WOODWARD

505E Digital Governor
for Extraction Steam Turbines

Volume 2

Manual 85018 consists of 2 volumes (85018V1 & 85018V2).

Installation and Operation Manual

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Important Definitions

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

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

⚠️**WARNING** **Overspeed / Overtemperature / Overpressure**	**The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.** **The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.**

⚠️**WARNING** **Personal Protective Equipment**	**The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:** • **Eye Protection** • **Hearing Protection** • **Hard Hat** • **Gloves** • **Safety Boots** • **Respirator** **Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.**

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

⚠️**WARNING** **Automotive Applications**	**On- and off-highway Mobile Applications: Unless Woodward's control functions as the supervisory control, customer should install a system totally independent of the prime mover control system that monitors for supervisory control of engine (and takes appropriate action if supervisory control is lost) to protect against loss of engine control with possible personal injury, loss of life, or property damage.**

NOTICE

Battery Charging Device

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.

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:

- Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).
- Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.
- Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.

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

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

Introduction

Manual 85018 Volume 2 is a dual purpose manual. It includes application-specific notes and 505E specific Service mode information.

The first part of this volume gives users an idea of the 505E Digital Control's capabilities, and how to apply them to a system. Typical applications are schematically shown and their functionality explained. Programming and Start/Run mode notes are given for each application to assist application programmers in configuring the 505E for their application.

The second part of this volume includes 505E program modes not covered in Volume 1 of this manual (Service, Debug, SYS_INFO, OPSYS Faults), PID dynamic setting specifics, and Hardware rating information.

General Installation and Operating Notes and Warnings

This equipment is suitable for use in Class I, Division 2 , Groups A, B, C, and D or non-hazardous locations.

This equipment is suitable for use in European Zone 2, Group II environments per compliance with EN60079-15, Electrical apparatus for explosive atmospheres – Type of protection 'n'

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

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

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

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

⚠ **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 2.

⚠ **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, Division 2.

Chapter 1.
Peripheral Devices

Overview

This chapter provides a brief explanation of peripheral devices, that can be used with the 505E. By understanding the functionality of a peripheral device, a better understanding of the overall control configuration can be achieved.

All the devices covered in this section are manufactured or supported by Woodward. Peripheral devices manufactured by other companies can be used with the 505E to perform the functions detailed bellow, however, the compatibility of them to the 505E and the application should be verified before system operation.

505 HMI Software

Woodward offers two different HMI software packages, OpView and 505View, which allow an operator to remotely view operating inputs, adjust control setpoints, issue Run mode commands, and monitor/troubleshoot the turbine control. Both HMI packages are self-configuring which eliminates all field engineering—they automatically configure their screens to match the control's programmed application.

The OpView is comprised of an industrialized NEMA 4 touchscreen hardware package bundles together with a Woodward developed software interface program. The 505View is a unbundled Intellution-based software package that runs on a pc (hardware can be optionally purchased). Both HMI packages are pre-configured to communicate via Modbus® * protocol with either a 505 or 505E Woodward steam turbine control and offer the following features.

*—Modbus is a trademark of Schneider Automation Inc.

- Automatic Screen Generation based on control configuration
- Security with multiple User Levels
- Remote Access Capability[1]
- Real-Time and Historical Trending[2]
- Alarm/Trip Status Indication
- Alarm/Trip Log with Time Tagging and First-Out Indication
- I/O and System Troubleshooting
- Graphic System Control screens
- Event Status Logging and History[3]

Notes:
[1] 505View only
[2] OpView has Real-Time Trending only; 505View has both
[3] OpView has Logging only; 505View has Logging and History
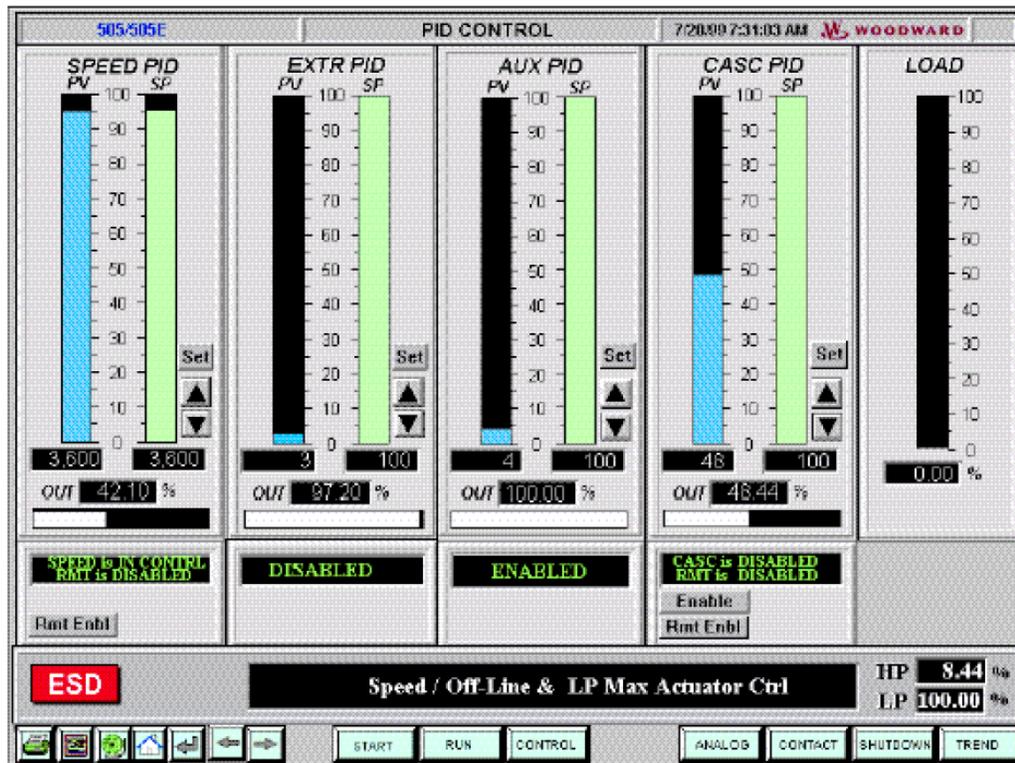
Figure 1-1. 505 HMI Software

By connecting the OpView or 505View to either 505E Modbus port, it automatically configures its screens to match the 505E's programmed application. If the 505E is not configured to accept Modbus commands, the HMI functions as a system monitor only. If the 505E is configured to accept Modbus commands, all 505E Run Mode operations can be monitored and performed through it (start, stop, mode enable/disable, setpoint raise/lower). For safety purposes, the Overspeed test function can not be performed through the HMI. See Volume 1, Chapter 7 of this manual for more information on programming Modbus ports.

User-friendly touch screens allow operators to view and control multiple modes of operation and setpoints from one screen. Ten different screens are available to allow operators the flexibility of viewing. These screens display the following information:
- Controlling parameter information
- Complete starting sequences
- Turbine and/or Generator information
- Speed, Extr/Adm, Aux, Casc, & Limiter information
- Analog Input and Output levels
- Contact Input and Relay Output states
- Alarm and Shutdown Log

The OpView or 505View can interface with the 505E through serial RS232, RS422, or RS485 communications. By using RS422 or RS485 communications, the HMI can be located up to 4,000ft (1,220meters) from the 505E digital control.

Digital Remote Final Driver

Digital Remote Final Driver (DRFD) is used to interface the 505E digital control to existing valve operators or Woodward actuators that are integrating in action or are not compatible with the 505E.

The 505E's actuator outputs have the capability of driving a 4–20 mA or 20–160 mA (200 mA max) proportional signal into an actuator coil. These 505E actuator output signals represent a demand signal equal to desired valve position (proportional). If the application's actuator or servo assembly requires a different drive signal, or control action (integrating with a null setting), a Digital Remote Final Driver or equivalent device must be used.
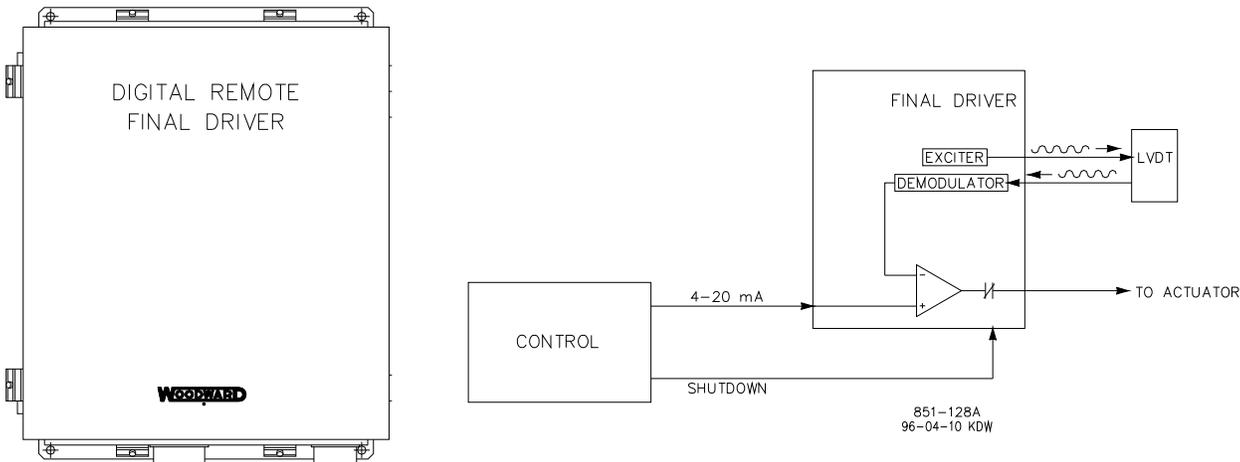
Figure 1-2. Digital Remote Final Driver

Woodward Digital Remote Final Drivers accept a 4–20 mA actuator-drive signal proportional to desired valve position, and position a servo assembly accordingly. Integrating or proportional type DRFDs are available depending on the servo assembly being interfaced to. Woodward DRFDs have the capability of driving unipolar or bipolar actuator demand signals, up to 0–400 mA or +400 mA respectively.

The Digital Remote Final Driver is housed in a NEMA-4X enclosure with a hinged cover and consists of driver and power supply modules. The driver module uses plug-in jumpers and an alphanumeric display to facilitate field configuration and calibration.

Proportional type DRFDs can provide an output drive signal of up to 400 mA, to be compatible with existing servo assemblies. This drive signal is proportional to the 4–20 mA input signal received from the 505E digital control.

Integrating type DRFDs sense actual valve position (through, LVDTs, RVDTs, MLDTs, or DC position feedback devices), compare this signal to the input position demand signal from the 505E, and output a drive signal to position a servo assembly accordingly. See Figure 1-2.

Please refer to Woodward Product Spec 85532 for more information on DRFDs and their capabilities.

Real Power Sensor

A Real Power Sensor is used to sense the real power produced by a generator or flowing through a tie line. Woodward Real Power Sensors sense three-phase volts, three-phase amps, compare each phase's voltage to current relationship, and develop a 4–20 mA output proportional to real power.
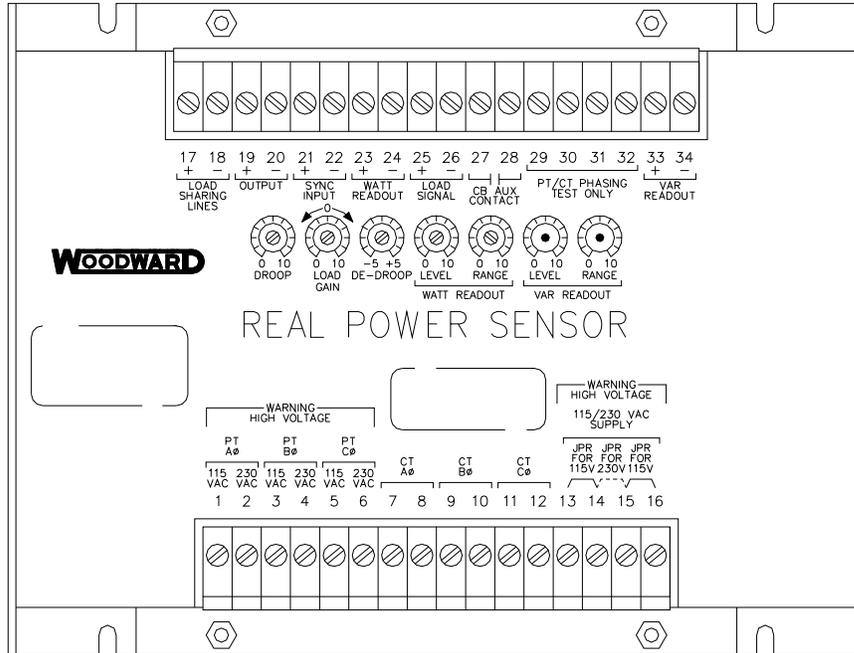
820-015 F1
96-04-11 KDW

Figure 1-3. Real Power Sensor

Woodward manufactures two types of Real Power Sensors. The first type of RPS is designed to sense power flow in one direction only (0 to +5 A CT current only), and output a proportional 4–20 mA signal. This type of RPS was designed for and should be used to sense generator power output. Many different real power sensors of this type exist. Some of the optional RPS features include VAR sensing, Loadsharing, 0–1 A CT current sensing, and multiple combinations of these. Please consult a Woodward certified distributor or a Woodward factory for the recommended RPS for your application.

The second type of RPS manufactured by Woodward is designed to sense power flow through a bus-to-bus tie line. This RPS (8272-726) senses –5A to +5A CT current to allow its output to represent power flow in both directions. This RPS provides a 4–20 mA power indication output signal where 12 mA represents 0 power flow. It is recommended that this RPS be used to sense power flow through a tie line only. This RPS or equivalent is required to sense plant Import and Export power.

Woodward Real Power Sensors have terminals labeled "Output" and terminals labeled "KW Readout". The "KW Readout" terminals provide a 4–20 mA signal proportional to real power which is used by and compatible with the 505E control. Thus the RPS terminals labeled "Output" are designed and typically compatible only to Woodward's 2301 type of control.

Woodward manufactured Real Power Sensors have a 2.5 Hz Low pass filter (400 ms lag time) on their output to filter out the high frequency noise typically created in a switch gear type environment. Thus if another vendor's watt transducer is used, verification that it has similar filtering criteria should be performed before it is applied with the 505E. For more information on Woodward Real Power Sensors, please refer to Woodward manual 82018.

Digital Synchronizer and Load Control (DSLC™)

The Woodward DSLC™ is a microprocessor based generator load control designed for use on three-phase AC generators with Woodward speed controls and automatic voltage regulators. The DSLC is a synchronizer, a load control, a dead bus closing system, a VAR/PF control, and a process control, integrated into one package.

The 505E can be programmed to use the DSLC as a synchronizer only, or as a synchronizer and load control. The DSLC provides either phase match or slip frequency synchronizing, and ties into the unit automatic voltage regulator to match voltages before paralleling. It interfaces with the 505E via a Speed bias signal to control generator frequency and phase. When configured to use the DSLC as a synchronizer only, the 505E must be programmed to receive the DSLC Speed Bias signal through an analog input and have this input enabled through a contact input or function key.

The DSLC communicates over a LAN using a digital Echelon network with other system DSLCs to enable it to perform safe deadbus closings. Because the DSLC performs all synchronizing functions simultaneously, synchronization typically takes only a few seconds.

When used as a synchronizer and load control, the DSLC performs automatic synchronization, and controls unit load based on the DSLCs mode of operation. The DSLC can be in a base-load, loadsharing, remote load setting, or Process control mode, depending on configuration and system conditions.

The DSLC's baseload mode of operation allows an operator to set the unit to a specified load. A proportional or integrating control action can be used with this mode of operation. The integrating mode of operation can be used with systems tying to an unstable grid to allow the unit to control at a constant load and not vary based on grid frequency.

The DSLC's loadsharing mode is used to share load with any other units using a DSLC and tied to the same isolated bus. This mode is used in conjunction with a Master Synchronizer & Load Control when paralleled to a utility to allow the MSLC to control plant frequency or load depending on its state of operation.

The DSLC's remote load setting mode allows load to be set by a remote 4–20 mA signal. The DSLC's Process control mode allows any process directly related to generator load to be controlled.

When using the DSLC as both a synchronizer and load control, the 505E control must be programmed to receive the DSLC Speed Bias signal through an analog input and have this input enabled through a contact input or function key.

After synchronization, unit load can be controlled by the DSLC (through the 505E Sync/Ld input) or by the 505E's internal speed/load setpoint. When the Sync/Ld Share input is programmed, the position of the Utility Tie Breaker Contact selects unit load control through the DSLC or through the 505E's internal load setpoint.
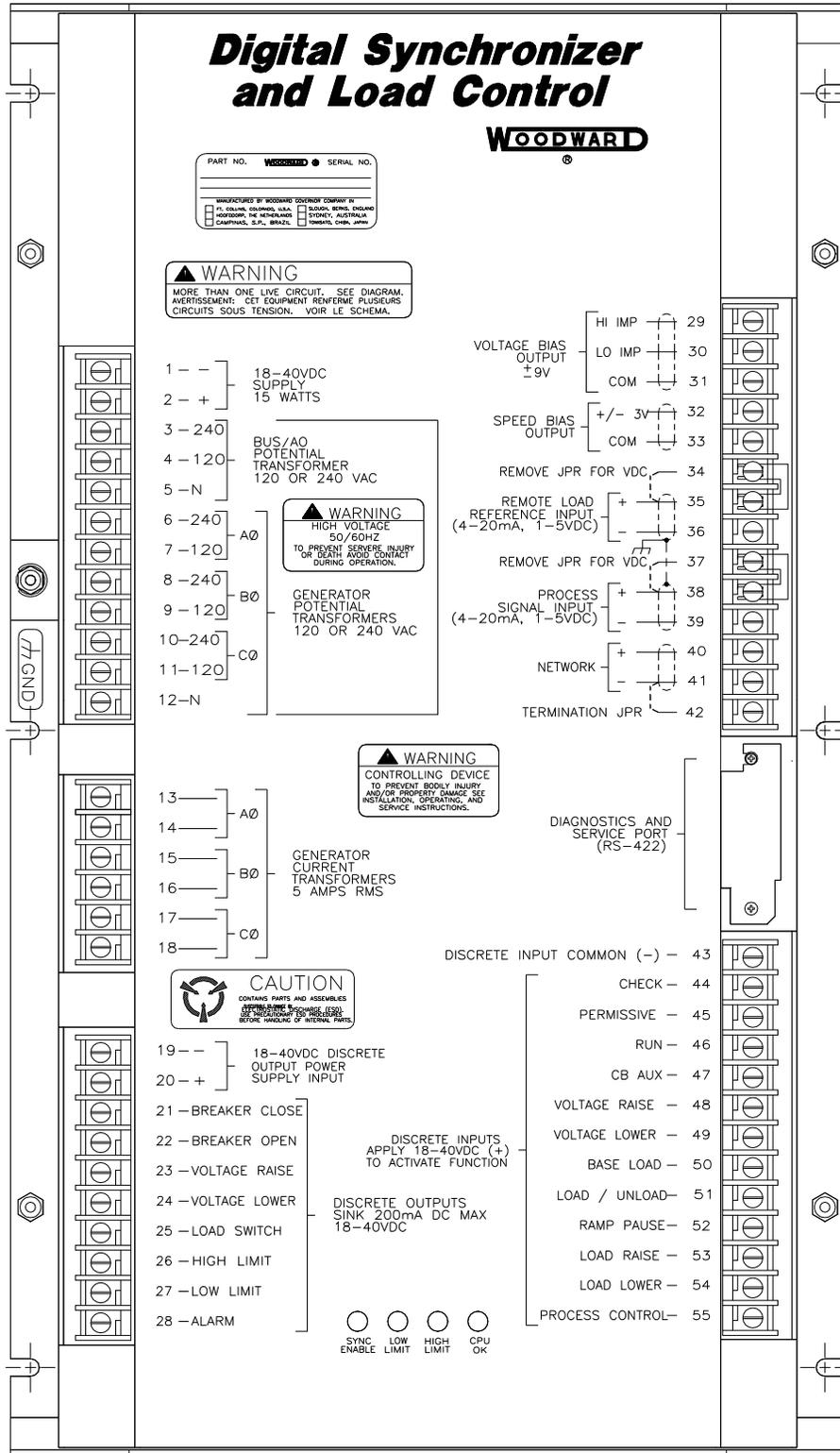
Figure 1-4a. Digital Synchronizer and Load Control

Figure 1-4b. Digital Synchronizer & Load Control

The DSLC interfaces to the 505E via a Speed Bias signal. From the many different types of DSLCs manufactured by Woodward only a few have a Speed Bias output (1–5 Vdc) compatible with the 505E control. The 505E's isolated analog #6 input is the only analog input that is directly compatible with the DSLC. Thus the DSLC's speed bias output should only be connected to the # 6 analog input. The DSLC's speed bias output is designed to drive into the 505E's low impedance input.

Once the generator is synchronized the DSLC soft-loads the unit to the load setting determined by the mode of operation (base load, loadsharing, Process control). When commanded the DSLC can also soft-unload the unit and issue a breaker-open command at a set power level.

Installation Notes

Hand-held Programmer (9905-292) is required and used by the DSLC to configure and calibrate it to the site specific application.

The DSLC requires a power source of +24Vdc @ 1 A. The 505E power supplies can not supply this much power, thus an external power supply may be required.

The DSLC can interface with the unit Automatic Voltage Regulator through contacts or a +9 volt bias signal.

For more information on Woodward's Digital Synchronizer & Load Control, please refer to Woodward manual 02007.

Figure 1-5. DSLC Interface Wiring

Master Synchronizer and Load Control (MSLC)

The Woodward MSLC is a microprocessor based plant load control designed for use in three-phase electric power generation sites equipped with Woodward DSLCs which operate in parallel with the utility. The MSLC is a tie-line synchronizer, a plant import/export load control, reactive load control (power factor), and a master process control integrated into one package.

Used as a synchronizer, the MSLC provides phase (or slip frequency) and voltage match synchronizing of the local plant bus to a main power grid. It communicates over a LAN using a digital Echelon network with system DSLCs to control plant frequency, phase, and voltage to perform automatic plant synchronization.

After the utility tie breaker is closed manually or by the MSLC, the MSLC then controls plant load to a baseload setting, remote load setting, import/export demand setting, or process control demand setting. If programmed, reactive tie line power can also be controlled by the MSLC through each DSLC interfacing to each unit's automatic voltage regulator.
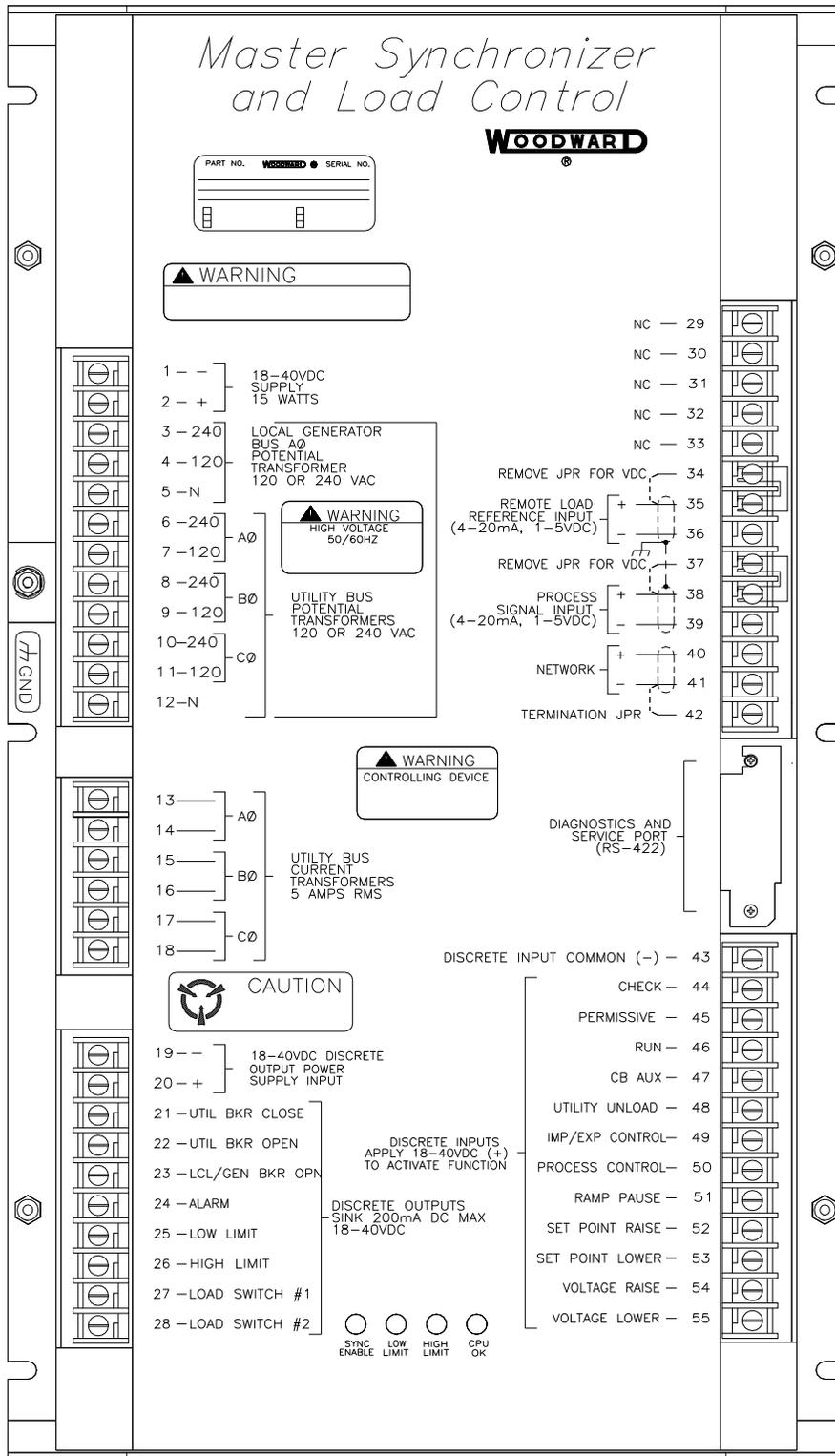
Figure 1-6a. Master Synchronizer & Load Control

Figure 1-6b. Master Synchronizer & Load Control

The MSLC's baseload mode of operation allows an operator to set the plant to a specified load. A proportional or integrating control action can be used with this mode of operation. The integrating mode of operation can be used with systems tying to an unstable grid to allow the plant to control at a constant load and not vary based on grid frequency.

The MSLC's remote load setting mode allows plant load to be set by a remote 4–20 mA signal.

The MSLC's import/export control mode, when enabled senses plant-to-utility tie line power flow and controls this flow based on a import/export setpoint.

The MSLC's process control mode allows any process directly related to plant load to be controlled.

Once the plant-to-utility tie breaker is closed the MSLC soft-loads the plant to a load setting determined by the mode of operation (base load, import/export, Process control). When commanded the MSLC can also soft-unload the plant and issue a plant-to-utility tie breaker open command at a set power level.

When using the MSLC as both a synchronizer and load control, the system DSLCs must be in their Loadsharing mode to enable the MSLC to control them. The MSLC is only active when synchronizing a plant bus to a utility bus, or when the utility tie breaker is closed to control tie line power (real & reactive). Once the utility tie breaker opens, the MSLC becomes disabled and does not effect DSLC load sharing control. Because the MSLC/DSLC network only allows one master controller at a time, only one MSLC at a time can be utilized to control plant load.

For more information on Woodward's Master Synchronizer & Load Control and how to apply it, please refer to Woodward manual 02022.

Installation Notes

Hand-held Programmer (9905-292) is required and used by the MSLC to configure and calibrate it to the site specific application.

The MSLC requires a power source of +24Vdc @ 1 A. The 505E power supplies can not supply this much power, thus an external power supply may be required.

For more information on Woodward's Master Synchronizer & Load Control, please refer to Woodward manual 02022.

Chapter 2.
Application Notes

Overview

This chapter is provided to give users an idea of the 505E Digital Control's capabilities and how to apply them to a system. Typical example applications are schematically shown and their functionality explained. In addition, programming and run mode notes are given for each example to assist programmers in configuring the 505E for their application. Basic peripheral device connections are shown in each application drawing to allow an understanding of how these devices interface to the 505E and expand system capabilities.

Speed/Load PID

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

The 505E's Speed PID can be used to control unit speed/frequency when isolated and unit load when paralleled to an infinite bus (utility). The Speed PID can be programmed to sense unit load via its actuator output signal or a 4–20 mA analog input signal from a generator power sensor. When programmed to sense and control generator load via a analog input, true unit load is sensed and controlled. By using the generator load signal to control from, any turbine inlet or exhaust pressure variation is sensed and compensated for, thus providing true load control.

A combination of the Speed PID and its setpoint limits allow this PID to limit unit load. When used as a unit load limiter, it is recommended that the 505E be configured to sense and control only true generator load. If applying the 505E system to a soft grid, where the utility frequency varies greatly, it is recommended that unit load limiting be performed by the Auxiliary PID—not the Speed PID.

Since this PID's output is connected directly to the 505E ratio/limiter, it directly positions one or both turbine throttle valves, depending on configuration, to control the above listed parameters.

Extr/ADM PID

The 505E's Extr/Adm PID can be programmed to control:
- Extraction and/or Admission Steam Pressure
- Extraction and/or Admission Steam Flow
- Turbine Exhaust Steam pressure
- Turbine Exhaust Steam Flow

The 505E's Extr/Adm PID can be used to control any of the listed parameters. This PID can be enabled and disabled by commands given through the 505E's front panel, contact inputs, or Modbus communications.

Since this PID's output is connected directly to the 505E ratio/limiter, it directly positions one or both turbine throttle valves, depending on configuration, to control the above listed parameters. Only when the 505E is configured for the "Decoupled HP & LP" mode, can the Extr/Adm PID control turbine exhaust pressure or flow.

Auxiliary PID

The 505E's Auxiliary PID can be programmed to control or limit:
- Turbine Inlet Steam Pressure
- Turbine Inlet Steam Flow
- Turbine Exhaust Steam pressure
- Turbine Exhaust Steam Flow
- Generator Power output
- Plant or Tie line Import/Export Power
- Process Temperature
- Compressor Suction pressure
- Compressor Suction Flow
- Compressor Discharge pressure
- Compressor Discharge Flow
- Any process parameter related to unit load, inlet pressure/flow, or exhaust pressure/flow (depending on configuration)

The 505E's Auxiliary PID can be used as a limiter or controller (enabled/disabled on command). When programmed as a limiter this, PID's output is Low Signal Selected with the Speed PID's output. This configuration allows the Auxiliary PID to limit the unit's load based on the parameter being sensed.

When the Auxiliary PID is configured as a controller, it must be enabled and disabled by commands given through the 505E's front panel, contact input, or Modbus communications. With this configuration when the Aux PID is enabled the Speed PID is disabled and tracks the Auxiliary PID's output.

To control or limit any of the listed parameters, the 505E must be programmed to accept an Auxiliary analog input signal representing that parameter's level. The exception to this rule is when controlling or limiting generator load, the Auxiliary PID can be programmed to use and share the KW/Unit load input with the Speed PID.

Cascade PID

The 505E's Cascade PID can be programmed to control:
- Turbine Inlet Steam Pressure
- Turbine Inlet Steam Flow
- Turbine Exhaust Steam pressure
- Turbine Exhaust Steam Flow
- Generator Power output
- Plant or Tie line Import/Export Power
- Process Temperature
- Compressor Suction pressure
- Compressor Suction Flow
- Compressor Discharge pressure
- Compressor Discharge Flow
- Any process parameter related to unit load, inlet pressure, or exhaust pressure (depending on the configuration)

The 505E's Cascade PID can be used to control any of the listed parameters. This PID must be enabled and disabled by commands given through the 505E's front panel, contact input, or Modbus communications.

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

Example Applications

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

Example—To configure the 505E to perform a Turbine Exhaust pressure limiting function use Example 1, the "Pump or Compressor Discharge Pressure Control with Turbine Inlet Pressure Limiting" application for reference. With this example substitute exhaust pressure for inlet pressure and disregard any program settings specified to control pump or compressor discharge pressure.

The examples shown in this chapter are summarized as follows:
- Example 1: Pump or Compressor Discharge Pressure Control with Inlet Pressure Limiting
- Example 2: Inlet Pressure Control with Auto Synchronizing and Generator Power Limiting
- Example 3: Exhaust Pressure Control with Plant Import/Export Power Limiting
- Example 4: Plant Import/Export Power Control with DRFD Servo Interface
- Example 5: Inlet Pressure Control with Isochronous Load Share Control in Island Mode
- Example 6: Plant Import/Export Power Control with Isochronous Load Share Control in Island Mode
- Example 7: Inlet Pressure Control and Exhaust Pressure Control with Generator Power Limiting
- Example 8: Admission Steam Control with Bootstrap Startup capability
- Example 9: Plant Load and Steam Pressure Control
- Example10: Induction Generator Control

The features and functionality shown in each example are summarized in Table 2-1.

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

855-659a
99-07-12 JMM

Table 2-1. Example Summary

Example 1—Pump or Compressor Discharge Pressure Control with Turbine Inlet Pressure Limiting
(Extraction Turbine, Coupled HP & LP mode)
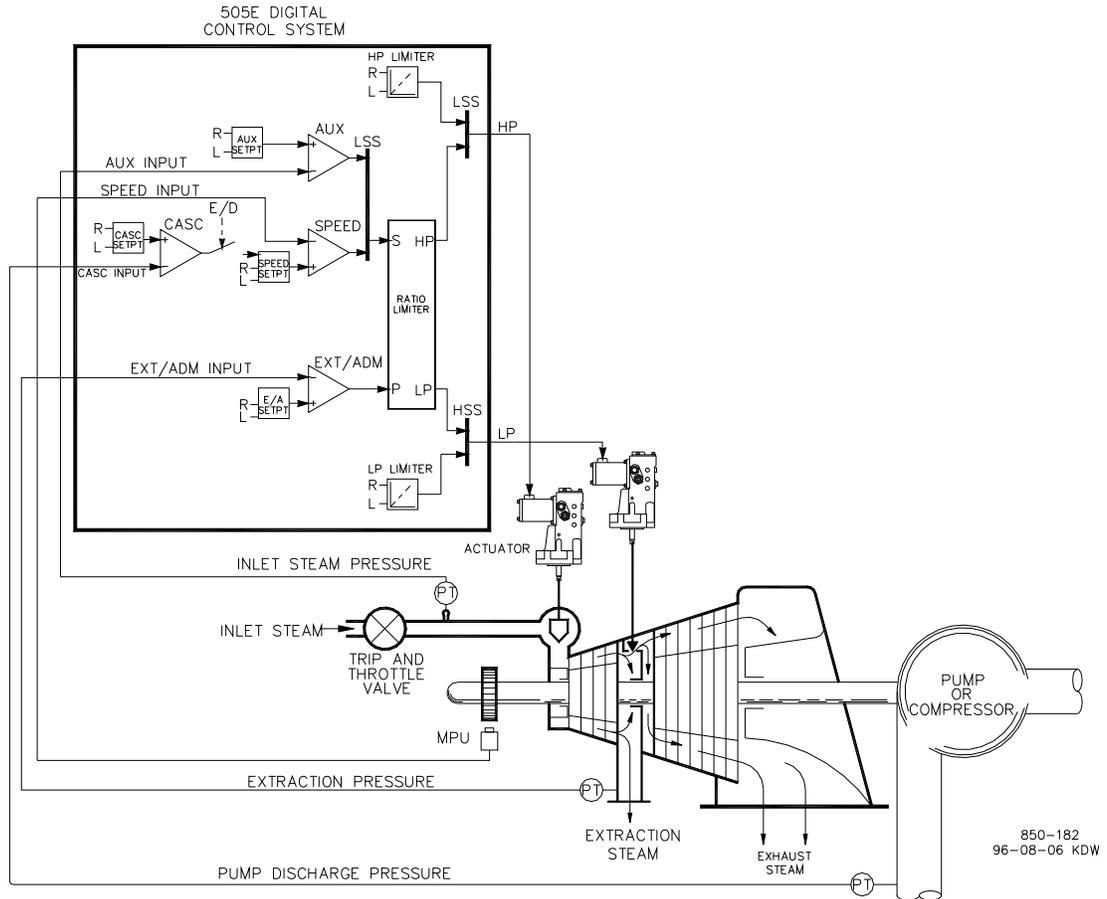
Figure 2-1. Pump or Compressor Discharge Pressure Control with Turbine Inlet Pressure Limiting

This is an example of a typical pump or compressor application. With this application the 505E is configured to normally control pump/compressor discharge pressure, extraction pressure, and limit governor valve position based on low turbine inlet steam pressure. Both the Auxiliary and Cascade modes were used for this example application. Other applications may or may not use all the functionality shown in Figure 2-1 and described below.

Extraction pressure is controlled by the Extr/Adm PID. This PID controller can be enabled automatically or manually depending on configuration. In all cases the 505E starts up with the Extr/Adm PID disabled and the LP valve at its maximum open position. This allows a turbine to warm-up in a uniform manner. With this application the Extr/Adm setpoint is only varied through the 505E's front panel. Optionally the 505E could be programmed to have the Extr/Adm setpoint varied through discrete inputs, a 4–20 mA signal, or Modbus communications.

With this application pump/compressor discharge pressure control is performed within the 505E through the Cascade controller. Because the discharge pressure being controlled, typically affects many other plant processes, a plant Distributed Control System (DCS) may be used to monitor plant process conditions and set the Cascade setpoint position. This can be performed through Modbus communications, discrete raise and lower commands, or with a Analog setpoint signal.

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

If a plant Distributed Control System is used to sense and control a process by positioning the load of multiple pumps or compressors (loadsharing), the DCS may interface directly to the 505E Speed PID setpoint through a programmed Remote Speed Setpoint analog input. This allows a DCS to monitor and compensate for plant and system conditions by directly changing the speed of multiple pumps or compressors simultaneously.

All 505E PID controller setpoints (Speed, Extr/Adm, Auxiliary, Cascade) may be changed through programmed raise and lower contacts, programmed 4–20 mA inputs, Modbus commands, or the 505E service panel.

The following list of notes is provided as a reference for application programmers to follow when configuring the 505E to achieve any of the control and limiting actions shown in Figure 2-1:

505E Configuration Notes for Example 1:
OPERATING PARAMETERS:
This is not a Generator application. (Generator Application?—No)

EXTR / ADM CONTROL:
The Extr/Adm control loop is defaulted to receive an extraction pressure or flow signal through Analog Input #1 (Analog Input #1 Function: Extr/Adm Input). The input's 4 mA and 20 mA values were programmed based on what the pressure transducer was ranged/calibrated for.

Since a two wire, loop powered transducer was used to sense extraction pressure, the 505E back cover was removed, JPR11 was removed, and JPR10 was installed.

Because of where the extraction transducer was placed with respect to the LP valve (refer to Figure 2-1) no input inversion was required. To increase turbine extraction header pressure, the HP valve must increase and the LP valve must decrease. This is considered a direct action and does not require the input to inverted. (Invert Extr/Adm Input?—No)

In this application, because the Extr/Adm PID is not sharing control of the extraction pressure with another controller, Droop is not required. (Extr/Adm Droop = 0%)

TURBINE PERFORMANCE VALUES:
Because it is desired to hold Pump Discharge Pressure constant for a changing extraction flow demand, and because Pump Discharge pressure is directly related to turbine load, the "Coupled HP & LP" ratio/limiter mode is used with this application. (Use Decoupling?—No)

From the turbine's steam map or performance envelope (provided with the turbine from the turbine manufacturer), the turbine's operating data/limits were entered as described in Volume #1 of this manual.

This application's turbine can only extract steam. (Extraction Only?—Yes)

Automatic enabling/disabling was selected with this application to allow an operator to automatically or manually enable/disable Extraction control (lower the LP valve limiter to its minimum position / raise the LP valve limiter to maximum position). The automatic enable/disable routine may be stopped at any time, and continued manually, or restarted as desired. (Use Automatic Enable?—Yes)

When the turbine is on an operating limit and only one valve is available to control with, Pump Discharge pressure is the desired parameter to be controlled (extraction pressure control will be sacrificed). Since Pump Discharge pressure is being controlled with the Cascade PID (the ratio limiter's "S" term) Speed priority is selected. (Speed Control Priority?—Yes)

When the turbine is on the LP Maximum Limiter (100% open), Pump Discharge pressure is the desired parameter to be controlled (extraction pressure control will be sacrificed). Since Pump Discharge pressure is being controlled with the Cascade PID (the ratio limiter's "S" term) Speed priority is selected. (LP Max Lmt E/A Priority?—No)

CASCADE CONTROL:
The Cascade control loop was configured to receive a pump/compressor discharge pressure signal through Analog input #2 (Analog Input #2 Function: Cascade Input) The input's 4 mA and 20 mA values were programmed based on what the pressure transducer was ranged/calibrated for.

Because a two wire, loop powered transducer is used to interface with this signal, the 505E back cover was removed, JPR9 was removed, and JPR8 as installed.

The 505E was configured to accept a contact from a panel mounted switch to externally enable and disable discharge pressure control. (Contact Input 1 Function: Casc Control Enable)

Pump/compressor discharge pressure is directly proportional to turbine inlet valve position, thus input inversion is not required. (Invert Cascade Input?—No)

With this application, Setpoint Tracking is not used because the system's pressure setpoint never changes. (Use Setpoint Tracking?—No)

In this application, because the Cascade PID is not sharing control of discharge pressure with another controller, Droop is not required. (Cascade Droop = 0%)

AUXILIARY CONTROL:
The Auxiliary control loop was configured to receive a turbine inlet header pressure signal through Analog input #3. (Analog Input #3 Function: Auxiliary Input) he input's 4 mA and 20 mA values were programmed based on what the pressure transducer was ranged/calibrated for.

Because a two wire, loop powered transducer is used to sense this pressure signal, the 505E back cover was removed, JPR15 was removed, and JPR14 was installed.

