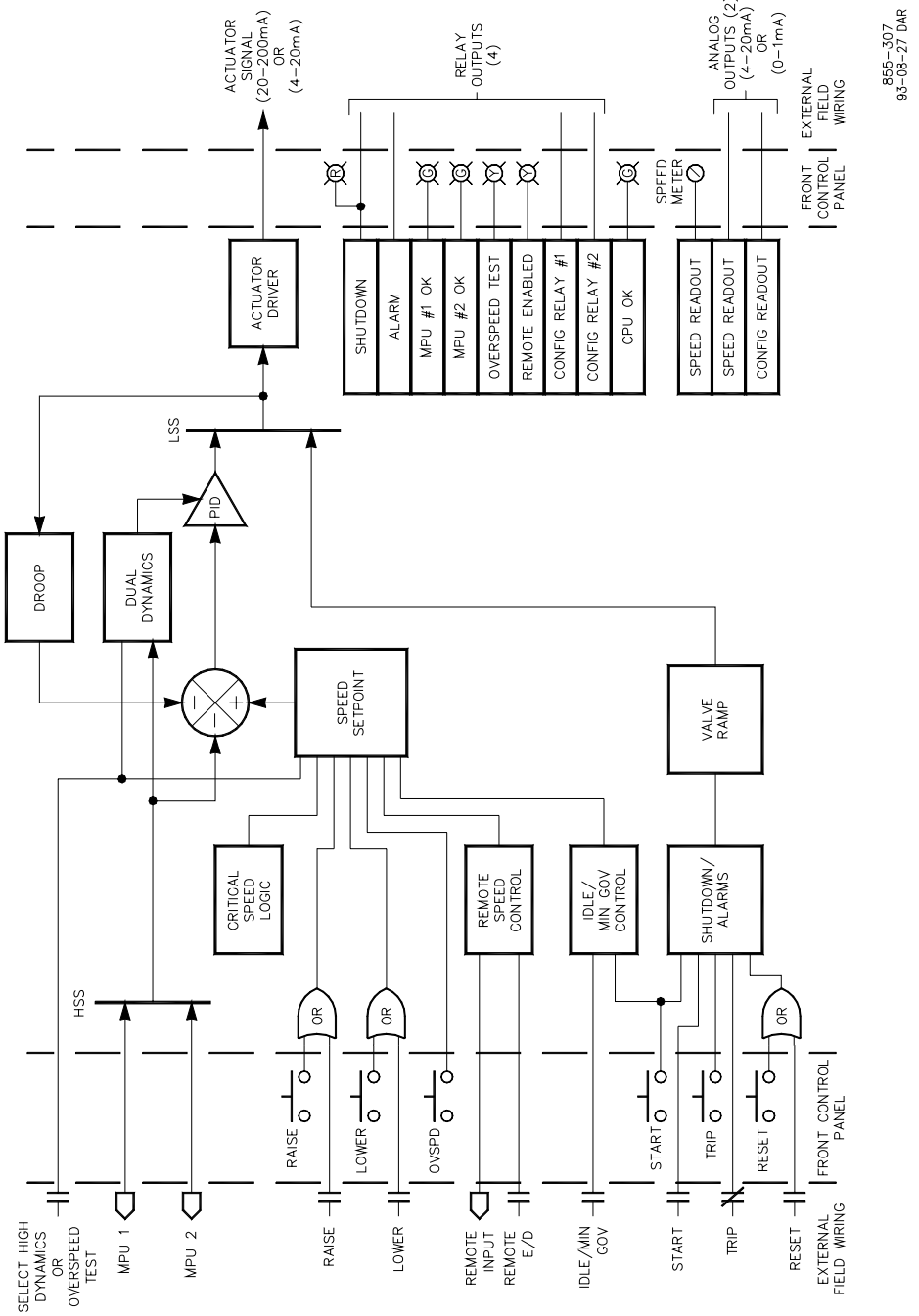


Figure 5-1. System Overview

Magnetic Pickups

If your application uses two MPUs (magnetic pickups), the MPUs may be mounted on separate gears, but each gear must have the same number of teeth and rotate at the same speed, so that both MPUs record the same speed. The Peak 150 control must receive an MPU signal of 1.0 Vrms minimum to detect speed. The maximum speed input is 15 kHz. If you are using only one MPU, connect it in parallel to both MPU inputs to prevent getting an alarm on the unused input.

Input frequency of the Peak 150 control is calculated by this formula:

Hz = (rpm x no. of teeth)/60

Analog Input

The 4 to 20 mA remote reference input is an isolated current-source input. The remote current source must be able to provide current sufficient for the 250 Ω internal control resistance plus any field wiring resistance (that is, a maximum load impedance for the current source equal to or greater than 250 Ω + wire resistance).

Contact Inputs

The eight hardwired contact inputs are:

- External Trip
- External Clear (Reset)
- External Start
- Raise Speed Reference
- Lower Speed Reference
- Idle/Minimum Governor Speed Ramp
- Remote Speed Set Enable
- Select High Dynamics or Overspeed Test

Before starting, the External Emergency Shutdown contact must be jumpered closed or must have an external switch wired in and closed. The control will initiate an emergency shutdown any time the contact is opened.

Minimum contact input voltage is 5 Vdc to turn the input on.

Actuator Driver

The actuator driver current can be either: (1) 20 to 160 mA signals for Woodward hydromechanical or pneumatic actuators; or (2) 4 to 20 mA signals for non-Woodward actuators. Actuator drive current is selected in the Configure Mode and by installing the appropriate actuator drive current jumpers (see Figure 4-9). Maximum external line resistance for each 4 to 20 mA actuator output is 450 Ω (actuator impedance + wire resistance). Maximum external line resistance for each 20 to 160 mA actuator output is 60 Ω (actuator impedance + wire resistance).

Analog Outputs

There is a speed readout and a configurable readout available. Depending on the jumper installed (see Jumper Option Chart) they are 4–20 mA or 0–1 mA outputs. The configurable meters are selected in the Configure Mode from five options:

- Speed Input
- Speed Reference
- Remote Process Input
- Valve Ramp Position
- Actuator Position

Maximum external line resistance for meter outputs is 600 Ω (meter impedance + wire resistance).

Relays

Two of the four relay outputs are dedicated:

- Trip Relay (Configurable to either energize or de-energize for trip).
- Alarm relay (Normally energized—de-energizes for alarm).

The configurable relays are selectable in the Configure Mode from 11 options:

- Alarm
- Trip Output
- Shutdown
- Remote Control
- Speed Control
- MPU Failure
- Overspeed Trip
- Overspeed Test
- Remote Signal OK
- Speed Switch or Hand Valve 1
- Speed Switch or Hand Valve 2

Normally-open or normally-closed contact is selectable (see Figure 4-9).

Relay contacts are rated at:

- 2.0 A of resistive load at 28 Vdc
- 0.75 A of inductive load at 28 Vdc
- 0.3 A of resistive load at 115 Vrms, 60–400 Hz
- (The relay contacts are not rated for 125 Vdc)

An interposing relay is required if more current is needed.

Speed Control

The speed control receives a turbine speed signal from one or two magnetic pickups. A frequency-to-voltage converter changes the speed frequency signal from each MPU into a proportional voltage signal. The PID (proportional, integrating, differentiating) control amplifier then compares this signal to the speed-reference set point to generate an output signal to the actuator driver and valve actuator.

The speed control amplifier also can receive a programmable (optional) droop feedback signal to increase the stability of the turbine/governor system. The droop signal is direct feedback using a portion of the speed control amplifier output.

Dual Dynamics

The Peak 150 control has two sets of Gain and Reset inputs for the control amplifier (PID). The transfer from one set of dynamics can be based on speed or selected as a contact closure.

Speed Set Point

The speed set point (or reference) is compared to the actual speed to generate an output signal to the actuator.

The speed set point can be adjusted either from the Raise or Lower commands on the front panel or through the Raise Speed or Lower Speed external contact inputs. It can also be manipulated indirectly from the critical-speed logic, remote process control, and idle/minimum governor control logic.

Remote Process Control

The remote process control can control the speed-reference set point. A process control external to the Peak 150 control receives a 4 to 20 mA/1 to 5 V input signal from a transducer. The external process control compares that signal with an external reference to generate an output to the remote speed setting portion of the Peak 150 control. An I/V converter changes this current signal to a proportional voltage. The Peak 150 control's internal process control compares the speed represented by this voltage to the actual speed to generate an output signal to the actuator. When the combination mode is configured, the speed reference and remote speed setting are high-signal selected to determine the demanded speed. If the remote Speed Setting mode is configured, the remote speed setting input directly manipulates the speed reference, providing bumpless transfer if the input fails.

Idle/Min Control

The speed reference can be taken from idle speed to minimum governor speed automatically. This can be done either with the Idle/Min Gov Ramp external contact or with the START command from the front panel. The Service Mode is used to select which feature, if any, is used.

Critical Speed Avoidance

In many turbines, it is desirable to avoid certain speeds or speed ranges (or pass through them as quickly as possible) due to excessive turbine vibration or other factors. During programming, you may identify a critical speed range. This may be any speed range below the minimum speed reference that is between idle speed and minimum speed. Within the critical speed range, the Peak 150 control moves the speed reference at the fast rate and does not allow the speed reference to stop within the critical speed range. The operator can reverse the upward direction of speed-reference movement through a critical-speed range by closing the Speed Lower (contact input or front panel). The lower or downward direction has a higher priority than the upward direction.

Valve Ramp Control

The valve ramp control opens and closes the steam valve to aid in starting and shutting down the turbine. The ramp can be adjusted through the hand-held programmer. In the Service mode, valve ramp control is normally automatic. On start, the ramp automatically goes to 100% at a controlled rate, and on trip, it is set to 0% instantly.

Diagnostics

When the control is powered up, the microprocessor will begin executing the software and will turn on the CPU OK LED on the front of the control. As long as the microprocessor is running, this LED will remain on. This LED is controlled in hardware by a watchdog timer circuit. If, for any reason, the microprocessor stops executing or if the program is not running correctly, the watchdog timer will time out and the CPU OK LED will turn off. If this happens, the I/O Lockout will be activated, which turns off all discrete and analog outputs. The only way to restart the control is to turn the power off and then back on.

When the control is powered on or when it is rebooting after being configured, the software performs several hardware diagnostic tests. If an error is found during this testing, it is annunciated through the tachometer display on the front of the control. The tachometer will display the message "ERR" followed by an error number. If any of these errors occur, the control must be returned to the factory for repair. Refer to Chapter 11 for an explanation of the diagnostic tests and their corresponding error numbers that are displayed if an error occurs.

- RAM Test Failure "Err0"
- Analog I/O Timer #1 Failure "Err1"
- Analog I/O Timer #2 Failure "Err2"
- I/O Lockout Failure "Err3"
- –12 V Power Supply Failure "Err4"
- +12 V Power Supply Failure "Err5"
- +12 V P Power Supply Failure "Err6"
- +4.5 V Power Supply Failure "Err7"

Shutdown and Alarm Summary

The following lists the various occurrences which constitute either an alarm or shutdown condition. Shutdown conditions are signaled by a relay which is configured by the user to either energize or de-energize for shutdown. The front panel display will also indicate the cause of the trip. Alarm conditions are signaled by a relay that de-energizes. Any common alarm or trip condition can be identified using the hand-held programmer. In addition, the cause of the last trip is held in a register and can be identified using the hand-held programmer.

Alarm conditions are:
- MPU #1 Failure
- MPU #2 Failure
- Remote Input Failure
- Shutdown (configurable)
- Communications Failure (if used)

Shutdown conditions are:
- Loss of both magnetic pickup signals
- Electrically-sensed overspeed trip
- Emergency Trip pushbutton is pushed
- Shutdown contact input initiated
- Trip initiated by Modbus device (if used)

Magnetic Pickup Failure Override

The magnetic pickup signal-failure shutdown is automatically overridden for starting the turbine. The override is automatically removed once an adequate speed for signal detection is reached. This speed is set by the user.

The speed-signal-failed override is delayed, when switched on, to differentiate between a sudden signal loss and loss of signal caused by roll down of the turbine. A sudden signal loss will thus command a shutdown before the override takes effect.

On a normal stop, however, the trip and throttle valve is closed gradually, with the Peak 150 control demanding the governing valve to be fully open as turbine speed decreases below the Idle set point.

Power Supplies

The Peak 150 control is available with the following power supplies:

Version	Input	Frequency
1 (24 Vdc)	18–32 Vdc	NA
2 (ac/dc)	90–150 Vdc	NA
	88–132 Vac	47–63 Hz

No power switch is provided; the Peak 150 control operates whenever power is applied.

If power is disconnected from the Peak 150 control, the control will continue to operate for at least the following holdup times:

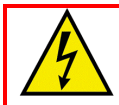
- Version 1: 28 milliseconds from 24 Vdc
- Version 2: 50 milliseconds from 120 Vdc
  4 cycles from 100 Vac

Input voltage fluctuations within the acceptable range will not affect operation of the Peak 150 control.

Input power is fused. The two fuses are user-replaceable. These fuses are sized to make nuisance trips unlikely. If fuses need to be replaced, this indicates that the control probably needs to be repaired.

Allowable fuse types are listed below:

- Version 1 (24 Vdc) 3A, 250 V, Slo-Blo, 3AG
- Version 2 (ac/dc) 1A, 250 V, Slo-Blo 3AG



WARNING—HIGH VOLTAGE

Before replacing fuses, remove all power from the control; high voltage is present on the fuse clips and elsewhere in the control. Contact with this voltage could cause personnel injury or death.

Communications (Optional)

The Peak 150 control is capable of communicating to a plant computer using Modbus protocol. All pertinent parameters are programmed to be transferred through this link. The following link parameters are configurable: data bits, stop bits, baud rate, and parity.

This option requires additional communication hardware not available unless purchased, make sure to specify the Modbus option if this is required.

See Chapter 11 for complete details.

Chapter 6.
Operating Procedures

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.

CAUTION—DO NOT START TURBINE
Do NOT attempt to operate the turbine until the Peak® 150 control has been programmed. Refer to the program worksheets.

Front Panel Operation

Figure 6-1 is shows the front panel of the Peak 150 control.

RPM Meter

The tachometer displays the speed sensed by the Peak 150 control. The minimum speed will depend on the MPU voltage level but can be no lower than 200 rpm.

When the Peak 150 control is tripped, the display flashes a trip code corresponding to the cause of the trip. The speed and trip code are alternately flashed on the display. Once the trip is cleared with a RESET command, the display will show the speed only. The trip code indicating the cause of the last trip can be found in the Service Mode using the hand-held programmer (see Service Mode program chapter). The trip cause can be determined as follows:

Code	Cause
1	External Trip (contact input opened)
2	Loss of Both MPU inputs
3	Overspeed Trip indication
4	Front Panel Trip indication
5	Modbus Trip indication

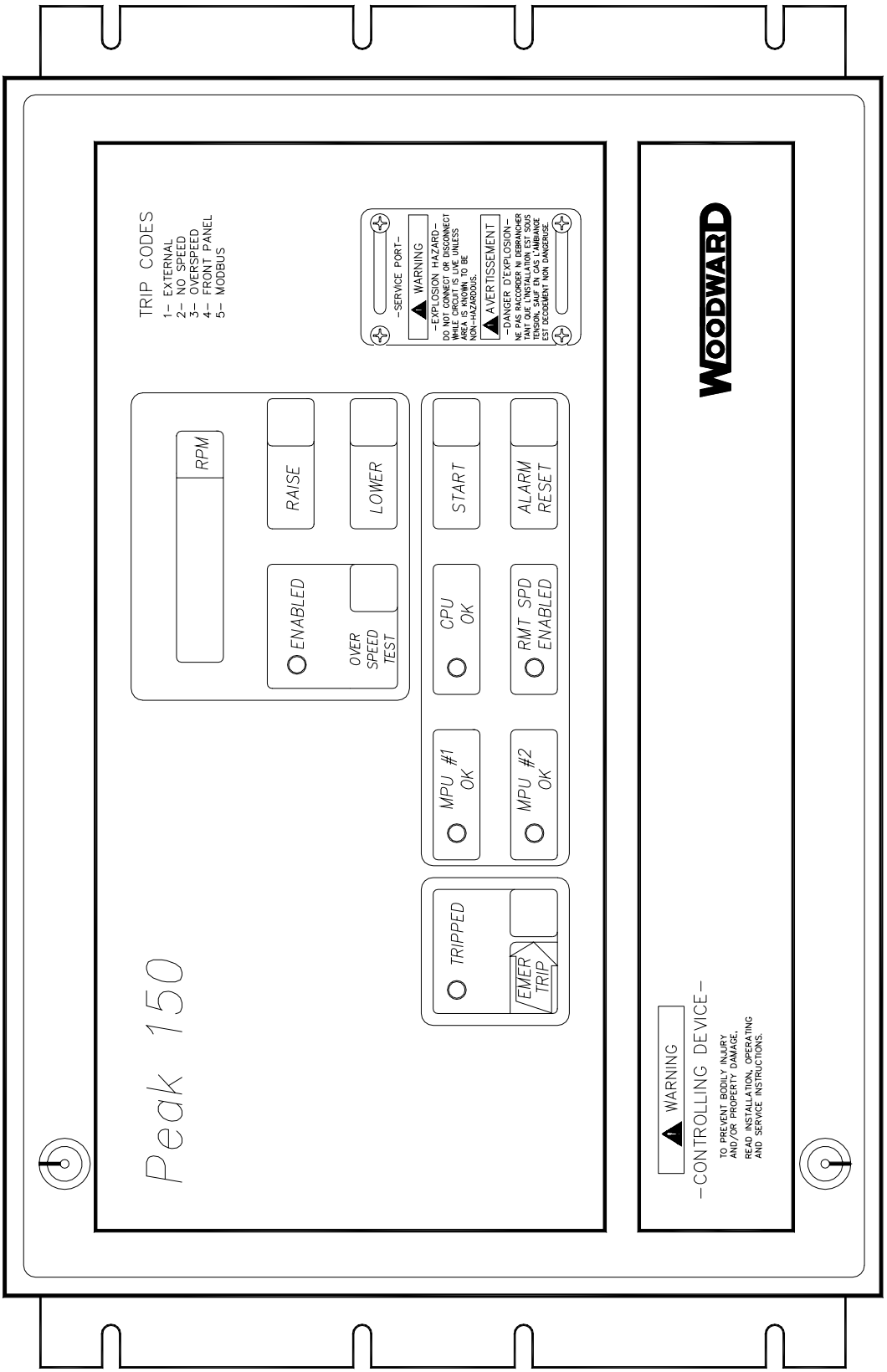


Figure 6-1. Front Panel of Peak 150 Control

LEDs

Tripped LED—This LED indicates tripped status of the control. The LED corresponds directly with the trip relay output. If the relay is in the tripped position, the LED will be ON. The trip relay can be reset with a Reset command even if a trip condition still exists, this enables the turbine trip string to be reset.

The tripped relay can be configured to either energize or de-energize on a trip. The LED will be ON when the control is reset and be OFF when a trip occurs if the proper jumper is not installed (see Figure 4-9 for jumper option chart).

Overspeed Test Enabled LED—This LED indicates that the Overspeed Test button on the front panel is pressed or, contact input #8 is configured to be an overspeed test command and closed (see overspeed test section of Operating Procedures chapter). This LED is on while the overspeed test is selected. It blinks at a slow rate when the turbine's speed is above the control's trip point, and blinks at a fast rate when the turbine's speed is above the external trip device's trip point.

CPU OK LED—This LED is always on when the control is operating properly. During power-up this LED is out until all power-up diagnostics are passed. If this LED is not on, the CPU is not running and indicates a hardware problem with the control. If the LED is out, try powering down the control and powering it back up.

MPU #1 OK and MPU #2 OK LEDs—These LEDs go out if the MPU is detected as failed. The LED is ON during start-up and as long as the pickup is within normal frequency range and voltage levels. The LED will be ON during a turbine start, indicating the failure is overridden (see Magnetic Pickup Failure Override section in Operating Procedures chapter).

Remote Spd Enabled LED—This LED is on when the remote analog input is in control of the Peak 150 control's set point. This LED blinks at a slow rate if remote control is selected (remote is configured and the remote enable contact is closed) and remote control is inhibited. This LED blinks at a fast rate when the remote input is configured for use and the input is detected as failed. The input failure is latching and requires a reset after the signal is restored. If remote is not configured for use, this LED will never turn on.

The Remote E/D contact enables the remote setting when closed and disables the remote setting when open. When open, the Remote Speed Enabled LED is OFF unless the input fails. If Remote is programmed and it fails (even if the Remote E/ D contact is open), the Remote Speed Status LED will blink at a fast rate.

The remote input is seen as failed if it drops below 2 mA (0.5 V) or goes above 22 mA (5.5 V). If the remote input fails, the set point remains at the last remote set point and the front panel LED flashes at fast rate. Any set point changes needed can be done with Raise or Lower commands at this point.

When the combination mode is configured (see Configuration and Operating chapters), the set point commanded is the higher of the local and remote settings. The Remote Speed Status LED is ON when remote is in control, is OFF when remote E/D is disabled (contact is open), blinks slowly when local is in control, and blinks fast when the remote signal is failed.

If the remote fails or is disabled with the E/D contact, the remote set point ramps to minimum governor speed at fast rate to allow the local set point to be the highest setting. Once restored and a RESET command is issued, the Actual Remote Set point will ramp towards the Remote Set Input value (when failed, the remote value is locked at minimum governor speed).

Pushbuttons

Emergency Trip—This pushbutton will trip the trip relay and reset the control set point to its starting position (normally idle speed). After a trip occurs, a Reset command is required to reset the latching trip condition. The reset command will also clear any alarms that no longer exist since the alarms are also latching.

Start—This pushbutton sends a signal to start opening the governor valve if all trip conditions are cleared. If the external start contact is closed when the control gets a Reset command, the governor will automatically initiate a start sequence. If a separate start command is not desired, put a jumper across the start contact input.

If configured the Start pushbutton can also be used to automatically initiate a set point ramp to minimum governor from idle speed (see Configuration section). This function will only work if configured and the Start contact input is open. If the Start contact input is closed, the ramp to minimum governor using the start pushbutton will not work.

Raise and Lower—These pushbuttons adjust the turbine's speed set point as long as remote control is not enabled. If the Combination Mode is configured, these commands will adjust the local set point (see Operating Procedures and Configuration sections).

The Raise or Lower commands will halt the idle-to-minimum governor set point ramp as long as the set point is not within a critical speed avoidance band. The Raise or Lower commands can be used to adjust the set point manually once the ramp is stopped. The ramp can be re-initiated by selecting the Start command.

Overspeed Test—This command allows the governor to raise its set point above the maximum governor speed to test the overspeed trip devices. This command is used to test both the Peak 150 control's overspeed trip and the external overspeed trip device (see Overspeed Test section in the Operating Procedures chapter).

The Overspeed Test command used together with the Raise and Lower commands will allow the set point to be increased above the maximum governor position to the Overspeed Test Limit programmed. The set point moves at the “Set Point Slow Rate” until the “Delay for Fast Rate” time has expired. The ramp rate will then switch to the “Set point Fast Rate”.

Once the speed is above the Overspeed Level, the Overspeed Enabled LED blinks at slow rate. If the Overspeed Test is released above this point the unit will trip. The "3" code will flash on the display and the Trips Service header indicates an overspeed trip has occurred.

If the speed reaches the external (mechanical) level programmed, the Overspeed Enabled LED will blink at the fast rate. This is used as an indication that the external trip device should have tripped or is about to trip.

If the overspeed test is aborted below the overspeed trip level, the set point ramps back to maximum governor and holds. If using combination mode, the local set point is used to perform the test, the remote cannot (remote can't go above maximum governor).

Initial Turbine Start

Before the turbine can be run, the Peak 150 control must be programmed for the specific turbine application (see Chapter 12 for program worksheet). In addition, the actuator linkage has to be adjusted to ensure the turbine can be shut down when calling for 0% steam and can reach full load when calling for 100% actuator position. This calibration is called stroking the actuator (see Stroking Actuator). As the Peak 150 control takes control of the speed, the system dynamics will have to be adjusted for proper response and stability (see Dynamics Adjustments).

NOTE
When starting the turbine, monitor the speed readout to ensure you have a good speed signal from the magnetic speed pickups, especially on initial turbine start.

NOTE
Refer to turbine manufacturer's operating procedures for complete information on turbine start-up.

Turbine Start

The Peak 150 control relies on an open governor valve or bypass system to allow enough steam flow through the turbine to roll it to a speed at which the governor can begin controlling the steam flow.

The minimum speed at which the Peak 150 control can control turbine speed depends on the greater of (1) the speed at which the signal from the magnetic pickups exceeds 1.0 Vrms and (2) the speed at which the actuator has sufficient work output to position the steam valve (see the actuator specifications).

Throttling of the steam flow up to this minimum speed must be done by external means. At start, with all alarm or shutdown conditions cleared, the Peak 150 control will command the governor valve to be full open (see Shutdowns and Alarms section for description of magnetic pickup failure override).

The throttling valve will then be gradually opened by whatever means available which will cause the turbine to roll up to a user defined Idle speed which must be set to a value above the minimum controllable speed and below any critical speed. Once the Idle speed is reached and the turbine is under control of the governor, the throttling valve can be fully opened.

Idle/Minimum Ramp

If the Peak 150 control is programmed for a manual start, this section can be ignored. When manual start is configured, speed control will begin at minimum governor speed which is much higher than idle speed. All speed control, including critical speed avoidance, is the responsibility of the operator until the turbine reaches minimum governor speed. If the control is programmed for automatic start, the Peak 150 control will take control of turbine speed at the programmed idle speed setting.

From idle speed, the turbine can be accelerated either automatically or manually to minimum governor speed (this is user-definable—could also be rated speed). The automatic mode is initiated using the Idle/Minimum Governor contact input or by pressing the Start button on the front panel, if configured. Initiating the automatic ramp to minimum governor will accelerate the turbine to minimum governor speed at a controlled rate (Idle to Minimum Rate).

If a critical speed band has been defined via the hand-held terminal, the rate of speed increase (or decrease) will adjust automatically to a user defined rate (Critical Rate) until the speed of the turbine is outside the critical speed band (see Critical Speed Band).

The speed ramp can be stopped at any point that is not within the critical speed band) by selecting the Raise or Lower speed functions from the front panel or external contact inputs. It can also be stopped by opening the idle/minimum contacts (with Ramp to Idle configured to FALSE). The automatic ramp to minimum governor can be restarted anytime the speed is below the minimum governor speed set point by pressing the front panel Start (if configured) or by toggling the Idle/Minimum contact input (opening and then re-closing it again).

When the Idle/Minimum contact is opened, the speed set point will move back to idle speed at the Idle/Minimum Rate (if configured to Ramp to Idle). This feature is not available if the front panel Start is configured to ramp to minimum governor speed. If the automatic ramp to minimum governor is selected above the minimum governor value set, the control will ignore the command and not return to minimum governor speed.

The Idle/Minimum contact can be open or closed on turbine start-up. If it is closed, as soon as the trips are cleared the set point will ramp to minimum governor. If it is open on start-up, the set point will remain at idle (if manual start is configured). From Idle the set point can be automatically moved to minimum governor (as described above) or manually with the Raise and Lower commands.

Critical Speed Band

If an attempt is made to stop the speed ramp within the critical-speed band, ramping will continue at the Critical Rate until the actual speed is outside the critical speed band. The ramp will then stop. The speed set point may then be adjusted from this point. The set point can be adjusted manually via either the front panel or external contact inputs and will change at the Slow Rate defined under the Speed Values service header or adjusted automatically by pressing the front panel Start (if configured) or by toggling the Idle/Minimum contact input (opening and then re-closing it again).

If the critical speed band is entered manually, the external commands will be disabled until the speed has moved through the critical band. The reference will ramp through the critical band at the Critical Rate without operator intervention. While in the critical band, the direction of the ramp is determined by the direction from which it was entered. However, if a Lower command is issued while increasing though the critical band, the direction will reverse and return to the minimum end of the critical band.

If the reference ramp is stopped outside the critical band, but below Minimum Governor speed, opening the Idle/Minimum Governor contact will restart the reference ramp toward Idle at the Idle to Minimum Rate (except while in critical speed band).

Speed Reference Operating Modes

Using the hand-held terminal, the user can choose one of three operating modes to adjust the speed reference between the Minimum and Maximum Governor set points. The span between Minimum Governor and Maximum Governor speeds is the speed range over which the turbine must operate in normally loaded conditions. The Minimum Governor Limit is set by the user. It is defined as the minimum speed at which the turbine will operate under normal load conditions. Maximum Governor Limit is likewise the highest speed at which the turbine is to be controlled during normal load conditions; it is also set by the user.

NOTE

If the control has been configured for droop, the turbine speed will always be less than the speed set point. The difference will depend on the amount (%) of droop selected during programming.

Manual Mode

The remote Raise and Lower Speed contact inputs and the front panel Raise and Lower Speed pushbuttons are used exclusively to adjust the speed reference in this mode. The speed reference will move at a user defined rate (Manual Minimum to Maximum Rate).

While in this mode, the Analog Remote Speed Setting input cannot be enabled and the LED indication on the front panel will remain unlighted. Opening the Idle/Minimum Governor remote contact input will result in the speed reference ramping back to Idle at the Idle to Minimum Rate.

Analog Remote Speed Set Mode

This mode incorporates the Analog Remote Speed Setting signal. This signal does not have direct control of the speed reference and is rate controlled.

By closing the Analog Remote Enable contact with the Idle/Minimum Governor remote contact input closed, the speed reference will ramp from Minimum Governor (once speed control is achieved) to a value set by the Analog Remote Speed Setting signal at a user defined rate (Manual Minimum to Maximum Rate).

Closure of the Analog Remote Enable contact will flash the Analog Remote Enabled status LED at a rate of once per second.

When the speed reference output and the Analog Remote Speed Setting signal match within a user defined value, the analog signal will control the speed reference output at another user defined rate (Analog Remote Rate). This rate is latched in and the Analog Remote Speed Setting signal is indicated as enabled by the Analog Remote Enabled status LED remaining on without flashing.

