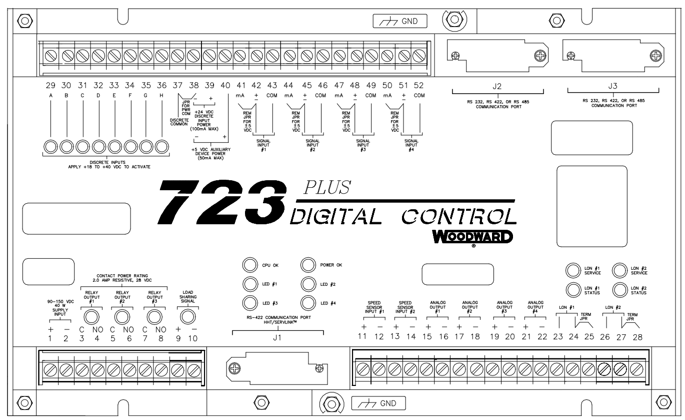
Product Manual 02883
(Revision B)
Original Instructions



723PLUS Digital Speed Control for Reciprocating Engines—Process Control

8280-464, 8280-465

Installation and Operation Manual

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

Revisions	**This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual *26311* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, on the *publications page* of the Woodward website:** **www.woodward.com/publications** **The latest version of most publications is available on the *publications page*. If your publication is not there, please contact your customer service representative to get the latest copy.**

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

Translated Publications	**If the cover of this publication states "Translation of the Original Instructions" please note:** **The original source of this publication may have been updated since this translation was made. 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 Out-of-date translations are marked with ⚠.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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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:** • **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*.**
Electrostatic Precautions	

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® Industrial Speed/Process Control, models 8280-464 (low voltage) and 8280-465 (high voltage).

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 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

This 723PLUS Digital Industrial Speed/Process Control controls the speed of reciprocating engines in variable speed applications, including those with flexible couplings (see Figure 1-1). The control includes inputs for two magnetic pickups (MPUs) or proximity switches for monitoring flexible coupling torsionals, an input for a remote speed setting, an input for output fuel limiting, an internal speed reference for local control of speed, and two inputs for process control or differential process control.

One LON®* channel can be used to support Woodward LINKnet input/output nodes for monitoring and control functions. The other LON channel is not used.

*—LON is a trademark of Echelon Corporation.

The three serial channels provide for various control interfaces. Port J1 is switchable to be a Watch Window PC interface or a hand-held programmer port for monitoring and programming the 723PLUS control. Port J2 is a Watch Window only port. Port J3 can interface to a Modbus®** master device such as a Human/Machine Interface (HMI) to monitor the control and engine parameters and to issue control commands.

**—Modbus is a trademark of Schneider Autiomation Inc.

The 723PLUS control system includes:
- a 723PLUS Digital Speed Control
- Servlink Watch Window (Figure 1-3) or a handheld terminal (Figure 1-4) for adjusting control parameters
- one or two proportional actuators to position the fuel metering
- an external power source
- one or two speed-sensing devices (two required for coupling torsional filtering)
- eight optional switch contacts to manage control functions
- an optional fuel limiting transducer
- three optional analog readout devices for display
- three optional relay-driven alarms and status indicators
- optional Modbus device for digital monitoring and control
- optional LINKnet Modules to provide additional I/O paths for the Modbus device

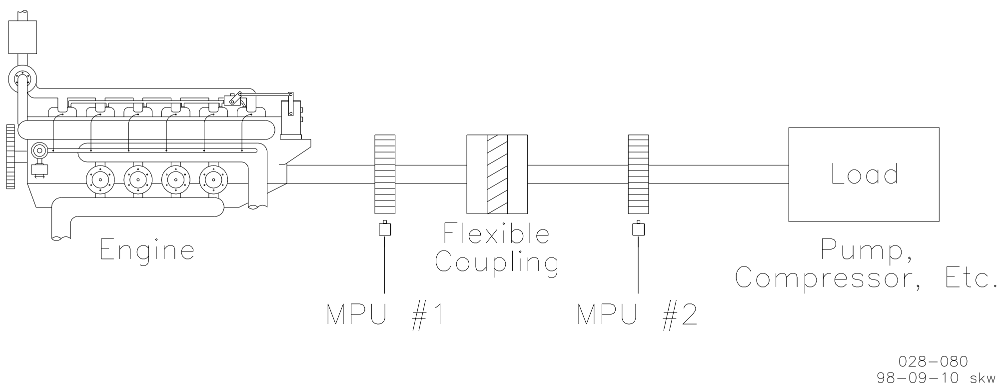


Figure 1-1. Flexible Coupled Driven Load

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.

Control Options

Each 723PLUS control requires 40 W of power. A nominal current in-rush of 7 A (low voltage) or 22 A (high voltage) is possible. Acceptable input voltage ranges are:
- low voltage—18 to 40 Vdc
- high voltage—90 to 150 Vdc

Discrete input voltages provide on/off command signals to the electronic control, such as Raise Speed, Lower Speed, etc. Each discrete input requires 10 mA at its 24 Vdc nominal voltage rating (2210 Ω load).

Other control options(On-board jumper configurations):
- proximity switch input for speed signal frequencies below 1000 Hz
- tandem actuator outputs
- 0–1 or 4–20 mA analog outputs
- 4–20 or 0–200 mA actuator outputs

Magnetic pickup inputs should only be used when operating speeds provide at least 400 Hz magnetic pickup frequency.

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 1-3 and 1-4.

Optional PC-based Control View software (part number 8928-056) is a graphical user interface product used for monitoring and adjusting software parameters of the 723PLUS/Process Control.

The two communication ports (J2 and J3) and the LON #1 data channel allow for digital communications between external Modbus compatible devices, Servlink devices, and Woodward LINKnet I/O modules. Port J2 is a dedicated port for Servlink clients like Watch Window and Control View. The LON #1 channel has been designated for use with up to 18 LINKnet modules. The inputs and outputs of these modules can be read and controlled with Modbus compatible devices connected to communication port J3. The number and types of LINKnet modules available:

Description	Nodes Available	Total Channels Available	Network Address	Module Part Numbers
J Thermocouple In–Fail High OR			9905-966	
J Thermocouple In–Fail Low	4	24	1, 2, 3, or 4	9905-967
100 A Am RTD Input	3	18	5, 6, or 7	9905-970
4–20 mA Input	2	12	8 or 9	9905-968
Discrete Input	4	64	10, 11, 12, or 13	9905-971
Relay Output	4	32	14, 15, 16, or 17	9905-973
4–20 mA Output	1	6	18	9905-972
TOTAL	**18**	**156**		

Table 1-1. LINKnet Modules (Summary)

Addr.	Description	Channels	Notes
1	J TC–Fail High	6	
2	J TC Input	6	
3	J TC Input	6	
4	J TC Input	6	
5	100 Ω Am RTD Input	6	
6	100 Ω Am RTD Input	6	
7	100 Ω Am RTD Input	6	
8	4–20 mA Input	6	
9	4–20 mA Input	6	
10	Discrete Input	16	
11	Discrete Input	16	
12	Discrete Input	16	
13	Discrete Input	16	
14	Relay Output	8	
15	Relay Output	8	
16	Relay Output	8	
17	Relay Output	8	
18	Analog Output	6	
Total		**156**	

Table 1-2. LINKnet Modules (Address)

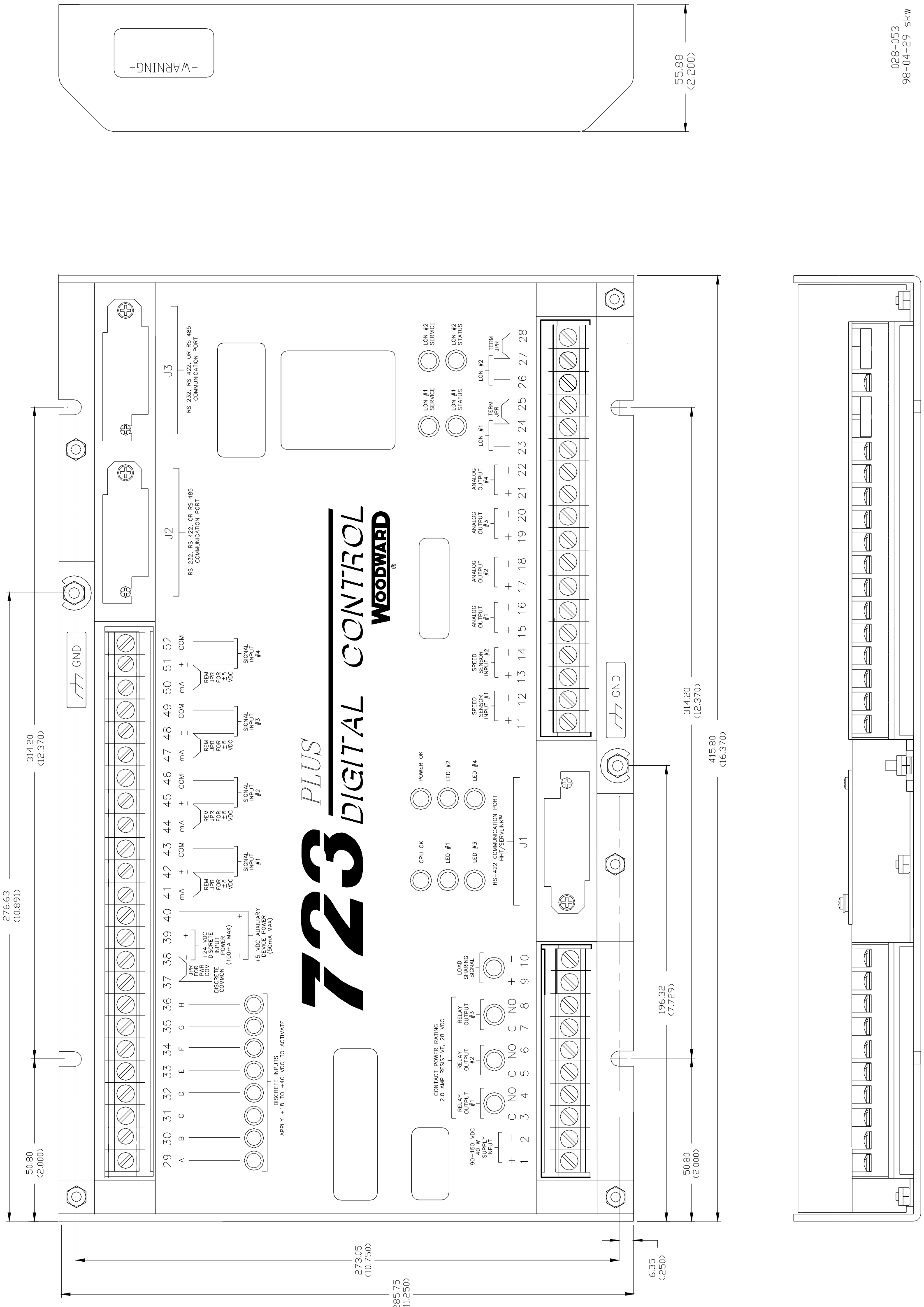


Figure 1-2. 723PLUS Digital Speed Control

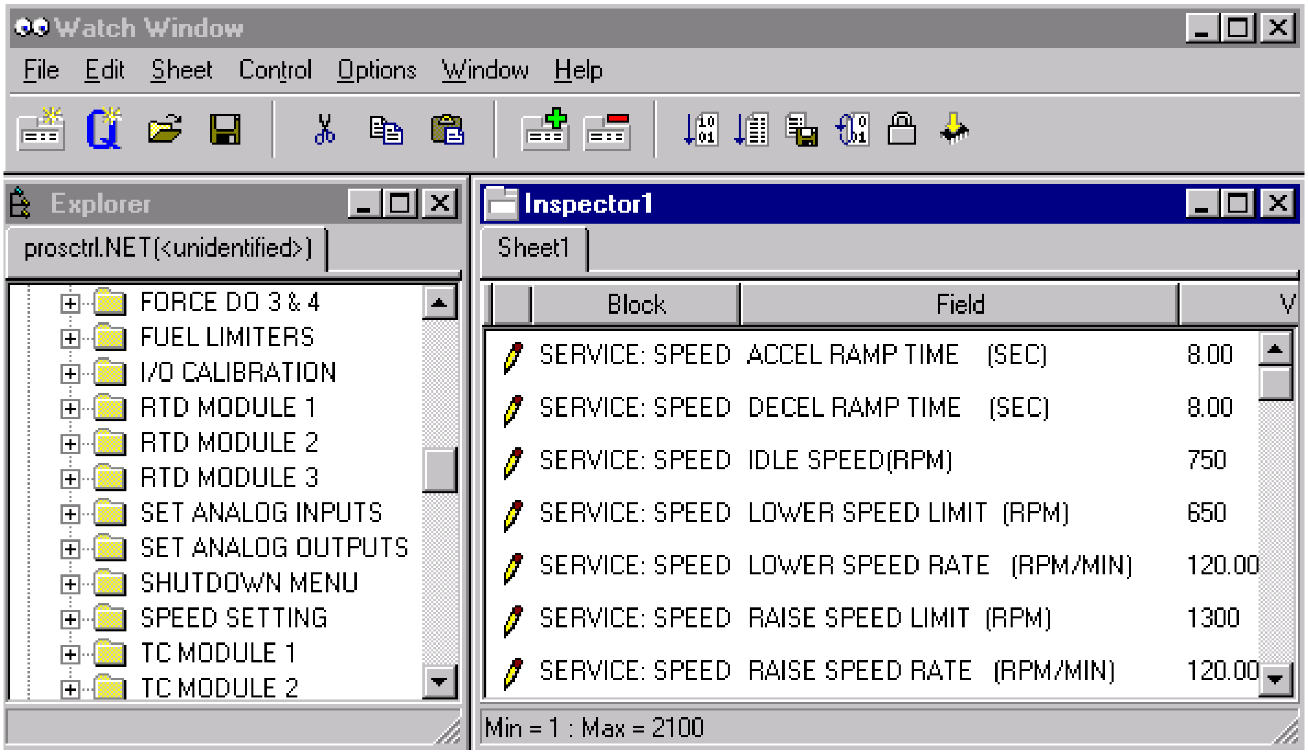
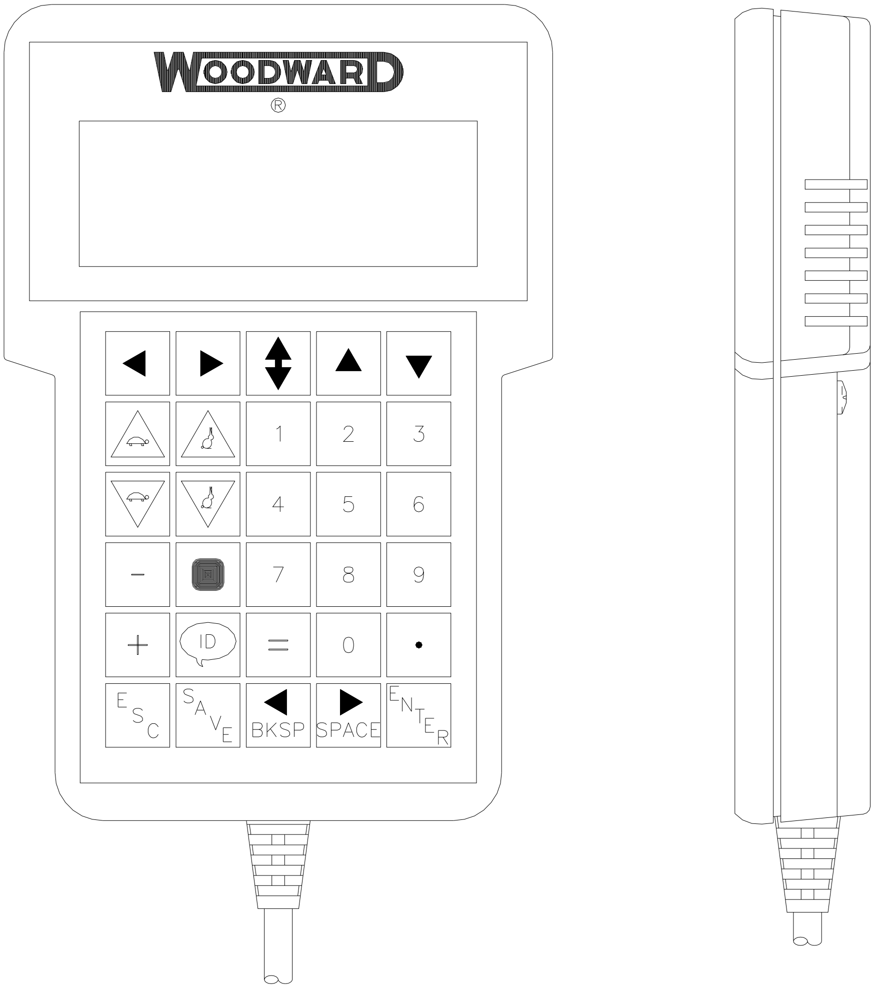
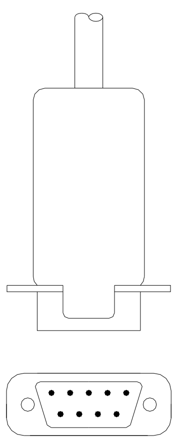


Figure 1-3. Watch Window Display





RS–422 SIGNAL	DE–9P PIN ASSIGNMENT
GROUND	7
XMIT–	2
RECV–	3
XMIT+	4
RECV+	5
POWER	9

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

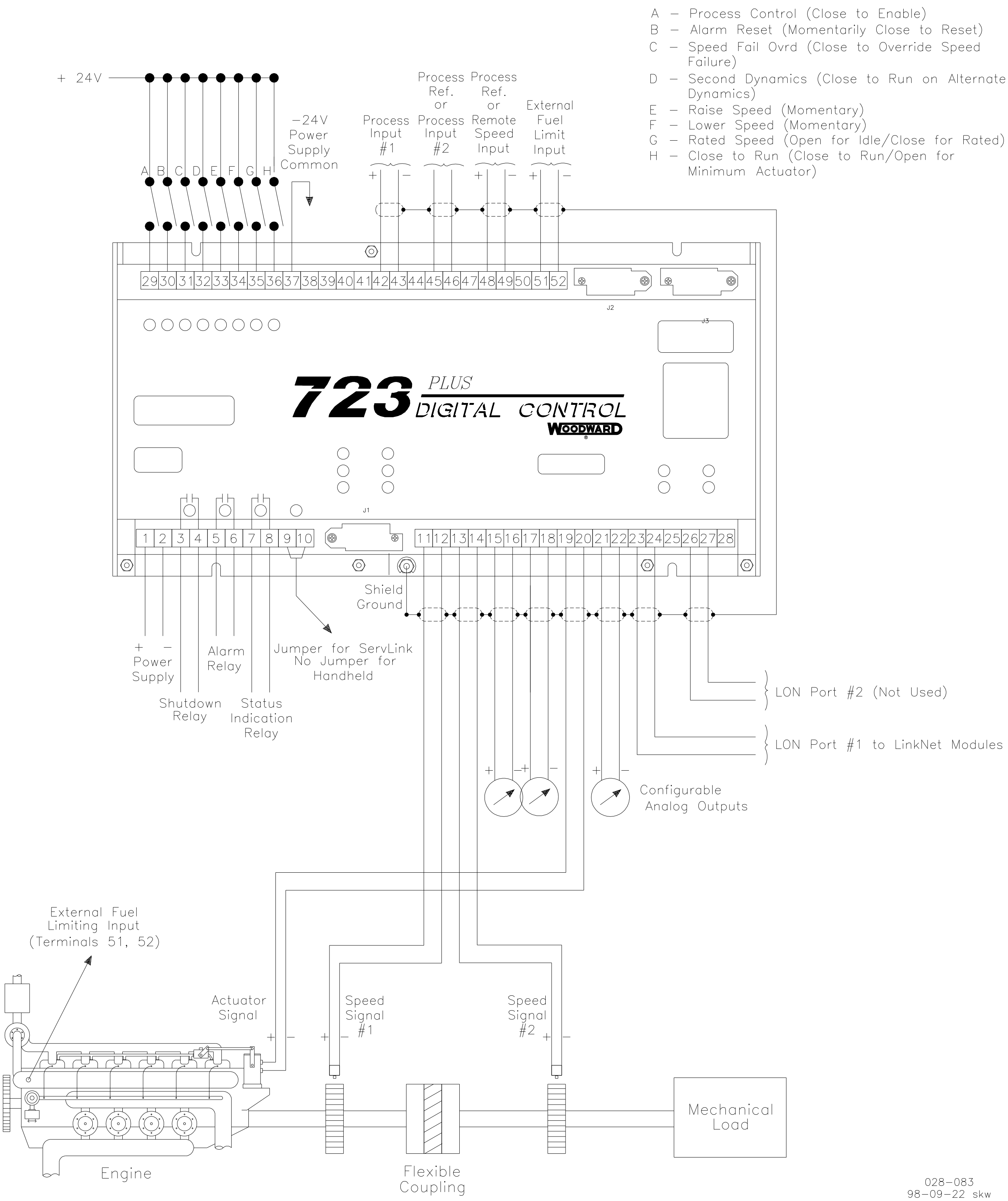


Figure 1-5. Typical 723PLUS Connections

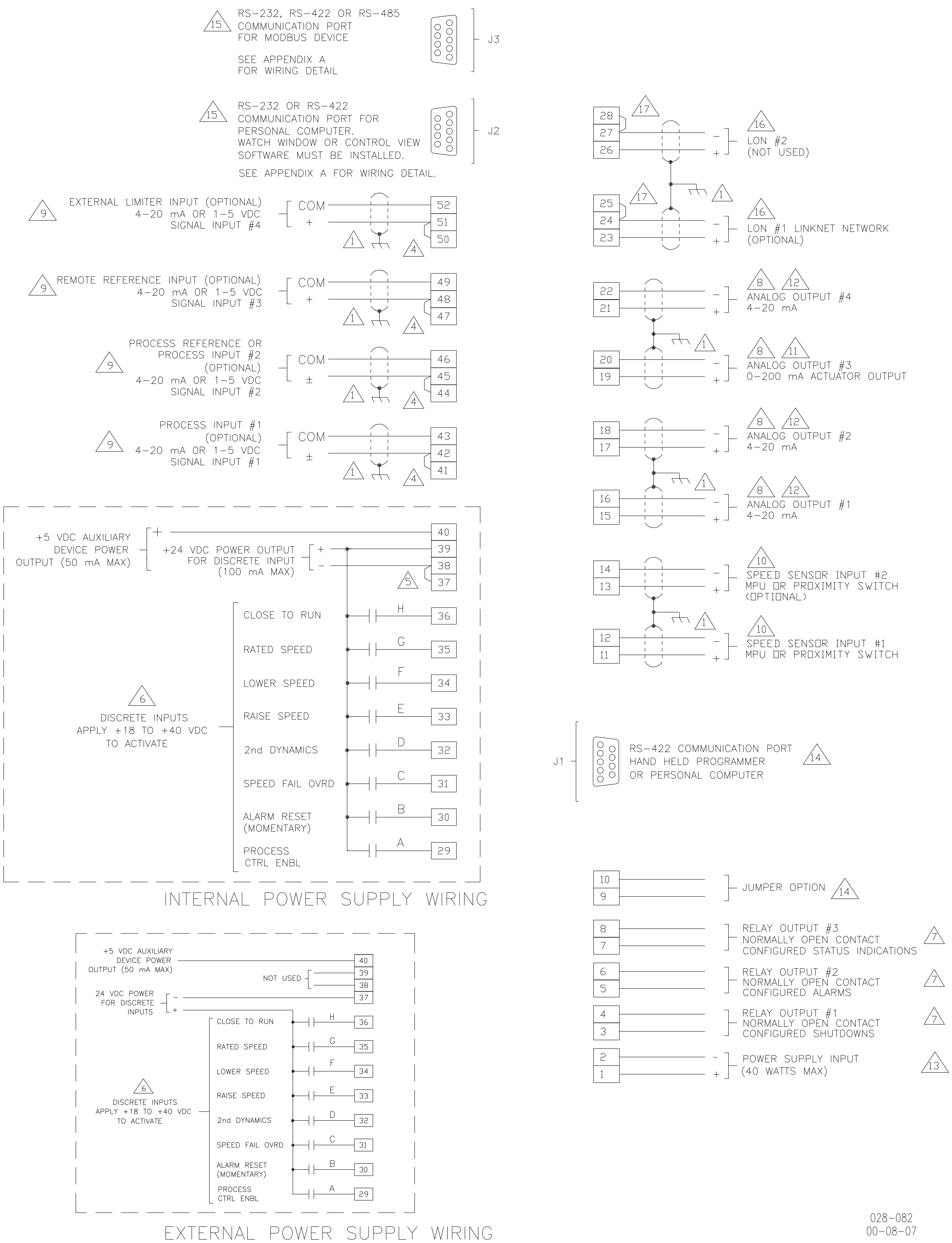


Figure 1-6a. Control Wiring Diagram

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. REMOVE JUMPER IF USING EXTERNAL DISCRETE INPUT POWER.

6. DISCRETE INPUTS ARE ISOLATED FROM OTHER CIRCUITS AND CAN BE POWERED BY TB1–39 (+24 VDC) LEAVING THE JUMPER IN PLACE. INPUT CURRENT IS NOMINALLY 10 MILLIAMPERES PER INPUT INTO 2210 OHM.

7. UNLESS OTHERWISE SPECIFIED:
   - A. RELAYS SHOWN DE–ENERGIZED
   - B. RELAYS ENERGIZE FOR FUNCTION
   - C. RELAY CONTACT RATINGS FOR MINIMUM 100,000 OPERATIONS:

     RESISTIVE– 2.0 AMPERES AT 28 VDC
     0.1 AMPERES AT 115 VAC 50 TO 400 Hz

     INDUCTIVE– 0.75 AMPERES AT 28 VDC 0.2 HENRY
     0.1 AMPERES AT 28 VDC LAMP

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.
       1. PERSONAL COMPUTER MUST HAVE WATCH WINDOW OR CONTROL VIEW SOFTWARE INSTALLED.
       2. NEED DOWNLOAD CABLE #5416–870 TO CONNECT FROM J1 (RS–422) TO PERSONAL COMPUTER (RS–232).

15. COMMUNICATION PORT J2 CAN BE CONFIGURED AS AN RS–232 OR RS–422 SERIAL INTERFACE. COMMUNICATION PORT J3 CAN BE CONFIGURED AS AN RS–232, RS–422, OR RS–485 SERIAL INTERFACE. PORT CONFIGURATION CAN BE DONE IN THE APPLICATION SOFTWARE ONLY. FOR THE PIN ASSIGNMENT OF J2 AND J3 SEE APPENDIX A.

16. THE LON MUST BE CONNECTED USING PROPER CABLE AS DESCRIBED IN APPENDIX B.

17. IF USED, LON NETWORKS NEED TO BE PROPERLY TERMINATED. THIS CAN BE DONE AT THE 723PLUS BY INSTALLING JUMPERS FROM TERMINALS 24 TO 25 FOR LON #1. REFER TO APPENDIX B FOR FURTHER DETAILS.

028–081
00–08–02

Figure 1-6b. Control Wiring Diagram

Chapter 2.
Installation

Introduction

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 Electrostatic Discharge Awareness (p.iv). 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 high-voltage versions of the 723PLUS Digital Industrial Speed/Process Control require a voltage source of 90 to 150 Vdc. The low-voltage versions require a voltage source of 18 to 40 Vdc.

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 will provide 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 Electrostatic Discharge Awareness (p.iv), before proceeding.

With the power off, remove the control cover. With a small pair of tweezers or needle-nose pliers, carefully remove the appropriate jumper and replace it securely over the proper two connectors (see Figure 3-1).

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

External wiring connections and shielding requirements for a typical 723PLUS control installation are shown in Figure 1-5. The control wiring connections (Figure 1-6) are explained 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.

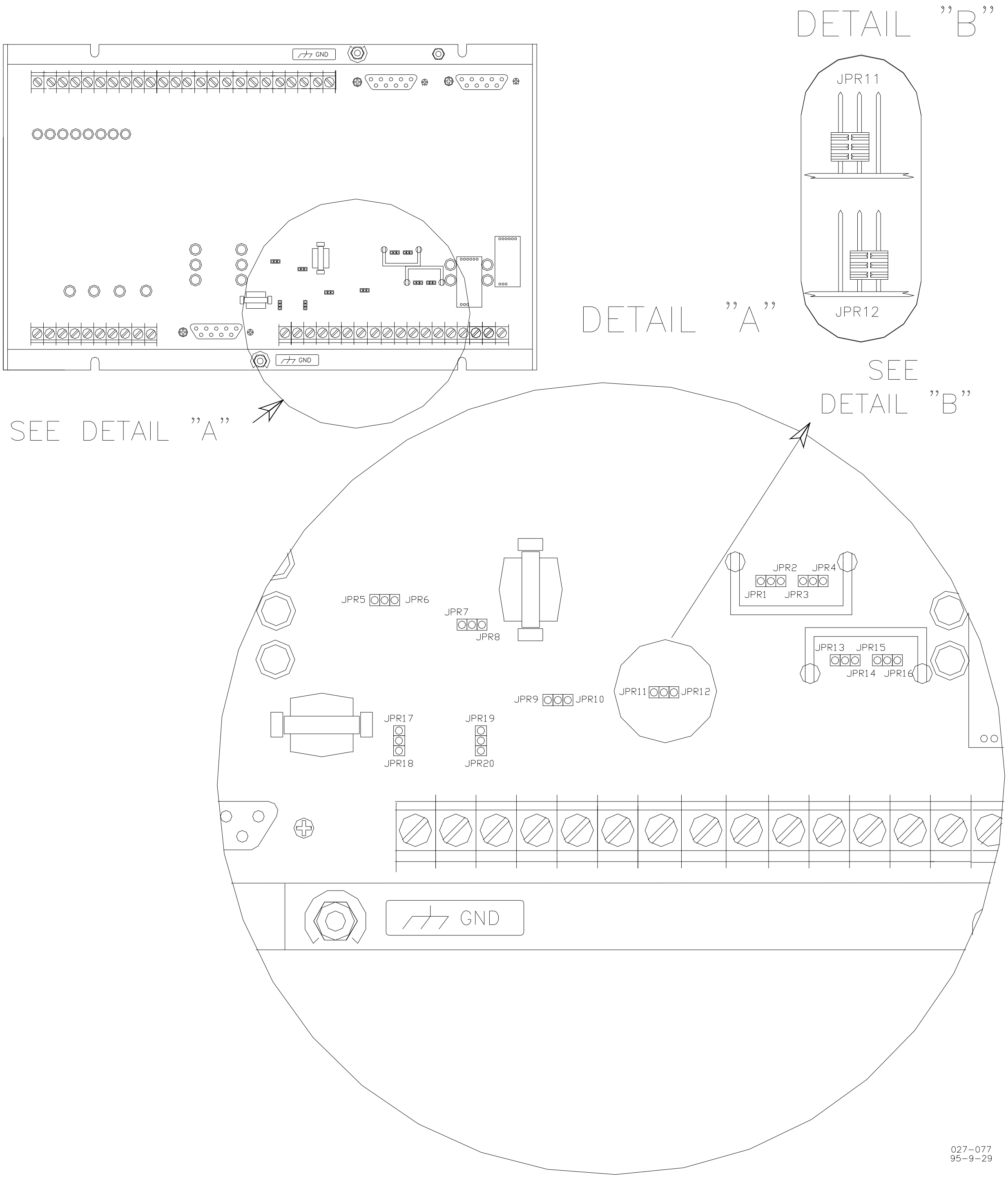


Figure 3-1. 723PLUS Control Internal Jumpers

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 inner conductor(s) out of the shield. If the shield is the braided type, twist it to prevent fraying.

4. Remove 6 mm (1/4 inch) of insulation from the inner conductors.

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

Power Supply (Terminals 1/2)

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 (7–22 A) to start properly.

NOTICE	**To prevent damage to the control, do not power a low-voltage control from high-voltage sources, and do not power any control from high-voltage sources 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 shutdown procedure. Use the Minimum Fuel (Run/Stop) discrete input (terminal 36) for 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 come on, because test failure turns off the output of the control.**

POWER OK and CPU OK LEDs

The POWER OK and CPU OK are green LEDs (light emitting diodes). These LEDs are illuminated when the internal power supply is functioning and the CPU is operating normally. When the LEDs are not illuminated, do *not* attempt to start or run the engine. The LEDs will turn off if the power supply is turned off or failed, the CPU is failed, or a watchdog error exists.

FAILED SPD SENSOR #1 and #2 LEDs

The FAILED SPD SENSOR #1 and #2 LEDs are red. The FAILED SPD SENSOR LEDs are programmed to illuminate if a speed sensor fault has been detected. LED #1 illuminates when a speed sensor 1 fault has been detected, and LED #2 illuminates when a speed sensor 2 fault has been detected. The speed sensor fault is activated if the sensed speed is below the failsafe speed setting.

ALARM #1 LED

The ALARM #1 LED (LED #3) is programmed to light if a configured shutdown condition is latched in the faulted state. The shutdown condition must be cleared and an alarm reset issued to extinguish LED #3.

ALARM #2 LED

The ALARM #2 LED (LED #4) is programmed to light if a configured alarm condition is latched in the faulted state. The alarm condition must be cleared and an alarm reset issued to extinguish LED #4.

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 a status indication condition. The contact ratings are shown on the control wiring diagram in Figure 1-6. 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 intended 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 or 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 internal alarm conditions are to be used by other devices in the application. No connection is required if the alarm function is not used in the application. The relay changes state if any configured alarm condition has occurred without being cleared or 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 internal status indication conditions are to be used by other devices in the application. No connection is required if the status indication function is not used in the application. The relay changes state if any configured status indication condition has occurred and will self-clear when the condition no longer exists. The state of the contact can be configured as either close on status or open on status. If power to the control is lost, the contact will open.

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

Connect a magnetic pick-up (MPU) or proximity switch to terminals 11 and 12. You may connect a second MPU/proximity switch to terminals 13 and 14. The second speed-sensing device may be used for redundancy and for torsional filtering if configured. The second device will provide 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.

If you have a flexible coupling between the engine and driven load, you must connect the first MPU (terminals 11/12) to detect engine speed, and the second MPU (terminals 13/14) to detect driven load. The speed sensors must be on shafts rotating at exactly the same speed (not a camshaft, nor on each side of a gearbox, etc). 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 if the 723PLUS control's analog inputs and outputs must both be used with non-isolated devices. A number of manufacturers offer 20 mA loop isolators.**

Analog Outputs #1, #2, and #4 (Terminals 15/16, 17/18, and 21/22)

The three 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 on Analog Outputs #1 and #2 and for either 0 to 200 mA or 4 to 20 mA on Analog Output #4. This current signal is supplied to terminals 15(+) and 16(–) for Analog Output #1, terminals 17(+) and 18(–) for Analog Output #2, and terminals 21(+) and 22(–) for Analog Output #4. Note that the these terminals must be isolated from ground.

Any of the three outputs can be software configured to one of several control parameters. These parameters include:
1—Engine Speed
2—Engine Speed Reference
3—Fuel Demand
4—Reverse Fuel Demand
5—Torsional Level
6—Remote Speed Set Point
7—J3 Modbus Analog Write Address
    4:0002 ANALOG OUTPUT #1
    4:0003 ANALOG OUTPUT #2
    4:0004 ANALOG OUTPUT #4
8—Process Input #1
9—Process Input #2
10—Process Differential

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

Analog Output #4 is factory set for 4 to 20 mA, representing the engine fuel demand. Default range is 0 to 100 %. 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 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)

The actuator wires connect to terminals 19(+) and 20(–). Use shielded wires with the shield connected to chassis at the control. The output current is hardware configurable for either 0–200 mA or 4–20 mA. If the hardware jumper is changed, the software settings must also be changed.

LON #1 and LON #2 (Terminals 23—28)

The 723PLUS control provides two separate LON communication channels for communicating with Echelon® networks.

LON #1 is used to connect up to eighteen Woodward LINKnet™ I/O modules. These modules provide values for temperature, 4 to 20 mA inputs, and discrete inputs for availability to the two serial communication ports (J2 and J3). Additionally, the information can be read on Watch Window or the Hand Held Programmer when connected to J1. Modules can also be used which will provide 4 to 20 mA outputs and relay outputs. These outputs are driven by the Modbus device connected to Communication Port J3.

LON #2 is not used. DO NOT CONNECT.

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.

Voltage is supplied to the discrete input terminal when an input switch or relay contact closes. This will cause the input state for that discrete input to be TRUE. The input terminal will be open circuited when the input switch or relay contact opens. This will cause the input state for that discrete input to be FALSE. 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 will illuminate for a valid TRUE state.

In systems which provide an external low voltage source to power the 723PLUS control (or other systems where external low voltage dc power is available), the discrete inputs may be powered by this external low voltage. The voltage source used must be capable of 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.**

In systems which provide a high voltage source to power the 723PLUS control (or systems where the external low voltage dc power is not appropriate), 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.

Process Ctrl Enbl (Input A; Terminal 29)

The input switch or relay contact used to enable the Process Control function connects to terminal 29 (Discrete Input A). This discrete input changes the control state between standard and process speed control. When the contact is open, Process Control is disabled and the control will operate as a standard variable speed control. In this state, the speed of the engine will be changed with the RAISE SPEED and LOWER SPEED contacts described below and the remote speed reference. With the contact closed (discrete input in the TRUE state), the speed of the engine will be changed with the Process Control input only. In this state, the speed of the engine will be changed by the process control (cascade or deadband). The Process Control must change engine speed in a direction which restores the process (single or differential) to a process set point.

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 will issue 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 will limit the command so that the reset condition will apply only for a short time within the control even if the external contact remains closed. With the contact open (discrete input in the FALSE state), the control will again be ready to respond to the external contact closing. The Alarm Reset command works in parallel with the command from Port J2, the command from Port J3, and a software switch from the Hand Held Programmer, Watch Window, or Control View.

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 will 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 will override 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 will force the fuel demand to increase if the electrical speed signal is lost, and relinquish 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 electrical 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 will use the 2nd Dynamics set. When the contacts are open (discrete input in the FALSE state), the control will use 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 ramp. The ramp can increase only to a software adjusted RAISE SPEED limit. The ramp will increase at a software adjusted rate. De-selecting the Rated Speed command (described below) *or* enabling Process Control will take command control away from Raise Speed and effectively disable the command. When the external switch or relay contacts are closed (discrete input in the TRUE state), the control will raise the speed reference. Raise is limited to the maximum speed limit. With the contacts open (discrete input in the FALSE state), the control will stop raising the speed reference. Maintained simultaneous closure of this Raise input contact, along with the Lower input contact, enables the Remote Speed input.

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 ramp. The ramp can decrease only to a software adjusted LOWER SPEED limit. The ramp will decrease at a software adjusted rate. De-selecting the Rated Speed command (described below) *or* enabling Process Control will take command control away from Lower Speed and effectively disable the command. When the external switch or relay contacts are closed (discrete input in the TRUE state), the control will lower the speed reference. Lower is limited to the minimum speed limit. With the contacts open (discrete input in the FALSE state), the control will stop lowering the speed reference. Maintained simultaneous closure of this Lower input contact, along with the Raise input contact, enables the Remote Speed input.

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 will ramp for a time set by the Accel Time to the rated speed control point. When the switch or relay contacts are open (discrete input in the FALSE state), the speed reference will ramp for a time set by the Decel Time to the idle speed control point. Closing the raise contact, the lower contact, (or both) *or* enabling Process Control will cancel the ramp functions initiated by the Rated Speed discrete input. For example, if the accel to rated or the decel to idle ramp is in process, these ramps will stop when the raise or lower contact is closed and will then be controlled at the rate set for these inputs. The remote and process ramp rates will apply when these inputs are selected and interrupt the accel or decel ramps.

Close to Run (Input H; Terminal 36)

The external contact used to activate the Close to Run command connects to terminal 36 (Discrete Input H). This discrete input changes the control operation by immediately decreasing the fuel demand to zero. When the switch or relay contacts are closed (discrete input in the TRUE state), the control is allowed to control the fuel in an attempt to control the speed/load of the prime mover. When the switch or relay contacts are open (discrete input in the FALSE state), the Minimum Fuel Function will immediately pull the fuel demand to zero.

The Close to Run command is the preferred means for a normal shutdown of the engine. The control output to the actuator will be minimum fuel demand when no voltage is applied to terminal 36.

⚠WARNING

The Close 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 Close to Run discrete input as the sole means of shutdown in any emergency stop sequence.

Process Input #1 (Signal Input #1; Terminals 42/43)

Connect a Process Transmitter #1 to Signal Input #1. The input signal must be an isolated high-quality signal. This signal input allows an external process to adjust engine speed for process (deadband or cascade) control. Also, Signal Input #1, in conjunction with Signal Input #2, allows an external differential process to adjust engine speed for differential process (deadband or cascade) control. 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 1 to 5 Vdc voltage transmitter to terminals 42(+) and 43(–). When using a voltage transmitter, remove the jumper between terminals 41 and 42. An input impedance of 255 Ω is present when the jumper is installed. Without the jumper installed, the input impedance will be greater than 10 MΩ. 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 detected failure will remain until the failure is repaired and an Alarm Reset is issued.

Process Input # 2 (Signal Input #2; Terminals 45/46)

Connect a Process Transmitter #2 to Signal Input #2. The input signal must be an isolated high-quality signal. This signal input in conjunction with Signal Input #1, allows an external differential process to adjust engine speed for differential process (deadband or cascade) control. 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 1 to 5 Vdc voltage transmitter to terminals 45(+) and 46(–). When using a voltage transmitter, remove the jumper between terminals 44 and 45. An input impedance of 255 Ω is present when the jumper is installed. Without the jumper installed, the input impedance will be greater than 10 MΩ. 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 detected failure will remain until the failure is repaired and an Alarm Reset is issued.

Remote Speed Reference (Signal Input #3; Terminals 48/49)

Connect a remote speed reference transmitter to Signal Input #3. The input signal must be an isolated high-quality signal. 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 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 255 Ω is present when the jumper is installed. Without the jumper installed, the input impedance will be greater than 10 MΩ. 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 values exceeding 21 mA (5.25 Vdc). A detected failure will remain until the failure is repaired and an Alarm Reset is issued.

