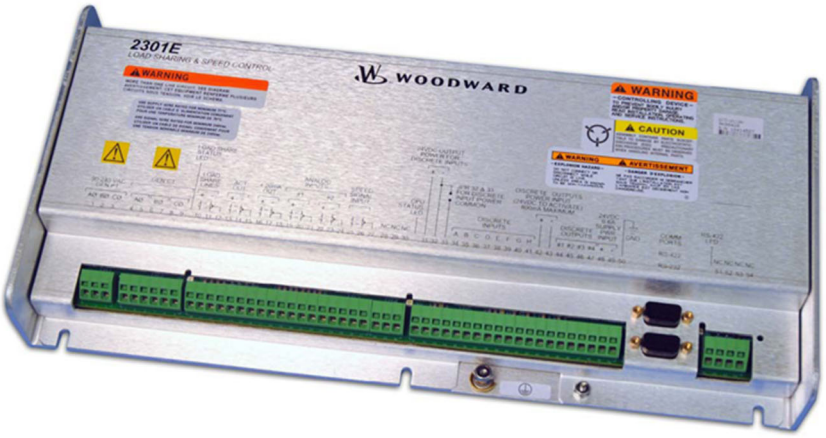
WOODWARD

Product Manual 26818
(Revision A, 9/2023)
Original Instructions



2301E-J Digital Speed and Load Control

For Medium and High Speed Engine-Generator Control with Automatic Load Sharing Function

Instruction Manual

General Precautions

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.

Practice all plant and safety instructions and precautions.

Failure to follow instructions can cause personal injury and/or property damage.

Revisions

This publication may have been revised or updated since this copy was produced. The latest version of most publications is available on the Woodward website.

http://www.woodward.com

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

Proper Use

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

Translated Publications

If the cover of this publication states "Translation of the Original Instructions" please note:

The original source of this publication may have been updated since this translation was made. The latest version of most publications is available on the Woodward website.

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Always compare with the original for technical specifications and for proper and safe installation and operation procedures.

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

Revisions—Changes in this publication since the last revision are indicated by a black line alongside the text.

Manual 26818

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Important Definitions

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

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

⚠WARNING

Lockout/Tagout LOTO

Ensure that personnel are fully trained on LOTO procedures prior to attempting to replace or service equipment on a "live" running engine. All safety protective systems (overspeed, over temperature, overpressure, etc.) must be in proper operational condition prior to the start or operation of a running engine. Personnel should be equipped with appropriate personal protective equipment to minimize the potential for injury due to release of hot hydraulic fluids, exposure to hot surfaces and/or moving parts, or any moving parts that may be activated and are located in the area of control of the unit.

⚠WARNING

Overspeed / Overtemperature / Overpressure

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

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

⚠WARNING

Personal Protective Equipment

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

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

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

⚠WARNING

Start-up

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

⚠WARNING

Automotive Applications

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

⚠WARNING

IOLOCK

IOLOCK: driving I/O into a known state condition. When a control fails to have all the conditions for normal operation, watchdog logic drives it into an IOLOCK condition where all output circuits and signals will default to their de-energized state as described below. *The system MUST be applied such that IOLOCK and power OFF states will result in a SAFE condition of the controlled device.*

- **Microprocessor failures will send the module into an IOLOCK state.**
- **Discrete outputs / relay drivers will be non-active and de-energized.**
- **Analog and actuator outputs will be non-active and de-energized with zero voltage or zero current.**

Network connections like CAN stay active during IOLOCK. This is up to the application to drive actuators controlled over network into a safe state.

The IOLOCK state is asserted under various conditions, including:

- **Watchdog detected failures**
- **Microprocessor failure**
- **PowerUp and PowerDown conditions**
- **System reset and hardware/software initialization**
- **PC tool initiated**

NOTE—Additional watchdog details and any exceptions to these failure states are specified in the related section of the product manual.

NOTICE

Battery Charging Device

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

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

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

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

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

Follow these precautions when working with or near the control.

1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
2. Touch your finger to a grounded surface to discharge any potential before touching the control, smart valve, or valve driver, or installing cabling connectors. Alternatively, ESD mitigation may be used as well: ESD smocks, ankle or wrist straps and discharging to a reference grounds surface like chassis or earth are examples of ESD mitigation.
    - ESD build up can be substantial in some environments: the unit has been designed for immunity deemed to be satisfactory for most environments. ESD levels are extremely variable and, in some situations, may exceed the level of robustness designed into the control. Follow all ESD precautions when handling the unit or any electronics.
        - I/O pins within connectors have had ESD testing to a significant level of immunity to ESD, however do not touch these pins if it can be avoided.
            - Discharge yourself after picking up the cable harness before installing it as a precaution.
        - The unit is capable of not being damaged or improper operation when installed to a level of ESD immunity for most installation as described in the EMC specifications. Mitigation is needed beyond these specification levels.

IMPORTANT

External wiring connections for reverse-acting controls are identical to those for direct-acting controls.

Safety Statement

WARNING

Safe work practices and procedures must be followed. Proper personal protective equipment must be worn at all times while handling, assembling, disassembling, or cleaning parts.

Regulatory Compliance

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

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

ATEX – Potentially Explosive Atmospheres Directive: Directive 2014/34/EU on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres.
Zone 2, Category 3, Group II G, Ex ec IIC T3 Gc
Zone 2, Category 3, Group II G, Ex ec IIC T4 Gc

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

Other European Compliance:
Compliance with the following European Directives or standards does not qualify this product for application of the CE Marking.

RoHS Directive: Restriction of Hazardous Substances 2011/65/EU:
This product is intended to be sold and used only as equipment that is specifically designed, and is to be installed, as part of another type of equipment that is excluded or does not fall within the scope of this Directive, which can fulfil its function only if it is part of that equipment, and which can be replaced only by the same specifically designed equipment, and therefore fulfills the requirements stated in Art.2.4(c), and as such, is excluded from the scope of the Directive.

United Kingdom Compliance for UKCA Marking:
These listings are limited only to those units bearing the UKCA Marking.
Units bearing the UKCA Mark in addition to the marking indicating Zone 2 are acceptable for use in UKEX Hazardous Locations.

EMC: S.I. 2016 No. 1091: Electromagnetic Compatibility Regulations 2016 and all applicable amendments.

UKEX: S.I. 2016 No.1107: Equipment and Protective Systems intended for use in Potentially Explosive Atmospheres Regulations 2016.

RoHS Directive: S.I. 2020 No. 1647: The Hazardous Substances and Packaging (Legislative Functions and Amendments) (EU Exit) Regulations 2020.

This product is intended to be sold and used only as equipment that is specifically designed, and is to be installed, as part of another type of equipment that is excluded or does not fall within the scope of this Regulation, which can fulfil its function only if it is part of that equipment, and which can be replaced only by the same specifically designed equipment and therefore fulfills the requirements stated in Part 2 of Schedule1 clause 16, and as such, is excluded from the scope of the Regulation.

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, T3 or 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.
T3 when the Potential Transformer input is 240 Vac
T4 when the Potential Transformer input is 120 Vac or less

Marine Compliance

American Bureau of Shipping: ABS Rules 2020 SVR 1-1-4/7.7, 1-1-A3, 4-2-1/7.3, 7.5.1; 4-9-3/17, 4-9-4/23 & 4-9-7/Table 9 (as appropriate).

Bureau Veritas: BV Rules for the Classification of Steel Ships, Approval valid for ships intended to be granted with the following additional class notations: AUT- UMS, AUT-CCS, AUT-PORT and AUT-IMS.

China Classification Society: CCS Chapter 2, Part Seven of CCS ~ “Rules for Classification of Sea-going Steel Ships~” 2021.

Del Norske Veritas: Type Approval Certification No. TAA000000H, 2022 Temperature Class B, Humidity Class B, Vibration Class A, EMC Class A, Enclosure required protection according to the rules to be provided upon installation onboard.

Lloyd’s Register of Shipping: LR Type Approval Test Specification No. 1, 2020 for Shipping: Environmental Categories ENV1, ENV2, ENV3 and ENV4.

Nippon Kaiji Kyokai: Requirements specified in Chapter 1, Part 7 of Guidance for the approval and Type Approval of materials and equipment for Marine use and relevant Society’s Rules.

Australia & New Zealand Compliance
These listings are limited to those units bearing the C-Tick mark:

C-Tick (ACA/RSM): Declared Separately to the Australian Radiocommunications Act of 1992 and the New Zealand Radiocommunications Act of 1989.

Special Conditions for Safe Use

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. Use supply wire rated for minimum 75 °C
Use signal wire rated for a minimum of 240 Vac.

ATEX/IECEx Zone 2, Category 3G applications require the final installation location provide a IP-54 or higher ingress protection enclosure against dust and water per IEC 60529. The enclosure must meet IEC 60079-0 Design & Test Requirements.

T3 when the Potential Transformer input is 240 Vac.
T4 when the Potential Transformer input is 120 Vac or less.

⚠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.

Chapter 1.
General Information

This manual describes the operation of Woodward's 2301E-J controller (P/N 8273-1019 revision New or newer)

Overview

The 2301E-J is a microcomputer-based digital control for engine generator set control with automatic load sharing function. This control is designed for controlling a medium and high speed diesel engine or a medium and high speed gas engine.

Control speed range (for medium and high speed engines): 400-3600 rpm

The 2301E-J functions like the 2301A LSSC, Woodward's conventional analog control, plus DRU (Digital Reference Unit) with the soft loading/unloading function. The 2301E-J also has the same function equal to 2301D.

The 2301E-J can bumplessly switch its operation mode from isochronous to droop and vice versa while the engine is operating.

The 2301E-J can be operated in automatic load sharing mode by communicating with a 2301 LSSC, 2301A LSSC, 2301D LSSC, 721DSC with automatic load sharing function, 723DSC with automatic load sharing function, or other Woodward electric controls having the load sharing function.

Combined with an external import/export control, the 2301E-J can control the import and export power to the mains (i.e. the commercial bus) using an analog remote speed setting signal (an optional function).

The 2301E-J can be operated in isochronous mode, isochronous baseload mode, kW droop mode, normal speed droop mode, and Mains parallel operation mode with GCP/EGCP.

In isochronous operation, 2301E-J can perform:

- Parallel operation to the bus that multiple engine generator sets are connected to with the automatic load sharing function (including soft loading and soft unloading).
- Baseload operation in the isochronous mode. (The load level is preset or tuned manually to a desired level with discrete inputs or an analog input.)
- Single engine generator operation. (The speed reference is tuned manually to a desired level with discrete inputs or an analog input.)

In kW droop operation, 2301E-J can perform:

- Parallel operation with the mains. (The load level or the speed reference is preset or tuned manually to a desired level with discrete inputs or an analog input.)
- Parallel operation with other engine generator sets. (The speed reference is tuned manually to a desired level with discrete inputs or an analog input.)
- Single engine generator set operation. (The speed reference is tuned manually to a desired level with discrete inputs or an analog input.)
-

In speed droop operation, 2301E-J can perform:

- Parallel operation with the mains. (The load level or the speed reference is tuned manually to a desired level with discrete inputs or an analog input.)
- Parallel operation with other engine generator sets. (The load level is tuned manually to a desired level with discrete inputs or an analog input.)
- Single engine generator set operation. (The speed reference is tuned manually to a desired level with discrete inputs or an analog input.)

The 2301E-J system has the following I/Os:

- 1 kW sensing input which consists of 3-phase PT inputs and 3-phase CT inputs
- 1 Speed sensing input (MPU input)
- 2 Analog inputs for (4-20 mA) current signal or (±2.5 V, 1-5 V or 0-5 V) voltage signal respectively
- 8 Discrete inputs
- 1 Actuator driver circuit
- 1 4-20 mA analog output (signal displayed through this output is selectable)
- 4 Discrete outputs (a low-side driver; maximum sink current is 200 mA)
- 2 Serial ports (RS-232 and RS-422)

The 2301E-J system has the following functions:

- Speed Control: isochronous operation, kW droop operation, speed droop operation
- Load Control: isochronous load sharing, isochronous baseload, soft loading/- unloading
- Isochronous/Droop operation transfer function with the generator loaded
- Fuel Limiter: start fuel limiter, torque fuel limiter, manifold fuel limiter, maximum fuel limiter

Equipment needed to operate an engine generator set using 2301E-J:

- 2301E-J control
- 24 Vdc power supply
- Speed sensing device (MPU, etc.,)
- Actuator to drive a fuel rack or a gas valve (proportional type)
- CTs and PTs for generator kW sensing or analog kW signal

The 2301E-J requires nominal 24 Vdc voltage source. (The supply voltage range is from 18 to 36 Vdc.) The control is housed in a sheet-metal chassis and consists of a single printed circuit board.

The 2301E-J setpoints are adjusted by Woodward “Toolkit” or “Control Assistant” software (Service Tool) which runs on a PC. Customers can download the Service Tool from the Woodward website. The PC is connected to the 2301E-J’s 9 pins D-sub connector with an RS-232 cable.

Specifications

Table 1-1. Control Part Numbers

8273-1019	2301E-J Control for Medium and High Speed Engines (400-3600 rpm)

Table 1-2. Electrical Specifications

Power Supply Rating	DC 18－36V (SELV)
Power Consumption	Less than 20W
Input Supply Voltage: 18V 24V 32V	Input Supply Current: 584mA 431mA 320mA
Inrush Current	7A for 0.1ms
Maximum Altitude	3000m / 10 000 feet
Steady State Speed Band	±0.25% of rated speed
3-phase CT Burden	3-7 A rms at full load, CT input burden at full load is 0.1 VA per phase
3-phase PT Burden	100–240 Vac line-to-line, 45–66 Hz. PT input burden is between 1.5 VA and 1.7 VA per phase at 240 Vac, and between 0.4 VA and 0.5 VA per phase at 120 Vac.
Discrete Input (8)	3mA (24V), impedance approximately 5.2kΩ
Analog Output#1	0-20mA, 4-20mA, 0-200mA (Actuator Output)
Analog Output #2	0-20mA, 4-20mA,
Discrete Output (PWM	Low-side drivers with overvoltage protection, 200mA Maximum

Table 1-3. Environmental Specifications

Ambient Operating Temperature	-40−+70 °C (-40−+158°F)
Storage Temperature	-40−+105 °C (-40−+221°F)
Humidity	Lloyd's Register Type Approval Specification No. 1 2002, Humidity Test 1, 95% at +20−+55 °C (+68−+131 °F) condensing
Mechanical Shock	US MIL-STD 810C, Method 516.2 Procedure I (basic design test) Procedure II (transit drop test, packaged) Procedure V (bench handling)
EMC Immunity Environment	Marine Type Tests & EN 61000-6-2 IEC 61000-4-2, ESD ±6 kV/±8 kV IEC 61000-4-3, RS 10 V/m + AM 80-3000 MHz IEC 61000-4-4, EFT ±2 kV Power & I/O IEC 61000-4-5, Surge ±1 kV I/O CM, ±0.5/±1.0 kV DC power DM/CM, & ±1.0/±2.0 kV AC power DM/CM IEC 61000-4-6, CRF 10 Vrms + AM 0.150-80 MHz. Marine Type Test CLFI 3.6 Vrms or 2 W, 50 Hz to 20 kHz. WWD (Marine) CLFI 3.6-0.36 Vrms or 2.0–0.2 W, 20 kHz to 150 kHz.
EMC Emission Environment	Marine Type Tests & EN 61000-6-4 Marine General Distribution Zone per CISPR 16 EC EN 61000-6-4 Industrial Limits (Class A)

Functions

The 2301E-J has speed control, load control, isochronous/droop transfer, and fuel limiter functions.

Speed Control Function

- Rated speed range is 400-3600 rpm
- Isochronous speed control
- kW droop speed control
- The simple speed droop control is selectable (when selected, the load control function is not available)
- Idle/Rated speed switching with a discrete input signal
- Speed reference raise/lower with discrete input signals
- Quick synchronization using an analog speed bias signal from a synchronizer
- (Optional) speed reference manipulation function using a remote analog signal
- A single point control gain setting (option)
- A control gain curve, consisting of 5 points 4 slopes, could be mapped for engines necessary to change the gain at various operating conditions.
- Dual dynamics function, which switches the control dynamics based on the engine load

Load Control Function

- Automatic isochronous load sharing function (including the soft-loading function processing from the generator circuit breaker close to the beginning of the automatic load sharing)
- Initial loading function just after generator circuit breaker closure in the kW droop operation.
- Automatic soft-unloading function (with the generator circuit breaker open output signal at the unload trip level)
- Isochronous baseload operation (with an optional remote load setting function)
- kW droop operation (with a remote load setting function via the remote speed setting signal)
- Generator loading operation using a speed droop function. (Load control functions are not available in the speed droop operation.)

Fuel Limiter Function

The 2301E-J has the following 6 fuel limit functions:

- Start fuel limiter (with lower limit, upper limit and ramp rate from the lower limit to the upper limit)
- Maximum fuel limit
- Torque limiter (5 points and 4 slopes)
- (Optional) boost pressure fuel limiter (5 points and 4 slopes)
- Discrete input fuel limit
- Fuel limit offset by discrete input signal

Isochronous/Droop Switching Function

- Isochronous/droop switching with a discrete input signal
- Transfers from the isochronous operation to the kW droop operation bumplessly
- Load ramp from kW droop level at paralleling with the mains to the isochronous load sharing level in parallel

Isochronous Baseload Operation

- Baseload setpoint raise/lower function with discrete inputs
- Generator kW load at a constant level disregarding mains frequency
- Baseload setpoint raise/lower by an analog remote signal

WARNING

The default setpoint value of the 2301E-J's 'rated speed' is set to 750 rpm and 'number of gear teeth' is set to 60. The wrong rated speed or the wrong number of gear teeth may cause engine overspeed resulting in PERSONAL INJURY, LOSS OF LIFE or property damage. To prevent possible serious injury from an overspeeding engine, read Chapter 4 of this manual before starting the engine.

WARNING

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

Reference Publications

Manuals and product specifications for installation of controls with the load sharing function are listed below. Dimension and wiring diagrams for the 2301E-J are shown in Figures 1-3 below.

Manuals

25070	Electric Governor Installation Guide
25195	Governing Fundamentals
82510	Magnetic Pickups and Proximity Switches for Electric Governors
82715	Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules

Product Specifications

03405	2300E Digital Load Sharing and Speed Control Hardware
82516	EG-3P/3PC Actuator
82575	EGB-1P/2P Governor/Actuator

Dimensions & Wiring Diagrams

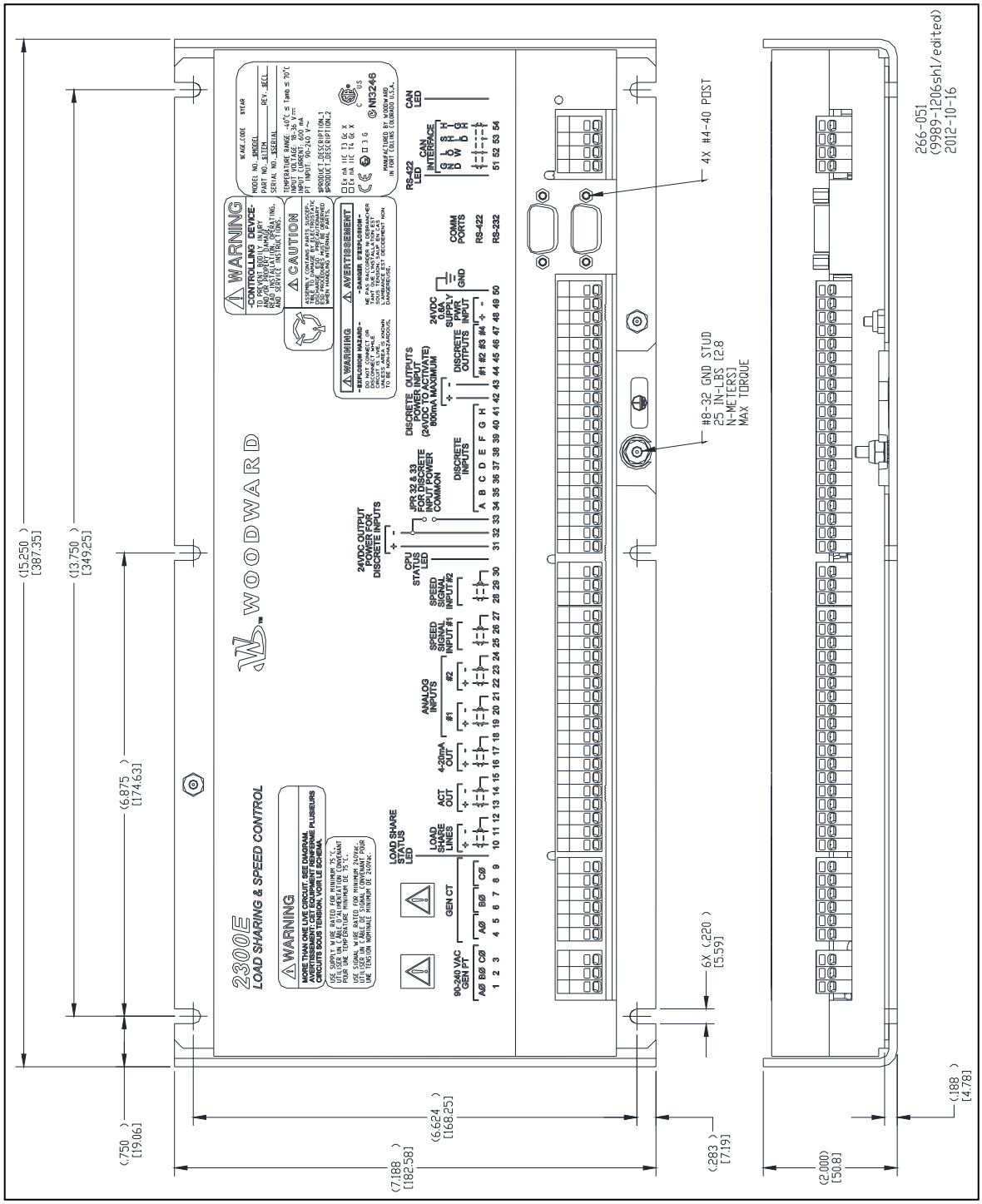


Figure 1-1a. 2301E-J Outline Drawing

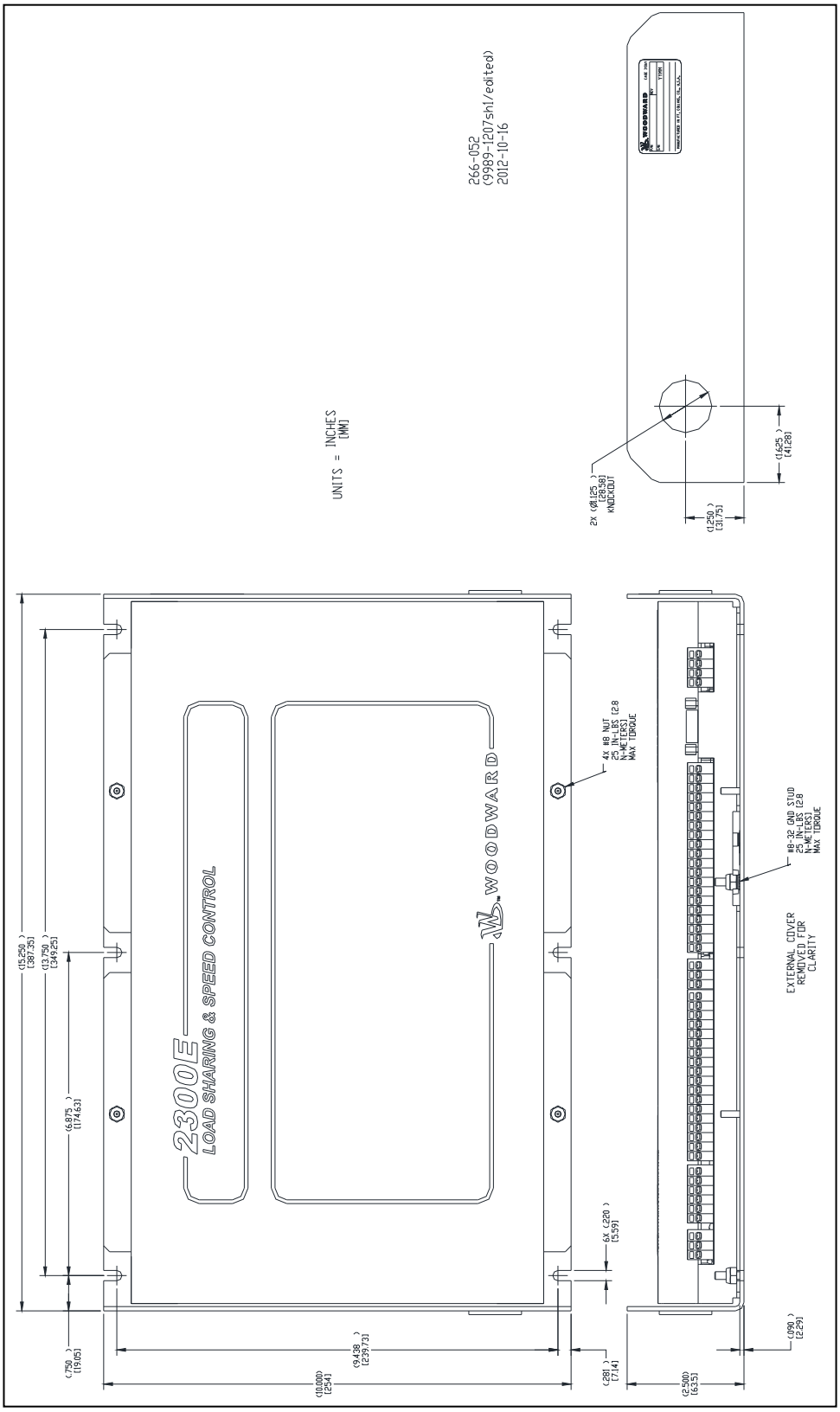


Figure 1-1b. 2301E-J Outline Drawing

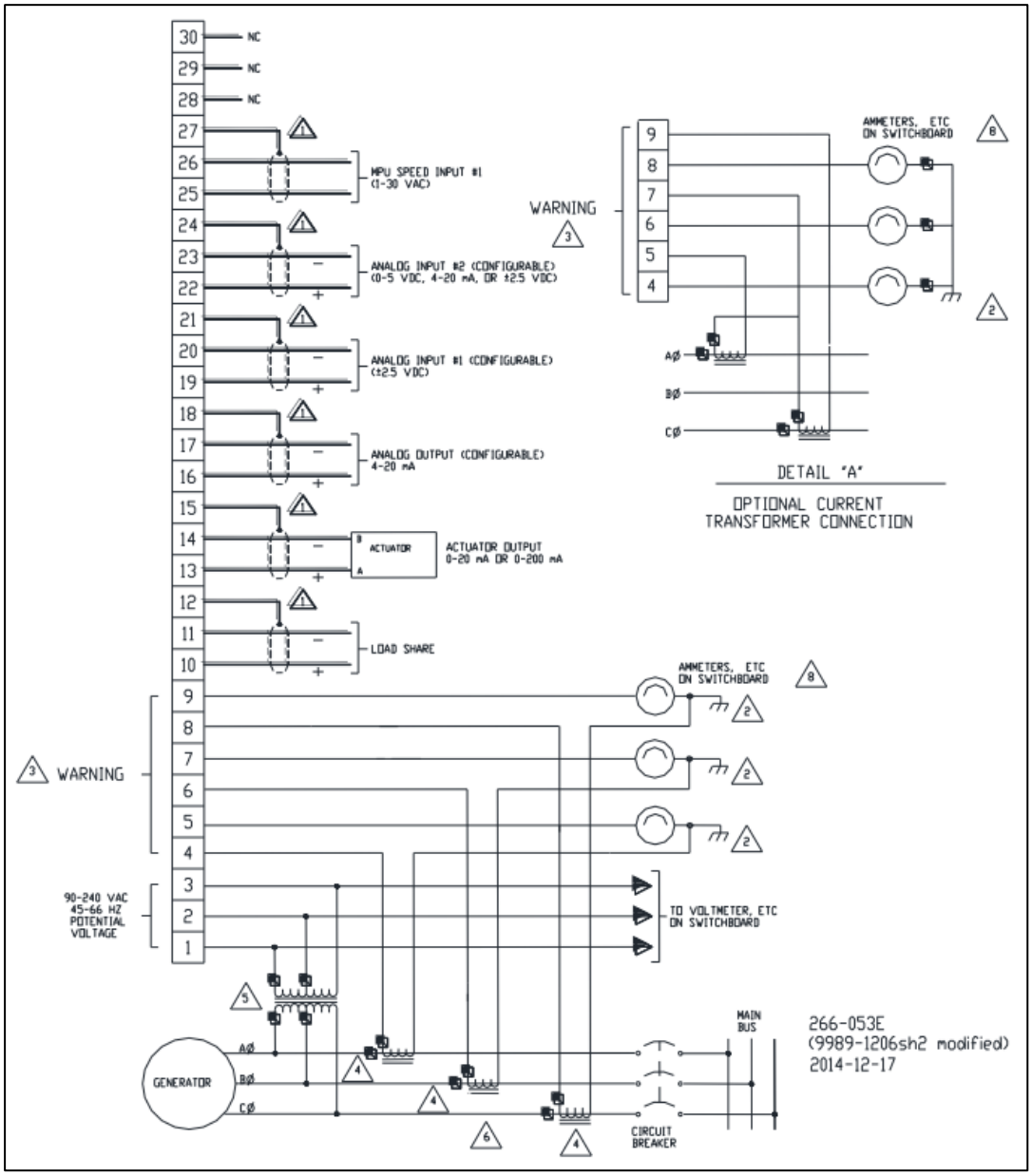


Figure 1-2a. 2301E-J Wiring Diagram (1/2)

See Figure 1-3 for Notes

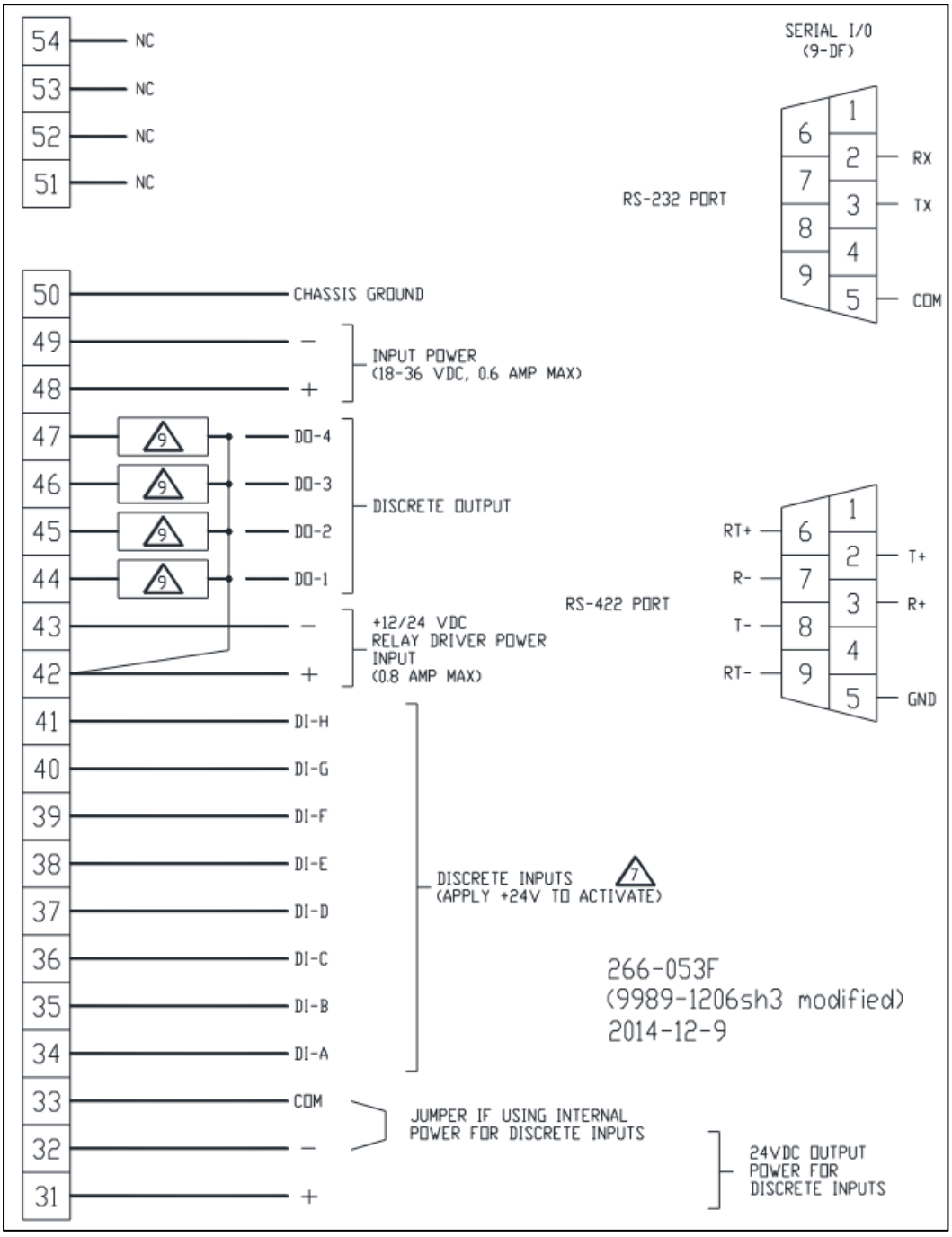


Figure 1-2b. 2301E-J Wiring Diagram (2/2)

See Figure 1-3 for Notes

NOTES:

1. SHIELDED WIRES ARE TWISTED PAIRS, WITH SHIELD GROUNDED AT CONTROL END ONLY.

2. GROUNDING POINT WHEN CT CIRCUIT IS NECESSARY TO BE GROUNDED.

3. DO NOT DISCONNECT CT LINES FROM 2301E-J, OTHERWISE HIGH VOLTAGE IS CAUSED BETWEEN CT LINES OPENED. THIS IS A VERY DANGEROUS CONDITION.

4. SET 'CT-RATIO' TO A VALUE WHICH ALLOWS CT CURRENT TO BE TUNED TO 5A AT THE RATED GENERATOR KW OUTPUT. POWER CONSUMPTION OF 2301E-J IS 0.1 VA PER PHASE.

5. TAKE CARE WITH THE ORDER OF PHASE WHEN WIRING CT INPUTS AND PT INPUTS. THE LOAD LEVEL AND THE POWER FACTOR MUST BE ALL THE SAME WITH EACH PHASE WHEN CT INPUTS AND PT INPUTS ARE CONNECTED TO THE CONTROL.

   PHASE A: CONNECT THE PT INPUT TO TERMINAL 1. CONNECT CT INPUT LINES IN PHASE WITH THE PT INPUT TO TERMINAL 4 AND 5.

   PHASE B: CONNECT THE PT INPUT TO TERMINAL 2. CONNECT CT INPUT LINES N PHASE WITH THE PT INPUT TO TERMINAL 6 AND 7.

   PHASE C: CONNECT THE PT INPUT TO TERMINAL 3. CONNECT CT INPUT LINES IN PHASE WITH THE PT INPUT TO TERMINAL 8 AND 9.

6. IN CASE TWO CTs ARE WIRED, REFER TO DETAIL 'A'.

7. **WARNING: DO NOT USE RUN/STOP CONTACT INPUT AS AN EMERGENCY STOP SWITCH. THE PRIME MOVER MUST BE EQUIPPED WITH AN OVERSPEED (OVERTEMPERATURE, OR OVERPRESSURE, WHERE APPLICABLE) SHUTDOWN DEVICE(S), THAT OPERATES TOTALLY INDEPENDENTLY OF THE PRIME MOVER CONTROL DEVICE(S) TO PROTECT AGAINST RUNAWAY OR DAMAGE TO THE PRIME MOVER WITH POSSIBLE PERSONAL INJURY OR LOSS OF LIFE.**

8. WHEN AN AMMETER IS NOT USED, CONNECT THE LINE WITH A JUMPER.

9. THE MAXIMUM OUTPUT CURRENT FROM A DISCRETE OUTPUT CHANNEL IS 200 mA.

10. NOT USED IN 2301E-J

Figure 1-3. 2301E-J Wiring Diagram Notes

Chapter 2.
Theory of Operation

Introduction

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

The 2301E-J Load Sharing and Speed Control uses a 32 bit microprocessor for all control functions. All control adjustments and parameter monitoring are made with the Watch Window software and 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.

The speed and load sharing features of the 2301E-J control monitors and controls two functions:

Speed: The speed control feature keeps the prime mover at the correct speed.

Load control: The load control feature, located next to the speed control section, manages the prime mover load based on the load control mode:

- During parallel operation of two or more generators, the load sharing section connected each other with the load sharing line senses the load carried by its generator and causes the loads of all generators in the system to be shared proportionally.
- During parallel operation of two or more generator or a generator paralleled against an infinite bus, the control may be operated in Baseload mode in which the generator keeps a constant output with disregard to the infinite bus frequency change.
- During parallel operation of two or more generator or a generator paralleled against an infinite bus, the control may be operated in Droop mode.
- In case a single generator is connected to an isolated bus, the 2301E-J controls the engine speed with respect to the generator load, without regard to its load control function.

Speed Control

The speed control system as shown in Figure 2-1 consists of:

- A device ① to sense the speed of the prime mover
- A frequency sensor to software converter ②
- A speed reference (software) ③ to which the prime mover speed can be compared
- A speed summer/amplifier (software) ④ with an output (software to hardware) proportional to the amount of fuel or steam required to maintain the desired speed at any given load.
- An actuator ⑤ to position the fuel or steam mechanism of the prime mover.

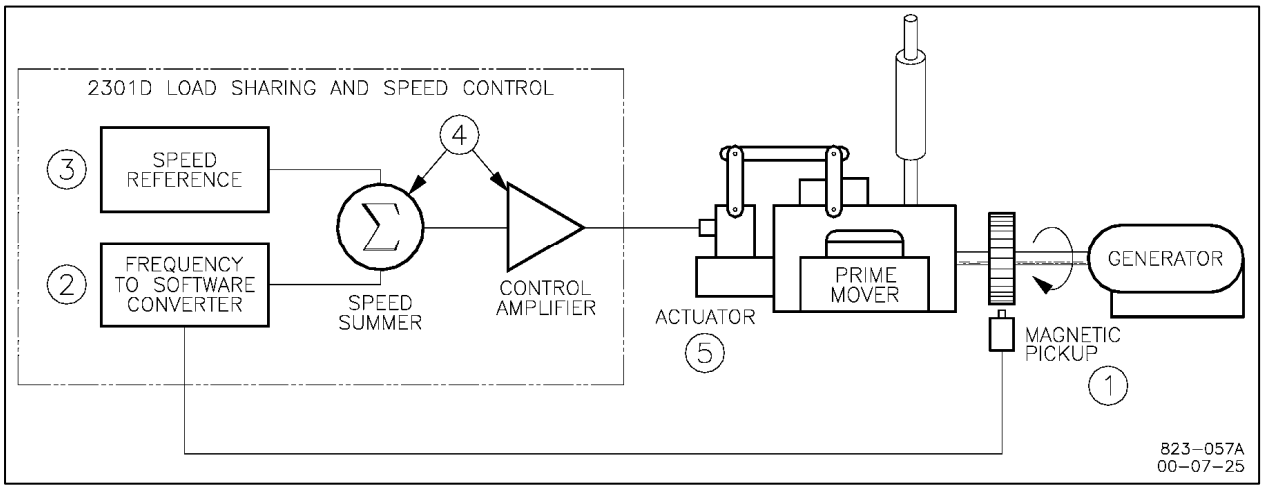


Figure 2-1. Speed Control System

A speed-sensing device, such as a magnetic pickup, senses the speed of the prime mover and converts it to an AC signal with a frequency proportional to prime mover speed. The frequency-to-software converter receives the AC signal from the speed sensor and changes it to a digital number representing prime mover rpm.

The digital control compares the numeric output of the speed sensor to the numeric number of the speed reference at the summing junction. If the speed is lower or higher than the reference, a response calculated by the PID (Proportional-Integral-Derivative) control is sent to the actuator driver calling for an increase or decrease in actuator current.

The actuator responds to the signal from the actuator driver by repositioning the fuel or steam rack, changing the speed of the prime mover until the speed signal and the reference are equal. The 2301E-J repeats this control loop until the engine speed is equal to the reference.

The 2301E-J has a speed sensor failure function and continues to monitor the speed signal. If the engine speed falls lower than the speed corresponding to ENTER FAILED SPD SENSE% while the engine is running, the actuator output is moved to the minimum fuel position and the engine will shut down. For controls with actuator current of 0 to 180 mA (forward acting), the minimum current will be defined as 0 mA. For controls with actuator current of 180 to 0 mA (reverse acting), the minimum current will be defined as 180 mA.

Because no speed signal exists before the engine start, it is necessary to disable the speed sensor failure function before starting the engine. OVERRIDE SPEED FAILSAFE discrete input (terminal 33) is supplied to open the fuel valve to the start fuel limit at the engine start.

Even if the speed sensor failure function is not used in engine cranking, the 2301E-J should detect the speed signal when the engine speed exceeds speed sensor failure speed setting and moves its operation mode to the start mode, thus opening the fuel valve to the start fuel limit position so that the engine can start.