The enabled condition is maintained after a match until one of the following occurs:

- The Analog Remote Enable contact is opened
- Speed is reduced to below Minimum Governor
- A shutdown or signal range fault occurs

The allowable signal range will be 2 mA to 22 mA. Except for Manual Mode, if the signal is not within this range, the Analog Remote Enabled status LED will flash at a fast rate and a general governor alarm will be initiated regardless of the state of the Analog Remote contact.

In Manual Mode, detection of an out-of-range signal will have no effect on the control. The speed set point will be determined by the output of the speed reference at the time of the out-of-range detection.

An alarm reset will be required to re-enable the analog speed input, once it is back in range, however the front panel Analog Remote Enabled status LED will cease flashing when the analog signal is within its defined range. It is not necessary to open and re-close the Analog Remote Enable contact to re-enable the analog remote input.

Opening of the Analog Remote Enable contact will result in disabling of analog remote speed setting, turning off the front panel status LED (unless out of range), and operation reverting to Manual Mode.

Opening of the Idle/Minimum Governor contact, with the Analog Remote Speed Setting signal enabled, will result in disabling of analog remote control and ramping of the speed reference back to Minimum Governor at the Manual Minimum to Maximum Rate, and then to Idle at the Idle to Minimum Governor Rate.

Combination Mode

This mode uses both the Analog Remote Speed Setting input and the remote and front panel Raise and Lower Speed discrete inputs. The demand from discrete inputs and analog input are compared for the highest output. The higher output is passed on to the speed controller as the commanded speed. If the analog speed setting signal is disabled for any reason, operation defaults to Manual Mode.

If the Idle Contact is opened, the Analog Remote Speed Setting input will be disabled and the speed reference will ramp down to Minimum Governor speed at the Idle to Minimum Governor Rate.

Overspeed Test

While the Overspeed Test button is pushed or the overspeed test contact is closed (if configured), the overspeed test LED on the front panel will illuminate to indicate that the speed reference upper limit has been raised. Turbine speed may now be raised up to the value entered via the hand-held terminal during setup (normally the upper tolerance limit of the mechanical overspeed trip speed). Selecting Overspeed Test will also disable the Analog Remote Speed Setting input without affecting the current speed set point.

As long as the Overspeed Test button is being pushed, only the OCP raise and lower buttons or the raise and lower contact inputs are operational and the reference is allowed to go up to the mechanical overspeed test limit.

If at any time during the test, the Overspeed Test button is released, the control reverts to the mode of operation that was selected by the user. For any of the three speed reference control modes, if the actual speed is less than the electrical overspeed-trip set point, the speed reference set point will be automatically ramped to Maximum Governor at the Manual Minimum to Maximum rate.

Control of the speed reference at this point will depend on the selected mode of operation. The Manual or Combination Modes will require further action to adjust the speed reference. If the Analog Remote Speed Set Mode was selected, the reference can ramp to the analog set point automatically subject to the conditions described above for this mode.

Release of the Overspeed Test button while turbine speed is greater than the electrical overspeed trip set point will result in immediate shutdown and reset of the speed reference to the start position. During an overspeed test, at speeds greater than or equal to the electrical overspeed-trip set point and less than the lower tolerance limit of mechanical overspeed-trip set point, the Overspeed Test pushbutton will flash at a rate of once per second. At speeds equal to or greater than the mechanical overspeed trip set point, the Overspeed Test pushbutton will flash at a rate of twice per second.

Shutdown and Alarm Function Summary

The following indicates the various conditions which constitute either an alarm or shutdown condition. A shutdown condition is signaled by the Trip relay and can be configured to either energize or de-energize by the user. An alarm condition is signaled by the Alarm relay de-energizing.

Alarm conditions are:
- MPU #1 Failure
- MPU #2 Failure
- Remote Input Failure
- Shutdown (configurable)
- Loss of Communications to Modbus Device (if used)

Shutdown conditions are:
- Loss of both magnetic pickup signals
- Electrically sensed overspeed trip
- Emergency Trip pushbutton is pushed
- Shutdown contact input initiated
- Trip Initiated by the Modbus Device (if used)

The Trip and Alarm functions are latching, a Reset command is required once the condition is corrected to clear the latch. If the governor is in a shutdown state, a Reset command will clear the trip relay output and front panel LED indication. If a trip still exists, the control will not allow a start to be initiated. A typical start requires a Reset command and a Start command. If these two separate commands are not desired, the Start command can be jumpered closed and only a Reset command would be required.

Magnetic Pickup Failure Override

The magnetic pickup signal failure shutdown is automatically overridden for starting the turbine. The override is automatically removed once an adequate speed for signal detection is reached. This speed is set by the user.

The speed-signal-failed override shall be delayed when switched on to differentiate between a sudden signal loss and loss of signal due to roll down of the turbine (if Use Rolldown Ovrd is configured). A sudden signal loss will thus command a shutdown before the override takes effect.

On a normal stop, the trip and throttle valve would be closed gradually with the Peak 150 control demanding the governing valve to be fully open as the turbine speed decreases below the Idle set point. With no fault conditions detected by the Peak 150 control, the throttling valve needs only to be opened to effect a start. If the governor initiated a shutdown, the Reset and Start buttons must be pushed before the turbine can again be started.

Stroking Actuator

WARNING—OVERSPEED

STEAM TO THE TURBINE MUST BE SHUT OFF BY OTHER MEANS DURING THIS PROCESS. Overspeed sensing and trip detection are disabled during this process. Overspeeding the turbine will cause damage to the turbine and can cause personnel injury or death to personnel.

The actuator output from the control can be stroked (or calibrated) from the Service Mode. Pressing the down arrow on the hand-held programmer when the display shows Woodward Governor Company will enter the Service Mode. Pressing the ESC key will display the Woodward message, if necessary.

Press the left arrow until the Valve header appears. Next, press the down arrow to enter this option. Continue pressing the down arrow until the "Stroke Vlv Output?" option appears. Press the turtle or rabbit adjust-up arrow to change the display to TRUE. **The control must be tripped to perform this function.**

Press the down arrow until the "Valve Position (%)" is on the top line of the display. Next, press the up-down arrow to change to the bottom display line. Get to the Valve header in the Service Mode as done previously. Press the up arrow until "Min/Max Switch" is displayed. Toggling this between TRUE and FALSE will change the output current between minimum and maximum.

The next option up, under the Valve header is the "Stroke Position (%)". This is an alternate way of stroking the valve. This allows the actuator to be set manually between 0% and 100% by using the rabbit or turtle adjust up and down keys. The Min/Max switch is a shortcut method of accomplishing this.

When the Valve Position (%) is equal to 0%, the actuator should be below minimum. This is important. The actuator must have sufficient overtravel at the minimum stop to ensure that the actuator can fully close the steam valve completely. When the Valve Position (%) is 100%, the actuator should be at maximum to ensure full load can be attained. This process of going between minimum and maximum will have to be repeated several times before the initial start to ensure the actuator and linkages are properly set up.

Dynamics Adjustments

Dynamics adjustments are made in the Service Mode. Pressing the down arrow on the hand-held programmer when the display shows Woodward Governor Company will enter the Service Mode. Pressing the ESC key will display the Woodward message, if necessary.

Press the right arrow until the Dynamics Adjustments header appears. Next, press the down arrow to enter this option. The first two options are "Low Speed Gain" and "Low Speed Reset" and will be referred to as gain and reset, respectively.

You must adjust the gain and reset to match the response of the turbine. To obtain a faster transient response, slowly increase the gain setting with the turtle-adjust- up key until the actuator of final driver output begins to oscillate or waver. The best way to verify this response is by placing an analog voltage meter across the actuator output line. Then adjust the reset as necessary to stabilize the output. If stability cannot be obtained with the reset adjustment, reduce the gain setting.

A second set of dynamics is available, if necessary. This second set is selected by closing the Select High Dynamics contact input (if configured) or with a speed setting. This speed setting is the next option under this header. Press the down arrow to get to "High Speed Switch Point". If only one set of dynamics is desired or the contact input is used, make sure this level is set above the absolute maximum speed setting (i.e., above overspeed test limit setting) to ensure the high dynamics are never selected.

Communications (Optional)

The Peak 150 control is capable of communicating to a plant computer using Modbus protocol. All pertinent parameters are programmed to be transferred through this link. The following link parameters are configurable: data bits, stop bits, baud rate, and parity.

This option requires additional communication hardware not available unless purchased, make sure to specify the Modbus option if this is required.

See Chapter 11 for complete details.

Chapter 7.
Programming

Introduction

The Peak® 150 control uses menu-driven software and is easy to program. Programming is divided into sections: Service Mode programming (see Chapter 8) and Configure Mode Programming (see Chapter 9).

Before the turbine can be run with the Peak 150 control, the control must be programmed. The Peak 150 control program worksheet (see Appendix) must be filled out and these values entered into the control. Different applications will have different programs because of speed range, relay options, readout options, mode of operation, or other programmable options.

NOTE

Any parameters that do not require an input are listed as "STATUS INDICATION ONLY" in the program worksheets. They are in the program to provide information to the operator or programmer only.

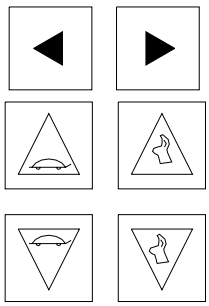
All Programming is done with the hand-held programmer (part number 9905-292 or CE version 9907-205) (See Figure 7-1) through the service port on the front of the Peak 150 control. It plugs into the 9-pin connector of the RS-485/422 port inside the service port. The service port is normally sealed by a removable cover. When not being used, the programmer can be (and should be) disconnected from the control to provide security against tampering.

WARNING—EXPLOSION HAZARD

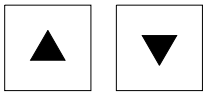
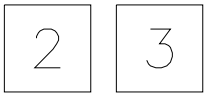
The programmer should not be connected or disconnected while an explosive gas is present.

Hand-Held Programmer

Key Functions



DISPLAY	A four-line digital display that can show two independent parameters at the same time. The current line is indicated by the @ sign.
LEFT/RIGHT Arrows	These keys are used to scroll through headers and categories.
ADJust Arrows	These keys are used to adjust the value of a parameter either (Rabbit & Turtle) up or down, at either a fast 10% (rabbit) or slow 1% (turtle) rate.

	**– (minus)**	This key is used to enter a negative value.
 	**ADJust Down/Up**	These keys are used to adjust the value of a parameter either up or down at a very slow rate (Integer values change by 1.0; Real values change by 0.01). (+ is up; – is down)
	**ESC**	The Escape key, when pressed once, will return to the top of the category. When pressed twice, it will exit the mode and save all changed tunables.
	**ID**	The ID key identifies the software used in your system.
	**SAVE**	This key saves all changed tunable values.
	**BKSP**	The BACKSPACE key scrolls to the left.
	**SPACE**	The SPACE key scrolls to the right.
	**=**	To enter the exact value of a tunable, press this key, then enter the number, then press ENTER. (must be within 10% of the value on the screen, except when in the configure mode.
	**ENTER**	This key enters the exact value of a tunable (see = above).
	**•**	This key selects the Configure mode or enters a decimal point in a number.
	**Up/Down Arrows**	Down arrow selects the Service mode or scrolls down through blocks. Up arrow scrolls up through blocks.
	**Up & Down Arrow**	This key with a double-ended arrows is used to select screens; the selected screen is identified by the @ sign.
	**Number Keys**	These keys (0 and 1–9) are used to enter the exact value of a tunable (see = and ENTER key descriptions).

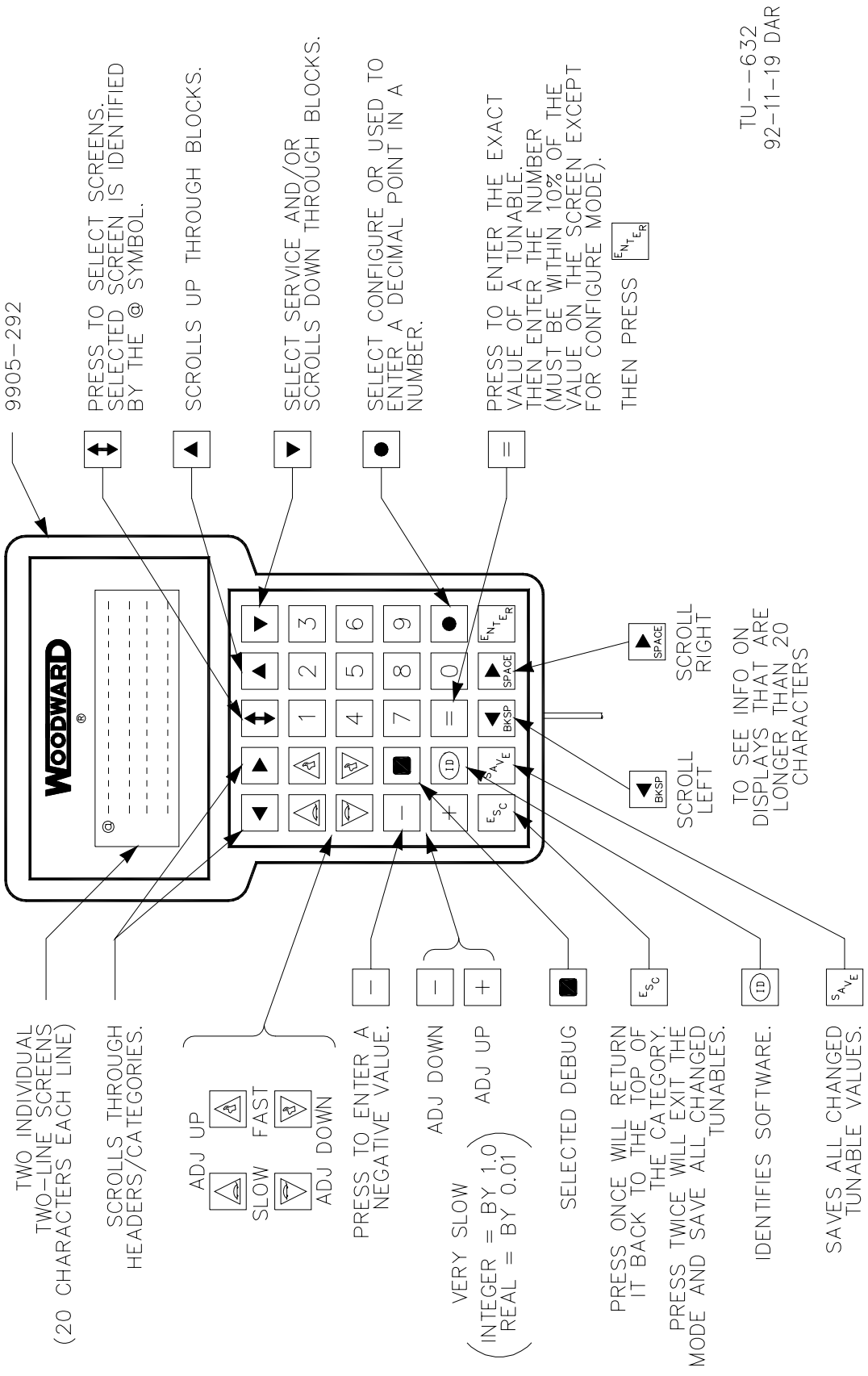


Figure 7-1. Hand-held Programmer

WARNING—OVERSPEED PROTECTION

Errors in configuration or programming of the Peak 150 control may create dangerous overspeed conditions. The turbine must be equipped with an overspeed device completely separate from the Peak 150 control or actuators attached to the Peak 150 control. The turbine must never be run when this device is not present and is not operating correctly.

Configure Mode

Items in the Configure Mode are parameters that can be adjusted or changed only while the turbine is shut down. When the Configure Mode is entered, all Peak 150 control outputs are disabled, the relays are de-energized, and the analog-output currents go to minimum.

Configure Mode Menus

There are eight Configure Mode menus:

Speed Configuration	Used to set maximum and minimum speed levels and to select MPU information
Start Mode	Used to select the desired starting mode
Actuator Configuration	Used to select the appropriate actuator current ranges
Operating Mode	Used to select the desired operating mode
Readouts	Used to select configurable readout and to scale readout values
Relays	Used to select configurable relay options and to configure the Trip relay.
Contact In #8	Used to select the operation of contact input #8 as overspeed test or select high dynamics.
Port Configuration	Used to select the proper port configuration parameters.

For details on these menus, refer to Chapter 9.

Service Mode

Items in the Service Mode are parameters that can be adjusted at any time, including while the turbine is running.

Service Mode Menus

There are 13 Service Mode menus, eight of which are always displayed. The remaining five menus appear conditionally. The Service Mode menus are:

Always Displayed Menus

Alarms	Displays the existing alarm conditions and allows a trip condition to be an alarm.
Trips	Displays the cause of the last trip and identifies existing trips.
Speed Dynamics	Used to adjust speed dynamics for stability and responsiveness.
Speed Values	Displays speed, local set point, remote set point, and sets the set point.
Failed MPU OVRD	Used to set MPU-failed override conditions and levels.
Valve	Displays valve position, ramp position, sets valve output offset and gain, sets ramp rate and dither, manually adjusts valve ramp, and strokes valve output.
Readout Adjustments	Used to adjust readout Gains and Offsets.
I/O Check	Displays the status of most I/O points. Very helpful when troubleshooting the control operation.

Conditionally Displayed Menus

The following menu displays if Remote is configured.

Remote Setting	Displays remote input and set point, and sets remote rates.

The following 2 menus display if Automatic Start is configured.

Idle/Min Ramp	Used to set idle speed and minimum speed, enables ramp to minimum and ramp to idle.
Critical Speed	Used to select critical speed band use, levels, and rate.

The following menu displays if speed switch or hand valve is configured.

SPD SW/Hand VLV	Used to set the position or speed at which the relays energize and de-energize.

The following menu displays if Use Modbus Port is configured.

Port Adjustments	Used to set the Modbus port communication parameters and displays error information.

Refer to Chapter 8 for information on these Service mode menus.

Basic Program Architecture

Figure 7-2 shows the basic program architecture of the Peak 150 control.

NOTE
Before the turbine can be run, the Peak 150 control must be programmed for the specific turbine application. Programming is divided into two sections: using the Configure mode and the Service mode.

Refer to the Appendix for programming worksheets.

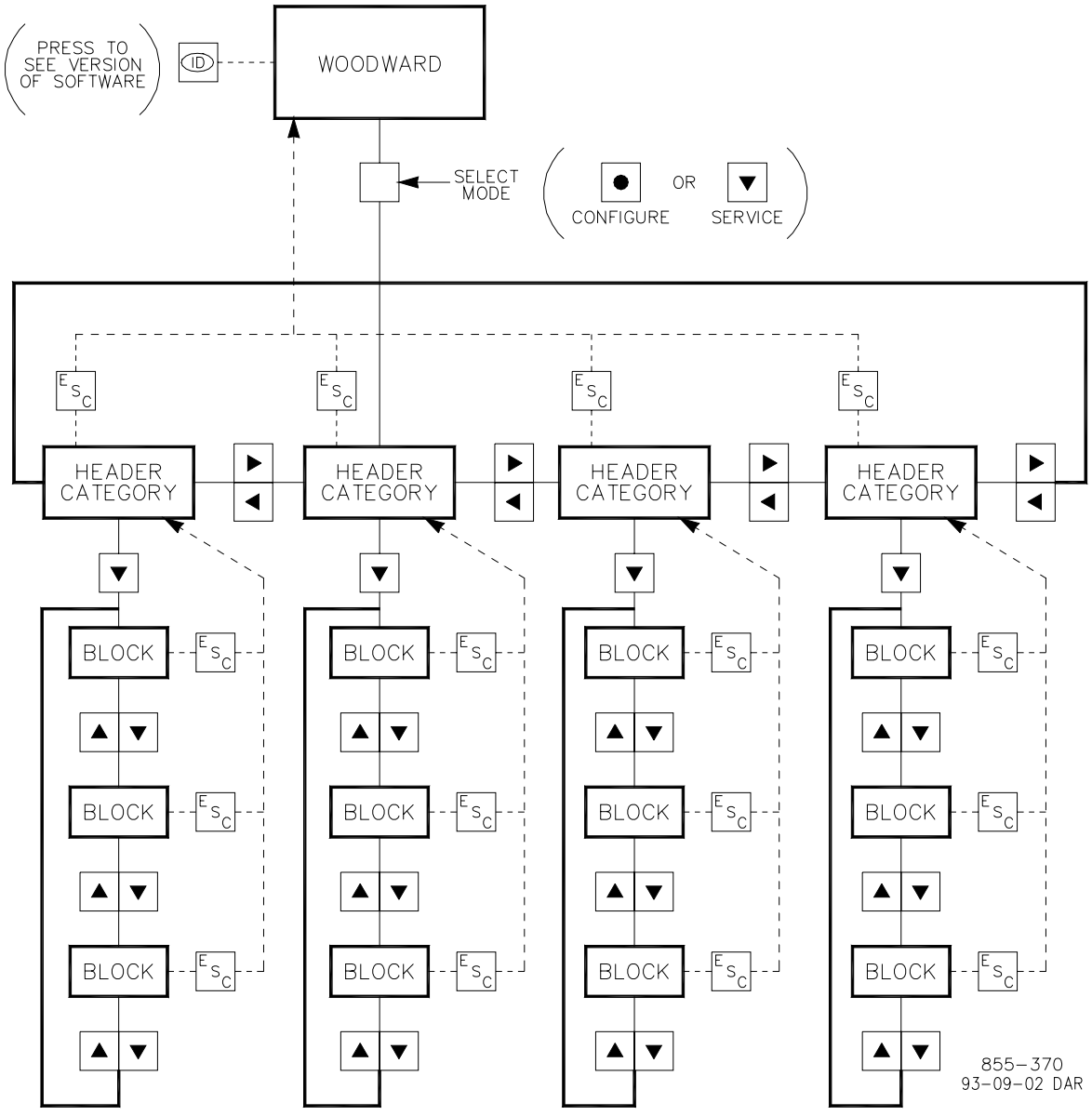


Figure 7-2. Basic Program Architecture

Speed Relationships

Figure 7-3 shows the relationships between the various set points, as well as the mode (Service or Configuration) in which they are adjusted.

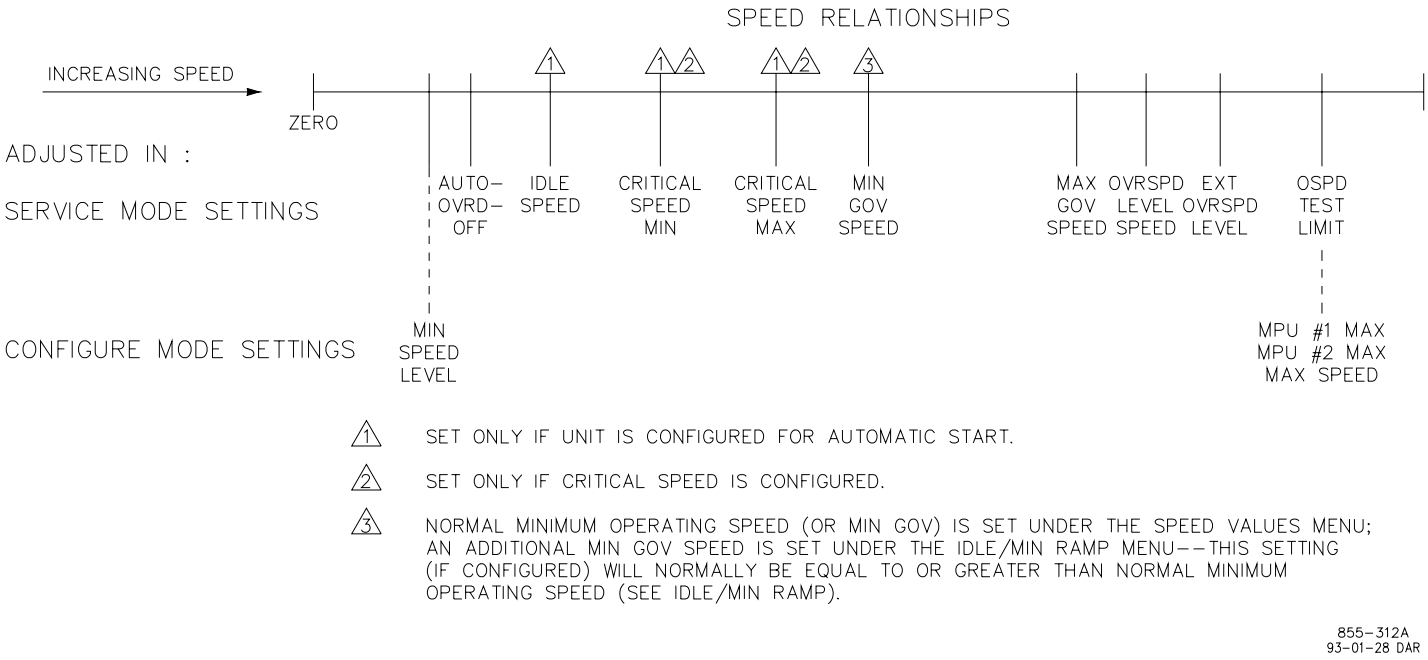


Figure 7-3. Speed/Mode Relationships

Configuration Mode Programming

WARNING—SAVE SET POINTS

To prevent damage to the turbine resulting from improper control settings, make sure you save the set points before removing power from the control. Failure to save the set points before removing power from the control causes them to revert to the previously saved settings. Dangerous conditions such as turbine overspeed may result from operating the turbine with incorrect settings, possibly resulting in equipment damage and injury or death of personnel.

WARNING—SHUT TURBINE DOWN

The turbine must be shut down during configuration. Permitting the turbine to run while the turbine is being configured can cause turbine overspeed.

Using Configure Menus

- Right and Left Arrows from top row of keys moves between Menu titles.
- Down Arrow from top row of keys enters the list of items in each menu.
- UP and DOWN arrows move through items in the menu.
- ESC key moves back to the menu title.
- ESC key again leaves the menu title and returns to the header. This records in the permanent memory any changes made.
- Control will reboot as you leave Configuration mode.

Procedure For Configure Mode

1. Plug the programmer into the service port (on the front panel) and wait until the self-test is complete (about 5 sec.). The back lighting will turn on and the Woodward header will appear. If the Woodward header does not appear, press the ESC key until it does.

2. Press "." for Configuration. Press "ENTER" and a line "Press ENTER to Shutdown" will appear. Press "ENTER" again and you will enter the first Configuration Menu.

   Two items always appear on the screen. An "@" indicates the item which the programmer buttons will change.

3. Use the toggle switch in the middle of the top row to change the "@" from the top to the bottom position. Menu changes can only be made in the item shown with an "@".

   The two items in the screen are independent displays. The other display will be tunable when the "@" sign is toggled from one position to the other.

4. Scroll through the configuration titles with the left and right arrows on the top line of buttons. The down arrow from the top line of buttons will enter you into the items in any specific menu. You can also scroll through the items with the UP and DOWN arrows, but to return to the menu header you must press the "ESC" button.

5. To leave configuration press "ESC" until the Woodward header appears in the window.

Making Changes In Configure Mode

Entering True/False Values—The Turtle or Rabbit arrow UP is True, the Turtle or Rabbit arrow DOWN is False.

Adjusting Numerical Values—The "Rabbit UP and Rabbit DOWN" keys change the existing values by 10 percent in the direction indicated.

The "Turtle UP and Turtle DOWN" keys change the existing values by 1 percent in the direction indicated.

Entering Numerical Values Directly—The number keys can be used to change the existing value. To make this type of entry:

1. Press the = key.

2. Enter the number you wish to record (plus, minus, and decimal point keys all work).

NOTE

The change is not limited to 10% in the Configure mode, as it is in the Service mode.

3. Press "ENTER" to activate the number on the screen.

   The screen is limited to 20 characters. Should the menu item be longer than 20 characters, scroll with the BKSP or SPACE keys.

Adjusting Integer Values—The ADJ up (+) and ADJ down (–) keys increment integers up or down by 1.0.

Service Mode Programming

The Service mode can be used while the turbine is running.

Using Service Menus

- Left and Right Arrows from top row of keys move between Menu titles.
- Down Arrow from top row of keys enters the list of items in each menu.
- UP and DOWN arrows move through items in the menu.
- ESC key moves back to the menu title.
- ESC key again leaves the menu title and returns to the header. This records in the permanent memory any changes made. Another way of permanently storing changes is pressing the "SAVE" key.
- Service Menus may be changed with the turbine running. Changes are immediately used by the Peak 150 control in operation of the turbine, but the changes are not saved until the operator returns to the WOODWARD headers by pressing "ESC" or "SAVE."
- A number of items in the service menus provide readouts for the information of the user. The items which provide readouts are shaded. These figures cannot be changed by the user, but they will change if the condition being monitored changes.
- On the programmer screen, tunable items are indicated by an asterisk (*) following the number. Numbers which are for readout only will not have an asterisk (*) following the number.

Procedure For Service Mode

To enter the service mode, press the down arrow when the Woodward header is displayed. To display the Woodward header, press the ESC key.

1. To enter a menu press the down arrow.

2. To scroll through an individual menu, use the top row left and right arrows. To return to a menu header, press ESC.

   Values changed will become active immediately, but will not become part of the permanent memory until the "ESC" button is pressed again and the Woodward header reappears or the SAVE button is pressed. Either method will save ALL changed parameters in permanent non-volatile memory.

Two items can appear on the screen at the same time. Changes can be made only to the item shown with an "@". To change the other item, toggle the "@" to it with the key in the middle of the top row. When scrolling through menu headers or items in a menu, changes will appear only in the window indicated by the "@". The other window, however, will remain active.

Making Changes In Service Mode

Entering True/False Values—The Turtle or Rabbit arrow UP is True, the Turtle or Rabbit arrow DOWN is False.

Adjusting Numerical Values—The "Rabbit UP and Rabbit DOWN" keys change the existing values by 10 percent in the direction indicated.

The "Turtle UP and Turtle DOWN" keys change the existing values by 1 percent in the direction indicated.

