





### 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

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### 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. Be sure to check manual **26311**, *Revision Status & Distribution Restrictions of Woodward Technical Publications*, to verify whether this translation is up to date. Out-of-date translations are marked with . Always compare with the original for technical specifications and for proper and safe installation and operation procedures.

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

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# Warnings and Notices

## Important Definitions



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

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

### **WARNING**

**Overspeed /  
Overtemperature /  
Overpressure**

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

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

### **WARNING**

**Personal Protective  
Equipment**

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

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

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

### **WARNING**

**Start-up**

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

### **WARNING**

**Automotive  
Applications**

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

**NOTICE**

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.

**Battery Charging  
Device**

## Electrostatic Discharge Awareness

**NOTICE**

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

**Electrostatic  
Precautions**

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

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

Follow these precautions when working with or near the control.

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



# Chapter 1.

## General Information

### Introduction

This manual describes the Woodward 723PLUS Digital Speed Control for Single Engine Marine Propulsion Applications, for part number 8280-1042. This control is similar to 8280-419, except that the water pressure input has been replaced with a DSLC™ input, for power generation/marine applications.

### Declaration of Incorporation

In accordance with the EMC Directive 89/336/EEC and its amendments, this controlling device, manufactured by the Woodward Governor Company, is applied solely as a component to be incorporated into an engine prime mover system. Woodward Governor declares that this controlling device complies with the requirements of EN50081-2 and EN50082-2 when put into service per the installation and operating instructions outlined in the product manual.

**NOTICE:** This controlling device is intended to be put into service only upon incorporation into an engine prime mover system that itself has met the requirements of the above Directive and bears the CE mark.

### Application

The 723PLUS single engine marine control described in this manual controls the speed and load of medium- and high-speed diesel reciprocating engines in variable speed marine propulsion service, including those with flexible couplings. The control includes inputs for two magnetic pickups (MPUs) or proximity switches for speed sensing, an input for lube oil pressure, a DSLC (Digital Synchronizer & Load Control) speed bias input, an input for remote speed reference, and an input for air manifold pressure to limit the fuel demand.

The control outputs include an actuator output, three configurable analog outputs, and three relay outputs. The relay outputs are for engine trouble, shutdown, and status indication. There are three communication ports on the 723PLUS control. One of these (J1) is dedicated to Watch Window or to a hand held programmer for software tuning. The other two communication ports (J2 and J3) are configurable to either RS-232, RS-422, or RS-485 communications. Port 2 (J2) is a spare (unused) port, configured for ServLink. Port 3 (J3) is a spare (unused) unconfigured port.

In addition to these communication ports, there are two LON® \* channels available for further communications. In this control, the LON #1 and the LON #2 channel are not used.

\*—LON is a trademark of Echelon Corporation.

The 8280-1042 single engine marine propulsion control is intended for use on single engine, single propeller (variable or fixed pitch) propulsion systems. A typical propulsion system is shown in Figure 1-1. The system is shown with a flexible coupling between the engine and the propeller. Protection is provided to the unit shown with the Fuel Limiters and special torsional detection and filtering across the flexible coupling.

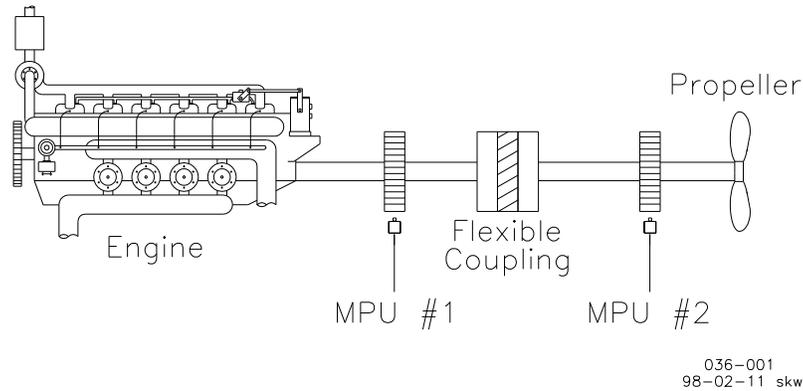


Figure 1-1. Flexible Coupled Propeller

The 723PLUS control (Figure 1-2) consists of a single printed circuit board in a sheet-metal chassis. Connections are via three terminal strips and three 9-pin subminiature D connectors.

The control system typically includes the following components:

- ◆ a 723PLUS Digital Speed Control
- ◆ one actuator to position the fuel metering device
- ◆ an external power source
- ◆ one or two speed-sensing devices
- ◆ eight optional switch contacts to manage control functions
- ◆ an optional lube oil pressure transducer
- ◆ an optional DSLC Digital Synchronizer & Load Control
- ◆ an optional fuel limiting air manifold pressure transducer
- ◆ three optional analog readout devices for display
- ◆ two optional relay-driven alarms

## Control Options

This manual describes the designed application of the 723PLUS marine control system, with low voltage power supply and torsional filtering.

Each 723PLUS control requires 40 W of power. A nominal current in-rush of 7 A is possible. Acceptable input voltage range is 18 to 40 Vdc.

Discrete input voltages provide on/off command signals such as Raise Speed and Lower Speed to the electronic control. Each discrete input requires 10 mA at 24 Vdc nominal voltage rating. The low voltage power supply may be used to power these command signals (see Figure 1-7 for vessel wiring.)

Torsional filtering is provided on the 723PLUS control model described in this manual. This filtering is specially designed to minimize the effects of flexible coupling torsionals. This control provides exceptionally smooth steady-state control which allows the control dynamics to be matched to the engine rather than detuned to compensate for coupling torsionals. Removing the torsional effects of the flexible coupling often provides a much longer life to the coupling. This model can alarm and limit the fuel demand if unacceptably high torsional levels occur.

These controls have a unique software function which allows the control dynamics to respond only to changes in speed which can be corrected by changing the amount of fuel to the engine. Variations in speed which are caused by torque changes across a flexible coupling are ignored. By dampening the dynamic response to these torque changes, the 723PLUS does not contribute to the oscillations, and so the stress on the coupling is less. This damped response occurs only when the instantaneous speed change is different between two speed sensor inputs. Two separate speed sensors must be used for this application to be effective (see Figure 1-7). In this case, a separate speed sensor must be located on each side of the flexible coupling.

## Hardware Options

The 723PLUS control has several hardware options available for signal inputs and outputs. The inputs for the two speed sensors can be configured with internal jumpers for either passive magnetic pickup units (MPUs) or active proximity switches. The four signal inputs can be configured with external jumpers for either milliamp or voltage sources. Analog Outputs #1 and #2 can be configured with internal jumpers to source either 4 to 20 mA or 0 to 1 mA. Analog Outputs #3 and #4 can be configured with internal jumpers to source either 0 to 200 mA or 0 to 20 mA. These options can be configured for each individual application.

## Software Options

In addition, there are several options available in the 723PLUS control software which allow considerable flexibility for the application of the hardware. Along with the typical adjustments for reference rates, limits, and dual dynamics, the software allows for two speed sensing detection methods, a speed filter function, an external fuel demand limit function, a start limit function, and a function to "bump" the actuator to allow testing the dynamics. The software also allows configuration of the two communication ports. One actuator output and both analog outputs are software configurable to output one of several different signals. All analog inputs and outputs are fully adjustable.

## 723PLUS Digital Speed Control Accessories

PC based Watch Window software (part number 8923-932) and a Hand Held Programmer (part number 9907-205) are used for monitoring and adjusting software parameters of the 723PLUS control, including the software options. They plug into communication port J1 of the control. [Hand Held Programmer part number 9905-292 can also be used.] See Figures 1-4 and 1-7.

A DSLC control (Digital Synchronizer and Load Control) for generator load management and load sharing between multiple generator sets can be used with the 723PLUS control. The 723PLUS controls described in this manual are designed to accept load and synchronizing inputs from the DSLC unit through Signal Input # 2.

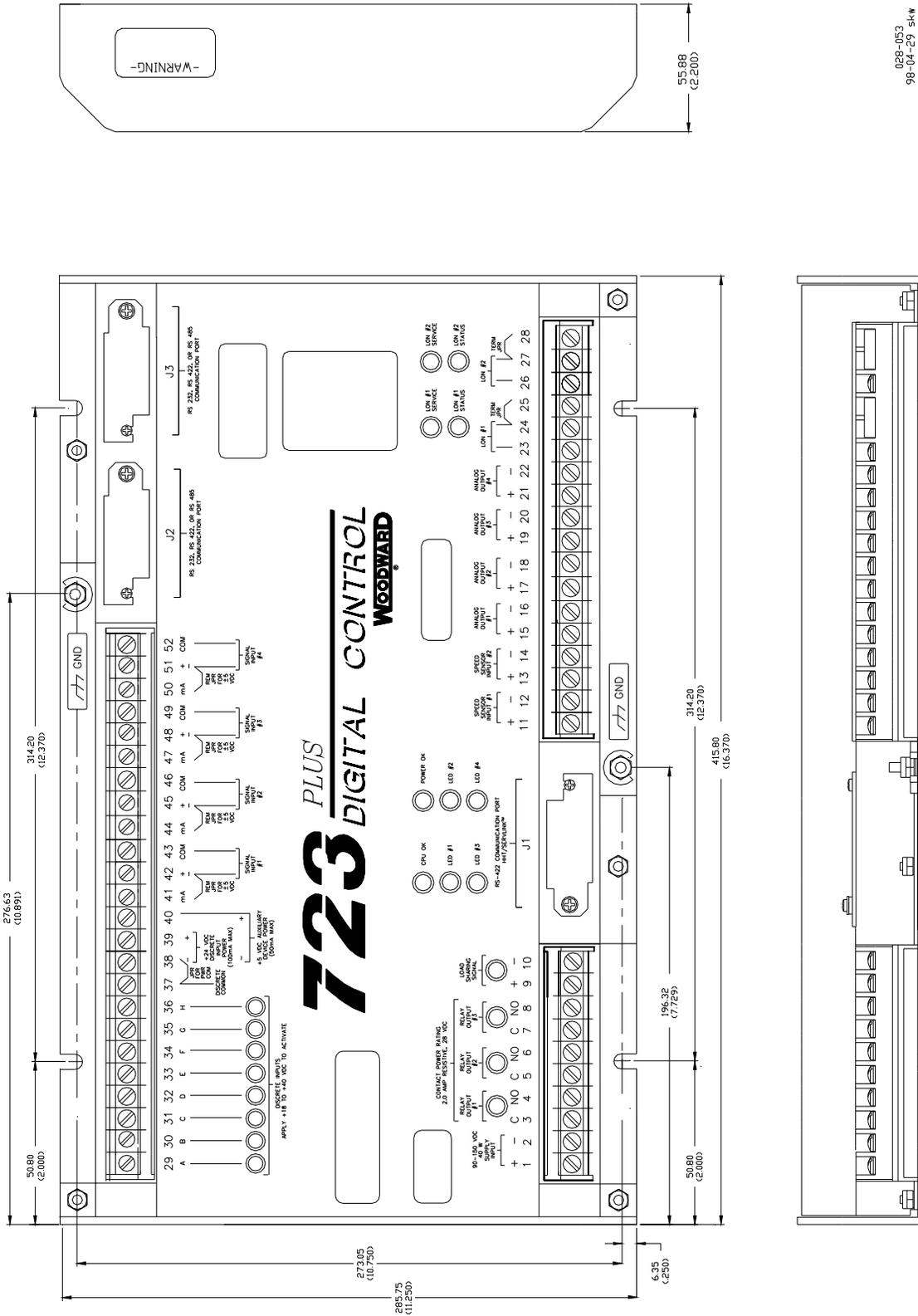


Figure 1-2. 723PLUS Digital Speed Control

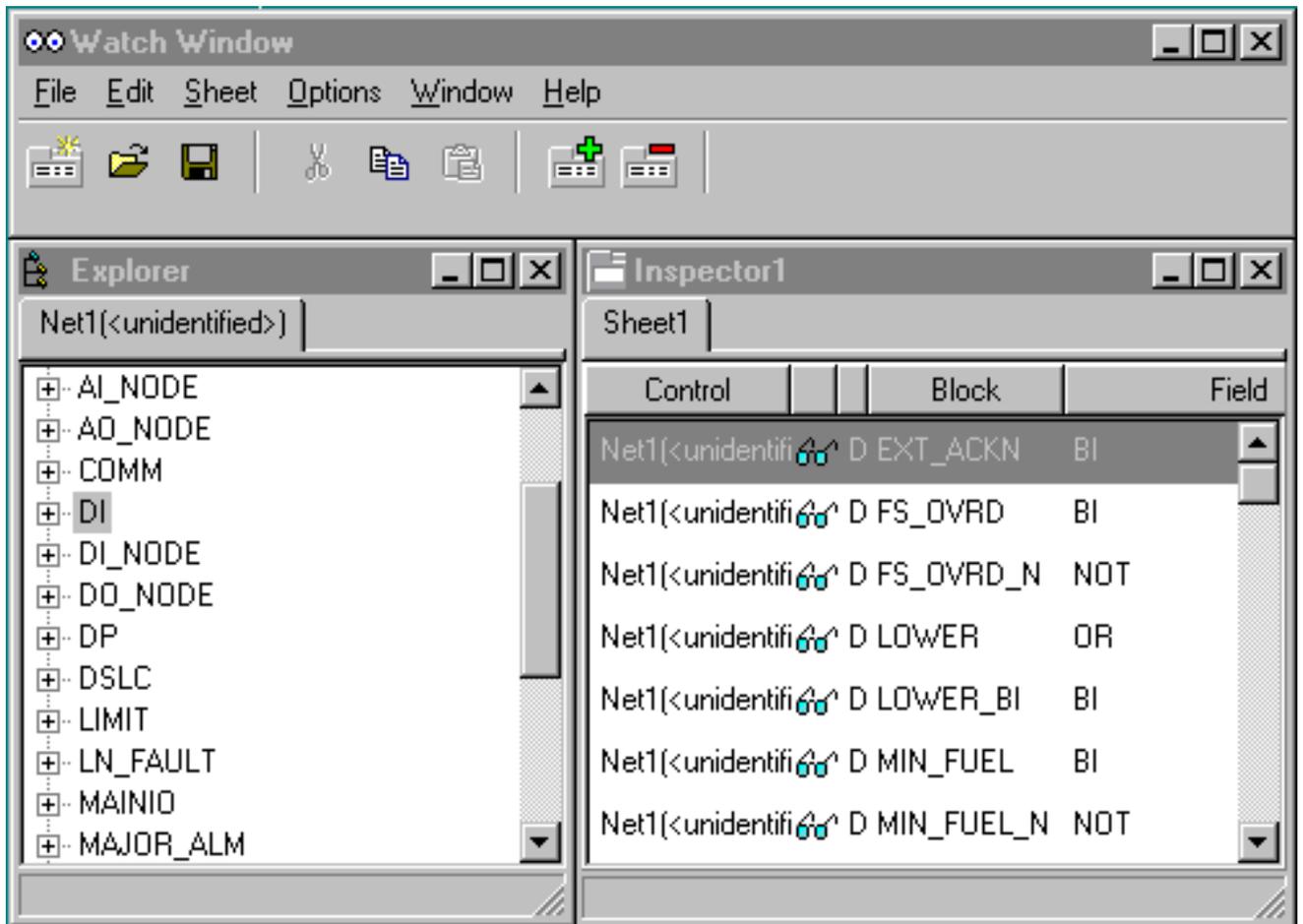
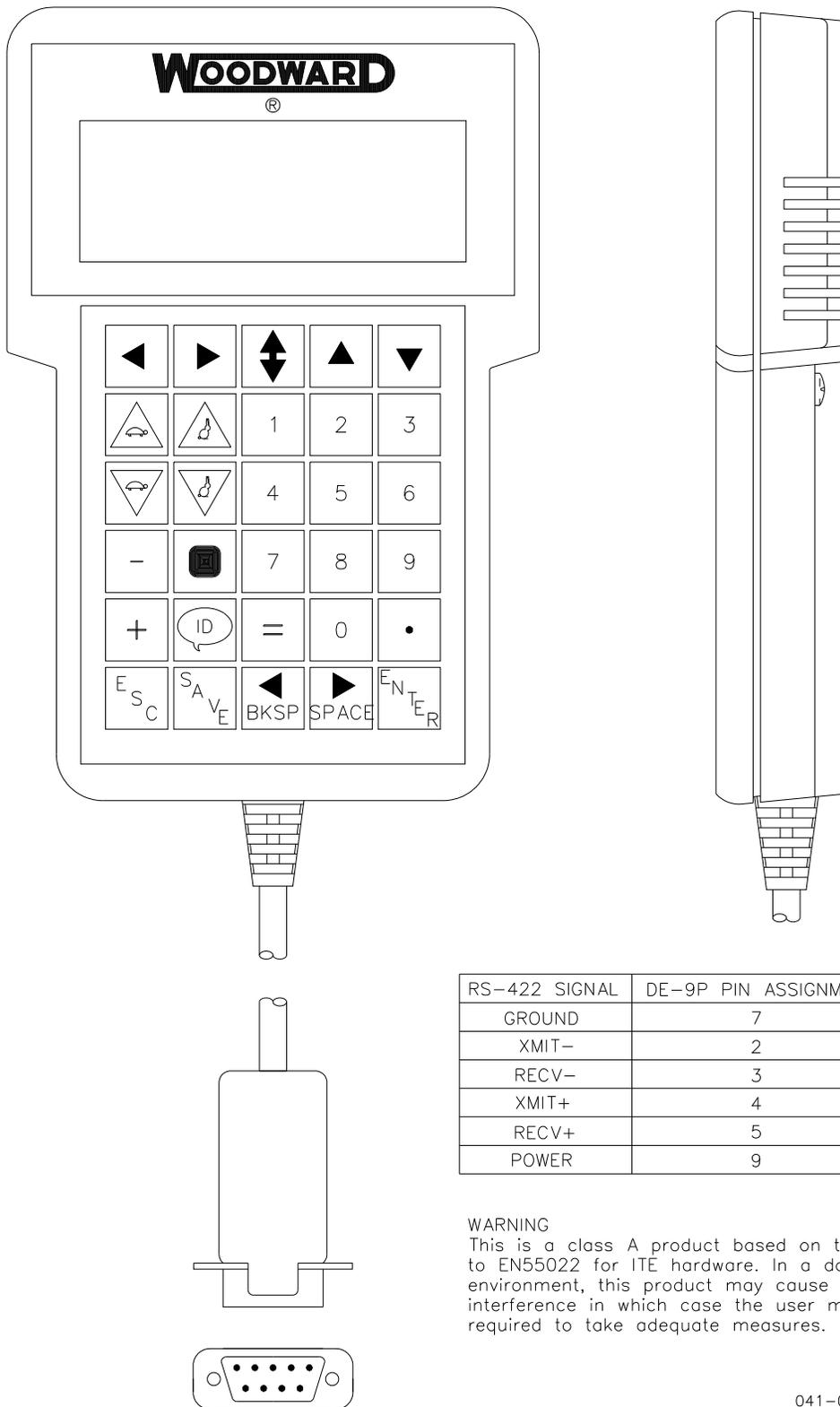


Figure 1-3. Watch Window Display



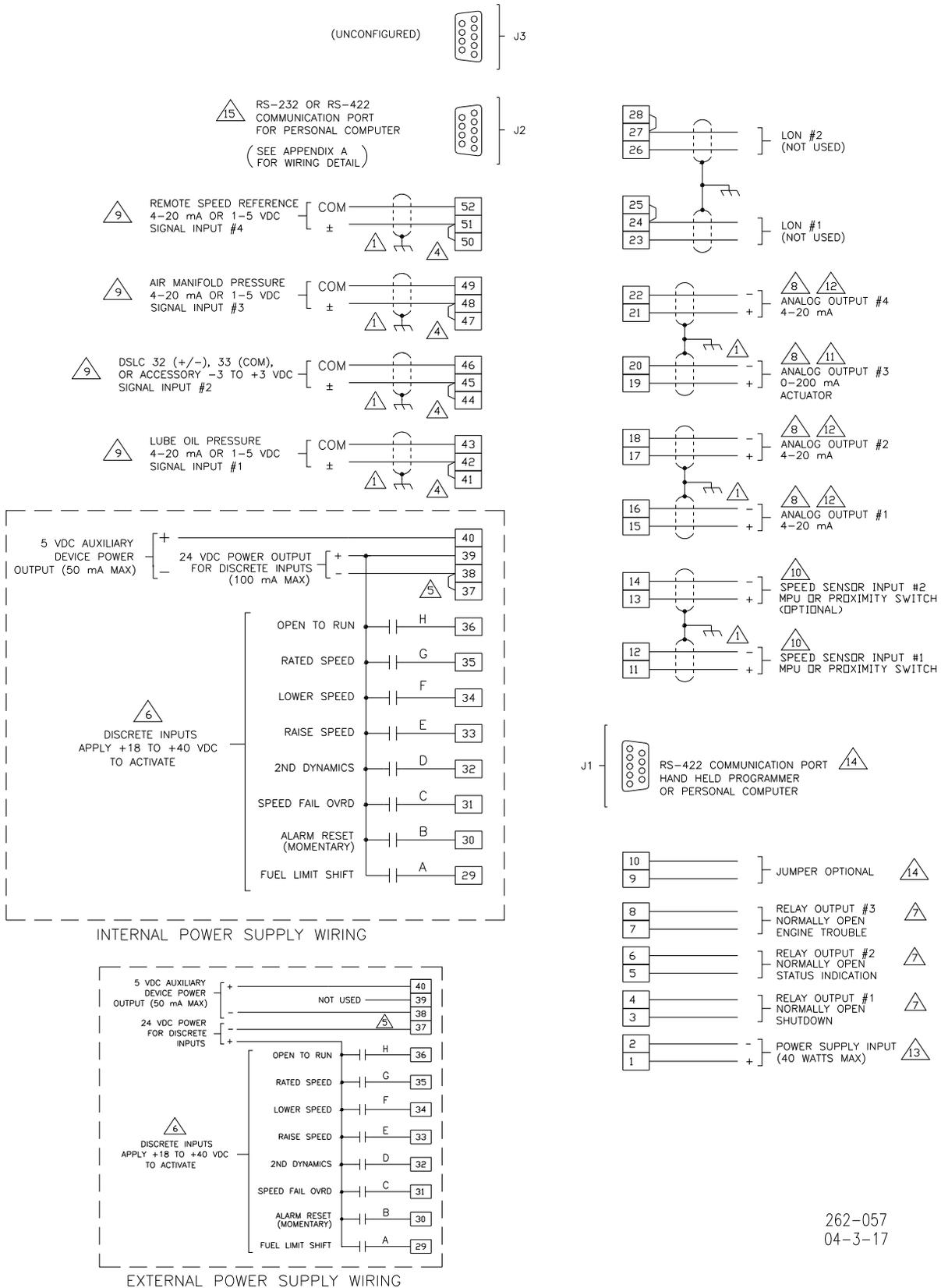
**WARNING**  
 This is a class A product based on testing to EN55022 for ITE hardware. In a domestic environment, this product may cause radio interference in which case the user may be required to take adequate measures.

041-010  
 96-07-25 skw

Figure 1-4. Hand Held Programmer

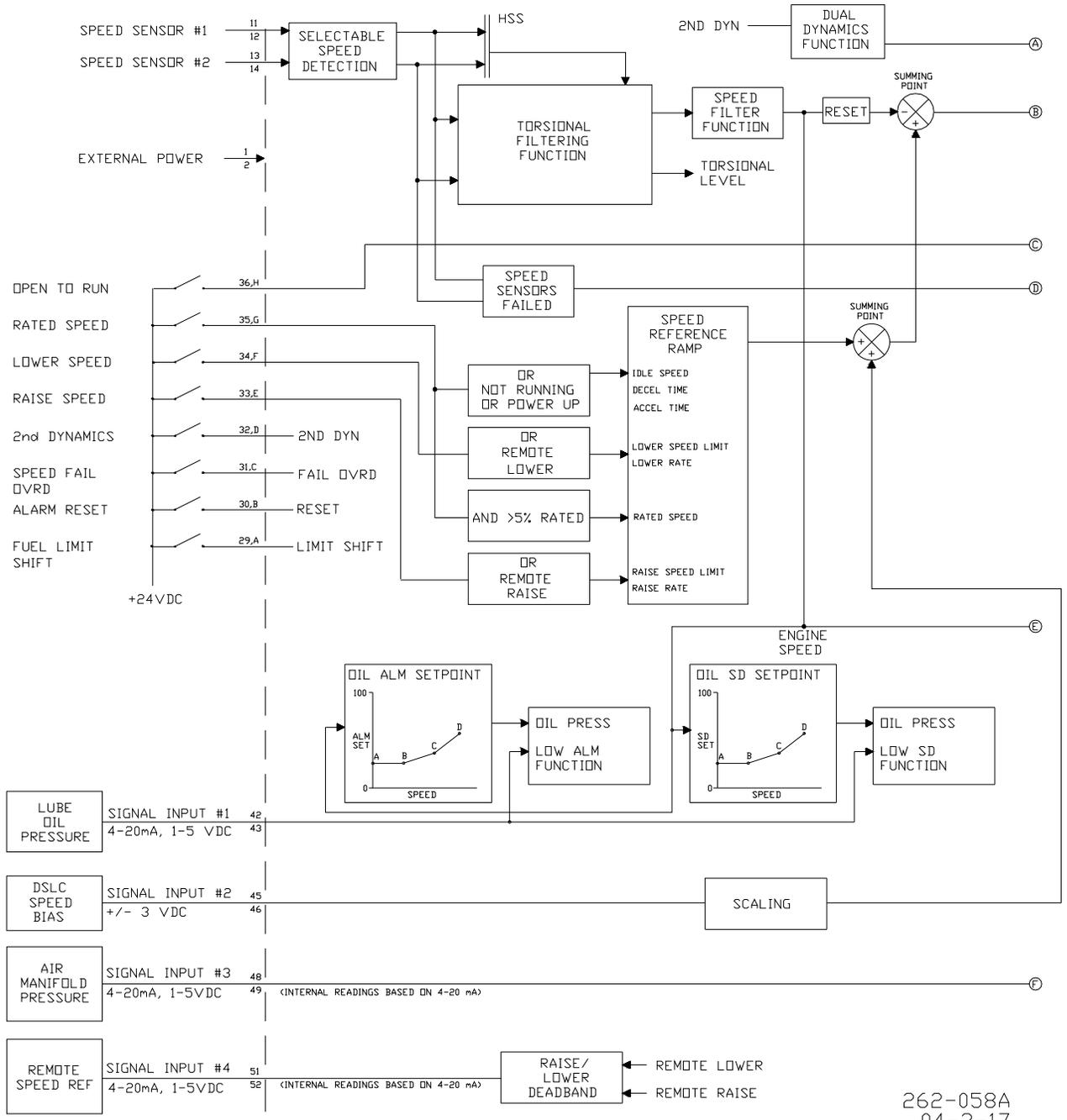
## NOTES:

1. SHIELDED WIRES ARE TWISTED PAIRS, WITH SHIELD GROUNDED AT ONE END ONLY. WHEN MOUNTING CONTROL TO BULKHEAD, USE THE GROUNDING STUD AND HARDWARE SUPPLIED WITH THE CHASSIS TO ENSURE PROPER GROUNDING.
2. SHIELDS MUST NOT BE GROUNDED AT ANY EXTERNAL POINT UNLESS OTHERWISE NOTED.
3. ALL SHIELDS MUST BE CARRIED CONTINUOUSLY THROUGH ALL TERMINAL BLOCKS AND MUST NOT BE TIED TO OTHER SHIELDS EXCEPT AT THE COMMON GROUND POINT. THE SHIELDS ARE TIED TOGETHER AT THE GROUND STUD.
4. REMOVE JUMPER FOR VOLTAGE INPUT.
5. A. INTERNAL POWER SUPPLY – ADD JUMPER FROM TERMINAL 37 TO 38.  
B. EXTERNAL POWER SUPPLY – REMOVE JUMPER FROM TERMINAL 37 TO 38.
6. DISCRETE INPUTS ARE ISOLATED FROM OTHER CIRCUITS AND CAN BE POWERED BY TERMINAL 39 (+24 VDC) LEAVING THE JUMPER IN PLACE.
7. ALL RELAY OUTPUTS WILL OPEN ON LOSS OF CONTROL POWER.
8. ANALOG OUTPUT SIGNALS TO OTHER SYSTEMS MUST BE ISOLATED FROM GROUND EITHER BY DESIGN OR EMPLOYMENT OF ISOLATION AMPLIFIERS.
9. ANALOG INPUT SIGNALS FROM OTHER SYSTEMS MUST BE ISOLATED FROM GROUND EITHER BY DESIGN OR EMPLOYMENT OF ISOLATION AMPLIFIERS. INPUTS MUST BE EXTERNALLY POWERED.
10. FACTORY SET FOR MPU INPUT.
11. FACTORY SET FOR 0–200 mA OUTPUT. OUTPUTS ARE INTERNALLY POWERED. DO NOT PROVIDE EXTERNAL POWER.
12. FACTORY SET FOR 4–20 mA OUTPUT. OUTPUTS ARE INTERNALLY POWERED. DO NOT PROVIDE EXTERNAL POWER.
13. INTERNAL POWER SUPPLY PROVIDES DC ISOLATION BETWEEN THE POWER SOURCE AND ALL OTHER INPUTS AND OUTPUTS.
14. COMMUNICATION PORT J1:  
A. HAND HELD PROGRAMMER – REMOVE JUMPER BETWEEN TERMINALS 9 AND 10.  
B. PERSONAL COMPUTER – ADD JUMPER BETWEEN TERMINALS 9 AND 10.
15. COMMUNICATION PORT J2 CAN BE CONFIGURED AS A RS–232 OR RS–422 SERIAL INTERFACE. PORT CONFIGURATION CAN BE DONE IN THE APPLICATION SOFTWARE ONLY. FOR THE PIN ASSIGNMENT OF J2 SEE APPENDIX A.



