WOODWARD

Product Manual 26144
(Revision D)
Original Instructions

2301D-GT Digital Electronic Load Sharing and Speed Control for Small Gas Turbine

8273-127, 8273-1002

Installation and Operation Manual

IMPORTANT

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.

DEFINITIONS

- **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

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.

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

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

www.woodward.com/pubs/current.pdf

The revision level is shown at the bottom of the front cover after the publication number. The latest version of most publications is available at:

www.woodward.com/publications

If your publication is not there, please contact your customer service representative to get the latest copy.

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

NOTICE

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.

NOTICE

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

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

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Regulatory Compliance

European Compliance for CE Mark
These listings are limited only to those units bearing the CE Marking.

EMC Directive: Declared to 89/336/EEC COUNCIL DIRECTIVE of 03 May 1989 on the approximation of the laws of the member states relating to electromagnetic compatibility.

Low Voltage Directive: Declared to the 73/23/EEC COUNCIL DIRECTIVE of 19 February 1973 on the harmonization of the laws of the Member States relating to electrical equipment designed for use within certain voltage limits.

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

CSA: CSA Certified for Class I, Division 2, Groups A, B, C, D, T4 Hazardous Locations and ordinary locations at 70 °C ambient. For use in Canada and the United States.
Certificate 1150575

NOTE—Wiring must be in accordance with applicable electric codes with the authority having jurisdiction.

Connector J1 must not be used in hazardous locations.

The control must be installed in a suitable enclosure. The final combination must be approved by the local authority having jurisdiction.

Connect the ground terminal to earth ground.

⚠WARNING

EXPLOSION HAZARD—Do not remove covers or connect/disconnect electrical connectors unless power has been switched off or the area is known to be non-hazardous.

Substitution of components may impair suitability for Class I, Division 2.

⚠AVERTISSEMENT

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

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

Electrostatic Discharge Awareness

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

Follow these precautions when working with or near the control.

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

2. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.

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

4. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:

    - Do not touch any part of the PCB except the edges.

    - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.

    - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

NOTICE

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

Chapter 1.
General Information

Description

The 2301D-GT is a digital control with integral application software program designed for single-shaft gas turbine applications. Like Woodward's 2301A line of controls, this control is housed in a sheet metal chassis and consists of a single printed circuit board. To facilitate unit retrofits, the 2301D-GT's I/O terminals are located in the same general location as Woodward's 2301A line of controls. This control is designed to perform the core fuel control functions of a small gas turbine package. The 2301D-GT's application software is field configurable, allowing it to be configured and modified to meet site-specific requirements.

With more I/O than its predecessor (the 2301A LSSC), the 2301D-GT also has serial communications, allowing it to easily interface with the package PLC or plant DCS. The 2301D-GT is configured and serviced (dynamic adjustments made) via a laptop computer connected to the control's RS-232 communications port. These configuration and dynamic settings are set, changed, tuned and saved via a laptop computer and Woodward's user-friendly Watch Window software program. This program allows users to set and adjust all application-based parameters, plus upload and download configurations to and from the control.

Model 8273-127 is intended for use in normal applications. Model 8273-1002 is intended for use in hazardous locations. Both models are functionally identical as specified below.

The 2301D-GT includes the following basic turbine control functions:

- Speed control
- Start Fuel Ramp
- Min/Max Fuel Limit
- Overspeed trip
- Shutdown logic
- Alarm Logic
- Platform Diagnostics

The following functions can be configured, depending on application requirements:

- EGT limiting
- CDP limiting
- Unit Load Control
- Speed Accel/Decel Limiting
- Droop/Isoch Control
- Power Actuator –Drive loop
- Load sharing with soft load / unload transfer
- Light off detect with EGT input
- SPM-A synchronizer Input
- Power sensor Input (CTs, PTs)
- Servlink DDE / Modbus® * communications
- Idle/Rated Input
- Base Load
- Power Limiting

*—Modbus is a trademark of Schneider Automation Inc.

The 2301D-GT Hardware includes:

- 1 Load Sensor
- 3 PT Inputs
- 3 CT Inputs
- 1 Actuator Driver
- 1 MPU Speed Sensor
- 1 Configurable Analog Output
- 2 Configurable Analog Inputs
- 8 Discrete (Switch) Inputs
- 4 Discrete (Relay Driver) Outputs

Applications

The 2301D-GT is a field-configurable control designed to perform the basic fuel control functions for single-shaft gas turbine applications. It can be configured to allow a user to match the control's functionality to the application. Configuration and service (dynamic adjustments made) is done via a laptop computer, connected to the control's RS-232 communications port and utilizing Woodward's Watch Window Window's based PC software program. These configuration and dynamic settings can be set, changed, tuned and saved using this same program. See Chapter 3 for instructions on configuring the control for your specific application.

Control Options

The 2301D-GT includes the following basic turbine control functions:

- Speed Control
- Start Fuel Ramp
- Min/Max Fuel Limits
- Overspeed Protection
- Shutdown Logic
- Alarm Logic
- Platform Diagnostics

Alternatively, the following functions can be configured, depending on application requirements (I/O limitations may prohibit selecting all listed functions at once):

- CDP Limiting (Accel/Decel)
- EGT Limiting
- Speed Accel/Decel Limiting
- Dual Speed/Load Dynamics
- Power/Actuator-Drive Droop
- Load Sharing (with soft load/unload)
- Light-off Detect (with EGT input)
- SPM-A (Synchronizer) Input
- Power Sensor Input (PTs & CTs)
- Servlink (DDE) / Modbus Communications
- Base Load
- Load Limiting

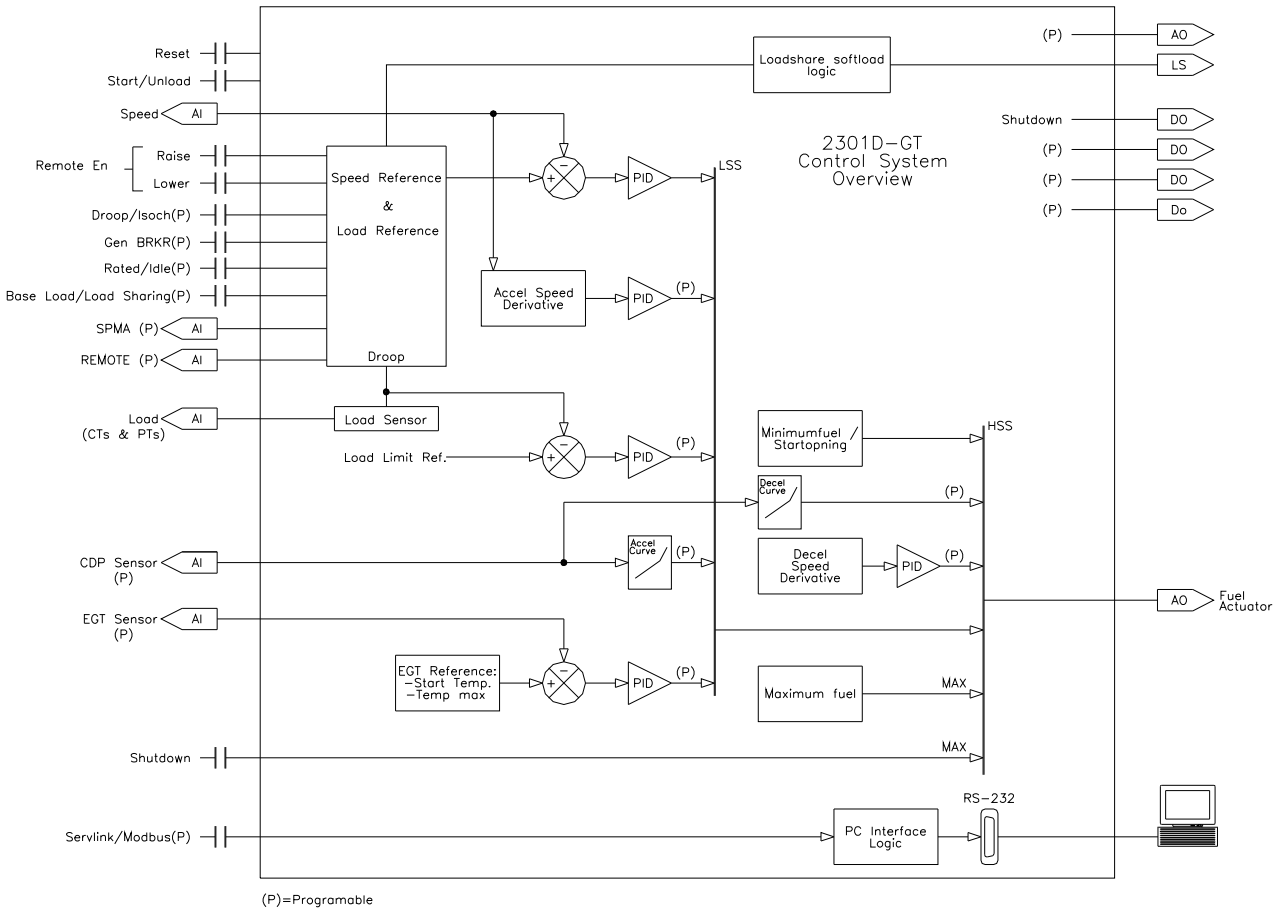


Figure 1-1. Functional Control Overview

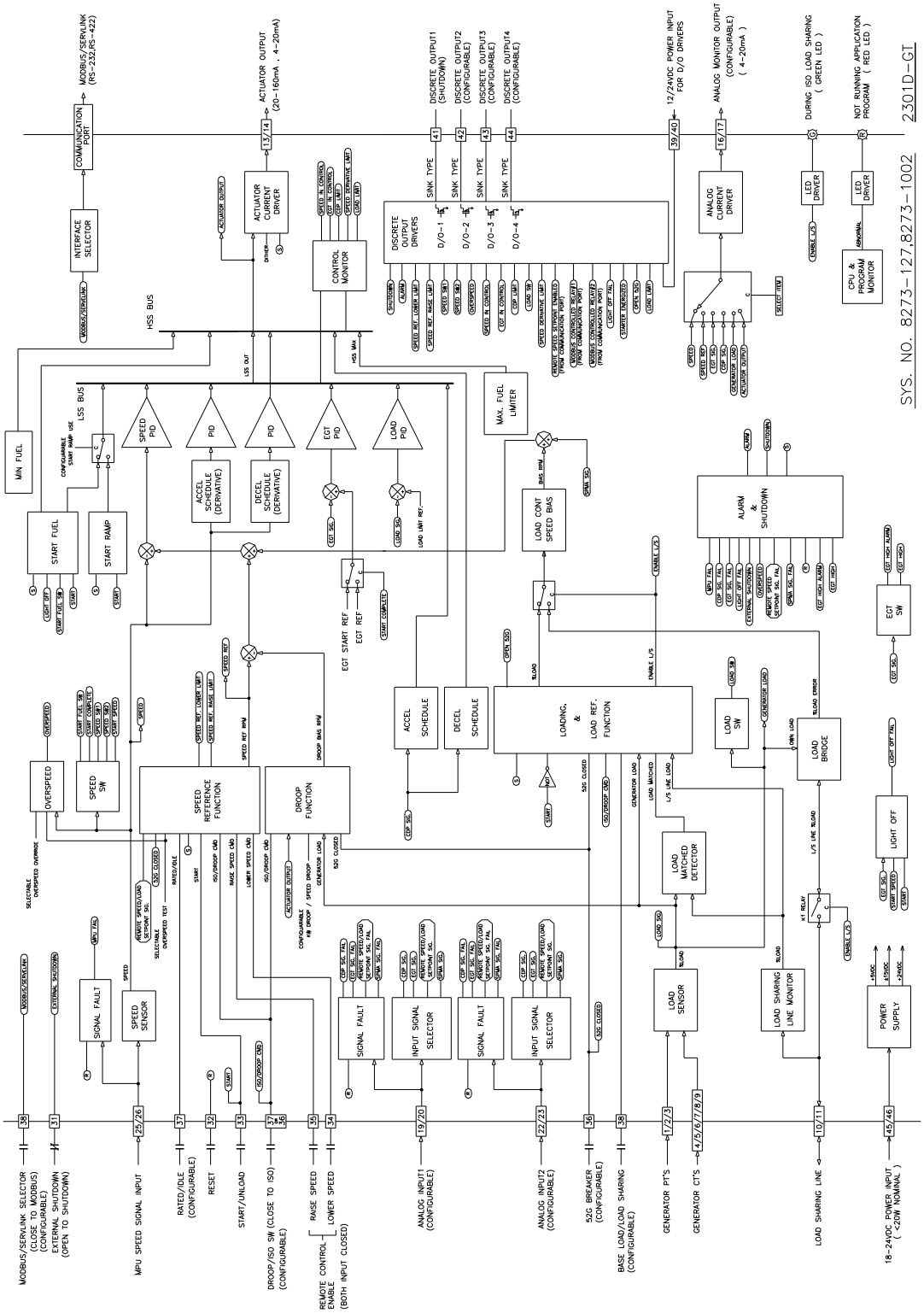


Figure 1-2. Functional Block Diagram (Detail)

Documentation References

The following publications contain additional product or installation information on Load Sharing and Speed Controls and related components. They can be ordered from any Woodward office.

Manual	Title
25070	*Electric Governor Installation Guide*
25195	*Governing Fundamentals*
82384	*SPM-A Synchronizer*
82510	*Magnetic Pickups and Proximity Switches for Electric Governors*
82715	*Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards and Modules*

Product Spec	Title
03236	*2301D-GT Digital 2301 Control*
82383	*SPM-A Synchronizer*
82516	*EG3P/3PC Actuator*
82575	*EGB1P/2P Governor/Actuator*
03202	*Woodward Watch Window Standard*

Chapter 2. Installation

Introduction

This chapter contains general installation instructions for the 2301D-GT control. Power requirements, environmental precautions and location considerations are included to determine the best location for the control. Additional information includes unpacking instructions, electrical connections and an installation checkout procedure.

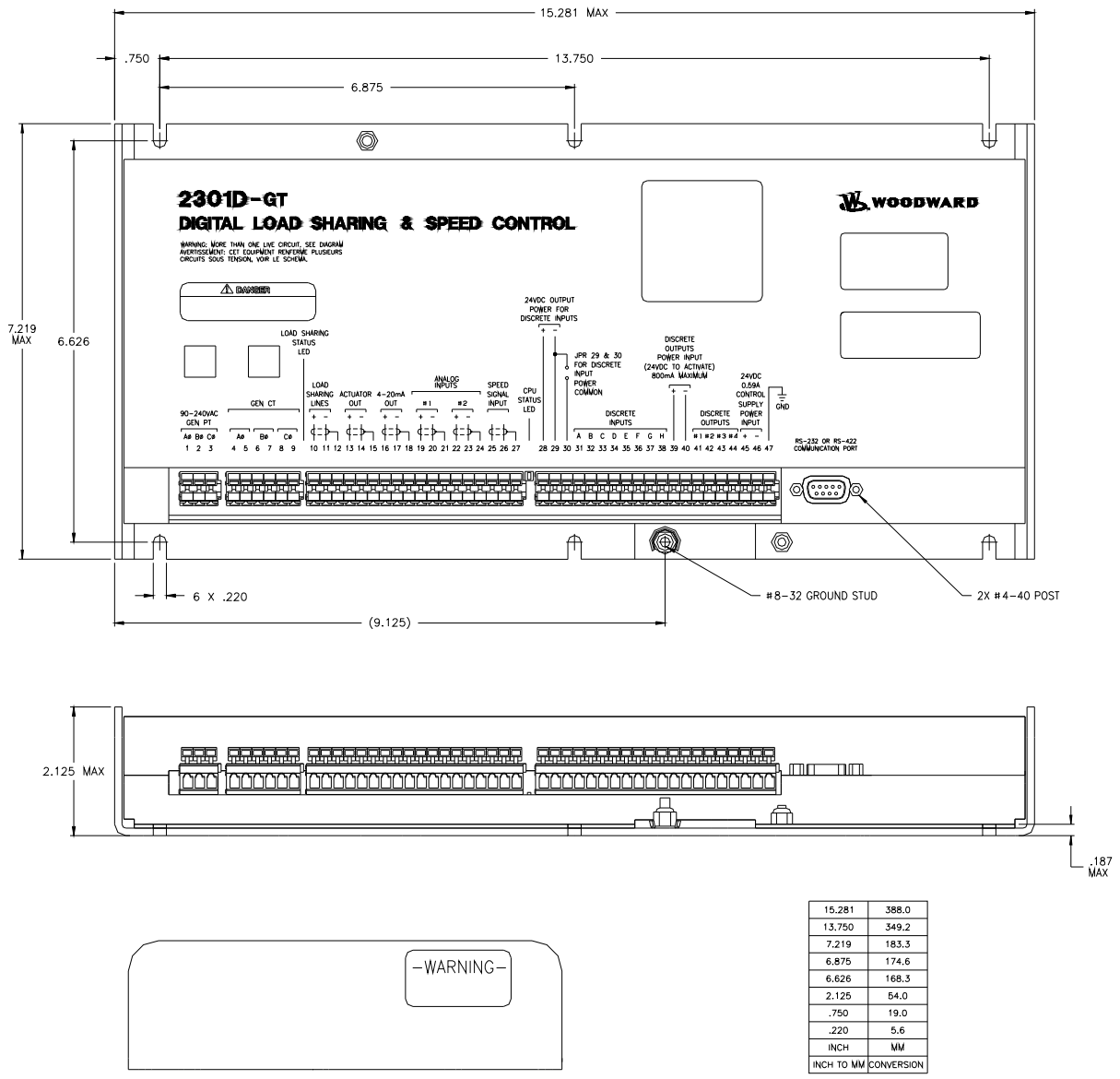
Unpacking

Before handling the control, read page v, ‘Electrostatic Discharge Awareness’. Be careful when unpacking the electronic control. Check the control for signs of damage such as bent or dented panels, scratches and loose or broken parts. If any damage is found, immediately notify the shipper.

Mounting Considerations

This product is intended for installation in a ‘closed electrical operating area’ or in an enclosed industrial control cabinet. Consider these requirements when selecting the mounting location:

- Adequate ventilation for cooling
- Space for servicing and repair
- Protection from direct exposure to water or to a condensation-prone environment
- Protection from high-voltage or high-current devices, or devices which produce electromagnetic interference
- Avoidance of vibration
- Selection of a location that will provide an operating temperature range of –40 to +70 °C (–40 to +158 °F)
- The control must NOT be mounted on the engine.



15.281	388.0
13.750	349.2
7.219	183.3
6.875	174.6
6.626	168.3
2.125	54.0
.750	19.0
.220	5.6
INCH	MM
INCH TO MM	CONVERSION

Figure 2-1. 2301D-GT P/N 8273-127 Outline Drawing
(for ordinary locations)

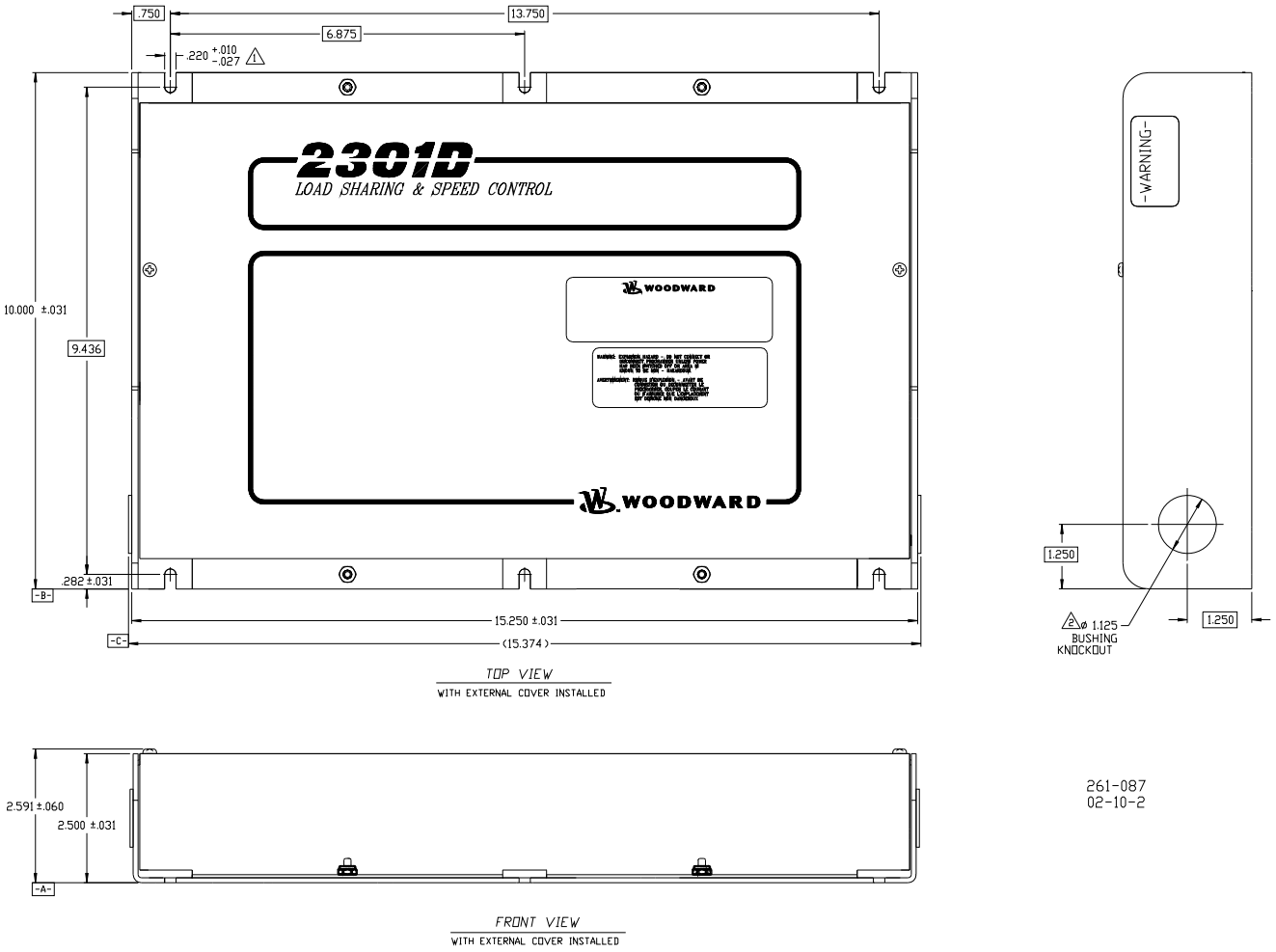


Figure 2-2. 2301D-GT P/N 8273-1002 Outline Drawing
(hazardous location w/ external cover installed)

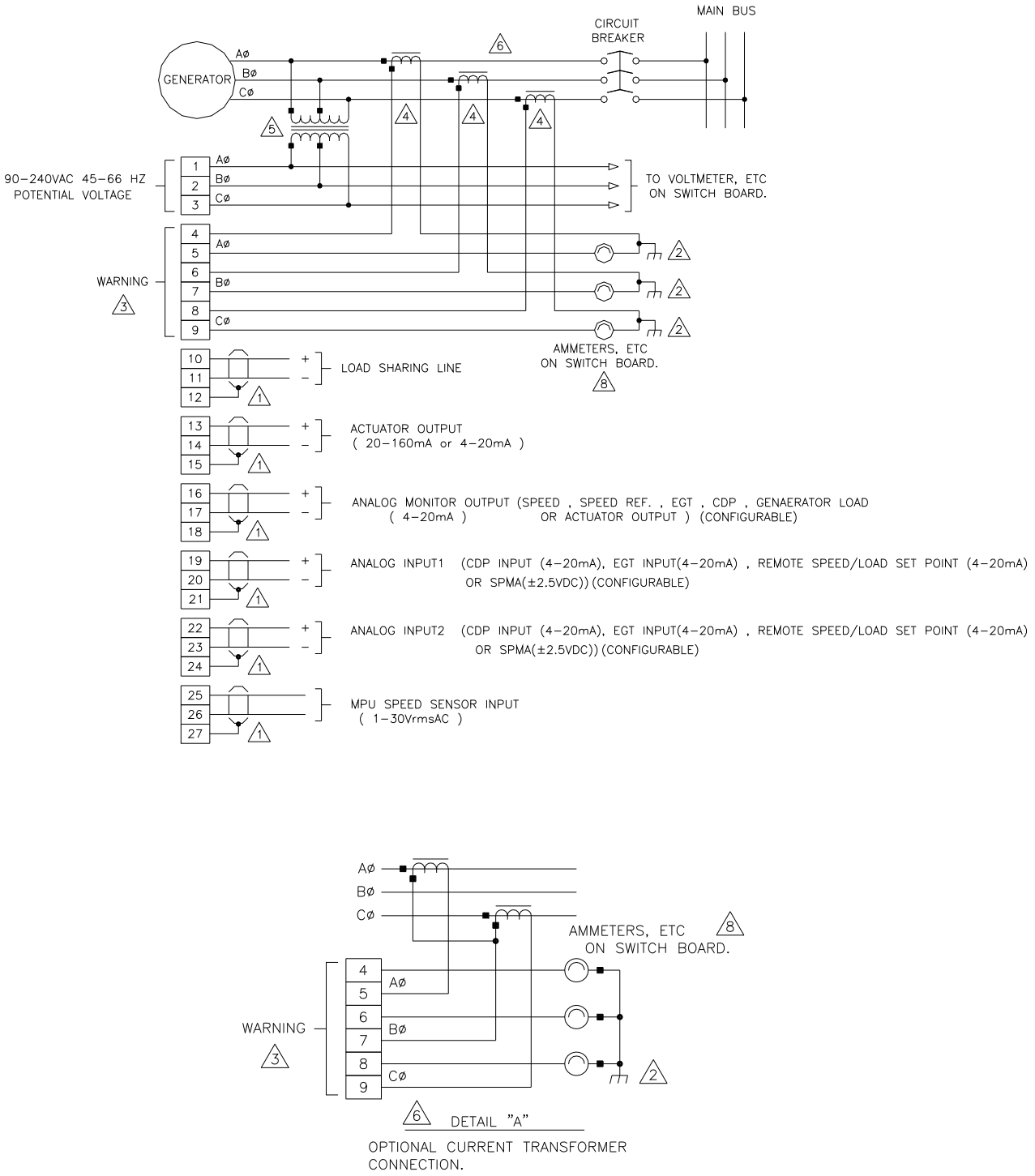


Figure 2-3. 2301D-GT Plant Wiring Diagram (sheet 1)

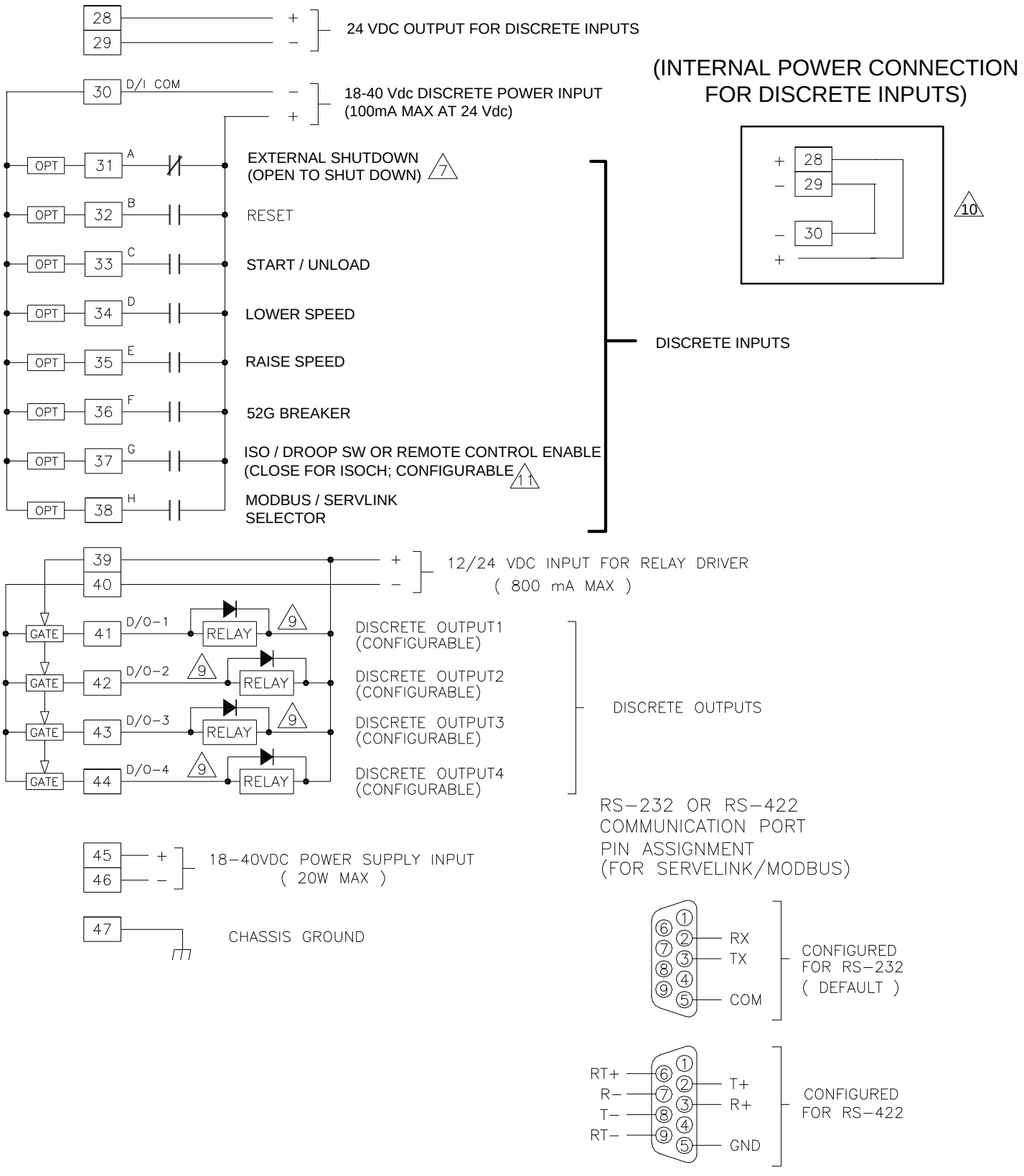


Figure 2-4. 2301D-GT Plant Wiring Diagram (sheet 2)

NOTES:

1. SHIELDED WIRES TO BE TWISTED PAIRS, WITH SHIELD GROUNDED AT CONTROL END ONLY.
2. POINT OF GROUNDING IF REQUIRED BY WIRING CODE.
3. INTERNAL CURRENT TRANSFORMER BURDEN MUST BE CONNECTED ACROSS POWER SOURCE CURRENT TRANSFORMER AT ALL TIMES, TO PREVENT LETHAL HIGH VOLTAGES.
4. POWER SOURCE CURRENT TRANSFORMERS SHOULD BE SIZED TO PRODUCE 5A SECONDARY CURRENT WITH MAXIMUM GENERATOR CURRENT. CURRENT TRANSFORMER BURDEN IS LESS THAN 0.1 VA PER PHASE.
5. WITH A BALANCED THREE PHASE LOAD AND UNITY POWER FACTOR, THE CURRENT TRANSFORMERS SHOULD BE WIRED IN THE CORRECT POTENTIAL LEG AND MUST BE PHASED AT THE CONTROL AS FOLLOWS:

   PHASE A: POTENTIAL TERMINAL 1, WITH RESPECT TO NEUTRAL, IN PHASE WITH CT TERMINALS 4 TO 5.
   PHASE B: POTENTIAL TERMINAL 2, WITH RESPECT TO NEUTRAL, IN PHASE WITH CT TERMINALS 6 TO 7.
   PHASE C: POTENTIAL TERMINAL 3, WITH RESPECT TO NEUTRAL, IN PHASE WITH CT TERMINALS 8 TO 9.

6. FOR OPTIONAL CURRENT TRANSFORMER CONNECTION, SEE DETAIL "A".
7. OPEN TO SHUTDOWN
8. IF METERS ARE NOT USED, JUMPERS MUST BE INSTALLED IN PLACE OF METERS SHOWN.
9. INDICATES RELAY COIL OR LAMP, 200 mA MAXIMUM PER CHANNEL.
10. JUMPER TERMINAL 29 TO 30 IF USING INTERNAL POWER FOR DISCRETE INPUTS. TERMINAL 28 AND 29 SHOULD NOT BE USED , IF EXTERNAL POWER IS USED.
11. CLOSE TO ISOCHRONOUS

Figure 2-5. 2301D-GT Plant Wiring Diagram (notes)

Electrical Connections

All inputs and outputs are made through screwless spring-actuated terminal blocks. For EMI reasons, it is recommend that all low-current wires be separated from all high-current wire.

The spring clamp can be actuated using a standard 2.5 mm or 3/32 inch flat bladed screwdriver. The terminal blocks accept wires from 0.08–4 mm² (27–12 AWG). Two 18 AWG or three 20 AWG wires can be easily installed in each terminal. Wires for the fixed mounted power terminals should be stripped 5–6 mm (0.22 inch) long.

IMPORTANT

It is recommended that stranded wire be used for connections to the terminal block. Do not tin (solder) the wires that terminate at the terminal blocks. The spring-loaded terminal blocks are designed to flatten stranded wire and if those strands are tinned together, the connection loses surface area and is degraded.

Shields and Grounding

An individual shield termination is provided at the terminal block for each of the signals requiring shielding. All of these inputs should be wired using shielded, twisted-pair wiring. The exposed wire length beyond the shield should be limited to one 25 mm (1 inch). Relay outputs, contact inputs and power supply wiring do not normally require shielding, but can be shielded if desired.

The 2301D-GT is designed for shield termination to earth ground at the control. If intervening terminal blocks are used in routing a signal, the shield should be continued through the terminal block. If shield grounding is desired at the terminal block, it should be ac coupled to earth. All other shield terminations except at the control should be ac coupled to earth through a capacitor. A 1000 pF, 500 V capacitor is sufficient. The intent is to provide a low impedance path to earth for the shield at frequencies of 150 kHz and up. Multiple direct connections of a shield to earth risk high levels of current to flow within the shield (exception, see note below on cabinet installations).

Shields can be grounded at both ends (2301D-GT and load) if the cable length is sufficiently short (i.e. within a cabinet) to prevent ground loop current in the shield.

IMPORTANT

Cabinet Installations: If the 2301D-GT is installed in a cabinet, shielded I/O can be terminated directly to the cabinet (earth ground) at the entry to the cabinet, as well as at the control.

For EMC reasons, it is recommend that all low-current wires be separated from all high-current wires. Input Power ground terminal should also be wired to earth ground.

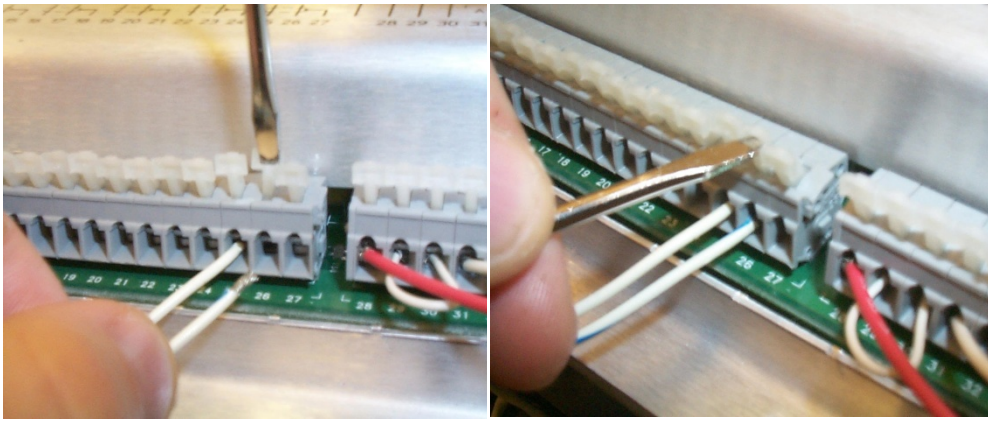


Figure 2-6. Installation of Wiring into Terminal

Power Supply Connections

The 2301D-GT requires a voltage source of 18 to 40 Vdc, with a current capacity of at least 900 mA for operating power. If a battery is used for operating power, an alternator or other battery-charging device is necessary to maintain a stable supply voltage.

Connect 18-40 Vdc input power to terminals 45(+) and 46(–).

IMPORTANT

The 18–40 Vdc input power must be supplied from a power supply/battery charger certified to IEC standard with SELV (Safety Extra Low Voltage) classified output. The installer should properly size wiring and fusing for the input power and PT/CT circuits.

Potential Transformer Connections

The control's potential transformer inputs accept line-to-line voltages of 90 to 240 Vac. Refer to plant wiring diagram Figure 2-3. Connect the potential transformer secondary leads to the following terminals:

Phase A to Terminal 1
Phase B to Terminal 2
Phase C to Terminal 3

Current Transformer Connections

The control's current transformer inputs accept a current range of 0 to 7.2 Amps. Refer to plant wiring diagram Figure 2-3. Connect the current transformer leads to the following terminals:

Phase A to Terminals 4 & 5
Phase B to Terminals 6 & 7
Phase C to Terminals 8 & 9

Load Sharing Lines Connections

The Load Sharing Lines provide an analog communication path between compatible controls. The 2301D-GT provides an internal relay for connecting the Load Sharing Signal to the internal circuitry at the appropriate times. When the internal relay is closed, a green LED will illuminate between terminals 9 and 10. Because the load-sharing-line relay is contained in the control, no relay is required between the control and the load-sharing-line bus. Use shielded cable and connect the load-sharing lines directly to terminals 10(+) and 11(–). Connect the shield to terminal 12. When all controls in the system are 2301D-GTs, the shields may be connected continuously between controls. When load sharing with different controls, do not connect the shields at the point where connections are made to the load-sharing-line bus. The droop/isoch contact is used in conjunction with the control's load sharing lines. When isochronous control is selected and the gen breaker is closed, the unit's load sharing lines are enabled.

Discrete Input Connections

In general, discrete inputs must change state for a minimum of 15 milliseconds for the control to sense and register a change in state. All contact inputs accept dry contacts. Contact wetting voltage is available through terminals 28 and 29. If desired, an external 18-40 Vdc power source can be used for the circuit wetting voltage. In this case terminal 30 (contact input common) must be connected to the external power source's negative common to establish a common reference point. Each contact input pulls 3 mA when closed and requires at least 14 Vdc to recognize a closure command. See Figure 2-3 for wiring information and 2301D-GT Control Specification for input specifications.

A positive voltage on any discrete input terminal is sensed by the control as a closed contact or 'TRUE' state. With no voltage applied to a discrete input terminal the control senses an open contact or 'False' state.

For power loading reasons, it is recommended that the control's internal 24 Vdc not be used to power other external devices.

IMPORTANT

Discrete inputs with cable lengths greater than 30 meters that are used for critical functions, such as emergency stop, should not be floated in either an on or off state. These inputs should be switched to +24 Vdc or ground.

External Shutdown Contact (Terminal 31)

Terminal 31 functions as the control's External Shutdown contact input. Before the unit can be started, this External Shutdown input command must be cleared. This input can be configured for open-to-shutdown or close-to-shutdown functionality. The control will initiate an emergency shutdown any time a shutdown command is given and will immediately step its actuator drive current to zero and, if so configured, change the state of its shutdown output. This input is typically tied into the system's trip string to enable it to react to any system trip command.

Reset Contact (Terminal 32)

Terminal 32 functions as the control's Reset contact input. The external Reset contact is used to reset any latched alarms and or shutdown conditions, if the condition has been cleared. If the alarm or shutdown condition has not been cleared the Reset command will not affect its status. To issue a reset, the contact must be pulsed to close. No action is taken if contact is either left close or open after pulse.

Start/Unload Contact (Terminal 33)

Terminal 33 functions as the control's External Start/Unload contact input. When an external start command is given (a closed contact state) and all shutdown conditions have been cleared, the control will cycle through its configured start routine. If all shutdown conditions have not been cleared the unit will not begin to cycle through its start routine.

This contact input also functions as an external unload command input, when the control is in the isochronous load-sharing mode or base load mode and this contact input is opened.

Lower Speed/Load Contact (Terminal 34)

Terminal 34 functions as a lower speed reference contact input when the control mode isn't BASE LOAD mode, and a lower load reference contact when the unit is in the BASE LOAD mode. When the control is in the isochronous load-sharing mode, this contact is lower speed.

If both a lower speed contact and a raise speed contact are input, the inputs are remote control enable.

Raise Speed/Load Contact (Terminal 35)

Terminal 35 functions as a raise speed reference contact input when the control mode isn't BASE LOAD mode, and a raise load reference contact when the unit is in the BASE LOAD mode. When the control is in the isochronous load-sharing mode, this contact will increase speed reference.

If both a lower speed contact and a raise speed contact are input, the inputs are remote control enable.

This remote control enable is used to enable and disable the remote 4–20 mA analog input. The control's internal speed/load setpoint will follow the respective analog input signal.

52G(Generator) Breaker Contact (Terminal 36)

Terminal 36 functions as the control's generator breaker contact input. The state of this input should directly reflect the state of the unit's generator breaker. This input is used to activate the correct control mode. When this contact input is open, the droop is disabled. When this contact input is closed, this input in conjunction with the Isoch/Droop contact determines the control's load mode.

If 'Configure: B **INPUT & OUTPUT OPTIONS**' '18:USE RTD/IDL SW AT DI G' is TRUE, terminal 36 is used for Iso/Droop.

Iso/Droop Select Contact (Terminal 37 or 36)

If 'Configure: B **INPUT & OUTPUT OPTIONS**' '18:USE RTD/IDL SW AT DI G' is FALSE, terminal 37 is used for Iso/Droop.
If 'Configure: B **INPUT & OUTPUT OPTIONS**' '18:USE RTD/IDL SW AT DI G' is TRUE, terminal 36 is used for Iso/Droop.

This contact is used to select which load control mode the control is in when the generator breaker is closed. With the generator breaker contact closed and this contact opened, the control will function in the droop load mode. With the generator breaker closed and this contact closed, the control will function in the isochronous, isochronous load-sharing mode or base load mode. In the isochronous load-sharing mode, the control's internal load-sharing-line relay is energized, connecting the control's load sharing circuitry to that of any other controls on the network.

Typically when used as the isoch/droop select contact, this contact is wired to directly reflect the state of the system's utility tie breaker, with a switch or relay wired in series with the tie breaker aux contact to allow users to manually select the load mode the control operates in when paralleled to the utility.

Rated/Idle Select Contact (Terminal 37)

If 'Configure: B **INPUT & OUTPUT OPTIONS**' '18:USE RTD/IDL SW AT DI G' is TRUE, terminal 37 is used for Rated/Idle.

This contact is used to select speed reference. If this contact is closed, the speed reference goes to rated speed setpoint. When the speed reference is ramping to rated, momentarily close raise contact or close lower contact, to halt the ramp. To continue to rated speed, pulse to close the Rated/Idle switch.

If this contact is opened, the speed reference goes to the idle speed setpoint. When the speed reference ramps down to idle, momentarily close raise contact or close lower contact, to halt the ramping. To continue to idle, pulse to open the Rated/Idle switch.

Modbus / Servlink DDE Mode (Terminal 38)

If 'Configure: B **INPUT & OUTPUT OPTIONS**' '19:USE BS LD/LS SW AT DI G' is FALSE, terminal 38 is used for Modbus/Servlink.

Terminal 38 functions as the control's Modbus communications enable contact input for the control's 9-Pin Sub-D communication port. When this contact is open or is not connected, the control's communications port communicates using a Servlink\DDE protocol. This is used to communicate with Woodward's Watch window program for unit configuration and/or service.

When this contact is closed, the control's 9-Pin Sub-D communications port communicates using a Modbus RTU protocol and the control functions as a Modbus Slave device. The 2301D-GT can be fully operated and all control values monitored via Modbus communications. Alternatively Modbus communications can be used to interface with a PLC or plant DCS.

Base Load / Load sharing (Terminal 38)

If 'Configure: B **INPUT & OUTPUT OPTIONS**' '19:USE BS LD/LS SW AT DI G' is TRUE, terminal 38 is used for Base Load / Load Sharing.

In case of closing 52 G breaker close and Iso/Droop contact close, the load control is Isochronous. Then Base load / Load Sharing contact is useful. When this contact goes from open to close, load reference gradually change to base load point.

When this contact goes from close to open, load control is in isochronous load sharing mode. Base load is not available via Modbus.

Actuator Output

Connect the unit's actuator wires to the control's actuator driver output on terminals 13(+), 14(–), and 15 (shield). This output's current range is software configurable and can be programmed to output a drive current of 20–160 mA or 4–20 mA. Do not connect the shield wire to the actuator or any other point. Verify that the output's shield wire has continuity its entire distance to the actuator and is insulated from all other conducting surfaces.

The maximum impedance that the control's actuator output can drive into, when configured as a 20–160 mA driver, is 80 Ω (actuator impedance + wire resistance). The maximum impedance that the control's actuator output can drive into, when configured as a 4–20 mA driver, is 620 Ω (actuator impedance + wire resistance).

Analog Input #1

Connect input wiring to terminals 19(+), 20(–), and 21(shield) to use Analog Input #1. Analog Input #1 is software configurable to function as one of the following options:

- CDP Input (4–20 mA signal)
- EGT Input (4–20 mA signal)
- Remote Speed/Load Setpoint (4–20 mA signal)
- SPM-A Synchronizer Input (-2.5 to 2.5 Vdc signal)

Verify that the input's shielded wire has continuity its entire distance to the input device and is insulated from all other conducting surfaces. An input impedance of 250 Ω is present across the input terminals when the 2301D-GT is configured as a current input. This input is not isolated from the other control inputs and outputs, thus an isolation device may be required with this input if the device being interfaced to is not isolated.

Analog Input #2

Connect input wiring to terminals 22(+), 23(–), and 24(shielded) to use Analog Input #2. Analog Input #2 is software configurable to function as one of the following options:

- CDP Input (4–20 mA signal)
- EGT Input (4–20 mA signal)
- Remote Speed/Load Setpoint (4–20 mA signal)
- SPM-A Synchronizer Input (-2.5 to 2.5 Vdc signal)

Verify that the input's shielded wire has continuity its entire distance to the input device and is insulated from all other conducting surfaces. An input impedance of 250 Ω is present across the input terminals when the 2301D-GT is configured as a current input. This input is not isolated from the other control inputs and outputs, thus an isolation device may be required with this input if the device being interfaced to is not isolated.

MPU Speed Sensor Input

To sense turbine speed, the control accepts a signal from a passive magnetic pickup unit (MPU) mounted off a gear connected or coupled to the turbine's rotor. Connect the MPU speed sensor to terminals 25, 26, and 27 (shield). This input is limited to a frequency range of 100-24 950 Hz (900–32 000 rpm) and a voltage range of 1.0–30 Vac (it needs the voltage as Fig.3-7). Verify that the input's shield wire has continuity its entire distance to the input sensor and is insulated from all other conducting surfaces.

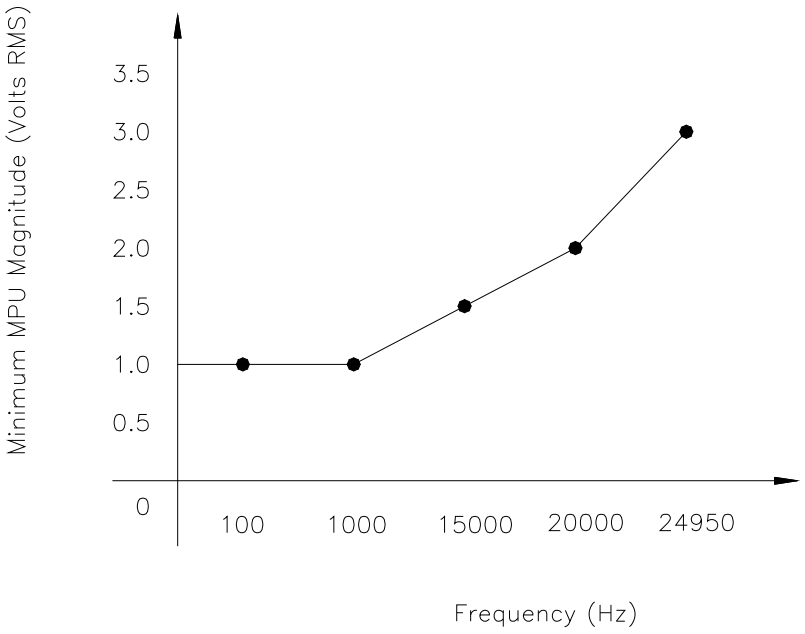


Figure 2-7. Minimum MPU Voltage

With proper MPU, gear size and MPU-to-gear clearance, speed measurement should be capable down to 100 Hz. Check the speed sensor for visible damage. Standard MPU clearance is recommended to be between 0.25 and 1.0 mm (0.010 and 0.040 inch) at the closest point. Make sure the gear has less than 0.5 mm (0.020 inch) diametric run out. See manual 82510, *Magnetic Pickups and Proximity Switches for Electric Governors*.

⚠WARNING **Paralleling MPUs may cause impedance mismatches that will result in erroneous readings.**

Relay Driver Outputs (Terminals 41–44)

The 2301D-GT has four discrete output driver channels. Terminal 41 functions as the control's emergency shutdown relay driver output. Terminals 42, 43, and 44 are configurable and can be programmed to perform one of the following functions:

- SHUTDOWN
- ALARM
- SPEED REF. LOWER LIMIT
- SPEED REF. RAISE LIMIT
- SPEED SW#1
- SPEED SW#2
- OVERSPEED
- SPEED IN CONTROL
- EGT IN CONTROL
- CDP LIMIT
- LOAD SW
- SPEED DERIV LIMIT REACHED

- REMOTE SPEED SETPOINT ENABLED
- MODBUS CONTROLLED RELAY #1
- MODBUS CONTROLLED RELAY #2
- SYNCHRONIZING ENABLED
- LIGHT OFF FAIL
- STARTER ENERGIZED
- OPEN 52G
- LOAD LIMIT

These discrete outputs are low-side drivers with a maximum output current of 160 mA. The discrete output drivers are isolated from the control's internal power supply, but not from each other and are powered by an external +12 Vdc or +24 Vdc source connected at terminals 39(+) and 40(–). Refer to Figure 2-4 for diagrammed wiring information.

Analog Output

Connect readout wiring to terminals 16(+), 17(–) and 18 (shield) to use the control's 4–20 mA Analog Output. This Analog is software configurable to function as one of the following readout options:

- SPEED READOUT
- SPEED REF. READOUT
- EGT READOUT
- CDP READOUT
- KW READOUT
- ACTUATOR READOUT

Verify that the output's shielded wire has continuity its entire distance to the output device and is insulated from all other conducting surfaces. This current driver based output is designed to drive into impedances of up to 250 Ω. This output is not isolated from the other control inputs and outputs, thus an isolation device may be required with this output if the device being interfaced to is not isolated.

This analog output's 4–20 mA current drive signal is directly proportional to the programmed function signal that it is configured to represent. Refer to Chapter 3 for output configuration instructions.

Communication Port

The control's serial communications port is used to configure and service the unit, as well as communicate to an HMI or plant distributed control system (DCS). This port's protocol can be changed via the control's 'Modbus communications enable' contact input. When this contact input is open or has no connection to it, the control's communications port communicates using an RS-232 driver and a Servlink DDE protocol. The Servlink DDE protocol is used to communicate with Woodward's Watch window program for unit configuration and or service. Refer to Chapter 3 for configuration and setup instructions.

When the control's 'Modbus communications enable' contact input is closed, the control's communications port then communicates using a Modbus RTU protocol, functioning as a Modbus Slave device, via RS-232 or RS-422 drivers, depending on the configuration. The 2301D-GT can be fully operated and all control values monitored via Modbus communications. Alternatively Modbus communications can be used to interface with a PLC or plant DCS. Refer to Figure 2-4 for diagram wiring information.

IMPORTANT

The communication port must be connected with an approved jacketed serial communication cable. The connector must be secured to the 2301D-GT to prevent contact with other circuits.

RS-232

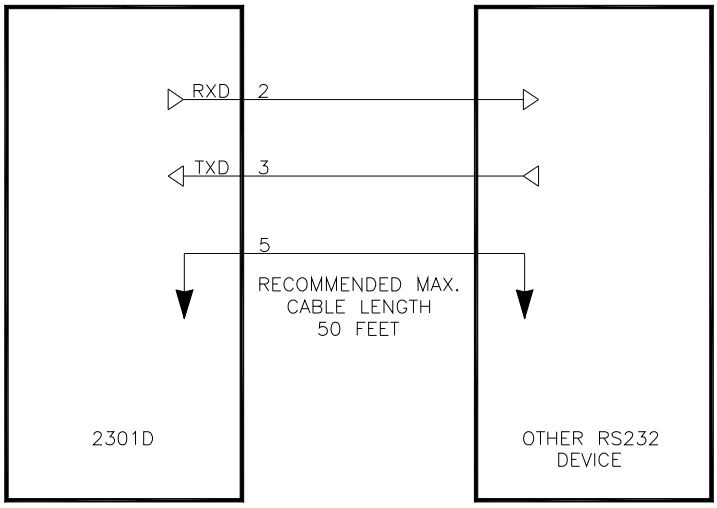


Figure 2-8. RS-232 Pin assignment for Serial Communication Cable

RS-422
See Figure 2-9 for termination and cable connection example.