Ext Fuel Limit (Signal Input #4; Terminals 51/52)

Connect an External Fuel Limit transmitter to Signal Input #4. The input signal must be an isolated high-quality signal representing the External Fuel Limit signal. This signal input will allow an external signal to limit the fuel demand. It is typically used to set a maximum fuel demand limit based on a parameter such as air manifold pressure. 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 External Fuel Limit current transmitter or 1 to 5 Vdc External Fuel Limit voltage transmitter to terminals 51(+) and 52(–). When using a voltage transmitter, remove the jumper between terminals 51 and 50. An input impedance of 255 Ω is present when the jumper is installed. Without the jumper installed, the input impedance will be greater than 10 MΩ. 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). A detected failure will remain until the failure is repaired and an Alarm Reset is issued.

RS-422 Communication Port (J1)

Port J1 is intended for use with the Woodward ST2000 Hand Held Programmer (part number 9907-205), Watch Window software (part number 8923-932), or Control View software (part number 8928-056). The RS-232/RS-422 download cable (part number 5416-870) or Hand Held Programmer plug into communication port J1 of the control. These allow the user to configure software, adjust set points, and display parameters. A jumper switches the port J1 function. See Chapters 3 and 4 for the menu items available. Contact your local distributor for other options.

Communication Port J2

Communication Port J2 is an alternate Servlink connection for use with Watch Window software or Control View software. Port J2 can be software configured to standard specifications for RS-232 or RS-422. BAUD rates can be set for 100, 300, 600, 1200, 1800, 2400, 4800, 9600, 19200, or 38400. Unlike Port J1, an RS-232 cable may be used to connect Port J2 to a personal computer. Watch Window or Control View can be used to display and modify tunable and configurable values in the control, shut down the control, restart the control, and upload and download tuning parameters. Multiple values are simultaneously displayed. The ability to link to a control over a network via network DDE is also provided.

Port J2 is a 9-pin subminiature D receptacle connector. See Appendix A for wiring detail.

Communication Port J3

Communication Port J3 is used to connect a separate Modbus device to the 723PLUS control. This device is used to read control parameters and inputs from connected LINKnet nodes. The Modbus device can drive LINKnet nodes and certain 723PLUS control parameters. The Modbus device can be any master device capable of communicating with Modbus standard protocol. This includes any Modbus compatible PC, any compatible SCADA system, etc.

Communication Port J3 can be software configured for a wide variety of serial communications. Port J3 can be software configured to standard specifications for RS-232, RS-422, or RS-485. BAUD rates can be independently set for 1200, 1800, 2400, 4800, 9600, 19200, or 38400. The only restrictions are that if port J2 is set for a BAUD rate of 19200, then port J3 BAUD rate cannot be 38400, and if port J2 is set for a BAUD rate of 38400, then port J3 BAUD rate cannot be 19200. Stop bits can be set at 1, 1.5, or 2. Parity can be set for OFF, ODD, or EVEN. The data may be formatted as either ASCII or RTU.

Communication Port J3 can read all 723PLUS control parameters, read all connected LINKnet inputs, send commands and values to all connected LINKnet outputs, and send limited commands and two signals to the 723PLUS control. The two signals which can be sent to the 723PLUS are the remote speed reference and a source value for configured analog outputs #1, #2, and #4. The commands which can be sent to the 723PLUS control are Alarm Reset, Close for Process Control, Close to Override Failsafe, Close for 2nd Dynamics, Raise Speed, Lower Speed, Close for Rated Speed, Close to Run, Use Process Control Remote Command, Use Failsafe Override Remote Command, Use 2nd Dynamics Remote Command, Use Raise Speed Remote Command, Use Lower Speed Remote Command, Use Rated/Idle Remote Command, Use Run/Stop Remote Command, and Use Remote Speed Reference. The Alarm Reset command works in parallel with the discrete input Alarm Reset command connected to terminal 30 (B), and a software switch from Watch Window, Control View, or the Hand Held Programmer. The Raise Speed and Lower Speed commands work independently (by configuration) from the discrete inputs Raise Speed (terminal 33/E) and Lower Speed (terminal 34/F) respectively. See Appendix C for complete listings of port addresses and description of values for port J3.

Port J3 is a 9-pin subminiature D receptacle connector. See Appendix A for wiring detail.

Optional LINKnet nodes provide system parameters that can be sent to and used by the Modbus devices connected to Communication Port J3. The LINKnet nodes can provide temperature signals from 24 type “J” thermocouples and 18 RTDs (3-wire, 100 A American curve). Nodes can also provide 12 analog inputs in the form of 4 to 20 mA signals and 64 discrete inputs. All signal input values sent to the Modbus device are scaled in milliamps x1000 (that is, a 12 mA signal input to a 4–20 input LINKnet node will be read as 12000 on the corresponding address by the Modbus device).

LINKnet nodes can also be used to provide system parameters from a Modbus device to the system. The LINKnet nodes can provide up to six 4 to 20 mA outputs and 32 Form C relay outputs (contacts are rated 5 A at 28 Vdc). The 4 to 20 mA outputs must be scaled as milliamps x1000 from the Modbus device (that is, to produce 12 mA from a particular output, the Modbus device must send a value 12000). The relay outputs will energize when the state of the correct address is set to TRUE. A FALSE state will cause the relay output to de-energize.

Modbus Analog Write Addresses 0002, 0003, and 0004 allow control of configurable analog outputs #1, #2, and #4 respectively. The signed 16-bit integer must be scaled as milliamps x1000 for communication (that is, to produce a 12 mA output from the 723PLUS, a value of 12000 must be applied to address 4:0002).

Modbus Analog Write Address 0005 allows control of the speed reference. The signed 16-bit integer must be scaled as rpm for communication (that is, to produce a 1300 rpm output from the 723PLUS, a value of 1300 must be applied to address 4:0005).

Installation Checkout Procedure

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

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, *Electronic Governor Installation Guide* for additional information on linkage.

⚠WARNING **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 control wiring diagram, Figure 1-6.
   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.

IMPORTANT **The smallest practical gap is preferred, typically smaller gaps can be set on smaller gears and larger gaps on larger gears.**

2. Check for grounds

   Check for grounds by measuring the resistance from all control terminals to chassis. All terminals except terminals 2 and 37 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 infinite 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 and repair the ground fault.

Chapter 3.
Entering Control Set Points

Introduction

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

This chapter contains information on how to enter control set points through the control's menu system using the Hand Held Programmer, Watch Window, and Control View. See the next chapter 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 was developed by Woodward to be a Servlink client software product to provide a generic 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. Tabbed pages can be added within each window for easy grouping and access to sets of parameters and values. 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 Process Control through ports J1 or J2. However, only port J1 can be used for loading the application software.

Port J1 is configured for RS-422 as a point-to-point only Servlink Server 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 or Control View, 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 by default 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. Port J2 configuration may be set for RS-422 as a point-to-point or multidrop Servlink Server.

Read 'Control Properties' 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 (write this information in the Programming Checklist, Appendix C). Read "Getting Started" included in the Watch Window Help file provided with the Watch Window install software.

723PLUS Control View

Woodward has created Control View as a PC interface for the 723PLUS Process Control. This custom graphical user interface is a Servlink client that has all 723PLUS Process Control tunable values and monitoring parameters laid out in an intuitive manner.

IMPORTANT **The Control View software is an OPTION and must be ordered separately from the 723PLUS Control. Refer to the inside back cover for the part number.**

This interface connects directly to the control values and parameters. Monitoring parameter updates are very fast. Tunable values may be changed directly and saved in the controller's EEPROM or saved to a file to be downloaded or uploaded. Control View communicates with the 723PLUS Process control through ports J1 or J2.

Port J1 is configured for RS-422 as a point-to-point only Servlink server 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 Control View or 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 by default 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. Port J2 configuration may be set for RS-422 as a point-to-point or multidrop Servlink Server.

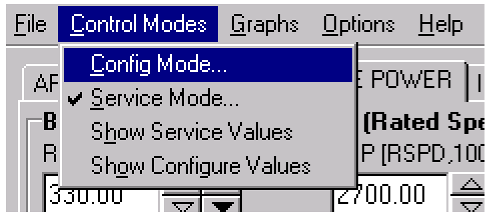
Read "Help About" to display the part number and revision letter of the software in the control. Refer to this number and revision level in any correspondence with Woodward (write this information in the programming checklist in the Appendix). Read the "Getting Started" notepad included with the Control View install software.

System Requirements

- Operating System: Windows 95 or Windows NT 4.0 *
- Processor: At least a Pentium 166 MHz or equivalent
- RAM: Recommended 32 MB (with Windows 95) and 64 MB (with Windows NT 4.0); Required 8 MB
- Communications: At least 1 free working COMM port

IMPORTANT *** It is likely that this program would run fine on Windows 98 and Beta Versions Windows NT 5.0, but these have not been tested and will not be supported by Woodward.**

Control Modes

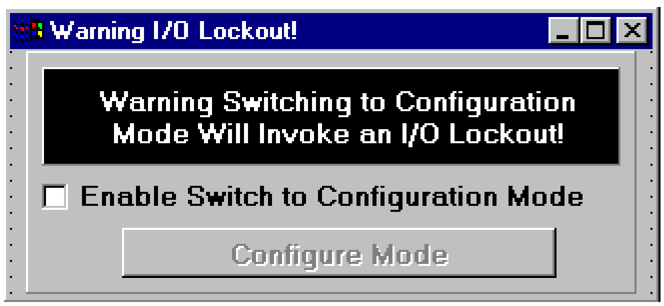


- Service Mode

When the controller is in use, it is in service mode. While in service mode, configuration values cannot be changed, and tunable values can be changed only within 10% of their value per single adjustment.

- Configure Mode

This mode is used to set up options that cannot be changed while the controller is in use (e.g., the number of teeth). Switching to configure mode will cause an I/O lockout. A conformation dialog is in place so that the control is not accidentally placed in configuration mode.



To continue and enter Configuration Mode, check the “Enable Switch to Configuration Mode” box, then press or click Configuration Mode. Close the window (click ☒) to cancel.

- Show Service Values

This will bring the service values to the top so they can be adjusted. If the control is in configure mode, the values can be adjusted by any amount within their allowed maximum and minimum ranges. The “within 10% of their value” rule does not apply in Configure mode.

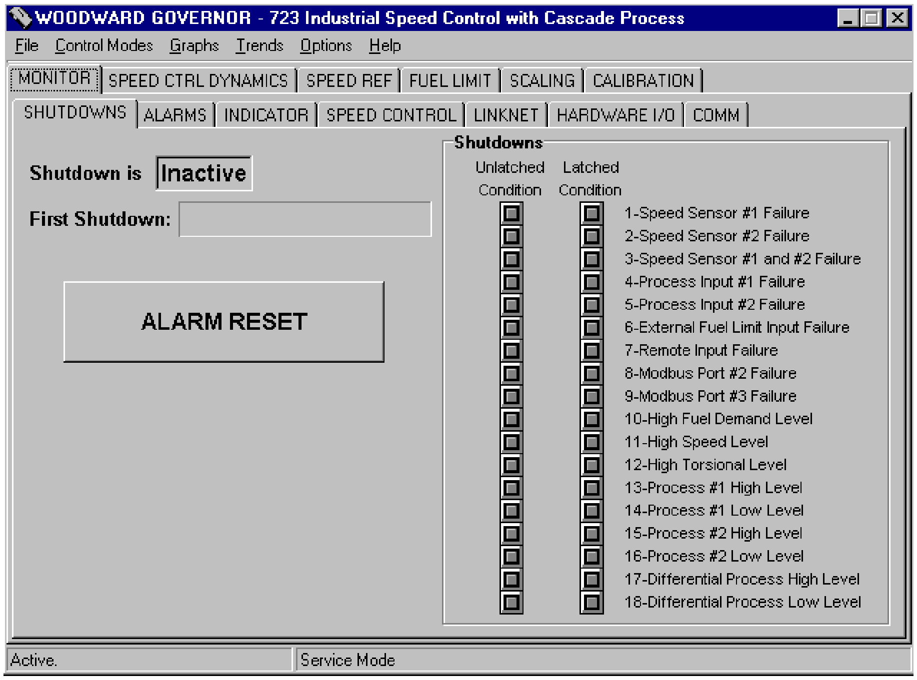
- Show Configure Values

This option will make the configure values visible. Note that if an attempt is made to change a configure value while the control is in service mode, an error will be generated indicating that this is not allowed.

IMPORTANT	**While in configure mode, the controller locks out all other input and output processing. This means that if the controller is put in configuration mode while its control device is still active (e.g. the engine is still running) results could be unpredictable.**

Startup Screen

This following Startup Screen appears when the 723PLUS Control View is opened.

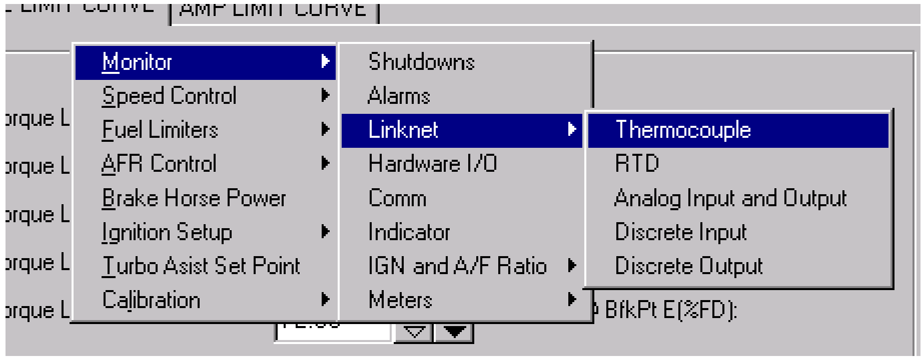


This shows the Monitor Shutdown screen and displays current status of all shutdowns. An Alarm Reset button is provided to reset any control alarms and shutdowns that have been cleared.

The Tabs across the top provide a word description of main screens and sub-screens of the Monitor screen and are a means of moving to another screen. To move to another screen, Click the appropriate tab. The ◄► arrows in the upper right hand corner are used to scroll to other tabs that may be hidden. Some screens when opened (e.g., Monitor), will display additional tabs to sub-screens. Clicking these tabs will move you into the sub-screens.

A quick means of moving directly to another screen or sub-screen from any screen is to right click anywhere on the tab sheet, *except on a gauge panel*. The main tabs list will pop up and an ➢ symbol will appear at the right edge of main lists which contain a sub-screen list. This facilitates moving to sub-screens. Left click when the cursor is over the desired screen or sub-screen name to move directly to that screen.

The following is an example of right clicking to select and move to the “Thermocouple” screen, which is a sub-screen of “LINKnet” and “Monitor”. It displays the full lists of other LINKnet sub-screens and Monitor sub-screens as well as all Main screens (including those that are hidden).

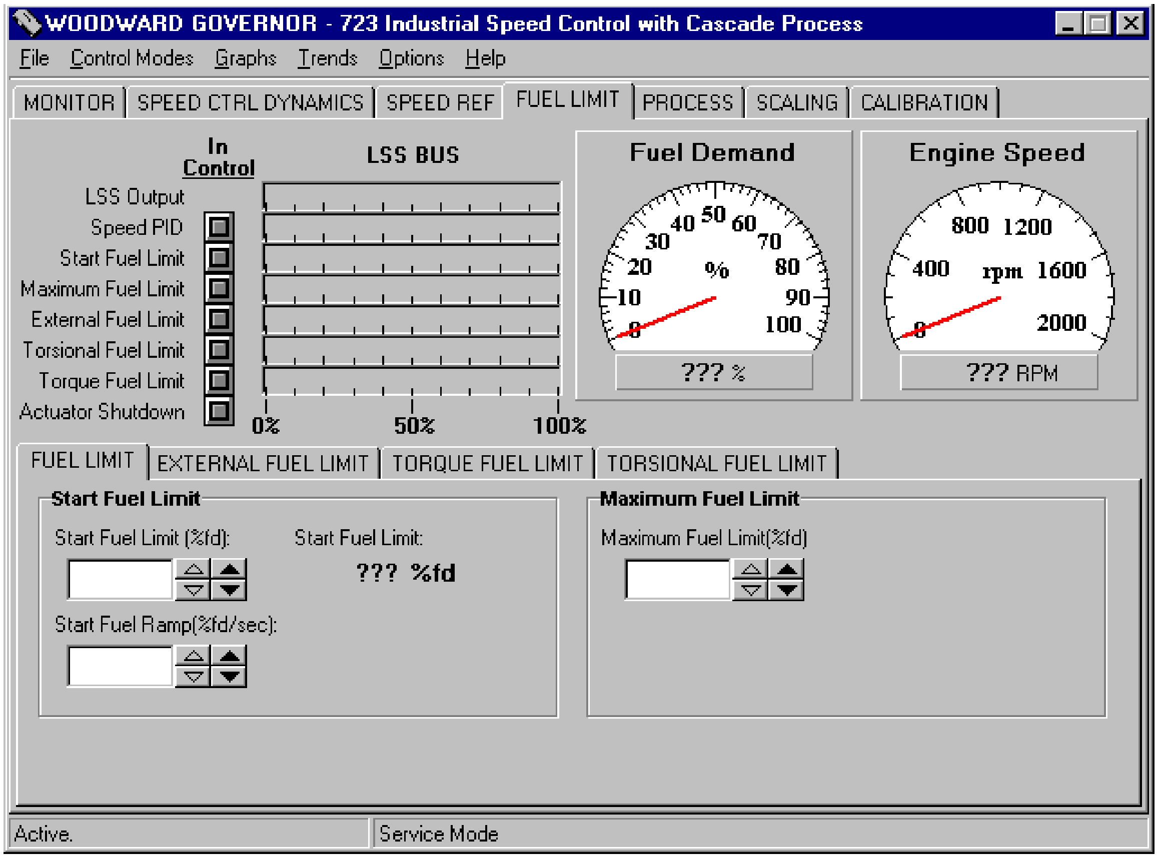


The Fuel Limiter screen, shown below, is typical of all screens except for the curve screens. You can see that the information is presented in various forms:

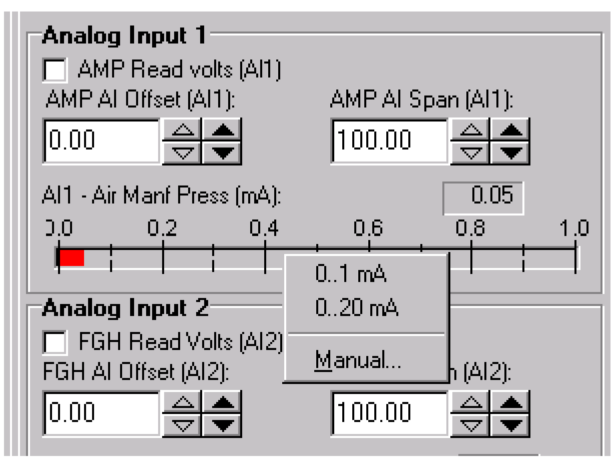
- Analog and digital displays of Engine Speed and Fuel Demand
- LED display of the Fuel Limiter in Control
- Bar graph display of all Fuel Limiters on the Fuel Demand LSS bus
- Sub-tabs for the Fuel Limiter Settings, External Fuel Limit Curve, Torque Limit Curve, and Torsional Limit Curve.

Two sets of raise/lower arrows accompany each tunable value. The hollow arrows produce “turtle” (slow) set point changes, and the solid arrows produce “rabbit” (fast) set point changes. Values may also be highlighted and typed in directly. This causes the raise/lower arrows to be replaced by an = sign. Typed values must be within 10% of the previous value to be accepted when in Service Mode. This rule does not apply when in Configuration Mode. Click the = sign or press the enter key to accept newly typed settings. All values in either mode must be within “max” and “min” limits fixed in the control software.

The following is the Fuel Limiter screen with the Fuel Limiter Settings sub-tab open.



Right clicking on a gauge panel will bring up a different quick menu.



This quick menu will appear when you right click on a gauge (or a group of gauges) that has a changeable range. There are always multiple quick options and a manual option. If the program is set to save settings on close, new gauge settings will automatically be saved when the program is closed.

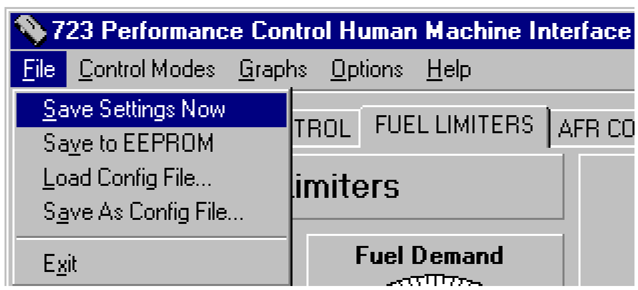
Saving Settings

The following shows how to set the program to save (or not save) gauge settings and screen position on close. Under the Options menu either check or uncheck Save Settings on Close for the desired action on close. This save option will only save screen position and gauge settings on close. To save all configuration and service tunables see File “Save to EEPROM” below.

The other Options are:

- Load Settings on Open automatically loads saved gauge settings on open.
- Reset to Default Settings will reset all the user options to their Default values.

Control and Program Settings can be saved in various ways at any time from the File menu.



Select File from the menu bar, for the following choices:

- Save Settings Now will save the programs screen position and gauge settings.
- Save to EEPROM will save all configuration and service tunables in the 723PLUS EEPROM.
- Load Config File will load settings from a saved Configuration File into the 723PLUS EEPROM, overwriting all previous values.
- Save As Config File will dump all settings from the 723PLUS controller EEPROM into a Configuration File.

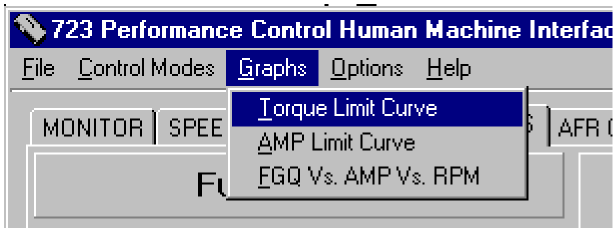
NOTICE

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.

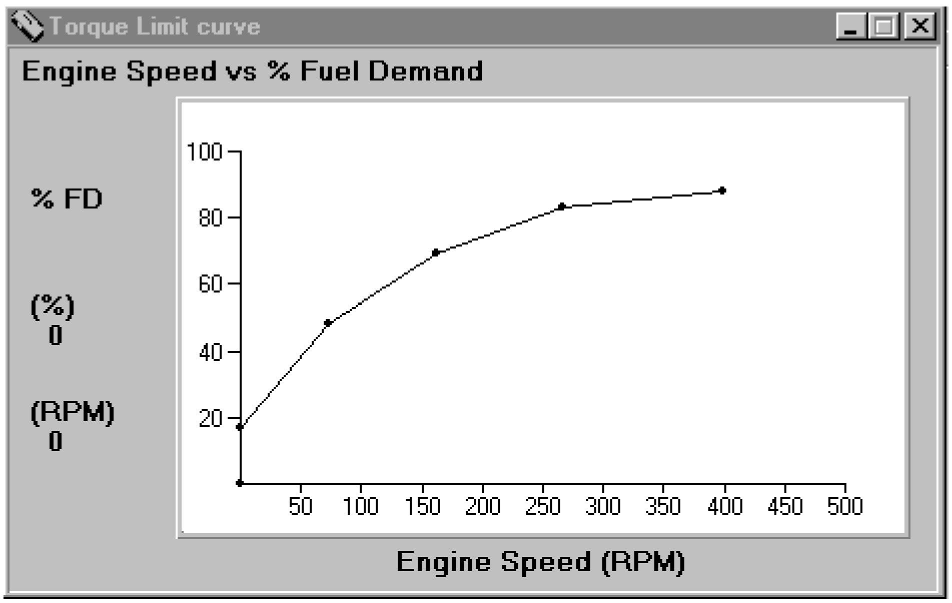
2D Curves

The 2D curve screens are unique. The Torque Limit Curve sub-screen with tabulated values and raise/lower arrows is shown on the Fuel Limiter screen. The following shows a different way of viewing and changing this same curve *as a graph* instead of as tabulated settings.

To view a curve, select Graphs from the menu bar, and a list of curves will pop-up. Click the desired curve.

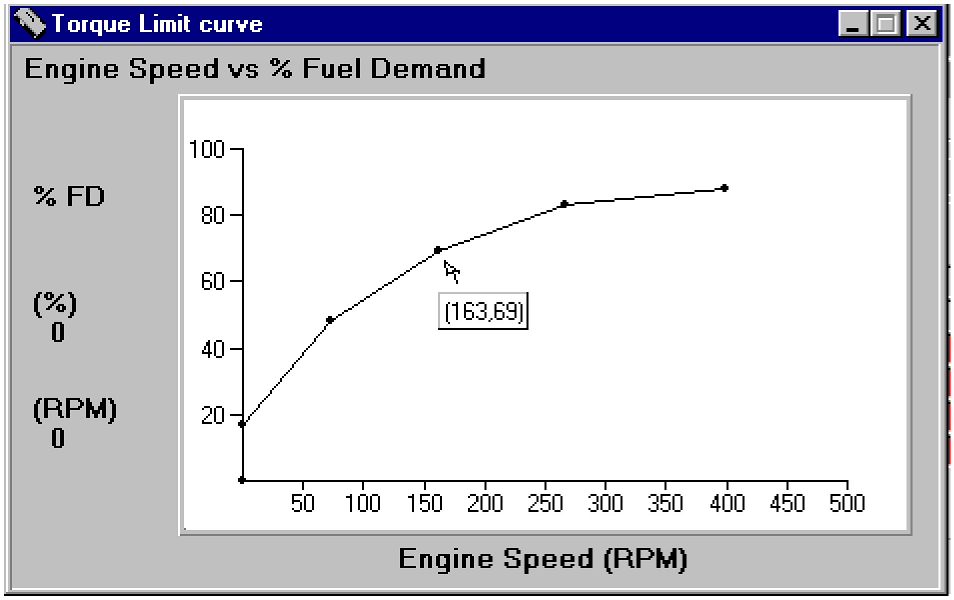


The following Torque Limit Curve screen, as well as screens for the other listed curves, are available for both viewing the curve graph and changing curve set points.

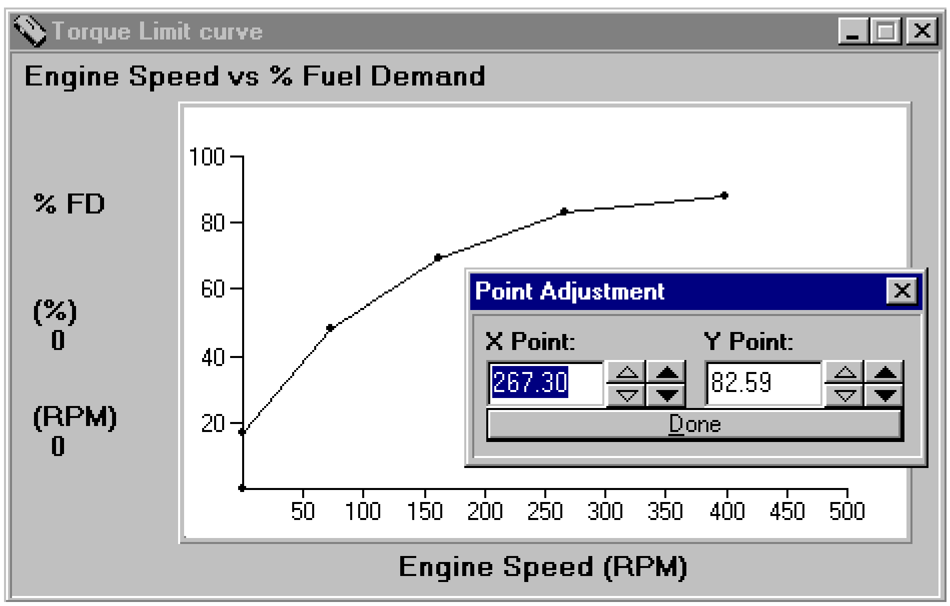


The above screen shows that the Torque Limit curve is a 2D curve with five breakpoints. It is set to limit torque by limiting maximum fuel demand at various engine speeds. A digital display of the current x (curve input) and y (curve output) values in engineering units is included. Y in this example is the fuel limit (as a % fuel demand) based on engine speed. X is engine speed.

Holding the cursor over a curve breakpoint will display the coordinates, in (x,y) format, for that specific point as shown below.

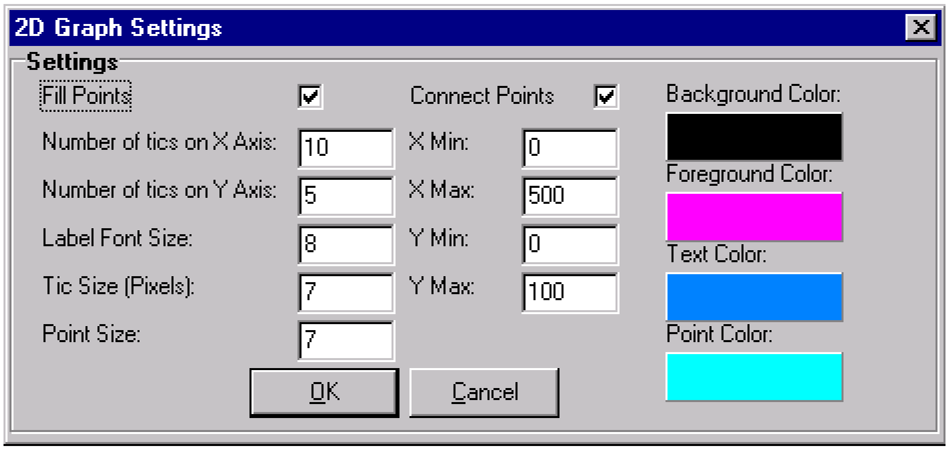


Right clicking on a breakpoint and selecting “properties” will pop-up a “Point Adjustment” window for that point as shown below.

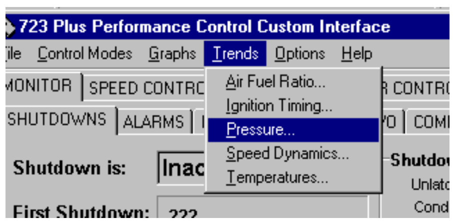


Adjustments to both the x and y breakpoint values can be made, as described earlier, by using the “turtle” and “rabbit” arrows or by typing in values and pressing the = key for the selected point. All breakpoints of all curves can be adjusted in this manner from the curve graph screens.

The setup dialog for a 2D graph axes and colors is shown below.

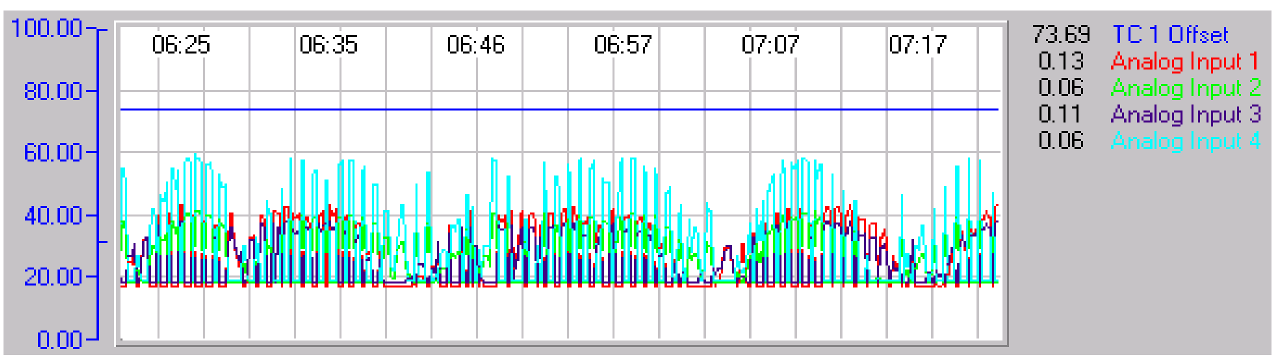


Trends



Purpose: The purpose of a Trend Graph is to provide a visual relational representation of data as it changes over time. This is especially useful when tuning an engine and when different fluctuations need to be seen and dealt with analytically.

Here is an example showing some analog inputs as well as a static value:

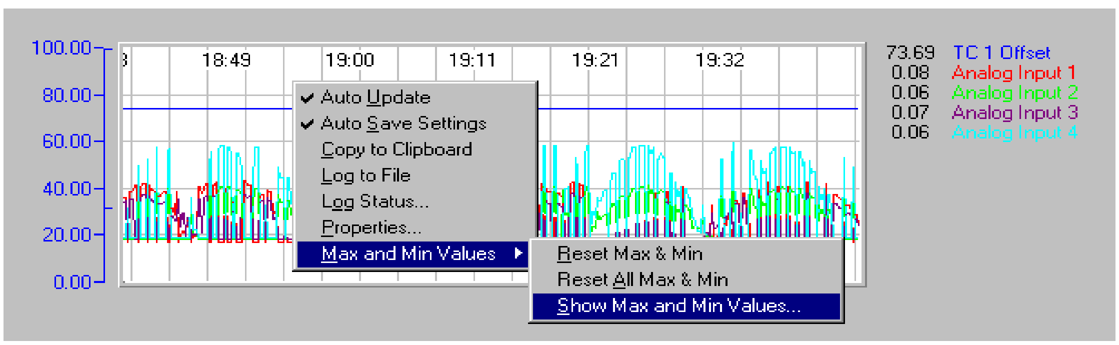


The Available Trends are listed below, with the items they contain:

Speed Dynamics
- Engine Speed (rpm)
- Speed Reference (rpm)
- Droop Bias (rpm)
- %Fuel Demand

Process
- Process Differential (EU)
- Process Input #1 (EU)
- Process Input #2 (EU)
- Process Reference (EU)
- Process Variable

How To Read and Use a Trend Graph
There are two features directly accessible on the Trend Graph
By right clicking anywhere on the graph a Quick Menu with different options will appear.
By left clicking on the description of a Trend Pen (e.g. "Engine Speed (rpm)") its axis will be shown on the left. Individual axes are available because different values need to be graphed on different ranges.



The axis provides another piece of information, the maximum and minimum value of its respective pen. This is indicated by two tick marks on the right side of the axis. When the program is first started, it initializes the values to 0, so it might be necessary to reset the Max and Min values once the program is running. This is accomplished by right clicking on the graph and selecting *Max and Min Values* and then selecting *Reset All Max and Min*.

Auto Update: Will pause and unpause the graph motion, as well as pause and unpause logging.

Auto Save Settings: If checked this will automatically save all settings as they are changed.

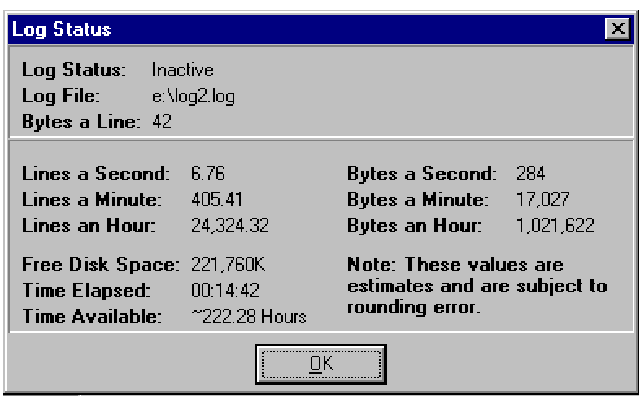
Copy to Clipboard: Copies the whole graph (axis, graph window, descriptions, and values) to the clipboard so that it can be pasted into any other Windows application capable of receiving a bitmap from the clipboard.

Log to File: Clicking on this will either enable or disable logging. Note that if no log file is specified, trying to start logging has no effect. This feature is provided if a history is needed. Data is logged on every update interval to a standard tab delimited ASCII text file. The log file can be changed in the trend configuration dialog. Note that if the log file exists it is automatically appended to (data is only added to the end). If you wish to start with a fresh log, put in a file name that does not exist, and it will be automatically created when logging is started.

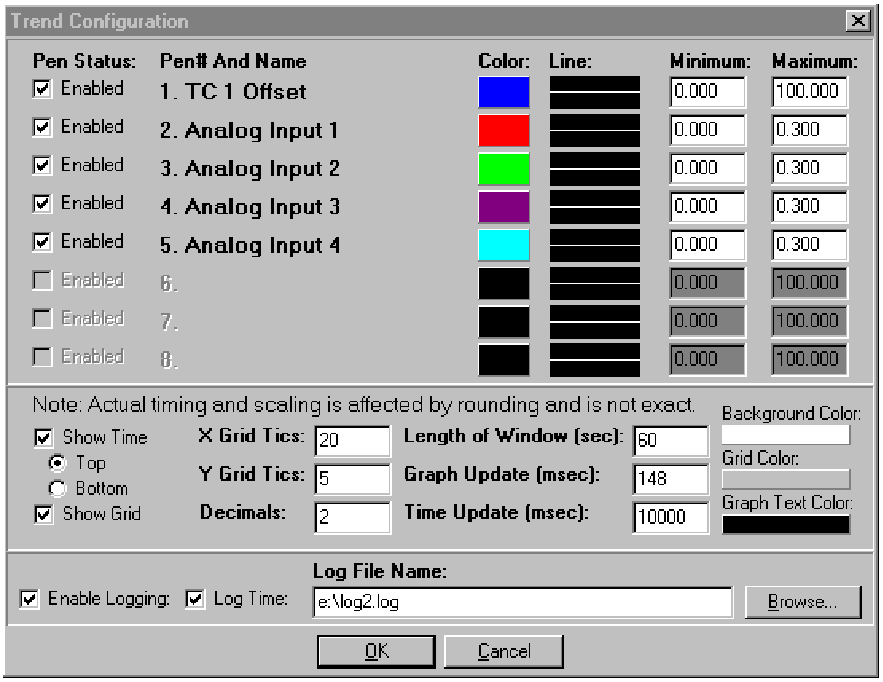
Here is a short sample of a log generated from the above trend. This sample covers almost three seconds of time.

```
Log Creation Time: 2:56:31 PM on 7/31/98.
Time TC 1      Analog  Analog  Analog  Analog
    Offset     Input 1 Input 2 Input 3 Input 4
00:22:36.110   72.23   0.05    0.12    0.05    0.17
00:22:36.120   72.23   0.05    0.12    0.05    0.17
00:22:36.270   72.23   0.11    0.06    0.10    0.06
00:22:36.421   72.23   0.11    0.06    0.10    0.06
00:22:36.571   72.23   0.05    0.12    0.05    0.17
00:22:36.721   72.23   0.05    0.12    0.05    0.17
00:22:36.871   72.23   0.05    0.12    0.05    0.17
00:22:37.21    72.23   0.05    0.12    0.10    0.06
00:22:37.172   72.23   0.12    0.06    0.11    0.06
00:22:37.322   72.23   0.05    0.12    0.05    0.16
00:22:37.472   72.23   0.05    0.12    0.05    0.16
00:22:37.622   72.23   0.05    0.12    0.05    0.16
00:22:37.772   72.23   0.05    0.12    0.05    0.16
00:22:37.923   72.23   0.10    0.06    0.05    0.16
00:22:38.73    72.23   0.10    0.06    0.05    0.16
00:22:38.223   72.23   0.12    0.06    0.11    0.06
00:22:38.373   72.23   0.12    0.06    0.05    0.15
00:22:38.524   72.23   0.13    0.06    0.11    0.06
00:22:38.674   72.23   0.12    0.06    0.11    0.06
00:22:38.824   72.23   0.12    0.06    0.11    0.06
00:22:38.974   72.23   0.13    0.06    0.11    0.06
```

Log Status: This will show a dialog with estimated data rate values indicating how much physical data is being logged per second, per minute, and per hour. This is useful if you wish to have a log file kept for a longer period of time and want to make sure that you won't run out of disk space. The estimate is based on every value being written at its Maximum Axis Value. In most cases the actual data rate should be less. If logging the time is enabled, then every time stamp is evaluated as having three decimal places for estimation purposes.



Properties: Will display this dialog.



Pen X Enabled: Enables or disables graph of data for that pen. This is useful if pens are overlapping or only certain values need to be monitored or logged.

Pen X Color: Change the color of the trace of the pen. Useful for maintaining contrast.

Pen X Line Style: Is also useful for maintaining contrast. However, if the update time and graph length are such that each update only moves the graph a couple of pixels, the line style appears not to have an effect. This is because each segment drawn is not long enough to show a complete cycle in the line style.

Pen X Minimum: This value is used in conjunction with Pen X Maximum.

Pen X Maximum: These values are used to scale the data in the graph window. Change these values to zoom in or out on a particular region for a given Pen.

Show Time (Top/Bottom): This option toggles if the time passed is written to the graph window, as well as if it is written to the top or bottom of the graph.

Show Grid: Toggles if the grid is drawn or not.

X Grid Tics: This Controls How many lines are drawn parallel to the Y Axis. Note that this value is not exact, but more a value used to generate the grid density. The best way to understand it is to change it to high and low values and see what happens.

Y Grid Tics: This controls how many lines are drawn parallel to the X Axis (Time Line), as well as how many tick marks are placed on the Y Axis.

Decimals: Controls how many decimal places are shown for all data displayed on the graph. This is also used to control how many decimals places are used when data is written to a log file.

Length of Window (sec): Approximate time that it takes a given point to go from the far right side of the graph to the left side.

Graph Update (msec): How often the graph is redrawn. Note that if this value is set too small (such that the graph will not be moved at least one pixel per update), it is automatically set so that the graph will move one pixel per update. This also controls how often data is written to a log file if logging is enabled.

Time Update (msec): Controls how often the time stamp is placed on the graph.

Background Color: Allows the background of the graph window to be changed. Useful for showing contrast.

Grid Color: Changes the grid color if the grid is displayed.

Graph Text Color: Changes the color of the text for the time when it is written to the graph window, if show time is enabled.

Enable Logging: Enables or disables logging.

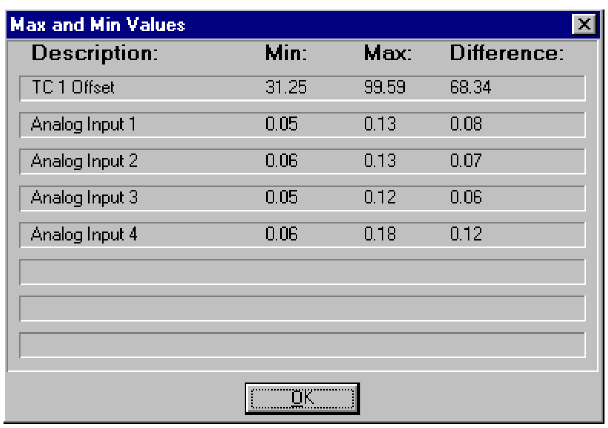
Log Time: Toggles whether or not the time stamp is placed with every data set in the log file. If a simple relational log is needed, it is not useful to log the time. However if you need to generate a scatter plot or perform more complex data analysis, a time stamp is necessary.

Log File Name: The path and filename of the log file.

Max and Min Values
Reset Max & Min: Will reset the Max and Min values for the current axis to the current value.