262-057  
04-3-17

Figure 1-5. Vessel Wiring Diagram



262-058A  
04-3-17

ENABLED IF BOTH RAISE AND LOWER  
DISCRETE INPUTS CLOSED, RATED  
DISCRETE INPUT CLOSED AND >5% RATED

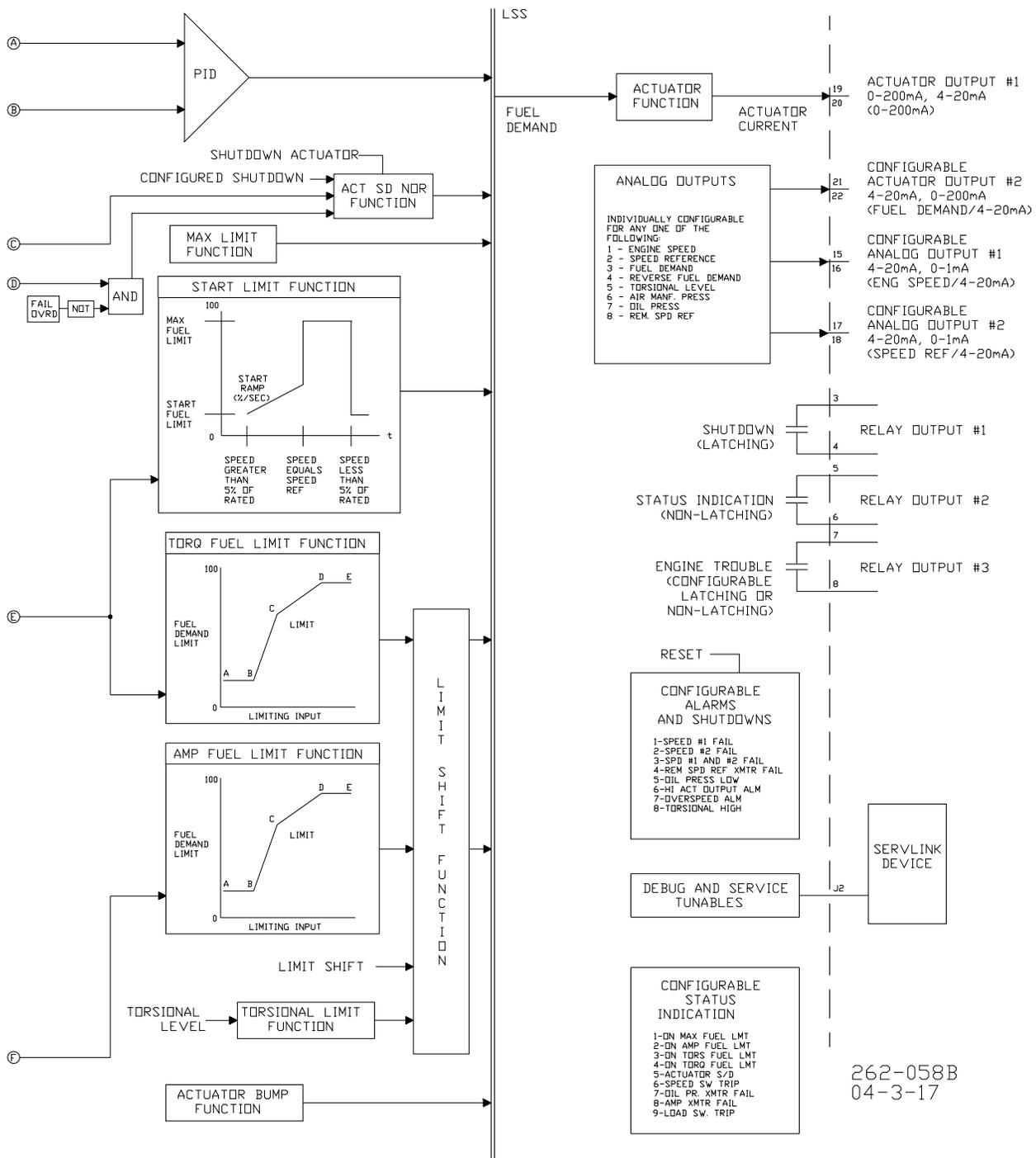


Figure 1-6. 723PLUS Block Diagram

- A - Fuel Limit Shift (close to briefly increase limit/open to reset)
- B - Alarm Reset (momentarily close to reset)
- C - Speed Fail Ovrd (close to override speed failure)
- D - Second Dynamics (close to run on alternate dynamics)
- E - Raise Speed (momentary) } Maintain both closed for
- F - Lower Speed (momentary) } remote speed reference.
- G - Rated Speed (open for Idle/close for rated)
- H - Open to Run (open to run/close for minimum actuator)

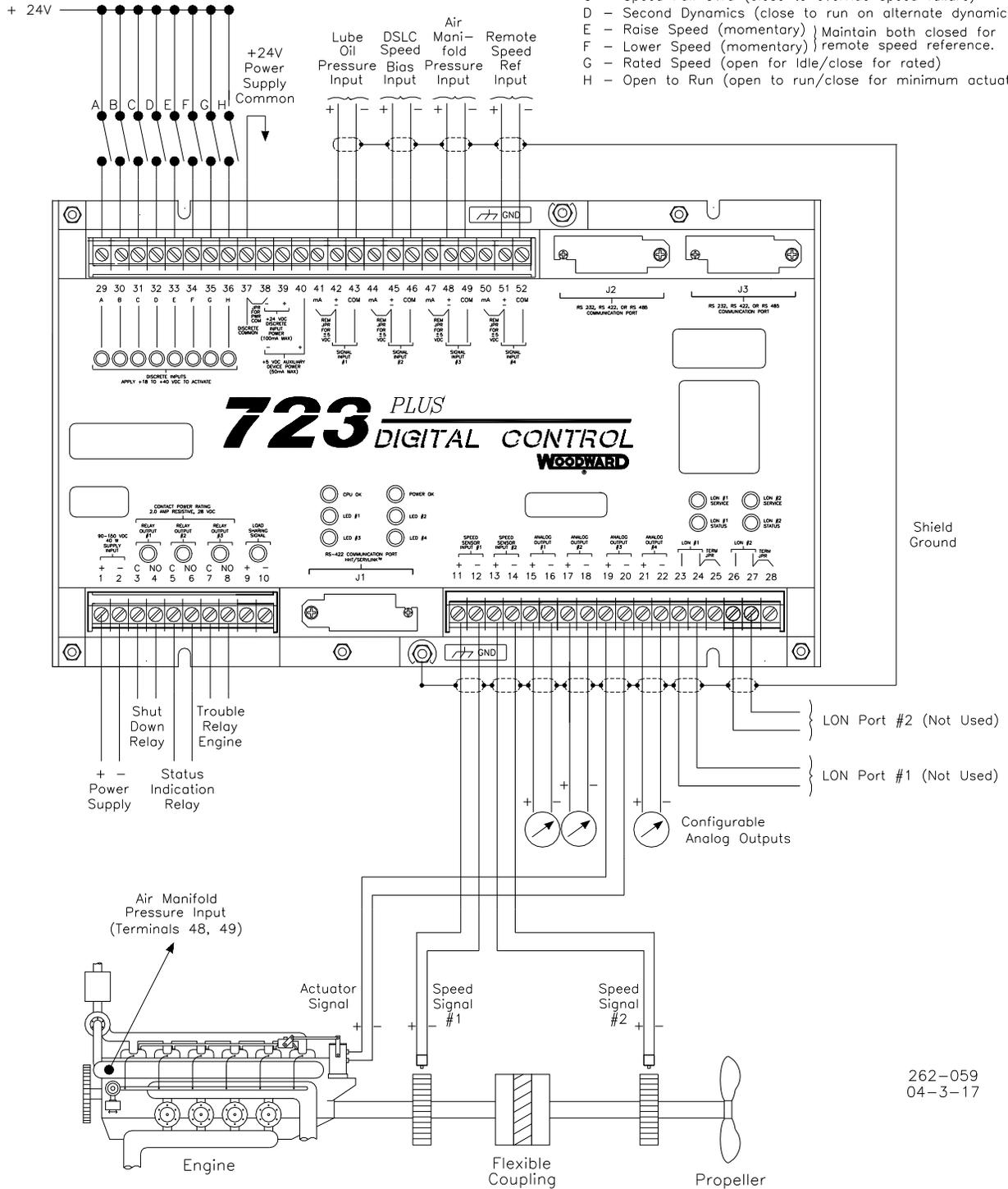


Figure 1-7. Typical 723PLUS Connections

## Chapter 2. Installation

### Scope

This chapter contains general installation instructions for the 723PLUS control. Power requirements, environmental precautions, and location considerations are included to help you determine the best location for the control. Additional information includes unpacking instructions, electrical connections, and installation checkout procedures.

### Unpacking

Before handling the control, read page iv, 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 723PLUS marine control requires a voltage source of 18 to 40 Vdc. The input power source must be capable of supplying 40 W and 7 A.

**NOTICE**

To prevent damage to the control, do not exceed the input voltage range.

**IMPORTANT**

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 the control, make sure that the alternator or other battery-charging device is turned off or disconnected before disconnecting the battery from the control.

### 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 which produce electromagnetic interference
- ◆ avoidance of vibration
- ◆ selection of a location that provides an operating temperature range of  $-40$  to  $+70$  °C ( $-40$  to  $+158$  °F).

The control must NOT be mounted on the engine.

## Internal Jumpers

The 723PLUS control has ten, two-position internal jumpers (JPR1 through JPR20) located on the top of the printed circuit board. If you need to change any jumper to match your control needs, be sure to read page iv, Electrostatic Discharge Awareness, before proceeding.

Remove power and all inputs. Wait at least 45 seconds, then remove the control cover. With your fingers or a small pair of tweezers, carefully remove the appropriate jumper and replace it securely over the proper two connectors (see Figure 2-1).

The following jumper options are available for these 723PLUS controls:

	JPR10	analog output #1	0–1 mA
*	JPR9	analog output #1	0–20 mA
	JPR12	analog output #2	0–1 mA
*	JPR11	analog output #2	0–20 mA
*	JPR13 & JPR2	analog output #3	0–200 mA, single
	JPR13 & JPR1	analog output #3	0–20 mA, single
&	JPR14 & JPR2	analog output #3	0–160 mA, tandem
	JPR15 & JPR3	analog output #4	0–200 mA, single
*	JPR15 & JPR4	analog output #4	0–20 mA, single
&	JPR16 & JPR3	analog output #4	0–160 mA, tandem
	JPR5 & JPR17	speed sensor #1	proximity switch
*	JPR6 & JPR18	speed sensor #1	magnetic pickup
	JPR7 & JPR20	speed sensor #2	proximity switch
*	JPR8 & JPR19	speed sensor #2	magnetic pickup

\*—default jumper settings

&—tandem outputs are designed to supply a maximum of 160 mA into two actuators connected in series

## Electrical Connections

The vessel wiring connections are shown in Figure 1-5. This shows the external wiring connections and shielding requirements for the controls described in this manual. These connections are explained in detail in the rest of this chapter.

## Shielded Wiring

All shielded cable must be twisted conductor pairs. Do not attempt to tin the braided shield. All signal lines should be shielded to prevent picking up stray signals from adjacent equipment. Connect the shields to the nearest chassis ground. Wire exposed beyond the shield should be as short as possible, not exceeding 25 mm (1 inch). The other end of the shields must be left open and insulated from any other conductor. DO NOT run shielded signal wires along with other wires carrying large currents. See Woodward application note 50532, *Interference Control in Electronic Governing Systems* for more information.

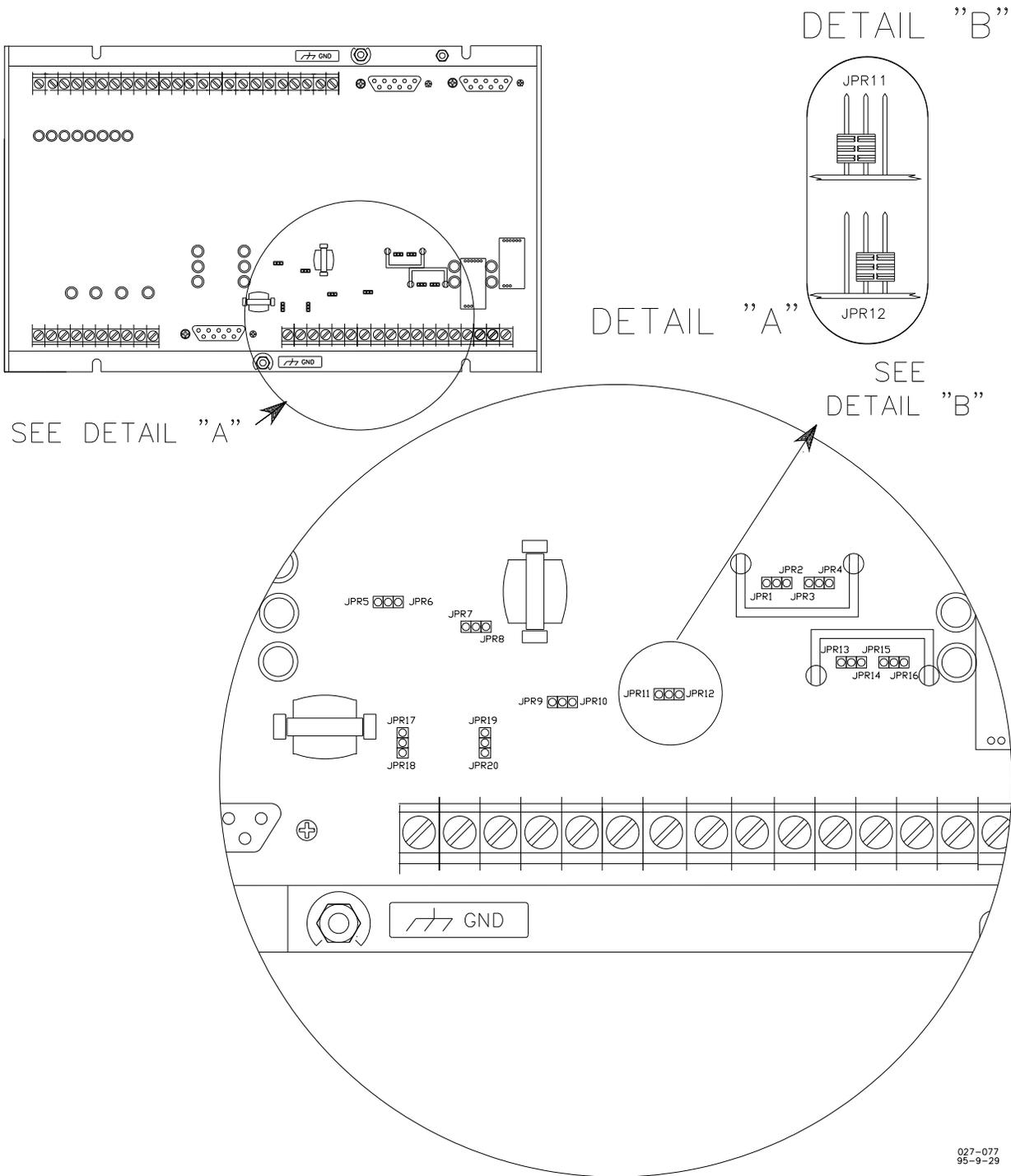


Figure 2-1. 723PLUS Control Internal Jumpers

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

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

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

## Supply Input (Terminals 1/2)

The power supply output must be low impedance (for example, directly from batteries). DO NOT power the control from high-voltage sources with resistors and zener diodes in series with the control power input. The 723PLUS control contains a switching power supply which requires a current surge to start properly.

### NOTICE

To prevent damage to the control, do not use a high-voltage power source, and do not use a high-voltage source with resistors and zener diodes in series with the power input.

Run the power leads directly from the power source to the control. DO NOT POWER OTHER DEVICES WITH LEADS COMMON TO THE CONTROL. Avoid long wire lengths. Connect the positive (line) to terminal 1 and negative (common) to terminal 2. If the power source is a battery, be sure the system includes an alternator or other battery-charging device.

If possible, do NOT turn off control power as part of a normal shutdown procedure. Use the Stop (Open to Run) discrete input (terminal 32) for normal shutdown. Leave the control powered except for service of the system and extended periods of disuse.

### NOTICE

Do NOT apply power to the control at this time. Applying power may damage the control.

### NOTICE

To prevent damage to the engine, apply power to the 723PLUS control at least 60 seconds prior to starting the engine. The control must have time to do its power-up diagnostics and become operational. Do not start the engine unless the green POWER OK and CPU OK indicators on the 723PLUS control cover comes on, because test failure turns off the control output.

## Relay Outputs (Terminals 3/4, 5/6, 7/8)

The three Relay Outputs provide Form A dry contact closures for controlling three discretely controlled devices. The three conditions which cause the relays to change state include a shutdown condition, an alarm condition, and an indication condition. The contact ratings are shown on the control specification sheet on the inside back cover of this manual. Interposing relays should be used if the application exceeds these ratings. Each relay is energized when the green light above the respective terminals is illuminated.

The relay contact on terminals 3/4 for Relay Output #1 is used when internal shutdown conditions are meant to externally shut down the engine. Relay Output #1 must be connected to the engine shutdown system to execute an engine shutdown. No connection is required if the shutdown function is not used in the application. The relay changes state if any configured shutdown condition has occurred without being cleared and reset. The state of the contact can be configured as either close on shutdown or open on shutdown. If power to the control is lost, the contact will open.

The relay contact on terminals 5/6 for Relay Output #2 is used when alarm conditions are to be used by other devices in the application. The relay changes state if any configured alarm condition has occurred without being cleared and reset. The state of the contact can be configured as either close on alarm or open on alarm. If power to the control is lost, the contact will open.

The relay contact on terminals 7/8 for Relay Output #3 is used when indication conditions are to be used by other devices in the application. The relay changes state if any configured indication condition has occurred without being cleared and reset or without being cleared only (when configured as a non-latching output). The state of the contact can be configured as either close on indication or open on indication. If power to the control is lost, the contact will open.

The contact ratings are shown on the 723PLUS Control Specifications (inside back cover). Interposing relays should be used if the application exceeds these ratings.

## RS-422 Communication Port (J1)

J1 is intended for use with Watch Window software (part number 8923-932) or with the Woodward ST2000 Hand Held Programmer (part number 9907-205). These allow the user to configure software, adjust set points, and display parameters. See Chapters 3 and 4 for the menu items available. Contact your local distributor for other options.

## Speed Signal Inputs #1 and #2 (Terminals 11/12 and 13/14)

The speed of the engine must be provided to the 723PLUS control by either a passive magnetic pickup (MPU) or an active proximity switch. The speed signal device should sense the exact speed of the engine. Using the camshaft or some other gear where backlash could occur is not recommended. The engine speed should be between 200 and 2100 rpm.

A second speed-sensing device may also be used for redundancy and for torsional filtering if applicable. The second device provides backup speed sensing in the event of a single speed sensor device failure. If two speed sensor devices are used, they must both sense the exact same speed of rotation. The usual location for both devices is on the upper half of the flywheel housing.

The Speed Sensor Input terminals can be hardware configured to accept speed sensing signals from proximity switches. In this configuration, the impedance of the input is at least 2 k $\Omega$ . This configuration requires that the proximity switches be powered by an external source. Refer to Manual 82510 for further information on mounting and using proximity switches.

The Speed Sensor Input is hardware configured for an MPU when the control is shipped from the factory. In this configuration, the impedance of the input could be as low as 200  $\Omega$ . An MPU used as a speed input device must provide a minimum amplitude signal of 1.5 V<sub>rms</sub> during all times while the engine is to be controlled. Refer to Manual 82510 for complete details on MPU selection, location, and mounting.

The Speed Sensor Input is software configurable for either a digital speed detection method or an analog speed detection method. The default is set for digital speed detection. The digital speed detection method is the same as used on other Woodward digital controls and is capable of receiving input frequencies of 90 to 15 000 Hz. An analog speed detection method is also available in the software. The analog speed detection can filter out frequency changes caused by the cylinder firing frequency. This filter allows the control loop to better respond to real engine speed changes if the firing frequency is within the bandwidth of the control loop. The analog detection method is capable of receiving input frequencies of 250 to 15 000 Hz.

Note that the engine speed must remain between 200 and 2100 rpm during all times of closed loop control.

If the torsional filtering 723PLUS control is to be used, both speed sensors must be used. The speed sensor on the engine side of the coupling should be connected to Speed Sensor Input #1 (terminals 11 and 12). The speed sensor on the load side of the coupling should be connected to Speed Sensor Input #2 (terminals 13 and 14.) The speed sensors can be either MPUs or proximity switches.

Use shielded wire for all speed sensor connections. Connect the shield to the chassis. Make sure the shield has continuity the entire distance to the speed sensor, and make sure the shield is insulated from all other conducting surfaces.

 **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.

**NOTICE**

To prevent possible damage to the control or poor control performance resulting from ground loop problems, we recommend using current-loop isolators for any inputs or outputs which connect to non-isolated devices. A number of manufacturers offer 20 mA loop isolators.

## Analog Outputs #1 and #2 (Terminals 15/16 and 17/18)

The two analog outputs can be configured several different ways depending on the application needs. The output current is hardware configurable for either 0 to 1 mA or 4 to 20 mA. This current signal is supplied to terminals 15(+) and 16(-) for Analog Output #1 and terminals 17(+) and 18(-) for Analog Output #2. Note that these terminals must be isolated from ground.

Either of the outputs can be software configured to one of several control parameters. These parameters include:

- ◆ Engine Speed
- ◆ Engine Speed Reference
- ◆ Fuel Demand
- ◆ Reverse Fuel Demand
- ◆ Torsional Level
- ◆ Air Manifold Pressure
- ◆ Lube Oil Pressure
- ◆ Remote Speed Reference

See the Description of Operation in Chapter 6 for further information on each of these parameters.

Analog Output #1 is factory set for 4 to 20 mA representing the engine speed (default range is 0–1300 rpm). Software settings must be changed if the hardware is configured for 0 to 1 mA.

Analog Output #2 is factory set for 4 to 20 mA representing the engine speed reference (default range is 0–1300 rpm). Software settings must be changed if the hardware is configured for 0 to 1 mA.

Use shielded twisted-pair wires. For electrically isolated devices such as 4 to 20 mA analog meters, the shield should be grounded at the control end of the cable. For input to other devices, use the recommendation of the device manufacturer.

## Analog Output #3 (Terminals 19/20)

Analog Output #3 provides a dedicated current signal to a single actuator or two actuators connected in series on a tandem system. This current signal is supplied at terminals 19(+) and 20(-). Software is available to tune the minimum and maximum levels of the actuator stroke. The output current can be hardware configured for either 0 to 200 mA, 0 to 160 mA, or 0 to 20 mA. The 0 to 200 mA range is for standard applications using single Woodward 20 to 160 mA proportional actuators and actuator drivers such as the EG3P or the EGB13P. This configuration allows up to 200 mA into 40  $\Omega$  impedance. The 0 to 160 mA range is for standard applications using Woodward proportional actuators which are connected in a tandem configuration. This configuration allows up to 160 mA into 80  $\Omega$  impedance. The 0 to 20 mA setting can be used as input to other devices and actuator drivers. This configuration allows up to 20 mA into 10 k $\Omega$  impedance. The software must also be configured to output 4 to 20 mA from the output even though the hardware is configured for 0 to 20 mA. Note that these terminals must be isolated from ground.

Use shielded twisted-pair wires to connect the actuator to the 723PLUS control. For electrically isolated devices such as standard Woodward actuators, the shield should be grounded at the control end of the cable. For input to other devices, use the recommendation of the device manufacturer.

## Analog Output #4 (Terminals 21/22)

Analog Output #4 can be configured several different ways depending on the application needs. The output current is hardware configurable for either 0 to 200 mA, 0 to 160 mA, or 4 to 20 mA. This actuator output can also be software configured to one of several control parameters similar to Analog Outputs #1 and #2 above. These parameters include:

- ◆ Engine Speed
- ◆ Engine Speed Reference
- ◆ Fuel Demand
- ◆ Reverse Fuel Demand
- ◆ Torsional Level
- ◆ Air Manifold Pressure
- ◆ Lube Oil Pressure
- ◆ Remote Speed Reference

Analog Output #4 is factory set for 4 to 20 mA representing the fuel demand (default range is 0–100%).

Note that the Actuator Position selection can be used to allow Analog Output #4 to have an actuator signal identical to Analog Output #3. Analog Output #4 can be connected to a second standard Woodward actuator by changing the hardware configuration to 0 to 200 mA. Software settings must be changed if the hardware is configured for 0 to 200 mA.

Use shielded twisted-pair wires. For electrically isolated devices such as 4 to 20 mA input analog meters, the shield should be grounded at the control end of the cable. For input to other devices, use the recommendation of the device manufacturer.

## LON #1 and LON #2 (Terminals 23—28)

The 723PLUS control provides two separate LON communication channels for communicating with Echelon<sup>®</sup> networks. The LON channels are not used in this control.

## Discrete Inputs (Terminals 29—36)

Discrete inputs are the switch input commands to the 723PLUS control. They interact in such a way as to allow engine control under a variety of conditions. Refer to Chapter 6 for a complete description of operations.

Voltage is supplied to the discrete input terminal when an input switch or relay contact closes. This causes the input state for that discrete input to be "TRUE". The input terminal is open circuited when the input switch or relay contact opens. This causes the input state for that discrete input to be "FALSE". When the input switch or relay contact is closed, the voltage supplying the discrete inputs should be present from the appropriate discrete input (terminal 29, 30, 31, 32, 33, 34, 35, or 36) to terminal 37 (common). Terminal 37 is the common return path for all of the discrete input channels. A lower voltage indicates that the switch contacts have too high a resistance when closed and should be replaced. These terminals must be isolated from ground. The green light above each input terminal illuminates for a valid "TRUE" state.

In this system, which provide an external low voltage source to power the 723PLUS control, the discrete inputs may be powered by this external low voltage. The voltage source used must be capable supplying 100 mA at a voltage level of 18 to 40 Vdc. Connect the external low voltage source negative to terminal 37(-). 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 on the 723PLUS control.

**NOTICE**

**Remove the factory installed jumper between terminal 37 and terminal 38 when using external discrete input power.**

As an alternative, the discrete inputs may be powered by the internal 24 Vdc Discrete Input Power source at terminal 39. 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 39 to the appropriate input switch or relay contact, and connect the mated switch or relay contact to the corresponding discrete input terminal on the 723PLUS control. Assure that a connection exists between terminal 37 and terminal 38 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.

### Fuel Limit Shift (Input A; Terminal 29)

The input switch or relay contact used to activate the Fuel Limit Shift function connects to terminal 29 (Discrete Input A). The external switch or relay contact is open during normal operation and is closed only during special conditions such as crash astern. This discrete input changes the control state between no fuel limit shift and fuel limit shift. When the external switch or relay contacts are closed, the control temporarily adds a tunable shift amount (% fuel demand) for a tunable shift duration (seconds) to all fuel limits. Normal limits are restored at the end of the shift duration time. With the contacts open (discrete input in the "FALSE" state), the shift amount is zero and the shift duration timer is reset.

## Alarm Reset (Input B; Terminal 30)

The input switch or relay contact used to activate the Alarm Reset command connects to terminal 30 (Discrete Input B). This discrete input issues a reset command to all parameters which can latch into an alarm state. Only those parameters which are in the normal state when the discrete input first goes "TRUE" will be reset to the no-alarm condition. When the external switch or relay contacts are closed (discrete input in the "TRUE" state), internal software limits the command so that the reset condition applies only for a short time within the control even if the external contact remains closed. With the contacts open (discrete input in the "FALSE" state), the control will again be ready to respond to the external contacts closing. The Alarm Reset command works in parallel with a software switch from the Hand Held Programmer. Automatic reset commands are temporarily issued during power up and, if configured, when engine speed reaches 5% of rated rpm.

## Speed Fail Override (Input C; Terminal 31)

The input switch or relay contact used to activate the Speed Fail Override command connects to terminal 31 (Discrete Input C). This discrete input changes the control operation to allow the fuel demand to increase even though the speed signal is not present. This command is normally used to allow the actuator to open for engine starting when the speed signal is too low to be detected. Note that most starting designs crank the engine fast enough to allow the speed signal to be detected by the control. For these designs, the override command is not needed, and this input can be left disconnected. When the external switch or relay contacts are closed (discrete input in the "TRUE" state), the control overrides the shutdown associated with losing the speed sensor. With the contacts open (discrete input in the "FALSE" state), the control will shut down if both speed sensor signals are lost.