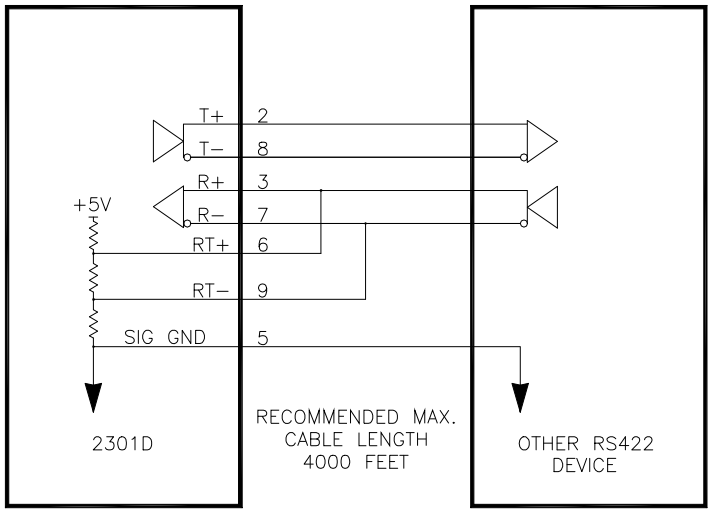


Figure 2-9. Typical RS-422 Communications Connections

Termination
For RS-422, termination should be located at the receiver when one or more transmitters are connected to a single receiver. When a single transmitter is connected to one or more receiver, termination should be at the receiver farthest from the transmitter. Figure 2-10 is an example.

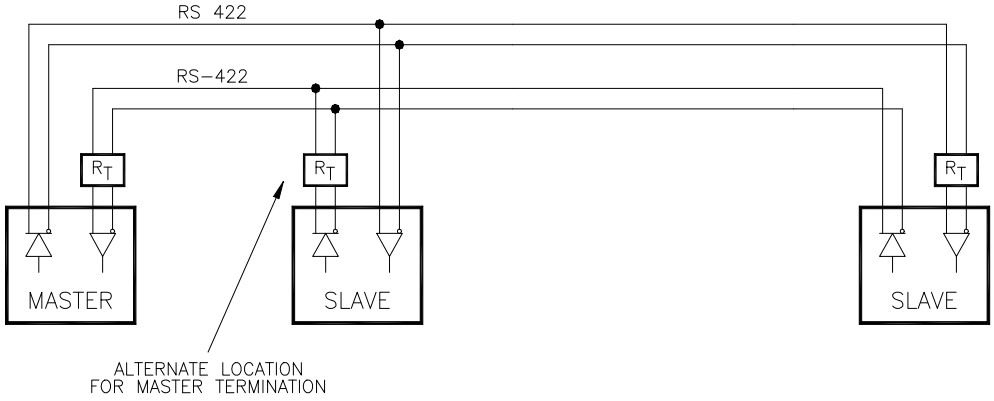


Figure 2-10. RS-422 Terminator Locations

Grounding and Shielding

The RS-422 specifications state that a ground wire is needed if there is no other ground path between units. The preferred method to do this is to include a separate wire in the cable that connects the circuit grounds together. Connect the shield to earth ground at one point only. The alternate way is to connect all circuit grounds to the shield, and then connect the shield to earth ground at one point only. If the latter method is used, and there are non-isolated nodes on the party line, connect the shield to ground at a non-isolated node, not at an isolated node. Figures 3-11 and 3-12 illustrate these cabling approaches.

IMPORTANT

Non-isolated nodes may not have a signal ground available. If signal ground is not available, use the alternate wiring scheme in Figure 2-11 with the signal ground connection removed on those nodes only.

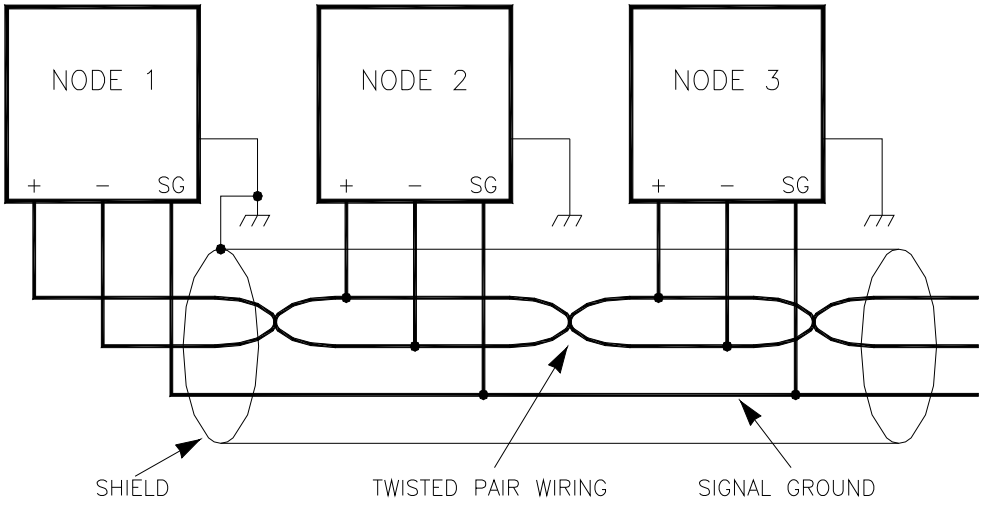


Figure 2-11. Preferred Multipoint Wiring Using Shielded Twisted-pair Cable with a Separate Signal Ground Wire

IMPORTANT

The SG (signal ground) connection is not required if signal ground is unavailable.

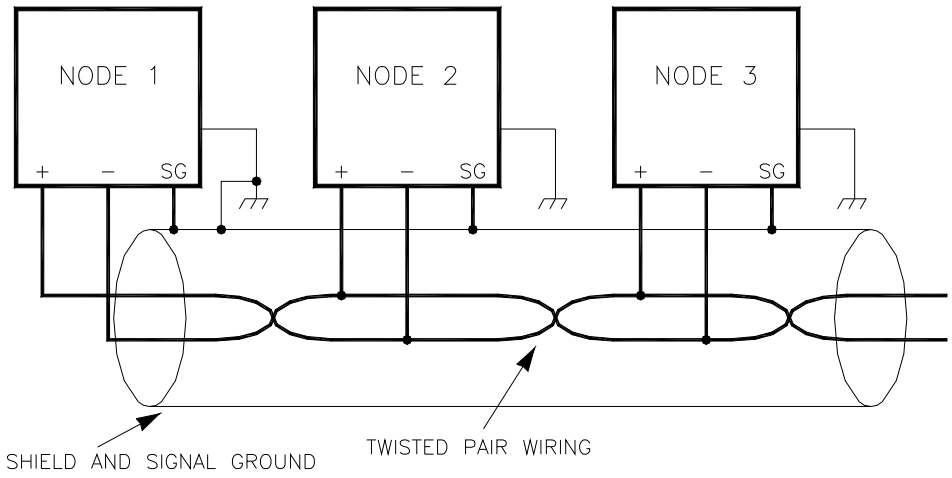


Figure 2-12. Alternate Multipoint Wiring Using Shielded Twisted-pair Cable without a Separate Signal Ground Wire

Installation Check-out Procedure

Once the 2301D-GT is installed, perform the following checkout procedure before beginning the start-up adjustments in Chapter 3.

Visual Inspection

1. Check the linkage between the actuator and the prime mover for looseness or binding. Refer to the appropriate actuator manual and to manual 25070, *Electric Governor Installation Guide*, for additional information on linkage.

⚠WARNING

The actuator lever should be near but not at the minimum position when the fuel or steam rack is at the minimum position. If the actuator lever gets to its minimum position before completely shutting off fuel or steam, the control may not be able to shut down the prime mover, causing damage to equipment or injury or death.

2. Check for correct wiring in accordance with the plant wiring diagram, Figures 3-3 and 3-4.
3. Check for broken terminals and loose terminal screws.
4. Check the speed sensor for visible damage.
5. Check the clearance of the magnetic pickup between the gear and the sensor and adjust if necessary.

Chapter 3.
Configuration Procedures

Introduction

This chapter contains information on control configurations, setting adjustments and the use of Woodward's Watch Window software tool. Because of the variety of installations, plus system and component tolerances, the 2301D-GT must be tuned and configured for each system to obtain optimum performance. Refer to Chapter 4 for start-up settings, adjustments and instructions.

⚠WARNING

An improperly calibrated control could cause an overspeed or other damage to the prime mover. To prevent possible serious injury from an overspeeding prime mover, read this entire procedure before starting the prime mover.

Watch Window Program

Watch Window is the primary troubleshooting tool for Woodward controls that support the Servlink protocol. Watch Window runs on a PC connected to the control system through a serial communications port. The Engineering work station PC may be permanently connected to the control or only as needed. The communications server, Servlink I/O Server, is included in the same installation with Watch Window.

An 'inspector' provides a window for real-time monitoring and editing of all control Configuration and Service Menu parameters and values. Custom 'inspectors' can easily be created and saved. Each window can display up to 28 lines of monitoring and tuning parameters without scrolling. The number with scrolling is unlimited. Two windows can be open simultaneously to display up to 56 parameters without scrolling. Tunable values can be adjusted at the inspector window. Watch Window communicates with the control through an RS-232 cable connection to the communications port configured as a point-to-point only Servlink Server.

Watch Window is a typical Microsoft Windows® application that provides a powerful and intuitive interface. The menu structures are familiar to Windows users. Variable navigation is provided through the Explorer window similar to the Explorer in Windows.

Watch Window performs three primary functions:

- Monitoring and Tuning of control variables—Watch Window presents variables in a tabular format. The user chooses the variables to view. Multiple pages of variables can be created, each with useful parameters for various troubleshooting or tuning procedures. The user can toggle between pages depending on the task being performed.

- Control Configuration and Set Point Management—Watch Window can upload or download all tunable variables from the control system. This feature allows a user (e.g., fleet owner, distributor, packager) to upload (and save) all tunable parameters from one control and download the same settings to other controls for similar engine configurations.

- Program Loading—Watch Window provides services to download a new program to the control. This is available in the Professional version only.

-  Watch Window version 1.05 and higher, allows for automatic generation of inspector sheets. Click on the Q icon (Quick Inspector) on the tool bar. A sheet will automatically be created from each Service and Configure Header programmed into the control. Multiple inspectors can be created to allow for viewing more than one sheet at a time.

-  To enter the I/O Lock mode and enable a configure value to be entered, click on the I/O Lock icon on the Tool Bar. Because the values set in Configure are critical to engine operation, it is not safe to operate the prime mover while these parameters are being configured. In the Configure mode the control outputs will be set to the off state and the microprocessor will stop executing the application code. The control will have to be reset to continue operation.

-  The Reset icon allows the microprocessor to store the configure parameters, to return the outputs to their active state and to resume executing the application software.

-  When the tuning or setting of parameters is complete, the values must be saved in the control's non-volatile memory. Go to the Tool Bar and click the PROM icon for Save Values. The values will be saved in non-volatile memory and will be unaffected by loss of power to the control.

-  If an application configuration has been previously saved to a *.CFG file, the saved set of parameters can be loaded into the 2301D-GT as a group by selecting the Load Application Settings icon.

-  To save the configuration to a file in the external computer for backup or download later into another 2301D-GT, select the Save Application Settings icon. All the tunable values presently set in the control will be saved to a file and can be loaded into this 2301D-GT to reprogram it to the saved values or into another 2301D-GT at a later time.

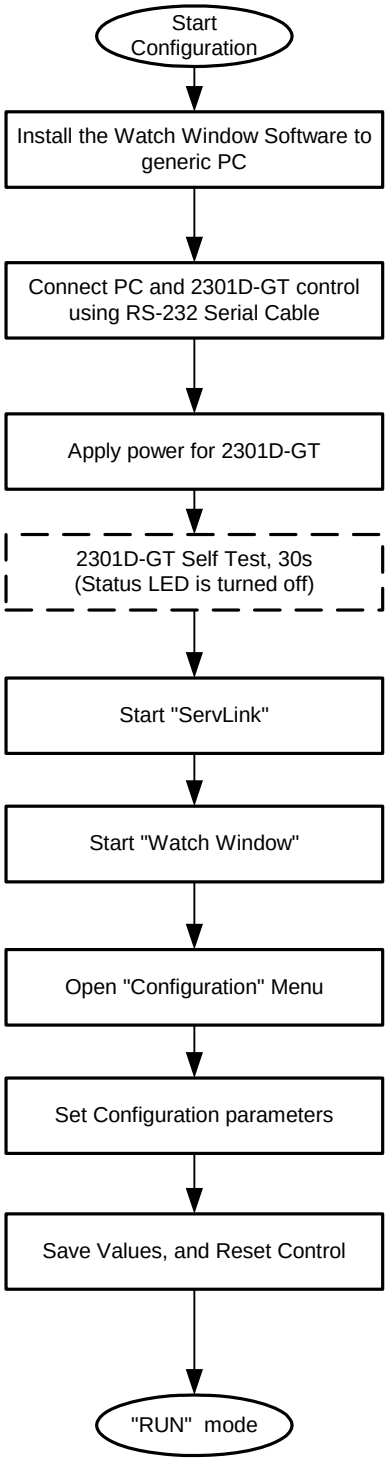


Figure 3-1. Basic Configuration Procedures

Install Watch Window software

Woodward's Watch Window Standard configuration and service tool may be downloaded at no cost from the Woodward website (www.woodward.com). As an alternative a Watch Window CD Install Kit may be purchased from the nearest Woodward distributor. Once downloaded, select the kit's Setup.exe program on the computer on which you wish to install the Watch Window software program. Please refer the product specification 03202 for detailed installation procedures.

Connect Generic PC to 2301D-GT

The connection of a computer is only required for calibration and setup of the 2301D-GT on a prime mover as shown in Figure 3-2 below. The computer and Watch Window software program are not required or necessary for normal operation of the control.

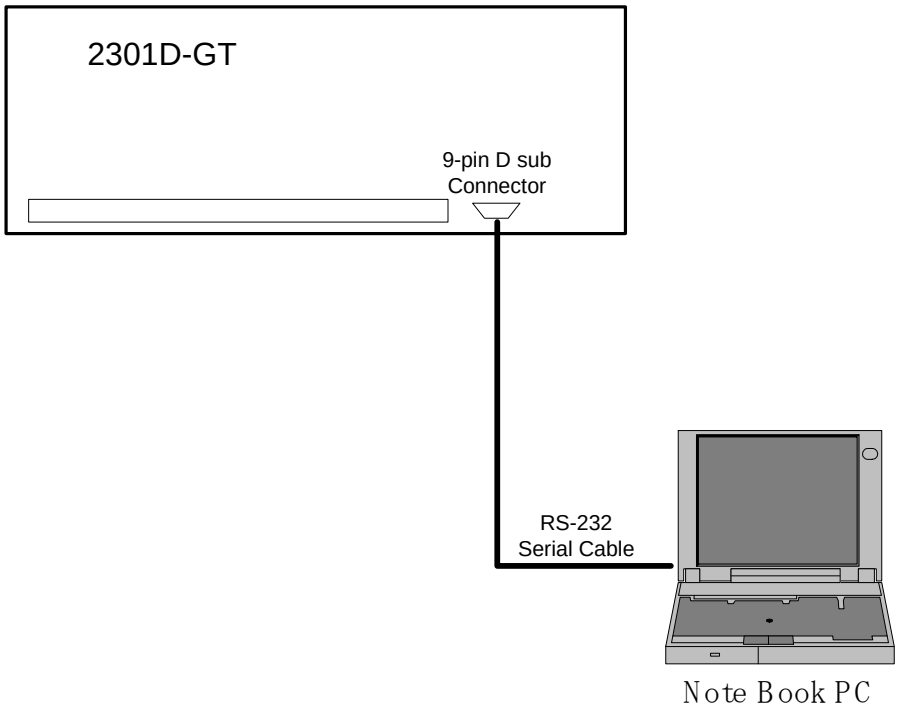


Figure 3-2. Connection between PC and 2301D-GT

Apply Power to the 2301D-GT

At power-up, the 2301D-GT runs through its boot-up routine and performs a set of initial diagnostics to verify CPU, memory and bus health. This boot-up routine takes approximately 30 seconds to execute. During this time, the control's red status LED (located between terminals 27 and 28) should be on. When boot-up is complete, the application program code begins running, the control outputs will be enabled and system control will begin–the control's red status LED will be turned off and should remain off as long as the control is running.

Opening Communications with a Control

Initial 2301D-GT communications:
Before communications can begin between the Watch Window program and a control, a network definition file must be created. Once this network definition file is created and saved, it never has to be recreated.

To create a network definition file:
1. Open the Watch Window program's associated Servlink server by Clicking on Start > Programs > Woodward > Servlink Server.exe
2. Select the communications port the control is connected to
3. Select 'Point-to-Point' communications
4. Select the a Baud Rate of 38000
5. Select the OK button

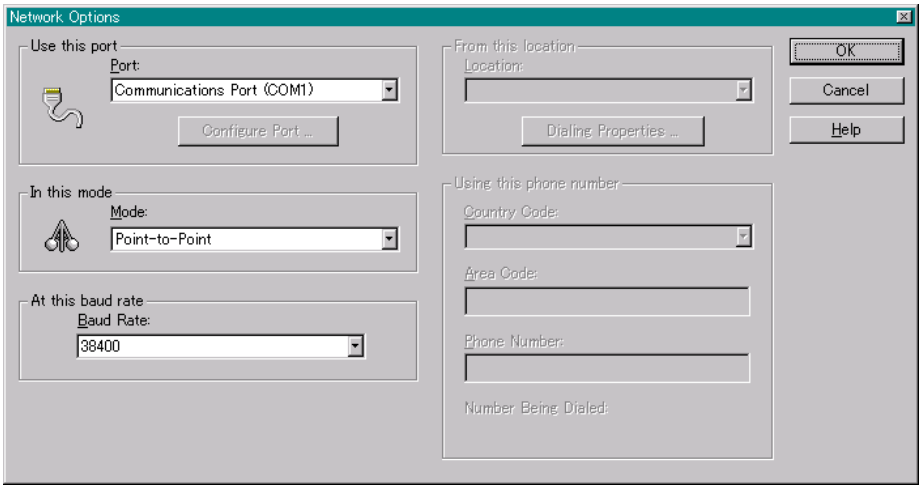


Figure 3-3. Setup Servlink Communication

At this point the Servlink Server program will establish control communications, begin reading all control setting registers and create a lookup table for these registers to expedite future control communications. Upon reading register location information from the control the following Windows pop-up box will appear. (This step can take several minutes to complete.)

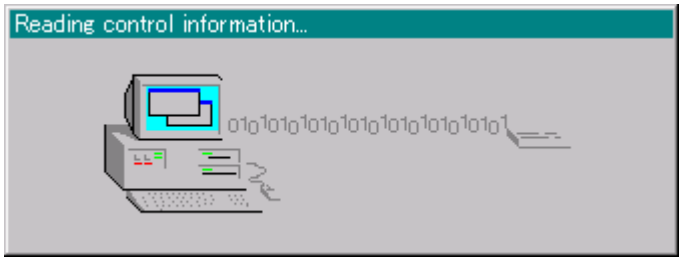


Figure 3-4. Reading Control Information

Once all control program registers have been read, the text 'Dflt Control ID' will appear within the Servlink program window and the network definition file can be saved for future retrieval by the Watch Windows program. If the network definition file is not saved it will have to be re-created before computer-to-control communications can be established again.

Start Watch Window Software

At this point, start the Watch Window software program by clicking on Start > Programs > Woodward > Watch Window Standard.exe.

The Watch Window Menu bar, Explorer and Inspector will appear as shown in Figure 3-5. Click on the icon (Quick Inspector) on the tool bar. Multiple sheets will automatically be created from each Service and Configure Header programmed into the control. Refer to Figure 3-6. Optionally, other inspectors can be created to allow viewing of more than one sheet at a time.

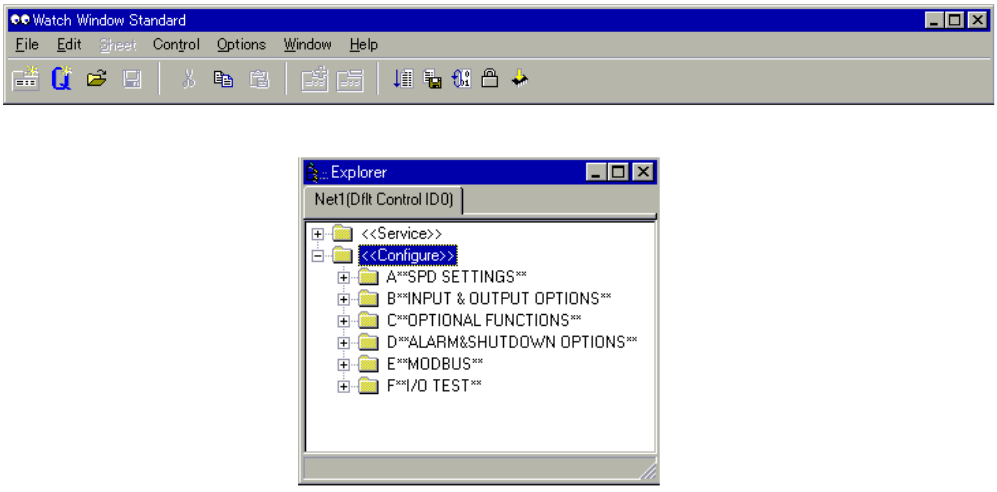


Figure 3-5. Watch Window Menu and Explore (Configure)

Configure Menu Descriptions

The 2301D-GT has six Configure menus and 33 Service menus to simplify and protect control settings and their adjustments. All menus appear as pages, are arranged alphabetically and can be located by using the inspector's arrow buttons located above the pages to scroll to the desired menu.

The program's Configure menu items are protected when the control is in operation and cannot be changed. Before configuration values can be changed the control must be in its I/O Lock mode. Service menus are not protected and can be modified at any time.

To enter the I/O Lock mode and enable configure changes, click on the  I/O Lock icon on the Tool Bar. Because the values set in Configure are critical to turbine operation, it is not safe to operate the prime mover while these parameters are being configured. In the I/O Lock mode the control outputs will be set to they're off state and the microprocessor will stop executing the application code.

Once the configuration changes have been completed click on the  Reset icon to allow the control to store the configured parameters, return the outputs to their active state and resume executing the application software.

Menus: / Control Features:	SPEED PID	ACCEL LIMIT	ACCEL SPD DERIV	EGT PID	STRT RAMP	STRT FUEL RAMP	DECEL LIMIT	DECEL SPD DERIV	MIN LIMIT	MAX LIMIT	REMOTE SPD SETPOINT	SPM-A	KW DROOP	SPD DROOP	LOAD SHARE	BASE LOAD	LOAD LIMIT
CONFIGURE																	
A:SPD SETTING	O																
B:INPUT&OUTPUT OPTIONS	O	O		O		O	O				O	O				O	
C:OPTIONAL FUNCTIONS	-	-	-	-	-	-	-	-	O	O	-	-	-	-	O	O	O
D:ALARM&SHUTDOWN OPTIONS	O	O		O			O				O						
E:MODBUS																	
F:I/O TEST																	
SERVICE																	
A:MONITOR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B:SPD DYNAMICS	O										O	O	O	O	O		
C:EGT DYNAMICS				O													
D:ACCEL SPD DERIV LIMIT			O														
E:DECEL SPD DERIV LIMIT								O									
F:ACCEL LIMIT CURVE		O															
G:DECEL LIMIT CURVE							O										
H:LT OFF FAIL SET																	
I:STRT RAMP					O												
J:STRT FUEL RAMP						O											
K:REMOTE SPD CONTROL											O						
L:OVSPD TEST	O																
M:SYNC SET												O					
N:CONTROL MODE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
O:ENBL CONTROL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P:SPD CONTROL SET	O																
Q:LOAD CONTROL SET(DROOP)	O												O	O			
R:LOAD SHARE SET(ISO)	O														O		
S:LOAD SENSOR SET	O												O		O	O	O
T:ANALOG OUT SETTING																	
U:DISCRETE OUTPUT SETTING																	
V:DISPLY A_I/O VAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W:DISPLAY D_I/O STATUS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
X:I/O TEST																	
Y:MODBUS																	
Z:ALARM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Z1:SHUTDOWN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Z2:APPLICATION ID	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Z3:BASE LOAD	O															O	
Z4:REMOTE BASE LOAD	O															O	
Z5:LOAD LIMIT																	O
Z6:IDLE RATED	O																

O :Should be set

\- :Monitor or it has been set

:Should be set when using that function

Table 3-1. Setting Table

CONFIGURE: A**SPD SETTING**

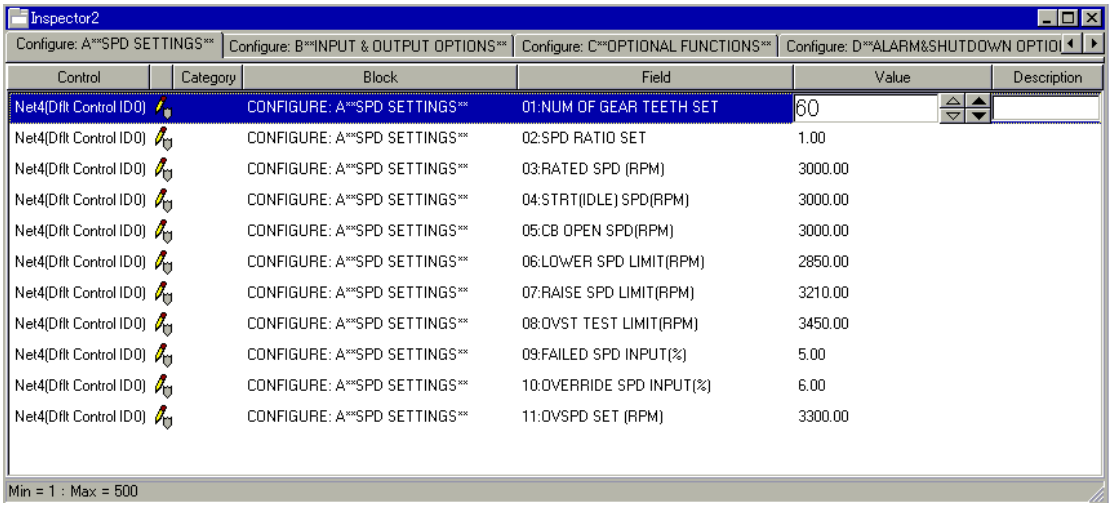


Figure 3-6. Configure: A**SPD SETTING** Menu

01: NUM OF GEAR TEETH SET **dflt=60 (1, 500)**

Enter the result of the (MPU gear speed) / (turbine shaft speed) speed ratio. This value is used to determine the internal hertz-to-rpm relationship of the turbine. This value will be 1 if the MPU gear is mounted directly on the shaft controlled by the 2301D-GT.

IMPORTANT

The maximum input frequency that can be measured by the speed sensing circuit is 24 950 Hz. Therefore to allow for transient conditions, the Number of Teeth times Rated RPM divided by 60 should be less than 19 000.

⚠WARNING

The number of gear teeth is used by the control to convert pulses from the speed-sensing device to turbine rpm. To prevent possible serious injury from an overspeeding turbine, make sure the control is properly programmed to convert the gear-tooth count into turbine rpm. Improper conversion could cause turbine overspeed.

02: SPD RATIO SET **dflt=1.0 (0.0999, 10.0)**

Enter the result of the (MPU gear speed) / (turbine shaft speed) speed ratio. This value is used to determine the internal hertz-to-rpm relationship and is calculated by dividing the speed of the MPU gear by the speed of the turbine shaft.

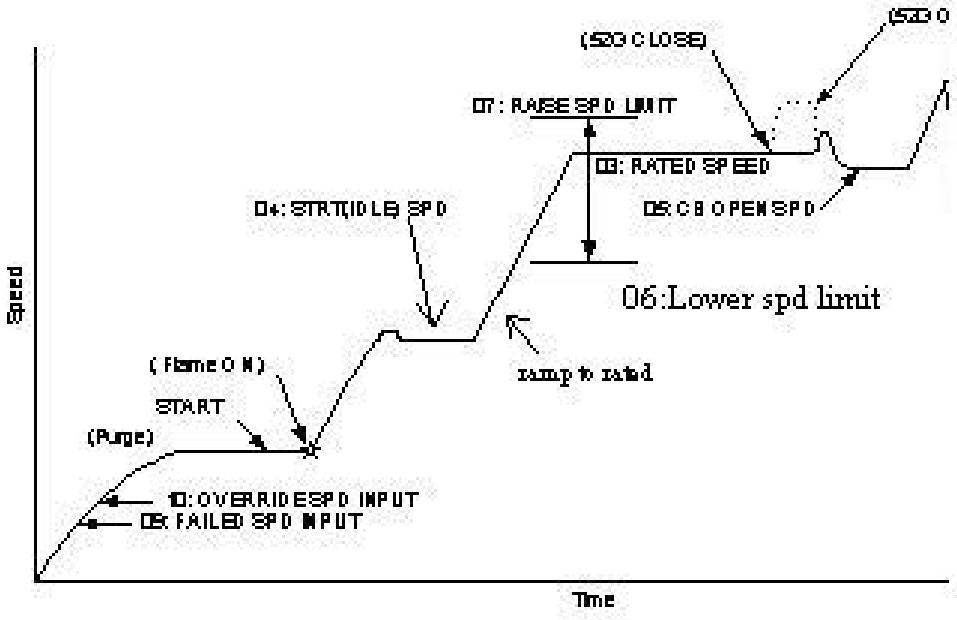


Figure 3-7. Speed Setting Relationships

03: RATED SPD (rpm) dflt=3000.0 (100.0, 32000.0)

Enter the rated operating turbine speed in rpm.

WARNING

The rated speed setting is factory set for 3000 rpm. Using the wrong rated speed setting, gear teeth setting, or speed ratio setting could cause an overspeed condition, resulting in damage to equipment, personal injury or death.

04: STRT(IDLE) SPD(rpm) dflt=3000.0 (100.0, 32000.0)

This entry defines either the turbine start speed or the turbine idle speed. If 'Configure: B**INPUT & OUTPUT OPTIONS** 18: USE RTD/IDL SW AT DI G' is TRUE, enter the turbine idle speed in rpm. Upon starting, the turbine will ramp to and run at this speed until told otherwise. Using the Raise/Lower contact, inputs can change the speed of a turbine running at idle speed. Closing the RTD/IDL contact will raise the turbine speed to rated speed. If 'Configure: B**INPUT & OUTPUT OPTIONS** 18: USE RTD/IDL SW AT DI G' is FALSE, enter the speed at which the 2301D-GT should consider the turbine started.

05: CB OPEN SPD (rpm) dflt=3000.0 (100.0, 32000.0)

This is the speed setpoint just after the 52G Breaker is opened. It is desirable to set this setpoint to the turbine speed when the generator is re-synchronized and re-connected to the bus after the generator breaker was tripped. This setpoint must be lower than or equal to the 'rated speed'. If the setpoint value entered is higher than the rated speed, control dynamics may be worse than that with lower value entered. If you want to make control dynamics at the generator breaker trip better, enter a lower value here.

If 'Configure: B **INPUT & OUTPUT OPTIONS**' '18:USE RTD/IDL SW AT DI G' is TRUE, this setting value is invalid, because there isn't 52G BREAKER contact input.

06: LOWER SPD LIMIT (rpm) **dflt=2850.0 (100.0, 32000.0)**
This is used to set the lower limit of turbine speed in (rpm).

07: RAISE SPD LIMIT (rpm) **dflt=3210.0 (100.0, 32000.0)**
This is used to set the upper limit of turbine speed in (rpm).

08: OVST TEST LIMIT (rpm) **dflt=3450.0 (100.0, 32000.0)**
Should be used to set turbine overspeed testing set-point in (rpm)

09: FAILED SPD INPUT (%) **dflt=5.0 (2.0, 50.0)**
If speed drops below this level (shown in percent of rated speed) after the turbine speed is up to the value set on 10:OVERRIDE SPD INPUT, the control will issue a Speed Sensor Failed shutdown.

10: OVERRIDE SPD INPUT (%) **dflt=6.0 (2.0, 50.0)**
This is the value that is used to override the Speed Sensor Failed Shutdown logic to allow the control to gain enough speed for the MPU to generate a steady signal. This value, in percent of rated speed, is typically set just above the FAILED SPD INPUT value.

11: OVSPD SET (rpm) **dflt=3300.0 (100.0, 32000.0)**
Set this to the overspeed detection point for overspeed protection.

CONFIGURE: BINPUT & OUTPUT OPTIONS****

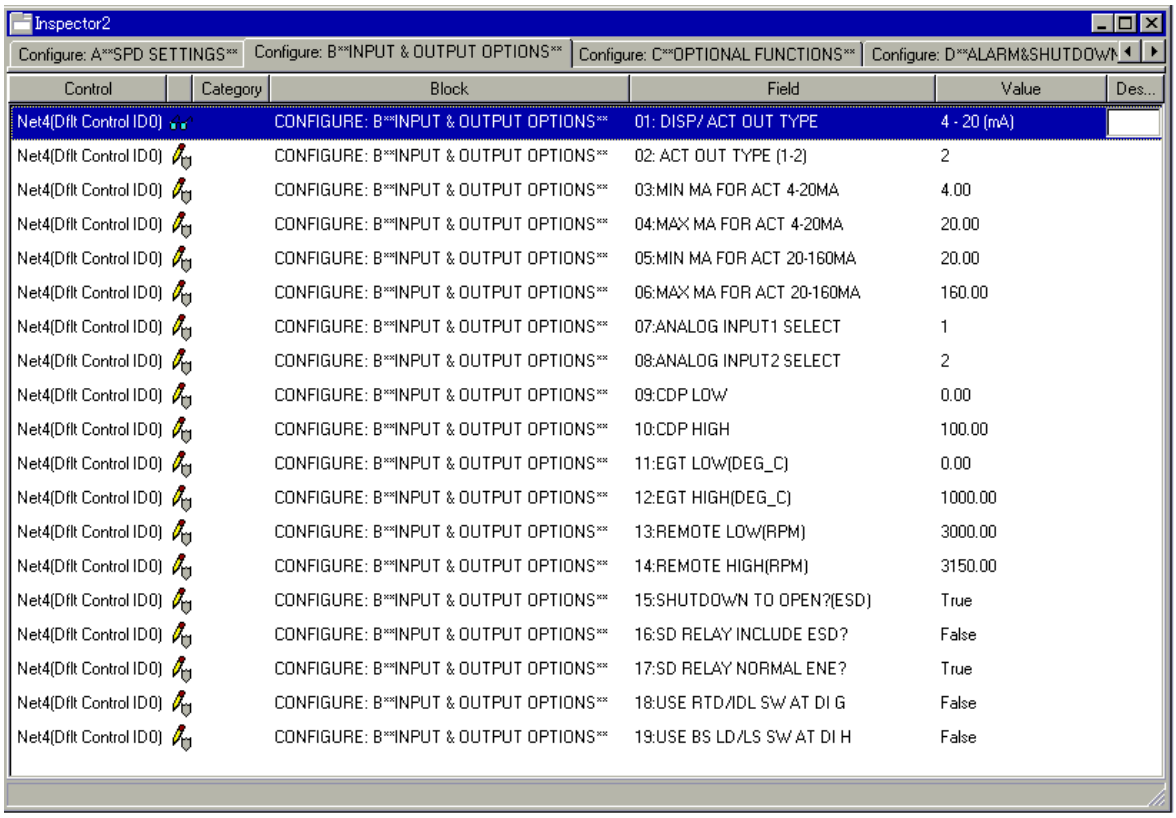


Figure 3-8. Configure: B**INPUT & OUTPUT OPTIONS** Menu

01: DISP/ ACT OUT TYPE
Displays configured actuator output type

02: ACT OUT TYPE (1-2) **dflt=2 (1, 2)**
This value is used to set the actuator output type.
1 = 20–160 (mA)
2 = 4–20 (mA)

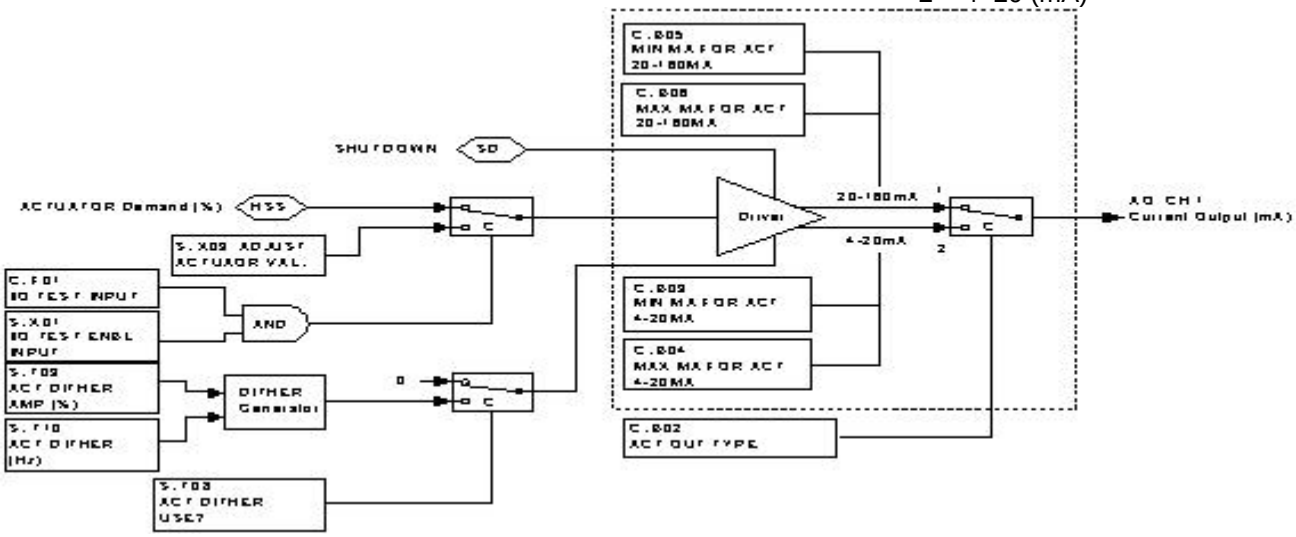


Figure 3-9. Actuator Control Logic

03: MIN mA FOR ACT 4-20 mA **dflt=4.0 (0.0, 20.0)**
Use this value to set the minimum current of Actuator Output when the control value is 0%.

04: MAX mA FOR ACT 4-20 mA **dflt=20.0 (4.0, 25.0)**
This value is used to set the maximum current of Actuator Output when the control value is 100%.

05: MIN mA FOR ACT 20-160 mA **dflt=20.0 (0.0, 160.0)**
This value is used to set the minimum current of Actuator Output when the control value is 0%.

06: MAX mA FOR ACT 20-160 mA **dflt=160.0 (20.0, 200.0)**
This value is used to set the maximum current of Actuator Output when the control value is 100%.

07: ANALOG INPUT1 SELECT **dflt=1 (1, 5)**
This value is used to set Analog Input #1's application functionality.
1: CDP INPUT
2: EGT INPUT
3: REMOTE SPEED/LOAD SETPOINT INPUT
4: SPM-A INPUT
5: NOT USED

08: ANALOG INPUT2 SELECT **dflt=2 (1, 5)**
This value is used to set Analog Input #2's application functionality.
1: CDP INPUT
2: EGT INPUT
3: REMOTE SPEED SETPOINT INPUT
4: SPM-A INPUT
5: NOT USED

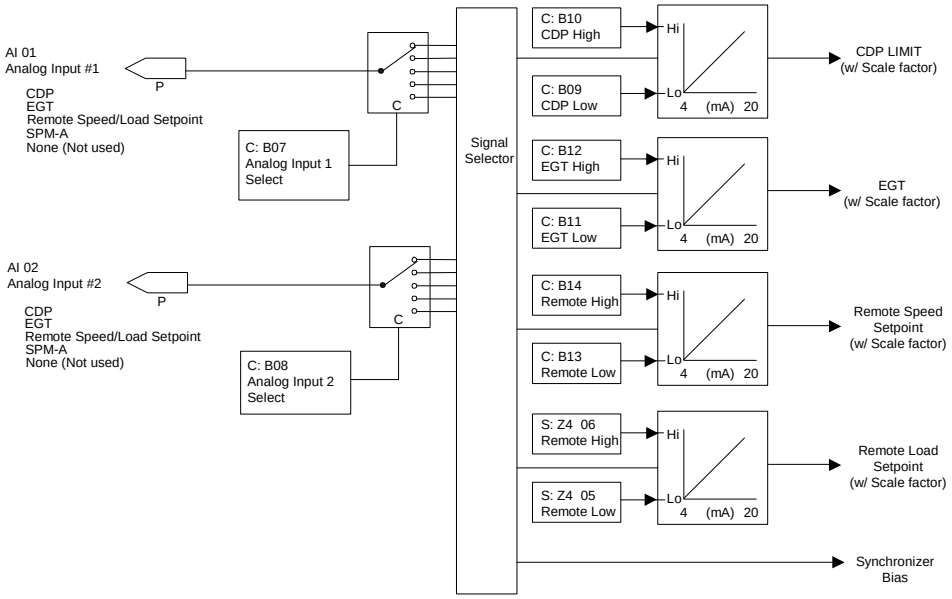


Figure 3-10. Selecting Analog Inputs

09: CDP LOW **dflt=0.0 (0.0, 10000.0)**

This value is used to set the minimum CDP input signal value that corresponds to 4mA.

10: CDP HIGH **dflt=100.0 (0.0, 10000.0)**

This value is used to set the maximum CDP input signal value that corresponds to 20 mA.

11: EGT LOW (DEG_C) **dflt=0.0 (0.0, 2000.0)**

This value is used to set the minimum EGT input signal value in Degrees C that corresponds to 4mA.

12: EGT HIGH (DEG_C) **dflt=1000.0 (0.0, 2000.0)**

This value is used to set the maximum EGT input signal value in Degrees C that corresponds to 20 mA.

13: REMOTE LOW (rpm) **dflt=3000.0 (0.0, 32000.0)**

This value is used to set the minimum remote speed setpoint input value that corresponds to 4mA.

14: REMOTE HIGH (rpm) **dflt=3150.0 (0.0, 32000.0)**

This value is used to set the maximum remote speed setpoint input value that corresponds to 20 mA.

15: SHUTDOWN TO OPEN? (ESD) **dflt=TRUE (FALSE, TRUE)**

This setting is used to configure the emergency shutdown contact input to open or close to initiate an emergency shutdown.

16: SD RELAY INCLUDE ESD? **dflt=FALSE (FALSE, TRUE)**

This setting is used to configure the emergency shutdown contact input to be included in the logic that affects the state of the control's Shutdown Relay output driver. This setting does not affect the emergency shutdown contact input's relationship with the fuel valve demand output driver.

17: SD RELAY NORMAL ENE? dflt=TRUE (FALSE, TRUE)

This setting is used to configure the Shutdown Relay driver to be energized or de-energized during normal operation. TRUE = Normally Energized, FALSE = Normally De-energized.

18: USE RTD/IDL SW AT DI G dflt=FALSE (FALSE, TRUE)

This setting is used to configure DI G to be ISO/DROOP input or RTD/IDLE input. TRUE = RTD/IDL, FALSE = ISO/DROOP. If TRUE, it automatically removes 52G switch from DI F and makes DI F ISO/DROOP switch.

19: USE BS LD/LS SW AT DI H dflt=FALSE (FALSE, TRUE)

This setting is used to configure DI H to be the MODBUS/SERVLINK input or the BS LD/LS input when in Isochronous load control. TRUE = BS LD/LS, FALSE = MODBUS/SERVLINK.

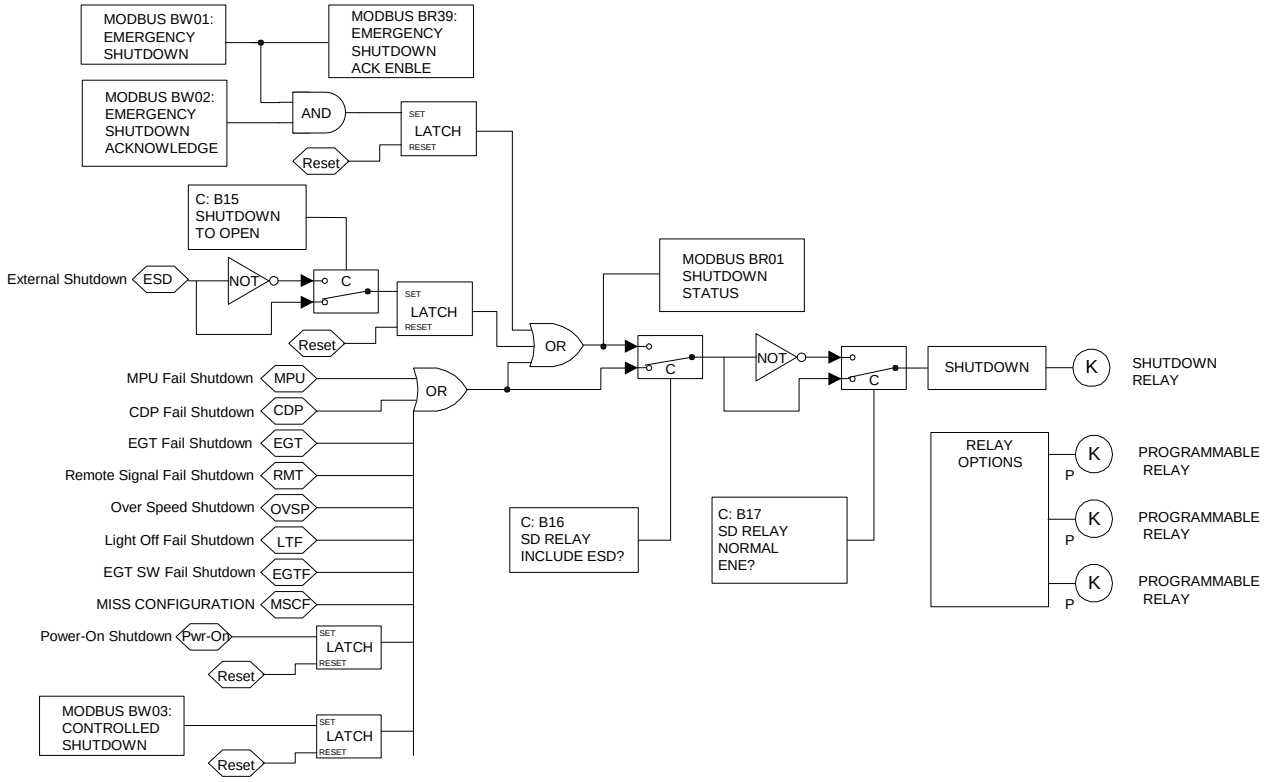


Figure 3-11. Shutdown Relay Configuration

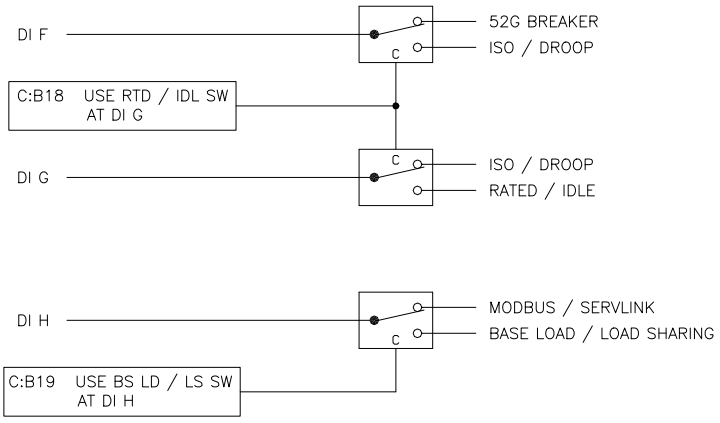


Figure 3-12. Discrete input Configuration

CONFIGURE: COPTIONAL FUNCTIONS****

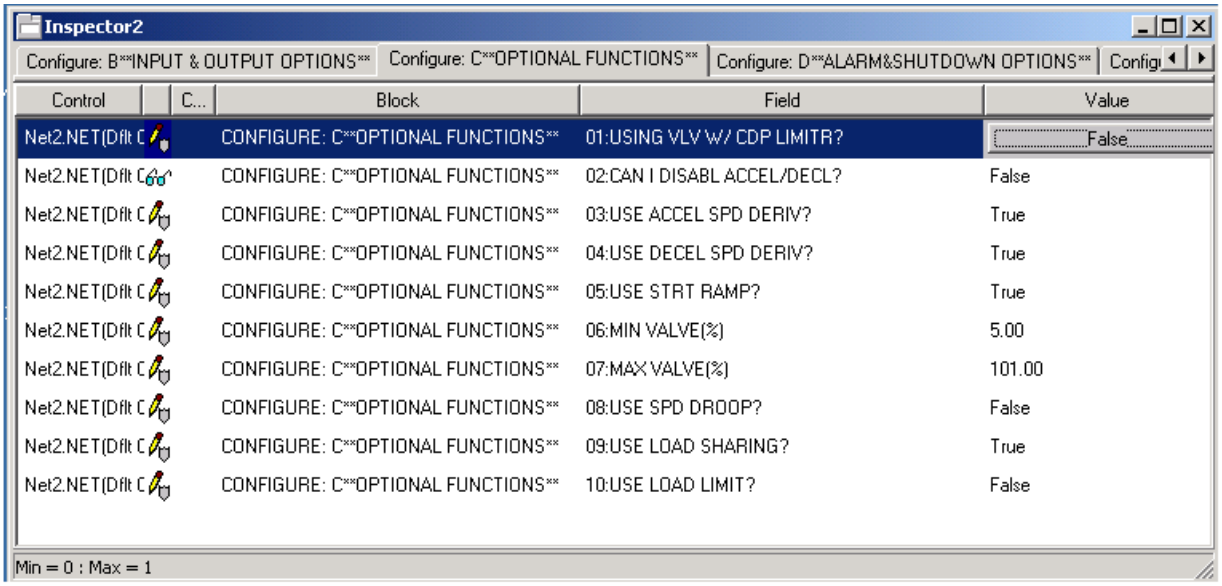


Figure 3-13. CONFIGURE: C** OPTIONAL FUNCTIONS** menu

01: USING VLV W/ CDP LIMITER? dflt=FALSE (FALSE, TRUE)
Confirms the type of fuel valve being used. If the CDP signal is not brought into the control, and this configurable is left FALSE, the user will not be allowed to disable the Accel and Decel Speed PIDs.

02: CAN I DISABLE ACCEL/DECEL?
A TRUE means that the user can turn off Accel and Decel PIDs.

03: USE ACCEL SPD DERIV? dflt=FALSE (FALSE, TRUE)
This setting is used to configure the use of the Accel Speed Derivative PID controller as shown in Figure 1-1.

04: USE DECEL SPD DERIV? dflt=FALSE (FALSE, TRUE)
Use this setting to configure the use of the Decel Speed Derivative PID controller as shown in Figure 1-1.

05: USE STRT RAMP? dflt=TRUE (FALSE, TRUE)
Use this setting to configure the control to use the Start Ramp Function or Start Fuel Ramp Function during the control's start routine.

Start Ramp Function.
With the Start Ramp Function configured, the Fuel Valve limiter begins ramping towards 101% when a Start Command is issued.

Start Fuel Ramp Function.
With the Start Fuel Ramp Function configured, the Fuel Valve limiter steps to the STRT Valve setting level when a Start Command is issued and holds at this level until Turbine Speed is greater than the Re-Open speed setting (set in Service: J **STRT FUEL RAMP**' '9:STRT FUEL SPD SW) or (and) unit Light-off is detected. The limiter then ramps towards 101%.