The override speed sensor failure function is enabled while OVERRIDE SPEED FAILSAFE discrete input is ON. This function is disabled automatically when the control mode is moved from the start fuel limit mode to the speed control mode due to the engine speed exceeding Idle speed whether OVERRIDE SPEED FAILSAFE discrete switch is closed or not. Make sure to open this discrete switch after completing the engine start. Note that this discrete switch is used as one of the SELECT BASELOAD switches in generator load operations. In case the OVERRIDE SPEED FAILSAFE discrete switch has not been opened after the engine start has completed, the control will not recognize the switch as SELECT BASELOAD switch until the switch is opened once.

Speed Control Dynamics

Reset, Gain, and Actuator Compensation adjust the control to accommodate various types of prime mover systems.

The Reset adjustment affects prime mover reaction time when recovering after a sudden load change. The magnitude of the speed change resulting from a sudden change in load is controlled by adjusting the Gain. Actuator Compensation compensates for the time the actuator and prime mover fuel system takes to react to signals from the control.

Constant dynamics refers to dynamics parameters that will remain constant as entered and do not vary with engine speed or engine load. Dynamics may be configured to vary with load by using the 5-Gain mapped dynamics. 2301E-J has both constant dynamics and 5 Gain mapped dynamics.

In addition, this control has two sets of dynamics, Dynamics#1 and Dynamics#2, which include constant dynamics or the 5 Gain mapped dynamics and Reset and Compensation respectively. These two dynamics sets are used to change Reset value or/and Compensation value if it is necessary while in the generator operation. To use Dynamics#1 and #2 switching function, select either the engine load or the generator kW load as a parameter and set a parameter level to switch the dynamics.

The 5 point Gain mapped dynamics are useful for fuel systems and processes which change characteristics largely through the engine speed and load (such as a gas engine) because the 5 point Gain mapped dynamics allow non-linear and more precise setting.

Constant dynamics (with one Gain setpoint therefore easy to tune) are useful for fuel systems and processes that tend to be equally stable throughout the prime mover's speed and load range (such as a diesel engine).

Idle Prop Gain 1 and Idle Reset 1 are both included in 5 point Gain mapped dynamics and Constant dynamics of Dynamics#1 to stabilize the engine speed at Idle speed. Tune these setpoints when stability at the idle speed is important.

The control can automatically switch between two gain settings, based on engine speed error, to provide improved transient load performance. Speed error is the difference between the speed reference and engine speed. The control automatically increases gain by an adjustable ratio when a speed error exceeding an adjustable window occurs. This increased gain produces a faster fuel response and quickly restores engine speed at the speed reference. The base gain is restored once the control senses a return to steady-state operation. This feature is available for all gain choices.

Set the setpoints for various type dynamics described above and functions which supplement them based on the control system's need.

RUN/STOP Function

To operate the engine, close the RUN/STOP contact by turning the switch to the RUN side. The engine can be started and operated in this state.

If the RUN/STOP contact is opened by turning the switch to the STOP side, actuator output will move to the minimum position, and the engine will shut down. When the engine stops by opening the RUN/STOP contact, the speed sensor failure function will not work, and the speed sensor failure alarm will not be output.

Do not use the RUN/STOP contact as an emergency stop switch. Install an overspeed shutdown device that operates totally independently of the 2301E-J.

⚠WARNING

Do NOT use the Run/Stop contact as part of any emergency stop sequence. In case of a malfunction with the 2301E-J or the actuator, the prime mover may overspeed because the emergency stop function will not work. The prime mover should be equipped with an overspeed shutdown device(s) that operates totally independently of 2301E-J to protect against runaway or damage to the prime mover with possible personal injury or loss of life.

Maximum Fuel Function

The Maximum Fuel Function is a software-adjustable maximum fuel limit on the fuel demand. It is used to set a maximum position of the actuator. This is generally used to prevent engine overloading or other situations where the maximum fuel delivered to the engine should be limited.

Note the engine dynamics near the rated load will be lowered (especially when the speed is increasing) if the maximum fuel limit is too low.

The function can be disabled by adjusting the Maximum Fuel Limit (%FD) to 101%.

Start Limit Function

The Start Limit Function provides a limit to the fuel demand which prevents overshooting and smoking due to over-fuel conditions during starting of the engine.

The Start Limit Function is enabled when the control detects the Start mode is enabled and is disabled when the control detects the Start mode completed.

The Start mode is enabled when RUN/STOP contact is closed, and OVERRIDE SPEED FAILSAFE contact is closed while the engine has stopped. Otherwise, when RUN/STOP contact is closed and the engine speed exceeds the speed sensor failure speed (i.e., the speed of Enter Failed Spd Sense %) in the engine cranking, the Start mode is enabled.

The Start mode finishes when the engine speed reaches Idle speed and the fuel control mode transfers from the Start limit mode to the Speed control mode. The Start Limit functions stops automatically.

The Start Limit functions consist of the Start Limiter Max function, Start Limiter Min function, and Start Lim Ramp function as shown in Figure 2-2.

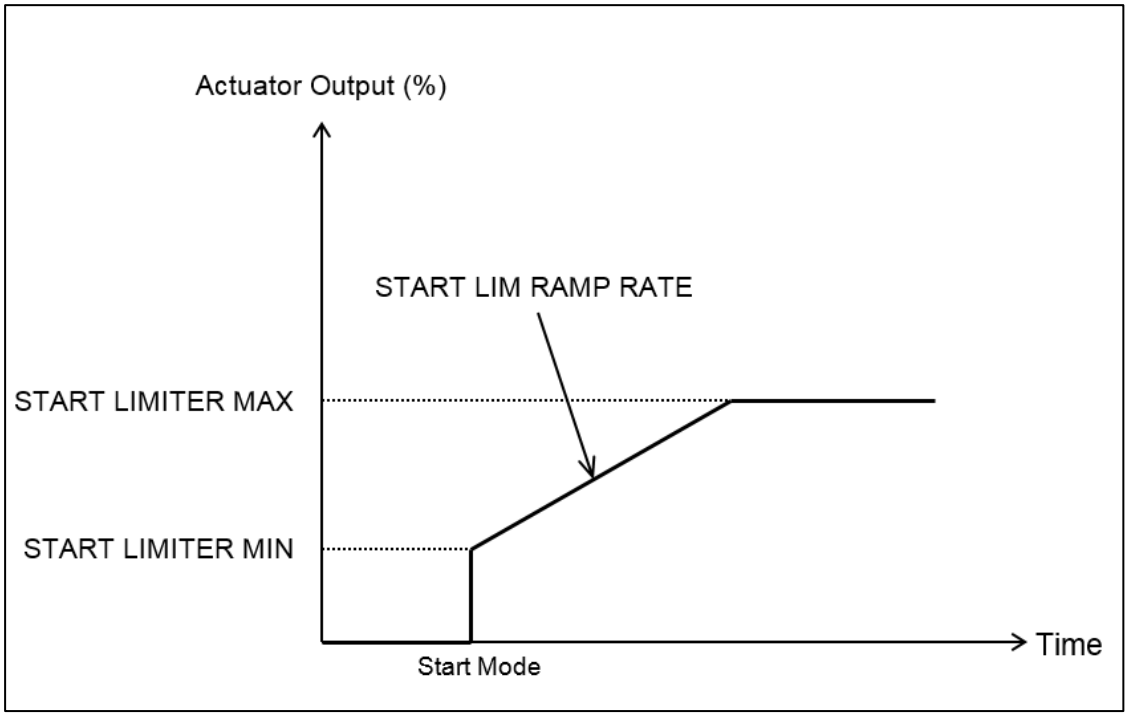


Figure 2-2. Start Fuel Limits

The function can be disabled by setting both the START LIMITER MAX (%FD) and the START LIMITER MIN (%FD) to 100%.

Make sure to open the OVERRIDE SPEED FAILSAFE contact after the engine start completes. Note that the OVERRIDE SPEED FAILSAFE contact is used as the SELECT BASELOAD contact in the generator load operation. In case this contact has not been opened after the engine start has completed, the control will not recognize the contact as SELECT BASELOAD contact until the switch is once opened.

Speed and Load Reference and Ramps

The 2301E-J 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.

The LOWER SPEED OR LOAD SET discrete input is used to lower the engine speed (or load), and the RAISE SPEED OR LOAD SET discrete input is used to raise the engine speed (or load). When the control mode is not the Baseload mode, these discrete inputs work as the Speed reference raise/lower inputs. When the control mode is the Baseload mode, these discrete inputs work as the Baseload raise/lower inputs.

Remote Speed/Load Reference setting is enabled when LOWER SPEED OR LOAD SET and RAISE SPEED OR LOAD SET contacts are both closed. However, this control cannot use both the remote speed setting function and the remote load setting function at one engine operation. In case ‘2:Remote speed setting input’ is selected at ANA-IN2 USED FOR (1-5) setpoint under B**INPUT & OUTPUT OPTIONS** header, the remote speed setting function is used. In case ‘3:Remote baseload setting input’ is selected at the setpoint above, the remote load setting function is used.

Speed Reference and Ramp Function

This section describes the operation of the speed reference and ramp functions and their relation to each other. Read this section carefully to be sure your sequencing provides the proper operating modes.

Before starting the engine, set the setpoints for Start speed (if used), Idle speed, Rated speed, Accel Ramp Time, Decel Ramp Time, RAISE SPEED LIMIT , LOWER SPEED LIMIT , SPEED TRIM INC TIME and SPEED TRIM DEC TIME to appropriate values.

The Idle speed, which is provided for the engine start up, must be lower than the rated speed. Set the Idle speed to 50% speed of the Rated speed even if the Idle speed is not used at all.

Set the Rated speed to the engine rpm when the generator frequency is the rated frequency.

Accel Ramp Time determines the time required for the engine to ramp from Idle speed to Rated speed when SELECT IDLE/RATED SPEED switch is closed; therefore, the acceleration rate at the same speed range is determined, too. Set this setpoint in seconds.

Decel Ramp Time determines the time required for the engine to ramp from Rated speed to Idle speed when SELECT IDLE/RATED SPEED switch is opened; therefore, the deceleration rate at the same speed range is determined, too. Set this setpoint in seconds.

SPEED TRIM INC TIME provides the time required for the engine-generator (which is not connected to the bus yet) to ramp from LOWER SPEED LIMIT to RAISE SPEED LIMIT when RAISE SPEED OR LOAD SET contact is closed. If the speed range between LOWER SPEED LIMIT and RAISE SPEED LIMIT does not correspond to the range of the upper limit and the lower limit of the generator frequency, calculate the time to ramp between speeds which are converted from the upper and lower frequency limit.

SPEED TRIM DEC TIME provides the time required for the engine-generator (which is not connected to the bus yet) to ramp from RAISE SPEED LIMIT to LOWER SPEED LIMIT when LOWER SPEED OR LOAD SET contact is closed. If the speed range between RAISE SPEED LIMIT and LOWER SPEED LIMIT does not correspond to the range of the upper limit and the lower limit of the generator frequency, calculate the time to ramp between speeds which are converted from the upper and lower frequency limit.

The Start speed setpoint provides a speed reference above cranking speed (ignitable speed) but below the Idle speed.

The Start speed function works only when this function is set to use in Configure menus (USE START SPEED is set to ‘True’) and the Idle speed is used at the engine start. When this function is configured, the Start speed is selected as the speed reference at engine start. When the engine speed exceeds the Start speed setpoint the speed will accelerate to the Idle speed by the ramp rate determined by START ACCEL TIME. The Start speed function completes when the speed reference reaches the Idle speed setpoint. This may not be the operation mode originally desired, therefore make sure to understand the implications of operating the control in this manner before using it.

The speed reference raise/lower functions by contact inputs being disabled when SELECT IDLE/ RATED SPEED contact is open.

Closing the SELECT IDLE/RATED SPEED contact ramps the speed reference from Idle to Rated. Closing either the RAISE SPEED OR LOAD SET or LOWER SPEED OR LOAD SET contacts while ramping from idle to rated results in immediate cancellation of the idle to rated ramp, and the ramp will stop at that point. After stopping the ramp to the rated speed, the raise and lower commands increase and decrease engine speed based on the raise and lower rate settings except that the lower command is given when the engine speed is lower than the LOWER SPEED LIMIT. In such a case, the speed reference will ramp to the LOWER SPEED LIMIT, disregarding the lower command.

The raise and lower commands will not increase the speed reference above the RAISE SPEED LIMIT or below the LOWER SPEED LIMIT.

If USE 2nd RAMP TIME (DI&RMT) is configured to 'True', the ramp rates calculated from SPD TRIM 2ND INC&DEC TIME are used when the generator breaker auxiliary contact is closed. These 2nd speed raise and lower rates are used in case the speed (or load) reference moves too fast to stabilize the engine speed by the ramp rates determined by the SPEED TRIM INC&DEC TIME when the generator is loaded in the droop operation.

When the control mode is switched to the Baseload mode, the roles of the RAISE SPEED OR LOAD SET and LOWER SPEED OR LOAD SET contacts are changed to the Baseload setpoint raise and lower contacts automatically. Therefore, the speed reference cannot be raised or lowered with contact inputs while in the Baseload operation.

If the analog input #2 is configured as the Remote speed setpoint input, the speed reference can be manipulated by the remote speed setpoint signal when SELECT IDLE/RATED SPEED contact is closed, and the LOWER SPEED OR LOAD SET and RAISE SPEED OR LOAD SET contacts are both closed. The raise limit, the lower limit, the speed trim inc and dec time and the speed trim 2nd inc and dec time must be set separately to the settings for the speed setpoint raise and lower function by contact inputs.

If the Remote speed setting function is selected when the speed reference is ramping to the rated speed by closing the SELECT IDLE/RATED SPEED contact, the ramp from idle to rated is cancelled immediately. The speed reference will follow the remote speed setting signal.

In the remote speed setting mode, if the remote speed reference ramps by a rate larger than the rate calculated from the REMOTE SPEED INC/DEC TIME, the speed reference will ramp to the Remote Reference input value at the ramp rate above.

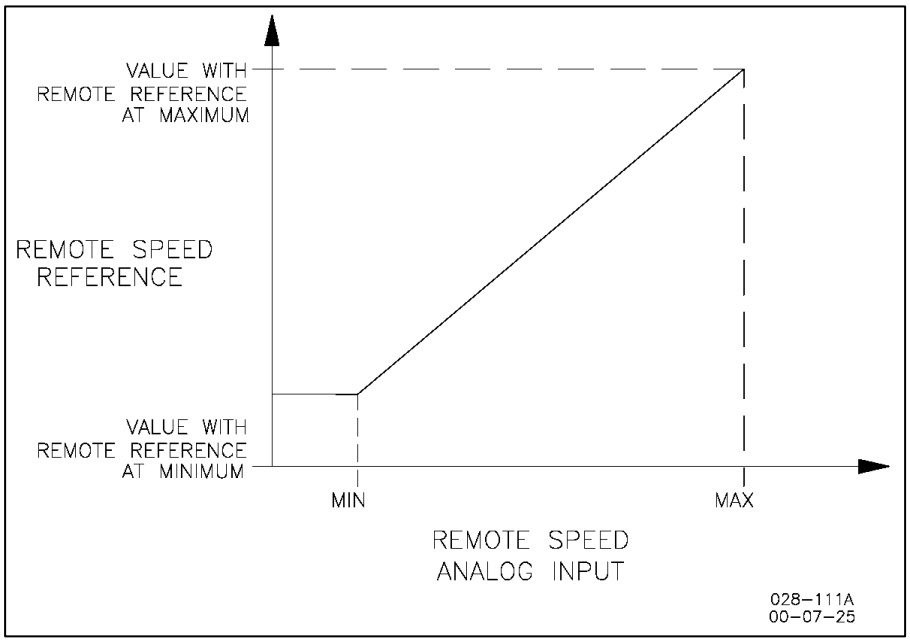


Figure 2-3. Remote Speed Reference

Before operating the generator in the remote speed setting mode, be sure to understand the implications of operating the control in this manner.

Speed Bias and Synchronizer Summing

This section describes the synchronizer signal for speed biasing and the remote speed bias signal used in process control.

Analog input #1 is the proprietary analog input channel for a synchronizer to synchronize the generator. If the speed bias signal is input from the synchronizer when synchronizing the generator, the speed reference is raised or lowered to the setpoint the speed bias is added. The speed bias function is enabled when the engine speed is equal to or greater than 80% of the rated speed and the generator circuit breaker is open. The speed bias signal is disabled when the generator circuit breaker is closed.

The default signal type of analog input #1 is configured as ±2.5 V. This can be changed if necessary.

The relationships between the signal type of the synchronizer input and the maximum speed bias are as follows:

±2.5 V:
- −2.5 V = −7.5% speed of the rated speed
- 0.0 V = zero bias
- +2.5 V = +7.5% speed of the rated speed

4-20 mA:
- 4.0 mA = −7.5% speed of the rated speed
- 12.0 mA = zero bias
- 20.0 mA = +7.5% speed of the rated speed

1-5 V:
- 1.0 V = −7.5% speed of the rated speed
- 3.0 V = zero bias
- 5.0 V = +7.5% speed of the rated speed

0-5 V:
- 0.0 V = −7.5% speed of the rated speed
- 2.5 V = zero bias
- 5.0 V = +7.5% speed of the rated speed

The operator can synchronize the generator with RAISE and LOWER SPEED OR LOAD SET contacts as well as the remote speed setting input.

The remote speed bias signal is available in case Analog input #2 is configured to a remote speed bias input. This bias signal has an effect on the control output only when the generator circuit breaker auxiliary contact is closed, and the engine is operating in the isochronous mode.

The signal type of the remote speed bias signal can be changed in Configure mode if necessary as well as the synchronizer signal input at Analog input #1. Refer to the explanation of Analog input #1 for the relationship between the signal type and the maximum speed bias.

If the generator circuit breaker aux contact is closed when operating in the isochronous mode, the speed bias to Analog input #2 is added to the speed reference in the control.

The remote speed bias function is designed for the purpose of increasing or decreasing the 2301E-J's fuel control signal using the signal from a process control. The zero bias level of the process control signal is the neutral state, which stops the increase or the decrease of the bias signal to 2301E-J. This function is designed to be used by the engine generator set paralleling with the mains.

Do not connect the output signal from Woodward Process Import/Export Control to Analog input #2 when this control is used for import and export control to the mains. Connect the output signal from the Process Import/Export Control to the load sharing line input terminals of this control. To begin the import and export operation, set the 2301E-J operation mode to the automatic isochronous load sharing mode.

Isochronous Load Control

This section describes the basic operations of the generator in the isochronous load sharing operation, in the baseload operation, and operation mode transferring between these two modes.

The isochronous load control system, shown in Figure 2-4, consists of Load matching circuit (1), kW sensor circuitry (2) and Speed reference and control circuitry (3).

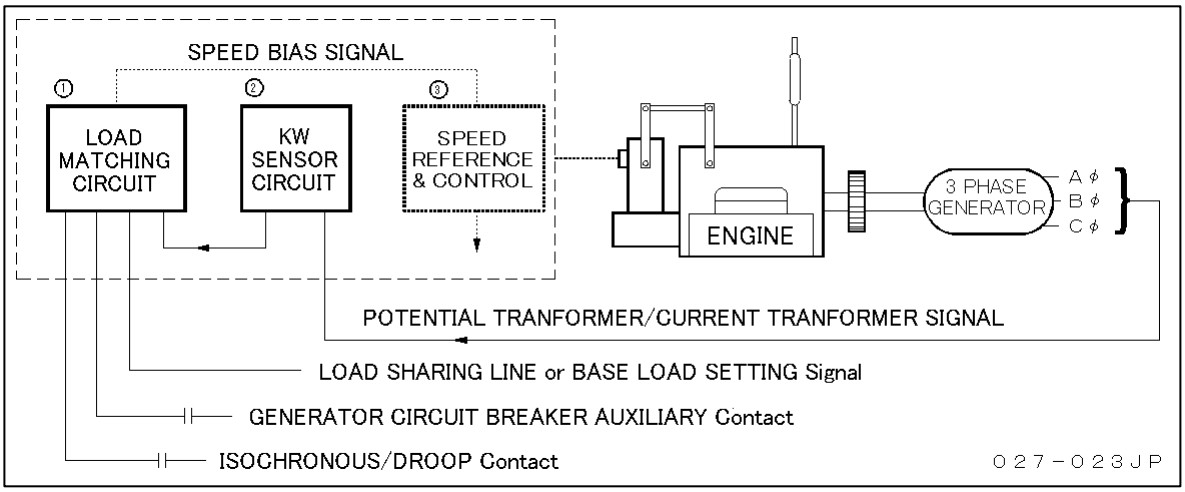


Figure 2-4. Isochronous Load Control System

To use a 2301E-J for generator isochronous operation, open the ISOCHRONOUS/ DROOP contact to select the isochronous mode.

The 2301E-J monitors the status of the generator breaker aux contact because the 2301E-J cannot begin generator kW load control unless the condition of the generator breaker aux contact is satisfied. So, the wires from the generator breaker aux contact must be connected to the 2301E-J contact input.

The kW sensor circuitry measures the generator CT signal and the phase difference between the PT and CT to calculate the real generator kW output. However, this is not the correct kW value because the exact PT voltage is not used for calculation.

If the generator operating in the isochronous mode is connected to an isolated bus, load matching circuitry in the 2301E-J will compare the signal on the load sharing lines and the kW generator signal from its own kW sensor continuously and output a speed bias signal to the speed reference and control circuitry until the kW generator signal equals the load sharing signal. The speed reference and control circuitry increase the fuel supply output following the increasing speed bias signal. As a result, the generator kW load will increase. When the kW generator signal catches up with the load sharing signal, load matching circuitry neutralizes the speed bias signal (i.e. fixes to zero) to stop to increase the generator kW load, then balances loads between generators. Load matching circuitry still continues to monitor the kW generator signal and the load sharing signal, and if it detects an error it will send a speed bias signal to speed reference and control circuitry again to balance loads.

In case the generator is operated in the isochronous base load mode, load matching circuitry compares the kW generator signal to the baseload setpoint inside the control, (not the signal on the load sharing lines) and raises or lowers the speed bias signal to speed reference and control circuitry to match the kW generator signal to the baseload setpoint. Consequently, the kW generator signal will be equal to the baseload setpoint. This is baseload operation by 2301E-J.

The isochronous load control functions of the 2301E-J include the load sharing operation between multiple engine generator sets, the parallel operation to the mains or an isolated bus in the baseload mode, the soft loading in transferring from one generator operation mode to another, automatic loading at the generator connecting to a bus, and automatic unloading at the generator disconnecting.

The isochronous mode is selected when ISOCHRONOUS/DROOP contact is open (turned to 'Isochronous' side).

To use a 2301E-J for the generator kW load control operation in the isochronous mode, the user needs to set ENTER GEN RATED LOAD (KW), BASELOAD MINIMUM (%LD), BASELOAD MAXIMUM (%LD), UNLOAD LIMIT (%LOAD), LOADING RATE (%/SEC), UNLOADING RATE (%/SEC), BASELOAD RAISE RATE (%/S), BASELOAD LOWER RATE (%/S) to the correct values before starting the engine.

Note the rated generator kW output must be set in kW at ENTER GEN RATED LOAD (KW) setpoint in Configure menus.

BASELOAD MINIMUM is the minimum load when the generator load is lowered by LOWER SPEED OR LOAD SET contact. When the baseload is lowered by the discrete input signal, the baseload decreases by BASELOAD LOWER RATE. The control will raise the generator load to this setpoint automatically while in the baseload operation after the generator circuit breaker is closed.

BASELOAD MAXIMUM is the maximum load when the generator load is raised by RAISE SPEED OR LOAD SET contact. When the baseload is raised by the discrete input signal, the baseload increases by BASELOAD RAISE RATE.

If the generator operation mode is switched to the baseload mode when the generator has been already loaded, the control will begin the baseload operation just after the operation mode change; but the generator load will not change as long as the operation mode stays at the baseload because the load reference is preset to the load level before the operation mode is switched.

Before operating a generator in the baseload mode connecting to an isolated bus to which other generators are connected, make certain the kW load of the isolated bus is always larger than the generator's baseload level. In case the kW load of the isolated bus is less than the baseload level, reverse power may result in other generators, or the bus frequency may be raised too high.

Soft-Loading

The loading rate used by the soft-loading function in the automatic loading sequence is specified at the LOADING RATE (%/Sec) setpoint.

If a generator operating in the isochronous load sharing mode is synchronized and connected to a bus which several other generators are connected to and load sharing on, the generator load will be raised to the load paralleling line level by the soft loading function and the operation mode will be changed to the normal load sharing mode when the generator load is balanced to the level of the total bus load.

Therefore, quick loading by a generator circuit breaker close should not happen.

If a generator operating in the baseload mode is synchronized and connected to a bus, the soft loading function will raise the generator load automatically to the load level determined by BASELOAD MINIMUM (%LD) setpoint.

In case the generator operation mode is changed from the baseload mode or the droop mode to the isochronous load sharing mode, the soft loading function will ramp the generator load bumplessly to the load level determined by the internal control algorithm if the current load level differs from the determined load level.

Automatic Unloading and Generator Circuit Breaker Open Permission Output

To disconnect a generator from a bus that may be the mains or an isolated bus that several other generators are connected together to in parallel, close the START TO UNLOAD GENERATOR contact. Then, the generator load will be lowered to the UNLOAD LIMIT (%LD) automatically by the rate specified at UNLOADING RATE (%Sec) and the control will output the generator circuit breaker open permission signal from Discrete output #4 when the generator load reaches the load level of Unload Limit.

Droop Operation

Two kinds of droop operation, kW droop operation and speed droop operation, are available with a 2301E-J. Because the operator can choose either of two droop modes only in the Configure menus, it is impossible to switch the droop mode from kW droop to speed droop or vice versa while the engine is running.

The droop mode is enabled when the ISOCHRONOUS/DROOP contact is closed (turned to DROOP side).

The load control functions available in the isochronous mode, like the automatic load sharing function, are not available when the generator is loaded in the droop mode.

To raise or lower the generator load paralleling to the mains or an isolated bus that several generators are connected to, raise or lower the speed reference of the engine-generator set if it is operated in droop mode. If the speed reference is raised, the generator load will increase. If the speed reference is lowered, the generator load will decrease.

If speed droop is selected at SET GOVERNOR TYPE (1-2) setpoint, the isochronous load control function will not work at all even if the contact is turned to ISOCHRONOUS side. In this case, only the single generator’s isochronous operation can be used.

If kW droop is selected, the control will change the operation mode to the preset load control mode applicable to a generator being operated in the isochronous mode as soon as the contact is turned to ISOCHRONOUS side. This mode transfer is bumpless with the generator frequency and the generator load. The soft-loading function will transfer the load between the generator and the bus bumplessly in case the load transfer is needed.

The operation mode is transferred bumplessly as well from the isochronous mode to the droop mode.

The 2301E-J is designed to make the speed reference step up or step down from the kW droop operation’s speed setpoint to the speed setpoint for the rated generator frequency when the generator circuit breaker aux contact is opened.

In the droop mode, the control will simply lower the speed reference by the portion specified at Droop Percent setpoint as the engine/generator load increases. Therefore, as the load increases, the generator frequency should lower.

At the engine-generator set paralleling to the mains or an isolated bus that several other generators are connected together to, the generator load can be tuned by changing the engine’s speed setpoint using the droop operation mechanism described above. Even if the speed setpoint is raised, the generator frequency will not increase following the speed setpoint rise because the generator frequency is regulated by the bus frequency. But the power to regulate differs depending on the ratio of the generation system’s total capacity and the generator’s capacity. In this case, the control will increase the actuator output (to increase fuel supply) in order to raise the engine speed up to the speed reference. As a result, the generator output will increase as much as the increased portion of fuel supply.

The droop mechanism lowers the speed reference proportionally to the generator output or the engine load. When the speed reference, after lowered, matches the speed which corresponds to the bus frequency, the control stops to increase the fuel supply and the generator will be operated stably keeping this load level.

However, as it is clear from the basic mechanism of the droop control, the bus/mains frequency change results in the generator output change. In order to make the generator output change smaller due to the mains frequency change, the droop rate needs to be set a larger value.

Power System Management Concept

This section provides a summary review of droop, isochronous, droop/isochronous, isochronous load sharing, and base load operating concepts.

Paralleling

There are two basic methods used for paralleling, droop and isochronous.

In droop operation, speed decreases with load increase, so the speed reference change results in a load change. However, it is inevitable from the load change due to the mains frequency change and from the generator frequency change due to the total kW load change because the engine speed changes proportionally to the kW load.

In the isochronous base load operation, the generator power remains constant in spite of frequency changes because the generator load itself is controlled to follow the load reference in this mode.

Use the isochronous base load operation or the droop operation to parallel a generator to an infinite bus.

In case a generator controlled by the 2301E-J is connected to an isolated bus and is used to parallel to a generator controlled by a Woodward mechanical governor, operate this control in droop mode. However, the isochronous base load operation can be used if the load connected to the isolated bus is larger than the capacity of the generator controlled by the 2301E-J.

In the case above, if this control is used to parallel to a generator(s) controlled by an electric control which has Woodward’s load paralleling line input and isochronous load sharing using this load paralleling line, operate the 2301E-J in isochronous load sharing mode.

If this control is used for a generator which is connected to a completely isolated bus, operate this control in isochronous mode to supply power to respond the demand of this isolated bus at all load level.

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 2-5. The right-descending linear line on the figure shows how the generator frequency is lowered by the droop function. The droop rate is set to 5% in this figure.

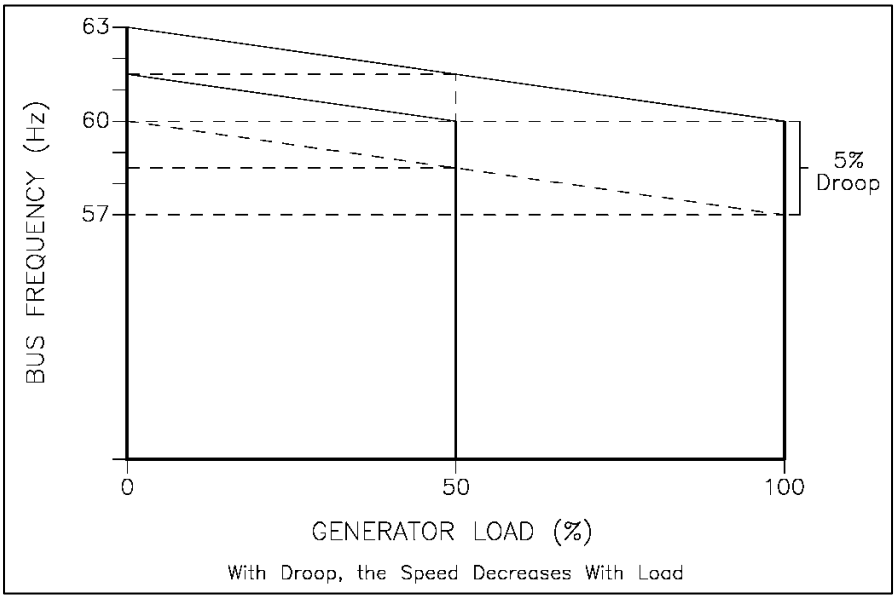


Figure 2-5. Droop Mode

When the engine generator set running in kW droop mode is connected to a bus with 60 Hz frequency, the engine speed just after connection has to be set to the speed corresponding to 60 Hz. In this case, the bus frequency matches the speed reference at the 0% load on the droop line, so the generator will not be loaded just after it is synchronized and connected to the bus.

After the generator is connected, (even if the speed reference is raised to the level of 61.5 Hz, as the generator frequency is regulated to 60 Hz by the bus), only the fuel supply to the engine is increased. Consequently, the speed reference will go down along the droop line as the load increases. The frequency of the droop line which crosses the 60 Hz bus line at 50% load is 61.5 Hz at no load. This means the generator will load 50% load when the speed reference is raised to 61.5 Hz if the droop rate is set to 5%.

If the speed reference is set to the level of 63 Hz in the case above, the generator load where the droop line crosses the 60 Hz bus line is 100% load. This means the speed reference needs to be set to the level of 63 Hz in order to operate the generator at 100% load.

To conclude, the generator cannot be operated at 100% load when it parallels to the 60 Hz frequency bus unless RAISE SPEED LIMIT (RPM) is set to the speed corresponding to the 63 Hz frequency or higher. To set a practical value at RAISE SPEED LIMIT (RPM) setpoint, choose an engine speed which enables the generator to operate at 100% load even if the bus frequency slightly increases due to possibility that the generator is connected to an unstable bus.

Isochronous Mode

Isochronous means repeating at a single rate or having 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 2-6). The generator frequency may change instantly in case of a step load change, but it always returns to the original frequency.

The isochronous operation that enables generators to operate in parallel at a constant frequency allows configuring a simpler generation system, as well as a generation system using a droop operation, because a generator frequency regulator is optional.

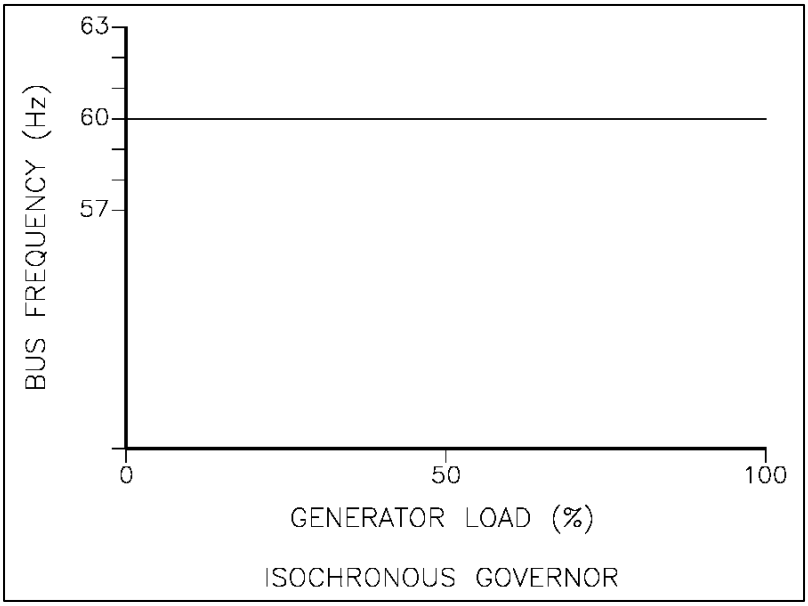


Figure 2-6. Isochronous Mode

Where a bus is imported from a commercial bus or multiple generators are paralleling and connected to an isolated bus, to connect a generator to the bus and operate it with load stably keeping a constant frequency, the generator load needs to be controlled directly while in operation. For this reason, the 2301E-J has a load control function.

Droop/Isochronous Load Sharing on an Isolated Bus

Droop/isochronous load sharing combines the droop mode and the isochronous mode. 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. The swing machine determines the bus frequency of this power system. It is usual that the generator with the highest output capacity is operated as the swing machine.

To determine the load sharing ratio between the swing machine and total droop machine, it is ideal that output power of the swing machine at the steady state operation is 50% of its capacity. Monitor slow periodical changes (like a 24-hour-cycle variation) of the bus load and tune the speed setpoint for the droop machines if it is necessary so that the generator load of the swing machine will not exceed the range where the bus frequency is regulated.

In such a generation system, the swing machine operated in the isochronous mode mainly absorbs the short-term system load variation to keep bus frequency constant, provided the system load varies in the range of the swing machine’s generation capacity. 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. On the other hand, if the system load exceeds the combined output of the swing machine at 100% output and the total set power of the droop machines, bus frequency will lower based on the droop rate set at the droop machines.

For the reason above, this generation system needs to change the total set power of the droop machines following the periodical system load change of a 24-hour cycle by changing the speed setpoint of the droop machines and managing the number of running generators.

Isochronous Load Sharing on an Isolated Bus

The isochronous load sharing function, one of the built-in functions of the 2301E-J, allows it to operate all generator sets connected to an isolated bus in the isochronous mode.

Bus frequency is kept constant in this generation system. However, bus frequency will be lowered if the system load exceeds the total capacity of running generators as other systems.

Any imbalance in load between units will cause a change to the regulating circuit in each governor to balance the portion of the present generator output to the generator's capacity. So, generators with different capacities can parallel together.

Such a generation system, (which makes all generator operating in the isochronous mode share the system load change at the same time), can be regarded as a single large generator operating in the isochronous mode that accepts a large system load change. This system can use all the generators' capacity more effectively than the droop/isochronous load sharing system because it does not demand operation of an isochronous machine at 50% output.

In the isochronous load sharing system, the high efficiency operation is realized by managing the number of running generators following the periodical system load variation of a 24-hour cycle.

Base Load on an Isolated Bus

Base load is a method of setting a base or fixed load on a machine operating in parallel on an isolated bus. Generally speaking, the base load is the load level where the engine-generator set is operated at highest efficiency. This method can only be used where other generator sets are producing enough power to meet the changes in load demand.

A condition to operate a generator(s) connected to an isolated bus in this mode is that the system load is always greater than the total power of the base load machine(s). If this condition does not exist, other generators connected to the bus will be motored.

Base Load to an Infinite Bus

Base load for a system paralleled to an infinite bus or utility is the same as base load in an isolated system.

When operating a generator connected to an infinite bus in the base load mode, other generators will never be motored even if the system load decreases. However, the power will be reversed to the infinite bus when the total power of the base load generator(s) exceeds the import power from the infinite bus. Take care to use this method in a power system that does not allow reverse powering.

Chapter 3
Installation

⚠WARNING

Due to typical noise levels in engine and turbine environments, hearing protection should be worn when working on or around the 2301E.

⚠WARNING

The surface of this product can become hot enough or cold enough to be a hazard. Use protective gear for product handling in these circumstances. Temperature ratings are included in the specification section of this manual.

⚠WARNING

External fire protection is not provided in the scope of this product. It is the responsibility of the user to satisfy any applicable requirements for their system.

Scope

This chapter contains general installation instructions for the 2301E-J control. Power requirements, environmental precautions, and location considerations are included to help you determine the best location for the control.

Unpacking

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

Power Requirements

The 2301E-J requires 18-36 Vdc, 600 mA or more as supply power.

NOTE: If a battery is used for operating power, an alternator or other battery charging device is necessary to maintain a stable supply voltage.

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.

Location Considerations

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 that 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 preferable operation range is 0 to +40 °C.
- The controller must NOT be mounted on the engine

Electrical Connections

All inputs and outputs to the 2301E-J are made through “Cage Clamp” terminal blocks. For noise suppression, it is recommended that all low-current wires be separated from all high-current wires.

The terminal blocks are screwless cage clamp style blocks. The spring clamp can be actuated by using a standard 2.5 mm or 3/21 in. flat bladed screwdriver. 2301E-J’s terminal blocks accept wires from 0.1-3.5 mm^2 (27- 12 AWG). Two 18 AWG or three 20 AWG wires can be easily installed in each terminal. Wires for the terminals should be stripped 5-6 mm (0.22 in) long.

IMPORTANT

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.

⚠WARNING

Due to the hazardous location listings associated with this product, proper wire type and wiring practices are critical to operation.

NOTICE

Do not connect any cable grounds to “instrument ground”, “control ground”, or any non-earth ground system. Make all required electrical connections based on the wiring diagrams (Figures 1-2a/b/c).

Shielded Wiring

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

The 2301E-J is designed for shield termination to earth ground at the 2301E-J side. 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 or a similar point, it should be AC coupled to earth. All other shield terminations except at the 2301E-J should be AC coupled to earth through a capacitor. A 1000 pF, 500 V capacitor is sufficient. The purpose is to provide a low impedance path to earth for the current on the shield at frequencies of 150 kHz or higher. Multiple direct connections of a shield to earth risk high levels of current to flow within the shield.

If the 2301E-J 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 terminated at the 2301E-J control terminals.

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

NOTICE

For noise suppression reasons, it is recommended that all low-current wires be separated from all high-current wires. Input Power ground terminal (47) should also be wired to earth ground.

IMPORTANT

CABINET INSTALLATIONS

If the 2301E is installed in a cabinet, shielded I/O can be terminated directly to the cabinet (earth ground) at the entry/exit of the cabinet, as well as at the control (recommended).

Installation concerns associated with wiring in systems with other devices are addressed in the electrical connections section.

Figure 3-1. Installation of Wiring to Terminal

Speed Setting Ranges

The microprocessor in the 2301E-J calculates the speed range (the detectable maximum engine speed) to be used by entering the engine/generator synchronous speed (i.e., the rated speed) and number of gear teeth. This configured speed sets the hardware-to-software scaling. The rated speed and the number of gear teeth are set in the configure mode with the engine stopped.

⚠WARNING

The number of gear teeth is used by the control to convert pulses from the speed sensing device to engine rpm. To prevent possible serious injury from an overspeeding engine, make sure the control is properly programmed to convert the gear-tooth count into engine rpm. Improper conversion could cause engine overspeed. See Chapter 4 for details on number of gear teeth setting.

⚠WARNING

The default setpoint value of the 2301E-J's 'rated speed' is set to 750Hz/750 rpm and 'number of gear teeth' is set to 60. The wrong rated speed or the wrong number of gear teeth may cause engine overspeed resulting in PERSONAL INJURY, LOSS OF LIFE or property damage. To prevent possible serious injury from an overspeeding engine, read Chapter 4 of this manual before starting the engine.

LED System Status Indicators

The LED located between terminals 30 and 31 is a two-colored LED. The following provides the functions of the LED status:

- LED Off = Power Off
- LED Green = System On
- LED Solid Red = I/O Lock
- LED Flashing Red = Fault (This indicates a major problem and should be returned to Woodward for service).