Reset All Max & Min: Will reset Max and Min values for all of the pens.

Show Max & Min: Will bring up a dialog displaying the Max, Min, and the difference in a numerical format.



Description:	Min:	Max:	Difference:
TC 1 Offset	31.25	99.59	68.34
Analog Input 1	0.05	0.13	0.08
Analog Input 2	0.06	0.13	0.07
Analog Input 3	0.05	0.12	0.06
Analog Input 4	0.06	0.18	0.12

On-Line Help
Extensive on-line Help is available. The above instructions are given as an overview only and are not intended to supplant the normal use of the on-line Help. On-line Help is interactive. Just click the Topic to open that Help page and disclose links to related Help Topics.

The Following is the On-line Help Table of Contents (without graphics):

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 serial 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.

The programmer does a power-up self-test whenever it is plugged into the control. When the self-test is complete, the screen will display two lines of information pertaining to 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 (write this information in the Programming Checklist, Appendix D).

The programmer screen is a four-line, backlighted LCD display. The display permits 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. The BKSP and SPACE keys will 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 may be entered only if the I/O is shut down (the engine is stopped).

Configure Menus

To access the Configure menus, the engine must be shutdown. Press the . key. The display will show, 'To select configure, press enter'. Press the ENTER key and the display will show, 'To shutdown I/O, press enter'. Press the ENTER key and this will allow you into the Configure menus. Note: If the engine is running during this process, it will be shutdown due to shutting down the I/O of the control. To move between the menus use the “Right Arrow” and “Left Arrow” keys. To move through the set points within a menu, use the “UP Arrow” and “Down Arrow” keys. Once within a menu, to return to the menu header, press the ESC key.

To leave the Configure menus press the ESC key. The set points will be automatically saved when leaving Configure.

Service Menus

To access the Service menus press the “Down Arrow” key. To move between menus, and to move through set points within menus follow the instructions as for the Configure menus. To return to the menu header, or to leave Service, press the ESC key.

Adjusting Set Points

To adjust a set point, use the “Turtle Up” or the “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 will make 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 in CONFIGURE MODE. This may also be done in SERVICE MODE only when the figure is within 10% of the existing value.

To save set points at any time, use the SAVE key. This will transfer all new set point values into the EEPROM memory. The EEPROM retains all set points when power is removed from the control.

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.

Hand Held Programmer Keys

The programmer keys do the following functions (see Figure 4-1):

(left arrow)	Moves backward through Configure or Service, one menu at a time.
(right arrow)	Advances through Configure or Service, one menu at a time.
(up/down arrow)	Toggles between the two displayed items.
(up arrow)	Moves backward through each menu, one step at a time.
(down arrow)	Advances through each menu, one step at a time. Selects Service from Main Screen.
(turtle up)	Increases the displayed set point value slowly.
(turtle down)	Decreases the displayed set point value slowly.
(rabbit up)	Increases the displayed set point value quickly (about 10 times faster than the turtle keys).
(rabbit down)	Decreases the displayed set point value quickly (about 10 times faster than the turtle keys).
+ (plus)	Increases set point values by one step at a time.
– (minus)	Decreases set point values by one step at a time. Also used for entering negative exact values.
(solid square)	Not used.
ID	Displays the 723PLUS control part number and software revision level (can only be accessed from the TOP main screen).
ESC	To return to menu header or to main screen, or to exit Configure and save set points.
SAVE	Saves entered values (set points).
BKSP	Scrolls left through line of display.
SPACE	Scrolls right through line of display.
ENTER	Used when entering exact values and accessing Configure.
= (equals)	For entering exact values (within 10%).
(decimal)	To select Configure. Also used for entering decimal exact values.

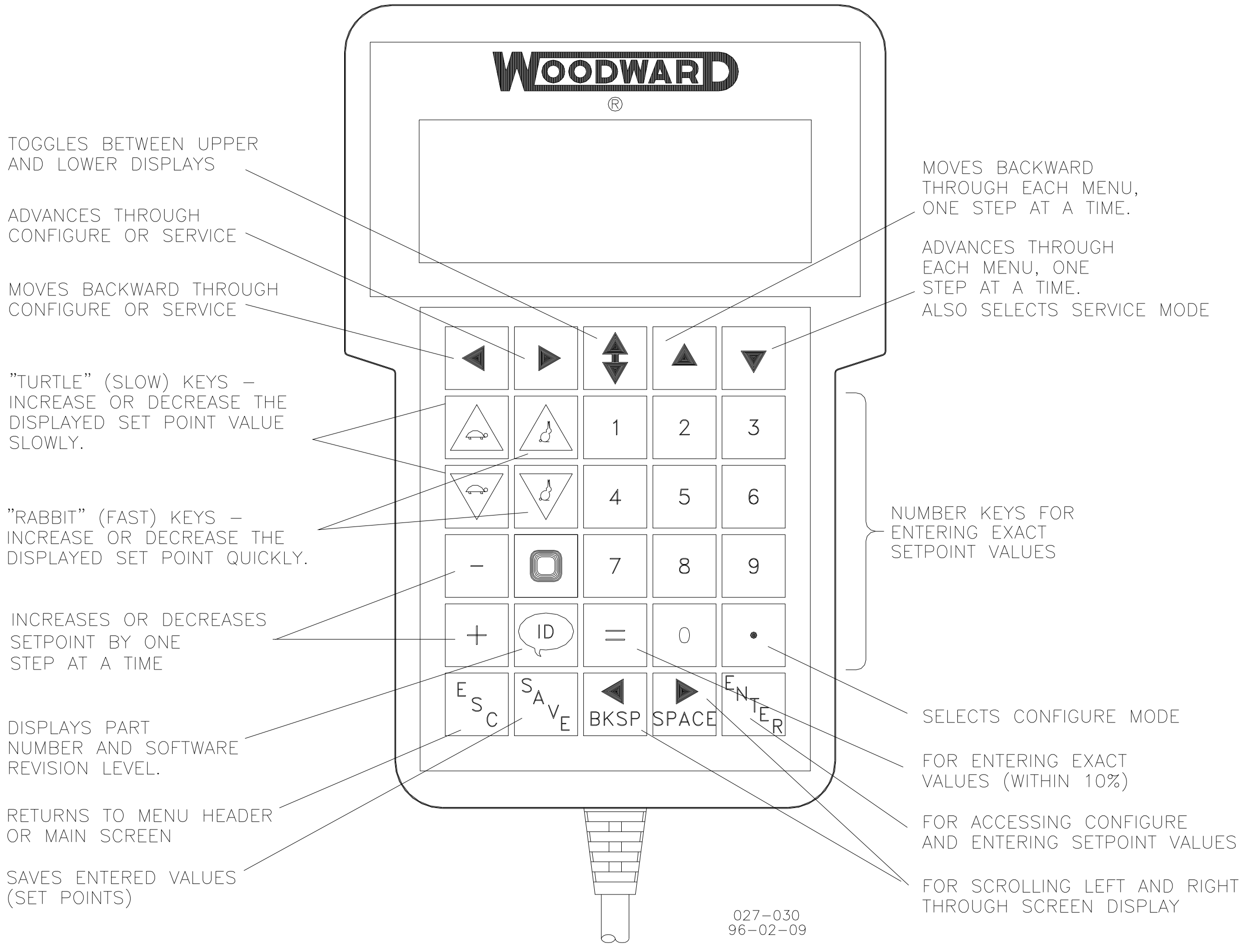


Figure 4-1. Hand Held Programmer Functions

Configuration Menu Descriptions

CFIG Options

1. **USE REVERSE ACTING** should be set to TRUE for reverse acting actuators and FALSE for forward acting actuators (default is FALSE). Forward-acting actuators require increased current to increase fuel. Reverse-acting actuators require decreased current to increase fuel (reverse-acting actuators should always incorporate a mechanical ballhead backup governor, such as the Woodward EGB).

2. **USE 2nd DYNAMICS** should be set TRUE to bring into view the 2nd SPEED DYNAMICS menu when the 2nd Dynamics discrete input is TRUE and permit the use of the 2nd Dynamics function. Set to FALSE to disable the 2nd Dynamics function and conceal the 2nd SPEED DYNAMICS menu.

3. **USE 5-GAIN MAP** should be set TRUE to bring into view the 1st DYNAMICS- 5 GAIN menu and permit the use of a 5-Gain Curve for setting the control gain as a function of fuel demand. If Use 2nd Dynamics is also set TRUE, the 2nd DYNAMICS- 5 GAIN menu will appear when the 2nd Dynamics discrete input is TRUE and permit the use of a second 5-Gain Curve. These two curves each provide 5 tunable gain settings at 5 tunable fuel demand breakpoints. When USE CONST DYNAMICS is also set FALSE, the 5-gain curve settings are varied by the ratio of actual engine speed to rated speed (e.g., at 50% speed the gain setting is also reduced by 50%). Set to FALSE to disable the 5-gain curve function and conceal the DYNAMICS- 5 GAIN menus.

4. **USE CONST DYNAMICS** should be set to TRUE to enable constant dynamics. Set to FALSE to allow variable dynamics which will vary the speed control gain setting by the ratio of actual engine speed to rated speed and the reset setting by the ratio of rated speed to actual engine speed.

5. **USE EXT FUEL LIMIT** should be set to TRUE to bring into view the EXT FUEL LIMIT CURVE menu and permit the use of the External Fuel Limit. The External Fuel Limit function provides five tunable limits of the fuel demand at five tunable external input breakpoints. Normally an air manifold pressure transmitter is used as the Ext Fuel Limit input device. Set to FALSE to disable the Ext Fuel Limit function and conceal the EXT FUEL LIMIT CURVE menu.

6. **USE COMM PORTS** should be set to TRUE to bring into view the configuration and service menus for Communication Ports 2 and 3. Set to FALSE to conceal the Communication Ports 2 and 3 configuration and service menus.

7. **USE REMOTE COMMANDS** is set to FALSE to block remote Modbus Boolean and Analog write commands and enable the discrete and analog hardware input commands. Set to TRUE to enable Modbus Boolean and Analog write commands. Modbus Boolean writes can also be used to enable specific hardware input commands instead of the Modbus commands.

8. **REMOTE LOCK IN LAST** is used to hold the last speed reference before failure when the Remote Speed or Process Reference inputs fail. Set to FALSE to disable REMOTE LOCK IN LAST. Set to TRUE to enable REMOTE LOCK IN LAST.

9. **RESET ALM ON CLEAR** is set to TRUE to issue an alarm reset whenever engine speed reaches 5% of rated speed during starting. Set to FALSE to block this alarm reset function. A FALSE setting does not block other types of alarm resets.

10. **FORCE DISCRETE OUTPUTS** should be set to TRUE to enable manual control of the discrete outputs and disable automatic control. Set to FALSE to disable manual control and enable automatic control (default is FALSE).

11. **USE TORQUE LIMIT** should be set to TRUE to bring into view the TORQUE LIMIT CURVE menu and permit the use of the Torque Fuel Limit. The Torque Fuel Limit function provides five tunable limits of the fuel demand at five tunable engine speed breakpoints. Set to FALSE to disable the Torque Limit function and conceal the TORQUE LIMIT CURVE menu.

12. **PROCESS CTRL OPTION** is used to set the Process Control mode according to the following selections:

    0 = Process Control disabled. DB PROCESS CONTROL and CASCADE PROC CTRL menus are concealed.

    1 = Process Control uses the Process Input #2 as the process reference and Process Input #1 as the process variable. Control will adjust engine speed until Process Input #1 equals the Process Input #2 process reference. Process control is disabled if Process Input #1 fails. Process reference will follow a failed or out of range Process Input #2 *unless* Remote Lock in Last is set TRUE in the CFIG Speed Control menu.

    2= Process Control uses the Remote Speed Input as the process reference and Process Input #1 as the process variable. Control will adjust engine speed until Process Input #1 equals the Remote Speed Input process reference. Process control is disabled if Process Input #1 fails. Process reference will follow a failed or out of range Remote Speed Input *unless* Remote Lock in Last is set TRUE in the CFIG Speed Control menu.

    3 = Differential Process Speed Control uses the Remote Speed Input as the process reference and Process Input #1 minus Process Input #2 differential as the process variable. Control will adjust engine speed until Process differential equals the Remote Speed Input process reference. Process control is disabled if Process Input #1 or Process Input #2 signal fails. Process reference will follow a failed or out of range Remote Speed Input *unless* Remote Lock in Last is set TRUE in the CFIG Speed Control menu.

13. **USE CASCADE PROCESS** should be set to TRUE to enable Cascade Process control and service menu. Set to FALSE to disable Cascade Process control and service menu and enable Deadband Process control and service menu. Use PROCESS CTRL OPTION menu to disable both Process control modes.

14. **PROCESS REV ACTING** is used for the Deadband Process Control only and should be set to FALSE if Process or Process Differential input values above the Process Reference must produce a decreased speed in order to reestablish the process variable at the Process Reference. Set to TRUE if Process or Process Differential input values above the Process Reference must produce an increased speed in order to reestablish the process variable at the Process Reference.

IMPORTANT

To reverse the action of the Cascade PID Process control, set the Spd Ref @ 0% PID value ABOVE the Spd Ref @ 100% PID value on the Cascade Proc Ctrl menu.

15. **USE TORSION FILTER** should be set to TRUE to bring into view the TORSIONAL FILTER menu and permit the use of the Flexible Coupling Torsional Filter or the Notch Filter function. Set to FALSE to disable these functions and conceal the TORSIONAL FILTER menu.

16. **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.

17. **ENABLE TORS LIMITER** should be set to TRUE to enable a tunable Torsional Fuel Limiter. Set FALSE to disable this Fuel Limiter.

18. **USE START SPEED** should be set to TRUE to enable a tunable Start Speed Reference. Set to FALSE to disable the Start Speed Reference.

CFIG Speed Control

1. **RATED SPEED** sets the rated engine speed in rpm. Refer to the engine nameplate for the engine speed rating. This sets the rated speed reference selected when the idle/rated input switch is closed. This setting is used to scale several internal control functions.

2. **ASPD #1 TEETH** is the number of teeth or holes in the gear or flywheel that speed sensor #1 is on. If the gear is running at camshaft speed (one-half engine speed), you must enter one-half the number of teeth on the gear. The control requires the number of teeth per engine revolution. If a flexible coupling is being used, ASPD #1 must be on the engine side of the coupling.

IMPORTANT **Always set ASPD #1 TEETH the same as DSPD #1 TEETH.**

3. **ASPD # 1 MAX FREQ** is used to set the range that the frequency-to-digital converter can sense. It should be set to the maximum running frequency multiplied by 1.2. To get operating frequency: Hz = #Teeth * rpm/60.

4. **ASPD #2 TEETH** is the number of teeth or holes in the gear or flywheel that speed sensor #2 is on. If the gear is running at camshaft speed (one-half engine speed), you must enter one-half the number of teeth on the gear. The control requires the number of teeth per engine revolution. If a flexible coupling is being used, ASPD #2 must be on the load side of the coupling.

IMPORTANT **Always set ASPD #2 TEETH the same as DSPD #2 TEETH.**

5. **ASPD # 2 MAX FREQ** is used to set the range that the frequency-to-digital converter can sense. It should be set to the maximum running frequency multiplied by 1.2. To get operating frequency: Hz = #Teeth * rpm/60.

IMPORTANT **Better control performance will be obtained when sensing speed from a gear rotating at full engine speed. Slower-speed gears (such as the camshaft) provide a lower sampling rate which increases control-loop response time and degrades performance.**

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.**

6. **DSPD #1 TEETH** is the number of teeth or holes in the gear or flywheel that speed sensor #1 is on. If the gear is running at camshaft speed (one-half engine speed) then you must enter one-half the number of teeth on the gear. The control requires the number of teeth per engine revolution. If a flexible coupling is being used, DSPD #1 must be on the engine side of the coupling.

> **IMPORTANT** — **Always set DSPD #1 TEETH the same as ASPD #1 TEETH above.**

7. **DSPD #2 TEETH** is the number of teeth or holes in the gear or flywheel that speed sensor #2 is on. If the gear is running at camshaft speed (one-half engine speed) then you must enter one-half the number of teeth on the gear. The control requires the number of teeth per engine revolution. If a flexible coupling is being used, DSPD #2 must be on the load side of the coupling.

> **IMPORTANT** — **Always set DSPD #2 TEETH the same as ASPD #2 TEETH above.**

8. **USE DIG SPD SENSOR** is set TRUE to use digital processing of the speed sensor input. Set to FALSE to disable digital processing and use Analog processing of the speed sensor input.

> **IMPORTANT** — **Better control performance will be obtained when sensing speed from a gear rotating at full engine speed. Slower-speed gears (such as the camshaft) provide a lower sampling rate which increases control-loop response time and degrades performance.**

> **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.**

9. **SS CLEAR PERCENTAGE** should be set to a percentage of rated engine speed that will verify a valid MPU signal exists while the engine is cranking (default is 5% of rated).

10. **FORCE TO IDLE** is set TRUE to make the Idle/Rated switch active for selecting Idle and Rated regardless of control mode (e.g., remote or process modes). Set to FALSE to inhibit the ramp to Rated when the Idle/Rated input switch contact is closed, but instead ramp from Idle to either the Remote or Process reference (whichever is enabled). Also, setting to FALSE inhibits the ramp to Idle when the input switch contact is opened and either the Remote or Process mode is active and in control, until these become inactive.

11. **MPU ALARM ARM TIME (SEC)** is the time delay to wait before latching armed the MPU Failure Alarm & Shutdown functions once a valid MPU signal is detected. Opening the “Close to Run” contact resets the latch block to prevent MPU Failure Alarm and Shutdown conditions from occurring with normal stops.

12. **AI ALARM ARM TIME (SEC)** is the time delay to wait, once the engine is running, before making active all configured low process alarm and shutdown functions.

CFIG Shutdown/Alarms

1. **SPEED #1 FAIL** sets the condition which will occur when a loss of the speed sensor #1 input signal has been detected. This condition may be enabled as a Shutdown, Alarm, or both, by selecting TRUE in the appropriate menu. This condition is disarmed when the Run/Stop discrete input is used to stop the engine.

2. **SPEED #2 FAIL** sets the condition which will occur when a loss of the speed sensor #2 input signal has been detected. This condition may be enabled as a Shutdown, Alarm, or both, by selecting TRUE in the appropriate menu. This condition is disarmed when the Run/Stop discrete input is used to stop the engine.

3. **SPEED #1 AND #2 FAIL** sets the condition which will occur when a loss of both speed sensor #1 and #2 input signals has been detected. This condition may be enabled as a Shutdown, Alarm, or both, by selecting TRUE in the appropriate menu. This condition is disarmed when the Run/Stop discrete input is used to stop the engine.

4. **PROCESS #1 IN FAIL** sets the condition which will occur when the PROCESS #1 input drops below 2 mA or increases above 21 mA. This condition may be enabled as a Shutdown, Alarm, or both, by selecting TRUE in the appropriate menu.

5. **PROCESS #2 IN FAIL** sets the condition which will occur when the PROCESS #2 input drops below 2 mA or increases above 21 mA. This condition may be enabled as a Shutdown, Alarm, or both, by selecting TRUE in the appropriate menu.

6. **REM INPUT FAIL** sets the condition which will occur when the Remote Speed Setting input drops below 2 mA or increases above 21 mA. This condition may be enabled as a Shutdown, Alarm, or both, by selecting TRUE in the appropriate menu.

7. **EXT FUEL LIMIT FAIL** sets the condition which will occur when the External Fuel Limit input drops below 2 mA or increases above 21 mA. This condition may be enabled as a Shutdown, Alarm, or both, by selecting TRUE in the appropriate menu.

8. **MODBUS PORT3 FAIL** sets the condition which will occur when a Port 3 Link Error occurs. This condition may be enabled as a Shutdown, Alarm, or both, by selecting TRUE in the appropriate menu.

9. **HIGH FUEL DEMND LEVEL** sets the condition which will occur when the fuel demand rises above the HIGH ACTUATOR LEVEL. This condition may be enabled as a Shutdown, Alarm,, or both, by selecting TRUE in the appropriate menu.

10. **HIGH SPEED LEVEL** sets the condition which will occur when the engine speed rises above the HI SPEED SETPOINT. This condition may be enabled as a Shutdown, Alarm, or both, by selecting TRUE in the appropriate menu.

11 **HI TORSIONAL LEVEL** sets the condition which will occur when the TORSION LEVEL SETPT has been exceeded. This condition may be enabled as a Shutdown, Alarm, or both, by selecting TRUE in the appropriate menu.

12. **PROCESS #1 HIGH** sets the condition which will occur when the PROCESS #1 input exceeds the PROCESS 1 HI LEVEL set point for the PROCESS 1 DELAY time. This condition may be enabled as a Shutdown, Alarm, or both, by selecting TRUE in the appropriate menu.

13. **PROCESS #1 LOW** sets the condition which will occur when the PROCESS #1 input drops below the PROCESS 1 LOW LEVEL set point for the PROCESS 1 DELAY time. This condition may be enabled as a Shutdown, Alarm, or both, by selecting TRUE in the appropriate menu.

14. **PROCESS #2 HIGH** sets the condition which will occur when the PROCESS #2 input exceeds the PROCESS 2 HI LEVEL set point for the PROCESS 2 DELAY time. This condition may be enabled as a Shutdown, Alarm, or both, by selecting TRUE in the appropriate menu

15. **PROCESS #2 LOW** sets the condition which will occur when the PROCESS #2 input drops below the PROCESS 2 LOW LEVEL set point for the PROCESS 2 DELAY time. This condition may be enabled as a Shutdown, Alarm, or both, by selecting TRUE in the appropriate menu.

16. **PROCESS DIFF HIGH** sets the condition which will occur when the PROCESS #1 minus PROCESS #2 differential exceeds the PROCESS DIFF HI LEVEL set point for the PROCESS DIFF DELAY time. This condition may be enabled as a Shutdown, Alarm, or both, by selecting TRUE in the appropriate menu.

17. **PROCESS DIFF LO** sets the condition which will occur when the PROCESS #1 minus PROCESS #2 differential falls below the PROCESS DIFF LO LEVEL set point for the PROCESS DIFF DELAY time. This condition may be enabled as a Shutdown, Alarm, or both, by selecting TRUE in the appropriate menu.

CFIG Indication

1. **ON START FUEL LIMIT** is set to TRUE to actuate Relay Output #3 when this fuel limit is in control and to display status on the DISPLAY INDICATOR menu. Set to FALSE to prevent Relay Output #3 actuation and display of limit status.

2. **ON MAX LIMIT** is set to TRUE to actuate Relay Output #3 when this fuel limit is in control and to display status on the DISPLAY INDICATOR menu. Set to FALSE to prevent Relay Output #3 actuation and display of limit status.

3. **ON EXT FUEL LIMIT** is set to TRUE to actuate Relay Output #3 when this fuel limit is in control and to display status on the DISPLAY INDICATOR menu. Set to FALSE to prevent Relay Output #3 actuation and display of limit status.

4. **ON TORSION LIMIT** is set to TRUE to actuate Relay Output #3 when this fuel limit is in control and to display status on the DISPLAY INDICATOR menu. Set to FALSE to prevent Relay Output #3 actuation and display of limit status.

5. **ON TORQUE LIMIT** is set to TRUE to actuate Relay Output #3 when this fuel limit is in control and to display status on the DISPLAY INDICATOR menu. Set to FALSE to prevent Relay Output #3 actuation and display of limit state.

6. **ACT SHUTDOWN** is set to TRUE to actuate Relay Output #3 when this fuel limit is in control and to display status on the DISPLAY INDICATOR menu. Set to FALSE to prevent Relay Output #3 actuation and display of limit state.

7. **SPEED SWITCH 1** is set to TRUE to actuate Relay Output #3 when this speed switch is triggered and display status on the DISPLAY INDICATOR menu. Set to FALSE to prevent Relay Output #3 actuation and display of speed switch state.

8. **SPEED SWITCH 2** is set to TRUE to actuate Relay Output #3 when this speed switch is triggered and display status on the DISPLAY INDICATOR menu. Set to FALSE to prevent Relay Output #3 actuation and display of speed switch state.

Shutdown Setup

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

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

3. **HI SPEED SETPOINT**—Enter the engine speed fault level (rpm) required to trigger the HI SPEED LEVEL shutdown.

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

5. **TORSION LEVEL SETPT**—Enter the engine torsional vibration fault level (%RPM) required to trigger the HI TORSIONAL LEVEL shutdown.

IMPORTANT	**The torsional vibration fault level is a percentage of the full scale torsional vibration which is scaled using TORS SCALE on the TORSIONAL FILTER service menu. 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 TORSION LEVEL SETPT of 50% rpm, a HI TORSIONAL LEVEL shutdown will be 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.**

6. **HI TORSION DELAY**—Enter the delay time in seconds that the torsional level is above the TORSION LEVEL SETPT before the HIGH TORSION LEVEL shutdown is activated.

7. **PROCESS 1 HI LEVEL**—Enter the Process 1 level (EU) required to trigger the PROCESS #1 HIGH shutdown.

8. **PROCESS 1 LOW LEVEL**—Enter the Process 1 level (EU) required to trigger the PROCESS #1 LOW shutdown.

9. **PROCESS 1 DELAY** is the delay time in seconds that the Process #1 level is above the PROCESS 1 HI LEVEL or below the PROCESS 1 LOW LEVEL set points before the PROCESS #1 HIGH and PROCESS #1 LOW shutdown conditions are activated.

10. **PROCESS 2 HI LEVEL**—Enter the Process 2 level (EU) required to trigger the PROCESS #2 HIGH shutdown.

11. **PROCESS 2 LOW LEVEL**—Enter the Process 2 level (EU) required to trigger the PROCESS #2 LOW shutdown.

12. **PROCESS 2 DELAY** is the delay time in seconds that the Process #2 level is above the PROCESS 2 HI LEVEL or below the PROCESS 2 LOW LEVEL set points before the PROCESS #2 HIGH and PROCESS #2 LOW shutdown conditions are activated.

13. **PROC DIFF HI LEVEL**—Enter the Process 1 minus Process 2 differential level (EU) required to trigger the PROCESS DIFF HIGH shutdown.

14. **PROC DIFF LO LEVEL**—Enter the Process 1 minus Process 2 differential level (EU) required to trigger the PROCESS DIFF LOW shutdown.

15. **PROCESS DIFF DELAY** is the delay time in seconds that the Process 1 minus Process 2 differential level is above the PROC DIFF HI LEVEL or below the PROC DIFF LO LEVEL set points before the PROCESS DIFF HIGH and PROCESS DIFF LOW shutdown conditions are activated.

16. **ENERGIZE FOR SHTDWN** is set to TRUE to energize Relay Output #1 with any configured shutdown condition. Set to FALSE to de-energize Relay Output #1 with any configured shutdown condition.

17. **SHUTDOWN ACT ON SD** is set to TRUE to shutdown the speed control fuel actuator with any shutdown condition. Set to FALSE to prevent shutdown of the speed control fuel actuator with any shutdown condition.

Alarm Setup

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

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

3. **HI SPEED SETPOINT**—Enter the engine speed fault level (rpm) required to trigger the HI SPEED LEVEL alarm.

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

5. **TORSION LEVEL SETPT**—Enter the engine torsional vibration fault level (%RPM) required to trigger the HI TORSIONAL LEVEL alarm.

IMPORTANT	**The torsional vibration fault level is a percentage of the full scale torsional vibration which is scaled using TORS SCALE on the TORSIONAL FILTER service menu. 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 TORSION LEVEL SETPT of 25% rpm, a HI TORSIONAL LEVEL alarm will be 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.**

6. **HI TORSION DELAY**—Enter the delay time in seconds that the torsional level is above the TORSION LEVEL SETPT before the HIGH TORSION LEVEL alarm is activated.

7. **PROCESS 1 HI LEVEL**—Enter the Process 1 level (EU) required to trigger the PROCESS #1 HIGH alarm.

8. **PROCESS 1 LOW LEVEL**—Enter the Process 1 level (EU) required to trigger the PROCESS #1 LOW alarm.

9. **PROCESS 1 DELAY** is the delay time in seconds that the process #1 level is above the PROCESS 1 HI LEVEL or below the PROCESS 1 LOW LEVEL set points before the PROCESS #1 HIGH and PROCESS #1 LOW alarm conditions are activated.

10. **PROCESS 2 HI LEVEL**—Enter the Process 2 level (EU) required to trigger the PROCESS #2 HIGH alarm.

11. **PROCESS 2 LOW LEVEL**—Enter the Process 2 level (EU) required to trigger the PROCESS #2 LOW alarm.

12. **PROCESS 2 DELAY** is the delay time in seconds that the process #2 level is above the PROCESS 2 HI LEVEL or below the PROCESS 2 LOW LEVEL set points before the PROCESS #2 HIGH and PROCESS #2 LOW alarm conditions are activated.

13. **PROC DIFF HI LEVEL**—Enter the Process 1 minus Process 2 differential level (EU) required to trigger the PROCESS DIFF HIGH alarm.

14. **PROC DIFF LO LEVEL**—Enter the Process 1 minus Process 2 differential level (EU) required to trigger the PROCESS DIFF LOW alarm.

15. **PROCESS DIFF DELAY** is the delay time in seconds that the Process 1 minus Process 2 differential level is above the PROC DIFF HI LEVEL or below the PROC DIFF LO LEVEL set points before the PROCESS DIFF HIGH and PROCESS DIFF LOW alarm conditions are activated.

16. **ENERGIZE FOR ALARM** is set to TRUE to energize Relay Output #2 with any configured alarm condition. Set to FALSE to de-energize Relay Output #2 with any configured alarm condition.

17. **SHUTDOWN ACT ON ALM** is set to TRUE to shutdown the speed control fuel actuator with any alarm condition. Set to FALSE to prevent shutdown of the speed control fuel actuator with any alarm condition.

Indication Setup

1. **SPD SWITCH 1 PICKUP**—Enter the engine speed level (rpm) required to trigger SPEED SWITCH 1 Indication (Modbus and Service Display).

2. **SPD SWITCH 1 DROPOUT**—Enter the engine speed level (rpm) required to clear SPEED SWITCH 1 Indication.

3. **SPD SWITCH 2 PICKUP**—Enter the engine speed level (rpm) required to trigger SPEED SWITCH 2 Indication (Modbus and Service Display).

4. **SPD SWITCH 2 DROPOUT**—Enter the engine speed level (rpm) required to clear SPEED SWITCH 2 Indication.

5. **ENRGIZE FOR INDICAT** is set to TRUE to energize Relay Output #3 with any configured indication condition. Set to FALSE to de-energize Relay Output #3 with any configured indication condition.

IMPORTANT

If PICKUP is less than DROPOUT, the switch will be on below the PICKUP setting, and off above the DROPOUT setting. If PICKUP is greater than DROPOUT, the switch will be on above the PICKUP setting, and off below the DROPOUT setting.

CFIG COMMUNICATION

The 723PLUS has two serial ports. Port 2 is configured as a Servlink port. Port 3 is configured to support the Modbus protocol. These ports are configured in this menu to set the network address that they will use and to set port 3 to use the Modbus ASCII or RTU mode. Only port 3 has monitoring information available that can be retrieved by a Modbus master device such as a PC-based Human Machine Interface (HMI). Port 3 allows commands to be sent from the Modbus master device to the control. (See the Modbus Register List, Appendix C, for the addresses.). USE COMM PORT found in menu CFIG OPTION must be set TRUE to bring this menu into view. This menu is concealed when USE COMM PORT is set FALSE.

1. **PORT 2 ADDRESS** determines the ports multidrop Servlink address from 1 to 15.

2. **PORT 3 ADDRESS** determines the ports multidrop Modbus address from 1 to 247.

3. **PORT3 MODE** determines if port J3 will use the Modbus ASCII or Modbus RTU mode:
   1 = ASCII
   2 = RTU

CFIG ANALOG OUTPUTS

This menu allows configuration of the four analog outputs. This configuration will determine which parameters are in control of the outputs. These menu items are also used along with the Hardware Jumper Configuration to determine the output current range.

1. **AOUT 1 SELECT** determines which parameter controls Analog Output #1. The parameters which can be selected are:
   1. Engine Speed
   2. Engine Speed Reference
   3. Fuel Demand
   4. Reverse Acting Fuel Demand
   5 Torsional Level
   6 Remote Speed Reference
   7. J3 Modbus Address 4:0002
   8. Process 1
   9 Process 2
   10. Process Differential

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

3. **AOUT 2 SELECT** determines which parameter controls Analog Output #2. The parameters which can be selected are:
   1. Engine Speed
   2. Engine Speed Reference
   3. Fuel Demand
   4. Reverse Acting Fuel Demand
   5 Torsional Level
   6 Remote Speed Reference
   7. J3 Modbus Address 4:0003
   8. Process 1
   9 Process 2
   10. Process Differential

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

5. **ACT OUT 1 4-20 mA** scales Analog Output #3 for 4 to 20 mA or 0 to 200 mA. A value of FALSE will scale the output for 0 to 200 mA. A value of TRUE will scale the output for 4 to 20 mA. Note that an internal jumper must be configured if this item is changed. Analog Output #3 is hard configured as the Speed Control Actuator output and does not offer an output configuration selection.

6. **ACT OUT 2 SELECT** determines which parameter controls Analog Output #4. The parameters which can be selected are:
   1. Engine Speed
   2. Engine Speed Reference
   3. Fuel Demand
   4. Reverse Acting Fuel Demand
   5 Torsional Level
   6 Remote Speed Reference
   7. J3 Modbus Address 4:0004
   8. Process 1
   9 Process 2
   10. Process Differential

7. **ACT OUT 2 4-20 mA** scales Analog Output #4 for 4 to 20 mA or 0 to 200 mA. A value of FALSE will scale the output for 0 to 200 mA. A value of TRUE will scale the output for 4 to 20 mA. Note that an internal jumper must be configured if this item is changed.

At this time, we recommend saving the settings by pressing the “SAVE” key on the Hand Held Programmer or save settings using Control View or Watch Window (Refer to “help” if you need help). The Programmer will display the message “Saving Changes”. Control View or Watch Window has a “Pop-Up” box that says the values have been saved.

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

Shutdown Menu

A shutdown condition must exist to bring into view the SHUTDOWN MENU. This menu displays configured shutdowns that have been triggered. A shutdown may be cleared, if the shutdown condition no longer exists, by activating the Alarm Reset (through the external discrete input, Modbus, Servlink, or the Hand Held Programmer).

1. **FIRST SHUTDOWN** displays the shutdown that occurred first. The number matches with the number of the shutdown in this menu.

2. **1-SPEED #1 FAIL** displays the present condition of the latched shutdown. This shutdown will only indicate if it has been activated in the CFIG SHUTDOWN menu.

3. **2-SPEED #2 FAIL** displays the present condition of the latched shutdown. This shutdown will only indicate if it has been activated in the CFIG SHUTDOWN menu.

4. **3-SPD #1 AND #2 FAIL** displays the present condition of the latched shutdown. This shutdown will only indicate if it has been activated in the CFIG SHUTDOWN menu.

5. **4-PROCESS #1 FAIL** displays the present condition of the latched shutdown. This shutdown will only indicate if it has been activated in the CFIG SHUTDOWN menu.

6. **5-PROCESS #2 FAIL** displays the present condition of the latched shutdown. This shutdown will only indicate if it has been activated in the CFIG SHUTDOWN menu.

7. **6-REMOTE INPUT FAIL** displays the present condition of the latched shutdown. This shutdown will only indicate if it has been activated in the CFIG SHUTDOWN menu.

8. **7-EXT FUEL LMT FAIL** displays the present condition of the latched shutdown. This shutdown will only indicate if it has been activated in the CFIG SHUTDOWN menu.

9. **8-MODBUS 3 FAIL** displays the present condition of the latched shutdown. This shutdown will only indicate if it has been activated in the CFIG SHUTDOWN menu.

10. **9-HI FUEL DEMAND** displays the present condition of the latched shutdown. This shutdown will only indicate if it has been activated in the CFIG SHUTDOWN menu.

11. **10-HI SPEED** displays the present condition of the latched shutdown. This shutdown will only indicate if it has been activated in the CFIG SHUTDOWN menu.

12. **11-HIGH TORSIONAL** displays the present condition of the latched shutdown. This shutdown will only indicate if it has been activated in the CFIG SHUTDOWN menu.

13. **12-PROCESS #1 HIGH** displays the present condition of the latched shutdown. This shutdown will only indicate if it has been activated in the CFIG SHUTDOWN menu.

14. **13-PROCESS #1 LOW** displays the present condition of the latched shutdown. This shutdown will only indicate if it has been activated in the CFIG SHUTDOWN menu.

15. **14-PROCESS #2 HIGH** displays the present condition of the latched shutdown. This shutdown will only indicate if it has been activated in the CFIG SHUTDOWN menu.

16. **15-PROCESS #2 LOW** displays the present condition of the latched shutdown. This shutdown will only indicate if it has been activated in the CFIG SHUTDOWN menu.

17. **16-PROCESS DIFF HI** displays the present condition of the latched shutdown. This shutdown will only indicate if it has been activated in the CFIG SHUTDOWN menu.

18. **17-PROCESS DIFF LOW** displays the present condition of the latched shutdown. This shutdown will only indicate if it has been activated in the CFIG SHUTDOWN menu.

19. **ALARM RESET** is used to reset all latched alarms and shutdowns once the condition which triggered the alarm or shutdown has been cleared. Toggle TRUE then FALSE to activate the reset.

Alarm Menu

An Alarm condition must exist to bring into view the ALARM MENU. This menu displays configured alarms that have been triggered. An alarm may be cleared, if the alarm condition no longer exists, by activating the Alarm Reset (through the external discrete input, Modbus, Servlink, or the Hand Held Programmer).

1. **FIRST ALARM** displays the alarm that occurred first. The number matches with the number of the alarm in this menu.

2. **1-SPEED #1 FAIL** displays the present condition of the latched alarm. This alarm will only indicate if it has been activated in the CFIG ALARM menu.

3. **2-SPEED #2 FAIL** displays the present condition of the latched alarm. This alarm will only indicate if it has been activated in the CFIG ALARM menu.

4. **3-SPD #1 AND #2 FAIL** displays the present condition of the latched alarm. This alarm will only indicate if it has been activated in the CFIG ALARM menu.

5. **4-PROCESS #1 FAIL** displays the present condition of the latched alarm. This alarm will only indicate if it has been activated in the CFIG ALARM menu.

6. **5-PROCESS #2 FAIL** displays the present condition of the latched alarm. This alarm will only indicate if it has been activated in the CFIG ALARM menu.

7. **6-REMOTE INPUT FAIL** displays the present condition of the latched alarm. This alarm will only indicate if it has been activated in the CFIG ALARM menu.

8. **7-EXT FUEL LMT FAIL** displays the present condition of the latched alarm. This alarm will only indicate if it has been activated in the CFIG ALARM menu.

9. **8-MODBUS 3 FAIL** displays the present condition of the latched alarm. This alarm will only indicate if it has been activated in the CFIG ALARM menu.

10. **9-HI FUEL DEMAND** displays the present condition of the latched alarm. This alarm will only indicate if it has been activated in the CFIG ALARM menu.

11. **10-HI SPEED** displays the present condition of the latched alarm. This alarm will only indicate if it has been activated in the CFIG ALARM menu.

12. **11-HIGH TORSIONAL** displays the present condition of the latched alarm. This alarm will only indicate if it has been activated in the CFIG ALARM menu.

13. **12-PROCESS #1 HIGH** displays the present condition of the latched alarm. This alarm will only indicate if it has been activated in the CFIG ALARM menu.

14. **13-PROCESS #1 LOW** displays the present condition of the latched alarm. This alarm will only indicate if it has been activated in the CFIG ALARM menu.

15. **14-PROCESS #2 HIGH** displays the present condition of the latched alarm. This alarm will only indicate if it has been activated in the CFIG ALARM menu.

16. **15-PROCESS #2 LOW** displays the present condition of the latched alarm. This alarm will only indicate if it has been activated in the CFIG ALARM menu.

17. **16-PROCESS DIFF HI** displays the present condition of the latched alarm. This alarm will only indicate if it has been activated in the CFIG ALARM menu.

18. **17-PROCESS DIFF LOW** displays the present condition of the latched alarm. This alarm will only indicate if it has been activated in the CFIG ALARM menu.

19. **ALARM RESET** is used to reset all latched alarms and shutdowns once the condition which triggered the alarm or shutdown has been cleared. Toggle TRUE then FALSE to activate the reset.

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 4-2.)

5. **WINDOW WIDTH** is the magnitude (in rpm) of a compensated speed error (Ec) at which the control automatically switches to fast response. The control uses the absolute value of compensated speed error (Ec) to make this switch. The absolute value is the difference between the speed reference (Nr) and the compensated speed (Nc). A Window Width too narrow will result in cycling that always factors in the Gain Ratio. (See Figure 4-2.)

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 4-3.)

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 Breakpoint adjustment to increase (or decrease) Gain when percent Actuator Output is greater than the breakpoint. 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 4-3.)

8. **SPEED FILTER** adjusts the cutoff frequency of a low pass filter used on the speed sensing input (see Figure 4-5). 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:

   camshaft frequency = (engine rpm)/60 [for 2-cycle engines]
   = (engine rpm)/120 [for 4-cycle engines]

   firing frequency = *camshaft frequency* x number of cylinders

   Initially set the filter frequency to the firing frequency.

   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.

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.