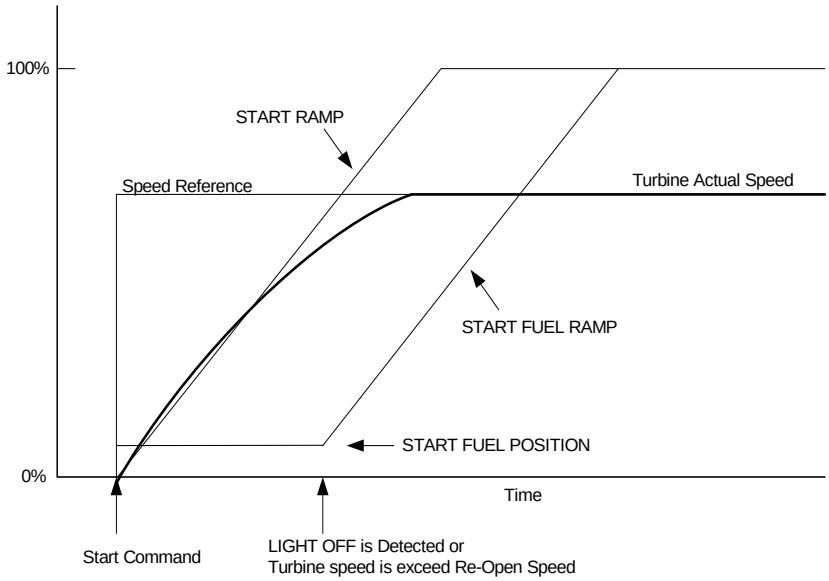


Figure 3-14. Unit Start Sequence Diagram

06: MIN VALVE (%) **dflt=5.0 (0.0, 60.0)**
This value sets the minimum position of the actuator output after inputting a Start Command.

07: MAX VALVE (%) **dflt=101.0 (0.0, 101.0)**
Sets the maximum position of the actuator output.

08: USE SPD DROOP? **dflt=FALSE (FALSE, TRUE)**
This parameter can be activated using the Speed Droop function as shown in Figure 3-49. If Speed Droop Function is used, the parameter should be set as TRUE. When the value is set as FALSE, KW Droop is activated as the default.

09: USE LOAD SHARING? **dflt=TRUE (FALSE, TRUE)**
This parameter can be activated using the LOAD SHARING function. If the LOAD SHARING function is used, the parameter should be set as TRUE.

10: USE LOAD LIMIT? **dflt=TRUE (FALSE, TRUE)**
This parameter can be activated using the LOAD LIMIT function. If the LOAD LIMIT function is used, the parameter should be set as TRUE.

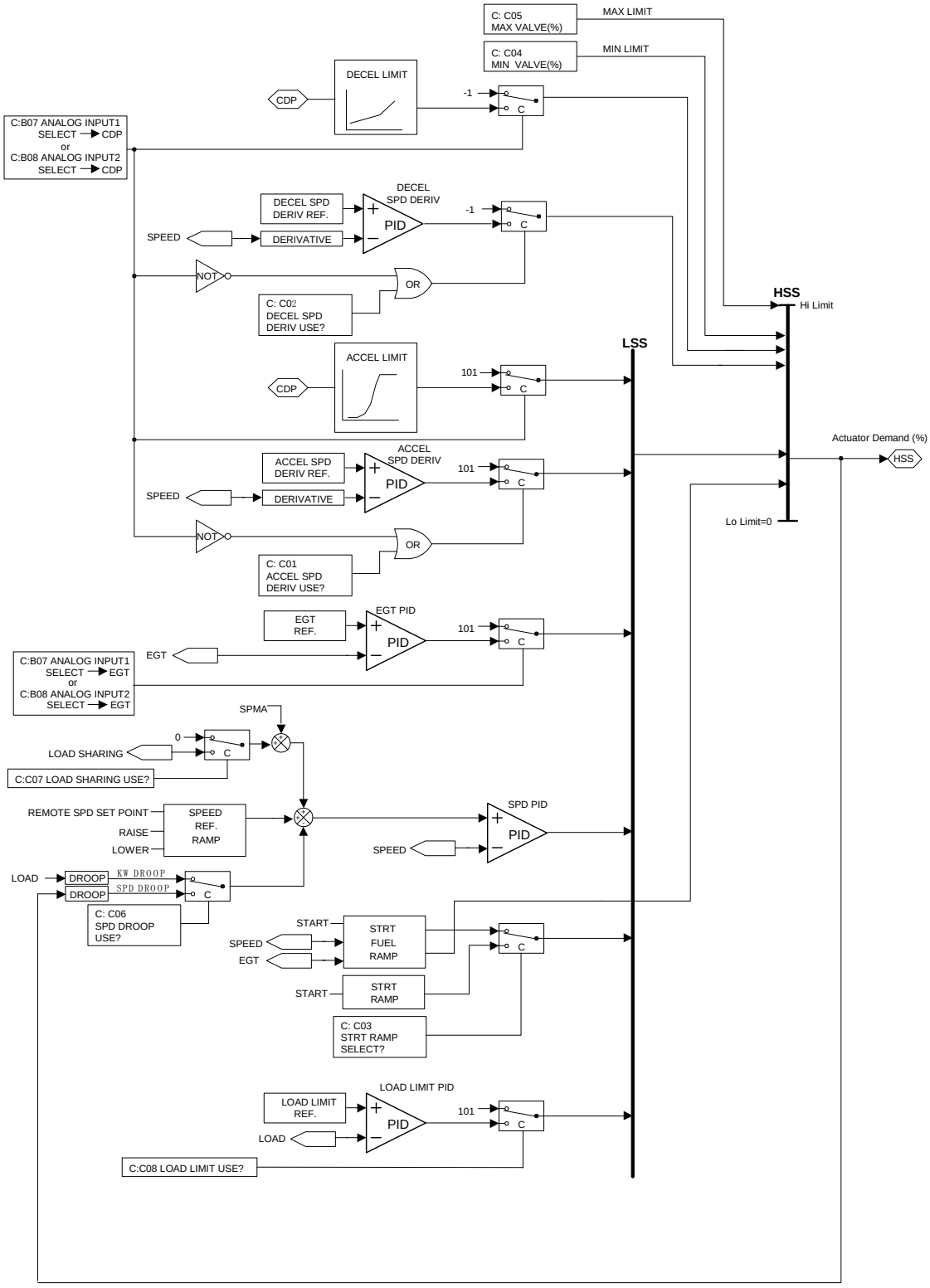


Figure 3-15. Control setting

CONFIGURE: DALARM&SHUTDOWN OPTIONS****

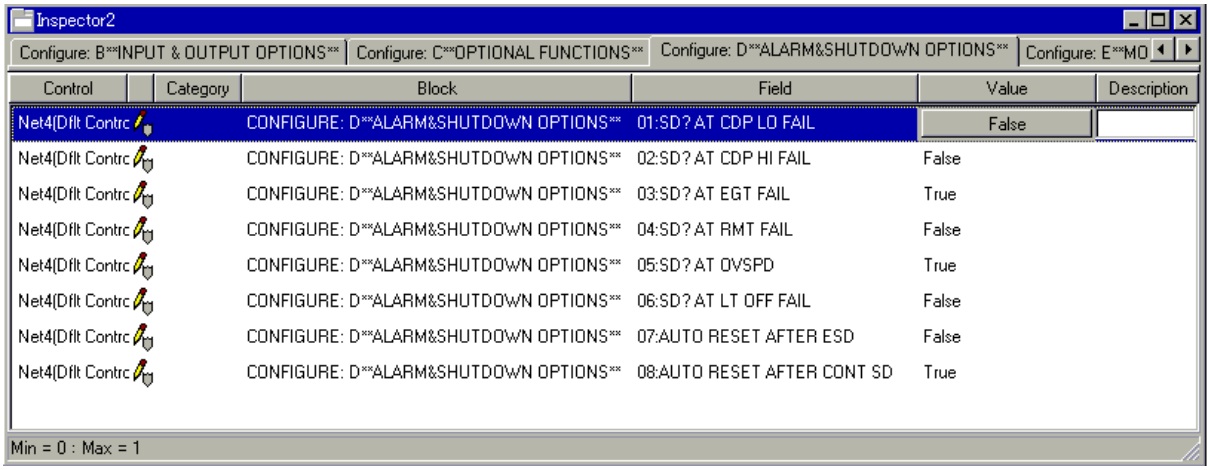


Figure 3-16. CONFIGURE: D**ALARM & SHUTDOWN OPTIONS** menu

01: SD? AT CDP LO FAIL **dflt=FALSE (FALSE, TRUE)**
This parameter can activate CDP LO signal fail shutdown functionality. If this setpoint was set to 'False', CDP LO fail is handled as an alarm. CDP LO FAIL means the CDP signal is below 3mA.

02: SD? AT CDP HI FAIL **dflt=FALSE (FALSE, TRUE)**
This parameter can activate CDP HI signal fail shutdown functionality. If this setpoint was set to 'False', CDP HI fail is handled as an alarm. CDP HI FAIL means the CDP signal is above 21mA. However, if CDP signal exceeds 21mA while limited by Accel limit. Then CDP fail is handled as a shutdown command even if this Boolean was set to 'FALSE'.

03: SD? AT EGT FAIL **dflt=TRUE (FALSE, TRUE)**
This parameter can activate the EGT fail shutdown function. When this setpoint is set to 'False', EGT fail is handled as an alarm. EGT FAIL means the EGT signal is below 3mA or above 21mA.

04: SD? AT RMT FAIL **dflt=FALSE (FALSE, TRUE)**
This parameter can activate Remote Speed Setpoint signal fail shutdown functionality. Setting this setpoint to 'False', will cause the Remote fail to be handled as an alarm. RMT FAIL means the Remote Speed setpoint signal is below 3mA or above 21mA.

05 SD? AT OVSPD **dflt=TRUE (FALSE, TRUE)**
This parameter activates the Overspeed Shutdown functionality. If this Boolean was set to 'False', Overspeed is handled as an alarm.

06: SD? AT LT OFF FAIL **dflt=FALSE (FALSE, TRUE)**
This parameter activates Misfire (No Flame) to shutdown functionality. If no flame is established, Fuel is shut off and Misfire trip occurs.

IMPORTANT **If you select this TRUE, EGT must be configured as an analog input on**

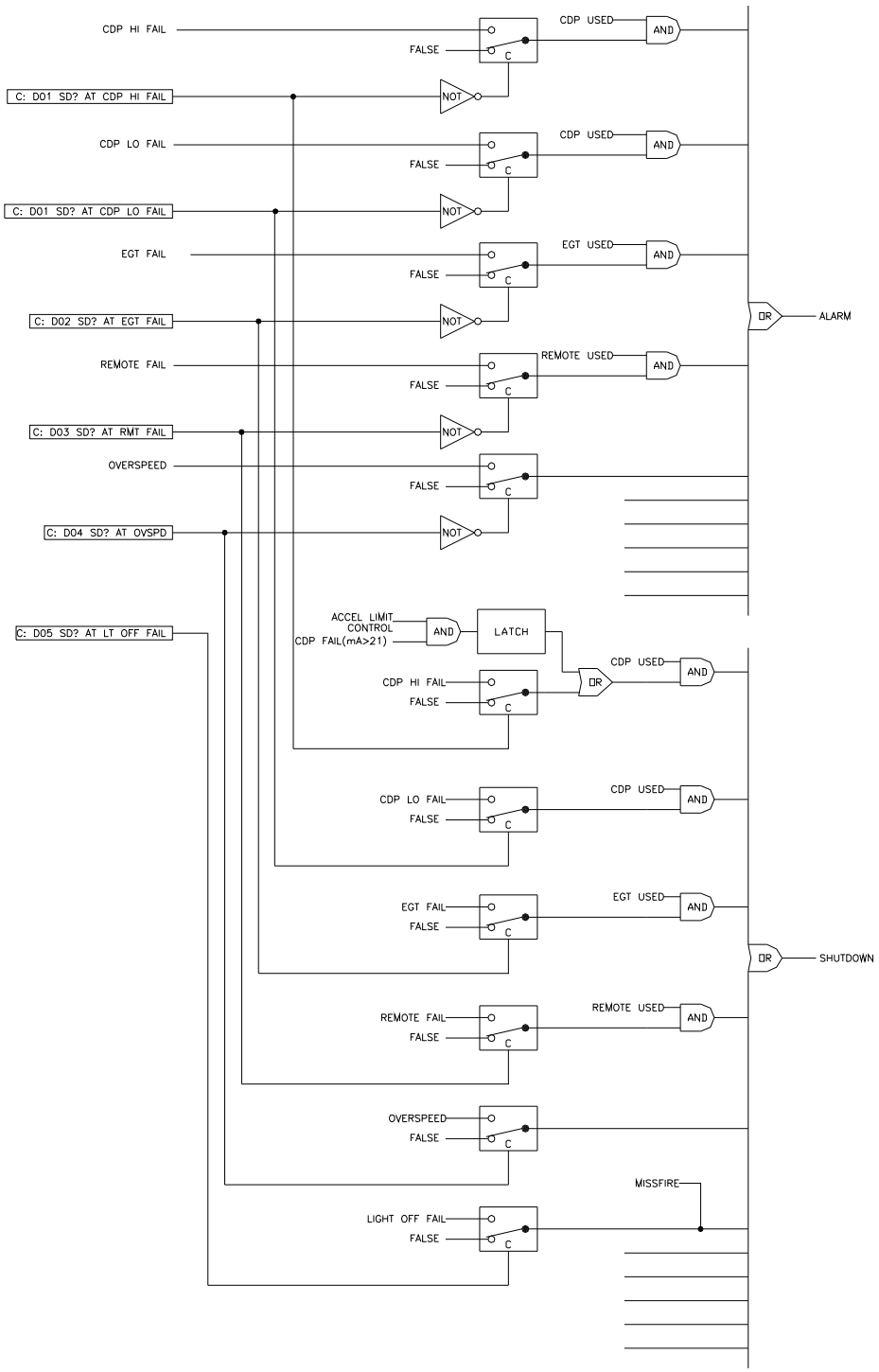


Figure 3-17. ALARM & SHUTDOWN SETTING

07: AUTO RESET AFTER ESD **dflt=FALSE (FALSE, TRUE)**
This parameter activates auto reset shutdown functionality. If shutdown by external shutdown input and actual speed is below override speed setpoint (set in Configure: A **SPD SETTING**' '10:OVERRIDE SPD INPUT), reset input is TRUE automatically and shutdown condition is clear.

08: AUTO RESET AFTER CONT SD **dflt=TRUE (FALSE, TRUE)**
This parameter activates auto reset to shutdown functionality. If shutdown by controlled shutdown input on Modbus is established and actual speed is below override speed setpoint (set in Service: P **SPD CONTROL SET**' '10: CONT SD SPD'), reset input is TRUE automatically and shutdown condition is clear.

CONFIGURE: EMODBUS&SRVLNK****

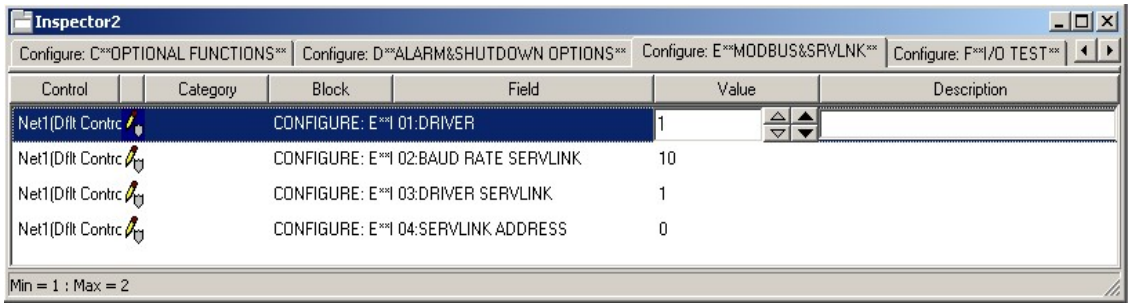


Figure 3-18. CONFIGURE: E**MODBUS&SRVLNK** menu

01: DRIVER **dflt=1 (1, 2)**
This setting is used to configure the communications port to use a RS-232 or RS-422 communications driver.
1: RS-232
2: RS-422

02: BAUD RATE SERVLINK **dflt=10(1,10)**
Adjust this value for the baud rate. NOTE: Changing the baud rate will cease current communications, and Servlink communication will have to be re-established.
1:110
2:300
3:600
4:1200
5:2400
6:300
7:4800
8:9600
9:19200
10:38400

03: DRIVER SERVLINK **dflt=1(1,2)**

This setting is used to configure the communications port to use a RS-232 or RS-422 (multi-drop) communications driver.
1: RS-232
2: RS-422

04: SERVLINK ADDRESS **dflt=0(1,15)**

The Servlink Address is used for Multi-drop communication. The value in this field gets appended to the end of the default control ID. If you are not multidropping, leave this input at ZERO.

IMPORTANT

Changing the Servlink communication settings will cease current communications once the control is reset, and Servlink communications must be closed and then re-established by user.

CONFIGURE: FI/O TEST****

01: I/O TEST INPUT **dflt=FALSE (FALSE, TRUE)**

This setting is used to enable the control's I/O test mode, which allows the control's discrete and analog outputs to be forced by a user to assist with unit testing and troubleshooting.

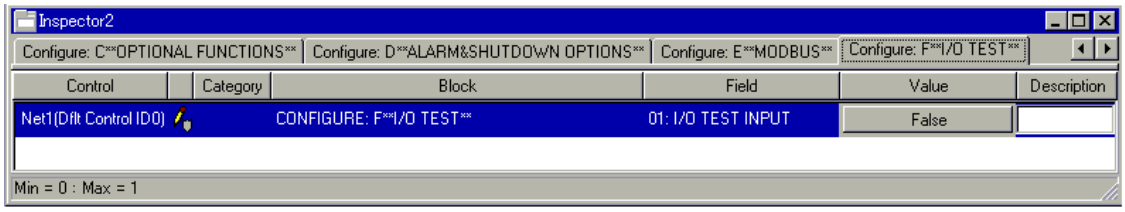


Figure 3-19. CONFIGURE: F**I/O TEST** menu

WARNING

The I/O TEST INPUT must be set FALSE during normal control operation or the control will not perform as designed, possibly resulting in damage to equipment, personal injury or death.

Save and Reset 2301D-GT Control

When the tuning or setting of parameters is complete, the values must be saved in the control's non-volatile memory. To do this, go to the tool bar and click the PROM icon for Save Values. The values will be saved in non-volatile memory and will be unaffected by loss of power to the control.

Once the configuration changes have been completed, click on the Watch Window program's Reset icon to allow the control to store the configured parameters, return the outputs to their active state and resume executing the application software.

Service Menu Descriptions

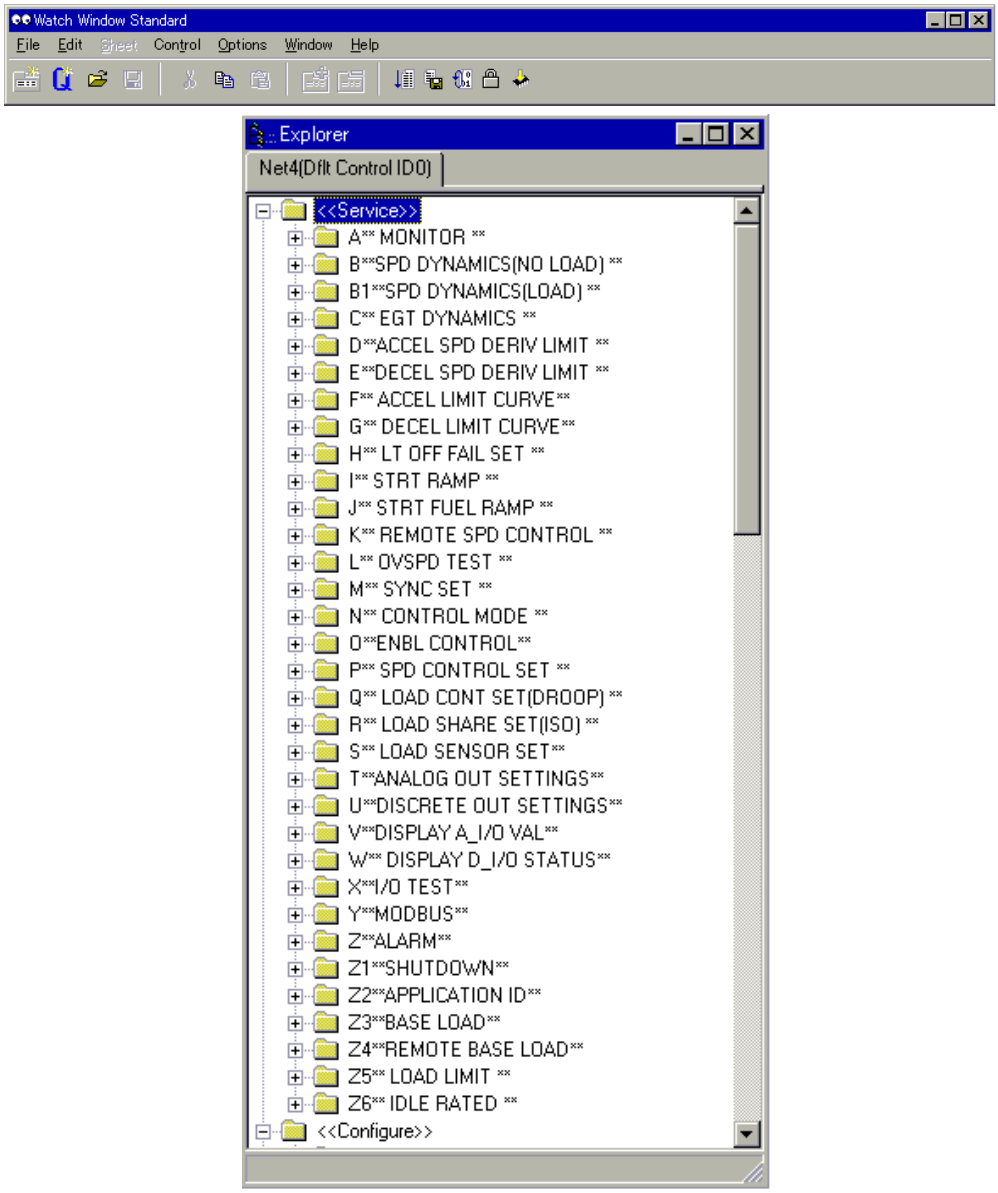


Figure 3-20. Watch Window Menu and Explore (Service)

A** MONITOR **

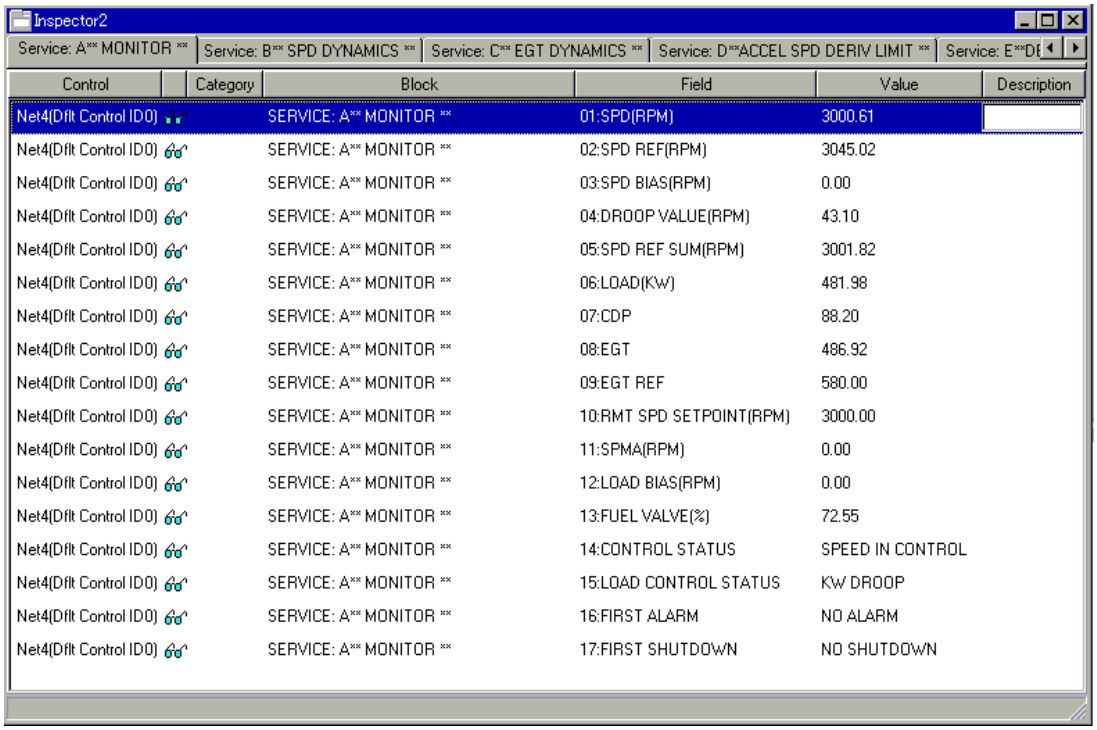


Figure 3-21. Service: A**MONITOR** Menu

This is a display group for general monitoring of the turbine/generator.

	Field	Displayed value indicates
01	**SPD (rpm)**	actual turbine rpm.
02	**SPD REF (rpm)**	turbine speed setpoint rpm.
03	**SPD BIAS (rpm)**	bias speed set point rpm.
04	**DROOP VALUE (rpm)**	droop rpm.
05	**SPD REF SUM (rpm)**	the total speed bias into the summing junction.
06	**LOAD (KW)**	generator load in kilowatts.
07	**CDP**	CDP.
08	**EGT**	EGT in deg_C.
09	**EGT REF**	EGT setpoint.
10	**RMT SPD SETPOINT (rpm)**	REMOTE SPEED SETPOINT in rpm.
11	**SPM-A (rpm)**	speed bias from the speed and phase match device input to the control.
12	**LOAD BIAS (rpm)**	LOAD BIAS on load sharing mode.
13	**FUEL VALVE (%)**	FUEL VALVE position control signal output.
14	**CONTROL STATUS**	CONTROL STATUS.
15	**LOAD CONTROL STATUS**	LOAD CONTROL STATUS.
16	**FIRST ALARM**	ALARM status.
17	**FIRST SHUTDOWN**	SHUTDOWN status.

BSPD DYNAMICS (NO LOAD) ****

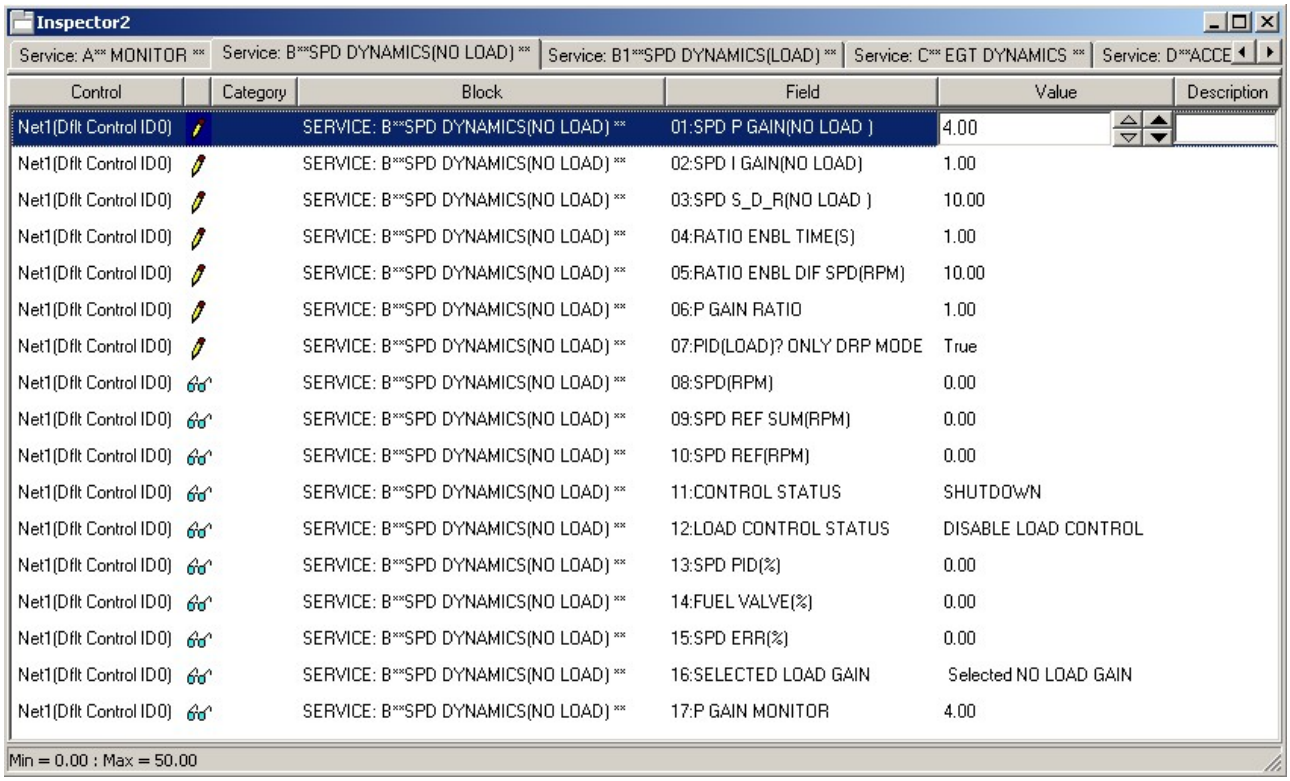


Figure 3-22. Service: B**SPD DYNAMICS (NO LOAD)** Menu

Dynamic adjustments are settings that affect the stability and transient performance of the gas turbine. There are two sets of dynamics provided. The 52G BREAKER and ISO/DROOP contact inputting select the Dynamics.

If ‘Configure: B **INPUT & OUTPUT OPTIONS**’ ‘18:USE RTD/IDL SW AT DI G’ is set TRUE, then load dynamics are configured as follows.
DI F close (ISO): select SPD DYNAMICS (LOAD)
DI F open (DROOP): select SPD DYNAMICS (NO LOAD)

If Select Modbus Speed PID Selector is set to ‘True’ at the Modbus console screen, Dynamics switching from Modbus console takes priority of the operation at the control.

When the one shot signal of Select Speed PID Dynamics Setting#1 is input, SPD P GAIN (No Load), SPD I GAIN (No Load) and SPD S_D_R (No Load) below are used in the control.

When the one shot signal of Select Speed PID Dynamics Setting#2 is input, SPD P GAIN (Load), SPD I GAIN (Load) and SPD S_D_R (Load) are used in the control. These are shown below.

01 SPD P GAIN (NO LOAD) dflt=4.0(0.0,50.0)
Determines how fast the control responds to an error in gas turbine speed from the speed-reference setting. The Gain provides stable control of the turbine at light or unloaded conditions.

02 SPD I GAIN (NO LOAD) dflt=1.0(0.0,50.0)
Compensates for the lag time of the gas turbine. It adjusts the time required for the control to return the speed to zero error after a disturbance. Adjustment of I GAIN prevents slow hunting and minimizes speed overshoot after a load disturbance.

03 SPD S_D_R (NO LOAD) dflt=10.0(0.01,100.0)
Compensates for the actuator and fuel system time constant. Increasing Compensation increases actuator activity and transient performance.

04 RATIO ENBL TIME(s) dflt=1.0(0.0,30.0)
Input time to be enable P GAIN RATIO after opened 52G BREAKER. If 'Configure: B **INPUT & OUTPUT OPTIONS**' '18:USE RTD/IDL SW AT DI G' is TRUE, this selecting is invalid.

05 RATIO ENBL DIF SPD (rpm) dflt=10.0(0.0,32000.0)
Input difference between actual speed and speed reference to be enable P GAIN RATIO after 52G BREAKER opened. If 'Configure: B **INPUT & OUTPUT OPTIONS**' '18:USE RTD/IDL SW AT DI G' is TRUE, this selecting is invalid.

06 P GAIN RATIO dflt=1.0(0.0,100.0)
Input ratio of p gain to be enable after opened 52G BREAKER. If 'Configure: B **INPUT & OUTPUT OPTIONS**' '18:USE RTD/IDL SW AT DI G' is TRUE, this selecting is invalid.

07 PID (LOAD)? ONLY DRP MODE dflt=TRUE (FALSE, TRUE)
This is set to true when LOAD Dynamics for droop only. If false, LOAD dynamics used when 52G BREAKER contact closed. If set true, load dynamics used when close the 52G BREAKER contact input and open the ISO/DROOP contact input. If 'Configure: B **INPUT & OUTPUT OPTIONS**' '18:USE RTD/IDL SW AT DI G' is TRUE, this selecting is invalid.

08 SPD (rpm) reflects actual turbine rpm.

09 SPD REF SUM (rpm) shows the total speed bias into the summing junction.

10 SPD REF (rpm) displays turbine speed setpoint rpm.

11 CONTROL STATUS reflects the CONTROL STATUS.

12 LOAD CONTROL STATUS—LOAD CONTROL STATUS.

13 SPD PID (%) shows the speed PID

14 FUEL VALVE (%) displays FUEL VALVE position as the control signal.

15 SPD ERR (%) displays the percent of the value taking SPD from SPD REF SUM against the rated speed.

16 **SELECTED LOAD GAIN** displays the selected gain whether NO LOAD GAIN or LOAD GAIN.

17 **P GAIN MONITOR** displays p gain used speed PID.

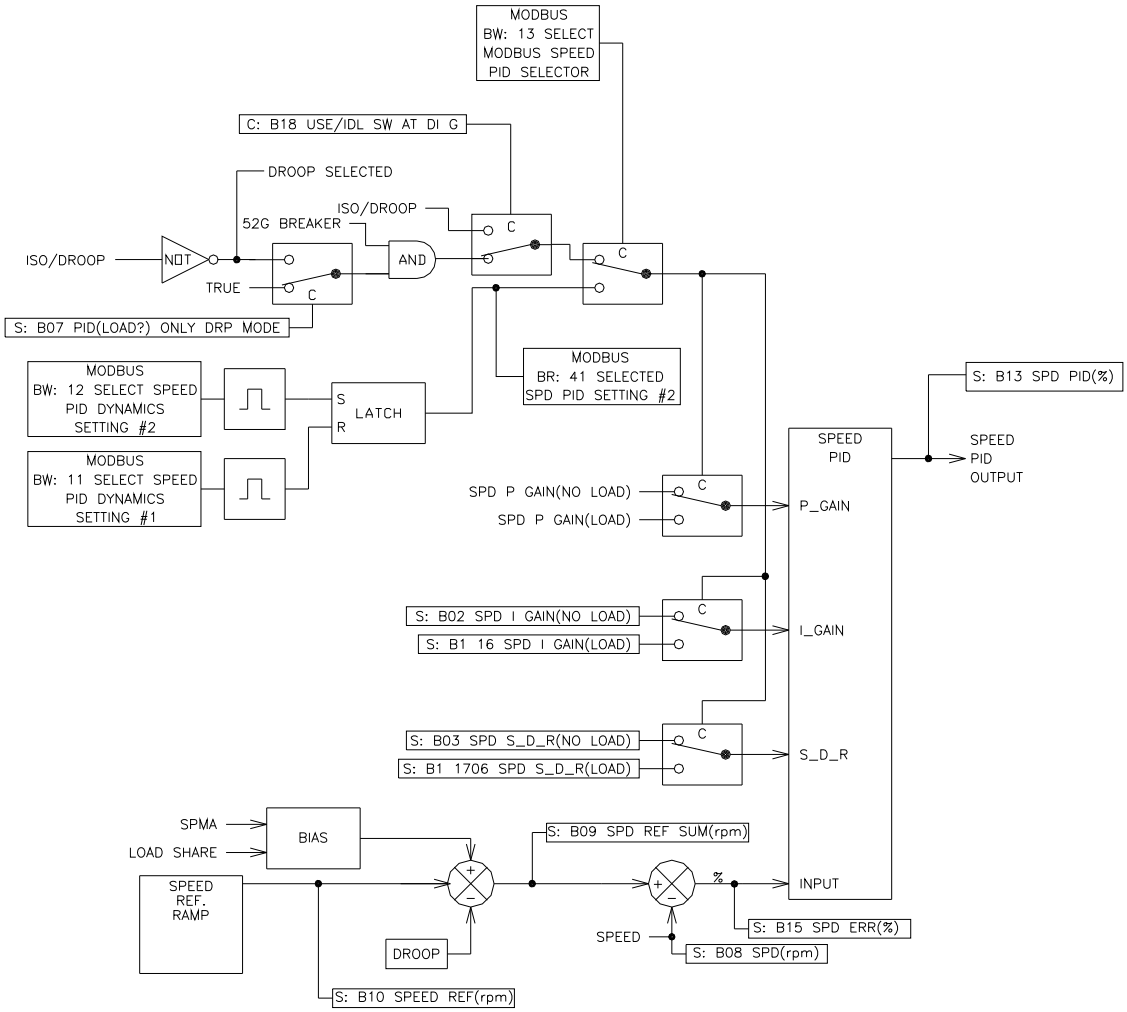


Figure 3-23a. SPEED PID SETTING1

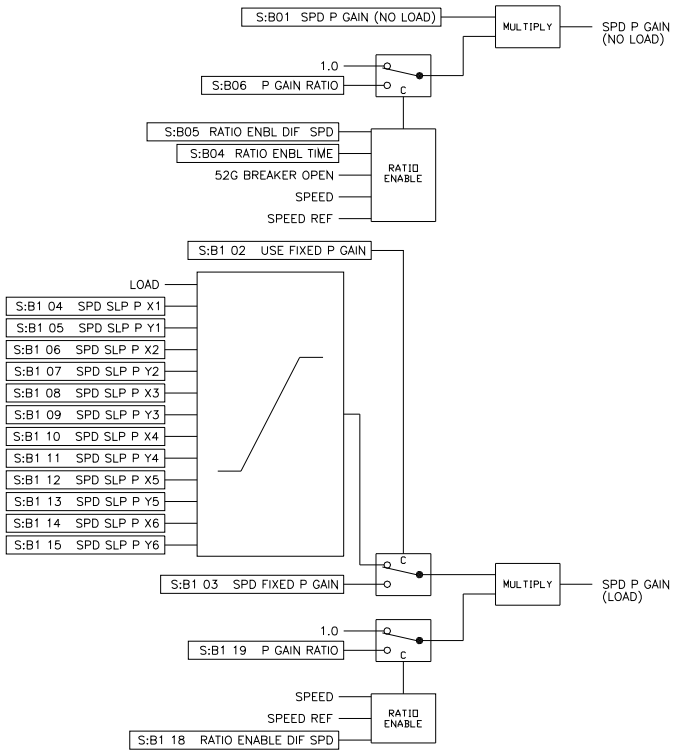


Figure 3-23b. SPEED PID SETTING2

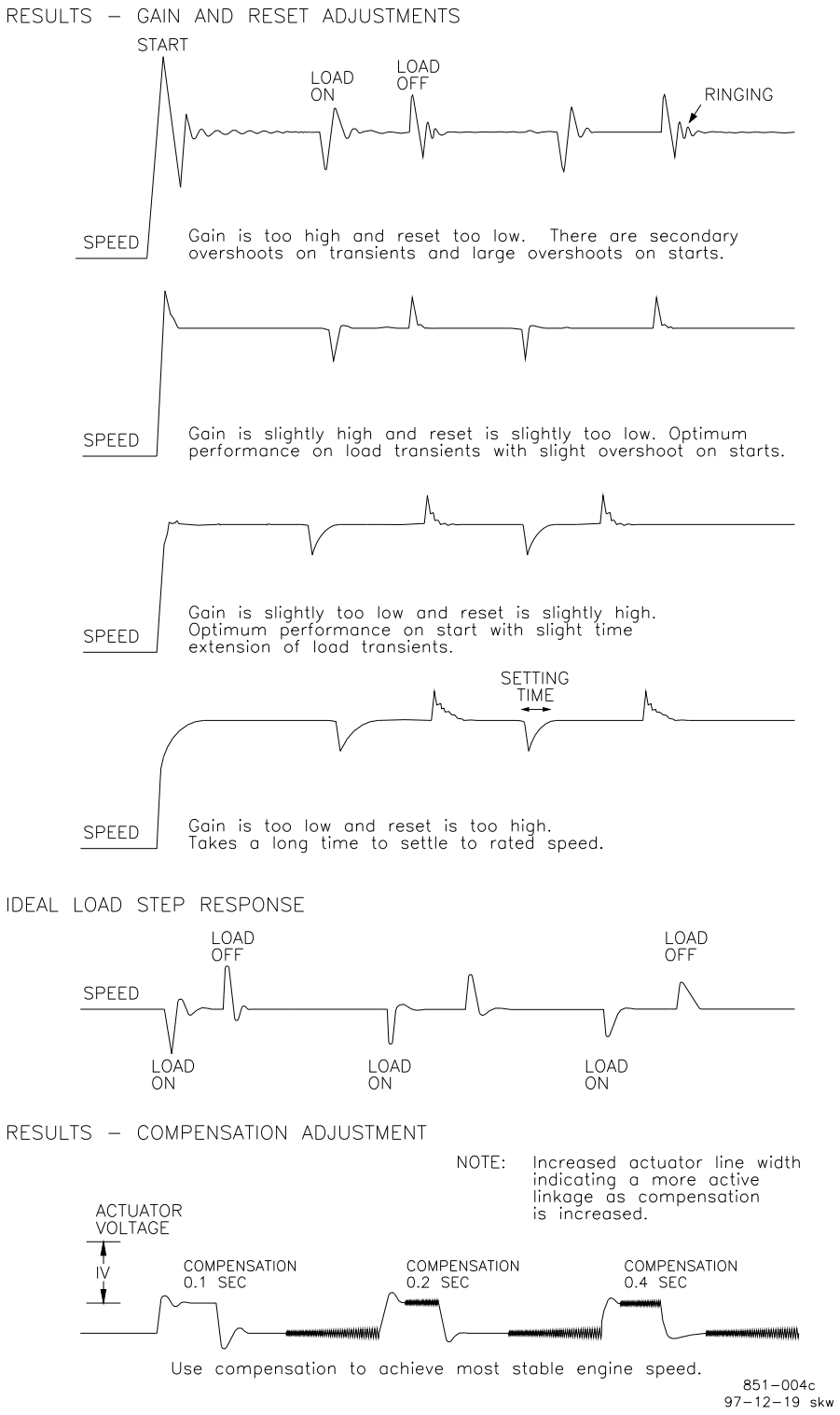


Figure 3-24. Typical Transient Response Curves

IMPORTANT **Be prepared to change the dynamics settings since the actuator bump transient may stimulate instability.**

B1SPD DYNAMICS (LOAD) ****

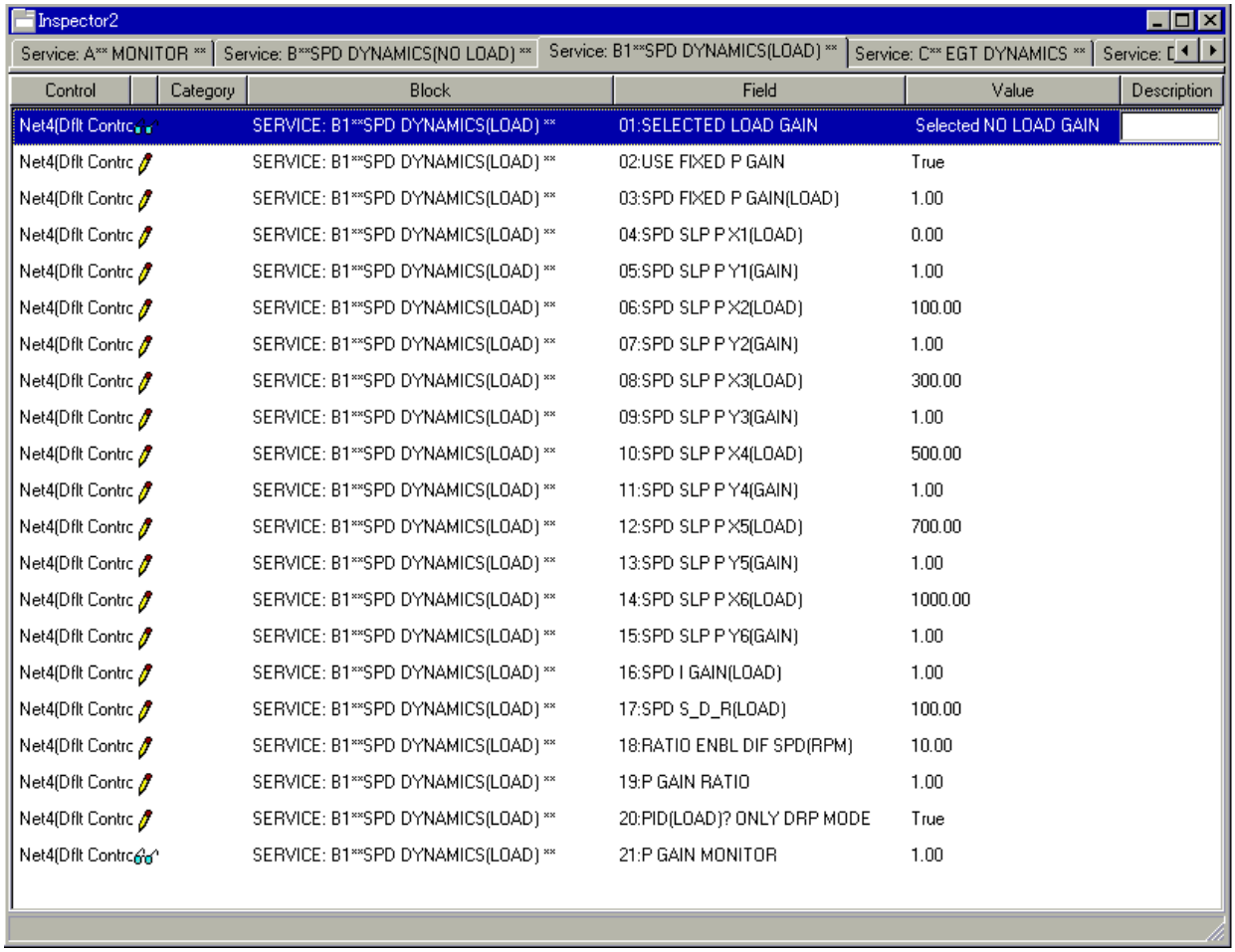


Figure 3-25. Service: B1**SPD DYNAMICS (LOAD)** Menu

Dynamic adjustments are settings that affect the stability and transient performance of the gas turbine. There are two sets of dynamics provided. The 52G BREAKER and ISO/DROOP contact inputting select the Dynamics.

If ‘Configure: B **INPUT & OUTPUT OPTIONS**’ ‘18:USE RTD/IDL SW AT DI G’ is TRUE, this selecting is follows.
DI F close (ISO): select SPD DYNAMICS (LOAD)
DI F open (DROOP): select SPD DYNAMICS (NO LOAD)

If Select Modbus Speed PID Selector is set to ‘True’ at the Modbus console screen, Dynamics switching from Modbus console takes priority of the operation at the control.

When the one shot signal of Select Speed PID Dynamics Setting#1(in Modbus commands) is input, SPD P GAIN (No Load), SPD I GAIN (No Load) and SPD S_D_R (No Load) below are used in the control.

When the one shot signal of Select Speed PID Dynamics Setting#2 (in Modbus commands) is input, SPD P GAIN (Load), SPD I GAIN (Load) and SPD S_D_R (Load) are used in the control. These are shown below.

01 SELECTED LOAD GAIN displays the selected gain whether NO LOAD GAIN or LOAD GAIN.

02 USE FIXED P GAIN dflt=TRUE (FALSE, TRUE)
Select whether use the fixed p gain or not. If sloped p gain is used, the parameter should be set as FALSE.

03 SPD FIXED P GAIN (LOAD) dflt=1.0(0.0,50.0)
Determines how fast the control responds to an error in gas turbine speed from the speed-reference setting. The Gain provides stable control of the loaded conditions.

04 SPD SLP P X1 (LOAD) dflt=0.0(0.0,32000.0)
Enter the value of LOAD on an SLOPED P GAIN curve. Creates curve with X1 on x-axis and Y1 output on y-axis, etc.

05 SPD SLP P Y1 (GAIN) dflt=1.0(0.0,50.0)
Enter the value of P GAIN on an SLOPED P GAIN curve.

06 SPD SLP P X2 (LOAD) dflt=100.0(0.0,32000.0)
Enter the value of LOAD on an SLOPED P GAIN curve.

07 SPD SLP P Y2 (GAIN) dflt=1.0(0.0,50.0)
Enter the value of P GAIN on an SLOPED P GAIN curve.

08 SPD SLP P X3 (LOAD) dflt=300.0(0.0,32000.0)
Enter the value of LOAD on an SLOPED P GAIN curve.

09 SPD SLP P Y3 (GAIN) dflt=1.0(0.0,50.0)
Enter the value of P GAIN on an SLOPED P GAIN curve.

10 SPD SLP P X4 (LOAD) dflt=500.0(0.0,32000.0)
Enter the value of LOAD on an SLOPED P GAIN curve.

11 SPD SLP P Y4 (GAIN) dflt=1.0(0.0,50.0)
Enter the value of P GAIN on an SLOPED P GAIN curve.

12 SPD SLP P X5 (LOAD) dflt=700.0(0.0,32000.0)
Enter the value of LOAD on an SLOPED P GAIN curve.

13 SPD SLP P Y5 (GAIN) dflt=1.0(0.0,50.0)
Enter the value of P GAIN on an SLOPED P GAIN curve.

14 SPD SLP P X6 (LOAD) dflt=1000.0(0.0,32000.0)
Enter the value of LOAD on an SLOPED P GAIN curve.

15 SPD SLP P Y6 (GAIN) dflt=1.0(0.0,50.0)
Enter the value of P GAIN on an SLOPED P GAIN curve.

16 SPD I GAIN (LOAD) dflt=1.0(0.0,50.0)
Compensates for the lag time of the gas turbine. It adjusts the time required for the control to return the speed to zero error after a disturbance. I GAIN is adjusted to prevent slow hunting and to minimize speed overshoot after a load disturbance.

17 SPD S_D_R (LOAD) dflt=100.0(0.01,100.0)
Compensates for the actuator and fuel system time constant. Increasing Compensation increases actuator activity and transient performance.

18 RATIO ENBL DIF SPD (rpm) dflt=10.0(0.0,32000.0)
Input difference between actual speed and speed reference to be enable P GAIN RATIO while selected LOAD GAIN.

19 P GAIN RATIO dflt=1.0(0.0,100.0)
Input ratio of p gain to be enable after opened 52G BREAKER.

20 PID (LOAD)? ONLY DRP MODE dflt=TRUE (FALSE, TRUE)
This is set to true when selected as PID for load. If selected, close the 52G BREAKER contact input and open the ISO/DROOP contact input. If 'Configure: B **INPUT & OUTPUT OPTIONS**' '18:USE RTD/IDL SW AT DI G' is TRUE, this selecting is invalid.

This value is the same as 'Service: B** SPD DYNAMICS (NO LOAD)**' '07:PID (LOAD) ONLY DRP MODE'.

21 P GAIN MONITOR displays p gain used speed PID.

CEGT DYNAMICS ****

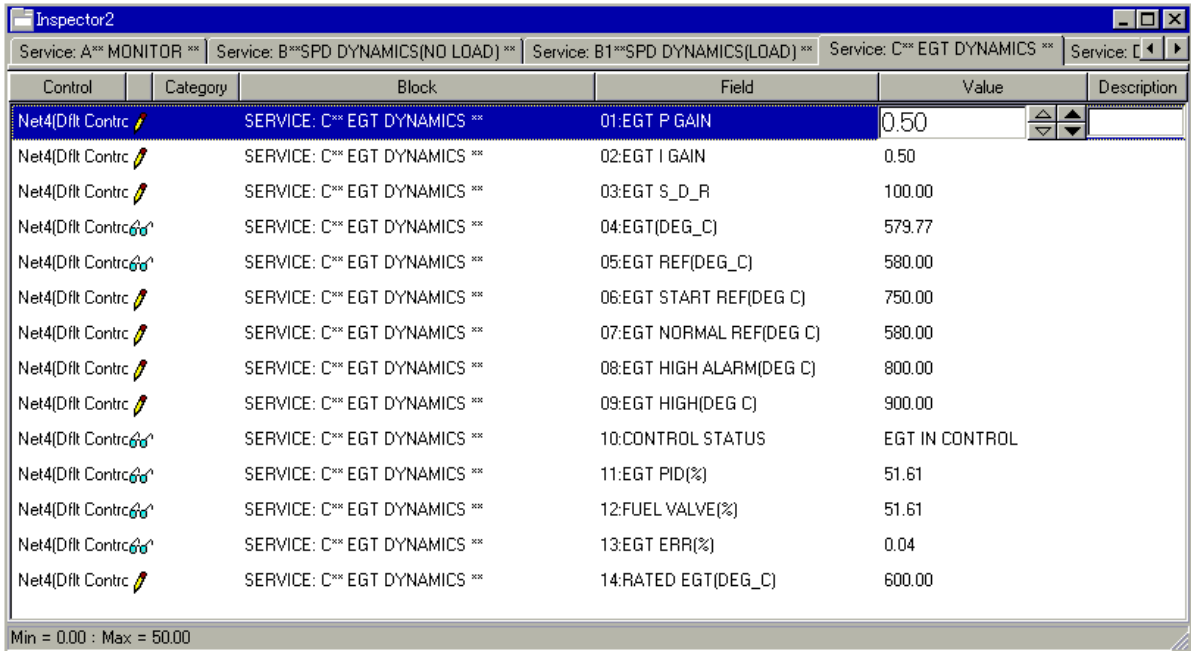


Figure 3-26. Service: C**EGT DYNAMICS** Menu

Dynamic adjustments are settings that affect the stability and transient performance of the gas turbine when actual EGT reaches EGT setpoint. Must use EGT analog input.