For reverse-acting systems where the fuel demand is allowed to increase to the speed setting of a mechanical governor when the electrical system fails, this discrete input should be set to the "TRUE" state. This can be done by connecting the input directly to the positive Discrete Input Power source. This action forces the fuel demand to increase if the electrical speed signal is lost, and relinquishes control to the mechanical governor. Be sure the mechanical governor is properly set up to assume control in the event of an electrical system failure. The mechanical governor must *not* be set up to assume control during normal electric governor operation. Such interaction produces undesirable instability.



### **WARNING**

To prevent possible serious injury from an overspeeding engine, the Speed Fail Override command must be "FALSE" during normal operating conditions of direct-acting systems. This is accomplished by open circuiting the discrete input at terminal 31. If switch or relay contacts are used to activate this command, the contacts must be designed to open when the engine is running under normal governor control.

## 2nd Dynamics (Input D; Terminal 32)

The input switch or relay contact used to activate the 2nd Dynamics command connects to terminal 32 (Discrete Input D). This discrete input changes the control operation to allow a second set of dynamic terms to be used. This command is normally used when the closed loop path needs two independent sets of dynamics such as with dual-fuel engines. When the input switch or relay contacts are closed (discrete input in the “TRUE” state), the control uses the 2nd Dynamics set. When the contacts are open (discrete input in the “FALSE” state), the control uses the 1st Dynamics set. No connection needs to be made to this input if only one set of dynamics is used.

## Raise Speed Contact (Input E; Terminal 33)

The input switch or relay contact used to activate the Raise Speed command connects to terminal 33 (Discrete Input E). This discrete input changes the control operation by increasing the speed reference. The reference can increase only to a software adjusted maximum speed limit. The reference increases at a software adjusted rate. The LOWER SPEED command or de-selecting the RATED SPEED command (described below) takes command control away from Raise Speed and effectively disables the command. This command is normally used to allow raising the engine speed manually and for testing high-speed operations such as overspeed. When the external switch or relay contacts are closed (discrete input in the “TRUE” state), the control raises the speed reference. Raise is limited to the software-adjusted maximum speed limit. With the contacts open (discrete input in the “FALSE” state), the control stops raising the speed reference.

## Lower Speed Contact (Input F; Terminal 34)

The input switch or relay contact used to activate the Lower Speed command connects to terminal 34 (Discrete Input F). This discrete input changes the control operation by decreasing the speed reference. The reference can decrease only to a software adjusted minimum speed limit. The reference decreases at a software adjusted rate. De-selecting the RATED SPEED command (described below) takes command control away from Lower Speed and effectively disables the command. This command is normally used to allow lowering the engine speed manually and for testing low speed operations such as critical speeds. When the external switch or relay contacts are closed (discrete input in the “TRUE” state), the control lowers the speed reference. Lower is limited to the software-adjusted minimum speed limit. With the contacts open (discrete input in the “FALSE” state), the control stops lowering the speed reference.

## Remote Speed Reference Contacts (Input E; Terminal 33 and Input F; Terminal 34)

The Raise Speed contact (Discrete Input E) in conjunction with the Lower Speed contact (Discrete Input F) is used to select the Remote Speed Reference. When both input switches or relay contacts are maintained closed (both discrete inputs in the “TRUE” state), the Remote Speed Reference is active.

## Rated Speed (Input G; Terminal 35)

The external contact used to activate the Rated Speed command connects to terminal 35 (Discrete Input G). This discrete input changes the control operation by increasing the speed reference to **rated speed** and decreasing the speed reference to **idle speed**. When the switch or relay contacts are closed (discrete input in the “TRUE” state), the speed reference ramps for a time set by the Accel Time to the rated speed control point. The Raise and Lower contacts or the Remote Speed Reference are also enabled. When the switch or relay contacts are open (discrete input in the “FALSE” state), the speed reference ramps for a time set by the Decel Time to the idle speed control point. The Raise and Lower contacts and the Remote Speed Reference are also disabled. If the application does not require an idle speed setting, the Rated Speed input can be left in the “TRUE” state at all times. This can be done by connecting the input directly to the positive Discrete Input Power source.

## Open to Run (Input H; Terminal 36)

The external contact used to activate the Open to Run command connects to terminal 36 (Discrete Input H). This discrete input changes the control operation by increasing the Min Fuel Function to allow other functions to control the fuel demand or by immediately decreasing the fuel demand to zero. When the switch or relay contacts are open (discrete input in the “FALSE” state), the Minimum Fuel Function is increased to 100 percent. When the switch or relay contacts are closed (discrete input in the “TRUE” state), the Minimum Fuel Function immediately pulls the fuel demand to zero.

The Open to Run command is the preferred means for a normal shutdown of the engine. The control output to the actuator is minimum when voltage is applied to terminal 36.



### **WARNING**

The Open to Run discrete input is not intended for use as the sole means of shutdown in any emergency stop sequence. To prevent possible serious injury and engine damage from an overspeeding engine, do NOT use the Open to Run discrete input as the sole means of shutdown in any emergency stop sequence.

## Lube Oil Pressure Input (Signal Input #1; Terminals 42/43)

Connect a Lube Oil Pressure transmitter to Signal Input #1. The input signal must be an isolated high-quality signal representing the Lube Oil Pressure signal. By configuration, this signal input allows engine shutdown protection or alarm protection or both to be provided. Oil pressure is displayed in software adjustable engineering units on the hand-held programmer and may be re-transmitted (by configuration) through one of the analog outputs to an external device (meter, recorder, etc.). Default engineering units setting is 0–100 psig. Engine alarms and shutdown are also displayed on the hand-held programmer. No connection is required to this input if this function is not needed by the application.

A shutdown condition activates Relay Output #1. Relay Output #1 must be connected to the engine shutdown system to execute an engine shutdown if this function is needed by the application. An engine alarm condition activates Relay Output #2. Relay Output #2 may be used if the engine alarm function is needed by the application.

Use a shielded twisted-pair cable to connect a 4 to 20 mA current transmitter or a 1 to 5 Vdc voltage transmitter to terminals 42(+) and 43(-). When using a voltage transmitter, the jumper between terminals 41 and 42 must be removed. An input impedance of 250  $\Omega$  is present when the jumper is installed. Without the jumper installed, the input impedance is greater than 10 M $\Omega$ . This input is not isolated from the other control inputs and outputs, and an isolation device must be installed if the transmitter output is not isolated.

A failure of the input signal is detected for input values less than 2.0 mA (0.5 Vdc) and for input values exceeding 21 mA (5.25 Vdc). A configured detected failure causes a Status Indication alarm and remains as a Status Indication alarm until the failure is repaired.

### **DSLCL™ Input (Signal Input #2; Terminals 45/46)**

Use a shielded twisted-pair cable to connect the low-impedance output from DSLCL™ terminals 32( $\pm$ ) and 33(COM) to terminals 45( $\pm$ ) and 46(COM). Also remove the factory installed jumper between terminals 44 and 45. The DSLCL unit is described in product specification 02006 and manual 02007. This input allows a change in speed reference by 3% of Rated speed per volt input to terminals 42 and 43.

#### **IMPORTANT**

Use only DSLCL bias output option  $\pm 3.0$  Vdc.

### **Air Manifold Pressure Input (Signal Input #3; Terminals 48/49)**

Connect an Air Manifold Pressure transmitter to Signal Input #3. The input signal must be an isolated high-quality signal representing the Air Manifold Pressure signal. By configuration, this signal input allows an air manifold pressure signal to limit fuel demand. Air manifold pressure is displayed in software adjustable engineering units on the hand-held programmer and may be re-transmitted (by configuration) through one of the analog outputs to an external device (meter, recorder, etc.). Default engineering units setting is 0–50 inches Hg. No connection is required to this input if this function is not needed by the application.

Use a shielded twisted-pair cable to connect a 4 to 20 mA current transmitter or a 1 to 5 Vdc voltage transmitter to terminals 48(+) and 49(-). When using a voltage transmitter, remove the jumper between terminals 48 and 47. An input impedance of 250  $\Omega$  is present when the jumper is installed. Without the jumper installed, the input impedance is greater than 10 M $\Omega$ . This input is not isolated from the other control inputs and outputs, and an isolation device must be installed if the transmitter output is not isolated.

A failure of the input signal is detected for input values less than 2.0 mA (0.5 Vdc) and for input values exceeding 21 mA (5.25 Vdc). A configured detected failure removes the air manifold pressure fuel limit and causes a Status Indication alarm. The fuel limit removal and Status Indication alarm remain until the failure is repaired.

### Remote Speed Reference Input (Signal Input #4; Terminals 51/52)

Connect a Remote Speed Reference transmitter to Signal Input #4. The input signal must be an isolated high-quality signal. This signal input allows remote speed reference set point changes and (by configuration) engine shutdown protection or alarm protection or both if the input signal fails. The remote speed reference is displayed in software adjustable engineering units on the hand-held programmer and may be re-transmitted (by configuration) through one of the analog outputs to an external device (meter, recorder, etc.). Default engineering units setting is 0 to 1200 rpm. Remote Speed Reference is activated by simultaneous and maintained closure of the Raise and Lower discrete inputs (terminals 33 and 34). The Rated Speed input (Input G; terminal 35) is a permissive for Remote Speed Reference control and must be closed to permit Remote Speed Reference control. No connection is required if this function is not needed by the application.

A failure of the input signal is detected for input values less than 2.0 mA (0.5 Vdc) and for input values exceeding 21 mA (5.25 Vdc). A configured detected failure will alarm and/or shutdown and remain alarmed and/or shut down until the failure is repaired and an Alarm Reset is issued.

#### **IMPORTANT**

**If the Remote Speed Reference is selected and the input goes below 2 mA, the speed reference will ramp down to minimum speed or shut down if the control is configured and connected for shutdown. Default is set not to shut down.**

### Communication Port J2

Communication Port J2 is configured as an optional connection, redundant to Port J1, to connect a ServLink device to the 723PLUS control. A ServLink device is used to display and modify tunable and configurable values in the control. Multiple values may be viewed simultaneously. ServLink includes the ability to shut down the control, restart the control, and upload and download tuning parameters. The ability is also provided to link to a control over a network via network DDE. Watch Window is a ServLink device.

Communication Port J3 is an unconfigured spare.

Both ports are 9-pin subminiature D receptacle connectors.

Communication Port J2 can be software configured for a wide variety of serial communications. The port can be set to standard specifications for RS-232 or RS-422. Additionally the BAUD rates can be independently set for 1200, 2400, 4800, 9600, 19 200, or 38 400. An INIT\_CMD field is the initialization command string that is sent to the modem. The default data value is "ATE0Q150=1&D0".

## Installation Checkout Procedure

With the installation complete as described in this chapter, do the following checkout procedure before beginning set point entry (Chapters 3 and 4) or initial start-up adjustments (Chapter 5).

### 1. Visual inspection

- A. Check the linkage between the actuator and fuel metering device for looseness or binding. Refer to the appropriate actuator manual, and Manual 25070, *Electric Governor Installation Guide* for additional information on linkage.



**To prevent possible serious injury from an overspeeding engine, the actuator lever or stroke should be near but not at the minimum position when the fuel valve or fuel rack is at the minimum fuel delivery position.**

- B. Check for correct wiring in accordance with the vessel wiring diagram, Figure 1-5.
- C. Check for broken terminals and loose terminal screws.
- D. Check the speed sensor(s) for visible damage. If the sensor is a magnetic pickup, check the clearance between the gear and the sensor and adjust if necessary. Clearance should be between 0.25 and 1.25 mm (0.010 and 0.050 inch) at the closest point. Make sure the gear runout does not exceed the pickup gap. A gap set too large will not produce a signal which meets the minimum voltage requirement listed under "Electrical Connections".

### 2. Check for grounds

Check for grounds by measuring the resistance from all control terminals to chassis. All terminals should measure infinite resistance (the resistance of terminals 2 and 37 depends on whether a floating or grounded power source is used). If a resistance less than infinity is obtained, remove the connections from each terminal one at a time until the resistance is infinite. Check the line that was removed last to locate the fault.

## Chapter 3.

# Standard Menu Items

### Introduction

Because of the variety of installations, plus system and component tolerances, the 723PLUS control must be tuned to each system for optimum performance.

This chapter contains information on how to enter control set points through the control's menu system using Watch Window and the Hand Held Programmer. See Chapter 4 for prestart-up and start-up settings and adjustments.



#### **WARNING**

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

### Watch Window PC Interface

Watch Window is a ServLink client software product that provides a PC interface to any 723PLUS control and is a very powerful setup, testing, and troubleshooting tool. Watch Window provides a means of loading the application software into the 723PLUS control, shutting down and placing the control in the configuration mode, saving values in the control EEPROM, and resetting the control. Application tunable values can be uploaded, downloaded, and saved to a file.

An "inspector" provides a window for real-time monitoring and editing of all control Configuration and Service Menu parameters and values. Custom "inspectors" can easily be created and saved. Each window can display up to 28 lines of monitoring and tuning parameters *without* scrolling. The number *with* scrolling is unlimited. Two windows can be open simultaneously to display up to 56 parameters without scrolling. Tunable values can be adjusted at the inspector window.

Watch Window communicates with the 723PLUS Single Engine Marine Control through ports J1 or J2.

Port J1 is configured for RS-422 and requires a special cable to convert from RS-422 to RS-232. The cable part number is 5416-870. RS-422 communications are less susceptible to noise than RS-232 and should be used when the control and computer are in noisy environments. When using port J1 with Watch Window, place a jumper across terminals 9 and 10. This tells the control that a computer is connected to J1. When using the Hand Held Programmer, remove the jumper.

Port J2 is configured for RS-232 and requires a widely available 9-pin 'null modem' cable. This cable should be available at almost any computer or electronics store. It does not matter if terminals 9 and 10 are jumpered or not when using port J2.

More information about Watch Window can be found in manual 26007, *Woodward Watch Window Software Getting Started*.

## Hand Held Programmer and Menus

The Hand Held Programmer is a hand-held computer terminal that gets its power from the 723PLUS control. The terminal connects to the RS-422 communication port on the control (terminal J1). To connect the terminal, slightly loosen the right-hand screw in the cover over J1 and rotate the cover clockwise to expose the 9-pin connector. Then firmly seat the connector on the terminal into J1. Remove the jumper between terminals 9 and 10 to set Port J1 for Hand Held Interface. Refer to Figure 3-1 for a description of the Hand Held Programmer keys.

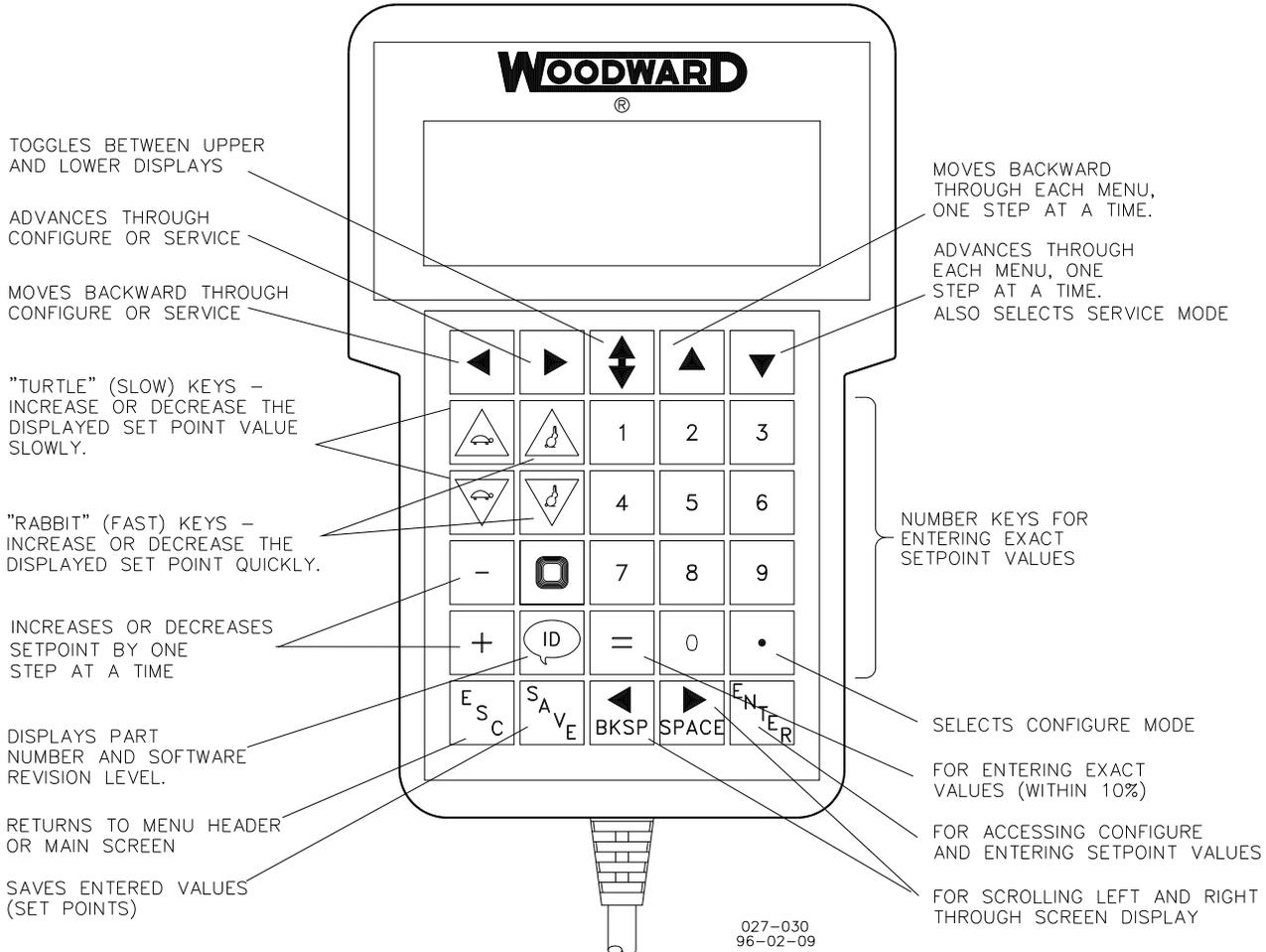


Figure 3-1. Hand Held Programmer Functions

The programmer does a power-up self-test whenever it is plugged into the control. When the self-test is complete, the screen displays two lines of information about the application. Press the **ID** key to display the part number and revision level of the software in the control. Refer to this number and revision level in any correspondence with Woodward Governor Company (write this information in the Programming Checklist in the Appendix).

The programmer screen is a four-line backlit LCD display. The display lets you to look at two separate functions or menu items at the same time. Use the **Up/Down Arrow** key to toggle between the two displayed items. Use the **BKSP** and **SPACE** keys to scroll through the display to show the remainder of a prompt if it is longer than the display screen's 19 characters.

The 723PLUS has two sets of menus—the Service menus and the Configure menus. The Service menus allow easy access and tuning while the engine is running. The Configure menus are used to access parameters that *should not* be changed while the engine is running.

## Hand Held Programmer Keys

The programmer keys do the following functions (see Figure 3-1):

<b>Left Arrow</b>	Moves backward through Configure or Service, one menu at a time.
<b>Right Arrow</b>	Advances through Configure or Service, one menu at a time.
<b>Up/Down Arrow</b>	Toggles between the two displayed items.
<b>Up Arrow</b>	Moves backward through each menu, one step at a time.
<b>Down Arrow</b>	Advances through each menu, one step at a time. Selects Service from Main Screen.
<b>Turtle Up</b>	Increases the displayed set point value slowly.
<b>Turtle Down</b>	Decreases the displayed set point value slowly.
<b>Rabbit Up</b>	Increases the displayed set point value quickly (about 10 times faster than the turtle keys).
<b>Rabbit Down</b>	Decreases the displayed set point value quickly (about 10 times faster than the turtle keys).
<b>+ (plus)</b>	Increases set point values by one step at a time.
<b>- (minus)</b>	Decreases set point values by one step at a time.
<b>Solid Square</b>	Not used.
<b>ID</b>	Displays the 723PLUS control part number and software revision level.
<b>ESC</b>	To return to menu header or to main screen.
<b>SAVE</b>	Saves entered values (set points).
<b>BKSP</b>	Scrolls left through line of display.
<b>SPACE</b>	Scrolls right through line of display.
<b>ENTER</b>	Used when entering exact values and accessing Configure.
<b>= (equals)</b>	For entering exact values (within 10%).
<b>• (decimal)</b>	To select Configure.

## Service Menus

If you have a blank screen or the “Woodward” message on the terminal, push the **Down Arrow** key once. Otherwise you should push the **SAVE** key, the **ESC** key twice, and the **Down Arrow** key once. This puts you at the menu title of the first Service menu.

### Moving from Menu to Menu

Menus are arranged horizontally. If you have a menu title on the screen, you can move between menus using the **Right Arrow** and **Left Arrow** keys. If you have a menu item on the screen, you must push **ESC** once to return to the menu title and then use the **Right Arrow** and the **Left Arrow** keys. If you press the **Right Arrow** or **Left Arrow** keys continually, you will cycle through all the menu titles repeatedly until you stop pressing the key.

### Moving Around Within a Menu

Items within a menu are arranged vertically. To enter a menu from a menu title use the **Down Arrow** key. To move through the items within a menu, use the **Down Arrow** and **Up Arrow** keys. If you press the **Down Arrow** or **Up Arrow** keys continually, you will cycle through all the menu items repeatedly until you stop pressing the key.

### Leaving a Menu or Returning to First Menu

Once within a menu, to return to the menu title, press the **ESC** key. To return all the way to the first menu, press the **ESC** key again and the **Down Arrow** key once.

### Viewing Dimension Information

The dimensions of several items extend beyond a single screen. Use the **BKSP** key to scroll left to view additional screen information.

## Configure Menus

Navigating through the Configure menus is similar to navigating through the Service menus except that the engine should be shut down to access the Configure menus. Press the **.** (decimal) key. The display shows, 'To select configure, press enter'. Press the **ENTER** key and the display shows, 'To shutdown I/O, press enter'. Press the **ENTER** key to enter the Configure menus.

### IMPORTANT

All outputs are brought to the powered-down state during this process. Both actuator outputs and both analog outputs go to zero milliamps, and the three relay outputs become de-energized.

To leave the Configure menus, press the **ESC** key twice. The set points are automatically saved when leaving Configure and the control reboots. After the control starts again, you will be at the top of the Service menus.

### IMPORTANT

Always enter Configure after initially setting the values in Service. This resets any out of range ramp values to their proper state.

## Adjusting Set Points

To adjust a set point, use the **Turtle Up** or **Rabbit Up** keys to increase the value, and the **Turtle Down** or **Rabbit Down** keys to decrease the value. The **Rabbit Up** and **Rabbit Down** keys makes the rate of change faster than the **Turtle Up** and **Turtle Down** keys. This is useful during initial setup where a value may need to be changed significantly. Where necessary, to select TRUE, use either the **Turtle Up** or the **Rabbit Up** keys, and to select FALSE, use the **Turtle Down** or **Rabbit Down** keys.

To obtain an exact value, press the **=** key. Key in the required figure and press **ENTER**.

### IMPORTANT

This may be done only if the figure is within 10% of the existing value in Service. In Configure, any value within range may be entered.

**WARNING**

To prevent possible serious injury from an overspeeding engine— When adjusting a running engine, **DO NOT** hold the keys down to adjust set points. Instead, make short taps on the keys. The 723PLUS is storing your input commands at a higher rate than can be seen on the hand held terminal. If you hold the keys down, the 723PLUS will appear to coast beyond the last value seen on the hand held at the time you release the button.

To save set points at any time, use the **SAVE** key. This transfers all new set point values into the EEPROM memory. The EEPROM retains all set points when power is removed from the control. Exiting to the Woodward logo also automatically saves all set points.

**NOTICE**

To prevent possible damage to the engine resulting from improper control settings, make sure you **SAVE** the set points before removing power from the control. Failure to **SAVE** the set points before removing power from the control causes them to revert to the previously saved settings.

## Configure Menu Descriptions

The following describes the Configure menus. The listing below shows the menu title in large **BOLD** type. The title is followed by the separate menu items. A complete listing of the menu titles and menu items can be found in the Appendix. The listing shows the minimum value of the item, the maximum value of the item, and the default value of the item. The units that describe the item are shown in the item title. Units can be viewed with the **BKSP** button on the Hand Held Programmer, if they are not visible.

The unit “RPM” represents revolutions per minute. The unit “RPM/MIN” represents change in rpm per minute. The unit “ENGR” represents engineering units which are user set (psi, kPa, etc). The unit “Hz” represents frequency in Hertz. The unit “SEC” represents seconds. The unit “%FD” represents a percentage of the Fuel Demand as described in the Description of Operation in Chapter 6. Use the Appendix to enter the specific values for your application.

### CFIG OPTIONS

The items under this menu configure general dynamics and fuel limit options. **Set the item value to TRUE to enable the option.**

**USE REV ACTUATOR**—Set to FALSE when the actuator current increases to increase fuel flow, and set to TRUE when the actuator current decreases to increase fuel flow. The TRUE setting is used with actuators that increase the fuel flow to the engine if the electrical signal to the actuator fails. Changing this setting to TRUE affects the operation of the Start Fuel Limit Function (see Description of Operation in Chapter 6 for details).

**USE 2nd DYNAMICS**—Allows the 2nd Dynamics discrete input to be active. This input is not active when set to FALSE.

**DYNAMICS 1 CONSTANT**—Determines whether the speed control GAIN and RESET values are constant or vary as a function of engine speed. GAIN and RESET vary with engine speed when set to FALSE.

**USE TORSIONAL FILTER**—Allows the ENABLE TORS FILTER to be active. The Torsional Filter is not active when set to FALSE even if ENABLE TORS FILTER is set TRUE.

**USE NOTCH FILTER**—Enables/disables a Notch Filter on the speed input(s). Set TRUE to enable the notch filter and disable the torsional filter. Set to FALSE to disable the notch filter and permit the torsional filter to be enabled.

**USE AIR MAN LIMIT**—Allows the ENABLE AMP FUEL LMT to be active. The Air Manifold Pressure Fuel Limit is not active when set to FALSE even if ENABLE AMP FUEL LMT is set TRUE.

**USE TORQ LIMIT**—Allows the ENABLE TORQ FUEL LMT to be active. The Torque Fuel Limit is not active when set to FALSE even if ENABLE TORQ FUEL LMT is set TRUE.

**RESET ALM ON CLEAR**—Enables automatic ALARM RESET on every start. The automatic ALARM RESET is not active when set to FALSE. Manual alarm reset through the discrete input or Hand Held programmer is not affected and always enabled.

**NON-LATCH ALM DOUT3**—Set FALSE to make Relay 3 output a latching output. A configured Engine Trouble condition must be **cleared and reset** to unlatch Relay 3 output. Set TRUE to make the Relay 3 output non-latching. A configured Engine Trouble condition must be **cleared only** to unlatch Relay 3 output.

### CFIG SPEED CONTROL

The items under this menu configure the speed inputs. It is critical to control operation that these items be set correctly.

**RATED SPEED (RPM)**—Enter the rated speed in rpm. This is the speed that the speed reference automatically ramps to when the Rated Speed discrete input is "TRUE".

**ASPD #1 TEETH**—This is the number of pulses per revolution seen by Speed Sensor #1. It is generally the number of teeth on the gear used by an MPU.

**ASPD 1 MAX FREQ (Hz)**—This is the absolute maximum frequency that is input to Speed Sensor #1. It is generally set greater than the frequency representing an overspeed condition.

**ASPD #2 TEETH**—This is the number of pulses per revolution seen by Speed Sensor #1. It is generally the number of teeth on the gear used by an MPU.

**ASPD 2 MAX FREQ (Hz)**—This is the absolute maximum frequency that is input to Speed Sensor #2. It is generally set greater than the frequency representing an overspeed condition.

**REVERSE ACTING**—Set to FALSE when the actuator current increases to increase fuel flow, and set to TRUE when the actuator current decreases to increase fuel flow. The TRUE setting is used with actuators that increase the fuel flow to the engine if the electrical signal to the actuator fails. Changing this setting to TRUE affects the operation of the Start Fuel Limit Function (see Description of Operation in Chapter 6 for details).

**DSPD #1 TEETH**—This is the number of pulses per revolution seen by Speed Sensor #1. It is generally the number of teeth on the gear used by an MPU.

**DSPD #2 TEETH**—This is the number of pulses per revolution seen by Speed Sensor #1. It is generally the number of teeth on the gear used by an MPU.

**MPU ALARM ARM TIME**—This is the time delay to wait before latching armed the MPU failure alarm and shutdown functions once a valid MPU signal is detected. Closing the "Open to Run" contact resets the latch block to prevent MPU failure alarm and shutdown conditions from occurring with normal stops.

#### **WARNING**

To prevent possible serious injury from an overspeed engine, assure that ASPD #1 TEETH and DSPD #1 TEETH are the same value, and that ASPD #2 TEETH and DSPD #2 TEETH are the same value. The number of gear teeth is used by the control to convert pulses from the speed-sensing device to engine rpm. Make sure the control is properly programmed to convert the gear-tooth count into engine rpm. Improper conversion could cause engine overspeed.

## CFIG INDICATION

This menu allows configuring which conditions are seen as status indications and the function of Relay Output #2. Set the item value to TRUE to enable the status condition.