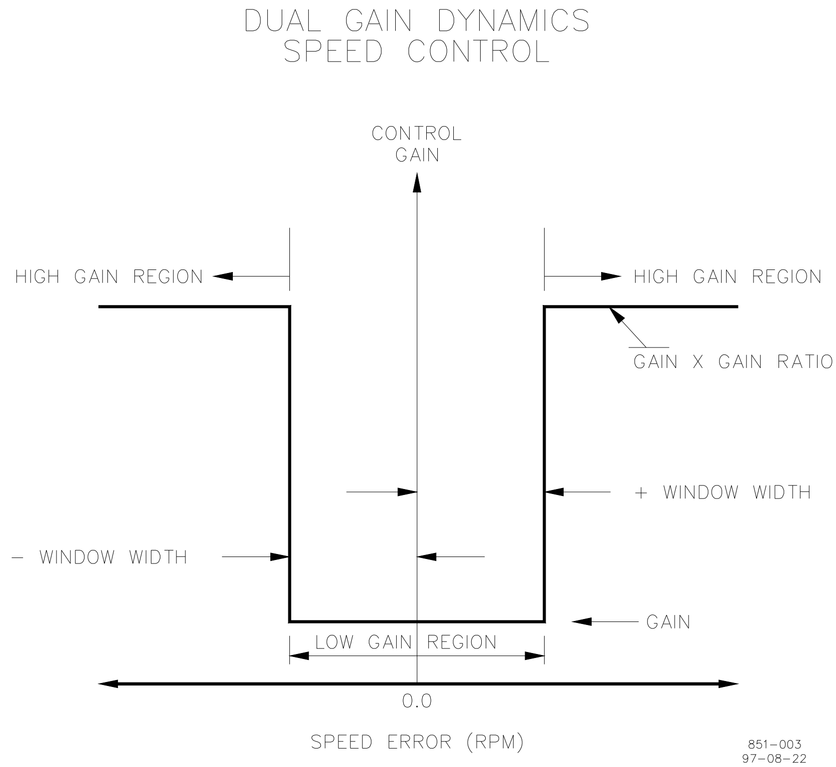


Figure 4-2. Control Gain as a Function of Speed Error

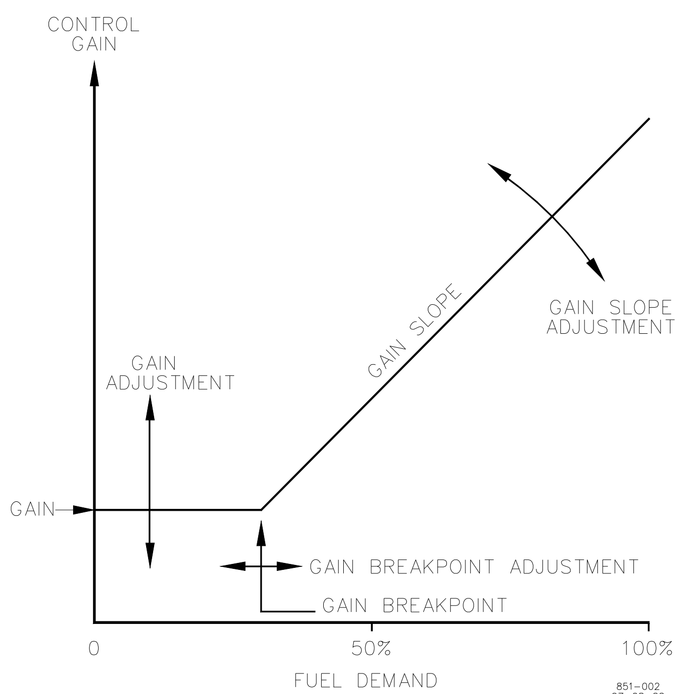


Figure 4-3. Control Gain as a Function of Control Output

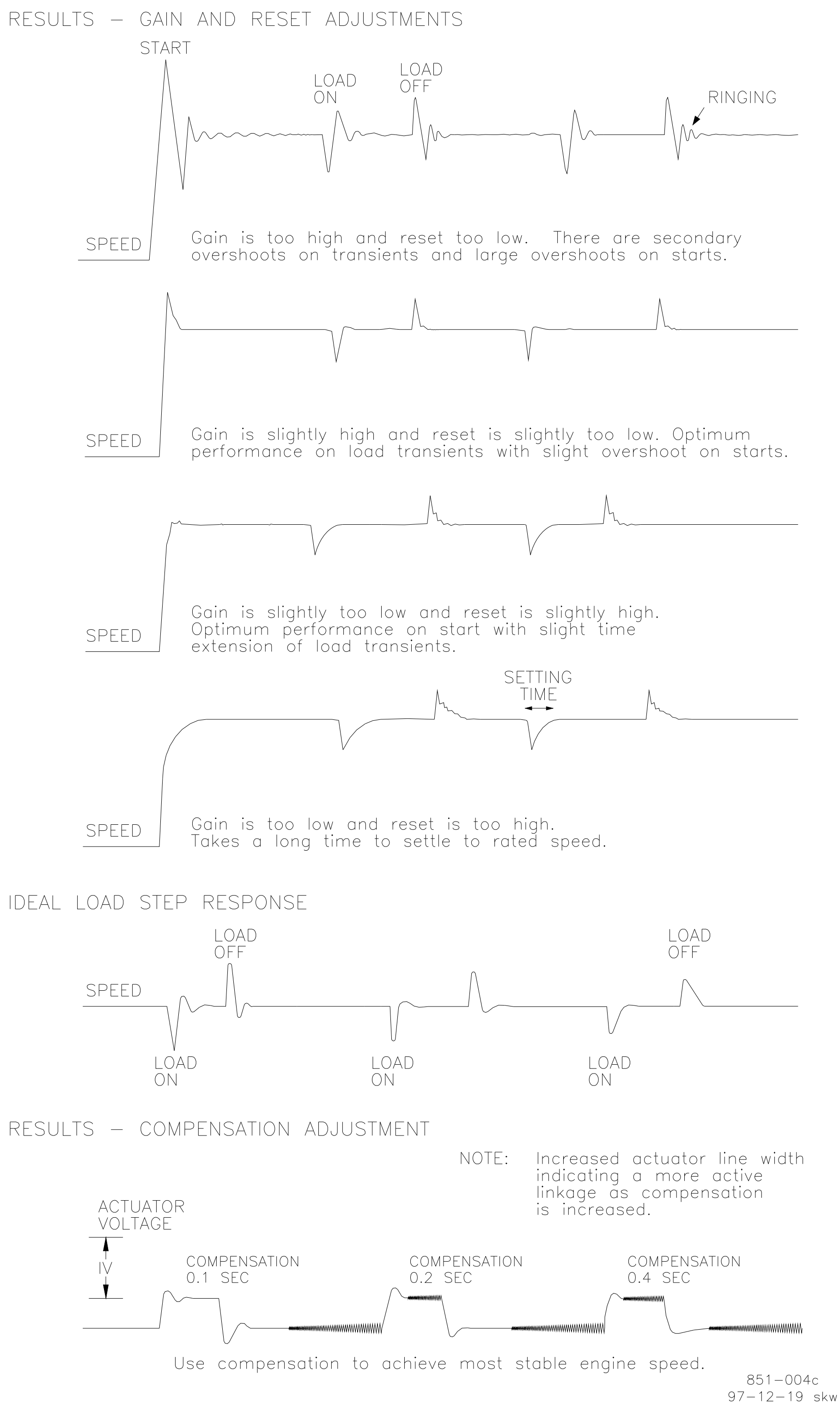


Figure 4-4. Typical Transient Response Curves

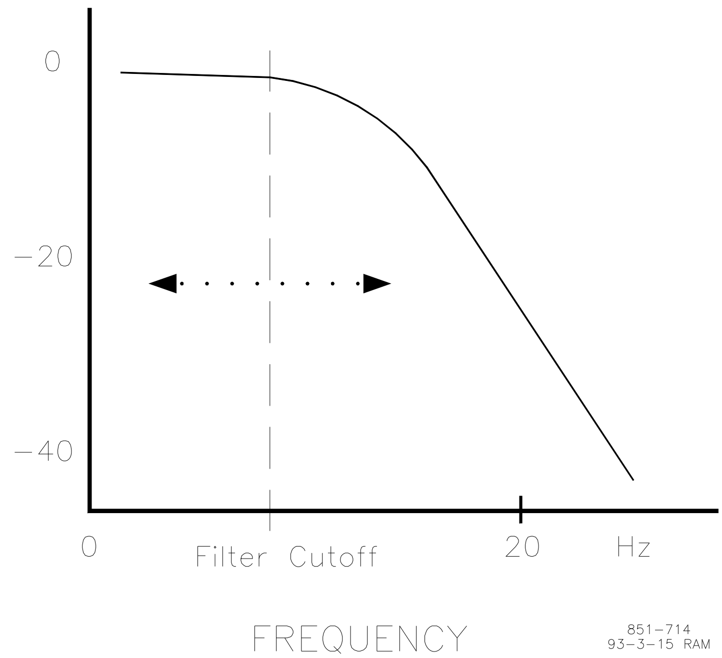


Figure 4-5. Speed Filter

1st DYNAMICS/2nd DYNAMICS–5 GAIN

This menu and control function is enabled when CFIG OPTION 'USE 5-GAIN MAP' is TRUE and provides a 5-point curve as a function of fuel demand for the variable GAIN set point. It is useful in applications that have a non-linear fuel valve (such as butterfly valves).

1. **BREAKPOINT A** is set at the no-load actuator 1 output % fuel demand.
2. **GAIN @ BREAKPOINT A** is the no-load GAIN setting.
3. **BREAKPOINT B** is set at the 25 % load actuator 1 output % fuel demand.
4. **GAIN @ BREAKPOINT B** is the 25 % load GAIN setting.
5. **BREAKPOINT C** is set at the 50 % load actuator 1 output % fuel demand.
6. **GAIN @ BREAKPOINT C** is the 50 % load GAIN setting.
7. **BREAKPOINT D** is set at the 75 % load actuator 1 output % fuel demand.
8. **GAIN @ BREAKPOINT D** is the 75 % load GAIN setting.
9. **BREAKPOINT E** is set at the 100 % load actuator 1 output % fuel demand.
10. **GAIN @ BREAKPOINT E** is the 100 % load GAIN setting.
11. **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 following a load disturbance.

12. **COMPENSATION** compensates for the actuator and fuel system time constant. Increasing Compensation increases actuator activity and improves transient performance. Decreasing compensation decreases actuator activity but transient performance may worsen.

13. **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 errors when loads are changing. This allows a lower gain at steady state for better stability and reduced steady-state actuator linkage movement (see Figure 4-2).

14. **WINDOW WIDTH** is the magnitude (in rpm) of a compensated speed error (Ec) at which the control automatically switches to fast response. The control uses the absolute value of the compensated speed error (Ec) to make this switch. The absolute value is the difference between the speed reference (Nr) and the compensated speed (Nc). A Window Width too narrow will result in cycling that always factors in the Gain Ratio (see Figure 4-2).

15. **SPEED FILTER FREQ** is the cutoff frequency of a low pass filter used on the speed sensing input (see Figure 4-5). To use this feature set the cutoff frequency below 15.915 Hz. The filter is used to attenuate engine firing frequencies. To calculate the desired filter cutoff point, use the following formulas:

    Camshaft frequency = (engine rpm)/60 [for 2 cycle engines]
    = (engine rpm)/120 [for 4 cycle engines]
    Firing frequency = *Camshaft frequency* x number of power cylinders

    Initially set the filter frequency to the *Firing frequency*.

    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.

16. **BUMP ACTUATOR** allows you to test your dynamics settings by temporarily applying a decrease fuel demand transient to stimulate a control response. Both the magnitude 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 to TRUE to enable the BUMP ACT function. See the ACTUATOR BUMP menu.**

ACTUATOR BUMP

1. **BUMP ENABLED** is set to TRUE to enable the actuator bump for 60 minutes. Set to FALSE to disable this function.

2. **ACT BUMP LEVEL** is set in % fuel demand for the desired bump level.

3. **ACT BUMP DURATION** is set in seconds for the desired bump duration.

TORSIONAL FILTER

Torsional filter adjustments are the settings that affect the control's ability to react to flexible coupling torsionals. 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.**

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.

The 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.

The NOTCH Q FACTOR is the width about the 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.

1. **ENABLE TORS FILTER** enables the Flexible Coupling filtering function when set to TRUE. When set to FALSE the function is disabled.

2. **ENG SENSOR WEIGHT** is the inertia ratio setting between the engine inertia and the system inertia. Set the value equal to engine inertia divided by (engine inertia + driven load inertia).

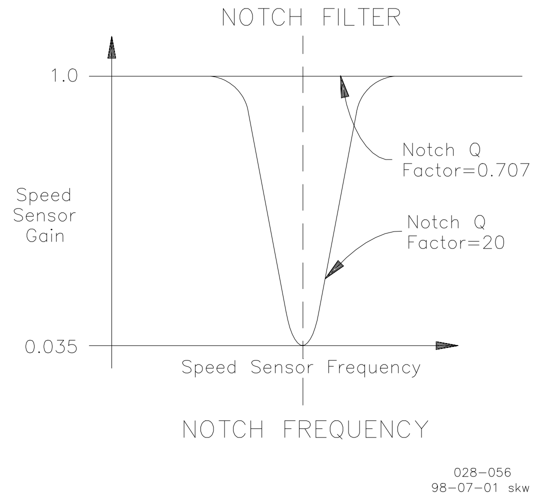


Figure 4-6. Notch Filter

3. **TORS SCALE (%RATED)** is the percentage of rated rpm that corresponds to 100% torsional measurement in the 723PLUS. Example: TORS SCALE=1%, RATED=1200 rpm, Torsional RPM=6 rpm, therefore torsional measurement = $\frac{6}{1200x.01}x100$ = 50%. This only has an effect on the measurement value and has NO effect on the actual dynamic response of the control. Should be left at default value for normal operation.

4. **TORSNL FUEL LIMIT** is the percentage of Fuel Demand the actuator output will be limited to when the torsional measurement level exceeds the TORSNL LEVEL @LIMIT(%).

5. **TORSNL LEVEL @LIMIT(%)** is the torsional level at which the TORSNL FUEL LIMIT is activated.

6. **TORSNL LEVEL @CLEAR(%)** is the torsional level at which the TORSNL FUEL LIMIT is deactivated.

7. **NOTCH FREQUENCY** is set at the center frequency in hertz of a band stop filter (see Figure 4-6).

8. **NOTCH Q FACTOR** will set the filter attenuation and width about the center frequency (see Figure 4-6).

9. **TORSIONAL LEVEL** displays the torsional level as a percentage of the full scale torsional vibration.

10. **TORSNL FILTR ACTIVE** displays whether the torsional filter is enabled and active (TRUE) or disabled (FALSE).

11. **TORSIONAL LIMIT LVL** displays the torsional limit applied to the speed control as a % fuel demand limit.

IMPORTANT	**The notch filter is enabled when CFIG 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.**

FUEL LIMITERS

Fuel limiters restrain the fuel demand from the control to the actuator.

1. **START FUEL LIMIT** limits the percent fuel demand when the engine is started. The limit is usually set at the fuel level required to start the engine. The limiter is disabled when the engine speed exceeds 95% of speed reference (see Figure 4-7).

   The limiter begins out of the way at 100% with no speed. Upon speed clear, START FUEL LIMIT immediately limits the fuel to the start fuel limit. The limiter then ramps at **START RAMP %/sec** until the speed has reached 95% of reference and the Speed Control PID is in control for 1 second.

2. **START RAMP %/sec** establishes the start limiter ramping rate at which the fuel demand increases to assist starting in colder ambient conditions.

3. **MAX FUEL LIMIT** sets the maximum percent fuel demand. Maximum (100%) is based on 200 mA. This is an electronic rack stop which is active in all modes of operation.

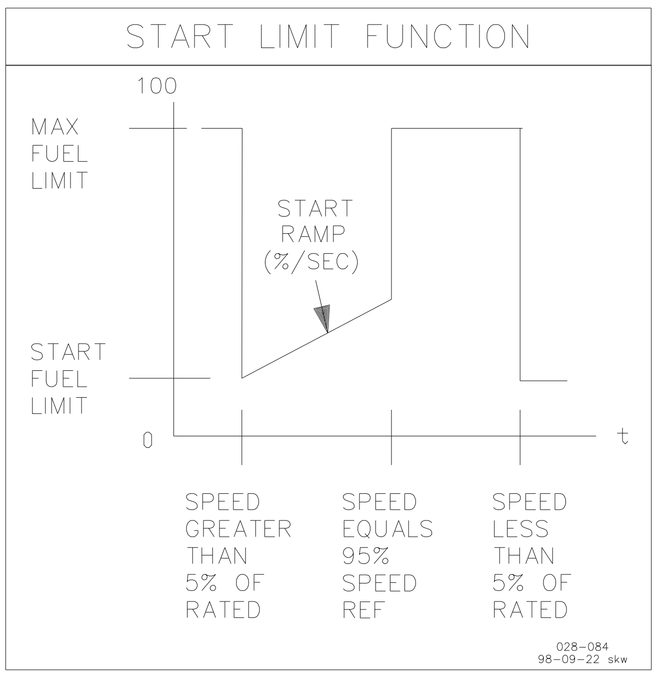


Figure 4-7. Start Limit Function

Speed Setting Menu

Speed adjustments are the settings that affect the speed reference.

1. **START SPEED** is the initial speed reference for the speed control prior to starting. Start Speed must be set above cranking speed and below the speed achieved with the start fuel limit setting (light-off speed). A ramp from the Start Speed to idle or rated, whichever is selected and permissive, begins when the engine accelerates to Start Speed. The ramp time is the accel ramp time setting or the decel ramp time setting as determined by the idle/rated selection and permissives.

2. **RAISE SPEED LIMIT** is the maximum speed reference setting. It is used to limit the Raise Speed and Remote Speed Setting inputs to a maximum. It normally is set at the speed at which the engine operates at full load.

3. **LOWER SPEED LIMIT** is the minimum speed reference setting. It is used to limit the Lower Speed and Remote Speed Setting inputs to a minimum. It normally is set at the minimum operating speed of the engine.

4. **IDLE SPEED** is the speed that the speed reference ramp goes to when the Close for Rated Discrete Input is OPEN. It is normally the speed at which the engine is operated at start-up. It is also used during cool down.

WARNING	**To prevent possible death or serious injury from an overspeeding engine, Idle speed must be set the same as or lower than Rated speed.**

NOTICE	**Be sure to avoid critical speeds when setting idle speed.**

5. **ACCEL RAMP TIME** is the time required for the control to ramp the engine speed from Idle speed to Rated speed. The ramp is started whenever the Idle/Rated contact is closed.

6. **DECEL RAMP TIME** is the time required for the control to ramp the engine speed from Rated speed to Idle speed. The ramp is started whenever the Idle/Rated contact is opened.

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

7. **RAISE SPEED RATE** is the rate at which the speed reference is ramped when using the Raise command as well as when the Remote Speed Setting input is changed in the increase direction. A step change on the remote input does not cause an immediate change in the reference. Instead, it is ramped to the new setting at the Raise Speed Rate.

8. **LOWER SPEED RATE** is the rate at which the speed reference is ramped when using the Lower Speed input, as well as when the Remote Speed Setting input is changed in the decrease direction. A step change on the remote input does not cause an immediate change in the reference. Instead, it is ramped to the new setting at the Lower Speed Rate.

DB Process Control

This menu is used to setup the Deadband Process Control. The CFIG OPTION menu item USE CASCADE PROCESS must be set to FALSE, and the PROCESS CTRL OPTION must *not* be set at zero to bring into view the DB PROCESS CONTROL menu.

1. **DEFAULT PROC STPT** establishes the default Process Reference to be applied when Process Control is selected (by discrete input) and Remote Process Control is not enabled. The default is also applied during initial control power-up. Set to the desired initial Process Reference in engineering units.

2. **PROCESS DEADBAND** sets the Deadband between the Process Reference and the Process Input. A **raise or lower speed** command is issued when the deadband is exceeded, to bring the Process Input back within the deadband. Set at the desired deadband in engineering units.

3. **DB INCR RATE** sets the Raise Rate for the **Speed Reference** when operating in Deadband Process Control mode. Set to the desired Raise Rate in rpm/min.

4. **DB DECR RATE** sets the Lower Rate for the **Speed Reference** when operating in Deadband Process Control mode. Set to the desired Lower Rate in rpm/min.

5. **PROC RAISE LIMIT** sets the **Process Reference** Raise Limit. Set to the desired Process Reference Raise Limit in engineering units.

6. **PROC LOWER LIMIT** sets the **Process Reference** Lower Limit. Set to the desired Process Reference Lower Limit in engineering units.

7. **PROC RAISE RATE** sets the Raise Rate for the **Process Reference** to the Process Control. Set to the desired Raise Rate in engineering units/minute (EU/min).

8. **PROC LOWER RATE** sets the Lower Rate for the **Process Reference** to the Process Control. Set to the desired Lower Rate in EU/min.

9. **PROCESS #1 FILTER** adjusts the cutoff frequency of a low pass filter for Analog Input #1 which may be used to smooth out the signal by ignoring noise from the input. To use this feature, set the cutoff frequency below 15.9 Hz. Set at 15.9 Hz or higher to disable filter.

10. **PROCESS #2 FILTER** adjusts the cutoff frequency of a low pass filter for Analog Input #2 which may be used to smooth out the signal by ignoring noise from the input. To use this feature set the cutoff frequency below 15.9 Hz. Set at 15.9 Hz or higher to disable filter.

11. **PROCESS INPUT #1 (EU)** is a **display only** of the Process #1 Input in engineering units.

12. **PROCESS INPUT #2 (EU)** is a **display only** of the Process #2 Input in engineering units.

13. **PROCESS DIFFERENCE (EU)** is a **display only** of the Process #1 minus Process #2 Input differential in engineering units.

14. **PROCESS REFERENCE (EU)** is a **display only** of the Process Reference in engineering units.

15. **PROCESS REM REF (EU)** is a **display only** of the Remote Process Reference in engineering units.

Cascade Proc Ctrl

This menu is used to set up the Cascade Process Control. The CFIG OPTION menu item USE CASCADE PROCESS must be set to TRUE, and the PROCESS CTRL OPTION must *not* be set at zero to bring into view the CASCADE PROC CTRL menu.

1. **DEFAULT PROC STPT** establishes the default Process Reference to be applied when Process Control is selected (by discrete input) and Remote Process Control is not enabled. The default is also applied during initial control power-up. Set to the desired initial Process Reference in engineering units.

2. **PROC GAIN** determines how fast the Process control responds to an error between the Process Reference and the Process Input. The gain is set to provide stable control of the speed reference for all operating conditions.

3. **PROC INTEGRAL GAIN** compensates for the lag time of the Cascade Process. It adjusts the time required for the control to return the Process Reference and the Process Input difference to zero error after a process disturbance. Integral is adjusted to prevent slow hunting and to minimize overshoot after a Process disturbance.

4. **PROC S D R** is derivative ratio field which affects the derivative component of the Process PID response.

5. **SPEED REF @ 0% PID** sets the minimum speed in rpm at 0% Process PID output.

6. **SPEED REF @ 100% PID** sets the maximum speed in rpm at 100% Process PID output.

IMPORTANT **The SPEED REF settings may have a large effect on the gain of the control loop.**

7. **CASC NOT MATCHED RT** sets the ramp rate for the **speed control** in rpm/min when the Cascade Process does not match the Cascade Process Reference within 5%. This allows engine speed to be ramped at a controlled rate into Cascade Process control.

8. **PROC RAISE LIMIT** sets the **Process Reference** Raise Limit. Set to the desired Process Reference Raise Limit in engineering units.

9. **PROC LOWER LIMIT** sets the **Process Reference** Lower Limit . Set to the desired Process Reference Lower Limit in engineering units.

10. **PROC RAISE RATE** sets the Raise Rate for the **Process Reference** of the Process Control. Set to the desired Raise Rate in engineering units/minute (EU/min).

11. **PROC LOWER RATE** sets the Lower Rate for the **Process Reference** of the Process Control. Set to the desired Lower Rate in EU/min.

12. **PROCESS #1 FILTER** adjusts the cutoff frequency of a low pass filter for Analog Input #1 which may be used to smooth out the signal by ignoring noise from the input. To use this feature set the cutoff frequency below 15.9 Hz. Set at 15.9 Hz or higher to disable filter.

13. **PROCESS #2 FILTER** adjusts the cutoff frequency of a low pass filter for Analog Input #2 which may be used to smooth out the signal by ignoring noise from the input. To use this feature set the cutoff frequency below 15.9 Hz. Set at 15.9 Hz or higher to disable filter.

14. **PROCESS INPUT #1 (EU)** is a **display only** of the Process #1 Input in engineering units.

15. **PROCESS INPUT #2 (EU)** is a **display only** of the Process #2 Input in engineering units.

16. **PROCESS DIFFERENCE (EU)** is a **display only** of the Process #1 minus Process #2 Input differential in engineering units.

17. **PROCESS REFERENCE (EU)** is a **display only** of the Process Reference in engineering units.

18. **PROCESS REM REF (EU)** is a **display only** of the Remote Process Reference in engineering units.

Torque Limit Curve

Torque Limiter limits the fuel demand based on a two-dimensional curve and an engine speed input. This fuel limit prevents overfueling which limits torque for up to five speed breakpoints. The input breakpoints 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 breakpoint rpm. Too low of a setting can degrade transient load performance.

A five-point curve is constructed for rpm versus Fuel Demand (refer to Figure 4-8). The ‘X’ values are the Breakpoints, and the ‘Y’ values are the Fuel Limit at the Breakpoints. All values between the designated breakpoints are interpolated.

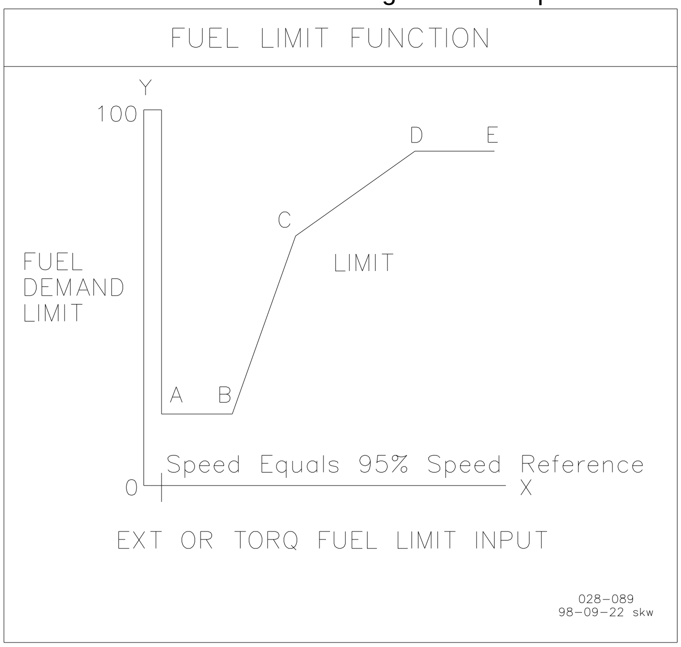


Figure 4-8. Torque Limit Curve

1. **ENABLE TORQUE LIMIT** enables and disables the fuel limiter, which uses the engine speed input to limit the actuator output. If the fuel limiter is disabled, the fuel limiter breakpoint settings will not be used.

2. **TORQUE LMT BRKPNT X** is the engine speed (rpm) that designates that particular breakpoint (x-axis input in Figure 4-8).

3. **FUEL LIMIT @ BRKPT X** is the percent fuel demand allowed when the engine speed is at that respective Breakpoint (y-axis output in Figure 4-8).

Droop

Droop adjustments are the settings that affect load parameters. Droop provides an alternate method for parallel operation. Isochronous Load Sharing is normally the preferred method for parallel operation.

1. **LOAD DROOP PERCENT** is the percentage of speed droop when the engine load is at maximum load. Set at zero to disable the droop function.

2. **FUEL DEMAND @ MIN LD** should be set to the percent fuel demand that the engine is operating at rated-speed/no-load. This establishes the 0% internal load measurement for droop.

3. **FUEL DEMAND @ MAX LD** should be set to the percent fuel demand when the engine is operating at rated-speed/full-load. This establishes the 100% internal load measurement for droop.

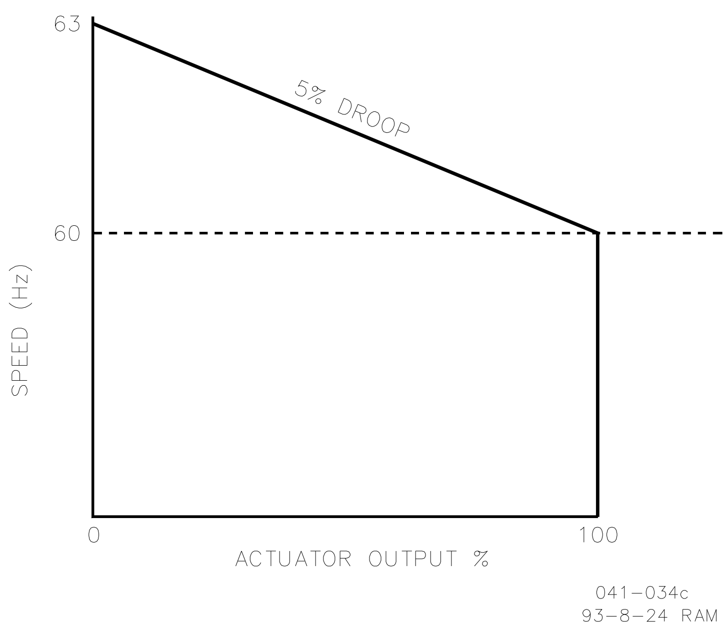


Figure 4-9. Droop Curve

Ext Fuel Lmt Curve

The External Fuel Limiter Curve limits the fuel demand based on a two-dimensional curve and an external 4–20 mA device connected to Analog Input #4. This function is predominantly used to limit fuel demand during a sudden load increase to prevent overfueling due to turbocharger lag as sensed by a Manifold Air Pressure input (although other inputs may be used). Limiting fuel demand minimizes smoke on diesel engines, and load transient detonation on gas and dual-fuel engines. In extreme cases, this limit can also prevent flooding of gas and dual-fuel engines. Normally, the load transient performance is not degraded since the lack of combustion air (not fuel) is the transient performance limiting factor. However, setting the fuel demand limit too low can degrade transient performance.

A five-point curve is constructed using the engine manufacturers recommended settings for EXT FUEL LMT versus Fuel Demand. Refer to Figure 4-8. The ‘X’ values are the Breakpoints and the ‘Y’ values are the Fuel Limit at the Breakpoints. All values between the designated breakpoints are interpolated.

1. **ENABLE EXT FUEL LMT** enables and disables the fuel limiter, which uses the External Fuel Limiter input to limit the actuator output. If the fuel limiter is disabled, the fuel limiter breakpoint settings will not be used.

2. **EXT LIMIT BRKPNT X** is the External Fuel Limiter value that designates that particular breakpoint (x-axis input in Figure 4-8).

3. **FUEL LIMIT @ BRKPNT X** is the percent fuel demand allowed when the External Fuel Limiter input is at that respective Breakpoint (y-axis output in Figure 4-8).

SET ANALOG INPUTS

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

1. **PROCESS #1 @ 4 mA (EU)**—Enter the preferred Process 1 engineering units (EU) at 4 mA from the PROCESS #1 input device. If a voltage sensing device is provided, enter the input EU at 1 Vdc.

2. **PROCESS #1 @ 20 mA (EU)**—Enter the preferred Process 1 EU at 20 mA from the PROCESS #1 input device. If a voltage sensing device is provided, enter the input EU at 5 Vdc.

3. **PROCESS #2 @ 4 mA (EU)**—Enter the preferred Process 2 EU at 4 mA from the PROCESS #2 input device. If a voltage sensing device is provided, enter the input EU at 1 Vdc.

4. **PROCESS #2 @ 20 mA (EU)**—Enter the preferred Process 2 EU at 20 mA from the PROCESS #2 input device. If a voltage sensing device is provided, enter the input EU at 5 Vdc.

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

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

7. **REM PROC @ 4 mA (EU)**—Enter the preferred Remote Process Reference set point in EU at 4 mA from the Remote Process Reference input device. If a voltage sensing device is provided, enter the input EU at 1 Vdc.

8. **REM PROC @ 20 mA (EU)**—Enter the preferred Remote Process Reference set point in EU at 20 mA from the Remote Process Reference input device. If a voltage sensing device is provided, enter the input EU at 5 Vdc.

IMPORTANT **Either Analog Input #2 or Analog Input #3 can be configured to be the remote process reference. Refer to Process Ctrl Option Setting and description in the CFIG Option menu.**

9. **EXT FUEL LMT @ 4 mA (EU)**—Enter the preferred External Fuel Limit set point in EU at 4 mA from the External Fuel Limit input device. If a voltage sensing device is provided, enter the input EU at 1 Vdc.

10. **EXT FUEL LMT @ 20 mA (EU)**—Enter the preferred External Fuel Limit set point in EU at 20 mA from the External Fuel Limit input device. If a voltage sensing device is provided, enter the input EU 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 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).

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

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

3. **ANALOG OUTPUT 2 MIN** is adjusted to the engineering units which will output 4 mA (or 0 mA if so configured) at Analog Output #2.

4. **ANALOG OUTPUT 2 MAX** is adjusted to the engineering units which will output 20 mA (or 1 mA if so configured) at Analog Output #2.

IMPORTANT **ANALOG OUTPUT 3 MIN is set for 0 mA output with the fuel demand at 0 percent, and ANALOG OUTPUT 3 MAX is set for 200 mA output (or 20 mA if configured) with the fuel demand at 100 percent. These settings are fixed and not tunable.**

5. **ACTUATOR OUT 2 MIN** is adjusted to the engineering units which will output 4 mA (or 0 mA if so configured) at Analog Output #4.

6. **ACTUATOR OUT 2 MAX** is adjusted to the engineering units which will output 20 mA (or 200 mA if so configured) at Analog Output #4.

7. **AO FILTER FREQUENCY** adjusts the cutoff frequency of a low pass filter used on Analog outputs 1, 2 and 4 **only** (see Figure 4-5). The filter is used to attenuate output signal noise. To use this feature, set the cutoff frequency below 15.9 Hz. Set the cutoff frequency at or above 15.9 Hz to disable this filter.

I/O CALIBRATION

This menu allows exact calibration of the analog input and outputs. The **offset** should be adjusted so that the *minimum input* or *output* produces the correct mA value. The **span** should be adjusted so that the *maximum input* or *output* produces the correct value. Values are shown on the DISPLAY ANALOG I/O menu. Analog input values displayed are **after** I/O calibration. Analog output values displayed are **before** I/O calibration. Monitor inputs with a milliamp meter in series with the source or from the source itself. Monitor outputs with a milliamp meter in series with the output device or at the output itself.

1. **PROC #1 OFFSET** adjusts the min displayed AI1 Process #1 mA.

2. **PROC #1 IN SPAN** adjusts the max displayed AI1 Process #1 mA.

3. **PROC #1 READ VOLTS** when TRUE changes the displayed AI1 Process #1 mA to read Volts instead of mA.

4. **PROC #2 OFFSET** adjusts the min displayed AI2 Process #2 mA.

5. **PROC #2 IN SPAN** adjusts the max displayed AI2 Process #2 mA.

6. **PROC #2 READ VOLTS** when TRUE changes the displayed AI1 Process #2 to read Volts instead of mA.

7. **REM IN OFFSET** adjusts the min displayed AI3 Remote Reference Input mA.

8. **REM IN SPAN** adjusts the max displayed AI3 Remote Reference Input mA.

9. **REM IN READ VOLTS** when TRUE changes the displayed AI3 Remote Reference Input to read Volts instead of mA.

10. **EXT LMT OFFSET** adjusts the min displayed AI4 External Limiter Input mA.

11. **EXT LIMIT SPAN** adjusts the max displayed AI4 External Limiter Input mA.

12. **EXT LMT READ VOLTS** when TRUE changes the displayed AI4 External Limiter Input mA to read Volts instead.

13. **AO 1 OFFSET** adjusts the Analog Output #1 mA minimum.

14. **AO 1 SPAN** adjusts the Analog Output #1 mA maximum.

15. **AO 2 OFFSET** adjusts the Analog Output #2 mA minimum.

16. **AO 2 SPAN** adjusts the Analog Output #2 mA maximum.

17. **ACT 1 OFFSET** adjusts the Analog Output #3 mA minimum. Provided to precisely set 0 mA with the fuel demand at 0 %. We do not recommend a different setting.

18. **ACT 1 SPAN** adjusts the Analog Output #3 mA maximum. Provided to precisely set 200 mA with the fuel demand at 100 %. We do not recommend a different setting unless the maximum output is configured for 20 mA.

19. **ACT 2 OFFSET** adjusts the Analog Output #4 mA minimum.

20. **ACT 2 SPAN** adjusts the Analog Output #4 mA maximum.

Comm Port Setup

The 723PLUS has two serial ports. Port 2 is configured as a Servlink port. Port 3 is configured to support the Modbus protocol. The ports are configured in this menu for the type of hardware interface and other parameters. Only port 3 has monitoring information available that can be retrieved by a Modbus master device such as a PC-based Human Machine Interface (HMI). Port 3 supports either Modbus ASCII or RTU. This is selected in the Configure Menu CFIG COMMUNICATION. Port 3 also allows commands to be sent from the Modbus master device to the control. (See the Modbus Register List, Appendix C, for the addresses.). USE COMM PORT found in menu CFIG OPTION must be set TRUE to bring this menu into view. This menu is concealed when USE COMM PORT is set FALSE.

1. **PORT 2 HARDWARE CFIG** determines if the port is set for RS-232 or RS-422 based on:
   1 = RS-232
   2 = RS-422

IMPORTANT	**If RS-422 is selected, the devices can be in a multi-drop configuration.**

2. **PORT 2 BAUD RATE** determines the ports baud rate, based on:
   1 = 110
   2 = 300
   3 = 600
   4 = 1200
   5 = 1800
   6 = 2400
   7 = 4800
   8 = 9600
   9 = 19200
   10 = 38400

IMPORTANT	**If port J2 is set for a 19200 baud rate, then port 3 cannot be 38400. If port J2 is set for a 38400 baud rate, then port 3 cannot be 19200. Also, if port J3 is set for a 19200 baud rate, then port 2 cannot be a 38400. If port J3 is set for a 38400 baud rate, then port 2 cannot be 19200.**

3. **PORT 3 HARDWARE CFIG** determines if the port is set for RS-232, RS-422, or RS-485 based on:
   1 = RS-232
   2 = RS-422
   3 = RS-485

IMPORTANT	**If RS-422 or RS-485 is selected, the devices can be in a multi-drop configuration.**

4. **PORT 3 BAUD RATE** determines the ports baud rate, based on:
   1 = 1200
   2 = 1800
   3 = 2400
   4 = 4800
   5 = 9600
   6 = 19200
   7 = 38400

IMPORTANT	**If port J2 is set for a 19200 baud rate, then port 3 cannot be 38400. If port J2 is set for a 38400 baud rate, then port 3 cannot be 19200. Also, if port J3 is set for a 19200 baud rate, then port 2 cannot be a 38400. If port J3 is set for a 38400 baud rate, then port 2 cannot be 19200.**

5. **PORT 3 STOP BITS** determines the Stop Bits, based on:
   1 = 1 stop bit
   2 = 1.5 stop bits
   3 = 2 stop bits

6. **PORT 3 PARITY** determines what parity the port uses, based on:
   1 = no parity
   2 = odd parity
   3 = even parity

7. **PORT 3 TIMEOUT** sets the time period, in seconds, the Modbus slave will wait for a master to query the 723PLUS. If the master connected to Port 3 does not poll within the timeout period, a configured MODBUS PORT 3 FAIL shutdown and/or alarm will be activated.

8. **PORT 3 LINK ERROR** is a **display only** of the Port 3 link error condition. (True or False).

9. **PORT 3 EXCEPTION ERR** is a **display only** of the Port 3 exception error condition. The following exception error codes will be displayed:
   Messages sent by a slave and displayed by Service.
   0 No error
   1 Illegal function
   2 Illegal data address
   Messages displayed by Service.
   9 Checksum error
   10 Message garbled
   The Alarm Reset will reset all of the exception errors.

TC MODULE 1/4

This menu displays and allows calibration of LINKnet Thermocouple input Modules 1 through 4. The **offset** and **span** should be adjusted to produces the correct temperature display of the input temperature. The LINKnet Module must be connected and properly addressed for these menus to come into view.

IMPORTANT **LINKnet nodes only reset their hardware switch addresses on power-up.**

1. **CH “x” TC DEGREES F** is a **display only** of the Channel **“x”** thermocouple input temperature, in °F, for the selected TC Module. **This value is sent to Modbus**.

2. **CH “x” TC OFFSET** sets the **minimum value** for the Channel **“x”** thermocouple input temperature, in °F, of the selected TC module.

3. **CH “x” TC SPAN** sets the **maximum value** of the Channel **“x”** thermocouple input temperature, in °F, the selected TC module.

RTD MODULE 1/3

This menu displays and allows calibration of LINKnet RTD Input Modules 1 through 3. The **offset** and **span** should be adjusted to produces the correct temperature display of the input temperature. The LINKnet Module must be connected and properly addressed for these menus to come into view.

IMPORTANT **LINKnet nodes only reset their hardware switch addresses on power-up.**

1. **CH “x” RTD DEGREES F** is a **display only** of the Channel **“x”** RTD input temperature, in °F, for the selected RTD Module. **This value is sent to Modbus**.

2. **CH “x” RTD OFFSET** sets the **minimum value** for the Channel **“x”** RTD input temperature, in °F, of the selected RTD module.

3. **CH “x” RTD SPAN** sets the **maximum value** of the Channel **“x”** RTD input temperature, in °F, of the selected RTD module.

AI MODULE 1/2

This menu displays and allows calibration of LINKnet Analog Input Modules 1 and 2. The **offset** and **span** should be adjusted to produces the correct mA display of the input present. The LINKnet Module must be connected and properly addressed for these menus to come into view.

IMPORTANT **LINKnet nodes only reset their hardware switch addresses on power-up.**

1. **AI “x” CH “x” - mA INPUT** is a **display only** of the Channel **“x”** mA input current for the selected AI Module. **This value times 1000 is sent to Modbus**.

2. **AI “x” CH “x” - AI OFFSET** sets the **minimum value** for the Channel **“x”** mA input current of the selected AI module.

3. **AI “x” CH “x” - AI SPAN** sets the **maximum value** of the Channel **“x”** mA input current of the selected AI module.

DI MODULE 1/4

This is a **display only** menu which displays the state of LINKnet Discrete Inputs of Modules 1 through 4. FALSE = Open and TRUE = Closed. The control automatically updates the display. The LINKnet Module must be connected and properly addressed for these menus to come into view.

IMPORTANT **LINKnet nodes only reset their hardware switch addresses on power-up.**

1. **CH “x” CONTACT CLOSED** displays the state of the Channel **“x”** discrete input for the selected DI module. **This state value is sent to Modbus**.

DO MODULE 1/4

This is a **display only** menu which displays the state of LINKnet Discrete Outputs of Modules 1 through 4. The LINKnet Module must be connected and properly addressed for these menus to come into view.

IMPORTANT **LINKnet nodes only reset their hardware switch addresses on power-up.**

1. **CH “x” ENERGIZED** displays the state of the Channel **“x”** discrete output for the selected DO module. FALSE = De-energized and TRUE = Energized. **This state value is also the value received from Modbus** *or* from the **FORCE DO 1 & 2** and **FORCE DO 3 & 4** menus.

AO MODULE 1

This menu displays and allows calibration of LINKnet Analog Output Module 1. The **offset** and **span** should be adjusted to produces the correct mA output for the input value (scaled in engineering units). The LINKnet Module must be connected and properly addressed for this menu to come into view.