01 EGT P GAIN dflt=0.5(0.0,50.0)
Determines how fast the control responds to an error in actual EGT from the EGT REF setting.

02 EGT I GAIN dflt=0.5(0.0,50.0)
Compensates for the lag time of the gas turbine. It adjusts the time required for the control to return the speed to zero error after a disturbance. I GAIN is adjusted to prevent slow hunting.

03 EGT S_D_R dflt=100.0(0.01,100.0)
Compensates for the actuator and fuel system time constant. Increasing compensation increases actuator activity and transient performance.

04 EGT (DEG_C) is the actual EGT in deg_C.

05 EGT REF (DEG_C) displays the EGT setpoint.

06 EGT START REF (DEG_C) dflt=750.0(0.0,2000.0)
This is the temperature setpoint (in Degree C.) at starting.

07 EGT NORMAL REF (DEG_C) dflt=580.0(0.0,2000.0)
This is the temperature setpoint (in Degree C.) after coming to start speed. In Configure: A **SPD SETTING**' '04:STRT (IDLE)).

08 EGT HIGH ALARM (DEG_C) dflt=800.0(0.0,2000.0)
This is the alarm temperature (in Degree C.).

09 EGT HIGH (DEG_C) dflt=900.0(0.0,2000.0)
This is the shutdown temperature (in Degree C.).

10 CONTROL STATUS reflects the CONTROL STATUS.

11 EGT PID (%) indicates the EGT PID.

12 FUEL VALVE (%) displays the FUEL VALVE position as the control signal.

13 EGT ERR (%) displays the percent of an error in actual EGT from the EGT REF against the 600 deg_C.

14 RATED EGT (deg_C) dflt=600.0(0.0,2000.0)
This is the rated EGT (in Degree C.) for scaling of EGT PID.

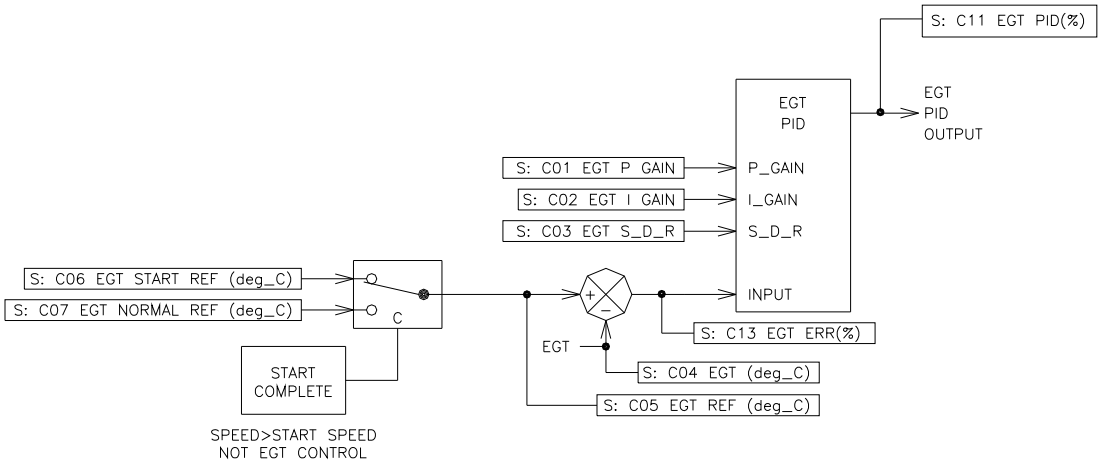
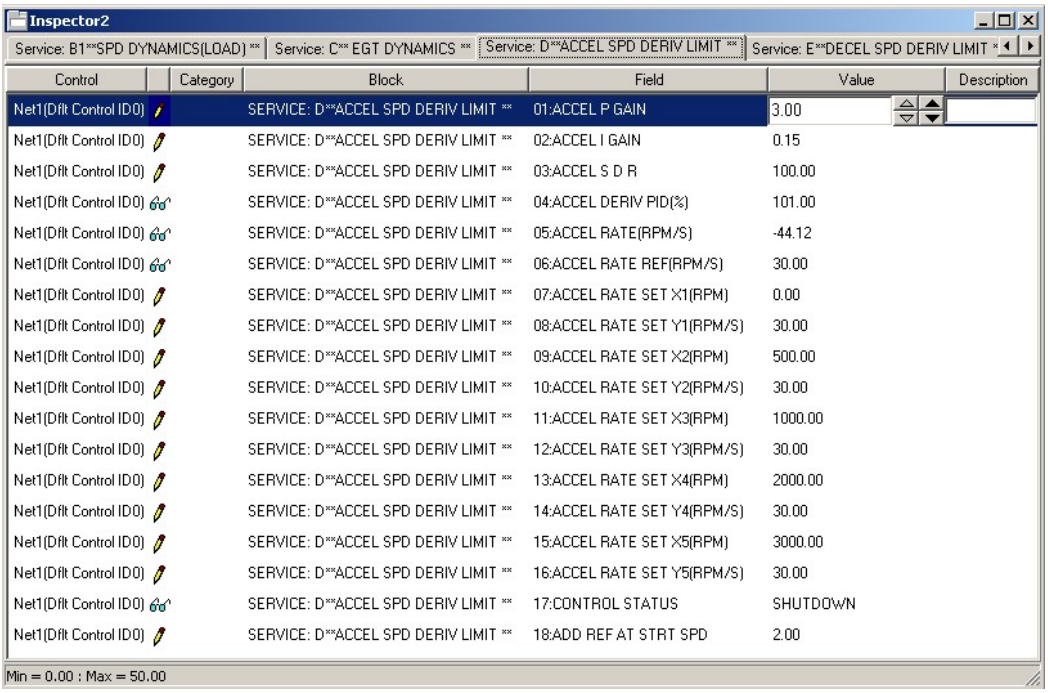


Figure 3-27. EGT PID SETTING

D**ACCEL SPD DERIV LIMIT **



Control	Category	Block	Field	Value	Description
Net1(Dflt Control ID0)		SERVICE: D**ACCEL SPD DERIV LIMIT **	01:ACCEL P GAIN	3.00	
Net1(Dflt Control ID0)		SERVICE: D**ACCEL SPD DERIV LIMIT **	02:ACCEL I GAIN	0.15	
Net1(Dflt Control ID0)		SERVICE: D**ACCEL SPD DERIV LIMIT **	03:ACCEL S D R	100.00	
Net1(Dflt Control ID0)		SERVICE: D**ACCEL SPD DERIV LIMIT **	04:ACCEL DERIV PID(%)	101.00	
Net1(Dflt Control ID0)		SERVICE: D**ACCEL SPD DERIV LIMIT **	05:ACCEL RATE(RPM/S)	-44.12	
Net1(Dflt Control ID0)		SERVICE: D**ACCEL SPD DERIV LIMIT **	06:ACCEL RATE REF(RPM/S)	30.00	
Net1(Dflt Control ID0)		SERVICE: D**ACCEL SPD DERIV LIMIT **	07:ACCEL RATE SET X1(RPM)	0.00	
Net1(Dflt Control ID0)		SERVICE: D**ACCEL SPD DERIV LIMIT **	08:ACCEL RATE SET Y1(RPM/S)	30.00	
Net1(Dflt Control ID0)		SERVICE: D**ACCEL SPD DERIV LIMIT **	09:ACCEL RATE SET X2(RPM)	500.00	
Net1(Dflt Control ID0)		SERVICE: D**ACCEL SPD DERIV LIMIT **	10:ACCEL RATE SET Y2(RPM/S)	30.00	
Net1(Dflt Control ID0)		SERVICE: D**ACCEL SPD DERIV LIMIT **	11:ACCEL RATE SET X3(RPM)	1000.00	
Net1(Dflt Control ID0)		SERVICE: D**ACCEL SPD DERIV LIMIT **	12:ACCEL RATE SET Y3(RPM/S)	30.00	
Net1(Dflt Control ID0)		SERVICE: D**ACCEL SPD DERIV LIMIT **	13:ACCEL RATE SET X4(RPM)	2000.00	
Net1(Dflt Control ID0)		SERVICE: D**ACCEL SPD DERIV LIMIT **	14:ACCEL RATE SET Y4(RPM/S)	30.00	
Net1(Dflt Control ID0)		SERVICE: D**ACCEL SPD DERIV LIMIT **	15:ACCEL RATE SET X5(RPM)	3000.00	
Net1(Dflt Control ID0)		SERVICE: D**ACCEL SPD DERIV LIMIT **	16:ACCEL RATE SET Y5(RPM/S)	30.00	
Net1(Dflt Control ID0)		SERVICE: D**ACCEL SPD DERIV LIMIT **	17:CONTROL STATUS	SHUTDOWN	
Net1(Dflt Control ID0)		SERVICE: D**ACCEL SPD DERIV LIMIT **	18:ADD REF AT STRT SPD	2.00	

Figure 3-28. Service: D**ACCEL SPD DERIV LIMIT** Menu

IMPORTANT **Dynamic adjustments are settings that affect the stability and transient performance of the gas turbine.**

01 ACCEL P GAIN dflt=3.0(0.0,50.0)
Determines control responsiveness to an error in ACCEL RATE from ACCEL RATE REF setting.

02 ACCEL I GAIN dflt=0.15(0.0,50.0)
Compensates for the lag time of the gas turbine. It adjusts the time required for the control to return the acceleration rate to zero error after a disturbance. I GAIN is adjusted to prevent slow hunting.

03 ACCEL S_D_R dflt=100.0(0.01,100.0)
Compensates for the actuator and fuel system time constant. Increasing compensation increases actuator activity and transient performance.

04 **ACCEL DERIV PID (%)** shows the acceleration speed derivative PID.

05 **ACCEL RATE (rpm/s)** displays actual acceleration rate.

06 ACCEL RATE REF (rpm/s) reflects the actual acceleration rate reference.

IMPORTANT **The Accel Schedule, Figure 3-29, is used when the Accel PID is configured for use, and determines the Max turbine acceleration rate limit based on the turbine speed level.**

07 ACCEL RATE SET X1 (rpm) dflt=0.0(0.0,32000.0)
Input point #1 of the ACCEL RATE CURVE in rpm.

08 ACCEL RATE SET Y1 (rpm/s) dflt=30.0(1.0,10000.0)
Output point #1 of the ACCEL RATE CURVE in rpm per second.

09 ACCEL RATE SET X2 (rpm) dflt=500.0(0.0,32000.0)
Input point #2 of the ACCEL RATE CURVE in rpm.

10 ACCEL RATE SET Y2 (rpm/s) dflt=30.0(1.0,10000.0)
Output point #2 of the ACCEL RATE CURVE in rpm per second.

11 ACCEL RATE SET X3 (rpm) dflt=1000.0(0.0,32000.0)
Input point #3 of the ACCEL RATE CURVE in rpm.

12 ACCEL RATE SET Y3 (rpm/s) dflt=30.0(1.0,10000.0)
Output point #3 of the ACCEL RATE CURVE in rpm per second.

13 ACCEL RATE SET X4 (rpm) dflt=2000.0(0.0,32000.0)
Input point #4 of the ACCEL RATE CURVE in rpm.

14 ACCEL RATE SET Y4 (rpm/s) dflt=30.0(1.0,10000.0)
Output point #4 of the ACCEL RATE CURVE in rpm per second.

15 ACCEL RATE SET X5 (rpm) dflt=3000.0(0.0,32000.0)
Input point #5 of the ACCEL RATE CURVE in rpm.

16 ACCEL RATE SET Y5 (rpm/s) dflt=30.0(1.0,10000.0)
Output point #5 of the ACCEL RATE CURVE in rpm per second.

17 CONTROL STATUS displays the status of the control.

18 ADD REF AT STRT SPD dflt=2.0(0.0,10.0)
Input times of added acceleration setpoint after actual speed is start speed.

IMPORTANT

When turbine speed exceeds the Start speed setting and the speed PID is in control, the acceleration rate limit is stepped to any times the rate determined by the schedule shown above. This prevents the Accel Spd limiter from interfering with the speed PID when it is in control.

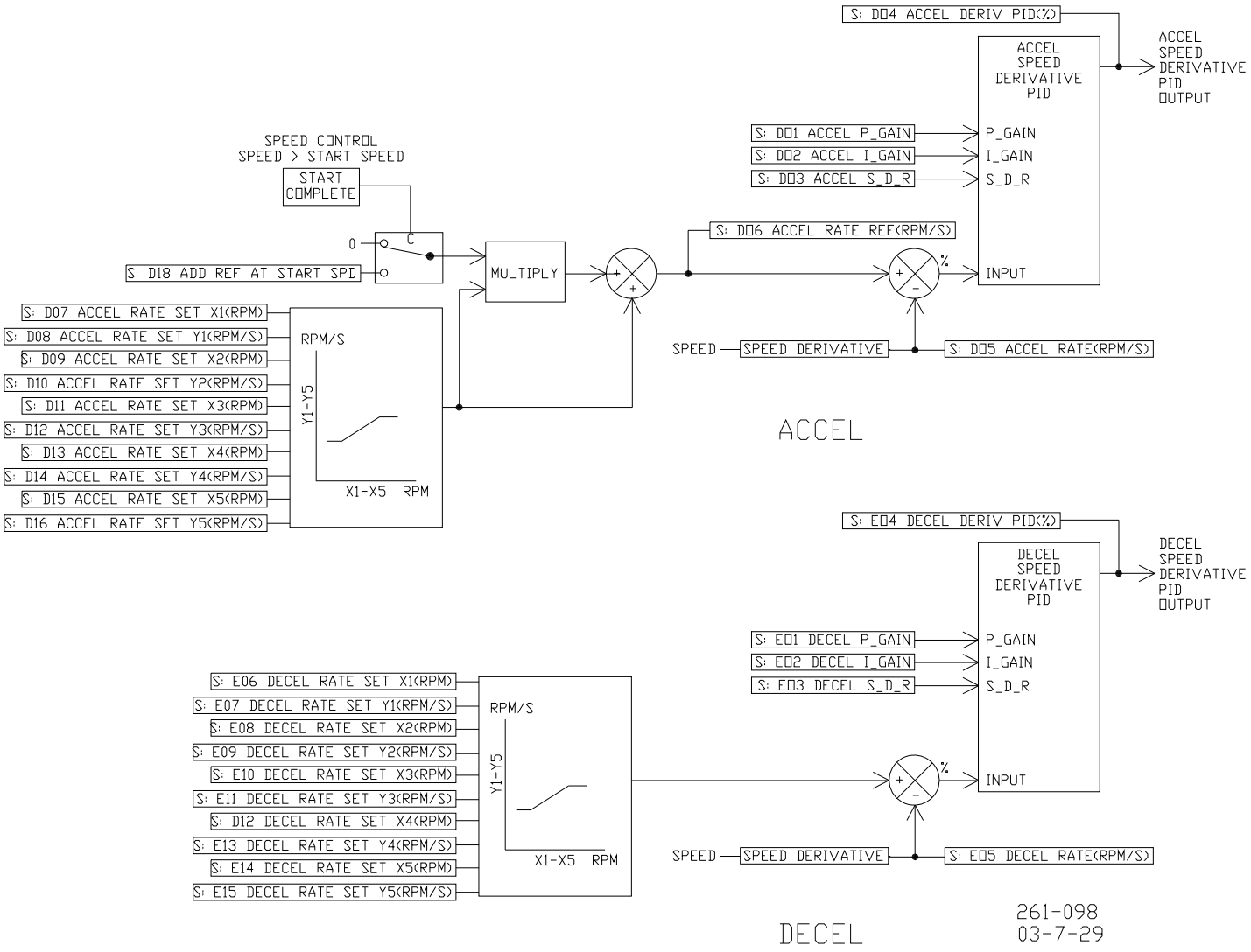


Figure 3-29 ACCEL & DECEL PID SETTING

EDECEL SPD DERIV LIMIT ****

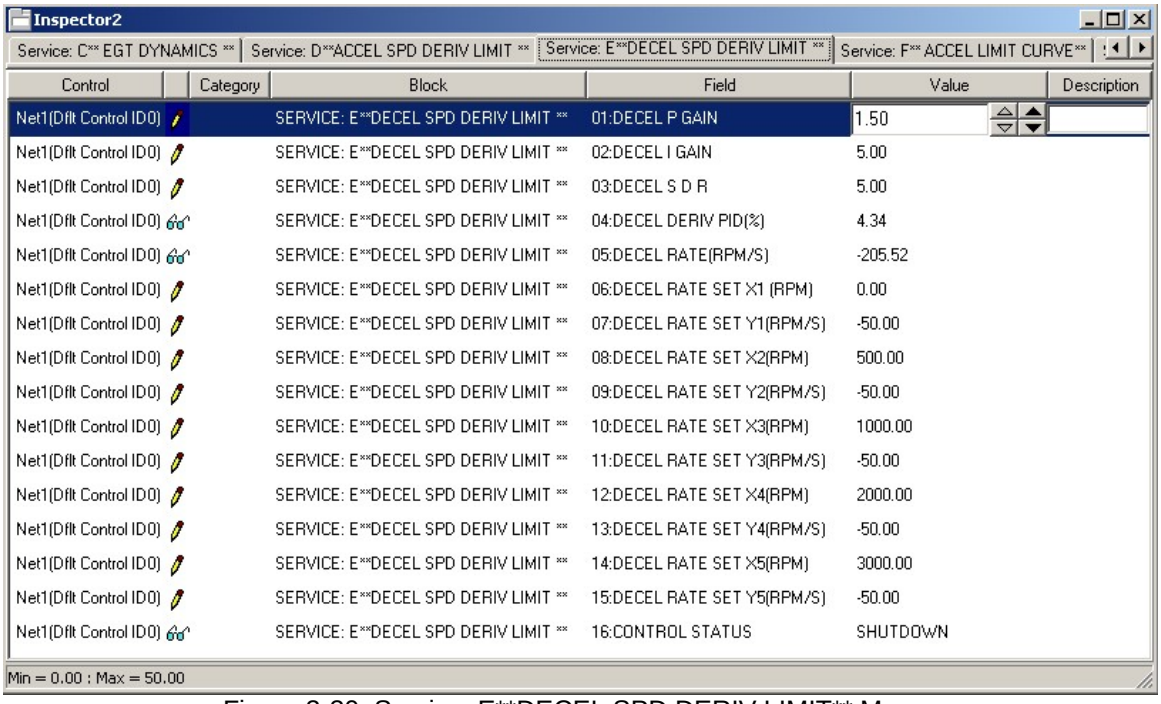


Figure 3-30. Service: E**DECEL SPD DERIV LIMIT** Menu

Dynamic adjustments are settings that affect the stability and transient performance of the gas turbine.

01 DECEL P GAIN dflt=1.5(0.0,50.0)
Determines how fast the control responds to an error in actual DECEL RATE from the DECEL RATE SET.

02 DECEL I GAIN dflt=5.0(0.0,50.0)
Compensates for the lag time of the gas turbine. It adjusts the time required for the control to return the deceleration rate to zero error after a disturbance. I GAIN is adjusted to prevent slow hunting.

03 DECEL S_D_R dflt=5.0(0.01,100.0)
Compensates for the actuator and fuel system time constant. Increasing compensation increases actuator activity and transient performance.

04 DECEL DERIV PID (%) shows the deceleration speed derivative PID.

05 DECEL RATE (rpm/s) displays the speed derivative.

IMPORTANT

The Decel Schedule, Figure 3-29, is used when the Decel PID is configured for use, and determines the Max turbine deceleration rate limit based on the turbine speed level.

06 DECEL RATE SET X1 (rpm) dflt=0.0(0.0,32000.0)
Input point #1 of the DECEL RATE CURVE in rpm.

07 DECEL RATE SET Y1 (rpm/s) dflt=–50.0(–10000.0,0.0)
Output point #1 of the DECEL RATE CURVE in rpm per second.

08 DECEL RATE SET X2 (rpm) dflt=500.0(0.0,32000.0)
Input point #2 of the DECEL RATE CURVE in rpm.

09 DECEL RATE SET Y2 (rpm/s) dflt=–50.0(–10000.0,0.0)
Output point #2 of the DECEL RATE CURVE in rpm per second.

10 DECEL RATE SET X3 (rpm) dflt=1000.0(0.0,32000.0)
Input point #3 of the DECEL RATE CURVE in rpm.

11 DECEL RATE SET Y3 (rpm/s) dflt=–50.0(–10000.0,0.0)
Output point #3 of the DECEL RATE CURVE in rpm per second.

12 DECEL RATE SET X4 (rpm) dflt=2000.0(0.0,32000.0)
Input point #4 of the DECEL RATE CURVE in rpm.

13 DECEL RATE SET Y4 (rpm/s) dflt=–50.0(–10000.0,0.0)
Output point #4 of the DECEL RATE CURVE in rpm per second.

14 DECEL RATE SET X5 (rpm) dflt=3000.0(0.0,32000.0)
Input point #5 of the DECEL RATE CURVE in rpm.

15 DECEL RATE SET Y5 (rpm/s) dflt=–50.0(–10000.0,0.0)
Output point #5 of the DECEL RATE CURVE in rpm per second.

16 CONTROL STATUS shows actual status of the control.

FACCEL LIMIT CURVE ****

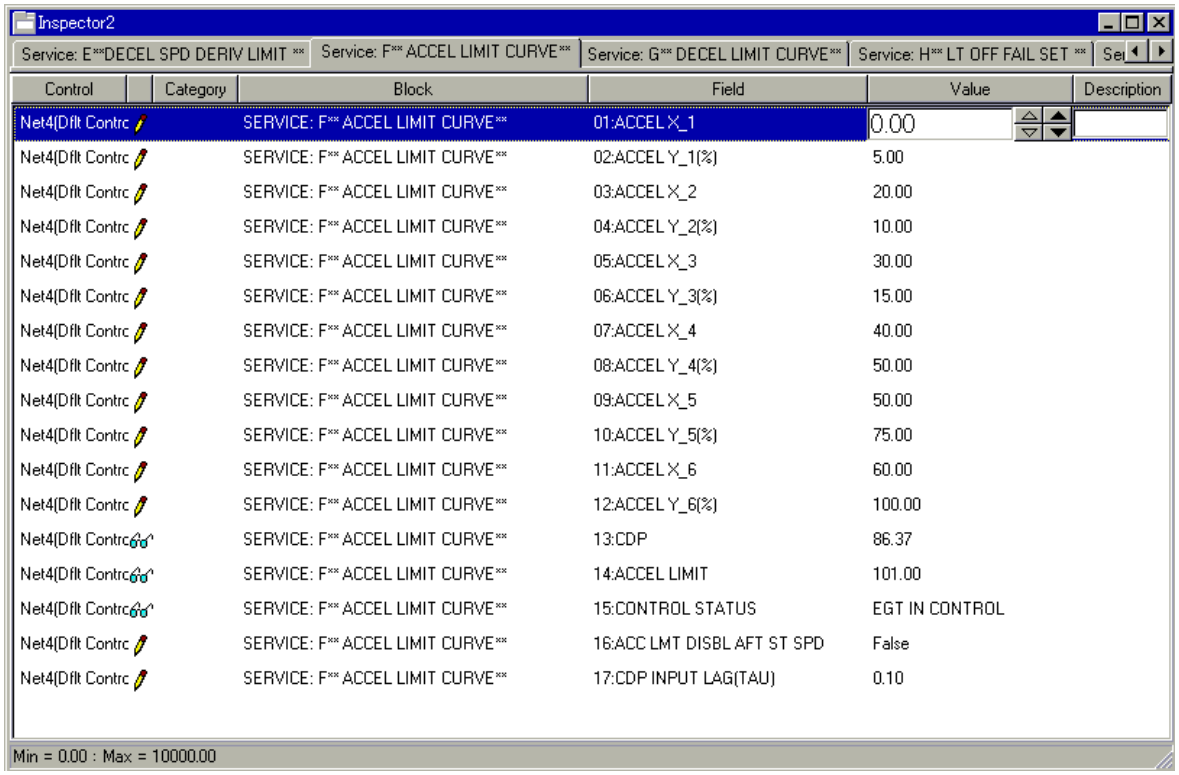


Figure 3-31. Service: F**ACCEL LIMIT CURVE** Menu

An acceleration limit curve is made using this menu. In accordance with the input of CDP (X_*), an acceleration curve output (Y_*) is set up using this block.

01 ACCEL X_1 dflt=0.0(0.0,10000.0)
Enter the value of CDP on an accel curve.

02 ACCEL Y_1(%) dflt=5.0(0.0,101.0)
Enter the value for limit on an accel curve.

03 ACCEL X_2 dflt=20.0(0.0,10000.0)
Enter the value of CDP on an accel curve.

04 ACCEL Y_2(%) dflt=10.0(0.0,101.0)
Input the value for limit on an accel curve.

05 ACCEL X_3 dflt=30.0(0.0,10000.0)
Enter the value of CDP on an accel curve.

06 ACCEL Y_3(%) dflt=15.0(0.0,101.0)
Enter the value for limit on an accel curve.

07 ACCEL X_4 dflt=40.0(0.0,10000.0)
Enter the value of CDP on an accel curve.

08 ACCEL Y_4(%) dflt=50.0(0.0,101.0)
Enter the value for limit on an accel curve.

09 ACCEL X_5 dflt=50.0(0.0,10000.0)
Enter the value of CDP on an accel curve.

10 ACCEL Y_5(%) dflt=75.0(0.0,101.0)
Enter the value for limit on an accel curve.

11 ACCEL X_6 dflt=60.0(0.0,10000.0)
Enter the value of CDP on an accel curve.

12 ACCEL Y_6(%) dflt=100.0(0.0,101.0)
Enter the value for limit on an accel curve.

13 CDP

14 ACCEL LIMIT displays the output of acceleration limit curve.

15 CONTROL STATUS show the actual status of the control.

16 ACC LMT DSBL AFT ST SPD dflt=FALSE (FALSE, TRUE)
This parameter inactivates ACCEL LIMIT to prevent interfering with other control by CDP signal fail. If CDP signal fail occurred after actual speed is up to start speed, shutdown function by CDP signal fail is invalid.

17 CDP INPUT LAG (TAU) dflt=0.1(0.0,10.0)
Enter the value for CDP input lag.

G**DECEL LIMIT CURVE **

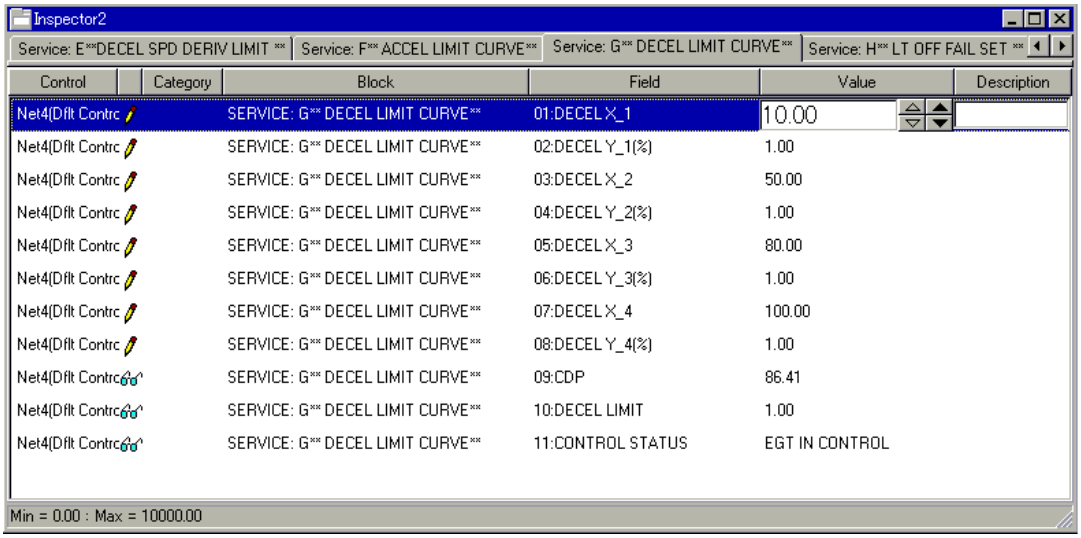


Figure 3-32. Service: G**DECEL LIMIT CURVE** Menu

A deceleration limit curve is made using this menu. In accordance with the input of CDP (X_*), a deceleration curve output (Y_*) is set up by this block.

01 DECEL X_1 dflt=10.0(0.0,10000.0)
Enter the value of CDP on a decel curve.

02 DECEL Y_1(%) dflt=1.0(0.0,101.0)
Enter the value for limit on a decel curve.

03 DECEL X_2 dflt=50.0(0.0,10000.0)
Enter the value of CDP on a decel curve.

04 DECEL Y_2(%) dflt=1.0(0.0,101.0)
Enter the value for limit on a decel curve.

05 DECEL X_3 dflt=80.0(0.0,10000.0)
Enter the value of CDP on a decel curve.

06 DECEL Y_3(%) dflt=1.0(0.0,101.0)
Enter the value for limit on a decel curve.

07 DECEL X_4 dflt=100.0(0.0,10000.0)
Enter the value of CDP on a decel curve.

08 DECEL Y_4(%) dflt=1.0(0.0,101.0)
Enter the value for limit on a decel curve.

09 **CDP** indicates compressor discharge pressure

10 **DECEL LIMIT** shows the output of deceleration limit curve

11 **CONTROL STATUS** indicates the status of the control

H**LT OFF FAIL SET **

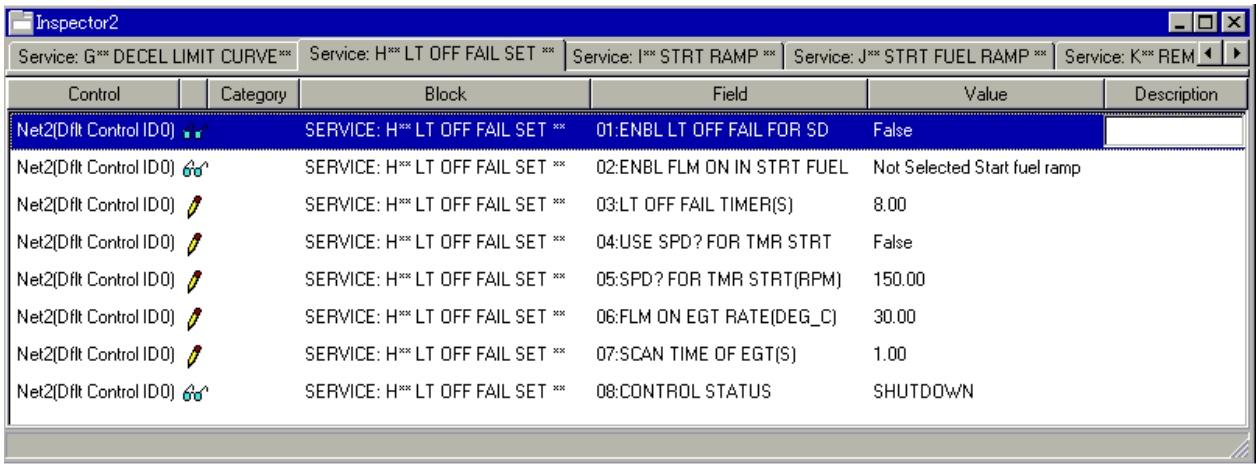


Figure 3-33. Service: H**LT OFF FAIL SET** Menu

This block is set for ignition check logic.

01 ENBL LT OFF FAIL FOR SD displays whether LIGHT OFF FAIL can be used for Shutdown. If it is TRUE, it is shown LIGHT OFF FAIL logic can be used for shutdown.

IMPORTANT

This can only be selected TRUE if the EGT signal is brought into the control. If tuned TRUE without having an EGT signal configured, a CONFIGURATION ERROR shutdown will occur.

02 ENBL FLM ON IN STRT FUEL displays whether LIGHT OFF can be used for trigger of reopening start fuel ramp. If it is 'Ramp reopen on FLM ON' or 'Ramp reopen by FLM ON&SPD SW', it is shown LIGHT OFF logic can be used for start fuel ramp.

03 LT OFF FAIL TIMER(s) dflt=8.0(0.0,50.0)
Enter time that the LIGHT OFF FAIL is overridden, until the following is accomplished.
1. The discrete input of start is closed.
2. Actual speed exceeds the set value (05 SPD? FOR TMR START).
(In case of being set '04: USE SPD? FOR TMR START' is TRUE.)

04 USE SPD? FOR TMR START dflt=FALSE (FALSE, TRUE)
Set to TRUE when **t**he timer used for an ignition check after checking the speed.

05 SPD? FOR TMR STRT (rpm) dflt=150.0(0.0,32000.0)
Set the speed which the timer starts, if 04 USE SPD? FOR TMR START is true.

06 FLM ON EGT RATE (DEG_C/s) dflt=30.0(0.0,2000.0)
Set the change rate of EGT to confirm ignition check.

07 SCAN TIME OF EGT(s) dflt=1.0(0.1,10.0)
Set the time to carry out sampling of the ignition failure.

08 CONTROL STATUS displays the actual status of the control

IMPORTANT

If 01 ENBL LT OFF FAIL FOR SD or 02 ENBL LT OFF IN STRT FUEL is set using the LT OFF logic, change setpoints from 03 LT OFF TIMER(s) to 07 SCAN TIME of EGT(s).

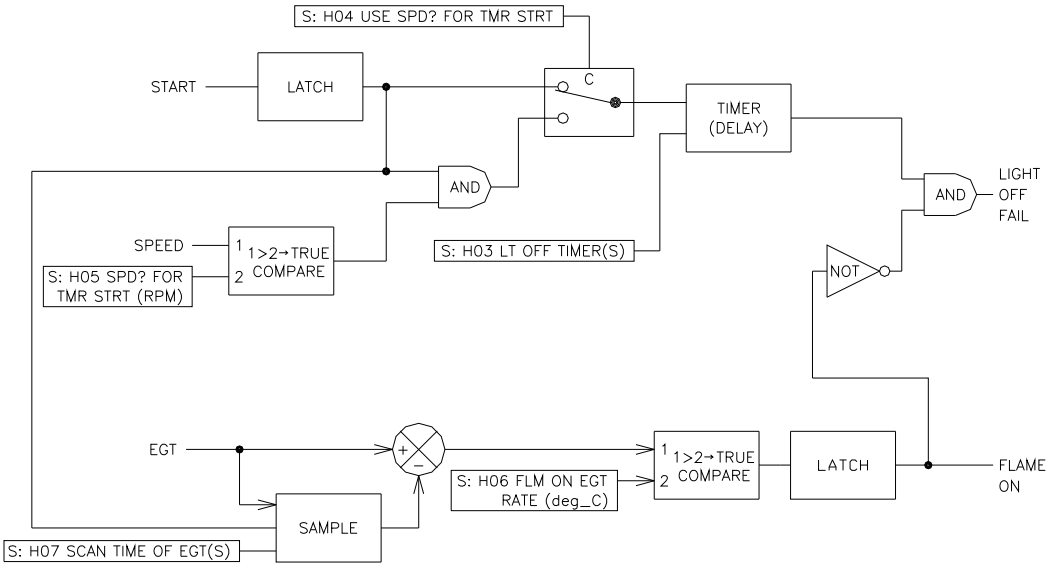


Figure 3-34 Light Off Fail Setting

ISTRT RAMP ****

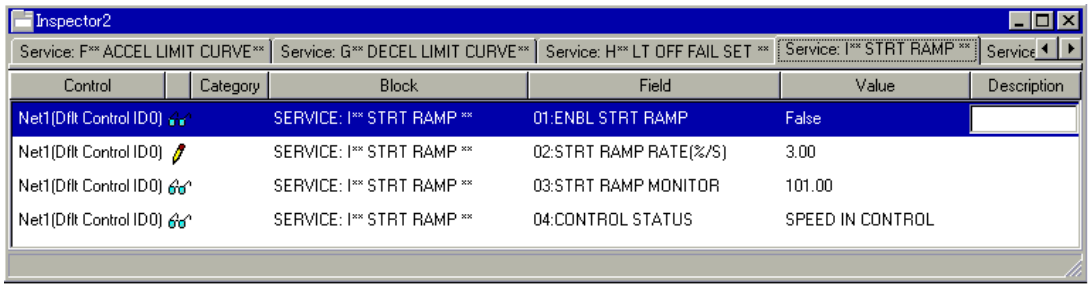


Figure 3-35. Service: I**STRT RAMP** Menu

This block is set for start ramp logic.

01 ENBL STRT RAMP
If START RAMP logic can be used, this display should be TRUE.

02 STRT RAMP RATE (%/s) dflt=3.0(0.0,1000.0)
Set to the value of STRT RAMP RATE.

03 STRT RAMP MONITOR—STRT RAMP valve %

04 CONTROL STATUS show status of control

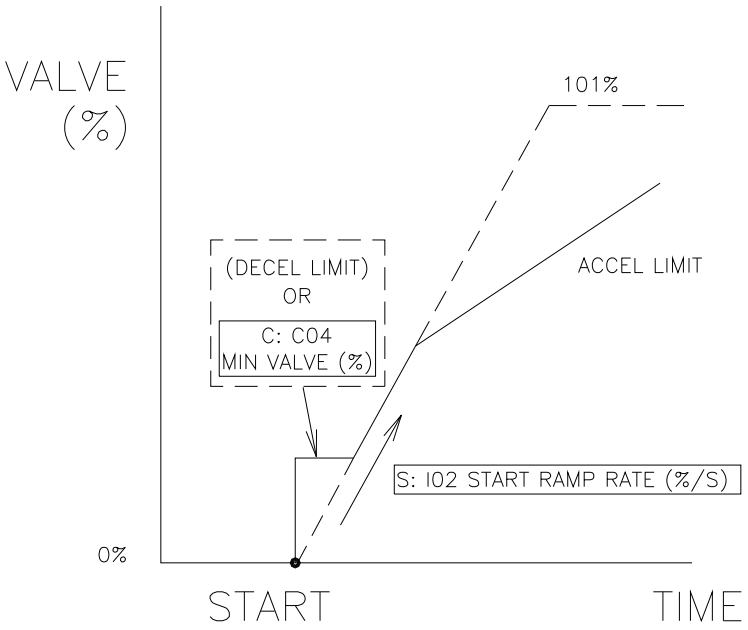


Figure 3-36. STRT RAMP SETTING

JSTRT FUEL RAMP ****

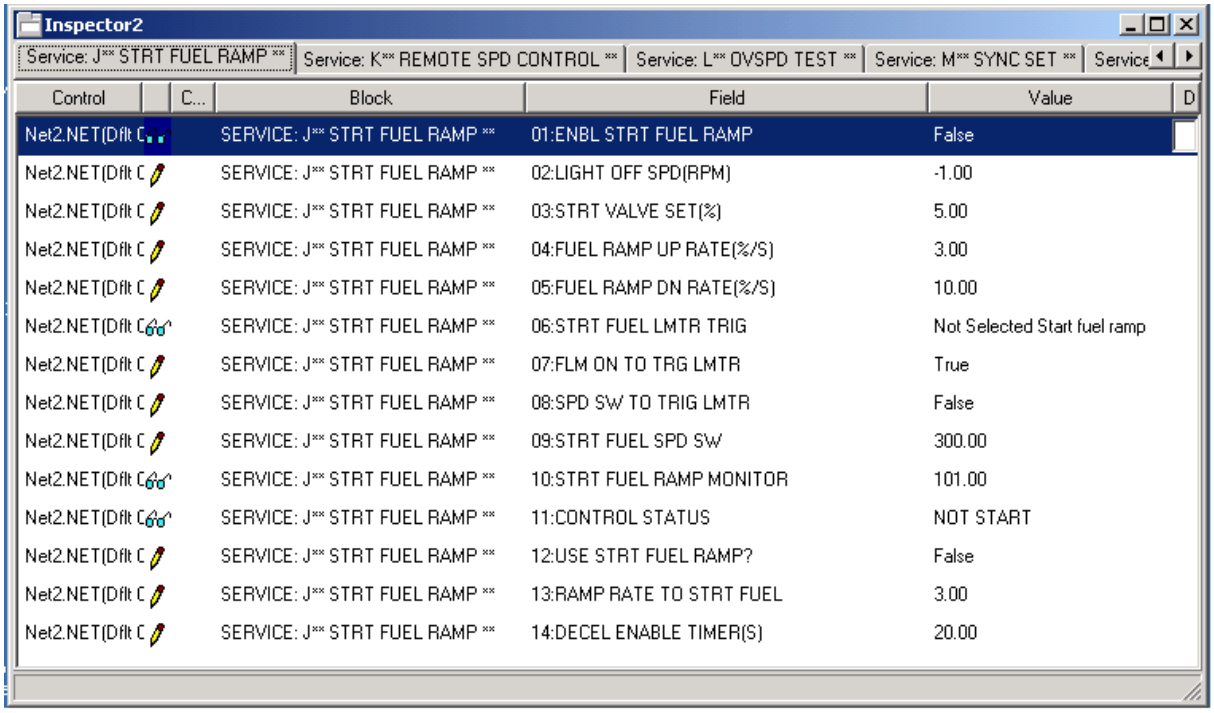


Figure 3-37. Service: J**STRT FUEL RAMP** Menu

This block is set for start fuel ramp and start ramp logic. Remember to set correct values from 03 Start Valve Set (%) to 09 REOPEN SPD? (rpm**)** when 01 ENBL STRT FUEL RAMP below set to ‘True’.

01 ENBL STRT FUEL RAMP displays whether START FUEL RAMP can be used. If true, START FUEL RAMP logic can be used.

02 LIGHT OFF SPD (rpm) dflt=-1.0(-1.0,32000.0)
Set to the speed, in rpm, the valve should open to allow minimum flow after the start contact is closed.

03 STRT VALVE SET (%) dflt=5.0(0.0,101.0)
Set to the percentage of valve opening needed for minimum flow when the start contact is closed and actual speed exceeds '02 LIGHT OFF SPD'.

04 STRT RAMP UP RATE (%/s) dflt=3.0(0.0,1000.0)
Set to the rate, in percent per second, when START FUEL RAMP on LSS bus reaches 101% after flame on.

05 STRT RAMP DN RATE (%/s) dflt=10.0(0.0,1000.0)
Set to the rate, in percent per second, when START RAMP on HSS bus reaches 0% after flame on.

06 START FUEL LMTR TRIG
This is the logic used to trigger the Start Fuel Limiter to ramp from the 'Min Fuel Limit level' to its 101% level position. This selected trigger logic is configured using the next two menu settings below.

07 FLM ON TO TRG LMTR dflt=TRUE (FALSE, TRUE)
Sets whether the control's 'Light Off Detection' logic is used to trigger the Start Fuel Limiter to ramp from the Min Fuel limit level to its 101% level position. (Alternatively, this setting can be 'ANDed' with the below 'SPD SW TO TRG LMTR' logic by programming both settings true.)

08 SPD SW TO TRIG LMTR dflt=FALSE (FALSE, TRUE)
Sets whether the control's 'Start Speed Switch' logic is used to trigger the Start Fuel Limiter to ramp from the Min Fuel limit level to its 101% level position. (Alternatively, this setting can be 'ANDed' with the above 'FLM ON TO TRG LMTR' logic by programming both settings true.)

09 STRT FUEL SPD SW dflt=300.0(0.0,32000.0)
If the above 'SPD SW TO TRG LMTR' setting is true, this value sets the speed at which the start fuel limiter will be triggered to begin ramping from the Min Fuel limit level to its 101% level position.

10 STRT FUEL RAMP MONITOR—START FUEL RAMP

11 CONTROL STATUS

12 USE STRT FUEL RAMP? dflt=FALSE (FALSE, TRUE)
Sets whether using the ramp to start fuel or not.

13 RAMP RATE TO STRT FUEL dflt=3.0(0.0,1000.0)
If the above 'RAMP USE? TO START FUEL' setting is true, this value sets the ramp rate to start fuel value.

14 DECEL ENABLE TIMER(s) dflt=20.0(0.0,60.0)
Input the time to enable decel limit curve after reopen trigger is valid.

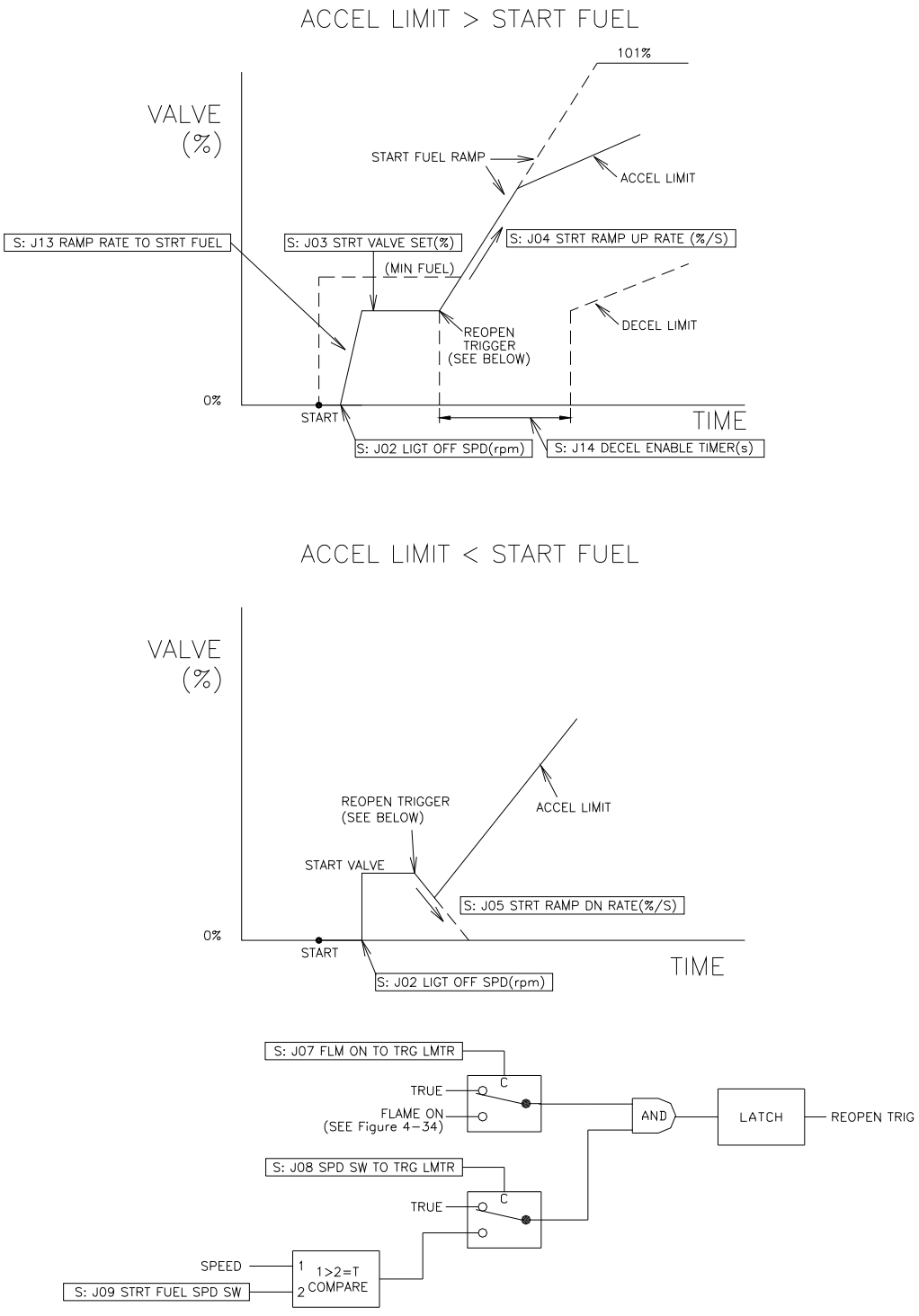


Figure 3-38. Start Fuel Ramp Setting

K**REMOTE SPD CONTROL **

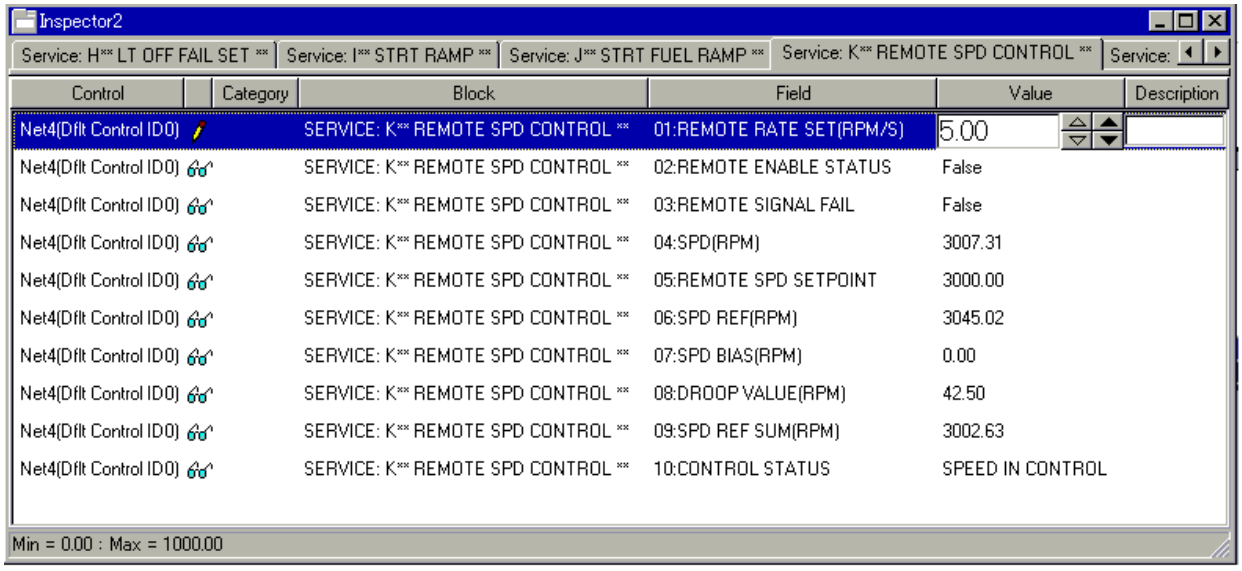


Figure 3-39. Service: K**REMOTE SPD CONTROL** Menu

This block is set for remote speed control logic.

01 REMOTE RATE SET (rpm/s) dflt=5.0(0.0,10000.0)
Should be set to the rate should change the speed reference to remote speed setpoint.