Potential Transformer Connections

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

The potential transformer secondary line-to-line voltage must produce 90 to 240 Vac. Refer to the plant wiring diagram, Figure 1-2.

Current Transformer Connections

The standard method of connecting the current transformers is shown in the plant wiring diagram, Figure 1-2. An alternate method is the open delta connection shown in the insert (as detail 'A') in Figure 1-2.

Load Sharing Lines

Load sharing lines provide an analog communication path between compatible controls, which is used for operating engine-generator sets in load sharing mode. The 2301E-J 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.

IMPORTANT

Do not touch load share pins without discharging ESD to physical earth first and making sure the control's PE terminal is connected to physical earth before wiring.

The load share signals have 4 kV ESD withstand when the control is not grounded rather than 8 kV or more on other pins. (Load Share Lines have at least 7 kV withstand when the control is grounded.)

Greater than 4 kV ESD events are uncommon in the typical installation environment, but may happen.

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 of the 2301E-J or 2301A types, and all controls are installed in the same cabinet, the shields may be connected continuously between controls as well as the load sharing-line bus. However, in case controls are installed in different cabinets and the Load Sharing Lines is long enough, take care for wiring the load sharing-line bus and its shield line so that the ground loop problem will not arise. When load sharing with different controls, do not connect the shields at the point where connections are made to the load sharing-line bus.

kW Droop/Isochronous Operation

For kW droop operation, connect the discrete power voltage to terminal 37 (Isochronous/Droop) by closing the contact switch to this terminal, and to terminal 40 by closing breaker auxiliary contact which closes at the same time with the generator circuit breaker.

For isochronous operation, connect terminal 40 to common (zero volt).

Import/Export Control and Process Control

To control import/export power to the mains using Woodward Process and Import/Export Control, connect the output signal from Process and Import/Export Control to terminal 10 (+) and 11 (–) of 2301E-J (load sharing line input). The operator needs to switch the control's function to the automatic load sharing function in isochronous mode before starting import/export control.

Power Supply

Run the power leads directly from the power source to the control, connecting the negative lead to terminal 49, and the positive lead to terminal 48. DO NOT POWER OTHER DEVICES WITH LEADS COMMON TO THE CONTROL.

When power is applied, the 2301E-J begins performing internal memory tests to 'boot-up' the processor, which 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 control the prime mover until the boot-up is complete. Therefore, do not begin the air run or other engine start operation until 30 seconds has passed after the control power-up.

⚠WARNING

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

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

IMPORTANT

The 18–36 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.

NOTICE

To prevent internal circuit damage, do not supply greater than 37 Vdc power voltage to the 2301E-J's power supply input.

Discrete Inputs

Terminals 34-41

Discrete inputs are the switch input commands to the 2301E-J control. They interact in such a way as to allow engine control and power management under a variety of conditions.

When the input switch or relay contact is closed, the voltage supplying the discrete inputs should be present from the appropriate discrete input (terminal 34 ~ 41) to terminal 33 (common). Terminal 33 is the common return path for all of the discrete input channels. Positive Voltage is supplied to the discrete input terminal when an input switch or relay contact closes. This will cause the input state for that discrete input to be 'True' (displayed as "CLOSED"). The input terminal will be open circuited when the input switch or relay contact opens. This will cause the input state for that discrete input to be 'False' (displayed as "OPEN"). Do not connect discrete inputs and common to the circuit ground of the control.

To use the discrete inputs, an independent external low voltage source is necessary. The voltage source used must be capable of supplying 100 mA at the voltage level of 24 Vdc. Connect the external low voltage source negative to terminal 33(–). Connect the external low voltage source positive to the appropriate input switch or relay contact and connect the mated switch or relay contact to the corresponding discrete input terminal 34 to 41 on the 2301E-J control.

In systems where the external low voltage DC power is not available, the discrete inputs may be powered by the internal 24 Vdc Discrete Input Power source at terminal 31 (+) and 32 (–). This source is capable of supplying 100 mA at a voltage level of 24 Vdc. Connect the internal 24 Vdc voltage source positive from terminal 31 to the appropriate input switch or relay contact and connect the mated switch or relay contact to the corresponding discrete input terminal on the 2301E-J control. Assure that a connection

exists between terminal 32 (–) and terminal 33 (COM) when using the internal Discrete Input Power. Do not power other devices with the internal discrete input power source, and assure that the switch or relay contacts used are isolated from any other circuit or system

IMPORTANT

Discrete inputs with cable lengths where the end points are physically greater than 30 meters apart and which 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 either +24 Vdc or ground, never floated or tied to reference with a resistor.

IMPORTANT

The discrete inputs are capable through software programming to change the logic or state of the input. Please verify the state of your input before starting the engine.

DI-A: Run/Stop Contact (Terminal 34)
The RUN/STOP discrete input is used for the engine start permissive or stop command. When the switch or relay contact is closed (the RUN state is selected), the control is allowed to control the fuel in an attempt to control the speed/load of the prime mover. When the switch or relay contact is open (the STOP state is selected), the Minimum Fuel Function will immediately pull the fuel demand to zero. The prime mover cannot be started while this switch or contact is open due to the Minimum Fuel Function.

⚠WARNING

DO NOT use the stop contact as part of any emergency stop sequence.

DI-B: Selectable Input (Terminal 35)
Discrete Input B can be configured for the following function:

1. IDLE/RATED
2. ALARM RESET
3. SELECT 2ND DYNAMICS
4. 50/60Hz OPERATION
5. DI FUEL LIMIT
6. FUEL LIMIT OFFSET

1. *SELECT IDLE/RATED* contact is used to set the speed reference to the idle speed or to the rated speed.

If this contact, which has been open, is closed, the engine speed will ramp from the idle speed to the rated speed by the preset ramp rate or follow another speed setting (which is the speed reference determined by Raise/Lower command or the remote speed reference). If this contact, which has been closed, is opened, the engine speed will ramp from the rated speed to the idle speed by another preset ramp rate.

Raise/Lower Speed functions by contact inputs and Remote Speed setting function by the remote signal are enabled only while the SELECT IDLE/RATED contact is closed. When the SELECT IDLE/RATED contact is open, the speed reference is set to the idle speed regardless of status of other contact inputs.

If this contact is not set to IDLE/RATED, Automatic IDLE/RATED function will be selected.

2. *ALARM RESET* is used to reset Shutdowns or Alarms.

If ALARM RESET is not configured to DI-B or DI-C, alarm is reset automatically during engine stop or can be reset using Service Tool/Modbus connection.

IMPORTANT

The engine speed has to be zero before the reset can function.

3. *SELECT 2ND DYNAMICS* is used to switchover between DYNAMICS #1 and #2. When this function is used, DYNAMIC #2 will automatically enabled regardless to setting at 「B**DYNAMICS #2** “01:USE 2ND DYNAMICS?”」

If 「B**DYNAMICS #2** “09:TRANSFER DYN-2 BY ISO?DROOP DI”」 setting is enabled, DYNAMICS #1 and #2 can be change using this contact or changes mode to Droop.

4. *50/60Hz OPERATION* is used to switchover of the Generator rated frequency.
Frequency switchover can only be done during engine stop condition. See Chapter 4 Entering Control Set Points for setting that affected by this operation.

5. *DI FUEL LIMIT* is used to enable optional Fuel Limit by discrete contact.
This function can be used to limit actuator output for generator overload detection by external circuit.

6. *FUEL LIMIT OFFSET* is used to decrease (- offset) or increase (+ offset) fuel limiter temporary using external contact. This offset will apply to all fuel limiter.

DI-C: SELECTABLE INPUT (TERMINAL 36)
Discrete Input C can be configured for the following function:

1. FAILED SPEED OVERRIDE/BASE LOAD
2. ALARM RESET
3. SELECT 2ND DYNAMICS
4. 50/60Hz OPERATION
5. DI FUEL LIMIT
6. FUEL LIMIT OFFSET

FAILED SPEED SIGNAL OVERRIDE contact is used to move the fuel rack to the Start Fuel Limiter position before the starter motor begins to rotate at an engine start.

This function works for a preset period just after this switch is turned from ‘open’ to ‘close’ when the engine has stopped, and the RUN/STOP switch is at RUN side. Failed Speed Signal Override function, enabled only at this moment, moves the actuator up to the Start Fuel Limiter position. The status of this contact is disregarded after the engine speed exceeded the idle speed.

In case the engine rpm exceeds the speed signal failure level (normally 5% of the rated speed) by the starter motor rotation, this contact is unnecessary. The engine will start automatically due to the Start Fuel Limiter being enabled when the engine rpm exceeds the speed signal failure level.

Function 2, 3, 4, 5, and 6 are same as DI-B.

DI-D: LOWER SPEED/LOAD (Terminal 37)
This contact is used to lower the speed reference or the generator load at the baseload operation. The Lower command is enabled when this contact is closed, and the lower command is disabled when this contact is open.

The Lower Speed/Load Set command functions only when the SELECT IDLE/RATED switch is turned to the ‘Rated’ side.

If the generator is operated in the baseload mode, this contact works as the baseload lower contact, or else, this contact works as the speed lower contact.

The speed reference or the baseload setpoint is lowered by a preset rate when this contact is closed.

DI-E: RAISE SPEED/LOAD (Terminal 38)
This contact is used to raise the speed reference or the generator load at the baseload operation. The Raise command is enabled when this contact is closed, and the raise command is disabled when this contact is open.

The Raise Speed/Load Set command functions only when the SELECT IDLE/RATED switch is turned to the 'Rated' side.

If the generator is operated in the baseload mode, this contact works as the baseload raise contact, or else, this contact works as the speed raise contact.

The speed reference or the baseload setpoint is raised by a preset rate when this contact is closed.

DI-F: START TO UNLOAD GENERATOR (Terminal 39)
This contact is used to ramp the generator load automatically until the load level where the generator breaker can be tripped.

This contact functions only when the generator breaker auxiliary contact is closed, otherwise the contact is disregarded.

When this contact is closed, the control will unload the generator to the lowest load level by a preset lower rate. When the generator load arrived at this level, the Permit Open Generator CB signal will be output from terminal 44 (DO-1 setting on default) .

DI-G: ISOCHRONOUS/DROOP (Terminal 40)
This contact is used to switch the engine generator operation between droop mode and isochronous mode. The generator is operated in the droop mode when this contact is closed and in the isochronous mode when this contact is open.

If this contact is closed while in the isochronous operation, the operation mode will be transferred to the droop mode bumplessly. If this contact is opened while in the droop operation, the operation mode will be transferred to the isochronous mode ramping the generator load to a preset level. However, when a single engine generator set operating in the droop mode transfers to the single isochronous operation, the generator load is changed to the assigned level instantly.

Although the generator load ramps from the droop operation level to the isochronous load sharing level while transferring to the isochronous load sharing operation by a constant rate gradually, the load changes quickly following the load sharing signal after the transfer has completed.

If the control mode is switched from Droop mode to Isochronous mode for the import/export control when the generator is operating with the mains in parallel, the generator load ramps from the droop operation level to the load level indicated by the import/export control via the load sharing line by a constant rate gradually. However, the load will change quickly following the signal from the import/export control after the transfer has completed.

DI-H: GCB CLOSE (Terminal 41)
CLOSED GENERATOR C.B. contact is used to input the status of the generator circuit breaker to the 2301E-J. It is typically connected to an auxiliary contact on the generator circuit breaker. When the breaker closes, the input switch or relay contact should also close. When the breaker opens, the external switch or relay contacts should be open.

If this contact (i.e. the generator C.B.) is closed when operating in isochronous load sharing mode, the control will raise the generator load gradually by a preset rate until it reaches the load sharing level, then the control will begin the load sharing operation.

If this contact is closed when operating in kW droop mode, the control will ramp the generator load by the preset rate until it reaches the preset initial kW droop load level.

If this contact is closed when operating in isochronous baseload mode, the control will ramp the generator load by the preset rate until it reaches the preset initial baseload level.

When this contact is opened, the control will set its Speed Reference to the rated speed instantly even if the generator has been operated in any operation mode only on condition that the control is in Normal 2301E-J mode (GOVERNOR TYPE = '1')..

Baseload Operation Selection (Terminals 36 & 41)
To operate the engine in Baseload mode, close the switch or the contact connected to terminal 36 after the engine has started. In case terminal 36 is used for FAILED SPEED SIGNAL OVERRIDE function, open the switch or the contact connected to terminal 36 once and then close it again to run the engine in Baseload mode. The control will not recognize the input signal to terminal 36 as the Baseload Operation command if the switch or the contact has been closed since the engine start. However, the engine can work in Baseload mode only when isochronous mode is selected and the generator circuit breaker (aux contact) is closed (or GCB signal is 'high').

Actuator Outputs

Terminals 13 – 15

The actuator wires connect to terminals 13(+) and 14(–). The current range to the actuator output is configured in software for a 0-180 mA, 0-20 mA, 4-20 mA or 180-0 mA actuator. 180-0 mA is for Reverse acting actuator. Use shielded twisted-pair wires with the shield connected to terminal 15. Do not connect the shield to the actuator or any other point. The shield must have continuity the entire distance to the actuator. If intervening terminal blocks are used in routing a signal, the shield should be continued through the terminal block.

Analog Input #1 (Terminals 19 - 21) / Analog Input #2 (Terminals 22 - 24)

WARNING **Do NOT configure Analog Inputs #1 and #2 for the same function.**

Analog Input #1 and #2 can be configured for the following function:

1. NOT USED
2. REMOTE SPEED SET
3. REMOTE BASE LOAD SET
4. REMOTE SPEED BIAS
5. BOOST AIR PRESSURE SIGNAL
6. LOAD SENSOR SIGNAL
7. SPM SYNCHRONIZER

This input channel is designed to receive either 4–20 mA, 0–5 Vdc, 1–5 Vdc, or ±2.5 V representing a minimum set point to a maximum set point, and the input signal type is configurable in software. Use a shielded twisted-pair cable for the wiring from SPM Synchronizer and connect the shield to terminal 21/24. Isolate the Aux signal generator output from any other equipment's circuits. The shield must be insulated from all other conducting surfaces including the Aux signal generator's grounding terminal. Make sure the shield has continuity the entire distance from the Aux signal generator. If intervening terminal blocks are used in routing a signal, the shield should be continued through the terminal block.

Speed Sensing Input

Terminals 25 - 27

Connect a speed-sensing device, such as a magnetic pickup, to terminals 25 and 26 using a shielded twisted pair cable. Connect the shield to terminal 27, making sure the shield has continuity the entire distance to the speed sensor, and the shield of MPU side should be insulated from all other conducting surfaces. If intervening terminal blocks are used in routing a signal, the shield should be continued through the terminal block.

Discrete Outputs

Terminals 42, 43, & 44 - 48

The 2301E-J contains four discrete output driver channels for driving external relays and LEDs. The discrete outputs are low-side drivers with a maximum output current of 200 mA. The discrete output drivers are not isolated from each other and are powered by an external +12 Vdc or +24 Vdc source connected at terminals 42 (+) and 43 (–).The Relay Driver Output pins are: #1(44), #2(43), #3(46), and #4(47). They are isolated from other control circuits and the internal power supplies of the 2301E-J control.

These 4 discrete outputs can be configured for the following functions:

1. CPU FAILURE / NORMAL ENGINE
2. MPU SPEED SIGNAL FAIL
3. MAJOR ALARM
4. MINOR ALARM
5. SPEED SWITCH
6. CB OPEN COMMAND
7. CLOSED CB WITH ISO MODE
8. CLOSED CB WITH DROOP MODE
9. ACTIVE BASE LOAD MODE
10. OPTIONAL LOAD SWITCH
11. LEVEL SWITCH

Relay driver #1 can be used as a PWM actuator driver or a relay driver depending on the selection of the Actuator Output in the Configure menu. When configured as a PWM, power wiring configuration is dictated.

Power wiring for using the PWM output function is required to be local and dedicated, only located on the engine skid or relatively close to the control and PWM load. The power connected to control 48(+) and 49(–) terminals must also be used for the relay driver external Vdc source connected at terminals 42(+) and 43(–). In addition, the PWM load device power must also be from the same source as the power connected to control terminals 48(+) and 49(–).

IMPORTANT

The PWM functionality is limited to use on skid applications. When PWM drivers are used, the 2301E-J must be located on the same power bus as the driven circuitry. The 2301E-J and the device being driven need to be co-located on the same engine. In addition, the power bus input for the 2301E-J must be used to power the DO signals.

Analog Outputs

Terminals 16 – 18)

The 4-20 mA current signal is supplied to terminals 16(+) and 17(–), where wires to the ammeter should be connected. Use shielded twisted pair wires for wiring, and connects the shield to terminal 18. The shield must be insulated from all other conducting surfaces including the ammeter's chassis. If intervening terminal blocks are used in routing a signal, the shield should be continued through the terminal block. When connecting this output to other control or equipment, use an isolator to isolate the driver circuit from the control or the equipment.

Note that these terminals must be isolated from ground. The Output can be software configured to one of several control parameters. These parameters include:

1. Engine RPM
2. Speed reference
3. Actuator output / Fuel demand
4. Generator Output
5. Load Reference

Serial Communication Ports

Serial Communication RS-232

The Serial Communication Port is the DB9 female connector at the end of the front terminal strip. This port is used to monitor control inputs, outputs, and operating parameters. The user can select its communication specification between RS-232 and RS-422. Control configuration changes and adjustments can also be made. The 2301E-J port is connected to a computer serial port, and the external computer software is used to display control parameters. The standard service tool used to communicate with the 2301E-J is Woodward's Toolkit or Control Assistant. This software can read all control parameters, and values.

IMPORTANT

The communication ports must be connected with an approved jacketed serial communication cable. The connector must be secured to the 2301E-J to prevent contact with other circuits.

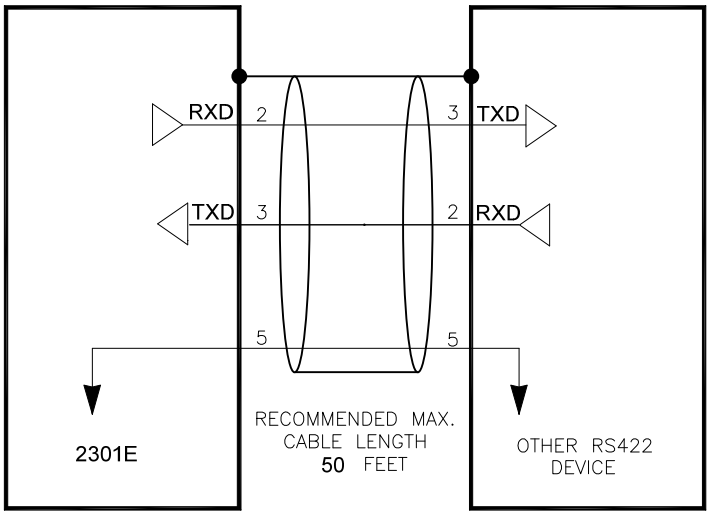


Figure 3-2. RS-232 Pin Assignments for Serial Communication Cable

Serial Communication RS-422

The serial communication port is the DB9 female connector at the end of the front terminal strip. This port is used to monitor control inputs, outputs, and operating parameters by other devices using Modbus communication.

NOTICE

When a single transmitter is connected to one or more receiver, termination should be at the receiver farthest from the transmitter. (Refer to Figure 3-3 if 2301E-J is the farthest device)

The communication ports must be connected with an approved jacketed serial communication cable. The connector must be secured to the 2301E-J to prevent contact with other circuits.

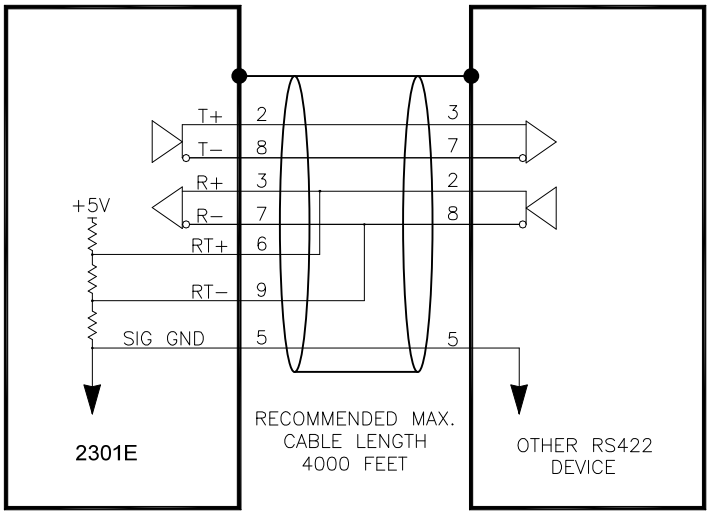


Figure 3-3. Typical RS-422 Communication Connections

Installation Check-out Procedure

With the installation completed as described in this chapter, perform the following check-out procedure before beginning the start-up adjustments.

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 the 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 diagrams, Figures 1-2 and 1-3.
3. Check for broken terminals and loose terminal screws.
4. Check the speed sensor for visible damage. Check the clearance of the magnetic pickup between the gear and the sensor and adjust if necessary. Clearance should be between 0.5 and 0.7 mm (0.020 and 0.028 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*

Chapter 4.
Entering Control Set Points

Introduction

This chapter describes entering and adjusting setpoints through the control's menu system using Toolkit.

It includes initial prestart-up and start-up settings and adjustments, and a current transformer phasing procedure.

Because of the variety of installations, plus system and component tolerances, the 2301E-J control must be tuned and configured for each system to obtain optimum performance.

See later sections in this chapter for prestart-up and start-up settings and adjustments.

⚠WARNING

An improperly calibrated control could cause an overspeed condition 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.

⚠WARNING

An unsafe condition could occur with improper use of these software tools. Only trained personnel should have access to these tools.

Toolkit PC Interface

Connection to a computer is only required for calibration and setup of the 2301E-J control on a prime mover. The computer and 2301E-J Toolkit Service Tool software is not required, and not necessary, for normal operation of the prime mover.

Toolkit is used for initial prestart-up settings of 2301E-J, engine operation monitoring and system troubleshooting. Therefore, a personal computer with Toolkit is necessary for the 2301E-J control's adjustment.

Toolkit Installation
The Toolkit Installation CD is contained in the 2301E-J's package. Toolkit software can be downloaded from the Woodward website if necessary.

PC Minimum Requirement
The personal computer used to run Toolkit software must meet minimum requirements, otherwise the software may not be executed properly.

- Microsoft Windows® 8.1, 7, Vista (32-& 64-bit)
- Microsoft .NET Framework ver. 4.5.1
- 1 GHz or faster x86 or x64 processor
- 512 MB of RAM
- Minimum 800 by 600 pixel screen with 256 colors
- Serial port
- Serial extension cable

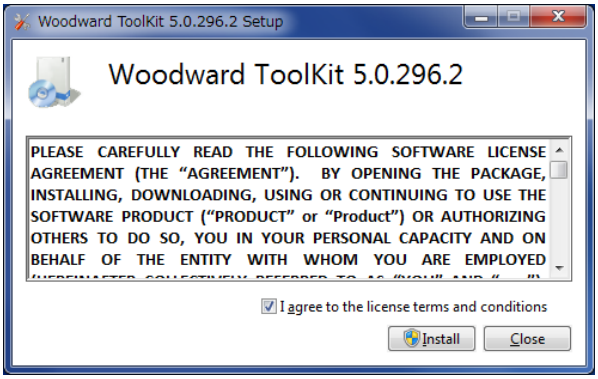
Other Interface
Another connection option for the 2301E-J is Control Assistant. Control Assistant functions similarly to the 2301E-J Toolkit Service Tool to monitor or change settings but a license is necessary when trending data.

Installing Procedure

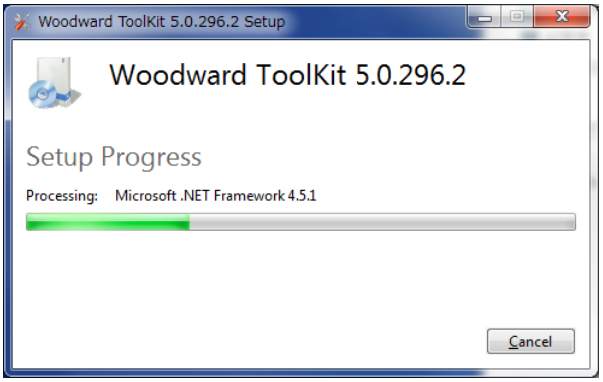
After inserting the Installation CD or downloading Toolkit Software, click on Toolkit Software file.

Window shown below will be displayed if .NET Framework 4.5.1 or above is not installed on the PC. Internet connection is necessary to install .NET Framework 4.5.1..

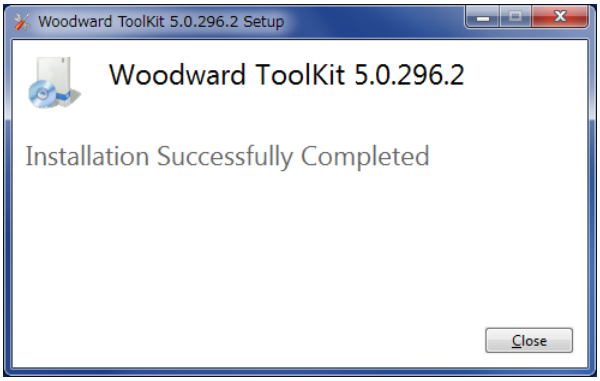
Read the license agreement; if you accept the terms, click “I Agree”, then “Next” to continue installing.



Window shown below will not be displayed if .NET Framework 4.5.1 or above is already installed.



Click “Close” to finish installation.



General Description of Toolkit

Toolkit was developed by Woodward to provide a generic PC interface to Woodward controllers, and can be used for monitoring and troubleshooting. Toolkit is also used to change settings, upload or download settings and save to or from a PC.

The 2301E-J Toolkit Service Tool communicates with the control through an RS-232 cable “null-modem” connection to the communication port.

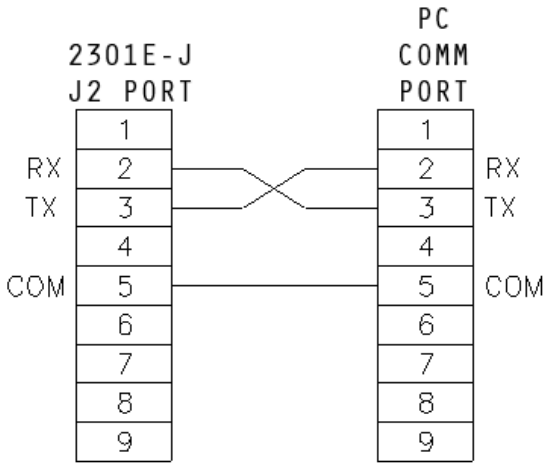


Figure 4-1. RS-232 Cable Wiring Diagram

Figure 4-1 shows the required connections in the null modem cable. These are the minimum connections; some purchased null modem cables have more interconnects, which are not used by the control.

Using Toolkit

1. Open Toolkit software. Click on 2301E-J SERVICE TOOL_B.wstool.
2. Navigation page will be displayed when Toolkit is open. Click on “Connect”. Select the correct communication port that your serial cable is connected to on your computer from “Select a Network” window.

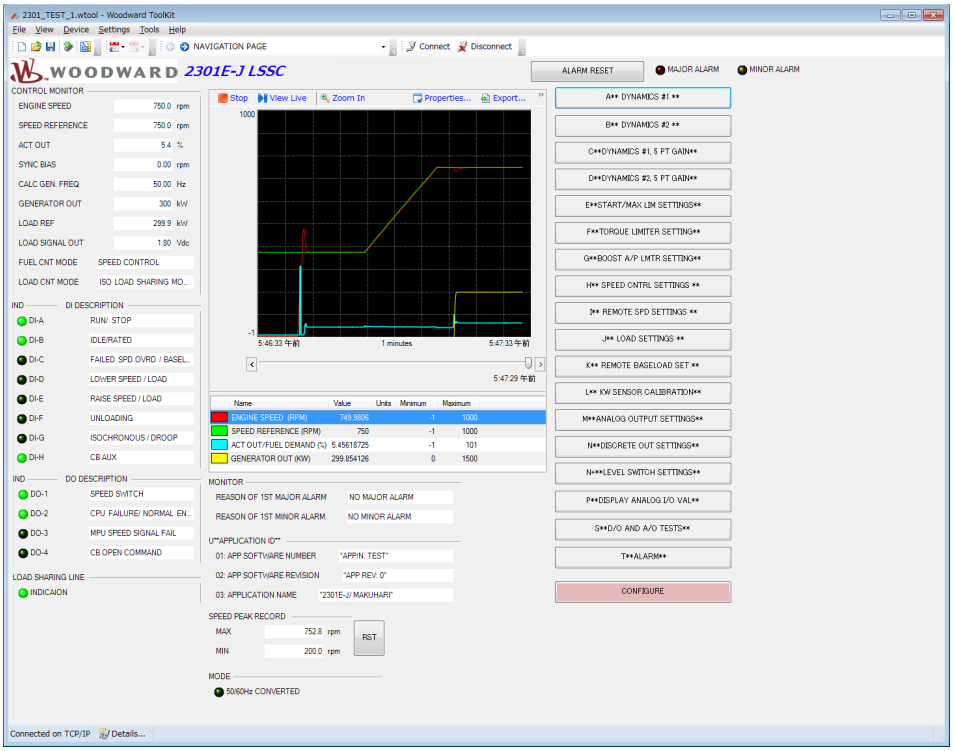


Figure 4-2. “Select a Network” Window

3. Security Login window will display when connected to 2301E-J. Choose your security level and enter correct password and click “Log In”.

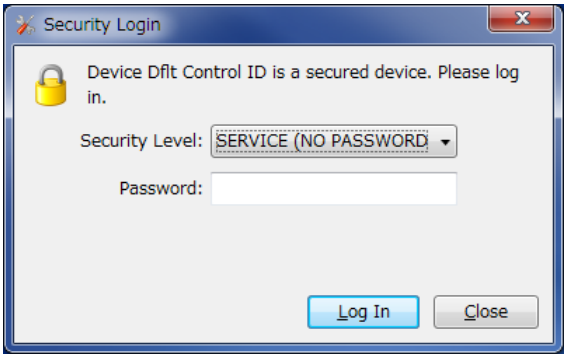


Figure 4-3. Security Login Window

4. Menus on Toolkit are restricted based on security levels in 2301E-J. There are 3 types of security levels:
   - SERVICE (NO PASSWORD):
     - Password is not necessary to login. (Leave password blank and click “Log in”.
     - All settings are displayed but setting change is restricted
   - CONFIGURE:
     - All settings in Toolkit are displayed and can be changed
   - WOODWARD:
     - For Woodward engineers only

Restriction in Change Settings

NOTICE

To prevent engine damage due to improper calibration, variables change is restricted to less than 10% of its value. Use up or down arrow（▲▼）to adjust variables near desired value (less than 10% of desired value). Then input the value directly and pushes ENTER. If directly input value is more than 10%, the value will be canceled.

IMPORTANT

The "Save Values" icon is very important. It assures that when pressed, the values in the 2301E-J are permanently saved to memory. Failure to save the variables, if changed, could result in a loss of changed values and the 2301E-J will revert to defaults.

Configure Menu

Settings on Configure Menu can only be changed during engine stop condition.

To change settings on Configure Menu, click "ENTER TO CONFIG" button. See Figure 4-4. This button will be not displayed during engine running condition. After finishing settings changes, click "ESC FROM CONFIGURE"; setting files will be saved automatically and 2301E-J will restart.

When using Control Assistant, it is necessary to lock I/O before changing variables in the configure menu. To lock I/O, click on "I/O LOCK" icon . Beware that by clicking on "I/O LOCK "icon during engine running, it will cause the engine to shut down. Remember to unlock I/O when finished changing variables on configure menu by click on "RESET" icon . Beware that if 2301E-J is powered off without saving, all changed values will revert back to original.

It is not necessary to lock I/O if you just want to see the variables without applying any changes.

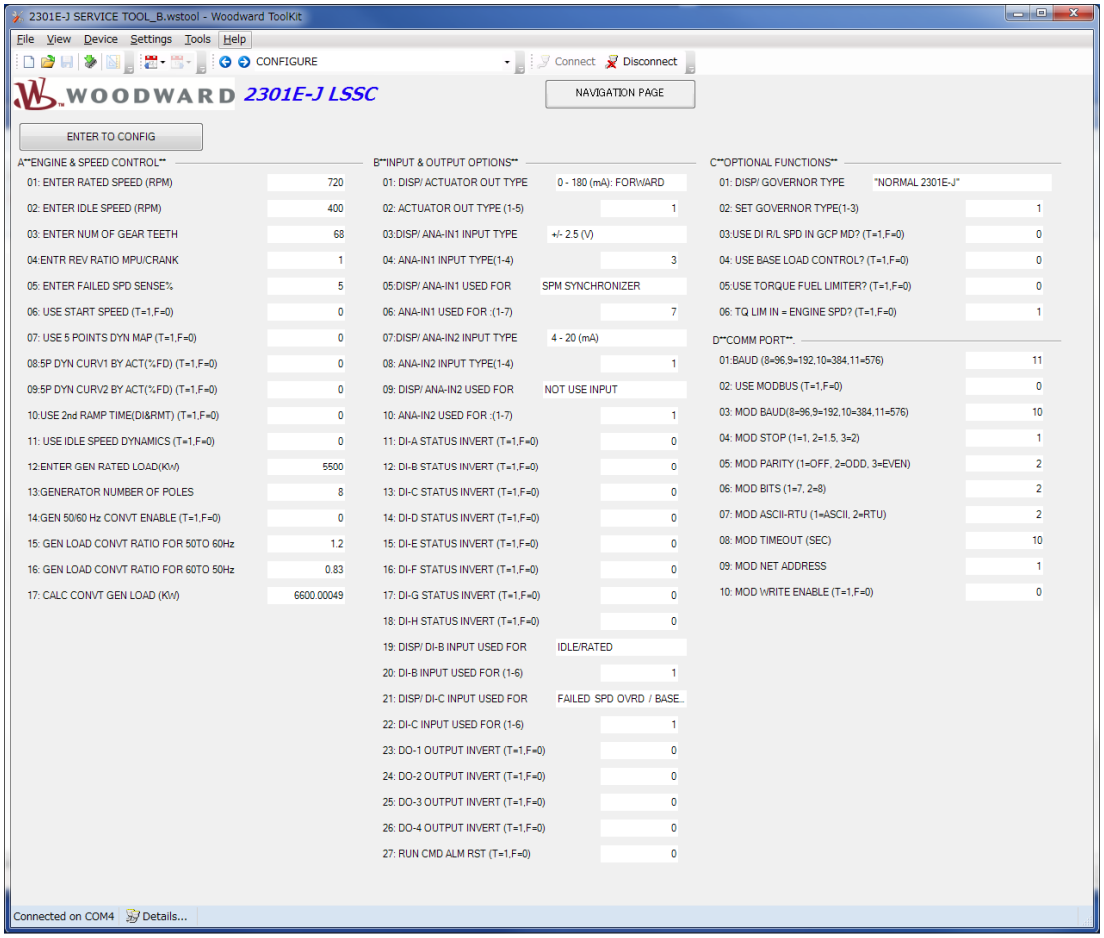


Figure 4-4: “ENTER TO CONFIG” Button

A**ENGINE & SPEED CONTROL**

Configure Menu for variables in “Configure:A**ENGINE & SPEED CONTROL**” menu is as follows:

01: ENTER RATED SPEED (RPM)

Set this setpoint to the rated synchronous rpm of the engine/generator. Generator rated frequency will be calculated using values in this setting and pole number setting.

02: ENTER IDLE SPEED (RPM)

Set the idle speed of the engine. If the idle speed is not used, set to 50% of the rated speed.

NOTICE

Do not set the idle speed within critical speed band

IMPORTANT

Idle speed is limited to a value between synchronous speed entered in configure and 20% of synchronous speed (a 5 to 1 speed range).

03: ENTER NUM OF GEAR TEETH
This is the number of teeth or holes of the gear or flywheel that the speed sensor is on.

⚠WARNING

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

04: ENTER REV RATIO MPU/CRANK
Set the ratio of the rpm of the shaft for gear teeth sensing to the rpm of the crank shaft. For instance, if the gear the MPU is attached to is rotating at one half of the crank shaft speed, enter 0.5 here.

IMPORTANT

The maximum input frequency that can be measured by the speed sensing circuit is 25,000 Hz. Therefore, to allow for transient conditions, the (Number of Teeth x Rated rpm) / 60 should be less than 19,000.

05: ENTER FAILED SPD SENSE%
This setpoint should be set to a percentage of rated prime mover speed that will verify a valid MPU signal exists while the prime mover is starting. If the engine speed lowers the rpm corresponding to this setpoint, Speed Sensing failure will be caused.

06: USE START SPEED (T=1,F=0)
This setpoint is set to ‘True’ to enable a tunable Start Speed Reference. Set to ‘False’ to disable the Start Speed Reference. This function is used to control the speed below the idle speed to allow acceleration to the Start Fuel Limiter without over fueling to prevent an overshoot and smoking at each engine start.

07: USE 5 POINTS DYN MAP (T=1,F=0)
This setpoint should be set to ‘True’ to permit the use of a 5-Gain Curve (4-slope gain map) for setting the control gain as a function of prime mover load. If this setpoint is set to ‘False’ only a single gain value will be used as the dynamic adjustment.

08: 5P DYN CURV1 BY ACT (%FD) (T=1,F=0)
This setpoint should be set to ‘True’ to select the 4-slope gain map load axis to be based on percent engine fuel demand (% Actuator output) for DYNAMICS#1. Set to ‘False’ to make slope breakpoints dependent on percent generator load (%KW). If “USE 2nd DYNAMICS” is set to ‘True’, the control switches the dynamics based on the parameter chosen at this setpoint.

09: 5P DYN CURV2 BY ACT (%FD) (T=1,F=0)
This setpoint should be set to ‘True’ to select the 4-slope gain map load axis to be based on percent engine fuel demand (% Actuator output) for DYNAMICS#2. Set to ‘False’ to make slope breakpoints dependent on percent generator load (%KW). If “USE 2nd DYNAMICS” is set to ‘True’, the control switches the dynamics based on the parameter chosen at this setpoint.

10: USE 2nd RAMP TMIE (DI&RMT) (T=1,F=0)
Set this setpoint to ‘True’ if 2nd rates are used to raise/lower the Speed reference by contact inputs or an analog remote input when the Generator C.B. Aux contact is closed. If 2nd rates are not used, set this setpoints to ‘False’.

11: USE IDLE SPEED DYNAMICS (T=1,F=0)
Set this setpoint to ‘True’ if the Idle gain, as the proprietary gain setpoint for the idle speed, is used. Otherwise, set this setpoint to ‘False’.

The Idle gain is switched to the Rated gain (normal gain) just after the rated speed is selected in case the speed reference is raised to the rated speed. The Rated gain is switched to the Idle gain at the point

when the actual engine speed passed the 2/3 distance from the rated speed to the idle speed in case the speed reference is lowered to the idle speed.

12: ENTER GEN RATED LOAD (KW)
Set the rated generator output in kW

13: ENTER NUMBER OF POLES
This setpoint (and alarm) is only necessary when 'GEN 50/60Hz CONVT ENABLE' setpoint is set to 'TRUE'. Set the number of poles. Improper setting will cause Major Alarm.

14: GEN 50/60Hz CONVT ENABLE (T=1,F=0)
Set this setpoint to 'TRUE' to enable Generator conversion 50/60Hz. Otherwise, set this setpoint to 'FALSE'. This setpoint is valid when the engine generator is used for 50/60Hz. This setting cannot be used to change frequency if the engine is connected to different generators with different number of poles.

Generator frequency can be changed by assigned DI-B or DI-C or using Toolkit. If the rated speed is set to 50Hz, conversion will change to 60Hz. If the rated speed is set to 60Hz, conversion will change to 50Hz. This setting is used based on 50Hz < 60Hz. Otherwise, this function is not applicable.

15: GEN LOAD CONVT RATIO FOR 50 TO 60Hz
Set generator rated power ratio of frequency change from 60Hz to 50Hz.

16: GEN LOAD CONVT RATIO FOR 60 TO 50Hz
Set generator rated power ratio of frequency change from 50Hz to 60Hz.

17: CALC CONVER GEN LOAD (KW)
Set rated power calculated value of "15: GEN LOAD CONVT RATIO FOR 50 to 60Hz".

B**INPUT & OUTPUT OPTIONS**

Configure Menu for variables in "Configure: B**INPUT & OUTPUT OPTIONS**" menu is as follows:

01: DISP / ACTUATOR OUT TYPE
This setpoint displays the actuator output type selected. The actuator output type can be selected at the next setpoint.

02: ACTUATOR OUT TYPE (1-5)
Input the figure from 1 to 5 that corresponds to the right actuator output type.

1. 0-180 mA / Forward Acting
2. 0-20 mA / Forward Acting
3. 4-20 mA / Forward Acting
4. 180-0 mA / Reverse Acting
5. PWM on DO#1 (When #5 is selected, the actuator output is switched to Discrete Output #1 to drive a Pulse Width Modulated signal into an actuator that will accept this type of signal. This is a low-current type of driver. The Frequency, Duty Cycle, Min and Max Limits are set up below).

03: DISP / ANA-IN1 INPUT TYPE
This setpoint displays the analog input #1 type selected. The analog input type can be selected at the next setpoint.