IMPORTANT **LINKnet Nodes only reset their hardware switch addresses on power-up.**

1. **AO1 CH “x” - mA OUT** is a **display only** of the Channel **“x”** value, in engineering units, which drives the output current for the AO1 Module. **This value times 1000 is also the value received from Modbus.**

2. **AO1 CH “x” OFFSET** sets the **minimum current** at the AO1 Module Channel **“x”** minimum input value, in engineering units.

3. **AO1 CH “x” SPAN** sets **maximum current** at the AO1 Module Channel **“x”** maximum input value, in engineering units.

DISPLAY DIGITAL I/O

The menu displays Digital input and output states. The control automatically updates the display.

1. **A-PROCESS ENABLE** shows the state of the Process Enable contact (TRUE = CLOSED).

2. **B-ALARM RESET** shows the state of the Alarm Reset contact (TRUE = CLOSED).

3. **C-SPEED FAIL OVRD** shows the state of the Failsafe Override contact (TRUE = CLOSED).

4. **D-2ND DYNAMICS** shows the state of the 2nd Dynamics contact (TRUE = CLOSED).

5. **E-RAISE SPEED** shows the state of the Raise Speed contact (TRUE = CLOSED).

6. **F-LOWER SPEED** shows the state of the Lower Speed contact (TRUE = CLOSED).

7. **G-RATED SPEED** shows the state of the Idle/Rated contact (TRUE = CLOSED).

8. **H-CLOSE TO RUN** shows the state of the Run/Stop contact (TRUE = CLOSED).

9. **DO1-SHUTDOWN** shows the state of the Shutdown Relay Output #1. TRUE indicates the relay is energized.

10. **DO2-ALARM** shows the state of the Alarm Relay Output #2. TRUE indicates the relay is energized.

11. **DO3-STAT INDICATOR** shows the state of the Status Indication Relay Output #3. TRUE indicates the relay is energized.

DISPLAY ANALOG I/O

This menu is for **display only** except for an Alarm Reset function.. It displays the analog inputs and outputs of the 723PLUS control.

1. **SPD SENS IN #1** shows the frequency, in hertz, of the Speed Sensor #1 input signal. This value is sent to Modbus.

2. **SPD SENS IN #2** shows the frequency, in hertz, of the Speed Sensor #2 input signal. This value is sent to Modbus.

3. **AI1-PROCESS IN #1** shows the value, in mA, of the Process Input #1 signal. This value times 1000 is sent to Modbus. The mA value is after the effect of the offset and span in the I/O CALIBRATION menu.

4. **AI2-PROCESS IN #2** shows the value, in mA, of the Process Input #2 signal. This value times 1000 is sent to Modbus. The mA value is after the effect of the offset and span in the I/O CALIBRATION menu.

5. **AI3-REMOTE IN** shows the value, in mA, of the Remote Speed Reference Input #3 Signal. This value times 1000 is sent to Modbus. The mA value is after the effect of the offset and span in the I/O CALIBRATION menu.

6. **AI4-EXT FUEL LIMIT** shows the value, in mA, of the External Fuel Limit Input #4 Signal. This value times 1000 is sent to Modbus. The mA value is after the effect of the offset and span in the I/O CALIBRATION menu.

7. **AI1-FAILED** shows the state of the Process Input #1 signal. (TRUE = FAILED). This value is sent to Modbus.

8. **AI2-FAILED** shows the state of the Process Input #2 signal. (TRUE = FAILED). This value is sent to Modbus.

9. **AI3-FAILED** shows the state of the Remote Speed Reference Input #3 Signal. (TRUE = FAILED). This value is sent to Modbus.

10. **AI4-FAILED** shows the state of the External Fuel Limit Input #3 Signal. (TRUE = FAILED). This value is sent to Modbus.

11. **ANALOG OUT 1** shows the value, in mA, of the Analog Output #1 Signal. This value times 1000 is sent to Modbus. The mA value is prior to the effect of the offset and span in the I/O CALIBRATION menu.

12. **ANALOG OUT 2** shows the value, in mA, of the Analog Output #2 Signal. This value times 1000 is sent to Modbus. The mA value is prior to the effect of the offset and span in the I/O CALIBRATION menu.

13. **ACTUATOR OUT 1** shows the value, in mA, of the speed control fuel demand signal at Analog Output #3. This value times 1000 is sent to Modbus. The mA value is prior to the calibration effect of the offset and span in the I/O CALIBRATION menu.

14. **ACTUATOR OUT 2** shows the value, in mA, of the Analog Output #4 Signal. This value times 1000 is sent to Modbus. The mA value is prior to the calibration effect of the offset and span in the I/O CALIBRATION menu.

15. **ALARM RESET** provides a means of resetting alarm conditions. Toggle TRUE then FALSE to issue a reset.

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 will cause Relay Output #3 (Status Indication) to activate. The status condition must be cleared for the Status Indication alarm to show FALSE.

1. **ON START FUEL LIMIT** will show TRUE when the fuel demand is being limited by the Start Fuel Limit.

2. **ON MAX LIMIT** will show TRUE when the fuel demand is being limited by the Max Fuel Limit.

3. **ON EXT FUEL LIMIT** will show TRUE when the fuel demand is being limited by the External Fuel Limit.

4. **ON TORSION LIMIT** will show TRUE when the fuel demand is being limited by the Torsional Fuel Limit.

5. **ON TORQUE LIMIT** will show TRUE when the fuel demand is being limited by the Torque Fuel Limit.

6. **ACT SHUTDOWN** will show TRUE when an Actuator Shutdown has been applied.

7. **SPEED SWITCH 1** will show TRUE when the Speed Switch 1 has been triggered. Display will show FALSE when the Speed Switch 1 is reset.

8. **SPEED SWITCH 2** will show TRUE when the Speed Switch 2 has been triggered. Display will show FALSE when the Speed Switch 2 is reset.

CONTROL MODE

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

1. **SPEED IN CONTROL (LSS)** will show TRUE when the fuel demand is being controlled by the Speed Control.

2. **ON START FUEL LIMIT (LSS)** will show TRUE when the fuel demand is being limited by the START FUEL LIMIT.

3. **ON MAXIMUM LIMIT (LSS)** will show TRUE when the fuel demand is being limited by the MAX FUEL LIMIT.

4. **ON EXTERNAL LIMIT (LSS)** will show TRUE when the fuel demand is being limited by the EXT FUEL LMT CURVE.

5. **ON TORSIONAL LIMIT (LSS)** will show TRUE when the fuel demand is being limited by the TORSNL FUEL LIMIT.

6. **ON TORQUE LIMIT** will show TRUE when the fuel demand is being limited by the TORQUE LIMIT CURVE.

7. **ACTUATOR SHUTDOWN** will show TRUE when an Actuator Shutdown has been applied.

8. **REMOTE SPEED ENBLD** will show TRUE when the REMOTE SPEED REFERENCE is enabled (AI3 input device or Modbus AW).

9. **REM PROCESS ENBLD** will show TRUE when the REMOTE PROCESS REFERENCE is enabled.

10. **CASCADE RAMP ACTIVE** will show TRUE when the Cascade Process Control is ramping the engine speed reference up or down. This occurs when the Process Variable is not within 5% of the Process Reference. During ramping, the Cascade Process Control is placed in a tracking mode.

11. **CASCADE PID ACTIVE** will show TRUE when the Cascade Process PID Control is actively controlling the engine speed reference.

12. **DB PROC CTRL ACTIVE** will show TRUE when the Deadband Process Control is actively controlling the engine speed reference.

13. **SPD SENSOR 1 ACTIVE** will show TRUE when speed sensor input #1 is actively used by the control.

14. **SPD SENSOR 2 ACTIVE** will show TRUE when speed sensor input #2 is actively used by the control.

15. **PORT 1 ON HANDHELD** will show TRUE when port 1 is set up to communicate with a hand held programmer.

16. **PORT 1 ON SERVLINK** will show TRUE when port 1 is set up to communicate by Servlink with a PC.

17. **RESET ALL ALARMS** provides a means of resetting all alarm conditions. Toggle TRUE then FALSE to issue a reset.

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.

1. **ENGINE SPEED** displays the present engine speed in rpm.

2. **SPEED REF** displays the output of the speed reference ramp which is the set point input to the speed control PID. Note that this may not be the speed the engine is presently running at due to the effect of droop, fuel limiters, etc.

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

4. **DROOP BIAS** displays the value in rpm that the droop percentage calculation is biasing the speed reference.

5. **REMOTE SPEED REF** displays the present remote speed reference signal in rpm.

6. **EXT FUEL LIMIT IN** displays the present external fuel limit input in engineering units.

7. **EXT FUEL LIMIT** displays the present percent fuel demand limit of the external fuel limiter.

8. **PROCESS INPUT #1** displays the present process #1 input in engineering units.

9. **PROCESS INPUT #2** displays the present process #2 input in engineering units.

10. **PROCESS DIFFERENCE** displays the present process #1 minus process #2 input difference in engineering units.

11. **PROCESS REFERENCE** displays the present process reference in engineering units.

FORCE 723 DO

This menu allows the **723PLUS Discrete Outputs** to be manually forced on or off during installation to test the output loops. This feature and menu is only available when FORCE DISCRETE OUTS on the CFIG OPTION menu is set TRUE.

NOTICE	**Before actuating any end device, be sure that forcing the end device to a different state will not cause an unsafe or unwanted condition or event to occur, and take comprehensive safety measures to nullify the effects of forcing the end device to a different state (such as closing manual isolation valves, venting pressurized lines, disconnecting power, independently disabling the device by other means, etc.). Have these measures checked by a separate cognizant person prior to forcing the end device to a different state. BE AWARE that incorrect wiring may inadvertently actuate the wrong end device.**

1. **DO1 FORCE** is set TRUE to force Discrete Output 1 to the energized state. Set value FALSE to force the Discrete Output 1 to the de-energized state.

2. **DO2 FORCE** is set TRUE to force Discrete Output 2 to the energized state. Set value FALSE to force the Discrete Output 2 to the de-energized state.

3. **DO3 FORCE** is set TRUE to force Discrete Output 3 to the energized state. Set value FALSE to force the Discrete Output 3 to the de-energized state.

IMPORTANT	**Be sure to set the 'FORCE DISCRETE OUTS' on the CFIG Option menu back to FALSE when discrete output testing is completed. Failure to do so will hold the output in the last forced state.**

FORCE DO 1 & 2

This menu allows **LINKnet Discrete Outputs 1 and 2** to be manually forced on or off during installation to test the output loops. This feature and menu is only available when FORCE DISCRETE OUTS on the CFIG OPTION menu is set TRUE.

NOTICE	**Before actuating any end device, be sure that forcing the end device to a different state will not cause an unsafe or unwanted condition or event to occur, and take comprehensive safety measures to nullify the effects of forcing the end device to a different state (such as closing manual isolation valves, venting pressurized lines, disconnecting power, independently disabling the device by other means, etc.). Have these measures checked by a separate cognizant person prior to forcing the end device to a different state. BE AWARE that incorrect wiring may inadvertently actuate the wrong end device.**

1. **DO1 CH1 FORCE** is set to TRUE to force Discrete Output 1, Channel 1 to the energized state. Set value to FALSE to force the Discrete Output 1, Channel 1 to the de-energized state.

2. **DO1 CH2 FORCE** is set to TRUE to force Discrete Output 1, Channel 2 to the energized state. Set value to FALSE to force the Discrete Output 1, Channel 2 to the de-energized state.

3. **DO1 CH3 FORCE** is set to TRUE to force Discrete Output 1, Channel 3 to the energized state. Set value to FALSE to force the Discrete Output 1, Channel 3 to the de-energized state.

4. **DO1 CH4 FORCE** is set to TRUE to force Discrete Output 1, Channel 4 to the energized state. Set value to FALSE to force the Discrete Output 1, Channel 4 to the de-energized state.

5. **DO1 CH5 FORCE** is set to TRUE to force Discrete Output 1, Channel 5 to the energized state. Set value to FALSE to force the Discrete Output 1, Channel 5 to the de-energized state.

6. **DO1 CH6 FORCE** is set to TRUE to force Discrete Output 1, Channel 6 to the energized state. Set value to FALSE to force the Discrete Output 1, Channel 6 to the de-energized state.

7. **DO1 CH7 FORCE** is set to TRUE to force Discrete Output 1, Channel 7 to the energized state. Set value to FALSE to force the Discrete Output 1, Channel 7 to the de-energized state.

8. **DO1 CH8 FORCE** is set to TRUE to force Discrete Output 1, Channel 8 to the energized state. Set value to FALSE to force the Discrete Output 1, Channel 8 to the de-energized state.

9. **DO2 CH1 FORCE** is set to TRUE to force Discrete Output 2, Channel 1 to the energized state. Set value to FALSE to force the Discrete Output 2, Channel 1 to the de-energized state.

10. **DO2 CH2 FORCE** is set to TRUE to force Discrete Output 2, Channel 2 to the energized state. Set value to FALSE to force the Discrete Output 2, Channel 2 to the de-energized state.

11. **DO2 CH3 FORCE** is set to TRUE to force Discrete Output 2, Channel 3 to the energized state. Set value to FALSE to force the Discrete Output 2, Channel 3 to the de-energized state.

12. **DO2 CH4 FORCE** is set to TRUE to force Discrete Output 2, Channel 4 to the energized state. Set value to FALSE to force the Discrete Output 2, Channel 4 to the de-energized state.

13. **DO2 CH5 FORCE** is set to TRUE to force Discrete Output 2, Channel 5 to the energized state. Set value to FALSE to force the Discrete Output 2, Channel 5 to the de-energized state.

14. **DO2 CH6 FORCE** is set to TRUE to force Discrete Output 2, Channel 6 to the energized state. Set value to FALSE to force the Discrete Output 2, Channel 6 to the de-energized state.

15. **DO2 CH7 FORCE** is set to TRUE to force Discrete Output 2, Channel 7 to the energized state. Set value to FALSE to force the Discrete Output 2, Channel 7 to the de-energized state.

16. **DO2 CH8 FORCE** is set to TRUE to force Discrete Output 2, Channel 8 to the energized state. Set value to FALSE to force the Discrete Output 2, Channel 8 to the de-energized state.

IMPORTANT **Be sure to set the 'FORCE DISCRETE OUTS' on the CFIG Option menu back to FALSE when discrete output testing is completed. Failure to do so will hold the output in the last forced state.**

FORCE DO 3 & 4

This menu allows **LINKnet Discrete Outputs 3 and 4** to be manually forced on or off during installation to test the output loops. This feature and menu is only available when FORCE DISCRETE OUTS on the CFIG OPTION menu is set TRUE.

NOTICE **Before actuating any end device, be sure that forcing the end device to a different state will not cause an unsafe or unwanted condition or event to occur, and take comprehensive safety measures to nullify the effects of forcing the end device to a different state (such as closing manual isolation valves, venting pressurized lines, disconnecting power, independently disabling the device by other means, etc.). Have these measures checked by a separate cognizant person prior to forcing the end device to a different state. BE AWARE that incorrect wiring may inadvertently actuate the wrong end device.**

1. **DO3 CH1 FORCE** is set to TRUE to force Discrete Output 3, Channel 1 to the energized state. Set value to FALSE to force the Discrete Output 3, Channel 1 to the de-energized state.

2. **DO3 CH2 FORCE** is set to TRUE to force Discrete Output 3, Channel 2 to the energized state. Set value to FALSE to force the Discrete Output 3, Channel 2 to the de-energized state.

3. **DO3 CH3 FORCE** is set to TRUE to force Discrete Output 3, Channel 3 to the energized state. Set value to FALSE to force the Discrete Output 3, Channel 3 to the de-energized state.

4. **DO3 CH4 FORCE** is set to TRUE to force Discrete Output 3, Channel 4 to the energized state. Set value to FALSE to force the Discrete Output 3, Channel 4 to the de-energized state.

5. **DO3 CH5 FORCE** is set to TRUE to force Discrete Output 3, Channel 5 to the energized state. Set value to FALSE to force the Discrete Output 3, Channel 5 to the de-energized state.

6. **DO3 CH6 FORCE** is set to TRUE to force Discrete Output 3, Channel 6 to the energized state. Set value to FALSE to force the Discrete Output 3, Channel 6 to the de-energized state.

7. **DO3 CH7 FORCE** is set to TRUE to force Discrete Output 3, Channel 7 to the energized state. Set value to FALSE to force the Discrete Output 3, Channel 7 to the de-energized state.

8. **DO3 CH8 FORCE** is set to TRUE to force Discrete Output 3, Channel 8 to the energized state. Set value to FALSE to force the Discrete Output 3, Channel 8 to the de-energized state.

9. **DO4 CH1 FORCE** is set to TRUE to force Discrete Output 4, Channel 1 to the energized state. Set value to FALSE to force the Discrete Output 4, Channel 1 to the de-energized state.

10. **DO4 CH2 FORCE** is set to TRUE to force Discrete Output 4, Channel 2 to the energized state. Set value to FALSE to force the Discrete Output 4, Channel 2 to the de-energized state.

11. **DO4 CH3 FORCE** is set to TRUE to force Discrete Output 4, Channel 3 to the energized state. Set value to FALSE to force the Discrete Output 4, Channel 3 to the de-energized state.

12. **DO4 CH4 FORCE** is set to TRUE to force Discrete Output 4, Channel 4 to the energized state. Set value to FALSE to force the Discrete Output 4, Channel 4 to the de-energized state.

13. **DO4 CH5 FORCE** is set to TRUE to force Discrete Output 4, Channel 5 to the energized state. Set value to FALSE to force the Discrete Output 4, Channel 5 to the de-energized state.

14. **DO4 CH6 FORCE** is set to TRUE to force Discrete Output 4, Channel 6 to the energized state. Set value to FALSE to force the Discrete Output 4, Channel 6 to the de-energized state.

15. **DO4 CH7 FORCE** is set to TRUE to force Discrete Output 4, Channel 7 to the energized state. Set value to FALSE to force the Discrete Output 4, Channel 7 to the de-energized state.

16. **DO4 CH8 FORCE** is set to TRUE to force Discrete Output 4, Channel 8 to the energized state. Set value to FALSE to force the Discrete Output 4, Channel 8 to the de-energized state.

IMPORTANT

Be sure to set the 'FORCE DISCRETE OUTS' on the CFIG Option menu back to FALSE when discrete output testing is completed. Failure to do so will hold the output in the last forced state.

Chapter 4.
Initial Adjustments

Introduction

This chapter contains information on control calibration. It includes initial 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.

Start-up Adjustments

1. Complete the installation checkout procedure in Chapter 2 and the prestart menu settings in Chapter 3.

2. Close the Run/Stop contact. Be sure the Idle/Rated 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 1.0 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 is cleared. 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 will reduce fuel as required when the speed setting is reached. It may require extra fuel to accelerate the engine to start speed or idle speed, whichever is configured.) It may take a few start attempts to determine the final setting of the Start Fuel Limit. If the start time is excessive (lightoff speed too slow), increase the Start Fuel Limit. If the start time/lightoff speed is too fast or flooding occurs, decrease the Start Fuel Limit. The start speed reference, if configured, must be set above cranking speed but below the speed achieved with the start fuel limit setting (light-off speed). We recommend trying both hot and cold starts to determine a final setting.

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 time. If increasing the Reset time 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 Control View or Watch Window (Refer to “help” if you need help). The Programmer will display the message “Saving Changes”. Control View or Watch Window has a “pop-up” box that says the value have been saved.

Dynamic Adjustments

The objective of the dynamic adjustments is to obtain the optimum, 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 actuator output or engine speed becomes slightly unstable, then reduce the Gain as necessary to stabilize the engine.

   After acceptable performance at no load, record the Actuator Output as read on the Display Menu. Set the Gain Slope Breakpoint (1st Dynamics Menu) to this reading.

   Observe the movement of the actuator. If the activity of the actuator is excessive, reduce the Gain set point slightly to achieve an acceptable actuator movement 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 Reset slightly. Observe the movement of the actuator or actuator output. Continue to increase Reset until the movement is active and acceptable but not rapid or 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.

   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 4-4.

⚠WARNING

The use of negative Gain Slope should be considered carefully. Low gain at high fuel levels will result in poor load rejection response or 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.

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 the Display Menu. 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.

Speed Adjustments

Adjustment of the start, idle, rated, raise, and lower references should not require further setting as they are precisely determined. The Remote Speed Setting input and the Tachometer Output, however, involve analog circuits and may require adjustment. These adjustments can be found on the Set Analog Inputs menu and Set Analog Outputs menu.

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.

2. 4 to 20 mA Tachometer Output

   Set engine speed to the speed desired for 4 mA output. If this is not possible, skip this step or use a signal generator into the speed input with the correct frequency corresponding to the desired rpm. Trim the Tach at 4 mA Output rpm set point for 4 mA set point output.

   Set engine speed to the speed desired for 20 mA output. Trim the Tach at 20 mA Output rpm set point for 20 mA set point output.

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

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 Control View or Watch Window (Refer to “help” if you need help). Run through all the set points and record them in Appendix D for future reference. Settings can also be saved to a file using Control View or 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). Control View or 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 features and operation of the 723PLUS Digital Industrial Speed/Process Control. Figure 6-1 shows the control block diagram for reference in the following descriptions.

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

The speed sensor inputs (8280-464 and 8280-465 controls) contain a special tracking filter designed for reciprocating engines, which minimizes the effects of firing torsionals so that the actuator will not respond to speed sensor changes it cannot control with the fuel. This provides exceptionally smooth steady-state control and allows the control dynamics to be matched to the engine rather than detuned to compensate for firing torsional frequencies. 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 that 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.

The 723PLUS control provides two separate serial interfaces. Servlink is available on port J2 for RS-232 or RS-422 communications. An industry-standard Modbus is available on port J3 for RS-232, RS-422, or RS-485 communications in both ASCII and RTU protocols.

The 723PLUS control communicates, using the LonTalk® protocol, with optional LINKnet modules. LINKnet modules can be added to provide additional I/O for monitoring and control. These modules are self-binding to the 723PLUS control. The LINKnet Nodes include J-Type Thermocouple, RTD, Analog Input, Analog Output, Discrete Input, and Discrete Output modules.

Control Dynamics

The control algorithms used in the 723PLUS Industrial Speed/Process Control are designed specifically for reciprocating engine applications. The control offers a powerful set of dynamics to closely match a wide variety of fuel delivery systems and processes.

Constant dynamics remain fixed as entered and do not vary with engine speed. Dynamics may still vary with fuel demand by using the 5-Gain mapped dynamics or the gain slope. Constant dynamics are useful for fuel systems and processes that tend to be equally stable at reduced speed and rated speed.

Variable dynamics vary gain by the ratio of actual engine speed to rated speed, and inversely vary reset by the ratio of rated speed to actual engine speed. The variable dynamics value is multiplied by the gain or the 5-Gain mapped dynamics setting (whichever is elected). Variable dynamics are useful for fuel systems and processes that tend to be less stable at reduced speed operation.

The 5-Gain mapped dynamics is a two-dimensional curve with five breakpoints that vary gain as a function of fuel demand. The 5-Gain mapped dynamics compensate for non-linear fuel systems and are useful for engines or processes whose dynamics change in a non-linear manner with load.

Gain slope and gain breakpoint vary the gain linearly as a function of fuel demand (load). This provides the flexibility to increase or decrease gain as load increases. Gain slope and gain breakpoint are available for both constant and variable dynamics choices. It is disabled when 5-Gain mapped dynamics is chosen. Gain slope and gain breakpoint are useful for fuel systems and processes that tend to be less stable at reduced or increased load operation. This function may be disabled by setting the gain slope at zero.

The control can automatically switch between two gain settings, based on engine speed error, to provide improved transient load performance. Speed error is the difference between the speed reference and compensated engine speed. During steady-state constant-load operation, the control uses the base gain setting. This base gain is adjusted by the user to a value which prevents the control from responding to minor speed fluctuations inherent with spark-ignited gas engines. This feature essentially eliminates harmful jiggle of the actuator and fuel system linkage. When the speed error exceeds an adjustable window width (e.g., during a load transient), the control automatically increases gain by an adjustable ratio. This increased gain produces a faster fuel response and quickly restores engine speed at the speed reference. The base gain is restored once the control senses a return to steady-state operation. This feature is available for all gain choices.

The control provides an actuator bump feature which can be set, by the bump level and duration, to simulate a load transient and test the window width and gain ratio dynamic settings before actual application of load.

The control also provides a second complete set of dynamic adjustments which are selected when the 2nd Dynamics discrete input is activated. Two sets of dynamics are useful where engine operating conditions change, such as in dual-fuel engines or systems with different processes which demand separate dynamic adjustments.

The Cascade Process Control dynamics are fixed as entered and do not include the various dynamic choices described above for the speed control.

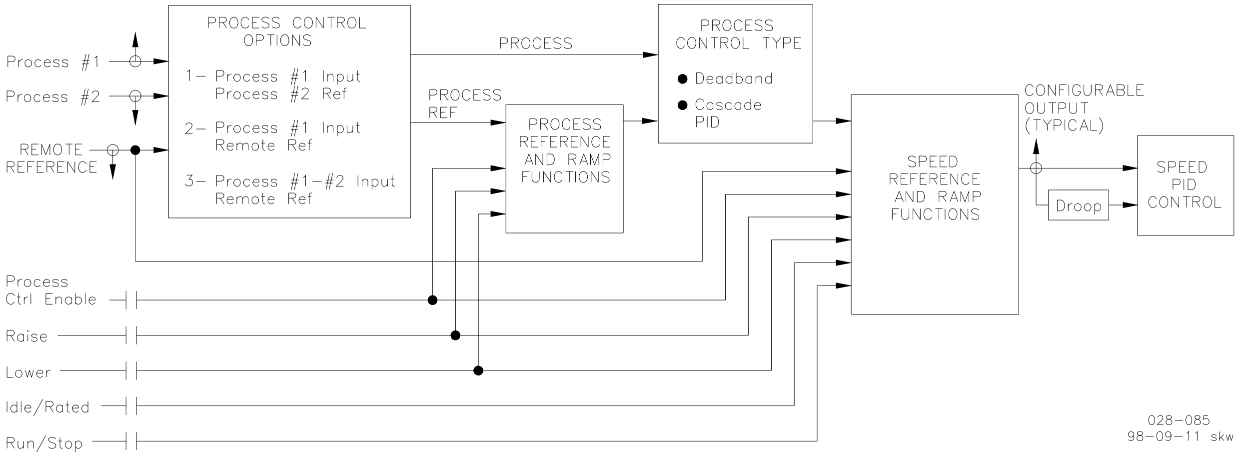


Figure 6-1. Simplified Block Diagram

Speed Input

One or two speed sensors provide an engine speed signal to the control. The method used to detect speed is configurable for either a digital type of detection or an analog type of detection. Set “Use Dig Spd Sensor” TRUE or FALSE in the CFIG Speed Control menu. 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 selects the higher of the two inputs for 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 driven load, and the coupling can also release energy as the engine decreases torque to the driven load. This effect causes the instantaneous change in speed of the driven load 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 Torsional Filter 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.

Notch Filter Function

When “Use Notch Filter” is configured FALSE, the notch filter function is disabled. When “Use Notch Filter” is configured TRUE, a notch filter is enabled for single speed sensor applications that will benefit from torsional filtering. “Use Torsional Filter” and “Enable Tors Filter” must also be set TRUE to use the notch filter. 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.

Minimum Fuel Function

The Minimum Fuel Function brings the fuel demand to zero. This occurs when the Close to Run discrete input goes FALSE. It also occurs if both speed sensor inputs have failed when the Spd Fail Ovrd discrete input contact is open. The Close to Run command is the preferred means for a normal shutdown of the engine.

⚠WARNING	**The Close 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 Close 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 engine 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 6-2). 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 at 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.

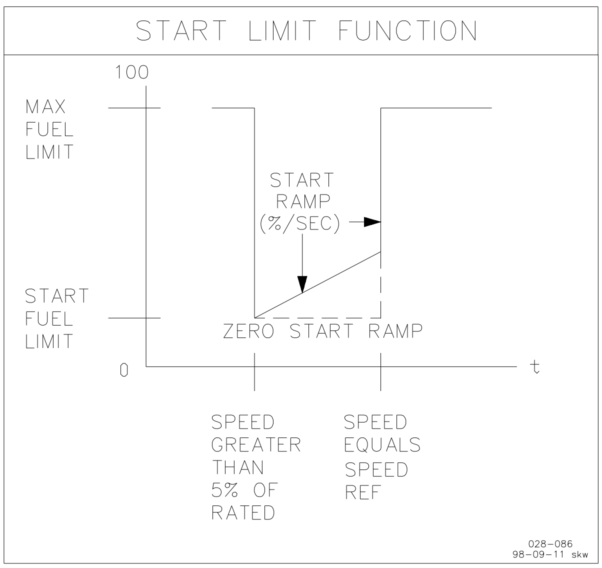


Figure 6-2. Start Limit Function

Fuel Limiting Function

Two separate Fuel Limiting Functions (EXT FUEL LIMIT curve and TORQUE LIMIT curve) provide limits to the fuel demand which prevents overfuel conditions. One function is based on an external transmitter signal provided at Signal Input #4. The other is based on the engine speed provided at the speed inputs. These Fuel Limiting Functions provide two software adjustable five-breakpoint 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 6-3. The functions are enabled when the engine speed first reaches 95 percent of the speed reference. They remain 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 EXT FUEL Limit Curve menu and the Torque Limit Curve menu.

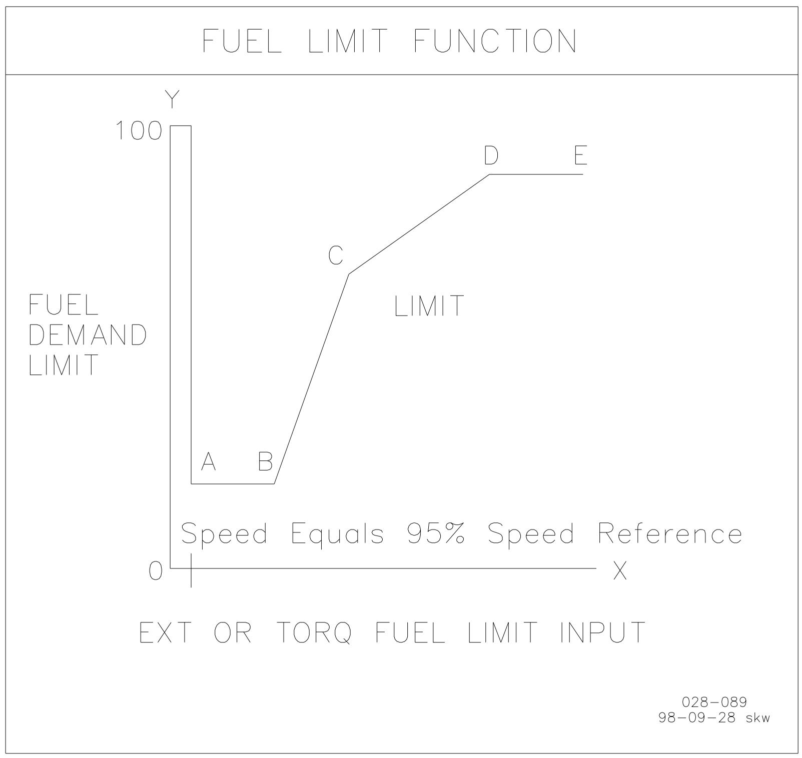


Figure 6-3. Fuel Limit Breakpoints

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).

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

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 the Shutdown menu, Alarm menu, or the Display Analog I/O menu using Watch Window, Control View, or with the Hand Held programmer. Toggling the Alarm Reset discrete input TRUE, then FALSE, issues the Alarm Reset command. An Alarm Reset is also issued when power is applied to the 723PLUS. And finally, the control issues an Alarm Reset during startup (when configured).

Speed and Process Reference and Ramps

The 723PLUS control provides local control with discrete inputs for raising and lowering speed or the process reference. For remote speed setting, the control provides a 4 to 20 mA or 1 to 5 Vdc Remote Reference input and a Modbus analog write (AW) address 4:0005. For remote process setting, the control provides a 4 to 20 mA or 1 to 5 Vdc input, configurable as a Remote Process Reference input, in addition to the Remote Speed Reference input. Input functions are enabled as follows:

- Local Speed Reference Raise/Lower discrete inputs are enabled when remote speed setting **is not** enabled and process control **is not** enabled.
- Local Process Reference Raise/Lower discrete inputs are enabled when remote process speed setting **is not** enabled and process control **is** enabled.
- Remote Speed Reference setting is enabled when the Raise Speed and Lower Speed contacts are both closed, the Rated contact is closed **or** Force to Idle is configured FALSE, Process Control **is not** enabled and Modbus Reference is configured FALSE.
- Modbus Speed Reference setting is enabled when the Raise Speed and Lower Speed contacts are both closed, the Rated contact is closed **or** Force to Idle is configured FALSE, Process Control **is not** enabled and Modbus Reference is configured TRUE.
- Remote Deadband Process setting is enabled when the Raise Process and Lower Process contacts are both closed, the Rated contact is closed **or** Force to Idle is configured FALSE, Process Control **is** enabled, the speed control is not on a fuel limit, and use Cascade Process **is FALSE**.
- Remote Cascade PID Process setting is enabled when the Raise Process and Lower Process contacts are both closed, the Rated contact is closed **or** Force to Idle is configured FALSE, Process Control **is** enabled, the speed control is not on a fuel limit, and use Cascade Process **is TRUE**.

Speed Reference and Ramp Functions

This section describes the operation of the speed reference and ramp functions and their relation to each other. The speed raise/lower, remote reference, and ramp functions are active when the process control **is not** enabled. The start and idle/rated references and accel/decel ramp functions are active in all modes. Priority can be assigned to the idle/rated reference or to the raise/lower and remote references. Start reference has the highest priority. Read this section carefully to be sure your sequencing provides the proper operating modes.

The control provides start, idle, lower limit, raise limit, and rated 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 start to idle speed and 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 reference and process reference inputs.

The start speed set point provides a speed reference above cranking speed but below the speed achieved with the start fuel limit setting (light-off speed). Achieving start speed begins a ramp to the selected speed reference (usually idle). This function is configurable. The default has this function disabled. It can be enabled for applications which need this function (e.g., spark gas recip engines). This Start reference is selected, at a very fast rate, by control power-up, engine not running, or engine cranking. When configured TRUE, the Start reference is given first priority over all other references.

A Force to Idle configuration option, provides a means of assigning priority to the idle/rated speed reference **or** to the raise/lower and remote references. When set to TRUE, priority is assigned to the Idle/Rated contact input. When set to FALSE priority is assigned to the Raise/Lower and Remote Reference inputs.

IMPORTANT

Setting 'Force to Idle' FALSE and enabling the remote speed reference prior to engine starting overrides the Idle/Rated switch. The speed reference will be the remote speed reference value when the engine is started. Do not enable the remote speed reference prior to starting if the idle speed reference is the preferred reference for starting.

When Force to Idle is set to FALSE, the Idle/Rated contact input function is the same, but since it has a lower priority than the raise/lower and remote references, activating these inputs will override the Idle/Rated contact input. Merely selecting the raise/lower or remote input initiates a ramp, at the Raise or Lower rate, to the value set by that particular input device, regardless of the Idle/Rated contact input position. This selection may be made at any time before or after starting the engine. The Idle and Rated speed references are canceled once this selection is made and the value set by the active input device becomes the speed reference. Note that the Start Speed reference, when configured, has first priority and is the speed reference until the engine starts. The ramp to the selected reference begins after the engine speed exceeds the start speed setting. Note also that after starting, if no priority input selection is made, speed will ramp to the reference selected by the Idle/Rated contact input. This may not be the desired mode of operation, so be sure to understand the implications of operating the control in this manner.

The idle speed set point is provided for engine warm-up or cool-down cycles. 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 at a lower speed. Idle speed cannot be changed except through adjustment of the idle speed set point. The idle speed set point is selected when the Rated contact is open, if no other priority input is assigned and active.

Closing the Rated contact ramps the speed set point from idle to rated if no other priority input is assigned and active.

When Force to Idle is set to TRUE, 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 settings. The raise and lower commands will not increase the speed reference above the raise limit or below the lower limit.

When Force to Idle is set TRUE, if remote operation is selected after the engine reaches rated speed, the control will ramp speed to the reference value set by the Remote Reference milliamp input or the Modbus AW value, as configured, at the raise or lower rate settings. The Remote Reference operates from 4 to 20 mA (1 to 5 Vdc). The rpm values of the 4 mA and 20 mA remote reference set points must be set between the raise and lower limit settings. 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 Force to Idle is configured TRUE and the Remote Reference input or the Modbus AW value is present and selected when the Idle/Rated contact is closed or during the idle to rated ramp, the speed reference will ramp to the rpm value set by the Remote Reference milliamp input or the Modbus AW value at the raise or lower rate settings. 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) or above 21 mA (5.25 Vdc), the Remote Reference input is considered failed or out of range. 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 and 20 mA Remote Reference set points (see Figure 6-4). If a difference is detected between the present speed reference and the remote reference rpm value, the present speed reference is ramped up or down at the raise or lower rate until the present speed reference matches the remote speed reference rpm value. The remote reference will not increase/decrease the speed reference above the raise limit or below the lower limit.

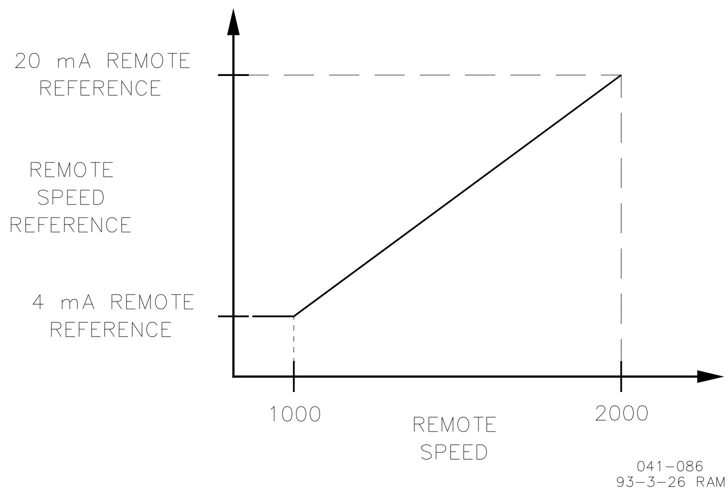


Figure 6-4. Remote Speed Reference

When operating in remote mode, if the remote input goes below 2 mA (0.5 Vdc) or above 21 mA (5.25 Vdc) or a Modbus communication link error occurs, the speed reference remains at the present value if the lock-in-last option is TRUE. Otherwise the reference follows the failed or out-of-range remote input value, or the Modbus default AW value, at the raise or lower rate, until a raise or lower limit is reached.

If the Idle/Rated contact is changed to idle after operating at rated, the control will immediately ramp engine speed to idle based on the decel time set point if Force to Idle is configured TRUE or if Force to Idle is configured FALSE but the remote speed reference is not enabled. Otherwise, the reference will remain at the remote reference setting. The remote speed reference must be adjusted to change speed in this situation.

Process Reference and Ramp Functions

This section describes the operation of the process reference and ramp functions and their relation to each other and to the speed reference. The process reference raise/lower, remote process reference, and ramp functions are active when the process control is enabled. Read this section carefully to be sure your sequencing provides the proper operating modes.

During process mode operation, the start, idle, rated, accel, and decel functions remain the same as previously described for remote speed reference and ramp functions. However, the control now uses process reference raise and lower limit settings and process reference raise and lower rates in place of speed limits and rates. The process reference limits and rates are active for all process control modes. Process reference raise and lower rates determine how fast the process reference is increased or decreased by the raise and lower command inputs and the remote process reference input. The control may be configured to use either the Process #2 or Remote Reference input as the Remote Process Reference setting.

The **Speed Reference Rates** are switched by the process operating modes as follows:

- When in Deadband Process Control mode, the **speed reference** is raised and lowered at the DB Increase and DB Decrease rate settings. These rates are in control when Deadband Process Control is configured and enabled.
- When switching to Cascade PID Process Control mode, if the absolute process error (process reference minus process) exceeds the present process reference by 5%, the **speed reference** is raised and lowered at the Cascade Not Matched rate. This rate is set to reduce the error rapidly before activating the Cascade PID control. An excessive rate may cause instability.
- Once in Cascade PID Process control, if the absolute process error is at or below 5% of the present process reference, the **speed reference** is raised and lowered at a very fast rate. The actual engine **speed reference** rate is determined solely by tuning of the Cascade PID control.

The maximum and minimum speed limit settings remain active and will override the process control should it attempt to change engine speed beyond these limits.

A Force to Idle configuration option provides a means of assigning priority to the idle/rated speed reference or to the process raise/lower and remote process reference. When set to TRUE, priority is assigned to the Idle/Rated contact input. When set to FALSE priority is assigned to the Process Raise/Lower and Remote Process Reference inputs.

IMPORTANT

Setting 'Force to Idle' false and enabling the remote process reference prior to engine starting overrides the Idle/Rated switch. The speed reference will be determined by the remote process reference value when the engine is started. Depending on the configuration of the process control, the speed reference may be driven to the maximum speed or minimum speed setting by the process control. Do not enable the remote process reference prior to starting if the idle speed reference is the preferred reference for starting.

When Force to Idle is set to FALSE, the Idle/Rated contact input function is the same, but since it has a lower priority than the Process raise/lower and remote process reference, activating these inputs will override the Idle/Rated contact input. Merely selecting the Process raise/lower or remote process reference input initiates a ramp, at the Process Raise or Lower rate, to the value set by that particular input device, regardless of the Idle/Rated contact input position. This selection may be made at any time before or after starting the engine. The Idle and Rated speed references are canceled once this selection is made and the value set by the active input device becomes the process reference. Note that the Start Speed reference, when configured, has first priority and is the speed reference until the engine starts. The ramp to the selected process reference begins after the engine speed exceeds the start speed setting. Note also that after starting, if no priority input selection is made, speed will ramp to the reference selected by the Idle/Rated contact input. This may not be the desired mode of operation, so be sure to understand the implications of operating the control in this manner.

The raise and lower commands increase and decrease the process reference based on the raise and lower process reference rate settings. The raise and lower commands will not increase or decrease the process reference above or below the process raise and lower limits. The process reference adjusts engine speed by applying a configured Deadband or Cascade PID control signal to the speed reference. The speed reference adjusts engine speed to regulate the process and keep the process at the process reference setting.