Entering Numerical Values Directly—The number keys can be used to change the existing value by as much as ±10% of its current value. To make this type of entry:

1. Press the = key.

2. Enter the number you wish to record (plus, minus, and decimal point keys all work).

3. Press "ENTER" to activate the number on the screen.

   If the number you enter is more than 10% greater or less than the existing value, the entry will be refused and an error message will appear on the screen. The error message will remain on the screen for about 5 seconds, and the previous value will be displayed.

   The screen is limited to 20 characters. Should the menu item be longer than 20 characters, scroll with the BKSP or SPACE keys.

Adjusting Integer Values—The ADJ up (+) and ADJ down (–) keys increment integers up or down by 1.0.

Chapter 8.
Service Menus

Introduction

Before the turbine can be run with the Peak® 150 control, the control must be programmed (see Program Mode Worksheets in the Appendix). The Peak 150 control uses easily programmable menu driven software. Programming is divided into two sections: Service Mode programming and Configure Mode Programming (see Chapter 7). After the initial programming is complete, the service mode parameters can be viewed and adjusted while the turbine is running. The configure mode parameters can only be changed while the turbine is shutdown.

Alarms Menu

The Alarms menu shows the alarms that have occurred.

MPU #1 Failed:	If MPU #1 is failed this will indicate TRUE (see MPU).
MPU #2 Failed:	If MPU #2 is failed this will indicate TRUE (see MPU).
Remote Input Failed:	If the remote input has failed this will indicate TRUE (see REMOTE inputs).
Comm Link Failure:	If the Modbus communication link has failed this will indicate TRUE.
Turbine Trip:	If the turbine has tripped this will indicate TRUE (see SHUTDOWNS).
Use Trip as Alarm:	Allows a trip condition to also be indicated as an alarm if TRUE. This is not an alarm condition. This is a question with a tunable answer.

Trips Menu

The Trips menu shows the trip conditions that have occurred.

Last Trip Code:	Displays the cause of the last trip in code form (see code translation below).
External Trip:	TRUE if an external trip has been initiated (see EXTERNAL TRIP).
Overspeed Trip:	TRUE if an overspeed trip has occurred (see OVERSPEED).
Loss of Both MPUs:	TRUE if both MPUs are lost (see MPUs).
Front Panel Trip:	TRUE if an emergency trip is initiated (see EMERGENCY TRIP).
Modbus Trip:	TRUE if a Modbus trip has been initiated (see Modbus).

Code	Cause
1	External Trip (contact input opened)
2	Loss of Both MPU inputs
3	Overspeed Trip indication
4	Front Panel Trip indication
5	Modbus Trip indication

Speed Dynamics Menu

This menu shows the dynamic values; these values can be seen without any other conditions occurring and can be adjusted if preceded by an "*".

Low Speed Gain:	Displays proportional gain for low speed.
Low Speed Reset:	Displays integral gain for low speed.
Hi Speed Switch Pt:	Displays point at which the dynamics would switch to high dynamics.
Hi Speed Gain:	Displays proportional gain for high speed.
Hi Speed Reset:	Displays integral gain for high speed.
Hi Speed Selected:	Indicates the selection of the high speed dynamics.

Adjusting Gain And Reset

See Dynamics Adjustments under Operating Procedures, Chapter 6.

Speed Values Menu

This menu shows speeds, speed rates, overspeed levels, and droop. These values can be seen without any other conditions occurring and can be adjusted if preceded by an "*" on the hand-held programmer. See Figure 7-3 for the relationships between all speed values and the mode in which the value is set.

- Actual Speed: Displays actual speed in rpm.
- Local Speed Set Point: Displays the local speed set point. This will also be the commanded speed set point if combination mode is used.
- Actual Speed Set Point: Displays the speed reference ramp output.

NOTE

Normally Local and Actual Speed set points will be the same. They may be different when remote setting is in control and high-signal- select is being used.

- Remote Speed Setting: Value for the remote input (the limited or actual value used—see Remote section.
- Start Ramp Rate: Rate at which the speed reference moves from 0 to Idle or Minimum Governor (depending on the start mode) on startup (Tunable Range 1–1000).
- Set Point Slow Rate: Rate at which the speed reference ramp will move for the slow rate (Tunable Range: 0 to 100).
- Delay for Fast Rate: Delay (in seconds) before the fast rate of set point change will kick in (Tunable Range: 0 to 100).
- Set Point Fast Rate: Rate at which the speed reference ramp will move for the fast rate (Tunable Range: 0 to 200).

- Min Governor Speed (rpm): Minimum governor set point. This is the lower limit of the normal operating range. Once speed is above this level, the speed reference is not allowed to go below this point. This also determines the minimum setting (4 mA value) reached by the remote speed set input when used, (Tunable Range: 0 to 15000).

- Max Gov Speed (rpm): Maximum governor set point. This is the upper limit of the normal operating range. Neither the Raise command (by itself — see overspeed test) nor the remote speed setting will be allowed to go above this setting. This value corresponds to the maximum speed setting (20 mA value) for the remote speed set input when used, (Tunable Range: 0 to 15000).

- Overspeed Level: Overspeed trip set point — unless an overspeed test is being performed, this is the speed at which the Peak 150 control will trip (Tunable Range: 0 to 15000).

- External Overspeed Level: Mechanical (or external trip device's) overspeed trip set point — the only function for this input is to flash the Overspeed Test LED on the front of the Peak 150 control. This value would typically be set to the lower end of the external trip device's trip range to let the operator know that the turbine should have (or will soon) trip (Tunable Range: 0 to 15000).

- Overspeed Test Limit: This limit should be greater than the overspeed trip set point and the mechanical-trip set point; when overspeed test is selected, this is the value to which the speed reference can go.

- Droop (%) = : Droop set point 2 = 2% droop (typically set 0% for mechanical drives) (Tunable Range: 0 to 10).

- Use Set Point Set-Back: Instantly resets the speed set point to the actual running speed when the raise or lower pushbuttons are released if set to TRUE.

Remote Setting Menu

This menu shows the remote settings and appears only if remote is configured.

- Actual Remote Set Point=: Value of the maximum remote set point

- Remote Set Input =: Value for the minimum remote set point

- Remote-Not Matched Rate: Value at which the speed reference would be biased when the remote and the speed reference are not matched

- Remote Rate-Max: Value at which the speed reference would be biased when the remote and speed reference are not matched. The only time this is in effect is when remote control is initially enabled. Once the remote and local set points are matched and remote is in control, the set point will move at the Remote Rate-Max rate of change (Tunable Range: 0 to 100).

- Modbus Remote Used: Enables the Modbus device to raise and lower the remote speed reference if set to TRUE.

Failed MPU Override Menu

This menu shows the values for MPU overrides. These values can be seen without any other conditions occurring and can be adjusted if preceded by an "*".

- Auto-Ovrd-Off Speed: Set point at which the auto MPU override goes off. Once the MPU speed is greater than this value, the MPU override will go off. If the speed drops below the Minimum Speed level (see Configure mode) after the override goes off, the turbine will trip on loss of speed (Code 2). If only one MPU drops below the Minimum Speed level after the override is off, that MPU OK LED will go out and an alarm will be issued (Tunable Range: 0 to 2000).

- Use MPU Override Timer?: If the override timer is to be used this should be set to TRUE. This option will limit the amount of time allowed to get to minimum speed (set in Configure mode). This is a protection against overspeed if both MPUs are bad.

- Max Starting Time: Maximum time required to start; if this time expires the MPU will no longer be overridden. If the turbine has not reached the Minimum Speed level before this time expires, the turbine will trip on loss of speed (Tunable Range: 0 to 3000).

- Use Rolldown Override?: Set this to TRUE if you want to use the rolldown MPU override. This option turns on the Failed MPU Override if the speed is being slowly reduced by closing the Trip-and-Throttle valve or stop valve — this override is turned on after the speed drops below a low speed setting for delay time. Using this option allows the operator to resume operation at the last set point on the next startup , rather than at minimum set point.

- Auto-Ovrd-On Speed: This is the set point where the rolldown override will start if Use Rolldown Override is set to TRUE. When the speed drops below this low-speed setting for the delay time, the override is turned on (Tunable Range: 0 to 2000).

- Auto-Ovrd-On Delay: Delay time before the slow-speed MPU override goes TRUE. It is for use with slow rolldown ovrd option — the delay time associated with turning on the override. If the speed drops below the Minimum Speed Level setting before the time expires, the unit will trip on loss of MPU signals and reset the speed set point to minimum (Tunable Range: 0 to 100).

- Ovrd ON Status: Indicates the status of the MPU override.

Idle/Min Ramp Menu

This menu shows the idle speed and minimum speed—displayed only if Automatic Start mode is configured.

- Idle Speed (rpm): The value for idle speed set point—where the Peak 150 control takes control of the turbine's speed (Tunable Range: 0 to 5000).

- Use Idle/Min Ramp? : If the idle/min ramp is to be used (either the idle/ min ramp contact input or the front-panel Start command), this should be set to TRUE.

- Min Governor Speed: Value to which the automatic ramp function will ramp (if used). This will typically be set at or above the Minimum Governor Speed set in the Speed Values Menu. It could be set to a rated speed level (Tunable Range: 0 to 15000).

- Idle/Min governor Rate = : Value for the rate at which the speed reference will go from idle to minimum governor in rpm/sec (Tunable rage: 0 to 1000).

- Use Ramp to Idle? : If this is TRUE, the speed reference will ramp to idle at the Idle/Minimum Governor Rate when the idle/ramp contact input is opened, This function is disabled if the Start = Ramp to Min input is set TRUE.

- Start = Ramp to Min: If this is set to TRUE, it allows using the front panel Start key in place of the Idle/Minimum Governor contact input. Pressing Start after the unit is running would start or resume ramping to minimum governor speed. When this function is used, the Ramp to Idle function is disabled.

- Ramping to Min: Indicates the ramp moving towards Minimum Governor

- Ramping to Idle: Indicates the ramp moving towards Idle.

Critical Speed Menu

This menu shows the critical speed band and rate—displayed only if Automatic Start Mode is configured.

- Use Critical Band? : If this is set to TRUE then the critical speed band is being used. The critical speed band is used if the turbine, driven device, or turbine skid has a high vibration speed.

- Critical Speed Min: Value for the minimum critical speed (beginning of the critical speed increasing). (Tunable Range: 0 to 10000).

- Critical Speed Max: Value for the maximum critical speed (end of the critical speed increasing) (Tunable Range: 0 to 10000).

- Critical Band Rate: Value that the reference will be moved when the speed is within the critical band (Tunable Range: 0 to 1000).

- In Critical Band: Indicates the speed is within the programmed critical speed band.

Hand Valves or Speed Switches Menu

This shows the relay on and off speeds or positions and is displayed only if either Hand Valves or Speed Switches are configured.

- RELAY #1 On (rpm or %): The speed level or valve-position level at which this relay turns on or energizes. A configurable relay must be using option 10, which is speed switch or hand valve #1, and "Use Speed Switch" or "Use Hand Valve" must be configured to TRUE (see Configuration chapter) (Tunable Range: 0 to 15000).

- RELAY #1 Off (rpm or %): The speed level or valve position level at which this relay turns off or de-energizes (Tunable Range: 0 to 15000).

- RELAY #2 On (rpm or %): The speed level or valve position level at which this relay turns on or energizes. A configurable relay must be using option 11, which is speed switch or hand valve #2, and "Use Speed Switch" or "Use Hand Valve" must be configured to TRUE to use this function.

- RELAY #2 Off (rpm or %): The speed level or valve position level at which this relay turns off or de-energizes (Tunable Range: 0 to 15000).

NOTE
A combination of both a hand valve and a speed switch is not possible. If both "Use Hand Valve" and "Use Speed Switch" are set to TRUE, hand valves will be selected (if Option 10 or 11 is selected in the relay options—see Configuration).

- Underspeed Level (rpm): The speed level setting to indicate an underspeed condition on decreasing speed. (When relay #2 is configured for underspeed indication in relay options). Underspeed indication is inactive until minimum governor speed is achieved.

Valve Menu

This menu shows the valve position, offset, gain, stroke position, and valve ramp position.

- Valve position (%): Displays actual valve position. This is the signal from the governor to the actuator (demanded valve position).

- Vlv-Offset Adjust: Displays offset adjustment for the valve (Tunable Range: -10000 to 10000).

- Vlv-Gain Adjust: Displays gain adjustment for the valve (Tunable Range: -2 to 2).

- Valve Ramp Pos'n = : Displays valve ramp position. When the unit is tripped, this value will be 0.0%, and after the unit is started, this value will be 100%. This ramp is low-signal-selected with the PID control's output to determine demanded valve position. If the ramp is lowered below the present Valve Position (%), it will become the lowest signal and thus control the output to the actuator. The next two parameters (Manual Rse or Lwr Ramp) can be used to adjust this valve ramp output.

- Manually Rse Ramp? : If this is set to TRUE the valve ramp can be manually raised. This can be helpful as a troubleshooting tool if the system becomes unstable, or as a valve-position limiter to limit the maximum lift of the valve. To allow the actuator full travel, make sure the valve ramp is returned to 100% after troubleshooting.

- Manually Lwr Ramp? : If this is set to TRUE the valve ramp can be manually lowered. This can be helpful as a troubleshooting tool if the system becomes unstable, or as a valve position limiter to limit the maximum lift of the valve. To allow the actuator full travel, make sure the valve ramp is returned to 100% after troubleshooting.

- Ramp Rate (%/sec): Displays the value at which the valve ramp can be raised or lowered in percent per second. This is the same rate at which the valve ramp can be adjusted with the Raise or Lower commands (Tunable Range: 0 to 100).

- Dither Adjust: Displays the value of the dither — normally set to zero (Tunable Range: 0 to 30).

- Stroke Valve Output? : If this set to TRUE, the valve can be stroked.

- Stroke Position (%): Adjusts the manual valve stroke position commanded by the Peak 150 control. This can be adjusted between 0% and 100% for stroking the valve as long as the Min/Max switch is set to FALSE (Tunable Range: 0 to 100).

- Min/Max Switch: If this is set to TRUE the valve will go to Maximum and if set to FALSE the valve will go to Minimum. By switching between FALSE and TRUE, the actuator can be stroked between 0 and 100%.

Readout Adjustments Menu

This menu shows the adjustments for readouts #1 and #2.

- RO #1-Offset Adjust: Value for readout #1 (Speed readout) offset adjustment (Tunable Range: -2000 to 2000).

- RO #1-Gain Adjust: Value for readout #1 (Speed readout) gain adjustment (Tunable Range: 0 to 4).

- RO #2-Offset Adjust: Value for readout #2 (configurable readout, see Configuration) offset adjustment (Tunable Range: -2000 to 2000).

- RO #2-Gain Adjust: Value for readout #2 (configurable readout, see Configuration) gain adjustment (Tunable Range: 0 to 4).

NOTE

The 4–20 mA readouts are factory calibrated. The adjustments are provided as compensation for external meters, etc. If the 0–1 mA readout option is required (see jumper option chart), the offset and gains will have to be adjusted for full range output calibration.

- RO #2 Value: Indicates the value of the parameter to be output by readout #2 as selected in Readouts options (see Configuration).

Port Adjustments Menu

This menu shows the adjustments for the Modbus Communication Port and is displayed only if "Use Modbus Port" is configured (see Configuration).

- Hardware Configuration: This adjustment sets the physical link to be used by the Modbus Communication. Following is a list of the codes and the corresponding hardware configuration associated with them.
  1 = RS-232 Communication
  2 = RS-422 Communication
  3 = RS-485 Communication

- Baud Rate: This adjustment sets the baud rate or speed of communication. The following list indicates the codes and the corresponding baud rates.
  1 = 1200 Baud
  2 = 1800 Baud
  3 = 2400 Baud
  4 = 4800 Baud
  5 = 9600 Baud
  6 = 19200 Baud

NOTE
To ensure the integrity and reliability of the data being transmitted, Woodward recommends that the baud rate used for the 8200-XXX series Peak 150 controls be at or below 9600 baud.

- Stop Bits: This adjustment sets the number of stop bits to be included in the data being transmitted. The following list shows the code and the corresponding number of stop bits to be used.
  1 = 1 stop bits
  2 = 1.5 stop bits
  3 = 2 stop bits

- Parity: This adjustment selects the parity to be used during transmission. The following list shows the code and the corresponding parity to be used.
  1 = Off
  2 = Odd
  3 = Even

- Link Error: This will indicate TRUE if the Modbus communication link has been lost.

- Exception Error: This will indicate TRUE if an exception error is found in the transmitted data.

- Error Number: This indicates the cause of the exception error. The following list shows the error codes and their meanings.
  1 = Illegal Function: The message function is not an allowable action.
  2 = Illegal Data Address: The message start address is not an allowable address.
  9 = Checksum Error: The received message had an incorrect error check code.
  10 = Garbled Message: The received message could not be decoded.

- Error Percent: This indicates the amount of time that an error has been detected in the data being transmitted (displayed as a percent).

I/O Check

This menu shows the status of the key input and output points of the control. This menu can be used for troubleshooting of I/O hardware and wiring. It can also be used to determine if an LED is bad.

- MPU #1: This is the value of the speed being sensed by MPU #1 (displayed in hertz).
- MPU #2: This is the value of the speed being sensed by MPU #2 (displayed in hertz).
- Analog Input: This is a percentage indication of the Remote Speed Setting Input value. The minimum governor speed setting being 0% and the maximum governor speed setting being 100%.
- DI #1: If contact input #1 is closed this will indicate True for a Lower Speed Reference command. If contact input #1 is open this will indicate False.
- DI #2: If contact input #2 is closed this will indicate True for a Raise Speed Reference command. If contact input #2 is open this will indicate False.
- DI #3: If contact input #3 is closed this will indicate True for an External Trip command. If contact input #3 is open this will indicate False.
- DI #4: If contact input #4 is closed this will indicate True for a Start command. If contact input #4 is open this will indicate False.
- DI #5: If contact input #5 is closed this will indicate True for a Reset command. If contact input #5 is open this will indicate False.
- DI #6: If contact input #6 is closed this will indicate True for an Idle/Min Gov command. If contact input #6 is open this will indicate False.
- DI #7: If contact input #7 is closed this will indicate True for a Remote Speed Enable command. If contact input #7 is open this will indicate False.
- DI #8: If contact input #8 is closed this will indicate True for a High Dynamic Select command. If contact input #8 is open this will indicate False.
- Trip P/B: If the front panel trip button is being pressed this will indicate True. If the front panel trip button is not being pressed this will indicate False.
- Ospd Test P/B: If the overspeed test button on the front panel is being pressed this will indicate True. If the overspeed test button is not being pressed this will indicate False.
- Raise P/B: If the front panel raise speed button is being pressed this will indicate True. If the front panel raise speed button is not being pressed this will indicate False.
- Lower P/B: If the front panel lower speed button is being pressed this will indicate True. If the front panel lower speed button is not being pressed this will indicate False.
- Start P/B: If the front panel start button is being pressed this will indicate True. If the front panel start button is not being pressed this will indicate False.

- Reset P/B: If the front panel reset button is being pressed this will indicate True. If the front panel start button is not being pressed this will indicate False.

- Tripped LED: This indicates the status of the control. When "Trip Relay Energizes" under "Relays" in the configure mode is tuned True and this indication is True, the front panel Tripped LED is ON to indicate a Trip condition. When this indication is False the front panel Tripped LED is OFF. When `Trip Relay Energizes' under `Relays' in the configure mode is tuned False and this indication is False, the front panel Tripped LED is ON to indicate a Trip condition. When this indication is True the front panel Tripped LED is OFF.

NOTE

If the trip relay is programmed to energize for a shutdown, Jumper 1 must be installed to properly display the unit's "Tripped" status on the front-panel LED. If the trip relay is programmed to de-energize for a shutdown, Jumper 2 must be installed.

- MPU #1 OK LED: This indicates the status of MPU #1. A True indication will illuminate the front panel MPU #1 OK LED. A False indication turns the LED off indicating a failed MPU #1.

- MPU #2 OK LED: This indicates the status of MPU #2. A True indication will illuminate the front panel MPU #2 OK LED. A False indication turns the LED off indicating a failed MPU #2.

- OSPD Enable LED: This indicates the status of the Overspeed test. A True indication will illuminate the front panel Overspeed Test Enabled LED. During the overspeed test this indication may begin to alternate True and False to indicate the expected overspeed levels.

- RMT SPD LED: This indicates the status of the Remote Speed input. A True indication will illuminate the front panel RMT SPD Enable LED to indicate that the remote speed setting option is enabled. While the remote speed input is enabled this indication may begin to alternate True and False to indicate the Remote Speed Analog input has failed.

- Trip RELAY ON: This indicates the status of relay output #1. When "Trip Relay Energizes" under "Relays" in the configure mode is tuned True and this indication is True, relay output #1 is energized to indicate a Trip condition. When this indication is False relay output #1 is de- energized. When "Trip Relay Energizes" under "Relays" in the configure mode is tuned False and this indication is False, relay output #1 is de- energized to indicate a Trip condition. When this indication is True relay output #1 is energized.

- Alarm RELAY ON: This indicates the status of relay output #2. When True, relay output #2 is energized to indicate an Alarm condition. When False relay output #2 is de-energized.

- Conf Rly #1 ON: This indicates the status of relay output #3. When True relay output #3, which is Configurable Relay #1, is energized. When False Configurable Relay #1 is de-energized.

- Conf Rly #2 ON: This indicates the status of relay output #4. When True relay output #4, which is Configurable Relay #2, is energized. When Configurable Relay #2 is de-energized.

Service Mode Flow Diagram

Refer to Figure 8-1 for a flow diagram of the service mode headers.

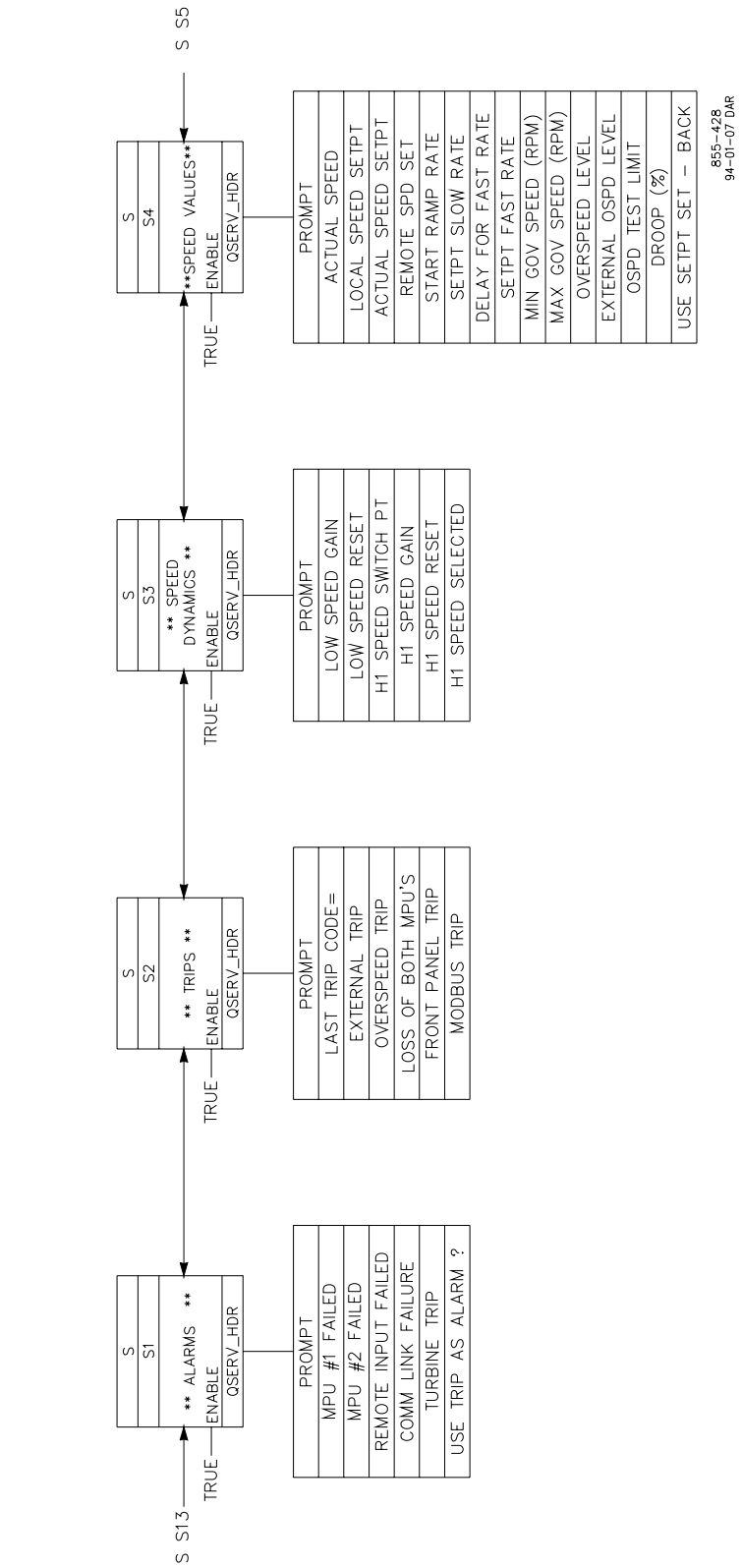
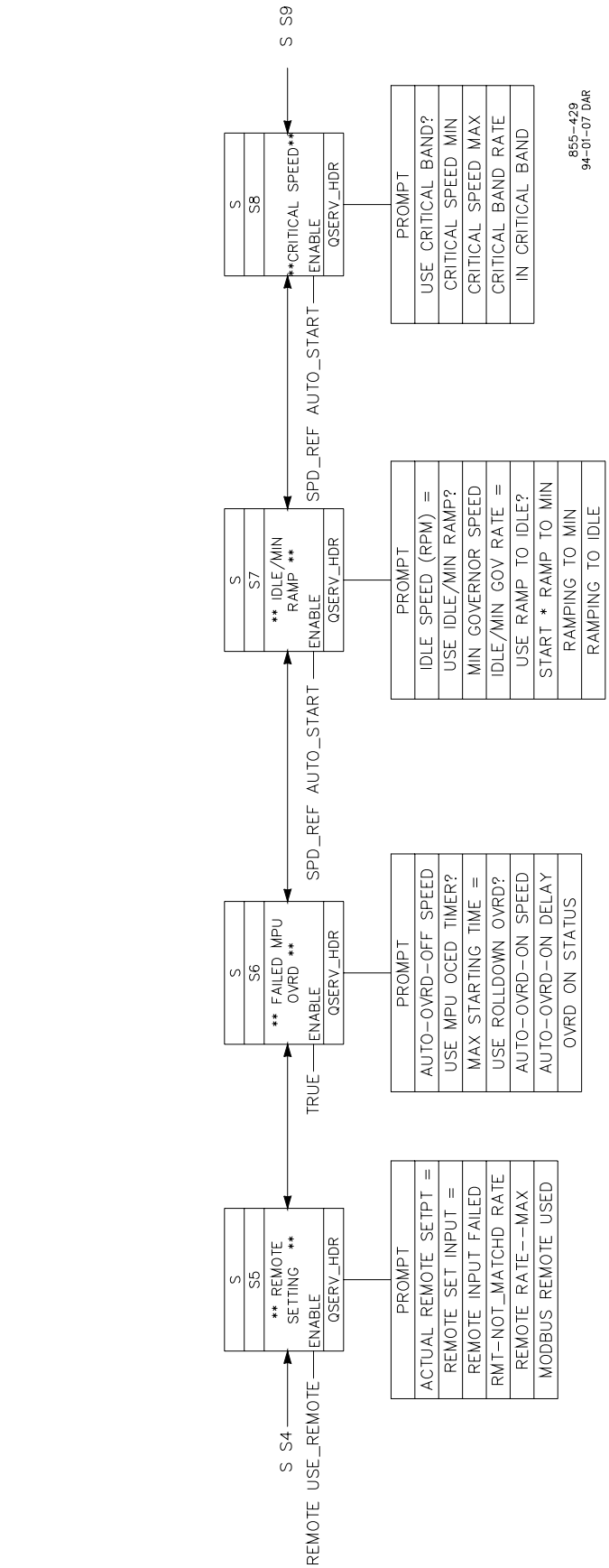
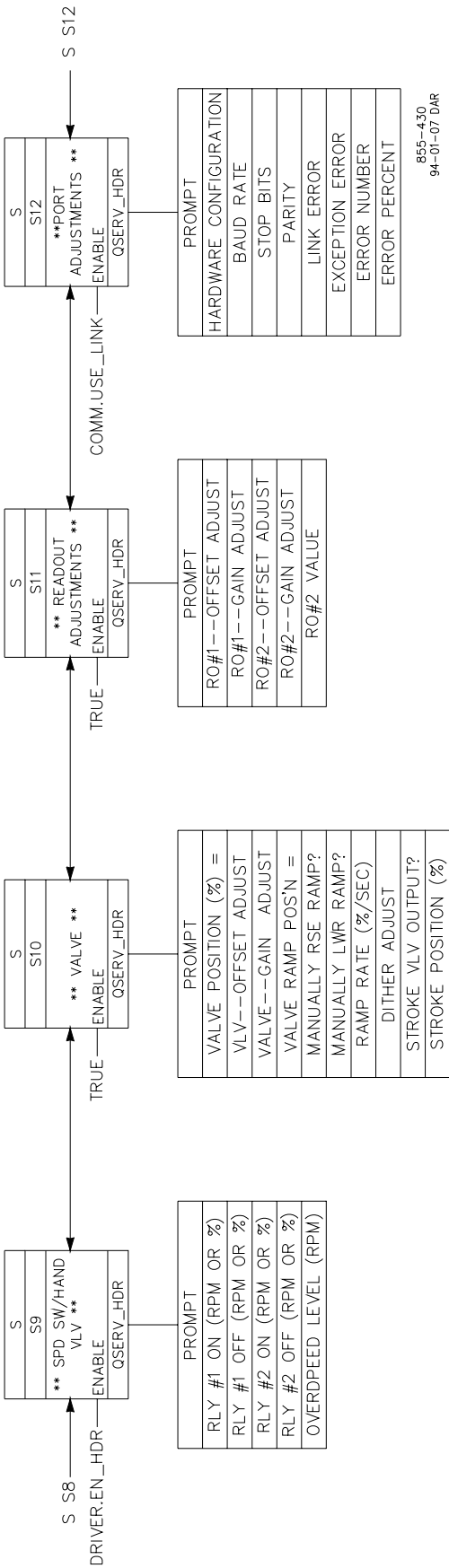
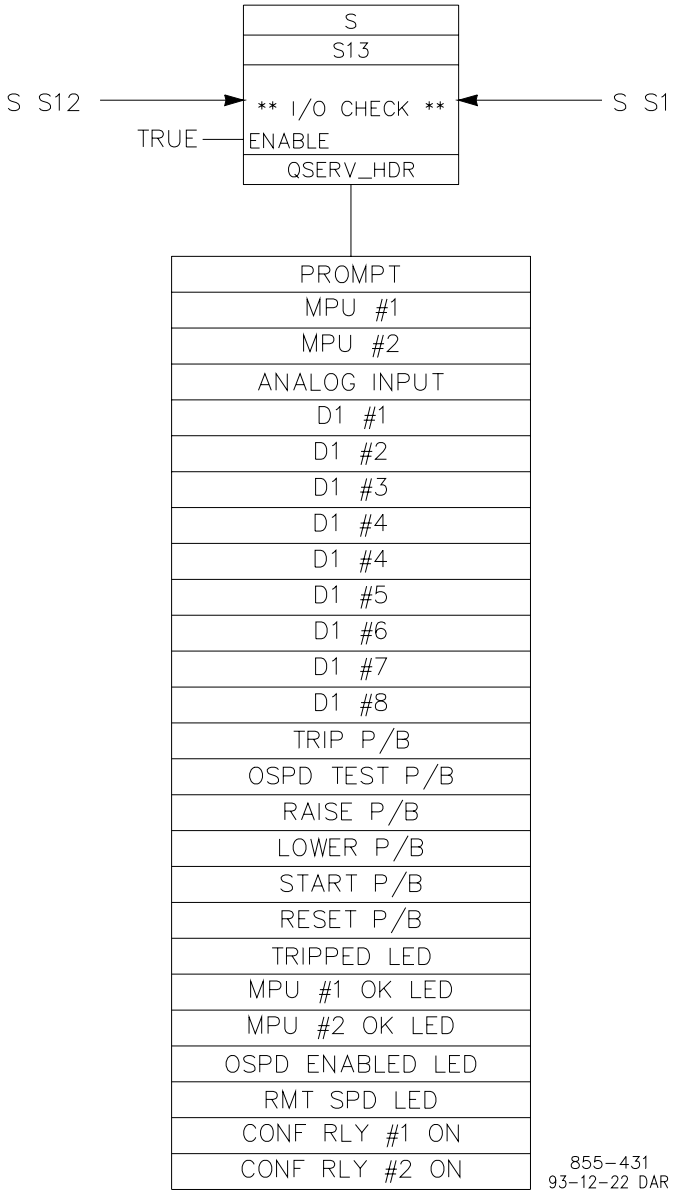