02 REMOTE ENABLE STATUS displays whether remote speed control is enabled.

03 REMOTE SIGNAL FAIL displays whether remote signal is enabled. If remote signal is failed, it is true.

04 SPD (rpm) displays the actual turbine speed in rpm.

05 REMOTE SPD SETPOINT displays REMOTE SPEED SETPOINT in rpm.

06 SPD REF (rpm) indicates turbine speed setpoint rpm.

07 SPD BIAS (rpm) shows the bias speed setpoint rpm.

08 DROOP VALUE (rpm) displays droop rpm.

09 SPD REF SUM (rpm) is a display of the total speed bias into the summing junction.

10 CONTROL STATUS show status of control.

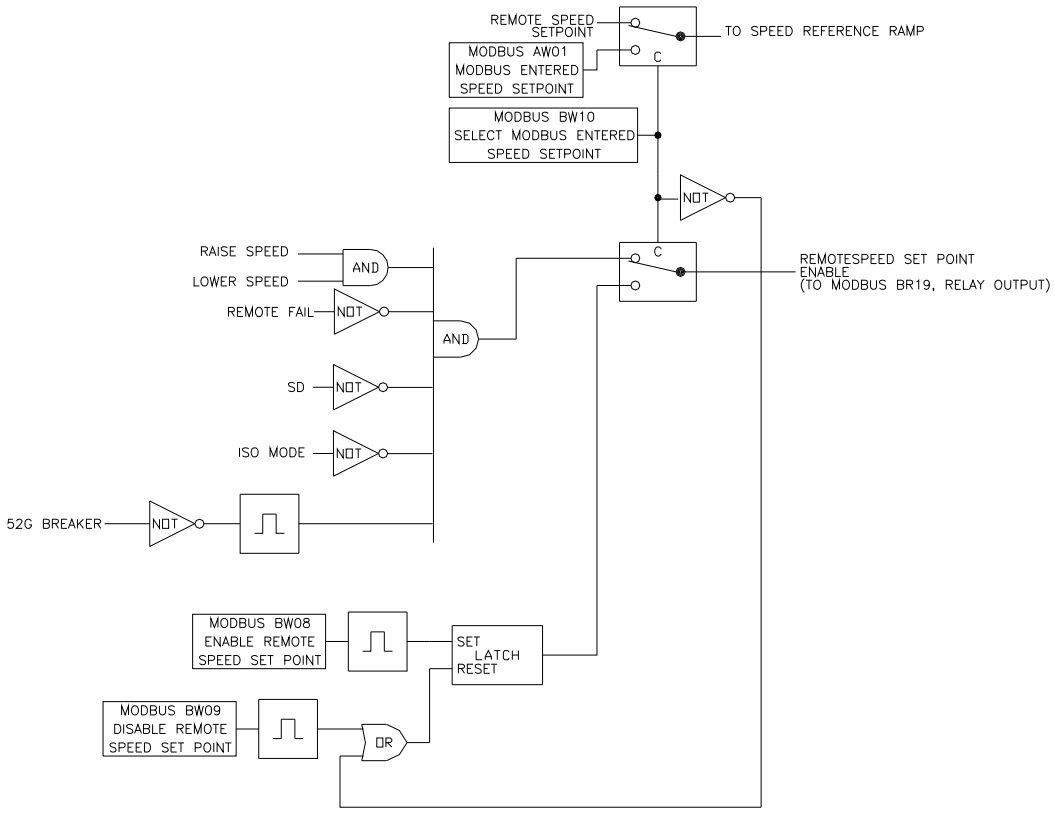
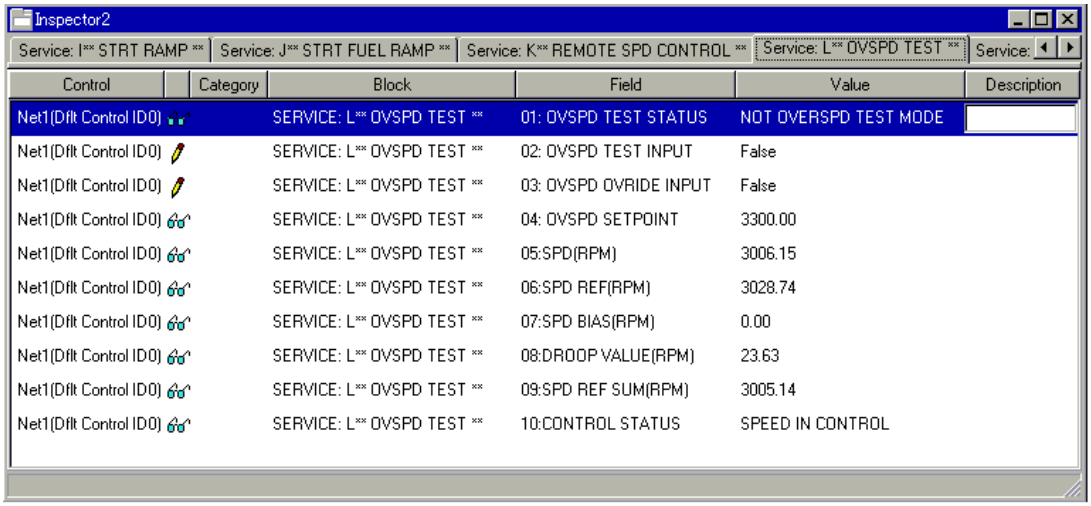


Figure 3-40. Remote Speed Control Setting

L**OVSPD TEST **



Control	Category	Block	Field	Value	Description
Net1(Dflt Control ID0)		SERVICE: L** OVSPD TEST **	01: OVSPD TEST STATUS	NOT OVERSPD TEST MODE	
Net1(Dflt Control ID0)		SERVICE: L** OVSPD TEST **	02: OVSPD TEST INPUT	False	
Net1(Dflt Control ID0)		SERVICE: L** OVSPD TEST **	03: OVSPD OVRIDE INPUT	False	
Net1(Dflt Control ID0)		SERVICE: L** OVSPD TEST **	04: OVSPD SETPOINT	3300.00	
Net1(Dflt Control ID0)		SERVICE: L** OVSPD TEST **	05:SPD(RPM)	3006.15	
Net1(Dflt Control ID0)		SERVICE: L** OVSPD TEST **	06:SPD REF(RPM)	3028.74	
Net1(Dflt Control ID0)		SERVICE: L** OVSPD TEST **	07:SPD BIAS(RPM)	0.00	
Net1(Dflt Control ID0)		SERVICE: L** OVSPD TEST **	08:DROOP VALUE(RPM)	23.63	
Net1(Dflt Control ID0)		SERVICE: L** OVSPD TEST **	09:SPD REF SUM(RPM)	3005.14	
Net1(Dflt Control ID0)		SERVICE: L** OVSPD TEST **	10:CONTROL STATUS	SPEED IN CONTROL	

Figure 3-41. Service: L**OVSPD TEST** Menu

This block is set for overspeed test logic.

01 OVSPD TEST STATUS displays whether it is in test state.

02 OVSPD TEST INPUT dflt=FALSE (FALSE, TRUE)
Set TRUE from FALSE when testing as overspeed test enabled. After an overspeed test ends it should be set FALSE. Overspeed test mode is canceled when it is shutdown by overspeed etc. In this case, since this input is still true, make it false.

03 OVSPD OVRIDE INPUT dflt=FALSE (FALSE, TRUE)
Set TRUE from FALSE when testing as overspeed override. After an overspeed override ends, it should be set FALSE. Overspeed override is canceled when it is shutdown by overspeed etc. In this case, since this input is still true, make it false.

04 OVSPD SETPOINT indicates the value of overspeed setpoint.

05 SPD (rpm) displays actual turbine speed in rpm.

06 SPD REF (rpm)—turbine speed setpoint rpm.

07 SPEED BIAS (rpm)—bias speed setpoint rpm.

08 DROOP VALUE (rpm)—droop rpm.

09 SPD REF SUM (rpm) the total speed bias into the summing junction.

10 CONTROL STATUS

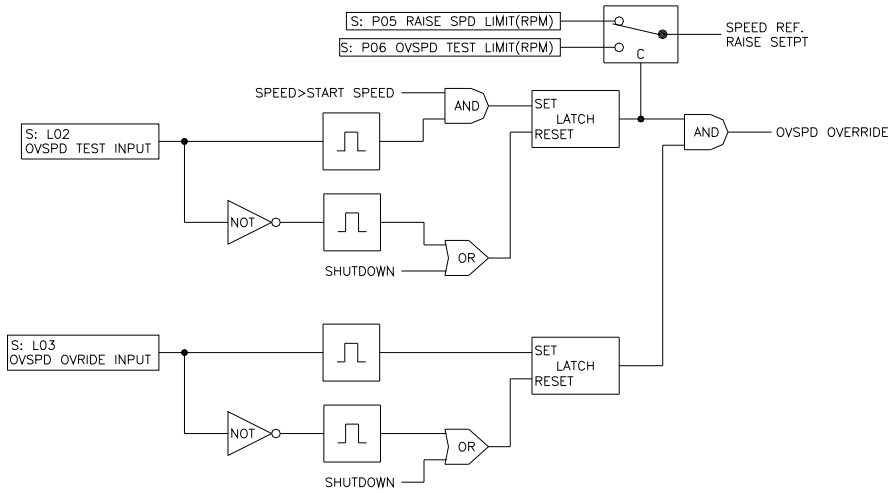


Figure 3-42. Overspeed test setting

M**SYNC SET **

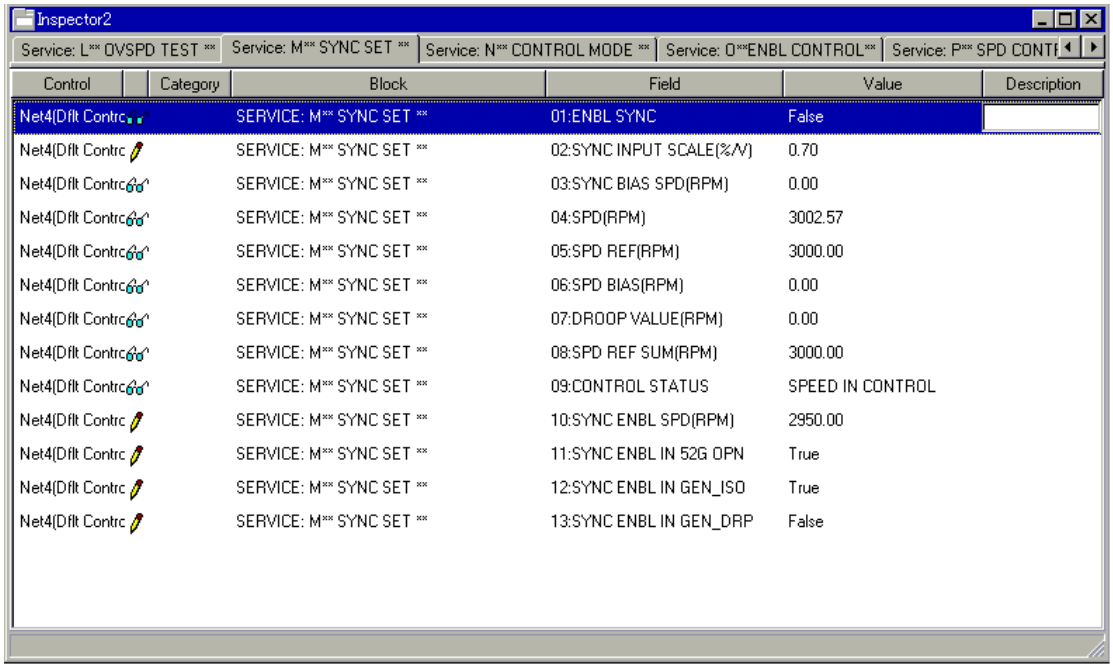


Figure 3-43. Service: M**SYNC SET** Menu

This block is set for synchronized logic. Remember to set the correct value at 02 SYNC INPUT SCALE (%/V) when 01 ENBL SYNC was set to 'True'.

01 **ENBL SYNC** displays whether sync enable can be used. If TRUE, then SYNC logic can be used.

02 **SYNC INPUT SCALE (%/V)** dflt=0.3(0.1,5.0)
Set to the Analog Input sync input scale.

03 **SYNC BIAS SPD (rpm)**—the value of sync bias speed.

04 **SPD (rpm)**—actual turbine rpm.

05 **SPD REF (rpm)**—turbine speed setpoint rpm.

06 **SPEED BIAS (rpm)**—bias speed setpoint rpm.

07 **DROOP VALUE (rpm)**—droop rpm.

08 **SPD REF SUM (rpm)** displays the total speed bias factored into the summing junction.

09 **CONTROL STATUS**—CONTROL STATUS.

10 **SYNC ENBL SPD (rpm)** dflt=2950.0(0.0,32000.0)
Set to the speed value to be enabling SYNC function.

11 **SYNC ENBL IN 52G OPN** dflt=TRUE (TRUE, FALSE)
Input whether SYNC function is valid or not while 52G open.

12 SYNC ENBL IN GEN_ISO dflt=TRUE (TRUE, FALSE)
Input whether SYNC function is valid or not while 52G close and selected iso.

13 SYNC ENBL IN GEN_DRP dflt=FALSE (TRUE, FALSE)
Input whether SYNC function is valid or not while 52G close and selected droop.

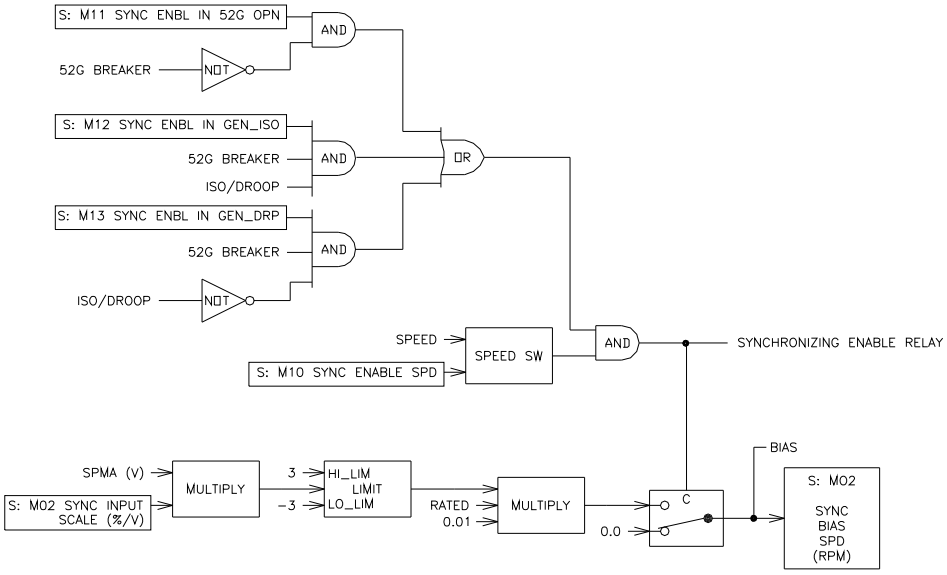
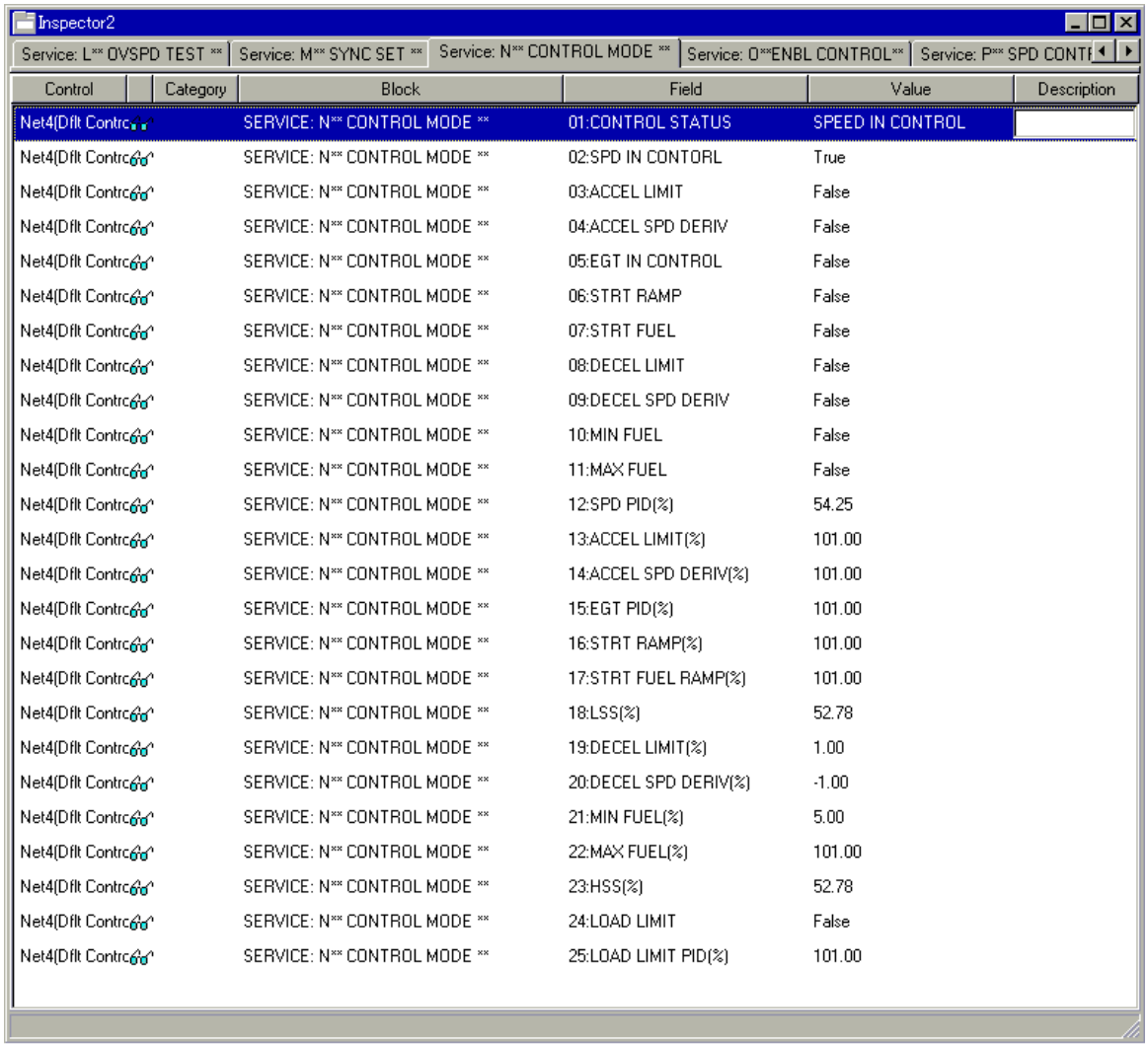


Figure 3-44. SYNC setting

N**CONTROL MODE **



Control	Category	Block	Field	Value	Description
Net4(Dflt Contrc		SERVICE: N** CONTROL MODE **	01:CONTROL STATUS	SPEED IN CONTROL	
Net4(Dflt Contrc		SERVICE: N** CONTROL MODE **	02:SPD IN CONTORL	True	
Net4(Dflt Contrc		SERVICE: N** CONTROL MODE **	03:ACCEL LIMIT	False	
Net4(Dflt Contrc		SERVICE: N** CONTROL MODE **	04:ACCEL SPD DERIV	False	
Net4(Dflt Contrc		SERVICE: N** CONTROL MODE **	05:EGT IN CONTROL	False	
Net4(Dflt Contrc		SERVICE: N** CONTROL MODE **	06:STRT RAMP	False	
Net4(Dflt Contrc		SERVICE: N** CONTROL MODE **	07:STRT FUEL	False	
Net4(Dflt Contrc		SERVICE: N** CONTROL MODE **	08:DECEL LIMIT	False	
Net4(Dflt Contrc		SERVICE: N** CONTROL MODE **	09:DECEL SPD DERIV	False	
Net4(Dflt Contrc		SERVICE: N** CONTROL MODE **	10:MIN FUEL	False	
Net4(Dflt Contrc		SERVICE: N** CONTROL MODE **	11:MAX FUEL	False	
Net4(Dflt Contrc		SERVICE: N** CONTROL MODE **	12:SPD PID(%)	54.25	
Net4(Dflt Contrc		SERVICE: N** CONTROL MODE **	13:ACCEL LIMIT(%)	101.00	
Net4(Dflt Contrc		SERVICE: N** CONTROL MODE **	14:ACCEL SPD DERIV(%)	101.00	
Net4(Dflt Contrc		SERVICE: N** CONTROL MODE **	15:EGT PID(%)	101.00	
Net4(Dflt Contrc		SERVICE: N** CONTROL MODE **	16:STRT RAMP(%)	101.00	
Net4(Dflt Contrc		SERVICE: N** CONTROL MODE **	17:STRT FUEL RAMP(%)	101.00	
Net4(Dflt Contrc		SERVICE: N** CONTROL MODE **	18:LSS(%)	52.78	
Net4(Dflt Contrc		SERVICE: N** CONTROL MODE **	19:DECEL LIMIT(%)	1.00	
Net4(Dflt Contrc		SERVICE: N** CONTROL MODE **	20:DECEL SPD DERIV(%)	-1.00	
Net4(Dflt Contrc		SERVICE: N** CONTROL MODE **	21:MIN FUEL(%)	5.00	
Net4(Dflt Contrc		SERVICE: N** CONTROL MODE **	22:MAX FUEL(%)	101.00	
Net4(Dflt Contrc		SERVICE: N** CONTROL MODE **	23:HSS(%)	52.78	
Net4(Dflt Contrc		SERVICE: N** CONTROL MODE **	24:LOAD LIMIT	False	
Net4(Dflt Contrc		SERVICE: N** CONTROL MODE **	25:LOAD LIMIT PID(%)	101.00	

Figure 3-45. Service: N**CONTROL MODE** Menu

This block displays control status.

01 CONTROL STATUS

02 SPD IN CONTROL displays whether speed control is selected. If it is TRUE, it is shown speed control is selected on control selector.

03 ACCEL LIMIT displays whether it is selected accel limit. If it is TRUE, it is shown accel limit is selected on control selector.

04 ACCEL SPD DERIV displays whether it is selected speed accel derivative control. If it is TRUE, it is shown speed accel derivative control is selected on control selector.

05 EGT IN CONTROL displays whether it is selected EGT control. If it is TRUE, it is shown EGT control is selected on control selector.

06 **STRT RAMP** displays whether it is selected start ramp. If it is TRUE, it is start ramp is selected on control selector.

07 **STRT FUEL** displays whether it is selected start fuel ramp. If it is TRUE, it is start fuel ramp is selected on control selector.

08 **DECEL LIMIT** displays whether it is selected decel limit. If it is TRUE, decel limit is shown and is selected on control selector.

09 **DECEL SPD DERIV** displays whether it is selected speed decel derivative control. If it is TRUE, speed decel is shown and derivative control is selected on control selector.

10 **MIN FUEL** displays whether it is selected minimum fuel. If it is TRUE, it is shown minimum fuel is selected on control selector.

11 **MAX FUEL** displays whether it is selected maximum fuel. If it is TRUE, it is shown maximum fuel is selected on control selector.

12 **SPD PID (%)**—speed PID.

13 **ACCEL LIMIT (%)**—accel limit.

14 **ACCEL SPD DERIV (%)**—speed accel derivative limit.

15 **EGT PID (%)**—EGT PID

16 **STRT RAMP (%)**—start ramp.

17 **STRT FUEL RAMP (%)**—start fuel ramp.

18 **LSS (%)**—LSS signal.

19 **DECEL LIMIT (%)**—decel limit.

20 **DECEL SPD DERIV (%)**—speed decel derivative limit.

21 **MIN FUEL (%)**—min fuel.

22 **MAX FUEL (%)**—max. fuel.

23 **HSS (%)—**HSS signal.

24 **LOAD LIMIT—**LOAD LIMIT.

25 **LOAD LIMIT PID (%)—**LOAD LIMIT PID signal.

O**ENBL CONTROL **

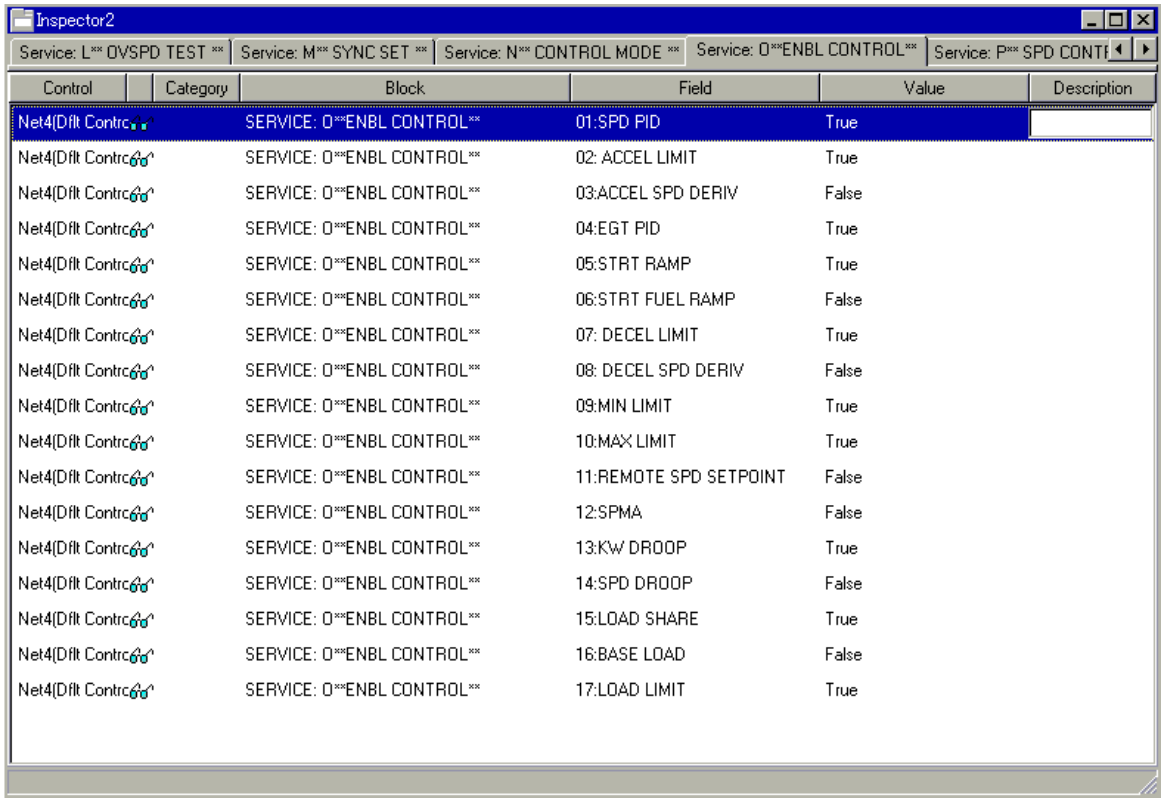


Figure 3-46. Service: O**ENBL CONTROL** Menu

This block displays whether this is in the state in which each control is possible after setting each configurable values.

01 **SPD PID** displays whether speed control PID is possible. If it is TRUE, it can be selected on control selector.

02 **ACCEL LIMIT** displays whether accel limit is possible. If it is TRUE, it can be selected on control selector.

03 **ACCEL SPD DERIV** displays whether speed accel derivative control is possible. If it is TRUE, it can be selected on control selector.

04 **EGT PID** displays whether EGT PID control is possible. If it is TRUE, it can be selected on control selector.

05 **STRT RAMP** displays whether start ramp is possible. If it is TRUE, it can be selected on control selector.

06 **STRT FUEL RAMP** displays whether start fuel ramp is possible. If it is TRUE, it can be selected on control selector.

07 **DECEL LIMIT** displays whether decel limit is possible. If it is TRUE, it can be selected on control selector.

08 **DECEL SPD DERIV** displays whether speed decel derivative control is possible. If it is TRUE, it can be selected on control selector.

09 **MIN LIMIT** displays whether min limit is possible If it is TRUE, it can be selected on control selector.

10 **MAX LIMIT** displays whether max limit is possible. If it is TRUE, it can be selected on control selector.

11 **REMOTE SPD SETPOINT** displays whether remote speed setpoint is possible. If TRUE, it is enabled to control. But this display isn't including whether remote speed setpoint is possible, when it changes the speed setpoint on Modbus.

12 **SPM-A** displays whether SPM-A is possible. If TRUE, it is enabled to control.

13 **KW DROOP** displays whether kW droop is possible. If TRUE, it is enabled to control.

14 **SPD DROOP** displays whether speed droop is possible. If TRUE, it is enabled to control.

15 **LOAD SHARE** displays whether LOAD SHARE is possible. If TRUE, it is enabled to control.

16 **BASE LOAD** displays whether BASE LOAD is possible. If TRUE, it is enabled to control.

17 **LOAD LIMIT** displays whether LOAD LIMIT is possible. If TRUE, it is enabled to control.

P**SPD CONTROL SET**

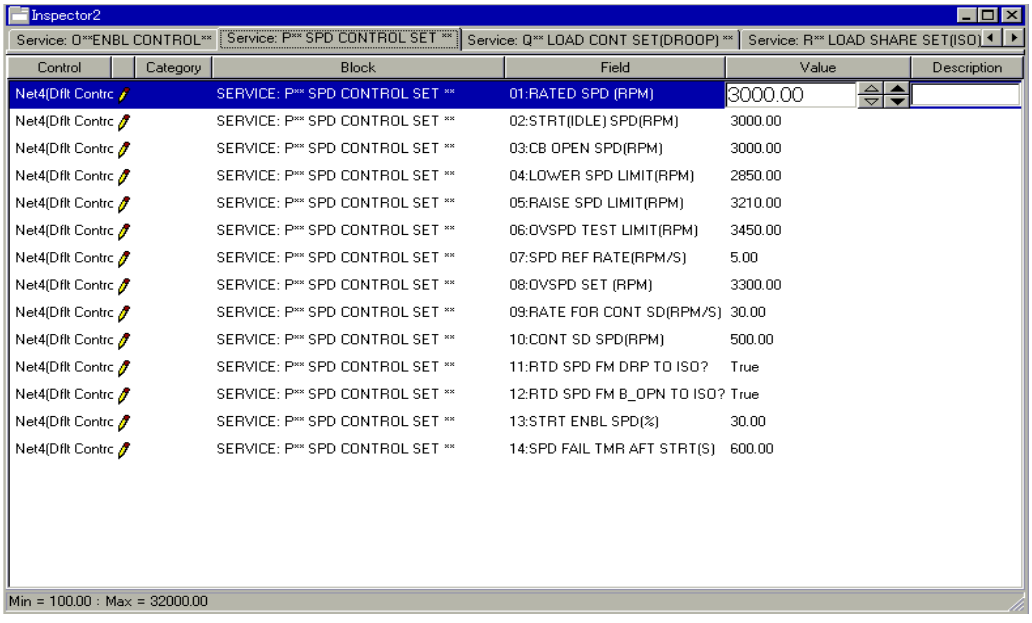


Figure 3-47. Service: P**SPD CONTROL SET** Menu

This block sets up the speed control values.
This setting is similar to the 'Configure: A SPD SETTING' except for 07:SPD REF RATE (rpm/s). See Fig. 4-7.

01:RATED SPD (rpm) dflt=3000.0(100.0,32000.0)
Enter the rated operating turbine speed in rpm. This value is used for calculation of droop function and so on. This value is the same as 'Configure: A **SPD SETTING**' '03:RATED SPD (rpm)'.

02:STRT (IDLE) SPD (rpm) dflt=3000.0(100.0,32000.0)
Use this for turbine starting speed in (rpm) for a tunable Start Speed Reference. Set the first speed setpoint reached after a turbine start. To change the speed setpoint after the turbine speed has reached this set point, use Raise/Lower contact input. This value is the same as 'Configure: A **SPD SETTING**' '04:STRT SPD (rpm)'.

03:CB OPEN SPD (rpm) dflt=3000.0(100.0,32000.0)
This is the speed setpoint after 52G Breaker opens. It is recommended that this be set to the turbine speed when the generator is re-synchronized and re-connected to the bus after the generator breaker has tripped. This setpoint must be less than or equal to the 'rated speed' for more stable control dynamics. This value is the same as 'Configure: A** SPD SETTING**' '05:CB OPEN SPD (rpm)'.

04:LOWER SPD LIMIT (rpm) dflt=2850.0(100.0,32000.0)
Set to the lower limit of turbine speed in (rpm) for a tunable Speed Reference. This value is the same as 'Configure: A** SPD SETTING**' '06:LOWER SPD LIMIT (rpm)'.

05:RAISE SPD LIMIT (rpm) dflt=3210(100,32000)
Set to the upper limit of turbine speed in (rpm) for a tunable Speed Reference. This value is the same as 'Configure: A** SPD SETTING**' '07:RAISE SPD LIMIT (rpm)'.

06:OVSPD TEST LIMIT (rpm) dflt=3450.0(100.0,32000.0)
Set to turbine overspeed testing set-point in (rpm) for a tunable Speed Reference. This value is the same as 'Configure: A** SPD SETTING**' '08:OVST TEST LIMIT (rpm)'.

07:SPD REF RATE (rpm/s) dflt=5.0(0.0,10000.0)
Set to the rate of speed reference in (rpm) for a tunable Speed Reference rate.

08:OVSPD SET (rpm) dflt=3300.0(100.0,32000.0)
Set to the overspeed detection point for overspeed protection. This value is the same as 'Configure: A** SPD SETTING**' '11:OVSPD SET (rpm)'.

09:RATE FOR CONT SD (rpm/s) dflt=30.0(0.0,10000.0)
Set to the rate of speed reference in (rpm) while control shutdown function by controlled shutdown inputting on Modbus.

10:CONT SD SPD (rpm) dflt=500.0(0.0,10000.0)
Set to the speed in (rpm) to shutdown while control shutdown function by controlled shutdown inputting on Modbus. The shutdown relay is normal in spite of shutdown condition by controlled shutdown.

11:RTD SPD FM DRP TO ISO? dflt=TRUE (FALSE, TRUE)
is input whether speed is referenced to rated speed or actual speed when the droop mode is changed to isochronous mode. If it is selected 'TRUE', the speed reference change to rated speed at ISO. If it is selected 'FALSE', the speed reference changes to actual speed at ISO.

12:RTD SPD FM B_OPN TO ISO? dflt=TRUE (FALSE, TRUE)
is input whether speed is referenced to rated speed or not when the 52G BREAKER is closed on selected isochronous control. If it is selected 'TRUE', the speed reference change to rated speed at 52G BREAKER close. If it is selected 'FALSE', the speed reference doesn't change to any speed at 52G BREAKER close.

13:STRT ENBL SPD (%) dflt=30.0(0.0,50.0)
Set to the speed in (%) to be enabling start input. If actual speed is lager than this speed, start input is invalid.

14:SPD FAIL TMR AFT STRT(s) dflt=600.0(0.0,32000.0)
Set to the time in (s) to cancel the override of speed fail. If actual speed is lower than the value of fail speed after passed this time, turbine is shutdown by speed fail.

Q LOAD CONT SET (DROOP) ****

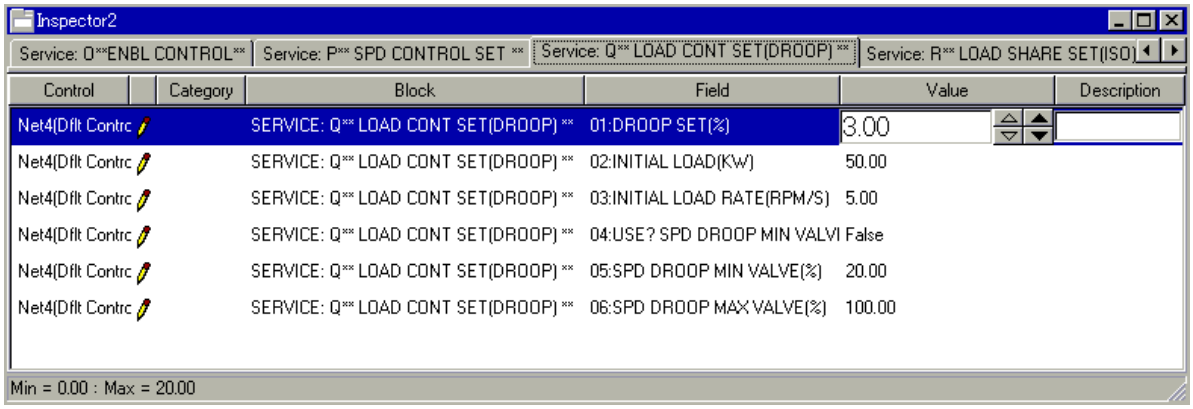


Figure 3-48. Service: Q**LOAD CONT SET (DROOP)** Menu

The load Setting section is the set-up of the generator load control parameters.

01 DROOP SET (%) dflt=3.0(0.0,20.0)
Set to desired droop percentage. This is the percentage of rated speed to which the speed reference will droop when the 52G (generator) BREAKER load is increased to maximum load in droop mode.

02 INITIAL LOAD (kW) dflt=50.0(0.0,32000.0)
Set to the desired initial load KW when in droop load control. This is the percentage of rated speed the speed reference will initially load when the 52G (generator) BREAKER is closed with selected droop. If 'Configure: B **INPUT & OUTPUT OPTIONS**' '18:USE RTD/IDL SW AT DI G' is TRUE, the there is not initial load when in droop control. Speed reference will have to be raised manually with discrete contact E: Raise to take on load.

03 INITIAL LOAD RATE (rpm/s) dflt=5.0(0.0,10000.0)
This is the rate the speed reference is increased to initial load when the 52G (generator) BREAKER is closed while selected droop. Set to desired initial load rate.

04 USE? SPD DROOP MIN VALVE dflt=FALSE (FALSE, TRUE)
Enter whether Spd droop min valve (%) is used or not when the Spd droop is selected. TRUE: The minimum value of SPD DROOP is '05 SPD DROOP MIN VALVE (%)'. FALSE: The minimum value to which SPD DROOP is held when 52G (generator) BREAKER is closed.

05 SPD DROOP MIN VALVE (%) dflt=20.0(0.0,100.0)
Set to desired minimum valve for speed droop. This is the minimum value of droop range when the droop mode is selected. This setpoint is valid when '04USE? SPD DROOP MIN VALVE (%)' is true.

06 SPD DROOP MAX VALVE (%) dflt=100.0(0.0,100.0)
Set to desired maximum valve for speed droop. This is the maximum value of droop range when the droop mode is selected to speed droop.

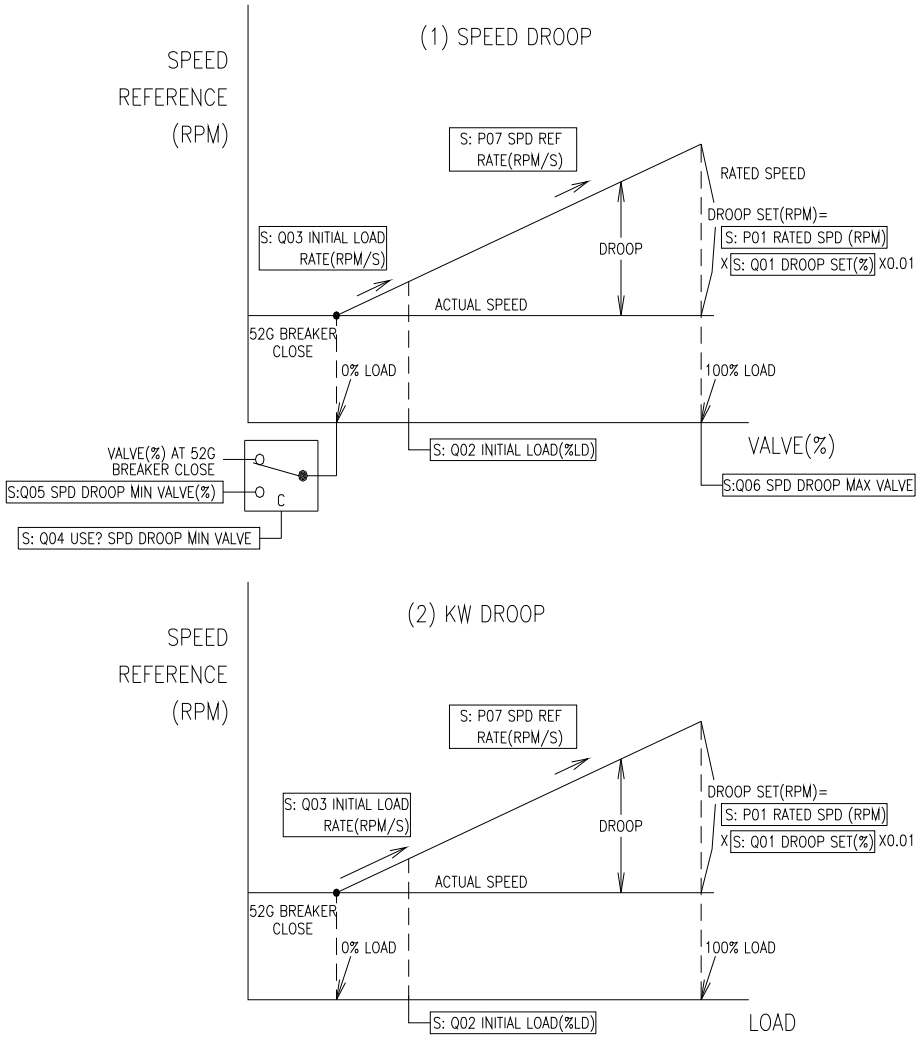


Figure 3-49. Load Control setting (Droop)

R**LOAD SHARE SET (ISO) **

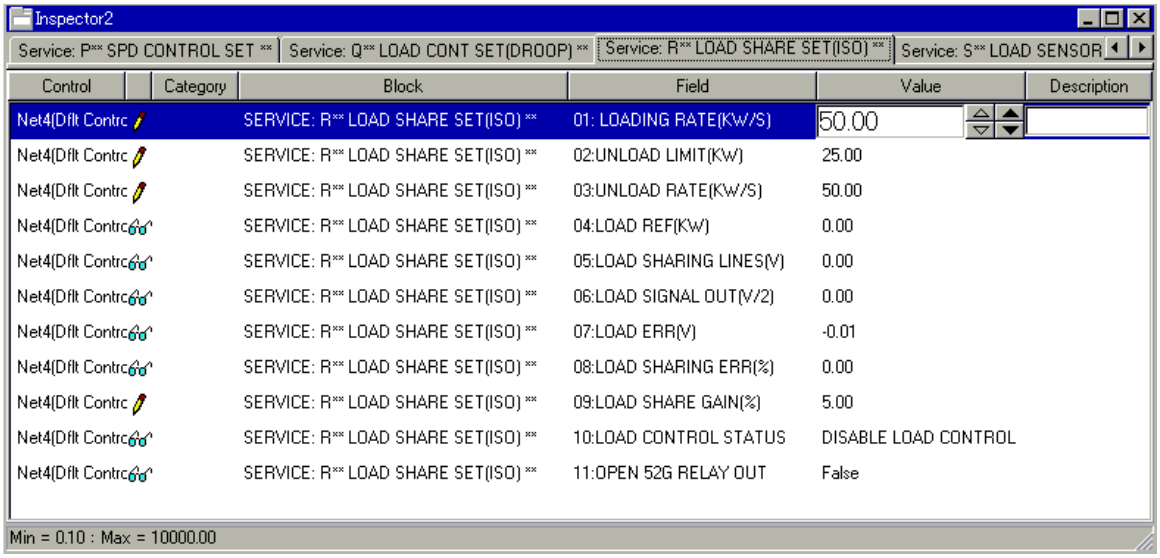


Figure 3-50. Service: R**LOAD SHARE SET (ISO)** Menu

This block is set for load sharing logic.

01 LOADING RATE (kW/s) dflt=50.0(0.1,10000.0)
Set to the Analog Input loading rate. This rate is used when the mode is changed to Load Sharing.

02 UNLOAD LIMIT (kW) dflt=25.0(0.0,32000.0)
Set to the Analog Input limit unload. This limit value is used when the start /unload contact input is open.

03 UNLOAD RATE (kW/s) dflt=50.0(0.1,10000.0)
Set to the Analog Input unloading rate. This limit value is used when the start /unload contact input is open.

04 LOAD REF (kW) should be set to the Analog Input full load (100%) in kW.

05 LOAD SHARING LINES (V) displays the voltage of load sharing line.

06 LOAD SIGNAL OUT (V/2) displays the output voltage to load sharing line.

07 LOAD ERR (V) displays the load err voltage.

08 LOAD SHARING ERR (%) displays the load percent.

09 LOAD SHARE GAIN (%) dflt=5.0(0.0,20.0)
Set to the load share gain.

10 LOAD CONTROL STATUS displays the load control status.

11 OPEN 52G RELAY OUT displays the status of 52G OPEN relay.

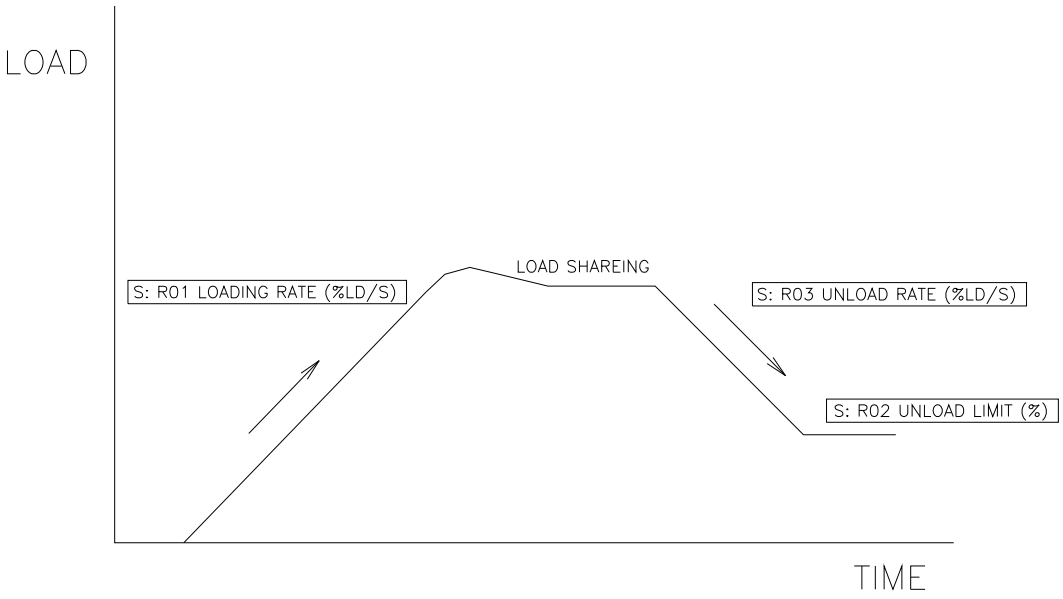


Figure 3-51. Load Sharing setting

S**LOAD SENSOR SET **

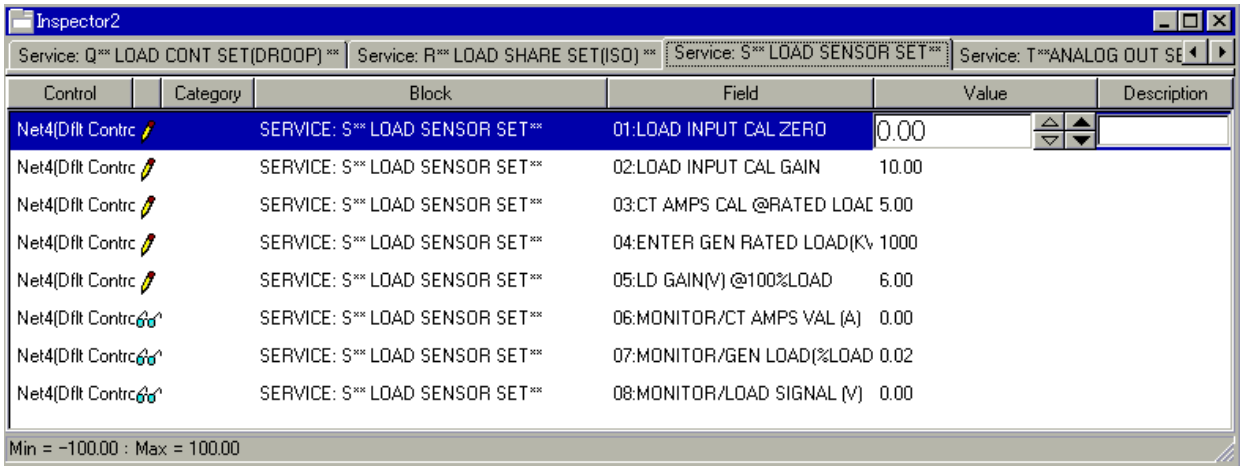


Figure 3-52. Service: S**LOAD SENSOR SET** Menu

This section calibrates the 2301D-GT internal load sensor to correspond its output to measured kilowatts. This calibration allows the control to calculate the 100% Load Gain voltage, droop % and load sharing ratio. For proper calibration the generator load should be as close as possible to required generator voltage and unity power factor.

01 LOAD INPUT CAL ZERO dflt=0.0(-100.0,100.0)
Adjust until the KW reading below is zero when the generator output is zero.

02 LOAD INPUT CAL GAIN dflt=10.0(5.0,40.0)
Adjust until the KW reading is same as rated KW when the generator output is at rated load. Adjust until load sensor matches the external instrumentation KW readings.

03 CT AMPS CAL @RATED LOAD dflt=5.0(1.0,7.5)
Sets the sensed CT current at rated load. Typically this value should match the current transformer's (CT's) output rating.

04 ENTER GEN RATED LOAD (kW) dflt=1000 (5, 32000)
This value sets the rated load of the turbine/generator.

05 LD GAIN (V)@100%LOAD dflt=6.0(0.1,7.5)
Adjust to match the load sensor output to the external instrumentation readings.

06 MONITOR/CT AMPS VAL (A)—the current of load input.

07 MONITOR/GEN LOAD (%LOAD)—generator load in percent.

08 MONITOR/LOAD SIGNAL (V)—the output of generator load in voltage.

T ANALOG OUT SETTINGS****

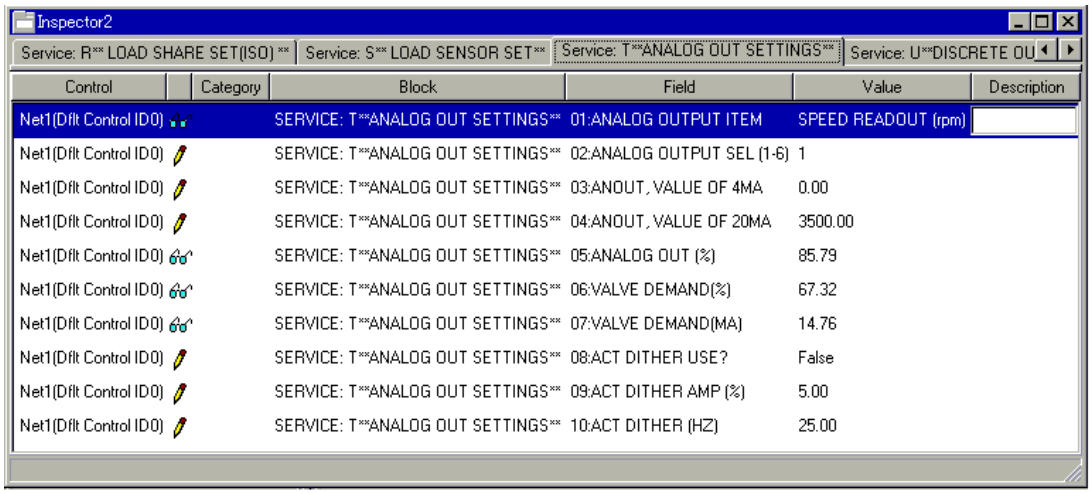


Figure 3-53. Service: T**ANALOG OUT SETTING** Menu

This section sets the parameter to be sent to the analog output driver and the desired scaling of the output.

01 ANALOG OUTPUT ITEM—the item name selected on next setting (T-02).

02 ANALOG OUTPUT SEL (1-6) dflt=1(1,6)
Select one of the following parameters for 4–20 mA output at terminals 16, 17, and 18.

1. SPEED READOUT (rpm)
2. SPEED REF. READOUT (rpm)
3. EGT READOUT
4. CDP READOUT
5. KW SIG. READOUT (kW)
6. ACTUATOR READOUT

03 ANOUT, VALUE OF 4 MA dflt=0.0(0.0,32000.0)
Adjust for the value of the displayed parameter when the analog output is 4 mA.

04 ANOUT, VALUE OF 20 mA dflt=3500.0(0.0,32000.0)
Adjust for the value of the displayed parameter when the analog output is 20.0 mA.

05 ANALOG OUT (%)—the analog output % as 0% is 4 mA and 100% is 20 mA.

06 VALVE DEMAND (%)—percentage of the controlled valve demand value.

07 VALVE DEMAND (mA)—the valve demand current controlled, in mA.

08 ACT DITHER USE dflt=FALSE (FALSE, TRUE)
Set to TRUE if the dither signal is used for the control valve.

09 ACT DITHER AMP (%) dflt=5.0(0.0,30.0)
Set the amplitude of dither if the dither signal is used for the control valve.

10 ACT DITHER (Hz) dflt=25.0(0.1,100.0)
Should be set the frequency of dither if the dither signal is used for the control valve.