When Force to Idle is set to TRUE, if remote process control is selected after the engine reaches rated speed, the control will ramp the process reference to the value set by the Remote Process Reference milliamp input at the process raise or lower rate settings. The Remote Process Reference operates from 4 to 20 mA (1 to 5 Vdc). The values of the 4 mA and 20 mA remote process reference set points must be set between the process raise and lower limit settings. The 4 mA Remote Process Reference set point may be set to a lower or higher value than the 20 mA set point, providing for either direct or reverse-acting remote process setting.

When Force to Idle is configured TRUE and the Remote Process Reference input is present and selected when the Idle/Rated contact is closed or during the idle to rated ramp, the process reference will ramp to the value set by the Remote Process Reference milliamps input at the process raise or lower rate settings. 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) or above 21 mA (5.25 Vdc), the Remote Process Reference input is considered failed or out of range. Between 4 and 20 mA (1 and 5 Vdc), the control determines the required process reference based on a straight line between the 4 mA and 20 mA Remote Process Reference set points. If a difference is detected between the present process reference and the remote process reference value, the process reference is ramped up or down at the process raise or lower rate until the present process reference matches the remote process reference value. The remote process reference will not increase the process reference above the process raise limit or decrease the process reference below the lower limit.

When operating in remote process mode, if the Remote Process Reference input goes below 2 mA (0.5 Vdc) or above 21 mA (5.25 Vdc), the process reference remains at the present value if the lock-in-last option is TRUE. Otherwise the process reference follows the failed or out-of-range remote input value, at the process raise or lower rate, until a process raise or lower limit is reached.

Process Control

The Process Control may be configured as either a Deadband or Cascade PID process control, and one of three process control operating modes may be selected. Process control may also be disabled by configuration. The following describes the configuration choices:

- Deadband Process control is configured by setting Use Cascade Process to FALSE in the CFIG Option menu.
- Cascade PID Process control is configured by setting Use Cascade Process to TRUE in the CFIG Option menu.
- PROCESS CTRL OPTION menu is used to choose the Process Control mode according to the following selections:

    0 = Process Control disabled. DB PROCESS CONTROL and CASCADE PROC CTRL menus are concealed and Process control is disabled.
    1 = Process Control using Process Input #2 as the Remote Process Reference and Process Input #1 as the single process variable.
    2 = Process Control using the Remote Reference Input as the Remote Process Reference and Process Input #1 as the single process variable.
    3 = Differential Process Control using the Remote Reference Input as the Remote Process Reference and Process Input #1 minus Process Input #2 difference as the differential process variable.

Deadband Process Control

The Deadband Process Control has three configurable operating modes as described earlier. In all three modes a process reference input and a single or differential process variable input are used by the Deadband Process Control to adjust the speed reference. The process reference will not increase above the Process Raise Limit setting nor decrease below the Process Lower Limit setting.

When the process variable is below the process reference by more than the tunable deadband setting, a raise speed reference command is issued. The speed reference is raised at the DB increase rate setting until the process variable is back within the deadband setting. The raise speed command will not increase speed above the Maximum Speed setting.

When the process variable is above the process reference by more than the tunable deadband setting, a lower speed reference command is issued. The speed reference is lowered at the DB decrease rate setting until the process variable is back within the deadband setting. The lower speed command will not decrease speed below the Minimum Speed setting.

The Deadband control action may be reversed, during configuration, by setting Process Rev Acting to TRUE on the CFIG Option menu. Set to TRUE for applications where **increasing** speed **decreases** the process variable (e.g., Suction Pressure control). Set to FALSE for applications where **increasing** speed **increases** the process variable (e.g., Flow or Discharge Pressure control). The default setting is FALSE.

Cascade PID Process Control

The Cascade PID Process Control has three configurable operating modes as described earlier. In all three modes a process reference input and a single or differential process variable input are used by the Cascade PID Process control to adjust the speed reference. The process reference will not increase above the Process Raise Limit setting nor decrease below the Process Lower Limit setting.

When the Cascade PID Process control is enabled, if the absolute process error (process reference minus process variable) exceeds the present process reference by 5%, the Cascade PID Process control switches to a tracking mode, and a deadband mode is activated. In this deadband mode the speed reference is raised and lowered at the Cascade Not Matched rate. The Cascade Not Matched rate is set on site to a rate which reduces the absolute process error rapidly without causing instability.

After the Cascade PID Process control is enabled and once the absolute process error is within 5% of the present process reference, the Cascade PID Process Control switches out of tracking mode and into a control mode. The deadband mode and the Cascade Not Matched speed reference rate are disabled. The speed reference rate is switched to a very fast rate. As stated earlier, the actual engine speed reference rate is determined solely by tuning of the Cascade PID control.

Once in Cascade PID Process control mode, the control will not switch back to the deadband control mode should the absolute process error again exceed 5%. The Cascade PID Process control must be disabled to switch out of Cascade PID Process Control mode.

The speed reference scale between 0 to 100% Cascade PID output is set by the SPD REF @ 0% PID and SPD REF @ 100% PID on the CASCADE PROC CTRL menu. The speed reference is linear between these two settings. The speed reference set point at 0% PID output may be set to a lower or higher speed than the speed reference set point at 100% PID output, providing for either direct or reverse-acting Cascade PID control action.

The Remote Reference operates from 4 to 20 mA (1 to 5 Vdc). The rpm values of the 4 mA and 20 mA remote reference set points must be set between the raise and lower limit settings. 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.

When the control is in the Cascade PID Process Control mode, the speed reference is regulated by the Cascade PID Control signal. The control is, by default settings, direct acting. When the process variable is below the process reference, the Cascade PID control signal increases the speed reference. When the process variable is above the process reference, the Cascade PID control signal decreases the speed reference.

IMPORTANT	**To reverse the action of the Cascade PID Process control, set the Spd Ref @ 0% PID value ABOVE the Spd Ref @ 100% PID value on the Cascade Proc Ctrl menu.**

Dynamic adjustments of the Cascade PID Process control are made to obtain optimum process transient response and stability.

- Proc Gain determines how fast the control responds to an error in process from the process reference setting. The Proc Gain is set to provide stable control of the process at all operating conditions. Increasing Proc Gain increases response, but decreases stability. Decreasing Proc Gain increases stability, but decreases response.
- Proc Integral Gain adjusts the time required for the control to return the process to zero error after a disturbance. Proc Integral Gain is adjusted to prevent slow hunting and to minimize process overshoot after a disturbance.

Droop

Droop is a tunable value which decreases the speed reference when load increases as determined by the actuator output. Droop is set as a percentage of rated speed. A setting of 0% disables the Droop function.

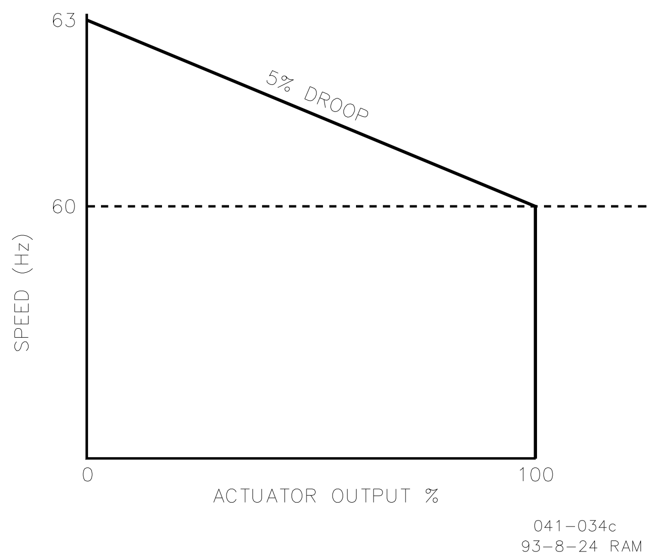


Figure 6-5. Droop Speed Setting

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 will turn off all outputs from the control. If diagnostic testing is successful, the green CPU OK indicator on the control cover will light.

Chapter 6.
Troubleshooting

General

The following troubleshooting guide is an aid in isolating trouble to the control box, actuator, control 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.

NOTICE	**The engine must be shut down for all system checks.**

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, Control View, 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 tests (if applicable). **Be sure the jumper between terminals 9 and 10 is removed to use the Hand Held Programmer** (do note remove the jumper to use Watch Window or Control View). Failure to do the power up test indicates that either the control or the 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 in Control View by clicking “help” then “about”. Verify the controller ID on the Hand Held Programmer by pressing the “ID” key. Verify the controller ID in Watch Window by reading “Control Properties”. The Application ID message “5414-148” 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 Control View or 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. Repeat this step for all discrete inputs. Close the appropriate input. The status in DISPLAY DIGITAL I/O should be TRUE. If the value does not change from FALSE to TRUE when the contact is closed, verify the LED is illuminated at the respective control terminal. If the LED is illuminated and correct voltage is verified, the control has failed and should be replaced. If the LED is NOT illuminated and correct voltage is verified at the terminal (common to terminal 37), the control has failed and should be replaced.

Process #1 Xdcr Input

The following tests calibrate and verify the function of the Process Input #1 Xdcr 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, a jumper must be installed across terminals 41 and 42. Connect a dc 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 (20.0 mA) on the meter. Select DISPLAY MENU on the Hand Held Programmer, Control View, or Watch Window. Select PROCESS INPUT #1.

3. The PROCESS INPUT #1 value should be equal to the PROCESS #1@20mA value set previously in the SET ANALOG INPUTS menu.

4. Set the source for 1.0 Vdc (4.0 mA). The PROCESS INPUT #1 value should be equal to the PROCESS #1@4mA value set previously in the SET ANALOG INPUTS menu. If the meter indicates proper voltages (or currents) are present on Signal Input #1, but readings on the Hand Held Programmer, Control View, or Watch Window are incorrect, the 723PLUS control is defective and should be replaced.

Process #2 Xdcr Input

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

1. Connect a 4 to 20 mA or 1 to 5 Vdc source to terminals 45(+) and 46(–). If a mA source is used, a jumper must be installed across terminals 44 and 45. Connect a dc voltmeter across terminals 45(+) and 46(–). Optionally, a mA meter may be installed in series with the 4 to 20 mA source.

2. Set the source for 5.0 Vdc (20.0 mA) on the meter. Select DISPLAY MENU on the Hand Held Programmer, Control View, or Watch Window. Select PROCESS INPUT #2.

3. The PROCESS INPUT #2 value should be equal to the PROCESS #2@20mA value set previously in the SET ANALOG INPUTS menu.

4. Set the source for 1.0 Vdc (4.0 mA). The PROCESS INPUT #2 value should be equal to the PROCESS #2@4mA value set previously in the SET ANALOG INPUTS menu. If the meter indicates proper voltages (or currents) are present on Signal Input #2, but readings on the Hand Held Programmer, Control View, or Watch Window are incorrect, the 723PLUS control is defective and should be replaced.

Remote Speed Xdcr Input

The following tests calibrate and verify the function of the Remote Speed Xdcr 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, a jumper must be installed across terminals 47 and 48. Connect a dc 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 (20.0 mA) on the meter. Select DISPLAY MENU on the Hand Held Programmer, Control View, or Watch Window. Select REMOTE SPEED REF.

3. The REMOTE SPEED REF value should be equal to the REM SPEED @20mA value set previously in the SET ANALOG INPUTS menu.

4. Set the source for 1.0 Vdc (4.0 mA). The REMOTE SPEED REF value should be equal to the REM SPEED @4mA value set previously in the SET ANALOG INPUTS menu. If the meter indicates proper voltages (or currents) are present on Signal Input #3, but readings on the Hand Held Programmer, Control View, or Watch Window are incorrect, the 723PLUS control is defective and should be replaced.

External Limiter Xdcr Input

The following tests calibrate and verify the function of the External Fuel Limiter Xdcr 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, a jumper must be installed across terminals 50 and 51. Connect a dc 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 (20.0 mA) on the meter. Select DISPLAY MENU on the Hand Held Programmer, Control View, or Watch Window. Select EXT FUEL LIMIT IN.

3. The EXT FUEL LIMIT IN value should be equal to the EXT FUEL LMT @ 20mA value set previously in the SET ANALOG INPUTS menu.

4. Set the source for 1.0 Vdc (4.0 mA). The EXT FUEL LIMIT IN input value should be equal to the EXT FUEL LMT @ 4mA value set previously in the SET ANALOG INPUTS menu. If the meter indicates proper voltages (or currents) are present on Signal Input #4, but readings on the Hand Held Programmer, Control View, or Watch Window are incorrect, the 723PLUS control is defective and should be replaced.

Actuator Output

The following tests verify the actuator output of the control.

1. Connect a frequency signal generator to Speed Sensor Input #1 (terminals 11/12). Set the output level above 1.0 Vrms, and the frequency to a value greater than 5% of rated *frequency* and less than 50% of rated *frequency*.

2. Close the 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 CFIG Option Menu on the Hand Held Programmer, Control View, or Watch Window. Set the Use Rev Actuator to Forward Acting (FALSE).

4. Select the Fuel Limiters Menu. Set Start Fuel Limit to 100%. Set Max Fuel Limit to 20%. The output current should be 42 ± 2 mA.

5. Set the Max Fuel Limit to 100%. The output current should be 210 ± 10 mA. If with all connections verified, the output of the control fails to perform as above, replace the control.

6. Return to the CFIG Option Menu on the Hand Held Programmer, Control View, or Watch Window. Set the Use Rev Actuator to the value as recorded during installation.

Speed Inputs

The following tests verify the operation of the speed inputs.

1. Connect a frequency signal generator to Speed Sensor Input #1 (terminal 11/12). Set the output level above 1.0 Vrms. Record the ASPD #1 TEETH and DSPD #1 TEETH set point from the CFIG SPEED CONTROL Menu. Temporarily set both 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. Increase the signal generator frequency to 2000 Hz. The value read should follow the signal generator frequency.

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

3. Return ASPD #1 TEETH and DSPD #1 TEETH on the CFIG Speed Control Menu to the previously recorded values for your engine.

4. Repeat steps 1–3 for Speed Sensor Input #2 (terminal 13/14).

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 Control View or 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.**

Disconnect the Hand Held Programmer from the control (if applicable). Control View or Watch Window may remain connected or removed from the control as desired. Close the cover over J1 and re-tighten the retaining screw if 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**) 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**.

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**.

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**.

You can also contact the Woodward Customer Service Department at one of the following Woodward facilities to obtain the address and phone number of the nearest facility at which you can obtain information and service.

Products Used In Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 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

Facility	Phone Number
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

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

For the most current product support and contact information, please visit our website directory at **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.) ______________________

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter ______________________

Control Description or Governor Type ______________________

Serial Number ______________________

Control/Governor #2

Woodward Part Number & Rev. Letter ______________________

Control Description or Governor Type ______________________

Serial Number ______________________

Control/Governor #3

Woodward Part Number & Rev. Letter ______________________

Control Description or Governor Type ______________________

Serial Number ______________________

Symptoms

Description ______________________

____

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

Appendix A. Serial Communication Port Wiring

Communication Port J2 can be configured for RS-232 or RS-422 serial communications. Communication Port J3 can be configured for RS-232, RS-422, or RS-485 serial communications. The default setting for both is for RS-232.

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

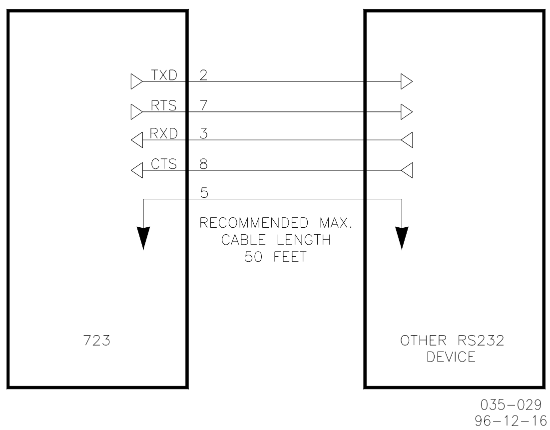


Figure A-1. 723PLUS RS-232 Connections

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

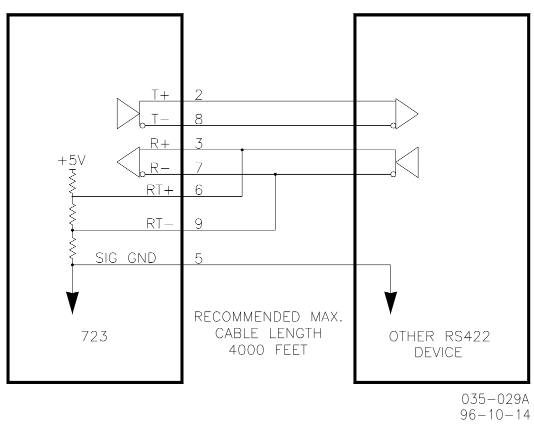


Figure A-2. 723PLUS RS-422 Connections with Optional Termination at Receiver

The RS-485 connections are shown in Figure A-3. The maximum distance from the master Modbus device to the 723PLUS control is 1219 m (4000 ft).

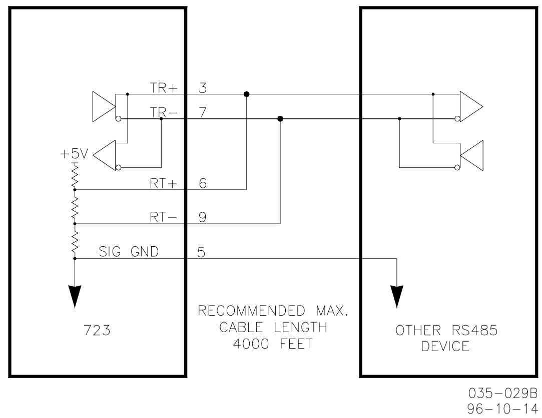


Figure A-3. 723PLUS RS-485 Connections with Optional Termination

RS-422 and RS-485 can use a multi-drop set-up where more than one device is connected to a master device. 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-4 is an example.

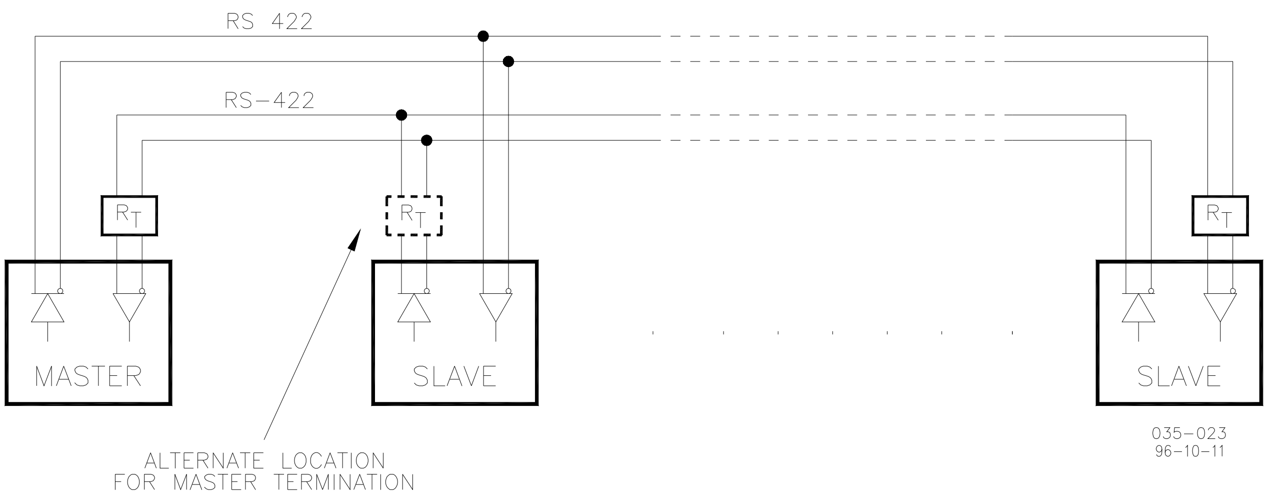


Figure A-4. RS-422 Terminator Locations

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 Ω. 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-5 with the signal ground connection removed on those nodes only.**

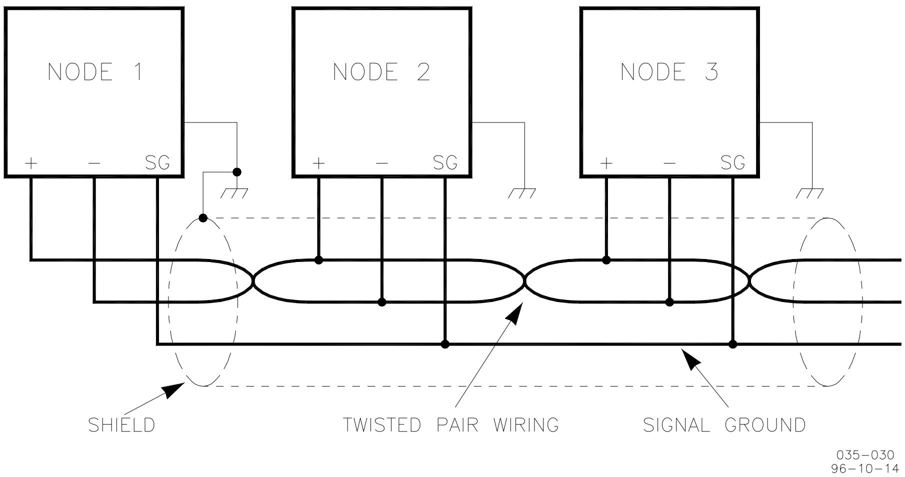


Figure A-5. Preferred Multipoint Wiring Using Shielded Twisted-pair Cable with a Separate Signal Ground Wire

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

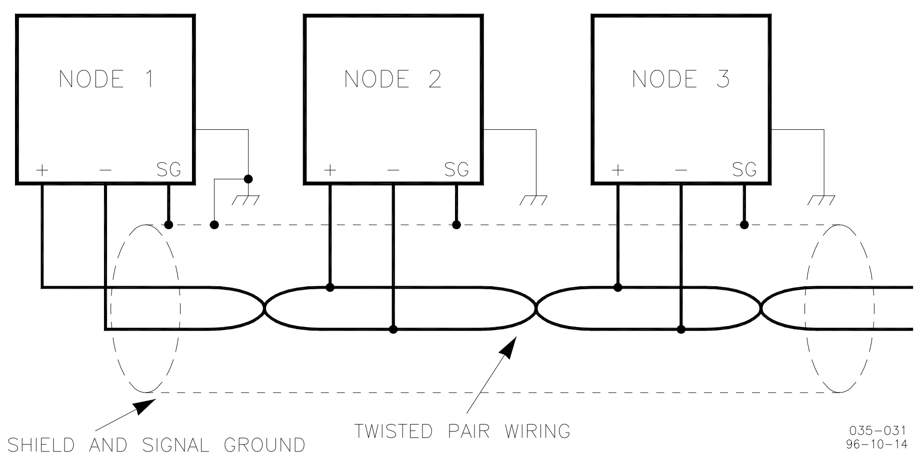


Figure A-6. Alternate Multipoint Wiring Using Shielded Twisted-pair Cable without a Separate Signal Ground Wire

Appendix B. LINKnet™ I/O Network

Introduction

The LINKnet™ option provides distributed I/O capabilities for the 723PLUS control system through LON #1. The LINKnet I/O modules, while slower and less powerful than on-board I/O, are well suited for functions which are not time-critical, such as sequencing and monitoring.

Network Architecture

An I/O network consists of the 723PLUS LON #1 channel, which provides independent network trunks of up to 18 I/O modules. The LINKnet I/O modules, or nodes, on each trunk are attached to the 723PLUS via a single twisted-pair wire (see end of this Appendix for correct wiring geometry).

Each LINKnet I/O module has two rotary switches that are used to set its network address. On installation, these switches must be dialed so that the I/O module's network address of 1–18 matches the network address defined for this I/O module in the application program. The I/O modules may be placed in any order on the network, and gaps are allowed in the address sequence.

Hardware

Each network consists of one LINKnet channel of a 723PLUS and many I/O modules. The I/O modules include thermocouple inputs, RTD inputs, 4–20 mA inputs, and discrete inputs as well as 4-20 mA and relay outputs. All of the analog modules consist of six channels per module. The Relay Output module contains eight channels, and the Discrete Input module has 16 channels.

Each I/O module is housed in a plastic, field-termination-module-type package for DIN rail mounting. The LINKnet I/O modules can be mounted in the control cabinet or in any convenient location in the vicinity of the engine that meets the temperature and vibration specifications.

I/O Module Specifications

Accuracy
1% at 25 °C without field calibration

Power Supply Input
18 to 32 Vdc

Isolation
Network to I/O channel: 277 Vac
Power supply input to network: 277 Vac
I/O channel to I/O channel: 0 V
Power supply input to I/O channel: 500 Vdc except for discrete inputs, discrete input power comes directly from power supply input

Scan Rate

Less than 7 output modules:

(# of I/O modules x 6 + 75) ms typical
(# of I/O modules x 6 + 100) ms max

7 or more output modules:

(# of I/O modules x 6 + # of output modules x 3 + 55) ms typical
(# of I/O modules x 6 + # of output modules x 3 + 80) ms max

Field Wiring

2 mm^2 (14 AWG) maximum wire size

Temperature Range

–40 to +55 °C

UL Listed Component

Class 1, Division 2, Groups A, B, C, and D, when wired in accordance with NEC Class 1 Div. 2 wiring methods

Shock and Vibration

US Mil-Std-810, 30 Gs sine wave at 11 ms
US Mil-Std-167, 18-50 Hz

EMC

Emissions: EN 55011, Class A, Group 1
ESD immunity: IEC 801-2 (1991) 8 kV air and 4 kV contact, HCP and VCP tests
Radiated RF immunity: IEC 801-3, 10 V/m +80% 1 kHz AM, 80–1000 MHz
Fast transient immunity: IEC 801-4 (1988) 2 kV directly coupled onto power lines and 2 kV capacitively coupled onto I/O network lines

Discrete Input Current

13.1 mA per channel when “on” (@ 24 V)

Relay Contacts

Ratings: 5.0 A @ 28 Vdc resistive
0.5 A @ 115 Vac resistive

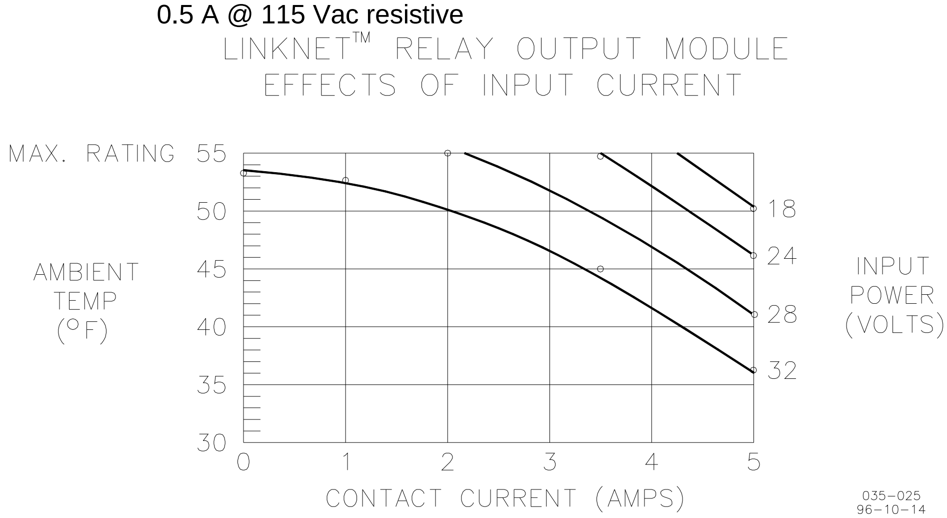


Figure B-1. LINKnet Relay Contacts

Individual I/O Module Specifications

I/O Module Type	Number of Channels	Resolution (bits)	Temp Coefficient (ppm/°C)	Input Impedance	Power Required at 24 V input
Discrete Input	16	N/A	N/A	N/A	6.5 W
Relay Output	8	N/A	N/A	N/A	5.0 W
4-20 mA Input with 24 V	6	12	235	250 Ω	5.3 W
4-20 mA Input	6	12	235	250 Ω	2.4 W
4-20 mA Out	6	12	250	N/A	6.0 W
RTD Input	6	12	290	2.2 MΩ	3.1 W
Thermocouple Input (J or K type +1 AD592)	6 +1 cold junction	12	235	2 MΩ	2.4 W

LINKnet I/O Module Descriptions

The FAULT LED denotes the status of the module processor, and will be off during normal operation. If the FAULT LED is on or is blinking, and cycling power to the module does not change it, then the I/O module should be replaced.

The module address circuit reads the selected module address from the rotary switches on each node. This address should correspond to the address of the I/O module hardware in the application program. If these rotary switches are set incorrectly, the node will not communicate with the 723PLUS, and a “no message” fault will be annunciated through the application program. If two nodes are set to the same address, an “address” fault will be annunciated through the application program, and both nodes will not function. If the node address switches are changed, power to the module must be cycled before it will read the new module address and change its communication accordingly.

A “type” fault is annunciated through the application program when the wrong module type is installed at a given address. For example, installing a thermocouple module in place of an RTD module generates a type fault. If an output node receives data intended for a different module type, it will not update its outputs, and will set them to the “off” state when its watchdog timer times out.

No-message faults, address faults, and type faults can be latching or non-latching (selectable within the 723PLUS control). When these faults occur for an input module, the application program can give default values for each channel.

Output modules contain readback circuits to verify proper operation of each output channel. Analog input modules monitor a reference voltage to verify proper operation of the A/D converter. Appropriate faults are annunciated through the application program.

The LINKnet system accommodates hot-replacement of faulty nodes. When replacing a node, the network cable connections must remain intact. A faulty node can be removed from the network by pulling both terminal blocks out of their headers, and removing the node from the DIN rail. The address switches of the replacement node should be set to match those of the faulty node. The replacement node can then be mounted on the DIN rail, and the terminal blocks pushed into the headers. It may be necessary to reset the node through the application program to reinitiate communications with the 723PLUS and to clear the “no message” fault.

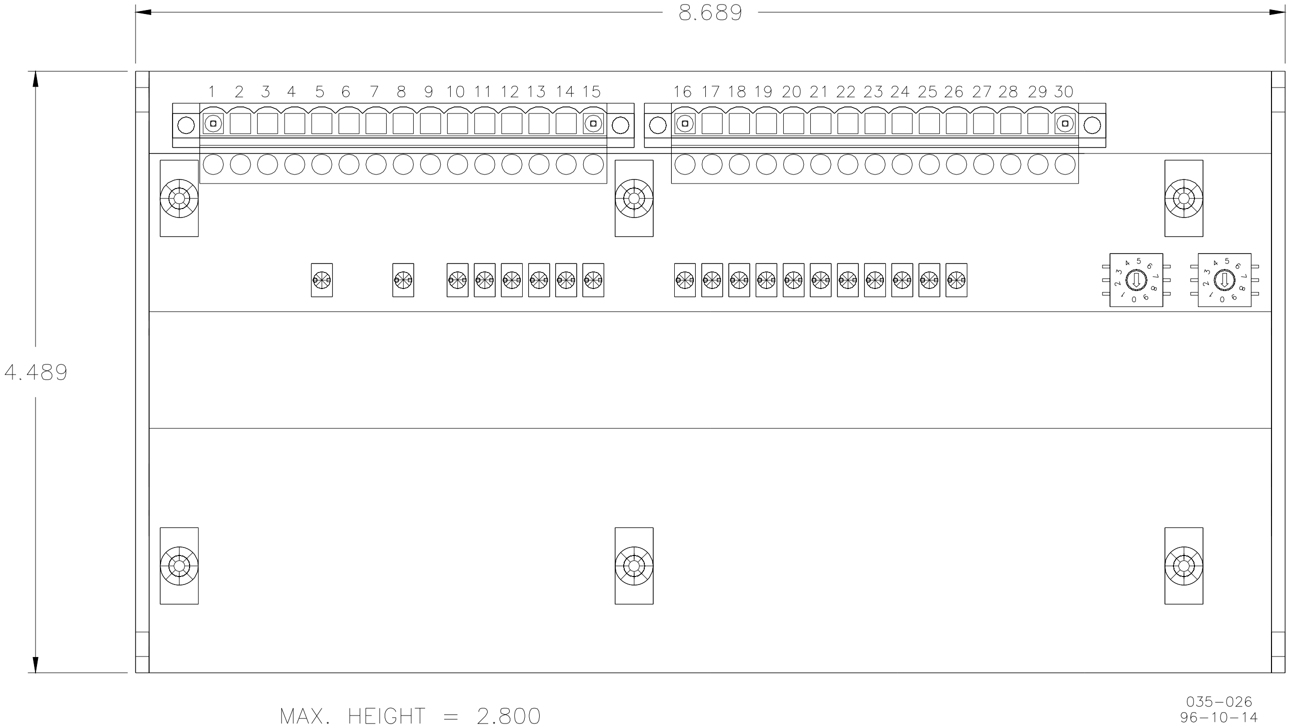


Figure B-2. Outline Drawing of I/O Module

Discrete Input Module

Figure B-3 is a block diagram and Figure B-4 is a wiring diagram of the Discrete Input module. The module receives information from field switches and relays. Power is provided for these contacts, on four terminal blocks, TB-5 through TB-8. The input power on TB-2 may also be used, but does not have the benefit of an internal fuse and some filtering, therefore external fusing should be provided. The state of each discrete input is passed through an optoisolator and an LED to the shift register. In this manner, the LEDs will light when a contact is closed. The module processor receives this information and transmits it through the transceiver to the 723PLUS.

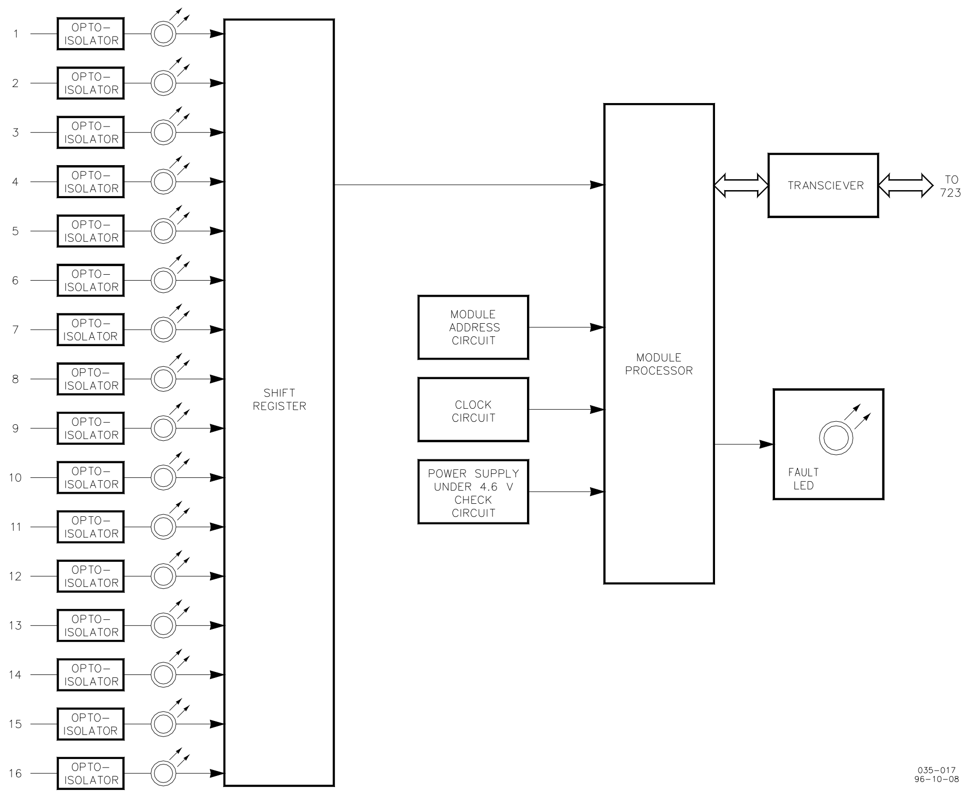


Figure B-3. Discrete Input Module Block Diagram

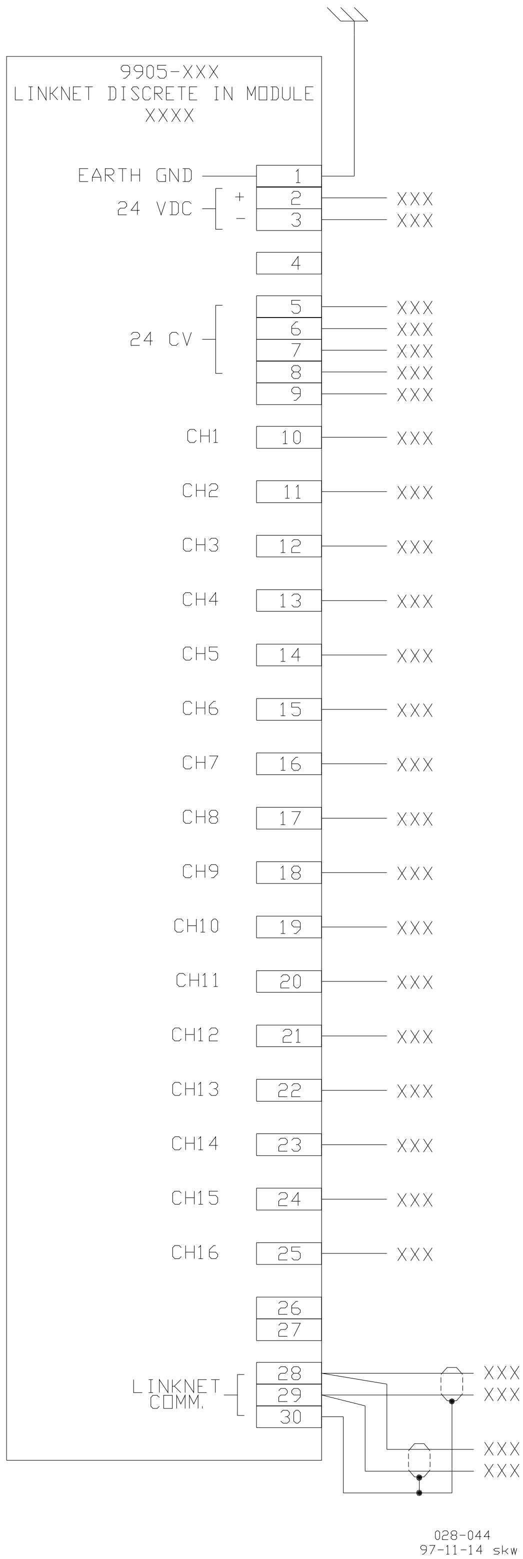


Figure B-4. Discrete Input Module Wiring Diagram

4–20 mA Input Module

Figure B-5 is a block diagram and Figure B-6 is a wiring diagram of the 4–20 mA Input module. The module receives information from 4–20 mA sources, such as transducers. Power is provided for these transducers on one version of the module, but all module inputs must use the power provided. No inputs may use a separate power source, as all of the negatives are tied together and to 24 V common. The advantage of this module version is that it simplifies wiring to devices such as transducers that require external power. Each input is converted to a 0–5 V signal, and then multiplexed to a voltage-to-frequency converter. The module processor reads the period of this signal and converts it to a count, which it transmits through the transceiver to the 723PLUS.

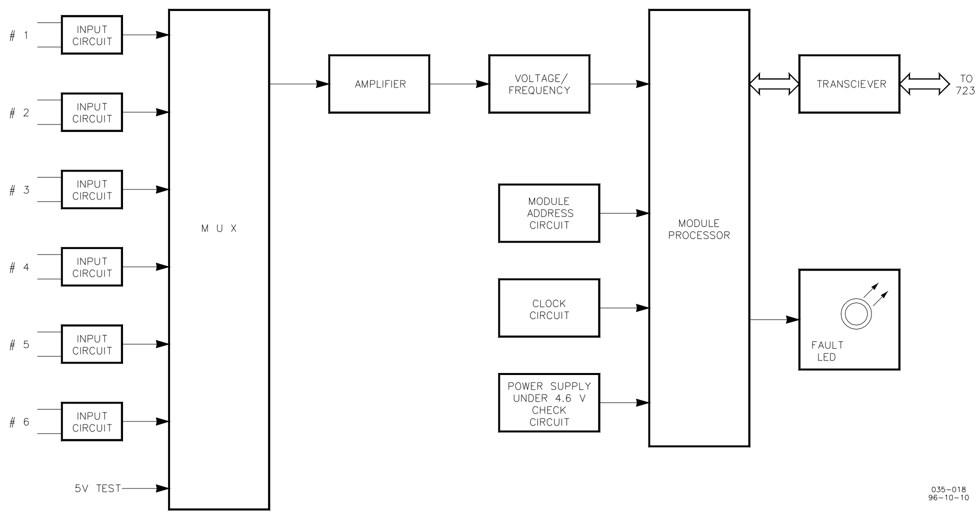


Figure B-5. 4–20 mA Input Module Block Diagram

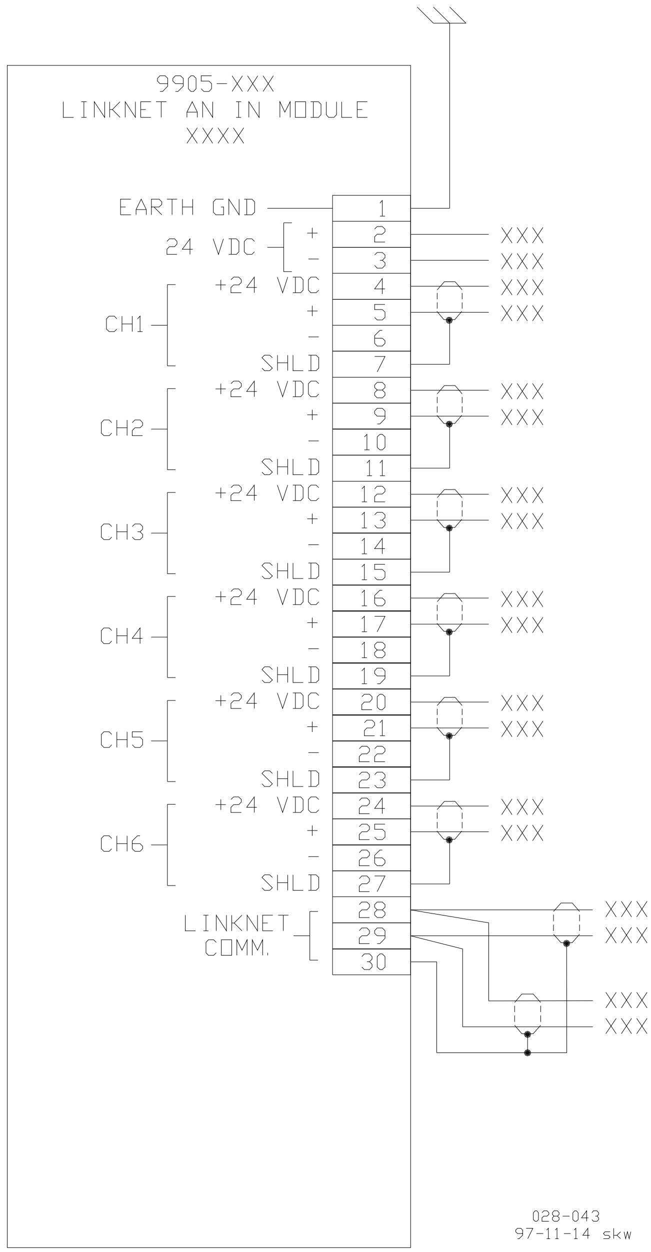


Figure B-6. 4–20 mA Input Module Wiring Diagram

Thermocouple Input Module

Figure B-7 is a block diagram and Figure B-8 is a wiring diagram of the Thermocouple Input module. The module receives information from thermocouples, which can be either J or K type. The type is selected in the application program. It also has an AD592 ambient temperature sensor mounted on the module for cold junction temperature sensing. The cold junction compensation is performed in software. There is a fail high and a fail low version of the module, selected by jumpers on the board, which allow the input channels to be pulled high or low on an open input. Each input is multiplexed to a voltage-to-frequency converter. The module processor reads the period of this signal and converts it to a count, which it transmits through the transceiver to the 723PLUS.