Figure 8-1. Service Mode Flow Diagram
(4 pages)


S S9
S
S8
CRITICAL SPEED
ENABLE
QSERV_HDR
PROMPT
USE CRITICAL BAND?
CRITICAL SPEED MIN
CRITICAL SPEED MAX
CRITICAL BAND RATE
IN CRITICAL BAND
855-429
94-01-07 DAR
SPD_REF AUTO_START
S
S7
** IDLE/MIN RAMP **
ENABLE
QSERV_HDR
PROMPT
IDLE SPEED (RPM) =
USE IDLE/MIN RAMP?
MIN GOVERNOR SPEED
IDLE/MIN GOV RATE =
USE RAMP TO IDLE?
START * RAMP TO MIN
RAMPING TO MIN
RAMPING TO IDLE
SPD_REF AUTO_START
S
S6
** FAILED MPU OVRD **
ENABLE
QSERV_HDR
PROMPT
AUTO-OVRD-OFF SPEED
USE MPU OCED TIMER?
MAX STARTING TIME =
USE ROLLDOWN OVRD?
AUTO-OVRD-ON SPEED
AUTO-OVRD-ON DELAY
OVRD ON STATUS
TRUE
S
S5
** REMOTE SETTING **
ENABLE
QSERV_HDR
PROMPT
ACTUAL REMOTE SETPT =
REMOTE SET INPUT =
REMOTE INPUT FAILED
RMT-NOT_MATCHD RATE
REMOTE RATE--MAX
MODBUS REMOTE USED
S S4
REMOTE USE_REMOTE


S S12
S
S12
**PORT
ADJUSTMENTS **
ENABLE
QSERV_HDR
PROMPT
HARDWARE CONFIGURATION
BAUD RATE
STOP BITS
PARITY
LINK ERROR
EXCEPTION ERROR
ERROR NUMBER
ERROR PERCENT
COMM.USE_LINK
S
S11
** READOUT
ADJUSTMENTS **
ENABLE
QSERV_HDR
PROMPT
RO#1--OFFSET ADJUST
RO#1--GAIN ADJUST
RO#2--OFFSET ADJUST
RO#2--GAIN ADJUST
RO#2 VALUE
TRUE
S
S10
** VALVE **
ENABLE
QSERV_HDR
PROMPT
VALVE POSITION (%) =
VLV--OFFSET ADJUST
VALVE--GAIN ADJUST
VALVE RAMP POS'N =
MANUALLY RSE RAMP?
MANUALLY LWR RAMP?
RAMP RATE (%/SEC)
DITHER ADJUST
STROKE VLV OUTPUT?
STROKE POSITION (%)
MIN/MAX SWITCH
TRUE
S
S9
** SPD SW/HAND
VLV **
ENABLE
QSERV_HDR
PROMPT
RLY #1 ON (RPM OR %)
RLY #1 OFF (RPM OR %)
RLY #2 ON (RPM OR %)
RLY #2 OFF (RPM OR %)
OVERDPEED LEVEL (RPM)
S S8
DRIVER.EN_HDR
855-430
94-01-07 DAR


S
S13
S S12
** I/O CHECK **
S S1
TRUE
ENABLE
QSERV_HDR
PROMPT
MPU #1
MPU #2
ANALOG INPUT
D1 #1
D1 #2
D1 #3
D1 #4
D1 #4
D1 #5
D1 #6
D1 #7
D1 #8
TRIP P/B
OSPD TEST P/B
RAISE P/B
LOWER P/B
START P/B
RESET P/B
TRIPPED LED
MPU #1 OK LED
MPU #2 OK LED
OSPD ENABLED LED
RMT SPD LED
CONF RLY #1 ON
CONF RLY #2 ON
855-431
93-12-22 DAR

Chapter 9.
Configuration Menus

Introduction

Before the turbine can be run with the Peak® 150 control, the control must be programmed (see Program Mode Worksheets in the Appendix). The configure mode parameters can only be changed while the turbine is shutdown.

Speed Configuration Menu

This menu shows the Hertz to rpm ratio, maximum Hertz #1 and #2, maximum speed level (Hz), and minimum speed level (Hz). See Figure 7-3 for the relationships between all speed values and the mode in which the value is set.

- Teeth seen by MPU: The number of teeth on the gear at which the magnetic pickup is looking (Tunable Range: 1 to 200).
- MPU Gear Ratio 1: The relationship between gear speed and turbine-shaft speed. This gear ratio is the result of dividing the speed of the MPU gear by the speed of the turbine shaft. (Tunable Range: 0 to 200).
- MPU #1-Max Hertz: The maximum speed in Hz for MPU #1 (Tunable Range: 0 to 15000).
- MPU #2-Max Hertz: The maximum speed in Hz for MPU #2 (Tunable Range: 0 to 15000).
- Max Speed Level (Hz): The maximum speed in Hz (Tunable Range: 0 to 15000).
- Minimum Spd Lvl (Hz): minimum speed level in Hz. This is the minimum detectable speed level for the control (see MPU Override). Below this level the MPU would be detected as failed and an alarm would be issued. The MPU input signal must be at least 1.0 Vrms at the minimum speed level programmed or the control will trip on loss of speed (Tunable Range: 0 to 2000).

NOTE

MPU #1—MAX Hz, MPU #2—MAX Hz, and Max Speed Level will normally all three be the same value. This setting must be greater than or equal to the Overspeed test Limit Speed (see Service Mode).

WARNING—SET POINT SETTINGS

Do not set any set points greater than the value set for MPU #1—Max, MPU #2—Max, and Max Speed Level. If the speed set point exceeds the maximum frequency set by these set points, the turbine will overspeed, resulting in possible equipment damage and personnel injury or death.

Start Mode Menu

This menu shows the starting modes.

- Manual Start Mode?: If this is set to TRUE the manual start mode will be selected.
- Automatic Start Mode? = : If this is set to TRUE the automatic start mode will be selected.

NOTE
In Manual Start Mode, governor speed control starts at minimum governor speed. In Auto Start Mode, speed control starts at idle speed which is much lower than minimum governor speed (see Start Modes in Operating Procedures chapter).

Actuator Configuration Menu

This menu shows the actuator configurations.

- Use 20–160 mA Actuator? : Displays TRUE when the 20–160 mA actuator driver is configured. All Woodward actuators are 20–160 mA actuators; check with vendor for proper drive current.
- Use 4–20 mA Actuator? : Displays TRUE when the 4–20 mA actuator driver is configured. This value is for status indication only and is the opposite of the "Use 2-160 mA" configuration.

NOTE
Check that the correct drive current jumpers are installed. For a 0–200 mA drive-current range, Jumpers 4 and 10 should be installed. For a 0–20 mA drive-current range, Jumpers 3 and 9 should be installed.

Operating Mode Menu

This menu shows the operating modes, manual, remote, HSS, and LSS.

- Manual Control Only?: If set to TRUE the manual control only will be selected. All speed control adjustments must be done with the Raise and Lower commands (front panel or contact inputs).
- Use Remote Speed Set?: If set to TRUE the remote control will be enabled (if "Manual Control Only" is set to FALSE).
- Use High Signal Select?: A TRUE enables high signal select (HSS) between local speed set point and local speed setting. "Manual Control Only" must be FALSE and "Remote Speed Setting" TRUE.
- Use Modbus Analog Input?: A TRUE enables using the remote speed setting through the Modbus link rather than with the analog 4–20 mA input. "Manual Control Only" must be FALSE and "Use Remote Speed Setting?" must be TRUE.

NOTE
For a description of operating modes, see Chapter 3.

Readouts Menu

This menu shows the readout options and values at 4 mA and 20 mA.

- Speed RO-4 mA value: Value for readout at 4 mA (Tunable Range: 0 to 10000).
- Speed RO-20 mA value: Value for readout at 20 mA (Tunable Range: 15000).
- Readout #2 Option?: A number 1–6 must be selected:
  1) Actual Speed readout
  2) Speed Set Point readout
  3) Actuator Output readout
  4) Remote Speed Set Point readout
  5) Valve Ramp Value readout
  6) NOT USED
- Readout #2-4 mA Value: Value for readout at 4 mA (Tunable Range: 0 to 10000).
- Readout #2-20 mA Value: Value for readout at 20 mA (Tunable Range: 0 to 15000).

Relays Menu

This menu shows the relay options, use speed switch, hand valve, and trip relay.

- Relay #3 Option?: an option 1 through 11 for the relay must be selected:
  1) Alarm
  2) Trip Output
  3) Shutdown
  4) Remote Control
  5) Speed Control
  6) Either MPU Failed
  7) Overspeed Trip
  8) Overspeed Test
  9) Remote Signal OK
  10) Speed Switch #1 or Hand Valve #1
  11) Speed Switch #2 or Hand Valve #2

- Relay #4 Option?: An option 1 through 11 for the relay must be selected:
  1) Alarm
  2) Trip Output
  3) Shutdown
  4) Remote Control
  5) Speed Control
  6) Either MPU Failed
  7) Overspeed Trip
  8) Overspeed Test
  9) Remote Signal OK
  10) Speed Switch #1 or Hand Valve #1
  11) Speed Switch #2 or Hand Valve #2
- Use Speed Switch? : If set to TRUE, the speed switch can be used and its switch point can be set in the service menu.
- Switch #2 Underspeed?: If set to TRUE, speed switch #2 will be used to indicate an underspeed condition.
- Use Hand Valve? : If set to TRUE the hand valve can be used and set in the service menu.

NOTE
A combination of both a hand valve and a speed switch is not possible. If both "Use Hand Valve" and "Use Speed Switch" are set to TRUE, hand valves will be selected (if Option 10 or 11 is selected above in the relay options).

- Trip Relay Energizes?: If set TRUE the trip relay will energize on shutdown; if set FALSE, it will de-energize.

NOTE
If the trip relay is programmed to energize for a shutdown, Jumper 2 must be installed to properly display the unit's "Tripped" status on the front-panel LED. If the trip relay is programmed to de-energize for a shutdown, Jumper 1 must be installed.

- Reset Clears Trip?: If set True the Trip relay will be reset when a Reset command is given. If set False all trip conditions including the External Trip input must be cleared before a reset command will reset the Trip relay.

Contact In #8

This menu is used to select the function of contact input #8.

- In #8 is Ospd Test: When tuned True the function of contact input #8 will be an Overspeed Test Enable. If tuned False the function of contact input #8 will be High Dynamics Select

Port Configuration

This menu is used to enable the Modbus option and set some communication parameters.

- Use Modbus Port?: If set True the Modbus port is enabled. If set False the Modbus port is disabled.
- Hardware Configuration: This adjustment sets the physical link to be used by the Modbus Communication. Following is a list of the codes and the corresponding hardware configuration associated with them.
  1 = RS-232 Communication
  2 = RS-422 Communication
  3 = RS-485 Communication
- Transmission Mode: This adjustment sets the type of protocol to be used by the Modbus Communication. Code 1 defines ASCII protocol to be used. A code of 2 will define RTU protocol to be used.
- Network Address: This adjustment sets the device number address for the Peak 150 control in a multidrop configuration. This is typically set to 01.

NOTE
When configuration is complete, press the ESC key until the display reads "Rebooting Control."

Configure Mode Flow Diagram

Refer to Figure 9-1 for a flow diagram of the configure mode headers.

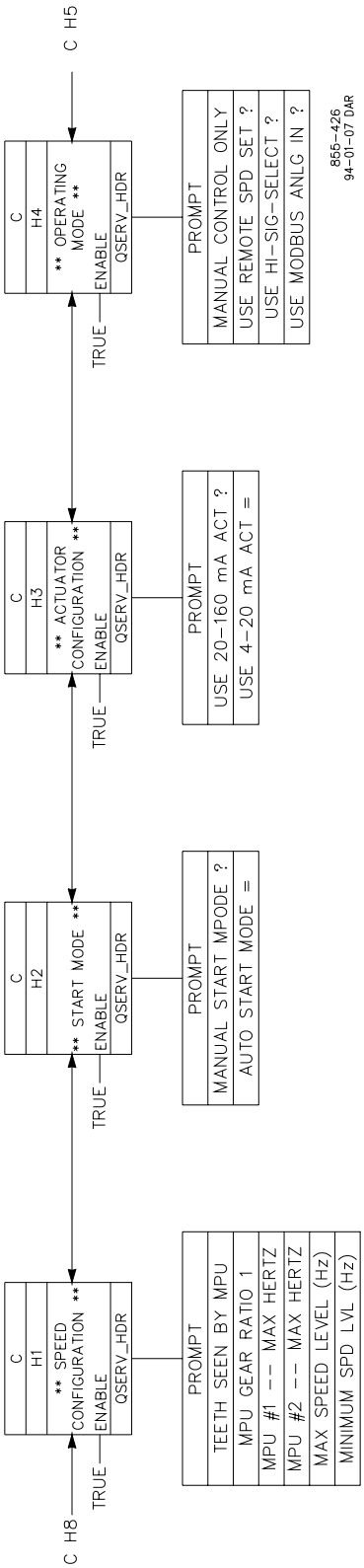
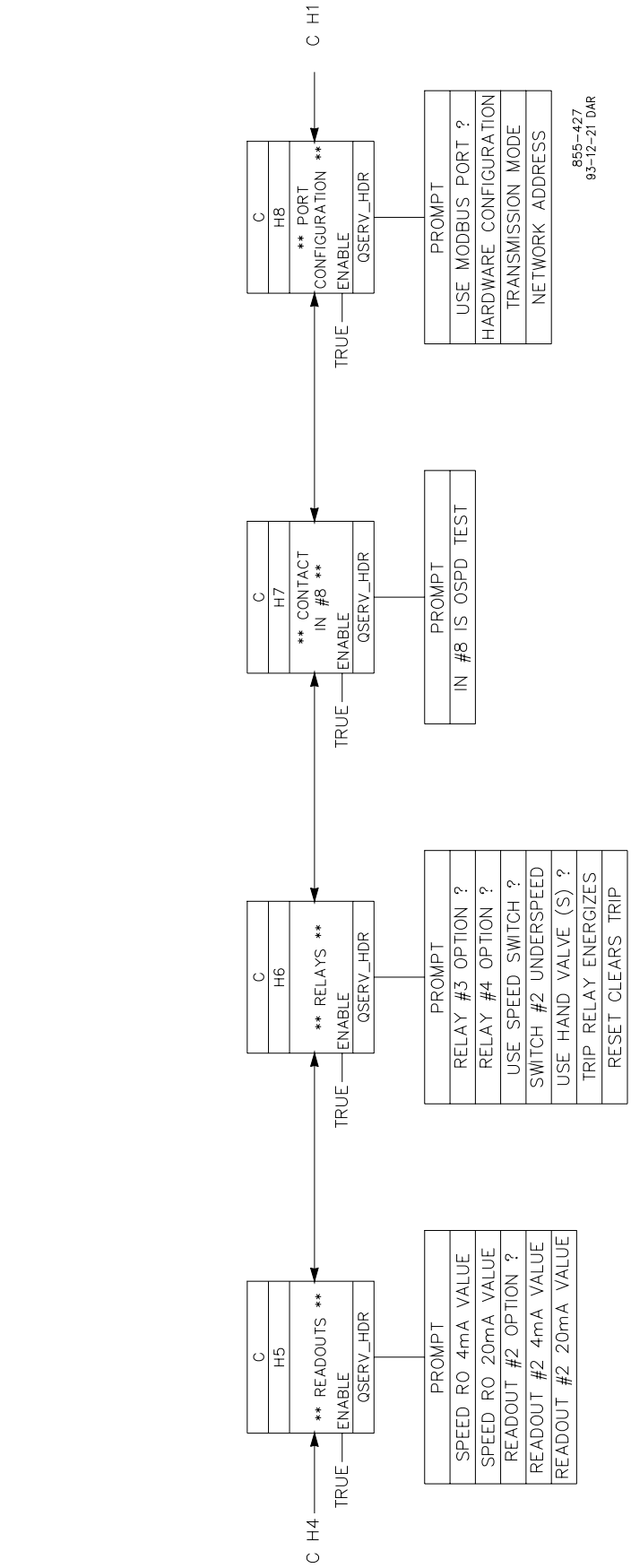


Figure 9-1. Configure Mode Flow Diagram
(2 pages)


C H1
C
H8
** PORT CONFIGURATION **
ENABLE
QSERV_HDR
TRUE
PROMPT
USE MODBUS PORT ?
HARDWARE CONFIGURATION
TRANSMISSION MODE
NETWORK ADDRESS
855-427
93-12-21 DAR
C
H7
** CONTACT IN #8 **
ENABLE
QSERV_HDR
TRUE
PROMPT
IN #8 IS OSPD TEST
C
H6
** RELAYS **
ENABLE
QSERV_HDR
TRUE
PROMPT
RELAY #3 OPTION ?
RELAY #4 OPTION ?
USE SPEED SWITCH ?
SWITCH #2 UNDERSPEED
USE HAND VALVE (S) ?
TRIP RELAY ENERGIZES
RESET CLEARS TRIP
C
H5
** READOUTS **
ENABLE
QSERV_HDR
TRUE
PROMPT
SPEED RO 4mA VALUE
SPEED RO 20mA VALUE
READOUT #2 OPTION ?
READOUT #2 4mA VALUE
READOUT #2 20mA VALUE
C H4

Chapter 10.
Functional Block Diagram

Explanation of Functional Block Diagram

The Functional Block Diagram explains how the Peak® 150 control operates in logic diagram form. Sheet one of the block diagram covers general and specific block diagram notes. Refer to this sheet for explanation of the information contained on the additional sheets. Sheet two of the diagram shows an overview of the system and identifies the following sheets on which detailed information can be located.

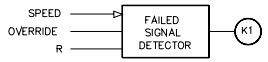
The additional sheets show the simplified block diagram of the control. These blocks represent the functional operational blocks of the control, the functions of which are performed by the computer in the control. The general block diagram notes cover the following topics:

- Signal flow
- Customer input/output (I/O)
- Interconnect code
- Operator control panels
- Switch contact inputs
- Function connectors
- Buses
- Function symbols
- Adjustable Parameter Codes

SIGNAL FLOW

SIGNAL FLOW IS FROM LEFT TO RIGHT. ALL INPUTS ENTER FROM THE LEFT. ALL OUTPUTS EXIT TO THE RIGHT. EXCEPTIONS ARE NOTED. SIGNAL VALUES ARE SHOWN WITH AN ARROW. LOGIC SIGNALS ARE SHOWN WITHOUT AN ARROW.

EXAMPLE:



CUSTOMER INPUT/OUTPUT (I/O)

INPUTS ORIGINATE ON THE LEFT SIDE OF THE DRAWING. OUTPUTS TERMINATE ON THE RIGHT SIDE OF THE DRAWING, WITH THE EXCEPTION OF RELAYS, WHICH ARE SHOWN NEAR THEIR ASSOCIATED FUNCTION BLOCK. VERTICAL DASHED LINES SEPARATE SIGNAL FLOW BETWEEN WOODWARD GOVERNOR AND CUSTOMER EQUIPMENT.

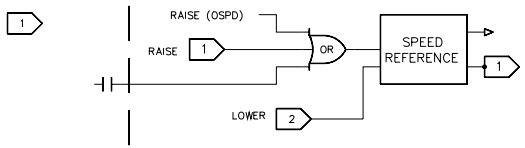
INTERCONNECT CODE

THE ⬠ SYMBOL INDICATES INTERCONNECTING SIGNAL FLOW BY CABLES WITH CONNECTORS ON BOTH ENDS. NO CUSTOMER WIRING REQUIRED. EACH CABLE IS DISTINGUISHED WITHIN THE BLOCK DIAGRAM NUMERICALLY AND GENERALLY EACH RACK WILL BE SHOWN ON SEPARATE SHEETS.

⬠1 INDICATES TO/FROM RS-232 DIVICE. THE NUMBER INSIDE THE SYMBOL CORRESPONDS TO THE MODBUS ADDRESS IDETIFIER.

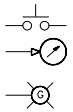
IDENTIFIER (CATEGORY) SYMBOL INDICATES INTERCONNECTION WITHIN THE SOFTWARE. THE INTERCONNECTION IS DESCRIBED BY THE IDENTIFIER IS FOLLOWED BY THE CATEGORY. THE CATEGORY AND ASSOCIATED SHEET NUMBER MATRIX CAN BE FOUND ON SHEET 1 OF THIS DOCUMENT.

EXAMPLE:



OPERATOR CONTROL PANELS

THE FOLLOWING SYMBOLS ARE USED TO DISPLAY OPERATOR CONTROL PANEL FUNCTIONS.



PUSHBUTTON SWITCH

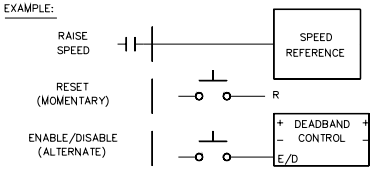
METER

INDICATOR; LED, LAMP OR BACKLIGHTED PUSHBUTTON SWITCH. COLOR SHOWN IN CIRCLE: G = GREEN, R = RED, W = WHITE, Y = YELLOW.

SWITCH CONTACT INPUTS

UNLESS OTHERWISE NOTED, ALL SWITCH CONTACTS CLOSE TO MAKE THE INPUT DESCRIPTION TRUE AND OPEN TO MAKE IT FALSE. SOME INPUTS ONLY REQUIRE A MOMENTARY CONTACT CLOSURE TO MAKE THE INPUT DESCRIPTION TRUE. THEY ARE LABELED AS MOMENTARY. SOME INPUTS REQUIRE AN ALTERNATE ACTION SWITCH CONTACT TO MAKE THE FIRST DESCRIPTION TRUE WHEN THE CONTACT IS CLOSED AND THE SECOND TRUE WHEN CONTACT IS OPENED. THEY ARE LABELED AS ALTERNATE.

EXAMPLE:



FUNCTION CONNECTORS

TO REDUCE THE NUMBER OF LINES ON THE DRAWING, SOME FUNCTIONS ARE CONNECTED TOGETHER BY USING LIKE CHARACTERS, WORDS, OR TIEPOINT SYMBOLS.

R – RESET
A SINGLE INPUT, RESET IS DISTRIBUTED TO ALL OF THE LATCHING FUNCTIONS. AFTER THE INPUT SIGNAL RETURNS TO NORMAL. A RESET IS REQUIRED TO RESTORE THE OUTPUT TO A NORMAL STATE.

S – SHUTDOWN
MULTIPLE INPUTS CAN INITIATE A SHUTDOWN. THE SHUTDOWN FUNCTION BLOCK IS USUALLY LOCATED PHYSICALLY ON THE DRAWING NEAR THE FINAL DRIVER.

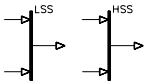
A – ALARM
MULTIPLE INPUTS CAN INITIATE AN ALARM. THE ALARM FUNCTION BLOCK IS USUALLY LOCATED ON THE DRAWING NEAR THE FINAL DRIVER.

⬡ – TIEPOINT SYMBOLS

BUSES

SIGNAL BUSES ARE SHOWN AS HEAVY LINES

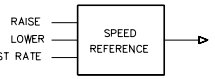
EXAMPLE:



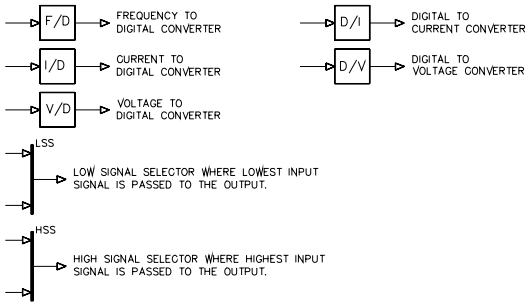
FUNCTION SYMBOLS

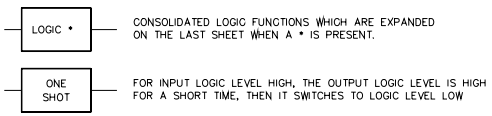
COMMON GOVERNOR FUNCTIONS ARE REPRESENTED BY RECTANGULAR BLOCKS. A DESCRIPTION OF THE FUNCTION IS SHOWN INSIDE THE BLOCK.