**ON MAX LIMIT**—Indicates status when the speed control is on the Max Fuel Limit.

**ON AIR PRESS LIMIT**—Indicates status when the speed control is on the Air Manifold Pressure Fuel Limit.

**ON TORSION LIMIT**—Indicates status when the speed control is on the Torsional Fuel Limit.

**ON TORQUE LIMIT**—Indicates status when the speed control is on the Torque Fuel Limit.

**ACT SHUTDOWN**—Indicates status when an Actuator Shutdown condition occurs. The Stop discrete input, both MPUs failed, or any Configured Shutdown can cause an Actuator Shutdown condition.

**SPEED SWITCH**—Indicates status when engine speed is above a programmable SPD SW PICKUP setting. Status clears when engine speed is below a programmable SPD SW DROPOUT setting.

**OIL XMTR FAULT**—Indicates status when the Oil Pressure transmitter output falls below 2 mA or increases above 21 mA.

**AIR XMTR FAULT**—Indicates status when the Air Manifold Pressure transmitter output falls below 2 mA or increases above 21 mA.

**LOAD SWITCH**—Indicates status when the fuel demand is above a programmable LOAD SW PICKUP setting. Status clears when fuel demand is below a programmable LOAD DROPOUT setting.

## CFIG ALARMS

This menu allows configuring what conditions are seen as engine trouble alarms and the function of Relay Output #3. **Set the item value TRUE to enable the alarm condition.**

**SPEED #1 FAIL**—Alarms when Speed Sensor #1 detects a speed less than five percent of rated speed.

**SPEED #2 FAIL**—Alarms when Speed Sensor #2 detects a speed less than five percent of rated speed.

**SPD #1AND#2 FAIL**—Alarms when Speed Sensor #1 and Speed Sensor #2 both detect speed is less than five percent of rated speed.

**REMOTE SR FAIL**—Alarms when Signal Input #4 (Remote Speed Reference Input) goes out of range (below 2 mA or above 21 mA).

**LOW OIL PR ALARM**—Alarms when oil pressure drops below the OIL ALM SET POINT for longer than the OIL PRESS DELAY time. Alarm is bypassed when speed is below the SD BYPASS SPEED, and is armed when speed is above the SD BYPASS SPEED for the SD BYPASS time.

**HI FUEL DEMND ALARM**—Alarms when the fuel demand exceeds the HI FUEL DEMND SETPT for longer than the HI FUEL DEMND DELAY time. This alarm is useful for detecting situations where the governor is not in control of the engine speed or load.

**HI SPEED ALARM**—Alarms when the engine speed exceeds the HI SPEED SET PNT for longer than the HI SPEED DELAY time.

**HIGH TORSION LEVEL**—Alarms when the torsional level exceeds the TORS LVL SETPT for longer than the HI TORSION DLY time.

**SPEED SWITCH ALM**—Alarms when engine speed is above a programmable SPD SW PICKUP setting. Alarm clears when engine speed is below a programmable SPD SW DROPOUT setting. See Indication Setup menu for speed switch configurable settings.

**LOAD SWITCH ALM**—Alarms when the fuel demand is above a programmable LOAD SW PICKUP setting. Alarm clears when the fuel demand is below a programmable LOAD SW DROPOUT setting. See Indication Setup menu for load switch configurable settings.

### CFIG SHUTDOWNS

This menu allows configuring what conditions are seen as shutdowns and the function of Relay Output #1. Relay Output #1 must be connected to the engine shutdown system to execute an engine shutdown. **Set the item value TRUE to enable the shutdown condition.**

**SPEED #1 FAIL**—Causes shutdown Relay Output #1 to change state when Speed Sensor #1 detects a speed less than five percent of rated speed.

**SPEED #2 FAIL**—Causes shutdown Relay Output #1 to change state when Speed Sensor #2 detects a speed less than five percent of rated speed.

**SPD #1AND#2 FAIL**—Causes shutdown Relay Output #1 to change state when Speed Sensor #1 and Speed Sensor #2 both detect speed is less than five percent of rated speed.

**REM SPEED REF FAIL**—Causes shutdown Relay Output #1 to change state when Signal Input #4 (Remote Speed Reference Input) goes out of range (below 2 mA or above 21 mA).

**LOW LUBE OIL PR SD**—Causes shutdown Relay Output #1 to change state when oil pressure drops below the OIL SD SET POINT for longer than the OIL PRESS DELAY time. Shutdown is bypassed when speed is below the SD BYPASS SPEED, and is armed when speed is above the SD BYPASS SPEED for the SD BYPASS time.

**HI FUEL DEMND SD**—Causes shutdown Relay Output #1 to change state when the fuel demand exceeds the HI FUEL DEMND SETPT for longer than the HI FUEL DEMND DELAY time. This shutdown is useful for stopping an engine in an overload condition.

**HI SPEED SD**—Causes shutdown Relay Output #1 to change state when the engine speed exceeds the HI SPEED SET PNT for longer than the HI SPEED DELAY time.

**HIGH TORSION LVL**—Causes shutdown Relay Output #1 to change state when the torsional level exceeds the TORS LVL SETPT for longer than the HI TORSION DLY time.

**SD BYPASS SPEED**—Speed setting where the Shutdown Bypass is removed after the SD BYPASS TIME expires to arm all active Alarms and Shutdowns.

**SD BYPASS TIME**—Sets delay time (in seconds) before the Shutdown Bypass is removed after the SD BYPASS SPEED is reached.

### INDICATION SETUP

This menu allows configuring the function of the Status Indication Relay, Output #2.

**ENERGIZE FOR STATUS**—Set TRUE to energize Status Indication Relay and close Output #2 contact on configured status conditions. Set FALSE to de-energize Status Indication Relay and open Output #2 contact on configured status conditions. Default is TRUE.

**SPD SW PICKUP**—Set speed (rpm) at which the SPEED SWITCH picks up on increasing speed to indicate status. Default setting is 500 rpm. Status Indication Relay state is determined by the ENERGIZE FOR STATUS setting.

**SPD SW DROPOUT**—Set speed (rpm) at which the SPEED SWITCH drops out on decreasing speed to indicate status. Default setting is 400 rpm. Status Indication Relay state is determined by the ENERGIZE FOR STATUS setting.

**LOAD SW PICKUP**—Set % fuel demand at which the LOAD SWITCH picks up on increasing load to indicate status. Default setting is 99.5%. Status Indication Relay state is determined by the ENERGIZE FOR STATUS setting.

**LOAD SW DROPOUT**—Set % fuel demand at which the LOAD SWITCH drops out on decreasing load to indicate status. Default setting is 99.0%. Status Indication Relay state is determined by the ENERGIZE FOR STATUS setting.

### ALARM SETUP

This menu allows configuring the Alarm conditions which affect the Display Engine Trouble menu and the function of Engine Trouble Relay, Output #3.

**OIL PRESS DELAY**—Enter the delay time (in seconds) to wait before the OIL LOW PR ALM is issued after oil pressure falls below the OIL ALM SETPOINT.

**HI FUEL DEMND SETPT**—Enter the % Fuel Demand fault level required to trigger the HI FUEL DEMND ALM.

**HI FUEL DEMND DELAY**—Enter the delay time (in seconds) to wait before the HI FUEL DEMND ALM is issued after the % Fuel Demand exceeds the HI FUEL DEMND SETPT.

**HI SPEED SETPT**—Enter the engine speed fault level (rpm) required to trigger the HI SPEED ALM.

**HI SPEED DELAY**—Enter the delay time (in seconds) to wait before the HI SPEED ALM is issued after engine speed exceeds the HI SPEED SETPT.

**TORS LVL SETPT**—Enter the engine torsional vibration level (%rpm) required to trigger the TORSIONAL ALARM.

#### IMPORTANT

The torsional vibration fault level is a percentage of the full scale torsional vibration in rpm which is scaled elsewhere by TORS SCALE. Scaling sets the value of torsional vibration (as a % rated engine rpm) which equals the full scale (100%) torsional vibration level.

For example, at a rated rpm of 1200 and a TORS SCALE setting of 1% of rated, the full scale torsional vibration in rpm is 1% of 1200 or 12 rpm. At a TORS LVL SETPT of 25%, a TORSIONAL ALARM is triggered when the torsional vibration level is at or above 25% of 12 rpm or 3 rpm torsional vibration.

#### IMPORTANT

Be sure the TORS SCALE (% RT RPM) is properly set. It can be found on the TORSIONAL FILTER Service Menu . Default setting is 1% of rated rpm.

**HI TORSION DLY**—Enter the delay time (in seconds) to wait before the TORSIONAL ALARM is issued after the torsional vibration level exceeds the TORS LVL SETPT.

**ENERGIZE FOR ALARM**—Set TRUE to energize Engine Trouble Relay and close Output #3 contact on configured alarm conditions. Set FALSE to de-energize Engine Trouble Relay and open Output #3 contact on configured alarm conditions. Default is TRUE.

### SHUTDOWN SETUP

This menu allows configuring the Shutdown conditions which affect the Display Shutdown menu and the function of Shutdown Relay, Output #1.

**SHUTDOWN ACTUATOR**—Set TRUE to shut down the fuel actuator on any configured shutdown. Set FALSE to prevent fuel actuator shutdown. **BE SURE OF WHICH VALUE YOU WANT—THIS AFFECTS ALL CONFIGURED SHUTDOWN CONDITIONS.**

**OIL PRESS DELAY**—Enter the delay time (in seconds) to wait before the OIL LOW PR SD is issued after oil pressure falls below the OIL SD SETPOINT.

**HI FUEL DEMND SETPT**—Enter the % Fuel Demand fault level required to trigger the HI FUEL DEMND SD.

**HI FUEL DEMND DELAY**—Enter the delay time (in seconds) to wait before the HI FUEL DEMND SD is issued after the % Fuel Demand exceeds the HI FUEL DEMND SETPT.

**HI SPEED SETPT**—Enter the engine speed fault level (rpm) required to trigger the HI SPEED SD.

**HI SPEED DELAY**—Enter the delay time (in seconds) to wait before the HI SPEED SD is issued after engine speed exceeds the HI SPEED SETPT.

**TORS LVL SETPT**—Enter the engine torsional vibration level (%rpm) required to trigger the TORSIONAL SD.

## IMPORTANT

The torsional vibration fault level is a percentage of the full scale torsional vibration in rpm which is scaled elsewhere by TORS SCALE. Scaling sets the value of torsional vibration (as a % rated engine rpm) which equals the full scale (100%) torsional vibration level.

For example, at a rated rpm of 1200 and a TORS SCALE setting of 1% of rated, the full scale torsional vibration in rpm is 1% of 1200 or 12 rpm. At a TORS LVL SETPT of 50%, a TORSIONAL SHUTDOWN is triggered when the torsional vibration level is at or above 50% of 12 rpm or 6 rpm torsional vibration.

## IMPORTANT

Be sure the TORS SCALE (% RT RPM) is properly set. It can be found on the TORSIONAL FILTER Service Menu . Default setting is 1% of rated rpm.

**HI TORSION DLY**—Enter the delay time (in seconds) to wait before the TORSIONAL SD is issued after the torsional vibration level exceeds the TORS LVL SETPT.

**ENERGIZE FOR SHTDN**—Set TRUE to energize Shutdown Relay and close Output #1 contact on configured shutdown conditions. Set FALSE to de-energize Shutdown Relay and open Output #1 contact on configured shutdown conditions. Default is TRUE.

## CFIG COMMUNICATION

This menu configures Communication Port J2.

**PORT 2 Address**—Determines the optional ServLink address from 1 to 247 for Port J2.

## CFIG ANALOG OUTPUTS

This menu allows configuring the two analog outputs and the two actuator outputs. This configuration determines what parameters are in control of the outputs. These menu items are also used along with the Hardware Configuration to determine the output current range.

**AOUT 1 SELECT**—This value determines what parameter controls Analog Output #1. The selections are:

- 1—Engine Speed
- 2—Engine Speed Reference
- 3—Fuel Demand
- 4—Reverse Fuel Demand
- 5—Torsional Vibration Level
- 6—Air Manifold Pressure
- 7—Oil Pressure
- 8—Remote Speed Reference

**AOUT 1 4–20 mA**—This item scales the Analog Output #1 for 4 to 20 mA or 0 to 1 mA. A value of TRUE scales the output for 4 to 20 mA. A value of FALSE scales the output for 0 to 1 mA. Note that the an internal hardware jumper must be configured if this item is changed.

**AOUT 2 SELECT**—This value determines what parameter controls Analog Output #2. The selections are the same as for AOUT 1 SELECTION above.

**AOUT 2 4–20 mA**—This item scales the Analog Output #2 for 4 to 20 mA or 0 to 1 mA. A value of TRUE scales the output for 4 to 20 mA. A value of FALSE scales the output for 0 to 1 mA. Note that an internal hardware jumper must be configured if this item is changed.

**ACT OUT 1 4–20 mA**—This item scales the Actuator Output #1 for 0 to 200 mA or 4 to 20 mA. A value of FALSE scales the output for 0 to 200 mA. A value of TRUE scales the output for 4 to 20 mA. Default is FALSE. Note that an internal hardware jumper must be configured if this item is changed.

**ACT OUT 2 SELECT**—This value determines what parameter controls Actuator Output #2. The selections are the same as for AOUT 1 SELECTION above.

**ACT OUT 2 4–20 mA**—This item scales the Actuator Output #2 for 4 to 20 mA or 0 to 200 mA. A value of TRUE scales the output for 4 to 20 mA. A value of FALSE scales the output for 0 to 200 mA. Default is FALSE. Note that an internal hardware jumper must be configured if this item is changed.

The Configure values are saved when exiting the configure mode. After the above items have been set and checked to assure that no errors are present, you must exit the configure mode by pressing the **ESC** key on the Hand Held Programmer twice.

## NOTICE

To prevent possible damage to the engine resulting from improper control settings, make sure you save the set points before removing power from the control. Failure to save the set points before removing power from the control causes them to revert to the previously saved settings.

## Service Menu Descriptions

The following describes the Service menus. The listing below shows the menu title in large **BOLD** type. The title is followed by the separate menu items. A complete listing of the menu titles and menu items can be found in the Appendix. The listing shows the minimum value of the item, the maximum value of the item, and the default value of the item. The units that describe the item are shown in the item title. Units can be viewed with the **BKSP** button on the Hand Held Programmer, if they are not visible.

The unit “RPM” represents revolutions per minute. The unit “RPM/MIN” represents change in rpm per minute. The unit “ENGR” represents engineering units which are user set (psi, kPa, etc). The unit “Hz” represents frequency in Hertz. The unit “SEC” represents seconds. The unit “%FD” represents a percentage of the Fuel Demand as described in the Description of Operation in Chapter 6. The unit “%FD/S” represents percent fuel demand change per second. The unit “ENGR” represents engineering units for items such as psi, bar, or degrees. Use the Appendix to enter the specific values for your application.

Following is a brief description of each menu and each menu item. A complete description of the control is provided in the Description of Operation in Chapter 6. Note that, with the Hand Held Programmer, the dynamic menus are first to be displayed. Using the **Right Arrow** key brings up menus initially set with the engine running. Using the **Left Arrow** key brings up several display menus. The first display menus found with the **Left Arrow** are DISPLAY MENU followed by CTRL MODE, SHUTDOWN AND ENGINE TROUBLE.

## 1st Dynamics/2nd Dynamics Menu

Dynamic adjustments are settings that affect the stability and transient performance of the engine. There are two sets of dynamics provided. The set being used is selected by the 2nd Dynamics contact input. The control uses the 1st dynamics when the 2nd Dynamics contact is open, and it uses the 2nd dynamics when the contact is closed.

The following descriptions of each menu item apply to either set. Also see Figures 4-2, 4-3, and 4-4.

1. **GAIN** determines how fast the control responds to an error in engine speed from the speed-reference setting. The Gain is set to provide stable control of the engine at light or unloaded conditions.
2. **RESET** 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.
3. **COMPENSATION** compensates for the actuator and fuel system time constant. Increasing Compensation increases actuator activity and transient performance.
4. **GAIN RATIO** 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. (See Figure 3-2.)
5. **WINDOW WIDTH** is the magnitude (in rpm) of a speed error at which the control automatically switches to fast response. The control uses the absolute value of speed error to make this switch. A Window Width too narrow will result in cycling that always factors in the Gain Ratio. (See Figure 3-2.)

DUAL GAIN DYNAMICS  
SPEED CONTROL

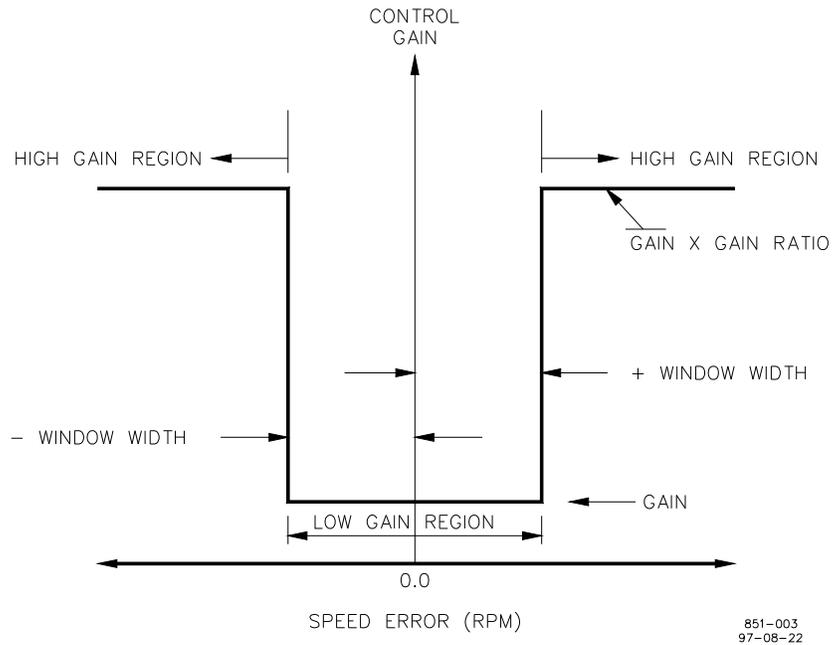


Figure 3-2. Control Gain as a Function of Speed Error

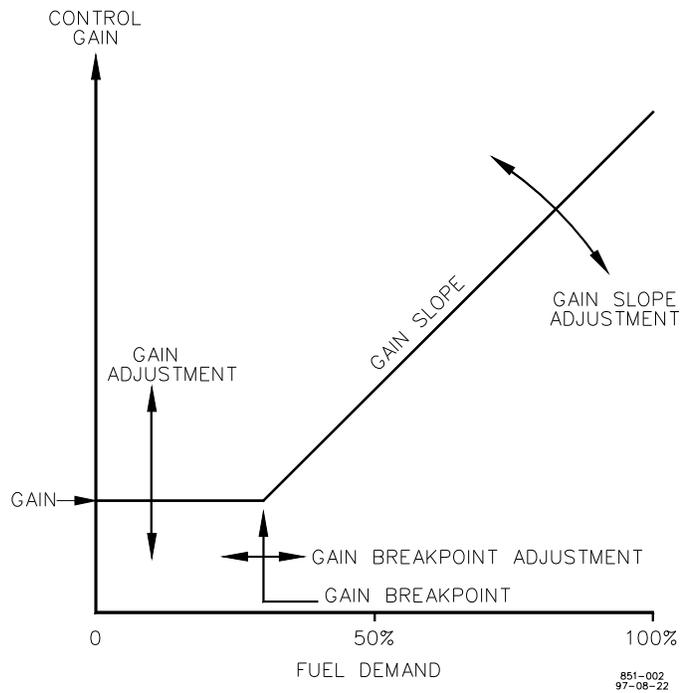
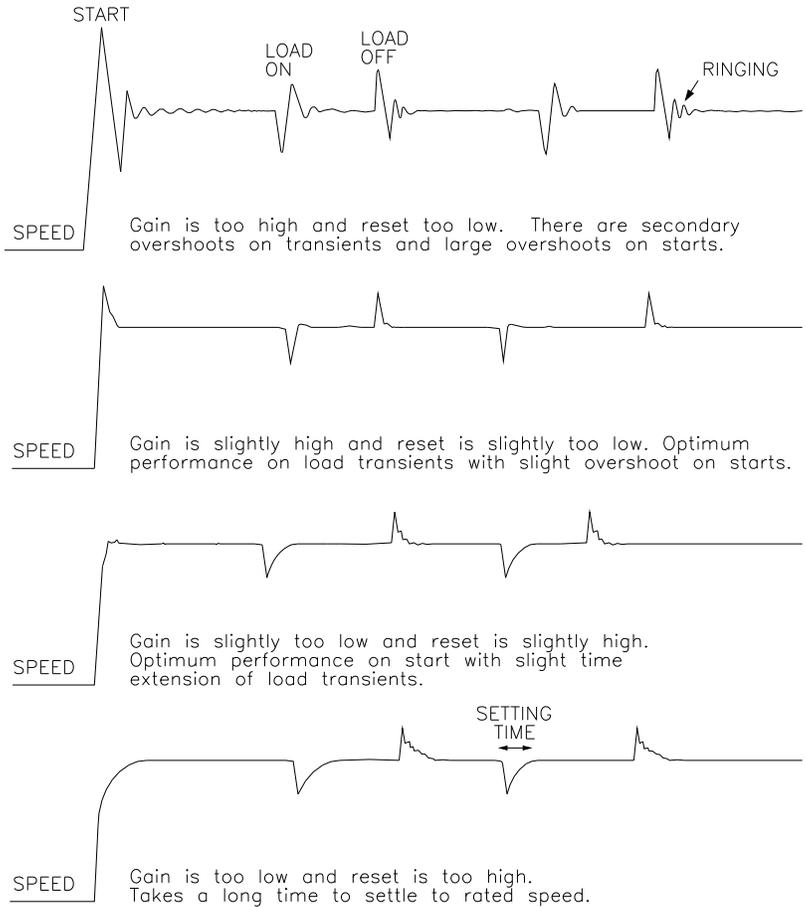
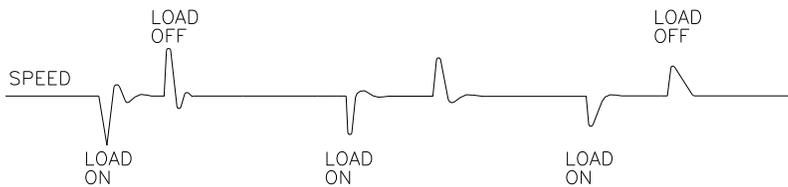


Figure 3-3. Control Gain as a Function of Control Output

RESULTS – GAIN AND RESET ADJUSTMENTS



IDEAL LOAD STEP RESPONSE



RESULTS – COMPENSATION ADJUSTMENT

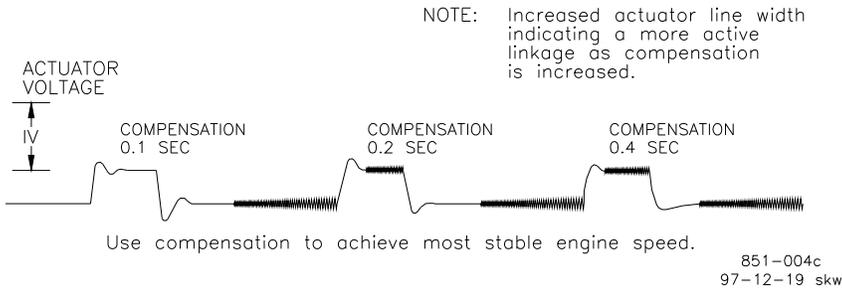


Figure 3-4. Typical Transient Response Curves

6. **GAIN SLOPE BK PNT** sets the percent output above which the Gain Slope becomes effective. It should usually be set just above the minimum load output. (See Figure 3-3.)
7. **GAIN SLOPE** changes Gain as a function of actuator output. Since actuator output is proportional to engine load, this makes Gain a function of engine load. Gain Slope operates in conjunction with the Gain Slope Break point adjustment to increase (or decrease) Gain when percent Actuator Output is greater than the break point. This compensates for systems having high (or low) gain at low load levels. This allows the Gain setting to be lower at light or no load for engine stability, yet provide good control performance under loaded conditions. (See Figure 3-3.)
8. **SPEED FILTER** adjusts the cutoff frequency of a low pass filter used on the speed sensing input (see Figure 3-5). To use this feature set **SPEED SETTING MENU - ENABLE SPEED FILTER** to **TRUE**. The filter is used to attenuate engine firing frequencies. To calculate the desired filter cutoff point, use the following formulas:

$$\begin{aligned} \text{camshaft frequency} &= (\text{engine rpm})/60 \text{ [for 2-cycle engines]} \\ &= (\text{engine rpm})/120 \text{ [for 4-cycle engines]} \end{aligned}$$

$$\text{firing frequency} = \text{camshaft frequency} \times \text{number of cylinders}$$

Initially set the filter frequency to the firing frequency.

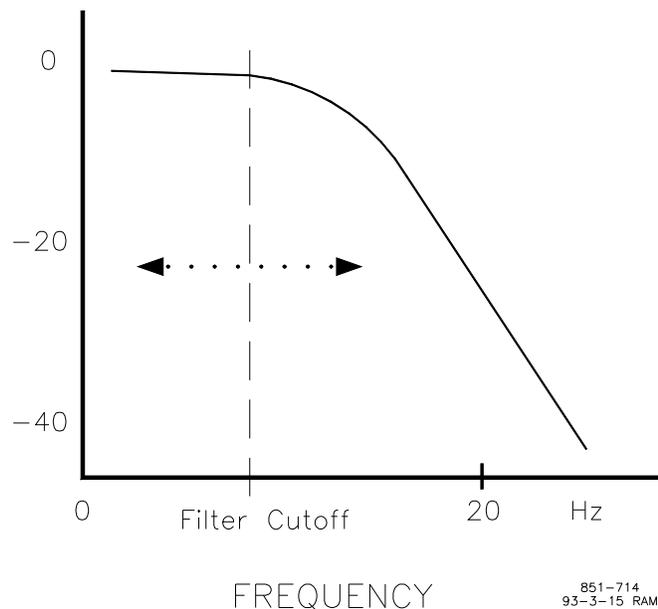


Figure 3-5. Speed Filter

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. **SPEED SETTING MENU - ENABLE SPEED FILTER** to **FALSE**.

9. **BUMP ACT** allows you to test your dynamics settings by temporarily applying a decreased fuel demand transient to stimulate a control response. Both the magnitude (Act Bump Level) and duration (Act Bump Duration) of the transient may be set. See the ACTUATOR BUMP menu. To initiate an actuator bump, toggle Bump Act to TRUE then back to FALSE while the engine is operating in a normal steady state loaded or unloaded condition.

**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** menu.

### ACTUATOR BUMP

This menu sets the parameters of the Bump Function.

**BUMP ENABLE**—This item enables the Bump Function. When the state is changed to TRUE, the Bump Function is enabled for 60 minutes. When the state is FALSE, the Bump Function does not change the fuel demand.

**ACT BUMP LEVEL (%FD)**—This sets the instantaneous decrease in fuel demand that occurs when the Bump Function is pulsed from either of the two dynamics menus.

**ACT BUMP DURATION (SEC)**—This sets the time that the Bump Function holds the fuel demand at the decreased level.

### FUEL LIMITERS

This menu sets the Start Limit Function, the Max Limit Function, and the Shift Fuel Limit Function.

**START FUEL LIMIT (%FD)**—This sets the maximum fuel demand when engine speed is less than five percent of the speed reference. This setting limits the fuel demand for starting, and is not removed until speed reaches 95% of the speed reference and the speed control PID is in control for 1 second. It is disabled for reverse acting systems when the Rated Speed discrete input is TRUE.

**START RAMP RATE (%FD/S)**—This sets the start ramp rate. The rate determines how fast the fuel demand is allowed to increase after engine speed has reached five percent of the speed reference. Increasing the fuel demand while the engine is cranking provides more starting fuel to the engine for starting on cold days.

**MAX FUEL LIMIT (%FD)**—This sets a maximum fuel limit on the fuel demand. It is typically used to electrically limit the amount of fuel to prevent overfueling.

**SHIFT FUEL LMT(%FD)**—This sets the % Fuel Demand increase to be added to all fuel limits when the “Fuel Limit Shift” discrete input is true. Limit is increased only for the SHIFT DURATION time setting.

**SHIFT DURATION(SEC)**—This sets the duration, in seconds, of the SHIFT FUEL LMT when the “Fuel Limit Shift” discrete input is true. The “Fuel Limit Shift” discrete input must be returned to false to reset the duration timer.

### SPEED SETTING

This menu sets the parameters of the Speed Reference. It also selects the speed input and whether or not the speed filter is enabled.

**RAISE SPEED LIMIT (RPM)**—This sets the maximum reference set point of the speed reference. This value should always be greater than the Rated Speed set point.

**LOWER SPEED LIMIT (RPM)**—This sets the minimum reference set point of the speed reference when the Rated Speed discrete input is TRUE. This value should always be less than the Rated Speed set point.

**IDLE SPEED (RPM)**—This sets the speed reference set point for idle speed. This speed reference is selected any time the Rated Speed discrete input is FALSE.

**ACCEL RAMP TIME (SEC)**—This sets the time in seconds that the speed reference increases from idle speed to rated speed when the Rated Speed discrete input goes TRUE.

**DECEL RAMP TIME (SEC)**—This sets the time in seconds that the speed reference decreases to idle speed from rated speed when the Rated Speed discrete input goes FALSE.