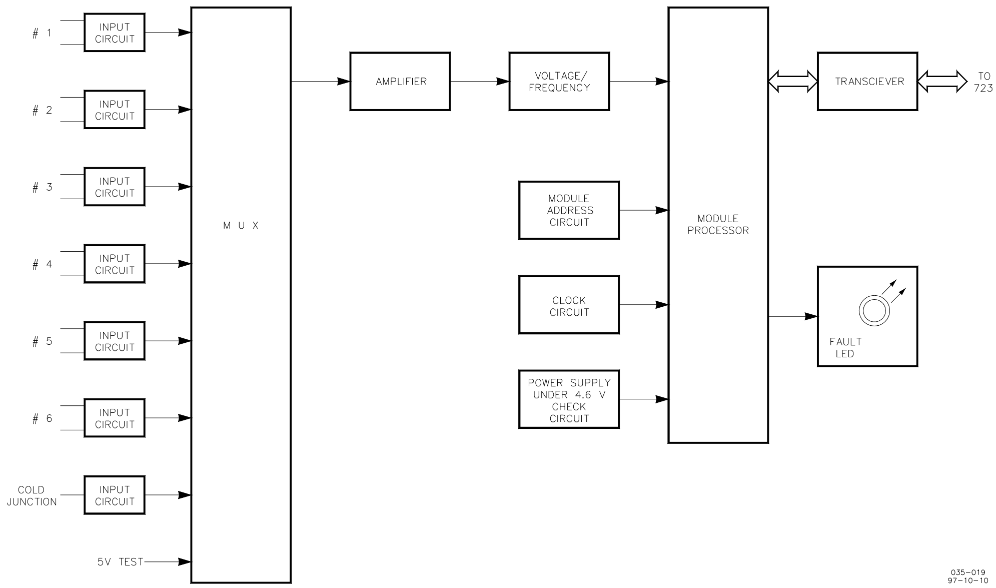


Figure B-7. Thermocouple Input Module Block Diagram

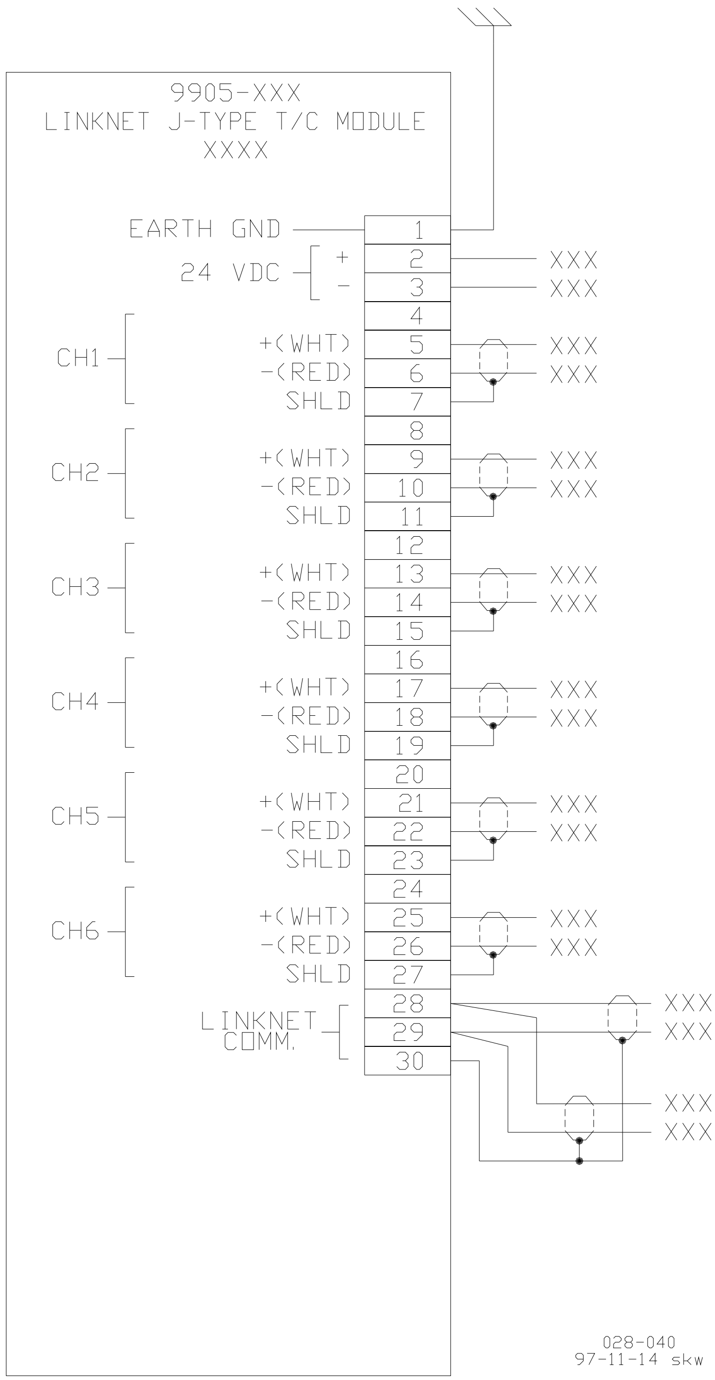


Figure B-8. Thermocouple Input Module Wiring Diagram

RTD Input Module

Figure B-9 is a block diagram and Figure B-10 is a wiring diagram of the RTD Input module. A 1 or 2 mA source is provided for each input. The module receives voltages from six 100 or 200 A, 3-wire RTDs. Each voltage is compensated for line resistance, and then is multiplexed to a voltage-to-frequency converter. The module processor reads the period of this signal and converts it to a count, which it transmits through the transceiver to the 723PLUS.

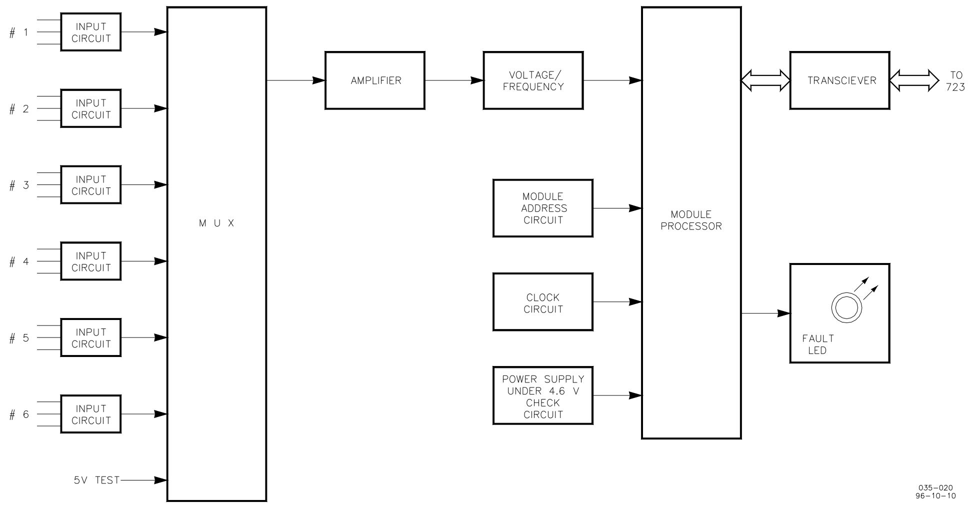


Figure B-9. RTD Input Module Block Diagram

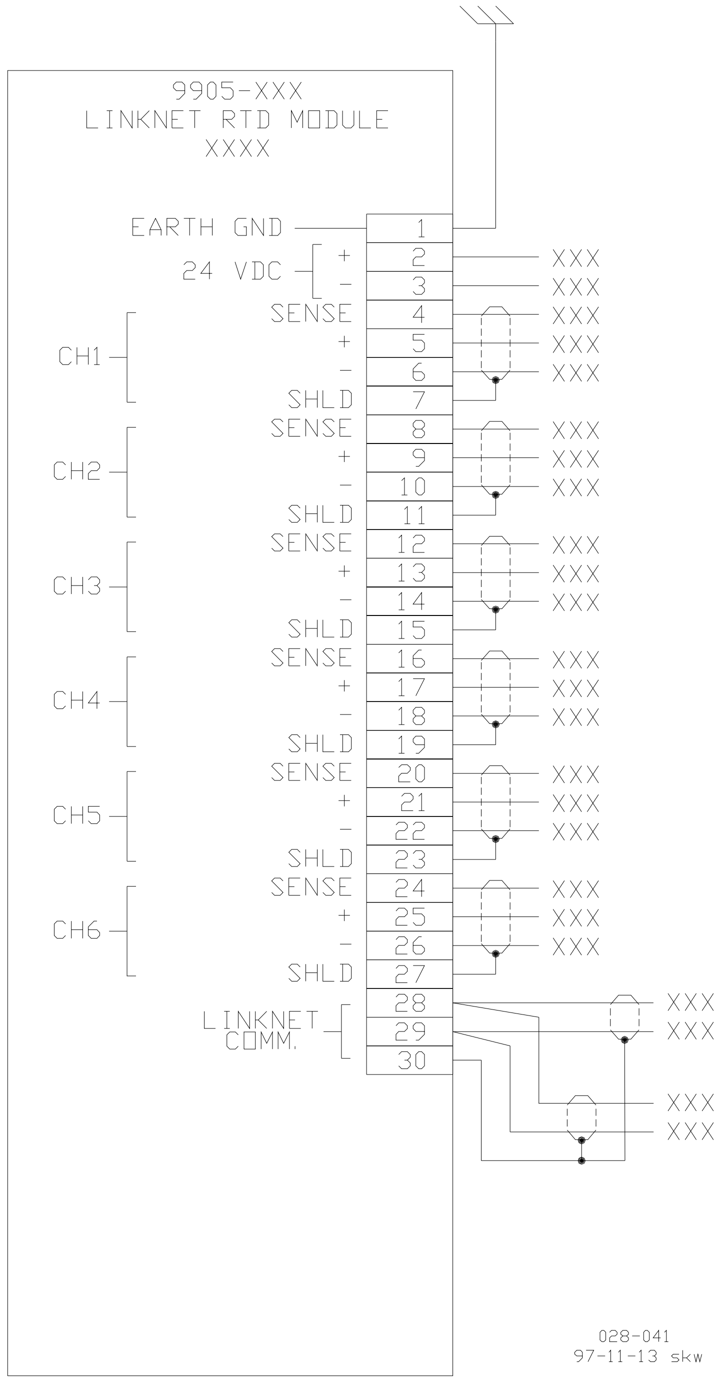


Figure B-10. RTD Input Module Wiring Diagram

Relay Output Module

Figure B-11 is a block diagram and Figure B-12 is a wiring diagram of the Relay Output module. The module outputs information through eight 5 A form C relays. The relay output module processor receives information through the transceiver, from the 723PLUS. The node then updates the status of the shift register which updates the relays and a status LED. The second set of relay contacts is input back into the module processor through a shift register, for readback status. The readbacks are compared with the desired outputs, and a status annunciated for each relay in the application program. The relay output module has a watchdog that monitors the communications from the module processor to the shift register, and disables the relay drivers upon a loss of communications of more than 1.2 seconds. The node will not function after a watchdog timeout, until its power is cycled or until the 723PLUS is reset.

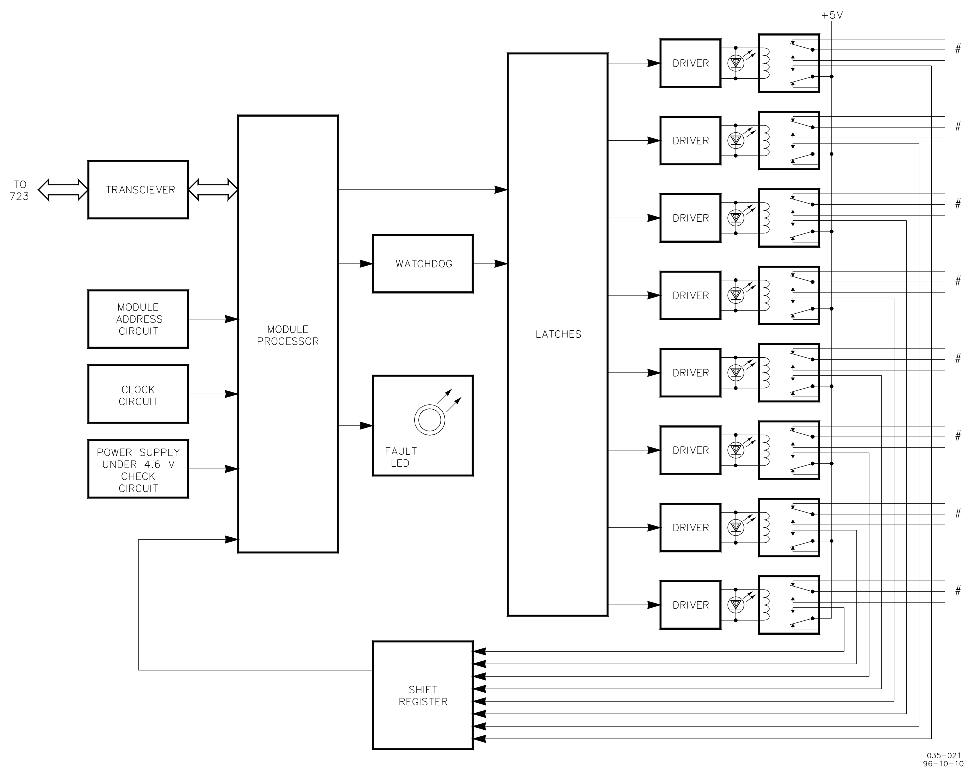


Figure B-11. Relay Output Module Block Diagram

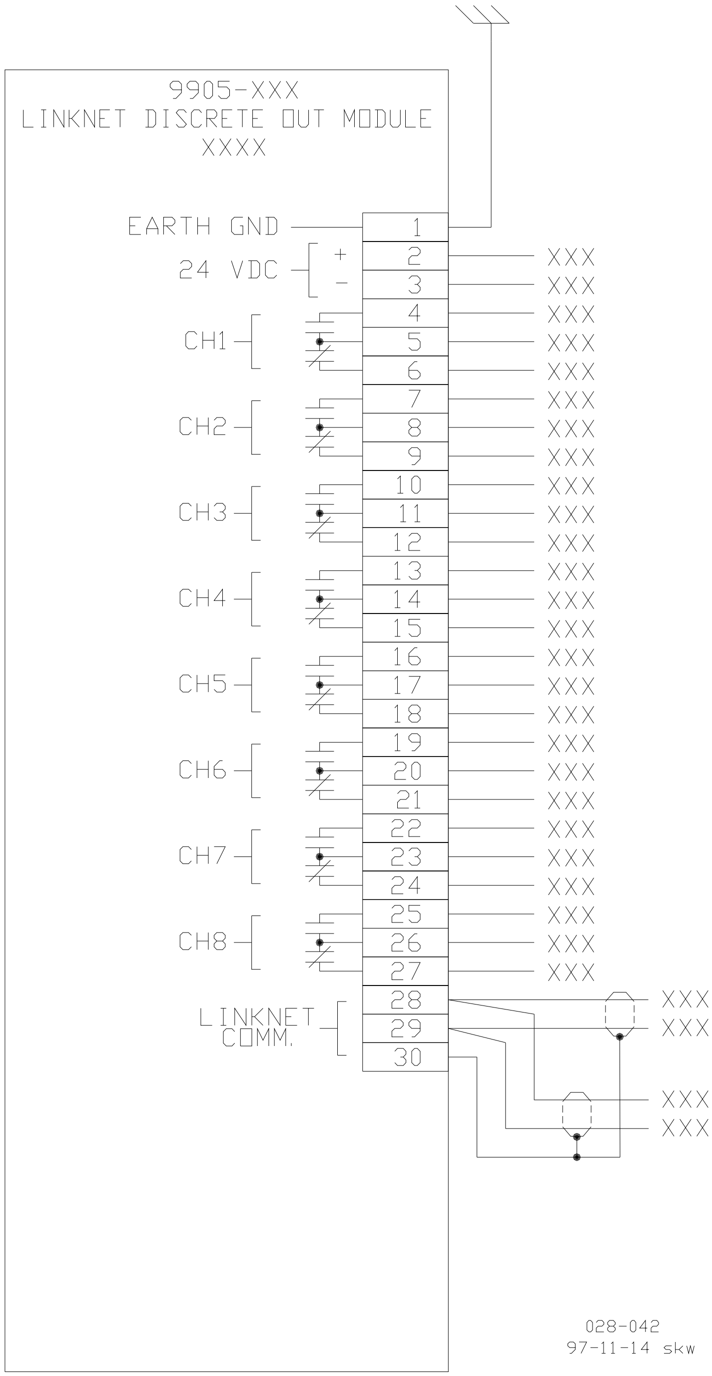


Figure B-12. Relay Output Module Wiring Diagram

4–20 mA Output Module

Figure B-13 is a block diagram and Figure B-14 is a wiring diagram of the 4–20 mA Output module. The 4–20 mA output module processor receives information through the transceiver, from the 723PLUS. The 4–20 mA output module then updates the status of the D/A converter which outputs voltages to the current drivers. The output current is monitored by the module processor through an A/D converter. The readback value and status are available through the application program. The 4–20 mA output module has a watchdog that monitors the communications from the module processor to the D/A converter, and disables the current drivers upon a loss of communications of more than 1.2 seconds. The module will not function after a watchdog timeout until its power is cycled or the 723PLUS is reset.

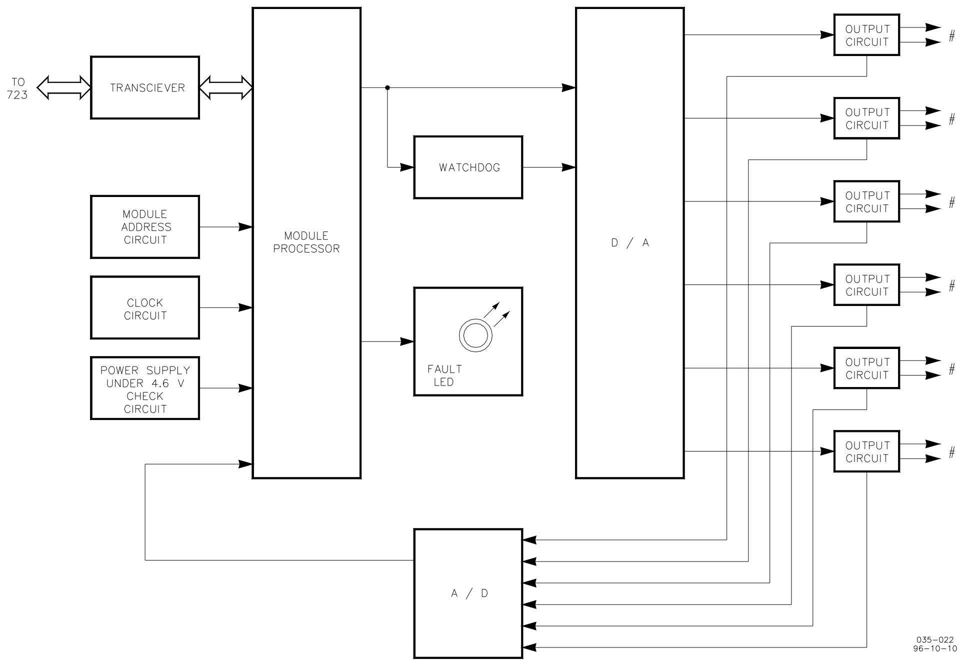


Figure B-13. 4–20 mA Output Module Block Diagram

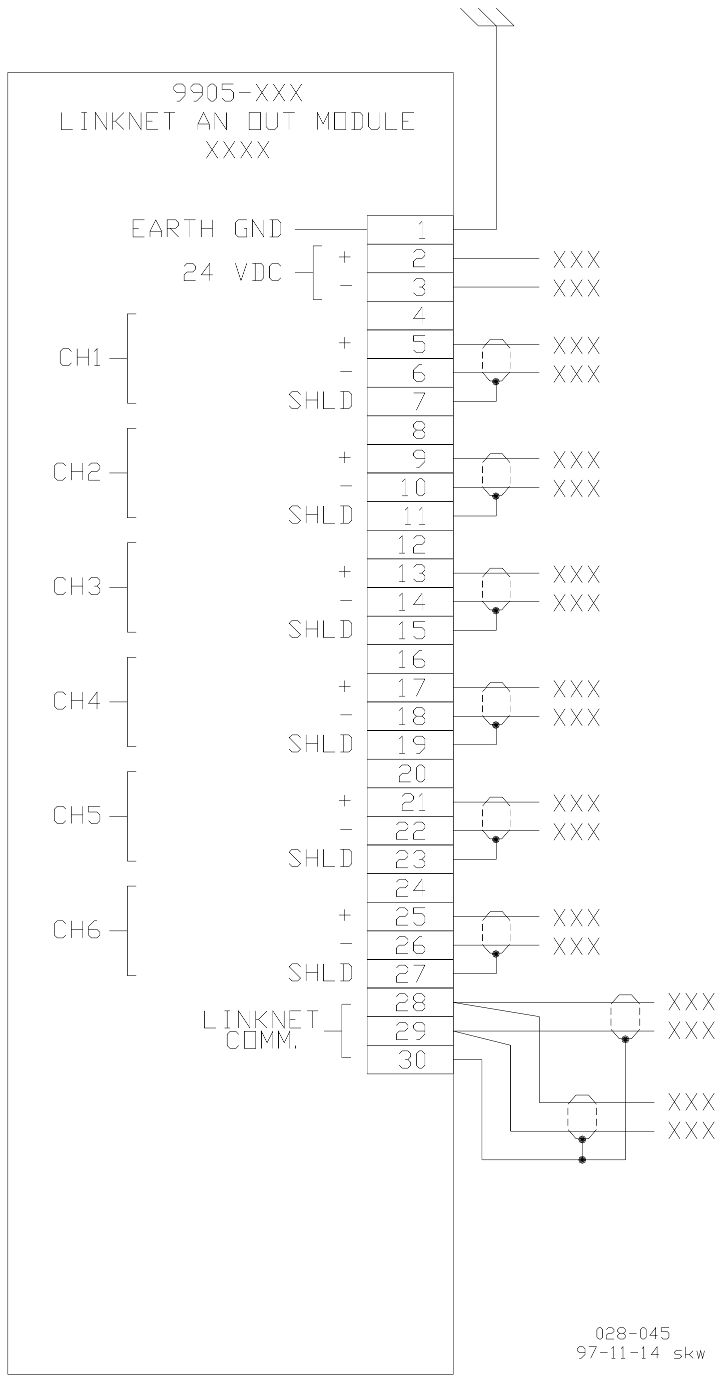


Figure B-14. 4–20 mA Output Module Wiring Diagram

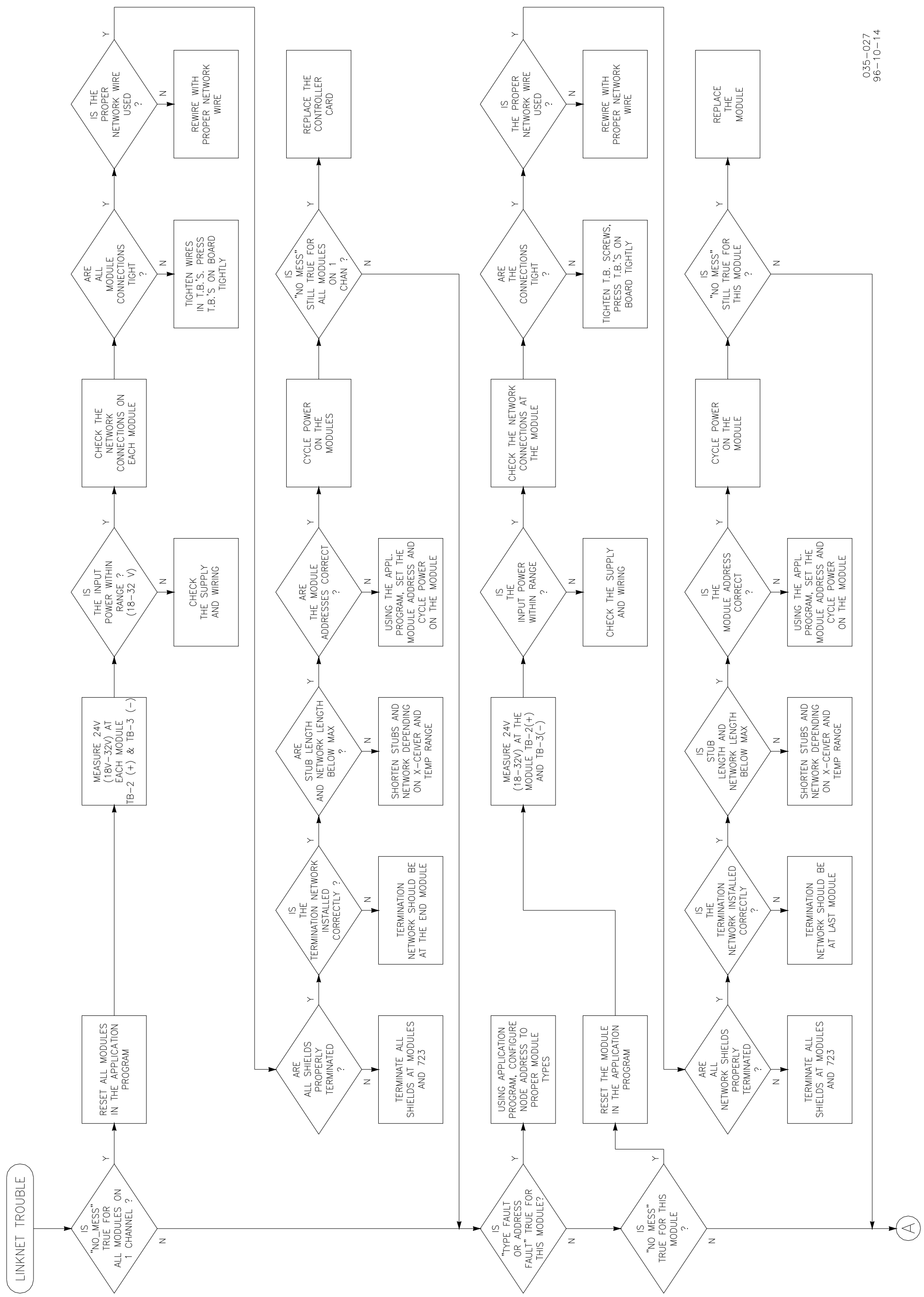


Figure B-15a. Troubleshooting Flowchart (1 of 2)

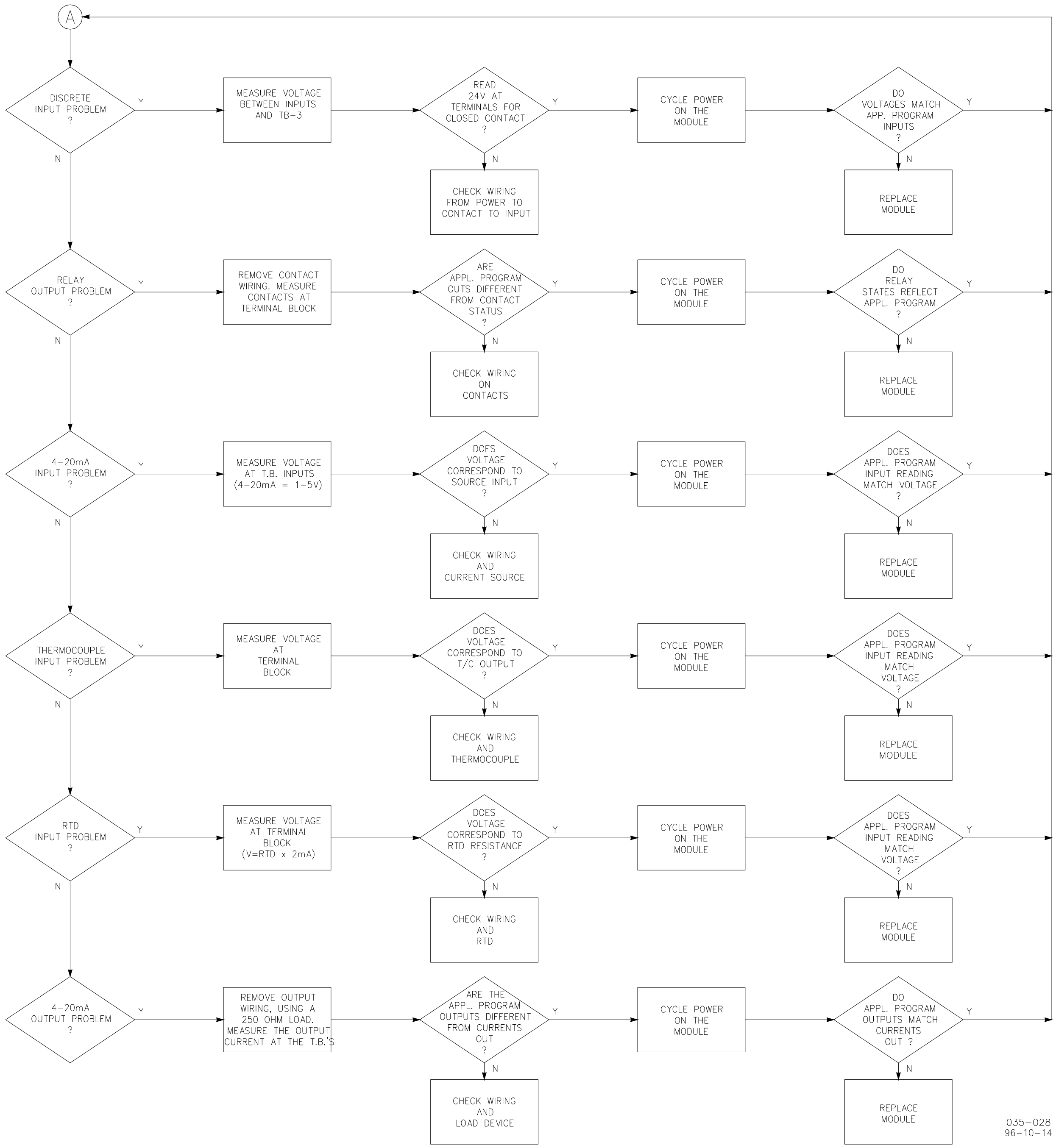


Figure B-15b. Troubleshooting Flowchart (2 of 2)

Troubleshooting Flowchart

If a problem occurs with the LINKnet network, use Figure B-15 (Troubleshooting Flowchart) as a guide to find and repair the problem.

Follow the flowchart down from the title block to the next block. This block may be a rectangular suggestion block, or a diamond shaped decision block. When a suggestion block is entered, do the check suggested. A suggestion block may refer you to the control wiring diagram, the application program, or the module field wiring.

If this check does no find the problem, continue down the flowchart.

When a decision block is entered, the question asked inside it must be answered. This answer then determines the proper exit from that block. The exit taken will lead you to another point on the flowchart.

By following the flowchart in this manner, you should be able to determine a course of action for most problems.

Wiring and Proper Cable

All LINKnet I/O modules communicate with the 723PLUS through shielded twisted pair wiring. The specifications for the LINKnet system require that listed level V type cable be used. The network may be wired directly from I/O module to I/O module, as shown in Figure B-16, or the I/O modules may be connected to the network via stubs as in Figure B-17. A termination network must be installed at the last LINKnet I/O module on the network. There is no polarity associated with the network wiring. For optimum EMC performance, the network cable shield should be landed at each I/O module, and the exposed wire length limited to 25 mm (1 inch). At the 723PLUS, the outer insulation should be stripped and the bare shield landed to the chassis.

All field wiring should be shielded. The shield should be landed in the terminal block provided, and the exposed wiring, after the shield is separated, should be limited to one inch.

IMPORTANT

The LINKnet modules should always be mounted in a cabinet, or be otherwise operator inaccessible. The modules should be accessed only for maintenance purposes, in which case, the ESD procedures on page iv should be followed.

Correct cable is available from Woodward, Belden, or other suppliers providing an equivalent cable.

Woodward part number 2008-349

Belden
PO Box 1980
Richmond IN 47375
telephone (317) 983-5200

Belden Part Number	Description
9207	PVC 20 AWG shielded. NEC Type CL2, CSA Cert. PCC FT 1.
89207	Teflon 20 AWG shielded, Plenum version. NEC Type CMP, CSA Cert. FT 4.
YR28867	PVC 22 AWG shielded.
YQ28863	Plenum 22 AWG shielded.

Cable Length and Number of LINKnet I/O Modules

Specification	**0 to 55 °C**	**–20 to +55 °C**	**–40 to +55 °C**
Maximum network cable length	150 m	150 m	50 m
Maximum number of I/O modules	60	32	20
Maximum stub length	300 mm	300 mm	300 mm

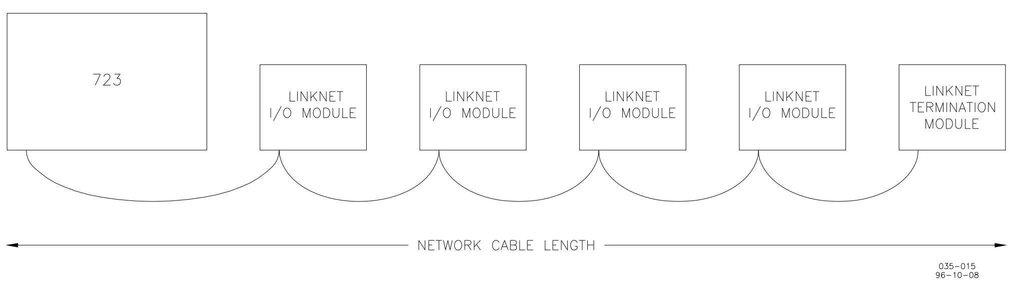


Figure B-16. Direct Wired Network

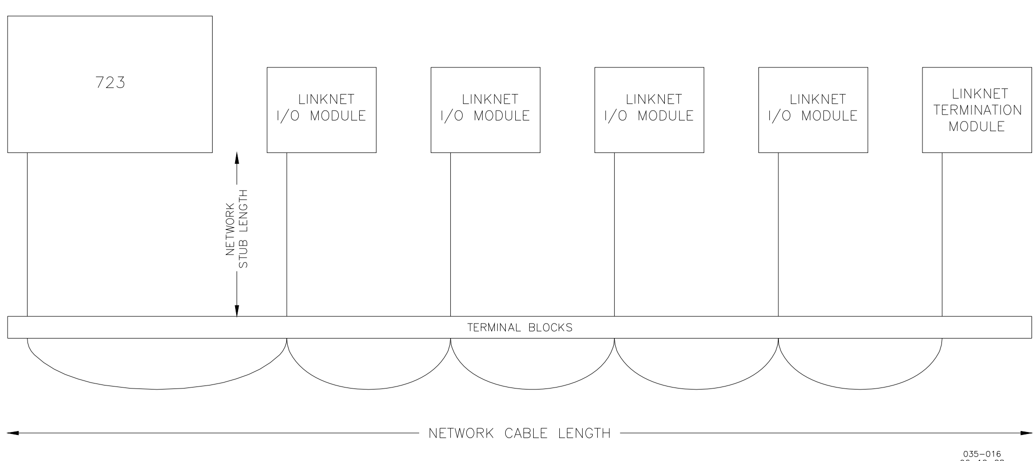


Figure B-17. Network Wired Via Stubs

Appendix C. Modbus Slave Address Information

Part Numbers 8280-464/-465

This appendix contains the Modbus slave address information for these 723PLUS part numbers.