The Auxiliary Input was inverted to allow the correct control action. To increase turbine inlet header pressure, the governor valve must decrease. This is considered an indirect action and requires the input to be inverted. (Invert Aux Input?—Yes)

The Auxiliary PID was programmed to perform as a limiter. (Use Aux Enable?—No)

Because the Auxiliary PID is used only as a limiter and is not sharing control of inlet pressure with another controller, Droop is not required. (Aux Droop = 0%)

TRIPS
In this example the turbine can be tripped by several devices, one of these devices is the 505E control. To provide feedback to the 505E control that the turbine is tripped, a contact from the trip string is wired into the External Emergency Shutdown input (TB12). With this application, the 'governor trip' annunciation should only occur if the 505E tripped the turbine and not annunciate when the other external devices shuts down the unit (Turbine Start: Ext Trips in Trip Relay ?—No)

Because the Shutdown relay is used in the trip string to shut down the turbine should the 505E initiate a trip, additional relays are required for annunciating any turbine trip and annunciating a 505E initiated trip. Relay #3 was programmed to annunciate any turbine trip as follows: (Relays: Use Relay #3—Yes ; Relay #3 is a Level Switch?—No ; Relay #3 Energizes on—Shutdown Condition) Relay #4 was programmed to indicate a 505E initiated trip as follows: (Relays: Use Relay #4—Yes ; Relay #4 is a Level Switch?—No ; Relay #4 Energizes on—Trip Relay) Note that Relay #4 de-energizes on a trip condition (excluding external trip inputs) and Relay #3 energizes on a trip (shutdown) condition.

Starting & Run Mode Notes for Example 1:
Starting and ramping to an idle or minimum speed position can be performed automatically, semi-automatically, or manually. After the unit is started, the Idle/Rated or Auto Start Sequence functions, if programmed, can be used to assist ramping the control to a rated speed position or an operator can give a raise command to manually increase turbine speed.

After the unit has been started and is controlling at a minimum/desired speed position, Cascade control (pump/compressor discharge pressure) can be enabled through contacts, Modbus commands, or the 505E service panel. When Cascade control is enabled, if the actual discharge pressure does not match the setpoint, the control will automatically ramp turbine speed at the "Speed Setpoint Slow Rate" setting until the pump/compressor discharge pressure does match the setpoint. This allows the Cascade control to be enabled in a controlled manner.

Because the 505E was programmed for the capability to automatically enable Extraction Control, the operator may choose to automatically or manually enable Extraction control. To manually enable Extraction control the operator must issue a LP valve limiter lower command from the 505E service panel, a contact input, or through Modbus communications. The LP valve limiter must be taken to its minimum position to fully enable Extraction control.

The enabling routine, which automatically lowers the LP valve limiter, may be issued from the 505E's service panel, contact input, or through Modbus communications. This routine automatically ramps the LP valve to its minimum position and may be stopped at any time by momentarily issuing a LP valve limiter raise or lower command. Once the automatic enabling routine has been stopped it may be restarted/enabled at any time by issuing a disable command followed by an Extr/Adm control enable command or, once stopped, the operator may continue the routine manually. (Disabling of Exhaust control can also be performed manually or automatically.)

When a letdown station is used as a backup to the turbine extraction pressure controller, it is required that the letdown station's setpoint be lower than that of the 505E extraction control's setpoint to prevent fighting and potential instability between the controllers.

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

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

Example 2—Inlet Pressure Control with Automatic Synchronizing & Generator Power Limiting

(Extraction Turbine, Decoupled Inlet mode)
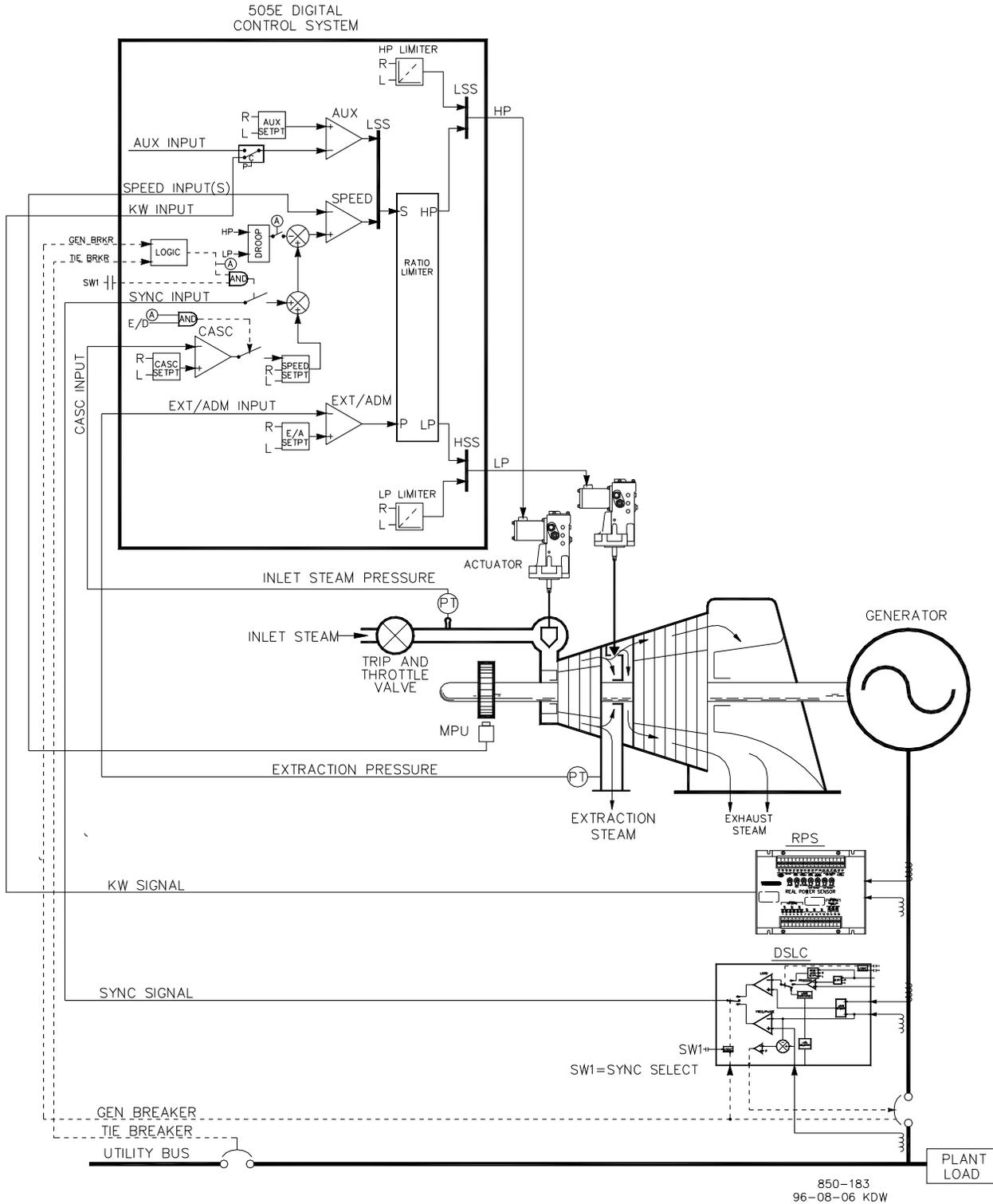
Figure 2-2. Inlet Pressure Control with Automatic Synchronizing & Generator Power Limiting

This is an example of a typical turbine generator application where plant process steam (turbine inlet header pressure) is desired to be controlled at a single pressure. With this type of application, turbine load varies based on the plant process steam demand. Both the Auxiliary and Cascade modes were used for this example application. Other applications may or may not utilize all the functionality shown in Figure 2-2 and described below.

With this application turbine inlet header pressure control is performed within the 505E through the Cascade PID controller. This is an ideal controller for this type of function because it can be enabled and disabled as desired by a system operator. This gives a system operator full authority of when to transfer process pressure control to or from a letdown station or turbine bypass valve.

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

Extraction pressure is controlled by the Extr/Adm PID. This PID controller can be enabled automatically or manually depending on configuration. In all cases the 505E starts up with the Extr/Adm PID disabled and the LP valve at its maximum open position. This allows a turbine to warm-up in a uniform manner. With this application the Extr/Adm setpoint is only varied through the 505E's front panel. Optionally the 505E could be programmed to have the Extr/Adm setpoint varied through discrete inputs, a 4–20 mA signal, or Modbus communications.

This application uses a DSLC for synchronization only. Because the DSLC interfaces to the 505E through an analog signal, an analog input must be programmed. The 505E's Analog Input #6 is the only analog input directly compatible with the DSLC, thus this input is programmed to receive the DSLC's Speed Bias signal. When a Synchronizing input/function is programmed, the input can be enabled through a contact input, function key, Modbus command, or the 505E service panel. As shown in Figure 2-2, a panel mounted (DPST) switch is used with this application to select automatic synchronization in both the DSLC and 505E.

All 505E PID controller setpoints (Speed, Extr/Adm, Auxiliary, Cascade) may be changed through programmed raise and lower contacts, programmed 4–20 mA inputs, Modbus commands, or the 505E service panel.

The following list of notes are provided as a reference for application programmers to follow when programming the 505E to achieve any of the control and limiting actions shown in Figure 2-2.

505E Configuration Notes for Example 2:
OPERATING PARAMETERS:
This is a Generator application. (Generator Application?—Yes)

Generator and Utility Tie breaker contact inputs are required to be programmed when a generator application is selected. (Contact Input #1 Function: Generator Breaker), (Contact Input #2 Function: Utility Tie Breaker)

Because the 505E is configured to control inlet pressure during normal operation, the ratio limiter is programmed to use the Decoupled Inlet mode of action. KW droop, however, acts as a form of valve coupling (both valves affect load) and will negate the decoupling action of the ratio limiter if used. For this reason, Speed droop is used with this application. (Use KW Droop?—No)

To achieve good response and load adjustment resolution, Droop was set to 5% of rated speed. (Droop = 5 %)

A Real Power Sensor (RPS) was used with this application to sense and display actual unit load. By programming an analog input for KW/unit load, the actual unit's load can be displayed. Without this actual unit load input, a calculated load percentage is displayed. The RPS and associated load input are not required by the 505E for control, this input is only used for monitor and display purposes. The 505E was configured to receive a generator load signal from a Real Power Sensor through Analog Input #2. (Analog Input #3 Function: KW / Unit Load Input) The input's 4 mA and 20 mA values were programmed based on what the PTs and CTs used by the Real Power Sensor were ranged for (4 mA = zero, 20 mA = unit power level at 5 A CT current).

Because the Real Power Sensor is self powered (provides it's own loop power), the 505E back cover was removed, JPR14 was removed, and JPR15 was installed.

It was desired to switch to Frequency control at all times, if the plant became isolated from the Utility bus. (Use Freq Arm/Disarm?—No)

EXTR / ADM CONTROL:
The Extr/Adm control loop is defaulted to receive an extraction pressure or flow signal through Analog Input #1 (Analog Input #1 Function: Extr/Adm Input). The input's 4 mA and 20 mA values were programmed based on what the pressure transducer was ranged/calibrated for.

Since a two wire, loop powered transducer is used to sense the pressure level, the 505E back cover was removed, JPR11 was removed, and JPR10 was installed.

Because of where the extraction transducer was placed with respect to the LP valve (refer to Figure 2-2), no input inversion was required. To increase turbine extraction header pressure, the HP valve must increase and the LP valve must decrease. This is considered a direct action and does not require the input to inverted. (Invert Extr/Adm Input?—No)

In this application, because the Extr/Adm PID is not sharing control of the extraction pressure with another controller, Droop is not required. (Extr/Adm Droop = 0%)

TURBINE PERFORMANCE VALUES:
Because it is desired to hold inlet pressure constant for a changing extraction flow demand, and vice versa the "Decoupled Inlet" ratio/limiter mode is used with this application. (Use Decoupling?—Yes), (Decoupled Inlet (HP)?—Yes)

From the turbine's steam map or performance envelope (provided with the turbine from the turbine manufacturer), the turbine's operating data/limits were entered as described in Volume #1 of this manual.

This application's turbine can only extract steam. (Extraction Only?—Yes)

Automatic enabling/disabling was selected with this application to allow an operator to automatically or manually enable/disable Extraction control (lower the LP valve limiter to minimum / raise the LP valve limiter to maximum). The automatic enable/disable routine may be stopped at any time, and continued manually, or restarted as desired. (Use Automatic Enable?—Yes)

With this turbine, the turbine manufacture requires that during normal operation the LP valve never be closed less than 5% to allow for adequate cooling steam through the turbine's back stages. (Min LP lift (%) = 5)

When the turbine is on an operating limit and only one valve is available to control with, inlet pressure is the desired parameter to be controlled (extraction pressure control will be sacrificed). Since inlet pressure is being controlled with the Cascade PID (the ratio limiter's "S" term) Speed priority is selected. (Speed Control Priority?—Yes)

When the turbine is on the LP Maximum Limiter (100% open), inlet pressure is the desired parameter to be controlled (extraction pressure control will be sacrificed). Since inlet pressure is controlled with the Cascade PID (the ratio limiter's "S" term) Speed priority is selected. (LP Max Lmt E/A Priority?—No)

CASCADE CONTROL:
The Cascade control loop was configured to receive an inlet header pressure signal through Analog Input #2. (Analog Input #2 Function: Cascade Input) he input's 4 mA and 20 mA values were programmed based on what the pressure transducer was ranged/calibrated for.

Because a two wire, loop powered transducer is used to sense the pressure level, the 505E back cover was removed, JPR9 was removed, and JPR8 was installed.

The 505E was configured to accept a contact from a panel mounted switch to externally enable and disable inlet header pressure control. (Contact Input #3 Function: Casc Control Enable)

The Cascade Input was inverted to allow the correct control action. To increase turbine inlet header pressure, the governor valve position must decrease. This is considered an indirect action and requires the input to be inverted. (Invert Cascade Input?—Yes)

With this application, Setpoint Tracking is used to allow the 505E to track inlet header pressure before being enabled, thus allowing a bumpless transfer to inlet header pressure control. (Use Setpoint Tracking? Yes)

To protect the generator from being reverse powered by the Cascade PID, the 'Speed Setpoint Lower Limit' value was set to 3% (5.4 rpm if rated speed is 3600 rpm and using 5% droop) above synchronous speed. The 505E will automatically limit the Speed Setpoint Lower Limit to a minimum of 3% (min load). If it is desired to allow the Cascade PID to lower load below this setting, the Service mode's (Cascade Control Settings, Use Min Load) setting must be set to "No".

In this case, because the Cascade PID, during normal operation, is not sharing control of inlet header pressure with another controller, Droop is not required. (Cascade Droop = 0%)

AUXILIARY CONTROL:
The Auxiliary control loop was configured to receive a generator load signal from a Real Power Sensor, through Analog Input #3. (Use KW Input?—Yes)

Unit load is directly proportional to turbine inlet valve position, thus no input inversion is required. (Invert Aux Input?—No)The Auxiliary PID was programmed to perform as a load limiter. (Use Aux Enable?—No)

In this case, because the Auxiliary PID is used only as a limiter, and is not sharing control of generator load with another control, Droop is not required. (Aux Droop = 0%)

With this application, it was desirable to only enable the Auxiliary PID if paralleled to the utility. (Tiebkr Open Aux Dsbl?—Yes), (Genbkr Open Aux Dsbl?—Yes)

AUTO SYNCHRONIZING:
The 505E's Analog input #6 was programmed to receive the DSLC's speed bias signal for automatic synchronization (Analog Input #6 Function: Synchronizing Input) With this configuration, the analog input's range is defaulted to provide a certain gain factor for best performance, thus the input's 4 mA and 20 mA program settings are not used and do not require programming.

A contact input was programmed to enable the Synchronizing analog input. (Contact Input #4 Function: Sync Enable)

Starting & Run Mode Notes for Example 2:
Starting and ramping to an idle or minimum speed position can be performed automatically, semi-automatically, or manually. After the unit is started, the Idle/ Rated or Auto Start Sequence functions, if programmed, can be used to assist ramping the control to a rated speed position. Alternatively an operator can give a manual raise command to increase turbine speed as desired.

After the unit has been started and is controlling at a rated speed position, the turbine generator can be synchronized. This can be done manually or automatically. The system operator can select automatic synchronization through the Auto-Sync select switch (switch SW1 in Figure 2-2). When this switch is closed the 505E's Synchronizing input is enabled and the DSLC's automatic synchronizing function is selected.

When the plant-to-utility tie-line breaker is closed and the unit generator breaker closes, the 505E steps the speed/load setpoint up to a minimum load level to reduce the chance of reverse powering or motoring the generator. This minimum load level is based on the speed/load setpoint and is defaulted to "3%". The defaulted value (stored as a setpoint "rpm" change) is adjustable through the 505E's Service mode (Breaker Logic, Min Load Bias = xxx rpm).

After synchronization the 505E's load setpoint can be positioned through raise and lower Speed/Load setpoint contacts, a programmed 4–20 mA input, Modbus commands, or the 505E service panel. This load control mode may be used to slowly increase turbine load, and take control away from a letdown station or turbine bypass valve. When a letdown station is used as a backup to the turbine pressure controller, it is required that the letdown station's setpoint be lower than that of the 505E control's setpoint to prevent fighting and potential instability between the controllers.

Cascade control (turbine inlet header pressure) can be enabled at any time after the Utility Tie breaker and Generator breakers are closed, through a contact input, Modbus command or the 505E service panel. With this configuration, when Cascade control is enabled, its setpoint will match the inlet header pressure level at that time, thus a bumpless transfer to inlet header pressure control is accomplished. After the Cascade controller has been enabled, the operator can increase or decrease the control setpoint as desired. The 505E's ratio/limiter uses the Coupled HP & LP mode when Cascade Control is disabled, and the Decoupled Exhaust mode when Cascade control is enabled.

Because the 505E was programmed for the capability to automatically enable Extraction Control, the operator may choose to automatically or manually enable Extraction control. To manually enable Extraction control the operator must issue a LP valve limiter lower command from the 505E service panel, a contact input, or through Modbus communications. The LP valve limiter must be taken to its minimum position to fully enable Extraction control.

If an operator chooses to use the automatic enabling routine to lower the LP valve limiter, he may issue an Extraction enable command from the 505E's service panel, contact input, or through Modbus communications. This routine automatically ramps the LP valve to its minimum position and may be stopped at any time by momentarily issuing a LP valve limiter raise or lower command. Once the automatic enabling routine has been stopped it may be restarted/enabled at any time by issuing an Extraction control disable command followed by an enable command or, once stopped, the operator may continue the routine manually.

The automatic extraction disabling routine is initiated by issuing an Extraction disable command from the 505E's service panel, contact input, or through Modbus communications. This routine instantly moves the LP valve limiter to the current LP valve position setting and automatically continues to move it to its maximum position. This routine may be stopped at any time by momentarily issuing a LP valve limiter raise or lower command. Once the automatic disabling routine has been stopped it may be restarted at any time by issuing an Extraction control enable followed by a disable command or, once stopped, the operator may continue the routine manually.

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

Example 3—Exhaust Pressure Control WITH Plant Import/Export Limiting

(Extraction Turbine, Decoupled Exhaust)
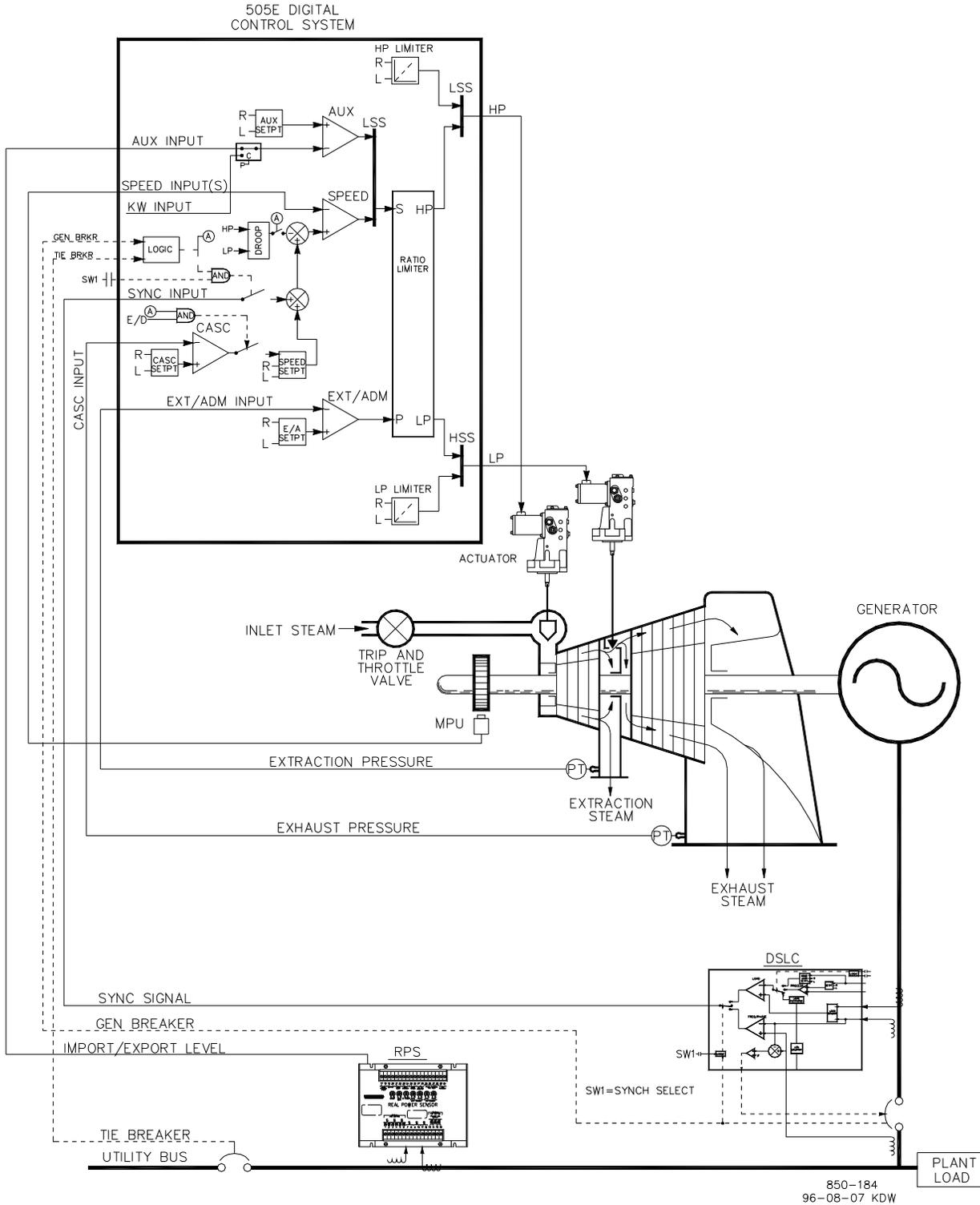
Figure 2-3. Exhaust Pressure Control with Generator Power Limiting and Plant Import/Export Limiting

This is an example of a typical turbine generator application where plant process steam (turbine exhaust pressure) is desired to be controlled at a single pressure level. With this type of application, turbine load varies based on the plant process steam demand. Both the Auxiliary and Cascade modes were used for this example application. Other applications may or may not utilize all the functionality shown in Figure 2-3 and described below.

With this application turbine exhaust pressure control is performed within the 505E through the Cascade PID controller. This is an ideal controller for this type of function because it can be enabled and disabled as desired by a system operator. This gives a system operator full authority of when to transfer process pressure control to or from a letdown station or turbine bypass valve.

Extraction pressure is controlled by the Extr/Adm PID. This PID controller can be enabled automatically or manually depending on configuration. In all cases the 505E starts up with the Extr/Adm PID disabled and the LP valve at its maximum open position. This allows a turbine to warm-up in a uniform manner. With this application the Extr/Adm setpoint is only varied through the 505E's front panel. Optionally the 505E could be programmed to have the Extr/Adm setpoint varied through discrete inputs, a 4–20 mA signal, or Modbus communications.

For this application a limiting type of control function was required to limit the plant export power to zero. The plant does not get reimbursed for any power exported, and it is more economical to make power than purchase it from the utility, thus a zero plant export power level is desired. Because the Auxiliary PID is the only 505E controller that has this limiting capability, it was used to sense tie line power and limit turbine/generator output, based on a zero export limit setting.

A Real Power Sensor #8272-726 was used with this application to sense utility tie line power. This RPS is special, in that it senses –5A to +5A CT current to allow its output to represent power flow in both the import and export directions. With this RPS 12 mA represents zero power flow. Because of this feature, the RPS #8272-726 can not be used with the 505E to sense the unit's generator load/ power.

This application uses a DSLC for synchronization only. Because the DSLC interfaces to the 505E through an analog signal, a 505E analog input must be programmed. The 505E's Analog Input #6 is the only analog input directly compatible with the DSLC, thus it is required that this input be programmed to receive the DSLC's Speed Bias signal. When a synchronizing input/function is programmed, the input can be enabled through a contact input, function key, Modbus command, or the 505E service panel. As shown in Figure 2-3 a panel mounted (DPST) switch is used with this application to select automatic synchronization in both the DSLC and 505E. Alternatively, this switch could come from a 505E relay programmed to energize for an F3/F4 Key Selected, a Modbus Command Selected, Sync Enabled, or a Speed Switch Level Reached.

All 505E PID controller setpoints (Speed, Extr/Adm, Auxiliary, Cascade) may be changed through programmed raise and lower contacts, programmed 4–20 mA inputs, Modbus commands, or the 505E service panel.

The following list of notes are provided as a reference for application programmers to follow when programming the 505E to achieve the control and limiting actions shown in Figure 2-3.

505E Configuration Notes for Example 3:
OPERATING PARAMETERS:
This is a Generator application. (Generator Application?—Yes)

Generator and Utility Tie breaker contact inputs are required to be programmed when a generator application is selected. (Contact Input #1 Function: Generator Breaker), (Contact Input #2 Function: Utility Tie Breaker)

Because the 505E is configured to control exhaust pressure during normal operation, the ratio limiter is programmed to use the Decoupled Exhaust mode of action. KW droop, however, acts as a form of valve coupling (both valves affect load) and will negate the decoupling action of the ratio limiter if used. For this reason, Speed droop is used with this application. (Use KW Droop?—No)
To achieve good response and load adjustment resolution, Droop was set to 5% of rated speed. (Droop = 5 %)

It was desired to switch to Frequency control at all times, if the plant became isolated form the Utility bus. (Use Freq Arm/Disarm?—No)

EXTR / ADM CONTROL:
The Extr/Adm control loop is defaulted to receive an extraction pressure or flow signal through Analog Input #1 (Analog Input #1 Function: Extr/Adm Input). The input's 4 mA and 20 mA values were programmed based on what the pressure transducer was ranged/calibrated for.

Since a two wire, loop powered transducer is used to sense the pressure level, the 505E back cover was removed, JPR11 was removed, and JPR10 was installed.

Because of where the extraction transducer was placed with respect to the LP valve (refer to Figure 2-3), no input inversion was required. To increase turbine extraction header pressure, the HP valve must increase and the LP valve must decrease. This is considered a direct action and does not require the input to inverted. (Invert Extr/Adm Input?—No)

In this application, because the Extr/Adm PID is not sharing control of the extraction pressure with another controller, Droop is not required. (Extr/Adm Droop = 0%)

TURBINE PERFORMANCE VALUES:
Because it is desired to hold exhaust pressure constant for a changing extraction flow demand, and vice versa the "Decoupled Exhaust" ratio/limiter mode is used with this application. (Use Decoupling?—Yes), (Decoupled Exhaust (LP)?—Yes)

From the turbine's steam map or performance envelope (provided with the turbine from the turbine manufacturer), the turbine's operating data/limits were entered as described in Volume #1 of this manual.

This application's turbine can only extract steam. (Extraction Only?—Yes)

Automatic enabling/disabling was selected with this application to allow an operator to automatically or manually enable/disable Extraction control (lower the LP valve limiter to min/raise the LP valve limiter to max). The automatic enable/disable routine may be stopped at any time, and continued manually, or restarted as desired. (Use Automatic Enable?—Yes)

When the turbine is on an operating limit and only one valve is available to control with, extraction pressure is the desired parameter to be controlled (exhaust pressure control will be sacrificed). Since extraction pressure is controlled with the Cascade PID (the ratio limiter's "P" term) Extr/Adm priority is selected. (Speed Control Priority?—No)

To simplify system startup and shutdown, the 505E was programmed to automatically select Extraction pressure priority when the selected permissives are met (LP valve limiter at min, extraction PID in-control). This allows a bumpless transfer into extraction priority. (Auto Switch E/A Priority?—Yes)

CASCADE CONTROL:
The Cascade control loop was configured to receive an exhaust header pressure signal through Analog Input #2. (Analog Input #2 Function: Cascade Input) The 4 mA and 20 mA values were programmed based on what the pressure transducer was ranged/calibrated for.

Since a two wire, loop powered transducer was used to sense the pressure level, the 505E back cover was removed, JPR9 was removed, and JPR8 was installed.

The Function Key F3 was programmed to allow an operator to easily enable and disable Cascade control (F3 Key Performs: Casc Control Enable)

Exhaust header pressure is directly proportional to turbine inlet valve position, thus no input inversion is required. (Invert Cascade Input?—No)

With this application, Setpoint Tracking is used to allow the 505E's Cascade control, when disabled, to track exhaust header pressure being controlled by a letdown station. (Use Setpoint Tracking?—Yes)

To protect the generator from being reverse powered by the Cascade PID, the 'Speed Setpoint Lower Limit' value was set to 3% (5.4 rpm if rated speed is 3600 rpm and using 5% droop) above synchronous speed.

In this case, because the Cascade PID, during normal operation, is not sharing control of exhaust header pressure with another control, Droop is not required. (Cascade Droop = 0%)

AUXILIARY CONTROL:
The Auxiliary control loop was configured to receive a utility tie line power signal through Analog Input #3. (Analog Input #3 Function: Auxiliary Input) The minimum analog input value was programmed for import power based on the tie line power level at –5A CT current (Input #3 4 mA Value =—XXXX) The maximum analog input value was programmed for export power based on the tie line power level at +5A CT current (Input #3 20 mA Value = +XXXX)

Because the RPS's KW readout is self powered, the 505E back cover was removed, JPR14 was removed, and JPR15 was installed.

The utility-tie Real Power Sensor's CT inputs were wired to allow the RPS's 4 mA value to represent full import power and the RPS's 20 mA value to represent full export power. Because this signal is directly proportional to turbine inlet valve position, no input inversion is required. (Invert Aux Input?—No)

The Auxiliary PID was programmed to perform as a limiter. (Use Aux Enable?—No)

In this case, because the Auxiliary PID is used as a limiter, and is not sharing control of inlet pressure with another control, Droop is not required. (Aux Droop = 0%)

With this application, it was desirable to only enable the Auxiliary PID if paralleled to the utility. (Tiebkr Open Aux Dsbl?—Yes), (Genbkr Open Aux Dsbl?—Yes)

AUTO SYNCHRONIZING:
The 505E's Analog input #6 was programmed to receive the DSLC's speed bias signal for automatic synchronization (Analog Input #6 Function: Synchronizing Input) With this configuration, the analog input's range is defaulted to a certain gain value, for best performance, thus the input's 4 mA and 20 mA settings are not used and do not require programming.

A contact input was programmed to enable the Synchronizing analog input (Contact Input #4 Function: Sync Enable)

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

After the unit has been started and is controlling at a rated speed position, the turbine generator can be synchronized. This can be done manually or automatically. The system operator can select automatic synchronization through the Auto-Sync select switch (SW1 in Figure 2-3). When this switch is closed the 505E's Synchronizing input is enabled and the DSLC's automatic synchronizing function selected.

When the plant to utility tie line/breaker is closed, and the unit generator breaker closes, the 505E steps the speed/load setpoint up to a minimum load level to reduce the chance of reverse powering or motoring the generator. This minimum load level is based on the speed/load setpoint and is defaulted to a "3%" (5.4 rpm if rated speed is 3600 rpm and using 5% droop) step change of the speed/load setpoint. The defaulted value is adjustable through the 505E's Service mode (BREAKER LOGIC, MIN LOAD BIAS = xxx rpm).

After synchronization the 505E's load setpoint can be positioned through raise and lower speed/load setpoint contacts, a programmed 4–20 mA input, Modbus commands, or the 505E service panel.

Since Decoupled Exhaust was the ratio/limiter action programmed with this application, it is recommended that Extraction control be enabled (the LP limiter lowered to min) before Exhaust control (which uses the LP valve to control with). It is also recommended that Cascade control be disabled before Extraction control is disabled (the LP limiter raised). By following these recommended procedures each control mode can be bumplessly taken into and out of control. The 505E's ratio/limiter uses the Coupled HP & LP mode when Cascade Control is disabled, and the Decoupled Exhaust mode when Cascade control is enabled.

Because the 505E was programmed for the capability to automatically enable Extraction Control, the operator may choose to automatically or manually enable Extraction control. To manually enable Extraction control the operator must issue a LP valve limiter lower command from the 505E service panel, a contact input, or through Modbus communications. The LP valve limiter must be taken to its minimum position to fully enable Extraction control.

The enabling routine, which automatically lowers the LP valve limiter, may be issued from the 505E's service panel, contact input, or through Modbus communications. This routine automatically ramps the LP valve to its minimum position and may be stopped at any time by momentarily issuing a LP valve limiter raise or lower command. Once the automatic enabling routine has been stopped it may be restarted/enabled at any time by issuing a disable command followed by an Extr/Adm control enable command or, once stopped, the operator may continue the routine manually. (Disabling of Exhaust control can also be performed manually or automatically.)

When a letdown station is used as a backup to the turbine extraction pressure controller, it is required that the letdown station's setpoint be lower than that of the 505E extraction control's setpoint to prevent fighting and potential instability between the controllers.

Cascade control (turbine exhaust pressure) can be enabled at any time after the utility tie breaker and generator breaker input contacts are closed. Cascade control can be enabled through a programmed contact, Modbus command, or the 505E service panel. Exhaust pressure control can be transferred from a letdown station to 505E Cascade Control in one of the following ways; enabling Cascade control, and backing down the letdown station's setpoint, or enabling Cascade control and raising the Cascade's setpoint.

After exhaust pressure control has been transferred to the 505E's Cascade PID, the letdown station or turbine bypass valve must be closed or in a manual control mode. This will stop the two controllers (505E Cascade PID and system letdown station) from fighting for control of one parameter and causing system instability. If both a turbine bypass valve, and the turbine's flow are required to satisfy the header flow requirements droop is required in one of the control loops for stability.

With this application the Auxiliary control is programmed as a limiter and is automatically enabled when both the utility tie and generator breakers are closed. When paralleled to the utility this 505E and RPS combination allows the plant to import power from the utility, but not export power. If the utility-to-plant tie line power reaches a zero import/export level, the Auxiliary PID will begin limiting generator output until plant conditions require power to be imported again. Optionally the Auxiliary PID's setpoint can be varied to limit plant power to a different import or export power level as required. This can be done from the plant DCS through the remote auxiliary 4–20 mA input setting or through raise and lower aux setpoint contacts, Modbus commands, or the 505E service panel.

Example 4—Plant Import/ Export Control with DRFD Servo Interface
(Adm or Extr/Adm Turbine, Coupled HP & LP mode)
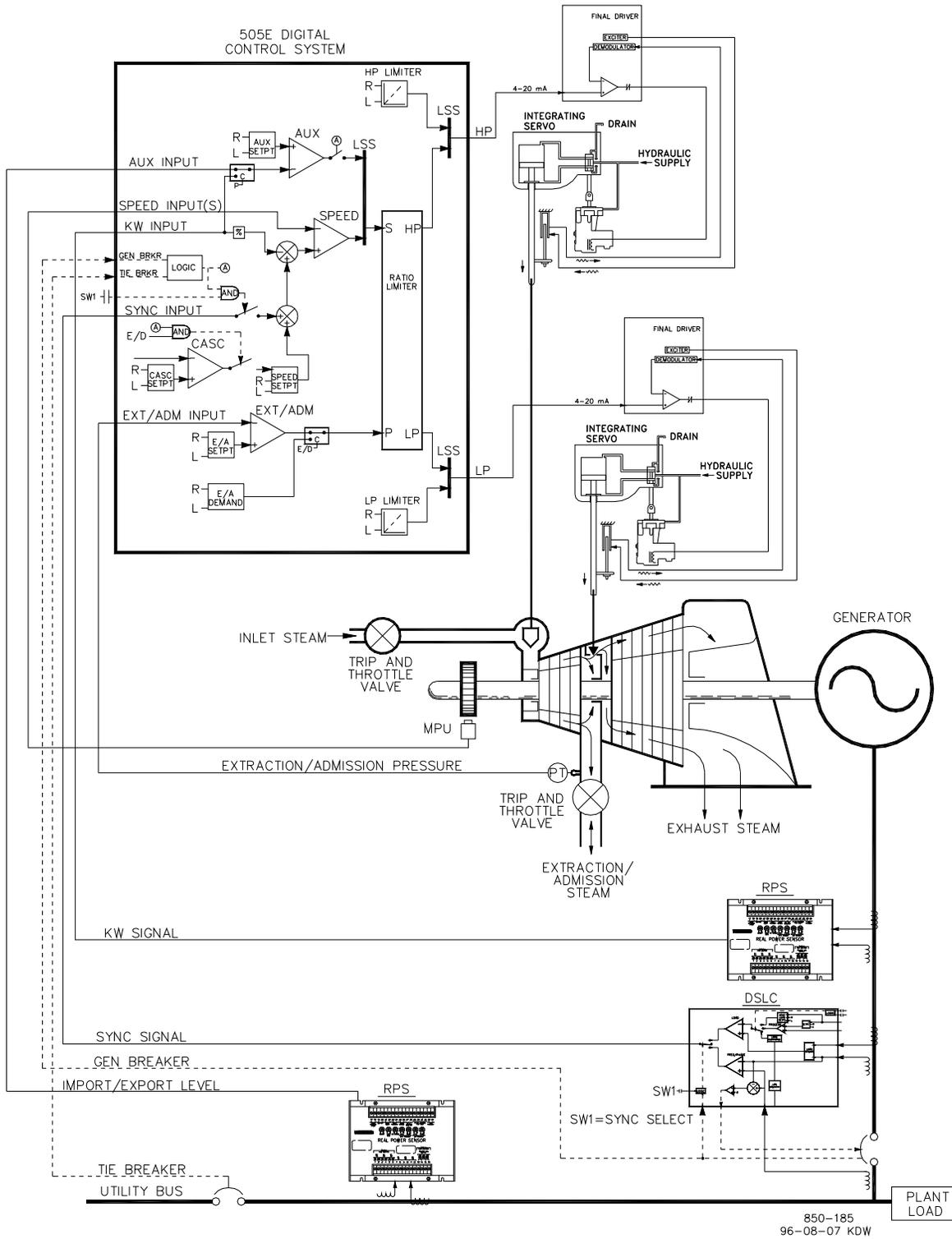
Figure 2-4. Plant Import/Export Control with DRFD Servo Interface

This is an example of a typical turbine generator application where plant import/ export control is desired when paralleled with the utility, and frequency control when isolated from the utility. With this type of application, when paralleled to the utility, turbine load varies based on the plant power demand. Other applications may or may not use all the functionality shown in Figure 2-4 and described below.

With this application, plant import/export control is performed within the 505E through the Auxiliary PID controller. Optionally the Cascade PID controller could have been used instead. Also, the Auxiliary PID is configured to be enabled and disabled on command, instead of performing a limiting action. This gives a system operator full authority of when to enable or disable plant import/export control. When programmed for this type of control action, the Speed PID is disabled when the Auxiliary PID is enabled and can only limit the 505E's valve output signal if unit load reaches 100%. Also, the Auxiliary setpoint automatically tracks the Auxiliary PID's input value when not in-control.

Two Real Power Sensors (RPS) were used with this application; one for sensing generator load to allow the 505E Speed/load PID to control and limit generator output, and one for sensing plant import/export tie line power to allow the 505E Auxiliary PID to control plant import or export power.

A Real Power Sensor #8272-726 was used with this application to sense utility tie line power flow. This RPS is special, in that it senses –5A to +5A CT current to allow its output to represent power flow in both the import and export directions. With this RPS 12 mA represents zero power flow. Because of this feature, the RPS #8272-726 can not be used with the 505E to sense generator load/power.

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

Adm or Extr/Adm pressure is controlled by the Extr/Adm PID. This PID must be manually enabled once the pressures on both sides of the admission trip-and-throttle (T&T) valve have been matched. A manual demand signal is available in the 505E to allow an operator to match the pressures across the Admission T&T valve before enabling the control loop. With this application the Extr/Adm setpoint is only varied through the 505E's front panel. Optionally the 505E could be programmed to have the Extr/Adm setpoint varied through discrete inputs, a 4–20 mA signal, or Modbus communications.

This application uses a DSLC for synchronization only. Because the DSLC interfaces to the 505E through an analog signal, an analog input must be programmed. The 505E's Analog Input #6 is the only analog input directly compatible with the DSLC, thus this input is programmed to receive the DSLC's Speed Bias signal. When a synchronizing input/function is programmed, the input can be enabled through a contact input, function key, Modbus command, or the 505E service panel. As shown in Figure 2-4, a panel mounted (DPST) switch is used with this application to select automatic synchronization in both the DSLC and the 505E. Alternatively, this switch could come from a 505E relay programmed to energize for an F3/F4 Key Selected, a Modbus Command Selected, Sync Enabled, or a Speed Switch Level Reached.

With this application the existing servo assemblies utilized actuators which required +50 mA for pilot valve positioning, and an electronic signal (a LVDT mounted to the valve rack) to feedback actual rack position. Because the 505E does not have a bipolar drive circuit, and cannot perform closed loop servo position control, a Woodward Digital Remote Final Driver (DRFD) was used to interface with the existing servo actuator. The integrating type of DRFD used, accepts a 4–20 mA valve demand signal from the 505E, monitors actual valve position (through, LVDTs, MLDTs, or other DC position feedback devices), compares the two signals, and outputs a drive signal to the servo assemblies actuator accordingly. The DRFD interfaces directly with an LVDT, (providing excitation, and demodulation) thus no external converter was required or used.

All 505E PID controller setpoints (Speed, Extr/Adm, Auxiliary, Cascade) may be changed through programmed raise and lower contacts, programmed 4–20 mA inputs, Modbus commands, or the 505E service panel.

The following list of notes are provided as a reference for application programmers to follow when programming the 505E to achieve any control and limiting actions shown in Figure 2-4.