**RAISE SPEED RATE (RPM/MIN)**—This sets the rate that the speed reference increases to the raise speed limit when the Raise Speed discrete input is TRUE. It is also the rate used for the Remote Raise Speed signal.

**LOWER SPEED RATE (RPM/MIN)**—This sets the rate that the speed reference decreases to the lower speed limit when the Lower Speed discrete input is TRUE. It is also the rate used for the Remote Lower Speed signal.

**SELECT DIGITAL SPD**—This item selects the Digital Speed Detection method. When the state is TRUE, the Digital Speed Detection method is selected and speed changes can be detected faster. When the state is FALSE, the Analog Speed Detection method is selected. Default is TRUE.

## TORQ LIMIT CURVE

This menu sets the Torque Limit Curve (TLC) to limit fuel demand based on the engine speed input. This fuel limit prevent overfueling which limits torque for up to five speed break points. The input break points units are in rpm. The fuel limits are in percent fuel demand. Fuel demand is generally set slightly above the fuel required to carry the allowable load for each specific break point rpm. Too low a setting can degrade transient load performance.

**ENBL TORQ FUEL LMT**—Set to TRUE to enable the TORQ LIMIT CURVE. Set to FALSE to remove (disable) the TORQ LIMIT CURVE.

**TQ LMT INPUT A (RPM)**—This sets the first break point of the TLC. It should be adjusted to the rpm which represents the first break point. Typically this is set at minimum speed. The limit on fuel demand below this point is extrapolated from this point and the TQ LMT INPUT B (RPM) below.

**FUEL LIMIT @ A (%FD)**—This sets the maximum fuel demand at the first break point. It may be set less than the start fuel limit and still allow the start fuel limit to function.

**TQ LMT INPUT B (RPM)**—This sets the second break point of the TLC. It should be adjusted to the rpm which represents the second break point.

**FUEL LIMIT @ B (%FD)**—This sets the maximum fuel demand at the second break point.

**TQ LMT INPUT C (RPM)**—This sets the third break point of the TLC. It should be adjusted to the rpm which represents the third break point.

**FUEL LIMIT @ C (%FD)**—This sets the maximum fuel demand at the third break point.

**TQ LMT INPUT D (RPM)**—This sets the fourth break point of the TLC. It should be adjusted to the rpm which represents the fourth break point

**FUEL LIMIT @ D (%FD)**—This sets the maximum fuel demand at the fourth break point.

**TQ LMT INPUT E (RPM)**—This sets the fifth break point of the TLC. It should be adjusted to the rpm which represents the fifth break point. Typically this is set at rated speed.

**FUEL LIMIT @ E (%FD)**—This sets the maximum fuel demand at the fifth break point.

## AMP LMT CURVE

This menu sets the Air Manifold Pressure Limit Curve (AMPLC) to limit fuel demand based on the air manifold pressure input. This fuel limit prevents overfueling and reduces diesel engine smoke during load increases due to turbocharger lag as sensed by air manifold pressure. The curve has five break points. The input break points units are in tunable engineering units. The fuel limits are in percent fuel demand. Fuel demand is generally set slightly above the fuel required to carry the allowable load for each specific break point air manifold pressure.

**ENBL AMP FUEL LMT**—Set to TRUE to enable the AMP LMT CURVE. Set to FALSE to remove (disable) the AMP LMT CURVE.

**AMP LMT INPUT A (ENGR)**—This sets the first break point of the AMPLC. It should be adjusted to the air manifold pressure which represents the first break point. The limit on fuel demand below this point is extrapolated from this point and the AMP LMT INPUT B (ENGR) below.

**FUEL LIMIT @ A (%FD)**—This sets the maximum fuel demand at the first break point. It may be set less than the start fuel limit and still allow the start fuel limit to function.

**AMP LMT INPUT B (ENGR)**—This sets the second break point of the AMPLC. It should be adjusted to the air manifold pressure which represents the second break point.

**FUEL LIMIT @ B (%FD)**—This sets the maximum fuel demand at the second break point.

**AMP LMT INPUT C (ENGR)**—This sets the third break point of the AMPLC. It should be adjusted to the air manifold pressure which represents the third break point.

**FUEL LIMIT @ C (%FD)**—This sets the maximum fuel demand at the third break point.

**AMP LMT INPUT D (ENGR)**—This sets the fourth break point of the AMPLC. It should be adjusted to the air manifold pressure which represents the fourth break point.

**FUEL LIMIT @ D (%FD)**—This sets the maximum fuel demand at the fourth break point.

**AMP LMT INPUT E (ENGR)**—This sets the fifth break point of the AMPLC. It should be adjusted to the air manifold pressure which represents the fifth break point.

**FUEL LIMIT @ E (%FD)**—This sets the maximum fuel demand at the fifth break point.

## TORSIONAL FILTER

Torsional filter adjustments are the settings that affect the control's ability to react to flexible coupling torsionals. See Initial Adjustments in Chapter 4 for a more detailed description of the adjustments for the Torsional Filter. A Notch Filter is also provided with this control as an alternate filtering means for single speed sensor applications requiring torsional filtering.



### WARNING

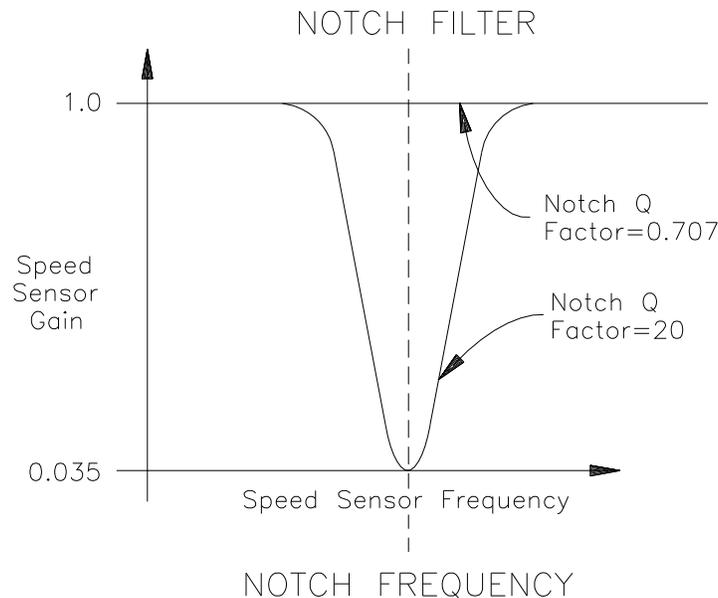
To use the notch filter, make sure that the speed sensor(s) used are only on the engine side of the flexible coupling. Otherwise, an overspeed with the possibility of serious injury or death is possible.

The notch filter is a bandstop filter. It rejects specific frequencies and allows all others to pass. The idea is to reject the torsional (frequency on a frequency) frequencies that the coupling produces, so that the actuator will not respond to speed sensor changes it cannot control with the fuel. Systems with low frequency oscillatory modes due to engine and driven load inertias and flexible couplings are difficult to control. In the notch filter approach, no attempt is made to map the oscillatory modes, but an effort is made to reduce the signal transmission through the controller by a filter that drastically reduces the signal gain at the resonant frequency.

There are two adjustments—NOTCH FREQUENCY and NOTCH Q FACTOR.

**NOTCH FREQUENCY** is the center frequency of rejection, and the units are defined in hertz. In tuning the notch filter, the resonant frequency must be identified and entered. The allowed frequency range of the notch filter is 0.5 to 16.0 Hz.

**NOTCH Q FACTOR** is the width about NOTCH FREQUENCY that the filter rejects, and is dimensionless. The Q factor has a tuning range of 0.707 to 25.0. At the minimum value 0.707, there is no attenuation of signal gain at the resonant frequency, and the filter gain equals one. At the maximum value 20.0, a maximum attenuation of signal gain occurs at the resonant frequency, and the filter gain equals 0.035. In general, the filter gain at the resonant frequency is  $0.707/Q$  factor.



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Figure 3-6. Notch Filter

**ENABLE TORS FILTER**—This item enables the Torsional Filter. When the state is changed to TRUE, the Torsional Filter is enabled to modify the speed input when torsionals are present. When the state is FALSE, the Torsional Filter is not active and the speed input is determined by the higher of the two input speeds.

**ENG SENSOR WEIGHT**—This value sets the amount of filtering which occurs to the two speed inputs when they deviate. A value of 0.50 causes both inputs to be weighted equally. A higher value uses more of the engine speed input and less of the load side speed input. Conversely, a lower value uses less of the engine speed input and more of the load side speed input.

**TORS SCALE (%RT RPM)**—This sets the value of torsional vibration (as a % rated engine rpm) which equals the full scale (100%) torsional vibration level. Default is set at 1%. (e.g., with a rated engine speed of 1200 rpm and a TORS SCALE of 1%, the full scale torsional vibration level is 12 rpm or 0.2 cycles/second).

**TORSNL FUEL LIMIT**—This is the maximum limit of the fuel demand if the Torsional Level has been greater than the TORSNL LEVEL @LIMIT setting and has not yet returned to a value less than the TORSNL LEVEL @CLEAR setting. Adjusting this value to 100.00 effectively deactivates the Torsional Limit Function.

**TORSNL LEVEL @LIMIT**—This is the Torsional Level which activates the Torsional Fuel Limit. This value should always be greater than the TORSNL LEVEL @CLEAR value.

**TORSNL LEVEL @CLEAR**—This is the Torsional Level which clears the fuel demand limit. This value should always be less than the TORSNL LEVEL @LIMIT value above.

**NOTCH FREQUENCY**—This is set at the center frequency in hertz of a band stop filter (see Figure 3-6).

**NOTCH Q FACTOR**—This will set the filter attenuation and width about the center frequency (see Figure 3-6).

## IMPORTANT

The notch filter is enabled when CFG OPTION menu items USE TORSION FILTER and USE NOTCH FILTER are set to TRUE, and TORSIONAL FILTER menu item ENABLE TORS FILTER is set to TRUE. Otherwise the notch filter is disabled.

## COMMUNICATIONS

This menu sets the communications for Port 2. Port 3 is not used.

**HARDWARE CONFIG**—This determines if Communications Port J2 is set for RS-232 or RS-422 based on:

- 1=RS-232
- 2=RS-422

**BAUD**—This determines what BAUD rate Communications Port J2 is set for based on:

- |        |                            |
|--------|----------------------------|
| 1=110  | 6=2400                     |
| 2=300  | 7=4800                     |
| 3=600  | 8=9600                     |
| 4=1200 | 9=19200                    |
| 5=1800 | 10=38400 (Default Setting) |

## OIL ALM SETPOINT

This menu sets the OIL ALM SETPOINT Curve (OASC) for the Engine Trouble OIL LOW PR ALM which triggers when the oil pressure input is less than the alarm set point curve. The curve has four break points. The input break points units are in rpm. The Oil Pressure set points are in tunable engineering units.

**SPEED INPUT A (RPM)**—This sets the first break point of the OASC. It should be adjusted to the engine rpm which represents the first break point. The set point below this point is extrapolated from this point and the SPEED INPUT B (RPM) below.

**OIL ALM SETPT A (EU)**—This sets the oil pressure alarm set point at the first break point.

**SPEED INPUT B (RPM)**—This sets the second break point of the OASC. It should be adjusted to the engine rpm which represents the second break point.

**OIL ALM SETPT B (EU)**—This sets the oil pressure alarm set point at the second break point.

**SPEED INPUT C (RPM)**—This sets the third break point of the OASC. It should be adjusted to the engine rpm which represents the third break point.

**OIL ALM SETPT C (EU)**—This sets the oil pressure alarm set point at the third break point.

**SPEED INPUT D (RPM)**—This sets the fourth break point of the OASC. It should be adjusted to the engine rpm which represents the fourth break point.

**OIL ALM SETPT D (EU)**—This sets the oil pressure alarm set point at the fourth break point.

### OIL SD SETPOINT

This menu sets the OIL SD SETPOINT Curve (OSDSC) for the OIL LOW PR SD which triggers shutdown when the oil pressure input is less than the shutdown set point curve. The curve has four break points. The input break points units are in rpm. The Oil Pressure set points are in tunable engineering units.

**SPEED INPUT A (RPM)**—This sets the first break point of the OSDSC. It should be adjusted to the engine rpm which represents the first break point. The set point below this point is extrapolated from this point and the SPEED INPUT B (RPM) below.

**OIL SD SETPT A (EU)**—This sets the oil pressure shutdown set point at the first break point.

**SPEED INPUT B (RPM)**—This sets the second break point of the OSDSC. It should be adjusted to the engine rpm which represents the second break point.

**OIL SD SETPT B (EU)**—This sets the oil pressure shutdown set point at the second break point.

**SPEED INPUT C (RPM)**—This sets the third break point of the OSDSC. It should be adjusted to the engine rpm which represents the third break point.

**OIL SD SETPT C (EU)**—This sets the oil pressure shutdown set point at the third break point.

**SPEED INPUT D (RPM)**—This sets the fourth break point of the OSDSC. It should be adjusted to the engine rpm which represents the fourth break point.

**OIL SD SETPT D (EU)**—This sets the oil pressure shutdown set point at the fourth break point.

### SET AI ENGR UNITS

This menu is provided to set the Analog Inputs engineering units. Be sure the units entered match the input sensing device calibration.

**OIL PRESS @ 4 mA (EU)**—Enter the input pressure from the oil pressure sensing device in preferred units (psi, kPa, bar, etc.) at 4 mA. If a voltage sensing device is provided, enter the input pressure at 1 Vdc.

**OIL PRESS @ 20 mA (EU)**—Enter the input pressure from the oil pressure sensing device in preferred units (psi, kPa, bar, etc.) at 20 mA. If a voltage sensing device is provided, enter the input pressure at 5 Vdc.

**AIR MAN PR @ 4 mA (EU)**—Enter the input pressure from the air manifold pressure sensing device in preferred units (psi, kPa, bar, etc.) at 4 mA. If a voltage sensing device is provided, enter the input pressure at 1 Vdc.

**AIR MAN PR @ 20 mA (EU)**—Enter the input pressure from the air manifold pressure sensing device in preferred units (psi, kPa, bar, etc.) at 20 mA. If a voltage sensing device is provided, enter the input pressure at 5 Vdc.

**REMOTE SR @ 4 mA (RPM)**—Enter the preferred engine speed reference set point from the Remote Speed Setpoint device in rpm at 4 mA. If a voltage sensing device is provided, enter the engine speed reference set point at 1 Vdc.

**REMOTE SR @ 20 mA (RPM)**—Enter the preferred engine speed reference set point from the Remote Speed Setpoint device in rpm at 20 mA. If a voltage sensing device is provided, enter the engine speed reference set point at 5 Vdc.

### SET ANALOG OUTPUTS

This menu sets the Analog Outputs to allow the proper scaling of each output based on the engineering units of the software configured input and type of hardware configured output. The value of the output can be displayed using the appropriate ANALOG OUT or ACTUATOR OUT item in the DISPLAY I/O menu. These items are displayed as milliamp outputs. The items below should be entered so that the MIN entry represents the configured value in engineering units at 4 mA (or 0 mA), and the MAX entry represents the configured value in engineering units at 20 mA (or 1 mA).

**ANALOG OUTPUT 1 MIN (ENGR)**—This is adjusted to the engineering units which outputs 4 mA (or 0 mA if so configured) at Analog Output #1.

**ANALOG OUTPUT 1 MAX (ENGR)**—This is adjusted to the engineering units which outputs 20 mA (or 1 mA if so configured) at Analog Output #1.

**ANALOG OUTPUT 2 MIN (ENGR)**—This is adjusted to the engineering units which outputs 4 mA (or 0 mA if so configured) at Analog Output #2.

**ANALOG OUTPUT 2 MAX (ENGR)**—This is adjusted to the engineering units which outputs 20 mA (or 1 mA if so configured) at Analog Output #2.

**ACTUATOR OUT 2 MIN (ENGR)**—This is adjusted to the engineering units which outputs 4 mA (or 0 mA if so configured) at Actuator Output #2.

**ACTUATOR OUT 2 MAX (ENGR)**—This is adjusted to the engineering units which outputs 20 mA (or 200 mA if so configured) at Actuator Output #2.

**ACTUATOR OUT 1 MIN**—Actuator Output #1 Minimum Position setting is fixed. It is factory set for 0 mA output with the fuel demand at 0 percent.

**ACTUATOR OUT 1 MAX**—Actuator Output #1 Maximum Position setting is fixed. It is factory set for 200 mA output with the fuel demand at 100 percent.

**AO FILTER HZ** adjusts the cutoff frequency of a low-pass filter used on Analog Outputs 1, 2, and 4. The filter is used to attenuate output signal noise. To use this feature, set the cutoff frequency below 15.9 Hz. To disable this filter, set the cutoff frequency at or above 15.9 Hz.

### I/O CALIBRATION

This menu allows exact calibration of the analog inputs and outputs. The **offset** value should be adjusted so that the *minimum input or output* provides the correct display value. The **span** value should be adjusted so that the *maximum input or output* provides the correct display value. The display values of the inputs can be read in the DISPLAY ANALOG I/O menu. The input currents should be monitored with a milliamp meter in series with the source or from the source itself. The display values of the outputs can also be read in the DISPLAY ANALOG I/O menu. The Actuator Output is either the Fuel Demand or (100 - FUEL DEMAND) for reverse acting systems. The output currents should be monitored with a milliamp meter in series with the Analog Output or at the output itself.

**OIL PR OFFSET(AI1)**—This input is displayed as AI1- LUBE OIL PR (mA) in the DISPLAY ANALOG I/O menu.

**OIL PRESS SPAN (AI1)**—This input is displayed as AI1- LUBE OIL PR (mA) in the DISPLAY ANALOG I/O menu.

**OIL PR READ VLT(AI1)**—Set to TRUE to read AI1- LUBE OIL PR volts instead of milliamps in the DISPLAY ANALOG I/O menu.

**ENABLE DSLC INPUT(AI2)**—This input enables or disables the biasing of the speed reference from a DSLC control connected to analog input 2. Set to TRUE to enable, FALSE to disable.

- DSLCL OFFSET (AI2)**—This input adjusts the displayed as AI2 DSLCL mA.
- AMP OFFSET(AI1)**—This input is displayed as AI3- AIR MANF PR (mA) in the DISPLAY ANALOG I/O menu.
- AIR MAN PR SPAN (AI1)**—This input is displayed as AI3- AIR MANF PR (mA) in the DISPLAY ANALOG I/O menu.
- AIR MP READ VLT(AI1)**—Set to TRUE to read AI3- AIR MANF PR volts instead of milliamps in the DISPLAY ANALOG I/O menu.
- REM SR OFFSET(AI1)**—This input is displayed as AI4- REM SPD REF (mA) in the DISPLAY ANALOG I/O menu.
- REM SR SPAN (AI1)**—This input is displayed as AI4- REM SPD REF (mA) in the DISPLAY ANALOG I/O menu.
- REM SR READ VLT(AI1)**—Set to TRUE to read AI4- REM SPD REF volts instead of milliamps in the DISPLAY ANALOG I/O menu.
- AO 1 OFFSET**—Refer to the DISPLAY MENU for the specific configured output.
- AO 1 SPAN**—Refer to the DISPLAY MENU for the specific configured output.
- AO 2 OFFSET**—Refer to the DISPLAY MENU for the specific configured output.
- AO 2 SPAN**—Refer to the DISPLAY MENU for the specific configured output.
- ACT 1 OFFSET**—Provided to precisely set 0 mA output with the fuel demand at 0%. We do not recommend a different setting.
- ACT 1 SPAN**—Provided to precisely set 200 mA output with the fuel demand at 100%. We do not recommend a different setting unless the maximum output is configured for 20 mA.
- ACT 2 OFFSET**—Refer to the DISPLAY MENU for the specific configured output.
- ACT 2 SPAN**—Refer to the DISPLAY MENU for the specific configured output.

**IMPORTANT**

The remaining Service menus display control information. The easiest access to these menus with the Hand Held Programmer is by keying to the left after initially entering the Service display.

**DISPLAY DIGITAL I/O**

This menu is for display only. It displays the digital inputs and outputs to the 723PLUS control.

- A- FUEL LIMIT SHIFT**—This shows the state of the A discrete input.
- B- ALARM RESET**—This shows the state of the B discrete input.
- C- SPEED FAIL OVRD**—This shows the state of the C discrete input.
- D- 2ND DYNAMICS**—This shows the state of the D discrete input.
- E- RAISE SPEED**—This shows the state of the E discrete input.
- F- LOWER SPEED**—This shows the state of the F discrete input.
- G- RATED SPEED**—This shows the state of the G discrete input.
- H- CLOSE TO STOP**—This shows the state of the H discrete input.
- SHUTDOWN (DO1)**—This shows the state of Relay Output #1. A TRUE indicates the relay is energized.
- STATUS INDICTR (DO2)**—This shows the state of Relay Output #2. A TRUE indicates the relay is energized.
- ENGINE TROUBLE (DO3)**—This shows the state of Relay Output #3. A TRUE indicates the relay is energized.

**DISPLAY ANALOG I/O**

This menu is for display only. It displays the analog inputs and outputs to the 723PLUS control.

- ANALOG SS IN #1 (Hz)**—This value is the frequency in hertz seen by Analog Speed Sensor #1.

**ANALOG SS IN #2 (Hz)**—This value is the frequency in hertz seen by Analog Speed Sensor #2.

**DIGITAL SS IN #1 (Hz)**—This value is the frequency in hertz seen by Digital Speed Sensor #1.

**DIGITAL SS IN #2 (Hz)**—This value is the frequency in hertz seen by Digital Speed Sensor #2.

**AI1- LUBE OIL PR (mA)**—This shows the value in mA of the Lube Oil Pressure input on Signal Input #1.

**AI2- DSLC (Vdc)**—This shows the value in volts of the DSLC Speed Bias input on Signal Input #2.

**AI3- AIR MANF PR (mA)**—This shows the value in mA of the Air Manifold Pressure input on Signal Input #3.

**AI4- REM SPD REF (mA)**—This shows the value in mA of the Remote Speed Reference input on Signal Input #4.

**ANALOG OUT 1 (mA)**—This shows the relative mA output of Analog Output #1. The mA value is prior to the effect of the offset and span in the I/O CALIBRATION menu.

**ANALOG OUT 2 (mA)**—This shows the relative mA output of Analog Output #2. The mA value is prior to the effect of the offset and span in the I/O CALIBRATION menu.

**ACTUATOR OUT 1 (mA)**—This shows the relative mA output of Actuator Output #1. The mA value is prior to the effect of the offset and span in the I/O CALIBRATION menu.

**ACTUATOR OUT 2 (mA)**—This shows the relative mA output of Actuator Output #2. The mA value is prior to the effect of the offset and span in the I/O CALIBRATION menu.

## DISPLAY INDICATION

This menu is for display only. It displays the configured Status Indications alarms in the 723PLUS control. Any Status Indication alarms which are TRUE cause Relay Output #2 (Status Indication) to activate. The status condition must be cleared for the Status Indication alarm to show FALSE.

**ON MAX LIMIT**—Display shows TRUE when the fuel demand is being limited by the Max Fuel Limit.

**ON AIR PRESS LIMIT**—Display shows TRUE when the fuel demand is being limited by the Air Manifold Pressure Fuel Limit.

**ON TORSION LIMIT**—Display shows TRUE when the fuel demand is being limited by the Torsional Fuel Limit.

**ON TORQUE LIMIT**—Display shows TRUE when the fuel demand is being limited by the Torque Fuel Limit.

**ACT SHUTDOWN**—Display shows TRUE when an Actuator Shutdown has been applied.

**SPEED SWITCH**—Display shows TRUE when the Speed Switch has been triggered. Display shows FALSE when the Speed Switch is reset.

**OIL XMTR FAIL**—Display shows TRUE when the Oil Pressure Transmitter input on Signal Input #1 has failed.

**AIR MANF XMTR FAIL**—Display shows TRUE when the Air Manifold Pressure Transmitter input on Signal Input #3 has failed.

**LOAD SWITCH**—Display shows TRUE when the Load Switch has been triggered. Display shows FALSE when the Load Switch is reset.

## DISPLAY ENG TROUBLE

This menu is for display only. It displays the configured Engine Trouble alarms in the 723PLUS control. Any Engine Trouble alarms which are TRUE cause Relay Output #3 (Engine Trouble) to activate and the Alarm #2 LED to illuminate. It also shows which configured alarm occurred first. The last item is a software switch which issues a pulse to Alarm Reset and reset all configured alarms and shutdowns which are no longer in an alarm or shutdown state.

**FIRST ALARM**—This integer indicates which of the Engine Trouble alarms occurred first. For example, if a Hi Speed alarm has been configured to activate the Engine Trouble relay, and a Hi Speed alarm has occurred during operation, prior to other alarm conditions, the value of this item would be “7”, indicating the Hi Speed alarm has occurred first.

**1-SPEED #1 FAIL**—Displays TRUE if the input has failed, the alarm has been configured to be enabled, and the Close To Stop discrete input is FALSE.

**2-SPEED #2 FAIL**—Displays TRUE if the input has failed, the alarm has been configured to be enabled, and the Close To Stop discrete input is FALSE.

**3-SPD #1 AND #2 FAIL**—Displays TRUE if both inputs have failed, the alarm has been configured to be enabled, and the Close To Stop discrete input is FALSE.

**4-REM SPD XMTR FAIL**—Displays TRUE if the input has failed and the alarm has been configured to be enabled.

**5-OIL LOW PR ALM**—Displays TRUE if the oil pressure is less than the tunable OIL ALM SETPOINT for the configured delay time and the alarm has been configured to be enabled.

**6-HI FUEL DEMAND ALM**—Displays TRUE if the fuel demand exceeds the configured HI FUEL DEMND SETPT for the configured delay time and the alarm has been configured to be enabled.

**7-HI SPEED ALARM**—Displays TRUE if the engine speed has exceeded the configured alarm HI SPEED SETPT for the configured delay time and the alarm has been configured to be enabled.

**8-TORSIONAL ALARM**—Displays TRUE if the torsional level exceeds the configurable TORS LVL SETPT for the configured delay time and the alarm has been configured to be enabled.

**9-SPEED SWITCH**—Displays TRUE if the Speed Switch has been triggered (Speed > SPD SW PICKUP setting). Displays FALSE if the Speed Switch is reset (Speed < SPD SW DROPOUT setting).

**10-LOAD SWITCH**—Displays TRUE if the Load Switch has been triggered (Load > LOAD SW PICKUP setting). Displays FALSE if the Load Switch is reset (Load < LOAD SW DROPOUT setting).

**ALARM RESET**—Toggle TRUE then FALSE to reset all configured alarms and shutdowns.

## DISPLAY SHUTDOWN

This menu is for display only. It displays the configured shutdowns in the 723PLUS control. Any shutdowns which are TRUE cause Relay Output #1 (Shutdown) to activate and the Alarm #1 LED to illuminate. It also shows which configured shutdown occurred first.

**FIRST SHUTDOWN**—This integer indicates which of the shutdowns occurred first. For example, if a Hi Speed shutdown has been configured to activate the Shutdown relay, and a Hi Speed shutdown has occurred during operation, prior to other shutdown conditions, the value of this item would be “7”, indicating the Hi Speed shutdown has occurred first.

**1-SPEED #1 FAIL**—Displays TRUE if the input has failed, the shutdown has been configured to be enabled, and the Close To Stop discrete input is FALSE.

**2-SPEED #2 FAIL**—Displays TRUE if the input has failed, the shutdown has been configured to be enabled and the Close To Stop discrete input is FALSE.

**3-SPD #1 AND #2 FAIL**—Displays TRUE if both inputs have failed, the shutdown has been configured to be enabled, and the Close To Stop discrete input is FALSE.

**4-REM SPD XMTR FAIL**—Displays TRUE if the input has failed and the shutdown has been configured to be enabled.

**5-OIL LOW PR SD**—Displays TRUE if the oil pressure is less than the tunable OIL SD SETPOINT for the configured delay time and the shutdown has been configured to be enabled.

**6-HI FUEL DEMAND SD**—Displays TRUE if the fuel demand exceeds the configured HI FUEL DEMND SETPT for the configured delay time and the shutdown has been configured to be enabled.

**7-HI SPEED SD**—Displays TRUE if the engine speed has exceeded the configured shutdown HI SPEED SETPT for the configured delay time and the shutdown has been configured to be enabled.

**8-TORSIONAL SD**—Displays TRUE if the torsional level exceeds the configurable TORS LVL SETPT for the configured delay time and the shutdown has been configured to be enabled.

### DISPLAY CTRL MODE

This menu is for display only. It displays the Control Modes in the 723PLUS control.

**IN SPEED CTRL (LSS)**—Display shows TRUE when the fuel demand is being controlled by the Speed Control.

**ON START LIMIT (LSS)**—Display shows TRUE when the fuel demand is being limited by the START FUEL LMT.

**ON MAX LIMIT (LSS)**—Display shows TRUE when the fuel demand is being limited by the MAX FUEL LIMIT.

**ON AMP LIMIT (LSS)**—Display shows TRUE when the fuel demand is being limited by the AMP LIMIT CURVE.

**ON TORQ FUEL LIMIT**—Display shows TRUE when the fuel demand is being limited by the TORQ LIMIT CURVE.

**ON TORSIONAL LIMIT (LSS)**—Display shows TRUE when the fuel demand is being limited by the TORSNL FUEL LIMIT.

**ACTUATOR SHUTDOWN**—Display shows TRUE when an Actuator Shutdown has been applied.

**TORSNL FILTR ACTIVE**—Display shows TRUE when USE TORSION FILTER is configured TRUE and the ENABLE TORS FILTER is enabled TRUE.