UDISCRETE OUT SETTINGS ****

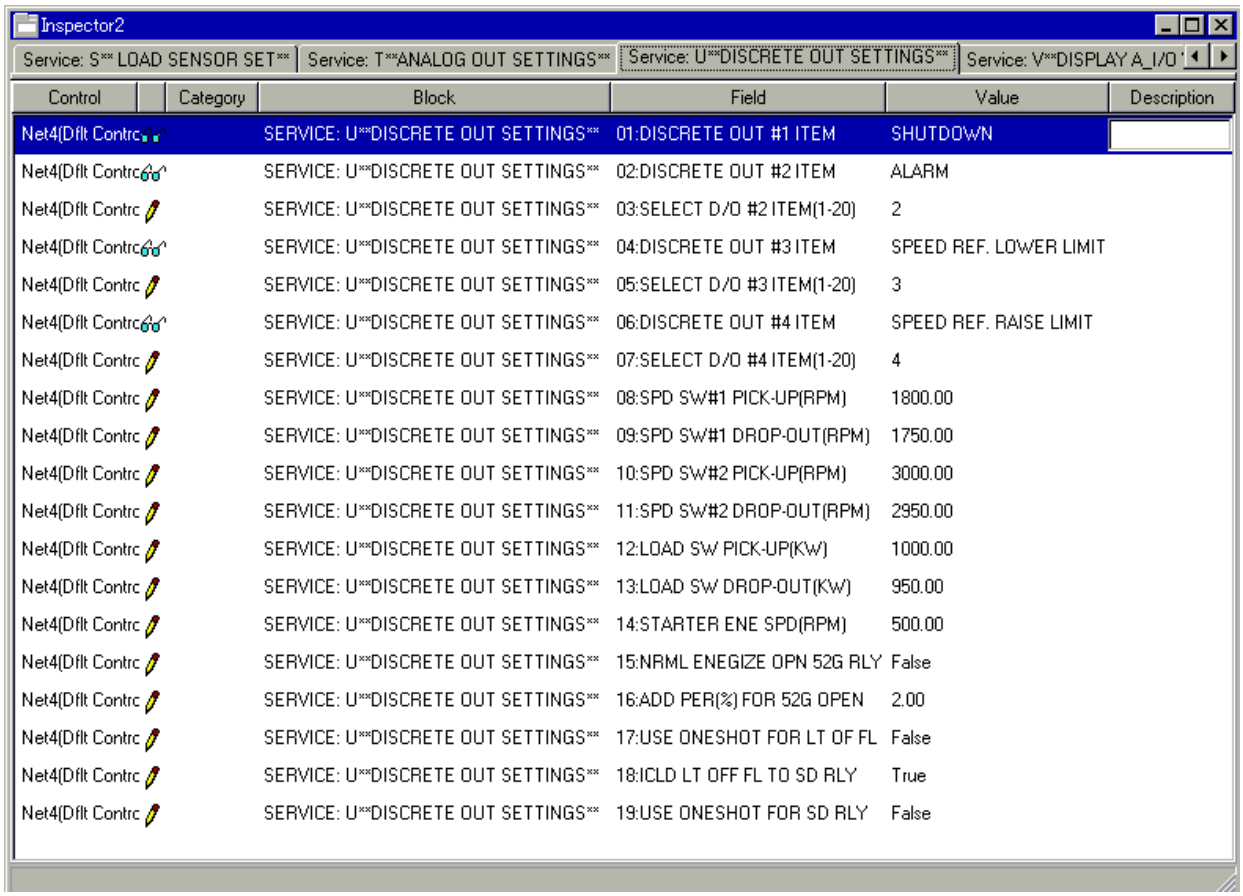


Figure 3-54. Service: U**DISCRETE OUT SETTINGS** Menu

This section determines the settings for Discrete Output (D/O) 2, 3, and 4.

01 DISCRETE OUT#1 ITEM displays the item name selected for terminal 41.

02 DISCRETE OUT#2 ITEM displays the item name selected for terminal 42.

03 SELECT D/O #2 ITEM (1-20) dflt=2(1,20)
Select one of the following parameters for discrete output at terminal 42.
1. SHUTDOWN
2. ALARM
3. SPEED REF. LOWER LIMIT
4. SPEED REF. RAISE LIMIT
5. SPEED SW1
6. SPEED SW2
7. OVERSPEED
8. SPEED IN CONTROL
9. EGT IN CONTROL
10. CDP LIMIT
11. LOAD SW
12. SPEED DERIV LIMIT REACHED
13. REMOTE SPEED SETPOINT ENABLED
14. MODBUS CONTROLLED RELAY1
15. MODBUS CONTROLLED RELAY2
16. SYNCHRONIZING ENABLED
17. LIGHT OFF FAIL
18. STARTER ENERGIZED
19. OPEN 52G BREAKER
20. LOAD LIMIT

04 DISCRETE OUT#3 ITEM displays the item name selected for terminal 43.

05 SELECT D/O #3 ITEM (1-20) dflt=3(1,20)
Select one of the following parameters for discrete output at terminal 43.
1. SHUTDOWN
2. ALARM
3. SPEED REF. LOWER LIMIT
4. SPEED REF. RAISE LIMIT
5. SPEED SW1
6. SPEED SW2
7. OVERSPEED
8. SPEED IN CONTROL
9. EGT IN CONTROL
10. CDP LIMIT
11. LOAD SW
12. SPEED DERIV LIMIT REACHED
13. REMOTE SPEED SETPOINT ENABLED
14. MODBUS CONTROLLED RELAY1
15. MODBUS CONTROLLED RELAY2
16. SYNCHRONIZING ENABLED
17. LIGHT OFF FAIL
18. STARTER ENERGIZED
19. OPEN 52G BREAKER
20. LOAD LIMIT

06 DISCRETE OUT#4 ITEM displays the item name selected for terminal 44.

07 SELECT D/O #4 ITEM (1-20) dflt=4(1,20)
Select one of the following parameters for discrete output at terminal 44.
1. SHUTDOWN
2. ALARM
3. SPEED REF. LOWER LIMIT
4. SPEED REF. RAISE LIMIT
5. SPEED SW1
6. SPEED SW2
7. OVERSPEED
8. SPEED IN CONTROL
9. EGT IN CONTROL
10. CDP LIMIT
11. LOAD SW
12. SPEED DERIV LIMIT REACHED
13. REMOTE SPEED SETPOINT ENABLED
14. MODBUS CONTROLLED RELAY1
15. MODBUS CONTROLLED RELAY2
16. SYNCHRONIZING ENABLED
17. LIGHT OFF FAIL
18. STARTER ENERGIZED
19. OPEN 52G BREAKER
20. LOAD LIMIT

08 SPD SW #1 PICK-UP (RPM) dflt=1800.0(0.0,32000.0)
The speed at which the discrete output driver at SW #1 is turned on (energized).

09 SPD SW #1 DROP-OUT (RPM) dflt=1750.0(0.0,32000.0)
The speed at which the discrete output driver at SW #1 is turned off.

10 SPD SW #2 PICK-UP (RPM) dflt=3000.0(0.0,32000.0)
The speed at which the discrete output driver at sw#2 is turned on (energized).

11 SPD SW #2 DROP-OUT (RPM) dflt=2950.0(0.0,32000.0)
The speed at which the discrete output driver at sw#2 is turned off.

12 LOAD SW PICK-UP (KW) dflt=1000.0(0.0,32000.0)
The load at which the discrete output driver at SW is turned on (energized).

13 LOAD SW DROP-OUT (KW) dflt=950.0(0.0,32000.0)
Discrete output driver at load SW is turned off when this load is reached

14 STARTER ENE SPD (rpm) dflt=500.0(0.0,32000.0)
Sets the speed the starter-energized relay will energize. This occurs when the actual speed falls below this value after the start input is closed.

15 NRML ENERGIZE OPN 52G RLY dflt=FALSE (TRUE, FALSE)
When false, OPN 52G RLY is energized to open 52G. If true, de-energized relay sends signal to open 52G..

16 ADD PER (%) FOR 52G OPEN dflt=2.0(0.0,100.0)
Sets the tolerance between actual load and unload value.

17 USE ONESHOT FOR LT OF FL dflt=FALSE (TRUE, FALSE)
Input whether LIGHT OFF FAIL relay is only one-shot or not at light off fail.

18 ICLD LT OFF FL TO SD RLY dflt=TRUE (TRUE, FALSE)
Input whether LIGHT OFF FAIL is included shutdown relay or not at light off fail.

19 USE ONESHOT FOR SD RLY dflt=FALSE (TRUE, FALSE)
Input whether SHUTDOWN relay is only one-shot or not at shutdown.

Relay Clarifications

1. SHUTDOWN
   See Figure 3-11.

2. ALARM
   The ALARM relay is normally de-energized. This relay will energize upon any alarm condition and stay energized until all alarms have been cleared and reset.

3. SPEED REF. LOWER LIMIT
   When the speed reference come down to the value configured by 'LOWER SPD LIMIT (RPM)' (CONFIGURE: A**SPD SETTING or SERVICE: P**SPD CONTROL SET**), this relay will energize.

4. SPEED REF. RAISE LIMIT
   When the speed reference come up to the value configured by 'RAISE SPD LIMIT (RPM)' (CONFIGURE: A**SPD SETTING or SERVICE: P**SPD CONTROL SET**), this relay will energize. But this relay stay de-energized while overspeed test mode.

5. SPEED SW1
   See 'SPD SW#1 PICK-UP (RPM)' and 'SPD SW#1 DROP-OUT (RPM)'. (SERVICE: U**DISCRETE OUTPUT SETTING**)

6. SPEED SW2
   See 'SPD SW#2 PICK-UP (RPM)' and 'SPD SW#2 DROP-OUT (RPM)'. (SERVICE: U**DISCRETE OUTPUT SETTING**)

7. OVERSPEED
   When the actual speed reaches the value configured by 'OVSPD SET (RPM)' (CONFIGURE: A**SPD SETTING or SERVICE: P**SPD CONTROL SET**), this relay will energize.

8. SPEED IN CONTROL
   When the speed control is selected, this relay will energize.

9. EGT IN CONTROL
   When the EGT control is selected, this relay will energize.

10. CDP LIMIT
    When the accel limit or decel limit control is selected, this relay will energize.

11. LOAD SW
    See 'LOAD SW PICK-UP (KW)' and 'LOAD SW DROP-OUT (KW)'. (SERVICE: U**DISCRETE OUTPUT SETTING**)

12. SPEED DERIV LIMIT REACHED
    If the speed accel derivative or speed decel derivative control is selected, this relay will energize.

13. REMOTE SPEED SETPOINT ENABLED
    See Figure 3-38

14. MODBUS CONTROLLED RELAY1
    See Figure 3-53

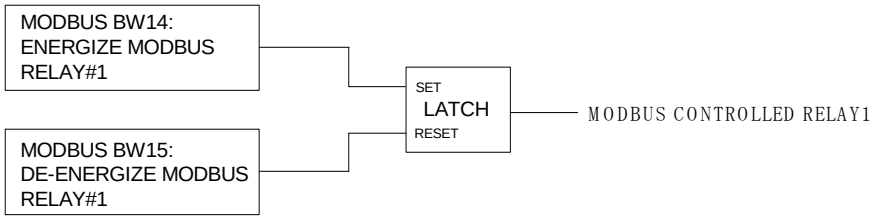


Figure 3-55. MODBUS CONTROLLED RELAY#1

15. MODBUS CONTROLLED RELAY2
    See Figure 3-54.

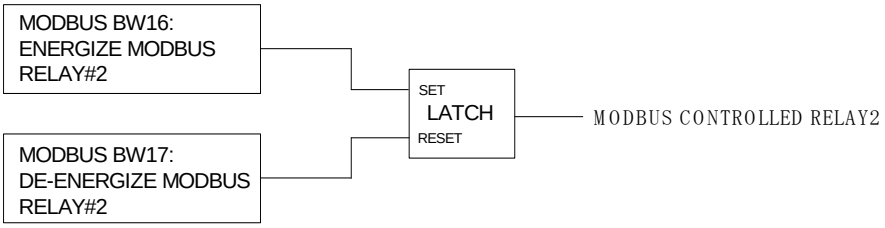


Figure 3-56. MODBUS CONTROLLED RELAY#2

16. SYNCHRONIZING ENABLED
    When the actual speed reaches the value configured by 'SYNCHRO ENBL SPD (RPM)'. (SERVICE: U**DISCRETE OUTPUT SETTING**) and not DROOP mode ,this relay will energize. (DROOP mode means 52G BREAKER contact input is closed and ISO/DROOP contact input is open)

17. LIGHT OFF FAIL
    See Figure 3-32

18. STARTER ENERGIZED
    The STARTER ENERGIZED relay energizes after start input when the actual speed reaches the value configured by 'STARTER ENE SPD (RPM)'. (SERVICE: U**DISCRETE OUTPUT SETTING**)
    .

19. OPEN 52G RELAY
    The OPEN 52G RELAY is actives after actual load and load reference is about unload value. And the relay is actives only 1 second when it is shutdown.

20. LOAD LIMIT
    When the load limit control is selected, this relay will energize.

V** DISPLAY A_I/O VAL **

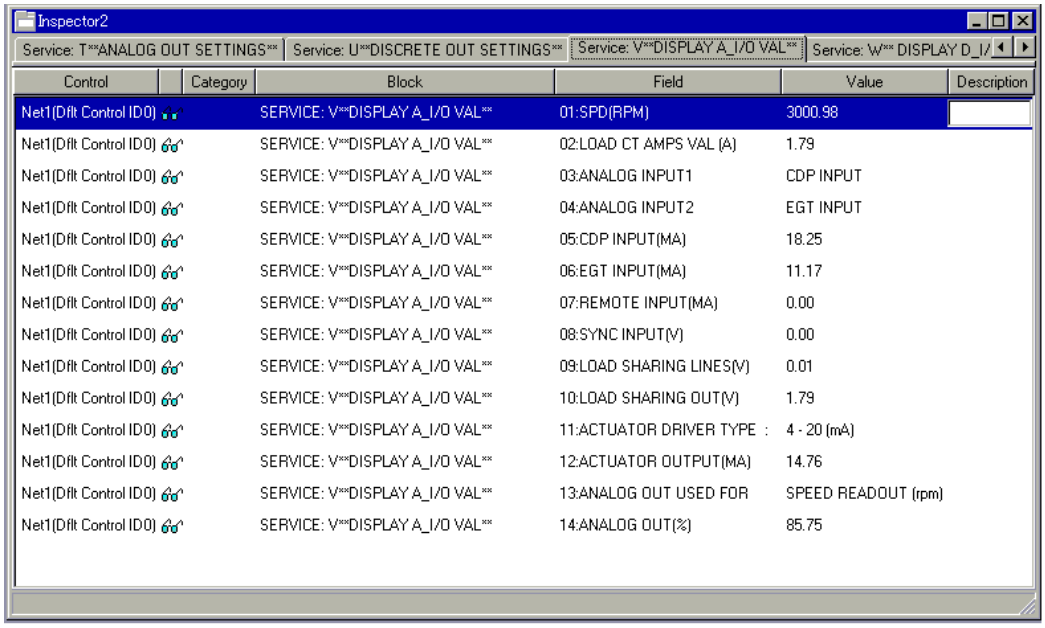


Figure 3-57. Service: V**DISPLAY A_I/O VAL** Menu

This section displays the analog inputs to and the outputs from the control.

01 SPD (rpm)—actual turbine speed.

02 LOAD CT AMPS VAL (A)—the current of load input.

03 ANALOG INTPUT1—the input signal selected for terminals 19, 20, and 21. (CDP INPUT, EGT INPUT, REMOTE SPEED SETPOINT INPUT, SPM-A INPUT, or NOT USED)

04 ANALOG INTPUT2—the input signal selected for terminals at terminals 22, 23, and 24. (CDP INPUT, EGT INPUT, REMOTE SPEED SETPOINT INPUT, SPM-A INPUT, or NOT USED)

05 CDP INPUT (mA)—the current of CDP input. If it is equal to 0, there is no signal or it hasn't been selected.

06 EGT INPUT (mA)—the current of EGT input. If it is equal to 0, there is no signal or it hasn't been selected.

07 REMOTE INPUT (mA)—REMOTE SPEED SETPOINT input. If it is equal to 0, there is no signal or it hasn't been selected.

08 SYNC INPUT (V)—the voltage input from a synchronizer. If it is equal to 0, there is no signal or it hasn't been selected.

09 LOAD SHARING LINES (V) reads the voltage at terminals 10 and 11.

10 LOAD SHARING OUT (V)—the voltage output to terminals 10 and 11.

11 ACTUATOR DRIVER TYPE:—the output range selected for terminals 13, 14, and 15. ('20−160(mA)' or '4−20(mA)')

12 **ACTUATOR OUTPUT (mA)** is the calculated actuator output current in milliamps. This calculation is based on the percent fuel demand and the actuator driver type selected. External wiring may affect the accuracy of the actual current.

13 **ANALOG OUT USED FOR:**—the output signal selected for terminals 16, 17, and 18. (SPD READOUT (rpm), SPEED REF. READOUT (rpm), EGT READOUT, CDP READOUT, KW SIG. READOUT (kW), ACTUATOR READOUT, or FORCE OUTPUT TEST)

14 **ANALOG OUT (%)—**the current of analog output.

W** DISPLAY D_I/O STATUS **

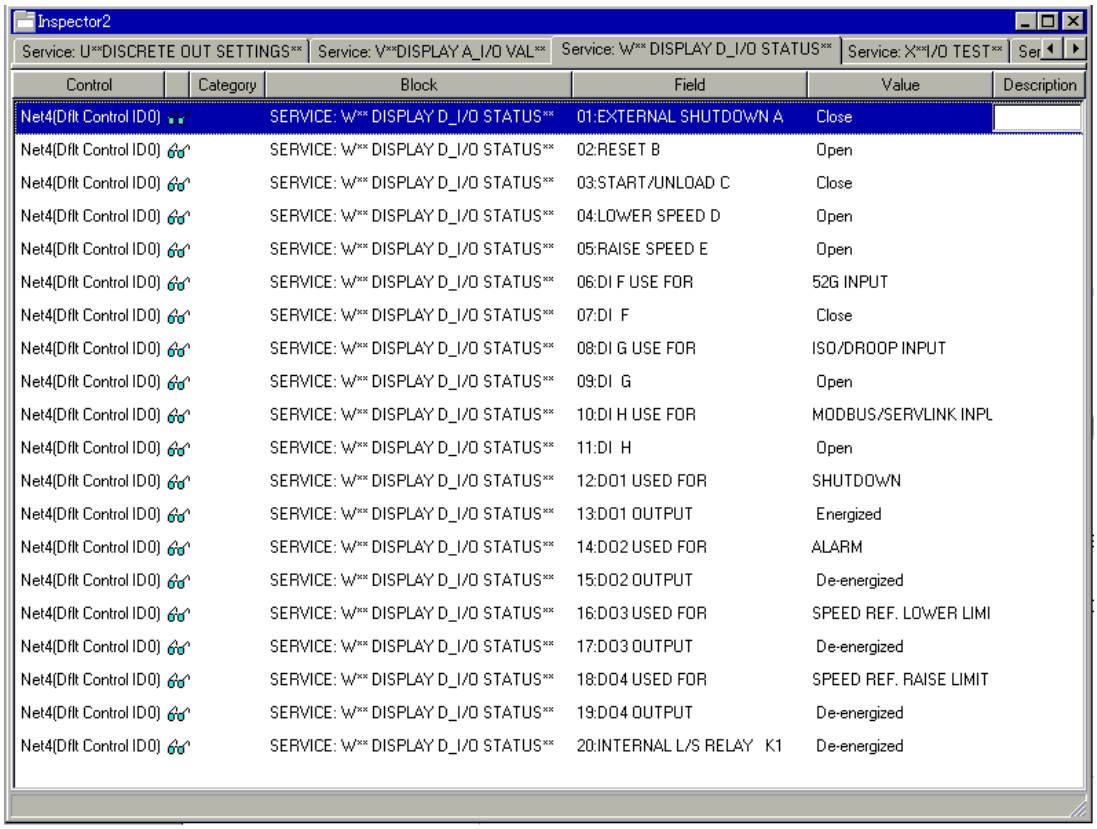


Figure 3-58. Service: W**DISPLAY I/O STATUS** Menu

This section is used only for display of OPEN or CLOSED status of discrete inputs and the ON or OFF status of the discrete outputs.

01 **EXTERNAL SHUTDOWN A**—status of discrete input A at terminal 31

02 **RESET B**—status of discrete input B at terminal 32

03 **START/UNLOAD C**—status of discrete input C at terminal 33

04 **LOWER SPEED D**—status of discrete input D at terminal 34

05 **RAISE SPEED E**—status of discrete input E at terminal 35

06 **DI F USE FOR**—the output name selected for terminals at terminals 36.

07 **DI F**—status of discrete input F at terminal 36

08 **DI G USED FOR**—the output name selected for terminals at terminals 37.

09 **DI G**—status of discrete input G at terminal 37

10 **DI H USED FOR**—the output name selected for terminals at terminals 38.

11 **DI H**—status of discrete input H at terminal 38

12 **DO1 USED FOR**—the item name selected for terminals 41.

13 **DO1 OUTPUT—**status of discrete output DO-1.

14 **DO2 USED FOR**—the item name selected for terminals 42.

15 **DO2 OUTPUT**—status of discrete output DO-2.

16 **DO3 USED FOR**—the item name selected for terminals 43.

17 **DO3 OUTPUT**—status of discrete output DO-3.

18 **DO4 USED FOR**—the item name selected for terminals 44.

19 **DO4 OUTPUT**—status of discrete output DO-4.

20 **INTERNAL L/S RELAY K1**—status of discrete output driving the internal load-sharing relay.

X*I/O TEST**

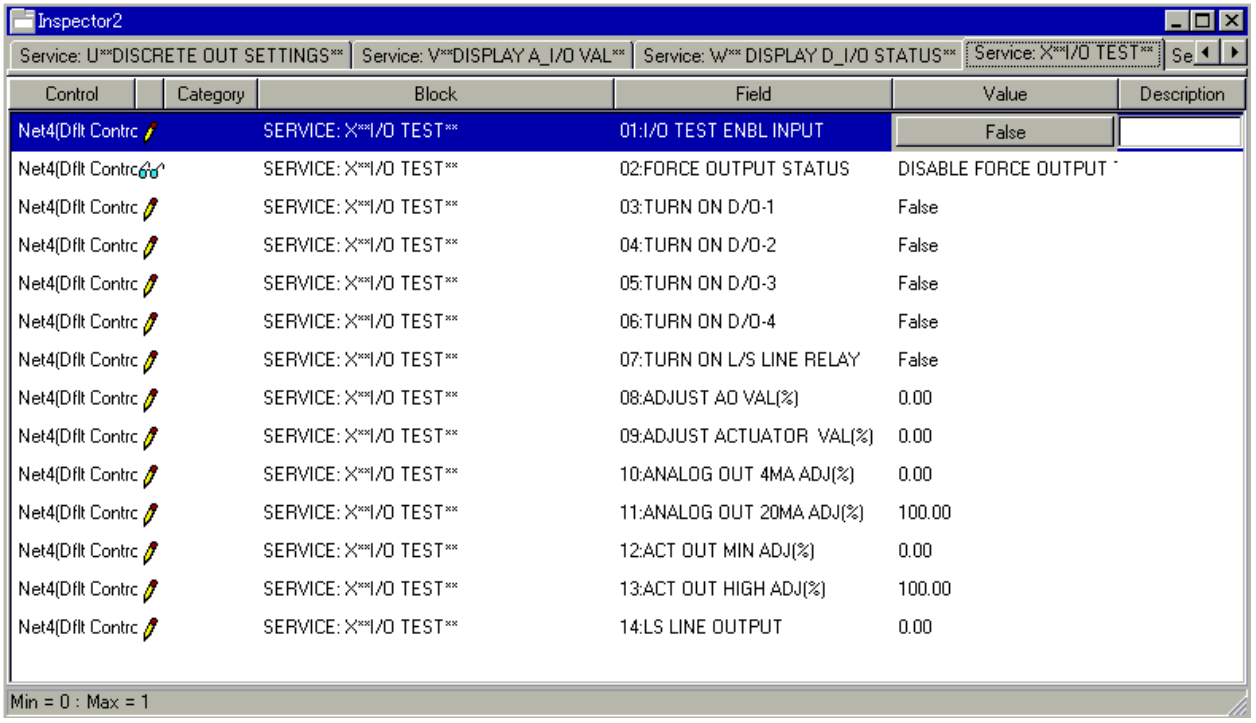


Figure 3-59. Service: X**I/O TEST** Menu

This section allows the operator to test the relay driver outputs and the analog output by artificially forcing its signal. The turbine must be shutdown to enable these tests. If the test is enabled, the actuator output will be the value set to '09 ADJUST ACTUATOR VAL (%)'.

01 I/O TEST ENBL INPUT dflt=FALSE (FALSE, TRUE)
When the turbine speed is zero, this input should be TRUE after 'CONFIGURE: F**I/O TEST** I/O TEST INPUT' is TRUE. The status below 02 will display 'ENABLE FORCE OUTPUT TEST'.
If I/O test is finished, these two settings should be FALSE.

02 FORCE OUTPUT STATUS—the following status.
If the I/O TEST is enabling, display changes to
'ENABLE FORCE OUTPUT TEST'.
If the above setting is right, display changes to
'DISABLE FORCE OUTPUT TEST'.
If the turbine speed is 30% or more, display changes to
'DISABLE FOR SPEED INPUT'.

03 TURN ON D/O-1 dflt=FALSE (FALSE, TRUE)
Tune to TRUE to turn the driver output #1 on.

04 TURN ON D/O-2 dflt=FALSE (FALSE, TRUE)
Tune to TRUE to turn the driver output #2 on.

05 TURN ON D/O-3 dflt=FALSE (FALSE, TRUE)
Tune to TRUE to turn the driver output #3 on.

06 TURN ON D/O-4 dflt=FALSE (FALSE, TRUE)
Tune to TRUE to turn the driver output #4 on.

07 TURN ON L/S LINE RELAY dflt=FALSE (FALSE, TRUE)
Tune to TRUE to energize the internal load-sharing relay, watch the green LED between terminals 9 and 10.

08 ADJUST AO VAL (%) dflt=0.0(0.0,100.0)
Adjust 0 to 100 for analog output at terminal blocks16 and 17 to change from 4 to 20 mA.

09 ADJUST ACTUATOR VAL (%) dflt=0.0(0.0,100.0)
Adjust 0 to 100 for analog output at terminals 13 and 14 to change to the calculated current.

10 ANALOG OUT 4mA ADJ (%) dflt=0.0(-20.0,20.0)
Adjust this value for an output of 4mA if the externally measured output is incorrect.

11 ANALOG OUT 20 mA ADJ (%) dflt=100.0(80.0,120.0)
Adjust this value for an output of 20 mA if the externally measured output is incorrect.

12 ACT OUT MIN ADJ (%) dflt=0.0(-20.0,20.0)
Adjust this value for a minimum current output when the output measured externally is incorrect.

13 ACT OUT HIGH ADJ (%) dflt=100.0(80.0,120.0)
Adjust this value for a maximum current output when the output measured externally is incorrect.

14 LS LINE OUTPUT dflt=0.0(0.0,750.0)
Adjust this value for a load sharing line voltage output when L/S LINE RELAY is close. This tuning value (0.0-750.0) output the range of 0.0–3.75 Vdc.

Y*MODBUS**

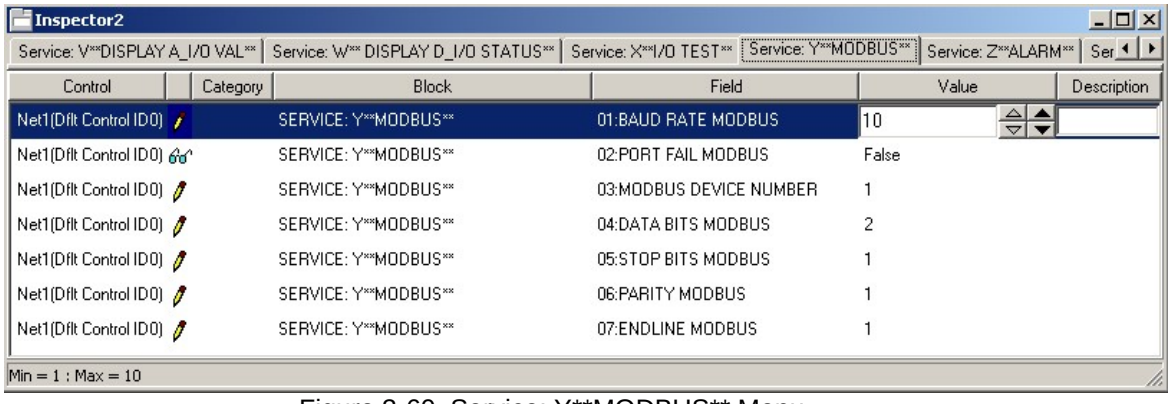


Figure 3-60. Service: Y**MODBUS** Menu

A setup about Modbus is performed.

01 BAUD RATE MODBUS dflt=10(1,10)
Adjust this value for the baud rate.
1:110
2:300
3:600
4:1200
5:2400
6:300
7:4800
8:9600
9:19200
10:38400

02 PORT FAIL MODBUS
When Port Fail Status output is TRUE, this indicates a hardware fault existing on the connected SIO port; and when it is FALSE, it shows that the hardware is operational.

03 MODBUS DEVICE NUMBER dflt=1(1,247)
Enter the integer corresponding to the Modbus device number/address. This is required.

04 DATA BITS MODBUS dflt=1(1,2)
Adjust this value for the data bits.
1:1 bit
2:2 bits

05 STOP BITS MODBUS dflt=1(1,3)
Adjust this value for the stop bits.
1:1 bit
2:1.5 bits
3:2 bits

06 PARITY MODBUS dflt=1(1,3)
Adjust this value for the parity.
1:OFF
2:ODD
3:EVEN

07 ENDLINE MODBUS dflt=1(1,3)
Adjust this value for the endline.
1:LF
2:CR
3:CRLF

Z** ALARM **

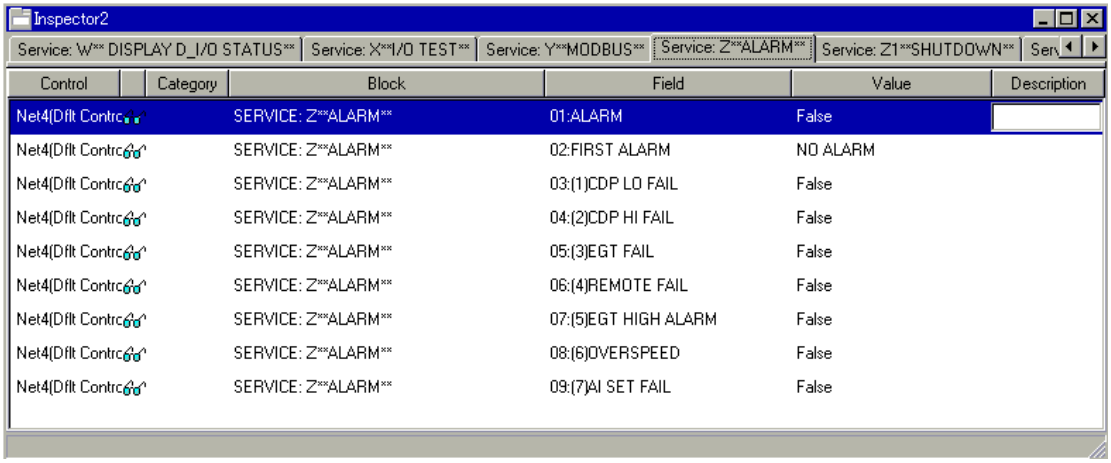


Figure 3-61. Service: Z**ALARM** Menu

This section shows the status of alarm detector.

01 **ALARM**—status of ALARM. If governor has the following alarms, this goes TRUE.

02 **FIRST ALARM**—status of FIRST ALARM. If the governor alarms, the number indicates the following as first alarm triggered:
1: CDP LO FAIL
2: CDP HI FAIL
3: EGT FAIL
4: REMOTE FAIL
5: EGT HIGH ALARM
6: OVERSPEED
7: ANALOG INPUT SET FAIL

03 **(1) CDP LO FAIL**—status of CDP lo signal fail on alarm bus.

04 **(2) CDP HI FAIL**—status of CDP hi signal fail on alarm bus.

05 **(3) EGT FAIL**—status of EGT fail on alarm bus.

06 **(4) REMOTE FAIL**—status of REMOTE fail on alarm bus.

07 **(5) EGT HIGH ALARM—**status of EGT HIGH ALARM on alarm bus.

08 **(6) OVERSPEED**—status of OVERSPEED on alarm bus.

09 **(7) AI SET FAIL**—status of ANALOG INPUT SE FAIL on alarm bus. If chose the same number in analog input1 and analog input2.

Z1** SHUTDOWN **

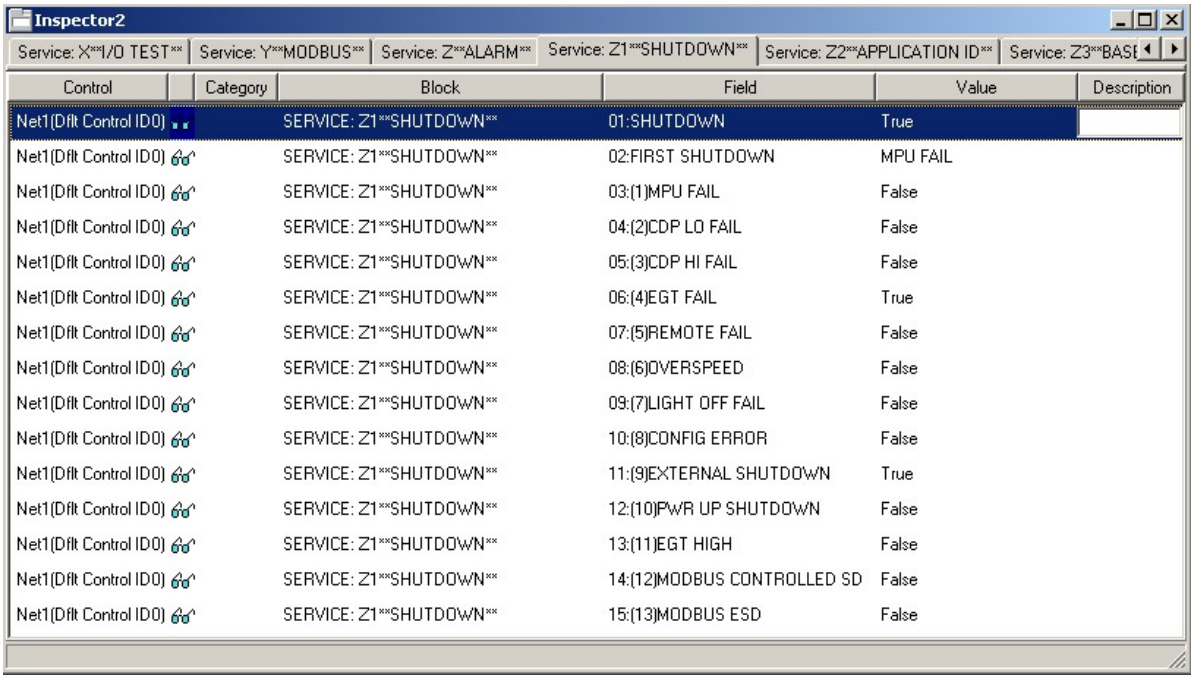


Figure 3-62. Service: Z1**SHUTDOWN** Menu

This section shows status of shutdown detector.

01 **SHUTDOWN**—status of SHUTDOWN. If governor has the following shutdown, TRUE is displayed.

02 FIRST SHUTDOWN—status of FIRST SHUTDOWN. If the governor shuts down, the number indicates the following as first shutdown triggered:

1: MPU FAIL
2: CDP LO FAIL
3: CDP HI FAIL
4: EGT FAIL
5: REMOTE HIGH
6: OVERSPEED
7: LIGHT OFF FAIL
8: CONFIG ERROR
9: EXTERNAL SHUTDOWN
10: PWR UP SHUTDOWN
11: EGT HIGH
12: MODBUS CONTROLLED SD
13: MODBUS ESD

03 **(1) MPU FAIL**—status of MPU fail on shutdown bus.

04 **(2) CDP LO FAIL**—status of CDP lo signal fail on shutdown bus.

05 **(3) CDP HI FAIL**—status of CDP hi signal fail on shutdown bus.

06 **(4) EGT FAIL**—status of EGT fail on shutdown bus.

07 **(5) REMOTE FAIL**—status of REMOTE FAIL on shutdown bus.

08 **(6) OVERSPEED**—status of OVERSPEED on shutdown bus.

09 **(7) LIGHT OFF FAIL**—status of LIGHT OFF FAIL on shutdown bus.

10 **(8) CONFIG ERROR**—status of Config Error on shutdown bus. If this displays TRUE, confirm there are not the following conflicts present:.

1. 'CONFIGURE: X F**I/O TEST' I/O TEST INPUT is TRUE or 'SERVICE: X**I/O TEST' is TRUE.
2. START FUEL RAMP is enabled and
   Both 'SERVICE: J**FLM ON TO TRG LMTR' is FALSE and 'SERVICE: J**SPD SW TO TRG LMTR' is FALSE.
3. LIGHT OFF FAIL logic is enabled and EGT signal isn't selected on the analog input setting.

11 **(9) EXTERNAL SHUTDOWN**—status of EXTERNAL SHUTDOWN on shutdown bus.

12 **(10) PWR UP SHUTDOWN**—status of power up shutdown on shutdown bus.

13 **(11) EGT HIGH**—status of EGT HIGH on shutdown bus.

14 **(12) MODBUS CONTROLLED SD**—status of MODBUS CONTROLLED SD on shutdown bus.

15 **(13) MODBUS ESD**—status of MODBUS ESD on shutdown bus.

Z2** APPLICATION ID **

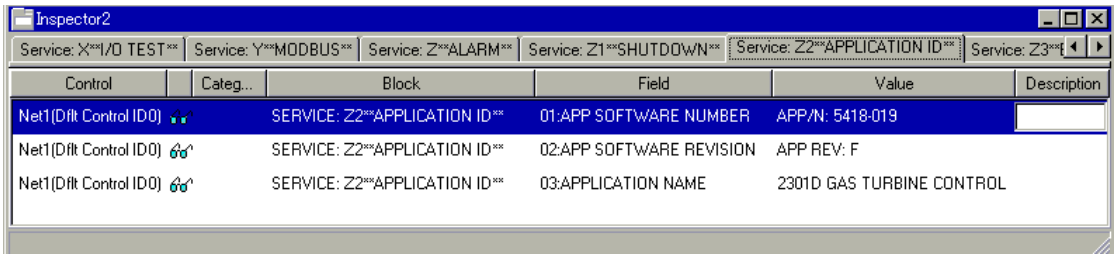


Figure 3-63. Service: Z2**APPLICATION ID** Menu

This section shows status of application ID.

01 **APP Software Number**—status of software number.

02 **APP Software Revision**—status of software revision.

03 **Application Name**—status of application name.

Z3**BASE LOAD**

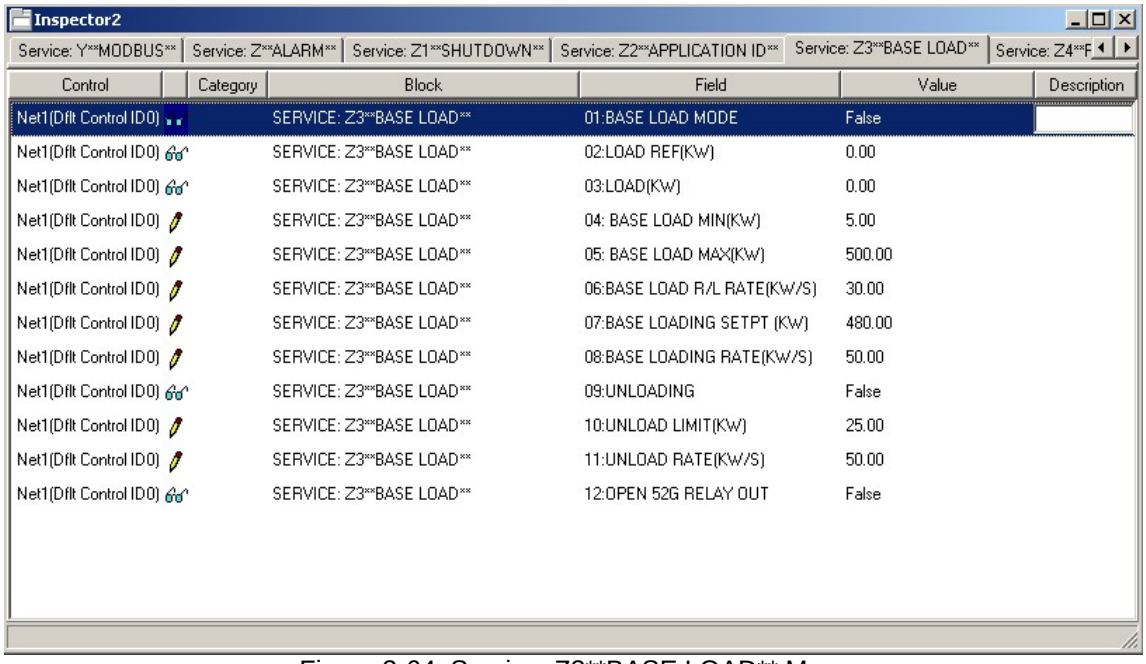


Figure 3-64. Service: Z3**BASE LOAD** Menu

This block sets up the base load control values.

01:BASE LOAD MODE—Indicated whether base load control is available or not.

02:LOAD REF (kW)—indicate load reference.

03:LOAD (kW)—indicate actual load.

04:BASE LOAD MIN (kW) dflt=5.0(0.0,32000.0)
Set to the lower limit of load in (kW) for a tunable Load Reference.

05:BASE LOAD MAX (kW) dflt=500.0(0.0,32000.0)
Set to the raise limit of load in (kW) for a tunable Load Reference.

06:BASE LOAD R/L RATE (kW/s) dflt=30.0(0.1,10000.0)
Set to the rate of load reference in (kW) for a tunable Load Reference rate.

07:BASE LOADING SETPT (kW) dflt=480.0(0.0,32000.0)
Set to the loading reference when it is base load mode.

08:BASE LOADING RATE (kW/s) dflt=50.0(0.1,10000.0)
Set to the rate of loading while base loading.

09:UNLOADING—Indicate whether control is in unloading mode or not.

10:UNLOADING LIMIT (kW) dflt=25.0(0.0,32000.0)
Set to the unloading reference when it is unloading mode.

11:UNLOAD RATE (kW/s) dflt=50.0(0.1,10000.0)
Set to the rate of unloading while unloading.

12:OPEN 52G RELAY OUT—Indicate whether open 52G relay active or not.

Z4**REMOTE BASE LOAD**

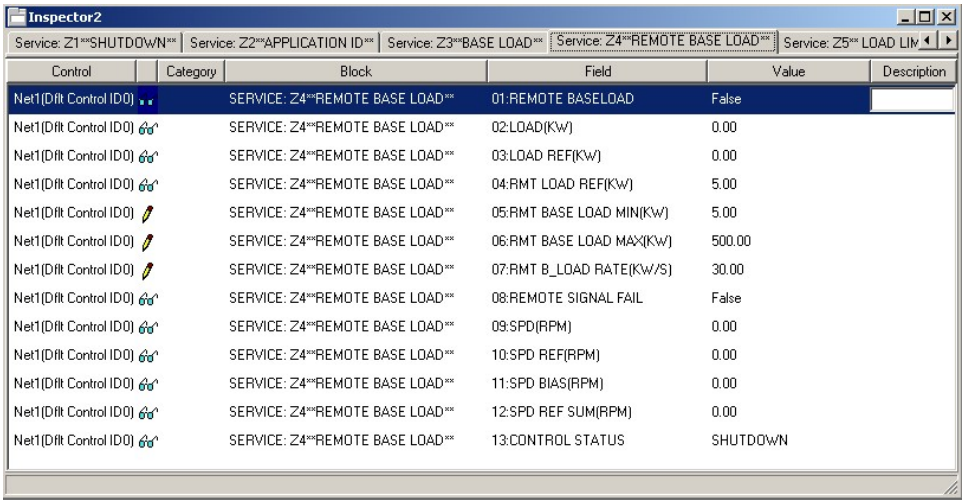


Figure 3-65. Service: Z4**REMOTE BASE LOAD** Menu

This block sets up the remote base load control values.

01:REMOTE BASE LOAD MODE—Indicate whether remote base load control or not.

02:LOAD (kW)—indicates actual load.

03:LOAD REF (kW)—indicates load reference.

04:RMT LOAD REF (kW)—indicates input value of remote load reference.

05:RMT BASE LOAD MIN (kW) dflt=5.0(0.0,32000.0)
Set to the 4mA value of remote input signal.

06:RMT BASE LOAD MAX (kW) dflt=500.0(0.0,32000.0)
Set to the 20 mA value of remote input signal.

07:RMT B_LOAD RATE (kW/s) dflt=30.0(0.1,10000.0)
Set to the rate of load reference in (kW) for remote base load control.

08:REMOTE SIGNAL FAIL—indicates remote signal fail.

09:SPD (rpm)—indicates actual speed.

10:SPD REF (rpm)—indicates speed reference.

11:SPD BIAS (rpm)—indicates speed bias.

12:SPD REF SUM (rpm)—indicates speed reference sum.

13:CONTROL STATUS—indicates control status.

Z5LOAD LIMIT ****

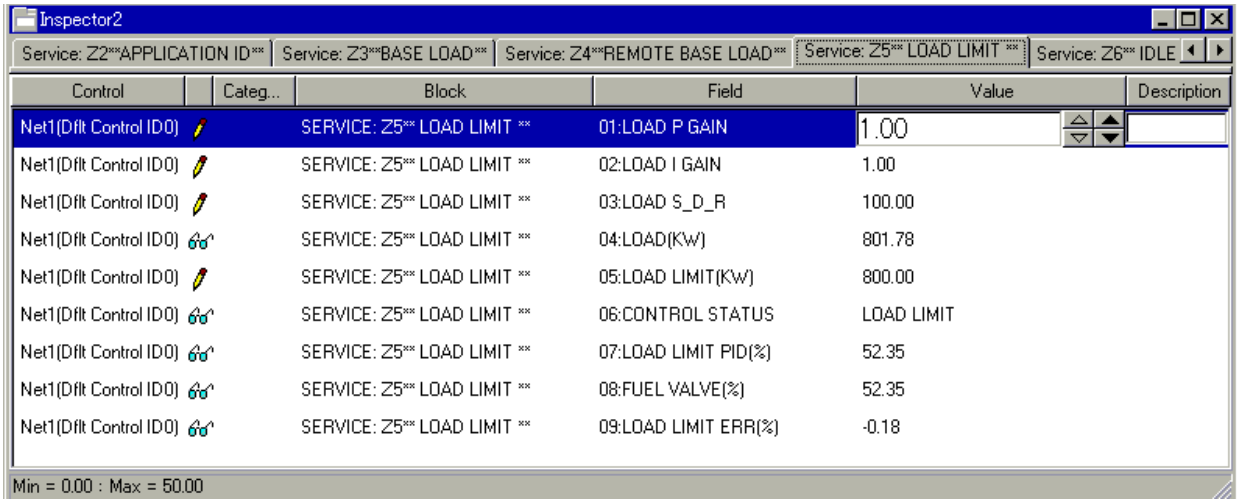


Figure 3-66. Service: Z5**LOAD LIMIT** Menu

Dynamic adjustments are settings that affect the stability and transient performance of the gas turbine.

01 LOAD P GAIN dflt=1.0(0.0,50.0)
Determines how fast the control responds to an error in actual LOAD from the LOAD REF setting.

02 LOAD I GAIN dflt=1.0(0.0,50.0)
Compensates for the lag time of the gas turbine. It adjusts the time required for the control to return the load to zero error after a disturbance. I GAIN is adjusted to prevent slow hunting.

03 LOAD S_D_R dflt=100.0(0.01,100.0)
Compensates for the actuator and fuel system time constant. Increasing compensation increases actuator activity and transient performance.

04 LOAD (kW)—indicate actual load.

05 LOAD LIMIT (kW) dflt=800.0(0.01,32000.0)
Input the value of LOAD LIMIT.

06 CONTROL STATUS reflects the CONTROL STATUS.

07 LOAD LIMIT PID (%) indicates the LOAD LIMIT PID.

08 FUEL VALVE (%) displays the FUEL VALVE position as the control signal.

09 LOAD LIMIT ERR (%) displays the percent of an error in actual LOAD from the LOAD LIMIT.

Z6IDLE RATED ****

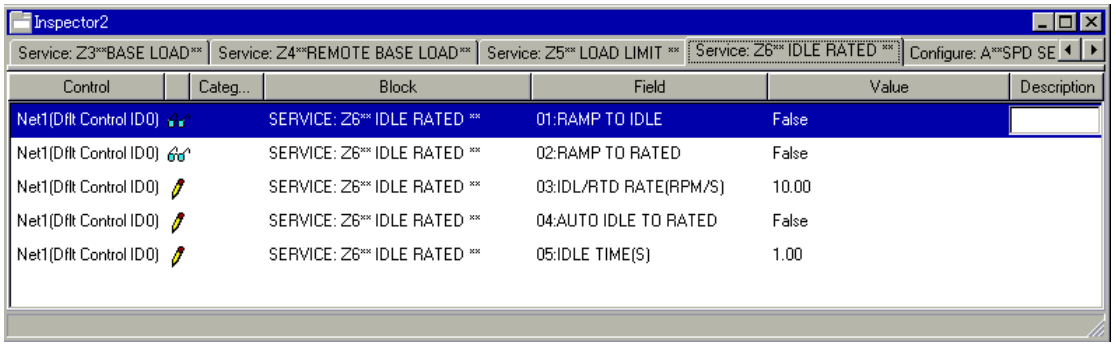


Figure 3-67. Service: Z6**IDLE RATED** Menu

01 RAMP TO IDLE

Indicate whether speed reference is ramping to idle setpoint as controlled by idle/rated function.

02 RAMP TO RATED

Indicate whether speed reference is ramping to rated setpoint as controlled by idle/rated function.

03 IDL/RTD RATE (rpm/s) dflt=10.0(0.0,10000.0)

Set the rate at which speed reference ramps to setpoint as controlled by idle/rated function

04 AUTO IDLE TO RATED dflt=FALSE (TRUE, FALSE)

Set to true if auto idle to rated function is desired.

04 IDLE TIME(s) dflt=1.0(0.0,600.0)

Set the idle time until go to rated when using auto idle to rated function.

⚠WARNING

Read this entire procedure before starting the prime mover.

Start-up Adjustments

1. Complete the Installation Procedure in Chapter 2 and the configuration procedure in this chapter.

NOTICE

Be sure the Rated Speed and Number of Teeth are set correctly for your application as described earlier in this chapter.

2. Apply input power to the control.
3. Check the speed reading.

When using a signal generator to verify the proper configuration setting, set the signal generator for the frequency of the speed sensor at rated speed and connect it to terminals 25 and 26. (The rated speed frequency in Hz equals the rated turbine speed in rpm times the number of teeth on the speed sensing gear divided by 60.)

Open the Service Menu A** MONITOR**: 01 SPD (rpm). The value should be equal to the RATED Speed (rpm). If the Monitor value is different, check the configuration parameters, such as Number of Gear teeth, etc.

Check Speed Sensor

Minimum voltage required from the speed sensor to operate the electronic control is 1.0 Vrms, measured at the lowest controlling speed. For this test, measure the voltage while spinning for purge, with the speed sensor connected to the control. Before purge, be sure to prevent the turbine from starting.

⚠WARNING **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.**

Check the Discrete Inputs.
The input switch or relay contact used to activate Discrete Input A to H. opens the Service Menu W** DISPLAY D I/O STATUS** window. Check to see if the Contact A to H displays TRUE (Close Contact) or FALSE (Open Contact). Discrete Input H should be confirmed on I/O TEST mode to prevent the MODBUS from being changed.

Check the Analog Inputs.
When using a signal generator to verify the proper configuration setting, set the signal generator for 4–20 mA signals, and connect it to each terminal. Open the Service Menu V** DISPLAY ANALOG I/O**: 03, 04 to see if the readings are correct for the signals supplied.

Function and I/O Setting

Set appropriate values to setpoints A-E in Configure menus, which determine functions and I/Os to be used and input/output ranges of I/Os.

Next, investigate which setpoints are set to 'True' under ‘O** ENBLE CONTROL** header in Service mode.

If there is any setpoint set to 'True', refer to Table 3-1 and set associated setpoints in Service menu to specified values in the table.

Thus, the control is configured to fit the turbine system.

Dynamic Adjustment

The object of the P_GAIN and I_GAIN adjustment is to obtain the optimum, or desired, stable prime mover speed response. Connect a dc analog voltmeter to terminals 13(+) and 14(–) to monitor the actuator voltage.

Increasing the setting of the P_GAIN to provide faster transient response (decreases the magnitude of the speed change from a sudden change in load). To achieve optimum response, slowly increase the P_GAIN until the voltage on the voltmeter becomes slightly unstable, then slowly lower the P_GAIN as necessary to stabilize the meter reading. Step load the generator, bump the actuator terminal shaft to make sure that the prime mover returns to the proper speed with little overshoot or undershoot of the speed setting. To reduce overshoot, decrease the I_GAIN. When the I_GAIN is in the lower part of its adjustment (0 to 3 on the scale), decreasing the I_GAIN clockwise may require decreasing the P_GAIN (turning the P_GAIN counterclockwise) to maintain stable operation. If the prime mover is slow in returning to the proper speed, increase the I_GAIN.

Speed Sensor Check

Measure the voltage across terminals 25 and 26 to be sure there is a minimum of 1.0 Vrms at low limit speed and a maximum of 30 Vrms at rated speed. If the voltage exceeds 30 Vrms, increase the gap of the speed sensor and be sure that there is still a minimum of 1.0 Vrms at low limit speed.

Current Transformer (CT) Phasing Check

IMPORTANT

This control contains internal current transformers. Due to their low impedance, shorting their inputs is not effective. The current input must be removed from the control and shorted externally.