04: ANA-IN1 INPUT TYPE (1-4)
Input the figure from 1 to 4 that corresponds to the right analog input #1 type:

1：4-20mA
2：0-5V
3：±2.5V
4：1-5V

05: DISP / ANA-IN1 USED FOR
This setpoint displays the input option of the analog input #1 selected. The input option can be selected at the next setpoint.

06: ANA-IN1 USED FOR (1-7)
Input function from 1 to 7 that corresponds to the right analog input #1 function.

1. NOT USED
2. REMOTE SPEED SET
3. REMOTE BASE LOAD SET
4. REMOTE SPEED BIAS
5. BOOST AIR PRESSURE SIGNAL
6. LOAD SENSOR SIGNAL
7. SPM SYNCHRONIZER

If, “C**OPTIONAL FUNCTIONS** 02:SET GOVERNOR TYPE (1-3)” is selected to 3(GCP/ECP), this setpoint will be automatically selected to 7.

07: DISP / ANA-IN2 INPUT TYPE
This setpoint displays the analog input #2 type selected. The analog input type can be selected at the next setpoint.

08: ANA-IN2 INPUT TYPE (1-4)
Input the figure from 1 to 4 that corresponds to the right analog input #2 type:

1：4-20mA
2：0-5V
3：±2.5V
4：1-5V

09: DISP / ANA-IN2 USED FOR
This setpoint displays the input option of the analog input #2 selected. The input option can be selected at the next setpoint.

10: ANA-IN2 USED FOR (1-7)
Input function from 1 to 7 that corresponds to the right analog input #2 function.

1. NOT USED
2. REMOTE SPEED SET
3. REMOTE BASE LOAD SET
4. REMOTE SPEED BIAS
5. BOOST AIR PRESSURE SIGNAL
6. LOAD SENSOR SIGNAL
7. SPM SYNCHRONIZER

11: DI-A STATUS INVERT (T=1,F=0)
To invert DI-A contact (Contact ‘OPEN’ to ON), set this setpoint to ‘TRUE’. For normal use (Contact ‘CLOSE’ to ON), set to ‘FALSE’

12: DI-B STATUES INVERT (T=1,F=0)
To invert DI-B contact (Contact ‘OPEN’ to ON), set this setpoint to ‘TRUE’. For normal use (Contact ‘CLOSE’ to ON), set to ‘FALSE’

13: DI-C STATUES INVERT (T=1,F=0)
To invert DI-C contact (Contact ‘OPEN’ to ON), set this setpoint to ‘TRUE’. For normal use (Contact ‘CLOSE’ to ON), set to ‘FALSE’

14: DI-D STATUES INVERT (T=1,F=0)
To invert DI-D contact (Contact ‘OPEN’ to ON), set this setpoint to ‘TRUE’. For normal use (Contact ‘CLOSE’ to ON), set to ‘FALSE’

15: DI-E STATUES INVERT (T=1,F=0)
To invert DI-E contact (Contact 'OPEN' to ON), set this setpoint to 'TRUE'. For normal use (Contact 'CLOSE' to ON), set to 'FALSE'

16: DI-F STATUES INVERT (T=1,F=0)
To invert DI-F contact (Contact 'OPEN' to ON), set this setpoint to 'TRUE'. For normal use (Contact 'CLOSE' to ON), set to 'FALSE'

17: DI-G STATUES INVERT (T=1,F=0)
To invert DI-G contact (Contact 'OPEN' to ON), set this setpoint to 'TRUE'. For normal use (Contact 'CLOSE' to ON), set to 'FALSE'

18: DI-H STATUES INVERT (T=1,F=0)
To invert DI-H contact (Contact 'OPEN' to ON), set this setpoint to 'TRUE'. For normal use (Contact 'CLOSE' to ON), set to 'FALSE'

19: DISP/ DI-B INPUT USED FOR
This setpoint displays the input option of the DI-B contact selected. The input option can be selected at the next setpoint.

20: DI-B INPUT USED FOR (1-6)
Input function from 1 to 6 that corresponds to the right DI-B function.

1. IDLE / RATED
2. ALARM RESET
3. SELECT 2ND DYNAMICS
4. 50/60Hz OPERATION
5. DI FUEL LIMIT
6. FUEL LIMIT OFFSET

21: DISP/ DI-C INPUT USED FOR
This setpoint displays the input option of the DI-C contact selected. The input option can be selected at the next setpoint.

22: DI-C INPUT USED FOR (1-6)
Input function from 1 to 6 that corresponds to the right DI-C function.

1. FAILED SPEED OVERRIDE
2. ALARM RESET
3. SELECT 2ND DYNAMICS
4. 50/60Hz OPERATION
5. DI FUEL LIMIT
6. FUEL LIMIT OFFSET

23: DO-1 OUTPUT INVERT (T=1,F=0)
To invert DO-1 driver output (DO-1 energize when activate), set this setpoint to 'TRUE'. For normal use (DO-1 de-energize when activate) , set to 'FALSE'

24: DO-2 OUTPUT INVERT (T=1,F=0)
To invert DO-2 driver output (DO-2 energize when activate), set this setpoint to 'TRUE'. For normal use (DO-2 de-energize when activate) , set to 'FALSE'

25: DO-3 OUTPUT INVERT (T=1,F=0)
To invert DO-3 driver output (DO-3 energize when activate), set this setpoint to 'TRUE'. For normal use (DO-3 de-energize when activate) , set to 'FALSE'

26: DO-4 OUTPUT INVERT (T=1,F=0)
To invert DO-4 driver output (DO-4 energize when activate), set this setpoint to 'TRUE'. For normal use (DO-4 de-energize when activate) , set to 'FALSE'

27: RUN CMD ALM RST (T=1,F=0)
If DI-B or DI-C is not set as ALARM RESET, ALARM RESET can be done by RUN command. Set this setpoint to 'TRUE' to reset alarm when RUN/STOP signal DI-A is ON. Set to 'FALSE' to reset alarm when RUN/STOP signal DI-A is OFF.

C**OPTIONAL FUNCTION**

Configure Menu for variables in "Configure: C**OPTIONAL FUNCTION*" menu is as follows:

01: DISP / GOVERNOR TYPE
This setpoint displays the control operation mode currently selected. The operation mode can be selected at the next setpoint.

02: SET GOVERNOR TYPE (1-3)
Input the figure of the operation mode to select.

1: Normal 2301E-J
   - The mode for an ordinary isochronous parallel operation, a kW droop operation or a baseload operation.

2: Simple Speed Droop/Alone Iso
   - The mode for a simple speed droop operation or a single isochronous operation. In this mode, the control does not use any load control function and does not demand PT or CT signals.

3. Simple Speed Governor for GCP/EGCP
   - This is the operation mode to connect a Woodward power management device, GCP series or EGCP series. In this operation mode, 2301E-J will control the engine speed, referring the speed bias signal through Analog input #1. However, the engine speed is fixed to Idle speed when the Idle speed is selected.

03: USE DI R/L SPD IN GCP MD? (T=1, F=0)
This setpoint determines if Raise and Lower Speed discrete inputs are used or not when 3 (Simple Speed Gov for GCP/EGCP) is selected at the setpoint above. Set this setpoint to 'True' to use Raise and Lower Speed discrete inputs, otherwise set to 'False'.

04: USE BASE LOAD CONTROL? (T=1, F=0)
Set this setpoint to 'True' if the engine generator may be operated in Baseload mode. Otherwise, set this setpoint to 'False'.

05: USE TORQUE FUEL LIMITER? (T=1, F=0)
Set this setpoint to 'True' if the torque limit function is used in the engine operation. Otherwise, set this setpoint to 'False'.

06: TQ LIM IN = ENGINE SPD? (T=1, F=0)
In case the torque limit function is used, set this setpoint to 'True' if the torque limit is determined basing on the actual engine speed, otherwise set to 'False'.

D**COMM PORT**

Configure Menu for variables in "Configure: D**COMM PORT*" menu is as follows:

01: BAUD (8=96, 9=192, 10=384, 11=576)
Set the baud rate of the serial communication port. Select the number which corresponds to the baud rate to use from 8 to 11.

8. 9,600bps
9. 19,200bps
10. 38,400bps
11. 57,600bps

02: USE MODBUS
Set this setpoint to 'True' if RS-422 serial port is used as Modbus connection. Otherwise, set this setpoint to 'False'

03: MOD BAUD (8=96, 9=192, 10=384, 11=576)
Set the baud rate of the RS-422 serial communication port for Modbus. Select the number that corresponds to the baud rate to use from 8 to 11.

8. 9,600bps
9. 19,200bps
10. 38,400bps
11. 57,600bps

04: MOD STOP (1=1, 2=1.5, 3=2)
Set the Stop Bits of the RS-422 serial communication port for Modbus. Select the number that corresponds to the Stop Bits from 1 to 3.

1. 1
2. 1.5
3. 2

05: MOD PARITY (1=OFF, 2=ODD.5, 3=EVEN)
Set the Parity setting of the RS-422 serial communication port for Modbus. Select the number that corresponds to the Parity setting from 1 to 3.

1. OFF
2. ODD
3. EVEN

06: MOD BIT (1=7, 2=8)
Set the Data Bit setting of the RS-422 serial communication port for Modbus. Select the number that corresponds to the Data Bit from 1 to 2

1. 7
2. 8

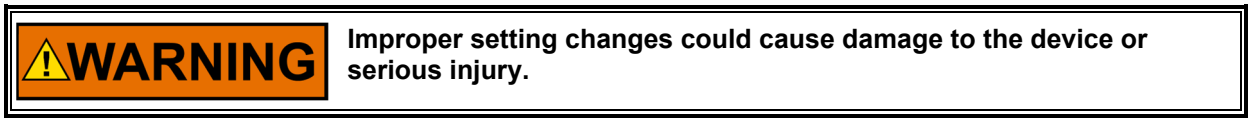
07: MOD ASCII-RTU (1=ASCII, 2=RTU)
Set the Data Bit setting of the RS-422 serial communication port for Modbus. Select the number that corresponds to the Data Bit from 1 to 2

1. ASCII
2. RTU

08: MOD TIMEOUT (SEC)
Set time delay for RS=422 MODBUS connection failure alarm. When connection failure condition exceeds setting time, minor alarm will occurred.

09: MOD ADDRESS
Set address of the RS-422 serial communication port for Modbus.

10: MOD WRITE ENABLE (T=1, F=0)
Set this setpoint to 'TRUE' to enable other device (master) to change 2301E-J settings by RS-422 Modbus serial connection. Otherwise, set this setpoint to 'FALSE'.



Service Menu

Setpoints in Service menus can be verified and changed, and the operating status can be monitored in Service menus whether the engine has been stopped or is being operated.

A**DYNAMICS #1**

Tuning setpoints in DYNAMICS #1 are enabled when “07:USE 5 POINTS GAIN MAP” under A**ENGINE & SPEED CONTROL** header is set to ‘False’.

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

There are two sets of dynamics provided. To enable the second set of dynamics go to B**DYNAMICS #2** and set the first prompt (“USE 2nd DYNAMICS?”) to ‘True’. There are 3 ways to change between these 2 dynamics.

1. Dynamics change automatically based on preset load level. The control uses the dynamics #1 when the engine load is lower than the preset level, and it uses the dynamics #2 when the engine load is higher than or equal to the preset level.
2. Using discrete input.
   - Set ‘2ND DYNAMICS SELECT’ to DI-B or DI-C. Dynamics will change based on discrete input’s contact close or open.
3. By ISO/DROOP MODE
   - Dynamics changes by ISO or DROOP mode.

Service Menu or service menu for “Service: A**DYNAMICS #1**” menu is as follows:

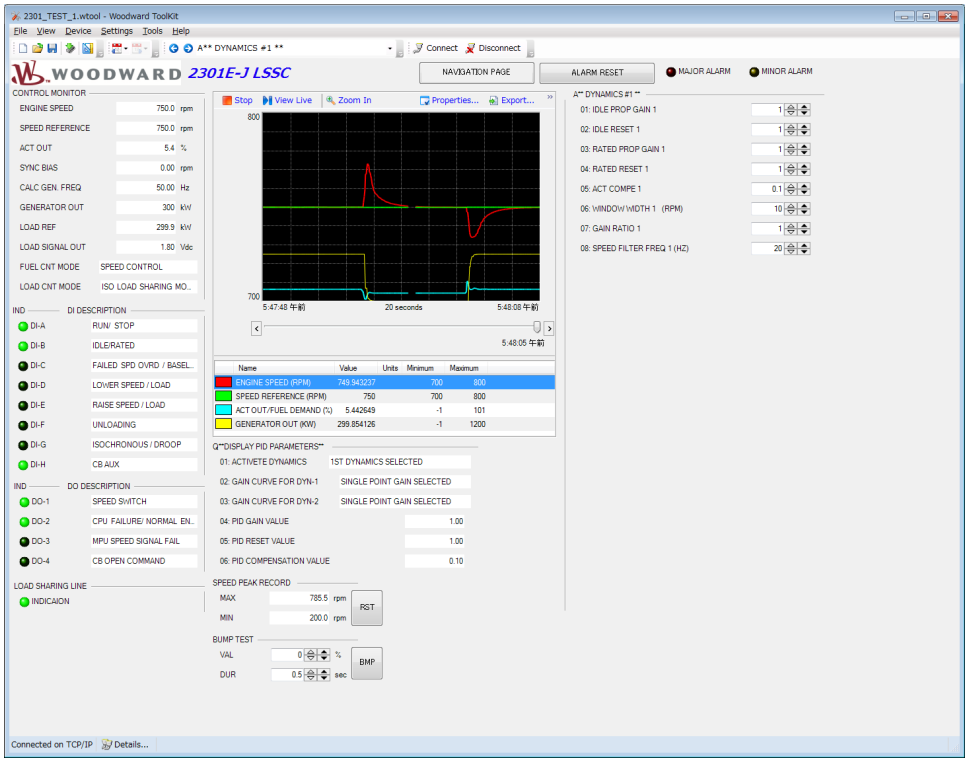


Figure 4-5. Service Menu for “Service: A**DYNAMICS #1**”

01: IDLE PROP GAIN 1
This setpoint determines how fast the control responds to an error in engine speed from the speed-reference setting around Idle speed. The control gain is determined referring both Idle gain and Rated gain (term 03 below).

- If this setpoint is too high, control output at the idle speed is sensitive, but will begin hunting easily.
- Idle gain tuning is effective only when “USE IDLE SPEED DYNAMICS” under A**ENGINE & SPEED CONTROL** header in Configure menu is set to ‘True’, and the Idle gain is enabled due to the condition described below.
- The Idle gain is selected as long as the SELECT IDLE/RATED SPEED contact switch is turned to the Idle side.
- The Rated gain is switched to the Idle gain at the point when the actual engine speed passed the 2/3 distance from the rated speed to the idle speed in case the speed reference is lowered to the idle speed.

02: IDLE RESET 1
This setpoint compensates for the lag time of the engine. It adjusts the time required for the control to return the speed to zero error after a disturbance. Reset is adjusted to prevent slow hunting and to minimize speed overshoot after a load disturbance. Normally, set this setpoint to a value between 0.4 and 2.0.

Idle Reset function is effective while Idle Prop Gain described above is effective.

03: RATED PROP GAIN 1
This setpoint determines how fast the control responds to an error in engine speed from the speed-reference setting around the rated speed (or all the control speed range when the Idle dynamics is not used). The Gain is set to provide stable control of the engine at light or unloaded conditions.

If this setpoint is too high, control output around the rated speed is sensitive, but will jiggle or begin hunting easily.

04: RATED RESET 1
This setpoint compensates for the lag time of the engine around the rated speed (or all the control speed range when the Idle dynamics is not used). It adjusts the time required for the control to return the speed to zero error after a disturbance. Reset is adjusted to prevent slow hunting and to minimize speed overshoot after a load disturbance. Too high a reset value results in quick return to the reference speed and likely hunting.

05: ACT COMPE 1
This setpoint compensates for the actuator and fuel system time constant. Increasing compensation increases actuator activity and transient performance. Set this setpoint to the value small enough to obtain steady control at all speed and load ranges. Too large compensation may cause hunting at unusual operating states.

06: WINDOW WIDTH 1 (RPM)
This setpoint is the magnitude (in rpm) of speed error at which the control automatically switches to fast response. The control uses the absolute value of speed error to make this switch. The absolute value is the difference between the speed reference and the speed. A Window Width too narrow will result in cycling that always factors in the Gain Ratio.

07: GAIN RATIO 1
This setpoints is the ratio of the Gain setting at steady state to the Gain setting during transient conditions. The Gain Ratio operates in conjunction with the Window Width and Gain adjustments by multiplying the Gain setpoint by the Gain Ratio when the speed error is greater than the Window Width. This makes the control dynamics fast enough to minimize engine speed overshoot on start-up and to reduce the magnitude of speed error when loads are changing. This allows a lower gain at steady state for better stability and reduced steady-state actuator linkage movement. If this function is not used, set this setpoint to 1.0.

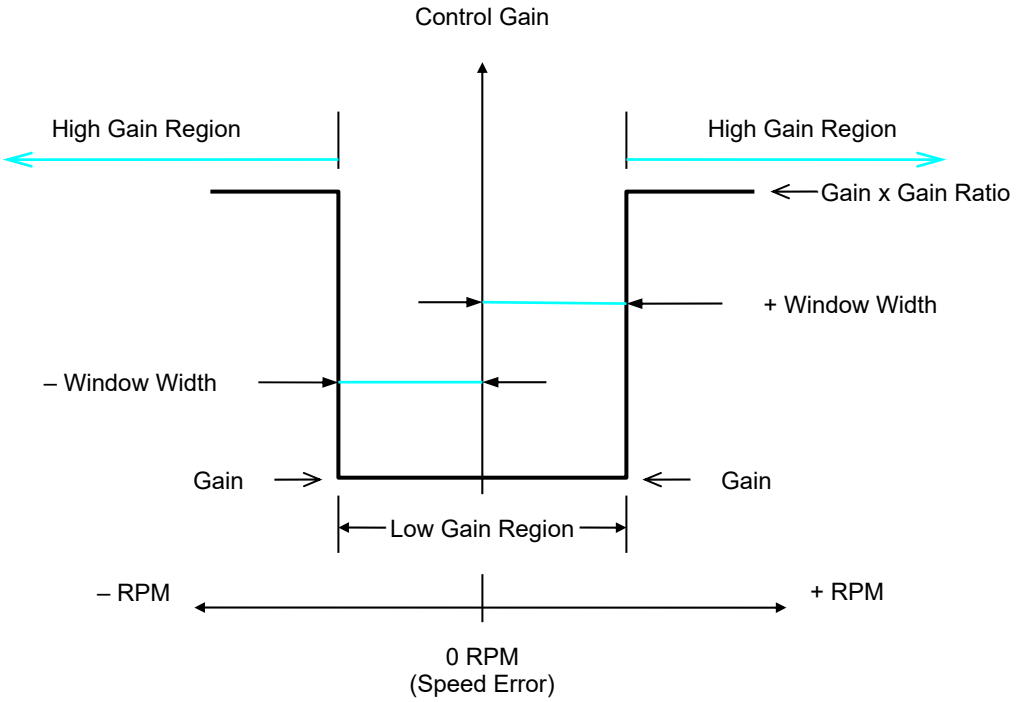


Figure 4-6. Control Gain as a Function of Speed Error

08: SPEED FILTER FREQ1(Hz)
This setpoint adjusts the cutoff frequency of a low pass filter used on the engine speed sensing input (see Figure 4-7). The filter is used to attenuate engine firing frequencies and to compose the actuator's cyclic fluctuation.

To use this feature set the cutoff frequency below 15.9 Hz.

Initially set the filter cut-off frequency to the firing frequency. To calculate the firing frequency, use the following formulas:

Firing frequency = camshaft speed / 60 (sec) * number of cylinders
Camshaft speed (rpm) = (engine rpm) / 2 [for 4-cycle engines]
Camshaft speed (rpm) = (engine rpm) [for 2-cycle engines]

As the filter frequency is reduced, steady state stability improves but transient performance may worsen. As the filter frequency is increased, steady state stability worsens but transient performance may improve.

IMPORTANT **If the calculated firing frequency is greater than 15.9 Hz, then disable the filter by setting the filter cutoff frequency at 20.0 Hz.**

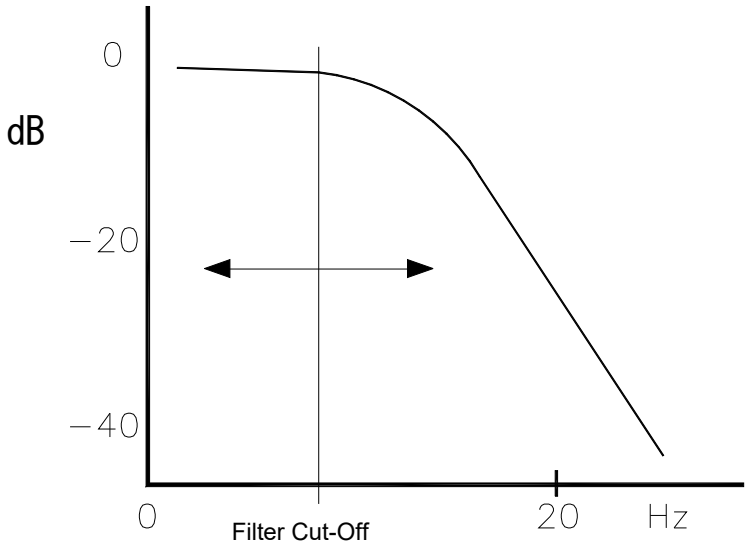


Figure 4-7. Speed Filter

IMPORTANT **Optimum performance is not necessarily obtained with the GAIN set to maximum (stable). In some cases, the gain must be reduced slightly to ensure stability under widely-varying conditions.**

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

IMPORTANT **BUMP ENABLE must be set TRUE to enable the BUMP ACT function. See the ACTUATOR BUMP SETUP menu.**

Figure 4-8 illustrates prime mover starts with the ramp time set to minimum (no ramp), step loadings at four different RESET settings, and stable, steady state running conditions. These are typical performance curves on a naturally aspirated (non-turbocharged) diesel engine.

All dynamics adjustment pages are included with trend, SPEED PEAK RECORD, and BUMP TEST function. BUMP TEST is a function to force VAL(%) offset for DUR(sec) to actuator output. Use BUMP TEST to make disturbance and tuning the dynamics while checking speed signal at trend. SPEED PEAK RECORD can be used to check on speed peak during overshoot or undershoot.

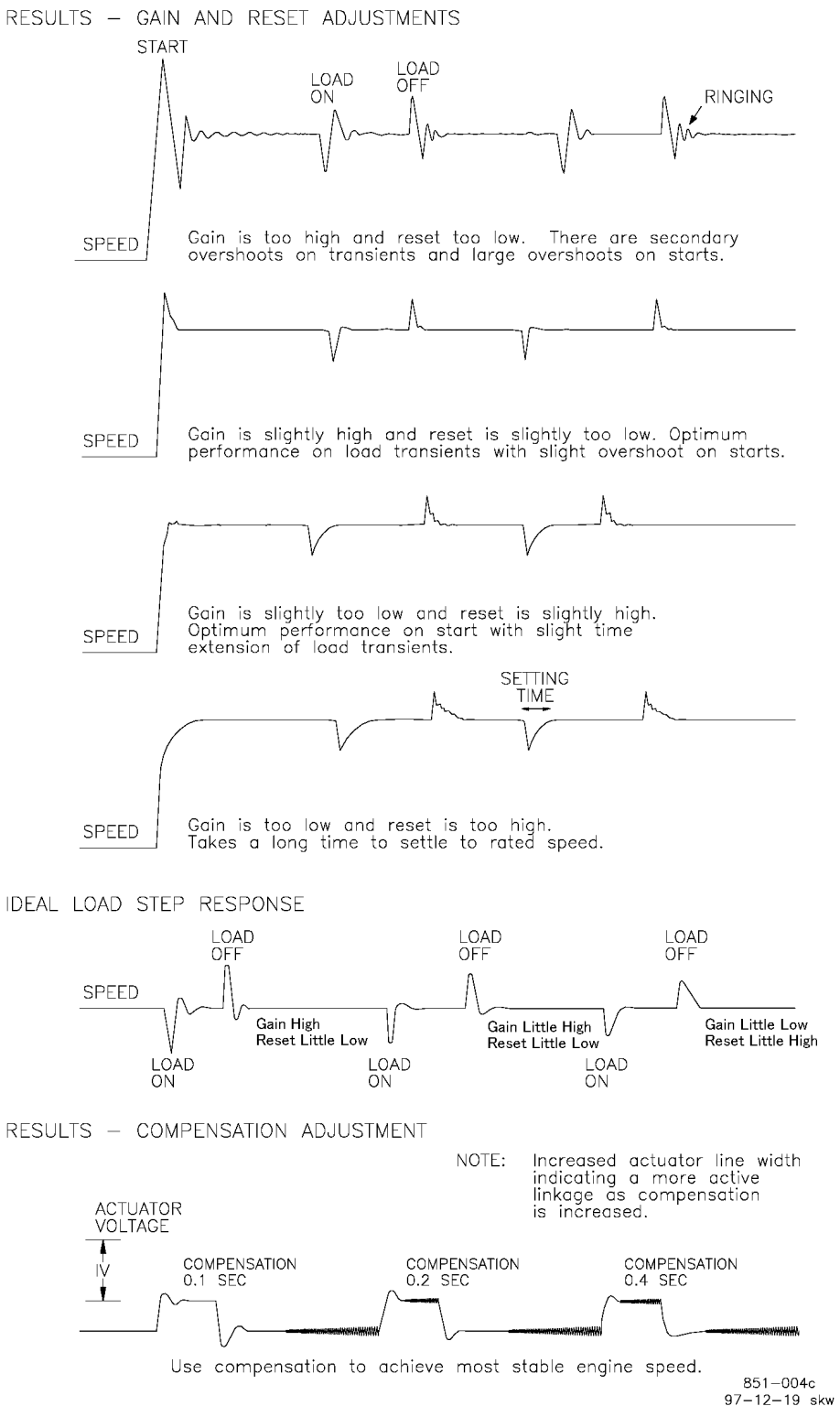


Figure 4-8. Typical Transient Response Curve

B**DYNAMICS #2**

To tune the second dynamics, it is necessary to set “USE 5 POINT GAIN MAP” (under A**ENGINE & SPEED CONTROL** header) to ‘False’, and to set “USE 2nd DYNAMICS?” below to ‘True’.

IMPORTANT

IDynamics #2** parameters 04 thru 10 have the same effect on speed control response as H**Dynamics #1** parameters 01 thru 07 described above.**

Refer to A**DYNAMICS#1** for DYNAMICS#1 and DYNAMICS#2 switch over method and how to adjust the dynamics.

The Service Menu to input and check setpoints in “Service: B**DYNAMICS #2**” menu is as follows:

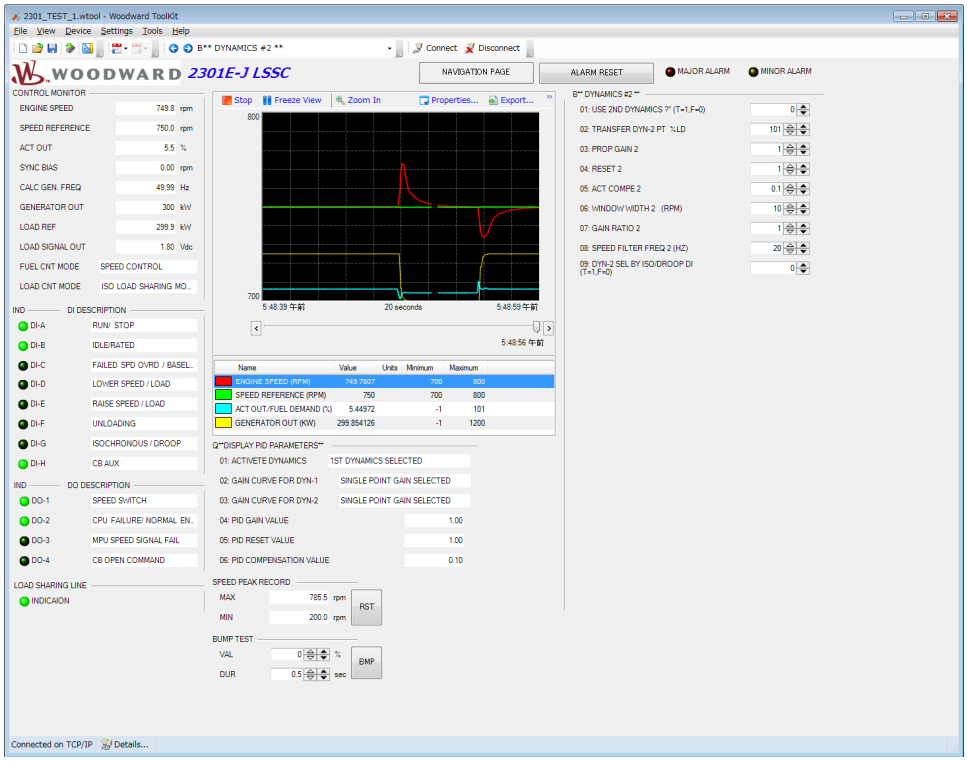


Figure 4-9. “Service: B**DYNAMICS #2**” Menu

01: USE 2ND DYNAMICS (T=1, F=0)

Set this setpoint to ‘True’ when the second set of dynamics is necessary, otherwise set to ‘False’. When this prompt is ‘False’, only Dynamics 1 will be used to set speed control response.

Note that there is not the Idle speed setpoint in Dynamics 2 menus.

02: TRANSFER DYN-2 PT %LD

Set this setpoint to the engine load to switch the control dynamics from Dynamics #1 to Dynamics #2, or vice versa. Set this setpoint in percent. Either percent actuator output or the generator load (kW) is selectable as the load level to switch the dynamics. If “5P GAIN CURVE BY ACT (%FD)” (under A**ENGINE & SPEED CONTROL** in the Configure menu) is set to ‘True’, percent actuator output is selected, otherwise the generator load is selected.

03: PROP GAIN 2

This setpoint is the same setpoint as PROP GAIN 1 in the first dynamics setpoint menus. If this setpoint is too high, control output at the rated speed is sensitive, but will begin hunting or jiggling easily.

04: RESET 2
This setpoint is the same setpoint as RESET 1 in the first setpoint menus. A too high reset value results in quick return to the reference speed and liable hunting.

05: ACT COMPE 2
This setpoint compensates for the actuator and fuel system time constant. Increasing compensation increases actuator activity and transient performance. Set this setpoint to the value small enough to obtain steady control at all the speed and load range. Too large compensation may cause hunting at an unusual operating state.

06: WINDOW WIDTH 2 (RPM)
This setpoint is the magnitude (in rpm) of speed error at which the control automatically switches to fast response. The control uses the absolute value of speed error to make this switch. The absolute value is the difference between the speed reference and the speed. A Window Width too narrow will result in cycling that always factors in the Gain Ratio.

07: GAIN RATIO 2
This setpoints is the ratio of the Gain setting at steady state to the Gain setting during transient conditions. The Gain Ratio operates in conjunction with the Window Width and Gain adjustments by multiplying the Gain set point by the Gain Ratio when the speed error is greater than the Window Width. This makes the control dynamics fast enough to minimize engine speed overshoot on start-up and to reduce the magnitude of speed error when loads are changing. This allows a lower gain at steady state for better stability and reduced steady-state actuator linkage movement. If this function is not used, set this setpoint to 1.0.

08: SPEED FILTER FREQ 2 (HZ)
This setpoint adjusts the cutoff frequency of a low pass filter used on the engine speed sensing input. The filter is used to attenuate engine firing frequencies.

09: DYN-2 SEL BY ISO/DROOP DI (T=1, F=0)
Set this setpoint to ‘TRUE’ to activate Dynamics-2 changeover using ISO/DROOP DI=G

C**DYNAMICS #1, 5 PT GAIN**
Setpoints under C**DYNAMICS #1, 5PT GAIN** are adjustable only when “USE 5 POINTS GAIN MAP” under A**ENGINE & SPEED CONTROL** header is set to ‘True’.

To adjust the gain and the reset around the Idle speed, “10: USE IDLE SPEED DYNAMICS” under A**ENGINE & SPEED CONTROL** header in Configure menus must be set to ‘True’ to enable the adjustment function.

The Breakpoint parameter is based on what is set in Configure: “5P GAIN CURVE BY ACT (%FD)”. The actuator output % (FALSE) or generator kilowatt % (TRUE) is used as the load axis. If “5P GAIN CURVE BY ACT (%FD)” is set to ‘True’, actuator output is the load axis, otherwise, generator Kilowatt is the load axis.

This function is generally used in applications that have a non-linear fuel valve (such as butterfly valves in gas engines). A plot of the fuel system must be determined to properly adjust the gain of the control to match the gain of the system at all loads.

See Tuning of Gain maps section for the detail of tuning with the 5-point curve.

Figure 4-10 shows an example of a 5-point gain curve to indicate the relationship between the curve and setpoints. Control gain interpolates between setpoints on the line connecting two setpoints.

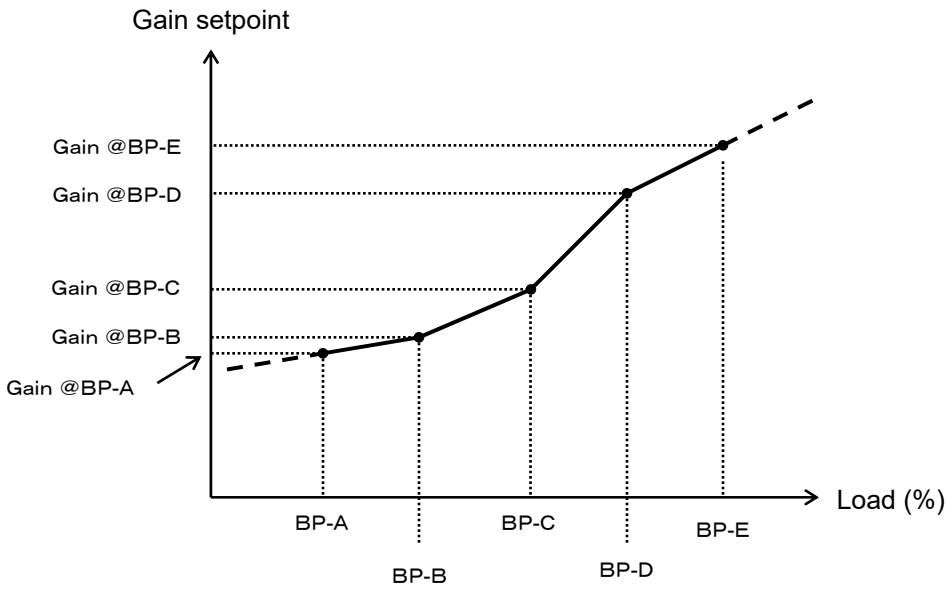


Figure 4-10. 5-Point Gain Curve

The Service Menu to input and check setpoints in “Service: C**DYNAMICS #1, 5PT GAIN**” menu is as follows.

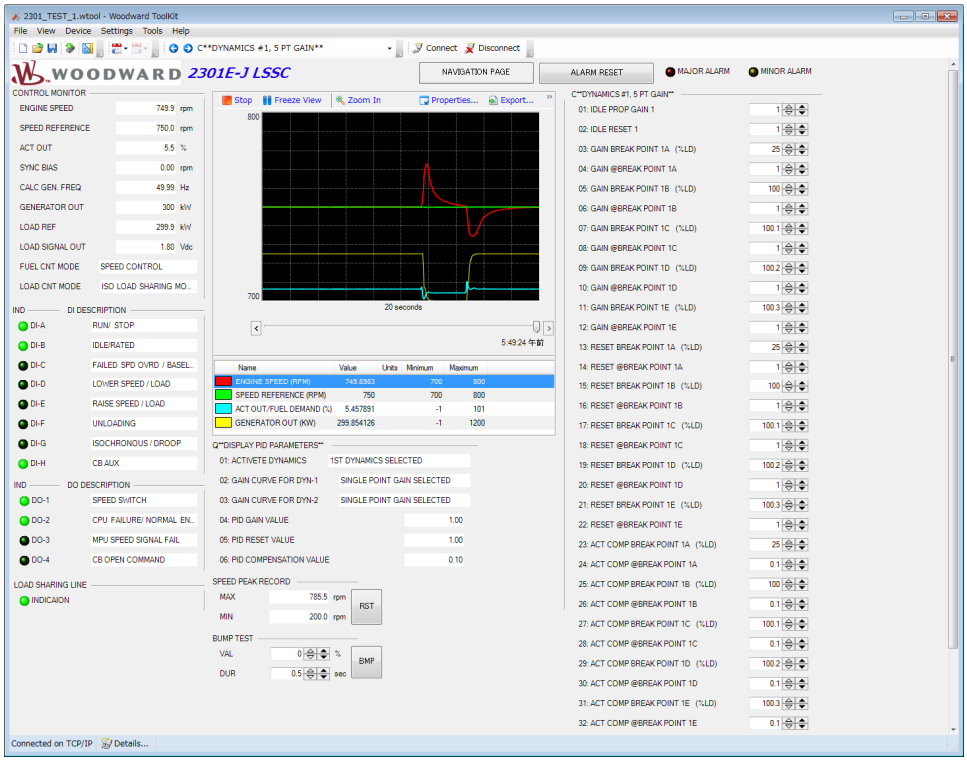


Figure 4-11. “Service: C**DYNAMICS #1, 5PT GAIN**” Menu

01: IDLE PROP GAIN 1
This setpoint determines how fast the control responds to an error in engine speed from the speed-reference setting around Idle speed. The control gain is determined referring both Idle gain and Rated gain curve (term 03 to 12 below). If this setpoint is too high, control output at the idle speed is sensitive, but will begin hunting easily.

Idle gain tuning is effective only when “USE IDLE SPEED DYNAMICS” under A**ENGINE & SPEED CONTROL** header in Configure menu is set to ‘True’, and the Idle gain is enabled due to the condition described below.

The Idle gain is selected as long as the SELECT IDLE/RATED SPEED contact switch is turned to the Idle side and switched to the rated gain when the contact switch is turned to the Rated side.

The Rated gain is switched to the Idle gain at the point when the actual engine speed passed the 2/3 distance from the rated speed to the idle speed in case the speed reference is lowered to the idle speed.

02: IDLE RESET 1
This setpoint compensates for the lag time of the engine. It adjusts the time required for the control to return the speed to zero error after a disturbance. Reset is adjusted to prevent slow hunting and to minimize speed overshoot after a load disturbance**.** Normally, set this setpoint to a value between 0.4 and 2.0.

Idle reset function is effective at the same time when Idle Prop Gain described above is effective.

03: BREAK POINT 1A (%LD)
This setpoint is set at the min load point of Break Point-A.

04: GAIN @BREAK POINT 1A
This setpoint is the GAIN value at Break Point-A (no load).

05: BREAK POINT 1B (%LD)
This setpoint is the load % at Break Point-B.

06: GAIN @BREAK POINT 1B
This setpoint is the GAIN value when the load is at Break Point-B.

07: BREAK POINT 1C (%LD)
This setpoint is the load % at Break Point-C.

08: GAIN @BREAK POINT 1C
This setpoint is the GAIN value when the load is at Break Point-C.

09: BREAK POINT 1D (%LD)
This setpoint is the load % at Break Point-D.

10: GAIN @BREAK POINT 1D
This setpoint is the GAIN value when the load is at Break Point-D.

11: BREAK POINT 1E (%LD)
This setpoint is the load % at Break Point-E.

12: GAIN @BREAK POINT 1E
This setpoint is the GAIN value when the load is at Break Point-E.

13: RESET BREAK POINT 1A (%LD)
This setpoint is the load % at Reset Break Point-A.

14: RESET @BREAK POINT 1A
This setpoint is the RESET value when the load is at Break Point-A.

15: RESET BREAK POINT 1B (%LD)
This setpoint is the load % at Reset Break Point-B.

16: RESET @BREAK POINT 1B
This setpoint is the RESET value when the load is at Break Point-B.

17: RESET BREAK POINT 1C (%LD)
This setpoint is the load % at Reset Break Point-C.

18: RESET @BREAK POINT 1C
This setpoint is the RESET value when the load is at Break Point-C.

19: RESET BREAK POINT 1D (%LD)
This setpoint is the load % at Reset Break Point-D.

20: RESET @BREAK POINT 1D
This setpoint is the RESET value when the load is at Break Point-D.

21: RESET BREAK POINT 1E (%LD)
This setpoint is the load % at Reset Break Point-E.

22: RESET @BREAK POINT 1E
This setpoint is the RESET value when the load is at Break Point-E.

23: ACT COMP BREAK POINT 1A (%LD)
This setpoint is the load % at Compensation Break Point-A.

24: ACT COMP @BREAK POINT 1A
This setpoint (sp) is the COMPENSATION value when the load is at Break Point-A.

25: ACT COMP BREAK POINT 1B (%LD)
This setpoint is the load % at Compensation Break Point-B.

26: ACT COMP @BREAK POINT 1B
This setpoint is the COMPENSATION value when the load is at Break Point-B.

27: ACT COMP POINT 1C (%LD)
This setpoint is the load % at Compensation Break Point-C.

28: ACT COMP @BREAK POINT 1C
This setpoint is the COMPENSATION value when the load is at Break Point-C.

29: ACT COMP BREAK POINT 1D (%LD)
This setpoint is the load % at Compensation Break Point-D.

30: ACT COMP @BREAK POINT 1D
This setpoint is the COMPENSATION value when the load is at Break Point-D.