**SPEED SENSOR 1 ACTIVE**—Display shows TRUE when the speed sensor 1 input is active as the primary input for speed control. The primary input is in control in single speed sensor applications, and assumes control if the secondary input fails in a two-speed sensor input application.

**SPEED SENSOR 2 ACTIVE**—Display shows TRUE when the speed sensor 2 input is active as the primary input for speed control. The primary input is in control in single speed sensor applications, and assumes control if the secondary input fails in a two-speed sensor input application.

### DISPLAY MENU

This menu is for display only. It shows several control parameters which are often used to determine the operation of the engine. Refer to Chapter 6 for a complete description of these terms.

**ENGINE SPEED (RPM)**—This displays the engine speed.

**BIASED SPEED REF (RPM)**—This displays the total output of the speed reference ramp and the DSLC bias. This biased speed reference is the setpoint input to the speed control PID. Note that this may not be the speed that the engine is presently running due to the effect of droop, fuel limiters, etc.

**SPEED REF (RPM)**—This displays the output of the speed reference ramp before DSLC Speed Bias.

**DSLCL BIAS (RPM)**—This displays the value, in rpm, that the DSLCL input is biasing the speed reference.

**FUEL DEMAND**—This displays the fuel demand. This is NOT the same as the actuator output if configured for reverse acting. This is the same if direct acting.

**OIL PRESSURE (EU)**—This displays the oil pressure in tunable engineering units.

**AIR MANF PRESS (EU)**—This displays the air manifold pressure in tunable engineering units.

**REM SPD REF (RPM)**—This displays the remote speed reference in tunable engineering units.

**TORQUE LIMIT (%FD)**—This displays the torque fuel limit.

**AMP FUEL LIMIT (%FD)**—This displays the air manifold pressure fuel limit.

**TORSNL LIMIT (%FD)**—This displays the torsional fuel limit.

**TORSIONL LEVEL (%RPM)**—This displays the torsional vibration level as a percentage of TORS SCALE rpm. Default TORS SCALE is 1% of rated rpm. It can be found in the TORSIONAL FILTER Service Menu.

## Conclusion of Setup Procedures

This completes the adjustment chapter. Save the set points by pressing the "SAVE" key on the Hand Held Programmer or save settings using Watch Window (refer to "help" if you need help). Run through all the set points and record them in the Appendix for future reference. Settings can also be saved to a file using Watch Window for later download. This can be very useful if a replacement control is necessary or for start-up of another similar unit. Power down the control for about 10 seconds. Restore power and verify that all set points are as recorded.

### NOTICE

**To prevent possible damage to the engine resulting from improper control settings, make sure you save the set points before removing power from the control. Failure to save the set points before removing power from the control causes them to revert to the previously saved settings.**

Disconnect the Hand Held Programmer from the control (if applicable). Watch Window may remain connected or removed from the control at the end user's discretion. Close the cover over J1 and re-tighten the retaining screw if connection is removed.

# Chapter 4.

## Initial Adjustments

### Introduction

This chapter contains information on control calibration. It includes initial prestart-up and start-up settings and adjustments. These adjustments are intended to allow starting the engine for the first time.

#### **WARNING**

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

### Start-up Adjustments

1. Complete the installation checkout procedure in Chapter 2 and review the menu settings in Chapter 3. Assure that all critical set points are correct. This includes the items in Configure menus CFG OPTION, CFG SPEED CONTROL, and Service menus 1st DYNAMICS, 2nd DYNAMICS, and SPEED SETTING. All other menu items critical to the specific application must also be determined and correctly set.
2. Open the Open to Run contact. Be sure the Rated Speed contact is in idle (open). Apply power to the control. Do NOT proceed unless the green POWER OK and CPU OK indicators on the front of the control are on.
3. Check the speed sensor.

Minimum voltage required from the speed sensor to operate the control is 1.5 Vrms, measured at cranking speed or the lowest controlling speed. For this test, measure the voltage while cranking with the speed sensor connected to the control. **Before cranking, be sure to prevent the engine from starting.** At 5% of rated speed and 1.0 Vrms, the failed speed sensing circuit function should clear. If the red FAILED SPD SENSOR #1 indicator remains on, shut down the engine.

#### **WARNING**

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

4. Start the engine.

If there is insufficient fuel to start the engine, increase the Start Fuel Limit (Fuel Limiters menu). The control reduces fuel as required when the speed setting is reached. It requires extra fuel to accelerate the engine to idle speed. It may take a few starts to determine the final setting of the Start Fuel Limit. If the start time is excessive, increase the Start Fuel Limit and/or the Start Ramp Rate. If the start time is too fast or flooding is occurring, decrease the Start Fuel Limit and/or the Start Ramp Rate. Both hot and cold starts should be performed to determine a final settings.

5. Adjust for stable operation.

If the engine is hunting at a rapid rate, slowly decrease the Gain until performance is stable. If the engine is hunting at a slow rate, increase the Reset value. If increasing the Reset value does not stabilize the engine, it also may be necessary to slowly decrease the Gain OR to slowly decrease the Gain and increase the Compensation.

This completes the start-up adjustments. We recommend saving the settings at this time by pressing the "SAVE" key on the hand-held programmer or by saving settings with Watch Window (refer to "Help" if you need help). The programmer will display the message "Saving Changes". Watch Window has a "pop-up" box that says the values have been saved.

## Dynamic Adjustments

The objective of the dynamic adjustments is to obtain acceptable, stable engine speed response from minimum Speed/Load to full speed and load. All adjustments apply to both 1st dynamics (2nd Dynamics contact open) and 2nd dynamics (2nd Dynamics contact closed).

Do the following adjustments first for 1st dynamics (2nd Dynamics contact open). Use the 1st Dynamics Menu to set the 1st dynamics if changes are needed.

Then repeat the adjustments for 2nd dynamics (2nd Dynamics contact closed). Use the 2nd Dynamics Menu to set the 2nd dynamics, if changes are needed.

1. No-Load Adjustments

Do this adjustment without load applied.

Slowly increase the Gain set point until the engine becomes slightly unstable, then reduce the Gain as necessary to stabilize the engine.

After acceptable performance at no load, record the Fuel Demand as read on Display Menu. Set the Gain Slope Break point to this reading. Observe the movement of the actuator. If the activity of the actuator is excessive, reduce the Gain set point slightly to get the actuator movement to an acceptable level.

If there is a slow periodic cycling of the engine speed above and below the speed setting, there are two possible causes:

Gain is too high and Reset is too low. Reduce the Gain by 50% (i.e., if the Gain was 0.02, reduce it to 0.01) and increase the Reset slightly. Observe the movement of the actuator. Continue to increase Reset until the movement is acceptable but not excessive. A final value of Reset should be between 1.0 and 2.0 for most large engines. If the Reset value exceeds 2.0, but this procedure continues to improve performance, increase the Compensation set point 50% and repeat the procedure.

Gain is too low. If the preceding procedure does not improve the slow periodic cycling of the engine speed, the control may be limiting cycling through the low gain control region set by the Window Width set point. Increase the Gain set point to minimize the cycling. If actuator movement becomes excessive, reduce the Compensation set point until movement is acceptable. In some cases, Compensation may be reduced to zero and only the Gain and Reset adjustments used. This should be done only if necessary to eliminate excessive actuator response to misfiring or other periodic disturbances. Reduce the Window Width set point until the limit cycle amplitude is acceptable without excessive rapid actuator movement.

## 2. Full Load Adjustment

Do these adjustments at the speed and load at which the engine is most often operated.

If operation in this range is satisfactory, no further dynamic adjustments are necessary. If during changes in load or an actuator bump, excessive speed errors occur, increase the Gain Slope adjustment until engine performance is satisfactory (see Figure 3-3). If excessive actuator movement again occurs, do procedure 3, then repeat procedure 2. If the settling time after a load change is too long, reduce the Reset set point slightly and increase the Gain slightly. If slow-speed hunting occurs after a load change but decreases or stops in time, increase the Reset set point slightly and reduce the Gain set point (see Figure 3-4).



### **WARNING**

**The use of negative Gain Slope should be considered carefully. Low gain at high fuel levels results in poor load rejection response and possible overspeed. To prevent possible serious injury from an overspeeding engine, the maximum fuel limit must be set near the full load output current demand to prevent excessive integrator windup and a subsequent low gain condition.**

3. When significant load changes occur, the control should switch automatically to high gain (gain x gain ratio) to reduce the amplitude of the speed error. Reduce (or increase) the Window Width set point to just greater than the magnitude of acceptable speed error. A value of Gain Ratio too high will cause the control to hunt through the low-gain region. This normally will occur only if the Window Width is too low. If necessary to decrease the Window Width to control limit cycling (identified by the engine speed slowly cycling from below to above the speed setting by the amount of Window Width), the Gain Ratio may be reduced for more stable operation (see Figure 3-2).
4. Verify that performance at all speed and load conditions is satisfactory and repeat the above procedures if necessary. Full load rejection testing is recommended as part of the performance testing.
5. While operating at full load, record the Actuator Output on Display Menu 1. Select the Maximum Fuel Limit set point on the Fuel Limiter Menu. Set at approximately 10% over the full load output if desired, otherwise leave at 100%.

We recommend you check the operation from both hot and cold starts to obtain the optimum stability under all conditions.

## Alternative Dynamic Adjustments Based on the Zeigler-Nichols Method

The procedure that follows is an empirical method to find first-pass settings for gain, reset, and actuator compensation in a PID controller. First, the controller is set up to act as a proportional-only controller by removing the effect of the reset and actuator compensation terms. The system is then bumped and the resulting response is examined. Gain is slowly increased until the point of marginal stability is found. Once that point is found, some calculations are done using the period of oscillation and the gain value. The results of the calculations are gain, reset, and actuator compensation that can be plugged into the control. This procedure has been used to find a good set of initial settings for the PID controller. This section also describes adjusting some other parameters to improve on the initial settings.

### Setup

1. **Complete** the start-up adjustments from earlier in the chapter. The engine should now be somewhat stable. The settings should also be saved to EEPROM.
2. **Copy** the settings you have right now from 1st dynamics to 2nd dynamics. Save these values to EEPROM. As you go through the following steps, you will be trying to find the point of marginal stability. That means that you will be very close to the point of instability. You are likely to adjust the gain a little bit too far and go into an unstable condition. When that happens, you will see the engine start to run away and approach overspeed or stall. The reason the dynamic settings are copied from 1st dynamics to 2nd dynamics is to allow you to quickly switch to settings that can control the engine and keep it from running away or dying. We recommend you use either a jumper or a switch to allow you to quickly select 2nd dynamics as you are performing this procedure so that you are confident you always have the ability to control the engine speed.
3. **Connect** a chart recorder to record engine speed. Analog output 1 default configuration provides a 4–20 mA signal proportional to engine speed. If necessary, set the CFG ANALOG OUTPUTS to read engine speed on another configurable analog output if analog output 1 is being used for something else.
4. **Enable** slight Firing Torsional Filtering by setting the SPEED FILTER frequency at 15.8 Hz. This setting is found in the Dynamics service menu. A lower setting may be necessary if firing torsionals are exceptionally high due to combustion instability, etc. However, a setting below 10 Hz is not recommended.

### Gain, Reset, and Actuator Compensation Adjustments

5. The engine should now be running at no load, idle speed. Start the chart recorder. Remember, when doing any of these adjustments, you can get the engine back to running stable by switching in the 2nd dynamics. Select 1st dynamics now. **Reduce** the gain by 50%.
6. **Disable** the Reset (integral) and Compensation (derivative) dynamic actions by setting both to 0.01.

7. **Disable** Window Width by setting the Gain Ratio at 1.0 and the Window Width at 60 rpm.
8. **Disable** Gain Slope by setting it at 0.0.
9. The engine should still be stable. If it is not, **reduce** the gain further.
10. With the engine running at no load, idle speed; **increase the gain** one rabbit click at a time until a sustained speed oscillation is only just obtained. In between rabbit clicks, use the actuator bump feature to introduce a very small bump to the system (1% fuel demand, 0.020 seconds works well). The system oscillations will either die out in a short amount of time (stable), stay at the same amplitude for a long time (marginally stable), or keep increasing in amplitude (unstable). To start with, you will most likely be in the stable range, where the oscillations die out with time. As you increase the gain, you will eventually go into the unstable region, where you might need to switch back to 2nd dynamics to get the engine under control. Reduce the gain and switch back to 1st dynamics. Keep slightly adjusting the gain up or down until you find the setting that gives you the point of marginal stability. When you are there, the oscillations will neither decrease nor increase in amplitude. If you can maintain a constant amplitude for 30 seconds to a minute, you have found the point. If the oscillations die out, your gain is too low. If they keep getting bigger, your gain is too high. Turtle adjust if required. The following trace is an example. Write down the **Gain** setting (5.92 in this example) and call it **Ku**. This is needed to calculate final settings.



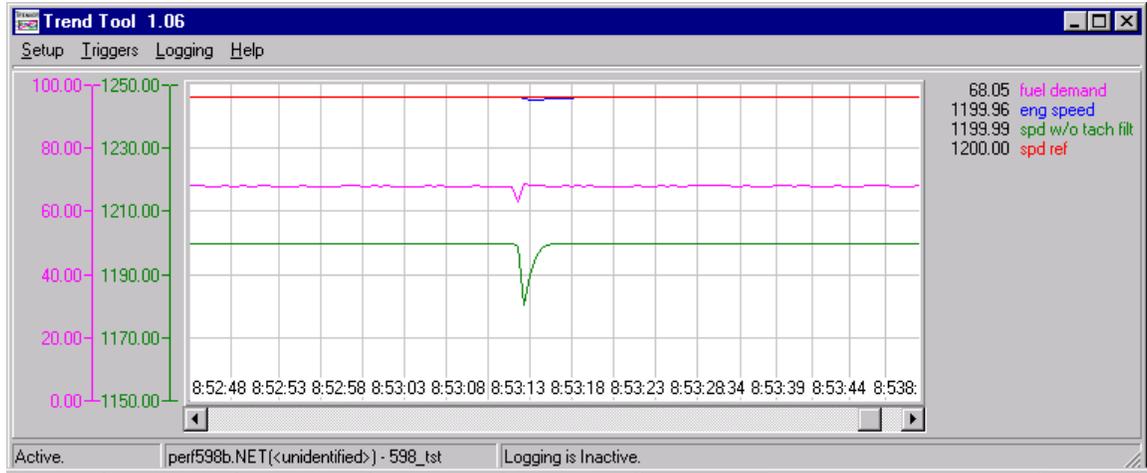
11. After recording the speed oscillations for 30–60 seconds, reduce the gain to stop the oscillations.
12. **Measure** the elapsed time for several speed cycles and calculate the time per cycle in seconds and call this value **Pu**. In the above trace, each vertical grid line represents 3 seconds elapsed time, so 15 speed cycles occur in 47 seconds. Pu in this example is 47 divided by 15, which equals 3.133 seconds per cycle.
13. **Calculate** dynamic settings as follows:

**Gain** = Ku divided by 1.7. In the above example this is  $5.92/1.7 = 3.48$ .

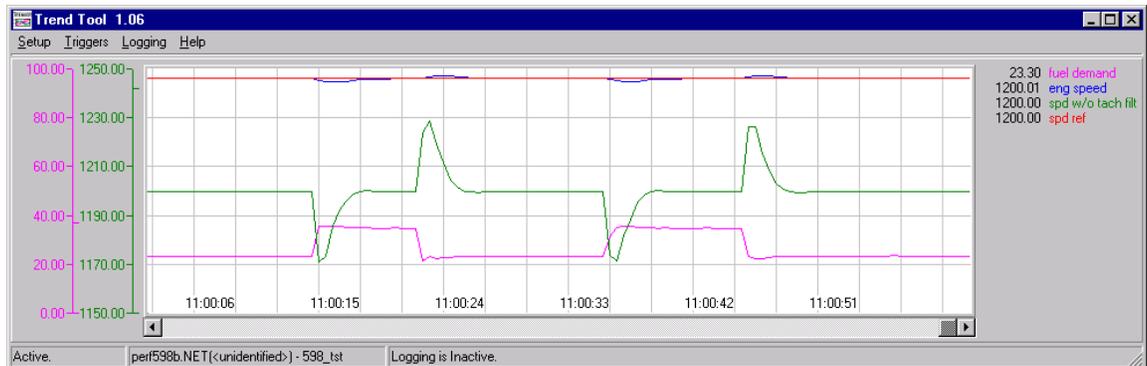
**Reset** = 2 divided by Pu. In the above example this is  $2/3.133 = 0.64$ .

**Compensation** = Pu divided by 8. In the above example this is  $3.133/8 = 0.39$ .

14. **Enter** the calculated Reset, Compensation, and Gain setting into the control. **Save** these settings in the control. The assumption is these settings will produce good performance as shown in the following example. If this is not the case, recheck all readings and calculations or repeat this entire procedure.



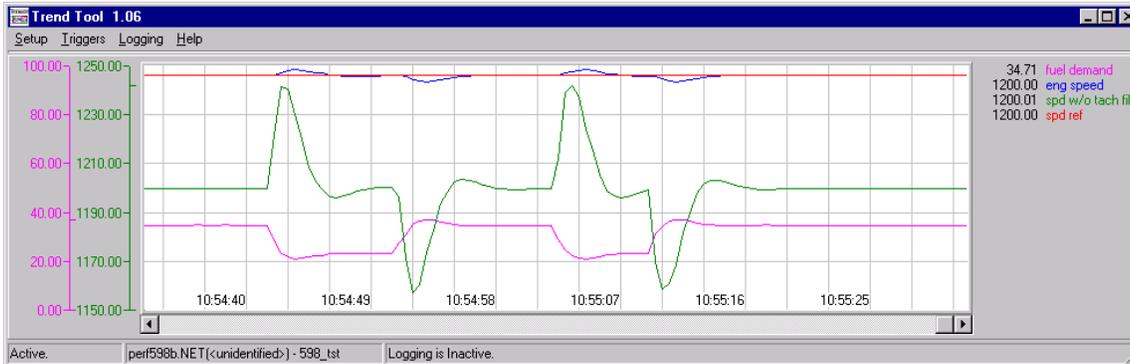
15. **Bump** the actuator (it is okay to use a larger bump this time) to test control response. The above trace shows the expected response.



16. **Initiate** load steps on and off to confirm acceptable and stable response. The above trace shows the expected response. Note how the fuel demand increases/decreases quickly with negligible overshoot.
17. *This usually concludes the dynamic adjustment for one set of dynamics.* These settings are typically robust. Overly aggressive adjustments should be avoided if possible. The Reset and Compensation settings produced by this procedure are normally not changed. Increases to the Gain may produce some improvement in the load transient response, however Window Width and Gain Ratio (to be described in the next few steps) may be more effective. It is also our experience that these settings are good for rated speed as well as idle speed. Verify this for yourself by changing to rated speed and performing some load transients. If you feel that the response can be improved, we recommend leaving Reset and Compensation as they are and only adjusting Gain.
18. **Repeat** this procedure for other dynamic adjustment sets as considered necessary for alternate fuel supplies or operating conditions.

## Gain, Window Width, and Gain Ratio Adjustments

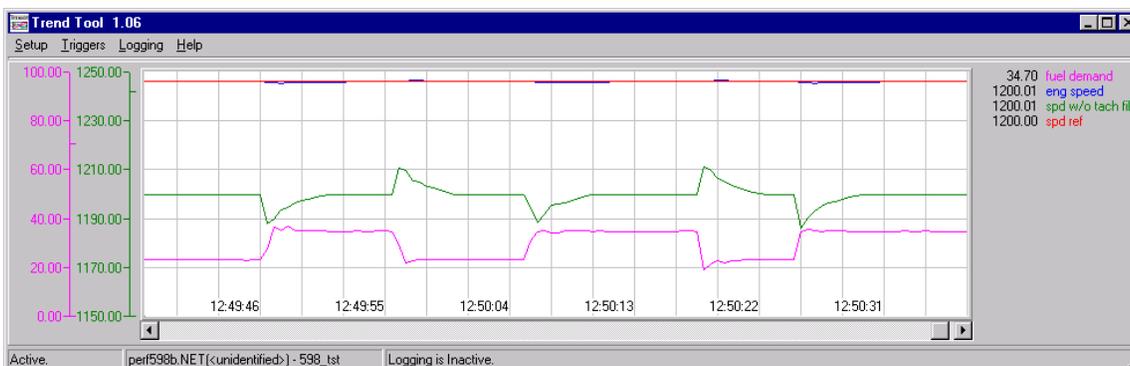
19. When extra load transient response improvement is needed, adjust the Gain and/or Gain Ratio and Window Width. The following traces show examples of the process used to obtain optimum transient response settings. The step that increases Gain may be skipped in favor of Window Width and Gain Ratio adjustments only.



20. This trace shows the transient response with the Gain Ratio and Window Width disabled. In this example Gain is 1.235; Reset is 0.28, and Compensation is 0.88. Load step is ~15%.



21. This trace shows results of just increasing Gain from 1.235 to 3.0. Gain Ratio and Window Width remain disabled. Peak rpm is reduced approximately 10–12 rpm.



22. This trace shows results of ultimately increasing Gain Ratio from 1.0 to 3.0 and decreasing Window Width from 60 rpm to 5 rpm. Overall peak rpm has been reduced approx 30 rpm. The fuel demand is steeper with little overshoot and roll-off. The speed roll-off is extended slightly by the Window Width and Gain Ratio settings. This is normal.
23. **Begin** the Window Width and Gain Ratio adjustment process by increasing the Gain Ratio from 1.0 to 2.0, then reduce the Window Width from 60 rpm in 10-rpm increments. Actuate an actuator bump or load on and load off step after each adjustment and observe the change in peak engine speed.

Initially, the window will be too wide to cause any change in peak speed. Eventually a reduction will be observed. **Be prepared to first reduce the Gain Ratio, or second increase the Window Width, if severe instability occurs** due to cycling through the low gain region. Do not attempt smaller Window Width settings if this occurs. It may be useful to set the alternate (1st or 2nd) dynamics to produce a stable engine speed and to switch to these dynamics should severe instability occur while setting Gain Ratio and Window Width.

Otherwise, continue the Window Width reduction and actuator bump response down to 10 rpm, and then reduce to 5 rpm. Reductions below 5 rpm are not recommended.

Increase the Gain Ratio as needed to obtain the desired response. The objective is to set the smallest Window Width with the highest Gain Ratio without going unstable. If the Gain Ratio setting that causes severe instability is known, then the final setting should not be more than half of this amount.

24. Eventually a point is reached where no further improvement is possible. The fuel demand overshoot should be minimal. Reduce the Gain or Gain Ratio as needed to reduce the fuel demand overshoot.

### Gain Slope and Gain Break point Adjustments

25. Gain Slope is an adjustment that increases gain as load (fuel demand) increases. This adjustment should not be changed from 0.0 until the previously described adjustments have been made. While it is possible to set a negative Gain Slope which decreases gain as load increases, it is considered unnecessary and not recommended.
26. The objective of these adjustments is to add gain at high engine loads to improve transient load response. If the transient load response is already acceptable, no adjustments are needed. Otherwise proceed as follows:
27. **Set the Gain Break point** equal to the no-load minimum speed fuel demand. The actual fuel demand minus the Gain Break point setting is multiplied by the Gain Slope to add gain when load increases. When the actual fuel demand is at no-load, the difference is zero, therefore zero gain is added at no-load.
28. **Set Gain Slope** while the engine is operating at or near rated load. Gradually increase the Gain Slope in 0.5 increments, and bump the actuator or make a step load change to measure the transient response. Continue this process until the desired transient load response is achieved or excessive instability occurs. Should excessive instability occur, reduce the setting to one-half of the setting that produced this instability.

## Torsional Adjustments

The Torsional Level is determined by the instantaneous difference in speed between the two speed sensors. The difference in speed is an indication of the energy stored or released by the flexible coupling. There are two separate functions which can occur with the Torsional Level. One function (the Torsional Filter Function) filters the two speed signals and provides a signal to the Speed Filter Function and to the PID which reduces the speed change caused by the flexible coupling. This function is adjusted by the value of item ENG SENSOR WEIGHT in the TORSIONAL FILTER menu. The other function (the Torsional Limit Function) provides a temporary maximum limit to the Fuel Demand. This limit is adjusted with item TORSNL FUEL LIMIT. The temporary limit is set if the Torsional Level exceeds the value adjusted by the item TORSNL LEVEL @LIMIT. The limit is removed when the Torsional Level reduces below the value adjusted by the item TORSNL LEVEL @CLEAR.

1. Set the ENG SENSOR WEIGHT with the following procedure. The Torsional Level is the ratio between the engine inertia and the system inertia. If you know these values then set the initial value of Engine Sensor Weight equal to the engine inertia divided by the quantity (engine inertia + generator inertia) and follow the procedure outlined below. If you don't know the system inertia values, then start with the default value and follow the procedure outlined below.
2. It is important to know what speed or load (or combination of speed and load) causes the system to go into torsional instability. This is referred to here as the torsional point. The torsional point can be found by bumping the system using the Actuator Bump function in the dynamics menu. Be prepared to move the system away from the torsional point if it goes unstable. Bump the system at several different speeds and loads. If the system remains stable, slightly increase the dynamic Gain and again bump the system at several different speeds and loads. At some point, a torsional oscillation may begin to occur which can be corrected with the Engine Sensor Weight. Begin by reducing the value a small amount. After each adjustment, approach the torsional point and see if the performance is improving or degrading. If the performance is improving, continue making small reductions until you find the value where no further improvements are seen. If the performance is getting worse, begin increasing the value above the initial Engine Sensor Weight and determine if any improvement is observed. If the performance is improving, continue making small increases until you find the value where no further improvements are seen.

Be sure to return the Dynamic Gain setting to its proper value.

3. TORSNL FUEL LIMIT can be adjusted by finding the torsional point and reducing the limit to a point where the Fuel Demand oscillations are eliminated or reduced to safe levels. Initially set the item TORSNL LEVEL @LIMIT to 0.00 to activate the limit (monitor the item TORSNL FILTER ACTIVE in the Display Ctrl Mode to be sure the limit is active). Monitor the item TORSIONAL LEVEL (%RPM) in the Display Menu and go to the torsional point. Record the value of the TORSIONAL LEVEL. Reduce the value of the TORSNL FUEL LIMIT in the Torsional Filter Menu to reduce or eliminate the Fuel Demand oscillations. Once the oscillations are reduced sufficiently again record the value of the TORSIONAL LEVEL(%RPM).
4. TORSNL LEVEL @LIMIT can be adjusted to the reading recorded above for the TORSIONAL LEVEL before the limit was reduced.

5. TORSNL LEVEL @CLEAR can be adjusted to the reading recorded above for the TORSIONAL LEVEL after the limit was reduced.

**IMPORTANT**

The Torsional Limit Function may not be required if the Torsional Filter Function can reduce oscillations sufficiently. This situation is desirable because the load is not affected while operating at the torsion point.

## Fuel Limiters Adjustments

Fuel limiters limit the fuel demand during various conditions.

1. Start Fuel Limit sets the maximum Fuel Demand when the engine is starting and the engine speed is below idle. The limit is usually set at the fuel level required to start the engine. It is usually greater than the Fuel Demand at Idle Speed and substantially less than 100 percent Fuel Demand.

Reduce the value of item START FUEL LIMIT(%FD) in menu FUEL LIMITERS and start the engine. Repeat until the engine no longer starts satisfactorily. Note that item ON START LIMIT (LSS) in the DISPLAY CTRL MODE menu can be monitored to determine when the Start Limiter is limiting Fuel Demand.

2. Start Ramp Rate sets how fast the Start Fuel Limit increases as the engine is cranking. The final adjustment should be made on a cold day when the normal starting Fuel Demand is insufficient to start the engine. Increase the Start Ramp Rate, if necessary, to achieve satisfactory starts.
3. Maximum Fuel Limit sets the maximum Fuel Demand. Adjust so that all loads and transients can be satisfactorily assumed by the genset. Note that very hot days may require more fuel for the engine to operate at full load.

## Speed Adjustments

Adjustment of the idle, rated, raise, and lower references should not require further setting as they are precisely determined. The Remote Speed Setting input, however, involves analog circuits and may require adjustment.

1. 4 to 20 mA Remote Speed Setting Input

Apply 4 mA to the Remote Speed Setting Input. Be sure remote operation is selected (Raise Speed and Lower Speed contacts both closed). If the engine rpm is lower or higher than desired, increase or decrease the 4 mA Remote Reference set point to obtain the correct speed. There may be a small difference between the set point and actual speed which compensates for the inaccuracies in the analog circuits.

Now apply 20 mA to the Remote Speed Setting Input. Wait until the ramp stops. Increase or decrease the 20 mA Remote Reference set point to obtain the engine rpm desired.

Repeat the above steps until the speeds at 4 mA and 20 mA are within your required range.

## Conclusion of Initial Adjustment Procedures

This completes the initial adjustments. Save the set points by pressing the "SAVE" key on the Hand Held Programmer or save settings using Watch Window (refer to "help" if you need help). Run through all the set points and record them in the Appendix for future reference. Settings can also be saved to a file using Watch Window for later download. This can be very useful if a replacement control is necessary or for start-up of another similar unit. Power down the control for about 10 seconds. Restore power and verify that all set points are as recorded.