⚠WARNING

HIGH VOLTAGE—Never disconnect any wire attached to load sensor terminals 4 through 9 when the prime mover is running unless temporary 0.5 Ω, 20 W resistors are installed as shown in Figure 3-68 and all load is removed. The current transformers can develop dangerously high voltages when open circuited while the prime mover is running.

1. Go to the **A**MONITOR **** sheet and observe **06 LOAD (kW) and S**LOAD SENSOR SET**, 07 MONITOR/LOAD SIGNAL (V)** to measure the load sensor output. The displayed values are not yet calibrated to read Kilowatts, but are used here for reference.

2. Start the prime mover. With the generator operating in the isochronous mode and not in parallel, load the generator to as near full load as possible.

3. Use a clamp-on ammeter and measure the per phase current of the Current transformer output. Check that current in each of the three CTs is equal. In a balanced three phase system the Load Signal Out reading will be approximately:

   (Rated KW Setting) x (Percent of Sensed Rated Current x Power Factor) = Load (KW) display value
   power factor = cos(phase angle between voltage and current)

4. If the Load Signal Out Reading is within 10% of the above calculation, the PT/CT phasing is correct. If the phasing is incorrect, proceed to the Phase Correction Procedure. If the phasing appears correct, skip the Phase Correction Procedure and go to the Load Calibration Adjustment procedure.

IMPORTANT

If after completing the LOAD SENSOR CALIBRATION and DROOP adjustments, the control loading is extremely sensitive to changes in the power factor when operating in parallel, complete the phase correction procedure.

IMPORTANT

The most accurate calibration is made at full load. However, if it is not possible to run the generator set at full load, run it at less than full load and reduce the voltage reading given in this calibration procedure proportionally. For example: run a 200 kW generator set at 100 kW and divide all voltages given in this calibration procedure by 2. If you reduce the load in this manner, be sure to reduce it by the same amount throughout the calibration procedure.

Phase Correction Procedure

IMPORTANT

This procedure requires a minimum power factor of (.9). If a 0.9 power factor cannot be obtained, tracing through the wiring is the only means of correcting the current transformer phasing.

The highest positive reading of kW or Load Signal Out will be obtained when the CTs are correctly matched to the load sensor terminals in both phase and polarity. The following procedure will assure the correct connection of the current transformers. It is required only if the phasing checks displays incorrect phasing, or loading stability is extremely sensitive to the power factor.

Make trial connections of the first CT to all three load sensor inputs, polarized both ways (a total of six connections). Record the Load Signal Out reading for each connection. Connect the first CT to the terminals that produce the highest positive reading and with the polarity that produces the highest positive voltage. The displayed Load Gain reading is limited to ≈ 0.2, therefore a negative reading displays a phasing or polarity error.

Try the second CT on each of the remaining two CT input terminals, in each polarity and record the Load Signal Out reading. Connect the second CT to the terminals that produce (and with the polarity that produces) the highest positive reading.

Try the last CT on the remaining input terminals, polarized both ways and record the voltage. Connect the last CT in the polarity that produces the highest Load Signal Out reading.

The Phase Correction Procedure requires that the prime mover be shut down many times to disconnect the current transformers. For convenience, a temporary method of connecting the current transformers shown in Figure 3-62 is recommended. Connecting a 0.5 Ω, 20 W burden resistor across each current transformer allows the current transformers to be disconnected from the terminal strip with the prime mover running without any load.

⚠WARNING

HIGH VOLTAGE—The current transformers can develop dangerously high voltages. Do not disconnect a current transformer while the prime mover is running unless temporary 0.5 Ω, 20 W resistors are installed as shown in Figure 3-68 and all loads is removed.

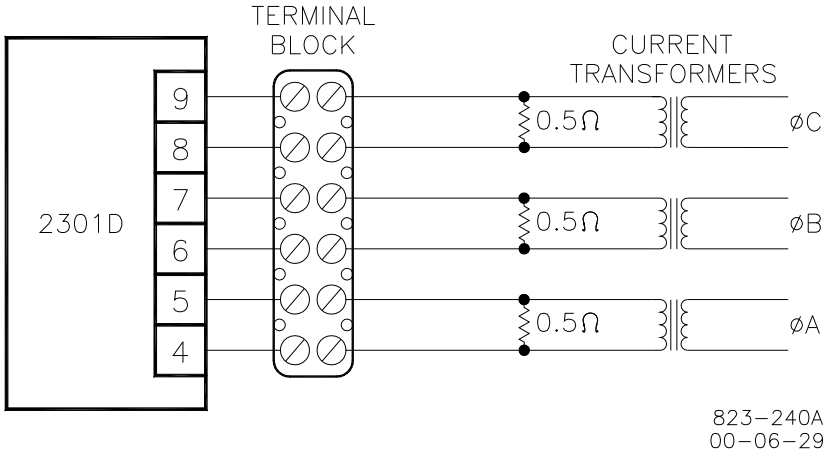


Figure 3-68. Temporary Wiring for Transformer Phase Correction

If the temporary burden resistors described above and shown in Figure 3-62 are not used, the prime mover MUST be shut down in addition to removing the load in the following procedure.

Monitor the load sensor output in this procedure by connecting an external computer and entering the Watch Window sheet for **A** MONITOR****. Observe **06 LOAD (KW)** Load Sensor calibration and monitoring. Since the kW calibration cannot be completed until the phasing is correct, the value shown is for reference only. The Load Sensor of the 2301D-GT will only read a small negative value.

1. Shutdown the prime mover.
2. Label each CT wire with the phase and polarity that you think it should be. Even though this identification may prove to be incorrect, this step is necessary so that the individual wires can be identified during the description of the procedure.
3. Disconnect the phase **B** CT wires from terminals 6 and 7. Connect these two wires together using a small screw and nut and tape the connection.
4. Disconnect the phase **C** CT wires from terminals 8 and 9. Connect and tape these two wires together as in Step 3.
5. Connect the two wires from the phase **A** CT to the phase **A** input terminals 4 and 5.
6. Start the prime mover, apply full load and monitor the load sensor output. Start a list and record this value.
7. Unload the system and reverse the phase **A** CT wires on terminals 4 and 5.*
8. Apply full load, monitor the load sensor and record this value.

9. Unload the system, remove phase **A** CT wires from terminals 4 and 5 and connect them to phase **B** input terminals 6 and 7.*
10. Apply full load, monitor the load sensor and record this value.
11. Unload the system and reverse the phase **A** CT wires on terminals 6 and 7.*
12. Apply full load, monitor the load signal and record this value.
13. Unload the system, remove phase **A** CT wires from terminals 6 and 7 and connect them to phase **C** input terminals 8 and 9.*
14. Apply full load, monitor the load sensor and record this value.
15. Unload the system and reverse the phase **A** CT wires on terminals 8 and 9.*
16. Apply full load, measure the load signal and record this reading.
17. Unload the system and compare the six readings taken.*
18. Remove the phase **A** CT wires from terminal 8 and 9 and connect the phase **A** wires to the pair of terminals that produced the highest positive load value and in the polarity that produced the highest positive load value.
19. Remove tape and disconnect the phase **B** CT wires. Connect the phase **B** CT wires to one pair of the two remaining pairs of CT input terminals on the load sensor.
20. Apply full load and measure the load signal. Start a new list and record this reading.
21. Unload the system and reverse the phase **B** CT wires on the same terminals.*
22. Apply full load, measure the load signal and record this reading.
23. Unload the system, remove phase **B** CT wires and connect them to the other pair of terminals.*
24. Apply full load, measure the load signal and record this reading.
25. Unload the system and reverse phase **B** CT wires on the same terminals.*
26. Apply full load and measure the load signal. Record this reading and compare the four readings on the list.
27. Unload the system. Remove the phase **B** CT wires and connect them to the pair of CT input terminals that produced the highest positive load signal reading and with the polarity that produced the highest positive load signal reading.*
28. Remove tape and disconnect the phase **C** CT wires. Connect these two wires to the remaining pair of CT input terminals.
29. Apply full load, measure the load signal and record this reading.
30. Unload the system and reverse the phase **C** CT wires on the same terminals.*
31. Apply full load, measure the load signal and record this reading.
32. Unload and shut down the system. Compare the two readings.*
33. Connect the phase **C** CT wires to the same pair of CT input terminals, but in the polarity that produced the highest positive load signal reading.
34. Re-label each wire with the phase designation of the terminal that it is now connected to.
35. Remove the burden resistors and terminal block.

⚠WARNING

HIGH VOLTAGE—The current transformers can develop dangerously high voltages. Do not disconnect a current transformer while the prime mover is running unless temporary 0.5 Ω, 20 W resistors are installed as shown in Figure 3-68 and all loads is removed.

Load Calibration Adjustment

For this procedure, the generator must be running isochronously and not paralleled.

Start the prime mover and apply full load. With the Watch Window at the **A**MONITOR **** sheet and observe **06 LOAD (kW).** If this reading does not match external instrumentation, adjust calibration ZERO LOAD and RATED LOAD until Watch Window value matches metering. The values should match at all intermediate points.

NOTICE

If values at full load (or a lower reading proportional to a load less than 100%) cannot be obtained and the phasing has been checked and is correct, the current transformers are probably the wrong size. The current-transformer output must be from 3 to 7 A (5 A nominal) at full load.

When in parallel operation in isochronous mode or on an isolated bus, generator speeds must be the same. If they are not equal, load sharing will not remain proportional as the load varies. Any difference in loads between the units can be corrected by adjusting the Load Gain. Increasing the RATED LOAD will cause that generator to carry less load. If stability problems occur when in parallel operation at a particular load signal reading, reduce the reading by reducing the RATED LOAD and reduce the load signal reading setting of all other generators in the system to the same reading. When the load signal readings of all generators in a system are reduced, the load sharing gain will be reduced and this may result in some loss of load sharing sensitivity.

It may be necessary to reduce the load signal reading of each unit in the system to as low as 3 volts in cases of extremely poor system dynamics. If your system requires a load signal reading as low as 3 volts, consult Woodward for suggestions for possible remedies.

Droop Adjustment

Because of the processing capabilities of the control, the droop percentage entered will result in the correct speed change if the KW sensor is properly calibrated. The droop percent is automatically corrected for load gain voltage values. If a remote reference source is used, its range can be set to give no load to full load limits.

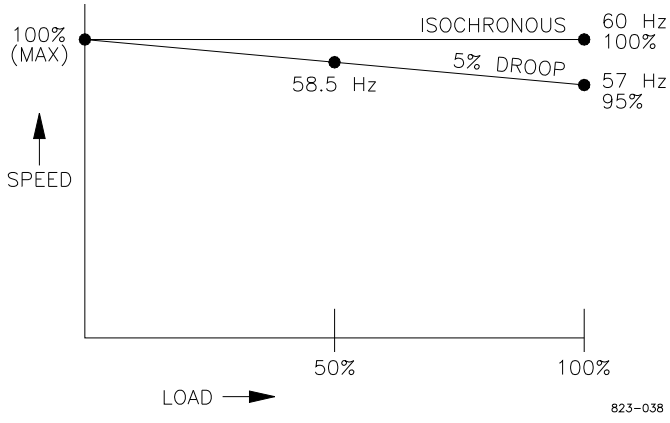


Figure 3-69. Droop Adjustment

Chapter 4.
Description of Operation

Introduction

This chapter provides an overview of the features and operation of the 2301D-GT Load Sharing and Speed Control.

The 2301D-GT Load Sharing and Speed Control use a 32-bit microprocessor for all control functions. All control adjustments are made with an external computer that communicates with the control via a serial port. The external computer can be disconnected from the control during normal operation, to provide security against tampering.

When power is applied, the 2301D-GT performs internal memory tests to 'boot-up' the processor. This takes approximately 30 seconds to complete. The CPU Status LED between terminals 27 and 28 remains on during this boot-up. The control will remain in I/O lock and will not provide control to the prime mover until the boot-up is complete. For systems requiring fast start functions, it is necessary to provide uninterrupted power the 2301D-GT.

⚠WARNING

DO NOT attempt to start the prime mover while the CPU Status RED LED is ON.

⚠WARNING

DO NOT apply power to the control at this time. Applying power before a control is completely connected may damage the control.

The 2301D-GT's normal operating architecture is divided into two sections: The Run Mode and the Configuration Mode. The Configuration Mode is used to configure the 2301D-GT for the specific application and to set all operating parameters (see Chapter 3). The Run Mode is the normal turbine operation mode and is used to view operating parameters and run the turbine.

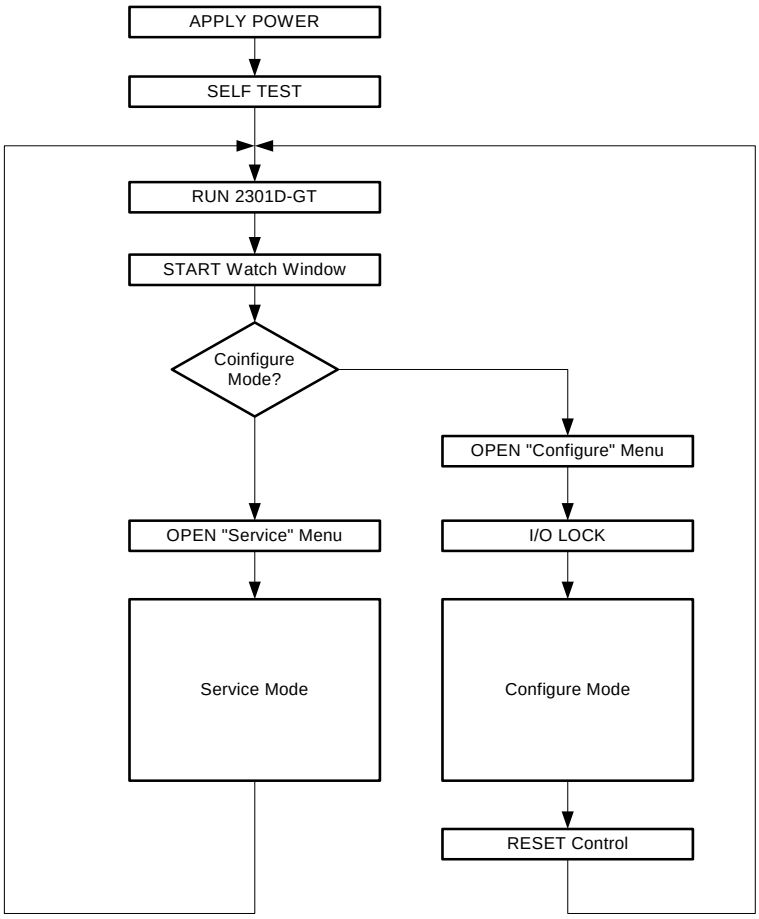


Figure 4-1. Basic Operational Architecture

1.	Initial	After all necessary wiring is completed, turn on the power for 2301D-GT, start Initial power up test then begin running the 2301D-GT application software to perform gas turbine control. At the time: Speed reference is set as 0%. EGT setpoint is EGT START VALUE. Actuator Output (Terminal 13-14) will be about 0mA. Shutdown Relay (Terminal 41) will be Shutdown condition. (Shutdown to de-energized) Discrete Inputs –A to H (Terminal 31−38) are opened. The turbine should be stopped; the speed signal (Terminal 25-26) is minimum. Analog Input 1 and 2, Load sharing line and PT's, CT's are normal range based on the configurations.
2.	Clear External Shutdown contact	This will close Discrete Input- A (Terminal 31).

3. Reset all alarms and shutdown latches

This will close Discrete Input- B (Terminal 32). This will take affect ONLY after all alarm or trip conditions are cleared.

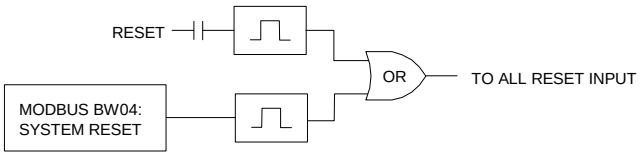


Figure 4-2. Reset Input

Shutdown Relay (Terminal 41) will be the Normal condition. (Normal to energized) due to clear Shutdown.
Actuator Output (Terminal 13-14) will be minimum current according to the current setting (4−20 mA or 20−160 mA).

4. Start

Discrete Input- C (Terminal 33) should be closed due to start up the turbine.

Speed reference will be set as initial value (based on configuration).
Actuator will be opened 'Minimum Fuel position' based on the following configuration.

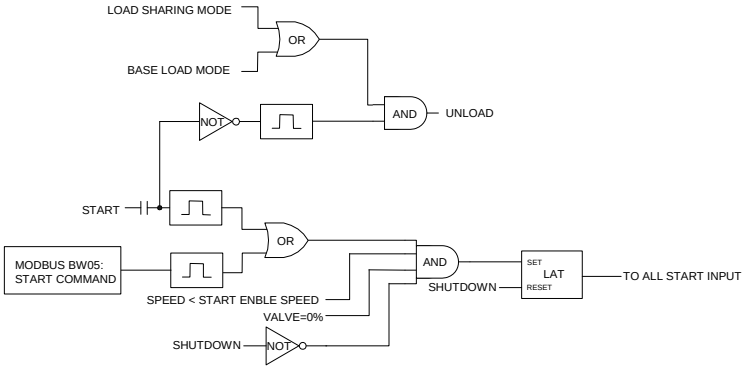


Figure 4-3. Start Input

Start Ramp

In case of 'START RAMP USE' =TRUE
The Start Ramp Value will raise up to 101% after Start Command issue. The Start Ramp rate is defined by Service Mode.
When the value of Start Ramp is higher than one of MIN VALVE (%) or DECEL LIMIT (%), ACT OUT (%) select Start Ramp. (See Figure 3-34)

Start Fuel Ramp

In case of 'START RAMP USE' =FALSE
The fuel demand is fixed according to the J:**STRT FUEL RAMP** 03: STRT VALVE SET (%). (See Figure 3-36)

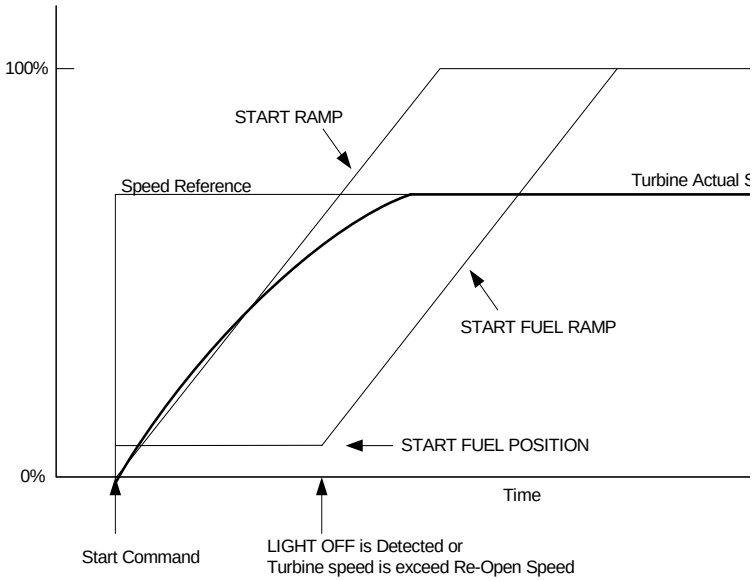


Figure 4-4. Start up Speed Settings

Light Off

When the 'LIGHT OFF' signal is detected, or turbine speed is FLAME ON or over **J:09 STRT FUEL SPD SW**, then START FUEL RAMP will begin to ramp up to 101% with configured ramp rate.
If Accel Limit is less than Start ramp, then Accel Limit will take the fuel limiting as lower signal selector logic. (See Figure 1-2)

Using LIGHT OFF FAIL shutdown:
CONFIGURE **D:05 SD? AT LT OFF FAIL** = TRUE
When the Exhaust Gas Temperature is not raised after the Start Command issued, LIGHT OFF FAIL will be set, and will make the turbine shutdown.

Accel Limit by CDP

Using ACCEL LIMIT control by CDP:
2301D-GT has CDP control 2-D map, CDP Value vs. ACCEL Limit. The map has 6 break points to program.

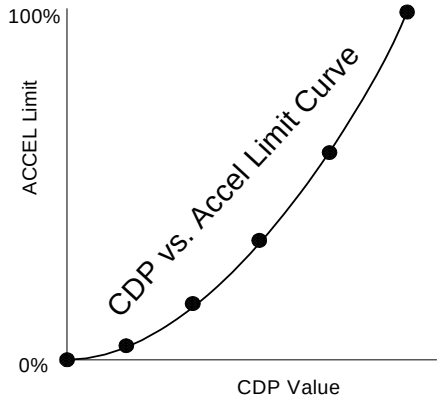


Figure 4-5. CDP Limiting

⚠WARNING **Once the turbine is started, Fuel Demand Value will be kept at more than minimum fuel setting until shutdown of the turbine.**

5.	Speed in Control	Turbine speed is sensed through one MPU. The MPU Gear Ratio and the Gear Teeth settings are configured to allow the 2301D-GT to calculate actual turbine speed. While in the speed control mode, the speed PID will control a turbine at the same speed or frequency regardless of the load it is supplying. When the 2301D-GT maintains the turbine speed, will issue 'SPEED IN CONTROL' status.
6.	Rated/Idle	When the Rated/Idle contact input is closed, the speed reference comes up to rated speed. If raise speed or lower speed contact input are close, the raising speed reference is canceled. When the Rated/Idle contact input is open, the speed reference comes down to idle speed. If raise speed or lower speed contact input are close, the lowering speed reference is canceled. If auto idle to rated is configured, the speed reference comes up to rated after passed idle time.
7.	Raise / Lower Speed	The speed PID's setpoint may be adjusted from the external contacts, Modbus commands, or through a 4−20 mA analog input. A specific setpoint setting can also be directly entered through Watch Window or Modbus communications. It can be remotely set by the remote Speed setpoint analog input. The speed setpoint reaches Lower Speed Limit, then 'SPEED REF. LOWER LIMIT' status will be issued, or the speed setpoint reaches raise limit, then 'SPEED REF. RAISE LIMIT' status will be issued. The 2301D-GT control provides local control with discrete inputs for raising and lowering speed/load. For remote speed/load setting, the control provides a remote reference analog input.
8.	EGT Control	When the turbine exhaust gas temperature exceed EGT LIMIT setpoint, EGT PID will take control the fuel demand to maintain the EGT. In this condition, 'EGT IN CONTROL' status will be issued.
9.	Remote Speed Control	The speed setpoint can be positioned remotely through an analog signal by the Remote Speed Input (both raise speed and lower speed contact input are close). This allows the Speed setpoint to be set remotely by a process control or distributed plant control system. • Local Speed/Load Reference Raise/Lower discrete inputs control the speed ramp while following. a. The 52G BREAKER input is open b. ISO MODE

10. Overspeed Test Function

The 2301D-GT's Overspeed Test Function allows an operator to increase turbine speed above its rated operating range to periodically test turbine electrical and / or mechanical overspeed protection logic and circuitry. An Overspeed Test will allow the control's speed setpoint to be increased above the normal maximum governor limit. This test can be performed from the Service Mode of Watch Window software. This test is not permissible through the Modbus.

- OVERSPEED TEST

Set the 'OVERSPEED TEST ENBL' =TRUE
Raise contact to be closure, to allow the speed setpoint can be set above rated speed range. The turbine will be shutdown caused by Overspeed Trip when its speed exceeds Overspeed setting.

- Mechanical OVERSPEED TEST

Set 'MOST ENABLE' = TRUE
Then, it allows an operator to raise above the OVERSPEED TEST speed without trip due to OVERSPEED detection.

When the OVERSPEED TEST ENABLE is set back as FALSE, the Speed reference will be decreased by RAISE SPEED LIMIT setting automatically.

⚠WARNING

OVERSPEED TRIP Functionality is overridden by MOST Mode. To prevent possible serious injury from an overspeeding turbine, make sure the turbine should be equipped with another shutdown device(s), that operate totally independently of the control to protect against runaway or damage to the turbine.

ACTION LOGIC

(In case of using NOT RATED/IDLE contact input.)

NO.	Control Mode	INPUTS : 52G	ISO/ DROOP	SPD/KW DROOP	SPM	REMOTE (Close raise & lower)	RAISE/ LOWER	SPD REF	DROOP VALUE	LS or BS LD	NOTE
1	SPD CONTROL	X	X	X	X	X	X--->O	RAISE/ LOWER	0	**X**	
2	SPD CONTROL	X	X	X	X	X--->O	X	REMOTE	0	X	REMOTE CONTROL
3	SPD CONTROL	X	X	X	X--->O	X	X	SPD -SPM	0	X	SPM-A
4	SPD CONTROL	X	O	X	X	X	X	ACTUAL SPD	0	X	SAME NO.1-3
5	DROOP	X--->O	X	SPD/KW	X	X	X	SPD+ INI LOAD	INI LOAD	X	INI LOAD
6	DROOP	O	X	SPD/KW	X	X	X--->O	RAISE/ LOWER	LOAD	X	CHANGE LOAD
7	DROOP	O	X	SPD/KW	X	X--->O	X	REMOTE	LOAD	X	REMOTE CONTROL
8	ISO+LS Or BASE LOAD	O	X--->O	X	X	X	X	ACTUAL SPD	0	O	LOAD SHARE Or BASE LOAD ENABLE
9	ISO+LS Or BASE LOAD	O	O	X	X	X	X--->O	LS:RAISE/ LOWER BS: LOAD REF RAISE/ LOWER	0	O	LOAD SHARE Or BASE LOAD ENABLE
10	DROOP	O	O--->X	SPD/KW	X	X	X	SPD+ DROOP	LOAD	X	DROOP MODE
11	ISO	O--->X	X	X	X	X	X	RATED	0	X	

O : CLOSE
X :OPEN
LS: Load share
BS LD :Base load

Table 4-1. Description of discrete input for load control

11.	Raise / Lower Speed Control	Table 4-1 shows the 2301D-GT mode transfer conditions. Manual speed control using Raise / Lower discrete inputs is shown in Table 4-1 No.1. 52G BREAKER Input = Open ISO/DROOP Input= Open (Droop)
12.	Remote Speed Control	Table 4-1 No.2 shows Speed control by REMOTE CONTROL SETPOINT input signal. The analog input #1 or #2 must be configured as Remote Speed Setting.
13.	SPM-A Synchronizer	Table 4-1 No.3 shows Speed control by SPM-A input. The analog input #1 or #2 must be configured as SPM-A. The synchronizer input is used to match the prime movers speed and generator phase with bus that it is being paralleled to. Analog input #1 at terminals 19, 20, and 21 (or Analog input #2 at terminals 22, 23, and 24) is used as the synchronizer input. The sensitivity of the synchronizer can be adjusted. The load bias is the signal from the load control function that will bias the speed reference to increase or decrease the speed or generator load. When the generator is paralleled to other units, a change in speed reference bias will result in a change in generator load, in an isolated generator the load bias will give a change in speed (droop).
14.	KW Droop Operation	Table 4-1 No. 5 shows the turbine will be controlled by kW Droop mode. The load sensor on the 2301D-GT must be connected to the generator. When 52G BREAKER input closed, Isoch / Droop input opened, then kW Droop mode is configured, the control uses the output from its integral power sensor to sense and control unit load. The control power sensor output can be monitored via serial communication or through the control's analog readout. If required, any of the control's four relay outputs can be configured as power level switches to drive auxiliary devices or indicators. The load set point is increased from no-load to the initial load setting with kW Droop. Table 4-1 No. 6 shows Operator can control the load setting with Raise or Lower discrete inputs. If the Speed Droop mode is configured, the load setting will be changed based on Speed Droop bias calculated.
15.	LOAD LIMIT Control	When the actual load exceed LOAD LIMIT setpoint, LOAD LIMIT PID will take control the fuel demand to maintain the LOAD. In this condition, 'LOAD LIMIT' status will be issued.
16.	Remote Speed Control	Table 4-1 No.7 shows Load control on droop mode by REMOTE SPEED SETPOINT input signal. The analog input #1 or #2 must be configured as Remote Speed Setting.

17.	Isochronous Load Control Operation	Table 4-1 No. 8 and 9 show the ISO/DROOP discrete input closed, Operator can control the speed setting with Raise or Lower discrete inputs. When this condition, the 2301D-GT will accept Load sharing operation. The 2301D-GT includes an analog load sharing network input that is compatible with Woodward's 2301A line of controls. The control's soft load / unload transfer function can also be configured to rate limit unit loading and unloading. The droop/isoch contact is used in conjunction with the control's load sharing lines. When isochronous control is selected and the gen breaker is closed, the unit's load sharing lines are enabled. When running a single unit on an infinite bus with a Generator Loading Control or Import/ Export Control, terminals 36 and 37 must be connected to terminal 28 to connect the Load Matching Circuit to the load-sharing lines. The load-sharing lines must be wired to the Generator Loading Control or Import/Export Control. The circuit-breaker auxiliary contact will then be connected to the Generator Loading Control or Import/Export Control and not to the 2301D-GT Load Sharing And Speed Control.
18.	BASE LOAD	If Base Load/Load Sharing contact input is close on Iso mode (52G Breaker and Iso/Droop are close), the Load Reference come up to the value of Base Loading Setpt by Base Loading rate. If Raise Speed contact input is close on Base Load mode (52G Breaker, Iso/Droop and Base Load/Load Sharing are close), the Load Reference come up to the value of Base Load Max by Base Load R/L Rate. If Lower Speed contact input is close on Base Load mode (52G Breaker, Iso/Droop and Base Load/Load Sharing are close), the Load Reference come down to the value of Base Load Min by Base Load R/L Rate.
19.	REMOTE BASE LOAD	If both Raise Speed and Lower Speed contact inputs are close on Base Load mode (52G Breaker, Iso/Droop and Base Load/Load Sharing are close), the Load Reference change to the value of Remote Speed Control Set point by RMT B_load Rate.
20.	Generator Breaker Opened	Table 4-1 No. 11 shows the 52G BREAKER discrete input opened, the 2301D-GT will maintain the turbine speed to keep at its rated speed.

ACTION LOGIC
(In case of using RATED/IDLE contact input.)

NO.	Control Mode	ISO/ DROOP	SPD/KW DROOP	SPD REF	DROOP VALUE	LS or BS LD	NOTE
1	ISO+LS Or ISO+BS LD	X--->O	X	ACTUAL SPD Or RATED	0	O	LOAD SHARE or BASE LOAD ENABLE
2	DROOP	O--->X	SPD/KW	RATED	LOAD	X	DROOP MODE

O : CLOSE
X :OPEN

Table 4-2. Description of Discrete Input for Using RATED/IDLE

	RATED/IDLE used	When the RATED/IDLE contact input is used, there isn't 52G Breaker contact input.
1.	Droop	Table 4-2 No. 2 shows the turbine will be controlled by kW/SPD Droop mode and speed reference is the value of Rated Speed.
2.	LOAD SHARING Or BASE LOAD	Table 4-2 No. 1 shows when the droop/isoch contact is closed, Load sharing or Base Load functions enable and speed reference is the value of actual speed or Rated Speed selected on service mode.

WARNING

When the control is configured to use Rated/Idle Discrete input and it is closed to rated, the speed reference will go to rated. When the 52G BREAKER is closed and in droop control, raise/lower contacts are used to change speed reference from rated in order to produce desired load.

IMPORTANT

In isolated bus applications, a brief speed transient may occur when the load sharing relay closes following transfer from droop mode back into isochronous load sharing.

Droop Function

The droop function supplies a feedback path to bias the speed reference. The function of droop is to increase the speed reference as the load increases. This is done by negatively biasing the output of the speed reference with the droop function. The 52G BREAKER discrete input contact is used to switch the droop function on and off.

Power System Management Concepts

This section provides a summary review of droop, isochronous, droop/isochronous and isochronous load sharing. These concepts provide an understanding for power management.

Paralleling

There are two basic methods used for paralleling: droop, where speed decreases with load increase and isochronous, where speed remains constant with load increase. The paralleling system shown in Figure 4-6 consists of a load matching circuit and kW sensor circuitry.

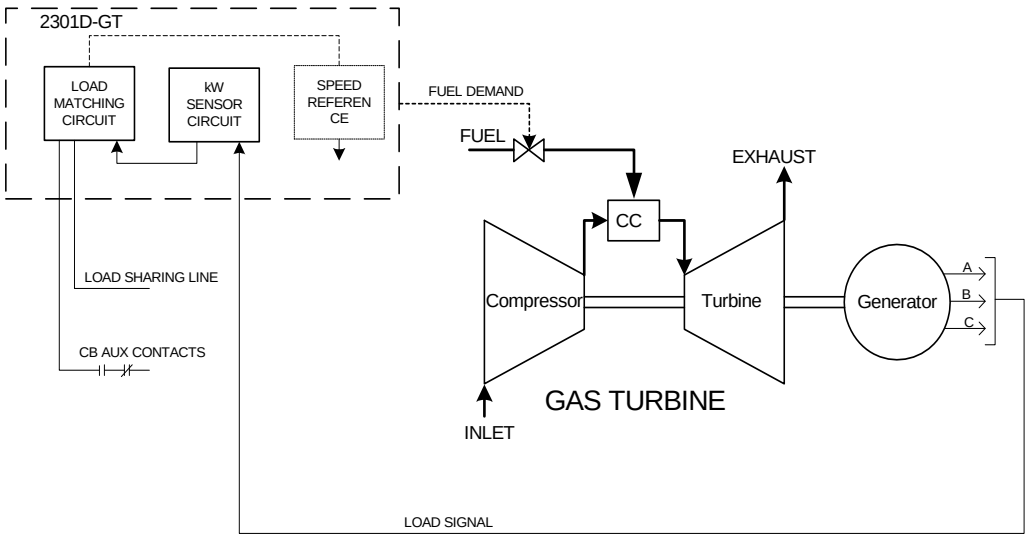


Figure 4-6. Paralleling System

An auxiliary contact on the generator breaker connected to terminal 36 is used to select speed and load control operation. When the input to the 52G BREAKER contact is open, the control is in isochronous speed control. When the 52G BREAKER contact is closed, the control is in isochronous load control or kW (Speed) droop control.

The Load sensor computes the load carried by each phase of the generator. The current load on each phase is multiplied by the cosine of the phase difference between the current and the voltage and the three phases are added to determine the total load.

The output of the load amplifier is adjusted by the load gain set point. By setting the load gain voltage on each unit to the same level at full load, proportional load sharing is achieved. Regardless of differences in generator set capacities in the system, each generator set is loaded to the same percentage of its capacity. A final adjustment of the individual load gain adjustment will compensate for minor differences in the generator sets.

Droop mode allows operation of a generator on an infinite bus or in parallel with other engine generator units using hydromechanical governors. In droop, speed changes as the load on the generator changes. An increase in load results in a decrease in speed. The amount of speed change or droop is expressed in percent (of rated speed) and is set by the load droop set point.

Droop Mode

Droop is a decrease in speed or frequency, proportional to load. That is, as the load increases, the speed or frequency decreases, as illustrated in Figure 4-7. This reduction in speed is accomplished with negative feedback. The feedback increases as the system is loaded.

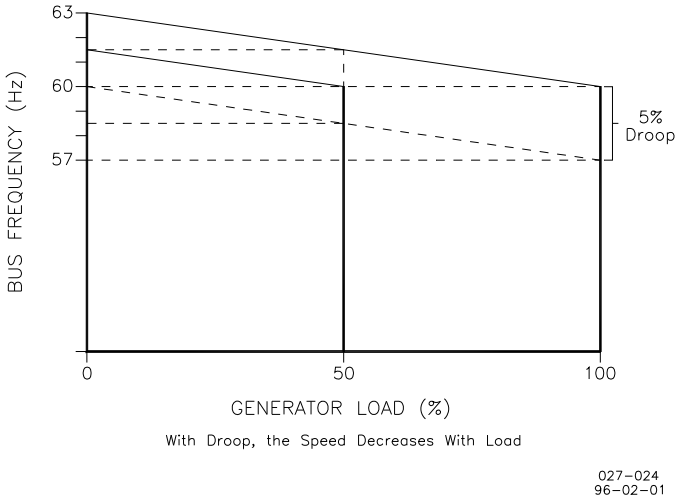


Figure 4-7. Droop Mode

Droop is the speed reduction, expressed in percentage that occurs when the generator is fully loaded. With a given droop setting, a generator set will always produce the same power output at a particular speed or frequency. Droop is sometimes called the percent speed regulation. If all generator sets in a droop system have the same droop setting, they will each share load proportionally. The amount of load will depend on their speed settings. If the system load changes, the system frequency will also change. A change in speed setting will then be required to offset the change in feedback and return the system to its original speed or frequency. In order for each generator set in the system to maintain the same proportion of the shared load, each generator will require the same change in speed setting.

Isochronous Mode

Isochronous repeats at a single rate or has a fixed frequency, or period. A generator set operating in the isochronous mode will operate at the same set frequency regardless of the load it is supplying, up to the full load capability of the generator set (see Figure 4-8). This mode can be used on one generator set running by itself in an isolated system.

The isochronous mode can also be used on a generator set connected in parallel with other generator sets. Unless the governors are load sharing and speed controls, however, no more than one of the generator sets operating in parallel can be in the isochronous mode. If two generator sets operating in the isochronous mode without load sharing controls are tied together to the same load, one of the units will try to carry the entire load and the other will shed all of its load. In order to share load with other units, some additional means must be used to keep each generator set from either trying to take all the load or from motoring.

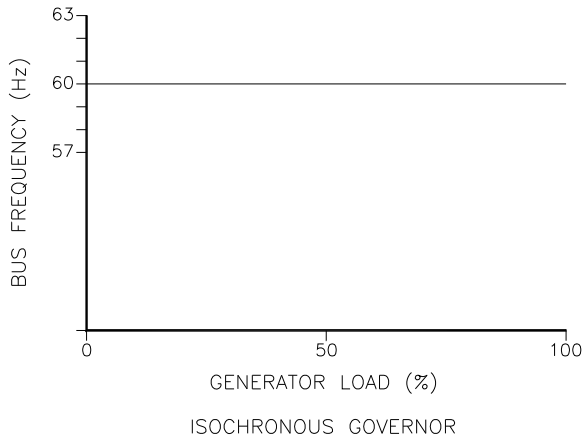


Figure 4-8. Isochronous Mode

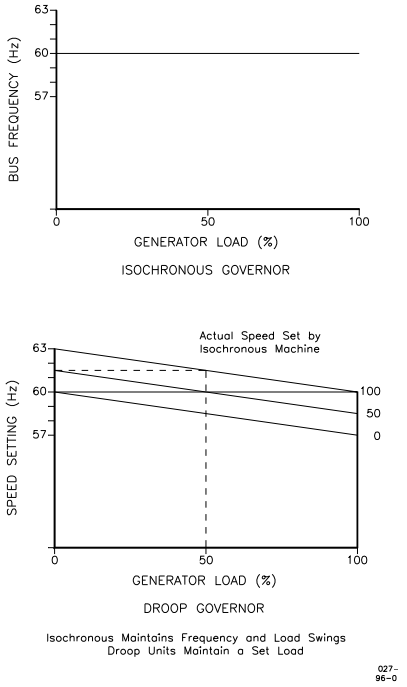


Figure 4-9. Droop/Isochronous Load Sharing

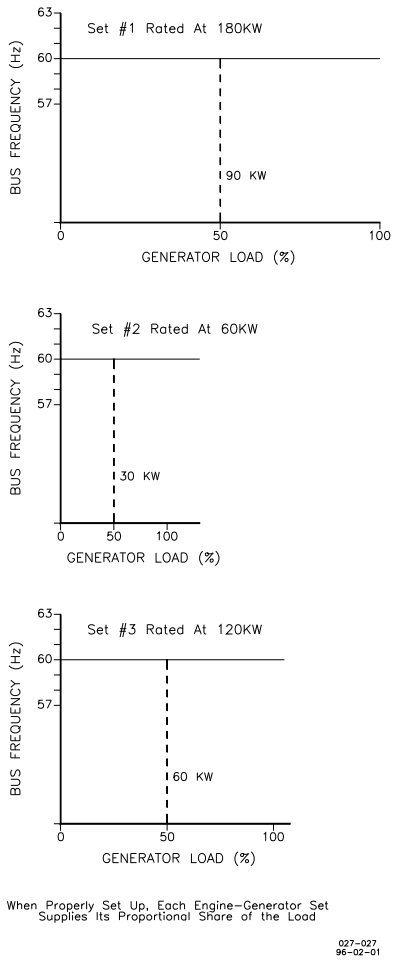


Figure 4-10. Isochronous Load Sharing

Droop/Isochronous Load Sharing on an Isolated Bus

Droop/isochronous load sharing combines the first two modes. All generator sets in the system, except one, are operated in the droop mode. The one unit not in droop is operated in the isochronous mode. It is known as the swing machine. In this mode, the droop machines will run at the frequency of the isochronous unit. The droop and speed settings of each droop unit are adjusted so that each generates a fixed amount of power (see Figure 4-9). The output power of the swing machine will change to follow changes in the load demand. Maximum load for this type of system is limited to the combined output of the swing machine and the total set power of the droop machines. The minimum system load cannot be allowed to decrease below the output set for the droop machines. If it does, the system frequency will change and the swing machine can be motored. The machine with the highest output capacity should be operated as the swing machine, so that the system will accept the largest load changes within its capacity.

Isochronous Load Sharing on an Isolated Bus

Isochronous load sharing operates all generator sets in a system in the isochronous mode. Load sharing is accomplished by adding a load sensor to each electric isochronous governor. The load sensors are interconnected by the load sharing lines. Any imbalance in load between units will cause a change to the regulating circuit in each governor. While each unit continues to run at isochronous speed, these changes force each machine to supply a proportional share of power to meet the total load demand on the system (see Figure 4-10).

Chapter 5. Troubleshooting

Introduction

The following troubleshooting guide is an aid in isolating trouble to the control box, actuator, plant wiring, or elsewhere. Troubleshooting beyond this level is recommended ONLY when a complete facility for control testing is available.

NOTICE

Incorrect voltage can damage the control. When replacing a control, check the power supply, battery, etc., for the correct voltage.

Troubleshooting Procedure

This chapter is a general guide for isolating system problems. The guide assumes that the system wiring, soldering connections, switch and relay contacts and input and output connections are correct and function properly. Make the checks in sequence. Various system checks assume that the prior checks have been done correctly.

⚠WARNING

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.

Control Start-up

When the control is powered on, the CPU begins execution of a section of the software program known as the boot code. This code performs hardware diagnostics and checks that a valid application program has been installed. During this period all control outputs will remain disabled. The boot code takes approximately 30 seconds to execute. During this period the red status LED should be on. When execution of the boot code has completed, control will be transferred to the application program. When the application program begins, the control outputs will be enabled and system control will begin. At that point the red status LED will be turned off and should remain off as long as the control is running.

If the control fails its self-test diagnostics during boot, fails its on-line self-tests while running the application program, or fails in any other way that it can detect, then the CPU will blink the red status LED to indicate the failure.

NOTICE

To prevent damage to the prime mover, the prime mover must be shut down for all system checks.

Control Test and Calibration

General

Conduct the following checks on the 2301D-GT. Then verify the functioning of set points and adjustments.

1. Connect a computer to the communication port. Start Watch Window HMI software in accordance with the instructions in Chapter 3. Verify that correct voltage and polarity are input to the control.
2. Verify the controller ID on the 2301D-GT Standard PC Interface by clicking ‘Control’ then ‘Properties’. The Application ID message ‘5418-019’ with the revision level (new, A, etc) should appear.
3. Select the Configure and Service Menu. Verify that all set points are as recorded during installation. Repeat for the other menus. If any differences are found, change the set point(s) to the correct value. Click the ‘SAVE VALUES’ icon on the tool bar. Remove power from the control for at least 10 seconds. Verify correct values were retained during power down. Failure—the control has failed and should be replaced.

Discrete Inputs

Run the following test to verify the function of the discrete inputs. DO NOT RUN THIS TEST WITH THE TURBINE RUNNING!

Repeat this step for all discrete inputs. Close the appropriate input. The status in W** DISPLAY D_I/O STATUS** should switch from OPEN to CLOSED. If the value does not change when the contact is closed, the control has failed and should be replaced.

Discrete Outputs

Verify operation of the Discrete Outputs, by referring to the Configure F**I/O TEST** sheet.

With the turbine shutdown, enable the manual relay driver test. Open another inspector sheet, select Service X**I/O TEST** and monitor the discrete outputs TURN ON D/O-1–D/O-4. From the relay test procedure, each discrete output may be activated and its operation verified. If the output is activated, the voltage measured between terminal 39 and the appropriate output terminal (41–44) should equal input voltage at terminal 39 and 40. Testing can be monitored visually by observation of the green LED near terminal 9 and 10, or by listening for an audible ‘click’. The manual relay test must be disabled or the control will hold the actuator current to minimum.

Symptom	Cause	Solution
Prime mover will not start. Actuator not moving to start fuel position. **IMPORTANT** *If the actuator moves to start position, a problem with the prime mover fuel supply is indicated.*	Supply voltage polarity reversed (dc only), or no supply voltage.	On power up the CPU status LED should come on for 30 seconds. Check for proper voltage from terminals 45(+) to 46(–). Reverse leads if polarity is incorrect.
	Actuator not responding to input signal from control. **IMPORTANT** The hydraulic actuator must have oil pressure and gear rotation to operate (respond).	If there is a voltage output at control terminals 13(+) and 14(–), but the actuator does not move, the wiring to the actuator should be checked for opens or shorts. With the EG3P actuator, remember that terminals C and D of the mating plug should be jumpered. Make resistance checks at the actuator. Coil resistance on Woodward actuators is approximately 35 Ω. (Read with leads at terminals 13 and 14 disconnected.)
	Shutdown cause	Check Shutdown status in the Service Menu Z1** SHUTDOWN** #01. If the status is TRUE, check all Shutdown causes, release each cause one by one. (See Chapter 3)
	Actuator or linkage.	Check actuator or linkage for proper installation and operation. Problems may be oil supply, direction of rotation, insufficient drainage, linkage, worn actuator components, or improper adjustment.
	No actuator voltage at terminals 13 and 14.	Check for shorted or grounded actuator leads by removing wires to terminals 13 and 14. Stop prime mover. Check for 18 to 22 V at terminals 13 and 14 Check that A**MONITOR** Menu is reading the turbine speed during spinning. If no speed reading, check the MPU.
	Speed sensor signal not clearing failed speed signal circuit.	Speed sensor not spaced properly—check for at least 1.0V ac at terminals 25 and 26 during cranking. If less that 1.0 Vac, magnetic pickup may be spaced too far from gear. Make sure there are no metal chips on end of pickup. If no voltage is present, magnetic pickup may be open-circuited or shorted. Make resistance check with the leads disconnected from control. Should be about 100 to 300 Ω. **WARNING** **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.**
	Faulty 2301D-GT control.	Replace.
Prime mover will not start.		Check for Fuel Demand % after Start command is issued.

Symptom	Cause	Solution
Prime mover overspeeds only on starts.	Ramp adjustment.	Increase RAMP TIME. This decreases acceleration rate.
	Wrong SPEED settings.	Check that SPEED settings are entered as described in Chapter 3. Verify the Fuel Demand % drops to minimum (0%) when turbine speed is greater than speed reference.
	Dynamics adjustment.	Dynamics may be adjusted for sluggish operation, causing overspeed on start. Adjust GAIN for fastest stable response. RESET may be adjusted too low. Increase RESET setting.
Prime mover overspeeds after operating at rated speed for some time.	Prime mover.	Check for proper operation of prime mover fuel system. If actuator moves toward minimum fuel during overspeed, problem is in fuel system.
	Magnetic pickup and 2301D-GT control.	Check the magnetic pickup output voltage at speeds above idle—at least 1.0 Vrms. If magnetic pickup should fail and the override failed speed signal circuit is disabled, the 2301D-GT will call for maximum fuel.
	2301D-GT control.	Control the prime mover manually at rated speed. If the turbine Speed reading in the Display Menu does not match external indicators, the control is not configured properly. When the turbine speed value is greater than the speed reference value, the output voltage should be zero. If speed range is correct for the application, replace the control.

Symptom	Cause	Solution
Prime mover will not stabilize at rated no load speed. The instability may occur at no load or it may vary with load Control may be erratic.	2301D-GT control.	Adjust GAIN as described in 'Adjust for Stable Operation' and 'Dynamic Adjustment' in Chapter 3.
	Speed reference controls.	Check display menu. The speed reference value should be constant. If speed reference is erratic, check remote input (if used), intermittent raise/lower contact inputs. The speed bias sum at no load should be constant.
	Improper linkage adjustment.	Make sure that actuator moves approximately 2/3 of its travel from no load to full load. Be sure linkage is linear on turbine, diesel and fuel-injected prime movers. Be sure linkage is non-linear on carbureted prime movers. Refer to actuator manual for proper installation.
	Necessary external wires not properly shielded. Electrical noise, caused by wiring carrying an ac voltage, stray magnetic fields from transformers, etc., can be picked up by improperly shielded wire. Noise will cause instability if picked up by lines associated with the amplifier summing point such as external speed trim, paralleling lines, droop contact, magnetic pickup lines and synchronizer input.	The following tests will isolate noise and interference. **NOTICE** **Do not perform these tests in other than single-unit operating configuration.** Verify that the switchgear frame, governor chassis and prime mover have a common ground connection. Temporarily remove the battery charger cables from the control battery system. If the prime mover operation is significantly improved by these modifications, replace the wiring one at a time to locate the source of the trouble. External wiring may require additional shielding or rerouting from high-current lines or components. If the problem cannot be resolved by these checks, it will be necessary to remove the 2301D-GT from the switchgear. Temporarily mount it next to the prime mover and connect only a battery, magnetic pickup and actuator to the control (use a separate battery placed next to the prime mover).
	Necessary external wires not properly shielded (continued).	If stability occurs when the control is mounted next to the prime mover, return the control to the switchgear. Run new magnetic pickup, actuator, and battery power lines. Shield all wires to the control. Route all wires through conduit or an outer shield. Tie the outer shield to system ground at end opposite of the control.
	Prime mover may not be receiving fuel as called for by the actuator voltage.	Check actuator linkage to fuel controlling mechanism for any lost motion, binding, or excessive loading. Verify a steady fuel pressure of proper value. Check actuator per appropriate actuator manual.

Symptom	Cause	Solution
Prime mover will not stabilize at rated no load speed. The instability may occur at no load or it may vary with load Control may be erratic. (cont.)	Prime mover not operating properly.	Prime mover may be causing speed variations. Control engine manually to determine if instability is in prime mover or governor control. Verify proper adjustment of fuel control linkage.
	Input voltage low.	Check supply voltage. It should be at least 18 Vdc.
Prime mover does not share load with other units.	Prime mover not receiving fuel as called for by the governor.	If voltage to actuator is max, visually determine actuator shaft is at maximum position. If it is not, an actuator problem is indicated, or the linkage or fuel system is restricted.
	Unequal speed settings.	Be sure that speed settings of all units at no load are identical.
	Unequal load gain voltages.	With the prime mover operating in single unit configuration, LD GAIN(V)@100%load must be set at 6.0 Vdc. See LOAD SENSOR SET in Chapter 3.
	Improper load sensing phasing.	Perform phasing procedure in Chapter 3.
	Circulating currents between generators.	Refer to appropriate voltage regulator manual.
Prime mover does not maintain constant speed (isochronous).	Actuator.	If actuator has a ballhead backup, verify that its hydraulic governor section, speed setting, and speed droop adjustments are properly set (see the applicable governor manual).
	Prime mover.	If the droop occurs near the full-load point only, it is possible the prime mover is not producing the horsepower called for by the fuel control, or is being overloaded. Either is indicated if the fuel control is at maximum position.

Chapter 6. Communications

Modbus Communication

The 2301D-GT control can communicate with plant distributed control systems or CRT based operator control panels through one Modbus communication port. The communication port support RS-232, RS-422 communications using RTU MODBUS transmission protocols. Modbus utilizes a master/slave protocol. This protocol determines how a communication network's master and slave devices establish and break contact, how a sender is identified, how messages are exchanged, and how errors are detected.

Monitor Only

The Modbus communication port, with factory defaults, is not programmed. Although this port is not programmed, it continues to update all information to all registers. This allows the 2301D-GT to be monitored, but not controlled, from an external device. By simply connecting a monitoring device configured to communicate through Modbus and to the 2301D-GT's defaulted protocol settings, this device can be used to monitor all the 2301D-GT's controlling parameters, modes, etc. without affecting control.

To use a 2301D-GT port it must be needed to close external contact between Terminal 38 (Discrete input H) and Terminal 30 (Discrete input common).

Monitor And Control

Once a Modbus port is activated by the Modbus selector command, the 2301D-GT will accept an external network master device (DCS, etc.). This allows a Modbus compatible device to monitor and perform all 2301D-GT RUN mode parameters and commands. To use a 2301D-GT port it must be needed to close external contact between Terminal 38 (Discrete input H) and Terminal 30 (Discrete input common).