EXAMPLE:

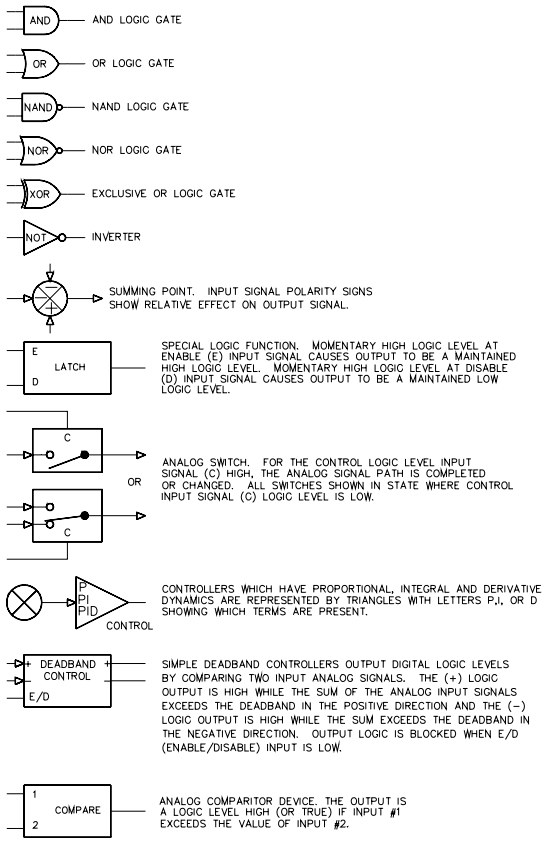


COMMONLY USED ABBREVIATED FUNCTIONS ARE:





COMMONLY USED ABBREVIATED FUNCTIONS ARE: (CONT)

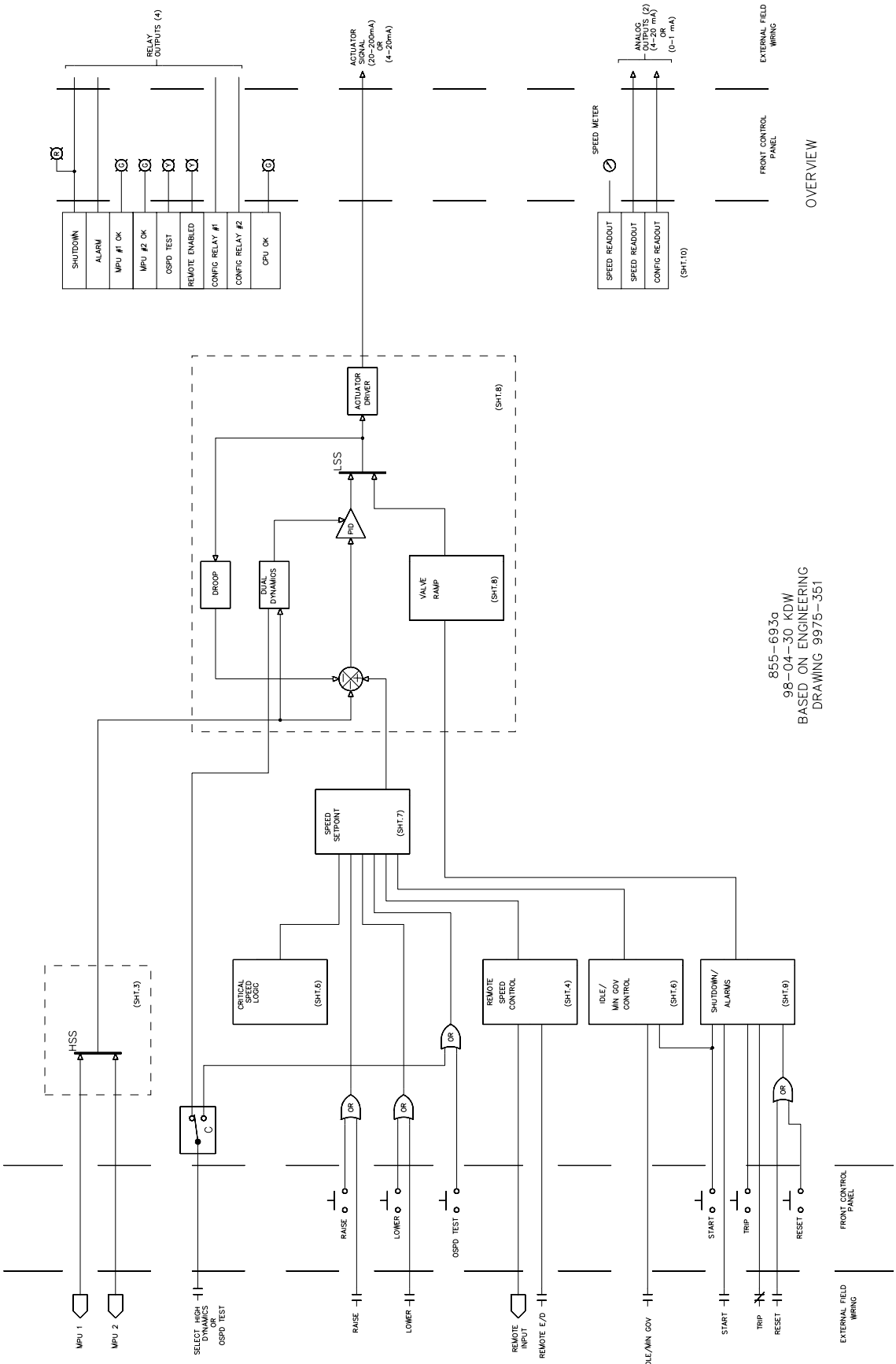


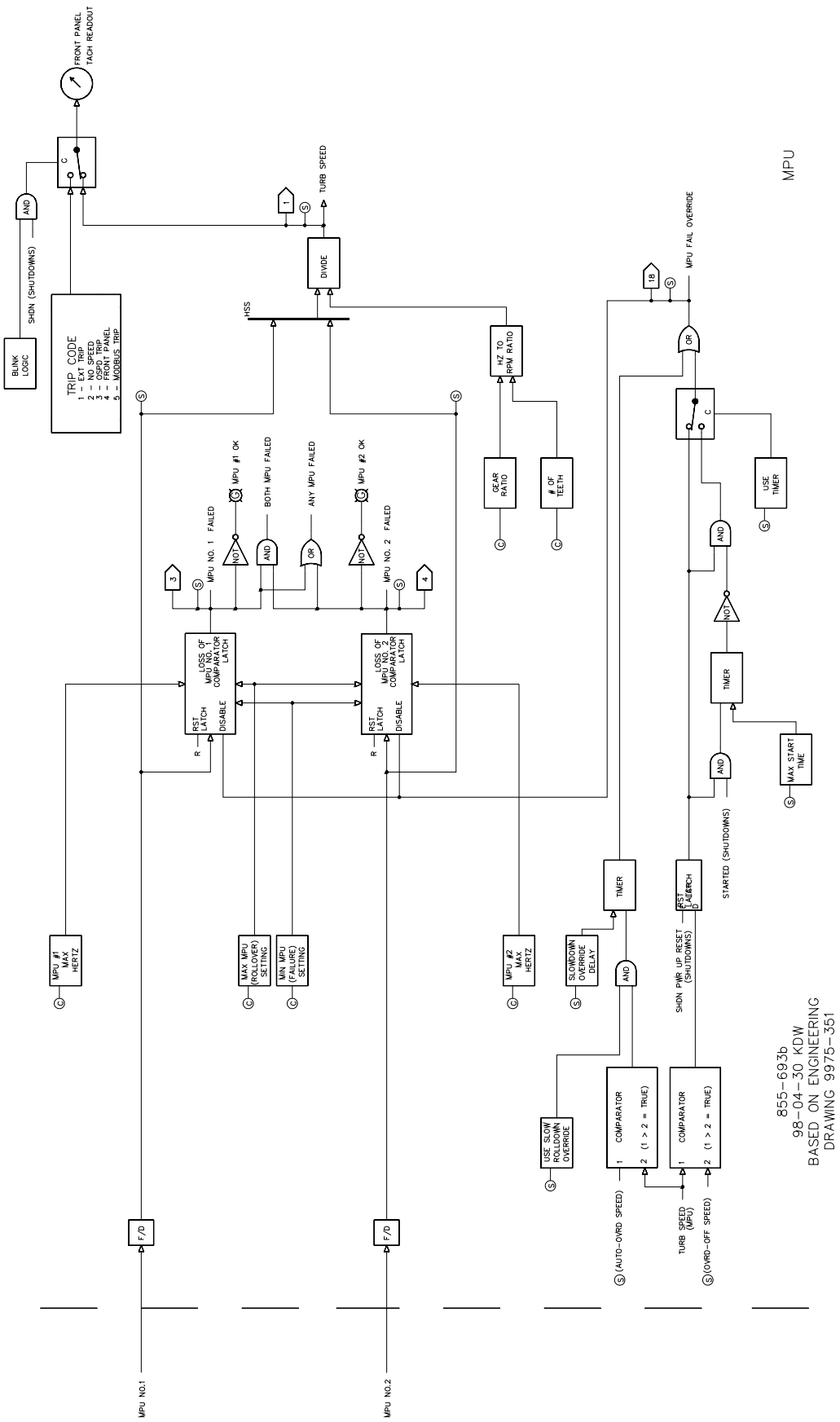
ADJUSTABLE PARAMETER CODES (TUNABLES):

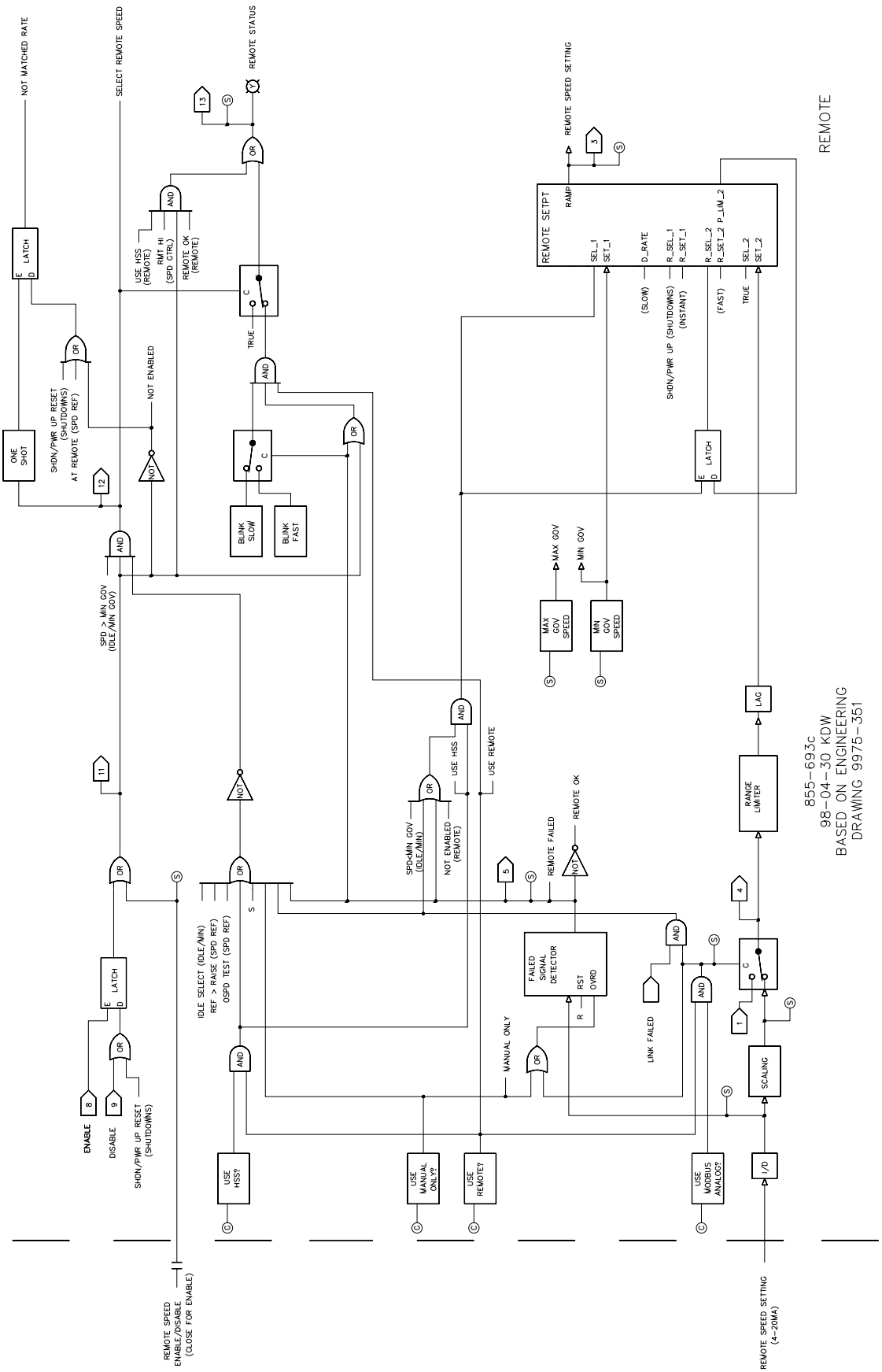
THE SYMBOL Ⓢ INDICATES A PARAMETER THAT IS ADJUSTABLE IN TYHE SERVICE MODE. THE SYMBOL Ⓓ INDICATES A PARAMETER THAT IS ADJUSTABLE IN THE DEBUG MODE BY TRAINED SERVICE PERSONNEL. BOTH SERVICEⓈ AND DEBUG Ⓓ MODE PARAMETERS ARE ADJUSTABLE WHILE THE TURBINE IS RUNNING. THE SYMBOL Ⓒ INDICATES A CONFIGURE MODE PARAMETER THAT IS ADJUSTABLE ONLY WHEN THE TURBINE IS SHUT DOWN.

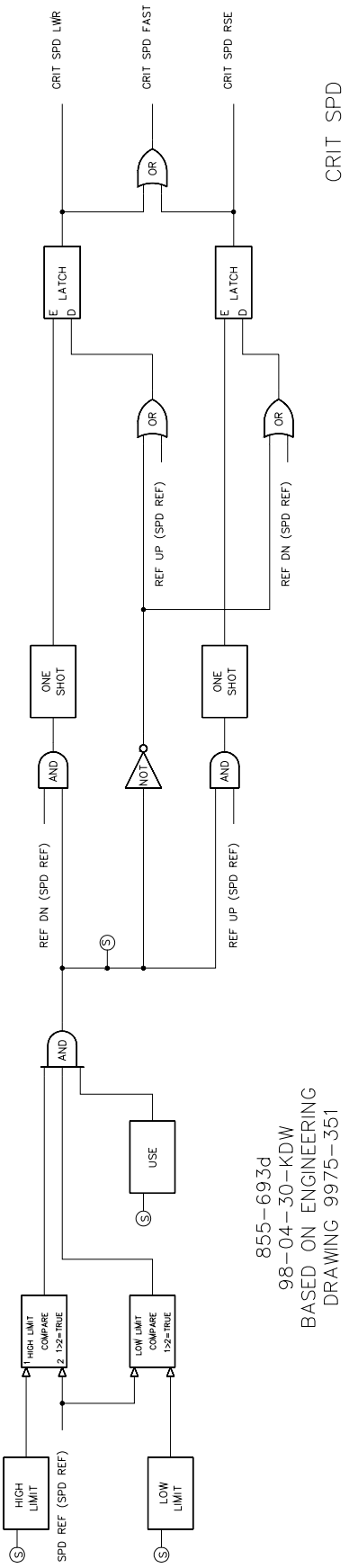
FUNCTIONAL BLOCK DIAGRAM NOTES

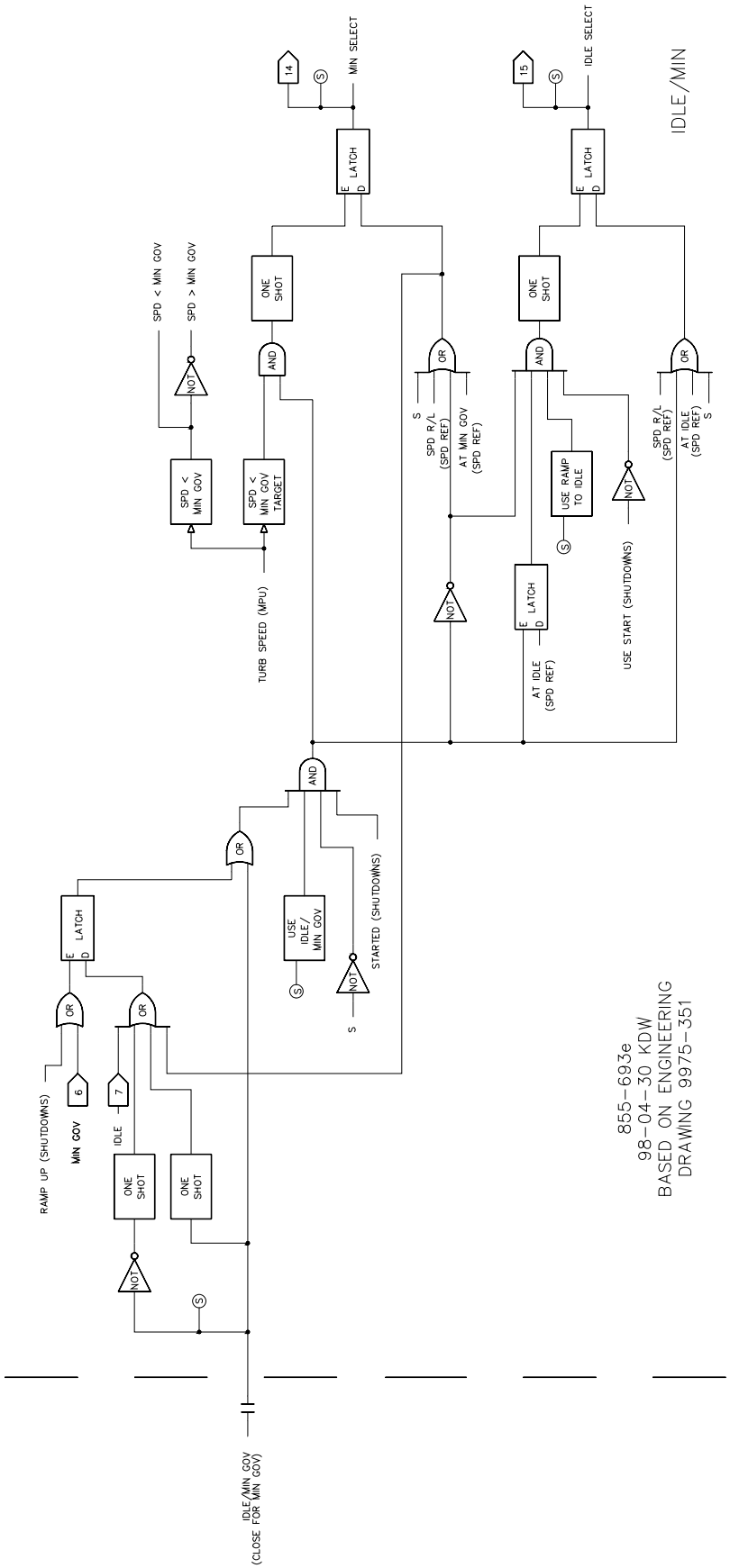
855-693
98-04-30 KDW
BASED ON ENGINEERING
DRAWING 9975-351

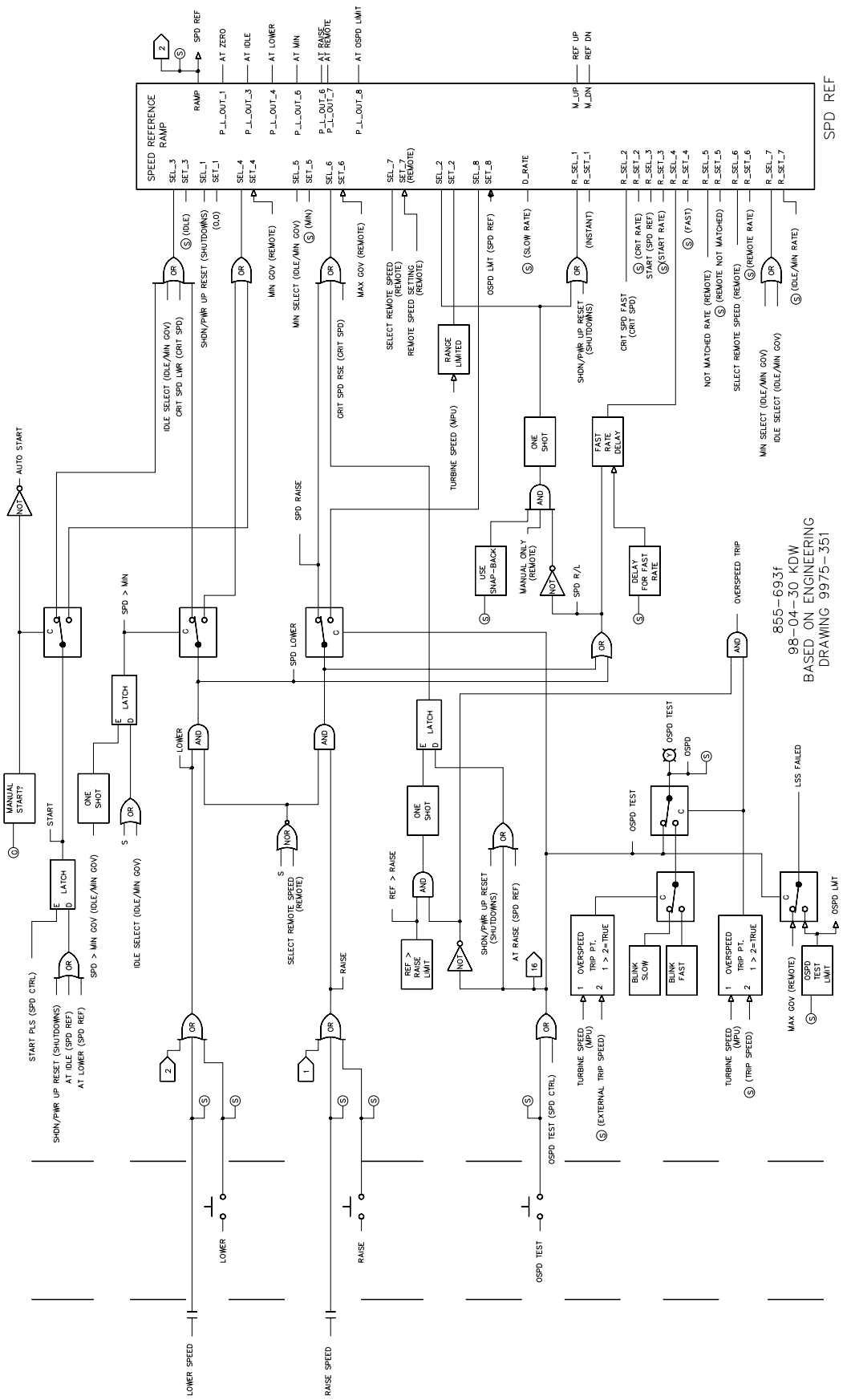

RELAY OUTPUTS (4)
ACTUATOR SIGNAL (20-200mA) OR (4-20mA)
ANALOG OUTPUTS (2) (4-20 mA) OR (0-1 mA)
EXTERNAL FIELD WIRING
SHUTDOWN
ALARM
MPU #1 OK
MPU #2 OK
OSPD TEST
REMOTE ENABLED
CONFIG RELAY #1
CONFIG RELAY #2
CPU OK
SPEED METER
SPEED READOUT
SPEED READOUT
CONFIG READOUT
(SHT.10)
FRONT CONTROL PANEL
OVERVIEW
ACTUATOR DRIVER
(SHT.8)
LSS
PID
DROOP
DUAL DYNAMICS
VALVE RAMP
(SHT.8)
855-693a
98-04-30 KDW
BASED ON ENGINEERING
DRAWING 9975-351
SPEED SETPOINT
(SHT.7)
CRITICAL SPEED LOGIC
(SHT.6)
REMOTE SPEED CONTROL
(SHT.4)
IDLE/ MIN GOV CONTROL
(SHT.6)
SHUTDOWN/ ALARMS
(SHT.9)
HSS
(SHT.3)
OR
C
RAISE
LOWER
OSPD TEST
START
TRIP
RESET
MPU 1
MPU 2
SELECT HIGH DYNAMICS OR OSPD TEST
RAISE
LOWER
REMOTE INPUT
REMOTE E/D
IDLE/MIN GOV
START
TRIP
RESET
FRONT CONTROL PANEL
EXTERNAL FIELD WIRING

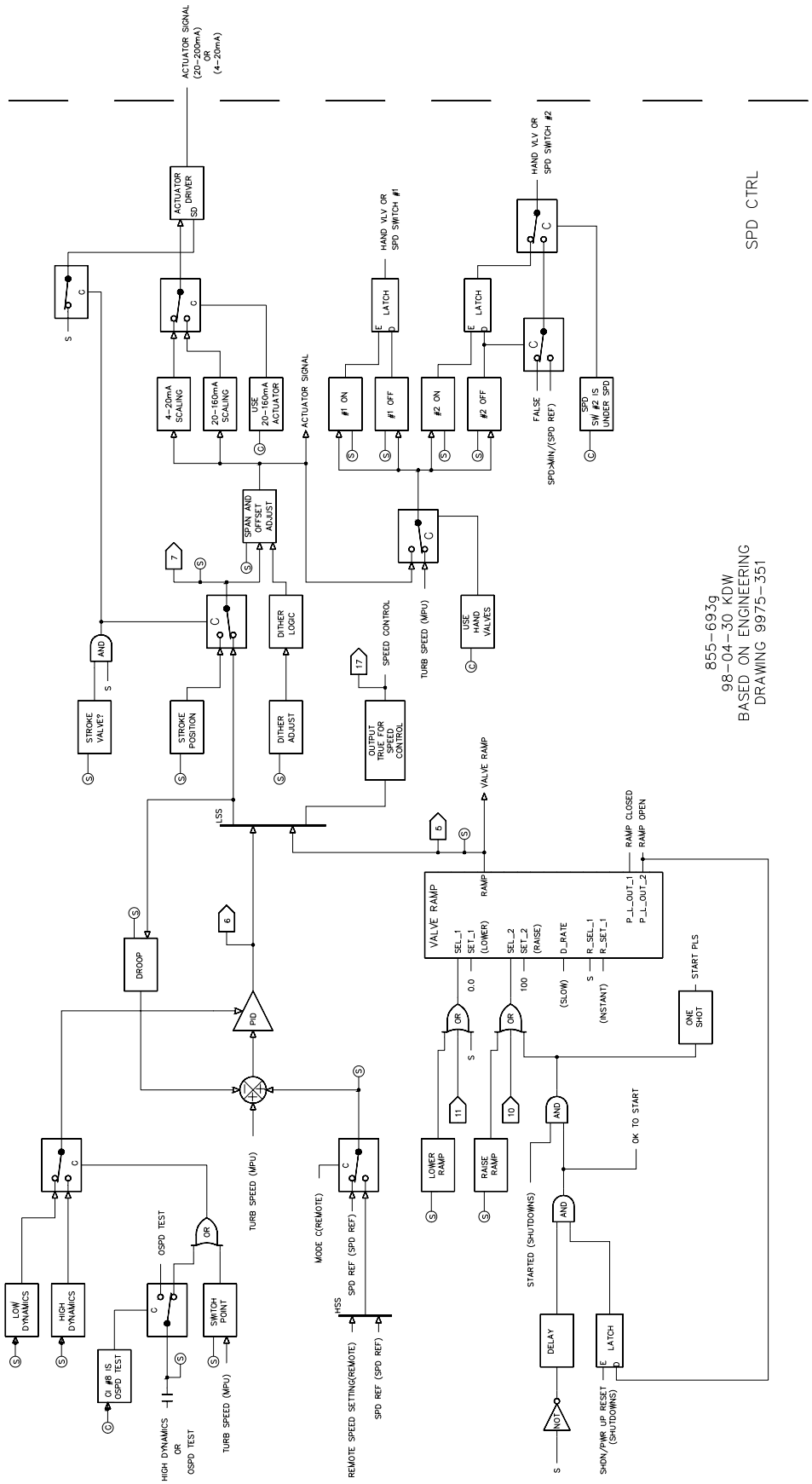

MPU
FRONT PANEL TACH READOUT
TURB SPEED
DIVIDE
HSS
HZ TO RPM RATIO
GEAR RATIO
OF TEETH
MPU FAIL OVERRIDE
OR
USE TIMER
AND
NOT
TIMER
MAX START TIME
STARTED (SHUTDOWNS)
SHDN (SHUTDOWNS)
BLINK LOGIC
TRIP CODE
1 – EXT TRIP
2 – NO SPEED
3 – OVER SPEED
4 – FRONT PANEL
5 – MODBUS TRIP
MPU NO. 1 FAILED
MPU #1 OK
BOTH MPU FAILED
ANY MPU FAILED
MPU #2 OK
MPU NO. 2 FAILED
LOSS OF MPU NO. 1 COMPARATOR LATCH
LOSS OF MPU NO. 2 COMPARATOR LATCH
RST LATCH
DISABLE
MPU #1 MAX HERTZ
MAX MPU (ROLLOVER) SETTING
MIN MPU (FAILURE) SETTING
MPU #2 MAX HERTZ
SLOWDOWN OVERRIDE DELAY
USE SLOW ROLLDOWN OVERRIDE
SHDN PWR UP RESET (SHUTDOWNS)
COMPARATOR
(1 > 2 = TRUE)
(AUTO-OVRD SPEED)
(OVRD-OFF SPEED)
TURB SPEED (MPU)
F/D
MPU NO.1
MPU NO.2
855-693b
98-04-30 KDW
BASED ON ENGINEERING
DRAWING 9975-351

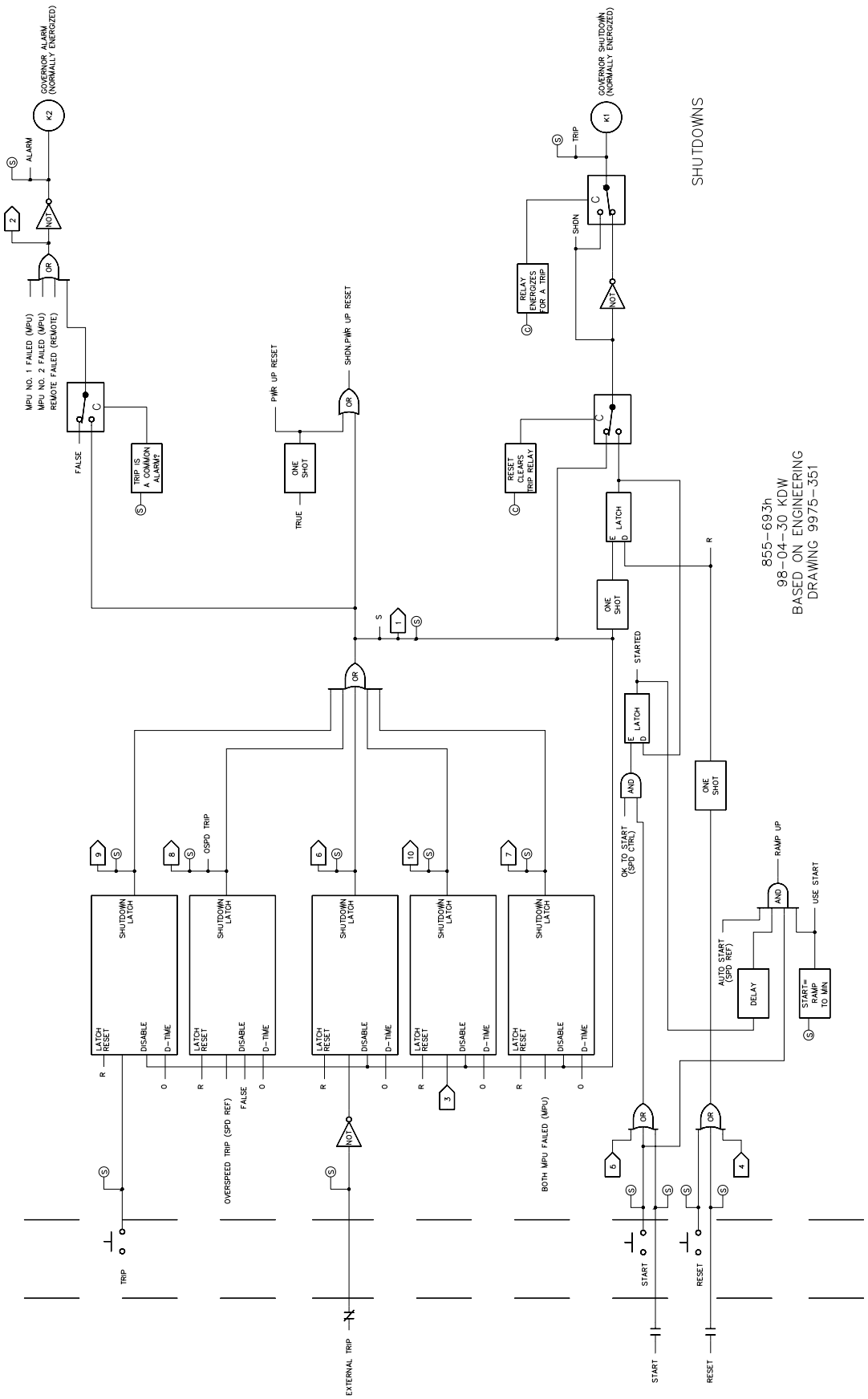

REMOTE
855-693c
98-04-30 KDW
BASED ON ENGINEERING
DRAWING 9975-351
NOT MATCHED RATE
SELECT REMOTE SPEED
REMOTE STATUS
REMOTE SPEED SETTING
LATCH
ONE SHOT
SHDN/PWR UP RESET (SHUTDOWNS)
AT REMOTE (SPD REF)
NOT ENABLED
USE HSS (REMOTE)
RMT HI (SPD CTRL)
REMOTE OK (REMOTE)
TRUE
BLINK SLOW
BLINK FAST
REMOTE SETPT
RAMP
SEL_1
SET_1
D_RATE
R_SEL_1
R_SET_1
R_SEL_2
R_SET_2
P_LIM_2
SEL_2
SET_2
(SLOW)
SHDN/PWR UP (SHUTDOWNS)
(INSTANT)
(FAST)
TRUE
MAX GOV
MIN GOV
MAX GOV SPEED
MIN GOV SPEED
SPD > MIN GOV (IDLE/MIN GOV)
USE REMOTE
USE HSS
SPD<MIN GOV (IDLE/MIN)
NOT ENABLED (REMOTE)
REMOTE FAILED
REMOTE OK
LAG
RANGE LIMITER
IDLE SELECT (IDLE/MIN)
REF > RAISE (SPD REF)
OSPD TEST (SPD REF)
FAILED SIGNAL DETECTOR
RST
OVRD
MANUAL ONLY
LINK FAILED
SCALING
ENABLE
DISABLE
SHDN/PWR UP RESET (SHUTDOWNS)
USE HSS?
USE MANUAL ONLY?
USE REMOTE?
USE MODBUS ANALOG?
I/D
REMOTE SPEED ENABLE/DISABLE (CLOSE FOR ENABLE)
REMOTE SPEED SETTING (4-20MA)