### **NOTICE**

**To prevent possible damage to the engine resulting from improper control settings, make sure you save the set points before removing power from the control. Failure to save the set points before removing power from the control causes them to revert to the previously saved settings.**

Disconnect the Hand Held Programmer from the control (if applicable). Watch Window may remain connected or removed from the control at the end user's discretion. Close the cover over J1 and re-tighten the retaining screw if connection is removed.

# Chapter 5.

## Description of Operation

### General

This chapter provides an overview of the operation of the 723PLUS Digital Speed Control. Figure 1-6 shows the control block diagram for reference in the following descriptions.

The 723PLUS Digital Speed Control uses a 32-bit microprocessor for all control functions. All control adjustments are made with Watch Window or with a hand-held terminal/display that communicates with the control via a serial port. The terminal/display is disconnected from the control when not in service, to provide security against tampering.

The 723PLUS controls engine speed at a reference set point. The closed-loop path is interrupted by an LSS (Low Signal Selector) which limits the fuel demand to the lowest value of all inputs. Inputs other than the PID control signal which can limit the fuel demand include an actuator shutdown function, a maximum fuel function, a start limit function, a torque fuel limit function, an air manifold pressure fuel limit function, and a torsional limit function. Also, a very short duration bump actuator function limits the fuel demand when it is applied. The fuel demand is a dimensionless value based on percentage of required fuel, where 0 percent generally represents no fuel and 100 percent represents maximum fuel. The fuel demand is supplied to the actuator function to produce an actuator current. The actuator current is supplied to the actuator which controls the fuel delivery system.

The speed sensors contain a special tracking filter designed for reciprocating engines, which minimizes the effects of flexible coupling torsionals. This provides exceptionally smooth steady-state control and allows the control dynamics to be matched to the engine rather than detuned to compensate for coupling torsionals. The speed signal itself is usually provided by a magnetic pickup or proximity switch supplying from 1 to 60 Vrms to the control. The control has two red indicators which illuminate if a speed sensor signal is lost.

The control has a switching power supply with excellent spike, ripple, and EMI (electromagnetic interference) rejection. Discrete inputs are optically isolated and capable of rejecting EMI and variable resistance in switch or relay contacts. Analog inputs are differential type with extra filtering for common-mode noise rejection. This protects the control from spurious interference and noise, which can cause speed and load shifts.

The control also provides 4 to 20 mA for configurable outputs. These outputs may be used for an analog meter, recorder, or as input to a computer.

## Speed Input

One or two speed sensors provide an engine speed signal to the control. The method used to detect speed is software-selectable (Select Digital Spd in the Speed Setting menu) for either a digital type of detection or an analog type of detection. The digital detection method senses speed very quickly and can respond to speed changes very quickly. The analog detection method averages the speed input and allows for speed changes caused by the firing of individual cylinders. Generally the digital detection method is used. If a stability problem exists which can be traced to the firing frequency of the cylinders, the analog detection method may correct the problem.

## Torsional Filter Function

When the “Use Torsional Filter” is configured FALSE, the two speed inputs are sent to an HSS (High Signal Selector) which outputs the higher of the two inputs to the speed control process function.

When the “Use Torsional Filter” is configured TRUE, the torsional filter function is enabled, which allow the control to effectively filter out the rapid speed changes which are caused by a system with a flexible coupling as shown in Figure 1-1. A flexible coupling can store energy when the engine is increasing torque to the generator, and the coupling can also release energy as the engine decreases torque to the generator. This effect causes the instantaneous change in speed of the generator to be different from the instantaneous change in speed of the engine. The difference between these two values is referred to as the torsional level. A high torsional level can cause the governor to over-respond to load and speed changes, which can make the entire system unstable. Without torsional filtering this would force the closed-loop dynamics to be “de-tuned” to prevent instability in the system. Worse, as the coupling ages and becomes softer, the closed loop dynamics need to be de-tuned further. At some point the engine will fail to respond aggressively to load changes. The system may also become unstable.

The torsional filtering function requires two speed sensors. The function is disabled if either of the speed sensors fail. A software switch in the Cfig Option Menu can also be used to disable the function and return to the HSS selection of the two speed sensors.

There are two separate actions which can be taken by the torsional filtering function. The first action reduces the dynamic response to the fast speed changes associated with the coupling while still allowing fast response to actual system speed changes. The second action limits the fuel demand at the LSS if the torsional value reaches an unacceptably high value. The Alarms and Shutdowns can be configured to activate if the torsional value gets too high.

## Speed Failures

A speed failure is detected any time the input frequency from the speed sensor is less than five percent of rated speed. The failure of either or both speed sensors can be used to activate an Alarm and/or a Shutdown.

The torsional filter will be deactivated but the engine will continue to run if one speed sensor fails. If both speed sensors fail, the control action is determined by the state of the Speed Fail Ovrd discrete input. The control will bring the fuel demand to zero if the override is FALSE. The control will allow the fuel demand to maximum if the override is TRUE. A true state is normally used for reverse-acting systems.

## Alarm Reset and Override

The Alarm Reset command can be issued from several different points. The command is a momentary true which resets any parameters which were latched in a failed state and are now valid when the reset occurs. The command can be issued from Watch Window or from the Engine Trouble menu with the Hand Held programmer. Toggling the Alarm Reset discrete input TRUE, then FALSE, issues the Alarm Reset command. An Alarm Reset is issued when power is applied to the 723PLUS. And finally, the control issues an Alarm Reset during startup (when configured).

## Speed Reference and Ramps

The 723PLUS control provides local control of the speed reference, with discrete inputs to issue raise and lower speed commands. For remote speed setting, the control provides a 4 to 20 mA/1 to 5 Vdc Remote Speed Setting input which is used for the speed reference. Remote is selected as long as the Raise Speed and Lower Speed contacts are both closed.

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.

The control provides idle, lower limit, rated, and raise limit set points, accel and decel times, and raise and lower rates, for local operation. Accel time determines the time required for the engine to ramp from idle to rated speed. Decel time determines the time required for the engine to ramp from rated speed to idle speed. Raise and lower rates determine how fast speed is increased or decreased by the raise and lower command inputs and the remote speed setting.

The idle speed set point is provided for engine start-up or cool down speed. Idle speed may be set equal to or less than the rated speed set point. Idle is independent of the lower limit set point and may be set to a lower speed. Idle speed cannot be changed except through adjustment of the idle speed set point.

Closing the Rate contact ramps the speed set point from idle to rated.

Closing either the Raise or Lower contacts while ramping from idle to rated results in immediate cancellation of the idle to rated ramp.

After acceleration to rated speed is completed, the raise and lower commands increase and decrease engine speed based on the raise and lower rate set points. The raise and lower limits determine the limits of these commands.

If remote operation is selected after the engine reaches rated speed, the control will ramp speed to the reference value set by the Remote Speed Setting milliamp input based on the raise or lower rate. The Remote Speed Setting operates from 4 to 20 mA (1 to 5 Vdc). The values of the 4 mA and 20 mA remote reference set points must be set between the raise and lower limit set points. The 4 mA Remote Reference set point may be set to a lower or higher speed than the 20 mA set point, providing for either direct or reverse-acting remote speed setting.

If a remote input is present and selected when the Rated Speed contact is closed or during the idle to rated ramp, the speed reference will ramp to the speed reference value determined by the milliamps on the Remote Speed Setting input, based on the raise rate set point. This may not be the desired mode of operation, so be sure to understand the implications of operating the control in this manner.

Below 2 mA (0.5 Vdc), the remote input is considered failed. Between 4 and 20 mA (1 and 5 Vdc), the control determines the required speed reference based on a straight line between the 4 mA Remote Reference and 20 mA Remote Reference set points. If a difference is detected between the current speed reference and the remote reference computed from the mA input, the current speed reference is raised or lowered at the rate determined by the raise or lower rate to bring the speed reference into agreement with the remote speed reference. The remote reference will not increase speed over the raise limit or lower it below the lower limit.

When in remote mode (Raise and Lower Speed contacts both closed), if the remote input goes below 2 mA (0.5 Vdc), the speed reference will ramp down to the lower limit.

If the Rated Speed contact is opened for idle after operating at rated, the control will immediately ramp engine speed to idle based on the decel time set point.

## Dual Dynamics

The PID dynamically changes the fuel demand based on the difference between the Spd Ref set point and engine speed. If engine speed is less than the Spd Ref, the PID will cause the fuel demand to increase. If engine speed is greater than the Spd Ref, the PID will cause the fuel demand to decrease.

The Dual Dynamics is two independent sets of dynamics which are used to control how the PID changes the fuel demand. The 2nd Dynamics discrete input determines which set of dynamics is used by the PID. The 1st Dynamics set is used when the discrete input is FALSE (with the contacts open) and the 2nd Dynamics is used for a TRUE discrete input. The two sets of dynamics are provided for use where engine operating conditions dramatically change, such as dual fuel applications.

Each set of dynamics can be varied automatically as a function of load. Refer to Initial Adjustments in Chapter 4 for a further description of the dynamic adjustments.

## Dual Gain Dynamics

During steady-state operation with a constant load, the control uses the initial gain setting. The control automatically increases the gain by an adjustable Gain Ratio when a speed error exists between engine speed and the Speed Reference larger than an adjustable Window Width (see Figure 3-2). The gain returns to the initial gain setting when engine speed is again close to the Speed Reference.

## Other Dynamics

The control can also compensate for non-linear fuel systems and changes in engine dynamics with load. With the fuel demand below an adjustable point (Gain Slope Bk Pnt), the control uses the initial gain setting. As the fuel demand increases above the Gain Slope Break Point, the gain changes according to the adjustable Gain Slope (see Figure 3-3). This provides optimal dynamics and smooth steady-state operation for all conditions from no load to full engine load.

In addition to varying the gain with load and with load transients, an adjustable Reset and an adjustable Compensation are part of the control dynamics.

## Actuator Bump Function

The Actuator Bump Function is a software-activated means of momentarily decreasing the fuel demand. It is used to determine how well the 723PLUS control is controlling the engine and generator. The function “bumps the actuator” with a consistent change in output. This change causes engine speed to vary, which causes a response from the PID. The response can be varied using the appropriate dynamic adjustments. The Actuator Bump Function is enabled in the Actuator Bump menu, and is activated in either Dynamic Menu. It is only available for 60 minutes after it has been enabled. The Actuator Bump Function must be disabled to reset the 60 minute timer.

## Minimum Fuel Function

The Minimum Fuel Function brings the fuel demand to zero. This occurs when the Open to Run discrete input goes TRUE. It also occurs if both speed sensor inputs have failed and the item Override Spd Fail has been configured FALSE as previously described. The Open to Run command is the preferred means for a normal shutdown of the engine.



### **WARNING**

The Open to Run discrete input is not intended for use as the sole means of shutdown in any emergency stop sequence. To prevent possible serious injury and engine damage from an overspeeding engine, do NOT use the Open to Run discrete input as the sole means of shutdown in any emergency stop sequence.

## 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 generator overloading or other situations where the maximum fuel delivered to the engine should be limited. The function can be disabled by adjusting the Max Fuel Limit to 100 percent.

## Start Limit Function

The Start Limit Function provides a limit to the fuel demand which prevents overfuel conditions during starting of the engine (see Figure 5-1). During startup, when engine speed reaches five percent of rated speed, the Start Limit Function is momentarily triggered to immediately limit the fuel demand to a software-adjustable start fuel limit. The start ramp begins increasing the fuel demand at a software-adjustable rate shortly after the start fuel limit is triggered. The rate can be set to zero to eliminate the start ramp function. When engine speed reaches 95% of the speed reference, and the PID is in control of the fuel demand for 1 second, the Start Limit Function will immediately increase to a maximum value of 100 percent. When engine speed decreases below five percent of rated speed from a shutdown, the Start Fuel Limit Function is re-armed for trigger during the next start. The start fuel limit function also works on reverse-acting systems. The function can be disabled by adjusting the Start Fuel Limit to a value of 100.

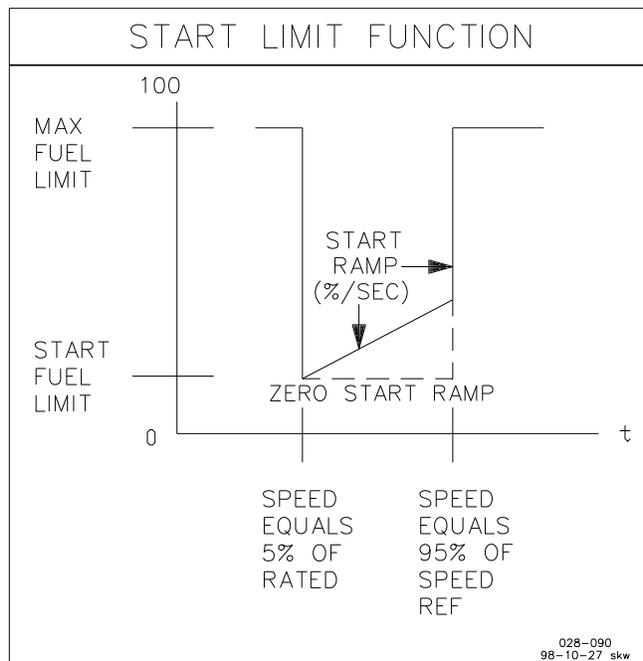


Figure 5-1. Start Limit Function

## Fuel Limiting Function

Two separate Fuel Limiting Functions (AMPLMT curve and TORQLIMIT curve) provide limits to the fuel demand which prevents overfuel conditions. One function is based on an external air manifold pressure transmitter signal provided at Signal Input #3. The other is based on the engine speed provided at the speed inputs. These Fuel Limiting Functions provide two software adjustable five-break point curves based on each signal. The display value of the input signal can be scaled according to the engineering units desired. The output used for fuel demand limiting is in percent. The limiting value is linear from set point to set point as shown in Figure 5-2. The functions are enabled when the engine speed first reaches 95 percent of the speed reference. They then remains enabled until the engine is shut down. These functions are also disabled if the input signal is failed. These functions can also be enabled or disabled by software at the AMP Limit Curve menu and the Torque Limit Curve menu.

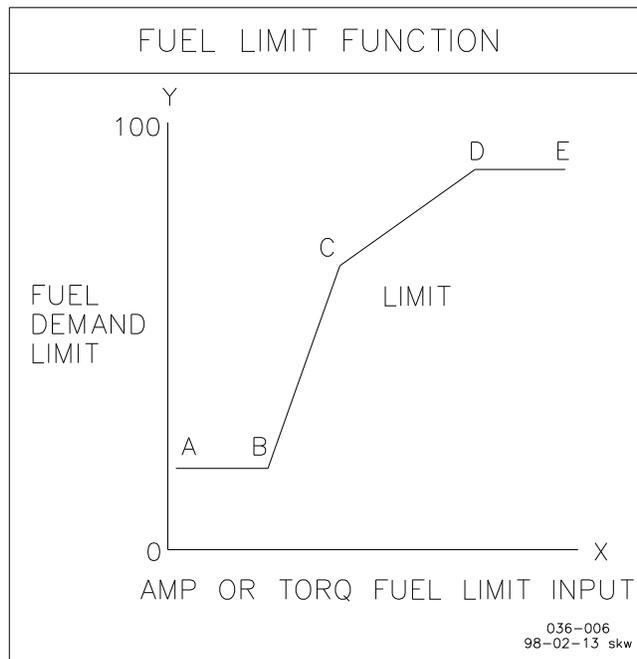


Figure 5-2. Fuel Limit Break points

## Actuator Function

The Actuator Function changes the fuel demand into a signal which can be used by Analog Output #3. This allows for either a direct-acting actuator or a reverse-acting actuator. A direct-acting fuel system is one where the signal to the actuator increases as the fuel demand increases. A reverse-acting fuel system is one where the signal to the actuator decreases as the fuel demand increases. In either system, the fuel to the engine increases as the fuel demand increases. A reverse-acting system allows for using actuators with mechanical governors which can control the engine if the electronic governor fails. Standard actuators use effective signals of 20 to 160 mA to travel from minimum position to maximum position (or 160 to 20 mA to travel from minimum position to maximum position on reverse-acting systems). The fuel demand is scaled from 0 to 100 percent for an output of 0 to 200 mA (or 200 to 0 mA if Reverse Acting is selected). This results in a fuel demand with a value of ten percent when the actuator is effectively at minimum (for either direct-acting or reverse-acting systems) and a fuel demand of 80 percent when the actuator is effectively at maximum (for either direct-acting or reverse-acting systems).

## Power-Up Diagnostics

The power-up diagnostics feature is provided to verify the proper operation of the microprocessor and memory components. The diagnostics take about 20 seconds after the control is powered on. A failure of the test turns off the outputs of the control. If diagnostic testing is successful, the green CPU OK indication on the control cover lights.

# Chapter 6.

## Troubleshooting

### General

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. Before using this procedure, make sure 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. Each system check assumes that the prior checks have been properly done.

### Control Test and Calibration

#### General

Do the following checks on the 723PLUS control. Then verify the functioning of set points and adjustments.

1. Connect the Hand Held Programmer or Watch Window to the control in accordance with the instructions in Chapter 3. Verify that correct voltage and polarity are applied to the control. Verify that the programmer does its power-up test (if applicable). Be sure the jumper between terminals 9 and 10 is removed to use the Hand Held Programmer (do NOT remove the jumper to use Watch Window). Failure to do the power up test indicates that either the control or Hand Held Programmer has failed. If so, try this step with another Hand Held Programmer. If the test still fails, replace the 723PLUS control. If the test passes with the second Hand Held Programmer, replace the Hand Held Programmer.
2. Verify the controller ID on the Hand Held Programmer by pressing the "ID" key. Verify the controller ID in Watch Window by right-clicking the explorer tab, then clicking "properties". The Application ID message "5414-1042" with the revision level (new, A, etc) should appear. Failure indicates either the control or Hand Held Programmer (if applicable) has failed. If so, try this step with another Hand Held Programmer. If the test still fails, replace the 723PLUS control. If the test passes with the second Hand Held Programmer, replace the first Hand Held Programmer.

3. Select the 1st Dynamics Menu. Verify that all set points are as recorded during installation. Repeat for the other menus. If any differences are found, change the set point(s) to the correct value. Press the "SAVE" key on the Hand Held Programmer or save settings using Watch Window (refer to "help" if you need help). The Hand Held Programmer message "Saving Changes" should be displayed. 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 these tests with the engine running.

1. Close the Open to Run contact. Verify the LED is illuminated at control terminal 36. If the LED is not illuminated and the correct voltage is verified, the control has failed and should be replaced. Select item H - Close to Stop on the Display I/O menu. The status should be TRUE. If the value does not change from TRUE to FALSE when the contact is closed and opened, the control has failed and should be replaced.
2. Repeat for all the discrete inputs. Verify the proper voltage exists at the terminal, the proper LED illuminates, and the proper status appears in the Display I/O menu.

## Lube Oil Pressure Input

The following tests verify the function of the Lube Oil Pressure Input (Signal Input #1).

1. Connect a 4 to 20 mA or 1 to 5 Vdc source to terminals 42(+) and 43(-). If a mA source is used, assure the jumper is installed across terminals 41 and 42. Connect a voltmeter across terminals 42(+) and 43(-). Optionally, a mA meter may be installed in series with the 4 to 20 mA source.
2. Set the source for 5.0 Vdc (20 mA) on the meter. Select Display Analog I/O on the Hand Held Programmer or Watch Window. Select AI1- Lube Oil Pr (mA). The value should equal the input based on 20 mA (5.0 Vdc = 20 mA on display).
3. Set the source for 1.0 Vdc (4.0 mA). The value of the display should equal the input based on 4.0 mA (1.0 Vdc = 4.0 mA on the display). If the meter indicates proper voltages (or currents) are present on Signal Input #1, but readings on the Hand Held Programmer or Watch Window are incorrect, the 723PLUS control is defective and should be replaced.

## DSLCL™ Input

The following tests calibrate and verify the function of the DSLCL™ input (Signal Input #2).

1. Connect a -5 to +5 Vdc source to terminals 45(+) and 46(-). Connect a dc voltmeter across terminals 45(+) and 46(-).
2. Set the source for +5.0 Vdc on the meter. Select Display Analog IO on the Hand Held Programmer or Watch Window. Select AI2-DSLCL Input.
3. Verify that the display reads  $+5.0 \pm 0.1$  Vdc.
4. Set the source for -5.0 Vdc. The DSLCL Input value should be  $-5.0 \pm 0.1$  Vdc. If the meter indicates proper voltages are present on Signal Input #2, but readings on the Hand Held Programmer or Watch Window are incorrect, the 723PLUS control is defective and should be replaced.

## Air Manifold Pressure Input

The following tests verify the function of the Air Manifold Pressure Input (Signal Input #3).

1. Connect a 4 to 20 mA or 1 to 5 Vdc source to terminals 48(+) and 49(-). If a mA source is used, assure the jumper is installed across terminals 47 and 48. Connect a voltmeter across terminals 48(+) and 49(-). Optionally, a mA meter may be installed in series with the 4 to 20 mA source.
2. Set the source for 5.0 Vdc (20 mA) on the meter. Select Display Analog I/O on the Hand Held Programmer or Watch Window. Select AI3- Air Manf Pr (mA). The value should equal the input based on 20 mA (5.0 Vdc = 20 mA on display).
3. Set the source for 1.0 Vdc (4.0 mA). The value of the display should equal the input based on 4.0 mA (1.0 Vdc = 4.0 mA on the display). If the meter indicates proper voltages (or currents) are present on Signal Input #3, but readings on the Hand Held Programmer or Watch Window are incorrect, the 723PLUS control is defective and should be replaced.

## Remote Speed Reference Input

The following tests verify the function of the Remote Speed Input (Signal Input #4).

1. Connect a 4 to 20 mA or 1 to 5 Vdc source to terminals 51(+) and 52(-). If a mA source is used, assure the jumper is installed across terminals 50 and 51. Connect a voltmeter across terminals 51(+) and 52(-). Optionally, a mA meter may be installed in series with the 4 to 20 mA source.
2. Set the source for 5.0 Vdc (20 mA) on the meter. Select Display Analog I/O on the Hand Held Programmer or Watch Window. Select AI4- Rem Spd Ref (mA). The value should equal the input based on 20 mA (5.0 Vdc = 20 mA on display).

3. Set the source for 1.0 Vdc (4.0 mA). The value of the display should equal the input based on 4.0 mA (1.0 Vdc = 4.0 mA on the display). If the meter indicates proper voltages (or currents) are present on Signal Input #4, but readings on the Hand Held Programmer or Watch Window are incorrect, the 723PLUS control is defective and should be replaced.

## Analog Output #3

The following tests verify the actuator output of the control.

1. Connect a frequency signal generator to Speed Sensor Input #1 (terminals 11 and 12). Set the output level above 1.0 Vrms, and the frequency to 400 Hz.
2. Open the Open to Run contact (terminal 36). Connect a milliamp meter across terminals 19(+) and 20(-) if no actuator is connected. Connect the milliamp meter in series with the actuator if one is connected to the control. (Alternately, a dc voltmeter may be connected across the output when an actuator is connected. The correct output currents must be computed using the voltage measured and the input resistance of the actuator.)
3. Select the CFG OPTION menu on the Hand Held Programmer or Watch Window and set the item Use REV ACTUATOR to FALSE. Select the FUEL LIMITERS menu and set item START FUEL LIMIT to 100 (%FD), then set item MAX FUEL LIMIT to 20 (%FD) . Select the TORQ LIMIT CURVE menu and set the ENBL TORQ FUEL LMT to FALSE. Select the AMP LMT CURVE menu and set THE ENABLE AMP FUEL LMT to FALSE. Select the TORSIONAL FILTER menu and set the ENABLE TORS FILTER to FALSE.
4. Set the MAX FUEL LIMIT to 100 (%FD). The output current should be  $200 \pm 2$  mA. If, with all the connections verified, the output of the control fails to perform as above, the control should be replaced.
5. **Return all the above items to the previously recorded value for your engine.**

## Speed Inputs

The following tests verify the operation of the speed inputs.

1. Connect a frequency signal generator to Speed Sensor Input #1 and Speed Sensor #2 (terminals 11/12 and 13/14). Set the output level above 1.0 Vrms. Record the ASPD #1 TEETH set point from the CFG SPEED CONTROL menu. Temporarily set the ASPD #1 TEETH, ASPD #2 TEETH, DSPD #1 TEETH, and DSPD #2 TEETH to 60 (this causes the rpm values and Hertz values to be the same, to make doing the tests easier).
2. Set the signal generator to 400 Hz. Read ENGINE SPEED value of 400 rpm on DISPLAY MENU 1. Increase the signal generator frequency to 2000 Hz.

### **IMPORTANT**

The value of the test frequency must not exceed the maximum frequency values set in the CFG SPEED CONTROL menu.

The value read should follow the signal generator frequency.

3. Return the ASPD #1 TEETH, ASPD #2 TEETH, DSPD #1 TEETH, and DSPD #2 TEETH set points on the CFG SPEED CONTROL menu to the previously recorded values for your engine.

## Conclusion of Test and Calibration Procedures

This completes the test and calibration chapter. Save the set points by pressing the **SAVE** key on the Hand Held Programmer, or save settings using Watch Window (refer to "Help" if you need help). Power down the control for about 10 seconds. Restore power and verify that all set points are as recorded.

### **NOTICE**

To prevent possible damage to the engine resulting from improper control settings, make sure you save the set points before removing power from the control. Failure to save the set points before removing power from the control causes them to revert to the previously saved settings. Be sure to verify that all items in all menus are correct and recorded in a separate location.

Disconnect the Hand Held Programmer from the control (if applicable). Watch Window may remain connected or be removed from the control as desired. Close the cover over J1 and retighten the retaining screw if the connection is removed.

### **WARNING**

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

# Chapter 7.

## 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](mailto: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/directory](http://www.woodward.com/directory).

### 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/directory](http://www.woodward.com/directory).

## Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory published at [www.woodward.com/directory](http://www.woodward.com/directory).

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

<u>Facility</u> -----	<u>Phone Number</u>
Brazil -----	+55 (19) 3708 4800
China -----	+86 (512) 6762 6727
Germany:	
Kempen----	+49 (0) 21 52 14 51
Stuttgart--	+49 (711) 78954-510
India -----	+91 (129) 4097100
Japan-----	+81 (43) 213-2191
Korea -----	+82 (51) 636-7080
Poland-----	+48 12 295 13 00
United States----	+1 (970) 482-5811

### Products Used In Engine Systems

<u>Facility</u> -----	<u>Phone Number</u>
Brazil -----	+55 (19) 3708 4800
China -----	+86 (512) 6762 6727
Germany-----	+49 (711) 78954-510
India -----	+91 (129) 4097100
Japan-----	+81 (43) 213-2191
Korea -----	+82 (51) 636-7080
The Netherlands-	+31 (23) 5661111
United States----	+1 (970) 482-5811

### Products Used In Industrial Turbomachinery Systems

<u>Facility</u> -----	<u>Phone Number</u>
Brazil -----	+55 (19) 3708 4800
China -----	+86 (512) 6762 6727
India -----	+91 (129) 4097100
Japan-----	+81 (43) 213-2191
Korea -----	+82 (51) 636-7080
The Netherlands-	+31 (23) 5661111
Poland-----	+48 12 295 13 00
United States----	+1 (970) 482-5811

For the most current product support and contact information, please visit our website directory at [www.woodward.com/directory](http://www.woodward.com/directory).

## 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.) \_\_\_\_\_

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### Control/Governor Information

#### Control/Governor #1

Woodward Part Number &amp; Rev. Letter \_\_\_\_\_

Control Description or Governor Type \_\_\_\_\_

Serial Number \_\_\_\_\_

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#### Control/Governor #2

Woodward Part Number &amp; Rev. Letter \_\_\_\_\_

Control Description or Governor Type \_\_\_\_\_

Serial Number \_\_\_\_\_

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#### Control/Governor #3

Woodward Part Number &amp; Rev. Letter \_\_\_\_\_

Control Description or Governor Type \_\_\_\_\_

Serial Number \_\_\_\_\_

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### 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.

## Serial Communication Port Wiring

The J2 Communication Port can be configured for RS-232 or RS-422 serial communications. The default setting is RS-232.

The RS-232 connections are shown in Figure A-1. The maximum distance from the PC to the 723PLUS control is 15 m (50 ft).

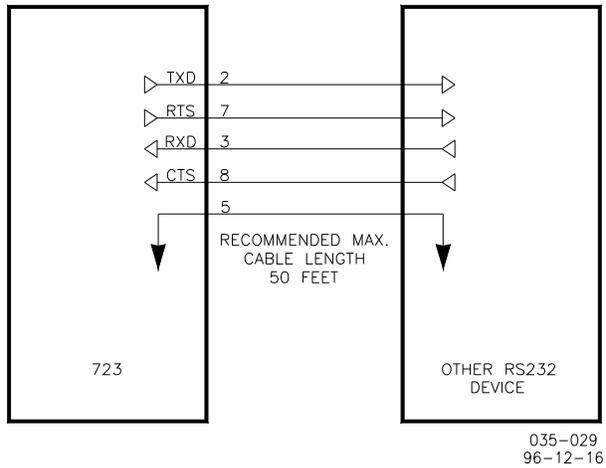


Figure A-1. 723PLUS RS-232 Connections

The RS-422 connections are shown in Figure A-2. The maximum distance from the PC to the 723PLUS control is 1219 m (4000 ft).