505E Configuration Notes for Example 4:
OPERATING PARAMETERS:
This is a Generator application. (Generator Application?—Yes)

Generator and Utility Tie breaker contact inputs are required to be programmed when a generator application is selected. (Contact Input #1 Function: Generator Breaker), (Contact Input #2 Function: Utility Tie Breaker)

A RPS was used with this application to sense unit load. By programming the Speed PID to use KW droop, the Speed PID can control and limit unit load when paralleled against a utility. (Use KW Droop?—Yes) For good response and load adjustment resolution, Droop was set to 5% of rated speed. (Droop = 5 %)

he 505E was configured to receive a generator load signal from a Real Power Sensor, through Analog Input #2. (Analog Input #2 Function: KW / Unit Load Input) The input's 4 mA and 20 mA values were programmed based on what the PTs and CTs used by the Real Power Sensor were ranged for (4 mA=zero, 20 mA=unit power level at 5 A CT current).

Because the Real Power Sensor is self powered (provides it's own loop power), the 505E back cover was removed, JPR8 was removed, and JPR9 was installed.

It was desired to switch to Frequency control at all times, if the plant became isolated form the Utility bus. (Use Freq Arm/Disarm?—No)

EXTR / ADM CONTROL:
The Extr/Adm control loop is defaulted to receive an Adm or Extr/Adm pressure or flow signal through Analog Input #1 (Analog Input #1 Function: Extr/Adm Input). The input's 4 mA and 20 mA values were programmed based on what the pressure transducer was ranged/calibrated for.

Since a two wire, loop powered transducer is used to sense the pressure level, the 505E back cover was removed, JPR11 was removed, and JPR10 was installed.

Because of where the Extr/Adm transducer was placed with respect to the LP valve (refer to Figure 2-4), no input inversion was required. To increase turbine extr/adm header pressure, the HP valve must increase and the LP valve must decrease. This is considered a direct action and does not require the input to inverted. (Invert Extr/Adm Input?—No)

In this application, because the Extr/Adm PID is not sharing control of the extr/adm pressure with another controller, Droop is not required. (Extr/Adm Droop = 0%)

TURBINE PERFORMANCE VALUES:
Because it is desired to hold turbine load constant for a changing Extr/Adm flow demand, and vice versa the "Coupled HP & LP" ratio/limiter mode is used with this application. (Use Decoupling?—No)

From the turbine's steam map or performance envelope (provided with the turbine from the turbine manufacturer), the turbine's operating data/limits were entered as described in Volume #1 of this manual.

This application's turbine has the capability for controlled extraction or admission steam. (Extraction & Admission?—Yes)

With this application, Setpoint Tracking is used to allow the 505E to track header pressure before being enabled, thus allowing a bumpless transfer into header pressure control. (Use Setpoint Tracking? Yes)

With this turbine, the turbine manufacture, requires that during normal operation the HP valve never be closed less than 5% to allow for adequate cooling steam through the turbine's front stages. This minimum lift is only activated after extr/adm is enabled and HP is above the minimum level. (Min HP lift (%) = 5)

When the turbine is on an operating limit and only one valve is available to control with, turbine load is the desired parameter to be controlled (Extr/Adm pressure control will be sacrificed). Since turbine/generator load is being controlled with the Speed PID (the ratio limiter's "S" term) Speed priority is selected. (Speed Control Priority?—Yes)

When the turbine is on the LP Maximum Limiter (100% open), turbine/ generator load is the desired parameter to be controlled (Extr/Adm pressure control will be sacrificed). Since turbine/generator load is being controlled with the Speed PID (the ratio limiter's "S" term) Speed priority is selected. (LP Max Lmt E/A Priority?—No)

DRIVER CONFIGURATION:
Because the Digital Remote Final Driver used to interface with the servo assembly only accepts a 4–20 mA valve demand signal, the 505E was configured to output a 4–20 mA valve demand signal. (Act #1 (HP) is 4–20ma?—Yes), (Act #2 (LP) is 4–20ma?—Yes)

Dither is a low frequency AC current modulated on to the 505E's DC actuator-drive current to reduce stiction in linear type actuators. Because the 505E's actuator output is connected to the DRFD, dither was not required or used with this application. (Act 1 (HP) Dither = 0.0%) (Act 2 (LP) Dither = 0.0%)

AUXILIARY CONTROL:
The Auxiliary control loop was configured to receive a utility tie line power signal through Analog input #3. (Analog Input #3 Function: Auxiliary Input) The minimum analog input value was programmed for import power based on the tie line power level at –5A CT current (Input #3 4 mA Value =—XXXX) The maximum analog input value was programmed for export power based on the tie line power level at +5A CT current (Input #3 20 mA Value = +XXXX)

Since the RPS's KW readout is self powered, the 505E back cover was removed, JPR14 was removed, and JPR15 was installed.

The utility-tie Real Power Sensor's CT inputs were wired to allow the RPS's 4 mA value to represent full import power and the RPS's 20 mA value to represent full export power. Because this signal is directly proportional to turbine inlet valve position, no input inversion is required. (Invert Aux Input?—No)

The Auxiliary PID was programmed to be enabled and disabled on command. (Use Aux Enable?—Yes)

The 505E was configured to accept a contact from a plant distributed control system to enable and disable import/export control. (Contact Input #3 Function: Aux Control Enable)

In this application, because the Auxiliary PID is not sharing control of the plant import/export power with another controller, Droop is not required. (Aux Droop = 0%)

With this application, it was desirable to only allow the Auxiliary PID to be enabled if paralleled to the utility. (Tiebkr Open Aux Dsbl?—Yes), (Genbkr Open Aux Dsbl?—Yes)

AUTO SYNCHRONIZING:
The 505E's Analog input #6 was programmed to receive the DSLC's speed bias signal for automatic synchronization (Analog Input #6 Function: Synchronizing Input) With this configuration, the analog input's range is defaulted to a certain gain value for best performance, thus the input's 4 mA and 20 mA settings are not used, and do not require programming.

A contact input was programmed to enable the Synchronizing analog input (Contact Input #4 Function: Sync Enable)

Starting & Run Mode Notes for Example 4:
Starting and ramping to an idle or minimum speed position can be performed automatically, semi-automatically, or manually. After the unit is started, the Idle/ Rated or Auto Start Sequence functions, if programmed, can be used to assist ramping the control to a rated speed position. Alternatively, an operator can give a manual raise command to increase turbine speed as desired.

After the unit has been started and is controlling at a rated speed position, the turbine generator can be synchronized. This can be done manually or automatically. The system operator can select automatic synchronization through the Auto-Sync select switch (SW1 in Figure 2-4). When this switch is closed the 505E's Synchronizing input is enabled and the DSLC's automatic synchronizing function selected.

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

When the plant-to-utility tie line/breaker is closed and the unit generator breaker closes, the 505E steps the speed/load setpoint up to a minimum load level to reduce the chance of reverse powering or motoring the generator. This minimum load level is based on the speed/load setpoint and is defaulted to a "3% or xxx RPM" step change of the speed/load setpoint. The defaulted value is adjustable through the 505E's Service mode (BREAKER LOGIC, MIN LOAD BIAS = xxx rpm).

After synchronization the 505E's load setpoint can be positioned through raise and lower speed/load setpoint contacts, a programmed 4–20 mA input, Modbus commands, or the 505E service panel.

Admission or Extr/Adm control can be enabled any time after the generator breaker is closed. To perform a bumpless transfer into Adm or Extr/Adm control the pressures on each side of the Adm Trip-&-Throttle valve should be matched. The 505E has a manual demand signal to allow operators to manually vary the pressure on the turbine side of the Adm T&T valve. Once these pressures are matched the operator can open the T&T valve, and then issue an Extr/Adm control enable command. The manual demand signal's raise and lower, and the Extr/Adm enable/disable commands can all be issued through the 505E's service panel, contact inputs, or Modbus communications.

When a letdown station is used as a backup to the turbine extraction pressure controller, it is required that the letdown station's setpoint be lower than that of the 505E extraction control's setpoint to prevent fighting and potential instability between the controllers.

With this configuration, Import/Export control (Auxiliary PID) can be enabled at any time after the utility tie breaker and generator breaker input contacts are closed. Auxiliary control can be enabled through the programmed contact, a Modbus command, or the 505E service panel. Because the Auxiliary Setpoint tracks plant Import/Export power before being enabled, the transfer to Auxiliary control is bumpless. Once enabled, the Auxiliary PID's setpoint can then be positioned to the desired import or export level.

Because of the 505E's configuration, this unit will automatically switch to Frequency control upon the opening of the plant-to-utility tie breaker.

Example 5—Inlet Pressure Control with Isochronous Loadsharing Control in Island Mode

(Extraction Turbine, Decoupled Inlet mode, Coupled HP & LP mode)
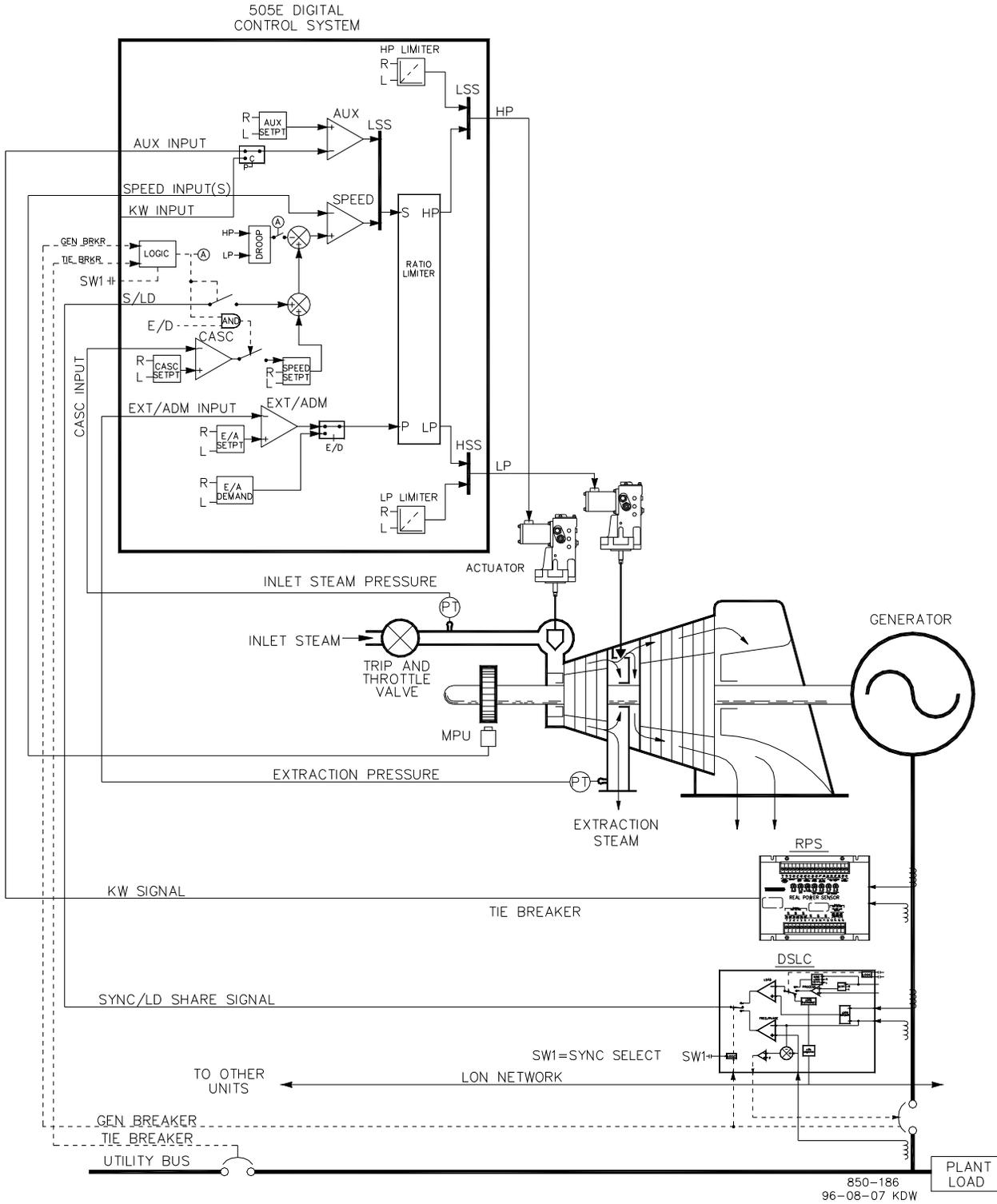
Figure 2-5. Inlet Pressure Control with Isochronous Loadsharing Control in Island Mode

For this application, it is desired to control Inlet Pressure when paralleled to the utility, and Plant Frequency while loadsharing with three other units, when isolated from the utility. With this type of application, when paralleled to the utility load varies based on plant process steam demand and, when isolated, load varies based on plant power demand. Other applications may or may not utilize all the functionality shown in Figure 2-5 and described below.

With this application, turbine inlet header pressure control is performed within the 505E through the Cascade PID controller. This is an ideal controller for this type of function because it can be enabled and disabled as desired by a system operator. This gives a system operator full authority of when to transfer process pressure control to or from a letdown station or turbine bypass valve.

Extraction pressure is controlled by the Extr/Adm PID. This PID controller can be enabled automatically or manually depending on configuration. In all cases the 505E starts up with the Extr/Adm PID disabled and the LP valve at its maximum open position. This allows a turbine to warm-up in a uniform manner. With this application the Extr/Adm setpoint is only varied through the 505E's front panel. Optionally the 505E could be programmed to have the Extr/Adm setpoint varied through discrete inputs, a 4–20 mA signal, or Modbus communications.

During normal operation, unit load is determined by the Cascade PID which is controlling inlet header pressure. Because turbine load may vary greatly, a limiter is used to protect the generator from being over powered. This protection is performed by the Auxiliary PID configured as a limiter. By configuring the Auxiliary PID as a limiter and using the generator load input as the PID's controlling parameter, the maximum generator load can be limited.

This application uses a DSLC for synchronization and isochronous loadsharing. With this configuration, the DSLC is disabled when the generator is paralleled to the utility and enabled when isolated from the utility. When the unit is paralleled to the utility, the DSLC is disabled and the 505E's internal load setpoint or Cascade PID (inlet header pressure) is used to control/set unit load. When the plant becomes isolated from the utility (utility tie breaker opens), the DSLC is enabled, Cascade control is disabled, and the 505E is switched to a Frequency control / loadsharing mode.

A DSLC can only interface to a 505E through an analog input signal. The 505E's Analog Input #6 is the only analog input directly compatible with the DSLC, thus this input is programmed to receive the DSLC's Speed Bias signal. When a Sync/ Ld Share analog input is programmed, the input is automatically enabled if the generator breaker input is closed and the utility tie breaker input is open.

Before the generator breaker is closed, the Sync/Ld Share input can be enabled to allow automatic synchronization by the DSLC. This synchronizing function/input can be enabled through a contact input, function key, Modbus command, or the 505E service panel. As shown in Figure 2-5 a panel mounted (DPST) switch is used with this application to select automatic synchronization in both the DSLC and 505E. Alternatively, this switch could come from a 505E relay programmed to energize for an F3/F4 Key Selected, a Modbus Command Selected, Sync Enabled, or a Speed Switch Level Reached.

All 505E PID controller setpoints (Speed, Extr/Adm, Auxiliary, Cascade) may be changed through programmed raise and lower contacts, programmed 4–20 mA inputs, Modbus commands, or the 505E service panel.

The following list of notes are provided as a reference for application programmers to follow when programming the 505E to achieve any control and limiting actions shown in Figure 2-5.

505E Programming Notes for Example 5:
OPERATING PARAMETERS:
This is a Generator application. (Generator Application?—Yes)

Generator and Utility Tie breaker contact inputs are required to be programmed when a generator application is selected. (Contact Input #1 Function: Generator Breaker), (Contact Input #2 Function: Utility Tie Breaker)

Because the 505E is configured to control inlet pressure during normal operation, the ratio limiter is programmed to use the Decoupled Inlet mode of action. KW droop, however, acts as a form of valve coupling (both valves affect load) and will negate the decoupling action of the ratio limiter if used. For this reason, Speed droop is used with this application. (Use KW Droop?—No)

To achieve good response and load adjustment resolution, Droop was set to 5% of rated speed. (Droop = 5 %)

It was desired to switch to Frequency control at all times, if the plant became isolated form the Utility bus. (Use Freq Arm/Disarm?—No)

EXTR / ADM CONTROL:
The Extr/Adm control loop is defaulted to receive an extraction pressure or flow signal through Analog Input #1 (Analog Input #1 Function: Extr/Adm Input). The input's 4 mA and 20 mA values were programmed based on what the pressure transducer was ranged/calibrated for.

Since a two wire, loop powered transducer is used to sense the pressure level, the 505E back cover was removed, JPR11 was removed, and JPR10 was installed.

Because of where the extraction transducer was placed with respect to the LP valve (refer to Figure 2-5), no input inversion was required. To increase turbine extraction header pressure, the HP valve must increase and the LP valve must decrease. This is considered a direct action and does not require the input to inverted. (Invert Extr/Adm Input?—No)

In this application, because the Extr/Adm PID is not sharing control of the extraction pressure with another controller, Droop is not required. (Extr/Adm Droop = 0%)

TURBINE PERFORMANCE VALUES:
Because it is desired to hold inlet header pressure constant for a changing extraction flow demand, and vice versa the "Decoupled Inlet" ratio/limiter mode is used with this application. (Use Decoupling?—Yes), (Decoupled Inlet (HP)?—Yes)

From the turbine's steam map or performance envelope (provided with the turbine from the turbine manufacturer), the turbine's operating data/limits were entered as described in Volume #1 of this manual.

This application's turbine can only extract steam. (Extraction Only?—Yes)

Automatic enabling/disabling was selected with this application to allow an operator to automatically or manually enable/disable Extraction control (lower the LP valve limiter to min/raise the LP valve limiter to max). The automatic enable/disable routine may be stopped at any time, and continued manually, or restarted as desired. (Use Automatic Enable?—Yes)

With this example application when the turbine is on an operating limit and only one valve is available to control with, inlet header pressure is the desired parameter to be controlled (extraction pressure control will be sacrificed). Since inlet header pressure is being controlled with the Cascade PID (the ratio limiter's "S" term) Speed priority is selected. (Speed Control Priority?—Yes)

With this example application when the turbine is on the LP Maximum Limiter (100% open), inlet pressure is the desired parameter to be controlled (extraction pressure control will be sacrificed). Since inlet pressure is being controlled with the Cascade PID (the ratio limiter's "S" term) Speed priority is selected. (LP Max Lmt E/A Priority?—No)

CASCADE CONTROL:
The Cascade control loop was configured to receive an inlet header pressure signal through Analog Input #2. (Analog Input #2 Function: Cascade Input) he input's 4 mA and 20 mA values were programmed based on what the pressure transducer was ranged/calibrated for.

Because a two wire, loop powered transducer is used to sense the pressure level, the 505E back cover was removed, JPR9 was removed, and JPR8 was installed.

The 505E was configured to accept a contact from a panel mounted switch to externally enable and disable inlet header pressure control. (Contact Input #3 Function: Casc Control Enable)

The Cascade Input was inverted to allow the correct control action. To increase turbine inlet header pressure, the governor valve position must decrease. This is considered an indirect action and requires the input to be inverted. (Invert Cascade Input?—Yes)

With this application, Setpoint Tracking is used to allow the 505E to track inlet header pressure before being enabled, thus allowing a bumpless transfer to inlet header pressure control. (Use Setpoint Tracking? No)

To protect the generator from being reverse powered by the Cascade PID, the 'Speed Setpoint Lower Limit' value was set to 3% (5.4 rpm if rated speed is 3600 rpm and using 5% droop) above synchronous speed.

In this application, because the Cascade PID, during normal operation, is not sharing control of inlet header pressure with another controller, Droop is not required. (Cascade Droop = 0%)

AUXILIARY CONTROL:
The Auxiliary control loop was configured to receive a generator load signal from a Real Power Sensor, through Analog Input #3. (Analog Input #3 Function: Auxiliary Input) The input's 4 mA and 20 mA values were programmed based on what the PTs and CTs used by the Real Power Sensor were ranged for (4 mA=zero, 20 mA=unit power level at 5 A CT current).

Because the Real Power Sensor is self powered (provides it's own loop power), the 505E back cover was removed, JPR14 was removed, and JPR15 was installed.

Unit load is directly proportional to turbine inlet valve position, thus no input inversion is required. (Invert Aux Input?—No)

The Auxiliary PID was programmed to perform as a load limiter. (Use Aux Enable?—No)

In this case, because the Auxiliary PID is used only as a limiter, and is not sharing control of generator load with another controller, Droop is not required. (Aux Droop = 0%)

With this application, it was desirable to only enable the Auxiliary PID if paralleled to the utility. (Tiebkr Open Aux Dsbl?—Yes), (Genbkr Open Aux Dsbl?—Yes)

SYNC/LD SHARING:
The 505E's Analog Input #6 was programmed to receive the DSLC's speed bias signal for automatic synchronization, and load sharing (Analog Input #6 Function: Sync/Load Share Input). With this configuration, the analog input's range is defaulted to a certain gain value, for best performance, thus the input's 4 mA and 20 mA settings are not used and do not require programming.

A contact input was programmed to enable the Sync/Load Share analog input and allow synchronization through the DSLC before the generator breaker is closed. (Contact Input #4 Function: Sync/Ld Share Enable)

Starting & Run Mode Notes for Example 5:
Starting and ramping to an idle or minimum speed position can be performed automatically, semi-automatically, or manually. After the unit is started, the Idle/Rated or Auto Start Sequence functions, if programmed, can be used to assist ramping the control to a rated speed position. Alternatively, an operator can give a manual raise command to increase turbine speed as desired.

When the unit has been started and is controlling at a rated speed position, the turbine generator can be synchronized. This can be done manually or automatically. The system operator can select automatic synchronization through the Auto-Sync select switch (SW1 in Figure 2-5). When this switch is closed the 505E's Sync/Load Sharing input is enabled and the DSLC's automatic synchronizing function is selected.

After synchronization, generator load is determined by the mode of operation selected, (the position of the utility tie breaker contact input). If the utility tie breaker contact is closed, generator load is determined by the 505E's internal load setpoint or, when enabled, inlet header pressure control (Cascade control). If the utility tie breaker contact is open, generator load is determined by the DSLC. The DSLC can be configured to operate in several different load control modes. For this application the DSLC is only used for isochronous loadsharing, when the plant is isolated from the utility.

In this plant four generating units use DSLCs and, upon the plant-to-utility tie breaker opening, they all switch to Frequency control and communicate with each other via a digital LON network to share load. Thus plant frequency is controlled by all units and plant load is shared proportionally by all four units. With this configuration, plant frequency will be the average frequency of all units. The 505E has a feature that resets its frequency setpoint to the 'RATED SPEED SETPOINT' setting upon the utility tie breaker opening, thus assuring that all units will be at synchronous speed. The DSLC's Frequency Trimmer function may also be programmed to trim system frequency to a desired frequency.

Cascade control (turbine inlet header pressure) can be enabled at any time after the Utility Tie breaker and Generator breakers are closed, through a contact input, Modbus command or the 505E service panel. When Cascade control is enabled, if the actual inlet header pressure does not match the Cascade setpoint, the control will automatically ramp turbine load at the "Speed Setpoint Slow Rate" setting until the inlet header pressure does match the setpoint. Once in-control, the Cascade PID will no longer be limited by the "Speed Setpoint Slow Rate" setting. The 505E's ratio/limiter uses the Coupled HP & LP mode when Cascade Control is disabled, and the Decoupled Inlet mode when Cascade control is enabled.

Example 6—Import/Export Control or Exhaust Pressure Control with Isoch Load Sharing in Island Mode
(Extraction Turbine, Decoupled Exhaust mode, Coupled HP & LP mode)
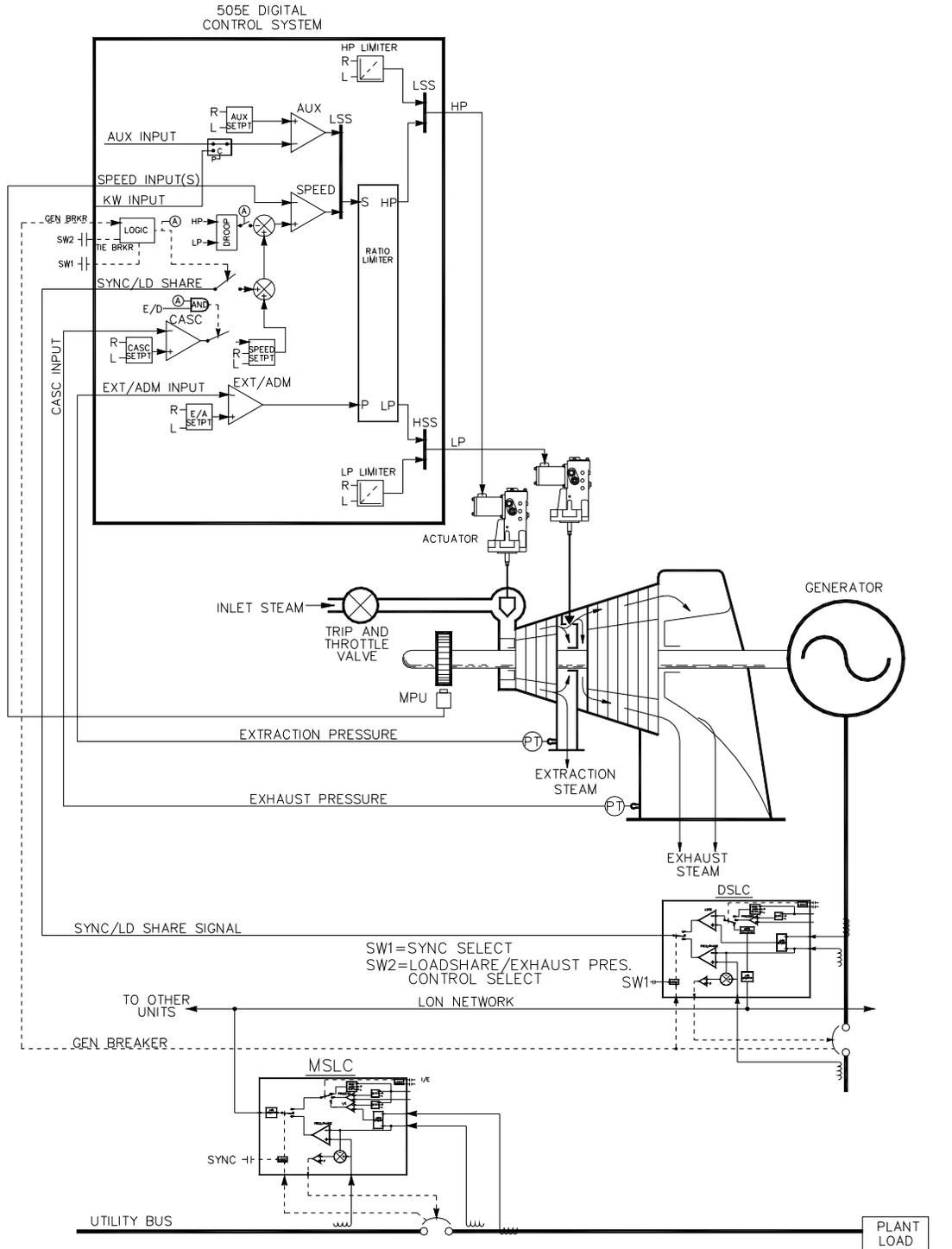
Figure 2-6. Import/Export Control or Exhaust Pressure Control with Isoch Load Sharing in Island Mode

This example utilizes multiple turbine generators, and requires that all units have the capability to control different plant parameters depending on the status and health of each unit. Normal operation is to have one unit control plant process steam (turbine exhaust pressure) and the other units be controlled based on plant import/export demand. Other applications may or may not utilize all the functionality shown in Figure 2-6 and described below.

One unit at a time, based on system health, is used to control plant process steam. The other units are used to control a plant export power level of 5 MW. Because the plant is contractually obligated to provide this level of power to the utility, a 5 MW plant export power level is desired.

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

When a unit is switched to a Manual load control mode, its 505E's internal load setpoint determines unit load. This allows an operator to manually load or unload a unit to a set level if desired.

When a unit is switched to the Plant Process control mode, turbine exhaust pressure control is performed within the 505E through the Cascade PID controller. This is an ideal controller for this type of function because it can be enabled and disabled as desired by a system operator. This gives a system operator full authority of when to transfer process pressure control to or from a letdown station or turbine bypass valve.

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

Extraction pressure is controlled by the Extr/Adm PID. This PID controller can be enabled automatically or manually depending on configuration. In all cases the 505E starts up with the Extr/Adm PID disabled and the LP valve at its maximum open position. This allows a turbine to warm-up in a uniform manner. With this application the Extr/Adm setpoint is only varied through the 505E's front panel. Optionally the 505E could be programmed to have the Extr/Adm setpoint varied through discrete inputs, a 4–20 mA signal, or Modbus communications.

A DSLC interfaces to a 505E through an analog input signal. The 505E's Analog Input #6 is the only analog input directly compatible with the DSLC, thus this input is programmed to receive the DSLC's Speed Bias signal. When a Sync/Ld Share analog input is programmed, the input is automatically enabled if the generator breaker input is closed and the utility tie breaker input is open.

Before the generator breaker is closed, the 505E's Sync/Ld Share analog input can be enabled to allow automatic synchronization by the DSLC. This synchronizing function/input can be enabled through a contact input, function key, Modbus command, or the 505E service panel. As shown in Figure 2-6 a panel mounted (DPST) switch is used, with this application, to select automatic synchronization in both the DSLC and 505E. Alternatively, this switch could come from a 505E relay programmed to energize for an F3/F4 Key Selected, a Modbus Command Selected, Sync Enabled, or a Speed Switch Level Reached.

All 505E PID controller setpoints (Speed, Extr/Adm, Cascade) may be changed through programmed raise and lower contacts, programmed 4–20 mA inputs, Modbus commands, or the 505E service panel.

The following list of notes are provided as a reference for application programmers to follow when programming the 505E to achieve any control and limiting actions shown in Figure 2-6.

505E Configuration Notes for Example 6:
OPERATING PARAMETERS:
This is a Generator application. (Generator Application?—Yes)

Generator and Utility Tie breaker contact inputs are required to be programmed when a generator application is selected. (Contact Input #1 Function: Generator Breaker), (Contact Input #2 Function: Utility Tie Breaker)

Because the 505E is configured to control exhaust pressure during normal operation, the ratio limiter is programmed to use the Decoupled Exhaust mode of action. KW droop, however, acts as a form of valve coupling (both valves affect load) and will negate the decoupling action of the ratio limiter if used. For this reason, Speed droop is used with this application. (Use KW Droop?—No)

To achieve good response and load adjustment resolution, Droop was set to 5% of rated speed. (Droop = 5 %)

It was desired to switch to Frequency control at all times, if the plant became isolated form the Utility bus. (Use Freq Arm/Disarm?—No)

EXTR / ADM CONTROL:
The Extr/Adm control loop is defaulted to receive an extraction pressure or flow signal through Analog Input #1 (Analog Input #1 Function: Extr/Adm Input). The input's 4 mA and 20 mA values were programmed based on what the pressure transducer was ranged/calibrated for.

Since a two wire, loop powered transducer is used to sense the pressure level, the 505E back cover was removed, JPR11 was removed, and JPR10 was installed.

Because of where the extraction transducer was placed with respect to the LP valve (refer to Figure 2-6), no input inversion was required. To increase turbine extraction header pressure, the HP valve must increase and the LP valve must decrease. This is considered a direct action and does not require the input to inverted. (Invert Extr/Adm Input?—No)

In this application, because the Extr/Adm PID is not sharing control of the extraction pressure with another controller, Droop is not required. (Extr/Adm Droop = 0%)

TURBINE PERFORMANCE VALUES:
Because it is desired to hold exhaust pressure constant for a changing extraction flow demand, and vice versa the "Decoupled Exhaust" ratio/limiter mode is used with this application. (Use Decoupling?—Yes), (Decoupled Exhaust (LP)?—Yes)

From the turbine's steam map or performance envelope (provided with the turbine from the turbine manufacturer), the turbine's operating data/limits were entered as described in Volume #1 of this manual.

This application's turbine can only extract steam. (Extraction Only?—Yes)

Automatic enabling/disabling was selected with this application to allow an operator to automatically or manually enable/disable Extraction control (lower the LP valve limiter to min/raise the LP valve limiter to max). The automatic enable/disable routine may be stopped at any time, and continued manually, or restarted as desired. (Use Automatic Enable?—Yes)

When the turbine is on an operating limit and only one valve is available to control with, extraction pressure is the desired parameter to be controlled (exhaust pressure control will be sacrificed). Since extraction pressure is being controlled with the Cascade PID (the ratio limiter's "P" term) Extr/Adm priority is selected. (Speed Control Priority?—No)

To simplify system startup and shutdown, the 505E was programmed to automatically select Extraction pressure priority when the selected permissives are met (LP valve limiter at min, extraction PID in-control). This allows a bumpless transfer into extraction priority. (Auto Switch E/A Priority?—Yes)

CASCADE CONTROL:
The Cascade control loop was configured to receive an exhaust header pressure signal through Analog Input #2. (Analog Input #2 Function: Cascade Input) he 4 mA and 20 mA values were programmed based on what the pressure transducer was ranged/calibrated for.

Since a two wire, loop powered transducer was used to sense the pressure level, the 505E back cover was removed, JPR9 was removed, and JPR8 was installed.

The Function Key F3 was programmed to allow an operator to easily enable and disable Cascade control (F3 Key Performs: Casc Control Enable)

Exhaust header pressure is directly proportional to turbine inlet valve position, thus no input inversion is required. (Invert Cascade Input?—No)

With this application, Setpoint Tracking is used to allow the 505E's Cascade control, when disabled, to track exhaust header pressure being controlled by a letdown station. (Use Setpoint Tracking?—Yes)

To protect the generator from being reverse powered by the Cascade PID, the 'Speed Setpoint Lower Limit' value was set to 3% (5.4 rpm if rated speed is 3600 rpm and using 5% droop) above synchronous speed.

In this case, because the Cascade PID, during normal operation, is not sharing control of exhaust header pressure with another control, Droop is not required. (Cascade Droop = 0%)

SYNC/LD SHARING:

The 505E's Analog Input #6 was programmed to receive the DSLC's speed bias signal for automatic synchronization, and load sharing (Analog Input #6 Function: Sync/Load Share Input). With this configuration, the analog input's range is defaulted to a certain gain value, for best performance, thus the input's 4 mA and 20 mA settings are not used and do not require programming.

A contact input was programmed to enable the Sync/Load Share analog input and allow synchronization through the DSLC before the generator breaker is closed. (Contact Input #4 Function: Sync/Ld Share Enable)

Starting & Run Mode Notes for Example 6:

Starting and ramping to an idle or minimum speed position can be performed automatically, semi-automatically, or manually. After the unit is started, the Idle/ Rated or Auto Start Sequence functions, if programmed, can be used to assist ramping the control to a rated speed position. Alternatively, an operator can give a manual raise command to increase turbine speed as desired.

After the unit has been started and is controlling at a rated speed position, the turbine generator can be synchronized. This can be done manually or automatically. The system operator can select automatic synchronization through the Auto-Sync select switch (SW1 in Figure 2-6). When this switch is closed the 505E's Synchronizing input is enabled and the DSLC's automatic synchronizing function selected.

With this configuration the mode of operation the system operates in is dependent on SW2's position. When SW2 is not selecting the Loadsharing mode, and the generator breaker is closed, unit load is set by the 505E's internal Speed/load setpoint, or the Cascade PID if enabled. Upon the generator breaker closing, the 505E steps the speed/load setpoint up to a minimum load level to reduce the chance of reverse powering or motoring the generator. This minimum load level is based on the speed/load setpoint and is defaulted to a speed setpoint RPM value equal to "3%" turbine/generator load. The defaulted value is adjustable through the 505E's Service mode (Breaker Logic, Min Load Bias = xxx rpm).

After synchronization the 505E's load setpoint can be positioned through raise and lower speed/load setpoint contacts, a programmed 4–20 mA input, Modbus commands, or the 505E service panel.

Since Decoupled Exhaust was the ratio/limiter action programmed with this application, it is recommended that Extraction control be enabled (the LP limiter lowered to min) before Exhaust control (which uses the LP valve to control with). It is also recommended that Cascade control be disabled before Extraction control is disabled (the LP limiter raised). By following these recommended procedures, each control mode can be bumplessly taken into and out of control. The 505E's ratio/limiter uses the Coupled HP & LP mode when Cascade Control is disabled, and the Decoupled Exhaust mode when Cascade control is enabled.

Because the 505E was programmed for the capability to automatically enable Extraction Control, the operator may choose to automatically or manually enable Extraction control. To manually enable Extraction control the operator must issue a LP valve limiter lower command from the 505E service panel, a contact input, or through Modbus communications. The LP valve limiter must be taken to its minimum position to fully enable Extraction control.

The enabling routine, which automatically lowers the LP valve limiter, may be issued from the 505E's service panel, contact input, or through Modbus communications. This routine automatically ramps the LP valve to its minimum position and may be stopped at any time by momentarily issuing a LP valve limiter raise or lower command. Once the automatic enabling routine has been stopped it may be restarted/enabled at any time by issuing a disable command followed by an Extr/Adm control enable command or, once stopped, the operator may continue the routine manually. (Disabling of Exhaust control can also be performed manually or automatically.)

Cascade control (turbine exhaust pressure) can be enabled at any time after the utility tie breaker and generator breaker input contacts are closed. Cascade control can be enabled through a programmed contact, Modbus command, or the 505E service panel. Exhaust pressure control can be transferred from a letdown station to 505E Cascade Control in one of the following ways; enabling Cascade control, and backing down the letdown station' s setpoint, or enabling Cascade control and raising the Cascade's setpoint. When a letdown station is used as a backup to the turbine pressure controller, it is required that the letdown station's setpoint be lower than that of the 505E control's setpoint to prevent fighting and potential instability between the controllers.

After exhaust pressure control has been transferred to the 505E's Cascade PID, the letdown station or turbine bypass valve must be closed or in a manual control mode. This will stop the two controllers (505E Cascade PID and system letdown station) from fighting for control of one parameter and causing system instability. If both a turbine bypass valve and the turbine's flow are required to satisfy the header flow requirements, droop is required in one of the control loops for stability. When a letdown station is used as a backup to the turbine pressure controller, it is required that the letdown station's setpoint be lower than that of the 505E control's setpoint to prevent fighting and potential instability between the controllers.

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

During normal operation, one unit is controlling plant process steam and the other units are in loadsharing control mode. The units sharing load are loaded based on the MSLC plant load demand. If the plant should become isolated from the utility, the MSLC is disabled and the loadsharing units will share plant load. When desired, the MSLC can be enabled to re-synchronize the plant bus to the utility bus and close the plant-to-utility tie breaker. After synchronization the MSLC will either ramp plant power to a 5 MW export power level or ramp plant load to a base load setting, depending on the mode of operation selected.

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

Example 7—Inlet Pressure Control & EXHAUST PRESSURE CONTROL with Generator Power Limiting
(Extraction Only Turbine, Decoupled HP & LP mode)
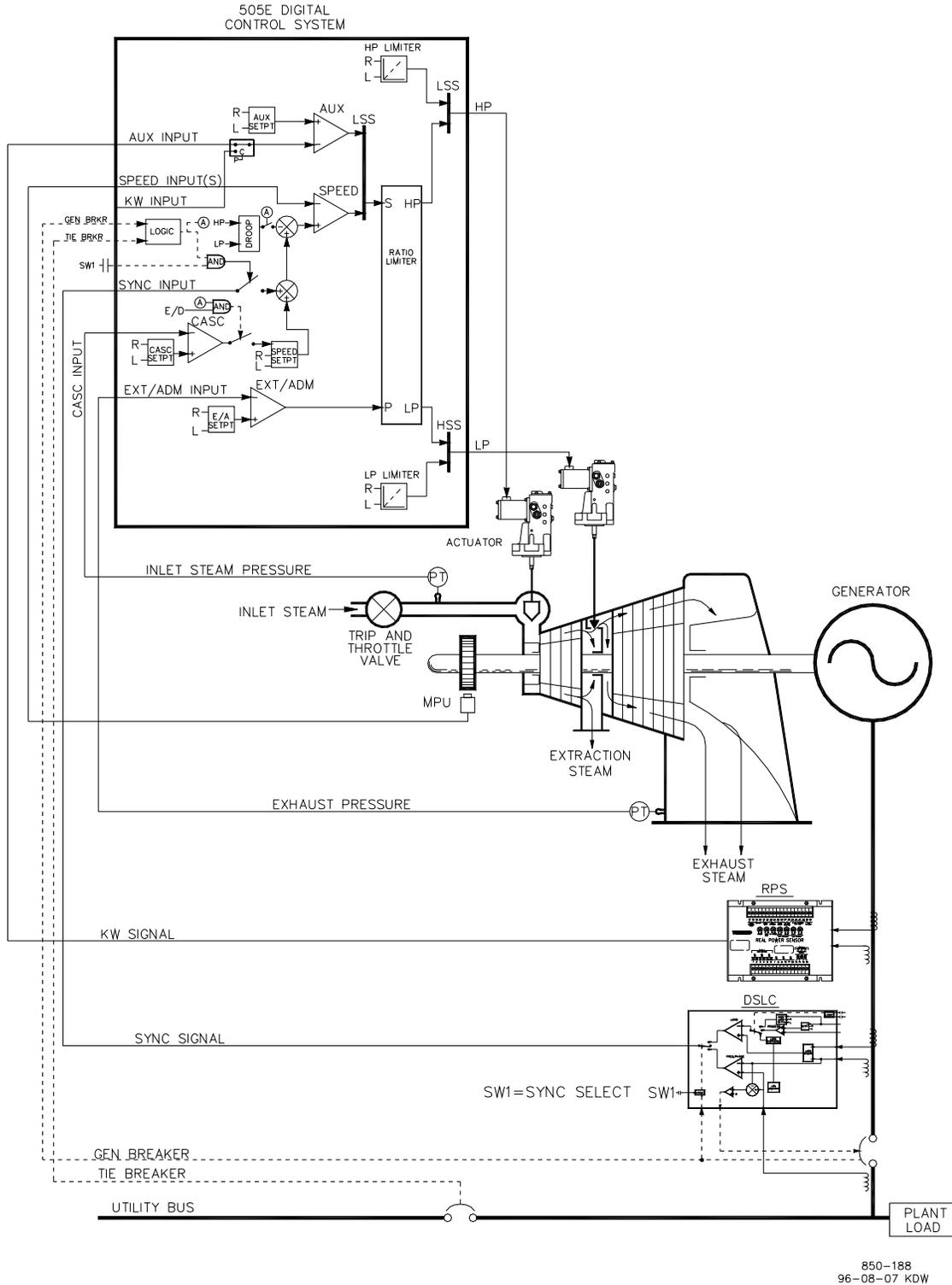
Figure 2-7. Inlet Pressure Control, Exhaust Pressure Control with Generator Power Limiting

This is an example of a typical turbine generator application where the turbine inlet and exhaust header pressures are desired to be controlled and the turbine's extraction header pressure is controlled by a system letdown station. With this type of application, turbine load varies based on the plant process steam demand. Both the Auxiliary and Cascade modes were used for this example application. Other applications may or may not utilize all the functionality shown in Figure 2 7 and described below.