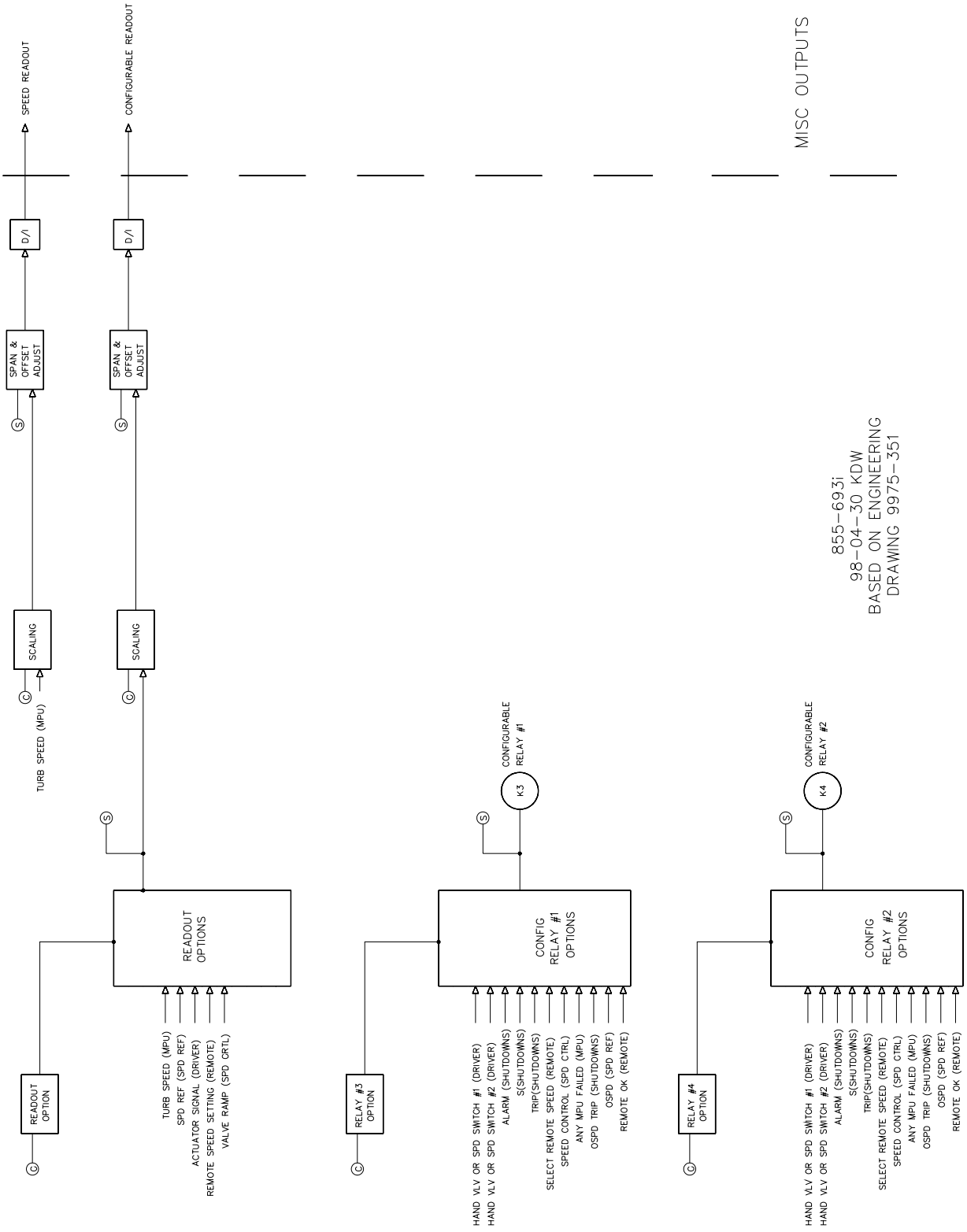

CRIT SPD LWR
CRIT SPD FAST
CRIT SPD RSE
OR
E LATCH D
E LATCH D
OR
OR
REF UP (SPD REF)
REF DN (SPD REF)
ONE SHOT
ONE SHOT
AND
NOT
AND
REF DN (SPD REF)
REF UP (SPD REF)
S
AND
USE
S
1 HIGH LIMIT COMPARE 2 1>2=TRUE
LOW LIMIT COMPARE 1>2=TRUE
HIGH LIMIT
LOW LIMIT
S
SPD REF (SPD REF)
S
CRIT SPD
855-693d
98-04-30-KDW
BASED ON ENGINEERING
DRAWING 9975-351


IDLE/MIN
14
MIN SELECT
15
IDLE SELECT
LATCH
ONE SHOT
AND
OR
NOT
SPD < MIN GOV
SPD > MIN GOV
SPD < MIN GOV
SPD < MIN GOV TARGET
TURB SPEED (MPU)
SPD R/L (SPD REF)
AT MIN GOV (SPD REF)
USE RAMP TO IDLE
AT IDLE (SPD REF)
USE START (SHUTDOWNS)
AT IDLE (SPD REF)
USE IDLE/ MIN GOV
STARTED (SHUTDOWNS)
RAMP UP (SHUTDOWNS)
6
MIN GOV
7
IDLE
IDLE/MIN GOV (CLOSE FOR MIN GOV)
855-693e
98-04-30 KDW
BASED ON ENGINEERING
DRAWING 9975-351


SPD REF
SPEED REFERENCE RAMP
RAMP
SPD REF
AT ZERO
AT IDLE
AT LOWER
AT MIN
AT RAISE
AT REMOTE
AT OSPD LIMIT
REF UP
REF DN
W_UP
W_DN
SEL_3
SET_3
SEL_1
SET_1
SEL_4
SET_4
SEL_5
SET_5
SEL_6
SET_6
SEL_7
SET_7
SEL_2
SET_2
SEL_8
SET_8
D_RATE
R_SEL_1
R_SET_1
R_SEL_2
R_SET_2
R_SEL_3
R_SET_3
R_SEL_4
R_SET_4
R_SEL_5
R_SET_5
R_SEL_6
R_SET_6
R_SEL_7
R_SET_7
(IDLE)
(0.0)
(SHUTDOWNS)
(MIN)
(REMOTE)
(SLOW RATE)
(INSTANT)
(CRIT RATE)
START (SPD REF)
(START RATE)
(FAST)
(REMOTE NOT MATCHED)
(REMOTE RATE)
(IDLE/MIN RATE)
IDLE SELECT (IDLE/MIN GOV)
CRIT SPD LWR (CRIT SPD)
SHDN/PWR UP RESET (SHUTDOWNS)
MIN GOV (REMOTE)
MIN SELECT (IDLE/MIN GOV)
CRIT SPD RSE (CRIT SPD)
MAX GOV (REMOTE)
SELECT REMOTE SPEED (REMOTE)
REMOTE SPEED SETTING (REMOTE)
RANGE LIMITED
TURBINE SPEED (MPU)
OSPD LMT (SPD REF)
SHDN/PWR UP RESET (SHUTDOWNS)
CRIT SPD FAST (CRIT SPD)
NOT MATCHED RATE (REMOTE)
SELECT REMOTE SPEED (REMOTE)
MIN SELECT (IDLE/MIN GOV)
IDLE SELECT (IDLE/MIN GOV)
AUTO START
NOT
MANUAL START?
START
ONE SHOT
OR
LATCH
E
D
S
SPD > MIN
SPD > MIN GOV (IDLE/MIN GOV)
IDLE SELECT (IDLE/MIN GOV)
START PLS (SPD CTRL)
SHDN/PWR UP RESET (SHUTDOWNS)
AT IDLE (SPD REF)
AT LOWER (SPD REF)
LOWER
AND
SPD RAISE
SPD LOWER
C
NOR
SELECT REMOTE SPEED (REMOTE)
RAISE
LOWER SPEED
RAISE SPEED
REF > RAISE
REF > RAISE LIMIT
NOT
SHDN/PWR UP RESET (SHUTDOWNS)
AT RAISE (SPD REF)
16
OSPD TEST (SPD CTRL)
OSPD TEST
TURBINE SPEED (MPU)
(EXTERNAL TRIP SPEED)
1 OVERSPEED TRIP PT, 1 > 2=TRUE
2
BLINK SLOW
BLINK FAST
OVERSPEED TRIP
OSPD TEST
OSPD
TURBINE SPEED (MPU)
(TRIP SPEED)
LSS FAILED
OSPD TEST LIMIT
OSPD LMT
MAX GOV (REMOTE)
USE SNAP-BACK
MANUAL ONLY (REMOTE)
SPD R/L
DELAY FOR FAST RATE
FAST RATE DELAY
855-693f
98-04-30 KDW
BASED ON ENGINEERING
DRAWING 9975-351


SPD CTRL
855-693g
98-04-30 KDW
BASED ON ENGINEERING
DRAWING 9975-351
ACTUATOR SIGNAL (20-200mA) OR (4-20mA)
ACTUATOR SD DRIVER
HAND VLV OR SPD SWITCH #1
HAND VLV OR SPD SWITCH #2
LATCH
4-20mA SCALING
20-160mA SCALING
USE 20-160mA ACTUATOR
#1 ON
#1 OFF
#2 ON
#2 OFF
FALSE
SPD SW #2 IS UNDER SPD
SPD>MIN/(SPD REF)
SPAN AND OFFSET ADJUST
DITHER LOGIC
USE HAND VALVES
TURB SPEED (MPU)
SPEED CONTROL
AND
STROKE VALVE?
STROKE POSITION
DITHER ADJUST
OUTPUT TRUE FOR SPEED CONTROL
LSS
VALVE RAMP
RAMP CLOSED
RAMP OPEN
DROOP
PID
VALVE RAMP
SEL_1
SET_1
(LOWER)
SEL_2
SET_2
(RAISE)
D_RATE
R_SEL_1
R_SET_1
P_L_OUT_1
P_L_OUT_2
RAMP
0.0
100
(SLOW)
(INSTANT)
START PLS
ONE SHOT
OR
LOWER RAMP
RAISE RAMP
OK TO START
STARTED (SHUTDOWNS)
DELAY
NOT
SHDN/PWR UP RESET (SHUTDOWNS)
LOW DYNAMICS
HIGH DYNAMICS
OSPD TEST
SWITCH POINT
OR #6 IS OSPD TEST
HIGH DYNAMICS OR OSPD TEST
TURB SPEED (MPU)
MODE C(REMOTE)
SPD REF (SPD REF)
HSS
REMOTE SPEED SETTING(REMOTE)
SPD REF (SPD REF)


SHUTDOWNS
855-693h
98-04-30 KDW
BASED ON ENGINEERING
DRAWING 9975-351
GOVERNOR ALARM
(NORMALLY ENERGIZED)
GOVERNOR SHUTDOWN
(NORMALLY ENERGIZED)
ALARM
TRIP
SHDN
MPU NO. 1 FAILED (MPU)
MPU NO. 2 FAILED (MPU)
REMOTE FAILED (REMOTE)
FALSE
TRIP IS A COMMON ALARM?
PWR UP RESET
SHDN,PWR UP RESET
TRUE
ONE SHOT
RELAY ENERGIZES FOR A TRIP
RESET CLEARS TRIP RELAY
E LATCH D
STARTED
OK TO START (SPD CTRL)
AND
RAMP UP
AUTO START (SPD REF)
DELAY
USE START
START= RAMP TO MIN
SHUTDOWN LATCH
LATCH RESET
DISABLE
D-TIME
OVERSPEED TRIP (SPD REF)
BOTH MPU FAILED (MPU)
EXTERNAL TRIP
START
RESET
OR
NOT


MISC OUTPUTS
SPEED READOUT
CONFIGURABLE READOUT
D/A
D/A
SPAN & OFFSET ADJUST
SPAN & OFFSET ADJUST
SCALING
SCALING
TURB SPEED (MPU)
READOUT OPTION
READOUT OPTIONS
TURB SPEED (MPU)
SPD REF (SPD REF)
ACTUATOR SIGNAL (DRIVER)
REMOTE SPEED SETTING (REMOTE)
VALVE RAMP (SPD CRTL)
CONFIGURABLE RELAY #1
K3
RELAY #3 OPTION
CONFIG RELAY #1 OPTIONS
HAND VLV OR SPD SWITCH #1 (DRIVER)
HAND VLV OR SPD SWITCH #2 (DRIVER)
ALARM (SHUTDOWNS)
S(SHUTDOWNS)
TRIP(SHUTDOWNS)
SELECT REMOTE SPEED (REMOTE)
SPEED CONTROL (SPD CTRL)
ANY MPU FAILED (MPU)
OSPD TRIP (SHUTDOWNS)
OSPD (SPD REF)
REMOTE Ok (REMOTE)
CONFIGURABLE RELAY #2
K4
RELAY #4 OPTION
CONFIG RELAY #2 OPTIONS
HAND VLV OR SPD SWITCH #1 (DRIVER)
HAND VLV OR SPD SWITCH #2 (DRIVER)
ALARM (SHUTDOWNS)
S(SHUTDOWNS)
TRIP(SHUTDOWNS)
SELECT REMOTE SPEED (REMOTE)
SPEED CONTROL (SPD CTRL)
ANY MPU FAILED (MPU)
OSPD TRIP (SHUTDOWNS)
OSPD (SPD REF)
REMOTE Ok (REMOTE)
855-693i
98-04-30 KDW
BASED ON ENGINEERING
DRAWING 9975-351

Chapter 11.
Modbus Communications

Introduction

The Peak® 150 control with Modbus option can communicate to one device via RS-232, RS-422 or RS-485 using an ASCII or RTU MODBUS transmission protocol. The pertinent serialport communications parameters are all adjustable in the service mode through the hand-held programmer of the Peak 150 control. The loss of the communications link is annunciated as a common alarm indication if the Modbus port is configured for use.

The transmission mode (ASCII or RTU), hardware configuration (RS-232, RS-422, or RS-485), and network address (if multidropping) are all defined in the Configure mode of the Peak 150 control (see Chapter 9). In addition, the baud rate, stop bits, parity, and hardware configuration are all set up in the Service mode (see Chapter 8).

All pertinent control parameters are programmed to be displayed on a CRT or plant DCS computer. In addition, all relevant control functions (i.e., raise/lower or enable) can be executed through this link. The functional block diagram (see Chapter 10) shows all Modbus parameters and their address. See Figure 11-1 for an example showing the Modbus communications connections. The example shows that boolean write registers 1 and 2 are for raising and lowering the speed set point, respectively. It also shows that analog read register 2 contains the speed set point value.

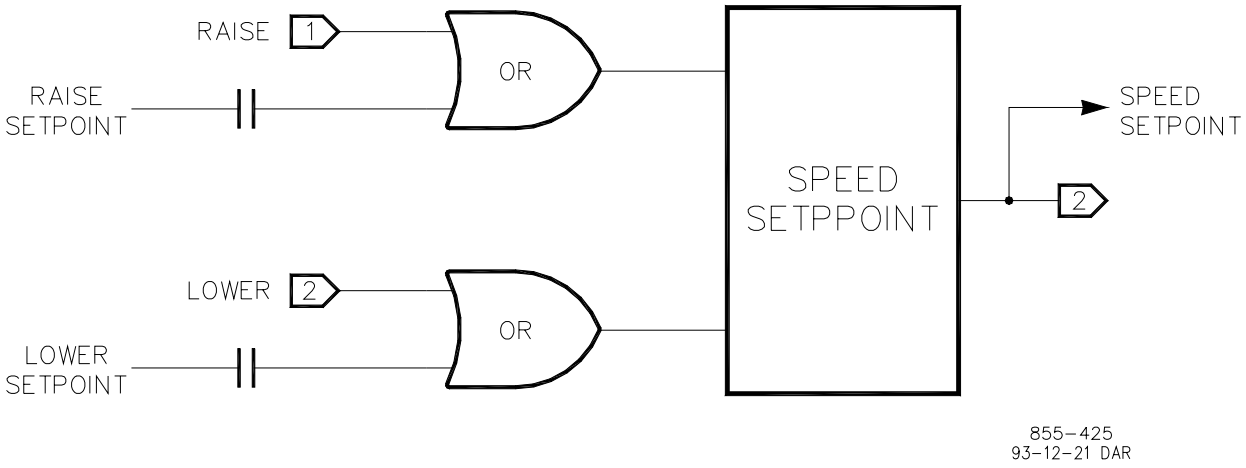


Figure 11-1. Modbus Communication Connections

Modbus Wiring

The Peak 150 control with Modbus option can communicate to one device via RS- 232, RS-422 or RS-485 using an ASCII or RTU MODBUS transmission protocol. The communications port is brought out to terminal blocks for wiring. Each communications mode is wired to different terminals. The following section identifies the terminal landings required for each mode.

RS-232 Wiring

An RS-232 link is limited to a distance of 50 feet. The Peak 150 control utilizes terminal blocks 22, 25, 26, and 27 for RS-232 connections. Figure 11-2 shows typical RS-232 communications connection. The transmit data (TXD), receive data (RXD), and signal ground (SIG GND) must be properly connected as shown. In addition, the shield (SHLD) should be connected at one end only. The data terminal ready (DTR) signal is a constant +12 Volt (+9 V typical) RS-232 signal that is usually left unconnected but is available if required.

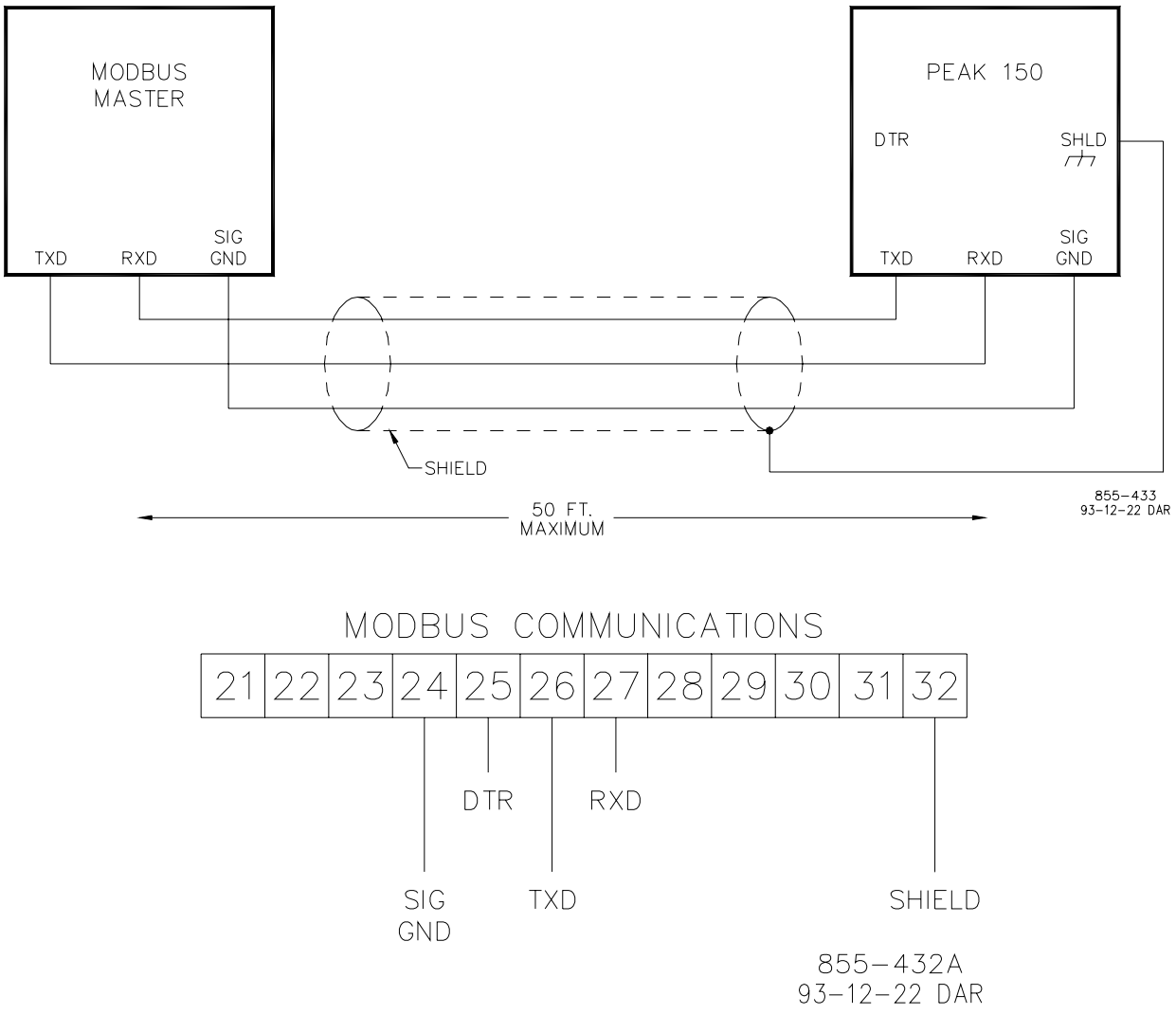


Figure 11-2. Typical RS-232 Communications

RS-422 Wiring

An advantage of RS-422 is that it uses a differential voltage and can accommodate much longer transmission distances. An RS-422 link can communicate up to a distance of 4000 feet. The Peak 150 control utilizes terminal blocks 22, 23, 24, 28, 29, 30, 31, and 32 for RS-422 connections. Figure 11-3 shows a typical RS- 422 communications connection. The transmit data (422T+ and 422T–), receive data (422R+ and 422R–), and signal ground (SIG GND) must be properly connected as shown. In addition, the shield (SHLD) should be connected at one end only. The last unit in the Modbus network chain should have it's receiver terminated with a resistor. The Peak 150 control has termination resistors built-in and available at the terminal block (TERM RES + and TERM RES –). The RS- 422 receiver should also be properly terminated at the Modbus master. Use the alternate wiring if no signal ground is available at the Modbus master.

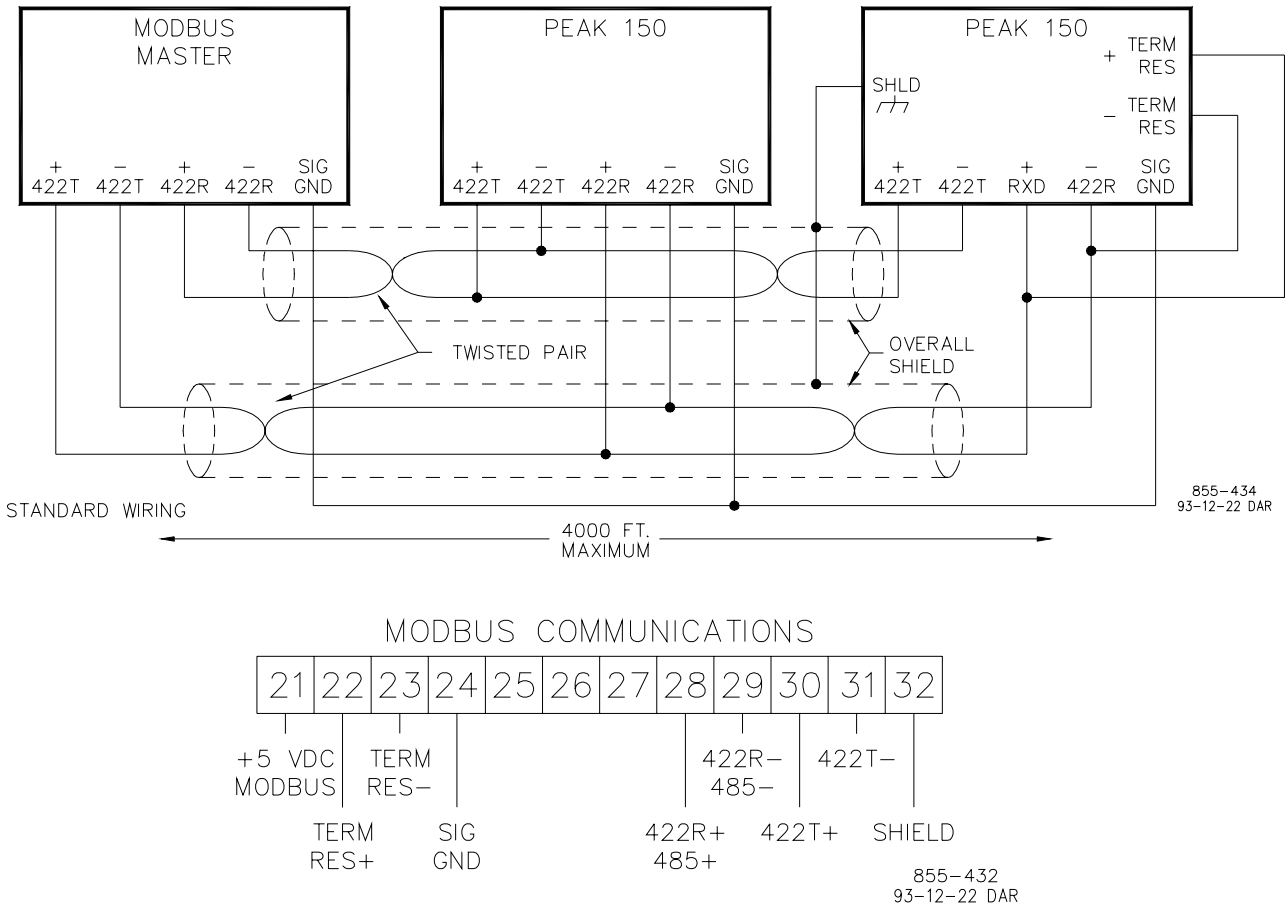


Figure 11-3. Typical RS-422 communications

RS-485 Wiring

RS-485 can also accommodate transmission distances of up to a distance of 4000 feet. The Peak 150 control utilizes terminal blocks 22, 23, 24, 28, 29, and 32 for RS-485 connections. Figure 11-4 shows a typical RS-485 communications connection. The data lines (422R+/485+ and 422R–/485–), and signal ground (SIG GND) must be properly connected as shown. In addition, the shield (SHLD) should be connected at one end only. The last unit in the Modbus network chain should have it's receiver terminated with a resistor. The Peak 150 control has termination resistors built-in and available at the terminal block (TERM RES + and TERM RES -). The RS-485 cable should also be properly terminated at the Modbus master. Use the alternate wiring if no signal ground is available at the Modbus master.