31: ACT COMP BREAK POINT 1E (%LD)
This setpoint is the load % at Compensation Break Point-E.

32: ACT COMP @BREAK POINT 1E
This setpoint is the COMPENSATION value when the load is at Break Point-E.

33: WINDOW WIDTH 1 (RPM)
This setpoint is the magnitude (in rpm) of speed error at which the control automatically switches to fast response. The control uses the absolute value of speed error to make this switch. The absolute value is the difference between the speed reference and the engine speed. A Window Width too narrow will result in cycling that always factors in the Gain Ratio.

34: GAIN RATIO 1
This setpoint is the ratio of the Gain setting at steady state to the Gain setting during transient conditions. The Gain Ratio operates in conjunction with the Window Width and Gain adjustments by multiplying the Gain set point by the Gain Ratio when the speed error is greater than the Window Width. This makes the control dynamics fast enough to minimize engine speed overshoot on start-up and to reduce the magnitude of speed error when loads are changing. This allows a lower gain at steady state for better stability and reduced steady- state actuator linkage movement. If this function is not necessary, set this setpoint to 1.0.

35: SPEED FILTER FREQ 1 (HZ)
This setpoint adjusts the cutoff frequency of a low pass filter used on the engine speed sensing input. The filter is used to attenuate engine firing frequencies. To use this feature set the cutoff frequency below 15.9 Hz.

Initially set the filter cut-off frequency to the firing frequency.

To calculate the firing frequency, use the following formulas:
Firing frequency = camshaft speed / 60 (sec) x number of cylinders
Camshaft speed (rpm) = (engine rpm) / 2 [for 4-cycle engines]
Camshaft speed (rpm) = (engine rpm) [for 2-cycle engines]

As the filter frequency is reduced, steady state stability improves but transient performance may worsen. As the filter frequency is increased, steady state stability worsens but transient performance may improve.

IMPORTANT

If the calculated firing frequency is greater than 15.9 Hz, then disable the filter by setting the filter cutoff frequency at 20.0 Hz.

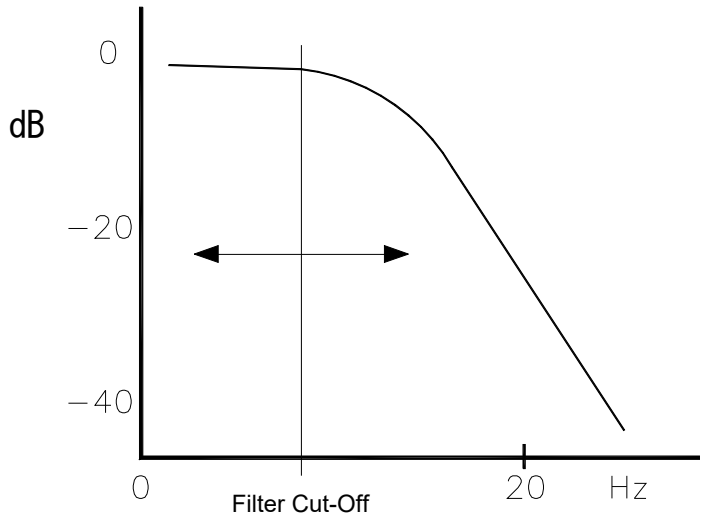


Figure 4-12. Speed Filter

NOTICE

Optimum performance is not necessarily obtained with the GAIN set to maximum (within the stable operation range). In some cases, the gain must be reduced slightly to ensure stability under widely varying conditions

D**DYNAMICS #2, 5 PT GAIN**

To tune the gain curve of the second dynamics, it is necessary to set “USE 5 POINTS GAIN MAP” (under A**ENGINE & SPEED CONTROL** header) to ‘True’, and to set “USE 2nd 5PT DYNAMICS?” below to ‘True’.

Refer to A**DYNAMICS#1** for DYNAMICS#1 and DYNAMICS#2 switch over method and how to adjust the dynamics.

The Dynamics 2 control parameters are adjusted in the same way as the gain curve of Dynamics 1 described above.

The Service Menu to input and check setpoints in “Service: D**DYNAMICS #2, 5 PT GAIN**” menu is as follows.

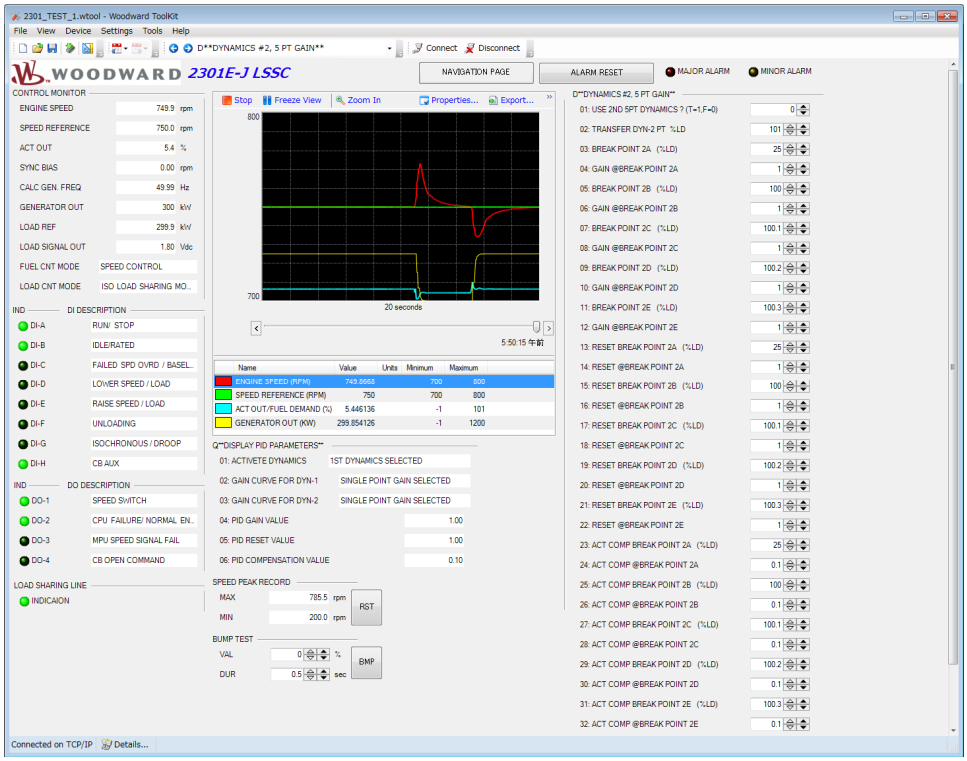


Figure 4-13. Service: D**DYNAMICS #2, 5 PT GAIN**” Menu

01: USE 2ND 5PT DYNAMICS ?
Set this setpoint to ‘True’ when the second set of dynamics is necessary, otherwise set to ‘False’. When this prompt is ‘False’, only Dynamics 1 will be used to set speed control response.

Note: There is not the Idle speed setpoint in Dynamics 2 setpoint menus.

02: TRANSFER DYN-2 PT %LD
Set this setpoint to the load level to switch the control dynamics from Dynamics #1 to Dynamics #2, or vice versa, in percent. Either percent actuator output or the generator kW load is selectable as the load axis. If “5P GAIN CURVE BY ACT (%FD)” (under A**ENGINE & SPEED CONTROL** in the Configure menu) is set to ‘True’, percent actuator output is selected, otherwise the generator kW load is selected.

03: BREAK POINT 2A (%LD)
This setpoint is set at the min load point of Break Point-A.

04: GAIN @BREAK POINT 2A
This setpoint is the GAIN value at Break Point-A.

05: BREAK POINT 2B (%LD)
This setpoint is the load % at Break Point-B.

06: GAIN @BREAK POINT 2B
This setpoint is the GAIN value when the load is at Break Point-B.

07: BREAK POINT 2C (%LD)
This setpoint is the load % at Break Point-C.

08: GAIN @BREAK POINT 2C
This setpoint is the GAIN value when the load is at Break Point-C.

09: BREAK POINT 2D (%LD)
This setpoint is the load % at Break Point-D.

10: GAIN @BREAK POINT 2D
This setpoint is the GAIN value when the load is at Break Point-D.

11: BREAK POINT 2E (%LD)
This setpoint is the load % at Break Point-E.

12: GAIN @BREAK POINT 2E
This setpoint is the GAIN value when the load is at Break Point-E.

13: RESET BREAK POINT 2A (%LD)
This setpoint is the load % at Reset Break Point-A.

14: RESET @BREAK POINT 2A
This setpoint is the RESET value when the load is at Break Point-A.

15: RESET BREAK POINT 2B (%LD)
This setpoint is the load % at Reset Break Point-B.

16: RESET @BREAK POINT 2B
This setpoint is the RESET value when the load is at Break Point-B.

17: RESET BREAK POINT 2C (%LD)
This setpoint is the load % at Reset Break Point-C.

18: RESET @BREAK POINT 2C
This setpoint is the RESET value when the load is at Break Point-C.

19: RESET BREAK POINT 2D (%LD)
This setpoint is the load % at Reset Break Point-D.

20: RESET @BREAK POINT 2D
This setpoint is the RESET value when the load is at Break Point-D.

21: RESET BREAK POINT 2E (%LD)
This setpoint is the load % at Reset Break Point-E.

22: RESET @BREAK POINT 2E
This setpoint is the RESET value when the load is at Break Point-E.

23: ACT COMP BREAK POINT 2A (%LD)
This setpoint is the load % at Compensation Break Point-A.

24: ACT COMP @BREAK POINT 2A
This setpoint is the COMPENSATION value when the load is at Break Point-A.

25: ACT COMP BREAK POINT 2B (%LD)
This setpoint is the load % at Compensation Break Point-B.

26: ACT COMP @BREAK POINT 2B
This setpoint is the COMPENSATION value when the load is at Break Point-B.

27: ACT COMP POINT 2C (%LD)
This setpoint is the load % at Compensation Break Point-C.

28: ACT COMP @BREAK POINT 2C
This setpoint is the COMPENSATION value when the load is at Break Point-C.

29: ACT COMP BREAK POINT 2D (%LD)
This setpoint is the load % at Compensation Break Point-D.

30: ACT COMP @BREAK POINT 2D
This setpoint is the COMPENSATION value when the load is at Break Point-D.

31: ACT COMP BREAK POINT 2E (%LD)
This setpoint is the load % at Compensation Break Point-E.

32: ACT COMP @BREAK POINT 2E
This setpoint is the COMPENSATION value when the load is at Break Point-E.

33: WINDOW WIDTH 2 (RPM)
This setpoint is the magnitude (in rpm) of speed error at which the control automatically switches to fast response. The control uses the absolute value of speed error to make this switch. The absolute value is the difference between the speed reference and the engine speed. A Window Width too narrow will result in cycling that always factors in the Gain Ratio.

34 : GAIN RATIO 2
This setpoint is the ratio of the Gain setting at steady state to the Gain setting during transient conditions. The Gain Ratio operates in conjunction with the Window Width and Gain adjustments by multiplying the Gain setpoint by the Gain Ratio when the speed error is greater than the Window Width. This makes the control dynamics fast enough to minimize engine speed overshoot on start-up and to reduce the magnitude of speed error when loads are changing. This allows a lower gain at steady state for better stability and reduced steady-state actuator linkage movement. If this function is not used, set this setpoint to 1.0.

35: SPEED FILTER FREQ 2 (HZ)
This setpoint adjusts the cutoff frequency of a low pass filter used on the engine speed sensing input. The filter is used to attenuate engine firing frequencies.

Tuning of Gain Maps
A butterfly valve is often used to control fuel in gas engines. The most adaptive gain of the control will vary following to the valve angle because the relationship between the valve angle and the engine load is non-linear.

In a gas engine with a butterfly valve to control fuel, a large capacity from the valve to cylinders causes a longer lag-time in the control system, and this results in an obstacle to stable engine operation.

The 5-point gain map is used for these engines in order to get most adaptive control gains at all the engine operating range by changing the gain smoothly following to the load.

Diesel engines will be operated with single gain and dual dynamics without any problem, but there is no problem using 5-point gain map if necessary.

The gain tuning procedures are as follows:

1. Set the load expected at the no-load operation to Break point A (%LD). Set 0 to this setpoint when the generator kW is used for the load axis of 5 point gain map.
    - The load level is displayed at the setpoint ACT OUT/FUEL DEMAND (%) or GENERATOR OUT (KW) in Display Menu.
    - Read the GENERATOR OUT (KW) display value if the generator kW is used for the load axis of 5 point gain map, otherwise read the ACT OUT/FUEL DEMAND (%).
2. Set Break Point B, C, D and E to 100%.
3. Start the engine and operate at the rated speed with no load. Tune the values of Gain @ Break Point A, Reset and Compensation(ACT COMPE) for the stable engine operation.
4. Set the value of Gain @ Break Point A to Gain @ Break Point B.
5. Raise the engine load gradually until the level where the engine dynamics is unsatisfactory (i.e. too sensitive or too dull).
6. Set the load level to Break Point B when the engine dynamics is unsatisfactory.
7. Tune Gain @ Break Point B to return the engine dynamics satisfactory again. Tune Reset and Compensation more accurately if necessary. In case Reset and Compensation are necessary to change largely, retune Reset and Compensation again, then restart this procedure from the beginning at no load.
8. Set the value of Gain @ Break Point B to Gain @ Break Point C if the engine could be operated stably without a large Reset or Compensation change.
9. Raise the engine load gradually until the level where the engine dynamics is unsatisfactory (i.e. too sensitive or too dull).
10. Set the load level to Break Point C where the engine dynamics is unsatisfactory.
11. Tune Gain @ Break Point C to return the engine dynamics satisfactory again. Tune Reset and Compensation more accurately if necessary.
12. In case Reset or Compensation is necessary to change largely at the step above, use the dynamics 2 as described at step 24 and later.
13. Set the value of Gain @ Break Point C to Gain @ Break Point D if the engine could be operated stably without a large Reset or Compensation change at step 11.
14. Raise the engine load gradually until the level where the engine dynamics is unsatisfactory (i.e. too sensitive or too dull).
15. Set the load level to Break Point D where the engine dynamics is unsatisfactory.
16. Tune Gain @ Break Point D to return the engine dynamics satisfactory again. Tune Reset and Compensation more accurately if necessary.
17. In case Reset or Compensation is necessary to change largely at the step above, use the dynamics 2 as described at step 24 and later.
18. Set the value of Gain @ Break Point D to Gain @ Break Point E if the engine could be operated stably without a large Reset or Compensation change at step 16.
19. Raise the engine load gradually until the level where the engine dynamics is unsatisfactory (i.e. too sensitive or too dull).

20. Set the load level to Break Point E where the engine dynamics is unsatisfactory.

21. Tune Gain @ Break Point E to return the engine dynamics satisfactory again. Tune Reset and Compensation finely if necessary.

22. In case Reset or Compensation is necessary to change largely at the step above, use the dynamics 2 as described at step 24 and later.

23. The engine could not be operated stably unless either Reset or Compensation is not changed largely at step 12, 17 or 21 above; set appropriate setpoints to Reset and Compensation in Dynamics 2 and use them.

24. If the control dynamics is switched from Dynamics 1 to Dynamics 2 in the engine operation, set appropriate values to following setpoints in Dynamics 2.

25. Set Break Point A and Gain @ Breakpoint A in Dynamics 2 to the breakpoint value and the gain value at the step of the Dynamics 1 where is before a large Reset or Compensation change is made. Then, set Break Point B and Gain @ Breakpoint B in Dynamics 2 to next setpoints in Dynamics 1.
    - Set TRANSFER DYN-2 PT (%LD) to the medium load level of Break Point A and Break Point B in D**DYNAMICS #2, 5 PT GAIN**.
    - Set RESET 2 and ACT COMPE 2 in D**DYNAMICS #2, 5 PT GAIN** to the reset value and the compensation value which were changed in the engine operation using Dynamics 1.

26. Set “USE 2nd 5 PT DYNAMICS?” in DYNAMICS #2, 5 PT GAIN menus to ‘True’ before using the 2nd dynamics. The control dynamics will be switched from Dynamics 1 to Dynamics 2 when the load level exceeded the medium level of Break Point A and Break Point B in “DYNAMICS #2, 5 PT GAIN” if these setpoints were set correctly as described above.

27. Break Point B to E and Gains at those break points are tuned similarly to those in Dynamics 1.

28. It is not indispensable to set all gain setpoints and break point setpoints in “DYNAMICS #1, 5 PT GAIN” menus and “DYNAMICS #2, 5 PT GAIN” menus. For instance, it is not necessary to set values to Break Point D and E if the engine could be operated stably by the setpoints of Break Point A to C.

E**START/MAX LIM SETTINGS**

Start Fuel Limit is a limit that is in place while the engine is starting. This limit helps reduce smoke and prevents overshoot during an engine start.

Max Fuel Limit sets the maximum percent actuator output at all the engine speeds and loads. Therefore, fuel supplied to the engine is always less than or equal to the fuel which corresponds to the Max Fuel Limit in any condition.

Figure 4-14 illustrates the Start Fuel Limit function.

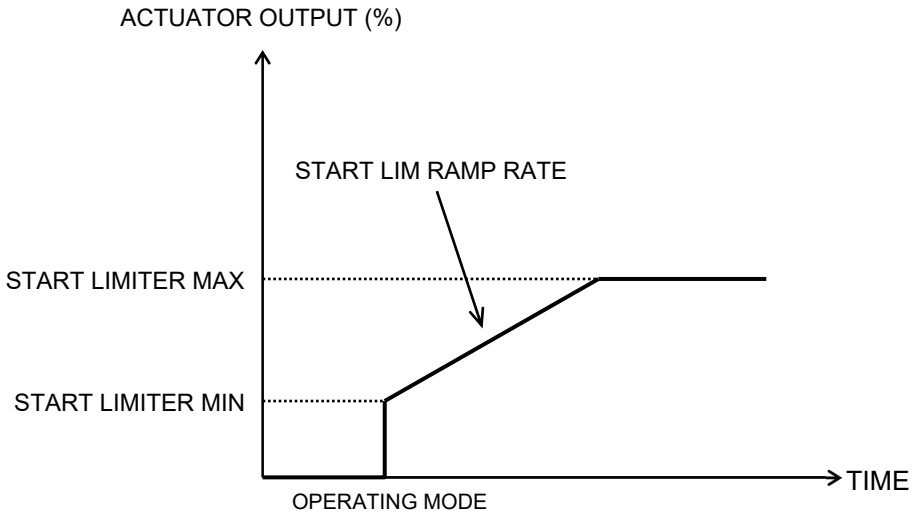


Figure 4-14. Start Fuel Limit

The Service Menu to input and check setpoints in “Service: E**START/MAX LIM SETTINGS**” menu is as follows.

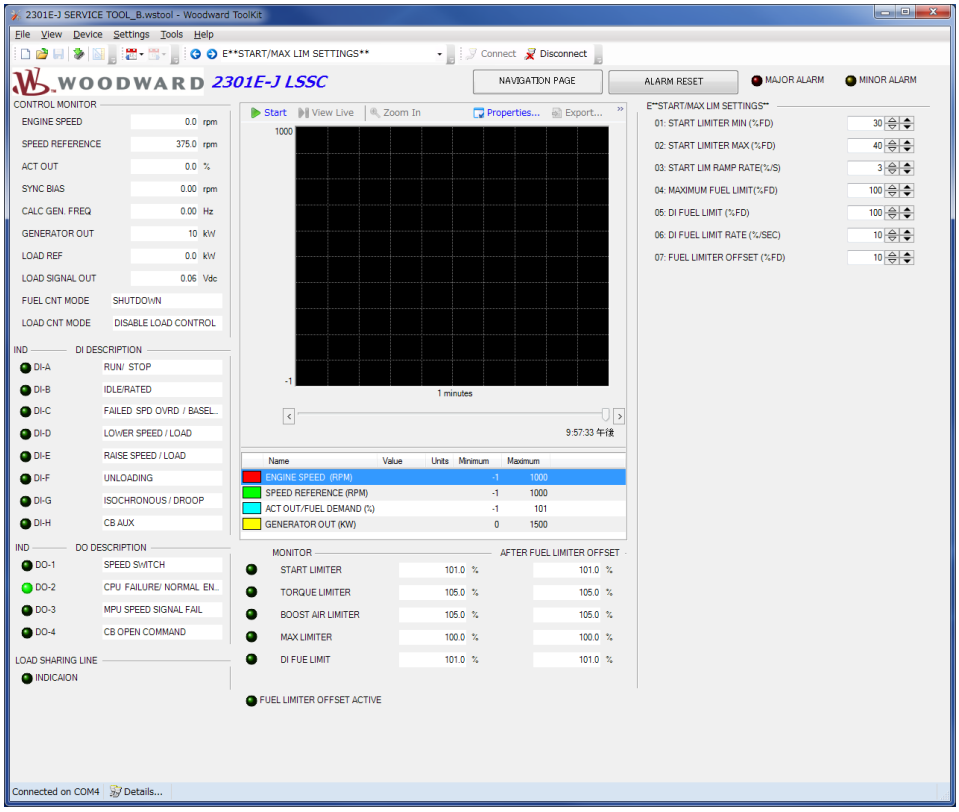


Figure 4-15. “Service: E**START/MAX LIM SETTINGS**” Menu

01: START LIMITER MIN (%FD)
This is the minimum fuel limit setting during the Start Fuel Limit function is enable. Set this setpoint in percent actuator output. The actuator is positioned to this setpoint level instantly when the start command is given to the 2301E-J.

02: START LIMITER MAX (%FD)
This is the maximum fuel limit setting during the Start Fuel Function is enable. The start fuel limit will ramp from Start Limiter Min to this setpoint after the engine start command is given, and will be held to this setpoint after it has reached this setpoint.

03: START LIM RAMP RATE (%/S)
This is the fuel limit ramp rate (per second) from START LIMITER MIN to START LIMITER MAX.

04: MAXIMUM FUEL LIMIT (%FD)
This is the maximum percent actuator output, set in percent actuator output. Fuel supply to the engine cannot exceed the level specified at this setpoint in any condition.

05: DI FUEL LIMIT (%FD)
This is fuel limiter percentage when DI FUEL LIMIT is activated by discrete input selected in Configure menu B** INPUT & OUTPUT OPTIONS**" item "20: DI-B INPUT USED FOR (1-6)" or "22: DI-C INPUT USED FOR (1-6)"

When DI FUEL LIMIT is activated, fuel limiter will transfer from MAX FUEL LIMIT to DI FUEL LIMIT by rate set in below parameter

06: DI FUEL LIMIT RATE (%/sec)
This is transfer rate (MAX FUEL LIMIT -> DI FUEL LIMIT when DI FUEL LIMIT is activated.

07: DI FUEL LIMITER OFFSET (%FD)
This is offset value for all fuel limiter (Start Limiter, Torque Limiter, Boost Limiter, Max Limiter) when DI FUEL LIMITER OFFSET is activated by discrete input selected in Configure menu B** INPUT & OUTPUT OPTIONS**" item "20: DI-B INPUT USED FOR (1-6)" or "22: DI-C INPUT USED FOR (1-6)".

F**TORQUE LIMITER SETTING**

Torque Limiter is usually used to prevent an engine overload by limiting fuel supply as a function of the engine speed. However, this function is unnecessary for a 2301E-J because it is designed for engine-generator control to operate in an isochronous speed at any generator load. The alternative usage for Torque Limiter of 2301E-J is to improve the exhaust gas quality at an engine start and in engine acceleration to the rated speed.

The Torque Limiter function is enabled when "USE TORQUE FUEL LIMITER?" is set to 'True' under C**OPTIONAL FUNCTIONS** header in Configure mode. Either the actual speed or the speed reference can be used as the input parameter to this function. If "TQ LIM IN = ENGINE SPD?" under C**OPTIONAL FUNCTIONS** header in Configure mode is set to 'True', the actual speed is used as the input parameter for the torque fuel limiter curve, otherwise, the speed reference is used.

Figure 4-16 shows the relationship between Torque Limiter setpoints on the "Limiter curve". Calculate the fuel limit below P1 on the extension of P1-P2 line. Also, calculate the fuel limit above P5 on the extension of P4-P5 line.

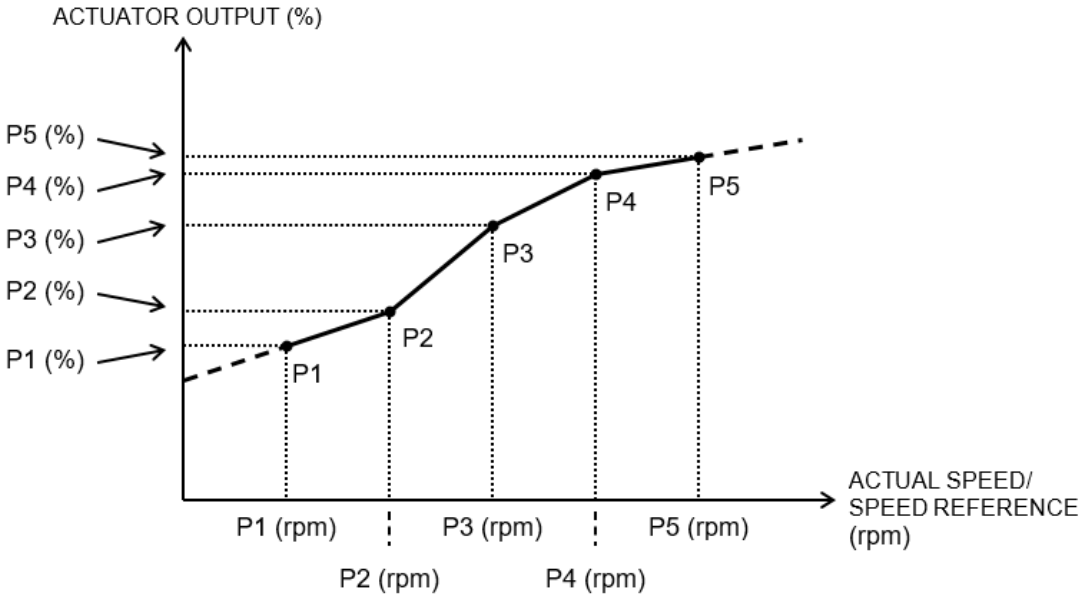


Figure 4-16. Torque Limit Curve

The Service Menu to input and check setpoints in “Service: F**TORQUE LIMITER SETTINGS**” menu is as follows.

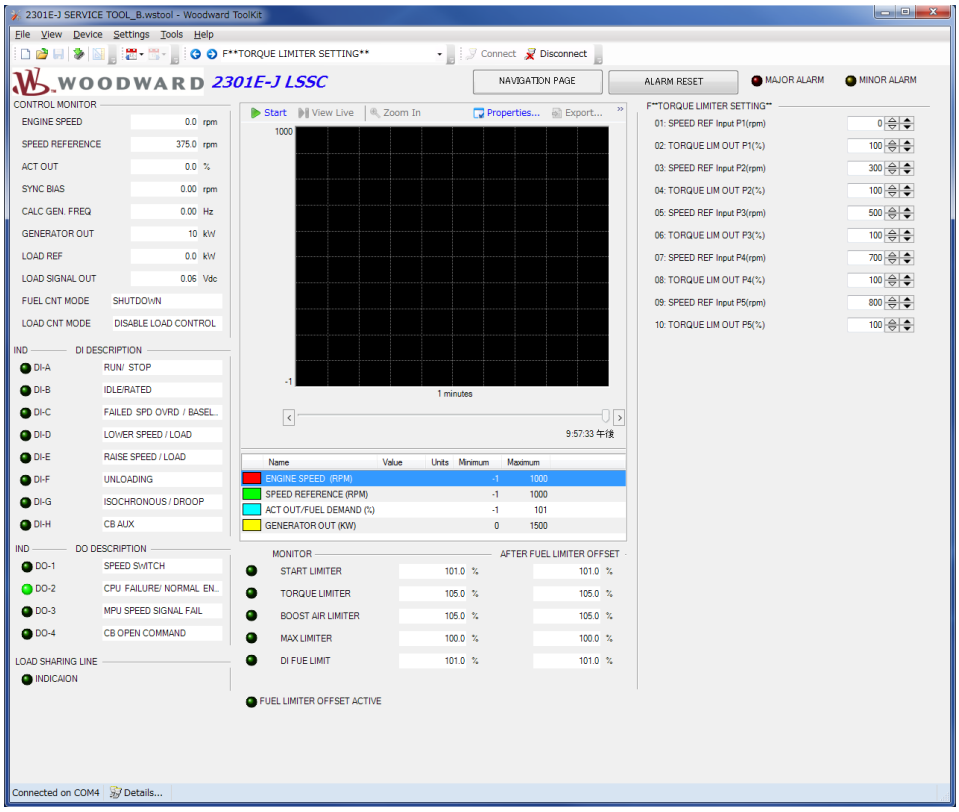


Figure 4-17. “Service: F**TORQUE LIMITER SETTINGS**” Menu

01: Speed/Ref Input P1 (rpm)
Set this setpoint to the engine speed or the speed reference for the break point P1 on the Torque Limiter curve.

02: Torque LimiterOut P1 (%)
Set this setpoint to the fuel limit value for the break point P1 in percent actuator output.

03: Speed/Ref Input P2 (rpm)
Set this setpoint to the engine speed or the speed reference for the break point P2 on the Torque Limiter curve.

04: Torque LimiterOut P2 (%)
Set this setpoint to the fuel limit value for the break point P2 in percent actuator output.

05: Speed/Ref Input P3 (rpm)
Set this setpoint to the engine speed or the speed reference for the break point P3 on the Torque Limiter curve.

06: Torque LimiterOut P3 (%)
Set this setpoint to the fuel limit value for the break point P3 in percent actuator output.

07: Speed/Ref Input P4 (rpm)
Set this setpoint to the engine speed or the speed reference for the break point P4 on the Torque Limiter curve.

08: Torque LimiterOut P4 (%)
Set this setpoint to the fuel limit value for the break point P4 in percent actuator output.

09: Speed/Ref Input P5 (rpm)
Set this setpoint to the engine speed or the speed reference for the break point P5 on the Torque Limiter curve.

10: Torque LimiterOut P5 (%)
Set this setpoint to the fuel limit value for the break point P5 in percent actuator output.

G**BOOST A/P LMTR SETTING**

The Boost Air Pressure Limit is used to prevent over fuel to the engine by limiting fuel supply basing on the turbo-boost air pressure. This function is useful to prevent smoking caused by a quick load increase while operating an engine with a load. Note that generator frequency will be lowered if fuel supply is limited excessively by the Boost Air Pressure Limit function.

The Boost Air Pressure Limit function is enabled if ‘5’(Boost Air pressure Sig) is selected at “ANA-IN2 USED FOR (1-5)” setpoint under B**INPUT & OUTPUT OPTIONS** header in Configure menu.

The control needs the Boost air pressure signal as an input signal to use the Boost Air Pressure Limit function. 4-20 mA, 0-5 Vdc, ±2.5 V or 1-5 Vdc signal can be used as the input signal. The type of the input signal is selected at “ANA-IN2 INPUT TYPE (1-4)” under B**INPUT & OUTPUT OPTIONS** header in Configure menus. The relationship between the number and the type of the signal is as follows.

1. 4-20 mA
2. 0-5 V
3. ±2.5 V
4. 1-5 V

Figure 4-18 shows the relationship between Boost Air Pressure Limit setpoints on the “Limiter curve”. Calculate the fuel limit below P1 on the extension of P1-P2 line. Also, calculate the fuel limit above P5 on the extension of P4-P5 line.

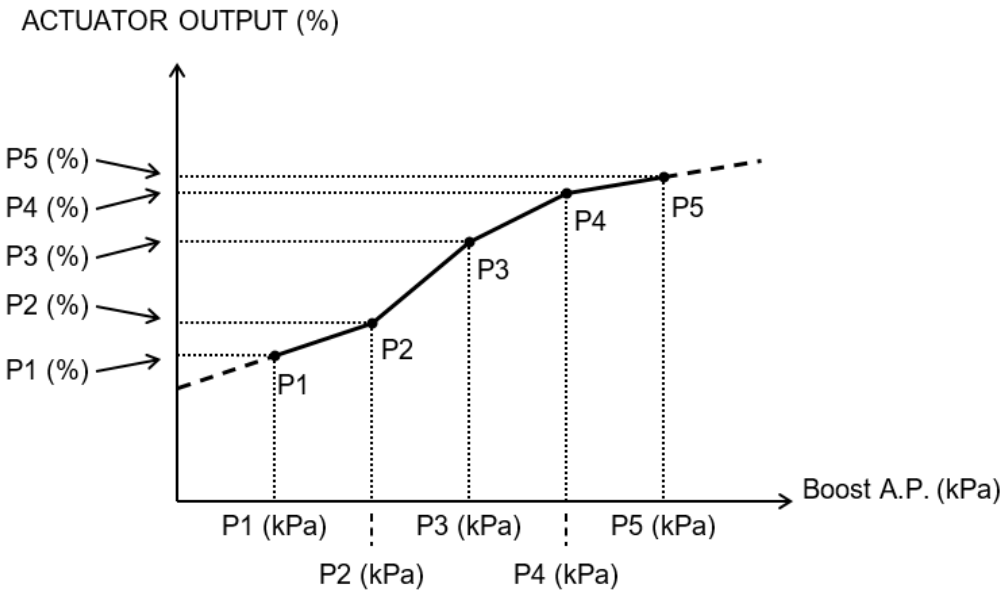


Figure 4-18. Boost Air Pressure Fuel Limiter Curve

The Service Menu to input and check setpoints in “Service: G**BOOST A/P LMTR SETTING **” menu is as follows.

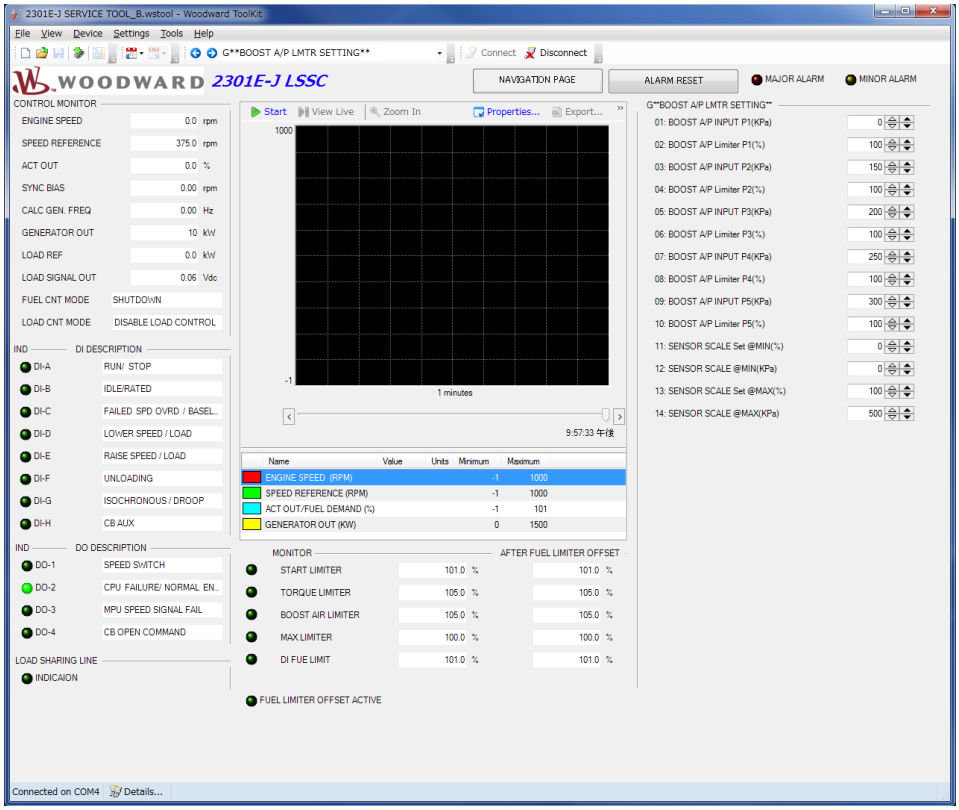


Figure 4-19. “Service: G**BOOST A/P LMTR SETTING **” Menu

01: Boost A/P Input P1 (kPa)
Set this setpoint to the turbo-boost air pressure for the break point P1 on the Boost Air Pressure Limiter curve in kilopascals.

02: Boost A/P Limiter P1 (%)
Set this setpoint to the fuel limit value for the break point P1 in percent actuator output.

03: Boost A/P Input P2 (kPa)
Set this setpoint to the turbo-boost air pressure for the break point P2 on the Boost Air Pressure Limiter curve in kilopascals.

04: Boost A/P Limiter P2 (%)
Set this setpoint to the fuel limit value for the break point P2 in percent actuator output.

05: Boost A/P Input P3 (kPa)
Set this setpoint to the turbo-boost air pressure for the break point P3 on the Boost Air Pressure Limiter curve in kilopascals.

06: Boost A/P Limiter P3 (%)
Set this setpoint to the fuel limit value for the break point P3 in percent actuator output.

07: Boost A/P Input P4 (kPa)
Set this setpoint to the boost air pressure for the break point P4 on the Boost Air Pressure Limiter curve in kilopascals.

08: Boost A/P Limiter (%)
Set this setpoint to the fuel limit value for the break point P4 in percent actuator output.

09: Boost A/P Input P5 (kPa)
Set this setpoint to the boost air pressure for the break point P5 on the Boost Air Pressure Limiter curve in kilopascals.

10: Boost A/P Limiter P5 (%)
Set this setpoint to the fuel limit value for the break point P5 in percent actuator output.

11: Sensor Scale Set @MIN (%)
Set the Boost Air Pressure signal level which corresponds to the boost air pressure set at the next setpoint in percent. The relationship between the input signal levels and the setpoints by each signal type is as follows.

4-20 mA signal:	4 mA=0%, 20 mA=100%
1-5 V signal:	1 V=0%, 5 V=100%
0-5 V signal:	0 V=0%, 5 V=100%

12: Sensor Scale @MIN (kPa)
Set this setpoint to the minimum boost air pressure in kilopascals.

13: Sensor Scale Set @MAX (%)
Set the Boost Air Pressure signal level which corresponds to the boost air pressure set at the next setpoint in percent.

14: Sensor Scale @MAX (kPa)
Set this setpoint to the maximum boost air pressure in kilopascals.

H**SPEED CNTRL SETTINGS**

Parameters that affect the speed reference are set in this section.

The Service Menu to input and check setpoints in “Service: H**SPEED CNTRL SETTINGS**” menu is as follows.

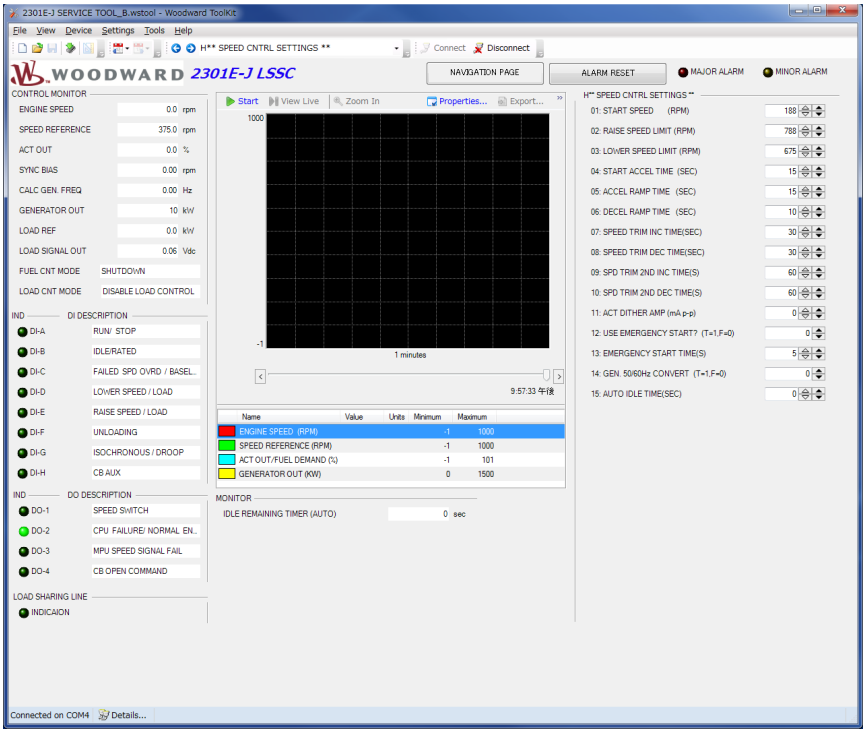


Figure 4-20. “Service: H**SPEED CNTRL SETTINGS**” Menu

01: START SPEED (RPM)

This is the Start speed setpoint referred by the start speed function at an engine start.
The start speed function is enabled when “USE START SPEED” under A**ENGINE & SPEED CONTROL** header is set to ‘True’.

Set this setpoint to the engine speed where the engine can start normally after cranking.

The start speed function sets the speed reference to the Start speed, which is below the idle speed, just after each engine start, then ramp the speed reference from the Start speed to the idle speed in order to prevent the speed overshoot and smoking. The speed ramp rate from the Start speed to the idle speed can be set at START ACCEL TIME (SEC) below.

02: RAISE SPEED LIMIT (RPM)

This is the maximum speed reference setting when the Raise Switch is closed. Set this setpoint to the value 105% of the rated speed in case of an ordinary engine. However, when Droop Percent is set to 5% or more, set the value which is the rated speed plus the speed droop at the full load.

If the speed lower than the rated speed is set here, the rated speed is the ｓ maximum speed reference.