With this application turbine inlet header pressure control is performed within the 505E through the Cascade PID controller. This is an ideal controller for this type of function because it can be enabled and disabled as desired by a system operator. This gives a system operator full authority of when to transfer process pressure control to or from a letdown station or turbine bypass valve.

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

Turbine Exhaust pressure is controlled by the Extr/Adm PID. This PID controller can be enabled automatically or manually depending on configuration. In all cases the 505E starts up with the Extr/Adm PID disabled and the LP valve at its maximum open position. This allows a turbine to warm-up in a uniform manner. With this application the Extr/Adm setpoint is only varied through the 505E's front panel. Optionally the 505E could be programmed to have the Extr/Adm setpoint varied through discrete inputs, a 4–20 mA signal, or Modbus communications.

This application uses a DSLC for synchronization only. Because the DSLC interfaces to the 505E through an analog signal, a 505E analog input must be programmed. The 505E's Analog Input #6 is the only analog input directly compatible with the DSLC, thus this input is programmed to receive the DSLC's Speed Bias signal. When a Synchronizing input/function is programmed, the input can be enabled through a contact input, function key, Modbus command, or the 505E service panel. As shown in Figure 2-7 a panel mounted (DPST) switch is used with this application to select automatic synchronization in both the DSLC and 505E. Alternatively, this switch could come from a 505E relay programmed to energize for an F3/F4 Key Selected, a Modbus Command Selected, Sync Enabled, or a Speed Switch Level Reached.

All 505E PID controller setpoints (Speed, Extr/Adm, Auxiliary, Cascade) may be changed through programmed raise and lower contacts, programmed 4–20 mA inputs, Modbus commands, or the 505E service panel.

The following list of notes are provided as a reference for application programmers to follow when programming the 505E to achieve any of the control and limiting actions shown in Figure 2-7.

505E Configuration Notes for Example 7:
OPERATING PARAMETERS:
This is a Generator application. (Generator Application?—Yes)

Generator and Utility Tie breaker contact inputs are required to be programmed when a generator application is selected. (Contact Input #1 Function: Generator Breaker), (Contact Input #2 Function: Utility Tie Breaker)

Because the 505E is configured to control both turbine inlet and exhaust pressures during normal operation, the ratio limiter is programmed to use the Decoupled HP & LP mode of action. KW droop, however, acts as a form of valve coupling (both valves affect load) and will negate the decoupling action of the ratio limiter if used. For this reason, Speed droop is used with this application. (Use KW Droop?—No)

To achieve good response and load adjustment resolution, Droop was set to 5% of rated speed. (Droop = 5 %)

It was desired to switch to Frequency control at all times, if the plant became isolated form the Utility bus. (Use Freq Arm/Disarm?—No)

EXTR / ADM (EXHAUST) CONTROL:
The Extr/Adm control loop is defaulted to receive a pressure or flow signal through Analog Input #1 (Analog Input #1 Function: Extr/Adm Input). The input's 4 mA and 20 mA values were programmed based on what the pressure transducer was ranged/calibrated for.

Since a two wire, loop powered transducer is used to sense the pressure level, the 505E back cover was removed, JPR11 was removed, and JPR10 was installed.

Because of where the exhaust header transducer is placed with respect to the LP valve (refer to Figure 2-7), an input inversion is required. To increase turbine exhaust header pressure, the HP valve position must increase and the LP valve position must increase. This is considered an indirect action and requires an input inversion. (Invert Extr/Adm Input?—Yes)

In this application, because the Extr/Adm PID is not sharing control of the exhaust pressure with another controller, Droop is not required. (Extr/Adm Droop = 0%)

TURBINE PERFORMANCE VALUES:
Because it is desired to hold inlet pressure constant for a changing exhaust flow demand, and vice versa the "Decoupled HP & LP" ratio/limiter mode is used with this application. (Use Decoupling?—Yes), (Decoupled HP & LP?—Yes)

This application's turbine can only extract steam. (Extraction Only?—Yes)

Automatic enabling/disabling was selected with this application to allow an operator to automatically or manually enable/disable Extraction control (lower the LP valve limiter to min/raise the LP valve limiter to max). The automatic enable/disable routine may be stopped at any time, and continued manually, or restarted as desired. (Use Automatic Enable?—Yes)

When the turbine is on an operating limit and only one valve is available to control with, inlet pressure is the desired parameter to be controlled (extraction pressure control will be sacrificed). Since inlet pressure is being controlled with the Cascade PID (the ratio limiter's "S" term) Speed priority is selected. (Speed Control Priority?—Yes)

When the turbine is on the LP Maximum Limiter (100% open), inlet pressure is the desired parameter to be controlled (extraction pressure control will be sacrificed). Since inlet pressure is being controlled with the Cascade PID (the ratio limiter's "S" term) Speed priority is selected. (LP Max Lmt E/A Priority?—No)

CASCADE CONTROL:
The Cascade control loop was configured to receive an inlet header pressure signal through Analog Input #2. (Analog Input #2 Function: Cascade Input) he input's 4 mA and 20 mA values were programmed based on what the pressure transducer was ranged/calibrated for.

Because a two wire, loop powered transducer is used to sense the pressure level, the 505E back cover was removed, JPR9 was removed, and JPR8 was installed.

The 505E was configured to accept a contact from a panel mounted switch to externally enable and disable inlet header pressure control. (Contact Input #3 Function: Casc Control Enable)

The Cascade Input was inverted to allow the correct control action. To increase turbine inlet header pressure, the governor valve position must decrease. This is considered an indirect action and requires the input to be inverted. (Invert Cascade Input?—Yes)

With this application, Setpoint Tracking is used to allow the 505E to track inlet header pressure before being enabled, thus allowing a bumpless transfer to inlet header pressure control. because the system's pressure setpoint never changes, thus system start-up is simpler. (Use Setpoint Tracking?—No)

To protect the generator from being reverse powered by the Cascade PID, the 'Speed Setpoint Lower Limit' value was set to 3% (5.4 rpm if rated speed is 3600 rpm and using 5% droop) above synchronous speed.

In this case, because the Cascade PID, during normal operation, is not sharing control of inlet header pressure with another controller, Droop is not required. (Cascade Droop = 0%)

AUXILIARY CONTROL:
The Auxiliary control loop was configured to receive a generator load signal from a Real Power Sensor, through Analog Input #3. (Analog Input #3 Function: Auxiliary Input) The input's 4 mA and 20 mA values were programmed based on what the PTs and CTs used by the Real Power Sensor were ranged for (4 mA=zero, 20 mA=unit power level at 5 A CT current).

Because the Real Power Sensor is self powered (provides it's own loop power), the 505E back cover was removed, JPR14 was removed, and JPR15 was installed.

Unit load is directly proportional to turbine inlet valve position, thus no input inversion is required. (Invert Aux Input?—No)

The Auxiliary PID was programmed to perform as a load limiter.

In this case, because the Auxiliary PID is used only as a limiter, and is not sharing control of generator load with another control, Droop is not required. (Aux Droop = 0%)

With this application, it was desirable to only enable the Auxiliary PID if paralleled to the utility. (Tiebkr Open Aux Dsbl?—Yes), (Genbkr Open Aux Dsbl?—Yes)

AUTO SYNCHRONIZING:
The 505E's Analog Input #6 was programmed to receive the DSLC's speed bias signal for automatic synchronization (Analog Input #6 Function: Synchronizing Input) With this configuration, the analog input's range is defaulted to provide a certain gain factor for best performance, thus the input's 4 mA and 20 mA program settings are not used do not require programming.

A contact input was programmed to enable the Synchronizing analog input (Contact Input #4 Function: Sync Enable)

Starting & Run Mode Notes for Example 7:
Starting and ramping to an idle or minimum speed position can be performed automatically, semi-automatically, or manually. After the unit is started, the Idle/Rated or Auto Start Sequence functions, if programmed, can be used to assist ramping the control to a rated speed position. Alternatively an operator can give a manual raise command to increase turbine speed as desired.

After the unit has been started and is controlling at a rated speed position, the turbine generator can be synchronized. This can be done manually or automatically. The system operator can select automatic synchronization through the Auto-Sync select switch (switch SW1 in Figure 2-7). When this switch is closed, the 505E's Synchronizing input is enabled and the DSLC's automatic synchronizing function is selected.

When the plant-to-utility tie-line breaker is closed and the unit generator breaker closes, the 505E steps the speed/load setpoint up to a minimum load level to reduce the chance of reverse powering or motoring the generator. This minimum load level is based on the speed/load setpoint and is defaulted to a "3%" step change of the speed/load setpoint. The defaulted 3% minimum load value (stored as a setpoint "rpm" change) is adjustable through the 505E's Service mode (Breaker Logic, Min Load Bias = X rpm).

After synchronization the 505E's load setpoint can be positioned through raise and lower Speed/Load setpoint contacts, a programmed 4–20 mA input, Modbus commands, or the 505E service panel. This load control mode may be used to slowly increase turbine load, and take control away from a letdown station or turbine bypass valve.

Cascade control (turbine inlet header pressure) can be enabled at any time after the Utility Tie breaker and Generator breakers are closed, through a contact input, Modbus command or the 505E service panel. When Cascade control is enabled the Cascade setpoint will match the inlet header pressure level at that time, thus a bumpless transfer to inlet header pressure control is accomplished. After the Cascade controller has been enabled, the operator can increase or decrease the control setpoint as desired. The 505E's ratio/limiter uses the Coupled HP & LP mode when Cascade Control is disabled and the Decoupled Exhaust mode when Cascade control is enabled.

Because the 505E was programmed for the capability to automatically enable Extraction Control, the operator may choose to automatically or manually enable Extraction control. To manually enable Extraction control, the operator must issue a LP valve limiter lower command from the 505E service panel, a contact input, or through Modbus communications. The LP valve limiter must be taken to its minimum position to fully enable Extraction control.

The enabling routine, which automatically lowers the LP valve limiter, may be issued from the 505E's service panel, contact input, or through Modbus communications. This routine automatically ramps the LP valve to its minimum position and may be stopped at any time by momentarily issuing a LP valve limiter raise or lower command. Once the automatic enabling routine has been stopped it may be restarted/enabled at any time by issuing a disable command followed by an Extr/Adm control enable command or, once stopped, the operator may continue the routine manually. (Disabling of Exhaust control can also be performed manually or automatically.)

When a letdown station is used as a backup to the turbine extraction pressure controller, it is required that the letdown station's setpoint be lower than that of the 505E extraction control's setpoint to prevent fighting and potential instability between the controllers.

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

Example 8—ADMISSION Steam Turbine Control with Bootstrap Start-up

(Admission Turbine, Coupled HP & LP mode)
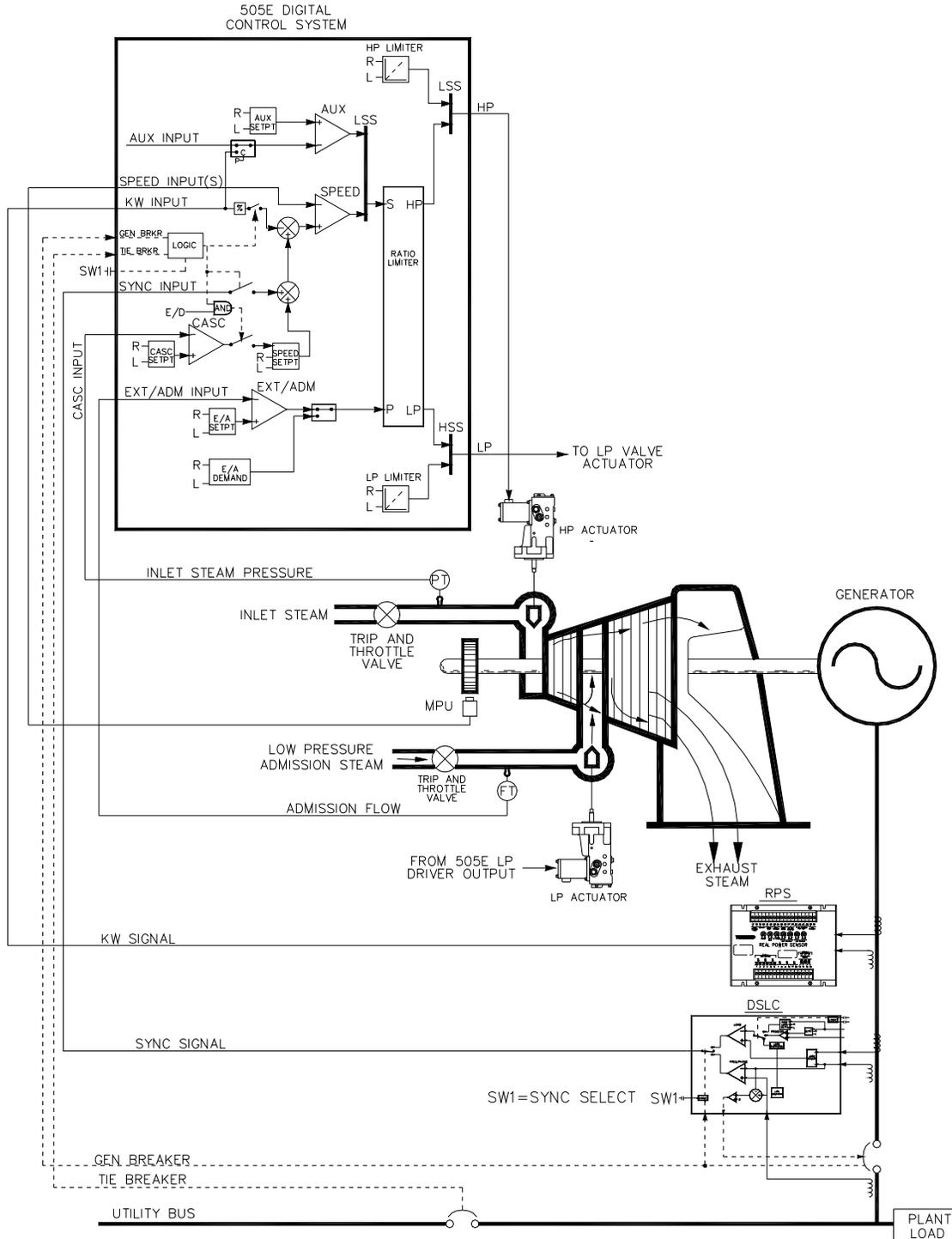
Figure 2-8. Admission Steam Turbine Control with Bootstrap Startup

This is an example of a typical turbine generator application where turbine load and admission flow are controlled. However, this application requires that the turbine be started with low pressure admission steam until the refinery can be bootstrapped up to begin producing high pressure inlet steam. Other applications may or may not use all the functionality shown in Figure 2-8 and described below.

With this application, a Real Power Sensor is used to sense generator load and allow the 505E Speed/load PID to control and limit generator load.

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

Adm pressure is controlled by the Extr/Adm PID. This PID must be manually enabled once the pressures on both sides of the admission trip-and-throttle valve have been matched. A manual demand signal is available to allow an operator to match the pressures across the Adm T&T valve before enabling the control loop. With this application the Extr/Adm setpoint is only varied through the 505E's front panel. Optionally the 505E could be programmed to have the Extr/Adm setpoint varied through discrete inputs, a 4–20 mA signal, or Modbus communications.

This application uses a DSLC for synchronization only. Because the DSLC interfaces to the 505E through an analog signal, a 505E analog input must be programmed. The 505E's Analog Input #6 is the only analog input directly compatible with the DSLC, thus this input is programmed to receive the DSLC's Speed Bias signal. When a synchronizing input/function is programmed, the input can be enabled through a contact input, function key, Modbus command, or the 505E service panel. As shown in Figure 2-8 a panel mounted (DPST) switch is used with this application to select automatic synchronization in both the DSLC and the 505E.

All 505E PID controller setpoints (Speed, Extr/Adm, Auxiliary, Cascade) may be changed through programmed raise and lower contacts, programmed 4–20 mA inputs, Modbus commands, or the 505E service panel.

The following list of notes are provided as a reference for application programmers to follow when programming the 505E to achieve any control and limiting actions shown in Figure 2-8.

505E Configuration Notes for Example 8:
OPERATING PARAMETERS:
This is a Generator application. (Generator Application?—Yes)

Generator and Utility Tie breaker contact inputs are required to be programmed when a generator application is selected. (Contact Input #1 Function: Generator Breaker), (Contact Input #2 Function: Utility Tie Breaker)

A RPS was used with this application to sense unit load. By programming the Speed PID to use KW droop, the Speed PID can control and limit unit load when paralleled against a utility. (Use KW Droop?—Yes)

For good response and load adjustment resolution, Droop was set to 5% of rated speed. (Droop = 5 %)

The 505E was configured to receive a generator load signal from a Real Power Sensor, through Analog Input #2. (Analog Input #2 Function: KW / Unit Load Input) The input's 4 mA and 20 mA values were programmed based on what the PTs and CTs used by the Real Power Sensor were ranged for (4 mA=zero, 20 mA=unit power level at 5 A CT current).

Because the Real Power Sensor is self powered (provides it's own loop power), the 505E back cover was removed, JPR8 was removed, and JPR9 was installed.

With this application it is desirable to switch to Frequency control at all times, if the plant becomes isolated form the Utility bus. (Use Freq Arm/Disarm?—No)

EXTR / ADM CONTROL:
The Extr/Adm control loop is defaulted to receive an Admission flow signal through Analog Input #1 (Analog Input #1 Function: Extr/Adm Input). The input's 4 mA and 20 mA values were programmed based on what the flow transducer was ranged/calibrated for.

Since a two wire, loop powered transducer is used to sense the admission flow, the 505E back cover was removed, JPR11 was removed, and JPR10 was installed.

Because of where the Extr/Adm transducer was placed with respect to the LP valve (refer to Figure 2-8), no input inversion was required. To increase turbine admission flow, the HP valve must decreased and the LP valve must increased. This is considered a direct action and does not require the input to inverted. (Invert Extr/Adm Input?—No)

In this application, because the Extr/Adm PID is not sharing control of the admission flow with another controller, Droop is not required. (Extr/Adm Droop = 0%)

To display flow instead of pressure, the unit of measure chosen was a flow unit. (Extr/Adm Units of Measure?—kg/hr)

TURBINE PERFORMANCE VALUES:
Because it is desired to hold turbine load constant for a changing admission flow, and vice versa the "Coupled HP & LP" ratio/limiter mode is used with this application. (Use Decoupling?—No)

From the turbine's steam map or performance envelope (provided with the turbine from the turbine manufacturer), the turbine's operating data/limits were entered as described in Volume #1 of this manual.

This application's turbine has the capability for controlled admission steam only. (Admission Only?—Yes)

With this application, Setpoint Tracking is used to allow the 505E to track header pressure before being enabled, thus allowing a bumpless transfer into header pressure control. (Use Setpoint Tracking? Yes)

When the turbine is on an operating limit and only one valve is available to control with, turbine load is the desired parameter to be controlled (Extr/Adm pressure control will be sacrificed). Since turbine/generator load is being controlled with the Speed PID (the ratio limiter's "S" term) Speed priority is selected. (Speed Control Priority?—Yes)

When the turbine is on the LP Maximum Limiter (100% open), turbine/ generator load is the desired parameter to be controlled (Extr/Adm pressure control will be sacrificed). Since turbine/generator load is being controlled with the Speed PID (the ratio limiter's "S" term) Speed priority is selected. (LP Max Lmt E/A Priority?—No)

AUTO SYNCHRONIZING:
The 505E's Analog Input #6 was programmed to receive the DSLC's speed bias signal for automatic synchronization (Analog Input #6 Function: Synchronizing Input) With this configuration, the analog input's range is defaulted to a certain gain value for best performance, thus the input's 4 mA and 20 mA settings are not used, and do not require programming.

A contact input was programmed to enable the Synchronizing analog input (Contact Input #4 Function: Sync Enable)

Starting & Run Mode Notes for Example 8:
Starting and ramping to an idle or minimum speed position can be performed automatically, semi-automatically, or manually. With this type of configuration, a semiautomatic start requires that the LP valve limiter be manually lowered to 0% before the Admission Trip-and-Throttle (T&T) valve is opened.

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

After the unit has been started and is controlling at a rated speed position, the turbine generator can be synchronized. This can be done manually or automatically. The system operator can select automatic synchronization through the Auto-Sync select switch (SW1 in Figure 2-8). When this switch is closed the 505E's Synchronizing input is enabled and the DSLC's automatic synchronizing function selected.

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

When the plant-to-utility tie line/breaker is closed, and the unit generator breaker closes, the 505E steps the speed/load setpoint up to a minimum load level to reduce the chance of reverse powering or motoring the generator. This minimum load level is based on the speed/load setpoint and is defaulted to a "3%" load. The defaulted value is adjustable through the 505E's Service mode (Breaker Logic, Min Load Bias = xxx).

After synchronization, the 505E's load setpoint can be positioned through raise and lower speed/load setpoint contacts, a programmed 4–20 mA input, Modbus commands, or the 505E service panel.

Once the inlet steam pressure is near rated level's, the HP T&T valve can be opened. As inlet steam capacity increases, the 505E will reposition the control valves to hold a constant load level (true load control is capable only if KW droop is used).

Admission control can be enabled any time after the generator breaker is closed, the HP trip-&-throttle valve has been opened, and the inlet steam source has the capacity to provide the steam required to hold the turbine at its current load level. To perform a bumpless transfer into Admission control the pressures on each side of the Adm trip-&-throttle valve should be matched. The 505E has a manual demand signal to allow operators to manually vary the pressure on the turbine side of the Adm T&T valve. Once these pressures are matched the operator can open the T&T valve, and then issue an Extr/Adm control enable command. The manual demand signal's raise/lower and the Extr/Adm enable/disable commands can be issued through the 505E's service panel, contact inputs, or Modbus communications.

Example 9—Typical Plant Load and Steam Pressure Control Application
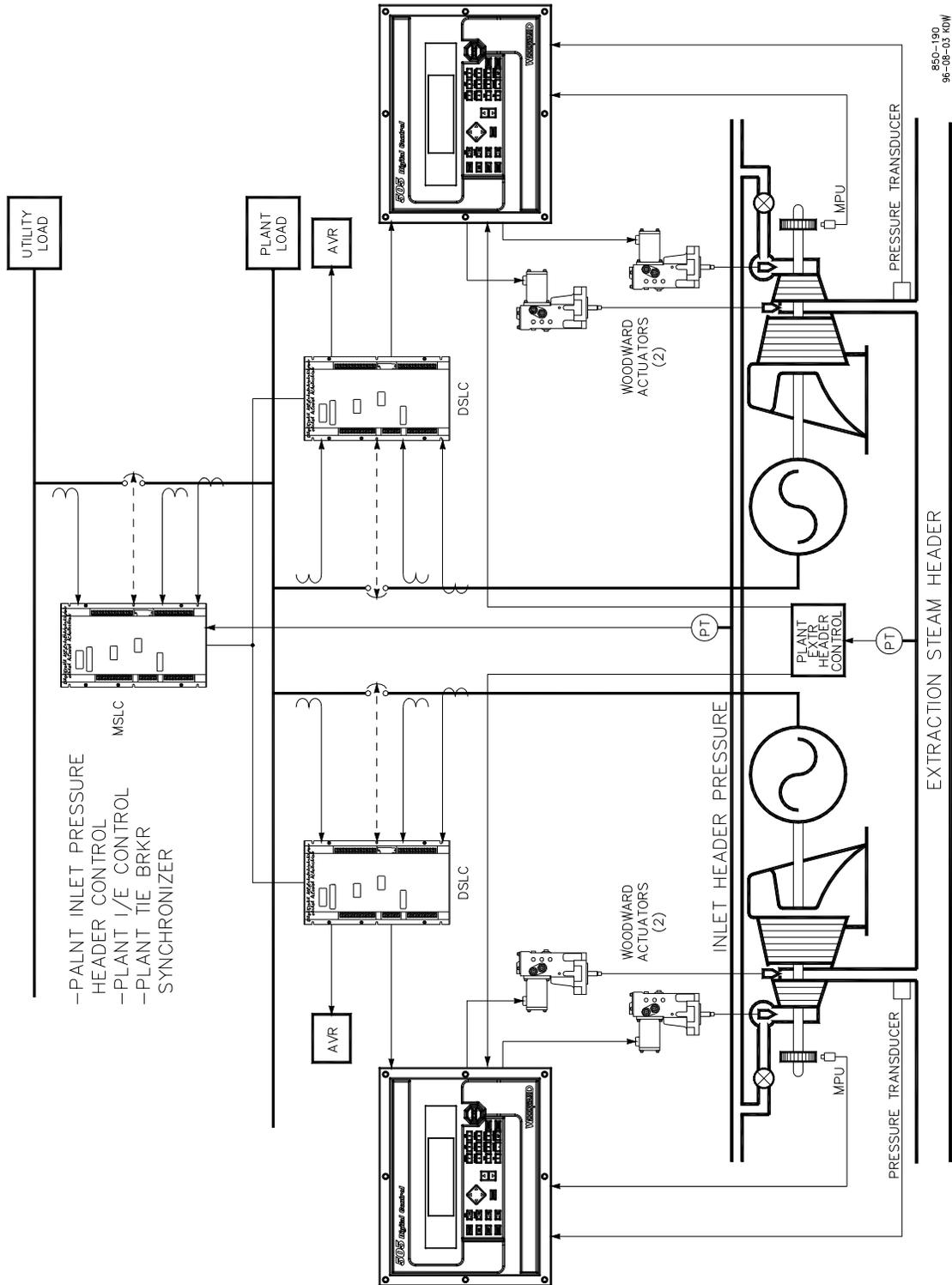
Figure 2-9. Plant Load and Steam Pressure Control Application

With this application a combination of 505E's, DSLCs, MSLCs, and a Single Loop PID controller allow the following plant parameters to be controlled:

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

This is an example of a typical plant application where multiple turbine generators are load and flow shared to control plant functions like import/export power or turbine inlet header pressure and extraction header pressure. When the plant is disconnected from a utility, this configuration allows all units to control plant frequency, load share, and continue flow sharing into the extraction header. Other applications may or may not use all the functionality shown in Figure 2-9 and described below.

With this application, each 505E is paired with a Digital Synchronizer and Load Control (DSLC). When enabled each DSLC interfaces with its respective 505E to determine the unit's load. Each DSLC when in the isochronous loadsharing mode interfaces with all other plant DSLCs and MSLCs via a Digital Echelon Network (LON). This digital network allows units to share load with each other or be controlled by a Master Synchronizer and Load Control (MSLC). Only one MSLC at a time can be on the LON network.

A MSLC, when enabled, can control the load of all units (via DSLCs and 505Es) on the LON network to control a common parameter. To have its load level set by the MSLC, a DSLC must be in the isochronous loadsharing mode. This allows an operator to determine which units will function together to control a common parameter (inlet header pressure, import/export power), and which units will function separately to control other parameters (exhaust pressure, unit load).

The MSLC senses plant import/export power and uses a "PI" controller to command any or all units on the LON to control plant import/export power. The MSLC can also accept and (with a "PI" controller) control any process signal which is directly related to each unit's load and which the units enabled all have in common (inlet header pressure, exhaust header pressure). By the MSLC forcing the load level of each enabled DSLC to be the same, all units are proportionally loaded the same and share the same burden.

When the utility tie breaker is open, the MSLC can be used to automatically synchronize the plant bus to the utility grid. Like controlling load, the MSLC varies the frequency setting of all DSLCs (turbine generators) on-line and enabled to match the plant's frequency and phase to that of the utility. By connecting each DSLC to its respective generator's automatic voltage regulator (AVR), the MSLC can also communicate with all the enabled DSLCs to match plant voltage to that of the utility.

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

The Plant Extraction Header Pressure Controller used with this application is a stand-alone "PI" controller. This controller senses extraction header pressure and outputs identical signals to all unit extraction pressure controllers thus forcing allow all units to equally flow share. The controller's output signal is used to drive each unit's extraction pressure setpoint. Unlike the MSLC this controller does not communicate over a Echelon Network, thus the Plant Extraction Header controller is required to have multiple outputs.

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

Another benefit of this MSLC—DSLC configuration, is that basically any prime mover that has a DSLC installed can be used to loadshare with (gas turbines, diesel engines, steam turbines, hydro turbines). Because each DSLC has an individual loadsharing gain setting, the response differences between units can be compensated for.

Example 10—Induction Generator Applications

When the 505E is configured for induction generator applications, typically there are only two differences in the programming of the 505E verses programming for synchronous generator applications.

The induction generator's slip frequency must be taken into account. This is achieved by compensating for the slip frequency with the 505E's maximum Speed Setpoint setting. The 'MAX GOVERNOR SPEED SETPOINT' setting must be equal to synchronous speed plus the droop percentage plus the full load slip frequency percentage.

- Max Governor Speed Setpoint = Sync Speed + (Sync Speed * Droop) + Max Slip RPM

- The USE TIE BREAKER OPEN TRIP setting must be set to "Yes" if a synchronous generator is not sharing the same plant bus. This will cause the generator to trip when the utility tie breaker opens.

Chapter 3.
Operator Interface

Introduction

Interface to the control may be performed through the 505E's service panel (located on the front of the control), remote switch contacts, analog inputs, meter readouts, relays, or a Modbus® communications line to an operator interface device.

Keypad and Display

The control's service panel consists of a keypad and LED display (two lines, 24 characters each) located on the front of the control.
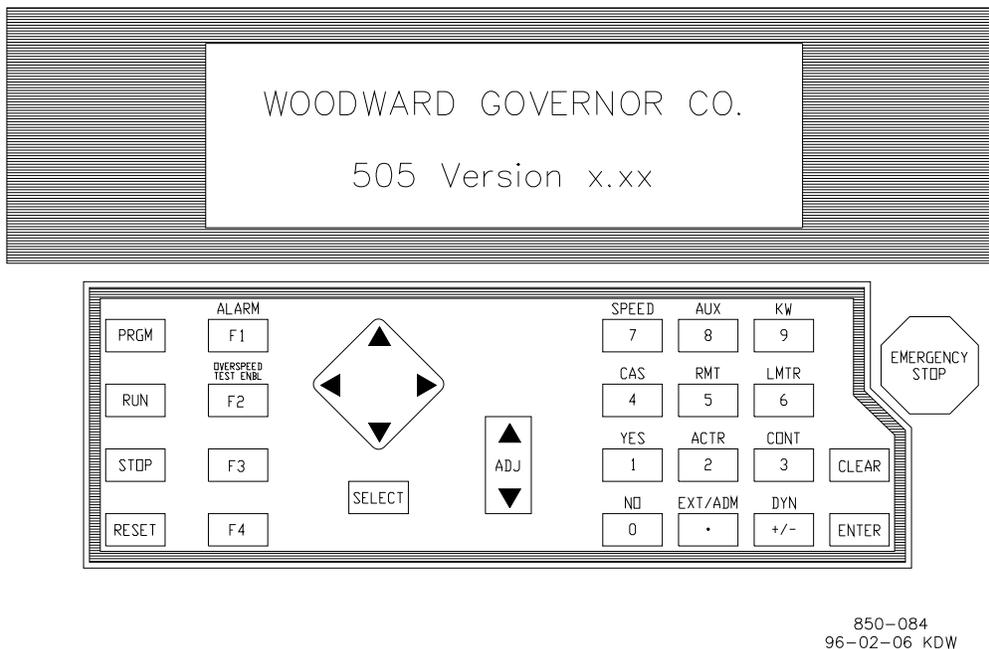
Figure 3-1. 505E Keypad and Display

The system operator uses the service panel to communicate with the 505E system. The service panel can be used only occasionally to communicate with the system, or it can continuously monitor a value for the operator to view.

The Service Panel, shown in Figure 3-1, includes the 30 key keypad and the split screen display. An overview of the software and information arrangement scheme for the Service Panel is shown in Figure 3-2.

Service Panel Modes

The 505E Service Panel operates in several access modes, each of which has a different purpose. These modes are: SERVICE, CONFIGURE, DEBUG, OS_FAULTS, and SYS_INFO. See Figure 3-2 , Software Structure Overview.
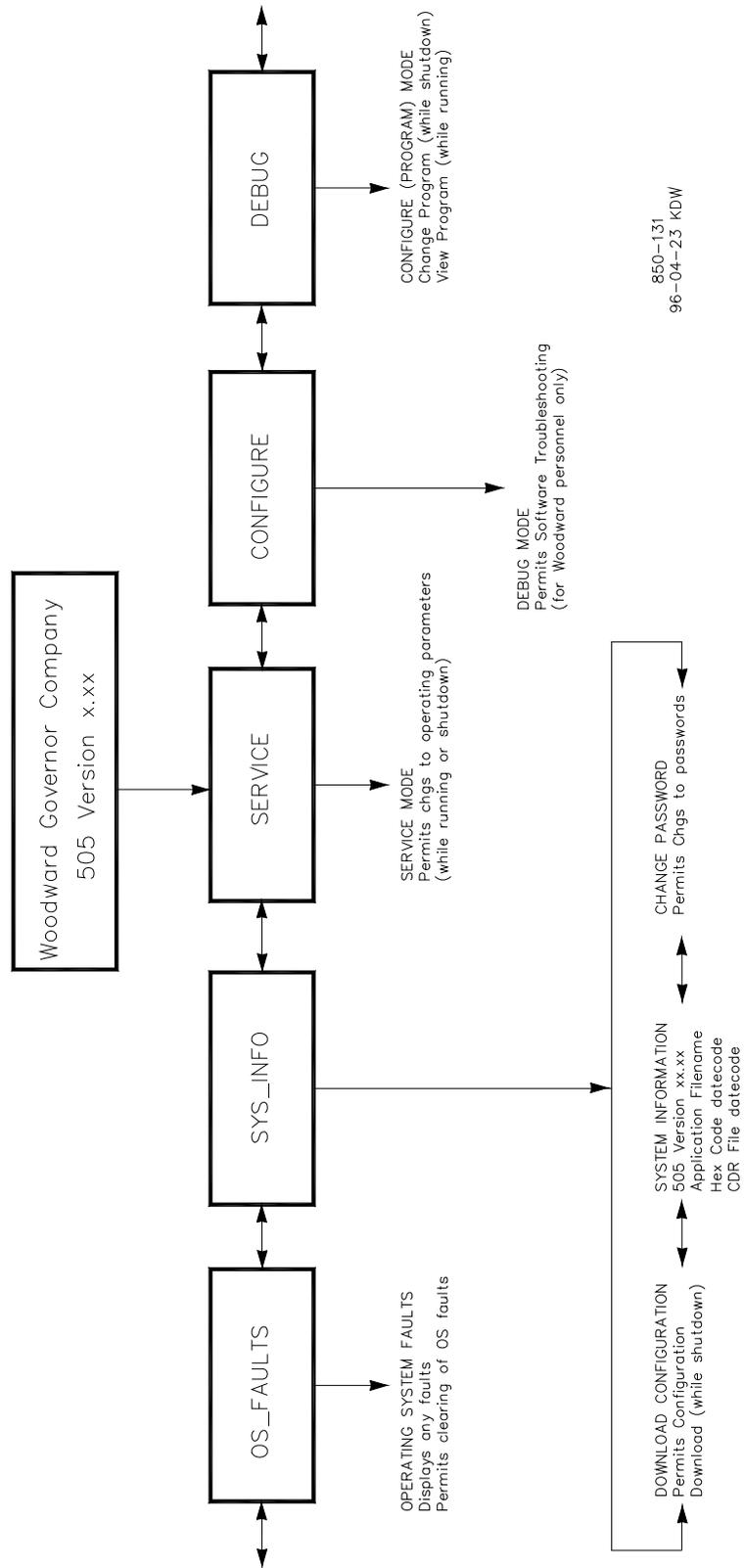
Figure 3-2. Software Structure Overview

The SERVICE mode can be used while the turbine is running. The SERVICE mode permits displaying the value of any SERVICE mode block, and changing the value of any of those blocks that are tunable. Entry into the SERVICE mode requires a password.

The CONFIGURE mode is also referred to as the PROGRAM mode and is used to set up the parameters for a specific application prior to operation of the unit. The turbine must be shut down (and the password entered correctly) to change any CONFIGURE values. If the control is not shutdown, pressing the PRGM key will allow viewing of CONFIGURE, but will not permit any changes to be made.

The DEBUG mode is used to troubleshoot a system during development and is not intended for general use. It should be used only by properly trained Woodward personnel or when expressly authorized by Woodward. Entry into the DEBUG mode requires a password.

The OS_FAULTS mode displays any operating system faults or alarms that have occurred, and permits resetting (clearing) the list of detected alarms. Entry into the OS_FAULTS mode requires a password.

The SYS_INFO mode is used to display system information, change passwords, or download a configuration file into the control.

Using the Service Mode

Information that can be displayed by the SERVICE mode and CONFIGURE mode is all arranged in the same way. There are three tiers or levels: modes, headers, and blocks. The modes each have a number of headers under them and each header usually has many blocks under it. The DEBUG mode, the OS_FAULTS mode, and the SYS_INFO use different arrangements and will be described later.

Top Level/Root System Block

This is normally the first block to appear on the display after power up, but may be overwritten by the application program. To get to the Root System block at any time push the CLEAR key once or sometimes twice depending where the user is in the programmable service. The block looks like this:

```
WOODWARD GOVERNOR CO.

505E Version x.x
```
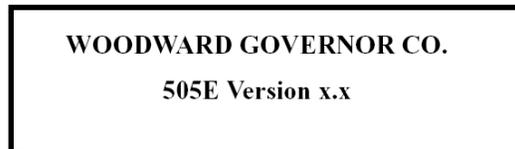
Pressing the scroll key takes the system to the first level, the mode level.

Select Mode Level

This first level (below the Top Level/Root System block) contains the five different programmable service mode blocks. The five mode blocks are arranged within the first level as shown in Figure 3-3. Scroll left or right to display each mode.
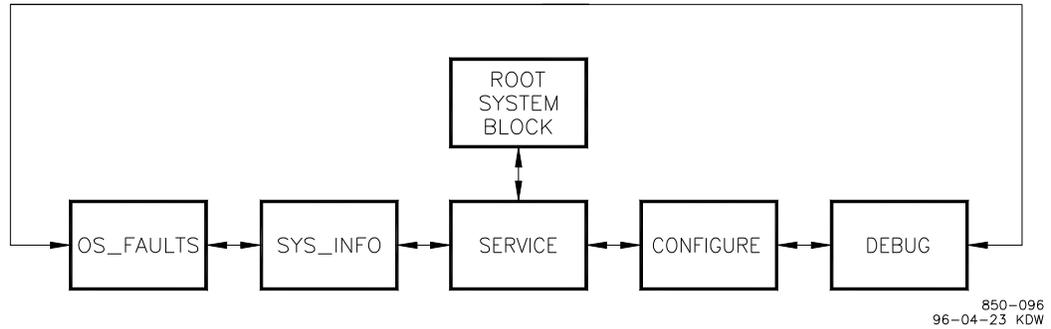
Figure 3-3. The Select Mode Level

When entering the mode level, the SERVICE mode will always be the one displayed first in the mode-level message.