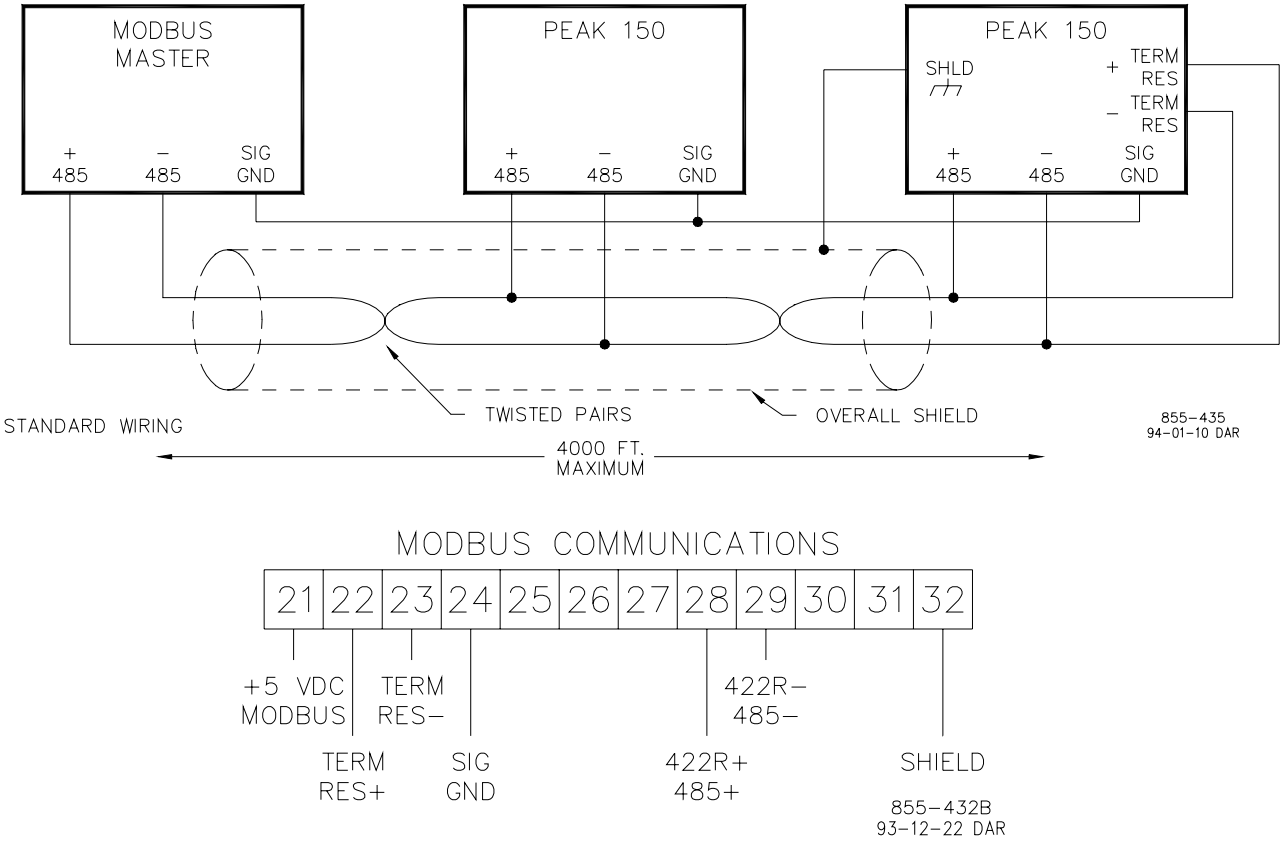


Figure 11-4. Typical RS-485 Communications

Basic Modbus Overview

The Peak 150 control utilizes Modicon Inc.'s Modbus® protocol (see Figure 11-5 for Basic Modbus Overview). There are two transmission modes available for use with the Modbus protocol, ASCII and RTU (see Figure11-6). The Peak 150 control can only act as a slave unit, it responds only after being asked for a set of parameters. Typically the Peak 150 control will communicate with a Modbus Master device with a separate link to each device (i.e., point to point wiring). However, if RS-422 or RS-485 is used, several Peak 150 controls can be connected to one Master device on a single link (i.e., multidropping). The data is passed between the Master and the Peak 150 control in the form of message frames (see figure 11-7). The default slave address for the Peak 150 control is 01, however, this address is adjustable in the configure mode (see Port Configuration in Chapter 9). On any single link, each slave address must be unique.

Modbus Points Of Interest

- Master, Slave network protocol.
- One master and up to 32 slaves on a common line.
- Only the master initiates a transaction.
- A transaction comprises a single query and a single response.
- Data is passed between master and slave in the form of message frames.
- Use 9600 baud or slower when using multidropping.

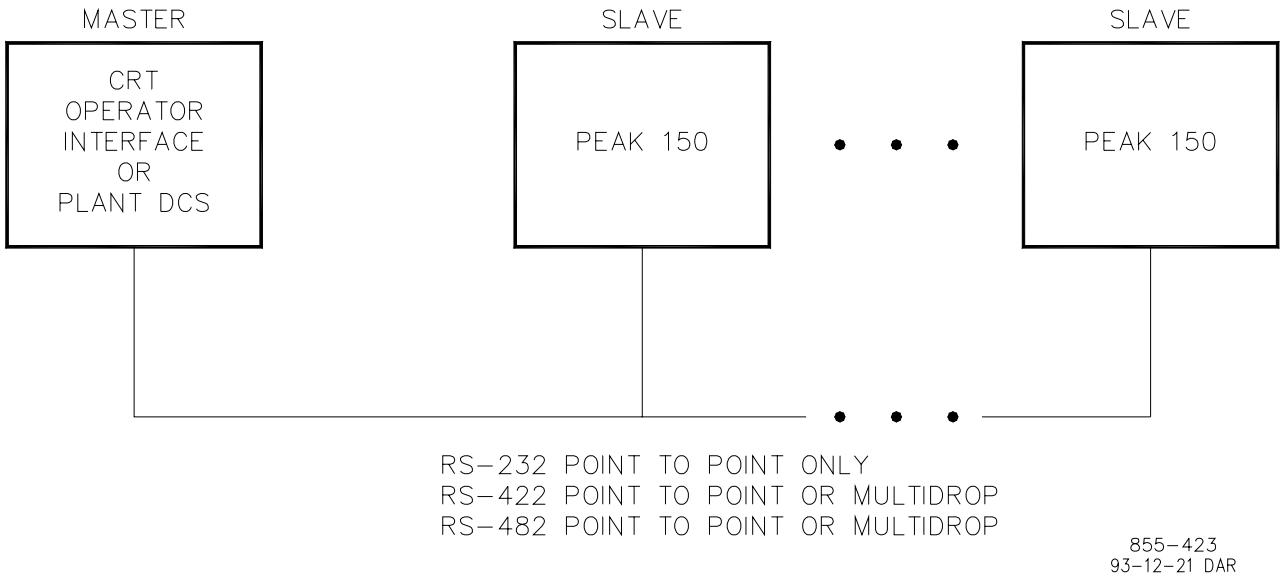


Figure 11-5. Basic Modbus Overview

Modes of Transmission

- ASCII and RTU are the two modes allowed.
- Mixing of modes is not allowed.
- ASCII mode requires twice as many characters as RTU mode to transmit the same amount of data.
- RTU mode has more elaborate error checking.

Characteristics of ASCII and RTU modes.

Characteristic	ASCII	RTU
Coding System	Hexadecimal	8 Bit Binary
Bits per Character	7	8
Parity	Even, Odd, None	Even, Odd, None
Stop Bits	1 or 2	1 or 2
Transmitted Data Per Character	4 bits	8 Bits
Error Checking	LRC (Longitude Redundancy Check)	CRC (Cyclical Redundancy Check)

Figure 11-6. Modbus Transmission Modes

Frame Definition

- Each slave must have a unique address.
- The function code tells the addressed slave what function to perform.
- The high order bit of the function code is used to indicate an exception response.
- The data field contains information needed by the slave or collected by a slave to perform a specific function.
- The error checking assures that the slave or master does not react to messages that have changed during transmission.

ASCII and RTU frame definition.

Function	ASCII	RTU
Beginning of Frame	:	3 Characters Dead Time
Slave Address	2 Characters, 8 Bits	1 Character, 8 Bits
Function code	2 Characters, 8 Bits	1 Character, 8 Bits
Data	4 Bits Data per Character	8 Bits Data per Character
Error Check Code	2 Characters, 8 Bits	2 Characters, 16 Bits
End of Frame	CR LF	3 Characters Dead Time

Figure 11-7. Modbus Frame Definition

The data is passed between the Master and the Peak 150 control in the form of message frames. The function code portion of the frame tells the addressed slave what function to perform (see Figure 11-8).

Function Code Definition

Code	Description
1	Read Digital Outputs
2	Read Digital Inputs
3	Read Analog Outputs
4	Read Analog Inputs
5	Write Single Digital Output
6	Write Single Analog Output
7	Loopback Test - Returns the Query Message
8	Write Digital Outputs
9	Write analog Outputs

Figure 11-8. Modbus Function Codes

Figure 11-9 shows typical Modbus frames for the various function codes. If a slave detects an error in a message, it will not act on or respond to that message. For any requested data that is undefined, the slave will respond with a value of zero. The slave will respond with an exception response if it detects illegal data in a message. The following table lists the exception errors displayed by the Peak 150 control. If the Peak 150 control has an exception error, it will be annunciated under the Port Adjustments heading in the Service mode (see Chapter 8).

Code	Name	Meaning
1	Illegal Function	The message function is not an allowable action
2	Illegal Data Address	The message start address is not an allowable address
9	Checksum Error	The received message had an incorrect error check code
10	Garbled Message	The received message could not be decoded

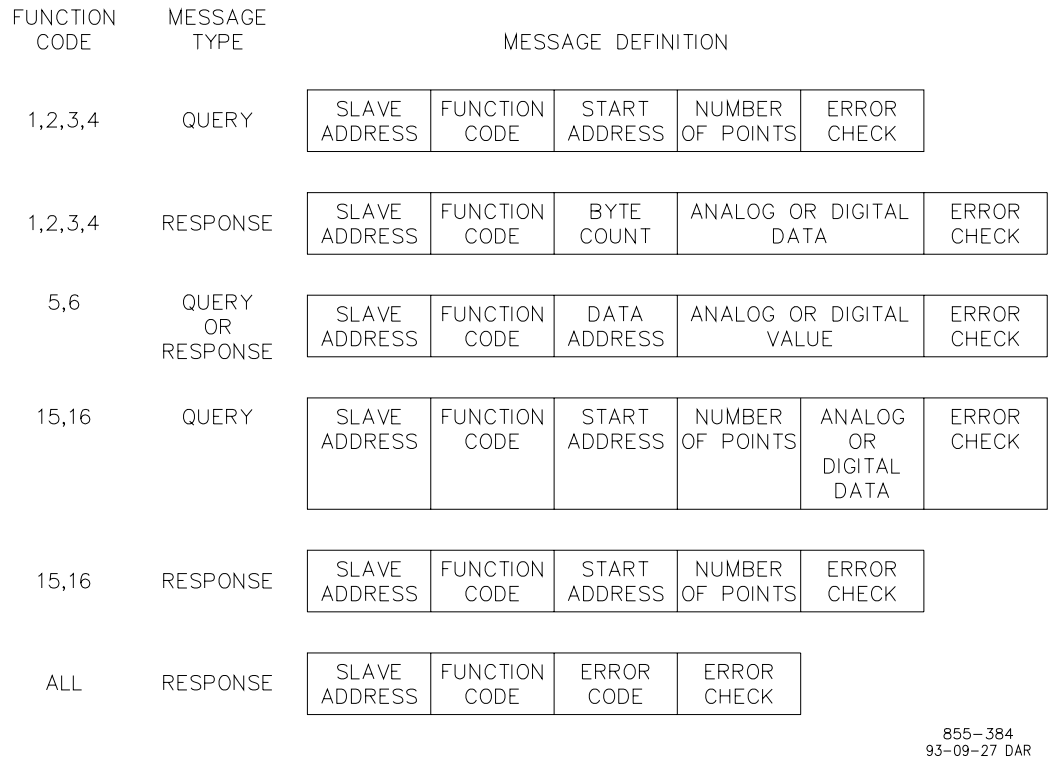


Figure 11-9. Modbus Messages

Port Adjustments

Following is listed the parameters that can be set in the SERVICE Mode under the PORT ADJUSTMENTS heading (see Chapter 8).

- Hardware Configuration: This adjustment sets the physical link to be used by the Modbus Communication. Following is a list of the codes and the corresponding hardware configuration associated with them.
  1 = RS-232 Communication
  2 = RS-422 Communication
  3 = RS-485 Communication
- Baud Rate: This adjustment sets the baud rate or speed of communication. The following list indicates the codes and the corresponding baud rates.
  1 = 1200 Baud
  2 = 1800 Baud
  3 = 2400 Baud
  4 = 4800 Baud
  5 = 9600 Baud
  6 = 19200 Baud

NOTE
To ensure the integrity and reliability of the data being transmitted, Woodward recommends that the baud rate used for the 8200-XXX series Peak 150 controls be at or below 9600 baud.

- Stop Bits: This adjustment sets the number of stop bits to be included in the data being transmitted. The following list shows the code and the corresponding number of stop bits to be used.
  1 = 1 stop bits
  2 = 1.5 stop bits
  3 = 2 stop bits
- Parity: This adjustment selects the parity to be used during transmission. The following list shows the code and the corresponding parity to be used.
  1 = Off
  2 = Odd
  3 = Even
- Link Error: This will indicate TRUE if the Modbus communication link has been lost.
- Exception Error: This will indicate TRUE if an exception error is found in the transmitted data.
- Error Number: This indicates the cause of the exception error. The following list shows the error codes and their meanings.
  1 = Illegal Function: The message function is not an allowable action.
  2 = Illegal Data Address: The message start address is not an allowable address.
  9 = Checksum Error: The received message had an incorrect error check code.
  10 = Garbled Message: The received message could not be decoded.

- Error Percent: This indicates the amount of time that an error has been detected in the data being transmitted (displayed as a percent).

Modbus Addresses

The Modbus communication port has address locations for the analog and boolean reads and writes. The boolean reads and writes are also referred to as input and holding coils. The analog reads are also referred to as input registers. Following is a list of these register values along with a brief description of the parameter.

Boolean Writes (holding coils)—Holding coils are logical signals that are both readable from and writable to the Peak 150 control. The holding coils available are listed below. A logical true denoted by the value 1 will cause the command listed in the description to be executed. For example, if a 1 is written to address 0:0001, the manual speed set point will increase until a 0 is written to address 0:0001. The Peak 150 control supports function codes 1, 5, and 15. These correspond to reading selected holding coils, writing to a single holding coil, and writing to multiple holding coils, respectively.

Address	Description
0:0001	Raise Speed
0:0002	Lower Speed
0:0003	Trip
0:0004	Reset
0:0005	Start
0:0006	Minimum Governor Select
0:0007	Idle Select
0:0008	Enable Remote
0:0009	Disable Remote
0:0010	Raise Valve Ramp
0:0011	Lower Valve Ramp

NOTE

The functional block diagram (Chapter 10) shows all Modbus communications inputs and outputs to the Peak 150 control's software. It shows both the functional location of the parameter as well as the Modbus address. This information is shown with the symbol xx where xx is the Modbus address.

Boolean Reads (input coils)—Input coils are logical signals that are readable from but not writable to the Peak 150 control. The input coils available are listed below. The input coil will have the value 1 if the statement in the description column is true and a 0 if false. The "1:" term in the address identifies an input coil. The Peak 150 control supports MODBUS function code 2, which involves reading selected input coils.

Address	Description
1:0001	Trip Status
1:0002	Alarm Status
1:0003	MPU #1 Failed
1:0004	MPU #2 Failed
1:0005	Remote Failed
1:0006	External Trip
1:0007	No Speed Trip
1:0008	Overspeed Trip
1:0009	Front Panel Trip
1:0010	Modbus Trip
1:0011	Remote Selected
1:0012	Remote Enabled
1:0013	HSS/LSS Remote Ctrl
1:0014	Ramping To Minimum Governor
1:0015	Ramping To Idle
1:0016	Overspeed Test Enabled
1:0017	Speed Control
1:0018	MPU Override On

Analog Reads (input registers)—Input registers are analog values that are readable from but not writable to the Peak 150 control. The input registers available are listed below. The value of the input registers are stored internal to the control as floating point numbers representing engineering units (i.e., rpm). The values that are transmitted are integer values ranging from -32767 to +32767. The Peak 150 control supports MODBUS function code 4, which involves reading selected input registers.

Address	Description
3:0001	Actual Speed
3:0002	Speed Set Point
3:0003	Remote Set Point
3:0004	Remote Input
3:0005	Valve Ramp Position
3:0006	Speed Demand
3:0007	Valve Position Demanded

Analog Writes (holding registers)—Holding registers are analog values that are readable from and writable to the Peak 150 control. The holding registers available are listed below. The values transmitted are integer values ranging from -32767 to + 32767. The Peak 150 control supports Modbus function codes 3, 6, and 16. These correspond to read analog output, write single analog output, and write analog outputs respectively.

Address	Description
4:0001	Remote Setting

Additional Information

Detailed information on the Modbus protocol is presented in "Reference Guide PI-MBUS-300" published by AEC Corp./Modicon Inc., formerly Gould Inc. To implement your own source code, you must register with Modicon. Registration includes purchasing document PI-MBUS-300 and signing a non-disclosure agreement. You can register to use Modbus at your nearest Modicon field office. To find the office nearest you, contact Modicon Technical Support at 1-800-468- 5342.

Chapter 12. Troubleshooting

General

Most problems you will encounter are covered in the manual. Use the index to locate the sections of the manual that may describe your problem. This troubleshooting section contains a description of the diagnostic programs as well as a few troubleshooting guidelines that our field service technicians and engineers have suggested.

Diagnostics

When the control is powered on or when it is rebooting after being configured, the software performs several hardware diagnostic tests. If an error is found, it is annunciated through the tachometer display on the front panel. The tachometer will display the string "Err" followed by an error number. If any of these diagnostic errors occur the control must be returned to the factory for repair.

The following is a list of the diagnostic tests and the corresponding error numbers that are displayed if an error occurs.

RAM Test Failure	"Err0"
Analog I/O Timer #1 Failure	"Err1"
Analog I/O Timer #2 Failure	"Err2"
I/O Lockout Failure	"Err3"
-12 V Power Supply Failure	"Err4"
+12 V Power Supply Failure	"Err5"
+12 VP Power Supply Failure	"Err6"
+4.5 V Power Supply Failure	"Err7"

Troubleshooting

When the control is powered on the microprocessor will begin executing the software and will turn on the CPU OK LED on the front panel. This LED remains on as long as the microprocessor is running. This LED is controlled in hardware by a watchdog timer circuit and under normal operating conditions, should never turn off. If for any reason, the microprocessor stops executing or if the program is not running correctly, the watchdog timer will time out and the CPU OK LED will turn off. If this happens the I/O Lockout will be activated, which will turn off all discrete outputs and all analog outputs. The only way to restart the control is to turn off the power and then turn the power back on.

The software in this control is user configurable. Before running the control, make sure that the software is configured properly for your application. See Chapter 7, Programming.

Troubleshooting Chart

Symptom:
- CPU OK LED is off, EMER TRIP arrow light is off, and tachometer display is blank.

Possible Causes:
- Ribbon cable from operator control panel module to the main control module is unplugged.
- Power supply input wiring is incorrect.
- Power supply input voltage is not present.
- Power supply fuse is blown.
- +5 Volt power supply is bad.

Solutions:
- Check the possible causes listed above. The +5 V power supply voltage can be measured at the test points shown in Figure 4-9. If the +5 V is incorrect, replace the power supply module.

Symptom:
- CPU OK LED is off and EMER TRIP arrow light is on.

Possible Causes:
- Application PROMs are missing or installed incorrectly.
- +5 Volt power supply is bad.
- The microprocessor has stopped because of a hardware failure.

Solutions:
- Check the application PROMs (U11 and U12) for proper installation. They are located underneath the power supply module.
- Measure the +5 V power supply at the terminals shown in Figure 4-9. If the +5 V is out of tolerance replace the power supply module.
- Cycle the input power off for several seconds and then back on. If the CPU OK LED does not come on after approximately ten seconds, the hardware has failed and must be returned to the factory.

Symptom:
- Discrete outputs are not operating correctly.

Possible Causes:
- Incorrect wiring.
- The CPU OK LED is off activating the I/O Lock mechanism.
- The Normally Open/Normally Closed jumper options are not properly selected.
- +21 Volt power supply is shorted or bad.
- The software is not configured properly.

Solutions:
- Remove the wiring and use an ohmmeter to check for proper contact closure. If the meter indicates the output is working properly, then there is a problem with the wiring.
- Check the CPU OK LED on the front door. If it is off, cycle the input power. This will reset the I/O Lock mechanism.
- Check the jumper options in Figure 4-9 to make sure the correct jumpers are in.

- Check the +21 V power supply voltages at the test points shown in Figure 4-9. If the +21 V power supply is shorted, the voltage measured at the test points will be low.
- Check the wiring at the (+) terminals of the analog outputs TB33, TB36, and TB39. The +21 V power supply is connected to these terminals. Remove the wiring from these terminals and check the +21 V power. If it is correct the wiring is shorting it out. If it is still incorrect replace the power supply module.
- Check the software to see what it is telling the outputs to do. To do this enter the "Service" mode on the hand-held programmer. Find the I/O Check category then check the fields listed below and see what its output is. "True" should energize the associated relay and "False" will de-energize it.

Trip Relay ON	RELAY OUTPUT #1
Alarm Relay ON	RELAY OUTPUT #2
Conf Rly #1 ON	RELAY OUTPUT #3
Conf Rly #2 ON	RELAY OUTPUT #4

Symptom:

- Discrete inputs are not operating correctly.

Possible Causes:

- Incorrect wiring.
- The external/internal power supply jumper options are not properly selected.
- The internal +21 Volt power supply is shorted or bad.
- The external power supply is bad or is wired incorrectly.

Solutions:

- Make sure that the wiring is correct. Refer to Figures 4-3 and 4-4 to see how the contacts and power supplies should be wired.
- Check that the correct jumper option is being used for the external/ internal power supply as shown in Figure 4-4.
- If the internal +21 V power supply is used, check the voltage at the test points shown in Figure 4-9. If the +21 V power supply is shorted, the voltage measured at the test points will be low. Check the wiring at the (+) terminals of the analog outputs, TB33, TB36, and TB39. The +21 V power supply is connected to these terminals. Remove the wiring from these terminals and check the +21 V power. If it is correct, the wiring is shorting it out. If it is still incorrect, replace the power supply module.
- If an external power supply is used, check it to make sure the voltage is correct. Refer to Figures 4-3 and 4-4 to see how the contacts and power supplies should be wired.
- Check the software to see what it senses at the inputs. To do this, enter the "Service" mode on the hand-held programmer. Find the I/O Check category then check the fields listed below and see what its input is. As a contact is closed, the associated variable should be "True" and when it is opened it should be "False". If this is not the case, make sure that the wiring is correct and that the correct jumper option is being used for the External/Internal power supply as shown in Figure 4-4.

DI #1	INPUT #1
DI #2	INPUT #2
DI #3	INPUT #3
DI #4	INPUT #4
DI #5	INPUT #5
DI #6	INPUT #6
DI #7	INPUT #7
DI #8	INPUT #8

Symptom:
- Analog outputs are not operating correctly.

Possible Causes:
- Incorrect wiring.
- +21 Volt power supply is shorted or bad.
- The CPU OK LED is off, activating the I/O Lock mechanism.
- The 4–20 mA/0–1 mA jumper options are not properly selected.
- +5 V power supply is bad.
- The software is not configured properly.

Solutions:
- Make sure that the wiring is correct. Refer to Figure 4-6 to see how the analog outputs should be wired.
- Check the +21 V power supply voltages at the test points shown in Figure 4-9. If the +21 V power supply is shorted, the voltage measured at the test points will be low. Check the wiring at the (+) terminals of the analog outputs, TB33, TB36, and TB39. The +21 V power supply is connected to these terminals. Remove the wiring from these terminals and check the +21 V power. If it is correct, the wiring is shorting it out. If it is still incorrect, replace the power supply module.
- Check the front door CPU OK LED. If off, cycle the input power. This will reset the I/O Lock mechanism.
- Check the jumper options (see Figure 4-9) to make sure the correct jumpers are in.
- Check the +5 V power supply voltage at the test points shown in Figure 4- 9). If it is incorrect the unit must be sent back to the factory for repair.
- Check what the software is telling the outputs to do. To do this, enter the "Service" mode on the hand-held programmer. Find the category and the fields listed below and observe its output. The output value will be in engineering units. How this value relates to current depends on how the control was configured.

Speed Values	Actual Speed	Output #1
Readout Adjustments	RO#2 Value	Output #2

Symptom:
- Actuator output is not operating correctly.

Possible Causes:
- Incorrect wiring.
- +21 Volt power supply is shorted or bad.
- The CPU OK LED is off, activating the I/O Lock.
- The 0–200 mA/0–20 mA jumper option is not properly selected.
- +5 V power supply is bad.
- The software is not configured properly.

Solutions:
- Make sure that the wiring is correct. Refer to Figure 4-6 to see how the actuator output should be wired.
- Check the +21 V power supply voltages at the test points shown in Figure 4-9. If the +21 V power supply is shorted, the voltage measured at the test points will be low. Check the wiring at the (+) terminals of the analog outputs, TB33, TB36, and TB39. The +21 V power supply is connected to these terminals. Remove the wiring from these terminals and check the +21 V power. If it is correct the wiring is shorting it out. If it is still incorrect replace the power supply module.

- Check the CPU OK LED on the front door. If it is off, cycle the input power. This will reset the I/O Lock mechanism.
- Check the jumper options (Shown in Figure 4-9) to make sure the correct jumpers are in.
- Check the +5 V power supply voltage at the test points shown in Figure 4- 9. If it is incorrect, the unit must be sent back to the factory for repair.
- Check the software to see what it is telling the output to do. To do this, enter the "Service" mode on the hand-held programmer. Find the category and field listed below and see what its output is. The output value will be in actuator position (0% - 100%). How this value relates to current depends on how the control was configured.
  Valve Valve Position (%)Actuator Output

Symptom:
- Speed sensor inputs are not operating correctly.

Possible Causes:
- Incorrect wiring.
- The magnetic pickup is not functioning properly.
- +12 V or -12 V power supply is bad.
- +4.5 V Ref, +4.5 V, +5 V, or -5 V power supply is bad.

Solutions:
- Make sure that the wiring is correct. Refer to Figure 10 to see how the speed sensor inputs should be wired.
- Check the magnetic pickup. It must be provide at least a 200 Hz, 1 V RMS signal.
- Check the +12 V and -12 V power supply voltages at the test points shown in Figure 4-9. If either is incorrect, replace the power supply module.
- Check the +4.5 V REF, +4.5 V, +5 V and -5 V power supply voltages at the test points shown in Figure 4-9. If any of them are incorrect, the unit must be sent back to the factory for repair.
- Check the software to see what it senses at the inputs. To do this, enter the "Service" mode on the hand-held programmer. Find the I/O Check category and the field listed below and see what its input is. The input value will be in Hz.
  MPU #1 SPEED SENSOR INPUT #1
  MPU #2 SPEED SENSOR INPUT #2

Symptom:
- Analog input is not operating correctly.

Possible Causes:
- Incorrect wiring.
- The 4–20 mA/1–5 V jumper option is not properly selected.
- +12 V or -12 V power supply is bad.
- +4.5 V REF, +5 V, or -5 V power supply is bad.

Solutions:
- Make sure that the wiring is correct. Refer to Figure 11 to see how the analog inputs should be wired.
- Check the jumper options (See Figure 4-9) to make sure the correct jumper is in.
- Check the +12 V and -12 V power supply voltages at the test points shown in Figure 4-9. If either is incorrect replace the power supply module.

- Check the +4.5 V REF, +5 V and -5 V power supply voltages at the test points shown in Figure 4-9. If any of them are incorrect, the unit must be sent back to the factory for repair.
- Check the software to see what it senses at the input. To do this, enter the "Service" mode on the hand-held programmer. Find the I/O Check category and the field listed below and observe its input. The input value will be 0–100, 0 represents 4 mA and 100 represents 20 mA.

  Analog Input Analog Input #1 Remote Speed Input

Symptom:

- Operator Control Panel not operating correctly.

Possible Causes:

- Ribbon cable from operator control panel module to the main control module is unplugged.

Solutions:

- Check the ribbon cable to make sure it is properly connected. If the ribbon cable is properly connected and there still seems to be a problem, check the hardware with the hand-held programmer. To check the operator control panel switches, enter the "Service" mode on the hand-held programmer. Find the I/O Check category and the field listed below and see what its input is. The input value should be "True" when the associated switch is pressed, and should be "False" when the switch is released.

Trip P/B	EMER TRIP
Ospd Test P/B	OVERSPEED TEST
Raise P/B	RAISE
Lower P/B	LOWER
Start P/B	START
Reset P/B	ALARM RESET

- To check the operator control panel LEDs enter the "Service" mode on the hand-held terminal. Find the I/O Check category and field listed below and see what its output is. The LED should be on when the associated output value is "True" and off when the output value is "False". The only exception to this is if the TRIPPED LED jumper option is set for trip relay de-energized for shutdown. (See Figure 4-9). If this is the case then the TRIPPED LED will be on when the output is "False" and off when the output is "True".

Tripped LED	Tripped
MPU #1 OK LED	MPU #1 OK
MPU #2 OK LED	MPU #2 OK
Ospd Enable LED	Overspeed Test Enabled
RMT SPD LED	Rmt Spd Enabled

NOTE

The CPU OK LED should always be on. If it is not, see the "CPU OK LED is off": Symptom above.

Symptom:

- The TRIPPED LED is on for normal operation and off when the turbine is tripped or is always off.

Cause:

- The trip relay energized/de-energized for shutdown jumper is in the wrong position or is not installed.

Solution:

- Install the jumper according to Figure 4-9.

Symptom:

- The hand-held programmer is not working.

Cause:

- +12 VP power supply is bad.

Solution:

- Check the +12 VP power supply at the test points shown in Figure 4-9. If incorrect, replace the power supply module. If correct, the hand-held terminal should beep and go through a self-test when plugged in.

Debug Mode Tunables

There are 15 tunables (16 for the 4-digit model) available in the debug mode that may be used for troubleshooting. These tunables are not intended for general use. They have been factory calibrated and should only be adjusted if necessary. The block and field names are listed and a brief description of that tunable's function follows. The "black square" key is used to enter the debug mode.