03: LOWER SPEED LIMIT (RPM)

This is the minimum speed reference setting when the Lower Switch is closed. Set this setpoint to the value 90-95% of the rated speed in case of an ordinary engine.

If the speed higher than the rated speed is set here, the rated speed is the minimum speed reference.

04: START ACCEL TIME (SEC)
This is the ramp time to raise the speed setpoint from Start Speed to Idle Speed at each engine start when Start Speed setpoint is used.

Set the time to ramp the speed reference from Start Speed to Idle Speed in seconds.

This setpoint is enabled only when “USE START SPEED” under A**ENGINE & SPEED CONTROL** header is set to ‘True’.

05: ACCEL RAMP TIME (SEC)
This is the time (in seconds) required for the control to ramp the engine speed from Idle speed to Rated speed. The ramp is started whenever the Idle/Rated contact is closed.

06: DECEL RAMP TIME (SEC)
This is the time (in seconds) required for the control to ramp the engine speed from Rated speed to Idle speed. The ramp is started whenever the Idle/Rated contact is open.

IMPORTANT

Actual engine deceleration may be slower than set by the Decel Ramp Time setpoint. This occurs when the Decel Ramp Time setpoint is faster than the amount of time that system inertias allow the engine to slow down. This condition is indicated by the control actuator output going to the minimum fuel position.

07: SPEED TRIM INC TIME (SEC)
This is the time (in second) for the speed reference to ramp from the LOWER SPEED LIMIT to the RAISE SPEED LIMIT when the Raise Speed switch is closed.

08: SPEED TRIM DEC TIME (SEC)
This is the time (in seconds) for the speed reference to ramp from the RAISE SPEED LIMIT to the LOWER SPEED LIMIT when the Lower Speed switch is closed.

09: SPD TRIM 2ND INC TIME (S)
This is the time (in seconds) for the speed reference to ramp from the LOWER SPEED LIMIT to the RAISE SPEED LIMIT by closing the Raise Speed switch.

This function is enabled when “USE 2nd RAMP TIME (DI&RMT)” under A**ENGINE & SPEED CONTROL** header in Configure menus is set to ‘True’ and the generator breaker (auxiliary) contact is closed.

This second raise rate, calculated here, is designed to be used when the engine generator set is paralleling with the mains in the droop mode.

10: SPD TRIM 2ND DEC TIME (S)
This is the time (in seconds) for the speed reference to ramp from the RAISE SPEED LIMIT to the LOWER SPEED LIMIT by closing the Lower Speed switch.

This function is enabled when “USE 2nd RAMP TIME (DI&RMT)” under A**ENGINE & SPEED CONTROL** header in Configure menus is set to ‘True’ and the generator breaker (auxiliary) contact is closed.

This second lower rate, calculated here, is designed to be used when the engine generator set is paralleling with the mains in the droop mode.

11: ACT DITHER AMP (mA p-p)
This is the amplitude of the dither signal to the actuator output channel. Set the peak- to-peak voltage of the dither at this setpoint.

The dither function is enabled when the actuator output signal is set to '0-180 mA (forward acting)' or '180-0 mA (reverse acting)'. Set 0 to this setpoint in case the dither function is not used.

This function is useful when Woodward UG type, PGA-EG type, PGG-EG type, PG-EG type or PG type actuator is connected.

12: USE EMERGENCY START
This setting is set when the engine's generator is used for Emergency Generator. When the setting is set 'TRUE', speed reference will ramp directly to rated speed if "RUN" contact closed at same time with "IDLE/RATED" contact (or "IDLE/RATED" contact already close before close "RUN" contact). With this, the engine will start quickly for Emergency Generator

For normal engine start, close "IDLE/RATED" contact after engine speed reached idle speed. Engine speed will ramp from idle speed to rated speed as normal operation.

When DI-B contact is assigned to other than IDLE/RATED, engine will always start in EMERGENCY START when the setting is set 'TRUE'. Time duration to reach rated speed can be set at 15:AUTO IDLE TIME(SEC)

13: EMERGENCY START TIME(S)
This is time (in seconds) for speed reference to ramp to rated speed in EMERGENCY START.

14: GEN 50/60Hz CONVERT
This setting is to convert 50/60Hz using service tool. When the setting is set 'TRUE', 50Hz settings will convert to 60Hz or 60Hz setting will convert to 50Hz.

NOTE: Change the setting only when engine is in stop condition. Beware: If the setting is changed while engine is in operation, frequency settings will change automatically.

This function is only available when Configuration Menu "A**ENGINE & SPEED CONTROL**" item "14: GEN 50/60HzCONVT ENABLE" is set 'TRUE'

15: AUTO IDLE TIME (SEC)
This is time (in seconds) for speed reference stay at IDLE speed before automatically ramp to RATED speed in AUTO IDLE MODE.

AUTO IDLE MODE is active when DI-B contact is set to other than IDLE/RATED and "12:USE EMERGENCY START" is set to 'FALSE'.

I**REMOTE SPD SETTINGS**

Parameters that affect the remote speed reference are set in this section.

The Service Menu to input and check setpoints in “Service: I**REMOTE SPD SETTINGS**” menu is as follows.

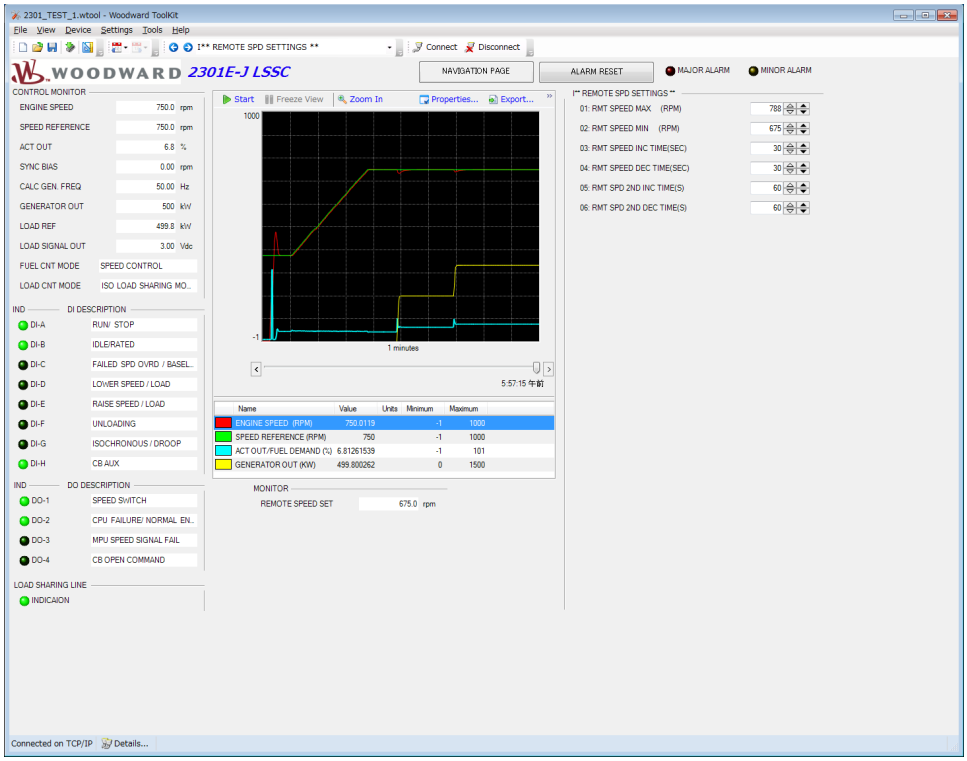


Figure 4-21. “Service: I**REMOTE SPD SETTINGS**” Menu

01: RMT SPEED MAX (RPM)

This is the maximum speed reference when the speed reference is raised by the analog remote speed reference signal.

If speed lower than the rated speed is set here, the rated speed is the maximum speed reference for the remote speed setting.

02: RMT SPEED MIN (RPM)

This is the minimum speed reference when the speed reference is lowered by the analog remote speed reference signal.

If speed higher than the rated speed is set here, the rated speed is the minimum speed reference for the remote speed setting.

03: RMT SPEED INC TIME (SEC)

This is the time (in seconds) required for the control to ramp the engine speed from RMT SPEED MIN (RPM) to RMT SPEED MAX (RPM) when the speed reference is changed by the analog remote speed reference.

A step change in the remote analog input does not cause an immediate change in the reference, which ramps to the new setting at the rate calculated from this setpoint.

04: RMT SPEED DEC TIME (SEC)

This is the time (in seconds) required for the control to ramp the engine speed from RMT SPEED MAX (RPM) to RMT SPEED MIN (RPM) when the speed reference is changed by the analog remote speed reference.

A step change in the remote analog input does not cause an immediate change in the reference, which ramps to the new setting at the rate calculated from this setpoint.

05: RMT SPD 2ND INC TIME (S)
This is the time (in seconds) required for the control to ramp the engine speed from RMT SPEED MIN (RPM) to RMT SPEED MAX (RPM) when the speed reference is changed by the analog remote signal. This function is enabled when “USE 2nd RAMP TIME (DI&RMT)” under A**ENGINE & SPEED CONTROL** header in Configure menus is set to ‘True’ and the generator breaker (auxiliary) contact is closed.

A step change in the remote analog input does not cause an immediate change in the reference, which ramps to the new setting at the rate calculated from this setpoint.

06: RMT SPD 2ND DEC TIME (S)
This is the time (in seconds) required for the control to ramp the engine speed from Rmt Speed Max to Rmt Speed Min when the speed reference is changed by the analog remote signal. This function is enabled when “USE 2nd RAMP TIME (DI&RMT)” under A**ENGINE & SPEED CONTROL** header in Configure menus is set to ‘True’ and the generator breaker (auxiliary) contact is closed.

A step change in the remote analog input does not cause an immediate change in the reference, which ramps to the new setting at the rate calculated from this setpoint.

J**LOAD SETTINGS**
Parameters that affect generator load control are set in this section.

The baseload operation is enabled when “USE BASE LOAD CONTROL?” under C**OPTIONAL FUNCTIONS** menu is set to ‘True’.

The Service Menu to input and check setpoints in “Service: J**LOAD SETTINGS**” menu is as follows.

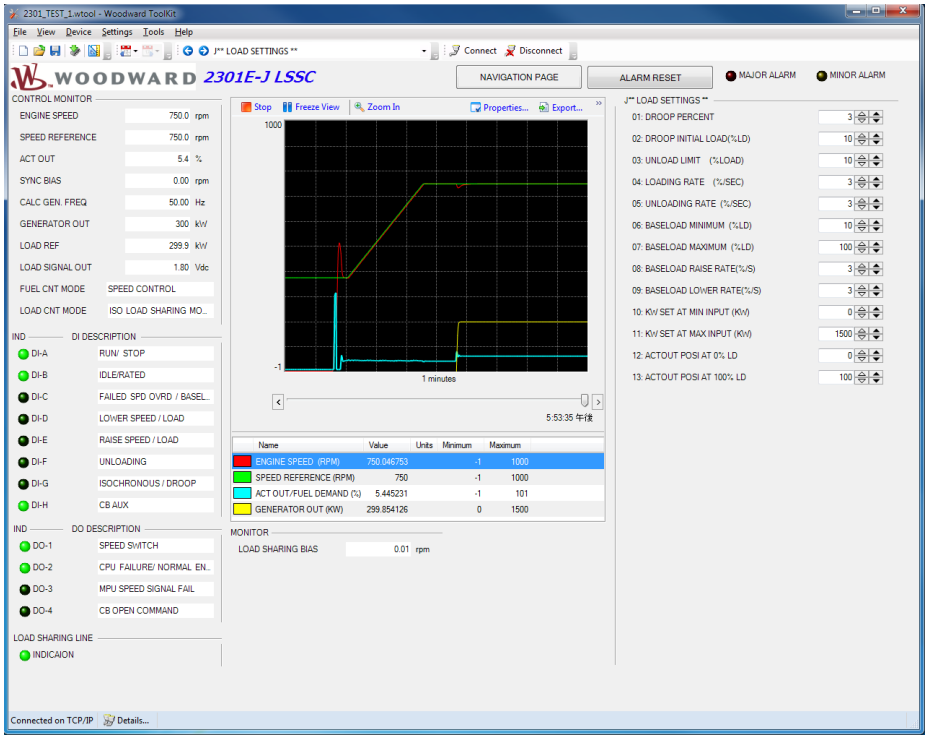


Figure 4-22. “Service: J**LOAD SETTINGS**” Menu

01: DROOP PERCENT
This is the percentage of the rated speed (or the rated frequency) the speed reference is lowered when the generator load is increased to the maximum load.

02: DROOP INITIAL LOAD (%LD)
The load of the generator will ramp to the initial load entered at this setpoint automatically after the generator breaker is closed when the generator is operated in droop mode. This function should not be used for the generator operated in the droop mode which does not parallel to the mains because the generator frequency will be raised by the speed droop range (that corresponds to the percent droop) specified at this setpoint just after the generator breaker is closed. Therefore, set this setpoint to zero if the engine-generator is usually operated as described above.

03: UNLOAD LIMIT (%LOAD)
This sets the lower limit of the generator load for the automatic unloading function which is used while the engine-generator set is paralleling in the isochronous mode, paralleling to the mains in the baseload isochronous mode, or paralleling to the mains in the kW droop mode. Set this setpoint to an appropriate rate of the rated generator kW in percent.

NOTICE

Do not use the automatic unload function on generators operating in the isochronous mode or the droop mode as a single unit. If this function is used on these units, the generator breaker will trip due to the generator frequency lowering at a different rate from the generator load.

04: LOADING RATE (%/SEC)
This is the generator load raise rate while the engine-generator set is loading to the initial load level in order to begin a parallel isochronous operation, a parallel operation to the mains in the baseload mode or a parallel operation to the mains in the kW droop mode, or else while the engine-generator set is transferring its operation mode from the kW droop to the isochronous parallel. Set this setpoint as a percent generator kW change rate per second (%/sec).

05: UNLOADING RATE (%/SEC)
This is the generator load lower rate by the automatic unload function while the engine- generator set is unloading in a parallel isochronous operation, a parallel operation to the mains in the baseload mode or a parallel operation to the mains in the kW droop mode. Set this setpoint as a percent generator kW change rate per second (%/sec).

06: BASELOAD MINIMUM (%LD)
This is the minimum load for the isochronous baseload operation while the generator load is being lowered by the Lower Speed or Load Set contact. Set this setpoint as a percent of the generator rated kW (%). The control will raise the generator load to this setpoint automatically when the generator circuit breaker is closed while in the baseload operation.

07: BASELOAD MAXIMUM (%LD)
This is the maximum load for the isochronous baseload operation while the generator load is being raised by the Raise Speed or Load Set contact. Set this setpoint in percent of the generator rated kW (%).

08: BASELOAD RAISE RATE (%/S)
This is the load raise rate for the isochronous baseload operation while the generator load is being raised by the Raise Speed or Load Set contact. Set this setpoint in percent generator rated kW per second (%/sec).

09: BASELOAD LOWER RATE (%/S)
This is the load lower rate for the isochronous baseload operation while the generator load is being lowered by the Lower Speed or Load Set contact. Set this setpoint in percent generator rated kW per second (%/sec).

10: KW SET AT Min Input (KW)
This is kW value when kW Signal Analog Input is 4mA (4-20mA input),0V (0-5V input) or 1V (1-5V input).

11: KW SET AT MAx Input (KW)
This is kW value when kW Signal Analog Input is 20mA (4-20mA input), 5V (0-5V input) or 5V (1-5V input).

12: ACTOUT POSI AT0% LD
This is actuator positon (%) at No (%) Load. This value will be used for Speed Droop calculation.

13: ACTOUT POSI AT100% LD
This is actuator position (%) at Full (100%) Load. This value will be used for Speed Droop calculation.

K**REMOTE BASELOAD SET**
Parameters that affect the remote baseload operation are set in this section.

The Service Menu to input and check setpoints in “Service: K**REMOTE BASELOAD SET **” menu is as follows.

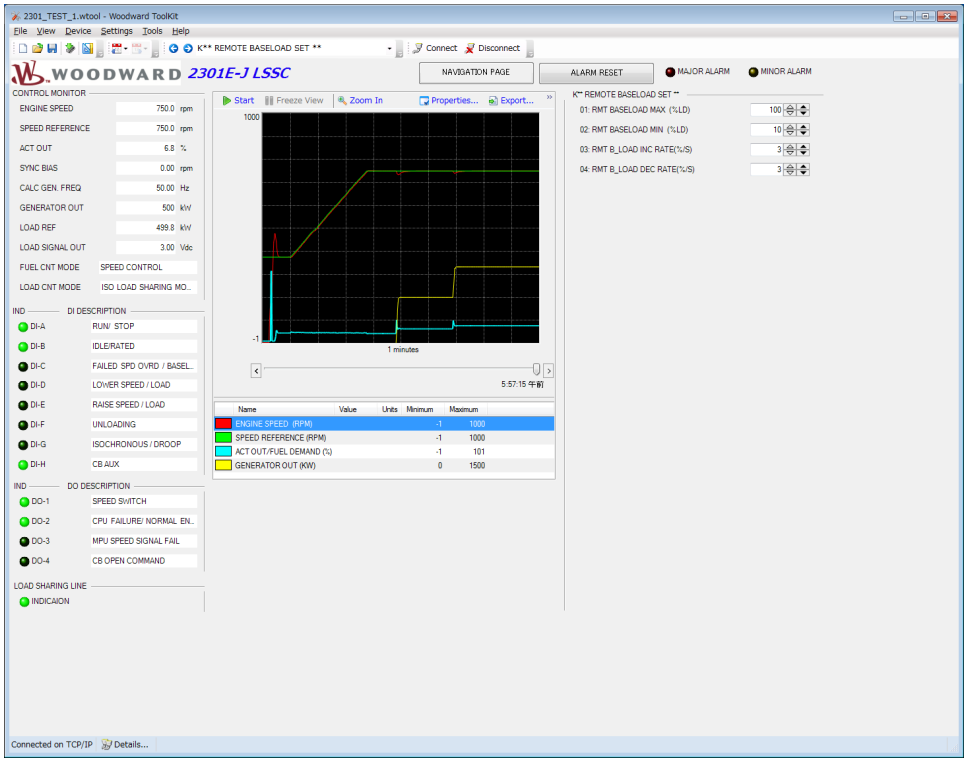


Figure 4-23. “Service: K**REMOTE BASELOAD SET **” Menu

01: RMT BASELOAD MAX (%LD)
This is the maximum baseload setpoint when the baseload setting is raised by the analog remote baseload setting signal while operating in the isochronous baseload mode. Set this setpoint in percent of the generator rated kW (%).

02: RMT BASELOAD MIN (%LD)
This is the minimum baseload setpoint when the baseload setting is lowered by the analog remote baseload setting signal while operating in the isochronous baseload mode. Set this setpoint in percent of the generator rated kW (%).

03: RMT B_LOAD INC RATE (%/S)

This is the raise rate of the baseload setting when the baseload setting is raised by the analog remote baseload setting signal while operating in the isochronous baseload mode. Set this setpoint in percent generator rated kW per second (%/sec).

A step change in the remote analog input does not cause an immediate change in the baseload setting, which ramps to the new setting at the rate calculated from this setpoint.

04: RMT B_LOAD DEC RATE (%/S)

This is the lower rate of the baseload setting when the baseload setting is lowered by the analog remote baseload setting signal while operating in the isochronous baseload mode. Set this setpoint in percent generator rated kW per second (%/sec).

A step change in the remote analog input does not cause an immediate change in the baseload setting, which ramps to the new setting at the rate calculated from this setpoint.

L**KW SENSOR CALIBRATION**

Parameters to calibrate PT signals, CT signals and kW sensors are set in this section.

The Service Menu to input and check setpoints in “Service: L**KWSENSOR CALIBRATION**” menu is as follows.

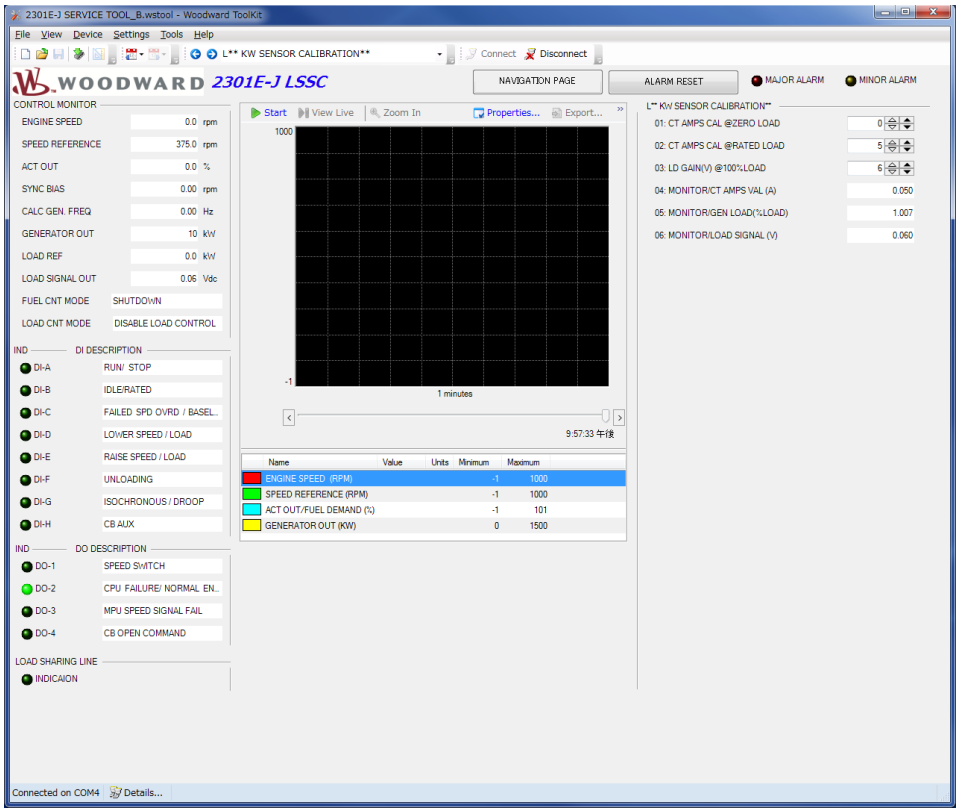


Figure 4-24. “Service: L**KWSENSOR CALIBRATION**” Menu

01: CT AMPS CAL @ZERO LOAD

Tune this setpoint as CT current displayed at “MONITOR/CT AMPS VAL (A)” is fixed to zero when the generator circuit breaker (auxiliary) contact is closed while operating in the rated generator frequency and the rated generator voltage.

This tuning is usually done once in the system installation and unnecessary to do while in ordinary operation.

02: CT AMPS CAL @RATED LOAD
Set this setpoint to the expected CT current at the rated generator kW load operation calculated from the CT ratio before the first engine-generator operation after the generator system is installed. Although the 2301E-J can control the load if CT current is between 3 and 7 A, adjust the CT ratio so that the CT current at the rated generator kW load is 5 A if possible.

Start the engine-generator set and load the generator, then monitor the displayed value at “MONITOR/CT AMPS VAL (A)” and memorize the value at the rated generator voltage and the rated generator kW. Set this setpoint to the memorized value after the generator circuit breaker is opened.

This tuning is usually done once in the system installation and unnecessary to do during ordinary operation.

NOTICE

The CT input signal must be lower than 7.2 A, because the kW sensor circuit cannot detect the correct generator load if the CT input current is 7.2 A or more. This may cause an overload, resulting in damage to the engine, the generator or facilities. To prevent this damage, the CT input signal must be lower than 7.2 A

03: LD GAIN(V) @100%LOAD
This is the voltage which should be biased to (the generator kW sensing input of) the load sharing error detection circuit when the generator load is 100%. The voltage biased to the load sharing line when the generator loads the 100% load will be half of this setpoint value.

Set this setpoint to 6.0 V. Therefore, 3.0 V should be biased to the load sharing line at 100% load. If this control is used for the load sharing operation with a Woodward 723 DSC, which demands 2.5 V as the bias voltage to the load sharing input at 100% load, set this setpoint to 5.0 V.

04: MONITOR/CT AMPS VAL (A)
The present CT current is displayed here in amperes.

05: MONITOR/GEN LOAD (%LOAD)
The generator kW sampled by the control via PTs and CTs, is displayed in percent rated generator kW at this setpoint.

06: MONITOR/LOAD SIGNAL (V)
This is the present voltage biased to the load sharing circuit of the control displayed in volts. This voltage corresponds to the voltage at 2301A LSSC’s load signal.

M**ANALOG OUTPUT SETTINGS**

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

The Service Menu to input and check setpoints in “Service: M**ANALOG OUTPUT SETTINGS**” menu is as follows.

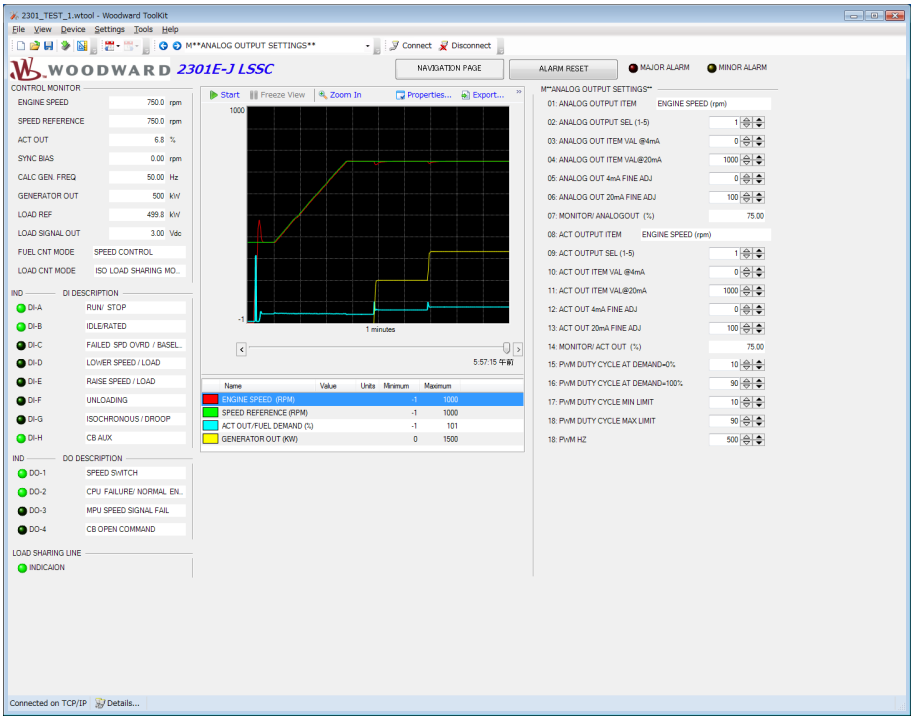


Figure 4-25. “Service: : M**ANALOG OUTPUT SETTINGS**” Menu

01: ANALOG OUTPUT ITEM
The analog parameter which is currently output from the 4-20 mA output channel is displayed.

02: ANALOG OUTPUT SEL (1-5)
Select one of the following parameters for 4-20 mA output.
1: Engine Speed (rpm)
2: Speed Reference (rpm)
3: Actuator Output (%)
4: Generator kW Output (kW)
5: Generator kW Reference (KW)

03: ANALOG OUT ITEM VAL @4mA
This is the value of the displayed parameter when the analog output is 4 mA.
The unit for the setpoint is as following
1, 2 : For Engine Speed and Speed reference (rpm)
3 : For the Actuator output (%)
4, 5 : For Generator kW Output and Generator kW Reference (kW).

04: ANALOG OUT ITEM VAL@20mA
This is the value of the displayed parameter when the analog output is 20 mA.

05: ANALOG OUT 4mA FINE ADJ
Use this setpoint to tune the 4 mA output level in case more precise tuning is necessary. Increase the setpoint value to raise the output current level.

06: ANALOG OUT 20mA FINE ADJ
Use this setpoint to tune the 20 mA output level in case more precise tuning is necessary. Increase the setpoint value to raise the output current level.

07: MONITOR/ ANALOGOUT (%)
The present analog output from the output channel is displayed in percent. It displays 0% when 4 mA, and 100% when 20 mA.

08: ACT OUTPUT ITEM
The analog parameter which is currently output from the Actuator Output channel is displayed. This setting is only available if Configure Menu , "B**INPUT & OUTPUT OPTIONS**" item "02: ACTUATOR OUTPUT TYPE" is set as "5 (PWM)"

09: ACT OUTPUT SEL (1-5)
Select one of the following parameters for Actuator Output channel.
1: Engine Speed (rpm)
2: Speed Reference (rpm)
3: Actuator Output (%)
4: Generator kW Output (kW)
5: Generator kW Reference (kW)

10: ACT OUT ITEM VAL @4mA
This is the value of the displayed parameter when the analog output is 4 mA.
The unit for the setpoint is the following:
1, 2 : For Engine Speed and Speed reference (rpm)
3 : For the Actuator output (%)
4, 5 : For Generator kW Output and Generator kW Reference (kW).

11: ACT OUT ITEM VAL@20mA
This is the value of the displayed parameter when the analog output is 20 mA.

12: ANALOG OUT 4mA FINE ADJ
Use this setpoint to tune the 4 mA output level in case more precise tuning is necessary. Increase the setpoint value to raise the output current level.

13: ACT OUT 20mA FINE ADJ
Use this setpoint to tune the 20 mA output level in case more precise tuning is necessary. Increase the setpoint value to raise the output current level.

14: MONITOR/ ACT OUT (%)
The present analog output from the output channel is displayed in percent. It displays 0% when 4 mA, and 100% when 20 mA.

15: PWM DUTY CYCLE AT DEMAND=0%
This is Duty Cycle setting at actuator output 0% when PWM output is selected for actuator control.

16: PWM DUTY CYCLE AT DEMAND=100%
This is Duty Cycle setting at actuator output 100% when PWM output is selected for actuator control.

17: PWM DUTY CYCLE MIN LIMIT
This is minimum limit setting for PWM output.

18: PWM DUTY CYCLE MAX LIMIT
This is maximum limit setting for PWM output.

19: PWM Hz
This is frequency setting for PWM output.

N**DISCRETE OUT SETTINGS**

This section determines the settings of the discrete output drivers.

The Service Menu to input and check setpoints in “Service: N**DISCRETE OUT SETTINGS **” menu is as follows.

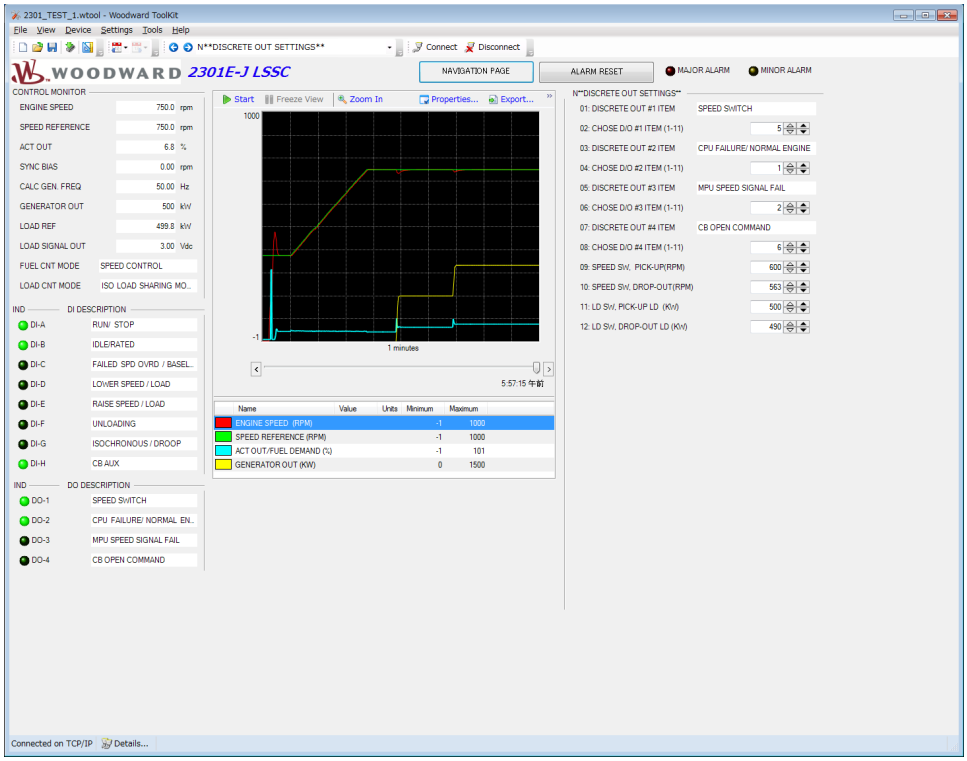


Figure 4-26. “Service: N**DISCRETE OUT SETTINGS **” Menu

01: DISCRETE OUT #1 ITEM

The parameter number currently selected for the Discrete output #1 is displayed here.

02: CHOOSE D/O #1 ITEM (1-11)

Select one of the following parameters for Discrete output #1:

1. CPU failure (Normally energized)
2. Speed sensor failure
3. Major Alarm (refer “T**ALARM**)
4. Minor Alarm (refer “T**ALARM**)
5. Speed Switch
6. CB Open Command
7. Generator breaker closure in the isochronous operation
8. Generator breaker closure in the droop operation
9. In the baseload operation
10. Optional load switch
11. Level Switch (refer “N+ LEVEL SWITCH SETTINGS**)

03: DISCRETE OUT #2 ITEM

The parameter number currently selected for Discrete output #2 is displayed here.

04: CHOOSE D/O #2 ITEM (1-11)
Select one of the following parameters for Discrete output #2:
1. CPU failure (Normally energized)
2. Speed sensor failure
3. Major Alarm (refer “T**ALARM**)
4. Minor Alarm (refer “T**ALARM**)
5. Speed Switch
6. CB Open Command
7. Generator breaker closure in the isochronous operation
8. Generator breaker closure in the droop operation
9. In the baseload operation
10. Optional load switch
11. Level Switch (refer “N+ LEVEL SWITCH SETTINGS**)

05: DISCRETE OUT #3 ITEM
The parameter number currently selected for Discrete output #3 is displayed here.

06: CHOOSE D/O #3 ITEM (1-11)
Select one of the following parameters for Discrete output #3:
1. CPU failure (Normally energized)
2. Speed sensor failure
3. Major Alarm (refer “T**ALARM**)
4. Minor Alarm (refer “T**ALARM**)
5. Speed Switch
6. CB Open Command
7. Generator breaker closure in the isochronous operation
8. Generator breaker closure in the droop operation
9. In the baseload operation
10. Optional load switch
11. Level Switch (refer “N+ LEVEL SWITCH SETTINGS**)

07: DISCRETE OUT #4 ITEM
The parameter number currently selected for Discrete output #4 is displayed here.

08: CHOOSE D/O #1 ITEM (1-11)
Select one of the following parameters for Discrete output #4:
1. CPU failure (Normally energized)
2. Speed sensor failure
3. Major Alarm (refer “T**ALARM**)
4. Minor Alarm (refer “T**ALARM**)
5. Speed Switch
6. CB Open Command
7. Generator breaker closure in the isochronous operation
8. Generator breaker closure in the droop operation
9. In the baseload operation
10. Optional load switch
11. Level Switch (refer “N+ LEVEL SWITCH SETTINGS**)

09: SPEED SW, PICK-UP (RPM)
Set the engine speed (in rpm) to energize the speed switch.

This setpoint may be either smaller or greater than the next setpoint, “SPEED SW DROP-OUT (RPM)”. If this setpoint is greater than the next setpoint, the speed switch will be energized when the engine speed is raised and reaches this setpoint. Otherwise, the speed switch will be energized when the engine speed is lowered to this setpoint.

10: SPEED SW, DROP-OUT (RPM)
Set the engine speed (in rpm) to de-energize the speed switch.

11: LD SW, PICK-UP LD (KW)
Set the generator output (in kW) to energize the optional load switch in case the optional load switch is selected.

This setpoint may either smaller or greater than the next setpoint, “LOAD SW, DROP-OUT LOAD (KW)”. If this setpoint is greater than the next setpoint, the load switch will be energized when the generator kW is raised and reaches this setpoint. Otherwise, the load switch will be energized when the generator output lowers to this setpoint.

12: LD SW, DROP-OUT LD (KW)
Set the generator output (in kW) to de-energize the optional load switch in case the optional load switch is selected.

NOTICE

If DI-B or DI-C is set for alarm reset, when Major Alarm occurs, it will latch, and engine cannot be started unless alarm is reset.

If DI-B or DI-C is NOT set for alarm reset, alarm can be automatically reset when engine speed reaches certain speed at cranking (in-case no action on “RUN” contact). Or, alarm can be reset by RUN/STOP contact when engine speed becomes 0 rpm.

N+** LEVEL SWITCH SETTINGS**

This section determines settings for Level Switch if Level Switch output is selected in N**DISCRETE OUT SETTINGS**. Level Switch detection can be set to be 1 point or 5 points curve.

The Service Menu to input and check setpoints in “Service: N+**LEVEL SWITCH SETTINGS **” menu is as follows.

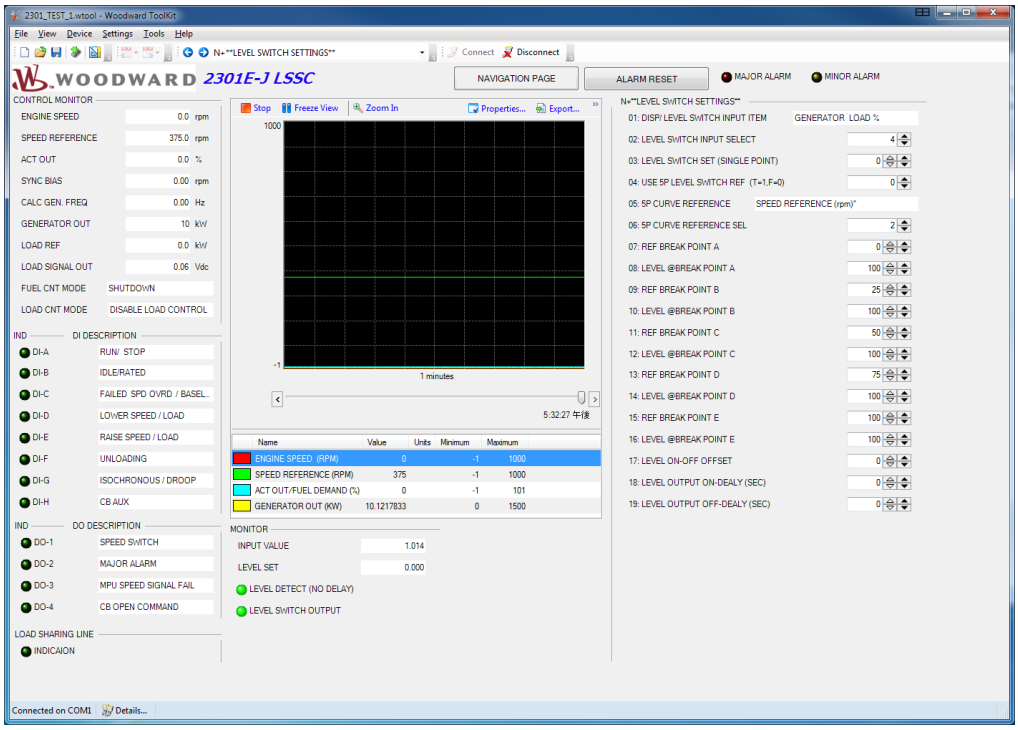


Figure 4-27. “Service: N+**LEVEL SWITCH SETTINGS **” Menu

01: DISP/LEVEL SWITCH INPUT ITEM
The item currently selected for Level Switch input is displayed.

02: LEVEL SWITCH INPUT SET
Select one of the following parameters for Level Switch input:
1: Engine Speed (rpm)
2: Speed Reference (rpm)
3: Actuator Output (%)
4: Generator kW Output (kW)
5: Boost Pressure Signal

03: LEVEL SWITCH SET (SINGLE POINT)
This is setpoint for Level Switch (Single Point).

04: USE 5P LEVEL SWITCH
This setting is to enable 5 Points detection. Set 'TRUE' for 5 Points detection.

05: 5P CURVE REFERENCE
The item currently selected for 5 Points Cure Reference is displayed.

06: 5P CURVE REFERENCE SEL
Select one of the following parameters for 5 Points Curve Reference:
1: Engine Speed (rpm)
2: Speed Reference (rpm)
3: Actuator Output (%)
4: Generator kW Output (kW)
5: Boost Pressure Signal

07: REF BREAK POINT A
Set this setpoint for the break point A on the 5 Curve Reference curve.

08: LEVEL @ BREAK POINT A
This is setting for the Level Switch at break point A.

09: REF BREAK POINT B
Set this setpoint for the break point B on the 5 Curve Reference curve.

10: LEVEL @ BREAK POINT B
This is setting for the Level Switch at break point B.

11: REF BREAK POINT C
Set this setpoint for the break point C on the 5 Curve Reference curve.

12: LEVEL @ BREAK POINT C
This is setting for the Level Switch at break point C.

13: REF BREAK POINT D
Set this setpoint for the break point D on the 5 Curve Reference curve.

14: LEVEL @ BREAK POINT D
This is setting for the Level Switch at break point D.

15: REF BREAK POINT E
Set this setpoint for the break point E on the 5 Curve Reference curve.

16: LEVEL @ BREAK POINT E
This is setting for the Level Switch at break point E

17: LEVEL ON-OFF OFFSET
This is offset value for Level Switch ON-OFF. If input value is less LEVEL ON-OFF OFFSET compare to reference value, Level Switch output will be OFF.