Header Level

The second level is the header level. This level contains the programmable service header blocks as shown in Figure 3-4. Scroll left or right to get to each header. Press CLEAR to get back to the Select Mode Level. Scroll down to get to any block under a header.
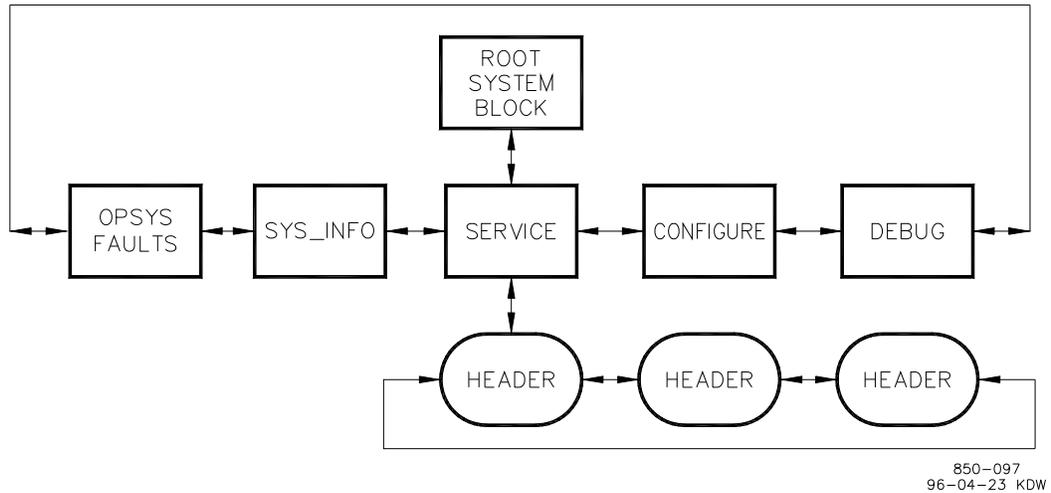
Figure 3-4. Header Level

Block Level

The third level, the block level, is shown in Figure 3-5. The programmable service blocks containing the values to be monitored or changed are found at this level. Scroll down or up to get to a different block. Push CLEAR to get back to the header level.
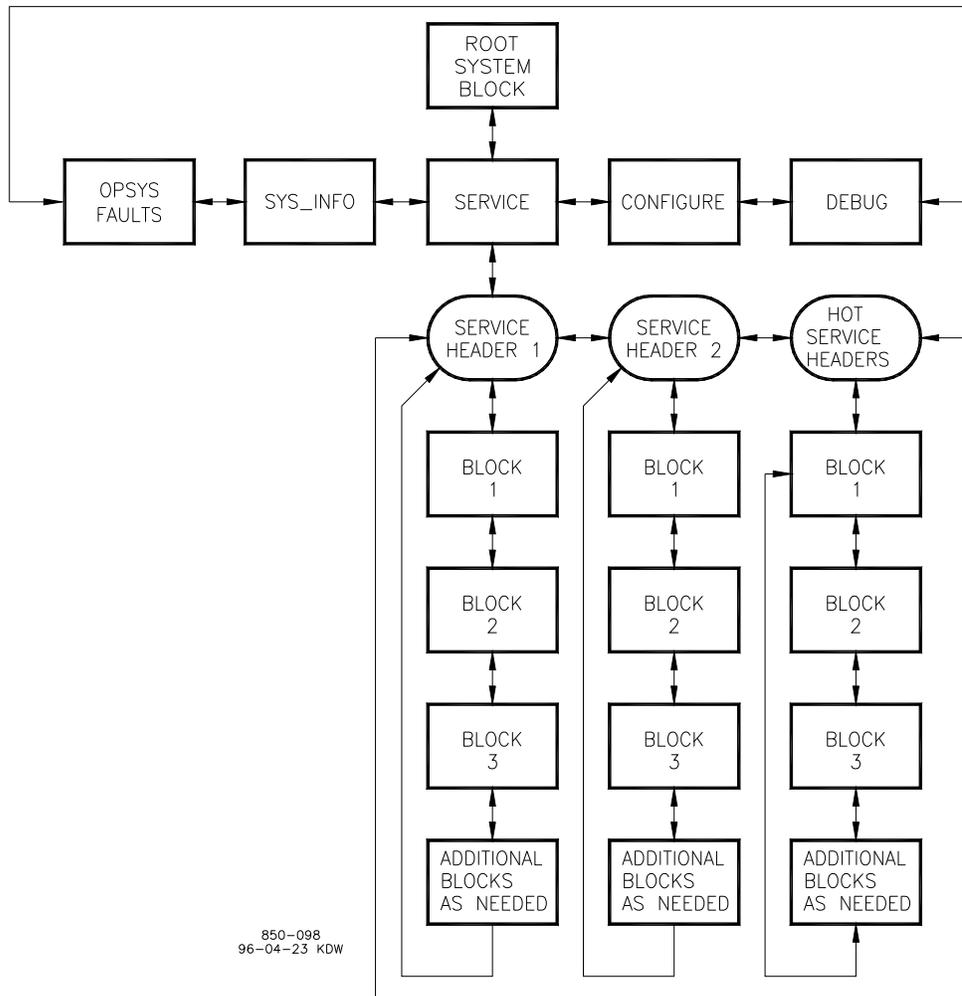
Figure 3-5. Block Level

Service Mode

The SERVICE mode can be used while the engine/turbine is running or shut down. The SERVICE mode permits displaying the value of any SERVICE mode block, and changing the value of any of those blocks that are tunable. Entry into the SERVICE mode requires a password.

In the SERVICE mode, the value displayed for a block can be changed by using either the ADJ   or ADJ   keys. The value can be changed if it is a tunable variable; in this case there will be a * before the value.

This mode can also be used to make direct numeric entries. However, because this mode is intended to be used while the turbine is running, the Service Panel will accept the entry of numeric values for a block only if the proposed change is very small. The block value proposed for entry must be within 1 percent of the current displayed value of that block, unless that current displayed value is between –0.1 and +0.1. If the current displayed value is between –0.1 and +0.1, the system will accept any entry between –0.1 and +0.1.

To make direct numeric entries, first bring the displayed value to within 1% of the value to be entered. Press the ENTER key. Press the numerical keys to input the value and press ENTER again.

If the value entered is less than the value displayed by more than 1% or greater than the value displayed by more than 1%, an appropriate message will be displayed indicating the value entered is too large or too small.

When using the SERVICE mode, refer to the Service Mode worksheet in Appendix B.

Entering the Service Mode

1. At the select mode level, the following message will appear on the display.

```
Push < or > for new mode
Press ENTER for MMMMMMMM
```

   (MMMMMMMM = name of mode: SERVICE, CONFIGURE, DEBUG, OS_FAULTS or SYS_INFO)

2. Press the scroll right key until the message indicates the SERVICE mode (unless it already does).

3. Press the ENTER key. The following message will be on the display.

```
Password SERVICE
```

IMPORTANT **For password information see Appendix C at the back of this manual. If the password information is not in this manual, see the supervisor or equipment engineer.**

4. Enter the password on the numeric keys, then press the ENTER key. The display will show a SERVICE mode header. An example is shown below.

```
@ SERVICE HEADER
XXXXXXXXXXXXXXXXXXX
```

IMPORTANT **The headers and blocks are assigned their names by the application programmer; this is only an example.**

5. The @ indicates which half of the split screen display that key entry will affect. Use the SELECT key to select either the top or bottom of the split screen display. (The Xs indicate another header or block which is being shown on the bottom half of the split screen display.)

6. Use the scroll right or scroll left key to select the desired SERVICE mode header.

7. Use the scroll up key or scroll down key to select the desired SERVICE mode block. A message similar to the one below will be displayed.

```
┌─────────────────────────────────────┐
│                                     │
│   @ On-Line Prop Gn    *5.000       │
│                                     │
│   On-Line Int Gn       *5.000       │
│                                     │
└─────────────────────────────────────┘
```

(The * indicates this block contains a tunable variable).

8. Use the ADJ ˏ or ADJ ˏ keys to increase or decrease the value of the block being displayed. If a faster rate of change is desired simply hold the key down and the rate of change will increase after two seconds and again after six seconds. If a slower rate of change is desired, repeatedly release the key after holding one second then press again.

IMPORTANT	**This mode can also be used to make direct numeric entries. However, because this mode is intended to be used while the engine/ turbine is running, the Service Panel will accept the entry of numeric values for a block, only if the proposed change is very small. The block value proposed for entry must be within 1 percent of the current displayed value of that block, unless that current displayed value is between –0.1 and +0.1. If the current displayed value is between –0.1 and +0.1, the system will accept any entry between –0.1 and +0.1.**

9. When setting the value of the block has been completed, either go to another block or exit out of the mode.
    *   To scroll to another block under the same header, use the scroll down or scroll up keys.
    *   To go back to the same header, press the CLEAR key.
    *   From header level, to go to a block under a different header, scroll to the new header by using the scroll right or scroll left key, then scroll to the new block by using the scroll down or scroll up key.
    *   To exit the mode, use the CLEAR key to get back to the header. Then press CLEAR again to get back to the Top Level/Root block. The values of all variables that were changed will then be stored in EEPROM.

IMPORTANT	**If the display will not be used for a while, it is a good idea to return to the Top Level/Root display and permit the system to blank the screen to save power and prolong the life of the display.**

Exiting Modes

When leaving the SERVICE mode or the CONFIGURE mode and returning to the Root level (by pressing CLEAR), the values of all variables that were changed (while in SERVICE mode or CONFIGURE mode) are stored in EEPROM.

⚠️ **WARNING**	**If variables are tuned or changed but not stored in EEPROM by pressing CLEAR to return to the root level, then those changes will be lost if power is removed from the control or if the control is reset.**

IMPORTANT	**When the display is showing the Top Level/Root block (shown below) the display will turn off if approximately 5 minutes elapse without a key being pressed. If the unit is powered up but the display is blank, press the CLEAR, scroll down, PRGM, or any hot key to turn the display on. This will turn the display block on.**

Configure Mode

The CONFIGURE mode is used to set a system up for a specific application, before actual operation of that system starts. The engine/turbine must be shut down when using the CONFIGURE mode, and numeric entries of any value (within the allowed range for that block) may be made.

Entry into the CONFIGURE mode requires a password. If the control is not shutdown, pressing the PRGM key will allow viewing of CONFIGURE, but will not permit changing the value of a block.

The structure of the CONFIGURE mode is identical to that of the SERVICE mode (see Figure 3-5).

NOTICE	**Entry into the CONFIGURE mode will cause an automatic shutdown of all control outputs. The control will prompt "SHUTDOWN CONTROL? Y/N". Entering YES will cause all milliamp outputs to go to zero and all relays to de-energize. Entering NO will abort the shutdown.**

When using the CONFIGURE mode, refer to CONFIGURE/PROGRAM MODE worksheet in Appendix A of Volume 1.

Since configuring a control or viewing how a control is configured is such a commonly used mode the PRGM (program) key has been designed to take the user directly to step 4 below from anywhere in programmable service except DEBUG, OS_FAULTS, or SYS_INFO. The CONFIGURE mode can also be reached like the other modes by following the steps below.

1.   At the mode level the following message will appear on the display.

> Push < or > for new mode
>
> Press ENTER for MMMMMMMM

(MMMMMMMM = name of mode: SERVICE, CONFIGURE, DEBUG, OS_FAULTS or SYS_INFO)

2. Press the scroll right or scroll left key until the message indicates the CONFIGURE mode.

3. Press the ENTER key. The following message will be on the display.

```
┌──────────────────────────────────┐
│                                  │
│                                  │
│         Password CONFIGURE       │
│                                  │
│                                  │
└──────────────────────────────────┘
```

IMPORTANT	**For password information see Appendix C at the back of this manual. If the password information is not in this manual, see the supervisor or equipment engineer.**

4. Enter the password on the numeric keys, then press the ENTER key. The system will display the following message.

```
┌──────────────────────────────────┐
│                                  │
│                                  │
│       SHUTDOWN CONTROL? Y/N       │
│                                  │
│                                  │
└──────────────────────────────────┘
```

If the NO key is pressed, the system will return to the mode level. If the YES key is pressed, the system will enter the CONFIGURE mode; all control outputs will shut off. The display will show a CONFIGURE mode header. An example is shown below.

```
┌──────────────────────────────────┐
│                                  │
│                                  │
│       CONFIGURATION HEADER        │
│                                  │
│                                  │
└──────────────────────────────────┘
```

IMPORTANT	**The headers and blocks are assigned their names by the application programmer; this is only an example. The CONFIGURE mode does not use the split-screen as does SERVICE, and DEBUG mode. In the CONFIGURE mode the prompt is displayed on the top line and the variable to be configured is displayed on the second line.**

5. Use the scroll right or scroll left key to select the desired CONFIGURE mode header.

6. Use the scroll down key or scroll up key to select the desired CONFIGURE mode block.

7. Enter the desired value on the numeric keys and press the ENTER key.

8. When setting the value of the block has been completed, either go to another block or exit out of the mode.

    *   To scroll to another block under the same header, use the scroll down or scroll up keys.
    *   To go back to the header, press the CLEAR key.
    *   From header level, to go to a block under a different header, scroll to the new header by using the scroll right or scroll left key, then scroll to the new block by using the scroll down or scroll up key.
    *   To exit the mode, use the CLEAR key to get back to the header. Then press CLEAR again to get back to the Top Level/Root block. The values of all variables that were changed will then be stored in EEPROM.

IMPORTANT	**If the display is not going to be used for a while, it is a good idea to return to the Top Level/Root display and permit the system to blank the display to save power and prolong its life.**

Debug Mode

The DEBUG mode is used to troubleshoot a system during development and is not intended for general use. It should be used only by properly trained Woodward personnel or when expressly authorized by Woodward. Entry into the DEBUG mode requires a password.

IMPORTANT	**For password information see Appendix C at the back of this manual. If the password information is not in this manual, see the supervisor or equipment engineer.**

⚠WARNING	**The DEBUG mode is intended for use only by authorized and trained personnel to maintain and troubleshoot the system. Use of the DEBUG mode by untrained or unauthorized personnel could result in inadvertently changing critical system values; changing critical system values could cause equipment damage or personnel injury or death. Do not permit unauthorized personnel to use the DEBUG mode.**

The information in the DEBUG mode is arranged as shown in Figure 3-6. Scroll down to go from a MOE category to a MOE block; scroll up or down to go to another MOE block. Scroll left or right to go from a MOE block to a field of that MOE block, or from one field to another field of the same MOE block.

All tunable values that are used in SERVICE or CONFIGURE modes will not show up in DEBUG mode. Any value that is tunable but is not used in SERVICE mode or CONFIGURE mode will appear as a tunable, and can be tuned, in DEBUG mode.

When exiting the DEBUG mode, all tunable values that have been changed will be stored in EEPROM memory.

Pressing the '.' key while in the DEBUG mode will switch the display to the SERVICE mode; pressing the '.' key again will switch the display back to the DEBUG mode.

```
                                            850-099
                                            96-02-06 KDW
```
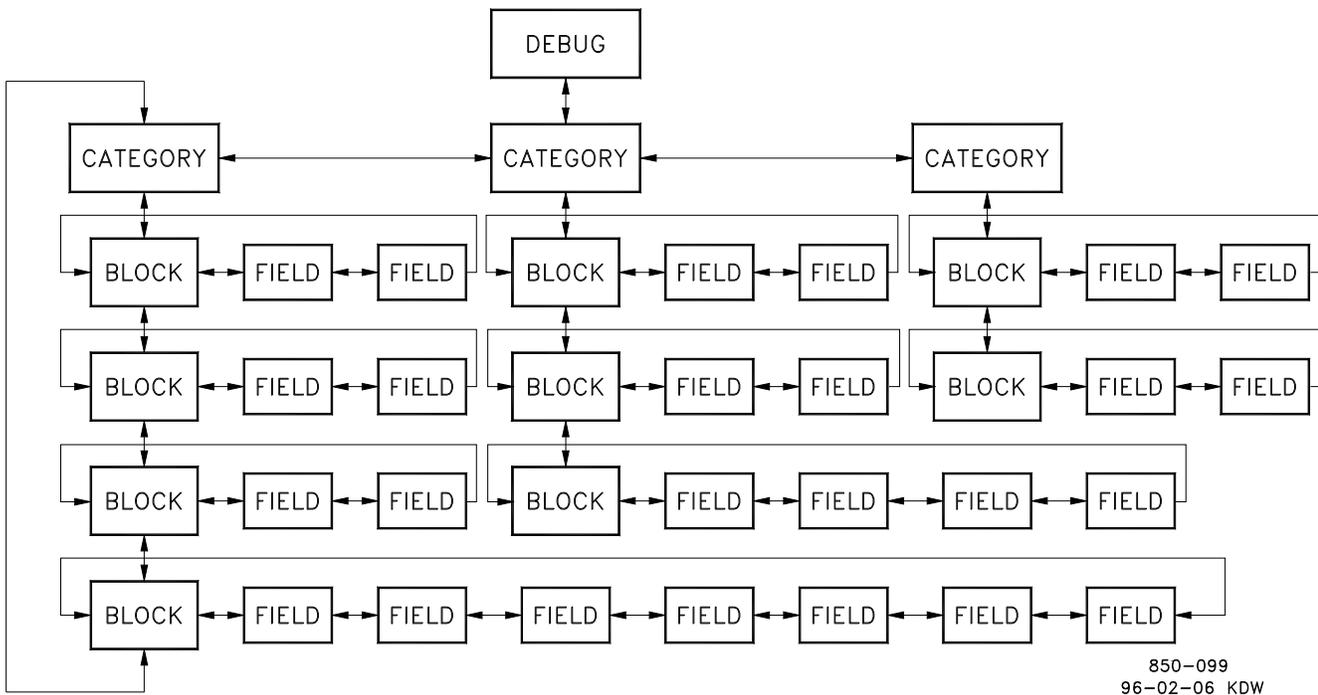
Figure 3-6. Debug Information Arrangement

OS_FAULTS Mode

The OS_FAULTS mode displays all operating system faults or alarms that have occurred since the last Faults Reset operation. It also permits resetting (clearing) the alarm list.

The OS_FAULTS mode headers are:
- Faults Detected—Displays faults detected since the last power down.
- Alarms Detected—Displays alarms detected since the last time the alarm list was cleared.
- Clear Alarms Detected—Clears the alarm list.

The information in the OS_FAULTS mode is arranged as shown in Figure 3-7.
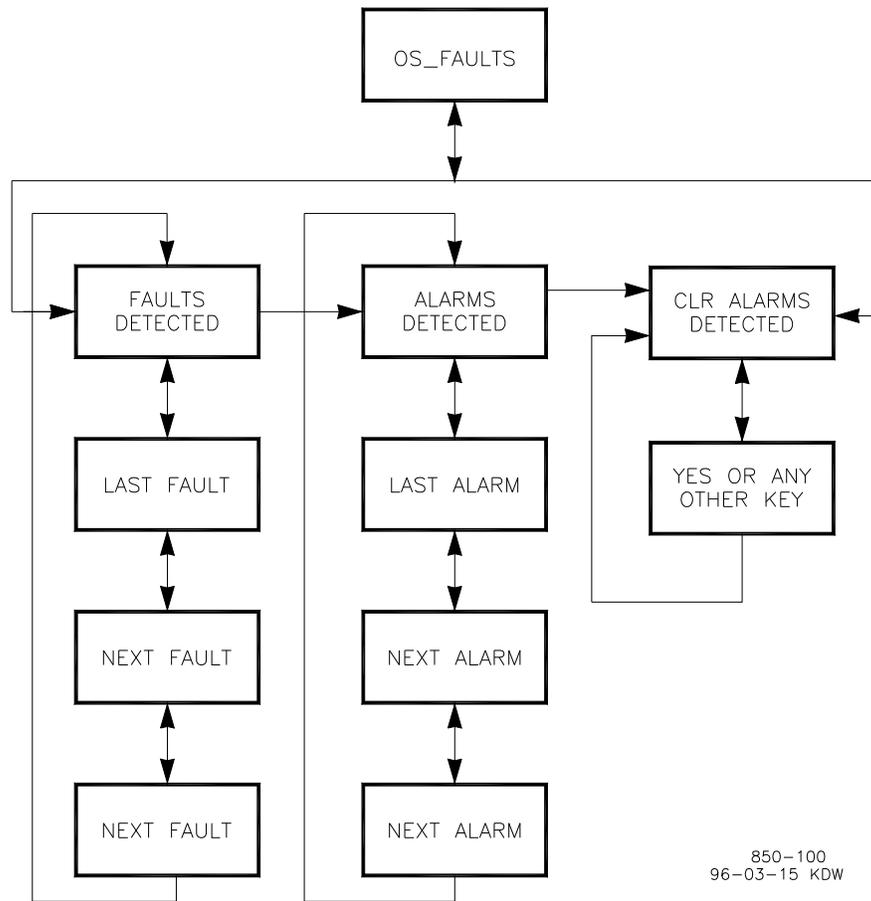
Figure 3-7. OS_FAULTS Mode Information Arrangement

To Enter the OS_FAULTS mode:

1. The following message will be displayed when the system is at the select mode level.

> **Push < or > for new mode**
>
> **Press ENTER for MMMMMMMM**

(MMMMMMMM = name of mode: SERVICE, CONFIGURE, DEBUG, OS_FAULTS or SYS_INFO)

2. Press the scroll left or scroll right key until the message indicates the OS_FAULTS mode.

3. Press the ENTER key. The following message will be on the display.

> **Password OS_FAULTS**

| | **IMPORTANT** | **For password information see Appendix C at the back of this manual. If the password information is not in this manual, see the supervisor or equipment engineer.** |

4. Enter the password on the numeric keys and press the ENTER key. The header shown below will be displayed.

```
┌──────────────────────────┐
│                          │
│      Faults Detected     │
│                          │
│                          │
└──────────────────────────┘
```

5. Use the scroll left or scroll right key to select the desired OS_FAULTS mode header. The header will display as shown below.

```
┌──────────────────────────┐
│                          │
│      Faults Detected     │
│                          │
│                          │
└──────────────────────────┘
```

or

```
┌──────────────────────────┐
│                          │
│      Alarms Detected     │
│                          │
│                          │
└──────────────────────────┘
```

or

```
┌──────────────────────────┐
│                          │
│   Clear Alarms Detected  │
│                          │
│                          │
└──────────────────────────┘
```

Faults Detected Header

1. While the Faults Detected header is displaying, use the scroll down key or scroll up key to display the faults detected under it. A message describing the most recent fault detected will display under the header message, as shown below.

```
┌──────────────────────────┐
│                          │
│   Faults Deteched        │
│   Local Ram Failed       │
│                          │
└──────────────────────────┘
```

2. Press scroll down to see the next fault detected. Each time scroll down or scroll up is pressed, another fault detected under this header will display. An example is shown below.

```
Faults Deteched
Checksum Error
```

If no faults have been detected, the following message will display for one second.

```
Faults Deteched
No Faults Detected
```

After one second, only the header message will display.

3. From a displaying fault message, to go back to the Faults Detected header, press the CLEAR key.

4. To go from the Faults Detected header to the Top Level/Root display, press the CLEAR key again.

IMPORTANT   **If the display is not going to be used for a while, it is a good idea to return to the Top Level/Root display and permit the system to blank the display to save power and prolong its life.**

The meanings of the fault messages generated by the 505E System are shown in Chapter 7.

Alarms Detected Header

1. While the Alarms Detected header is displaying, use the scroll down key to display the alarms detected under it. A message describing the most recent alarm detected will display under the header message, as shown below.

```
Alarms Detected
FP Math Error
```

2. Press scroll down to see the next alarm detected. Each time scroll down or scroll up is pressed, another detected alarm will display. An example is shown below.

```
Alarms Detected
System Error #18
```

If no alarms have been detected, the following message will display for one second.

```
          Alarms Detected
        No Alarms Detected
```

After one second, only the header message will display.

3. From a displaying alarm message, to go back to the Alarms Detected header, press the CLEAR key.

4. To go from the Alarms Detected header to the Top Level/Root display, press the CLEAR key.

IMPORTANT	**If the display is not going to be used for a while, it is a good idea to return to the Top Level/Root display and permit the system to blank the display to save power and prolong its life.**

The meanings of the alarm messages generated by the 505E System are shown in Chapter 7.

Clear Alarms Detected Header

1. To clear the alarm list, while the Clear Alarms Detected header is displaying, press the scroll down key. The following message will be displayed.

```
        Clear All Alarms? Y/N
```

2. To clear the alarm list, press Y (for Yes). The alarm list will be cleared. The following message will appear for one second.

```
        Alarms Have Been Cleared
```

If any other key is pressed, the display will return to the header level and only the following message will appear.

```
         Clear Alarms Detected
```

3. To go from the Clear Alarms Detected header to the Top Level/Root display, press the CLEAR key.

IMPORTANT	**If the display is not going to be used for a while, it is a good idea to return to the Top Level/Root display and permit the system to blank the display to save power and prolong its life.**

SYS_INFO Mode

The SYS_INFO mode displays information about the system. It also permits changing passwords for the different modes and loading a configuration file from a personal computer.

The SYS_INFO mode headers are:
- System Information—Displays software version and information about the application program.
- Change Password—Allows user to change all the system passwords for the various modes.
- Download Configuration—Allows the user to download a configuration file from a personal computer.

The information in the SYS_INFO mode is arranged as shown in Figure 3-8.
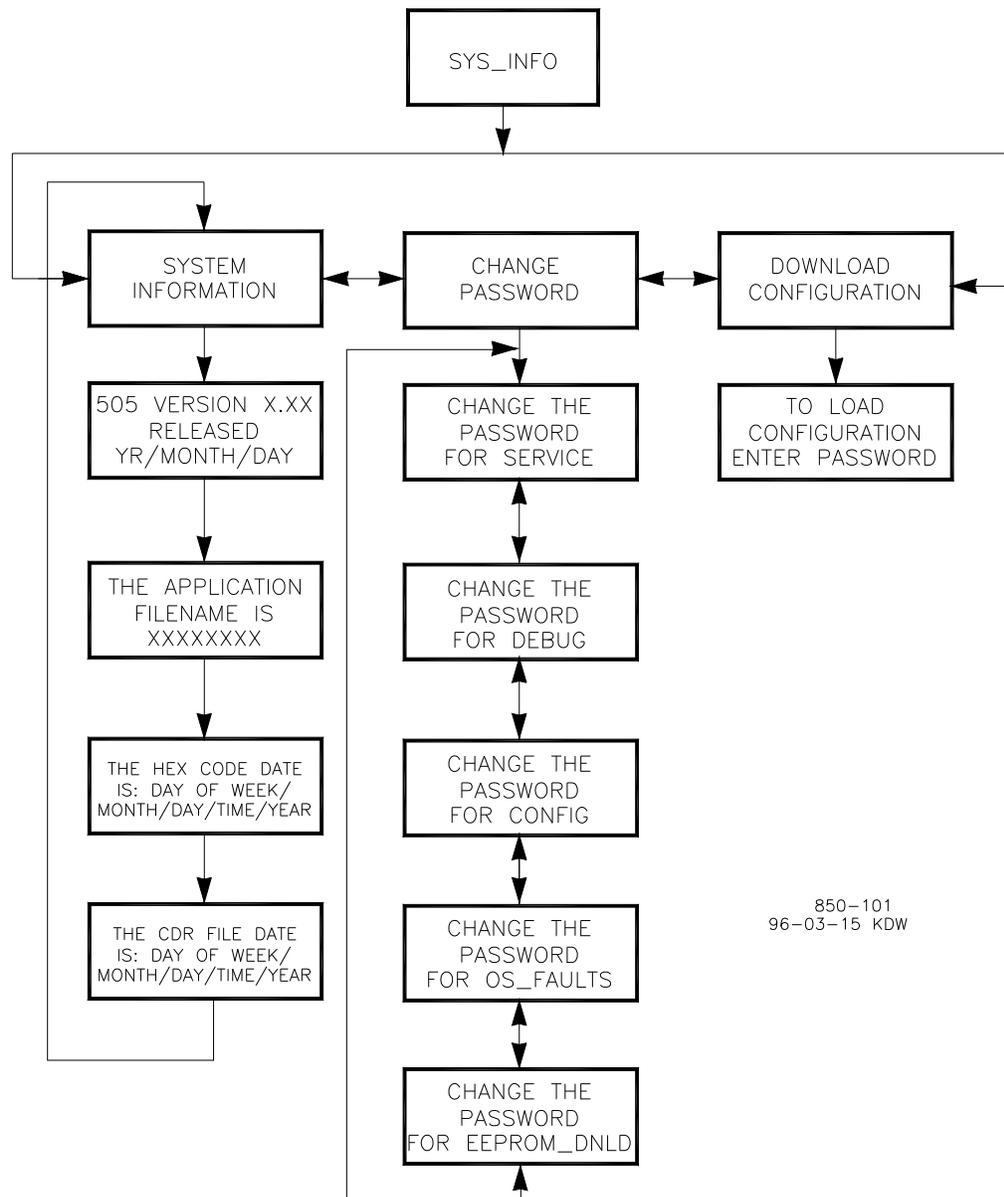
Figure 3-8. SYS_INFO Mode Information Arrangement

To enter the SYS_INFO mode:

1. The following message will be displayed when the system is at the select mode level.

┌────────────────────────────────────┐
│   │
│   **Push < or > for new mode**   │
│   **Press ENTER for MMMMMMMM**   │
│   │
│   │
└────────────────────────────────────┘

    (MMMMMMMM = name of mode: SERVICE, CONFIGURE, DEBUG, OS_FAULTS or SYS_INFO)

2. Press the scroll left or scroll right key until the message indicates the SYS_INFO mode.

3. Press the ENTER key. The header shown below will be displayed.

┌────────────────────────────────────┐
│   │
│   │
│   **System Information**   │
│   │
│   │
└────────────────────────────────────┘

4. Use the scroll left or scroll right key to select the desired SYS_INFO mode header. The header will display as shown below.

┌────────────────────────────────────┐
│   │
│   │
│   **System Information**   │
│   │
│   │
└────────────────────────────────────┘

or

┌────────────────────────────────────┐
│   │
│   │
│   **Change Password**   │
│   │
│   │
└────────────────────────────────────┘

or

┌────────────────────────────────────┐
│   │
│   │
│   **Download Configuration**   │
│   │
│   │
└────────────────────────────────────┘

System Information Header

1. While the System Information header is displaying, use the scroll down key to display the system information under it. A message will display as shown below.

> Clear Alarms Detected

This is information about the version being used.

2. Continue to Press scroll down to see more system information. The messages will appear as shown below.

> **505E Version X.XX**
> **YR-MO-DAY**

> **The Hex Code date is:**
> **Day of Week/Month/Day/Time/Year**

> **The CDR Code date is:**
> **Day of Week/Month/Day/Time/Year**

3. From a system information message, to go back to the System Information header, press the CLEAR key.

4. To go from the System Information header to the Top Level/Root display, press the CLEAR key.

IMPORTANT   If the display is not going to be used for a while, it is a good idea to return to the Top Level/Root display and permit the system to blank the display to save power and prolong its life.

Change Password Header

⚠ **WARNING**	**If any password is changed and that new password is forgotten or lost, the user will be locked out of that mode or function forever. It is suggested that changed passwords be documented and kept in a secure place so that authorized personnel have access to them.**

1. While the Change Password header is displaying, use the scroll down key or scroll up key to enter the Change Password blocks. The following message will be displayed.

> **Push ENTER to change the**
> **Passwaord for MMMMMMMM**

   (MMMMMMMM = name of mode: SERVICE, CONFIGURE, DEBUG, OS_FAULTS, or EEPROM_DNLD)

2. Press scroll left or scroll right to see the next passworded mode or function. Push ENTER when the desired mode or function is displayed. Carefully follow the instructions displayed on the screen.

3. From a change password message, to go back to the Change Password header, press the CLEAR key.

4. To go from the Change Password header to the Top Level/Root display, press the CLEAR key again.

IMPORTANT	**If the display is not going to be used for a while, it is a good idea to return to the Top Level/Root display and permit the system to blank the display to save power and prolong its life.**

Download Configuration Header

The Download function is to be used only by Woodward certified technicians.

1. While the Download Configuration header is displaying, use the scroll down key to enter this function. A message will display as shown below.

> **To Load Configuration**
> **Enter Password**

IMPORTANT	**For password information, see Appendix D at the back of this manual. If the password information is not in this manual, see the supervisor or equipment engineer.**

2. Enter the password on the numeric keys, then press the ENTER key. The system will display the following message.

NOTICE   **Entry into the SYS_INFO mode while the turbine is running will cause an automatic shutdown of the turbine with resulting process stoppage. The control will prompt "SHUTDOWN CONTROL? Y/N". Entering YES will shutdown the turbine. All milliamp outputs will go to zero and all relays will de-energize. Entering NO will abort the shutdown.**

```
SHUTDOWN CONTROL? Y/N
```

3. If the NO key is pressed the system will return to the Download Configuration header. If the YES key is pressed, the system will display the following message.

```
Ready For Cnf Download
Push CLEAR for run mode
```

4. Push CLEAR to abort the configuration download, else download the configuration. Then push the CLEAR key to begin running the control with the new configuration parameters.

Chapter 4.
Service Mode Procedures

Overview

The service mode of the 505E control has the same easy to follow format as the program mode. The service mode can be used to customize the control to be more application specific. The parameters that are tuned in the service mode may affect system performance, caution is advised.

The service mode of the 505E can be accessed at any time the control is powered up. The turbine doesn't need to be shutdown. This will allow tuning while the turbine is on-line. Figure 4-1 illustrates the steps to enter the service mode.

The service mode is password protected. The password is required to protect against both intentional and inadvertent program changes. The password can be changed if desired, refer to Chapter 3 of this manual for information on changing passwords.

Steps to enter the service mode:
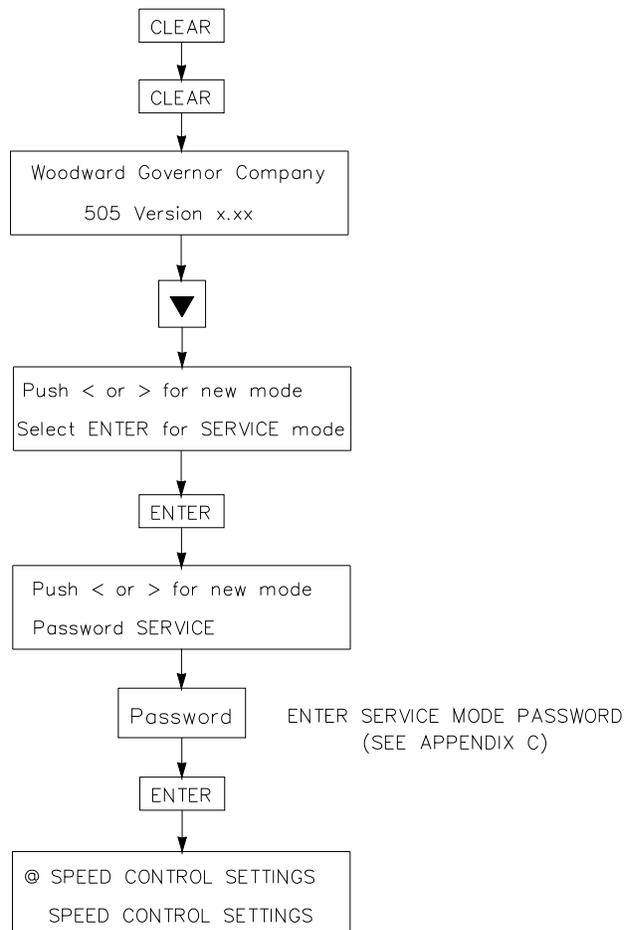
Figure 4-1. Service Mode Entry

The 505E Service Mode

Using Service Menus

Once the Service Mode has been entered with the password, any of service value that has a * before it can be adjusted. A work sheet is provided at the end of this manual, to document any changes for future reference. Figure 4-2 illustrates the 505E service menus and the questions/options available under each block.

The arrow keys (STEP LEFT, STEP RIGHT) allow you to move right or left across the tops of the function the Service mode columns. The STEP UP and STEP DOWN keys allow you to move up or down the columns.

Not all of the service headers listed below will appear at all times. Only the headers that are necessary for the application will appear. Some of the headers will not appear unless the turbine is shutdown.

Figure 4-2a. Service Mode Blocks

Figure 4-2b. Service Mode Blocks

Figure 4-2c. Service Mode Blocks

D ► ◄ ► ► ◄ ◄ ► ◄ ► ◄ ◄ E

REMOTE CASC SETTINGS
- RMT N MTCHD RTE
- RMT CASC MAX RTE
- MIN CASC SET
- MAX CASC SET
- RMT DDBND VALUE
- LAG-TAU VALUE
- HLD RMT CAS CHNG

AUX CONTROL SETTINGS
- SLOW RATE (/SEC)
- FAST RATE DELAY
- SETPT FAST RATE
- SETPT ENTRD RATE
- DROOP (%)
- RATED AUX SETPT
- AUX DERIV RATIO
- THRESHOLD (LMTR)
- THRESHOLD (CNTRLR)
- PID MIN OUTPUT
- HOLD AUX CHNG

REMOTE AUX SETTINGS
- RMT N MTCHD RTE
- RMT AUX MAX RATE
- MIN RMT AUX SET
- MAX RMT AUX SET
- RMT DDBND VALUE
- LAG-TAU VALUE
- HOLD RMT AUX CHNG

BREAKER LOGIC
- FREQ CNTRL ARMD
- SYNC WINDOW RPM
- SYNC WINDOW RATE
- TIEBRKR OPN RMP
- TIE OPEN RATE
- GEN OPEN SETBACK
- GEN OPEN SETPT
- USE MIN LOAD
- MIN LOAD BIAS
- ZERO LOAD VALUE
- HOLD BRKR CHNG

CLEAR → TO EXIT THE SERVICE MODE PUSH (CLEAR)

850-108b
97-08-07 JMM

Figure 4-2d. Service Mode Blocks

E ▶ ◀ ◀ ▶ ◀ ◀ ▶ ◀ ▶ ◀ ◀ F

```
VALVE LIMITER          LOCAL REMOTE          MONITOR CONTACT          RELAY
   SETTINGS              FUNCTIONS               INPUTS              OUTPUTS

      ▼                      ▼                      ▼                    ▼

  HP LIMITER              REMOTE                ESD INPUT            SHT DN RLY
     RATE                ENABLED                   CLSD               ENRGZD

  HP ENTERED             ENABLE                 RST INPUT            ALRM RLY
     RATE               CONTACTS                   CLSD               ENRGZD

   HP MAX                CONTACTS                RSE SPD              RELAY 1
    LIMIT                ENABLED                 IN CLSD              ENRGZD

   HP MIN                ENABLE                  LWR SPD              RELAY 2
    LIMIT               MODBUS 1                 IN CLSD              ENRGZD

  LP LIMITER            MODBUS 1                 CONT #1              RELAY 3
     RATE               ENABLED                  CLOSED              ENRGZD

  LP ENTERED             ENABLE                  CONT #2              RELAY 4
     RATE               MODBUS 2                 CLOSED              ENRGZD

   LP MAX               MODBUS 2                 CONT #3              RELAY 5
    LIMIT               ENABLED                  CLOSED              ENRGZD

   LP MIN                                        CONT #4              RELAY 6
    LIMIT                                        CLOSED              ENRGZD

 HOLD LIMITER                                    CONT #5
     CHG                                         CLOSED

                                                 CONT #6
                                                 CLOSED

                                                 CONT #7
                                                 CLOSED

                                                 CONT #8
                                                 CLOSED

                                                 CONT #9
                                                 CLOSED

                                                 CONT #10
                                                 CLOSED

                          TO EXIT THE            CONT #11
  CLEAR                   SERVICE MODE           CLOSED
                          PUSH (CLEAR)
                                                 CONT #12          850-178b
                                                 CLOSED            97-08-07 JMM
```

Figure 4-2e. Service Mode Blocks

F →

FORCE RELAY OUTPUTS

- FORCE RELAYS?
- FORCE RLYS ENBL
- SHUTDOWN RELAY
- ALARM RELAY
- FORCE RLY #1 ON
- FORCE RLY #2 ON
- FORCE RLY #3 ON
- FORCE RLY #4 ON
- FORCE RLY #5 ON
- FORCE RLY #6 ON
- TURN ON LED'S
- LED'S ON STATUS

MONITOR SPEED INPUTS

- SPEED INPUT #1
- SPEED INPUT #2

MONITOR ANALOG INPUTS

- EXT/ADM (%)=
- ANLG IN #2 (%)=
- ANLG IN #3 (%)=
- ANLG IN #4 (%)=
- ANLG IN #5 (%)=
- ANLG IN #6 (%)=

ANALOG INPUTS ADJUST

- EXT/ADM OFFSET
- EXT/ADM GAIN
- INPUT #2 OFFSET
- INPUT #2 GAIN
- INPUT #3 OFFSET
- INPUT #3 GAIN
- INPUT #4 OFFSET
- INPUT #4 GAIN
- INPUT #5 OFFSET
- INPUT #5 GAIN
- INPUT #6 OFFSET
- INPUT #6 GAIN

G

CLEAR → TO EXIT THE PROGRAM MOD PUSH (CLEAR)

850−179a
97−08−07 JMM

Figure 4-2f. Service Mode Blocks

Figure 4-2g. Service Mode Blocks

Figure 4-2h. Service Mode Blocks

Figure 4-2i. Service Mode Blocks

Service Mode Blocks

Figure 4-2 shows the 31 service columns/blocks. The actual blocks that appear will vary with the program configuration. To enter the Service Mode, use the procedure described above. To use the Service mode, simply step through the blocks as described above and change the control features for your application. The first sixteen service columns will appear for every installation. The remaining fifteen columns contain optional features which can be selected if desired. The 31 columns and their basic functions are described in detail below.

Service Blocks

Speed Control Settings—monitor or change the program speed control settings;
Alarm Settings—monitor or change the program alarm settings;
Key Options—allow or disable controlled stop and dynamics adjustments,
MPU Override Settings—monitor or change MPU override program settings;
Extr/Adm Settings—monitor or change program extraction/admission parameter
    settings;
Steam Map Test—allows testing of the steam map entries;
Steam Map Constants—monitor or change program steam map parameters;
Valve Limiter Settings—monitor or change program valve limiter settings;
Monitor Contact Inputs—monitor the status of the contact inputs;
Monitor Relay Outputs—monitor the status of the relay outputs;
Force Relay Outputs—allows testing of relay outputs and associated wiring by
    forcing of the relay outputs between de-energized and energized state,
    when the turbine is shutdown;
Monitor Speed Inputs—monitors the speed input (s)
Monitor Analog Inputs—monitor the status of the analog inputs;
Analog Input Adjustments—offset and gain adjustments to the analog inputs;
Monitor Analog Outputs—monitor the status of the analog outputs;
Analog Output Adjustments—offset and gain adjustments to the analog outputs;
Valve Linearization—provides actuator 1 and actuator 2 output linearization
    adjustments;
Port Configurations—change or view the default settings of baud rate, stop bits,
    parity, driver, communications mode, device number, time out delay for
    ports 1 & 2, and settings for PC port;

Optional Service Blocks

Speed Control Droop Settings—monitor or change the droop default settings;
Auto Start Sequence Settings—monitor the status of; low idle delay; rate to hi
    idle; hi idle delay; rate to rated; hrs since trip;
Idle/Rated Ramp Settings—change the program or default settings of; idle rated
    rate; use ramp to idle; idle priority;
Sync / Load Share Settings—monitor or change the synchronizing, loadsharing,
    or sync/load share default settings;
Remote Speed Settings—monitor or change the remote speed setpoint default
    settings;
Remote Extr Settings—monitor or change the remote extraction setpoint default
    settings;
Cascade Control Settings—monitor or change the cascade control default
    settings;
Remote Cascade Settings—monitor or change the remote cascade setpoint
    default settings;
Auxiliary Control Settings—monitor or change the auxiliary control default
    settings;

           Remote Auxiliary Settings—monitor or change the remote auxiliary setpoint
               default settings;
           Breaker Logic Values—monitor or change the generator and utility tie breaker
               default settings;
           Local/Remote Functions—monitor or change the local/remote default settings;
           Port 1 Settings—monitor or change the port 1 settings;
           Port 2 Settings—monitor or change the port 2 settings;
           Communication Analog Scaling Settings—monitor or change the communication
               scale factor default settings;

Each of the service blocks are described in detail below. Figure 4-2 can be
referred to for a graphical service mode block reference. Pressing the down
arrow key will step through the column and back to the top of the column, use the
left or right arrow keys to select the next column to change/check.