Modbus Communication Mode

The 2301D-GT control supports two Modbus transmission modes. A mode defines the individual units of information within a message and the numbering system used to transmit the data. Only one mode per Modbus network is allowed. It supported RTU (Remote Terminal Unit). These modes are defined in the following table.

CHARACTERISTIC	RTU
Coding System	8-bit binary
Start Bits	1
Data Bits per Char	8
Parity	none
Stop Bits	1 to 2, ODD, or EVEN
Baud Rate	110, 300, 600, 1200, 1800, 2400, 4800, 9600, 19200, or 38400
Error Checking	CRC (Cyclical
	Redundancy Check)

Table 6-1. RTU Modbus

In the RTU mode, data is sent in 8-bit binary characters and transmitted in a continuous stream.

The Modbus protocol allows one master and up to 247 slaves on a common Network. Each slave is assigned a fixed, unique device address in the range of 1 to 247. With the Modbus protocol, only the network master can initiate a Transaction. A transaction consists of a request from the master to a slave unit and the slave's response. The protocol and Modbus device number are set in the Program Mode and can be adjusted in the Service Mode, if required.

The 2301D-GT control is programmed to function as a slave unit only. As a slave unit, the 2301D-GT will only respond to a transaction request by a master device. The 2301D-GT can directly communicate with a DCS or other Modbus supporting device on a single communications link, or through a multi-dropped network. If multi-dropping is used, up to 246 devices (2301D-GTs or other customer devices) can be connected to one Master device on a single network. The control address is programmed under the 2301D-GT's communications block.

Each message to or from a master has a defined structure called the message 'frame'. A frame consists of the slave device address, a code defining the requested data and error checking information. See Figure 6-1.

	Beginning of Frame	SLAVE Address	Function Code	DATA	Error Check Code	End of Frame
RTU	3-Char Dead Time	1 Char 8 bits	1 Char 8 bits	8 bits Data per Char	1 Char 8 bits	3-Char Dead Time

Figure 6-1. Modbus Frame Definition

The Modbus function code tells the addressed slaves what function to perform. The following table lists the function codes supported by this control.

Modbus Function Codes

CODE ADDRESS	DEFINITION	REFERENCE
01	Read Digital Outputs	0XXXX
	(Raise/Lower and Enable/Disable Commands)	
02	Read Digital Inputs	1XXXX
	(Status Indications / Alarms and Trips)	
03	Read Analog Outputs	4XXXX
04	Read Analog Inputs	3XXXX
	(Speed, Setpt, etc.)	
05	Write Single Discrete Output	0XXXX
	(Raise/Lower and Enable/Disable Commands)	
08	Loopback Diagnostic Test	N/A
	(Subfunction 0 only)	
15	Write Digital Outputs	0XXXX
16	Write Analog Outputs	4XXXX

Table 6-2. Modbus Function Codes

Port Adjustments

Before the 2301D-GT will communicate with the master device, the communication parameters must be verified. These values are set from the Service Mode.

Modbus Communication PARAMETER	Port Adjustments ADJUSTMENT RANGE
Baud Rate	110 TO 38400
Parity	NONE
Stop Bits	1
Driver	RS-232 or RS-422

2301D-GT Control Modbus Addresses

The Modbus communication ports in the 2301D-GT are programmed for unique Modbus addresses. A complete listing of these addresses for your application is located at the end of this section in the manual. The Modbus address listing consists of Boolean Writes, Boolean Reads, Analog Reads and Analog Writes. The Boolean reads and writes are also referred to as input and holding coils. The analog reads and writes are also referred to as input registers and holding registers. All values that can be addressed by Modbus are considered to be discrete and numeric. The discrete values are a 1 bit binary, on or off value and the numerics are 16 bit values. Discrete values are sometimes referred to as coils or digitals and numerics are referred to as registers or analogs. All read/write registers are interpreted by the 2301D-GT as signed 16 bit integer values. Since Modbus can only handle integers, values that require a decimal point in the Modbus Master Device are multiplied by a scaling constant before being sent by 2301D-GT. See Appendix B for defaulted communication constants and ranges.

Boolean Writes (Holding Coils)

Holding coils are logical signals that are both readable from and writeable to the 2301D-GT control. An example of a Boolean write value would be raise or lower commands. A logical true denoted by the value 1 will cause the command listed in the description to be executed.

Boolean Reads (Input Coils)

Input coils are logical signals that are readable from, but not writeable to, the 2301D-GT. An example of a Boolean read value would be a turbine trip status indication. The input coil will have the value 1 if the statement in the description column is true and a 0 if false. The ‘1:’ term in the address identifies an input coil. The 2301D-GT supports Modbus function code 2, which involves reading selected input coils.

Analog Reads (Input Registers)

Input registers are analog values that are readable from, but not writeable to, the 2301D-GT. Turbine speed is an example of an analog read value. The values of the input registers are stored internally to the control as floating point numbers representing engineering units (i.e. kPa or rpm). The values that are transmitted are integers ranging from -32767 to +32767. Since Modbus can only handle integers, values that have a decimal point are multiplied by a constant before being sent by Modbus. For example, these input registers may be listed as the Modbus value `x100’ or `x10’ under the description heading to denote the value is multiplied by a scaling constant. This will allow transmission of decimal parts of a unit if this is necessary for better resolution.

See the 2301D-GT Service mode for defaulted communication constants and ranges. The 2301D-GTsupports Modbus function code 4, which involves reading selected input registers.

Analog Writes (Holding Registers)

Holding registers are analog values that are writeable to the 2301D-GT. These values can also be read by a device performing an error check. An example of an analog write value would be a direct speed setpoint as opposed to raise and lower commands. The values of the holding registers are also stored in the control as numbers representing engineering units (i.e. kPa or rpm). The 2301D-GT supports Modbus function codes 3, 6, and 16. These correspond to reading selected holding registers, writing to a single holding register and writing to multiple holding registers, respectively. The following tables give the address and description of all Boolean and analog reads and writes:

Modbus Scale Factors

Modbus has two limitations:

- Only integers can be sent across.
- The value is limited between -32767 and 32767.

These limitations can be overcome by scaling the value before it is sent across the Modbus. The default scale factor for the analog values is 1. The scale factor can be changed in the service mode between 1 and 100. These scaled parameters and their scale factor are available through the Modbus. Values that require a decimal point must be multiplied by the scale factor (10 or 100) prior to being sent across the Modbus. The value sent is then divided by the scale factor in the Master. The Scale Factor adjusts all associated analog reads accordingly.

Modbus Emergency Shutdown

Two different types of shutdown commands (emergency and controlled) can be issued through Modbus. The Emergency Shutdown command instantly takes the speed setpoint and actuator current to zero. Optionally the 2301D-GT can be configured to ignore this Emergency Shutdown command if it is desired to not allow the unit to be tripped through Modbus.

To avoid an inadvertent trip, the emergency shutdown command from Modbus can be configured to require a two step process before a shutdown command is issued. After Boolean write address 0001 is given the shutdown process, an ‘ESD ACKN ENABLE’ feedback (1:0039) is given. An acknowledge on address 0002 has to be given for the control to issue a shutdown command.

Modbus Conditional Shutdown

The controlled shutdown is similar to a normal stop input on other controls. Once the Modbus command for a controlled shut down is issued, the speed reference will ramp down to a debug configured speed setpoint (defaulted to zero). Once the actual speed reaches Service: P**SPD CONTROL SET** Menu 10:CONT SD SPD (rpm), if configured to be used, the Discrete Out Open 52G relay will be triggered. Then control will reset automatically as configured in Configure: D **Alarm & Shutdown Options** Menu 08:Auto Reset after cont SD if set true. Otherwise continue ramping down to debug configured speed setpoint. If necessary the control will close valve all the way to min gov. valve % and remain there. An external shutdown will need to be issued to take actual speed and gov. valve % to zero. If the Discrete In RESET or START is pulsed any time throughout the controlled shutdown, the control will cease to shutdown and return to start up operation.

For More Modbus Information

Detailed information on the Modbus protocol is presented in ‘Reference Guide PI-MBUS-300’ published by AEC Corp./Modicon Inc., formerly Gould Inc. To implement your own source code, you must register with Modicon. Registration includes purchasing document PI-MBUS-303 and signing a non-disclosure agreement. You can register to use Modbus at your nearest Modicon field office. To find the office nearest you, contact Modicon Technical Support at 1-800-468-5342.

Chapter 7.
Service Options

Product Service Options

If you are experiencing problems with the installation, or unsatisfactory performance of a Woodward product, the following options are available:

- Consult the troubleshooting guide in the manual.
- Contact the manufacturer or packager of your system.
- Contact the Woodward Full Service Distributor serving your area.
- Contact Woodward technical assistance (see “How to Contact Woodward” later in this chapter) and discuss your problem. In many cases, your problem can be resolved over the phone. If not, you can select which course of action to pursue based on the available services listed in this chapter.

OEM and Packager Support: Many Woodward controls and control devices are installed into the equipment system and programmed by an Original Equipment Manufacturer (OEM) or Equipment Packager at their factory. In some cases, the programming is password-protected by the OEM or packager, and they are the best source for product service and support. Warranty service for Woodward products shipped with an equipment system should also be handled through the OEM or Packager. Please review your equipment system documentation for details.

Woodward Business Partner Support: Woodward works with and supports a global network of independent business partners whose mission is to serve the users of Woodward controls, as described here:

- A **Full Service Distributor** has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.
- An **Authorized Independent Service Facility (AISF)** provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.
- A **Recognized Engine Retrofitter (RER)** is an independent company that does retrofits and upgrades on reciprocating gas engines and dual-fuel conversions, and can provide the full line of Woodward systems and components for the retrofits and overhauls, emission compliance upgrades, long term service contracts, emergency repairs, etc.
- A **Recognized Turbine Retrofitter (RTR)** is an independent company that does both steam and gas turbine control retrofits and upgrades globally, and can provide the full line of Woodward systems and components for the retrofits and overhauls, long term service contracts, emergency repairs, etc.

A current list of Woodward Business Partners is available at **www.woodward.com/support/directory.cfm**.

Woodward Factory Servicing Options

The following factory options for servicing Woodward products are available through your local Full-Service Distributor or the OEM or Packager of the equipment system, based on the standard Woodward Product and Service Warranty (5-01-1205) that is in effect at the time the product is originally shipped from Woodward or a service is performed:

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

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

This option allows you to call your Full-Service Distributor in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Full-Service Distributor.

Charges for the Replacement/Exchange service are based on a flat rate plus shipping expenses. You are invoiced the flat rate replacement/exchange charge plus a core charge at the time the replacement unit is shipped. If the core (field unit) is returned within 60 days, a credit for the core charge will be issued.

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

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

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned for repair, please contact your Full-Service Distributor in advance to obtain Return Authorization and shipping instructions.

When shipping the item(s), attach a tag with the following information:

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

Packing a Control

Use the following materials when returning a complete control:

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

NOTICE

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

Replacement Parts

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

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

Engineering Services

Woodward offers various Engineering Services for our products. For these services, you can contact us by telephone, by email, or through the Woodward website.

- Technical Support
- Product Training
- Field Service

Technical Support is available from your equipment system supplier, your local Full-Service Distributor, or from many of Woodward's worldwide locations, depending upon the product and application. This service can assist you with technical questions or problem solving during the normal business hours of the Woodward location you contact. Emergency assistance is also available during non-business hours by phoning Woodward and stating the urgency of your problem.

Product Training is available as standard classes at many of our worldwide locations. We also offer customized classes, which can be tailored to your needs and can be held at one of our locations or at your site. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability.

Field Service engineering on-site support is available, depending on the product and location, from many of our worldwide locations or from one of our Full-Service Distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface.

For information on these services, please contact us via telephone, email us, or use our website: **www.woodward.com/support**.

How to Contact Woodward

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

Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany:	
Kempen	+49 (0) 21 52 14 51
Stuttgart	+49 (711) 78954-0
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany:	
Stuttgart	+49 (711) 78954-0
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Turbine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

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

Technical Assistance

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

Your Name	
Site Location	
Phone Number	
Fax Number	
Engine/Turbine Model Number	
Manufacturer	
Number of Cylinders (if applicable)	
Type of Fuel (gas, gaseous, steam, etc)	
Rating	
Application	
Control/Governor #1	
Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	
Control/Governor #2	
Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	
Control/Governor #3	
Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	

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

Appendix A.
Service/Configure Chart

Configure

CONFIGURE:A**SPD SETTINGS**		PROGRAM VALUE	DEFAULT	TUNABLE RANGE
01	NUM OF GEAR TEETH SET		60	1, 500
02	SPD RATIO SET		1.0	0.0999, 10.0
03	RATED SPD(rpm)		3000.0	100.0, 32000.0
04	STRT(IDLE) SPD(rpm)		3000.0	100.0, 32000.0
05	CB OPEN SPD(rpm)		3000.0	100.0, 32000.0
06	LOWER SPD LIMIT(rpm)		2850.0	100.0, 32000.0
07	RAISE SPD LIMIT (rpm)		3210.0	100.0, 32000.0
08	OVST TEST LIMIT(rpm)		3450.0	100.0, 32000.0
09	FAILED SPD INPUT(%)		5.0	2.0, 50.0
10	OVERRIDE SPD INPUT(%)		6.0	2.0, 50.0
11	OVSPD SET(rpm)		3300.0	100.0, 3200.0

CONFIGURE:B **INPUT & OUTPUT OPTIONS**		PROGRAM VALUE	DEFAULT	TUNABLE RANGE
01	DISP/ACT OUT TYPE		Monitor	-
02	ACT OUT TYPE(1-2)		2	1, 2
03	MIN mA FOR ACT 4–20 mA		4.0	0.0, 20.0
04	MAX mA FOR ACT 4–20 mA		20.0	4.0, 22.0
05	MIN mA FOR ACT 20–160 mA		20.0	0.0, 160.0
06	MAX mA FOR ACT 20–160 mA		160.0	20.0, 198.0
07	ANALOG INPUT1 SELECT		1	1, 5
08	ANALOG INPUT2 SELECT		2	1, 5
09	CDP LOW		0.0	0.0,10000.0
10	CDP HIGH		100.0	0.0,10000.0
11	EGT LOW(DEG_C)		0.0	0.0,2000.0
12	EGT HIGH(DEG_C)		1000.0	0.0,2000.0
13	REMOTE LOW(rpm)		3000.0	0.0,32000.0
14	REMOTE HIGH(rpm)		3150.0	0.0,32000.0
15	SHUTDOWN TO OPEN?(ESD)		TRUE	FALSE, TRUE
16	SD RELAY INCLUDE ESD?		FALSE	FALSE, TRUE
17	SD RELAY NORMAL ENE?		TRUE	FALSE, TRUE
18	USE RTD/IDL SW AT DI G		FALSE	FALSE, TRUE
19	USE BS LD/LS SW AT DI H		FALSE	FALSE, TRUE

CONFIGURE:C **OPTIONAL FUNCTIONS**		PROGRAM VALUE	DEFAULT	TUNABLE RANGE
01	ACCEL SPD DERIV USE?		FALSE	FALSE, TRUE
02	DECEL SPD DERIV USE?		FALSE	FALSE, TRUE
03	STRT RAMP SELECT?		TRUE	FALSE, TRUE
04	MIN VALVE(%)		5.0	0.0,60.0
05	MAX VALVE(%)		101.0	0.0,101.0
06	SPD DROOP USE?		FALSE	FALSE, TRUE
07	LOAD SHARING USE?		TRUE	FALSE, TRUE
08	LOAD LIMIT USE?		TRUE	FALSE, TRUE

CONFIGURE:D **ALARM&SHUTDOWN OPTIONS**		PROGRAM VALUE	DEFAULT	TUNABLE RANGE
01	SD? AT CDP LO FAIL		FALSE	FALSE, TRUE
02	SD? AT CDP HI FAIL		FALSE	FALSE, TRUE
03	SD? AT EGT FAIL		TRUE	FALSE, TRUE
04	SD? AT RMT FAIL		FALSE	FALSE, TRUE
05	SD? AT OVSPD		TRUE	FALSE, TRUE
06	SD? AT LT OFF FAIL		FALSE	FALSE, TRUE
07	AUTO RESET AFTER ESD		FALSE	FALSE, TRUE
08	AUTO RESET AFTER CONT SD		TRUE	FALSE, TRUE

CONFIGURE:E**MODBUS**		PROGRAM VALUE	DEFAULT	TUNABLE RANGE
01	DRIVER		1	1, 2

CONFIGURE:F**I/O TEST**		PROGRAM VALUE	DEFAULT	TUNABLE RANGE
01	I/O TEST INPUT		FALSE	FALSE, TRUE

SERVICE:A**MONITOR**		PROGRAM VALUE	DEFAULT	TUNABLE RANGE
01	SPD(rpm)		Monitor	-
02	SPD REF(rpm)		Monitor	-
03	SPD BIAS(rpm)		Monitor	-
04	DROOP VALUE(rpm)		Monitor	-
05	SPD REF SUM(rpm)		Monitor	-
06	LOAD(kW)		Monitor	-
07	CDP		Monitor	-
08	EGT		Monitor	-
09	EGT REF		Monitor	-
10	RMT SPD SETPOINT(rpm)		Monitor	-
11	SPM-A(rpm)		Monitor	-
12	LOAD BIAS(rpm)		Monitor	-
13	FUEL VALVE(%)		Monitor	-
14	CONTROL STATUS		Monitor	-
15	LOAD CONTROL STATUS		Monitor	-
16	FIRST ALARM		Monitor	-
17	FIRST SHUTDOWN		Monitor	-

SERVICE:B **SPD DYNAMICS(NO LOAD)**		PROGRAM VALUE	DEFAULT	TUNABLE RANGE
01	SPD P GAIN(NO LOAD)		1.0	0.0, 50.0
02	SPD I GAIN(NO LOAD)		1.0	0.0, 50.0
03	SPD S D R(NO LOAD)		10.0	0.01, 100.0
04	RATIO ENBL TIME(s)		1.0	0.0, 30.0
05	RATIO ENBL DIF SPD(rpm)		10.0	0.0, 32000.0
06	P GAIN RATIO		1.0	0.0, 100.0
07	PID(LOAD)? ONLY DRP MODE		TRUE	FALSE, TRUE
08	SPD(rpm)		Monitor	-
09	SPD REF SUM(rpm)		Monitor	-
10	SPD REF(rpm)		Monitor	-
11	CONTROL STATUS		Monitor	-
12	LOAD CONTROL STATUS		Monitor	-
13	SPD PID(%)		Monitor	-

14	FUEL VALVE(%)		Monitor	-
15	SPD ERR(%)		Monitor	-
16	SELECTED LOAD GAIN		Monitor	-
17	P GAIN MONITOR		Monitor	-

SERVICE:B1 **SPD DYNAMICS(LOAD)		**PROGRAM VALUE**	**DEFAULT**	**TUNABLE RANGE**
01	SELECTED LOAD GAIN		Monitor	-
02	USE FIXED P GAIN		TRUE	FALSE, TRUE
03	SPD FIXED P GAIN(LOAD)		1.0	0.0, 50.0
04	SPD SLP P X1(LOAD)		0.0	0.0, 32000.0
05	SPD SLP P Y1(GAIN)		1.0	0.0, 50.0
06	SPD SLP P X2(LOAD)		100.0	0.0, 32000.0
07	SPD SLP P Y2(GAIN)		1.0	0.0, 50.0
08	SPD SLP P X3(LOAD)		300.0	0.0, 32000.0
09	SPD SLP P Y3(GAIN)		1.0	0.0, 50.0
10	SPD SLP P X4(LOAD)		500.0	0.0, 32000.0
11	SPD SLP P Y4(GAIN)		1.0	0.0, 50.0
12	SPD SLP P X5(LOAD)		700.0	0.0, 32000.0
13	SPD SLP P Y5(GAIN)		1.0	0.0, 50.0
14	SPD SLP P X6(LOAD)		1000.0	0.0, 32000.0
15	SPD SLP P Y6(GAIN)		1.0	0.0, 50.0
16	SPD I GAIN(LOAD)		1.0	0.0, 50.0
17	SPD S_D_R(LOAD)		100.0	0.01, 100.0
18	RATIO ENBL DIF SPD(rpm)		10.0	0.0, 32000.0
19	P GAIN RATIO		1.0	0.0, 100.0
20	PID(LOAD)? ONLY DRP MODE		TRUE	FALSE, TRUE
21	P GAIN MONITOR		Monitor	-

SERVICE:CEGT DYNAMICS**		**PROGRAM VALUE**	**DEFAULT**	**TUNABLE RANGE**
01	EGT P GAIN		0.5	0.0, 50.0
02	EGT I GAIN		0.5	0.0, 50.0
03	EGT S_D_R		100.0	0.01,100.0
04	EGT(DEG_C)		Monitor	-
05	EGT REF(DEG_C)		Monitor	-
06	EGT START REF(DEG_C)		750.0	0.0, 2000.0
07	EGT NORMAL REF(DEG_C)		580.0	0.0, 2000.0
08	EGT HIGH ALARM(DEG_C)		800.0	0.0, 2000.0
09	EGT HIGH(DEG_C)		900.0	0.0, 2000.0
10	CONTROL STATUS		Monitor	-
11	EGT PID(%)		Monitor	-
12	FUEL VALVE(%)		Monitor	-
13	EGT ERR(%)		Monitor	-
14	RATED EGT(DEG_C)		600.0	0.0, 2000.0

SERVICE:D **ACCEL SPD DERIV LIMIT		**PROGRAM VALUE**	**DEFAULT**	**TUNABLE RANGE**
01	ACCEL P GAIN		1.0	0.0, 50.0
02	ACCEL I GAIN		0.1	0.0, 50.0
03	ACCEL S_D_R		100.0	0.01, 100.0
04	ACCEL DERIV PID(%)		Monitor	-
05	ACCEL RATE(rpm/s)		Monitor	-

06	ACCEL RATE REF(rpm/s)		Monitor	-
07	ACCEL RATE SET X1(rpm)		0.0	0.0, 32000.0
08	ACCEL RATE SET Y1(rpm/s)		30.0	1.0, 10000.0
09	ACCEL RATE SET X2(rpm)		500.0	0.0, 32000.0
10	ACCEL RATE SET Y2(rpm/s)		30.0	1.0, 10000.0
11	ACCEL RATE SET X3(rpm)		1000.0	0.0, 32000.0
12	ACCEL RATE SET Y3(rpm/s)		30.0	1.0, 10000.0
13	ACCEL RATE SET X4(rpm)		2000.0	0.0, 32000.0
14	ACCEL RATE SET Y4(rpm/s)		30.0	1.0, 10000.0
15	ACCEL RATE SET X5(rpm)		3000.0	0.0, 32000.0
16	ACCEL RATE SET Y5(rpm/s)		30.0	1.0, 10000.0
17	CONTROL STATUS		Monitor	-
18	ADD REF AT STRT SPD		2.0	0.0, 10.0

SERVICE:E **DECEL SPD DERIV LIMIT**		**PROGRAM VALUE**	**DEFAULT**	**TUNABLE RANGE**
01	DECEL P GAIN		0.05	0.0, 50.0
02	DECEL I GAIN		20.0	0.0, 50.0
03	DECEL S_D_R		5.0	0.01, 100.0
04	DECEL DERIV PID(%)		Monitor	-
05	DECEL RATE(rpm/s)		Monitor	-
06	DECEL RATE SET(rpm/s)		-50.0	-10000.0, -1.0
07	CONTROL STATUS		Monitor	-

SERVICE:FACCEL LIMIT CURVE****		**PROGRAM VALUE**	**DEFAULT**	**TUNABLE RANGE**
01	ACCEL X_1		0.0	0.0, 10000.0
02	ACCEL Y_1(%)		5.0	0.0, 101.0
03	ACCEL X_2		20.0	0.0, 10000.0
04	ACCEL Y_2(%)		10.0	0.0, 101.0
05	ACCEL X_3		30.0	0.0, 10000.0
06	ACCEL Y_3(%)		15.0	0.0, 101.0
07	ACCEL X_4		40.0	0.0, 10000.0
08	ACCEL Y_4(%)		50.0	0.0, 101.0
09	ACCEL X_5		50.0	0.0, 10000.0
10	ACCEL Y_5(%)		75.0	0.0, 101.0
11	ACCEL X_6		60.0	0.0, 10000.0
12	ACCEL Y_6(%)		100.0	0.0, 101.0
13	CDP		Monitor	-
14	ACCEL LIMIT		Monitor	-
15	CONTROL STATUS		Monitor	-
16	ACC LMT DISBL AFT ST SPD		FALSE	FALSE, TRUE
17	CDP INPUT LAG(TAU)		0.1	0.0, 10.0

SERVICE:GDECEL LIMIT CURVE****		**PROGRAM VALUE**	**DEFAULT**	**TUNABLE RANGE**
01	DECEL X_1		10.0	0.0, 10000.0
02	DECEL Y_1(%)		1.0	0.0, 101.0
03	DECEL X_2		50.0	0.0, 10000.0
04	DECEL Y_2(%)		1.0	0.0, 101.0
05	DECEL X_3		80.0	0.0, 10000.0
06	DECEL Y_3(%)		1.0	0.0, 101.0
07	DECEL X_4		100.0	0.0, 10000.0
08	DECEL Y_4(%)		1.0	0.0, 101.0

09	CDP		Monitor	-
10	DECEL LIMIT		Monitor	-
11	CONTROL STATUS		Monitor	-

SERVICE:H**LT OFF FAIL SET**		PROGRAM VALUE	DEFAULT	TUNABLE RANGE
01	ENBL LT OFF FAIL FOR SD		Monitor	-
02	ENBL FLM ON IN STRT FUEL		Monitor	-
03	LT OFF FAIL TIMER(s)		8.0	0.0, 50.0
04	USE SPD? FOR TMR STRT		FALSE	FALSE, TRUE
05	SPD? FOR TMR STRT(rpm)		150.0	0.0, 32000.0
06	FLM ON EGT RATE(DEG_C/s)		30.0	0.0, 2000.0
07	SCAN TIME OF EGT(s)		1.0	0.1, 10.0
08	CONTROL STATUS		Monitor	-

SERVICE:I**STRT RAMP**		PROGRAM VALUE	DEFAULT	TUNABLE RANGE
01	ENBL STRT RAMP		Monitor	-
02	STRT RAMP RATE(%/s)		3.0	0.0, 1000.0
03	STRT RAMP MONITOR		Monitor	-
04	CONTROL STATUS		Monitor	-

SERVICE:J**STRT FUEL RAMP**		PROGRAM VALUE	DEFAULT	TUNABLE RANGE
01	ENBL STRT FUEL RAMP		Monitor	-
02	LIGHT OFF SPD(rpm)		-1.0	-1.0, 32000.0
03	STRT VALVE SET(%)		5.0	0.0, 101.0
04	STRT RAMP UP RATE(%/s)		3.0	0.0, 1000.0
05	STRT RAMP DN RATE(%/s)		10.0	0.0, 1000.0
06	STRT FUEL LMTR TRIG		Monitor	-
07	FLM ON TO TRG LMTR		TRUE	FALSE, TRUE
08	SPD SW TO TRIG LMTR		FALSE	FALSE, TRUE
09	STRT FUEL SPD SW		300.0	0.0, 32000.0
10	STRT FUEL RAMP MONITOR		Monitor	-
11	CONTROL STATUS		Monitor	-
12	RAMP USE? TO STRT FUEL		FALSE	FALSE, TRUE
13	RAMP RATE TO STRT FUEL		3.0	0.0, 1000.0
14	DECEL ENABLE TIMER(s)		20.0	0.0, 60.0

SERVICE:K **REMOTE SPD CONTROL**		PROGRAM VALUE	DEFAULT	TUNABLE RANGE
01	REMOTE RATE SET(rpm/s)		5.0	0.0, 10000.0
02	REMOTE ENABLE STATUS		Monitor	-
03	REMOTE SIGNAL FAIL		Monitor	-
04	SPD(rpm)		Monitor	-
05	REMOTE SPD SETPOINT		Monitor	-
06	SPD REF(rpm)		Monitor	-
07	SPD BIAS(rpm)		Monitor	-
08	DROOP VALUE(rpm)		Monitor	-
09	SPD REF SUM(rpm)		Monitor	-
10	CONTROL STATUS		Monitor	-

SERVICE:L**OVSPD TEST**		PROGRAM VALUE	DEFAULT	TUNABLE RANGE
01	OVSPD TEST STATUS		Monitor	-
02	OVSPD TEST INPUT		FALSE	FALSE, TRUE

03	OVSPD OVRIDE INPUT		FALSE	FALSE, TRUE
04	OVSPD SETPOINT		Monitor	-
05	SPD(rpm)		Monitor	-
06	SPD REF(rpm)		Monitor	-
07	SPD BIAS(rpm)		Monitor	-
08	DROOP VALUE(rpm)		Monitor	-
09	SPD REF SUM(rpm)		Monitor	-
10	CONTROL STATUS		Monitor	-

SERVICE:MSYNC SET****		**PROGRAM VALUE**	**DEFAULT**	**TUNABLE RANGE**
01	ENBL SYNC		Monitor	-
02	SYNC INPUT SCALE(%/V)		0.7	0.1, 5.0
03	SYNC BIAS SPD(rpm)		Monitor	-
04	SPD(rpm)		Monitor	-
05	SPD REF(rpm)		Monitor	-
06	SPD BIAS(rpm)		Monitor	-
07	DROOP VALUE(rpm)		Monitor	-
08	SPD REF SUM(rpm)		Monitor	-
09	CONTROL STATUS		Monitor	-
10	SYNC ENBL SPD(rpm)		2950.0	0.0, 32000.0
11	SYNC ENBL IN 52G OPN		TRUE	FALSE, TRUE
12	SYNC ENBL IN GEN_ISO		TRUE	FALSE, TRUE
13	SYNC ENBL IN GEN_DRP		FALSE	FALSE, TRUE

SERVICE:NCONTROL MODE****		**PROGRAM VALUE**	**DEFAULT**	**TUNABLE RANGE**
01	CONTROL STATUS		Monitor	-
02	SPD IN CONTROL		Monitor	-
03	ACCEL LIMIT		Monitor	-
04	ACCEL SPD DERIV		Monitor	-
05	EGT IN CONTROL		Monitor	-
06	STRT RAMP		Monitor	-
07	STRT FUEL		Monitor	-
08	DECEL LIMIT		Monitor	-
09	DECEL SPD DERIV		Monitor	-
10	MIN FUEL		Monitor	-
11	MAX FUEL		Monitor	-
12	SPD PID(%)		Monitor	-
13	ACCEL LIMIT(%)		Monitor	-
14	ACCEL SPD DERIV(%)		Monitor	-
15	EGT PID(%)		Monitor	-
16	STRT RAMP(%)		Monitor	-
17	STRT FUEL RAMP(%)		Monitor	-
18	LSS(%)		Monitor	-
19	DECEL LIMIT(%)		Monitor	-
20	DECEL SPD DERIV(%)		Monitor	-
21	MIN FUEL(%)		Monitor	-
22	MAX FUEL(%)		Monitor	-
23	HSS(%)		Monitor	-
24	LOAD LIMIT		Monitor	-
25	LOAD LIMIT PID(%)		Monitor	-

SERVICE:O**ENBL CONTROL**		PROGRAM VALUE	DEFAULT	TUNABLE RANGE
01	SPD PID		Monitor	-
02	ACCEL LIMIT		Monitor	-
03	ACCEL SPD DERIV		Monitor	-
04	EGT PID		Monitor	-
05	STRT RAMP		Monitor	-
06	STRT FUEL RAMP		Monitor	-
07	DECEL LIMIT		Monitor	-
08	DECEL SPD DERIV		Monitor	-
09	MIN LIMIT		Monitor	-
10	MAX LIMIT		Monitor	-
11	REMOTE SPD SETPOINT		Monitor	-
12	SPM-A		Monitor	-
13	KW DROOP		Monitor	-
14	SPD DROOP		Monitor	-
15	LOAD SHARE		Monitor	-
16	BASE LOAD		Monitor	-
17	LOAD LIMIT		Monitor	-

SERVICE:P**SPD CONTROL SET**		PROGRAM VALUE	DEFAULT	TUNABLE RANGE
01	RATED SPD(rpm)		3000.0	100.0, 32000.0
02	STRT(IDLE) SPD(rpm)		3000.0	100.0, 32000.0
03	CB OPEN SPD(rpm)		3000.0	100.0, 32000.0
04	LOWER SPD LIMIT(rpm)		2850.0	100.0, 32000.0
05	RAISE SPD LIMIT(rpm)		3210.0	100.0, 32000.0
06	OVSPD TEST LIMIT(rpm)		3450.0	100.0, 32000.0
07	SPD REF RATE(rpm/s)		5.0	0.0, 10000.0
08	OVSPD SET(rpm)		3300.0	100.0, 3200.0
09	RATE FOR CONT SD(rpm/s)		30.0	0.0, 10000.0
10	CONT SD SPD(rpm)		500.0	0.0, 32000.0
11	RTD SPD FM DRP TO ISO?		TRUE	TRUE, FALSE
12	RTD SPD FM B_OPN TO ISO?		TRUE	TRUE, FALSE
13	STRT ENBL SPD(%)		30.0	0.0, 50.0
14	SPD FAIL TMR AFT STRT(s)		600.0	0.0, 32000.0

SERVICE:Q **LOAD CONT SET(DROOP)**		PROGRAM VALUE	DEFAULT	TUNABLE RANGE
01	DROOP SET(%)		3.0	0.0, 20.0
02	INITIAL LOAD(kW)		50.0	0.0, 32000.0
03	INITIAL LOAD RATE(rpm/s)		5.0	0.0, 10000.0
04	USE? SPD DROOP MIN VALVE		FALSE	TRUE, FALSE
05	SPD DROOP MIN VALVE(%)		20.0	0.0, 100.0
06	SPD DROOP MAX VALVE(%)		100.0	0.0, 100.0

SERVICE:R**LOAD SHARE SET(ISO)**		PROGRAM VALUE	DEFAULT	TUNABLE RANGE
01	LOADING RATE(kW/s)		50.0	0.1, 10000.0
02	UNLOAD LIMIT(kW)		25.0	0.0,32000.0
03	UNLOAD RATE(kW/s)		50.0	0.1, 10000.0
04	LOAD REF(kW)		Monitor	-
05	LOAD SHARING LINES(V)		Monitor	-
06	LOAD SIGNAL OUT(V/2)		Monitor	-
07	LOAD ERR(V)		Monitor	-

08	LOAD SHARING ERR(%)		Monitor	-
09	LOAD SHARE GAIN(%)		5.0	0.0,20.0
10	LOAD CONTROL STATUS		Monitor	-
11	OPEN 52G RELAY OUT		Monitor	-

SERVICE:SLOAD SENSOR SET****		**PROGRAM VALUE**	**DEFAULT**	**TUNABLE RANGE**
01	LOAD INPUT CAL ZERO		0.0	-100.0,100.0
02	LOAD INPUT CAL GAIN		10.0	5.0,40.0
03	CT AMPS CAL @RATED LOAD		5.0	1.0, 7.50
04	ENTER GEN RATED LOAD(kW)		1000	5, 32000
05	LD GAIN(V) @100%LOAD		6.0	0.1, 7.5
06	MONITOR/CT AMPS VAL(A)		Monitor	-
07	MONITOR/GEN LOAD(%LOAD)		Monitor	-
08	MONITOR/LOAD SIGNAL(V)		Monitor	-

SERVICE:T **ANALOG OUT SETTINGS**		**PROGRAM VALUE**	**DEFAULT**	**TUNABLE RANGE**
01	ANALOG OUTPUT ITEM		Monitor	-
02	ANALOG OUTPUT SEL(1-6)		1	1, 6
03	ANOUT, VALUE OF 4MA		0.0	0.0, 32000.0
04	ANOUT, VALUE OF 20 mA		3500.0	0.0, 32000.0
05	ANALOG OUT(%)		Monitor	-
06	VALVE DEMAND(%)		Monitor	-
07	VALVE DEMAND(mA)		Monitor	-
08	ACT DITHER USE?		FALSE	TRUE, FALSE
09	ACT DITHER AMP(%)		5.0	0.0, 30.0
10	ACT DITHER(Hz)		25.0	0.1, 100.0

SERVICE:U **DISCRETE OUT SETTINGS**		**PROGRAM VALUE**	**DEFAULT**	**TUNABLE RANGE**
01	DISCRETE OUT #1 ITEM		Monitor	-
02	DISCRETE OUT #2 ITEM		Monitor	-
03	SELECT D/O #2 ITEM(1-20)		2	1, 20
04	DISCRETE OUT #3 ITEM		Monitor	-
05	SELECT D/O #3 ITEM(1-20)		3	1, 20
06	DISCRETE OUT #4 ITEM		Monitor	-
07	SELECT D/O #4 ITEM(1-20)		4	1, 20
08	SPD SW#1 PICK-UP(rpm)		1800.0	0.0, 32000.0
09	SPD SW#1 DROP-OUT(rpm)		1750.0	0.0, 32000.0
10	SPD SW#2 PICK-UP(rpm)		3000.0	0.0, 32000.0
11	SPD SW#2 DROP-OUT(rpm)		2950.0	0.0, 32000.0
12	LOAD SW PICK-UP(kW)		1000.0	0.0, 32000.0
13	LOAD SW DROP-OUT(kW)		950.0	0.0, 32000.0
14	STARTER ENE SPD(rpm)		500.0	0.0, 32000.0
15	NRML ENERGIZE OPN 52G RLY		FALSE	TRUE, FALSE
16	ADD PER(%) FOR 52G OPEN		2.0	0.0, 100.0
17	USE ONESHOT FOR LT OF FL		FALSE	TRUE, FALSE
18	ICLD LT OFF FL TO SD RLY		TRUE	TRUE, FALSE
19	USE ONESHOT FOR SD RLY		FALSE	TRUE, FALSE

SERVICE:VDISPLAY A_I/O VAL****		**PROGRAM VALUE**	**DEFAULT**	**TUNABLE RANGE**
01	SPD(rpm)		Monitor	-

02	LOAD CT AMPS VAL(A)		Monitor	-
03	ANALOG INPUT1		Monitor	-
04	ANALOG INPUT2		Monitor	-
05	CDP INPUT(mA)		Monitor	-
06	EGT INPUT(mA)		Monitor	-
07	REMOTE INPUT(mA)		Monitor	-
08	SYNC INPUT(V)		Monitor	-
09	LOAD SHARING LINES(V)		Monitor	-
10	LOAD SHARING OUT(V)		Monitor	-
11	ACTUATOR DRIVER TYPE		Monitor	-
12	ACTUATOR OUTPUT(mA)		Monitor	-
13	ANALOG OUT USED FOR		Monitor	-
14	ANALOG OUT(%)		Monitor	-

SERVICE: WDISPLAY D_ I/O STATUS****		**PROGRAM VALUE**	**DEFAULT**	**TUNABLE RANGE**
01	EXTERNAL SHUTDOWN A		Monitor	-
02	RESET B		Monitor	-
03	START/UNLOAD C		Monitor	-
04	LOWER SPEED D		Monitor	-
05	RAISE SPEED E		Monitor	-
06	DI F USE FOR		Monitor	-
07	DI F		Monitor	-
08	DI G USE FOR		Monitor	-
09	DI G		Monitor	-
10	DI H USE FOR		Monitor	-
11	DI H		Monitor	-
12	DO1 USED FOR		Monitor	-
13	DO1 OUTPUT		Monitor	-
14	DO2 USED FOR		Monitor	-
15	DO2 OUTPUT		Monitor	-
16	DO3 USED FOR		Monitor	-
17	DO3 OUTPUT		Monitor	-
18	DO4 USED FOR		Monitor	-
19	DO4 OUTPUT		Monitor	-
20	INTERNAL L/S RELAY K1		Monitor	-

SERVICE:XI/O TEST****		**PROGRAM VALUE**	**DEFAULT**	**TUNABLE RANGE**
01	I/O TEST ENBL INPUT		FALSE	TRUE,FALSE
02	FORCE OUTPUT STATUS		Monitor	-
03	TURN ON D/O-1		FALSE	TRUE,FALSE
04	TURN ON D/O-2		FALSE	TRUE,FALSE
05	TURN ON D/O-3		FALSE	TRUE,FALSE
06	TURN ON D/O-4		FALSE	TRUE,FALSE
07	TURN ON L/S LINE RELAY		FALSE	TRUE,FALSE
08	ADJUST AO VAL(%)		0.0	0.0, 100.0
09	ADJUST ACTUATOR VAL(%)		0.0	0.0, 100.0
10	ANALOG OUT 4mA ADJ(%)		0.0	-20.0, 20.0
11	ANALOG OUT 20 mA ADJ(%)		100.0	80.0, 120.0
12	ACT OUT MIN ADJ(%)		0.0	-20.0, 20.0
13	ACT OUT HIGH ADJ(%)		100.0	80.0, 120.0
14	LS LINE OUTPUT		0.0	0.0, 750.0

SERVICE:Y**MODBUS**		PROGRAM VALUE	DEFAULT	TUNABLE RANGE
01	BAUD RATE		10	1, 10
02	PORT FAIL		Monitor	-
03	MODBUS DEVICE NUMBER		1	1, 247
04	DATA BITS		2	1, 2
05	STOP BITS		1	1, 3
06	PARITY		1	1, 3
07	ENDLINE		1	1, 3

SERVICE:Z**ALARM**		PROGRAM VALUE	DEFAULT	TUNABLE RANGE
01	ALARM		Monitor	-
02	FIRST ALARM		Monitor	-
03	(1)CDP LO FAIL		Monitor	-
04	(2)CDP HI FAIL		Monitor	-
05	(3)EGT FAIL		Monitor	-
06	(4)REMOTE FAIL		Monitor	-
07	(5)EGT HIGH ALARM		Monitor	-
08	(6)OVERSPEED		Monitor	-
09	(7)AI SET FAIL		Monitor	-

SERVICE:Z1**SHUTDOWN**		PROGRAM VALUE	DEFAULT	TUNABLE RANGE
01	SHUTDOWN		Monitor	-
02	FIRST SHUTDOWN		Monitor	-
03	(1)MPU FAIL		Monitor	-
04	(2)CDP LO FAIL		Monitor	-
05	(3)CDP HI FAIL		Monitor	-
06	(4)EGT FAIL		Monitor	-
07	(5)REMOTE FAIL		Monitor	-
08	(6)OVERSPEED		Monitor	-
09	(7)LIGHT OFF FAIL		Monitor	-
10	(8)MISS CONF		Monitor	-
11	(9)EXTERNAL SHUTDOWN		Monitor	-
12	(10)PWR UP SHUTDOWN		Monitor	-
13	(11)EGT HIGH		Monitor	-
14	(12)MODBUS CONTROLLED SD		Monitor	-
15	(13)MODBUS ESD		Monitor	-

SERVICE:Z2**APPLICATION ID**		PROGRAM VALUE	DEFAULT	TUNABLE RANGE
01	APP Software Number		Monitor	-
02	APP Software Revision		Monitor	-
03	Application Name		Monitor	-

SERVICE:Z3**BASE LOAD**		PROGRAM VALUE	DEFAULT	TUNABLE RANGE
01	BASE LOAD MODE		Monitor	-
02	LOAD REF(kW)		Monitor	-
03	LOAD (kW)		Monitor	-
04	BASE LOAD MIN(kW)		5.0	0.0, 32000.0
05	BASE LOAD MAX(kW)		500.0	0.0, 32000.0
06	BASE LOAD R/L RATE(kW/s)		30.0	0.1, 10000.0
07	BASE LOADING SETPT(kW)		480.0	0.0, 32000.0

08	BASE LOADING RATE(kW/s)		50.0	0.1, 10000.0
09	UNLOADING		Monitor	-
10	UNLOAD LIMIT(kW)		25.0	0.0, 32000.0
11	UNLOAD RATE(kW/s)		50.0	0.1, 10000.0
12	OPEN 52G RELAY OUT		Monitor	-

SERVICE:Z4**REMOTE BASE LOAD**		PROGRAM VALUE	DEFAULT	TUNABLE RANGE
01	REMOTE BASE LOAD		Monitor	-
02	LOAD(kW)		Monitor	-
03	LOAD REF(kW)		Monitor	-
04	RMT LOAD REF(kW)		Monitor	-
05	RMT BASE LOAD MIN(kW)		5.0	0.0, 32000.0
06	RMT BASE LOAD MAX(kW)		500.0	0.0, 32000.0
07	RMT B_LOAD RATE(kW/s)		30.0	0.1, 10000.0
08	REMOTE SIGNAL FAIL		Monitor	-
09	SPD(rpm)		Monitor	-
10	SPD REF(rpm)		Monitor	-
11	SPD BIAS(rpm)		Monitor	-
12	SPD REF SUM(rpm)		Monitor	-
13	CONTROL STATUS		Monitor	-

SERVICE:Z5**LOAD LIMIT**		PROGRAM VALUE	DEFAULT	TUNABLE RANGE
01	LOAD P GAIN		1.0	0.0, 50.0
02	LOAD I GAIN		1.0	0.0, 50.0
03	LOAD S_D_R		100.0	0.01, 100.0
04	LOAD(kW)		Monitor	-
05	LOAD LIMIT(kW)		800.0	0.0, 32000.0
06	CONTROL STATUS		Monitor	-
07	LOAD LIMIT PID(%)		Monitor	-
08	FUEL VALVE(%)		Monitor	-
09	LOAD LIMIT ERR(%)		Monitor	-

SERVICE:Z6**IDLE RATED**		PROGRAM VALUE	DEFAULT	TUNABLE RANGE
01	RAMP TO IDLE		Monitor	-
02	RAMP TO RATED		Monitor	-
03	IDL/RTD RATE(rpm/s)		10.0	0.0, 10000.0
04	AUTO IDLE TO RATED		FALSE	TRUE,FALSE
05	IDLE TIME(s)		1.0	0.0, 600.0

Appendix B.
Modbus Communication List

Boolean Write

Address	Description
0:0001	Emergency Shutdown
0:0002	Emergency Shutdown Acknowledge
0:0003	Controlled Shutdown
0:0004	System Reset
0:0005	Start Command
0:0006	Lower Speed
0:0007	Raise Speed
0:0008	Enable Remote Speed Setpoint
0:0009	Disable Remote Speed Setpoint
0:0010	Select Modbus Entered Speed Setpoint
0:0011	Select Speed PID Dynamic Settings #1
0:0012	Select Speed PID Dynamic Settings #2
0:0013	Select Modbus Speed PID Selector
0:0014	Energize Modbus Relay #1
0:0015	De-energize Modbus Relay #1
0:0016	Energize Modbus Relay #2
0:0017	De-energize Modbus Relay #2
0:0018	Idle/Rated Enable
0:0019	Idle Input
0:0020	Rated Input
0:0021	Load/Unload Enable
0:0022	Load Input
0:0023	Unload Input

Boolean Read

Address	Description
1:0001	Shutdown Status
1:0002	External Shutdown
1:0003	General Control Shutdown
1:0004	Overspeed Trip
1:0005	Modbus Issued Trip
1:0006	MPU Failed Trip
1:0007	CDP Input Failed Trip
1:0008	EGT Input Failed Trip
1:0009	REMOTE Input Failed Trip
1:0010	Analog Input #1 Failed
1:0011	Analog Input #2 Failed
1:0012	Speed PID In Control
1:0013	In Droop Control Indication
1:0014	EGT PID In Control
1:0015	CDP Accel Limit In Control
1:0016	CDP Decel Limit In Control
1:0017	Speed Derivative Accel Limit In Control
1:0018	Speed Derivative Decel Limit In Control
1:0019	Remote Speed Setpoint Enabled
1:0020	Synchronizing Enabled

1:0021	Min Limit In Control
1:0022	Max Limit In Control
1:0023	Start Ramp Controlled
1:0024	Start Fuel Ramp Control
1:0025	KW Level Switch On
1:0026	Load Sharing Enabled
1:0027	Discrete Input A State
1:0028	Discrete Input B State
1:0029	Discrete Input C State
1:0030	Discrete Input D State
1:0031	Discrete Input E State
1:0032	Discrete Input F State
1:0033	Discrete Input G State
1:0034	Discrete Input H State
1:0035	Relay Output #1 State
1:0036	Relay Output #2 State
1:0037	Relay Output #3 State
1:0038	Relay Output #4 State
1:0039	Emergency Shutdown ACK Enable
1:0040	Alarm
1:0041	Selected SPD PID setting#2
1:0042	Load Limit in Control

Analog Read

Address	**Description**	**Multiplier**
3:0001	First Cause of Trip	1.0
3:0002	Turbine Speed (rpm)	1.0
3:0003	Speed Setpoint (rpm)	1.0
3:0004	Turbine Load (kW)	1.0
3:0005	Actuator Output (%)	100.0
3:0006	Speed PID Output (%)	100.0
3:0007	EGT PID Output (%)	100.0
3:0008	Analog Input #1 (%)	100.0
3:0009	Analog Input #2 (%)	100.0
3:0010	**Speed Derivative Signal**	10.0
3:0011	Remote Speed Setpoint (rpm)	1.0
3:0012	System Load–Load Sharing Lines (%)	100.0
3:0013	**Speed Bias(rpm)**	10.0
3:0014	Speed value (rpm)	10.0
3:0015	Load Ref (kW)	1.0

Analog Write

Address	**Description**	**Multiplier**
4:0001	Modbus Entered Speed Setpoint	1.0

2301D-GT Control Specifications

Woodward Part Numbers:	
8273-127	Load Sharing and Speed Control CSA certified for ordinary location
8273-1002	Load Sharing and Speed Control CSA certified for Class I Division 2 locations
8923-932	Watch Window Installation
Power Supply Rating	18–40 Vdc (SELV)
Power Consumption	less than or equal 20 W nominal
Input Supply Voltage	Input Supply Current
18 V	589 mA
24 V (nominal)	431 mA
32 V	319.6 mA
Inrush Current	7 A for 0.1 ms (low-voltage model)
Inrush Current	22 A for 15 ms (high-voltage model)
Steady State Speed Band	±0.25% of rated speed
Magnetic Pickup	100–24 950 Hz (900–32000 rpm)
Discrete Inputs (8)	3 mA at 24 Vdc, impedance approximately 5.2 kΩ
Analog Input #1, #2	4–20 mA
SPM-A Input	±2.5 Vdc, externally powered
Analog Output #1	4–20 or 20–198 mA to actuator, software configurable
Analog Output #2	4–20 mA to monitor, internally powered
Discrete Outputs (4)	configured to provide two speed switches & two load switches, power by external +12 Vdc or +24 Vdc source, max output current 200 mA
Discrete Output Ratings	Low-side drivers with overvoltage protection, 200 mA maximum
Communication Port (J2)	RS-232, RS-422, 9-pin connector, 1200 to 38 400 baud, full duplex
Ambient Operating Temperature	–40 to +70 °C (–40 to +158 °F)
Storage Temperature	–40 to +105 °C (–40 to +221 °F)
Humidity	95% at +20 to +55 °C (+68 to +131 °F) Lloyd’s Register of Shipping Specification Humidity Test 1
Mechanical Vibration	Lloyd’s Register of Shipping Specification Vibration Test 2
Mechanical Shock	US MIL-STD 810C, Method 516.2, Procedure I (basic design test), Procedure II (transit drop test, packaged), Procedure V (bench handling)
Equipment Classification	1 (grounded equipment)

DECLARATION OF CONFORMITY

According to ISO/IEC Guide 22 and EN 45014

Manufacturer's Name:	WOODWARD GOVERNOR COMPANY (WGC) Industrial Controls Group
Manufacturer's Address:	1000 East Drake Road P.O. Box 3800 Fort Collins, Colorado, USA 80525-1519
European Representative's Name:	WOODWARD GOVERNOR NEDERLAND BV
European Representative's Address:	Hoofdweg 601 P. O. Box 34 2130 AA Hoofddorp, The Netherlands
Model Name(s)/Number(s):	2301D Digital LSSC
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. 73/23/EEC COUNCIL DIRECTIVE of 19 February 1973 on the harmonization of the laws of the Member States relating to electrical equipment designed for use within certain voltage limits.
Applicable Standards:	EN-50081-2, August 1993: EMC Generic Emissions Standard, Part 2: Industrial Environment. EN 61000-6-2, April 1999: Electromagnetic Compatibility (EMC), Immunity for Industrial environments. EN 50178, October 1997: Electronic Equipment for use in Power Installations

We, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s).

MANUFACTURER	LEGAL REPRESENTATIVE IN EUROPE
Jennifer R. Williams **Signature**	**Signature**
Jennifer R. Williams **Full Name**	**Full Name**
Engineer Process/Project Manager **Position**	**Position**
WGC, Fort Collins, CO, USA **Place**	**Place**
6-29-00 **Date**	**Date**

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

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PO Box 1519, Fort Collins CO 80522-1519, USA
1000 East Drake Road, Fort Collins CO 80525, USA
Phone +1 (970) 482-5811 • Fax +1 (970) 498-3058

Email and Website—www.woodward.com

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2010/7/Colorado