This offset value is valid to both 1 Point and 5 Point Curve

18: LEVEL OUTPUT ON-DELAY (SEC)
This is delay setting (in seconds) before Level Switch turn ON when input value become higher than reference value.

19: LEVEL OUTPUT OFF-DELAY (SEC)
This is delay setting (in seconds) before Level Switch turn OFF when input value becomes lower than reference value (more than OFFSET value.

Below is Level Switch logic for reference.

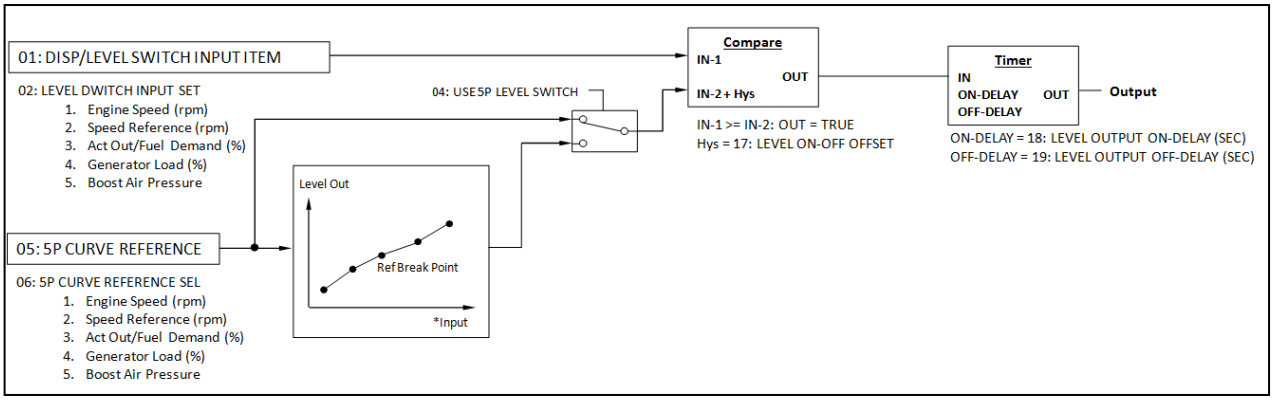


Figure 4-28. Level Switch

P**DISPLAY ANALOG I/O VAL**

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

The Service Menu to view monitoring parameters in “Service: P**DISPLAY ANALOG I/O VAL **” menu is as follows.

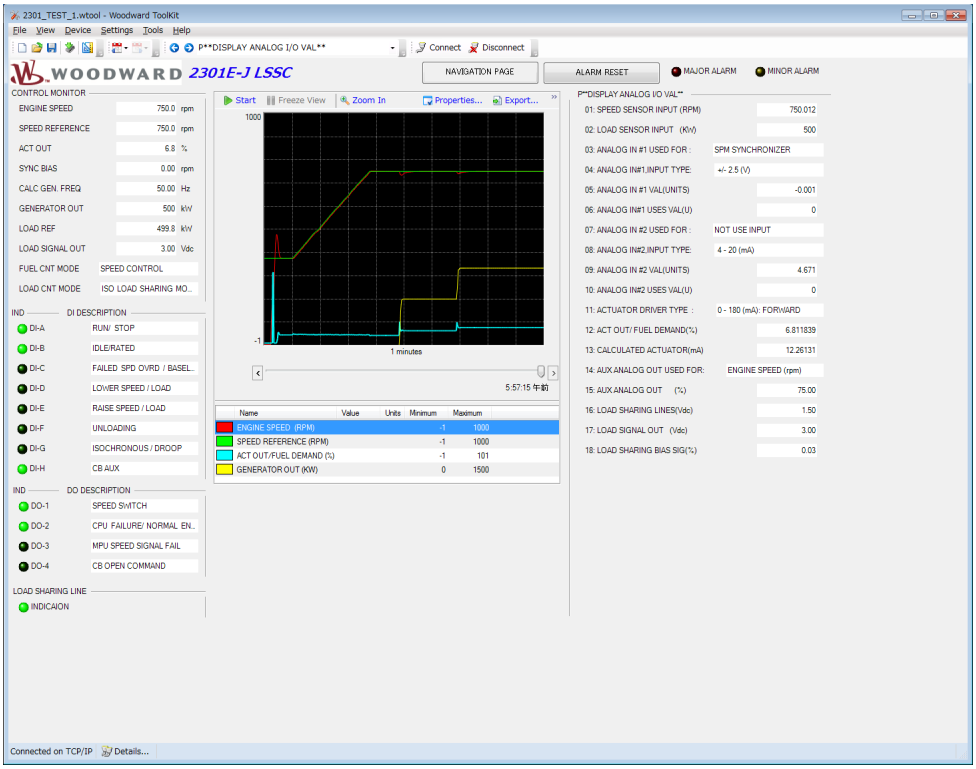


Figure 4-29. “Service: P**DISPLAY ANALOG I/O VAL **” Menu

01: SPEED SENSOR INPUT (RPM)
This term displays actual engine speed in rpm which is input to terminal 25-26.

02: LOAD SENSOR INPUT (KW)
This term displays generator load in kilowatts calculated from PT signals and CT signals input to terminal 1-9.

03: ANALOG IN#1 USED FOR:
The parameter name selected for the Analog Input#1 is displayed here.

04: ANALOG IN#1 INPUT TYPE:
This term displays the signal type of Analog input #1 currently selected.

05: SYNC/ANALOG INPUT#1 INPUT VAL (U)
This term displays SPM synchronizer input signal in engineering units.

06: SYNC INPUT BIAS (RPM)
This term displays the speed bias to the summing junction in rpm.

07: ANALOG IN #2 USED FOR:
This term displays the parameter name currently input to Analog input #2.

08: ANALOG IN#2, INPUT TYPE:
This term displays the signal type of Analog input #2 currently selected.

09: ANALOG IN #2 VAL (UNITS)
This term displays Analog input #2 signal in engineering units.

10: ANALOG IN#2 USES VAL (U)
This term displays the physical quantity corresponding to Analog input #2 in engineering units.

11: ACTUATOR DRIVER TYPE:
This term displays the signal type of Actuator output currently selected.

12: ACT OUT/ FUEL DEMAND (%)
This term displays the current Actuator output in percent.

13: CALCULATED ACTUATOR (mA)
This term is the calculated actuator output current in milliamps. This calculation is based on the percent fuel demand and the actuator type/range selected. External wiring may affect the accuracy of the actual current.

14: AUX ANALOG OUT USED FOR:
This term displays the parameter name currently output from 4-20 mA Analog output.

15: AUX ANALOG OUT (%)
This term displays present analog output % of the output channel. It displays 0% when output current is 4 mA, and 100% when 20 mA.

16: LOAD SHARING LINES (Vdc)
This term displays the voltage of the load sharing (bus) lines. If the load sharing lines are not connected to the load sharing circuit, the calculated voltage basing on the generator kW output will be displayed.

17: LOAD SIGNAL OUT (Vdc)
This term displays the load signal voltage which is proportional to the generator output. This signal range is 0-6 Vdc in case the load sharing line's signal range is 0-3 Vdc.

18: LOAD SHARING BIAS SIG (%)
This term displays the load signal error (from the load sharing line) in percent generator kW while operating in load sharing mode.

S**D/O AND A/O TESTS**

This section is used to set discrete outputs and analog outputs to an assigned value from the PC's keyboard manually while in the interface test between 2301E-J and other equipment.

The Service Menu to input and check setpoints in "Service: S**D/O and A/O TESTS **" menu is as follows.

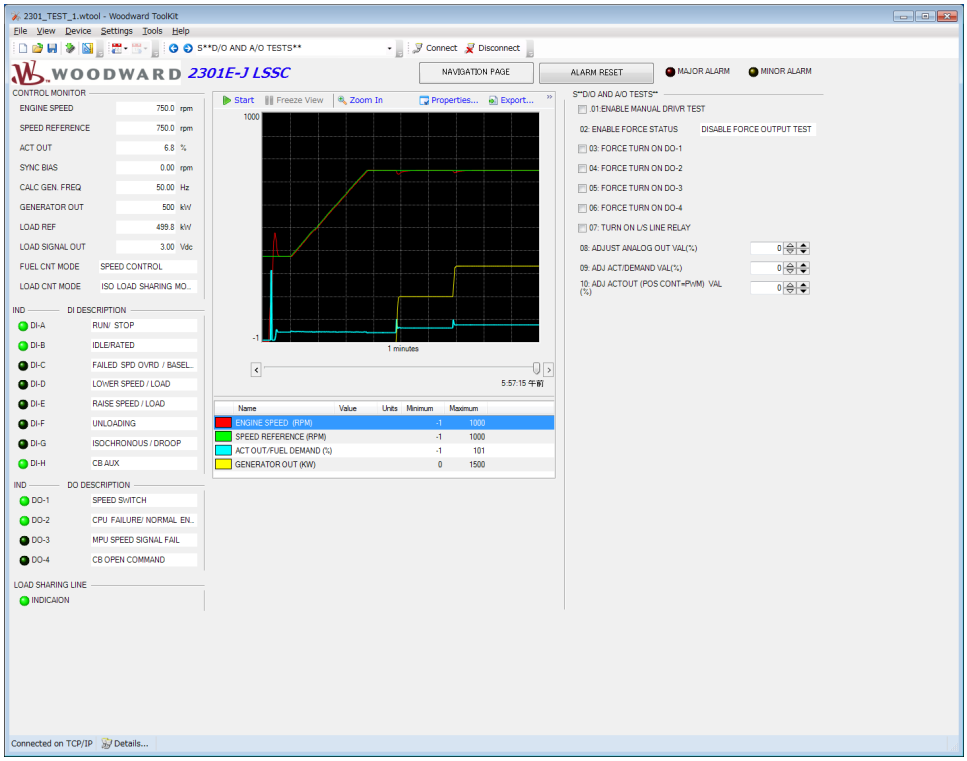


Figure 4-30. “Service: S**D/O and A/O TESTS **” Menu

01: ENABLE MANUAL DRIVR TEST
This setpoint determines if the manual input/output operation is used or not. Set this setpoint to ‘True’ if the manual operation is used, otherwise set to ‘False’. Be sure to revert this setpoint to ‘False’ when the manual operation is finished.

02: ENABLE FORCE STATUS
This term displays if the manual operation is set to available or not.

03: FORCE TURN ON D/O-1
This setpoint is used to switch the Discrete #1 output state. To energize Discrete #1 output, set this setpoint to ‘True’. To de-energize Discrete #1 output, set this setpoint to ‘False’. This function is enabled only when “Enable Force Output Test” is displayed at the setpoint “ENABLE FORCE STATUS” above.

04: FORCE TURN ON D/O-2
This setpoint is used to switch the Discrete #2 output state. To energize Discrete #2 output, set this setpoint to ‘True’. To de-energize Discrete #2 output, set this setpoint to ‘False’. This function is enabled only when “Enable Force Output Test” is displayed at the setpoint “ENABLE FORCE STATUS” above.

05: FORCE TURN ON D/O-3
This setpoint is used to switch the Discrete #3 output state. To energize Discrete #3 output, set this setpoint to ‘True’. To de-energize Discrete #3 output, set this setpoint to ‘False’. This function is enabled only when “Enable Force Output Test” is displayed at the setpoint “ENABLE FORCE STATUS” above.

06: FORCE TURN ON D/O-4
This setpoint is used to switch the Discrete #4 output state. To energize Discrete #4 output, set this setpoint to ‘True’. To de-energize Discrete #4 output, set this setpoint to ‘False’. This function is enabled only when “Enable Force Output Test” is displayed at the setpoint “ENABLE FORCE STATUS” above.

07: TURN ON L/S LINE RELAY
This setpoint is used to switch the load sharing-line relay output state. To close the load- sharing-line relay contacts, set this setpoint to 'True'. To open the load sharing-line relay contacts, set this setpoint to 'False'. This function is enabled only when "Enable Force Output Test" is displayed at the setpoint "ENABLE FORCE STATUS" above.

08: ADJUST ANALOG OUT VAL (%)
This setpoint is used set the 4-20 mA analog output to an assigned value manually. 4 mA is output when 0% is set, and 20 mA is output when 100% is set. This function is enabled only when "Enable Force Output Test" is displayed at the setpoint "ENABLE FORCE STATUS" above.

09: ADJ ACT/DEMAND VAL (%)
This setpoint is used to set the actuator output to an assigned value manually. The output current is assigned in percent and its output range is determined by the actuator signal type. This function is enabled only when "Enable Force Output Test" is displayed at the setpoint "ENABLE FORCE STATUS" above.

10: ADJ ACTOUT (POS CONT=PWM) VAL (%)
This setpoint is used to set the actuator output (when PWM output is selected) to an assigned value manually. The output current is assigned in percent and its output range is determined by the actuator signal type. This function is enabled only when "Enable Force Output Test" is displayed at the setpoint "ENABLE FORCE STATUS" above.

T**ALARM**

This section is used to view and set alarm parameters. In the 2301E-J, when Major Alarm occurred, actuator output will instantly move to 0%

The Service Menu to input and check setpoints in "Service: T**Alarm**" menu is as follows.

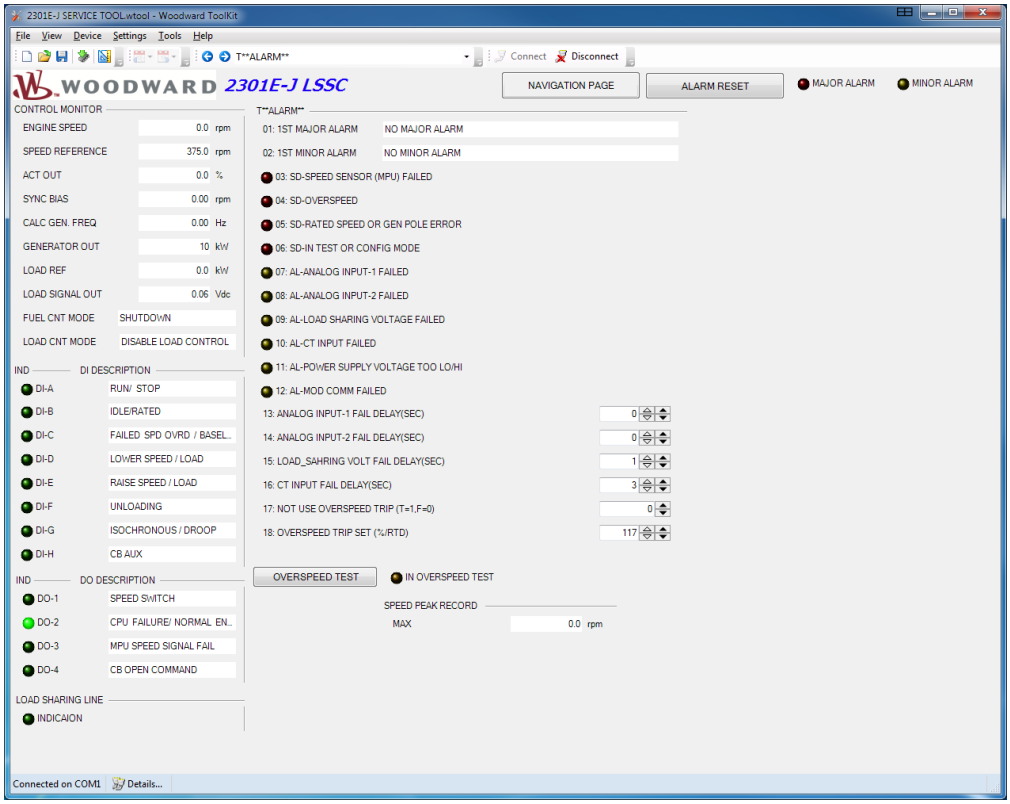


Figure 4-31. "Service: T**Alarm **" Menu

01: 1ST MAJOR ALARM
First Major Alarm is displayed.

02: 1ST MINOR ALARM
First Minor Alarm is displayed.

03: SD-SPEED SENSOR (MPU) FAILED
This LED turns on when Speed Sensor failure occurred. Major Alarm.

04: SD-OVERSPEED
This LED turns on when Overspeed occurred. Major Alarm.

05: SD-RATED SPEED OR GEN POLE ERROR
This LED turns on when frequency calculation (from rated speed and pole number) is not 50-60Hz. Major Alarm.

06: SD-IN TEST OR CONFIG MODE
This LED turns on when in Test Mode or interlock in Configuration Mode. Major Alarm.

07: AL-ANALOG INPUT-1 FAILED
This LED turns on when Analog Input #1 is out of range. Minor Alarm.

08: AL-ANALOG INPUT-2 FAILED
This LED turns on when Analog Input #2 is out of range. Minor Alarm.

09: AL-LOAD SHARING VOLTAGE FAILED
This LED turns on when Load Sharing voltage is less than 0.1V or higher than 3.6V. Minor Alarm.

10: AL-CT INPUT FAILED
This LED turns on when CT current less than -1A or higher than 7A. Minor Alarm.

11: AL-POWER SUPPLY VOLTAGE TOO LO/HI
This LED turns on when Power Supply voltage is lower than 16V or higher than 41V.Minor Alarm.

12: AL-MOD COMM FAILED
This LED turns on when Modbus communication error occurred. Minor Alarm.

13: ANALOG INPUT-1 FAIL DELAY (sec)
This is time delay (in seconds) before Minor Alarm occurred when Analog Input #1 become out of range.

14: ANALOG INPUT-2 FAIL DELAY (sec)
This is time delay (in seconds) before Minor Alarm occurred when Analog Input #2 become out of range.

15: LOAD SHARING VOLTAGE FAILE DELAY (sec)
This is time delay (in seconds) before Minor Alarm occurred when Load Sharing voltage is out of range.

16: CT INPUT FAIL DELAY (sec)
This is time delay (in seconds) before Minor Alarm occurred when CT current is out of range.

17: NOT USE OVERSPEED
This is setting to enable Overspeed function. True to enable Overspeed.

18: OVERSPEED TRIP SET (%/RTD)
This is setpoint for Overspeed setting. Rated speed is 100%

OVERSPEED TEST is for Test purposes only.

When the button is clicked, Raise Speed Limit will be increased 5% higher than Overspeed Trip Set momentary (3 minutes). In this time, engine speed can be increased to Overspeed Trip Set to conduct Overspeed test using Raise contact.

Initial Prestart Settings

NOTICE **Read all the below explanations for engine operation before starting the engine.**

Initial Prestart Setpoint Inputs

The prestart settings can be viewed and/or adjusted at the setpoints below using Watch Window software.

1. Check the idle speed setpoint below to confirm if the correct value is set.
   - Configure Menu: A**ENGINE & SPEED CONTROL**
   - 02: ENTER IDLE SPEED (RPM)

2. Check the rated speed setpoint below to confirm if the correct value is set.
   - Configure Menu: A**ENGINE & SPEED CONTROL**
   - 01: ENTER RATED SPEED (RPM)

3. Check the number of gear teeth setpoint below to confirm if the correct value is set.
   - Configure Menu: A**ENGINE & SPEED CONTROL**
   - 03: ENTER NUM OF GEAR TEETH

4. Check the ratio of the rpm of the shaft for gear teeth sensing to the rpm of the crank shaft to confirm if the correct value is set.
   - Configure Menu: A**ENGINE & SPEED CONTROL**
   - 04: ENTR REV RATIO MPU/CRANK

5. Check if the actuator signal type (Forward/Reverse, 20-180 mA/4-20 mA) matches the input signal of the actuator used for the engine operation referring setpoints below.
   - Configure Menu: B**INPUT & OUTPUT OPTIONS**
   - 01: DISP/ACTUATOR OUT TYPE
   - 02: ACTUATOR OUT TYPE (1-4)

6. Use only Dynamics #1 at the initial engine start. Set Configure Menus and Dynamics #2 as follows:
   - Configure Menu: A**ENGINE & SPEED CONTROL**
   - 07: USE 5 POINTS GAIN MAP = False
   - 10: USE IDLE SPEED DYNAMICS = False
   - Service Menu: B** DYNAMICS #2 **
   - 01: USE 2ND DYNAMICS ? = False

7. Set the Gain 1 value to 1.0.
   - Service Menu: A** DYNAMICS #1 **
   - 03: RATED PROP GAIN 1 = 1.00

8. Set the Reset 1 value to 1.0.
   - Service Menu: A** DYNAMICS #1 **
   - 04: RATED RESET 1 = 1.00

9. Set the Compensation 1 value to 0.1.
   - Service Menu: A** DYNAMICS #1 **
   - 05: ACT COMPE 1 = 0.10

10. Set the Gain Ratio 1 value to 1.0 so that the gain ratio function has no effect.
    - Service Menu: A** DYNAMICS #1 **
    - 07: GAIN RATIO 1 = 1.00

11. Set the Accel Ramp Time to 15 seconds and the Decel Ramp Time to 10 seconds.
    - Service Menu: H** SPEED CNTRL SETTINGS **
    - 05: ACCEL RAMP TIME (SEC) = 15.00
    - 06: DECEL RAMP TIME (SEC) = 10.00

12. Set Start Fuel Limiters as follows:
    - Service Menu: E**START/MAX LIM SETTINGS**
    - 01: START LIMITER MIN (%FD) = 30.00
    - 02: START LIMITER MAX (%FD) = 40.00
    - 03: START LIM RAMP RATE (%/S) = 3.00

13. Set the Max Fuel Limiter to 100%.
    - Service Menu: E**START/MAX LIM SETTINGS**
    - 04: MAXIMUM FUEL LIMIT (%FD) = 100.00

14. Check if wiring from the actuator is connected to terminal 13(+) and 14(−) correctly.

15. Check if the setpoint of the rated generator kW is set correctly.
    - Configure Menu: A**ENGINE & SPEED CONTROL**
    - 11: ENTER GEN RATED LOAD (KW)

16. Set the Load Gain value to 6.0.
    - Service Menu: L** KW SENSOR CALIBRATION**
    - 03: LD GAIN(V) @100%LOAD = 6.00

Prestart Settings Review

Connect a frequency generator to the control to simulate the engine start before starting the engine in order to confirm that all necessary setpoints are set correctly and the engine can be started.

Rotate the gear using the engine starter and check if MPU signal voltage is adequate.

1. Reconfirm that all the setpoints in configuration menus are correct.

NOTICE

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

2. Connect the frequency generator to terminal 25 and 26 in order to simulate the MPU signal input. Do not supply the frequency signal yet.

3. Connect an ammeter between the terminal 13 and the actuator to measure the actuator output current.

4. Power on the 2301E-J.

5. Open SELECT IDLE/RATED SPEED contact so that the speed reference will be raised to Idle speed.

6. Open ISOCHRONOUS/DROOP contact so that the engine is operated in isochronous mode.

IMPORTANT

The control is in the droop mode whenever the circuit-breaker auxiliary contact is open. If a single prime mover is required to run isochronously with an isolated load, enter Load Droop Percent = 0.0 when making *LOAD SETTING * adjustments.

7. Close RUN/STOP ENGINE contact by turning the switch to the Run side.

8. Supply the frequency signal raising from 0 Hz to the 10% of the rated speed gradually. Observe whether the current ramps from the minimum fuel level to the start fuel limit level.

9. Raise the frequency of the signal to the level little higher than the frequency of idle speed. Observe whether the actuator current ramps to the minimum fuel level from the start fuel limit level.

10. Close the SELECT IDLE/RATED SPEED contact to raise the speed reference to the rated speed. Observe whether the actuator current ramps to the maximum fuel level.

11. Next, raise the frequency of the signal to the level little higher than the frequency of the rated speed. Observe whether the actuator current ramps to the minimum fuel level.

12. Tune the frequency signal to the frequency of the rated speed. Check that the 2301E-J's engine speed display is the rated speed.

13. Open the RUN/STOP contact by turning the switch to the Stop side. Observe whether the actuator current drops to the minimum fuel level instantly.

Now, start-up adjustment should have completed normally. In case the actuator did not work as described above in any step of the start-up adjustment, return to the stage of "Initial pre-start setting", re-check all the setpoints.

If the start-up adjustment above finished without any problem, remove the frequency generator and the ammeter, then reconnect the MPU and the actuator to the control.

Speed Sensor Signal Check

1. Before starting the engine, measure the MPU signal voltage at the cranking speed by rotating the engine with the engine starter. Make sure the engine cannot accelerate beyond the cranking speed at this stage.

⚠WARNING

TO PROTECT AGAINST POSSIBLE PERSONAL INJURY, LOSS OF LIFE, and/or PROPERTY DAMAGE WHEN STARTING the engine, turbine, or other type of prime mover, BE PREPARED TO MAKE AN EMERGENCY SHUTDOWN to protect against runaway or overspeed should the mechanical-hydraulic governor(s), or electric control(s), the actuator(s), fuel control(s), the driving mechanism(s), the linkage(s), or the controlled device(s) fail.

2. The control can sense the speed signal without any problem if the MPU voltage is more than 1.0 Vrms. In case MPU voltage at the engine's cranking speed is less than 1.0 Vrms, check whether the voltage is in increasing direction following the engine acceleration at cranking.

3. If the apparent voltage is not in increasing direction with the engine acceleration at cranking, check the MPU wiring, the gap between MPU and the gear teeth top and the MPU device.

4. If there is no problem with the MPU voltage in the engine cranking, prepare to start the engine.

5. To start the engine, make sure the operator can make an emergency shutdown whenever it is necessary at the initial engine start.

6. Set the speed reference to Idle speed. If Idle speed is not used, set the speed reference to the lowest operating speed.

7. Start the engine**.** If the engine cannot be started, check whether the actuator position cranking or engine start is enough to start the engine.

8. If the actuator is working correctly, check the engine and the fuel system to ensure that fuel can be supplied normally.

9. If the engine started, observe whether acceleration stops at Idle speed or the lowest operating speed. If the acceleration did not stop, make an emergency stop. Review all setpoints and wiring after the engine stops.

10. If hunting is evident after the engine starts, tune the 2301E-J's control dynamics, referring to the "Start-up adjustment" described below.

11. If the engine can be operated at Idle speed stably, check that the voltage of the MPU signal is 1.0 Vrms or higher. If the engine start speed is equal to or approximates to the rated speed, check if the voltage of the MPU signal is from 2.0 Vrms to 25.0 Vrms at the engine start speed. If the voltage of the MPU signal at the rated speed is more than 25.0 Vrms, stop the engine and extend the gap between the MPU and the gear tops so that the voltage of the MPU signal at the rated speed is within 25.0 Vrms.

12. Stop the engine when all MPU signal voltage checks are completed.

Start-Up Adjustment
Tune the control dynamics based on the dynamic adjustment described below if the engine speed is not stable while in Speed sensor signal check described above.

If the engine is hunting at fast rate, lower the Gain setpoint slowly until the engine speed is stable

If the engine is hunting at a slow rate with the period more than a several seconds, increase the Reset setpoint slowly until the engine stabilizes. If increasing the Reset does not stabilize the engine, it may be necessary to either:
- Increase the Gain slowly or
- Increase the Compensation and decrease the Gain slowly

Dynamic Adjustment
To check if the control has optimum response, give an external disturbance to the engine, then observe the actuator movement and the engine speed change.

Tune the Gain value to minimize the speed error after a load change. However, do not raise the Gain value too high because a too-high Gain is apt to cause hunting due to excessive control response. The most basic procedure of Gain setpoint tuning is to search the point where the actuator position is unstable by raising the Gain setpoint slowly, then reducing the Gain setpoint little by little until the actuator position is stable.

Next, give external disturbances to the engine to observe the total control response. The method to give an external disturbance is to make a step load change of the generator driven by the engine, or to push the actuator output shaft or the fuel rack toward the minimum fuel position by hand for a moment.

Check if the engine speed returns to the speed reference after a minimum overshoot (or undershoot). In case this overshoot (or undershoot) is too big, reduce the Reset value. If there is no overshoot (or undershoot) but the engine speed recovering time is too long, raise the Reset value.

If the engine hunts after raising the Reset value to minimize the time till the speed error due to the external disturbance disappears, raise the Reset value and Lower the Gain value.

Actuator Compensation Adjustment

Actuator Compensation is used to compensate the lag time of the fuel system including the actuator and the fuel valve for stabilizing the engine easier and improving the control response at transient states. Because the engine may hunt at a particular load due to the too-high Compensation value, do not increase the Compensation too much.

In case both good transient control response and the engine stability could not be obtained, increase the Compensation value a little and readjust the Gain and the Reset.

If the actuator seems to be jiggling due to the too-high Compensation, reduce the Compensation.

NOTICE

Make certain that the actuator position is above the minimum fuel position (mechanical stop) of the actuator when the engine is operated at Idle speed. Also make certain that the fuel valve is shut off completely before the actuator lever gets to its minimum position.

NOTICE

Make certain that Idle speed is outside of the engine's critical speed band.

Adjustment of Accel/Decel Ramp Time

ACCEL RAMP TIME is the time required for the control to ramp the engine speed from Idle speed to Rated speed. This is set in seconds.

Because too short an ACCEL RAMP TIME causes an overshoot when the engine speed arrive at Rated speed, set the ACCEL RAMP TIME estimating the size of overshoots.

DECEL RAMP TIME is the time required for the control to ramp the engine speed from Rated speed to Idle speed. This is set in seconds. Because too short a DECEL RAMP TIME causes undershoot when the engine speed arrives at Idle speed and the engine may shut down as the result, do not set too small of a value at DECEL RAMP TIME.

Adjustment of Speed Trim Inc/Dec Time

SPEED TRIM INC TIME is the time required for the control to ramp the generator frequency from the frequency lower limit to the frequency upper limit. This is set in seconds. If the values set at the RAISE and LOWER SPEED LIMIT are not equal to engine speeds at the generator frequency lower limit and the generator frequency upper limit, calculate the required time to raise the speed reference from the engine speed at the frequency lower limit to the engine speed at the frequency upper limit, and set SPEED TRIM INC TIME to this calculated time.

SPEED TRIM DEC TIME is the time required for the control to ramp the generator frequency from the frequency upper limit to the frequency lower limit. This is set in seconds. If the values set at the RAISE and LOWER SPEED LIMIT are not equal to engine speeds at the generator frequency lower limit and the generator frequency upper limit, calculate the required time to lower the speed reference from the engine speed at the frequency upper limit to the engine speed at the frequency lower limit, and set SPEED TRIM DEC TIME to this calculated time.

Adjusting Start Fuel Limit
The start fuel limit provides a limit to the fuel demand which prevents an overfuel condition during starting of the engine to the idle speed (or the rated speed).

Set START LIMITER MIN to the actuator output (%) for operating the engine at Start Speed. Set START LIMITER MAX to the value of START LIMITER MIN plus 10%. Set START LIM RAMP RATE to 3 (%/sec).

Start the engine after setting setpoints as above, and observe if the engine starts smoothly and if smoking occurs. Retune setpoints if necessary.

The start fuel limit function is cancelled automatically when the fuel control mode is switched from the start fuel limit mode to the speed control mode.

NOTICE

If the start fuel limit function is not used in each engine start, set both START LIMITER MIN and START LIMITER MAX to 100%. The start fuel limit function is cancelled by setting as above.

Speed Sensor Check

Observe the MPU signal voltage operating the engine at the idle speed and make certain the signal voltage is 1.0 Vrms or more. If the signal voltage measured is less than 1.0 Vrms, stop the engine and reinstall the MPU closer to the top of the gear tooth to raise the signal voltage at the idle speed. In case the idle speed is not used, check the MPU signal voltage at the rated speed.

Make certain that the voltage of the MPU signal is from 2.0 Vrms to 25.0 Vrms when the engine is operated at the rated speed. In case the voltage of the MPU signal at the rated speed is more than 25.0 Vrms, stop the engine and extend the gap between the MPU and the gear tops so that the voltage of the MPU signal at the rated speed is within 25.0 Vrms.

Current Transformer (CT) Phasing Check

NOTICE

This control contains internal current transformers. Due to their low impedance, shorting their inputs is not effective to check the CT input circuit when there is no input signal. The current input wirings must be removed from the control and shorted externally not to develop dangerously high voltages.

⚠WARNING

Never disconnect any wires 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 4-11, and all load is removed. The current transformers can develop dangerously high voltages when open circuited while the prime mover is running.

1. Start the engine. With the generator operating in the isochronous mode and not paralleled, load the generator to as near to full load as possible. Operate the generator at the stated Power Factor as close to 1.0 as possible, in the range of −0.9 to +0.9.

2. 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 are equal and the difference between the measured current and the displayed value at MONITOR/CT AMPS VAL (A) under L** KW SENSOR CALIBRATION ** header is within 10% of the measured current.

3. Set CT AMPS CAL @ RATED LOAD under L** KW SENSOR CALIBRATED ** header in Service menus to the measured current value above.

4. If the difference between the measured current and the displayed value at step 1 above is within 10%, the PT/CT phasing is correct. Otherwise, PT/CT phasing is incorrect. If the phasing is incorrect, proceed to the next section, Phase Correction Procedure.

NOTICE

After completing Load Calibration Adjustment and Droop Adjustments, if the generator load seems to be excessively influenced by the power factor fluctuation when operating in parallel, retry Phase Correction Procedure more strictly.

NOTICE

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 (like MONITOR/CT AMPS VAL (A) under LKW SENSOR CALIBRATION**) 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

NOTICE

This procedure requires a minimum power factor of 0.9. 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 check indicates incorrect phasing, or if 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 about 0.2; therefore, a negative reading indicates 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 or short the current transformers. Figure 4-32 shows recommended connections for current transformers.

⚠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 A, 20 W resistors are installed as shown in Figure 4-11, and all load is removed.

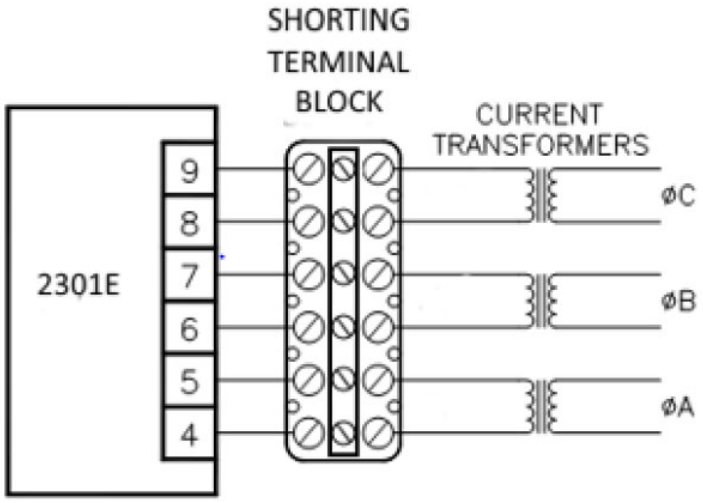


Figure 4-32. Temporary Wiring for Transformer Phase Correction

If the shorting terminal block is 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 Control Assistant menu L**KW SENSOR CALIBRATION** or the 2301E-J Toolkit Service Tool. Observe 04 MONITOR/CT AMPS VAL (A) 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 2301E-J will only read a small negative value.

1. Shut down the prime mover.

⚠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 A, 20 W resistors are installed as shown in Figure 4-32, and all load is removed.

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. Using the Shorting Terminal block, screw in the screw that shorts the phase B phase CT wires from terminals 6 and 7. Remove the wires on terminals 6 and 7 on the 2301E-J.
4. Using the Shorting Terminal block, screw in the screw that shorts the phase C phase CT wires from terminals 8 and 9. Remove the wires on terminals 8 and 9 on the 2301E-J.
5. Connect the two wires from the phase A phase 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, short the A phase CT and reverse the phase A CT wires on terminals 4 and 5. Un-short the A phase CT.
8. Apply full load, monitor the load sensor, and record this value.
9. Unload the system, Short the A phase CT remove phase A CT wires from terminals 4 and 5, and connect them to phase B input terminals 6 and 7. Un-short the A Phase CT.
10. Apply full load, monitor the load sensor, and record this value.

11. Unload the system, short the A phase CT and reverse the phase A CT wires on terminals 6 and 7. Un-short the A phase CT.
12. Apply full load, monitor the load signal, and record this value.
13. Unload the system, short the A phase CT, remove phase A CT wires from terminals 6 and 7, and connect them to phase C input terminals 8 and 9. Un-short A phase CT.
14. Apply full load, monitor the load sensor, and record this value.
15. Unload the system, short the A phase CT 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. Short the A Phase CT, remove the phase A CT wires from terminals 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. Un-short the B phase CT and connect the B phase CT wires to terminals 6 and 7.
20. Un-short B phase CT, apply full load and measure the load signal. Start a new list and record this reading.
21. Unload the system, short the B phase CT, and reverse the phase B CT wires on the same terminals. Un-short the B phase CT.
22. Apply full load, measure the load signal, and record this reading.
23. Unload the system, short the B Phase CT and remove phase B CT wires, and connect them to terminals 8 and 9.
24. Un-short the B Phase CT and apply full load, measure the load signal, and record this reading.
25. Unload the system, short the B phase CT and reverse phase B CT wires on the same terminals.
26. Un-short the B phase CT and apply full load and measure the load signal. Record this reading and compare the four readings on the list.
27. Unload the system, short the B phase CT. 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. Connect these C phase CT wires to terminals 8 and 9.
29. Un-short the C phase CT, apply full load, measure the load signal, and record this reading.
30. Unload the system, short the C phase CT and reverse the C phase CT wires on the same terminals.
31. Un-short the C phase CT, 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 C phase 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. Verify all CTs are not shorted on the terminal block.

Load Calibration Adjustment

Start the engine and operate in a mode independent of PT and CT signal, such as a single isochronous operation.

First, set the ENTER GEN RATED LOAD (KW) setpoint to the rated generator output in kW. ENTER GEN RATED LOAD (KW is under A**ENGINE & SPEED** header in Configure menus.

1. Start the engine and operate with no load.
2. Record the reading of MONITOR/CT AMPS VAL (A) under L**KW SENSOR CALIBRATION** in Service menus. This is the CT signal at the load detection circuit.
3. Input the reading above to CT AMPS CAL @ ZERO LOAD under L**KW SENSOR CALIBRATION** in Service menus.
4. Apply full load to the generator.
5. Record the reading of MONITOR/CT AMPS VAL (A) under L**KW SENSOR CALIBRATION** in Service menus again.
6. Input the reading above to CT AMPS CAL @ RATED LOAD under L**KW SENSOR CALIBRATION** in Service menus.
7. Read the percent generator load at MONITOR/GEN LOAD (%LOAD) under L**KW SENSOR CALIBRATION** header in Service menus, then check if this value is equal to the percentage of the generator load displayed on the gear box to the rated generator kW .
8. If they were not equal, tune CT AMPS CAL @ RATED LOAD setpoint under L** KW SENSOR CALIBRATION** header in Service menus until they are equal.

If the adjustment above is completed, change the generator load from the minimum to the maximum, observing GENERATOR OUT (KW) under R**DISPLAY MENU** header and the generator load displayed on the gear box to make certain they are equal at full load range.

NOTICE

If the control's generator load display differs from the generator load display on the gear box even though the phasing for PTs and CTs have been checked and are correct, the current transformers are probably the wrong size. The current-transformer output must be from 3 to 7 A (5A nominal) at full load.

NOTICE

The CT input signal must be lower than 7.2 A, because the kW sensor circuit cannot detect the correct generator load if the CT input current is 7.2 A or more. This may cause an overload, resulting in damage to the engine, the generator or facilities. To prevent this damage the CT input signal must be lower than 7.2 A

When engine-generator sets paralleling in isochronous mode are connected to a common load through a bus line, the signal voltage ranges of all load paralleling lines must be the same. The 2301E-J's factory setting of 0-100% load paralleling signal corresponds to 0-3 V load paralleling line voltage. If the load difference between generators increases as the common load increases, improve the load balance by changing the load reference voltage at the rated load. The load reference voltage at the rated load is tuned at the setpoint below.

Service menus: L**KW SENSOR CALIBRATION**
03: LD GAIN(V) @100%LOAD - - -
Initial setpoint=6.00

Lower this setpoint to increase the load sharing portion.
Raise this setpoint to decrease the load sharing portion.

When this control parallels with a Woodward 2301A LSSC, the LOAD SIGNAL of the 2301A might not be set to 6.0 V. In such a case, operate the 2301A LSSC with full load and measure the LOAD SIGNAL. Set LD GAIN (V) @ 100% LOAD setpoint in the 2301E-J to this measured value later.

Droop Adjustment

The 2301E-J has two droop functions, kW droop and speed droop. Select the droop function from Configure menus. The selection cannot be changed while the engine is operating.

Configure menu: C**OPTIONAL FUNCTIONS**
02: SET GOVERNOR TYPE (1-3)

Select ‘1’ to use/enable kW droop.
Select ‘2’ or ‘3’ to use/enable speed droop.

NOTE: When selecting “2:Simple Speed Droop/Alone Iso” or “3:Simple Speed Gov for GCP” at the setpoint above: because the available operation modes are limited to “a single operation on an isolated bus in Speed droop mode”, “a parallel operation with the mains in speed droop mode” and “a single operation in isochronous mode” is the result.

The droop rate is adjusted at the setpoint below.
Service menu: J** LOAD SETTINGS **
01: DROOP PERCENT

In kW droop operation, the generator frequency will be lowered by the droop rate set at the setpoint above when the generator is operated at the rated generator kW.