All service program questions will display on the left side of the line the @ symbol
is on, all entries made will be displayed on the right side of the same line. At the
beginning of each column the control will display the header, pushing the down
arrow will access the column. The line the @ symbol is on will be affected, the
other line of the display will not change, use the SELECT button to move the @
symbol to the other line of the display so another parameter can be displayed.
This gives the operator the flexibility in the service mode to display or tune two
different values by using the SELECT button .

The service blocks contain information detailing each question and/or 505E
program service option. Each question/option shows the default (dflt) value and
the adjustable range of that parameter (shown in parentheses). In addition, any
additional constraints on the configuration are shown in italics following the
description. There is a service mode worksheet in the appendix of this manual
that should be completed and filled-in and used as a guide the site specific
application. This worksheet can also be used for future reference to document
your application program.

Service Mode Worksheet Parameters

Speed Control Settings

When this header appears in the display, press the down arrow key to view or
change this block or press the left or right arrow key to select another block to
change.

RATE TO MIN (RPM/SEC)   dflt= xxx (0.01, 2000)
    Adjusts the rate the setpoint moves from zero to the minimum controlling
    speed when the unit is started. The minimum controlling speed will be either
    'idle' if idle/rated is used or 'low idle' if the auto start sequence is used. If
    neither of these startup features is used, the min speed will be the minimum
    governor speed setpoint. This value is set in the program mode.
SETPOINT SLOW RATE (RPM/SEC)   dflt= xxx (0.01, 100)
    Normal speed setpoint rate of change. This value is set in the program
    mode.
FAST RATE DELAY (SEC)   dflt= 3.0 (0, 100)
    Delay, in seconds, before the 'Setpt Fast Rate' is selected.
SETPT FAST RATE (RPM/SEC)   dflt= xxx (0.01, 500)
    This rate is defaulted to three times (3x) the 'Setpoint Slow Rate'. This value
    can be changed to a new value, however, the HOLD CHANGES prompt
    must be set to YES to retain the change. If not, the value will return to the
    default on the next initialization.

SETPT ENTERED RATE (RPM/SEC)   dflt= xxx (0.01, 100)
 This is the rate that the Speed setpoint will move when setpoint is entered
 from the front panel of the control or from the communication links. This rate
 is defaulted to the Speed setpoint slow rate. This value can be changed to a
 new value, however, the HOLD CHANGES prompt must be set to YES to
 retain the change. If not, the value will return to the default on the next
 initialization.

UNDERSPEED SETTING (RPM)   dflt= xxx (0.0, 20000)
 Only used if an underspeed relay is programmed. Speed setting for the
 underspeed indication. This rate is defaulted to 100 rpm below the 'Minimum
 Governor Speed Setpt'. This value can be changed to a new value,
 however, the HOLD CHANGES prompt must be set to YES to retain the
 change. If not, the value will return to the default on the next initialization.

ON-LINE DERIVATIVE RATIO   dflt= xxx (0.01, 100)
 Speed PID Derivative Ratio when in on-line mode. When this value is
 between 0.01 and 1.0, the derivative term is considered to be 'input
 dominant' and the derivative is equal to (Deriv Ratio)/(Integral Gain). When
 this value is between 1.0 and 100, the derivative term is considered to be
 'feedback dominant' and the derivative is equal to1.0/[(Deriv Ratio)*(Integral
 Gain)] . This value is set in the program mode.

OFF-LINE DERIVATIVE RATIO   dflt= xxx (0.01, 100)
 Speed PID Derivative Ratio when in off-line mode. When this value is
 between 0.01 and 1.0, the derivative term is considered to be 'input
 dominant' and the derivative is equal to (Deriv Ratio)/(Integral Gain). When
 this value is between 1.0 and 100, the derivative term is considered to be
 'feedback dominant' and the derivative is equal to 1.0/[(Deriv Ratio)*(Integral
 Gain)]. This value is set in the program mode.

HOLD SPEED CHANGES ?   dflt= NO (Yes/No)
 Set to YES to permanently Hold the changes made to the Setpoint Fast
 Rate, the Entered Rate, and Underspeed settings. To permanently save
 these changes into the 505E, set to YES and select the 'CLEAR' key twice.

Alarm Settings

When this header appears in the display, press the down arrow key to view or
change this block or press the left or right arrow key to select another block to
change.

IS TRIP AN ALARM ?   dflt= YES (Yes/No)
 When set to YES, any trip condition will also be annunciated as an alarm.
 When NO, a trip condition will not necessarily mean an alarm will be issued.

BLINK ALARMS ?   dflt= NO (Yes/No)
 Set to YES if want an indication if another alarm occurs when an alarm is
 already present. When set to YES, the alarm relay blinks when an alarm
 condition occurs until a reset command is issued. If the alarm still exists, the
 relay will stay energized, but will stop blinking until another alarm occurs.
 When NO, the alarm relay indicates an alarm continuously whenever an
 alarm condition exists.

JUMP TO ALARMS SCREEN ?   dflt= NO (Yes/No)
 When set to YES, the alarm (F1) menu automatically appears on the front
 panel display identifying the cause of the alarm at the time of the alarm.
 When NO, the alarm only shows up when the F1 key is pressed. Also
 disables the controlling parameter message from automatically appearing
 when all alarms are cleared.

Key Options

When this header appears in the display, press the down arrow key to view or change this block or press the left or right arrow key to select another block to change.

USE 'STOP' COMMAND ?   dflt= YES (Yes/No)
    When set to YES, allows the Controlled Stop command to be used. When NO, the Controlled Stop feature is disabled from front panel, Modbus, and contact commands.
USE DYNAMICS KEY ADJUSTMENTS ?   dflt= YES (Yes/No)
    When set to YES, allows the dynamics of all PIDs to be adjusted. When NO, the DYN (dynamics) key and PID proportional and integral gain adjustments are no longer available.

Speed Control Droop Settings (only if a generator unit)

When this header appears in the display, press the down arrow key to view or change this block or press the left or right arrow key to select another block to change.

DROOP (%)   dflt= xxx (0.0, 10)
    Speed/load control droop setting. This value is set in the program mode.
USE KW DROOP ?   dflt= YES (Yes/No)
    When set to NO, the unit is forced to use speed demand/actuator position droop. This setting is only used and relevant if KW Droop was programmed.
GEN LOAD UNITS = MW ?   dflt= NO (Yes/No)
    When set to NO the generator load units are 'KW'. When YES the units are set to 'MW' under the KW/9 key of the 505E front panel. This allows the 505E to display load units in terms of MW as opposed to KW.

MPU Override

When this header appears in the display, press the down arrow key to view or change this block or press the left or right arrow key to select another block to change.

USE MPU OVERRIDE TIMER ?   dflt= NO (Yes/No)
    When set to YES, the MPU override will go OFF when the MPU Override Time expires after a start is initiated. This provides a maximum time for speed to be sensed on startup before a loss of speed is detected.
MPU OVERRIDE TIME (SEC)   dflt= 600.0 (00, 600)
    Sets the maximum time after a start is initiated for speed to be sensed above the failure level. Only valid if 'Use MPU Override Timer?' is YES.
MPU #1 OVERRIDE ON STATUS   (status indication only)
    Indicates when the speed probe failure override is on.
MPU #2 OVERRIDE ON STATUS   (status indication only)
    Indicates when the speed probe failure override is on. This status message only appears if the application is using two speed probes.

Auto Start Sequence (only displayed if configured)

When this header appears in the display, press the down arrow key to view or change this block or press the left or right arrow key to select another block to change.

The following information is provided to display the information useful to the auto start sequence. It allows the operator to check all the times and rates that the 505E is using for the present start sequence.

LOW IDLE DELAY (MIN)   (status indication only)
    Indicates the hold time at Low Idle, in minutes.
RATE TO HI IDLE (RPM/SEC)   (status indication only)
    Indicates the acceleration rate, in rpm/sec; used by the control from Low Idle
    to High Idle.
HI IDLE DELAY (MIN)   (status indication only)
    Indicates the hold time at High Idle, in minutes.
RATE TO RATED (RPM/SEC)   (status indication only)
    Indicates the acceleration rate, in rpm/sec; used by the control from High
    Idle to Rated.
HOURS SINCE TRIP (HRS)   (status indication only)
    Indicates the number of hours the unit was tripped, as determined by the
    control.

Idle / Rated Ramp (only displayed if configured)

When this header appears in the display, press the down arrow key to view or change this block or press the left or right arrow key to select another block to change.

IDLE/RATED RATE (RPM/SEC)   dflt= xxx (0.01, 2000)
    Rate at which the speed setpoint will ramp from idle to rated speed. This
    value is set in the program mode.
USE RAMP TO IDLE FUNCTION?   dflt= YES (Yes/No)
    Set to YES if want to return to idle speed with this function. If set to NO, the
    Idle/ Rated function acts as a 'Ramp to Rated' function and will not return to
    idle. When set to NO, closing the Idle/Rated contact accelerates the speed
    setpoint towards Rated and opening the contact stops the acceleration.
IDLE PRIORITY ?   dflt= NO (Yes/No)
    If YES, the setpoint will move to Idle whenever Idle is selected. If NO, the
    setpoint will move to Idle only if Remote Speed Setpoint is not enabled,
    Cascade control is not enabled, Auxiliary 'controller' is not enabled,
    Extraction/Admission control is not enabled, and the Generator Breaker is
    open.

Sync / Load Share Settings (only displayed if configured)

When this header appears in the display, press the down arrow key to view or change this block or press the left or right arrow key to select another block to change.

INPUT BIAS GAIN (%)   dflt= xxx (0.0, 100)
    Affects the RPM bias the Sync / Load Sharing input has on the speed
    setting. This setting is defaulted to the Droop (%) value or 3%, whichever is
    higher. This value can be changed to a new value, however, the HOLD
    CHANGES prompt must be set to YES to retain the change. If not, the value
    will return to the default on the next initialization.
INPUT BIAS DEADBAND VALUE   dflt= 0.0 (0.0, 100)
    Load Share deadband in RPM.
LAG-TAU VALUE   dflt= 0.0 (0.0, 10)
    Load Sharing input lag setting.
HOLD BIAS CHANGES ?   dflt= NO (Yes/No)
    Set to YES to permanently Hold the changes made to the Load Share Gain
    (%). To permanently save these changes into the 505E, set to YES and
    select the 'CLEAR' key twice.

Remote Speed Settings (only displayed if configured)

When this header appears in the display, press the down arrow key to view or
change this block or press the left or right arrow key to select another block to
change.

NOT MATCHED RATE   dflt= xxx (0.01, 200)
    Rate the setpoint moves when remote is enabled and the remote input
    doesn't match the actual setpoint. This rate is defaulted to the setpoint slow
    rate. This value can be changed to a new value, however, the HOLD
    CHANGES prompt must be set to YES to retain the change. If not, the value
    will return to the default on the next initialization.
SPEED SETPT MAX RATE   dflt= xxx (0.01, 500)
    Rate the setpoint moves once the remote input and actual setpoint are
    matched. This is a maximum rate. Normally the setpoint will follow the
    remote input setting. This value is set in the program mode.
MINIMUM SPEED SETTING   dflt= xxx (0.0, 20000)
    Minimum setting allowed by the remote input. This setting is defaulted to the
    Speed Setpoint Minimum Governor Speed Value. This value can be
    changed to a new value, however, the HOLD CHANGES prompt must be
    set to YES to retain the change. If not, the value will return to the default on
    the next initialization.
    (Must be between the 'Minimum Governor Speed' and the 'Maximum
    Governor Speed'' settings)
MAXIMUM SPEED SETTING   dflt= xxx (0.0, 20000)
    Maximum setting allowed by the remote input. This setting is defaulted to
    the Speed Setpoint Maximum Governor Speed Value. This value can be
    changed to a new value, however, the HOLD CHANGES prompt must be
    set to YES to retain the change. If not, the value will return to the default on
    the next initialization.
    (Must be between the 'Minimum Governor Speed' and the 'Maximum
    Governor Speed'' settings and greater than Minimum Speed Setting)
REMOTE DEADBAND VALUE   dflt= 0.0 (0.0, 100)
    Remote speed setting deadband in RPM.
REMOTE LAG-TAU VALUE   dflt= 0.0 (0.0, 10)
    Remote Setpoint input lag setting.

USE MIN LOAD ?   dflt= YES (Yes/No)
When set to YES, the speed setpoint cannot be lowered/decreased by the
Remote Speed Setpoint input below the rated/synchronous speed setpoint
plus the 'Min Load Bias' setting. This is used to prevent a reverse power
condition as well as allowing the plant to utilize a minimum load setting for
the generator. When NO, the remote speed setpoint can move the speed
setpoint down to the higher of the minimum governor setting or the RSS
4ma value.

HOLD RMT CHANGES ?   dflt= NO (Yes/No)
Set to YES to permanently Hold the changes made to the Remote Not
Matched Rate and the Maximum and Minimum Speed Settings. To
permanently save these changes into the 505E, set to YES and select the
'CLEAR' key twice.

Extraction Control Settings

SLOW RATE (UNITS/SEC)   dflt= xxx (0.01, 1000)
Normal setpoint rate of change. This value is set in the program mode.

FAST RATE DELAY (SEC)   dflt= 3.0 (0.0, 1000)
Delay, in seconds, before the 'Fast Rate' of change is selected.

SETPT FAST RATE (UNITS/SEC)   dflt= xxx (0.01, 5000)
This rate is defaulted to three times (3x) the 'Setpoint Slow Rate'. This value
can be changed to a new value, however, the HOLD CHANGES prompt
must be set to YES to retain the change. If not, the value will return to the
default on the next initialization.

ENTERED RATE (UNITS/SEC)   dflt= xxx (0.01, 1000)
This rate is defaulted to the 'Extr Setpoint Slow Rate'. This value can be
changed to a new value, however, the HOLD CHANGES prompt must be
set to YES to retain the change. If not, the value will return to the default on
the next initialization.

DROOP (%)   dflt= xxx (0.0, 100)
Extraction control droop setting. This value is set in the program mode.

RATED SETPT   dflt= xxx (–20000, 20000)
Only used to determine the extraction control Droop.

This setpoint is defaulted to the extr maximum setpoint limit. This value can
be changed to a new value, however, the HOLD CHANGES prompt must be
set to YES to retain the change. If not, the value will return to the default on
the next initialization.
*(Must be between the 'Minimum Extr Setpt' and the 'Maximum Extr Setpt'
settings)*

PID INT DEADBAND   dflt= 0.0 (0.0, 50)
Extraction PID controller integrator deadband setting in percent.

PID DERIV RATIO   dflt= 0.01 (0.01, 100)
Extraction PID controller derivative ratio setting. When this value is between
0.01 and 1.0, the derivative term is considered to be 'input dominant' and
the derivative is equal to (Deriv Ratio)/(Integral Gain). When this value is
between 1.0 and 100, the derivative term is considered to be 'feedback
dominant' and the derivative is equal to 1.0/[(Deriv Ratio) * (Integral Gain)].
This value is set in the program mode.

PID THRESHOLD   dflt= 100.0 (0.0, 100)
Extraction PID controller threshold setting.

INITIAL DEMAND SETTING (%)   dflt= xxx (–25, 125)
>   Initial Extraction demand setting in percent. Used mainly for admission or extraction/admission control to balance the pressure across the admission stop valve prior to opening the valve. Using this setting, the default can be programmed to be close to the correct value to minimize adjustments required while starting-up. The default value is the 505Es calculated zero extraction flow based on performance map entries. This value can be changed to a new value, however, the HOLD CHANGES prompt must be set to YES to retain the change. If not, the value will return to the default on the next initialization.

HOLD EXTR CHANGES ?   dflt= NO (Yes/No)
>   Set to YES to permanently Hold the changes made to the Setpoint Fast Rate, Entered Rate, Rated Extr Setpoint, and Initial Demand Setting. To permanently save these changes into the 505E, set to YES and select the 'CLEAR' key twice.

Remote Extr Settings (only displayed if configured)

REMOTE NOT MATCHED RATE   dflt= xxx (0.01, 1000)
>   Rate the setpoint moves when remote is enabled and the remote input doesn't match the actual setpoint. This rate is defaulted to the 'Extr Setpoint Slow Rate'. This value can be changed to a new value, however, the HOLD CHANGES prompt must be set to YES to retain the change. If not, the value will return to the default on the next initialization.

RMT EXTR SETPT MAX RATE   dflt= xxx (0.01, 1000)
>   Rate the setpoint moves once the remote input and actual setpoint are matched. This is a maximum rate. Normally the setpoint will follow the remote input setting. This value is set in the program mode.

MINIMUM EXTR SETTING   dflt= xxx (–20000, 20000)
>   Minimum setting allowed by the remote input. This setting is defaulted to the Extr Setpoint Minimum Value. This value can be changed to a new value, however, the HOLD CHANGES prompt must be set to YES to retain the change. If not, the value will return to the default on the next initialization.
>   *(Must be between the 'Minimum Extr Setpt' and the 'Maximum Extr Setpt' settings)*

MAXIMUM EXTR SETTING   dflt= xxx (–20000, 20000)
>   Maximum setting allowed by the remote input. This setting is defaulted to the Extr Setpoint Maximum Value. This value can be changed to a new value, however, the HOLD CHANGES prompt must be set to YES to retain the change. If not, the value will return to the default on the next initialization.
>   *(Must be between the 'Minimum Extr Setpt' and the 'Maximum Extr Setpt' settings)*

REMOTE DEADBAND VALUE   dflt= 0.0 (0.0, 500)
>   Remote Extr setting input deadband in engineering units.

REMOTE LAG-TAU VALUE   dflt= 0.0 (0.0, 10)
>   Remote Setpoint input lag setting.

HOLD RMT EXTR CHANGES?   dflt= NO (Yes/No)
>   Set to YES to permanently Hold the changes made to the Remote Not Matched Rate and the Maximum and Minimum Extr Settings. To permanently save these changes into the 505E, set to YES and select the 'CLEAR' key twice.

Cascade Control (only displayed if configured)

When this header appears in the display, press the down arrow key to view or change this block or press the left or right arrow key to select another block to change.

SLOW RATE (UNITS/SEC)   dflt= xxx (0.01, 1000)
  Normal setpoint rate of change. This value is set in the program mode.
FAST RATE DELAY (SEC)   dflt= 3.0 (0.0, 100)
  Delay, in seconds, before the 'Setpt Fast Rate' is selected.
SETPT FAST RATE (UNITS/SEC)   dflt= xxx (0.01, 5000)
  This rate is defaulted to three times (3x) the setpoint 'Slow Rate'. This value
  can be changed to a new value, however, the HOLD CHANGES prompt
  must be set to YES to retain the change. If not, the value will return to the
  default on the next initialization.
SETPT ENTERED RATE (UNITS/SEC)   dflt= xxx (0.01, 1000)
  This is the rate that the Cascade setpoint will move when setpoint is entered
  from the front panel of the control or from the communication links. This rate
  is defaulted to the Cascade setpoint slow rate. This value can be changed to
  a new value, however, the HOLD CHANGES prompt must be set to YES to
  retain the change. If not, the value will return to the default on the next
  initialization.
DROOP (%)   dflt= xxx (0.0, 100)
  Cascade control droop setting. This value is set in the program mode.
RATED CASC SETPT   dflt= xxx (–20000, 20000)
  This setting is only used to determine the cascade control droop. This
  setpoint is defaulted to the cascade maximum setpoint limit. This value can
  be changed to a new value, however, the HOLD CHANGES prompt must be
  set to YES to retain the change. If not, the value will return to the default on
  the next initialization.
  (Must be between the 'Minimum Cascade Setpoint' and the 'Maximum
  Cascade Setpoint' settings)
CASC NOT MATCHED RATE   dflt= xxx (0.01, 1000)
  This rate is defaulted to the 'Speed Setpoint Slow Rate'. This value can be
  changed to a new value, however, the HOLD CHANGES prompt must be
  set to YES to retain the change. If not, the value will return to the default on
  the next initialization.
MAX SPEED SETPT RATE   dflt= xxx (0.1, 100)
  The maximum rate at which the cascade control can vary the speed
  setpoint. This value is set in the program mode.
MAXIMUM SPEED SETTING   dflt= xxx (0.0, 20000)
  This setting is defaulted to the maximum speed setpoint value set in the
  program mode. This value can be changed to a new value, however, the
  HOLD CHANGES prompt must be set to YES to retain the change. If not,
  the value will return to the default on the next initialization.
  (Must be between the 'Minimum Governor Speed' and the 'Maximum
  Governor Speed' settings)
MINIMUM SPEED SETTING   dflt= xxx (0.0, 20000)
  This setting is defaulted to the minimum speed setpoint value set in the
  program mode. This value can be changed to a new value, however, the
  HOLD CHANGES prompt must be set to YES to retain the change. If not,
  the value will return to the default on the next initialization.
  (Must be between the 'Minimum Governor Speed' and the 'Maximum
  Governor Speed' settings)
CASC PID INT DEADBAND   dflt= 0.1 (0.0, 50)
  Cascade PID controller integrator deadband setting in engineering units.

CASC PID DERIV RATIO   dflt= xxx (0.01, 100)

Cascade PID controller derivative ratio setting. When this value is between 0.01 and 1.0, the derivative term is considered to be 'input dominant' and the derivative is equal to (Deriv Ratio)/(Integral Gain). When this value is between 1.0 and 100, the derivative term is considered to be 'feedback dominant' and the derivative is equal to 1.0/[(Deriv Ratio)*(Integral Gain)]. This value is set in the program mode.

RAISE /LOWER CASCADE SETPOINT ONLY ?   dflt= NO (Yes/No)

When set to NO, the cascade raise/lower commands will adjust the speed setpoint when cascade control is disabled and adjust the cascade setpoint when cascade control is enabled. When YES, the cascade raise/lower commands adjust the cascade setpoint only.

USE MIN LOAD ?   dflt= YES (Yes/No)

When set to YES, the speed setpoint cannot be lowered/decreased by the Cascade control PID below the rated/synchronous speed setpoint plus the 'Min Load Bias' setting. This is used to prevent a reverse power condition as well as allowing the plant to utilize a minimum load setting for the generator. When NO, the Cascade control PID can move the speed setpoint down to the cascade minimum speed setting value.

HOLD CASC CHANGES ?   dflt= NO (Yes/No)

Set to YES to permanently Hold the changes made to the Fast Rate, Entered Rate, Rated Setpt, Casc Not Matched Rate, Maximum Speed Setting and Minimum Speed Setting. To permanently save these changes into the 505E, set to YES and select the 'CLEAR' key twice.

Remote Casc Settings (only displayed if configured)

When this header appears in the display, press the down arrow key to view or change this block or press the left or right arrow key to select another block to change.

REMOTE NOT MATCHED RATE   dflt= xxx (0.01, 1000)

Rate the setpoint moves when remote is enabled and the remote input doesn't match the actual setpoint. This rate is defaulted to the 'Cascade Setpoint Slow Rate'. This value can be changed to a new value, however, the HOLD CHANGES prompt must be set to YES to retain the change. If not, the value will return to the default on the next initialization.

RMT CASC SETPT MAX RATE   dflt= xxx (0.01, 1000)

Rate the setpoint moves once the remote input and actual setpoint are matched. This is a maximum rate. Normally the setpoint will follow the remote cascade input setting. This rate is set in the Program Mode.

MINIMUM CASC SETTING   dflt= xxx (–20000, 20000)

Maximum setting allowed by the remote input. This setting is defaulted to the Minimum Cascade Setpoint Value. This value can be changed to a new value, however, the HOLD CHANGES prompt must be set to YES to retain the change. If not, the value will return to the default on the next initialization.
(Must be between the 'Minimum Cascade Setpoint' and the 'Maximum Cascade Setpoint' settings)

MAXIMUM CASC SETTING   dflt= xxx (–20000, 20000)

Minimum setting allowed by the remote input. This setting is defaulted to the Maximum Cascade Setpoint Value. This value can be changed to a new value, however, the HOLD CHANGES prompt must be set to YES to retain the change. If not, the value will return to the default on the next initialization.
(Must be between the 'Minimum Cascade Setpoint' and the 'Maximum Cascade Setpoint' settings)

REMOTE DEADBAND VALUE   dflt= 0.0 (0.0, 500)
    Remote cascade setting input deadband in engineering units.
REMOTE LAG-TAU VALUE   dflt= 0.0 (0.0, 10)
    Remote Setpoint input lag setting.
HOLD RMT CASC CHANGES ?   dflt= NO (Yes/No)
    Set to YES to permanently Hold the changes made to the Remote Not
    Matched Rate and the Maximum and Minimum Casc Settings. To
    permanently save these changes into the 505E, set to YES and select the
    'CLEAR' key twice.

Aux Control Settings (only displayed if configured)

When this header appears in the display, press the down arrow key to view or
change this block or press the left or right arrow key to select another block to
change.

SLOW RATE (UNITS/SEC)   dflt= xxx (0.01, 1000)
    Normal setpoint rate of change. This value is set in the program mode.
FAST RATE DELAY (SEC)   dflt= 3.0 (0.0, 100)
    Delay, in seconds, before the 'Fast Rate' of change is selected.
FAST RATE (UNITS/SEC)   dflt= xxx (0.01, 5000)
    This rate is defaulted to three times (3x) the 'Setpoint Slow Rate'. This value
    can be changed to a new value, however, the HOLD CHANGES prompt
    must be set to YES to retain the change. If not, the value will return to the
    default on the next initialization.
SETPT ENTERED RATE (UNITS/SEC)   dflt= xxx (0.01, 1000)
    This is the rate that the Aux setpoint will move when setpoint is entered from
    the front panel of the control or from the communication links. This rate is
    defaulted to the Aux setpoint slow rate. This value can be changed to a new
    value, however, the HOLD CHANGES prompt must be set to YES to retain
    the change. If not, the value will return to the default on the next
    initialization.
DROOP (%)   dflt= xxx (0.0, 100)
    Aux control droop setting. This value is set in the program mode.
RATED AUX SETPT   dflt= xxx (–20000, 20000)
    Only used to determine the auxiliary control Droop. This setpoint is
    defaulted to the aux maximum setpoint limit. This value can be changed to a
    new value, however, the HOLD CHANGES prompt must be set to YES to
    retain the change. If not, the value will return to the default on the next
    initialization.
    *(Must be between the 'Minimum Auxiliary Setpoint' and the 'Maximum
    Auxiliary Setpoint' settings)*
AUX PID DERIV RATIO   dflt= 100 (0.01, 100)
    Aux PID controller derivative ratio setting. When this value is between 0.01
    and 1.0, the derivative term is considered to be 'input dominant' and the
    derivative is equal to (Deriv Ratio)/(Integral Gain). When this value is
    between 1.0 and 100, the derivative term is considered to be 'feedback
    dominant' and the derivative is equal to 1.0/ [(Deriv Ratio)*(Integral Gain)].
    This value is set in the program mode.
AUX PID THRESHOLD (LIMITER)   dflt= 100 (0.0, 110)
    Aux PID threshold setting when Aux is used as a limiter.
AUX PID THRESHOLD (CONTROLLER)   dflt= 10.0 (0.0, 110)
    Aux PID controller threshold setting when Aux is used as a controller.
AUX PID MIN OUTPUT   dflt= 0.00 (0.0, 50)
    Auxiliary PID min output setting. The Auxiliary PID can not output a lower
    value to the LSS. This can be used to stop the Aux PID from taking the LSS
    low enough to take the unit off-line or below min gov.

HOLD AUX CHANGES ?   dflt= NO (Yes/No)

> Set to YES to permanently Hold the changes made to the Setpoint Fast Rate, Entered Rate, and Rated Aux Setpoint. To permanently save these changes into the 505E, set to YES and select the 'CLEAR' key twice.

Remote Aux Settings (only displayed if configured)

When this header appears in the display, press the down arrow key to view or change this block or press the left or right arrow key to select another block to change.

REMOTE NOT MATCHED RATE   dflt= xxx (0.01, 1000)

> Rate the setpoint moves when remote is enabled and the remote input doesn't match the actual setpoint. This rate is defaulted to the 'Aux Setpoint Slow Rate'. This value can be changed to a new value, however, the HOLD CHANGES prompt must be set to YES to retain the change. If not, the value will return to the default on the next initialization.

RMT AUX SETPT MAX RATE   dflt= xxx (0.01, 1000)

> Rate the setpoint moves once the remote input and actual setpoint are matched. This is a maximum rate. Normally the setpoint will follow the remote input setting. This value is set in the program mode.

MINIMUM AUX SETTING   dflt= xxx (–20000, 20000)

> Minimum setting allowed by the remote input. This setting is defaulted to the Aux Setpoint Minimum Value. This value can be changed to a new value, however, the HOLD CHANGES prompt must be set to YES to retain the change. If not, the value will return to the default on the next initialization.
> *(Must be between the 'Minimum Auxiliary Setpoint' and the 'Maximum Auxiliary Setpoint' settings)*

MAXIMUM AUX SETTING   dflt= xxx (–20000, 20000)

> Maximum setting allowed by the remote input. This setting is defaulted to the Aux Setpoint Maximum Value. This value can be changed to a new value, however, the HOLD CHANGES prompt must be set to YES to retain the change. If not, the value will return to the default on the next initialization.
> *(Must be between the 'Minimum Auxiliary Setpoint' and the 'Maximum Auxiliary Setpoint' settings)*

REMOTE DEADBAND VALUE   dflt= 0.0 (0.0, 500)

> Remote aux setting input deadband in engineering units.

REMOTE LAG-TAU VALUE   dflt= 0.0 (0.0, 10)

> Remote Setpoint input lag setting.

HOLD RMT AUX CHANGES ?   dflt= NO (Yes/No)

> Set to YES to permanently Hold the changes made to the Remote Not Matched Rate and the Maximum and Minimum Aux Settings. To permanently save these changes into the 505E, set to YES and select the 'CLEAR' key twice.

Breaker Logic (only displayed if a generator)

When this header appears in the display, press the down arrow key to view or change this block or press the left or right arrow key to select another block to change.

FREQ CONTROL ARMED   (status indication only)

SYNC WINDOW (RPM)   dflt= 10.0 (0.0, 200)

> A setpoint window, in rpm, that the setpoint moves at a slower rated to accommodate synchronizing to the bus. This rate is only active while within this window and the generator breaker is open.

SYNC WINDOW RATE (RPM/SEC)   dflt= 2.0 (0.1, 100)
    The rate the speed setpoint moves at when within the 'Sync Window' and
    the generator beaker is open. This is normally slower than the slow rate to
    accommodate synchronizing to the bus.

TIEBRKR OPEN SYNC RAMP ?   dflt= YES (Yes/No)
    If NO, the speed setpoint is instantly set to the last utility bus speed setting
    and holds. When set to YES, the speed setpoint is instantly set to the last
    utility bus speed setting and moves to the synchronous (rated) speed
    setpoint after the utility tie breaker opens and the generator breaker is still
    closed.

TIEBRKR OPEN RATE (RPM/SEC)   dflt= 1.0 (0.1, 20000)
    Rate the setpoint moves to rated speed after the utility tie breaker opens
    (only used if 'Tiebrkr Open Sync Ramp' is YES).

GEN BRKR OPEN SETBACK?   dflt= YES (Yes/No)
    When set to YES, the speed setpoint is instantly set to the 'Gen Breaker
    Open Setpt' when the generator breaker opens.

GEN BRKR OPEN SETPT (RPM)   dflt= xxx (0.0, 20000)
    This setpoint is defaulted to 50 rpm below the synchronous (rated) speed
    setpoint (only used if 'Gen Breaker Open Setback' is YES). This value can
    be changed to a new value, however, the HOLD CHANGES prompt must be
    set to YES to retain the change. If not, the value will return to the default on
    the next initialization.
    (Must be between the 'Minimum Governor' and 'Rated Speed Setpt'
    settings)

USE MIN LOAD ?   dflt= YES (Yes/No)
    When set to YES, the speed setpoint automatically increases to the
    rated/synchronous speed setpoint plus the 'Min Load Bias' setting when the
    generator breaker is closed and the unit is on-line (the utility tie breaker is
    closed). When NO, no automatic setpoint action occurs.

MIN LOAD BIAS (RPM)   dflt= xxx (0.0, 500)
    This value is the rpm bias above rated speed and the default is calculated
    as 3% of full load. This is the value the speed setpoint will increase to upon
    the generator breaker closure (when the utility tie is closed).

ZERO LOAD VALUE (%)   dflt= xxx (–30, 100)
    This value is automatically sampled and held at the actuator/load demand
    value when the generator breaker is closed. When the steam conditions are
    not at rated conditions when the breaker is closed, this value can be
    adjusted to a more reasonable value (2–10%). Every time the generator
    breaker closes, this value is re-sampled.

HOLD BREAKER CHANGES ?   dflt= NO (Yes/No)
    Set to YES to permanently Hold the changes made to the Gen Breaker
    Open Setpoint and Min Load Bias. To permanently save these changes into
    the 505E, set to YES and select the 'CLEAR' key twice.

Valve Limiter Settings

HP LMTR RATE (%/SEC)   dflt= xxx (0.1, 25)
    HP valve limiter rate. This value is set in the program mode.

HP LMTR ENTERED RATE (%/SEC)   dflt= xxx (0.1, 100)
    This rate is defaulted to the slow rate. This value can be changed to a new
    value, however, the HOLD CHANGES prompt must be set to YES to retain
    the change. If not, the value will return to the default on the next
    initialization.

HP MAX LIMIT (%)   dflt= 100 (55, 101)
    Valve Maximum setting. Normally set to 100%, but this can be set lower to
    provide a maximum valve lift setting.

HP MIN LIMIT (%)   dflt= 0.00 (0.0, 45)
  Valve Limiter Minimum setting. Normally set to 0%, but this can be set to
  provide a minimum valve lift setting—when using admission steam only.
  This value can be changed to a new value, however, the HOLD CHANGES
  prompt must be set to YES to retain the change. If not, the value will return
  to the default on the next initialization.
LP LMTR RATE (%/SEC)   dflt= xxx (0.1, 25)
  LP valve limiter rate. This value is set in the program mode.
LP LMTR ENTERED RATE (%/SEC)   dflt= xxx (0.1, 100)
  This rate is defaulted to the slow rate. This value can be changed to a new
  value, however, the HOLD CHANGES prompt must be set to YES to retain
  the change. If not, the value will return to the default on the next
  initialization.
LP MAX LIMIT (%)   dflt= 100 (55, 101)
  Valve Maximum setting. Normally set to 100%, but this can be set lower to
  provide a maximum valve lift setting.
LP MIN LIMIT (%)   dflt= 0.00 (0.0, 45)
  Valve Limiter Minimum setting. Normally set to 0%, but this can be set to
  provide a minimum valve lift setting for cooling the LP section. This value
  can be changed to a new value, however, the HOLD CHANGES prompt
  must be set to YES to retain the change. If not, the value will return to the
  default on the next initialization.
HOLD LIMITER CHANGES?   dflt= NO (Yes/No)
  Set to YES to Hold the changes made to the Entered Rate and Min Limit
  setting. To permanently save these changes into the 505E, set to YES and
  select the 'CLEAR' key twice.

Local / Remote Functions (Only Displayed If Configured)

When this header appears in the display, press the down arrow key to view or
change this block or press the left or right arrow key to select another block to
change.

Normally the Local/Remote function will disable all inputs except the front panel
commands when Local is selected. The following questions can customize this
feature by allowing the Contacts, Modbus 1, and/or Modbus 2 to be active also
when local is selected.

REMOTE MODE ENABLED ?   (status indication only)
  Indicates when the Remote mode is enabled. When the indication is NO,
  remote control is disabled and local control only is selected.
ENABLE CONTACTS ?   dflt= NO (Yes/No)
  When set to YES, the contacts are always active regardless of the
  Local/Remote selection. When set to NO, the contact inputs are disabled
  when the local mode is selected.
CONTACTS ENABLED ?   (status indication only)
  Indicates the status of the Contact input commands. When the indication is
  NO, local control is selected and remote control from the contact inputs is
  disabled.
ENABLE MODBUS 1 ?   dflt= NO (Yes/No)
  When set to YES, the Modbus #1 commands are always active regardless
  of the Local/Remote selection. When set to NO, the Modbus #1 commands
  are disabled when the local mode is selected.
MODBUS 1 ENABLED ?   (status indication only)
  Indicates the status of the Modbus #1 commands. When the indication is
  NO, local control is selected and remote control from the Modbus #1 inputs
  is disabled.

ENABLE MODBUS 2 ?   dflt= NO (Yes/No)
  When set to YES, the Modbus #2 commands are always active regardless of the Local/Remote selection. When set to NO, the Modbus #2 commands are disabled when the local mode is selected.

MODBUS 2 ENABLED ?   (status indication only)
  Indicates the status of the Modbus #2 commands. When the indication is NO, local control is selected and remote control from the Modbus #2 inputs is disabled.

Monitor Contact Inputs

When this header appears in the display, press the down arrow key to view or change this block or press the left or right arrow key to select another block to change.

This block monitors the status of the contact input and can be used when troubleshooting or for initial wiring checkout procedures.

EMERGENCY SHUTDOWN CLOSED ?   (status indication only)
RESET INPUT CLOSED ?   (status indication only)
RAISE SPEED INPUT CLOSED ?   (status indication only)
LOWER SPEED INPUT CLOSED ?   (status indication only)
CONT IN #1 CLOSED ?   (status indication only)
CONT IN #2 CLOSED ?   (status indication only)
CONT IN #3 CLOSED ?   (status indication only)
CONT IN #4 CLOSED ?   (status indication only)
CONT IN #5 CLOSED ?   (status indication only)
CONT IN #6 CLOSED ?   (status indication only)
CONT IN #7 CLOSED ?   (status indication only)
CONT IN #8 CLOSED ?   (status indication only)
CONT IN #9 CLOSED ?   (status indication only)
CONT IN #10 CLOSED ?   (status indication only)
CONT IN #11 CLOSED ?   (status indication only)
CONT IN #12 CLOSED ?   (status indication only)

Monitor Relay Outputs

When this header appears in the display, press the down arrow key to view or change this block or press the left or right arrow key to select another block to change.

This block monitors the status of the relay output command and can be used when troubleshooting or for initial wiring checkout procedures when used with the 'Force Relay Outputs' function in the Service Mode.

SHUTDOWN RELAY ENERGIZED ?   (status indication only)
ALARM RELAY ENERGIZED ?   (status indication only)
RELAY 1 ENERGIZED ?   (status indication only)
RELAY 2 ENERGIZED ?   (status indication only)
RELAY 3 ENERGIZED ?   (status indication only)
RELAY 4 ENERGIZED ?   (status indication only)
RELAY 5 ENERGIZED ?   (status indication only)
RELAY 6 ENERGIZED ?   (status indication only)

Force Relay Outputs (only displayed if shut down)

Set to YES to allow testing of the relay outputs or associated external logic. Only active if the 'Force Relays Enabled' value is true (next display value-below). To be active, the unit must be shut down and the turbine speed less than 1000 rpm.

FORCE RELAYS ?	dflt= NO (Yes/No)

    Set to YES to allow testing of the relay outputs or associated external logic.

FORCE RELAYS ENABLED ?	(status indication only)
FORCE SHUTDOWN RELAY ON ?	dflt= NO (Yes/No)
FORCE ALARM RELAY ON ?	dflt= NO (Yes/No)
FORCE RELAY #1 ON ?	dflt= NO (Yes/No)
FORCE RELAY #2 ON ?	dflt= NO (Yes/No)
FORCE RELAY #3 ON ?	dflt= NO (Yes/No)
FORCE RELAY #4 ON ?	dflt= NO (Yes/No)
FORCE RELAY #5 ON ?	dflt= NO (Yes/No)
FORCE RELAY #6 ON ?	dflt= NO (Yes/No)
TURN ON LEDs ?	dflt= NO (Yes/No)

    When set to YES, turns on all front-panel LEDs to test them.

LED ON STATUS ?	(status indication only)

Monitor Speed Inputs

When this header appears in the display, press the down arrow key to view or change this block or press the left or right arrow key to select another block to change.

Used to monitor the speed inputs. The input is shown in RPM.

Speed Input#1	(status indication only)
Speed Input 2	(status indication only)

Monitor Analog Inputs

When this header appears in the display, press the down arrow key to view or change this block or press the left or right arrow key to select another block to change.

Used to monitor the analog input. The input is shown in percent (%).

EXT/ADM INPUT	(status indication only)
ANALOG IN #2	(status indication only)
ANALOG IN #3	(status indication only)
ANALOG IN #4	(status indication only)
ANALOG IN #5	(status indication only)
ANALOG IN #6	(status indication only)

Analog In Adjustments

When this header appears in the display, press the down arrow key to view or change this block or press the left or right arrow key to select another block to change.

Used to adjust the analog input. The offset units are in percent (%).

EXTR/ADM OFFSET?	dflt= 0.0 (−20, 20)
EXTR/ADM GAIN?	dflt= 1.0 (0.00, 2.0)
INPUT #2 OFFSET?	dflt= 0.0 (−20, 20)
INPUT #2 GAIN?	dflt= 1.0 (0.00, 2.0)
INPUT #3 OFFSET?	dflt= 0.0 (−20, 20)
INPUT #3 GAIN?	dflt= 1.0 (0.00, 2.0)
INPUT #4 OFFSET?	dflt= 0.0 (−20, 20)
INPUT #4 GAIN?	dflt= 1.0 (0.00, 2.0)
INPUT #5 OFFSET?	dflt= 0.0 (−20, 20)
INPUT #5 GAIN?	dflt= 1.0 (0.00, 2.0)
INPUT #6 OFFSET?	dflt= 0.0 (−20, 20)
INPUT #6 GAIN?	dflt= 1.0 (0.00, 2.0)

Monitor Analog Outputs

When this header appears in the display, press the down arrow key to view or change this block or press the left or right arrow key to select another block to change.

Indication of the milliamp signal demanded by the control. This is not actual milliamps.

ANALOG OUT #1 Demand(mA)	(status indication only)
ANALOG OUT #2 Demand(mA)	(status indication only)
ANALOG OUT #3 Demand(mA)	(status indication only)
ANALOG OUT #4 Demand(mA)	(status indication only)
ANALOG OUT #5 Demand(mA)	(status indication only)
ANALOG OUT #6 Demand(mA)	(status indication only)

Analog Output Adjustments

When this header appears in the display, press the down arrow key to view or change this block or press the left or right arrow key to select another block to change.

Used to adjust the analog output. The offset units are milliamps (mA).