COMM.CRT.RST	Clears Modbus exception errors generated by the Peak 150 control. (Range = True to False, Default = False)
COMM.CRT.INIT_MOD	Re-initializes the Peak 150 control Modbus outputs to their default values. (Range = True to False, Default = False)
COMM.CRT.TIME_OUT	The dead time allowed on the Modbus comm link before a link error is generated. (Range = 0.00 to 100.00, Default = 3.000)
IO.INPUT1.OFFSET	Offset adjustment for the remote speed analog input calibration. An input of 4 mA is equal to 0%. (Range = -20.00 to 20.00, Default = 0.000)
IO.INPUT1.GAIN	Gain adjustment for the remote speed analog input calibration. An input of 20 mA is equal to 100%. (Range = 0.00 to 2.00, Default = 1.000)
OSPD.HOLD_TRIP.DLY_TIME	Trip code sampling hold delay time. Do not adjust. (Range = 0.00 to 1.00, Default = 0.100)
OSPD.SPD_LAG.LAG_TAU	Front panel display speed filter. (Range = 0.00 to 10.00, Default = 1.000)
OSPD.XXDISPLAY.NC	Front panel display update time. Do not adjust below 0.250. (Range = 0.01 to 2.00, Default = 1.000)
REMOTE.RMT_IN.LAG_TAU	Noise filter for the remote speed analog input. (Range = 0.00 to 10.00, Default = 0.000)
SHUTDOWN.TRIP_OUT.CTRL	This tunable is in debug mode for the 4-digit version only. The 5-digit version has this function in the configure mode. See the Configure mode, Relays heading, Reset Clears Trip Relay field for a description of this function. (Default = True for the 4-digit version)
SPD_CTRL.DROOP_LAG.LAG_TAU	Speed Droop delay. Typically set to 10/I when droop is used. (Range = 0.00 to 10.00, Default = 0.200)

SPD_CTRL.I_SCALED.IN_1	Normalizing value for the Integral constant. Factory set, do not adjust. (Range = 0.01 to 100.00, Default = 0.100)
SPD_CTRL.P_SCALED.IN_1	Normalizing value for the Proportional constant. Factory set, do not adjust. (Range = 1.00 to 100.00, Default = 100.000)
SPD_CTRL.SPD_PID.S_D_R	The PID speed derivative ratio. This affects the derivative portion of the speed PID. Typically set to 100 for mechanical drive applications. (Range = 0.01 to 100.00, Default = 100.000)
SPD_CTRL.VLV_RAMP.P_SP_2	The maximum valve position limit in %. (Range = 0.00 to 100.00, Default = 100.000)
SPD_REF.SETBACK.DLY_TIME	The set point setback pulse time. Factory set, do not adjust. (Range = 0.00 to 1.00, Default = 0.100)

Alarms / Shutdowns

If the control shuts down due to a CPU fault or watchdog timer failure, indicated by the CPU OK LED being off, you must turn off control power then turn the power back on. Until you do, you cannot step through any functions in the hand-held programmer.

After any shutdown, the Shutdown relay contacts should be reset to ensure proper start-up.

Wiring / Component Problems

Most Peak 150 control problems are caused by wiring problems. Carefully and thoroughly check all wiring connections at both ends. Be very careful when installing wires into the Peak 150 control terminal blocks. Check all shields for proper grounding at the control end only.

You can measure all inputs and outputs directly at the terminal strips. The hand-held display will show what the Peak 150 control measures. This comparison will tell you if the Peak 150 control is interpreting the input signal correctly.

WARNING—EXPLOSION HAZARD

Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.

Substitution of components may impair suitability for Class I, Division or Zone applications.

AVERTISSEMENT—RISQUE D'EXPLOSION

Ne pas raccorder ni débrancher tant que l'installation est sous tension, sauf en cas l'ambiance est décidément non dangereuse.

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

Actuators / Control Adjustments

If the actuator output is unsteady or hunts, try blocking the steam valve by closing the valve ramp. If you block the steam valve in this manner and the actuator output is steady but the turbine still hunts, then the problem is outside the governor. If an actuator hunts, it may need dither (especially TM type).

If the Peak 150 control is not able to fully close or open the actuator, check to make sure that the actuator is calibrated correctly. If the Peak 150 control is not able to control speed above or below a certain speed, the steam valve may not be adjusted correctly. An indication of this is if the control is calling for minimum actuator but the speed is still climbing or staying the same, or if the control is calling for maximum actuator but the speed will not increase. Shut down the control and verify that the actuator is closed. If it is, then partially open the T&T valve and verify that the turbine does not turn.

If the T&T valve allows the turbine to turn, then the steam valve is not seated.

Other Operating Problems

If actual speed is less than the speed called for by the speed reference, check for speed droop. Droop causes the actual speed to be less than the speed reference.

If the Remote Speed input values are reading incorrectly, check that the input wire shielding is properly grounded at the Peak 150 control end only.

Chapter 13.
Service Options

Product Service Options

CAUTION—SERVICING

Do not attempt to service internal electronic components nor attempt to remove any of the circuit boards. If the control requires repair, contact Woodward or your nearest Woodward authorized service facility.

The field-configured portion of the program will be zeroed out after factory repair. To prevent damage to your equipment, you must reconfigure the Program Mode before the unit is put back into service.

The following factory options are available for servicing Woodward equipment, based on the standard Woodward Product and Service Warranty (5-01-1205) that is in effect at the time the product is purchased from Woodward or the service is performed:

- Replacement/Exchange (24-hour service)
- Flat Rate Repair
- Flat Rate Remanufacture

If you are experiencing problems with installation or unsatisfactory performance of an installed system, the following options are available:

- Consult the troubleshooting guide in the manual.
- Contact Woodward technical assistance (see “How to Contact Woodward” later in this chapter) and discuss your problem. In most cases, your problem can be resolved over the phone. If not, you can select which course of action you wish to pursue based on the available services listed in this section.

Replacement/Exchange

Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime. This is also a flat rate structured program and includes the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205).

This option allows you to call in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Woodward facility as explained below (see “Returning Equipment for Repair” later in this chapter).

Charges for the Replacement/Exchange service are based on a flat rate plus shipping expenses. You are invoiced the flat rate replacement/exchange charge plus a core charge at the time the replacement unit is shipped. If the core (field unit) is returned to Woodward within 60 days, Woodward will issue a credit for the core charge. [The core charge is the average difference between the flat rate replacement/exchange charge and the current list price of a new unit.]

Return Shipment Authorization Label. To ensure prompt receipt of the core, and avoid additional charges, the package must be properly marked. A return authorization label is included with every Replacement/Exchange unit that leaves Woodward. The core should be repackaged and the return authorization label affixed to the outside of the package. Without the authorization label, receipt of the returned core could be delayed and cause additional charges to be applied.

Flat Rate Repair

Flat Rate Repair is available for the majority of standard products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be. All repair work carries the standard Woodward service warranty (Woodward Product and Service Warranty 5-01-1205) on replaced parts and labor.

Flat Rate Remanufacture

Flat Rate Remanufacture is very similar to the Flat Rate Repair option with the exception that the unit will be returned to you in “like-new” condition and carry with it the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205). This option is applicable to mechanical products only.

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned to Woodward for repair, please contact Woodward in advance to obtain a Return Authorization Number. When shipping the item(s), attach a tag with the following information:

- name and location where the control is installed;
- name and phone number of contact person;
- complete Woodward part number(s) and serial number(s);
- description of the problem;
- instructions describing the desired type of repair.

CAUTION—ELECTROSTATIC DISCHARGE

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*.

Packing a Control

Use the following materials when returning a complete control:

- protective caps on any connectors;
- antistatic protective bags on all electronic modules;
- packing materials that will not damage the surface of the unit;
- at least 100 mm (4 inches) of tightly packed, industry-approved packing material;
- a packing carton with double walls;
- a strong tape around the outside of the carton for increased strength.

Return Authorization Number

When returning equipment to Woodward, please telephone and ask for the Customer Service Department [1 (800) 523-2831 in North America or +1 (970) 482-5811]. They will help expedite the processing of your order through our distributors or local service facility. To expedite the repair process, contact Woodward in advance to obtain a Return Authorization Number, and arrange for issue of a purchase order for the item(s) to be repaired. No work can be started until a purchase order is received.

NOTE

We highly recommend that you make arrangement in advance for return shipments. Contact a Woodward customer service representative at 1 (800) 523-2831 in North America or +1 (970) 482-5811 for instructions and for a Return Authorization Number.

Replacement Parts

When ordering replacement parts for controls, include the following information:

- the part number(s) (XXXX-XXXX) that is on the enclosure nameplate;
- the unit serial number, which is also on the nameplate.

How to Contact Woodward

In North America use the following address when shipping or corresponding:

Woodward Governor Company
PO Box 1519
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Fax—+1 (970) 498-3058

For assistance outside North America, call one of the following international Woodward facilities to obtain the address and phone number of the facility nearest your location where you will be able to get information and service.

Facility	Phone Number
Brazil	+55 (19) 3708 4800
India	+91 (129) 4097100
Japan	+81 (476) 93-4661
The Netherlands	+31 (23) 5661111

You can also contact the Woodward Customer Service Department or consult our worldwide directory on Woodward's website (**www.woodward.com**) for the name of your nearest Woodward distributor or service facility.

Engineering Services

Woodward Industrial Controls Engineering Services offers the following after-sales support for Woodward products. For these services, you can contact us by telephone, by email, or through the Woodward website.

- Technical Support
- Product Training
- Field Service

Contact information:

Telephone—+1 (970) 482-5811
Toll-free Phone (in North America)—1 (800) 523-2831
Email—icinfo@woodward.com
Website—**www.woodward.com**

Technical Support is available through our many worldwide locations or our authorized distributors, depending upon the product. This service can assist you with technical questions or problem solving during normal business hours. Emergency assistance is also available during non-business hours by phoning our toll-free number and stating the urgency of your problem. For technical support, please contact us via telephone, email us, or use our website and reference ***Customer Services*** and then ***Technical Support***.

Product Training is available at many of our worldwide locations (standard classes). We also offer customized classes, which can be tailored to your needs and can be held at one of our locations or at your site. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability. For information concerning training, please contact us via telephone, email us, or use our website and reference ***Customer Services*** and then ***Product Training***.

Field Service engineering on-site support is available, depending on the product and location, from one of our many worldwide locations or from one of our authorized distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface. For field service engineering assistance, please contact us via telephone, email us, or use our website and reference ***Customer Services*** and then ***Technical Support***.

Technical Assistance

If you need to telephone for technical assistance, you will need to provide the following information. Please write it down here before phoning:

General

Your Name _____
Site Location _____
Phone Number _____
Fax Number _____

Prime Mover Information

Engine/Turbine Model Number _____
Manufacturer _____
Number of Cylinders (if applicable) _____
Type of Fuel (gas, gaseous, steam, etc) _____
Rating _____
Application _____

Control/Governor Information

Please list all Woodward governors, actuators, and electronic controls in your system:

Woodward Part Number and Revision Letter _____
Control Description or Governor Type _____
Serial Number _____

Woodward Part Number and Revision Letter _____
Control Description or Governor Type _____
Serial Number _____

Woodward Part Number and Revision Letter _____
Control Description or Governor Type _____
Serial Number _____

If you have an electronic or programmable control, please have the adjustment setting positions or the menu settings written down and with you at the time of the call.

Appendix.
Program Mode Worksheets

Introduction

The program mode worksheets provide a step-by-step guide for programming the Peak® 150 control. You may copy or print out the worksheet for your use.

To program the Peak 150 control, a hand-held programmer must be used (see Chapter 7, Programming for information on this unit and its use).

WARNING—EXPLOSION HAZARD
The Peak 150 control box should not be opened when a hazardous atmosphere is present. Wiring connections which could cause sparks are exposed inside the cabinet.

WARNING—OVERSPEED PROTECTION
Errors in configuration or programming of the Peak 150 control may create dangerous overspeed conditions. The turbine must be equipped with an overspeed device completely separate from the Peak 150 control or actuators attached to the Peak 150 control. The turbine must never be run when this device is not present or not operating correctly.

WARNING—SAVE SET POINTS
To prevent damage to the turbine resulting from improper control settings, make sure you save the set points before removing power. Failure to save the set points before removing power causes them to revert to the previously saved settings. Dangerous conditions such as turbine overspeed may result from operating the turbine with incorrect settings, possibly resulting in equipment damage and injury or death of personnel.

CAUTION—DO NOT START TURBINE
Do NOT attempt to operate the turbine until the Peak 150 control has been programmed. To do so could cause equipment damage; the turbine will start, come up to idle speed, trip and shutdown.

Governor Serial Number _____

Application _____

Configure Mode Program

(The turbine must be shut down to enter this mode.)

Enter the configure mode by pressing the "." key when the screen displays the "Woodward Governor Company" message. The "Woodward Governor Company" heading can be displayed by pressing the "ESC" (escape) key.

Speed Configuration

Teeth Seen by MPU _____
(number of teeth on the gear the magnetic speed pickup is looking at)

MPU Gear Ratio 1: _____
(relationship to turbine shaft—the gear ratio is the result of dividing the MPU gear speed by the turbine shaft speed)

MPU #1 Max Hz _____
(maximum speed seen by the speed pickup)

MPU #2 Max Hz _____
(maximum speed seen by the speed pickup)

Max Speed Level (Hz) _____
(maximum speed level seen by the control)

NOTE
MPU #1 Max Hz, MPU #2 Max Hz, and Max Speed Level will normally all be the same setting. These speed levels must be above the overspeed test limit setting.

Minimum Speed Level (Hz) _____
(minimum detectable speed level for the control—below this level the MPU would be detected as failed and an alarm will be issued. The MPU input signal must be at least 1.0 Vrms at the minimum speed level programmed.

NOTE
Pressing the "ESC" (escape) key will return the display to the heading, which would be Speed Configuration in this case. Using the right (or left) arrow key at the header will advance the display to the next header.

Start Mode

Manual Start Mode? _____
(choose manual start mode vs. automatic start mode)

Automatic Start Mode = ***(status indication only)***
(indication of auto start mode status-no config req'd)

NOTE
With manual start mode, governor speed control starts at minimum governor speed. With auto start mode, speed control starts at idle speed which is much lower than minimum governor speed.

Actuator Configuration

Use 20–160 mA Actuator? _____

Use 4–20 mA Actuator = ***(status indication only)***
(indication of 4–20 mA driver status-no config req'd)

NOTE
Check that the proper jumpers are installed to provide the proper drive current. For a 0–200 mA drive current range, jumpers 4 and 10 should be installed. For a 0–20 mA drive current range, jumpers 3 and 9 should be installed.

Operating Mode

Manual Control Only? _____
(all speed adjustments done with raise/lower contacts)

Use Remote Speed Setting? _____
(enables use of the remote 4–20 mA/1–5 V speed input if "Manual Control Only" is set to FALSE)

NOTE
Jumper must be selected for preferred input.

Use High-Signal-Select? _____
(enables high-signal-selection option between local speed set point and remote speed setting if "Manual Control Only" is set to FALSE and "Use Remote Speed Setting?" is set to TRUE)

Use Modbus Analog Input? _____
(enables using the remote speed setting through the Modbus link rather than with the analog 4–20 mA input if "Manual Control Only" is set to FALSE and "Use Remote Speed Setting?" is set to TRUE. Most importantly, you must have a unit capable of Modbus communications)

Readouts

Speed Readout—4 mA Value = _____

Speed Readout—20 mA Value = _____

Readout #2 Option? _____

Readout #2 Options (enter option number) :

1. Actual Speed
2. Speed Set Point
3. Actuator Output
4. Remote Speed Set Point
5. Valve Ramp Value
6. Not Used

NOTE
Use the "+" and "–" keys to adjust the desired option number up or down respectively.

Readout #2—4 mA Value = _____

Readout #2—20 mA Value = _____

Relays

Configurable Relay #3 Option? _____
(enter option number from list below)

Configurable Relay #4 Option? _____
(enter option number from list below)

Configurable Relay Options:

1. Alarm Condition (normally energized)
2. Trip Output (same as trip relay output)
3. Shutdown Condition (energizes on trip condition)
4. Remote Speed Control
5. Speed Control
6. Either/Any MPU Failed
7. Overspeed Trip
8. Overspeed Test
9. Remote Signal OK
10. Speed Switch or Hand Valve #1
11. Speed Switch or Hand Valve #2

NOTE
Use the "+" and "–" keys to adjust the desired option number up or down respectively.

Use Speed Switch? _____
(enables setting and adjustment of speed switch levels in the service mode)

Switch #2 Underspeed? _____
(enables speed switch #2 to be used as an underspeed indication)

Use Hand Valve(s)? _____
(enables setting and adjustment of hand valve levels in the service mode)

NOTE
A combination of both a hand valve and a speed switch is not possible. If both "Use Hand Valve" and "Use Speed Switch" are set to TRUE, hand valves will be selected if option 10 or 11 is selected above in the Relay Options.

Trip Relay Energizes for Trip? _____
(trip relay to energize rather than de-energize on a trip condition)

NOTE
If the trip relay is programmed to energize for a shutdown, jumper 2 should be installed to properly display the units "Tripped" status on the front-panel LED. If the trip relay is programmed to de-energize for a shutdown, jumper 1 should be installed.

Reset Clears Trip? _____
(enables the trip output to be reset when a reset command is given without clearing the external trip input)

NOTE
When configuration is complete, press the "ESC" key until the display reads "Rebooting Control".

Contact In #8

Configurable Contact #8 is Overspeed Test Enable? _____
(True selects Contact #8 for Overspeed Test Enable, False selects Contact #8 for Fast Dynamics)

Modbus Communication Port Configuration

Use Modbus Communication Port? _____
(enables Modbus communication port)

Hardware Configuration? _____
(enter option number from list below) :

Modbus Port Hardware Configuration Options:
1 = RS 232
2 = RS 422
3 = RS 485

Transmission Mode Configuration? _____
(enter option number from list below) :

Modbus Port Transmission Mode Configuration Options:
1 = ASCII
2 = RTU

Modbus Port Network Address Configuration? _____
(enter number of address the control is on the network)

Service Mode Program

Enter the service mode by pressing the down arrow key when the screen displays the "Woodward Governor Company" message.

Alarms

MPU #1 Failed (***status indication only***)

MPU #2 Failed (***status indication only***)

Remote Input Failed (***status indication only***)

Comm Link Failure (***status indication only***)

Turbine Trip (***status indication only***)

Use Trip as Common Alarm? _____
(provides a common alarm condition when a trip condition exists)

Trips

Last Trip Code = (***status indication only***)
(displays the cause of the last trip in code form—see below)

External Trip (***status indication only***)

Overspeed Trip (***status indication only***)

Loss of Both MPUs (***status indication only***)

Front Panel Trip (***status indication only***)

Modbus Trip (***status indication only***)

Last Trip Code (in Service mode) or
Trip Cause Code on rpm display (flashed when a trip occurs):

1)External Trip to the Peak 150 control
2)Loss of both MPU inputs
3)Overspeed Trip indication
4)Front Panel Trip indication
5)Modbus Trip indication

Speed Dynamics

Low Speed Gain _____*0.8_____

Low Speed Reset _____*5.0_____

High Speed Switch Point (rpm) _____

High Speed Gain _____*0.8_____

High Speed Reset _____*5.0_____

Hi Speed Selected (***status indication only***)

Speed Values

Actual Speed = (***status indication only***)

Local Speed Set Point = (***status indication only***)

Actual Speed Set Point = (***status indication only***)

NOTE
Normally the Local and Actual Speed Set Points will be the same. They will be different if remote speed setting is used as a high-signal- select and the remote setting is in control. Also, actual speed will differ from actual speed set point when droop is utilized.

Remote Spd Setting = ***(status indication only)***
(displays Actual Remote Set Point)

Start Ramp Rate (rpm/sec) _____
(rate of change for startup control operation)

Set Point Slow Rate (rpm/sec) _____
(rate of change for normal manual control operation)

Delay for Fast Rate (sec) _____
(manual mode delay time before fast rate of change starts)

Set Point Fast Rate (rpm/sec) _____
(manual mode fast rate of set point change)

Min Governor Speed (rpm) _____
(normal governor operation lower limit)

Max Governor Speed (rpm) _____
(normal governor operation upper limit)

Overspeed Level (rpm) _____
(governor only—not to be used as ultimate trip protection)

External Ospd Level (rpm) _____
(lower limit of external overspeed trip device)

Overspeed Test Limit _____
(absolute maximum speed allowed for overspeed test)

NOTE
The overspeed test limit cannot exceed the Max Hz settings from page 100.

Droop (%) *0.0 _____
(droop percentage—typically set to 0.0)

Use Set Point Set-Back _____
(instantly resets the speed set point to the actual running speed when the raise or lower pushbuttons are released)

Remote Setting

(displayed only if Remote is configured)

Actual Remote Set Point = ***(status indication only)***

Remote Set Input = ***(status indication only)***

NOTE
Normally the "Actual Remote Set Point" and "Remote Set Input" will be the same. They will be different if the analog (remote) input is being rate limited or the analog input is failed.

Remote-Not-Matched Rate _____
(speed set point rate used before the local and remote settings are matched)

Remote Rate—Max (rpm/sec) _____
(maximum allowed rate of change to the speed set point allowed—used to rate limit the analog input's effect on speed)

Modbus Remote Used = (***status indication only***)

Failed MPU Override

Auto-Ovrd-Off Speed (Hz) = _____
(speed that failed MPU override is turned off—MPU must be providing at least 1.0 Vrms)

Use MPU Override Timer? _____
(the timer limits the time after a start command for speed to be detected— if set properly, this is a protection against overspeed if both MPUs are bad)

Max Starting Time (sec) = _____
(if using timer, this sets the maximum starting time allowed after a start is initiated to sense the "Auto-Ovrd-Off Speed" set above)

Use Slow Rolldown Ovrd? _____
(turns on the failed MPU override if the speed is being slowly reduced by closing the trip and throttle or stop valve—this override is turned on after the speed drops below a low speed setting for delay time. Using this option allows the operator to resume operation at the last set point on the next startup rather than at minimum set point)

Auto-Ovrd-On Speed (Hz) = _____
(for use with the slow rolldown ovrd option—when speed drops below this low speed setting for the delay time, the override is turned on)

Auto-Ovrd-On Delay (sec) = _____
(for use with the slow rolldown ovrd option—the delay time associated with turning on the override. If the speed drops below the "minimum speed level" setting before the time expires, the unit will trip on loss of MPU signals and reset the speed set point to minimum)

Ovrd ON Status = (***status indication only***)

Idle/Min Gov Ramp

(displayed only if Auto Start is configured)

Idle Speed (rpm) _____
(absolute lowest speed set point - where speed control initially starts if using automatic start mode)

Use Idle/Min Gov Ramp? _____
(allows the operator to close the idle/min gov contact to automatically ramp from idle speed to minimum governor speed)

Minimum Governor Speed (rpm) _____
(set point that the idle/minimum governor ramp heads toward when the function is enabled)

Idle/Min Gov Rate (rpm/sec) _____
(rate the set point changes at when ramping to minimum governor or back to idle)

Use Ramp to Idle Function? _____
(allows the operator to open the idle/min governor contact to automatically ramp the speed set point to idle speed - this function is disabled if "Start=Ramp to Min Gov" is set to TRUE)

Start = Ramp to Min Gov? _____
(allows using the front panel "Start" key in place of the idle/min governor contact input - pressing start after the unit is running would start or resume ramping to minimum governor speed. When this function is used, the "Ramp to Idle Function" is disabled)

Ramping to Min = (***status indication only***)

Ramping to Idle = (***status indication only***)

Critical Speed Band

(displayed only if Auto Start is configured)

Use Critical Band? _____

Critical Speed Min (rpm) = _____
(critical speed band lower limit)

Critical Speed Max (rpm) = _____
(critical speed band upper limit)

Critical Band Rate (rpm/sec) = _____
In Critical Band = (***status indication only***)

SPD SW/Hand VLV

(displayed only if configured)

Relay #1 On (rpm or %) _____
(the speed level or valve position level this relay turns on or energizes at. A configurable relay must be using option 10, which is speed switch or hand valve #1, and "Use Speed Switch" or "Use Hand Valve" must be configured to true to use this function)

Relay #1 Off (rpm or %) _____
(the speed level or valve position level this relay turns off or de-energizes at)

Relay #2 On (rpm or %) _____
(the speed level or valve position level this relay turns on or energizes at. A configurable relay must be using option 11, which is speed switch or hand valve #2, and "Use Speed Switch" or "Use Hand Valve" must be configured to true to use this function)

Relay #2 Off (rpm or %) _____
(the speed level or valve position level this relay turns off or de-energizes at)

Underspeed Level (rpm) _____
(the speed level where an underspeed condition will occur on decreasing speed, overridden until Minimum Governor Speed Is Achieved.)

Valve Output

Valve Position (%) = (***status indication only***)

Valve - Offset Adjust _____*0.0_____

Valve - Gain Adjust _____*1.0_____

Valve Ramp Position = (***status indication only***)

Manually Raise Ramp ? _____*false_____
(no configuration req'd - this function is provided as a troubleshooting tool)

Manually Lower Ramp ? _____*false_____
(no configuration req'd - this function is provided as a troubleshooting tool)

Ramp Rate (%/sec) = _____
(this rate determines how fast the governor valve will open during a turbine start)

Dither Adjust _____*0.0_____
(normally set to 0.0 - if dither is necessary, this adjustment can be set to a higher value)

Stroke Valve Output? _____*false_____
(this function can only be performed when the turbine is shutdown)

Stroke Position (%) _____*0.0_____
(this can be adjusted between 0% and 100% for stroking the valve as long as min/max switch is set to false)

Min/Max Switch _____*false_____
(shortcut used in stroking the valve - by adjusting between false to true the output strokes between 0 to 100%)

Readout Adjustments

Readout #1 (Speed Readout) - Offset Adjust _____*0.0_____

Readout #1 (Speed Readout) - Gain Adjust _____*1.0_____

Readout #2 (Config Readout) - Offset Adjust _____*0.0_____

Readout #2 (Config Readout) - Gain Adjust _____*1.0_____

Readout #2 Value (***indication only***)
(value of the configured parameter to be output by readout #2)

Modbus Communication Port Adjustments

Modbus Port Hardware Configuration? _____
(enter option number from list below):

Modbus Post Hardware Configuration Options:
- 1 = RS 232
- 2 = RS 422
- 3 = RS 485

Modbus Port Baud Rate Configuration? _____
(enter option number from list below):

Modbus Port Baud Rate Configuration Options:
1 = 1200 Baud
2 = 1800 Baud
3 = 2400 Baud
4 = 4800 Baud
5 = 9600 Baud
6 = 19200 Baud

Modbus Port Stop Bit Configuration? _____
(enter option number from list below):

Modbus Port Stop Bit Configuration Options:
1 = 1 Stop Bit
2 = 1.5 Stop Bits
3 = 2 Stop Bits

Modbus Port Parity Configuration? _____
(enter option number from list below):

Modbus Port Parity Configuration Options:
1 = Off Parity
2 = Odd Parity
3 = Even Parity

Link Error = (***status indication only***)

Exception Error = (***status indication only***)

Error Number = (***status indication only***)

Error Percent = (***status indication only***)

I/O Check

MPU #1 = (***rpm status indication only***)

MPU #2 = (***rpm status indication only***)

Analog Input = (***% status indication only***)

DI #1 = (***Lower Speed – True or False status indication only***)

DI #2 = (***Raise Speed – True or False status indication only***)

DI #3 = (***External Trip – True or False status indication only***)

DI #4 = (***Start – True or False status indication only***)

DI #5 = (***Reset – True or False status indication only***)

DI #6 = (***Idle/Min Gov – True or False status indication only***)

DI #7 = (***Remote Speed Enable – True or False status indication only***)

DI #8 = (***Ospd Test/Select Hi Dyn – True or False status indication only***)

Trip P/B = (***OCP Trip – True or False status indication only***)

Ospd Test P/B = (***OCP Ospd Test – True or False status indication only***)

Raise P/B = (***OCP Raise Speed – True or False status indication only***)

Lower P/B = (***OCP Lower Speed – True or False status indication only***)

Start P/B = (***OCP Start – True or False status indication only***)

Reset P/B = (***OCP Reset – True or False status indication only***)

Tripped LED = (***True or False status indication only***)

MPU #1 OK LED = (***True or False status indication only***)

MPU #2 OK LED = (***True or False status indication only***)

Ospd Enabled LED = (***True or False status indication only***)

RMT SPD LED = (***True or False status indication only***)

Trip RELAY ON = (***True or False status indication only***)

Alarm RELAY ON = (***True or False status indication only***)

Conf Rly #1 ON = (***True or False status indication only***)

Conf Rly #2 ON = (***True or False status indication only***)

Peak 150 Control Specifications

Inputs	
Magnetic Pickup Inputs (2)	Two identical inputs, high-signal-selected Minimum input voltage 1 Vrms, minimum frequency 200 Hz, maximum frequency 15 kHz
Analog Input (1)	Remote Speed Setting signal (4–20 mA or 1–5 Vdc, internal jumper selectable)
Discrete Inputs (8)	Remote (isolated, 5–28 Vdc)
Options	Raise speed Lower speed Emergency stop Alarm reset Remote speed set enable Start Idle/minimum governor Select high dynamics or overspeed test
Outputs	
Analog Outputs (2)	Actual speed output (scalable, 4–20/0–1 mA) Configurable readout (scalable, 4–20/0–1 mA)
Options	Actual speed Speed setpoint Actuator output Remote speed setpoint Valve ramp value
Actuator Output (1)	4–20 or 0–200 mA (internal jumper selectable)
Relay Outputs (4)	Internal jumpers provide choice of normally-open or normally-closed contacts
Contact ratings are	2 A resistive @ 28 Vdc 0.3 A resistive @ 115 Vac
	Shutdown (de-energizes or energizes for shutdown) Alarm (de-energizes for alarm) Configurable Relay #1 Configurable Relay #2
Options	Alarm Trip output Shutdown Remote control Speed control MPU failure Overspeed trip Overspeed test Remote signal OK Speed switch #1 Speed switch #2 Hand valve #1 Hand valve #2
Operator Control Panel	
Keypad Switches (6)	
Options	Raise speed Lower speed Emergency trip Start Overspeed test Alarm reset
LED Indicators (6)	Remote speed setting signal status Shutdown status MPU #1 status MPU #2 status CPU status Overspeed test status
Digital Display	Five-digit LED speed display

Power	
Input	Models are available with these input power requirements: 24 Vdc 90–150 Vdc or 88–132 Vac, 47–63 Hz
Maximum power consumption, all models:	38 W
Environmental Specifications	
Operating Ambient Temperature	–25 to +65 °C (–13 to +149 °F)
Storage Ambient Temperature	–40 to +85 °C (–40 to +185 °F)
Humidity	Designed to meet US MIL-STD-810D, Method 507.2, Procedure II, induced, non-hazardous, cycle 5 (fifteen 24-hour cycles, varying 19–75% humidity, over 33–63 °C)
Vibration	US MIL-STD-167, Type 1
Shock	US MIL-STD-810C, Method 516.2, Procedure 1
North American Regulatory Compliance	UL and cUL listed for Class I, Division 2, Groups A, B, C, & D
Dimensions	
Width	483 mm (19 inches)
Height	310 mm (12.2 inches)
Depth	105 mm (4.1 inches)

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please include the manual number from the front cover of this publication.

WOODWARD

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