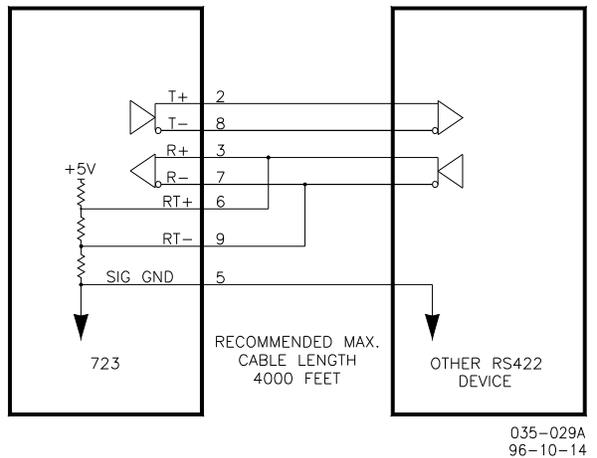


Figure A-2. 723PLUS RS-422 Connections with Optional Termination at Receiver

RS-422 can use a multi-drop set-up where more than one device is connected to a PC. A termination should be located at the receiver when one or more transmitters are connected to a single receiver. When a single transmitter is connected to one or more receivers, termination should be at the receiver farthest from the transmitter. Figure A-3 is an example.

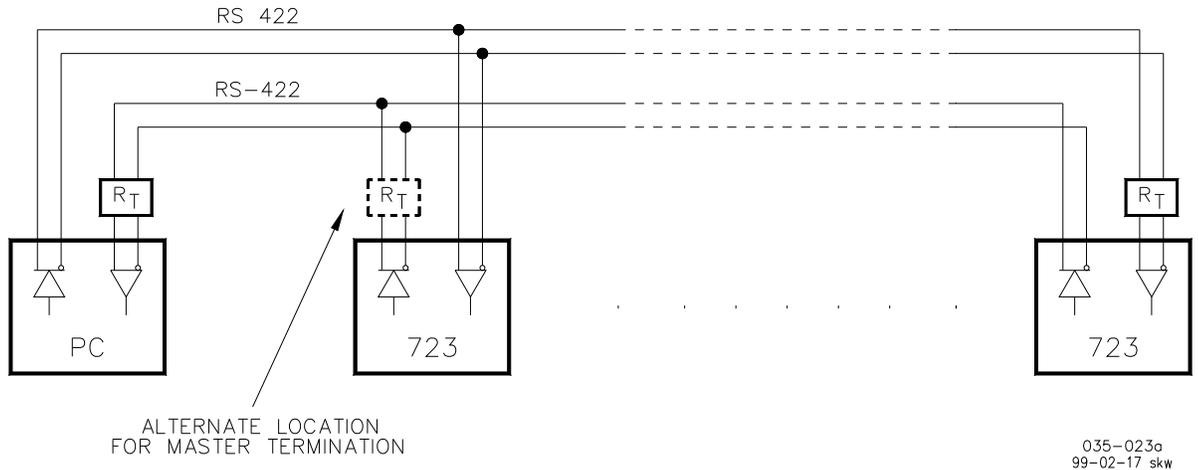


Figure A-3. RS-422 Terminator Locations

Termination is accomplished using a three-resistor voltage divider between a positive voltage and ground. The impedance of the resistor network should be equal to the characteristic impedance of the cable. This is usually about 100 to 120  $\Omega$ . The purpose is to maintain a voltage level between the two differential lines so that the receiver will be in a stable condition. The differential voltage can range between 0.2 and 6 V. The maximum voltage between either receiver input and circuit ground must be less than 10 V. There is one termination resistor network for each port located on the 723PLUS board. Connection to this resistor network is made through the 9-pin connectors on pins 6 and 9.

## Grounding and Shielding

The RS-422 specifications state that a ground wire is needed if there is no other ground path between units. The preferred method to do this is to include a separate wire in the cable that connects the circuit grounds together. Connect the shield to earth ground at one point only. The alternate way is to connect all circuit grounds to the shield, and then connect the shield to earth ground at one point only. If the latter method is used, and there are non-isolated nodes on the party line, connect the shield to ground at a non-isolated node, not an isolated node. Figures A-5 and A-6 illustrate these cabling approaches.

### **IMPORTANT**

**Non-isolated nodes may not have a signal ground available. If signal ground is not available, use the alternate wiring scheme in Figure A-4 with the signal ground connection removed on those nodes only.**

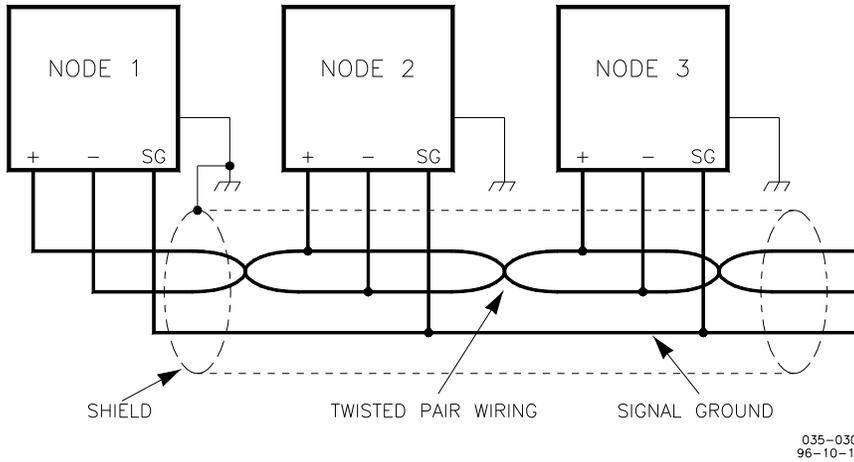


Figure A-4. Preferred Multipoint Wiring Using Shielded Twisted-pair Cable with a Separate Signal Ground Wire

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

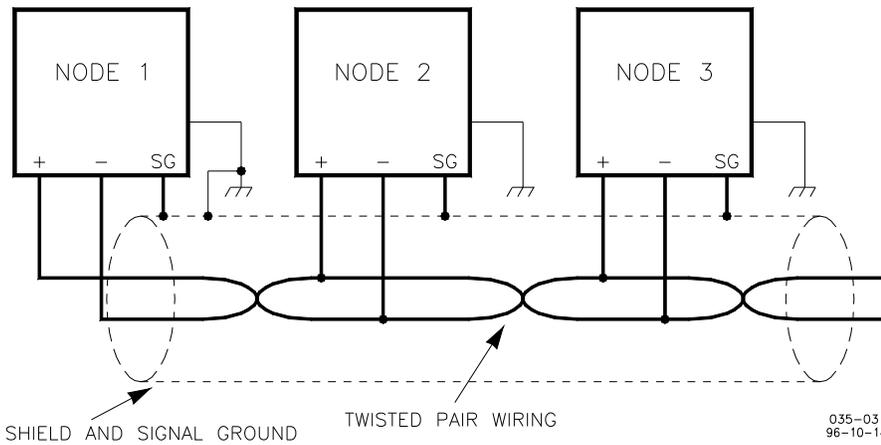


Figure A-5. Alternate Multipoint Wiring Using Shielded Twisted-pair Cable without a Separate Signal Ground Wire

## Appendix B. Programming Checklist

We recommend you write down the final value of each menu item here so you will have a record if you later need to reprogram or replace the control.

\_\_\_\_\_ Software Part Number and Revision Letter

Woodward SERVICE and CONFIGURE Blocks  
WOODWARD GOVERNOR COMPANY  
INDUSTRIAL CONTROLS GROUP  
8280-1042  
723PLUS DIGITAL SPEED CONTROL  
SINGLE ENGINE MARINE PROPULSION  
WITH DSLC INPUT

	<i>CONFIGURE</i>	
<b>Menu Item</b>	<b>Default(Low, High)</b>	<b>As Left</b>
<b>CFIG OPTION</b>		
USE REV ACTUATOR	#FALSE	
USE 2nd DYNAMICS	#TRUE	
DYNAMICS 1 CONSTANT	#FALSE	
USE TORSION FILTER	#TRUE	
USE AIR MAN LIMIT	#TRUE	
USE TORQ LIMIT	#TRUE	
RESET ALM ON CLEAR	#TRUE	
NON-LATCH ALM DOUT3	#FALSE	
<b>CFIG SPEED CONTROL</b>		
RATED SPEED(RPM)	#1200 (1, 2100)	
ASPD #1 TEETH	#16 (16, 500)	
ASPD 1 MAX FREQ(Hz)	#5000 (10, 17500)	
ASPD #2 TEETH	#16 (16, 500)	
ASPD 2 MAX FREQ(Hz)	#5000 (10, 17500)	
REVERSE ACTING	#FALSE	
DSPD #1 TEETH	#16 (16, 500)	
DSPD #2 TEETH	#16 (16, 500)	
<b>CFIG INDICATION</b>		
ON MAX LIMIT	#FALSE	
ON AIR PRESS LIMIT	#FALSE	
ON TORSION LIMIT	#FALSE	
ON TORQUE LIMIT	#FALSE	
ACT SHUTDOWN	#FALSE	
SPEED SWITCH	#FALSE	
OIL XMTR FAULT	#FALSE	
AIR XMTR FAULT	#FALSE	
LOAD SWITCH	#FALSE	
<b>CFIG ALARMS</b>		
SPEED #1 FAIL	#FALSE	
SPEED #2 FAIL	#FALSE	
SPD #1AND#2 FAIL	#FALSE	
REMOTE SR FAIL	#FALSE	

LOW OIL PR ALARM	#FALSE	
HI FUEL DEMND ALARM	#FALSE	
HI SPEED ALARM	#FALSE	
HIGH TORSIONAL LEVEL	#FALSE	
SPEED SWITCH ALM	#FALSE	
LOAD SWITCH ALM	#FALSE	
<b>CFIG SHUTDOWNS</b>		
SPEED #1 FAIL	#FALSE	
SPEED #2 FAIL	#FALSE	
SPD #1AND#2 FAIL	#FALSE	
REM SPEED REF FAIL	#FALSE	
LOW LUBE OIL PR SD	#FALSE	
HI FUEL DEMND SD	#FALSE	
HI SPEED SD	#FALSE	
HIGH TORSION LVL	#FALSE	
SD BYPASS SPEED(RPM)	#200.0 (0.0, 2200.0)	
SD BYPASS TIME	#0.0 (0.0, 120.0)	
<b>INDICATION SETUP</b>		
ENERGIZE FOR STATUS	#TRUE	
SPD SW PICKUP	*500.0 (0.0, 2200.0)	
SPD SW DROPOUT	*400.0 (0.0, 2200.0)	
LOAD SW PICKUP	*99.5 (0.0, 1000.0)	
LOAD DROPOUT	*99.0 (0.0, 1000.0)	
<b>ALARM SETUP</b>		
OIL PRESS DELAY(SEC)	#10.0 (0.0, 10800.0)	
HI FUEL DEMND SETPT(%FD)	#100.0 (0.0, 100.0)	
HI FUEL DEMND DELAY(SEC)	#10.0 (0.0, 10800.0)	
HI SPEED SETPT (RPM)	#1320.0 (0.0, 2500.0)	
HI SPEED DELAY(SEC)	#0.2 (0.0, 10800.0)	
TORS LVL SETPT(%RPM)	#25.0 (0.0, 2500.0)	
HI TORSION DLY(SECS)	#10.0 (0.0, 10800.0)	
ENERGIZE FOR ALARM	#TRUE	
<b>SHUTDOWN SETUP</b>		
SHUTDOWN ACTUATOR	#TRUE	
OIL PRESS DELAY(SEC)	#0.2 (0.0, 10800.0)	
HI FUEL DEMND SETPT(%FD)	#100.0 (0.0, 100.0)	
HI FUEL DEMND DELAY(SEC)	#10.0 (0.0, 10800.0)	
HI SPEED SETPT(RPM)	#1320.0 (0.0, 2500.0)	
HI SPEED DELAY(SEC)	#0.2 (0.0, 10800.0)	
TORS LVL SETPT(%RPM)	#50.0 (0.0, 2500.0)	
HI TORSION DLY(SECS)	#10.0 (0.0, 10800.0)	
ENERGIZE FOR SHTDN	#TRUE	
<b>CFIG COMMUNICATION</b>		
PORT 2 Address	#0 (0, 15)	
<b>CFIG ANALOG OUTPUTS</b>		
AOUT 1 SELECT	#1 (1, 8)	
AOUT 1 4-20 mA	#TRUE	
AOUT 2 SELECT	#2 (1, 8)	
AOUT 2 4-20 mA	#TRUE	
ACT OUT 1 4-20 mA	#FALSE	
ACT OUT 2 SELECT	#3 (1, 8)	
ACT OUT 2 4-20 mA	#TRUE	
<b>SERVICE</b>		
Menu Item	Default(Low, High)	As Left

<b>1st DYNAMICS</b>		
GAIN 1	*2.0 (0.0015, 1000.0)	
RESET 1	*0.35 (0.01, 50.0)	
COMPENSATION 1	*0.2 (0.01, 1.0)	
GAIN RATIO 1	*1.0 (0.0, 1000.0)	
WINDOW WIDTH 1(RPM)	*60.0 (1.0, 2100.0)	
GAIN SLOPE BK PNT 1(%FD)	*20.0 (0.0, 100.0)	
GAIN SLOPE 1	*0.0 (-50.0, 50.0)	
SPEED FILTER 1(HZ)	*15.0 (0.0, 20.0)	
BUMP ACT	*FALSE	
<b>2nd DYNAMICS</b>		
GAIN 2	*2.0 (0.0015, 1000.0)	
RESET 2	*0.35 (0.01, 50.0)	
COMPENSATION 2	*0.2 (0.01, 1.0)	
GAIN RATIO 2	*1.0 (0.0, 1000.0)	
WINDOW WIDTH 2(RPM)	*60.0 (0.0, 2100.0)	
GAIN SLOPE BK PNT 2(%FD)	*20.0 (0.0, 100.0)	
GAIN SLOPE 2	*0.0 (-50.0, 50.0)	
SPEED FILTER 2(HZ)	*15.0 (0.0, 20.0)	
BUMP ACT	*FALSE	
<b>ACTUATOR BUMP</b>		
BUMP ENABLE	*FALSE	
ACT BUMP LEVEL(%FD)	*1.0 (0.0, 100.0)	
ACT BUMP DURATN(SEC)	*0.1 (0.01, 2.0)	
<b>FUEL LIMITERS</b>		
START FUEL LMT(%FD)	*10.0 (0.0, 100.0)	
START RAMP RATE(%FD/S)	*2.0 (0.0, 1000.0)	
MAX FUEL LIMIT(%FD)	*100.0 (0.0, 100.0)	
SHIFT FUEL LMT(%FD)	*10.0 (0.0, 100.0)	
SHIFT DURATION(SEC)	*10.0 (0.0, 20.0)	
<b>SPEED SETTING</b>		
RAISE SPEED LMT(RPM)	*1300 (1, 2100)	
LOWER SPEED LMT(RPM)	*600 (1, 2100)	
IDLE SPEED(RPM)	*750 (1, 2100)	
ACCEL RAMP TIME(SEC)	*8.0 (0.0, 500.0)	
DECEL RAMP TIME(SEC)	*8.0 (0.0, 500.0)	
RAISE SPD RATE(RPM/MIN)	*100.0 (0.0, 32767.0)	
LOWER SPD RATE(RPM/MIN)	*100.0 (0.0, 32767.0)	
SELECT DIGITAL SPD	*TRUE	
<b>TORQ LIMIT CURVE</b>		
ENBL TORQ FUEL LMT	*FALSE	
TQ LMT INPUT A(RPM)	*400.0 (0.0, 1600.0)	
FUEL LIMIT @ A(%FD)	*100.0 (0.0, 100.0)	
TQ LMT INPUT B(RPM)	*600.0 (0.0, 1600.0)	
FUEL LIMIT @ B(%FD)	*100.0 (0.0, 100.0)	
TQ LMT INPUT C(RPM)	*800.0 (0.0, 1600.0)	
FUEL LIMIT @ C(%FD)	*100.0 (0.0, 100.0)	
TQ LMT INPUT D(RPM)	*1000.0 (0.0, 1600.0)	
FUEL LIMIT @ D(%FD)	*100.0 (0.0, 100.0)	
TQ LMT INPUT E(RPM)	*1200.0 (0.0, 1600.0)	
FUEL LIMIT @ E(%FD)	*100.0 (0.0, 100.0)	
<b>AMP LMT CURVE</b>		
ENABLE AMP FUEL LMT	*FALSE	
AMP LMT INPUT A(ENGR)	*0.0 (0.0, 100.0)	
FUEL LIMIT @ A(%FD)	*100.0 (0.0, 100.0)	

AMP LMT INPUT B(ENGR)	*10.0 (0.0, 100.0)	
FUEL LIMIT @ B(%FD)	*100.0 (0.0, 100.0)	
AMP LMT INPUT C(ENGR)	*20.0 (0.0, 100.0)	
FUEL LIMIT @ C(%FD)	*100.0 (0.0, 100.0)	
AMP LMT INPUT D(ENGR)	*30.0 (0.0, 100.0)	
FUEL LIMIT @ D(%FD)	*100.0 (0.0, 100.0)	
AMP LMT INPUT E(ENGR)	*40.0 (0.0, 100.0)	
FUEL LIMIT @ E(%FD)	*100.0 (0.0, 100.0)	
<b>TORSIONAL FILTER</b>		
ENABLE TORS FILTER	*FALSE	
ENG SENSOR WEIGHT	*0.5 (0.0, 1.0)	
TORS SCALE(% RT RPM)	*1.0 (0.01, 100.0)	
TORSNL FUEL LIMIT	*100.0 (0.0, 100.0)	
TORSNL LEVEL @LIMIT	*100.0 (0.001, 100.0)	
TORSNL LEVEL @CLEAR	*0.1 (0.001, 100.0)	
<b>COMMUNICATIONS</b>		
HARDWARE CONFIG	*1 (1, 2)	
BAUD	*10 (1, 10)	
<b>OIL ALM SETPOINT</b>		
SPEED INPUT A(RPM)	*0.0 (0.0, 2200.0)	
OIL ALM SETPT A(EU)	*0.0 (-32000.0, 32000.0)	
SPEED INPUT B(RPM)	*250.0 (0.0, 2200.0)	
OIL ALM SETPT B(EU)	*10.0 (-32000.0, 32000.0)	
SPEED INPUT C(RPM)	*500.0 (0.0, 2200.0)	
OIL ALM SETPT C(EU)	*20.0 (-32000.0, 32000.0)	
SPEED INPUT D(RPM)	*750.0 (0.0, 2200.0)	
OIL ALM SETPT D(EU)	*30.0 (-32000.0, 32000.0)	
<b>OIL SD SETPOINT</b>		
SPEED INPUT A(RPM)	*0.0 (0.0, 2200.0)	
OIL SD SETPT A(EU)	*0.0 (-32000.0, 32000.0)	
SPEED INPUT B(RPM)	*250.0 (0.0, 2200.0)	
OIL SD SETPT B(EU)	*8.0 (-32000.0, 32000.0)	
SPEED INPUT C(RPM)	*500.0 (0.0, 2200.0)	
OIL SD SETPT C(EU)	*15.0 (-32000.0, 32000.0)	
SPEED INPUT D(RPM)	*750.0 (0.0, 2200.0)	
OIL SD SETPT D(EU)	*25.0 (-32000.0, 32000.0)	
<b>SET AI ENGR UNITS</b>		
OIL PRESS @ 4 mA(EU)	*0.0 (-100.0, 100.0)	
OIL PRESS @ 20mA(EU)	*100.0 (0.0, 1000.0)	
AIR MAN PR @ 4mA(EU)	*0.0 (-100.0, 100.0)	
AIR MAN PR @ 20mA(EU)	*50.0 (0.0, 1000.0)	
REMOTE SR @ 4mA(RPM)	*0.0 (-2000.0, 2000.0)	
REMOTE SR @ 20mA(RPM)	*1200.0 (0.0, 2200.0)	
<b>SET ANALOG OUTPUTS</b>		
ANALOG OUTPUT 1 MIN(ENGR)	*0.0 (-30000.0, 30000.0)	
ANALOG OUTPUT 1 MAX(ENGR)	*1300.0 (-30000.0, 30000.0)	
ANALOG OUTPUT 2 MIN(ENGR)	*0.0 (-30000.0, 30000.0)	
ANALOG OUTPUT 2 MAX(ENGR)	*1300.0 (-30000.0, 30000.0)	
ACTUATOR OUT 2 MIN(ENGR)	*0.0 (-30000.0, 30000.0)	
ACTUATOR OUT 2 MAX(ENGR)	*100.0 (-30000.0, 30000.0)	
AO FILTER Hz	*20.0 (0.01, 20.0)	
<b>I/O CALIBRATION</b>		
OIL PR OFFSET(AI1)	*0.0 (-200.0, 200.0)	
OIL PRESS SPAN(AI1)	*100.0 (50.0, 200.0)	
OIL PR READ VLT(AI1)	*FALSE	

ENABLE DSLC INPUT	*TRUE	
DSLCL OFFSET	*0 (-5000, 5000)	
AMP OFFSET(AI3)	*0.0 (-200.0, 200.0)	
AIR MAN PR SPAN(AI3)	*100.0 (50.0, 200.0)	
AIR MP READ VLT(AI3)	*FALSE	
REM SR OFFSET(AI4)	*0.0 (-200.0, 200.0)	
REM SR SPAN(AI4)	*100.0 (50.0, 200.0)	
REM SR READ VLT(AI4)	*FALSE	
AO 1 OFFSET	*0.0 (-4095.0, 4095.0)	
AO 1 SPAN	*100.0 (50.0, 200.0)	
AO 2 OFFSET	*0.0 (-4095.0, 4095.0)	
AO 2 SPAN	*100.0 (50.0, 200.0)	
ACT 1 OFFSET	*0.0 (-4095.0, 4095.0)	
ACT 1 SPAN	*100.0 (50.0, 200.0)	
ACT 2 OFFSET	*0.0 (-4095.0, 4095.0)	
ACT 2 SPAN	*100.0 (50.0, 200.0)	
<b>DISPLAY DIGITAL I/O</b>		
A-FUEL LIMIT SHIFT		
B-ALARM RESET		
C-SPEED FAIL OVRD		
D-2ND DYNAMICS		
E-RAISE SPEED		
F-LOWER SPEED		
G-RATED SPEED		
H-CLOSE TO STOP		
SHUTDOWN(DO1)		
STATUS INDICTR(DO2)		
ENGINE TROUBLE(DO3)		
<b>DISPLAY ANALOG I/O</b>		
ANALOG SS IN #1(Hz)		
ANALOG SS IN #2(Hz)		
DIGITAL SS IN #1(Hz)		
DIGITAL SS IN #2(Hz)		
AI1-LUBE OIL PR(mA)		
AI2-DSLCL(Vdc)		
AI3-AIR MANF PR(mA)		
AI4-REM SPD REF(mA)		
ANALOG OUT 1(mA)		
ANALOG OUT 2(mA)		
ACTUATOR OUT 1(mA)		
ACTUATOR OUT 2(mA)		
<b>DISPLAY INDICATION</b>		
ON MAX LIMIT		
ON AIR PRESS LIMIT		
ON TORSION LIMIT		
ON TORQUE LIMIT		
ACT SHUTDOWN		
SPEED SWITCH		
OIL XMTR FAIL		
AIR MAN XMTR FAIL		
LOAD SWITCH		
<b>DISPLAY ENG TROUBLE</b>		
FIRST ALARM		
1-SPEED #1 FAIL		
2-SPEED #2 FAIL		

3-SPD #1AND#2 FAIL		
4-REM SPD XMTR FAIL		
5-OIL LOW PR ALM		
6-HI FUEL DEMND ALM		
7-HI SPEED ALARM		
8-TORSIONAL ALARM		
9-SPEED SWITCH		
10-LOAD SWITCH		
ALARM RESET		
<b>DISPLAY SHUTDOWN</b>		
FIRST SHUTDOWN		
1-SPEED #1FAIL		
2-SPEED #2 FAIL		
3-SPD #1AND#2 FAIL		
4-REM SPD XMTR FAIL		
5-OIL LOW PR SD		
6-HI FUEL DEMND SD		
7-HI SPEED SD		
8-TORSIONAL SD		
<b>DISPLAY CTRL MODE</b>		
IN SPEED CTRL(LSS)		
ON START LIMIT(LSS)		
ON MAX LIMIT(LSS)		
ON AMP LIMIT(LSS)		
ON TORQ FUEL LIMIT		
ON TORSIONAL LIMIT (LSS)		
ACTUATOR SHUTDOWN		
TORSNL FILTR ACTIVE		
<b>DISPLAY MENU</b>		
ENGINE SPEED(RPM)		
BIASED SPEED REF(RPM)		
SPEED REF(RPM)		
DSLCL BIAS (RPM)		
FUEL DEMAND(%)		
OIL PRESSURE (EU)		
AIR MANF PRESS (EU)		
REMOTE SPD REF (RPM)		
TORQUE LIMIT (%FD)		
AMP FUEL LIMIT(%FD)		
TORSNL LIMIT (%FD)		
TORSIONL LEVEL(%RPM)		

# 723PLUS Control Specifications

## Woodward Part Numbers:

8280-1042 723PLUS Single Engine Marine control  
9907-205 Hand Held Programmer  
8923-932 Watch Window Installation \*  
5416-870 RS-422 PC Interface Cable

Power Supply Rating 18–40 Vdc (24 or 32 Vdc nominal)  
Power Consumption 40 W nominal  
Inrush Current 7 A for 0.1 ms (low-voltage model)

## Speed Signal Inputs (2)

Speed Input Voltage 1.0–50.0 Vrms  
Speed Input Frequency Magnetic Pickup: 400 Hz to 15 kHz  
Proximity Switch: 30Hz to 15 kHz  
Speed Input Impedance 10 k $\Omega$   $\pm$  15%

Note: EU Directive compliant applications are not currently able to use proximity switches due to the sensitivity of the switches.

## Discrete Inputs (8)

Discrete Input 24 Vdc, 10 mA nominal, 18–40 Vdc range  
Response Time 10 ms  $\pm$  15%  
Impedance 2.3 k $\Omega$

Note: For Lloyd's Register applications, use only control-supplied power.

## Analog Inputs (4)

Analog Input  $\pm$ 5 Vdc or 0–20 mA, transducers externally powered  
Common Mode Voltage  $\pm$ 40 Vdc  
Common Mode Rejection 0.5% of full scale  
Accuracy 0.5% of full scale

## Load Sharing Input

Analog Input 0–4.5 Vdc  
Common Mode Voltage  $\pm$ 40 Vdc  
Common Mode Rejection 1.0% of full scale  
Accuracy 1.0% of full scale

## Analog Outputs 0–1 or 4–20 mA (2)

Analog Output 0–1 mA or 4–20 mA (max. 600  $\Omega$  load)  
Accuracy 0.5% of full scale

## Analog Outputs 0–20 or 0–200 mA (2)

Analog Output 0–20 mA (max. 600  $\Omega$  load) or  
0–200 mA (max. 70  $\Omega$  load)  
Accuracy 0.5% of full scale

## Relay Contact Outputs (3)

Contact Ratings 2.0 A resistive @ 28 Vdc; 0.5 A resistive @ 125 Vdc

## Environment

Operating Temperature –40 to +70 °C (–40 to +158 °F)  
Storage Temperature –55 to +105 °C (–67 to +221 °F)  
Humidity 95% at +20 to +55 °C (+68 to +131 °F)  
Lloyd's Register of Shipping Spec. Humidity Test 1  
Mechanical Vibration Lloyd's Register of Shipping Spec. Vibration Test 1  
Mechanical Shock US MIL-STD 801C Method 516.2, Proc. I, II, V  
EMI/RFI Specification Lloyd's Register of Shipping Specification  
EN 50081–2 and EN 50082–2

## Compliance

UL/cUL Listing Class 1, Division 2, Groups A, B, C, D  
Lloyd's Register of Shipping LR Type Approval Test Specification No. 1 (1996) for  
environmental categories ENV1, ENV2, & ENV3  
Germanischer Lloyd Regulations for the Performance of Type Tests;  
Regulations for the Use of Computer and Computer on  
Board  
American Bureau of Shipping (ABS) Rules (1997) 4/4.11.6, 4/5C2.17, 4/11.3.11 and 4/11.7.2  
European Union (EU) Compliant with EMC Directive 89/336/EEC  
(Low Voltage Model Only)  
Det Norske Veritas (DNV) Rules for Classification of Ships and Mobile Offshore Units

We appreciate your comments about the content of our publications.

Send comments to: [icinfo@woodward.com](mailto:icinfo@woodward.com)

Please reference publication **26264A**.



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1000 East Drake Road, Fort Collins CO 80525, USA  
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Email and Website—[www.woodward.com](http://www.woodward.com)

Woodward has company-owned plants, subsidiaries, and branches,  
as well as authorized distributors and other authorized service and sales facilities throughout the world.

Complete address / phone / fax / email information for all locations is available on our website.