OUTPUT #1 OFFSET?	dflt= 0.0 (−20, 20)
OUTPUT #1 GAIN?	dflt= 1.0 (0.00, 2.0)
OUTPUT #2 OFFSET?	dflt= 0.0 (−20, 20)
OUTPUT #2 GAIN?	dflt= 1.0 (0.00, 2.0)
OUTPUT #3 OFFSET?	dflt= 0.0 (−20, 20)
OUTPUT #3 GAIN?	dflt= 1.0 (0.00, 2.0)
OUTPUT #4 OFFSET?	dflt= 0.0 (−20, 20)
OUTPUT #4 GAIN?	dflt= 1.0 (0.00, 2.0)
OUTPUT #5 OFFSET?	dflt= 0.0 (−20, 20)
OUTPUT #5 GAIN?	dflt= 1.0 (0.00, 2.0)
OUTPUT #6 OFFSET?	dflt= 0.0 (−20, 20)
OUTPUT #6 GAIN?	dflt= 1.0 (0.00, 2.0)

ACT1 Linearization

When this header appears in the display, press the down arrow key to view or
change this block or press the left or right arrow key to select another block to
change. The actuator linearization settings can be checked or verified by using
the actuator stroke feature when the unit is shut down.

X-1 VALUE   dflt= 0.0 (–5, 110)
   Input point #1 of the actuator linearization curve, in percentage.
   (Must be less than the 'X-2 Value')
Y-1 VALUE   dflt= 0.0 (–5, 110)
   Output point #1 of the actuator linearization curve, in percentage.
X-2 VALUE   dflt= 10.0 (–5, 110)
   Input point #2 of the actuator linearization curve, in percentage.
   (Must be between the 'X-1 Value' and the 'X-3 Value' settings)
Y-2 VALUE   dflt= 10.0 (–5, 110)
   Output point #2 of the actuator linearization curve, in percentage.
X-3 VALUE   dflt= 20.0 (–5, 110)
   Input point #3 of the actuator linearization curve, in percentage.
   (Must be between the 'X-2 Value' and the 'X-4 Value' settings)
Y-3 VALUE   dflt= 20.0 (–5, 110)
   Output point #3 of the actuator linearization curve, in percentage.
X-4 VALUE   dflt= 30.0 (–5, 110)
   Input point #4 of the actuator linearization curve, in percentage.
   (Must be between the 'X-3 Value' and the 'X-5 Value' settings)
Y-4 VALUE   dflt= 30.0 (–5, 110)
   Output point #4 of the actuator linearization curve, in percentage.
X-5 VALUE   dflt= 40.0 (–5, 110)
   Input point #5 of the actuator linearization curve, in percentage.
   (Must be between the 'X-4 Value' and the 'X-6 Value' settings)
Y-5 VALUE   dflt= 40.0 (–5, 110)
   Output point #5 of the actuator linearization curve, in percentage.
X-6 VALUE   dflt= 50.0 (–5, 110)
   Input point #6 of the actuator linearization curve, in percentage.
   (Must be between the 'X-5 Value' and the 'X-7 Value' settings)
Y-6 VALUE   dflt= 50.0 (–5, 110)
   Output point #6 of the actuator linearization curve, in percentage.
X-7 VALUE   dflt= 60.0 (–5, 110)
   Input point #7 of the actuator linearization curve, in percentage.
   (Must be between the 'X-6 Value' and the 'X-8 Value' settings)
Y-7 VALUE   dflt= 60.0 (–5, 110)
   Output point #7 of the actuator linearization curve, in percentage.
X-8 VALUE   dflt= 70.0 (–5, 110)
   Input point #8 of the actuator linearization curve, in percentage.
   (Must be between the 'X-7 Value' and the 'X-9 Value' settings)
Y-8 VALUE   dflt= 70.0 (–5, 110)
   Output point #8 of the actuator linearization curve, in percentage.
X-9 VALUE   dflt= 80.0 (–5, 110)
   Input point #9 of the actuator linearization curve, in percentage.
   (Must be between the 'X-8 Value' and the 'X-10 Value' settings)
Y-9 VALUE   dflt= 80.0 (–5, 110)
   Output point #9 of the actuator linearization curve, in percentage.
X-10 VALUE   dflt= 90.0 (–5, 110)
   Input point #10 of the actuator linearization curve, in percentage.
   (Must be between the 'X-9 Value' and the 'X-11 Value' settings)
Y-10 VALUE   dflt= 90.0 (–5, 110)
   Output point #10 of the actuator linearization curve, in percentage.

X-11 VALUE   dflt= 100.0 (–5, 110)
Input point #11 of the actuator linearization curve, in percentage.
(Must be greater than the 'X-10 Value')
Y-11 VALUE   dflt= 100.0 (–5, 110)
Output point #11 of the actuator linearization curve, in percentage.
ACT1 DEMAND (%) =   (status indication only)
Displays the actuator demand (%) before the linearization curve.
ACT1 OUTPUT (%) =   (status indication only)
Displays the actuator demand (%) after the linearization curve.

ACT2 Linearization

When this header appears in the display, press the down arrow key to view or change this block or press the left or right arrow key to select another block to change. The actuator linearization settings can be checked or verified by using the actuator stroke feature when the unit is shut down.
X-1 VALUE   dflt= 0.0 (–5, 110)
Input point #1 of the actuator linearization curve, in percentage.
(Must be less than the 'X-2 Value')
Y-1 VALUE   dflt= 0.0 (–5, 110)
Output point #1 of the actuator linearization curve, in percentage.
X-2 VALUE   dflt= 10.0 (–5, 110)
Input point #2 of the actuator linearization curve, in percentage.
(Must be between the 'X-1 Value' and the 'X-3 Value' settings)
Y-2 VALUE   dflt= 10.0 (–5, 110)
Output point #2 of the actuator linearization curve, in percentage.
X-3 VALUE   dflt= 20.0 (–5, 110)
Input point #3 of the actuator linearization curve, in percentage.
(Must be between the 'X-2 Value' and the 'X-4 Value' settings)
Y-3 VALUE   dflt= 20.0 (–5, 110)
Output point #3 of the actuator linearization curve, in percentage.
X-4 VALUE   dflt= 30.0 (–5, 110)
Input point #4 of the actuator linearization curve, in percentage.
(Must be between the 'X-3 Value' and the 'X-5 Value' settings)
Y-4 VALUE   dflt= 30.0 (–5, 110)
Output point #4 of the actuator linearization curve, in percentage.
X-5 VALUE   dflt= 40.0 (–5, 110)
Input point #5 of the actuator linearization curve, in percentage.
(Must be between the 'X-4 Value' and the 'X-6 Value' settings)
Y-5 VALUE   dflt= 40.0 (–5, 110)
Output point #5 of the actuator linearization curve, in percentage.
X-6 VALUE   dflt= 50.0 (–5, 110)
Input point #6 of the actuator linearization curve, in percentage.
(Must be between the 'X-5 Value' and the 'X-7 Value' settings)
Y-6 VALUE   dflt= 50.0 (–5, 110)
Output point #6 of the actuator linearization curve, in percentage.
X-7 VALUE   dflt= 60.0 (–5, 110)
Input point #7 of the actuator linearization curve, in percentage.
(Must be between the 'X-6 Value' and the 'X-8 Value' settings)
Y-7 VALUE   dflt= 60.0 (–5, 110)
Output point #7 of the actuator linearization curve, in percentage.
X-8 VALUE   dflt= 70.0 (–5, 110)
Input point #8 of the actuator linearization curve, in percentage.
(Must be between the 'X-7 Value' and the 'X-9 Value' settings)
Y-8 VALUE   dflt= 70.0 (–5, 110)
Output point #8 of the actuator linearization curve, in percentage.

X-9 VALUE   dflt= 80.0 (–5, 110)
    Input point #9 of the actuator linearization curve, in percentage.
    (Must be between the 'X-8 Value' and the 'X-10 Value' settings)
Y-9 VALUE   dflt= 80.0 (–5, 110)
    Output point #9 of the actuator linearization curve, in percentage.
X-10 VALUE   dflt= 90.0 (–5, 110)
    Input point #10 of the actuator linearization curve, in percentage.
    (Must be between the 'X-9 Value' and the 'X-11 Value' settings)
Y-10 VALUE   dflt= 90.0 (–5, 110)
    Output point #10 of the actuator linearization curve, in percentage.
X-11 VALUE   dflt= 100.0 (–5, 110)
    Input point #11 of the actuator linearization curve, in percentage.
    (Must be greater than the 'X-10 Value')
Y-11 VALUE   dflt= 100.0 (–5, 110)
    Output point #11 of the actuator linearization curve, in percentage.
ACT2 DEMAND (%) =   (status indication only)
    Displays the actuator demand (%) before the linearization curve.
ACT2 OUTPUT (%) =   (status indication only)
    Displays the actuator demand (%) after the linearization curve.

Steam Map Test (only displayed if shut down)

ENABLE MAP TEST?   dflt= NO (Yes/No)
    Set to YES to allow testing of the 505E's internal steam map constants and
    limiters. Only active when the 'Map Test Enabled' value on the next screen
    is true. To be active, the unit must be shut down and the turbine speed less
    than 1000 rpm.
MAP TEST ENABLED   (status indication only)
SPEED/LOAD DEMAND (%)   dflt= 0.0 (0.00, 100)
EXTRACTION DEMAND (%)   dflt= 0.0 (0.00, 100)
HP VALVE DEMAND (%)   (status indication only)
LP VALVE DEMAND (%)   (status indication only)
AT MAP LIMIT   (status indication only)
PRESSURE PRIORITY?   dflt= NO (Yes/No)
    Set to YES to test the steam map using pressure priority for all limiters
    except the LP Maximum Limiter. Set to NO for speed priority on these
    limiters. This setting is only used during this test, the control will use the
    priority programmed and only when the permissives are met for that priority.
    This setting allows the limits to be checked for either priority situation.
LP MAX PRS PRIORITY?   dflt= NO (Yes/No)
    Set to YES to test the steam map using pressure priority for the LP
    Maximum Limiter. Set to NO for speed priority on this limiter. This setting is
    only used during this test, the control will use the priority programmed and
    only when the permissives are met for that priority.

Steam Map Constants

SPEED/LOAD DEMAND (%)   (status indication only)
EXTRACTION DEMAND (%)   (status indication only)
HP VALVE DEMAND (%)   (status indication only)
LP VALVE DEMAND (%)   (status indication only)
AT MAP LIMIT   (status indication only)

The below constants are calculated based on the turbine performance parameters entered in the program mode. These values can be changed to a new value, however, the HOLD CHANGES prompt must be set to YES to retain the change. If not, the value will return to the default on the next initialization.

K1 (dHP/dS) VALUE   dflt= xxx (0.00, 4.0)
K2 (dHP/dP) VALUE   dflt= xxx (0.00, 4.0)
K3 (HP Offset) VALUE   dflt= xxx (–300, 30)
K4 (dLP/dS) VALUE   dflt= xxx (0.00, 4.0)
K5 (dLP/dP) VALUE   dflt= xxx (–4.0, 4.0)
K6 (LP Offset) VALUE   dflt= xxx (–300, 100)

The below constants appear only if a decoupled mode is programmed and is calculated based on the turbine performance parameters entered in the program mode. These values can be changed to a new value, however, the HOLD CHANGES prompt must be set to YES to retain the change. If not, the values will return to the default on the next initialization.

D1 (dHP/dE) VALUE   dflt= xxx (0.00, 4.0)
D2 (dHP/dP) VALUE   dflt= xxx (0.00, 4.0)
D3 (HP Offset) VALUE   dflt= xxx (–300, 30)
D4 (dLP/d I) VALUE   dflt= xxx (0.00, 4.0)
D5 (dLP/dP) VALUE   dflt= xxx (–4.0, 4.0)
D6 (LP Offset) VALUE   dflt= xxx (–300, 100)
AUTO SWITCH PRIORITY?   dflt= xxx (Yes/No)
    When programmed for pressure priority, set to YES will result in the priority to automatically switch from speed to pressure when the permissives for pressure priority are met. This value is set in the Program Mode. When set to NO, pressure priority must be selected before pressure priority will get enabled.
LP MAX PRS PRIORITY?   dflt= xxx (Yes/No)
    This value is set in the Program Mode. Set to YES for pressure priority for the LP Maximum Limiter. Set to NO for speed priority on this limiter.
HOLD MAP CHANGES?   dflt= NO (Yes/No)
    Set to YES to Hold the changes made to the K1–K6 Steam Map Constants. To permanently save these changes into the 505E, set to YES and select the 'CLEAR' key twice.

Port 1 Settings (only displayed if configured)

When this header appears in the display, press the down arrow key to view or change this block or press the left or right arrow key to select another block to change.

PORT 1 LINK ERROR   (status indication only)
    Displays a YES message if the port has a communication error. The `Time-out Delay` or port configuration may need to be adjusted under `PORT CONFIGURATIONS`.
EXCEPTION ERROR   (status indication only
    Displays a YES message if the port has a exception error
ERROR CODE   (status indication only)
    Displays the error code related to the communication problem.
    0 = No Errors   1 = Illegal Function
    2 = Illegal Data Address   3 = Illegal Data Value
    9 = Checksum Error   10= Garbled Message
    Press RESET to clear the port error.
USE MODBUS 1 TRIP ?   dflt= YES (Yes/No)
    Use trip command through the Modbus link from the Modbus device.

USE 2-STEP TRIP ?   dflt= NO (Yes/No)
   If using a Modbus Trip, is this a two-step trip. If YES, requires both the Trip
   command and the Trip Acknowledge command to go YES before a trip from
   the Modbus link will executed.
ENABLED WHEN LOCAL IS SELECTED ?   dflt= NO (Yes/No)
   If using Local/Remote only. If YES, allows commands from Modbus to be
   active even when LOCAL mode is selected. When NO, the Modbus
   commands are disabled when in LOCAL.
ALWAYS ENABLE MODBUS TRIP ?   dflt= NO (Yes/No)
   If using Local/Remote only and if the Modbus is disabled on Local selection.
   If YES, the TRIP from the Modbus is still active event though all other
   Modbus commands are disabled. When NO, all Modbus commands are
   disabled when in LOCAL.

Port 2 Settings (only displayed if configured)

When this header appears in the display, press the down arrow key to view or
change this block or press the left or right arrow key to select another block to
change.

PORT 2 LINK ERROR   (status indication only)
   Displays a YES message if the port has a communication error. The `Time-
   out Delay` or port configuration may need to be adjusted under `PORT
   CONFIGURATIONS`.
EXCEPTION ERROR   (status indication only
   Displays a YES message if the port has a exception error
ERROR CODE   (status indication only)
   Displays the error code related to the communication problem.
   0 = No Errors   1 = Illegal Function
   2 = Illegal Data Address   3 = Illegal Data Value
   9 = Checksum Error   10= Garbled Message
   Press RESET to clear the port error.
USE MODBUS 2 TRIP ?   dflt= YES (Yes/No)
   Use trip command through the Modbus link from the Modbus device.
USE 2-STEP TRIP ?   dflt= NO (Yes/No)
   If using a Modbus Trip, is this a two-step trip. If YES, requires both the Trip
   command and the Trip Acknowledge command to go YES before a trip from
   the Modbus link will executed.
ENABLED WHEN LOCAL IS SELECTED ?   dflt= NO (Yes/No)
   If using Local/Remote only. If YES, allows commands from Modbus to be
   active even when LOCAL mode is selected. When NO, the Modbus
   commands are disabled when in LOCAL.
ALWAYS ENABLE MODBUS TRIP ?   dflt= NO (Yes/No)
   If using Local/Remote only and if the Modbus is disabled on Local selection.
   If YES, the TRIP from the Modbus is still active event though all other
   Modbus commands are disabled. When NO, all Modbus commands are
   disabled when in LOCAL.

Comm Analog Scaling (if communications is used)

When this header appears in the display, press the down arrow key to view or change this block or press the left or right arrow key to select another block to change.

CASCADE SCALING FACTOR   dflt= 1.0 (1.0, 100)
  Multiplier constant for all Cascade analog values sent over both Modbus
  links. When set to a value other than one (1.0), allows the Modbus device to
  scale inputs that are too small or to allow decimal places to be displayed.
AUX SCALING FACTOR   dflt= 1.0 (1.0, 100)
  Multiplier constant for all Auxiliary analog values sent over both Modbus
  links. When set to a value other than one (1.0), allows the Modbus device to
  scale inputs that are too small or to allow decimal places to be displayed.
KW SCALING FACTOR   dflt= 1.0 (1.0, 100)
  Multiplier constant for all KW analog values sent over both Modbus links.
  When set to a value other than one (1.0), allows the Modbus device to scale
  inputs that are too small or to allow decimal places to be displayed.
FSP SCALING FACTOR   dflt= 1.0 (1.0, 100)
  Multiplier constant for all First Stage Pressure analog values sent over both
  Modbus links. When set to a value other than one (1.0), allows the Modbus
  device to scale inputs that are too small or to allow decimal places to be
  displayed.
LOAD SHARE SCALING FACTOR   dflt= 1.0 (1.0, 100)
  Multiplier constant for all Load Share analog values sent over both Modbus
  links. When set to a value other than one (1.0), allows the Modbus device to
  scale inputs that are too small or to allow decimal places to be displayed.
EXTRACTION SCALING FACTOR   dflt= 1.0 (1.0, 100)
  Multiplier constant for all Extraction analog values sent over both Modbus
  links. When set to a value other than one (1.0), allows the Modbus device to
  scale inputs that are too small or to allow decimal places to be displayed.

Port Configurations

When this header appears in the display, press the down arrow key to view or change this block or press the left or right arrow key to select another block to change.

PORT 1 SETTINGS
STATUS   (status indication only)
  Indicates a hardware communications problem.
BAUD   dflt = scroll thru options
  This value is set in the program mode.
STOP BITS   dflt = scroll thru options
  This value is set in the program mode.
PARITY   dflt = scroll thru options
  This value is set in the program mode.
DRIVER   dflt = scroll thru options
  This value is set in the program mode.
ASCII OR RTU   dflt= xx (1, 2)
  1 = ASCII 2 = RTU This value is set in the program mode.
MODBUS DEVICE NUMBER   dflt= xx (1, 247)
  Enter a number from 1 to 247. This value is set in the program mode.
TIME-OUT DELAY (SEC)   dflt= 10.0 (0, 100)
  Sets the delay for no communication on the Modbus link before the link is
  considered failed and issues an alarm.

PORT 2 SETTINGS

STATUS (status indication only)
Indicates a hardware communications problem.
BAUD dflt = scroll thru options
This value is set in the program mode.
STOP BITS dflt = scroll thru options
This value is set in the program mode.
PARITY dflt = scroll thru options
This value is set in the program mode.
DRIVER dflt = scroll thru options
This value is set in the program mode.
ASCII OR RTU dflt= xx (1, 2)
1 = ASCII 2 = RTU This value is set in the program mode.
MODBUS DEVICE NUMBER dflt= xx (1, 247)
Enter a number from 1 to 247. This value is set in the program mode.
TIME-OUT DELAY (SEC) dflt= 10.0 (0, 100)
Sets the delay for no communication on the Modbus link before the link is
considered failed and issues an alarm.

PC PORT SETTINGS

STATUS (status indication only)
Indicates a hardware communications problem.
BAUD dflt = scroll thru options
BITS / CHAR dflt = scroll thru options
STOP BITS dflt = scroll thru options
PARITY dflt = scroll thru options
READ MODE dflt = scroll thru options
FLOW dflt = scroll thru options
ECHO dflt = scroll thru options
ENDLINE dflt = scroll thru options
IGNORE CR dflt = scroll thru options

Chapter 5.
Understanding PID Settings

Overview

The Speed, Cascade, Extr/Adm, and Auxiliary controls utilize PID controllers. The response of each control loop can be adjusted for optimum response, however it is important to understand what a PID controller is and the effect each controller adjustment has on the controller response. Proportional gain, integral gain (stability), and DR (speed derivative ratio) are the adjustable and interacting parameters used to match the response of the control loop with the response of the system. They correspond to the P (proportional), I (integral), and D (derivative) terms, and are displayed by the 505E as follows:

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

Proportional Control

Proportional response is directly proportional to a process change.

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

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

Integral Control

Integral compensates for process and setpoint load changes.

Analogy: Cruise control maintains constant speed regardless of hills.

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

Derivative

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

Analogy: Accelerating into high speed lane with merging traffic.

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

Proportional Response

The amount of controller change is directly related to the process change and the Proportional gain setting on the controller; Controller output change is Proportional to the process change. If there is no process change, there is no change in output from the controller (or valve change) regardless of the deviation. This results in an undesired offset between the original desired Setpoint and the resulting drop in the Control Point.
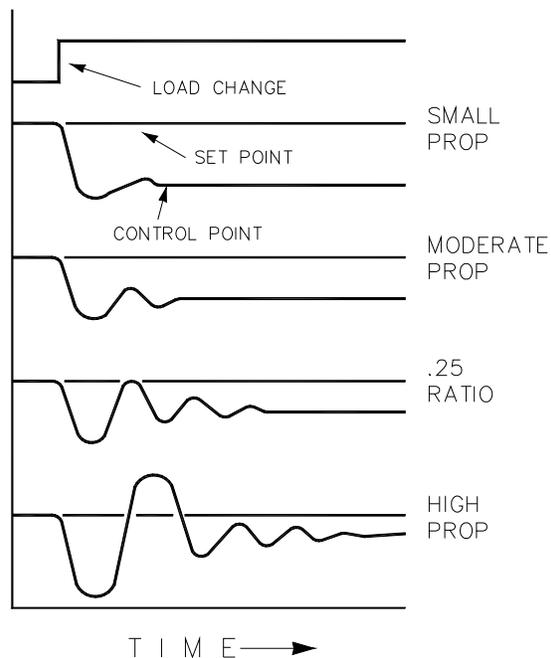
Figure 5-1. Proportional Gain Setting Effects

Proportional Gain (Effect Of Settings)

Figure 5-1 shows the effect of Proportional gain settings on control. Starting at the top of the graph a load change is introduced. With a small Proportional gain (meaning a large process change is required to produce full valve travel), stability is good but offset is very high. With a moderate gain setting (higher number setting) stability is still good—offset is still fairly high. With a high setting, offset is considerably smaller but the stability is poor. The 0.25 ratio effects a minimum area whereby the offset is reduced to a minimum while stability is in a decaying manner at 0.25% ratio. The decay ratio used (0.25%) means that if the second cycle is 1/4 of the first cycle, then each succeeding cycle will be 1/4 of the preceding cycle until the cycle is not visible.

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

Integral Response

Integral Gain as stated in the Woodward controls is repeats per minute (or Reset Rate). Therefore, a high amount of Integral gain (high number) would result in a large amount of Reset action. Conversely, a low Integral gain (low number) would result in a slower reset action.
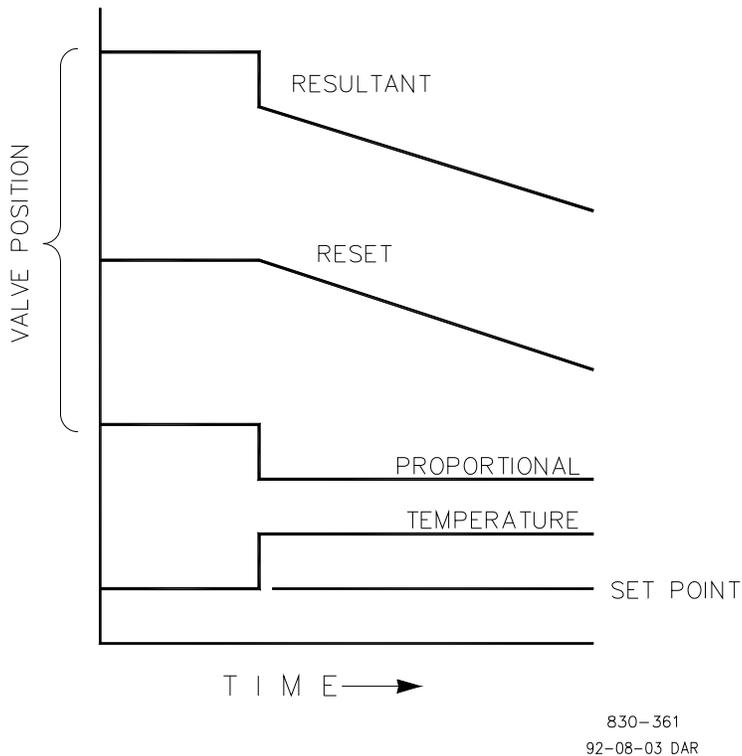
Figure 5-2. Open Loop Proportional and Integral Response

Integral response is provided to eliminate the offset that resulted from straight Proportional control. Figure 5-2 shows how the controller action is Proportional to the measurement change, but as we saw earlier, this results in offset. The Integral (or Reset) action is a function of both time and magnitude of the deviation. As long as an offset condition (due to load changes) exists, Integral action is taking place.
The amount of Integral action is a function of four things:
- The magnitude of the deviation.
- The duration of the deviation.
- The Proportional gain setting.
- The Integral setting.

In this Open Loop figure (5-2), the Integral response is shown increasing due to the offset condition existing between the temperature and the setpoint. The resultant action is the top curve showing the step Proportional response that ends as soon as the measurement stops changing. Then the Integral (or reset) action is added to the Proportional action in an amount equal to the Integral of the deviation. In other words, Reset action continues (in either or both directions) as long as there is a difference (deviation) between the setpoint and the process measurement.

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

Proportional + Integral (Closed Loop)

Figure 5-3 shows the closed loop effects of integral action. The bottom curve displays the load change. The next curve up shows the setpoint and the measured variable, temperature. With the load change the temperature droops or deviates from the setpoint.

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

In Closed Loop, however (as opposed to Open Loop), as the measurement decays toward the Setpoint the Proportional action is taking place Proportionally to the measurement change, and the Integral action is decaying proportionately to the magnitude and duration of the deviation until the measurement reaches the setpoint at which time the Integral action is zero.
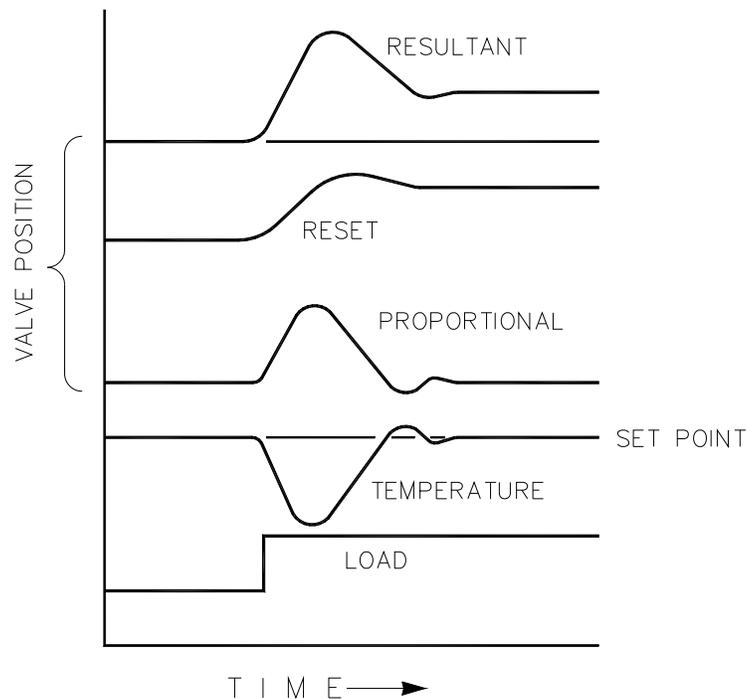
830-362
92-08-03 DAR

Figure 5-3. Closed Loop Proportional and Integral Response

Integral (Effects Of Settings)

Figure 5-4 shows the effect of fast or slow Integral action. For a given load change an offset results with Proportional response only. Since recovery time (for a given load change) is important, the Integral setting should remove the offset in minimum time without adding additional cycling. If two cycles are added, then too much Integral Gain has been added. Of course, Proportional only must first establish the 1/4 decay ratio. If increased cycling occurs, the Integral must be turned off or the controller switched to "manual" if allowed to go too far. Ideally, the process should not continue to cycle after the setpoint has been reached as in the second curve from the bottom.
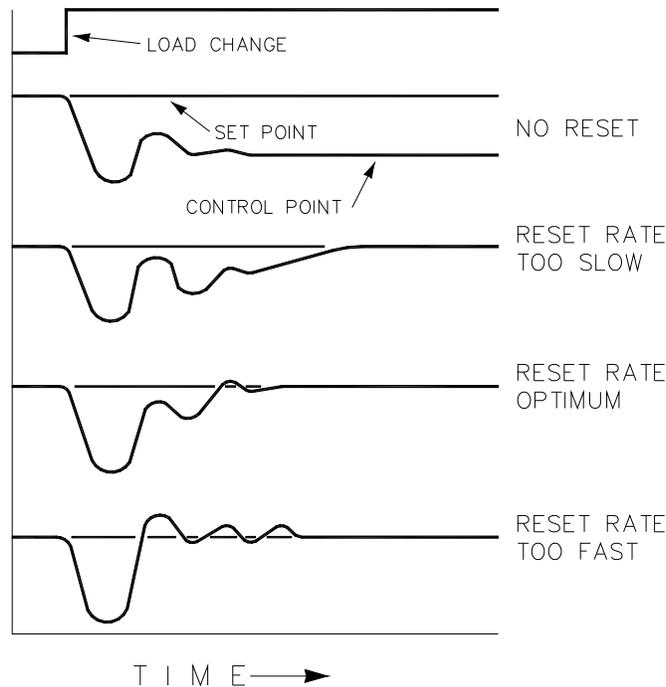
Figure 5-4. Integral Gain (Reset) Setting Responses

Derivative Response

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

Derivative action takes place at only three times:
- When the process starts to change.
- When the rate of change takes place in the process.
- When the process stops changing.

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

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

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

Input dominant derivative applies the DR term before the integrator term of the PID equation. When the DR is less than 1, the derivative is input dominant and reacts very quickly to process upsets. This function is very adapted for PIDs that control the load parameter, such as load shaft turbine speed. Since the input dominant derivative is so sensitive, it should be reserved only for applications without high frequency noise.

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

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

Proportional + Derivative (Closed Loop)
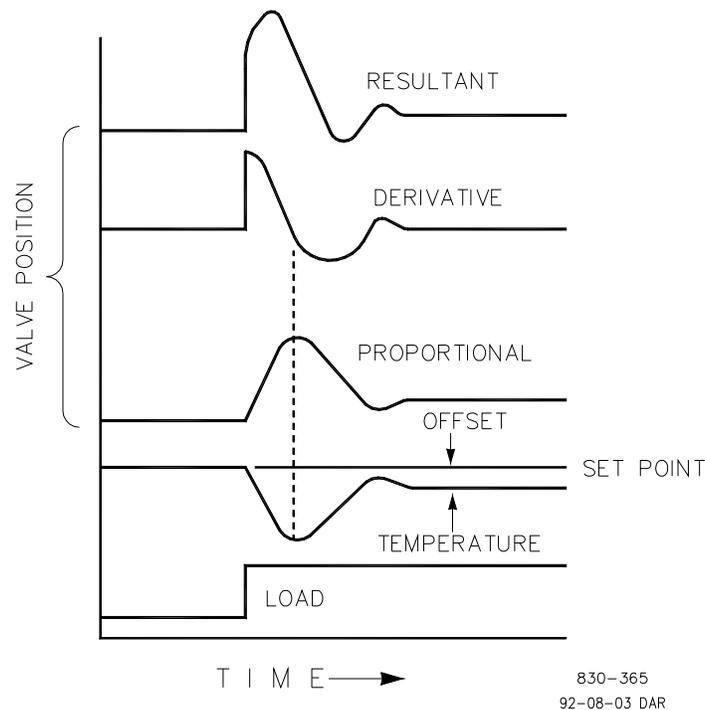
Figure 5-5. Closed Loop Proportional and Derivative Action

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

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

Derivative (Effects Of Settings)
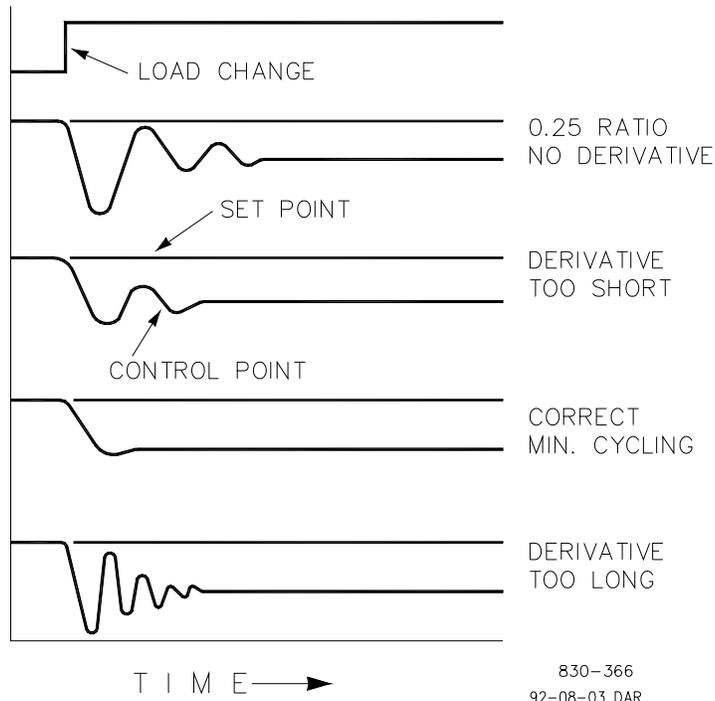
Figure 5-6. Derivative Setting Effects

Figure 5-6 shows the effect of different Derivative settings. The curves are relative since it depends on what type of control is desired in order to properly adjust Derivative time. For example, if minimum cycling is desired (as is shown here) then Derivative is added to the 1/4 decay cycle provided by Proportional until more than one cycle is removed and of course the 1/4 decay is destroyed. However, in most cases it is desirable to retain the 1/4 decay cycle, in which case Derivative is added to the point of removing only one cycle from the 1/4 decay ratio then the gain is increased until the 1/4 decay ratio is restored.

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

Proportional + Integral + Derivative (Closed Loop)

Figure 5-7 shows the relationship of valve position to the interaction of the PID modes of control whenever a load change takes place in closed loop. As the temperature drops due to the load change, the proportional action moves the control valve proportionately to the measurement (temperature) change. The integral gain/reset adds to the proportional action as a result of the magnitude and time (duration) of the deviation. And the derivative temporarily over-corrects based on the speed at which the measurement moves in any direction. The resultant curve (at the top) shows a similar over-correction (in this case), but in addition the valve will stay at the new position required to keep the measurement at the setpoint.
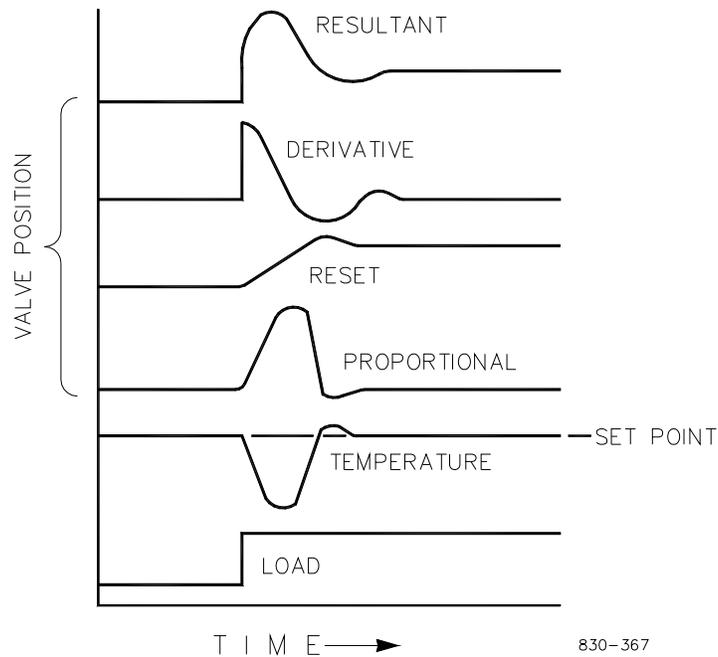
Figure 5-7. Closed Loop Proportional, Integral and Derivative Action

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

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

Adding Derivative

The value of the Derivative Ratio (DR) term can range from 0.01 to 100. In order to simplify adjustment of the dynamics of the 505E, adjusting the integral gain value sets both the I and D terms of the PID controller. The DR term establishes the degree of effect the integral gain value has on the "D" term, and changes the configuration of a controller from input rate sensitive (input dominant) to feedback rate sensitive (feedback dominant) and vice versa.

Another possible use of the DR adjustment is to reconfigure the controller from a PID to a PI controller. This is done by adjusting the DR term to its upper or lower limits, depending on whether an input or feedback dominant controller is desired.
* A DR setting of 1 to 100 selects feedback dominant mode.
* A DR setting of .01 to 1 selects input dominant mode.
* A DR setting of .01 or 100 selects a PI only controller, input and feedback dominant respectively.

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

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

A controller configured as feedback dominant is more sensitive to the change-of-rate of its feedback (LSS). A feedback dominant controller has the ability to limit the rate of change of the LSS bus when a controller is near its setpoint but is not yet in control. This limiting of the LSS bus allows a feedback dominant controller to make smoother control transitions than an input dominant controller.

General Field Tuning Guidelines

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

This procedure will lead to controller settings which will provide:
* Process control without sustained cycling
* Process recovery in a minimum time

Controller settings derived for given operating conditions are valid over a narrow range of load change. The settings made for one operating set of conditions may result in excessive cycling or highly damped response at some other operating condition. This procedure should be applied under the most difficult operating conditions to assure conservative settings over the normal operating range.

It is good practice to keep the average of the setpoint changes near the normal setpoint of the process to avoid excessive departure from normal operating level.

After each setpoint change, allow sufficient time to observe the effect of the last adjustment (see Figure 5-8). It is wise to wait until approximately 90% of the change has been completed.
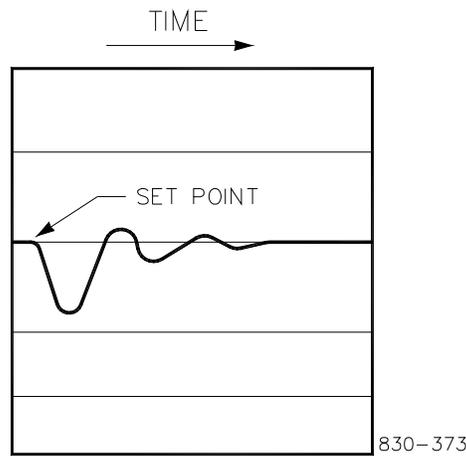
Figure 5-8. Typical Response to Load Change

Tuning Example

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

On an initial startup with the 505E, all PID dynamic gain terms will require adjustment to match the respective PID's response to that of its control loop. There are multiple dynamic tuning methods available that can be used with the 505E's PIDs to assist in determining the gain terms that provide optimum control loop response times.

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

1. Increase Derivative Ratio (DR) to 100 (Service Mode adjustment)
2. Reduce integral gain to 0.01 (Run Mode adjustment)
3. Increase proportional gain until system just starts to oscillate (Run Mode).
4. The optimum gain for this step is when the system just starts to oscillate and maintains a self-sustaining oscillation that does not increase or decrease in magnitude.
5. Record the control gain (Kc) and oscillation period (T) in seconds.
6. Set the dynamics as follows:
    For PI control : G=P(I/s + 1)
        Set: Proportional gain = 0.45*Kc
        Integral gain = 1.2/T
        Derivative ratio = 100
    For PID control : G=P(I/s + 1 + Ds)
        Set: Proportional gain = 0.60*Kc
        Integral gain = 2/T
        Deriv ratio   = 8/(T*Integral Gain) for fdbk dominant
                      = (T*Integral Gain)/8 for input dominant

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

Chapter 6.
Hardware/Operating System Faults

General

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

⚠ 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.**

Most 505E problems which will be encountered are covered in the manual. Use the table of contents to locate the sections of the manual that may describe a specific problem. Refer to the CONTROLLING PARAM DISPLAYS and ALARM DISPLAYS sections of this manual for display descriptions and corrective actions. This troubleshooting section contains a few guidelines that Woodward field service technicians and engineers have suggested.

Off-Line Diagnostics

When the 505E control is powered up the microprocessor and other hardware is reset and the self-test begins. The first thing that the self-test does is turn off all five of the LED lamps. If these LEDs do not turn off this means that the microprocessor is not working and that the CPU module has failed. The self-test tests the RAM, system clock, LED display, EEPROM, communications memory, and application memory before beginning execution of the application program. If an error is found during the self-test it is annunciated on the front panel LED display. It also indicates the error by flashing the F1/Alarm LED a certain number of times repetitively for errors when the LED display may not be functioning. The table below shows the errors indicated by flashing the LED.

LED Flashes	Error
1	RAM Test Failed
2	Unexpected Exception
3	Clock Interrupt Test Failed
4	Display Test Failed
5	EEPROM Test Failed
6	Communications Memory Test Failed
7	Flash Memory Test Failed

It is also possible to see the errors below on the front panel LED display. These errors could occur at anytime during the self-test or during execution of the application program. These indicate that an illegal reset condition has occurred.

"Reset caused by"
"WATCHDOG TIMEOUT"

"Reset caused by"
"HALT MONITOR"

"Reset caused by"
"LOSS OF CLOCK"

"Reset caused by"
"SOFTWARE RESET"

"Reset caused by"
"TEST SUBMODULE RESET"

All the above errors indicate a problem with the CPU module except the "Display Test Failed" which indicates a problem with the display module.

On-Line Diagnostics

As soon as the application program starts running, the system will use a small portion of run time to continuously run the following on-line diagnostic tests.

TEST	MESSAGE ON FAILURE
Local Memory Test	This test gets a RAM location, saves the data from that location, then writes several different values to that location. It reads each value back, and checks it to be sure it is correct. It then restores the saved original data aback to the RAM and repeats the process at another location.
Application Memory Test	This test reads all flash memory, then calculates the sumcheck value and compares it to the sumcheck value previously calculated offline and stored in memory.
Task Overflow	This test checks the last eight locations in the task that has just completed to make sure that the values that were set up when the task was created have not changed. If they have, it indicates that the task has overflowed its memory, and destroyed memory in another task.

A failure of any one of the on-line tests results in the I/O lock being asserted and display of a message as shown in the following table. The message will be displayed on the Service Panel at the time the error occurs, and it also will go into the Fault Mode Buffer so that it can be displayed in the Fault Mode.