In speed droop operation, the generator frequency will be lowered by the droop rate set at the setpoint above when the actuator output is 100%. To get the proper droop rate for generator operations, operate the generator and record the actuator output at no load and at full load, then calculate the difference between at full load and at no load. The quotient for the demanding droop rate divided by the difference above should be set to the setpoint above. (For instance, if the actuator output difference between the no load and the rated generator load is 60% and the generator system demands 5% speed droop, set Droop Percent to 8.3)

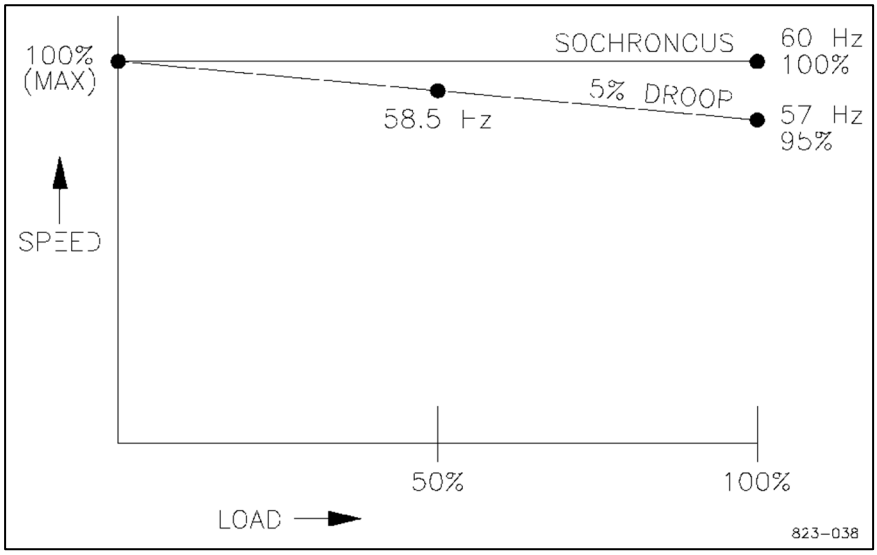


Figure 4-33. Droop Adjustment

Chapter 5.
Troubleshooting

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

The control can be damaged with the wrong voltage. 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 in good working order. Make the checks in the order indicated. Various system checks assume that the prior checks have been properly done.

⚠WARNING

TO PROTECT AGAINST POSSIBLE PERSONAL INJURY, LOSS OF LIFE, and/or PROPERTY DAMAGE WHEN STARTING the engine, turbine, or other type of prime mover, BE PREPARED TO MAKE AN EMERGENCY SHUTDOWN to protect against runaway or overspeed should the mechanical-hydraulic governor(s), or electric control(s), the actuator(s), fuel control(s), the driving mechanism(s), the linkage(s), or the controlled device(s) fail.

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.

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 like CPU failure, then the control will blink the red status LED to indicate that the engine control program has stopped.

When the user enters into Configure mode at the Watch Window screen, an I/O Lock command is sent to the control and the red status LED will blink to indicate the engine control program has stopped. The red status LED will stop blinking when I/O Lock is canceled, and the CPU resumes execution of the engine control program.

NOTICE

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

Control Test and Calibration

Test Environment Setting

Install Toolkit to a computer and connect it to the communication port. Start Toolkit software in accordance with the instructions in Chapter 4.

Verification of Setpoints Storage Function

Follow the procedure below to check if changed setpoints are stored correctly into EEPROM.

Select A** DYNAMICS #1 ** or C** DYNAMICS #1 5 PT GAIN ** in the Service menu. Verify that all setpoints are as recorded during installation. Repeat for the other menus. If any differences are found, change the setpoint(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 indicates the control has failed and should be replaced.

Discrete Inputs

Do the following test to verify the function of the discrete inputs. Do NOT do this test while the engine is running.

Repeat this step for all discrete inputs. Close the appropriate input. The status in O** DISPLAY D_I/O STATES** should switch from ‘Open’ to ‘Closed’. If either the value does not change following the contact state change, or the value changes although the contact state is not changed, the control has failed and should be replaced.

Discrete Outputs

To verify operation of the Discrete Outputs, go to S**D/O AND A/O TEST** in the Service menu.

With the engine shut down, enable the manual relay driver test. Go to each setpoint under the S**D/O AND A/O TESTS** header and turn the setpoint value from ‘False’ to ‘True’, then ‘True’ to ‘False’, monitoring the output voltage at discrete outputs DO1 – DO4. From the relay test procedure, each discrete output may be activated, and its operation verified. If the output is activated, the same voltage as applied at terminals 39 and 40 should be measured between terminal 39 and the appropriate output terminals (41–44). Testing of the internal load sharing line relay can be done by observing the green LED near terminal 9 and 10 or hearing an audible ‘click’. Enable Manual Driver Test setpoint must be set to ‘False’ when this test completed.

Troubleshooting Guide

Table 5-1. 2301E-J Troubleshooting Chart

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 supply voltage is too low.	On power up, the red CPU STATUS LED should come on for 30 seconds, then 2301E-J will enter the normal operation mode. Check for proper voltage from terminals 45(+) to 46(−) if CPU STATUS LED does not illuminate on power up or it does not extinguish when 30 seconds passed. 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 correct voltage and current output at control terminals 13(+) and 14(–), but the actuator does not work, the wiring to the actuator should be checked for opens or shorts. With an EG3P or the EG10P actuator, remember that terminals C and D of the mating plug should be jumpered. Make resistance checks at the actuator. Coil resistance on 20-160 mA actuator should be 20-40 Ω. Coil resistance on 4-20 mA actuator should be approximately 250 Ω. (Read with leads at terminals 13 and 14 disconnected.)
	Start limiter min/max set too low	Check Act Out/Fuel Demand (%) in DISPLAY ANALOG I/O VAL Menu. If it is not going to Start Limiter value when cranking, check to see Engine Speed (RPM) is reading cranking speed. If Act Out/Fuel Demand is too low although the engine speed is sensed normally, increase the Start Fuel Limit.
	Actuator or linkage	Check actuator and 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. Stop the engine and close switches on terminal 31 (RUN/STOP ENGINE) and terminal 33 (OVERRIDE SPEED FAILSAFE). Check for 20 V at terminals 13 and 14 for forward acting controls, and approximate 0 V for reverse acting controls.
	Speed setting too low on initial start.	Monitor Engine Speed display at the engine start. If the Speed Reference is lower than the lower limit of the engine's operable speed, check setpoints in Configure menus and Service menus.
	RUN/STOP ENGINE contact open.	Check terminal 31. RUN/STOP ENGINE contact must be closed for normal operation. Check for 24 Vdc from terminal 31(+) to 30(–).

Table 5-1. 2301E-J Troubleshooting Chart (cont'd.)

Symptom	Cause	Solution
Prime mover will not start Actuator not moving to start fuel position (cont'd.)	Speed sensor signal not clearing failed speed signal circuit	If the engine stopped but the RUN/STOP ENGINE contact remained closed after the engine speed has exceeded the idle speed, the failed speed signal is enabled. Because the actuator output is forced to 0% while the failed speed is enabled, the engine cannot be started unless the failed speed signal is reset. Failed speed signal circuit may be disabled by connecting terminal 28 to terminal 33. **⚠WARNING** ***BE PREPARED TO MAKE AN EMERGENCY SHUTDOWN to protect against runaway or over speeding.***
	Faulty 2301E-J control	Replace.
	Ramp adjustment	Increase Accel Ramp Time (SEC). This decreases acceleration rate (from idle to rated) and an overshoot.
	Speed setting at start too high	Monitor Speed Reference until the engine start completes. Check if all speed setpoints are entered correctly. If there is any wrong setpoint, correct it referring the explanation in Chapter 4.
Prime mover overspeeds only on starts	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.
	Determine if engine is malfunctioning	Verify that fuel rack is not binding, and linkage is properly adjusted. Determine if the fuel rack is quickly following the actuator input voltage. Check operation of overspeed protection device(s).
Prime mover over speeds or causes excessive smoke only on start	Start Fuel Limit is inactive	Power up 2301E-J 30 seconds before cranking engine.
	2301E-J control	If the control does not cut back the actuator voltage [terminals 13(+) and 14(–)] when engine speed is greater than speed reference, the control may be programmed for the wrong speed range. Monitor Speed Reference display and check if it is correct. If the voltage is cut back, look for a problem in the linkage or actuator.

Table 5-1. 2301E-J Troubleshooting Chart (cont'd.)

Symptom	Cause	Solution
Prime mover sometimes overspeeds at rated speed operations	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 2301E-J control's speed sensor circuit	Check the magnetic pickup output voltage at speeds above idle—at least 1.0 Vrms. Check for at least 1.0 Vrms at terminals 25 and 26 during engine running. If less than 1.0 V, 2301E-J cannot sense engine speed normally. Readjust the sensor gap. If the magnetic pickup output voltage at rated speed is higher than 2.0 Vrms, replace the control.
	2301E-J control	Control the prime mover manually at rated speed. If the Engine Speed reading in the Display Menu does not match external indicators, the control is not configured properly. Check Configure menus. When the engine speed value is greater than the speed reference value, the actuator output should go to zero percent. If speed range is correct for the application, replace the control.
Low speed is not regulated by Enter Idle Speed setpoint	Supplied fuel to the engine is greater than actuator output ***IMPORTANT*** **On carbureted prime movers with a pilot outlet, the minimum fuel stop rpm setting will vary with prime mover temperature. An improper cold setting may give interference with the idle speed setting when the prime mover is hot.**	The Enter Idle Speed setting may be lower than the idle speed given by positioning the carburetor valve to its minimum position. In this case, the output voltage to the actuator will be zero. For such an engine, readjust the pilot outlet of the carburetor. In case of diesel engines, the engine operation may be maintained at the minimum fuel position by the actuator or the prime mover minimum fuel stop. The conditions above indicate that the prime mover minimum fuel position should be decreased by linkage adjustment or Enter Idle Speed setting should be raised. If this action does not correct the problem, the 2301E-J control may be faulty.
Prime mover does not decelerate when SELECT IDLE/RATED SPEED contact is open	Faulty SELECT IDLE/RATED SPEED discrete input	Check the contact. Remove wire from terminal 32. Prime mover should decelerate. Otherwise, the discrete input is faulty.
	2301E-J control	Review the idle speed setpoint referring "Initial Prestart Setpoint inputs" in Chapter 4. Readjust Gain, Reset, and Actuator Compensation as described in "Start-up adjustment" in Chapter 4.

continued . . .

Table 5-1. 2301E-J Troubleshooting Chart (cont'd.)

Symptom	Cause	Solution
. . .continued Prime mover does not decelerate when SELECT IDLE/RATED SPEED contact is open	Speed reference controls	Check display menu. The Speed Reference value should be constant. If Speed Reference is erratic, check remote input (if any remote speed setting transmitter or synchronizer is used), or 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 diesel prime movers. Be sure linkage is non-linear on carbureted prime movers. Refer to actuator manual for proper installation.
Prime mover will not stabilize at rated speed. The instability occurs especially at no load	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. **⚠CAUTION** ***Do not perform these tests in other than single-unit operating configuration.*** Jumper terminal 28 to terminal 32 and remove wires to SELECT IDLE/RATED SPEED contact. Remove wires to terminals 10, 11, 34-38, 19, and 20. Connect terminal 28 to terminal 31via the RUN/STOP switch. Jumper terminal 29 and 30. 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 when testing the control. 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.
		If external wiring causing speed instability is identified, the external wiring may require additional shielding or rerouting from high-current lines or components causing Electromagnetic Interference. Use double shielded wire if it is necessary. If the problem cannot be resolved by these checks, it will be necessary to remove the 2301E-J control 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 temporary separate battery placed next to the prime mover). After starting the prime mover, place a small jumper wire across terminals 28 to 32 and terminals 29 to 30 to cause the prime mover to accelerate to the rated speed. If necessary, apply load to check stability. 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 metallic conduit or an outer shield. Tie the outer shield to system ground at end opposite of the control. *continued . . .*

Table 5-1. 2301E-J Troubleshooting Chart (cont'd.)

Symptom	Cause	Solution
. . .continued Prime mover will not stabilize at rated speed. The instability occurs especially at no load	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. Check if actuator torque is enough to drive the fuel valve. Verify a steady fuel pressure of proper value. Check actuator per appropriate actuator manual.
	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. It must also be lower than 40 Vdc.
	Prime mover not receiving fuel as called for by the governor	If voltage to actuator is maximum, visually determine if actuator shaft is at maximum position. If it is not, an actuator problem is indicated, or the linkage or fuel system is restricted. If it is, suspect the fuel system.
Prime mover does not share load with other units.	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 at rated load in single unit configuration, Load Gain (V) must be set at 6.0 Vdc. See Load Calibration Adjustment in Chapter 4.
	Generator circuit breaker auxiliary contact is open	Check Circuit breaker auxiliary contact. Check for 24 Vdc from terminal 30 to 38 on the control.
	Improper load sensing phasing	Perform Phase Correction Procedure in Chapter 4.
	Circulating currents between generators	Refer to appropriate voltage regulator manual.
	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 does not maintain constant speed (isochronous).	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.
Product Support and Service Options

Product Support Options

If you are experiencing problems with the installation, or unsatisfactory performance of a Woodward product, the following options are available:

1. Consult the troubleshooting guide in the manual.
2. Contact the **OE Manufacturer or Packager** of your system.
3. Contact the **Woodward Business Partner** serving your area.
4. Contact Woodward technical assistance via email (**EngineHelpDesk@Woodward.com**) with detailed information on the product, application, and symptoms. Your email will be forwarded to an appropriate expert on the product and application to respond by telephone or return email.
5. If the issue cannot be resolved, you can select a further course of action to pursue based on the available services listed in this chapter.

OEM or Packager Support: Many Woodward controls and control devices are installed into the equipment system and programmed by an Original Equipment Manufacturer (OEM) or Equipment Packager at their factory. In some cases, the programming is password-protected by the OEM or packager, and they are the best source for product service and support. Warranty service for Woodward products shipped with an equipment system should also be handled through the OEM or Packager. Please review your equipment system documentation for details.

Woodward Business Partner Support: Woodward works with and supports a global network of independent business partners whose mission is to serve the users of Woodward controls, as described here:

- A **Full-Service Distributor** has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.
- An **Authorized Independent Service Facility (AISF)** provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.
- A **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 current list of Woodward Business Partners is available at www.woodward.com/local-partner.

Product Service Options

Depending on the type of product, the following options for servicing Woodward products may be available through your local Full-Service Distributor or the OEM or Packager of the equipment system.

- 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 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.

Flat Rate Repair: Flat Rate Repair is available for many of the standard mechanical products and some of the electronic 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.

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. 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 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's Full-Service Distributors offer various Engineering Services for our products. For these services, you can contact the Distributor by telephone or by email.

- 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.

Product Training is available as standard classes at many Distributor locations. Customized classes are also available, which can be tailored to your needs and held at one of our Distributor 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 one of our Full-Service Distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface.

For information on these services, please contact one of the Full-Service Distributors listed at www.woodward.com/local-partner.

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory at www.woodward.com/support, where you may also find the most current product support and contact information.

You can also contact the Woodward Customer Service Department at one of the following Woodward facilities to obtain the address and phone number of the nearest facility at which you can obtain information and service.

Products Used in Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 8818 5515
Germany:	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (32) 422-5551
Poland	+48 (12) 295 13 00
United States	+1 (970) 482-5811

Products Used in Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 8818 5515
Germany	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+ 82 (32) 422-5551
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Products Used in Industrial Turbomachinery Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 8818 5515
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+ 82 (32) 422-5551
The Netherlands	+31 (23) 5661111
Poland	+48 (12) 295 13 00
United States	+1 (970) 482-5811

Technical Assistance

If you need to contact technical assistance, you will need to provide the following information. Please write it down here before contacting the Engine OEM, the Packager, a Woodward Business Partner, or the Woodward factory:

General

Your Name _____

Site Location _____

Phone Number _____

Fax Number _____

Prime Mover Information

Manufacturer _____

Engine Model Number _____

Number of Cylinders _____

Type of Fuel (gas, gaseous, diesel, dual-fuel, etc.) _____

Power Output Rating _____

Application (power generation, marine, etc.) _____

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Control/Governor #2

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Control/Governor #3

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Symptoms

Description _____

_____

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

Appendix A. Parameter List

Configure Menus

Table A-1. Configure Menus

Configure Menu	Range			Default	Set Value
AENGINE & SPEED CONTROL****					
01: ENTER RATED SPEED (RPM)	400	,	3600	750	
02: ENTER IDLE SPEED (RPM)	120	,	3600	375	
03: ENTER NUM OF GEAR TEETH	16	,	500	60	
04:ENTR REV RATIO MPU/CRANK	0	,	10	1	
05: ENTER FAILED SPD SENSE%	2	,	50	5	
06: USE START SPEED (T=1,F=0)	0	,	1	0	
07: USE 5 POINTS DYN MAP (T=1,F=0)	0	,	1	0	
08: 5P DYN CURV1 BY ACT(%FD) (T=1,F=0)	0	,	1	1	
09: 5P DYN CURV2 BY ACT(%FD) (T=1,F=0)	0	,	1	1	
10: USE 2nd RAMP TIME(DI&RMT) (T=1,F=0)	0	,	1	0	
11: USE IDLE SPEED DYNAMICS (T=1,F=0)	0	,	1	0	
12: ENTER GEN RATED LOAD(KW)	5	,	7500	1000	
13: GENERATOR NUMBER OF POLES	2	,	18	8	
14: GEN 50/60 Hz CONVT ENABLE (T=1,F=0)	0	,	1	0	
15: GEN LOAD CONVT RATIO FOR 50TO 60Hz	1	,	1.5	1.2	
16: GEN LOAD CONVT RATIO FOR 60TO 50Hz	0.6	,	1	0.83333	
BINPUT & OUTPUT OPTIONS****					
02: ACTUATOR OUT TYPE (1-5)	1	,	5	1	
04: ANA-IN1 INPUT TYPE(1-4)	1	,	4	3	
06: ANA-IN1 USED FOR :(1-7)	1	,	7	7	
08: ANA-IN2 INPUT TYPE(1-4)	1	,	4	1	
10: ANA-IN2 USED FOR :(1-7)	1	,	7	1	
11: DI-A STATUS INVERT (T=1,F=0)	0	,	1	0	
12: DI-B STATUS INVERT (T=1,F=0)	0	,	1	0	
13: DI-C STATUS INVERT (T=1,F=0)	0	,	1	0	
14: DI-D STATUS INVERT (T=1,F=0)	0	,	1	0	
15: DI-E STATUS INVERT (T=1,F=0)	0	,	1	0	
16: DI-F STATUS INVERT (T=1,F=0)	0	,	1	0	
17: DI-G STATUS INVERT (T=1,F=0)	0	,	1	0	
18: DI-H STATUS INVERT (T=1,F=0)	0	,	1	0	
20: DI-B INPUT USED FOR (1-6)	1	,	6	1	
22: DI-C INPUT USED FOR (1-6)	1	,	6	1	

Table A-1. Configure Menus (cont'd.)

Configure Menu	Range			Default	Set Value
23: DO-1 OUTPUT INVERT (T=1,F=0)	0	,	1	0	
24: DO-2 OUTPUT INVERT (T=1,F=0)	0	,	1	0	
25: DO-3 OUTPUT INVERT (T=1,F=0)	0	,	1	0	
26: DO-4 OUTPUT INVERT (T=1,F=0)	0	,	1	0	
27: RUN CMD ALM RST (T=1,F=0)	0	,	1	0	
COPTIONAL FUNCTIONS****					
02: SET GOVERNOR TYPE(1-3)	1	,	3	1	
03:USE DI R/L SPD IN GCP MD? (T=1,F=0)	0	,	1	0	
04: USE BASE LOAD CONTROL? (T=1,F=0)	0	,	1	0	
05:USE TORQUE FUEL LIMITER? (T=1,F=0)	0	,	1	0	
06: TQ LIM IN = ENGINE SPD? (T=1,F=0)	0	,	1	1	

Service Menus

Table A-2. Service Menus

Service Menu	Range			Default	Set Value
A DYNAMICS #1**					
01: IDLE PROP GAIN 1	0.01	,	50	1	
02: IDLE RESET 1	0.01	,	50	1	
03: RATED PROP GAIN 1	0.01	,	50	1	
04: RATED RESET 1	0.01	,	50	1	
05: ACT COMPE 1	0	,	5	0.1	
06: WINDOW WIDTH 1 (RPM)	0	,	100	10	
07: GAIN RATIO 1	1	,	20	1	
08:SPEED FILTER FREQ 1 (HZ)	4	,	20	20	
B DYNAMICS #2 ****					
01: USE 2ND DYNAMICS ?" (T=1,F=0)	0	,	1	0	
02: TRANSFER DYN-2 PT %LD	5	,	101	101	
03: PROP GAIN 2	0.01	,	50	1	
04: RESET 2	0.01	,	50	1	
05: ACT COMPE 2	0	,	5	0.1	
06: WINDOW WIDTH 2 (RPM)	0	,	100	10	
07: GAIN RATIO 2	1	,	20	1	
08:SPEED FILTER FREQ 2 (HZ)	4	,	20	20	
09: DYN-2 SEL BY ISO/DROOP DI(T=1,F=0)	0	,	1	0	
CDYNAMICS #1, 5 PT GAIN****					
01: IDLE PROP GAIN 1	0.01	,	50	1	
02: IDLE RESET 1	0.01	,	50	1	

Table A-2. Service Menus (cont'd.)

Service Menu	Range	Default	Set Value
03: GAIN BREAK POINT 1A (%LD)	0 , 100	25	
04: GAIN @BREAK POINT 1A	0.01 , 50	1	
05: GAIN BREAK POINT 1B (%LD)	0 , 100.1	100	
06: GAIN @BREAK POINT 1B	0.01 , 50	1	
07: GAIN BREAK POINT 1C (%LD)	0 , 100.2	100.1	
08: GAIN @BREAK POINT 1C	0.01 , 50	1	
09: GAIN BREAK POINT 1D (%LD)	0 , 100.3	100.2	
10: GAIN @BREAK POINT 1D	0.01 , 50	1	
11: GAIN BREAK POINT 1E (%LD)	0 , 100.4	100.3	
12: GAIN @BREAK POINT 1E	0.01 , 50	1	
13: RESET BREAK POINT 1A (%LD)	0 , 100	25	
14: RESET @BREAK POINT 1A	0.01 , 50	1	
15: RESET BREAK POINT 1B (%LD)	0 , 100.1	100	
16: RESET @BREAK POINT 1B	0.01 , 50	1	
17: RESET BREAK POINT 1C (%LD)	0 , 100.2	100.1	
18: RESET @BREAK POINT 1C	0.01 , 50	1	
19: RESET BREAK POINT 1D (%LD)	0 , 100.3	100.2	
20: RESET @BREAK POINT 1D	0.01 , 50	1	
21: RESET BREAK POINT 1E (%LD)	0 , 100.4	100.3	
22: RESET @BREAK POINT 1E	0.01 , 50	1	
23: ACT COMP BREAK POINT 1A (%LD)	0 , 100	25	
24: ACT COMP @BREAK POINT 1A	0 , 5	0.1	
25: ACT COMP BREAK POINT 1B (%LD)	0 , 100.1	100	
26: ACT COMP @BREAK POINT 1B	0 , 5	0.1	
27: ACT COMP BREAK POINT 1C (%LD)	0 , 100.2	100.1	
28: ACT COMP @BREAK POINT 1C	0 , 5	0.1	
29: ACT COMP BREAK POINT 1D (%LD)	0 , 100.3	100.2	
30: ACT COMP @BREAK POINT 1D	0 , 5	0.1	
31: ACT COMP BREAK POINT 1E (%LD)	0 , 100.4	100.3	
32: ACT COMP @BREAK POINT 1E	0 , 5	0.1	
33: WINDOW WIDTH 1 (RPM)	0 , 100	10	
34: GAIN RATIO 1	1 , 20	1	
35:SPEED FILTER FREQ 1 (HZ)	4 , 20	20	

Table A-2. Service Menus (cont'd.)

Service Menu	Range			Default	Set Value
DDYNAMICS #2, 5 PT GAIN****					
01: USE 2ND 5PT DYNAMICS ? (T=1,F=0)	0	,	1	0	
02: TRANSFER DYN-2 PT %LD	5	,	101	101	
03: BREAK POINT 2A (%LD)	0	,	100	25	
04: GAIN @BREAK POINT 2A	0.01	,	50	1	
05: BREAK POINT 2B (%LD)	0	,	100.1	100	
06: GAIN @BREAK POINT 2B	0.01	,	50	1	
07: BREAK POINT 2C (%LD)	0	,	100.2	100.1	
08: GAIN @BREAK POINT 2C	0.01	,	50	1	
09: BREAK POINT 2D (%LD)	0	,	100.3	100.2	
10: GAIN @BREAK POINT 2D	0.01	,	50	1	
11: BREAK POINT 2E (%LD)	0	,	100.4	100.3	
12: GAIN @BREAK POINT 2E	0.01	,	50	1	
13: RESET BREAK POINT 2A (%LD)	0	,	100	25	
14: RESET @BREAK POINT 2A	0.01	,	50	1	
15: RESET BREAK POINT 2B (%LD)	0	,	100.1	100	
16: RESET @BREAK POINT 2B	0.01	,	50	1	
17: RESET BREAK POINT 2C (%LD)	0	,	100.2	100.1	
18: RESET @BREAK POINT 2C	0.01	,	50	1	
19: RESET BREAK POINT 2D (%LD)	0	,	100.3	100.2	
20: RESET @BREAK POINT 2D	0.01	,	50	1	
21: RESET BREAK POINT 2E (%LD)	0	,	100.4	100.3	
22: RESET @BREAK POINT 2E	0.01	,	50	1	
23: ACT COMP BREAK POINT 2A (%LD)	0	,	100	25	
24: ACT COMP @BREAK POINT 2A	0	,	5	0.1	
25: ACT COMP BREAK POINT 2B (%LD)	0	,	100.1	100	
26: ACT COMP @BREAK POINT 2B	0	,	5	0.1	
27: ACT COMP BREAK POINT 2C (%LD)	0	,	100.2	100.1	
28: ACT COMP @BREAK POINT 2C	0	,	5	0.1	
29: ACT COMP BREAK POINT 2D (%LD)	0	,	100.3	100.2	
30: ACT COMP @BREAK POINT 2D	0	,	5	0.1	
31: ACT COMP BREAK POINT 2E (%LD)	0	,	100.4	100.3	
32: ACT COMP @BREAK POINT 2E	0	,	5	0.1	
33: WINDOW WIDTH 2 (RPM)	0	,	100	10	
34: GAIN RATIO 2	1	,	20	1	
35:SPEED FILTER FREQ 2 (HZ)	4	,	20	20	

Table A-2. Service Menus (cont'd.)

Service Menu	Range	Default	Set Value
D+ACTUATOR BUMP TEST****			
01: BUMP VALUE (%)	-20 , 20	0	
02: BUMP DURATION (SEC)	0 , 3	0.5	
03: BUMP TRIGGER	FALSE , TRUE	FALSE	
ESTART/MAX LIM SETTINGS****			
01: START LIMITER MIN (%FD)	0 , 100	30	
02: START LIMITER MAX (%FD)	0 , 100	40	
03:START LIM RAMP RATE(%/S)	0 , 30	3	
04: MAXIMUM FUEL LIMIT(%FD)	0 , 101	100	
05: DI FUEL LIMIT (%FD)	0 , 101	100	
06: DI FUEL LIMIT RATE (%/SEC)	0 , 101	10	
07: FUEL LIMIT OFFSET (%FD)	10 -100	100	
FTORQUE LIM SETTINGS****			
01: SPEED REF Input P1(rpm)	0 , 4000	0	
02: TORQUE LIM OUT P1(%)	0 , 105	100	
03: SPEED REF Input P2(rpm)	0 , 4000	300	
04: TORQUE LIM OUT P2(%)	0 , 105	100	
05: SPEED REF Input P3(rpm)	0 , 4000	500	
06: TORQUE LIM OUT P3(%)	0 , 105	100	
07: SPEED REF Input P4(rpm)	0 , 4000	700	
08: TORQUE LIM OUT P4(%)	0 , 105	100	
09: SPEED REF Input P5(rpm)	0 , 4000	800	
10: TORQUE LIM OUT P5(%)	0 , 105	100	
GBOOST A/P LMTR SETTING****			
01: BOOST A/P INPUT P1(KPa)	0 , 4000	0	
02: BOOST A/P Limiter P1(%)	0 , 3500	100	
03: BOOST A/P INPUT P2(KPa)	0 , 3500	150	
04: BOOST A/P Limiter P2(%)	0 , 105	100	
05: BOOST A/P INPUT P3(KPa)	0 , 3500	200	
06: BOOST A/P Limiter P3(%)	0 , 105	100	
07: BOOST A/P INPUT P4(KPa)	0 , 3500	250	
08: BOOST A/P Limiter P4(%)	0 , 105	100	
09: BOOST A/P INPUT P5(KPa)	0 , 3500	300	
10: BOOST A/P Limiter P5(%)	0 , 105	100	
11:SENSOR SCALE Set @MIN(%)	-110 , 110	0	
12: SENSOR SCALE @MIN(KPa)	-1500 , 1500	0	
13:SENSOR SCALE Set @MAX(%)	-110 , 110	100	
14: SENSOR SCALE @MAX(KPa)	-1500 , 1500	500	

Table A-2. Service Menus (cont'd.)

Service Menu	Range	Default	Set Value
H SPEED CNTRL SETTINGS ****			
01: START SPEED (RPM)	100 , 3600	188	
02: RAISE SPEED LIMIT (RPM)	400 , 4140	788	
03: LOWER SPEED LIMIT (RPM)	120 , 3600	675	
04: START ACCEL TIME (SEC)	1 , 120	15	
05: ACCEL RAMP TIME (SEC)	1 , 120	15	
06: DECEL RAMP TIME (SEC)	1 , 120	10	
07:SPEED TRIM INC TIME(SEC)	1 , 300	30	
08:SPEED TRIM DEC TIME(SEC)	1 , 300	30	
09:SPD TRIM 2ND INC TIME(S)	1 , 600	60	
10:SPD TRIM 2ND DEC TIME(S)	1 , 600	60	
11: ACT DITHER AMP (mA p-p)	0 , 30	0	
12: USE EMERGENCY START? (T=1,F=0)	0 , 1	0	
13: EMERGENCY START TIME(S)	1 , 40	5	
14: GEN, 50/60Hz CONVERT (T=1,F=0)	0 , 1	0	
15: AUTO IDLE TIME(SEC)	0 , 3600	0	
I REMOTE SPD SETTINGS ****			
01: RMT SPEED MAX (RPM)	400 , 4140	788	
02: RMT SPEED MIN (RPM)	120 , 3600	675	
03: RMT SPEED INC TIME(SEC)	1 , 300	30	
04: RMT SPEED DEC TIME(SEC)	1 , 300	30	
05: RMT SPD 2ND INC TIME(S)	1 , 600	60	
06: RMT SPD 2ND DEC TIME(S)	1 , 600	60	
J LOAD SETTINGS ****			
01: DROOP PERCENT	0 , 20	3	
02: DROOP INITIAL LOAD (%LD)	0 , 50	10	
03: UNLOAD LIMIT (%LOAD)	0 , 50	10	
04: LOADING RATE (%/SEC)	0.1 , 100	3	
05: UNLOADING RATE (%/SEC)	0.1 , 100	3	
06: BASELOAD MINIMUM (%LD)	3 , 100	10	
07: BASELOAD MAXIMUM (%LD)	3 , 120	100	
08:BASELOAD RAISE RATE(%/S)	0.1 , 100	3	
09:BASELOAD LOWER RATE(%/S)	0.1 , 100	3	
10: KW SET AT MIN INPUT (KW)	-10000 , 0	0	
11: KW SET AT MAX INPUT (KW)	0 , 10000	1500	
12: ACTOUT POSI AT 0% LD	0 , 100	0	
13: ACTOUT POSI AT 100% LD	0 , 100	100	

Table A-2. Service Menus (cont'd.)

Service Menu	Range	Default	Set Value
K REMOTE BASELOAD SET ****			
01: RMT BASELOAD MAX (%LD)	3 , 120	100	
02: RMT BASELOAD MIN (%LD)	3 , 100	10	
03:RMT B_LOAD INC RATE(%/S)	0.1 , 100	3	
04:RMT B_LOAD DEC RATE(%/S)	0.1 , 100	3	
L KW SENSOR CALIBRATION****			
01: CT AMPS CAL @ZERO LOAD	-100 , 100	0	
02: CT AMPS CAL @RATED LOAD	1 , 7	5	
03: LD GAIN(V) @100%LOAD	0.1 , 7.5	6	
MANALOG/PWM OUTPUT SETTINGS****			
02: ANALOG OUTPUT SEL (1-5)	1 , 5	1	
03:ANALOG OUT ITEM VAL @4mA	0 , 10000	0	
04:ANALOG OUT ITEM VAL@20mA	0 , 10000	1000	
05: ANALOG OUT 4mA FINE ADJ	-20 , 20	0	
06:ANALOG OUT 20mA FINE ADJ	80 , 120	100	
09: ACT OUTPUT SEL (1-5)	1 , 5	1	
10:ACT OUT ITEM VAL @4mA	0 , 10000	0	
11:ACT OUT ITEM VAL@20mA	0 , 10000	1000	
12: ACT OUT 4mA FINE ADJ	-20 , 20	0	
13:ACT OUT 20mA FINE ADJ	80 , 120	100	
15: PWM DUTY CYCLE AT DEMAND=0%	0 , 100	10	
16: PWM DUTY CYCLE AT DEMAND=100%	0 , 100	90	
17: PWM DUTY CYCLE MIN LIMIT	0 , 100	10	
18: PWM DUTY CYCLE MAX LIMIT	0 , 100	90	
18: PWM HZ	300 , 2000	500	
NDISCRETE OUT SETTINGS****			
02: CHOSE D/O #1 ITEM (1-11)	1 , 11	5	
04: CHOSE D/O #2 ITEM (1-11)	1 , 11	1	
06: CHOSE D/O #3 ITEM (1-11)	1 , 11	2	
08: CHOSE D/O #4 ITEM (1-11)	1 , 11	6	
09: SPEED SW, PICK-UP(RPM)	10 , 4320	600	
10: SPEED SW, DROP-OUT(RPM)	10 , 4320	563	
11: LD SW, PICK-UP LD (KW)	0 , 7500	500	
12: LD SW, DROP-OUT LD (KW)	0 , 7500	490	

Table A-2. Service Menus (cont'd.)

Service Menu	Range			Default	Set Value
N+LEVEL SW SETTINGS****					
02: LEVEL SWITCH INPUT SELECT	1	,	5	1	
03: LEVEL SWITCH SET (SINGLE POINT)	-3500	,	3500	0	
04: USE 5P LEVEL SWITCH REF (T=1,F=0)	0	,	1	0	
06: 5P CURVE REFERENCE SEL	1	,	5	1	
07: REF BREAK POINT A	-3500	,	3500	0	
08: LEVEL @BREAK POINT A	-3500	,	3500	100	
09: REF BREAK POINT B	-3500	,	3500	25	
10: LEVEL @BREAK POINT B	-3500	,	3500	100	
11: REF BREAK POINT C	-3500	,	3500	50	
12: LEVEL @BREAK POINT C	-3500	,	3500	100	
13: REF BREAK POINT D	-3500	,	3500	75	
14: LEVEL @BREAK POINT D	-3500	,	3500	100	
15: REF BREAK POINT E	-3500	,	3500	100	
16: LEVEL @BREAK POINT E	-3500	,	3500	100	
17: LEVEL ON-OFF OFFSET	0	,	1000	0	
18: LEVEL OUTPUT ON-DEALY (SEC)	0	,	600	0	
19: LEVEL OUTPUT OFF-DEALY (SEC)	0	,	600	0	
R DISPLAY MENU ****					
13: PEAK SPEED RECRD, RESET	FALSE	,	TRUE	FALSE	
SD/O AND A/O TESTS****					
01:ENABLE MANUAL DRIVR TEST	FALSE	,	TRUE	FALSE	
03: FORCE TURN ON DO-1	FALSE	,	TRUE	FALSE	
04: FORCE TURN ON DO-2	FALSE	,	TRUE	FALSE	
05: FORCE TURN ON DO-3	FALSE	,	TRUE	FALSE	
06: FORCE TURN ON DO-4	FALSE	,	TRUE	FALSE	
07: TURN ON L/S LINE RELAY	FALSE	,	TRUE	FALSE	
08: ADJUST ANALOG OUT VAL(%)	0	,	100	0	
09: ADJ ACT/DEMAND VAL(%)	0	,	100	0	
10: ADJ ACTOUT (POS CONT=PWM) VAL(%)	0	,	100	0	
TALARM****					
13: ANALOG INPUT-1 FAIL DELAY(SEC)	0	,	60	0	
14: ANALOG INPUT-2 FAIL DELAY(SEC)	0	,	60	0	
15: LOAD_SAHRING VOLT FAIL DELAY(SEC)	0	,	60	1	
16: CT INPUT FAIL DELAY(SEC)	0	,	60	3	
17: NOT USE OVERSPEED TRIP (T=1,F=0)	0	,	1	0	
18: OVERSPEED TRIP SET (%/RTD)	100	,	150	117	
19: OVER SPEED TEST	FALSE	,	TRUE	FALSE	
20: ALARM RESET	FALSE	,	TRUE	FALSE	

Revision History

Changes in Revision A—

- Added Lockout/Tagout and IOLOCK warnings
- Updated Electrostatic Discharge Awareness section
- Updated Regulatory Compliance section and added United Kingdom Compliance for UKCA Marking
- Updated Declarations and added UKCA Conformity Declarations

Declarations

EU DECLARATION OF CONFORMITY

EU DoC No.:	00448-04-EU-02-01
Manufacturer's Name:	WOODWARD INC.
Manufacturer's Contact Address:	1041 Woodward Way Fort Collins, CO 80524 USA
Model Name(s)/Number(s):	2300E, 2301E
The object of the declaration described above is in conformity with the following relevant Union harmonization legislation:	Directive 2014/34/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility (EMC) Directive 2014/35/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits
Markings in addition to CE marking:	Ex II 3 G, Ex ec IIC T3 Gc Ex II 3 G, Ex ec IIC T4 Gc
Applicable Standards:	
ATEX:	EN IEC 60079-0, 2018: Explosive Atmospheres - Part 0: Equipment – General requirements EN 60079-7:2015, EN IEC 60079-7:2015/A1:2018: Explosive Atmospheres - Part 7: Equipment protection by type of protection "ec"
EMC:	EN 61000-6-2:2005, EN61000-6-2:2005/AC: 2005: EMC Part 6-2: Generic Standards - Immunity for Industrial Environments EN 61000-6-4:2007, EN 61000-6-4:2007/A1:2011: EMC Part 6-4: Generic Standards - Emissions for Industrial Environments
LVD:	EN 61010-1:2010, EN 61010-1:2010/A1:2019/AC:2019-04, EN 61010-1:2010/A1:2019 - Electrical Equipment for measurement, control, and laboratory use – Part 1: General requirements

This declaration of conformity is issued under the sole responsibility of the manufacturer
We, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s).

MANUFACTURER

Annette Lynch

Signature

Annette Lynch

Full Name

Engineering Manager

Position

Woodward, Fort Collins, CO, USA

Place

07 July 2023

Date

5-09-1183 Rev 39

UKCA DECLARATION OF CONFORMITY

UKCA DoC No.: 00448-04-UKCA-02-01
Manufacturer's Name: WOODWARD INC.

Manufacturer's Contact Address: 1041 Woodward Way
Fort Collins, CO 80524 USA

Model Name(s)/Number(s): 2300E, 2301E

Markings in addition to CE marking: Ex II 3 G, Ex ec IIC T3 Gc
Ex II 3 G, Ex ec IIC T4 Gc

The object of this Declaration is in full conformity with the following UK Statutory Instruments (and their amendments):

S.I. 2016 No. 1107	Equipment and Protective Systems Intended for use in Potentially Explosive Atmospheres Regulations 2016
S.I. 2016 No. 1091	Electromagnetic Compatibility Regulations 2016
S.I. 2016 No. 1101	Electrical Equipment (Safety) Regulations 2016

The Object of this Declaration is in conformity with the applicable requirements of the following designated standards and technical specifications.

EN IEC 60079-0:2018	Explosive Atmospheres - Part 0: Equipment – General requirements
EN 60079-7:2015, EN IEC 60079-7:2015/A1:2018	Explosive Atmospheres - Part 7: Equipment protection by type of protection "ec"
EN 61000-6-2:2005, EN 61000-6-2:2005/AC:2005	EMC Part 6-2: Generic Standards - Immunity for Industrial Environments
EN 61000-6-4:2007, EN 61000-6-4:2007/A1:2011	EMC Part 6-4: Generic Standards - Emissions for Industrial Environments
EN 61010-1:2010, EN 61010-1-2010/A1:2019/AC:2019-04, EN 61010-1:2010/A1:2019	Electrical Equipment for measurement, control, and laboratory use – Part 1: General requirements

This declaration of conformity is issued under the sole responsibility of the manufacturer
We, the undersigned, hereby declare that the equipment specified above conforms to the above Regulation(s).

MANUFACTURER

Annette Lynch
Signature

Annette Lynch
Full Name

Engineering Manager
Position

Woodward, Fort Collins, CO, USA
Place

07 July 2023
Date

5-09-1183 Rev 39

We appreciate your comments about the content of our publications.

Send comments to: industrial.support@woodward.com

Please reference publication 26818.

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