TEST	MESSAGE ON FAILURE
Local RAM	Local Ram Railed
Application Checksum	Checksum Error
During execution, an operating system task ran out of memory, or its memory was corrupted by a different task.	Task Overrun in Task XX

Operation Errors and Faults

Certain other errors can also occur during system operation. I any of the below error messages appear:
- Disconnect all field wiring to the 505E control, except input power.
- Perform a power-up reset (for 30 seconds or more, temporarily remove input power, or press the "System Reset Switch". See Volume 1, Figure 2-4 for location).

If the problem disappears, troubleshoot field wiring errors or check for and correct noise on the input power. If the problem does not disappear, replace the control.

Operation Error Messages
System Error (#)
EEPROM Fault
Rate Group Slip (#)
EE Initialization Fault
Exception Error (#)

Wiring Problems

Most 505E problems are caused by wiring problems. Carefully and thoroughly check all wiring connections at both ends. Be very careful when installing wires into the 505E control terminal blocks. Check all shields for proper grounding.

All inputs and outputs can be measured directly at the terminal strips. In addition, from the Service Mode, the LED display will show what the 505E measures. This comparison can be used to determine if the 505E is interpreting the input signal correctly. The Service Mode can be used to monitor and adjust analog inputs and outputs, monitor speed inputs, monitor and adjust actuator outputs, monitor contact inputs, and monitor and force relay outputs.

Contact inputs can be verified by measuring the voltage at the terminal blocks. The contact power supply voltage should measure approximately 24 Vdc from any contact (+) terminal to the contact GND terminal (11). If 24 Vdc is not the voltage measured, disconnect all wiring to the 505E except input power, then remeasure this power supply voltage. If 24 Vdc is not the voltage measured, check for wiring problems. If 24 Vdc is not measured across the contact input (+) and contact GND terminal (11) with input wiring disconnected, replace the 505E.

The operation of a contact input to the 505E can be checked by verifying that the voltage from the contact input's (+) terminal measures 24 Vdc with respect to the contact input GND, terminal (11), when the external contact is closed.

Any 4–20 mA input or output problem can be checked by placing a milliamp meter in series with the input or output.

Refer to Volume 1, Chapter 3 of this manual for actuator wiring concerns or questions.

If the serial communications line is not working, check the wiring first. Then check the Program Mode entries for matching communications setup.

Control Adjustments

If, while trying to adjust the Speed Setpoint in the Run Mode, the ADJ up and ADJ down keys will not work, check to make sure that CAS (cascade control) and RMT (remote control) are both disabled.

If the system's steam valve is unsteady or hunts, try manually positioning the steam valve by closing the valve limiter. If the steam valve is blocked 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, or appears sticky, it may need dither (especially TM type).

If the 505E control is not able to fully close or open the governor valves, check to make sure that the actuators are calibrated correctly, and valve linkage is correctly set.

If the 505E control is not able to control speed above or below a certain speed, the steam valve may not be adjusted correctly. Verify that the steam valve position is indeed in the position indicated by the 505E (by pressing the ACT key). If these positions do not match, correct the problem (actuator linkage, or current calibration).

If an overspeed condition is reached on start-up, verify that the governor valve is closed. Next verify that the governor valve is seated correctly by opening the T&T valve with the governor valve closed. If the T&T valve allows the turbine to turn, then the governor valve is not correctly seated.

Other Operating Problems

If CAS or RMT will not work, check that the generator and tie breakers are both closed.

If actual speed is less than the speed called for by the speed setpoint, check for droop (kW or speed). Droop causes the actual speed to be less than the speed reference.

Appendix A.
505E Design Specifications

Hardware Specifications

Package
Flush Mount Package
Approximate Physical Size Of 11" X 14" X 4"
Environmental Category: Lloyd's Type Env2
                                 NEMA: Type 4x or IEC 60529, IP 56
                                 (applies only to front of flush mount
                                 package)
Optional Bulkhead Enclosure (Approximate Size: 20" X 20" X 7")

Humidity
Lloyd's Test Specification No. 1, 1996, Humidity Test #1:
Two Temperature Cycles Between 20 and 55 °C at 95% Relative Humidity
within 48 Hours

Operating Temperature
without Enclosure (8923-439):   −25 to +65 °C, still air, no external heat
                                loads.
                                Passes Lloyd's Type ENV3 Dry Heat Test
with Enclosure (8923-439):   −20 to +60 °C, still air, no external heat
                                loads.
                                Passes Lloyd's Type ENV3 Dry Heat Test

        Passes Lloyd's type ENV3 Dry Heat test

Storage Temperature
−40 to +85 °C. For longest life, store near room temperature and limit the thermal
   cycle range.

Shock
USMIL-STD-810C, Figure 516.2-1 Procedure 1b
(30g 11ms Half Sine Pulse)

Vibration
Lloyd's Test Specification No. 1, 1996, Vibration Test #1: 5-13.2 Hz, 1.0
mm; 13.2–100 Hz, 0.7g

Pollution Resistance
Particulates:
IEC 664-1 Pollution Degree 2 (Normally only nonconductive pollution
occurs. Temporary conductivity caused by condensation is to be expected.)

Gaseous Pollutants:
The polyacrylate conformal coating withstands NO_2, CO_2, SO_2, and H_2S
gases per IEC 60068-2-60:1995 Part 2.60 Methods 1 and 4 (Flowing Mixed
Gas Corrosion Test). It will withstand levels typical of telecommunications
and computer installations as defined by Battelle Labs Class III (between
IEC 60721-3-3 classification 3C1 and 3C2, light industrial to urban industrial,
heavy traffic).

Power Supply Specification
    Insulation Resistance/HiPot
      24 Vdc power supply: 707 Vdc from power input to chassis
      120 Vac/dc and 220 Vac version: 2200 Vdc from power input to chassis

    Power Inputs
1. Low Voltage DC (18–32 Vdc)
   Input Power Fuse Rating (F1 & F2)—6.25a Slow Blow
   Holdup Time = 14 Milliseconds
2. AC/DC (90–150 Vdc or 88–132 Vac, 47–63 Hz)
   Input Power Fuse Rating (F1 & F2)—2.5a Slow Blow
   Holdup Time = 30 Milliseconds
3. High Voltage AC (180–264 Vac, 47–63 Hz)
   Input Power Fuse Rating (F1 & F2)—1.5a Slow Blow
   Holdup Time = 58 Milliseconds

    Power Outputs
1. Three 5 Vdc communications port isolated power supplies (100 mA max.)
2. 5 Vdc digital power (2.5 A max.)
3. 24 Vdc analog power (1.275 A max.)
4. 15 Vdc analog power (150 mA max.)
5. –15 Vdc analog power (150 mA max.)
6. 24 Vdc isolated contact input power (100 mA max.)
7.

Microprocessor
    Motorola 68332 Microcontroller 20 MHz

General I/O Specifications

Analog Inputs
1. Six 4–20 mA inputs
   a. One isolated input (input #6).
   b. Five non-isolated differential inputs or may use 24V provided with
      single common.
2. 16 Bit resolution over 0–25 mA full-scale range.
3. 200 Ω input impedance on all inputs.
4. Accuracy
   a. Non-isolated input: 0.145% of full-scale input worst case @ 25° C
      ambient.
   b. Isolated input: 0.186% of full-scale input worst case @ 25° C ambient.
5. Temperature drift.
   a. Non-isolated inputs: 130ppm/°C worst case, 40ppm/°C root sum
      square.
   b. Isolated input: 245ppm/°C worst case, 60ppm/°C root sum square.
6. Isolation
   a. Non-isolated input: 2 MΩ to chassis.
   b. Isolated input: infinite Ω to chassis.

Speed Sensor Inputs
1. Two channels, jumper selectable between MPU input and Proximity input.
2. MPU input.
   a. Two isolated, independent channels.
   b. 1—25 VRMS input voltage range.
   c. 100—15000 Hz.
   d. Input impedance of approximately 1.5 kΩ

3. Proximity input.
   a. Two isolated channels, independent channels.
   b. 16–28 Vdc voltage range, at the input.
   c. 0.5–15 000 Hz.
   d. Input impedance of approximately 7.1 kΩ
4. Minimum of 12 bit resolution, 16 bit resolution at 100 Hz.
5. Speed range software selectable, 0–5000, 0–10000, or 0–15000.
6. Software filtering.
7. Accuracy is 0.027% worst case over temperature and time.

Actuator Drivers
1. Two channels, software selectable for 4–20 mA range, or 20–160 mA range.
2. Current readback on each channel, to detect over/under current.
3. Dither is software selectable (0–10 mA).
4. 45 Ω maximum load on the 20–160 mA version.
5. 360 Ω maximum load on the 4–20 mA version.
6. 10 bit resolution over 24 mA (4–20 mA) or 196 mA (20–160 mA) full scale range.
7. Temperature drift is 153ppm/°C worst case and 143ppm/°C root sum squared.
8. Accuracy is 0.25% of full scale output worst case @ 25° C ambient.

Analog Outputs
1. Six software configurable 4–20 mA outputs.
2. 600 Ω maximum load.
3. 10 bit resolution over 25 mA full scale range.
4. Temperature drift is 118ppm/°C worst case and 100ppm/°C root sum squared.
5. Accuracy is 0.25% of 25 mA full scale output worst case @ 25° C ambient

Relay Outputs
1. Eight software configurable relay outputs
2. One set of form C contacts provided for each relay output.

    European ratings
    European ratings restrict use to applications with voltages not subject to the Low Voltage Directive (73/23/EEC).

Rated Voltage	Resistive	Inductive
28 Vdc	5	1 A

    UL Recognized Ratings

Rated Voltage	Resistive
28 Vdc	5 A
115 Vac	0.5 A

    Relay Manufacturer's Ratings

Rated Voltage	Resistive	Inductive
28 Vdc	5 A	1 A
115 Vac	0.5 A	0.3 A
125 Vdc	0.2 A	0.1 A

Discrete Inputs
1. 16 isolated discrete inputs.
2. Isolated +24 V power provided for discrete inputs.
3. 2.5 mA draw on each input when contact is closed.
4. 18–26 Vdc external contact power may be used instead of the 505E's internal power supply.
5. Solid state relays may be used to drive any discrete input:
   a. 505E Discrete Input Thresholds: <8 Vdc = "OFF", >16 Vdc = "ON"
   b. 505E Discrete Input Impedance = 25 kΩ, at "ON" threshold

Modbus Communications Ports
1. Two isolated Modbus communications ports.
2. Supports RTU and ASCII protocol.
3. Baud rates to 57600.
4. Supports RS-232, RS-422, and RS-485 hardware.
5. Maximum network cable length is 4000 feet (50 feet with RS-232).

Personal Computer Communications Port
1. One isolated PC communications port.
2. Supports RS-232 only.
3. Baud rates to 57600.
4. Maximum cable length is 50 feet.

Built-In Operator Interface
1. Two line x 24 character LED display.
2. 30 key multi-function keypad.
3. Emergency stop and overspeed test buttons.
4. Alarm and overspeed test LED indicators.

Software Specifications

Speed/Load Control
    NEMA D or better speed regulation.

Nominal Software Execution Rate
1. Speed/Load Control: 10 ms
2. Extraction/Admission Control: 20 ms
3. Auxiliary Control: 20 ms
4. Cascade Control: 40 ms
5. Remote Speed Setpoint: 120 ms
6. Remote Extr/Adm Setpoint: 120 ms
7. Remote Aux Setpoint: 120 ms
8. Remote Cascade Setpoint: 120 ms
9. Sync/Load Share Control: 40 ms
10. Ratio/Limiting: 10 ms
11. Actuator Outputs: 10 ms
12. Shutdowns: 10 ms
13. Alarms: 20 ms
14. Relays:
    a. Trip Relay: 10 ms
    b. Alarm Relay: 20 ms
    c. Configurable Relays: 120 ms
15. Readouts: 40 ms
16. Contact Inputs:
    a. External Trip & Configurable Inputs: 10 ms
    b. Reset: 40 ms
    c. Speed Raise & Lower: 20 ms

IMPORTANT	The "nominal rate" listed is the fastest update rate, the worst case response would be twice the nominal rate.

Appendix B.
505E Service Mode Worksheet

Governor Serial Number _____

Application _____   Date _____

SPEED CONTROL SETTINGS

Rate to Min =		RPM/SEC
Slow Rate /sec =		RPM/SEC
Fast Rate Dly =		SEC
Fast Rate =		RPM/SEC
Entered Rate =		RPM/SEC
Underspd Setting =		RPM
On-line Deriv Ratio=		%
Off-line Deriv Ratio =		%
Hold Speed Chng	Yes	No

ALARM SETTINGS

Is Trip an Alarm	Yes	No
Blink Alarms	Yes	No
Jump to Alm Scrn	Yes	No

KEY OPTIONS

Use 'Stop' Cmd	Yes	No
Use Dyn Key Adj	Yes	No

SPD CNTRL DROOP SETTINGS (if generator)

Droop (%) =		%
Use KW Droop?	Yes	No
Gen Load Units = MW	Yes	No

MPU OVERRIDE

Use MPU Ovrd Tmr?	Yes	No
MPU Ovrd Time =		SEC
MPU #1 Ovrd On		(Status Only)
MPU #2 Ovrd On		(Status Only)

AUTO START SEQUENCE (if configured)

Low Idle Delay	(status only - MIN)
Rate To Hi Idle	(status only - RPM/SEC)
Hi Idle Delay	(status only - MIN)
Rate To Rated	(status only - RPM/SEC)
Hrs Since Trip	(status only - HRS)

IDLE / RATED SETTINGS (if configured)

Idle/Rated Rate =		RPM/SEC
Use Ramp To Idle	Yes	No
Idle Priority?	Yes	No

SYNC/LD SHARE SETTINGS (if configured)

nput Bias Gain =		%
Input Bias Dband =		RPM
Lag-Tau Value =		%
Hold Bias Chng	Yes	No

REMOTE SPEED SETTINGS (if configured)

Not Mtchd Rate =		RPM/SEC
Spd Setpt Mx Rte =		RPM/SEC
Min Speed Set =		RPM
Max Speed Set =		RPM
Rmt Dbnd Value =		RPM
Lag-Tau Value =		%
Use Min Load?	Yes	No
Hold Rmt Chng	Yes	No

EXTR /ADM CNTRL SETTINGS

Slow Rate (/Sec) =		UNITS/SEC
Fast Rate Delay =		SEC
Setpt Fast Rate =		UNITS/SEC
Entered Rate =		UNITS/SEC
Droop (%) =		%
Rated Setpt =		UNITS
PID Int Deadband =		UNITS
PID Deriv Ratio =		%
PID Threshold =		%
Initial Demand =		UNITS
Hold Ext Changes	Yes	No

REMOTE EXTR SETTINGS (if configured)

Not Matched Rate =		UNITS/SEC
Rmt Ext Max Rate =		UNITS/SEC
Min Extr Setting =		UNITS
Max Extr Setting =		UNITS
Rmt Dbnd Value =		UNITS
Rmt Lag-Tau =		%
Hold Rmt Ext Chg	Yes	No

CASCADE CTRL SETTINGS (if configured)

Slow Rate (/Sec) =		UNITS/SEC
Fast Rate Delay =		SEC
Setpt Fast Rate =		UNITS/SEC
Septpt Entrd RatE =		UNITS/SEC
Droop (%) =		%
Rated Casc Setpt =		UNITS
Casc N Mtchd Rte =		UNITS
Max Speed Rate =		RPM/SEC
Max Speed Set =		RPM
Min Speed Set =		RPM
Cascade Dbnd =		UNITS
Casc Deriv Ratio =		%
R/L Casc Only?	Yes	No
Use Min Load?	Yes	No
Hold Casc Chng	Yes	No

REMOTE CASC SETTINGS (if configured)

Rmt N Mtchd Rte =		UNITS/SEC
Rmt Casc Max Rte =		UNITS/SEC
Min Casc Set =		UNITS
Max Casc Set =		UNITS
Rmt Dbnd Value =		UNITS
Lag-Tau Value =		SEC
Hld Rmt Cas Chng	Yes	No

AUX CONTROL SETTINGS (if configured)

Slow Rate (/Sec) =		UNITS/SEC
Fast Rate Delay =		SEC
Setpt Fast Rate =		UNITS/SEC
Setpt Entrd Rate =		UNITS/SEC
Droop (%) =		%
Rated Aux Setpt =		UNITS
Aux Deriv Ratio =		%
Aux Threshold =		%
PID Min Output =		%
Hold Aux Chng	Yes	No

REMOTE AUX SETTINGS (if configured)

Rmt N Mtchd Rte =		UNITS/SEC
Rmt Aux Max Rate =		UNITS/SEC
Min Rmt Aux Set =		UNITS
Max Aux Set =		UNITS
Rmt Dbnd Value =		UNITS
Lag-Tau Value =		%
Hold Rmt Aux Chng	Yes	No

BREAKER LOGIC (if generator)

Freq Cntrl Armd		(status only)
Sync Window Rpm =		RPM
Sync Window Rate =		RPM/SEC
Tiebrkr Opn Rmp	Yes	No
Tie Open Rate =		RPM/SEC
Gen Open Setback	Yes	No
Gen Open Setpt =		RPM
Use Min Load	Yes	No
Min Load Bias =		RPM
Zero Load Value =		%
Hold Brkr Chng	Yes	No

VALVE LIMITER SETTINGS

HP Limitr Rate =		%/SEC
HP Entered Rate =		%/SEC
HP Max Limit =		%
HP Min Limit =		%
LP Lmtr Rate =		%/SEC
LP Entered Rate =		%/SEC
LP Max Limit =		%
LP Min Limit =		%
Hold Limiter Chng	Yes	No

LOCAL / REMOTE FUNCTIONS (if configured)

Remote Enabled		(status only)
Enable Contacts	Yes	No
Contacts Enabled		(status only)
Enable Modbus 1	Yes	No
Modbus 1 Enabled		(status only)
Enable Modbus 2	Yes	No
Modbus 2 Enabled		(status only)

MONITOR CONTACT INPUTS

ESD Input Clsd	(status only)
Rst Input Clsd	(status only)
Rse Spd In Clsd	(status only)
Lwr Spd In Clsd	(status only)
Cont In #1 Closed	(status only)
Cont In #2 Closed	(status only)
Cont In #3 Closed	(status only)
Cont In #4 Closed	(status only)
Cont In #5 Closed	(status only)
Cont In #6 Closed	(status only)
Cont In #7 Closed	(status only)
Cont In #8 Closed	(status only)
Cont In #9 Closed	(status only)
Cont In #10 Closed	(status only)
Cont In #11 Closed	(status only)
Cont In #12 Closed	(status only)

MONITOR RELAY OUTPUTS

Sht Dn Rly Enrgzd	(status only)
Alrm Rly Enrgzd	(status only)
Relay 1 Enrgzd	(status only)
Relay 2 Enrgzd	(status only)
Relay 3 Enrgzd	(status only)
Relay 4 Enrgzd	(status only)
Relay 5 Enrgzd	(status only)
Relay 6 Enrgzd	(status only)

FORCE RELAY OUTPUTS (if shut down)

Force Relays ?	(troubleshooting only)
Force Rlys Enbl	(status only)
Shutdn Rly	(troubleshooting only)
Force Alarm Rly On?	(troubleshooting only)
Relay #1 On	(troubleshooting only)
Relay #2 On	(troubleshooting only)
Relay #3 On	(troubleshooting only)
Relay #4 On	(troubleshooting only)
Relay #5 On	(troubleshooting only)
Relay #6 On	(troubleshooting only)
Turn On LED's	(troubleshooting only)
LED's ON Status	(status only)

MONITOR SPEED INPUTS

Speed Input #1 =	(status only)
Speed Input #2 =	(status only)

MONITOR ANALOG INPUTS

Extr/Adm (%) =	(status only)
Anlg In #2 (%) =	(status only)
Anlg In #3 (%) =	(status only)
Anlg In #4 (%) =	(status only)
Anlg In #5 (%) =	(status only)
Anlg In #6 (%) =	(status only)

ANALOG IN ADJUSTMENTS

Extr/Adm Offset =
Extr/Adm Gain =
Input #2 Offset =
Input #2 Gain =
Input #3 Offset =
Input #3 Gain =
Input #4 Offset =
Input #4 Gain =
Input #5 Offset =
Input #5 Gain =
Input #6 Offset =
Input #6 Gain =

MONITOR ANALOG OUTPUTS

Anlg Out # 1 (mA) =	(status only)
Anlg Out # 2 (mA) =	(status only)
Anlg Out # 3 (mA) =	(status only)
Anlg Out # 4 (mA) =	(status only)
Anlg Out # 5 (mA) =	(status only)
Anlg Out # 6 (mA) =	(status only)

ANALOG OUTPUT ADJUSTMENTS

Out #1 Offset =
Out #1 Gain =
Out #2 Offset=
Out #2 Gain =
Out #3 Offset =
Out #3 Gain =
Out #4 Offset =
Out #4 Gain =
Out #5 Offset =
Out #5 Gain =
Out #6 Offset =
Out #6 Gain =

ACT1 LINEARIZATION

X-1 Value =
Y-1 Value =
X-2 Value =
Y-2 Value =
X-3 Value =
Y-3 Value =
X-4 Value =
Y-4 Value =
X-5 Value =
Y-5 Value =
X-6 Value =
Y-6 Value =
X-7 Value =
Y-7 Value =
X-8 Value =
Y-8 Value =
X-9 Value =
Y-9 Value =
X-10 Value =
Y-10 Value =
X-11 Value =
Y-11 Value =

ACT2 LINEARIZATION

X-1 Value =
Y-1 Value =
X-2 Value =
Y-2 Value =
X-3 Value =
Y-3 Value =
X-4 Value =
Y-4 Value =
X-5 Value =
Y-5 Value =
X-6 Value =
Y-6 Value =
X-7 Value =
Y-7 Value =
X-8 Value =
Y-8 Value =
X-9 Value =
Y-9 Value =
X-10 Value =
Y-10 Value =
X-11 Value =
Y-11 Value =

STEAM MAP TEST (only displayed if shut down)

Enable Map Test?	Yes	No
Map Test Enabled		(status only)
Speed/Ld Dmd (%) =		(troubleshooting only)
Extr/Adm Dmd (%) =		(troubleshooting only)
HP Valve Dmd (%) =		(status only)
LP Valve Dmd (%) =		(status only)
At Map Limit		(status only)
Pressure Priority	Yes	No
LP Max Prs Prior	Yes	No

STEAM MAP CONSTANTS

Speed/Ld Dmd (%) =		(status only)
Extr/Adm Dmd (%) =		(status only)
HP Valve Dmd (%) =		(status only)
LP Valve Dmd (%) =		(status only)
S-Dmd Limted (%) =		(status only)
P-Dmd Limted (%) =		(status only)
At Map Limit		(status only)
K1 (dHP/dS) =		
K2 (dHP/dP) =		
K3 (HP Offset) =		
K4 (dLP/dS) =		
K5 (dLP/dP) =		
K6 (LP Offset) =		
D1 (dHP/dE) =		
D2 (dHP/dP) =		
D3 (HP OFFSET) =		
D4 (dLP/dI) =		
D5 (dLP/dP) =		
D6 (LP OFFSET) =		
Auto Sw Priority	Yes	No
LP Max Prs Prior	Yes	No
Hold Map Changes	Yes	No

PORT 1 SETTINGS (if configured)

Port 1 Link Error		(status only)
Exception Error		(status only)
Error Code		(status only)
Use Modbus 1 Trip?	Yes	No
Use 2-Step Trip?	Yes	No
Enbl When Local	Yes	No
Trp Always Enbld	Yes	No

PORT 2 SETTINGS (if configured)

Port 2 Link Err		(status only)
Exception Error		(status only)
Error Code		(status only)
Use Mod 2 Trip	Yes	No
Use 2-Step Trp?	Yes	No
Enbl When Local	Yes	No
Trp Always Enbld	Yes	No

COMM ANALOG SCALING (if using Modbus)

Cas Scale Factor =	
Aux Scale Factor =	
KW Scale Factor =	
FSP Scale Factor =	
Load Share Scale =	
EXT Scale Factor =	

PORT CONFIGURATIONS

PORT 1 SETTINGS

STATUS	(status only)
BAUD =	
STOP BITS =	
PARITY =	
DRIVER =	
ASCII OR RTU =	
MODBUS DEVICE # =	
TIME OUT DELAY (SEC) =	

PORT 2 SETTINGS

STATUS	(status only)
BAUD =	
STOP BITS =	
PARITY =	
DRIVER =	
ASCII OR RTU =	
MODBUS DEVICE # =	
TIME OUT DELAY (SEC) =	

PC PORT SETTINGS

STATUS	(status only)
BAUD =	
STOP BITS =	
PARITY =	
DRIVER =	

Appendix C.
Password Information

General

The 505E Series control system requires a password to be entered before access can be given to the SERVICE, CONFIGURE, DEBUG, or OS_FAULTS modes. The Download Configuration function also requires a password. These passwords are intended to help prevent unauthorized or untrained personnel from accessing these modes and possibly making changes that could cause damage to the turbine or associated process. If only certain people are to know these passwords, remove this appendix and keep it in a separate place, apart from the manual.

Service Mode Password

When the display reads:

```
┌─────────────────────────────────────┐
│                                      │
│         Password SERVICE             │
│                                      │
│                                      │
└─────────────────────────────────────┘
```

The password for your control is: 1 1 1 1

Press the keys on the 505E front panel in this sequence followed by ENTER to gain access to the SERVICE mode.

Debug Mode Password

When the display reads:

```
┌─────────────────────────────────────┐
│                                      │
│          Password DEBUG              │
│                                      │
│                                      │
└─────────────────────────────────────┘
```

The password for your control is: 1 1 1 2

Press the keys on the 505E front panel in this sequence followed by ENTER to gain access to the DEBUG Mode.

Configure Mode Password

When the display reads:

```
┌─────────────────────────────────────┐
│                                      │
│          Password CONFIGURE          │
│                                      │
│                                      │
└─────────────────────────────────────┘
```

The password for your control is: 1 1 1 3

Press the keys on the 505E front panel in this sequence followed by ENTER to gain access to the CONFIGURE mode.

Os_Faults Mode Password

When the display reads:

```
┌─────────────────────────────────────┐
│                                      │
│          Password OS_FAULTS          │
│                                      │
│                                      │
└─────────────────────────────────────┘
```
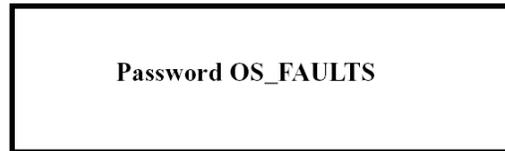
The password for your control is: 1 1 1 4

Press the keys on the 505E front panel in this sequence to gain access to the Os_Faults Mode.

Download Configuration Function Password

When the display reads:

```
┌─────────────────────────────────────┐
│                                      │
│        To Load Configuration         │
│        Enter Password                │
│                                      │
└─────────────────────────────────────┘
```
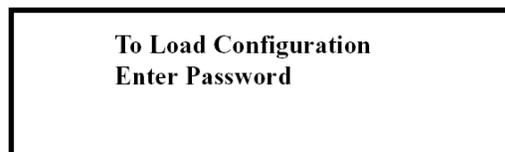
The password for your control is: 1 1 1 6

Press the keys on the 505E front panel in this sequence followed by ENTER to gain access to the Load Configuration function.

Revision History

Changes in Revision F—
- Changed field wiring requirement (page 1)

Declarations

<table>
<tr><td colspan="2" align="center">**DECLARATION OF CONFORMITY**
According to EN 45014</td></tr>
</table>

Manufacturer's Name: WOODWARD GOVERNOR COMPANY (WGC)
Industrial Controls Group

Manufacturer's Address: 1000 E. Drake Rd.
Fort Collins, CO, USA, 80525

Model Name(s)/Number(s): 505 Control: 18-32 Vdc (9907-164 and similar)
505E Control: 18-32 Vdc (9907-167 and similar)
505H Control: 18-32 Vdc (9907-117 and similar)

Conformance to Directive(s): 89/336/EEC COUNCIL DIRECTIVE of 03 May 1989 on the
approximation of the laws of the Member States relating to
electromagnetic compatibility.

94/9/EC COUNCIL DIRECTIVE of 23 March 1994 on the
approximation of the laws of the Member States concerning equipment
and protective systems intended for use in potentially explosive
atmospheres

Applicable Standards: EN61000-6-2, 1999: EMC Generic Standards - Immunity for
Industrial Environments
EN50081-2, August 1993: EMC Generic Emissions Standard, Part 2:
Industrial Environment
EN50082-2, March 1995: EMC Generic Immunity Standard, Part 2:
Industrial Environment
EN 60079-15, 2003: Electrical apparatus for potentially explosive
atmospheres - Type of protection 'n'

We, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s).

MANUFACTURER
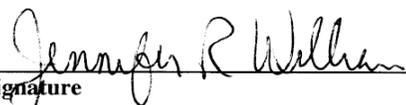
Jennifer R Williams
Signature

Jennifer Williams
Full Name

Engineering Manager
Position

WGC, Fort Collins, CO, USA
Place

7-9-04
Date

СИСТЕМА СЕРТИФИКАЦИИ ГОСТ Р
ГОССТАНДАРТ РОССИИ

СЕРТИФИКАТ СООТВЕТСТВИЯ

№ РОСС US.ГБ04.В01002

Срок действия с 20.06.2008 г. по 20.06.2011 г.

7888214

ОРГАН ПО СЕРТИФИКАЦИИ

Рег. № РОСС RU.0001.11ГБ04 ЦЕНТР СЕРТИФИКАЦИИ «СТВ»
607190, г. Саров Нижегородской обл., пр. Мира, 37
телефон (83130) 454-78, факс (83130) 455-30

ПРОДУКЦИЯ

Программируемые контроллеры моделей 505, 505E с маркировкой
взрывозащиты 2ExnAIIT3X;

серийный выпуск

код ОК 005 (ОКП):
40 0000

СООТВЕТСТВУЕТ ТРЕБОВАНИЯМ НОРМАТИВНЫХ ДОКУМЕНТОВ

ГОСТ Р 51330.0-99
ГОСТ Р 51330.14-99

код ТН ВЭД России:
8537 10 910 0

ИЗГОТОВИТЕЛЬ

Woodward Governor Co.
1000 East Drake Road, Fort Collins CO 80525, USA

СЕРТИФИКАТ ВЫДАН

Woodward Governor Co.
1000 East Drake Road, Fort Collins CO 80525, USA
Тел.: +1 (970) 482 5811,   Факс: +1 (970) 498 3058

НА ОСНОВАНИИ

- протокола оценки и испытаний № С3-622/08 от 17.06.2008 г. Центра сертификации "СТВ"
(Рег. № РОСС RU.0001.11ГБ04);
- акта о результатах анализа состояния производства от 23.05.2008 г. Центра сертификации "СТВ"
(Рег. № РОСС RU.0001.11ГБ04)

ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ

Специальные условия безопасного применения - в соответствии с Дополнением к сертификату
Схема сертификации 3а

Руководитель органа _____ В.В. Байрак
                                                                    инициалы, фамилия

Эксперт _____ В.Н. Липавский
                                             инициалы, фамилия

Сертификат имеет юридическую силу на всей территории Российской Федерации

ЦЕНТР СЕРТИФИКАЦИИ СТВ

Орган по сертификации взрывозащищенного, рудничного и электрооборудования общепромышленного назначения

Аккредитован ФА Ростехрегулирование
Рег. номер
РОСС RU.0001.11ГБ04

607190, г. Саров Нижегородской обл., а/я 640   Тел. (83130) 454-78, факс (83130) 455-30, E-mail: stv@stv.vniief.ru

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ДОПОЛНЕНИЕ
к сертификату соответствия № РОСС US.ГБ04.В01002

Лист 1 / 3

1. Назначение и область применения электрооборудования

Программируемые контроллеры моделей 505, 505Е предназначены для управления одноклапанными паровыми турбинами и паровыми турбинами с одной системой клапанов.

Контроллеры выполнены во взрывозащищенном исполнении и могут применяться во взрывоопасных зонах в соответствии с главой 7.3 "Правил устройства электроустановок" и ГОСТ Р 51330.13-99 "Электрооборудование взрывозащищенное. Часть 14. Электроустановки во взрывоопасных зонах (кроме подземных выработок)" согласно маркировке их взрывозащиты.

2. Основные технические характеристики

2.1 Маркировка взрывозащиты	2ExnAПТ3Х
2.2 Степень защиты, обеспечиваемая оболочкой	IP66
2.3 Электропитание:	
напряжение постоянного тока	18…32 В; 90…150 В
напряжение переменного	88…132 В; 180…264 В
2.4 Класс электрооборудования по способу защиты от поражения электрическим током	I
2.5 Допустимый диапазон температуры окружающей среды в месте размещения контроллера:	-25°С … +65°С

3. Описание электрооборудования

Программируемые контроллеры моделей 505, 505Е выполнены в виде единого блока. Обе модели имеют одинаковое исполнение и отличаются программным обеспечением. Оболочка контроллера выполнена в виде прямоугольной коробки, на лицевой стенке которой размещена панель задания параметров, контроля и управления, а на задней стенке размещены соединительные устройства: клеммные терминалы и штекеры для подключения внешних электрических цепей.

4. Обеспечение взрывозащиты

Программируемые контроллеры выполнены во взрывозащищенном исполнении с защитой вида "n" по ГОСТ Р 51330.14-99. Взрывозащищенное исполнение обеспечивается исключением в нормальном режиме работы электрооборудования дуговых и искровых разрядов, величиной электрических зазоров и путей утечки между токоведущими частями электрооборудования, максимальной температурой поверхности ниже значения,

Руководитель органа   В.В. Байрак

Эксперт   В.Н. Липавский

ЦЕНТР СЕРТИФИКАЦИИ СТВ
Орган по сертификации взрывозащищенного,
рудничного и электрооборудования
общепромышленного назначения

*Аккредитован ФА
Ростехрегулирование
Рег. номер
РОСС RU.0001.11ГБ04*

Дополнение к сертификату соответствия № РОСС US.ГБ04.В01002

соответствующего температурному классу Т3, высокой степенью защиты от внешних воздействий (IP66), а также регламентированием режима включения и выключения электропитания. Контроллеры имеют соединительные устройства для подключения внешних цепей.

Монтаж и эксплуатация контроллеров во взрывоопасных зонах должна осуществляться в соответствии с требованиями инструкции по эксплуатации, требований главы 7.3 "Правил устройства электроустановок", ГОСТ Р 51330.13-99, ГОСТ Р 51330.16-99, ГОСТ Р 51330.18-99, а также с учетом раздела "Специальные условия безопасного применения" настоящего Дополнения.

5 Специальные условия безопасного применения

5.1 Программируемые контроллеры моделей 505, 505Е разрешается размещать только во взрывоопасной зоне класса 2 по ГОСТ Р 51330.9-99.

5.2 Запрещается открывать оболочку контроллера при наличии взрывоопасной атмосферы.

5.3 Все подключения и отключения должны производиться при условии отсутствия взрывоопасной атмосферы.

6. Перечень согласованной технической документации

Номер документа	Дата утверждения
9933-299	апрель.2005
901-1201	июль.2006
9933-364	февраль 2004
9933-365	март.2006
26347V1 (ревизия В)	

7. Маркировка

7.1 Маркировка наносится на специальной табличке, устанавливаемой на оболочке контроллера. Она должна включать следующие данные:

- наименование изготовителя или его товарный знак;

- тип и серийный номер;

- российскую маркировку взрывозащиты;

- аббревиатуру органа сертификации и номер сертификата: СТВ № РОСС US.ГБ04.В01002;

- допустимый диапазон температуры окружающей среды в месте установки изделия;

- знак соответствия по ГОСТ Р 50460-92.

7.2 На оболочке контроллера должна быть установлена табличка со следующей

Руководитель органа   В.В. Байрак

Эксперт   В.Н. Липавский

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предупреждающей надписью на русском языке:

ВНИМАНИЕ!
КОНТРОЛЛЕР РАЗРЕШАЕТСЯ РАЗМЕЩАТЬ
ТОЛЬКО ВО ВЗРЫВООПАСНОЙ ЗОНЕ КЛАССА 2
*
ЗАПРЕЩАЕТСЯ ОТКРЫВАТЬ ОБОЛОЧКУ КОНТРОЛЛЕРА
ПРИ НАЛИЧИИ ВЗРЫВООПАСНОЙ АТМОСФЕРЫ
*
ВСЕ ПОДКЛЮЧЕНИЯ И ОТКЛЮЧЕНИЯ ДОЛЖНЫ
ПРОИЗВОДИТЬСЯ ПРИ УСЛОВИИ ОТСУТСТВИЯ
ВЗРЫВООПАСНОЙ АТМОСФЕРЫ

8. Комплект документации при поставке

В комплект документации при поставке должны входить:

- техническое описание и руководство по эксплуатации на контроллер;

- сертификат соответствия UL E156028;

- настоящий сертификат с Дополнением.

Руководитель органа   В.В. Байрак

Эксперт   В.Н. Липавский

ЦЕНТР СЕРТИФИКАЦИИ СТВ
Орган по сертификации взрывозащищенного, рудничного и электрооборудования общепромышленного назначения

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Рег. номер
РОСС RU.0001.11ГБ04

607190, г. Саров Нижегородской обл., а/я 640   Тел. (83130) 454-78, факс (83130) 455-30, E-mail: stv@stv.vniief.ru

УТВЕРЖДАЮ
Руководитель ОС

В.В. Байрак
"   "   2008 г.

РЕШЕНИЕ № С3-623/08

Органа по сертификации взрывозащищенного, рудничного и электрооборудования общепромышленного назначения Центра сертификации "СТВ" о выдаче фирме "Woodward Governor Company" на серийно выпускаемое электрооборудование Программируемые контроллеры моделей 505, 505E сертификата соответствия требованиям ГОСТ Р 51330.0-99, ГОСТ Р 51330.14-99

В результате рассмотрения заявки фирмы "Woodward Governor Company", юридический адрес: 1000 East Drake Road, Fort Collins CO 80525 USA поданной через уполномоченную ею организацию ООО "Интерпромприбор" юридический адрес: 129085 г. Москва, Звездный бульвар дом 21, стр.1, офисы 6.10 и 6.11 телефон (495) 615-51-47, факс (495) 616-34-64

на сертификацию электрооборудования: Программируемые контроллеры моделей 505, 505E с маркировкой взрывозащиты 2ExnAIIT3X, код ОК 005 (ОКП): 40 0000, код ТН ВЭД: 8537 10 910 0 серийно выпускаемого заявителем,

на соответствие требованиям ГОСТ Р 51330.0-99, ГОСТ Р 51330.14-99

и анализа результатов сертификации, изложенных в:
- протоколе оценки и испытаний № С3-622/08 от 17.06.2008 г.
- акте о результатах анализа состояния производства от 23.05.2008 г.

Орган по сертификации взрывозащищенного, рудничного и электрооборудования общепромышленного назначения Центра сертификации "СТВ" принимает следующее РЕШЕНИЕ:

1. Электрооборудование Программируемые контроллеры моделей 505, 505E с маркировкой взрывозащиты 2ExnAIIT3X, код ОК 005 (ОКП): 40 0000, код ТН ВЭД: 8537 10 910 0, серийно выпускаемые фирмой "Woodward Governor Company" (США), соответствуют требованиям ГОСТ Р 51330.0-99, ГОСТ Р 51330.14-99

2. Выдать фирме "Woodward Governor Company" (США), на серийно выпускаемое электрооборудование Программируемые контроллеры моделей 505, 505E
с маркировкой взрывозащиты 2ExnAПT3X,
код ОК 005 (ОКП): 40 0000, код ТН ВЭД: 8537 10 910 0
сертификат соответствия требованиям ГОСТ Р 51330.0-99, ГОСТ Р 51330.14-99
сроком на 3 года.

3. Маркирование электрооборудования производить знаком соответствия по ГОСТ Р 50460-92. Знак соответствия наносить на каждый экземпляр электрооборудования рядом с маркировкой взрывозащиты, на сопроводительную и техническую документацию на свободном поле.

4. Для серийно выпускаемого электрооборудования: Программируемые контроллеры моделей 505, 505E установить инспекционный контроль с периодичностью один раз в год, начиная с 2009 г., путем испытаний образцов текущего производства со склада фирмы "Woodward Governor Company" (США) в объеме ГОСТ Р 51330.0-99, ГОСТ Р 51330.14-99 в Испытательном центре промышленной продукции РФЯЦ-ВНИИЭФ, рег. номер РОСС RU.0001.21МЕ17.

5. Работы по инспекционному контролю проводятся на основе отдельных договоров между ООО "Интерпромприбор" с одной стороны, и Органом по сертификации взрывозащищенного, рудничного и электрооборудования общепромышленного назначения Центра сертификации "СТВ" с другой стороны.

Эксперт   В.Н. Липавский

ФЕДЕРАЛЬНАЯ СЛУЖБА
ПО ЭКОЛОГИЧЕСКОМУ, ТЕХНОЛОГИЧЕСКОМУ И АТОМНОМУ НАДЗОРУ

РАЗРЕШЕНИЕ

№ РРС 00-30562

На применение

Оборудование (техническое устройство, материал):
Программируемые контроллеры моделей 505, 505Е
с маркировкой взрывозащиты 2ExnAIIT3X.

Код ОКП (ТН ВЭД): 40 0000 (8537 10 910 0)

Изготовитель (поставщик): Фирма "Woodward Governor Company"
(США).

Основание выдачи разрешения: Техническая документация, сертификат
соответствия ЦС "СТВ" № РОСС US.ГБ04.В01002 от 20.06.2008 г.

Условия применения:
1. Применять на поднадзорных производствах и объектах
согласно маркировке взрывозащиты в соответствии с Руководством
по эксплуатации, а также требованиями главы 7.3 ПУЭ.
2. Внесение изменений в техническую документацию и конструкцию
технических устройств возможно только по согласованию с аккреди-
тованной испытательной организацией и Федеральной службой
по экологическому, технологическому и атомному надзору.

Срок действия разрешения   до 24.07.2013

Дата выдачи   24.07.2008

Начальник Управления государственного
горного и металлургического надзора
Ш.М. Тугуз
(по доверенности № КП-23/1046 от 10.12.2007)

АВ 045296

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Please reference publication **85018V2F**.

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