MODBUS PORT3

Boolean Writes

Addr	Description
0:0001	ALARM RESET
0:0002	
0:0003	
0:0004	
0:0005	
0:0006	
0:0007	
0:0008	
0:0009	
0:0010	
0:0011	USE PROCESS ENABLE REMOTE COMMAND
0:0012	
0:0013	USE FAILSAFE OVERRIDE REMOTE COMMAND
0:0014	USE SECOND DYNAMICS REMOTE COMMAND
0:0015	USE RAISE SPEED REMOTE COMMAND
0:0016	USE LOWER SPEED REMOTE COMMAND
0:0017	USE RATED/IDLE REMOTE COMMAND
0:0018	USE RUN REMOTE COMMAND
0:0019	USE REMOTE SPEED REFERENCE
0:0020	
0:0021	723 COMMAND CLOSE FOR PROCESS CONTROL
0:0022	
0:0023	723 COMMAND CLOSE TO OVERRIDE FAILSAFE
0:0024	723 COMMAND CLOSE FOR SECOND DYNAMICS
0:0025	723 COMMAND CLOSE TO RAISE SPEED REF
0:0026	723 COMMAND CLOSE TO LOWER SPEED REF
0:0027	723 COMMAND CLOSE FOR RATED SPEED
0:0028	723 COMMAND CLOSE TO RUN
0:0029	
0:0030	
0:0031	CHANNEL 1 DISCRETE OUTPUT MODULE 1
0:0032	CHANNEL 2 DISCRETE OUTPUT MODULE 1
0:0033	CHANNEL 3 DISCRETE OUTPUT MODULE 1
0:0034	CHANNEL 4 DISCRETE OUTPUT MODULE 1
0:0035	CHANNEL 5 DISCRETE OUTPUT MODULE 1
0:0036	CHANNEL 6 DISCRETE OUTPUT MODULE 1
0:0037	CHANNEL 7 DISCRETE OUTPUT MODULE 1
0:0038	CHANNEL 8 DISCRETE OUTPUT MODULE 1
0:0039	CHANNEL 1 DISCRETE OUTPUT MODULE 2
0:0040	CHANNEL 2 DISCRETE OUTPUT MODULE 2
0:0041	CHANNEL 3 DISCRETE OUTPUT MODULE 2
0:0042	CHANNEL 4 DISCRETE OUTPUT MODULE 2
0:0043	CHANNEL 5 DISCRETE OUTPUT MODULE 2
0:0044	CHANNEL 6 DISCRETE OUTPUT MODULE 2
0:0045	CHANNEL 7 DISCRETE OUTPUT MODULE 2
0:0046	CHANNEL 8 DISCRETE OUTPUT MODULE 2
0:0047	CHANNEL 1 DISCRETE OUTPUT MODULE 3
0:0048	CHANNEL 2 DISCRETE OUTPUT MODULE 3
0:0049	CHANNEL 3 DISCRETE OUTPUT MODULE 3

0:0050	CHANNEL 4 DISCRETE OUTPUT MODULE 3
0:0051	CHANNEL 5 DISCRETE OUTPUT MODULE 3
0:0052	CHANNEL 6 DISCRETE OUTPUT MODULE 3
0:0053	CHANNEL 7 DISCRETE OUTPUT MODULE 3
0:0054	CHANNEL 8 DISCRETE OUTPUT MODULE 3
0:0055	CHANNEL 1 DISCRETE OUTPUT MODULE 4
0:0056	CHANNEL 2 DISCRETE OUTPUT MODULE 4
0:0057	CHANNEL 3 DISCRETE OUTPUT MODULE 4
0:0058	CHANNEL 4 DISCRETE OUTPUT MODULE 4
0:0059	CHANNEL 5 DISCRETE OUTPUT MODULE 4
0:0060	CHANNEL 6 DISCRETE OUTPUT MODULE 4
0:0061	CHANNEL 7 DISCRETE OUTPUT MODULE 4
0:0062	CHANNEL 8 DISCRETE OUTPUT MODULE 4

Boolean Reads

Addr	Description
1:0001	H-CLOSE TO RUN CONTACT
1:0002	G-RATED CONTACT
1:0003	F-LOWER SPEED/LOAD CONTACT
1:0004	E-RAISE SPEED/LOAD CONTACT
1:0005	D-2nd DYNAMICS CONTACT
1:0006	C-SPEED FAIL OVERRIDE
1:0007	B-ALARM RESET
1:0008	A-PROCESS CONTROL ENABLE
1:0009	DO1-SHUTDOWN RELAY
1:0010	DO2-ALARM RELAY
1:0011	DO3-STATUS INDICATOR RELAY
1:0012	
1:0013	MPU 1 FAILED
1:0014	MPU 2 FAILED
1:0015	PROCESS INPUT #1 FAILED
1:0016	PROCESS INPUT #2 FAILED
1:0017	REMOTE SPEED INPUT FAILED
1:0018	EXTERNAL FUEL LIMIT FAILED
1:0019	HANDHELD SELECTED
1:0020	LAPTOP SELECTED
1:0021	SHUTDOWN IS ACTIVE
1:0022	1-SPEED #1FAIL SHUTDOWN
1:0023	2-SPEED #2 FAIL SHUTDOWN
1:0024	3-SPD #1 AND #2 FAIL SHUTDOWN
1:0025	4-PROCESS #1 FAIL SHUTDOWN
1:0026	5-PROCESS #2 FAIL SHUTDOWN
1:0027	6-EXT FUEL LMT FAIL SHUTDOWN
1:0028	7-EXT FUEL LMT FAIL SHUTDOWN
1:0029	8-MODBUS 3 FAIL SHUTDOWN
1:0030	9-HI FUEL DEMND SHUTDOWN
1:0031	10-HIGH SPEED SHUTDOWN
1:0032	11-TORSIONAL HIGH SHUTDOWN
1:0033	12-PROCESS #1 HIGH SHUTDOWN
1:0034	13-PROCESS #1 LOW SHUTDOWN
1:0035	14-PROCESS #2 HIGH SHUTDOWN
1:0036	15-PROCESS #2 LOW SHUTDOWN
1:0037	16-PROCESS DIFF HI SHUTDOWN
1:0038	17-PROCESS DIFF LOW SHUTDOWN
1:0039	
1:0040	
1:0041	
1:0042	
1:0043	
1:0044	
1:0045	
1:0046	
1:0047	
1:0048	
1:0049	

1:0050	
1:0051	
1:0052	
1:0053	
1:0054	
1:0055	
1:0056	
1:0057	
1:0058	
1:0059	
1:0060	
1:0061	ALARM IS ACTIVE
1:0062	1-SPEED #1FAIL ALARM
1:0063	2-SPEED #2 FAIL ALARM
1:0064	3-SPD #1 AND #2 FAIL ALARM
1:0065	4-PROCESS #1 FAIL ALARM
1:0066	5-PROCESS #2 FAIL ALARM
1:0067	6-EXT FUEL LMT FAIL ALARM
1:0068	7-EXT FUEL LMT FAIL ALARM
1:0069	8-MODBUS 3 FAIL ALARM
1:0070	9-HI FUEL DEMND ALARM
1:0071	10-HIGH SPEED ALARM
1:0072	11-TORSIONAL HIGH ALARM
1:0073	12-PROCESS #1 HIGH ALARM
1:0074	13-PROCESS #1 LOW ALARM
1:0075	14-PROCESS #2 HIGH ALARM
1:0076	15-PROCESS #2 LOW ALARM
1:0077	16-PROCESS DIFF HI ALARM
1:0078	17-PROCESS DIFF LOW ALARM
1:0079	
1:0080	
1:0081	
1:0082	
1:0083	
1:0084	
1:0085	
1:0086	
1:0087	
1:0088	
1:0089	
1:0090	
1:0091	
1:0092	
1:0093	
1:0094	
1:0095	
1:0096	
1:0097	
1:0098	
1:0099	
1:0100	
1:0101	SPEED IN CONTROL (LSS)
1:0102	ON START LIMIT (LSS)
1:0103	ON MAX LIMIT (LSS)
1:0104	EXT FUEL LIMIT (LSS)
1:0105	ON TORSIONAL LIMIT (LSS)
1:0106	ACT SHUTDOWN (LSS)
1:0107	ON TORQUE LIMIT (LSS)
1:0108	TORSIONAL FILTER ACTIVE
1:0109	SPEED SWITCH #1 ACTIVE
1:0110	SPEED SWITCH #2 ACTIVE
1:0111	REMOTE SPEED ENABLED
1:0112	REMOTE PROCESS ENABLED
1:0113	DEADBAND PROCESS CONTROL ENABLED
1:0114	CASCADE PROCESS CONTROL ENABLED
1:0115	CASCADE RAMP ENABLED

1:0116	PRIMARY SPEED INPUT ACTIVE
1:0117	STANDBY SPEED INPUT ACTIVE
1:0118	
1:0119	
1:0120	
1:0121	DISCRETE IN MOD 1 CHANNEL 1
1:0122	DISCRETE IN MOD 1 CHANNEL 2
1:0123	DISCRETE IN MOD 1 CHANNEL 3
1:0124	DISCRETE IN MOD 1 CHANNEL 4
1:0125	DISCRETE IN MOD 1 CHANNEL 5
1:0126	DISCRETE IN MOD 1 CHANNEL 6
1:0127	DISCRETE IN MOD 1 CHANNEL 7
1:0128	DISCRETE IN MOD 1 CHANNEL 8
1:0129	DISCRETE IN MOD 1 CHANNEL 9
1:0130	DISCRETE IN MOD 1 CHANNEL 10
1:0131	DISCRETE IN MOD 1 CHANNEL 11
1:0132	DISCRETE IN MOD 1 CHANNEL 12
1:0133	DISCRETE IN MOD 1 CHANNEL 13
1:0134	DISCRETE IN MOD 1 CHANNEL 14
1:0135	DISCRETE IN MOD 1 CHANNEL 15
1:0136	DISCRETE IN MOD 1 CHANNEL 16
1:0137	DISCRETE IN MOD 2 CHANNEL 1
1:0138	DISCRETE IN MOD 2 CHANNEL 2
1:0139	DISCRETE IN MOD 2 CHANNEL 3
1:0140	DISCRETE IN MOD 2 CHANNEL 4
1:0141	DISCRETE IN MOD 2 CHANNEL 5
1:0142	DISCRETE IN MOD 2 CHANNEL 6
1:0143	DISCRETE IN MOD 2 CHANNEL 7
1:0144	DISCRETE IN MOD 2 CHANNEL 8
1:0145	DISCRETE IN MOD 2 CHANNEL 9
1:0146	DISCRETE IN MOD 2 CHANNEL 10
1:0147	DISCRETE IN MOD 2 CHANNEL 11
1:0148	DISCRETE IN MOD 2 CHANNEL 12
1:0149	DISCRETE IN MOD 2 CHANNEL 13
1:0150	DISCRETE IN MOD 2 CHANNEL 14
1:0151	DISCRETE IN MOD 2 CHANNEL 15
1:0152	DISCRETE IN MOD 2 CHANNEL 16
1:0153	DISCRETE IN MOD 3 CHANNEL 1
1:0154	DISCRETE IN MOD 3 CHANNEL 2
1:0155	DISCRETE IN MOD 3 CHANNEL 3
1:0156	DISCRETE IN MOD 3 CHANNEL 4
1:0157	DISCRETE IN MOD 3 CHANNEL 5
1:0158	DISCRETE IN MOD 3 CHANNEL 6
1:0159	DISCRETE IN MOD 3 CHANNEL 7
1:0160	DISCRETE IN MOD 3 CHANNEL 8
1:0161	DISCRETE IN MOD 3 CHANNEL 9
1:0162	DISCRETE IN MOD 3 CHANNEL 10
1:0163	DISCRETE IN MOD 3 CHANNEL 11
1:0164	DISCRETE IN MOD 3 CHANNEL 12
1:0165	DISCRETE IN MOD 3 CHANNEL 13
1:0166	DISCRETE IN MOD 3 CHANNEL 14
1:0167	DISCRETE IN MOD 3 CHANNEL 15
1:0168	DISCRETE IN MOD 3 CHANNEL 16
1:0169	DISCRETE IN MOD 4 CHANNEL 1
1:0170	DISCRETE IN MOD 4 CHANNEL 2
1:0171	DISCRETE IN MOD 4 CHANNEL 3
1:0172	DISCRETE IN MOD 4 CHANNEL 4
1:0173	DISCRETE IN MOD 4 CHANNEL 5
1:0174	DISCRETE IN MOD 4 CHANNEL 6
1:0175	DISCRETE IN MOD 4 CHANNEL 7
1:0176	DISCRETE IN MOD 4 CHANNEL 8
1:0177	DISCRETE IN MOD 4 CHANNEL 9
1:0178	DISCRETE IN MOD 4 CHANNEL 10
1:0179	DISCRETE IN MOD 4 CHANNEL 11
1:0180	DISCRETE IN MOD 4 CHANNEL 12
1:0181	DISCRETE IN MOD 4 CHANNEL 13

1:0182 DISCRETE IN MOD 4 CHANNEL 14
1:0183 DISCRETE IN MOD 4 CHANNEL 15
1:0184 DISCRETE IN MOD 4 CHANNEL 16

Analog Reads

Addr	Description
3:0001	AI1-PROCESS INPUT #1 (uA)
3:0002	AI2-PROCESS INPUT #2 (uA)
3:0003	AI3-REMOTE SPEED INPUT (uA)
3:0004	AI4-EXT FUEL LIMIT INPUT (uA)
3:0005	
3:0006	
3:0007	AO1-CONFIGURED ANALOG OUTPUT(uA)
3:0008	AO2-CONFIGURED ANALOG OUTPUT(uA)
3:0009	ACT1-OUTPUT TO ACTUATOR (uA,mAx100)
3:0010	ACT2-CONFIGURED ACT OUTPUT(uA,mAx100)
3:0011	SPEED INPUT #1 (rpm)
3:0012	SPEED INPUT #2 (rpm)
3:0013	ENGINE SPEED (rpm)
3:0014	BIASED SPEED REFERENCE (rpm)
3:0015	SPEED REFERENCE (rpm)
3:0016	DROOP BIAS(rpm)
3:0017	PROCESS REFERENCE(EU)
3:0018	REMOTE PROCESS REFERENCE(EU)
3:0019	
3:0020	
3:0021	
3:0022	
3:0023	
3:0024	
3:0025	
3:0026	
3:0027	
3:0028	
3:0029	
3:0030	
3:0031	FUEL DEMAND (%fd * 10)
3:0032	TORSIONAL LIMIT LEVEL (%fd)
3:0033	TORSIONAL LEVEL (% OF RATED)
3:0034	EXT FUEL LIMIT LEVEL (% fd)
3:0035	
3:0036	
3:0037	
3:0038	
3:0039	
3:0040	
3:0041	AI1-PROCESS INPUT #1 (EU)
3:0042	AI2-PROCESS INPUT #2 (EU)
3:0043	AI3-REMOTE SPEED INPUT (rpm)
3:0044	AI4-EXT FUEL LIMIT INPUT (engr)
3:0045	AO1-CONFIGURED ANALOG OUTPUT(engr)
3:0046	AO2-CONFIGURED ANALOG OUTPUT(engr)
3:0047	ACT1-OUTPUT TO ACTUATOR (%)
3:0048	ACT2-CONFIGURED ANALOG OUTPUT(engr)
3:0049	PROCESS DIFFERENCE (EU) (AI1-AI2)
3:0050	
3:0051	FIRST OUT SHUTDOWN
3:0052	FIRST OUT ALARM
3:0053	
3:0054	
3:0055	
3:0056	
3:0057	
3:0058	
3:0059	

3:0060	
3:0061	TC 1 CHANNEL 1 (deg F)
3:0062	TC 1 CHANNEL 2 (deg F)
3:0063	TC 1 CHANNEL 3 (deg F)
3:0064	TC 1 CHANNEL 4 (deg F)
3:0065	TC 1 CHANNEL 5 (deg F)
3:0066	TC 1 CHANNEL 6 (deg F)
3:0067	TC 2 CHANNEL 1 (deg F)
3:0068	TC 2 CHANNEL 2 (deg F)
3:0069	TC 2 CHANNEL 3 (deg F)
3:0070	TC 2 CHANNEL 4 (deg F)
3:0071	TC 2 CHANNEL 5 (deg F)
3:0072	TC 2 CHANNEL 6 (deg F)
3:0073	TC 3 CHANNEL 1 (deg F)
3:0074	TC 3 CHANNEL 2 (deg F)
3:0075	TC 3 CHANNEL 3 (deg F)
3:0076	TC 3 CHANNEL 4 (deg F)
3:0077	TC 3 CHANNEL 5 (deg F)
3:0078	TC 3 CHANNEL 6 (deg F)
3:0079	TC 4 CHANNEL 1 (deg F)
3:0080	TC 4 CHANNEL 2 (deg F)
3:0081	TC 4 CHANNEL 3 (deg F)
3:0082	TC 4 CHANNEL 4 (deg F)
3:0083	TC 4 CHANNEL 5 (deg F)
3:0084	TC 4 CHANNEL 6 (deg F)
3:0085	RTD 1 CHANNEL 1 (deg F)
3:0086	RTD 1 CHANNEL 2 (deg F)
3:0087	RTD 1 CHANNEL 3 (deg F)
3:0088	RTD 1 CHANNEL 4 (deg F)
3:0089	RTD 1 CHANNEL 5 (deg F)
3:0090	RTD 1 CHANNEL 6 (deg F)
3:0091	RTD 2 CHANNEL 1 (deg F)
3:0092	RTD 2 CHANNEL 2 (deg F)
3:0093	RTD 2 CHANNEL 3 (deg F)
3:0094	RTD 2 CHANNEL 4 (deg F)
3:0095	RTD 2 CHANNEL 5 (deg F)
3:0096	RTD 2 CHANNEL 6 (deg F)
3:0097	RTD 3 CHANNEL 1 (deg F)
3:0098	RTD 3 CHANNEL 2 (deg F)
3:0099	RTD 3 CHANNEL 3 (deg F)
3:0100	RTD 3 CHANNEL 4 (deg F)
3:0101	RTD 3 CHANNEL 5 (deg F)
3:0102	RTD 3 CHANNEL 6 (deg F)
3:0103	AI 1 CHANNEL 1 (uA)
3:0104	AI 1 CHANNEL 2 (uA)
3:0105	AI 1 CHANNEL 3 (uA)
3:0106	AI 1 CHANNEL 4 (uA)
3:0107	AI 1 CHANNEL 5 (uA)
3:0108	AI 1 CHANNEL 6 (uA)
3:0109	AI 2 CHANNEL 1 (uA)
3:0110	AI 2 CHANNEL 2 (uA)
3:0111	AI 2 CHANNEL 3 (uA)
3:0112	AI 2 CHANNEL 4 (uA)
3:0113	AI 2 CHANNEL 5 (uA)
3:0114	AI 2 CHANNEL 6 (uA)

Analog Writes

Addr	Description
4:0001	
4:0002	723 ANALOG OUTPUT #1
4:0003	723 ANALOG OUTPUT #2
4:0004	723 ANALOG OUTPUT #4
4:0005	723 REMOTE REFERENCE
4:0006	
4:0007	

4:0008	
4:0009	
4:0010	
4:0011	ANALOG OUT CHANNEL 1
4:0012	ANALOG OUT CHANNEL 2
4:0013	ANALOG OUT CHANNEL 3
4:0014	ANALOG OUT CHANNEL 4
4:0015	ANALOG OUT CHANNEL 5
4:0016	ANALOG OUT CHANNEL 6

Appendix D. 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.

From the Handheld Main Menu Header press 'ID', or from Watch Window or Control View, select "Control Properties" to get the Software Part Number and revision level. Record Here ___________________

Configure Menus

CFIG OPTION	Default	Field Settings
USE REV ACTUATOR	#FALSE	
USE 2nd DYNAMICS	#FALSE	
USE 5-GAIN MAP	#FALSE	
USE CONST DYNAMICS	#FALSE	
USE EXT FUEL LIMIT	#FALSE	
USE COMM PORTS	#FALSE	
USE REMOTE COMMANDS	#FALSE	
REMOTE LOCK IN LAST	#FALSE	
RESET ALM ON CLEAR	#FALSE	
FORCE DISCRETE OUTS	#FALSE	
USE TORQUE LIMIT	#FALSE	
PROCESS CTRL OPTION	#0 (0, 3)	
USE CASCADE PROCESS	#FALSE	
PROCESS REV ACTING	#FALSE	
USE TORSION FILTER	#FALSE	
USE NOTCH FILTER	#FALSE	
ENABLE TORS LIMITER	#FALSE	
USE START SPEED	#FALSE	
CFIG SPEED CONTROL	**Default (Low, High)**	
RATED SPEED(RPM)	#1200 (1, 2100)	
ASPD #1 TEETH	#16 (16, 500)	
ASPD#1 MAX FREQ(Hz)	#6000 (10, 17500)	
ASPD #2 TEETH	#16 (16, 500)	
ASPD#2 MAX FREQ(Hz)	#6000 (10, 17500)	
DSPD #1 TEETH	#16 (16, 500)	
DSPD #2 TEETH	#16 (16, 500)	
USE DIG SPD SENSOR	#TRUE	
SS CLEAR PERCENTAGE	#5.0 (1.0, 10.0)	
FORCE TO IDLE	#TRUE	
MPU ALARM ARM TIME (SEC)	#10.0 (0.0, 120.0)	
AI ALARM ARM TIME (SEC)	#10.0 (0.0, 10800.0)	

CFIG SHUTDOWN	Default	
SPEED #1 FAIL	#FALSE	
SPEED #2 FAIL	#FALSE	
SPD #1AND#2 FAIL	#FALSE	
PROCESS #1 IN FAIL	#FALSE	
PROCESS #2 IN FAIL	#FALSE	
REMOTE INPUT FAIL	#FALSE	
EXT FUEL LIMIT FAIL	#FALSE	
MODBUS PORT3 FAIL	#FALSE	
HI FUEL DEMND LEVEL	#FALSE	
HIGH SPEED LEVEL	#FALSE	
HI TORSIONAL LEVEL	#FALSE	
PROCESS #1 HIGH	#FALSE	
PROCESS #1 LOW	#FALSE	
PROCESS #2 HIGH	#FALSE	
PROCESS #2 LOW	#FALSE	
PROCESS DIFF HIGH	#FALSE	
PROCESS DIFF LOW	#FALSE	
CFIG ALARM	**Default**	
SPEED #1 FAIL	#FALSE	
SPEED #2 FAIL	#FALSE	
SPD #1AND#2 FAIL	#FALSE	
PROCESS #1 IN FAIL	#FALSE	
PROCESS #2 IN FAIL	#FALSE	
REMOTE INPUT FAIL	#FALSE	
EXT FUEL LIMIT FAIL	#FALSE	
MODBUS PORT3 FAIL	#FALSE	
HI FUEL DEMND LEVEL	#FALSE	
HIGH SPEED LEVEL	#FALSE	
HI TORSIONAL LEVEL	#FALSE	
PROCESS #1 HIGH	#FALSE	
PROCESS #1 LOW	#FALSE	
PROCESS #2 HIGH	#FALSE	
PROCESS #2 LOW	#FALSE	
PROCESS DIFF HIGH	#FALSE	
PROCESS DIFF LOW	#FALSE	
CFIG INDICATION	**Default**	
ON START FUEL LIMIT	#FALSE	
ON MAX LIMIT	#FALSE	
ON EXT FUEL LIMIT	#FALSE	
ON TORSION LIMIT	#FALSE	
ON TORQUE LIMIT	#FALSE	
ACT SHUTDOWN	#FALSE	
SPEED SWITCH 1	#FALSE	
SPEED SWITCH 2	#FALSE	

SHUTDOWN SETUP	Default (Low, High)	
HI FUEL DEMND SETPT(%FD)	#100.0 (0.0, 100.0)	
HI FUEL DEMND DELAY(SEC)	#10.0 (0.0, 10800.0)	
HI SPEED SETPOINT (RPM)	#1320.0 (0.0, 2500.0)	
HI SPEED DELAY(SEC)	#0.2 (0.0, 10800.0)	
TORSION LEVEL SETPT(%RPM)	#50.0 (0.0, 100.0)	
HI TORSION DELAY (SECS)	#10.0 (0.0, 10800.0)	
PROCESS 1 HI LEVEL	#12.0 (-30000.0, 30000.0)	
PROCESS 1 LOW LEVEL	#12.0 (-30000.0, 30000.0)	
PROCESS 1 DELAY	#10.0 (0.0, 10800.0)	
PROCESS 2 HI LEVEL	#12.0 (-30000.0, 30000.0)	
PROCESS 2 LOW LEVEL	#12.0 (-30000.0, 30000.0)	
PROCESS 2 DELAY	#10.0 (0.0, 10800.0)	
PROC DIFF HI LEVEL	#12.0 (-30000.0, 30000.0)	
PROC DIFF LO LEVEL	#12.0 (-30000.0, 30000.0)	
PROCESS DIFF DELAY	#10.0 (0.0, 10800.0)	
ENERGIZE FOR SHTDWN	#TRUE	
SHUTDOWN ACT ON SD	#FALSE	
ALARM SETUP	**Default (Low, High)**	
HI FUEL DEMND SETPT(%FD)	#100.0 (0.0, 100.0)	
HI FUEL DEMND DELAY(SEC)	#10.0 (0.0, 10800.0)	
HI SPEED SETPOINT (RPM)	#1320.0 (0.0, 2500.0)	
HI SPEED DELAY(SEC)	#0.2 (0.0, 10800.0)	
TORSION LEVEL SETPT(%RPM)	#50.0 (0.0, 100.0)	
HI TORSION DELAY (SECS)	#10.0 (0.0, 10800.0)	
PROCESS 1 HI LEVEL	#12.0 (-30000.0, 30000.0)	
PROCESS 1 LOW LEVEL	#12.0 (-30000.0, 30000.0)	
PROCESS 1 DELAY	#10.0 (0.0, 10800.0)	
PROCESS 2 HI LEVEL	#12.0 (-30000.0, 30000.0)	
PROCESS 2 LOW LEVEL	#12.0 (-30000.0, 30000.0)	
PROCESS 2 DELAY	#10.0 (0.0, 10800.0)	
PROC DIFF HI LEVEL	#12.0 (-30000.0, 30000.0)	
PROC DIFF LO LEVEL	#12.0 (-30000.0, 30000.0)	
PROCESS DIFF DELAY	#10.0 (0.0, 10800.0)	
ENERGIZE FOR ALARM	#TRUE	
SHUTDOWN ACT ON ALM	#FALSE	
INDICATION SETUP	**Default (Low, High)**	
SPD SWITCH1 PICKUP (RPM)	#500.0 (0.0, 2200.0)	
SPD SWITCH1 DROPOUT(RPM)	#400.0 (0.0, 2200.0)	
SPD SWITCH2 PICKUP (RPM)	#500.0 (0.0, 2200.0)	
SPD SWITCH2 DROPOUT(RPM)	#400.0 (0.0, 2200.0)	
ENRGIZE FOR INDICAT	#TRUE	
CFIG COMMUNICATION	**Default (Low, High)**	
PORT 2 ADDRESS	#0 (0, 15)	
PORT 3 ADDRESS	#1 (1, 247)	
PORT 3 MODE	#2 (1, 2)	

CFIG ANALOG OUTPUTS	Default (Low, High)	
AOUT 1 SELECT	#1 (1, 10)	
AOUT 1 4-20 mA	#TRUE	
AOUT 2 SELECT	#2 (1, 10)	
AOUT 2 4-20 mA	#TRUE	
ACT OUT 1 4-20 mA	#FALSE	
ACT OUT 2 SELECT	#3 (1, 10)	
ACT OUT 2 4-20 mA	#TRUE	

Service Menus

SHUTDOWN MENU	Default	Field Settings
FIRST SHUTDOWN		
1-SPEED #1FAIL		
2-SPEED #2 FAIL		
3-SPD #1AND#2 FAIL		
4-PROCESS #1 FAIL		
5-PROCESS #2 FAIL		
6-REMOTE INPUT FAIL		
7-EXT FUEL LMT FAIL		
8-MODBUS 3 FAIL		
9-HI FUEL DEMAND		
10-HIGH SPEED		
11-HIGH TORSIONAL		
12-PROCESS #1 HIGH		
13-PROCESS #1 LOW		
14-PROCESS #2 HIGH		
15-PROCESS #2 LOW		
16-PROCESS DIFF HI		
17-PROCESS DIFF LOW		
ALARM RESET	*FALSE	
ALARM MENU	**Default**	
FIRST ALARM		
1-SPEED #1FAIL		
2-SPEED #2 FAIL		
3-SPD #1AND#2 FAIL		
4-PROCESS #1 FAIL		
5-PROCESS #2 FAIL		
6-REMOTE INPUT FAIL		
7-EXT FUEL LMT FAIL		
8-MODBUS 3 FAIL		
9-HI FUEL DEMAND		
10-HIGH SPEED		
11-HIGH TORSIONAL		
12-PROCESS #1 HIGH		
13-PROCESS #1 LOW		
14-PROCESS #2 HIGH		
15-PROCESS #2 LOW		
16-PROCESS DIFF HI		
17-PROCESS DIFF LOW		
ALARM RESET	*FALSE	

1st SPEED DYNAMICS	Default (Low, High)	
GAIN 1	*10.0 (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 (1.0, 10.0)	
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 FREQ 1(HZ)	*15.0 (0.5, 20.0)	
BUMP ACT	*FALSE	

2nd SPEED DYNAMICS	Default (Low, High)	
GAIN 2	*10.0 (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 (1.0, 10.0)	
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 FREQ 2(HZ)	*15.0 (0.5, 20.0)	
BUMP ACT	*FALSE	

1st DYNAMICS-5 GAIN	Default (Low, High)	
BREAKPOINT 1A (%FD)	*99.6 (0.00, 100.0)	
GAIN @BREAKPOINT 1A	*10.0 (0.0015, 1000.0)	
BREAKPOINT 1B (%FD)	*99.7 (0.00, 100.0)	
GAIN @BREAKPOINT 1B	*10.0 (0.0015, 1000.0)	
BREAKPOINT 1C (%FD)	*99.8 (0.00, 100.0)	
GAIN @BREAKPOINT 1C	*10.0 (0.0015, 1000.0)	
BREAKPOINT 1D (%FD)	*99.9 (0.00, 100.0)	
GAIN @BREAKPOINT 1D	*10.0 (0.0015, 1000.0)	
BREAKPOINT 1E (%FD)	*100.0 (0.00, 100.0)	
GAIN @BREAKPOINT 1E	*10.0 (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 (1.0, 10.0)	
WINDOW WIDTH 1(RPM)	*60.0 (1.0, 2100.0)	
SPEED FILTER FREQ 1(HZ)	*15.0 (0.5, 20.0)	
BUMP ACT	*FALSE	

2nd DYNAMICS-5 GAIN	Default (Low, High)	
BREAKPOINT 2A (%FD)	*99.6 (0.00, 100.0)	
GAIN @BREAKPOINT 2A	*10.0 (0.0015, 1000.0)	
BREAKPOINT 2B (%FD)	*99.7 (0.00, 100.0)	
GAIN @BREAKPOINT 2B	*10.0 (0.0015, 1000.0)	
BREAKPOINT 2C (%FD)	*99.8 (0.00, 100.0)	
GAIN @BREAKPOINT 2C	*10.0 (0.0015, 1000.0)	
BREAKPOINT 2D (%FD)	*99.9 (0.00, 100.0)	
GAIN @BREAKPOINT 2D	*10.0 (0.0015, 1000.0)	
BREAKPOINT 2E (%FD)	*100.0 (0.00, 100.0)	
GAIN @BREAKPOINT 2E	*10.0 (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 (1.0, 10.0)	
WINDOW WIDTH 2(RPM)	*60.0 (0.0, 2100.0)	
SPEED FILTER FREQ 2(HZ)	*15.0 (0.5, 20.0)	
BUMP ACT	*FALSE	
ACTUATOR BUMP	**Default (Low, High)**	
BUMP ENABLE	*FALSE	
ACT BUMP LEVEL(%FD)	*1.0 (0.0, 100.0)	
ACT BUMP DURATION (SEC)	*0.1 (0.01, 2.0)	
TORSIONAL FILTER	**Default (Low, High)**	
ENABLE TORS FILTER	*FALSE	
ENG SENSOR WEIGHT	*0.5 (0.0, 1.0)	
TORS SCALE (%RATED)	*1.0 (0.0, 100.0)	
TORSNL FUEL LIMIT (%FD)	*100.0 (0.0, 100.0)	
TORSNL LEVEL @LIMIT(%)	*100.0 (0.001, 100.0)	
TORSNL LEVEL @CLEAR(%)	*1.0 (0.000, 100.0)	
NOTCH FREQUENCY (HZ)	*15.9 (0.01, 16.0)	
NOTCH Q FACTOR	*0.707 (0.707, 25.0)	
TORSIONAL LEVEL(%)		
TORSNL FILTR ACTIVE		
TORSIONAL LIMIT LVL(%FD)		
FUEL LIMITERS	**Default (Low, High)**	
START FUEL LIMIT (%FD)	*100.0 (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)	
SPEED SETTING	**Default (Low, High)**	
START SPEED	*125 (1, 2100)	
RAISE SPEED LIMIT (RPM)	*1300 (1, 2100)	
LOWER SPEED LIMIT (RPM)	*650 (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 SPEED RATE (RPM/MIN)	*120.0 (0.01, 32767.0)	
LOWER SPEED RATE (RPM/MIN)	*120.0 (0.01, 32767.0)	

DB PROCESS CONTROL	**Default (Low, High)**	
DEFAULT PROC STPT (EU)	*12.0 (-16384.0, 16384.0)	
PROCESS DEADBAND (EU)	*2.0 (0.01, 32767.0)	
DB INCR RATE (RPM/MIN)	*60.0 (0.01, 32767.0)	
DB DECR RATE (RPM/MIN)	*60.0 (0.01, 32767.0)	
PROC RAISE LIMIT (EU)	*20.0 (-16384.0, 16384.0)	
PROC LOWER LIMIT (EU)	*4.0 (-16384.0, 16384.0)	
PROC RAISE RATE (EU/MIN)	*60.0 (0.01, 32767.0)	
PROC LOWER RATE (EU/MIN)	*60.0 (0.01, 32767.0)	
PROCESS #1 FILTER (HZ)	*15.9 (0.01, 15.9)	
PROCESS #2 FILTER (HZ)	*15.9 (0.01, 15.9)	
PROCESS INPUT#1(EU)		
PROCESS INPUT#2(EU)		
PROCESS DIFFERENCE (EU)		
PROCESS REFERENCE (EU)		
PROCESS REM REF(EU)		
CASCADE PROC CTRL	**Default (Low, High)**	
DEFAULT PROC STPT (EU)	*12.0 (-16384.0, 16384.0)	
PROC GAIN	*1.0 (0.01, 100.0)	
PROC INTEGRAL GAIN	*1.0 (0.01, 50.0)	
PROC S D R	*10.0 (0.01, 100.0)	
SPEED REF@0% PID (RPM)	*650 (1, 2100)	
SPEED REF@100% PID (RPM)	*1300 (1, 2100)	
CASC NOT MATCHED RT(RPM/MIN)	*10.0 (0.01, 32767.0)	
PROC RAISE LIMIT (EU)	*20.0 (-16384.0, 16384.0)	
PROC LOWER LIMIT (EU)	*4.0 (-16384.0, 16384.0)	
PROC RAISE RATE (EU/MIN)	*60.0 (0.01, 32767.0)	
PROC LOWER RATE (EU/MIN)	*60.0 (0.01, 32767.0)	
PROCESS #1 FILTER (HZ)	*15.9 (0.01, 15.9)	
PROCESS #2 FILTER (HZ)	*15.9 (0.01, 15.9)	
PROCESS INPUT#1(EU)		
PROCESS INPUT#2(EU)		
PROCESS DIFFERENCE (EU)		
PROCESS REFERENCE (EU)		
PROCESS REM REF(EU)		
TORQUE LIMIT CURVE	**Default (Low, High)**	
ENABLE TORQUE LIMIT	*FALSE	
TORQUE LMT BRKPNT A(RPM)	*600.0 (0.0, 2200.0)	
FUEL LIMIT@BRKPNT A(%FD)	*20.0 (0.0, 100.0)	
TORQUE LMT BRKPNT B(RPM)	*700.0 (0.0, 2200.0)	
FUEL LIMIT@BRKPNT B(%FD)	*40.0 (0.0, 100.0)	
TORQUE LMT BRKPNT C(RPM)	*900.0 (0.0, 2200.0)	
FUEL LIMIT@BRKPNT C(%FD)	*60.0 (0.0, 100.0)	
TORQUE LMT BRKPNT D(RPM)	*1000.0 (0.0, 2200.0)	
FUEL LIMIT@BRKPNT D(%FD)	*80.0 (0.0, 100.0)	
TORQUE LMT BRKPNT E(RPM)	*1200.0 (0.0, 2200.0)	
FUEL LIMIT@BRKPNT E(%FD)	*100.0 (0.0, 100.0)	
DROOP	**Default (Low, High)**	
LOAD DROOP PERCENT	*0.0 (0.0, 100.0)	
FUEL DEMAND @MIN LD(%FD)	*20.0 (0.0, 100.0)	
FUEL DEMAND @MAX LD(%FD)	*80.0 (0.0, 100.0)	

EXT FUEL LMT CURVE	Default (Low, High)	
ENABLE EXT FUEL LMT	*FALSE	
EXT LIMIT BRKPNT A (EU)	*6.0 (-16384.0, 16384.0)	
FUEL LIMIT@BRKPNT A(%FD)	*100.0 (0.0, 100.0)	
EXT LIMIT BRKPNT B (EU)	*8.0 (-16384.0, 16384.0)	
FUEL LIMIT@BRKPNT B(%FD)	*100.0 (0.0, 100.0)	
EXT LIMIT BRKPNT C (EU)	*10.0 (-16384.0, 16384.0)	
FUEL LIMIT@BRKPNT C(%FD)	*100.0 (0.0, 100.0)	
EXT LIMIT BRKPNT D (EU)	*15.0 (-16384.0, 16384.0)	
FUEL LIMIT@BRKPNT D(%FD)	*100.0 (0.0, 100.0)	
EXT LIMIT BRKPNT E (EU)	*20.0 (-16384.0, 16384.0)	
FUEL LIMIT@BRKPNT E(%FD)	*100.0 (0.0, 100.0)	
SET ANALOG INPUTS	**Default (Low, High)**	
PROCESS #1@4mA(EU)	*4.0 (-16384.0, 16384.0)	
PROCESS #1@20mA(EU)	*20.0 (-16384.0, 16384.0)	
PROCESS #2@4mA(EU)	*4.0 (-16384.0, 16384.0)	
PROCESS #2@20mA(EU)	*20.0 (-16384.0, 16384.0)	
REMOTE SPD @4mA (RPM)	*600.0 (-16384.0, 16384.0)	
REMOTE SPD @20mA (RPM)	*1300.0 (-16384.0, 16384.0)	
REM PROC@4mA(EU)	*4.0 (-16384.0, 16384.0)	
REM PROC@20mA(EU)	*20.0 (-16384.0, 16384.0)	
EXT FUEL LMT@4mA (EU)	*4.0 (-16384.0, 16384.0)	
EXT FUEL LMT@20mA (EU)	*20.0 (-16384.0, 16384.0)	
SET ANALOG OUTPUTS	**Default (Low, High)**	
ANALOG OUTPUT 1 MIN(EU)	*0.0 (-32767.0, 32767.0)	
ANALOG OUTPUT 1 MAX(EU)	*1300.0 (-32767.0, 32767.0)	
ANALOG OUTPUT 2 MIN(EU)	*0.0 (-32767.0, 32767.0)	
ANALOG OUTPUT 2 MAX(EU)	*1300.0 (-32767.0, 32767.0)	
ACTUATOR OUT 2 MIN (EU)	*0.0 (-32767.0, 32767.0)	
ACTUATOR OUT 2 MAX (EU)	*100.0 (-32767.0, 32767.0)	
AO FILTER FREQUENCY(HZ)	*15.0 (0.01, 20.0)	
I/O CALIBRATION	**Default (Low, High)**	
PROC#1 OFFSET(AI1)	*0.0 (-20.0, 20.0)	
PROC#1 IN SPAN(AI1)	*100.0 (50.0, 200.0)	
PROC#1 READ VOLTS (AI1)	*FALSE	
PROC#2 OFFSET(AI2)	*0.0 (-20.0, 20.0)	
PROC#2 IN SPAN(AI2)	*100.0 (50.0, 200.0)	
PROC#2 READ VOLTS (AI2)	*FALSE	
REM IN OFFSET(AI3)	*0.0 (-20.0, 20.0)	
REM IN SPAN(AI3)	*100.0 (50.0, 200.0)	
REM IN READ VOLTS (AI3)	*FALSE	
EXT LMT OFFSET(AI4)	*0.0 (-20.0, 20.0)	
EXT LIMIT SPAN(AI4)	*100.0 (50.0, 200.0)	
EXT LMT READ VOLTS (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)	

COMM PORT SETUP	Default (Low, High)	
PORT2 HARDWARE CFIG	*1 (1, 2)	
PORT 2 BAUD RATE	*9 (1, 10)	
PORT3 HARDWARE CFIG	*1 (1, 3)	
PORT 3 BAUD RATE	*6 (1, 7)	
PORT 3 STOP BITS	*1 (1, 3)	
PORT 3 PARITY	*1 (1, 3)	
PORT 3 TIMEOUT(SEC)	*10.0 (0.5, 30.0)	
PORT3 LINK ERROR		
PORT3 EXCEPTION ERR		
TC MODULE 1	**Default (Low, High)**	
CH1 - TC DEGREES F		
CH2 - TC DEGREES F		
CH3 - TC DEGREES F		
CH4 - TC DEGREES F		
CH5 - TC DEGREES F		
CH6 - TC DEGREES F		
CH1 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH1 - TC SPAN	*100.0 (50.0, 200.0)	
CH2 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH2 - TC SPAN	*100.0 (50.0, 200.0)	
CH3 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH3 - TC SPAN	*100.0 (50.0, 200.0)	
CH4 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH4 - TC SPAN	*100.0 (50.0, 200.0)	
CH5 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH5 - TC SPAN	*100.0 (50.0, 200.0)	
CH6 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH6 - TC SPAN	*100.0 (50.0, 200.0)	
TC MODULE 2	**Default (Low, High)**	
CH1 - TC DEGREES F		
CH2 - TC DEGREES F		
CH3 - TC DEGREES F		
CH4 - TC DEGREES F		
CH5 - TC DEGREES F		
CH6 - TC DEGREES F		
CH1 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH1 - TC SPAN	*100.0 (50.0, 200.0)	
CH2 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH2 - TC SPAN	*100.0 (50.0, 200.0)	
CH3 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH3 - TC SPAN	*100.0 (50.0, 200.0)	
CH4 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH4 - TC SPAN	*100.0 (50.0, 200.0)	
CH5 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH5 - TC SPAN	*100.0 (50.0, 200.0)	
CH6 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH6 - TC SPAN	*100.0 (50.0, 200.0)	

TC MODULE 3	Default (Low, High)	
CH1 - TC DEGREES F		
CH2 - TC DEGREES F		
CH3 - TC DEGREES F		
CH4 - TC DEGREES F		
CH5 - TC DEGREES F		
CH6 - TC DEGREES F		
CH1 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH1 - TC SPAN	*100.0 (50.0, 200.0)	
CH2 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH2 - TC SPAN	*100.0 (50.0, 200.0)	
CH3 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH3 - TC SPAN	*100.0 (50.0, 200.0)	
CH4 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH4 - TC SPAN	*100.0 (50.0, 200.0)	
CH5 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH5 - TC SPAN	*100.0 (50.0, 200.0)	
CH6 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH6 - TC SPAN	*100.0 (50.0, 200.0)	
TC MODULE 4	**Default (Low, High)**	
CH1 - TC DEGREES F		
CH2 - TC DEGREES F		
CH3 - TC DEGREES F		
CH4 - TC DEGREES F		
CH5 - TC DEGREES F		
CH6 - TC DEGREES F		
CH1 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH1 - TC SPAN	*100.0 (50.0, 200.0)	
CH2 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH2 - TC SPAN	*100.0 (50.0, 200.0)	
CH3 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH3 - TC SPAN	*100.0 (50.0, 200.0)	
CH4 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH4 - TC SPAN	*100.0 (50.0, 200.0)	
CH5 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH5 - TC SPAN	*100.0 (50.0, 200.0)	
CH6 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH6 - TC SPAN	*100.0 (50.0, 200.0)	

RTD MODULE 1	Default (Low, High)	
CH1 - RTD DEGREES F		
CH2 - RTD DEGREES F		
CH3 - RTD DEGREES F		
CH4 - RTD DEGREES F		
CH5 - RTD DEGREES F		
CH6 - RTD DEGREES F		
CH1 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH1 - RTD SPAN	*100.0 (50.0, 200.0)	
CH2 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH2 - RTD SPAN	*100.0 (50.0, 200.0)	
CH3 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH3 - RTD SPAN	*100.0 (50.0, 200.0)	
CH4 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH4 - RTD SPAN	*100.0 (50.0, 200.0)	
CH5 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH5 - RTD SPAN	*100.0 (50.0, 200.0)	
CH6 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH6 - RTD SPAN	*100.0 (50.0, 200.0)	
RTD MODULE 2	**Default (Low, High)**	
CH1 - RTD DEGREES F		
CH2 - RTD DEGREES F		
CH3 - RTD DEGREES F		
CH4 - RTD DEGREES F		
CH5 - RTD DEGREES F		
CH6 - RTD DEGREES F		
CH1 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH1 - RTD SPAN	*100.0 (50.0, 200.0)	
CH2 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH2 - RTD SPAN	*100.0 (50.0, 200.0)	
CH3 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH3 - RTD SPAN	*100.0 (50.0, 200.0)	
CH4 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH4 - RTD SPAN	*100.0 (50.0, 200.0)	
CH5 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH5 - RTD SPAN	*100.0 (50.0, 200.0)	
CH6 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH6 - RTD SPAN	*100.0 (50.0, 200.0)	

RTD MODULE 3	Default (Low, High)	
CH1 - RTD DEGREES F		
CH2 - RTD DEGREES F		
CH3 - RTD DEGREES F		
CH4 - RTD DEGREES F		
CH5 - RTD DEGREES F		
CH6 - RTD DEGREES F		
CH1 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH1 - RTD SPAN	*100.0 (50.0, 200.0)	
CH2 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH2 - RTD SPAN	*100.0 (50.0, 200.0)	
CH3 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH3 - RTD SPAN	*100.0 (50.0, 200.0)	
CH4 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH4 - RTD SPAN	*100.0 (50.0, 200.0)	
CH5 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH5 - RTD SPAN	*100.0 (50.0, 200.0)	
CH6 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH6 - RTD SPAN	*100.0 (50.0, 200.0)	

AI MODULE 1	Default (Low, High)	
AI1 CH1 - mA INPUT		
AI1 CH2 - mA INPUT		
AI1 CH3 - mA INPUT		
AI1 CH4 - mA INPUT		
AI1 CH5 - mA INPUT		
AI1 CH6 - mA INPUT		
AI1 CH1 - AI OFFSET	*0.0 (-20.0, 20.0)	
AI1 CH1 - AI SPAN	*100.0 (50.0, 200.0)	
AI1 CH2 - AI OFFSET	*0.0 (-20.0, 20.0)	
AI1 CH2 - AI SPAN	*100.0 (50.0, 200.0)	
AI1 CH3 - AI OFFSET	*0.0 (-20.0, 20.0)	
AI1 CH3 - AI SPAN	*100.0 (50.0, 200.0)	
AI1 CH4 - AI OFFSET	*0.0 (-20.0, 20.0)	
AI1 CH4 - AI SPAN	*100.0 (50.0, 200.0)	
AI1 CH5 - AI OFFSET	*0.0 (-20.0, 20.0)	
AI1 CH5 - AI SPAN	*100.0 (50.0, 200.0)	
AI1 CH6 - AI OFFSET	*0.0 (-20.0, 20.0)	
AI1 CH6 - AI SPAN	*100.0 (50.0, 200.0)	

AI MODULE 2	Default (Low, High)	
AI2 CH1 - mA INPUT		
AI2 CH2 - mA INPUT		
AI2 CH3 - mA INPUT		
AI2 CH4 - mA INPUT		
AI2 CH5 - mA INPUT		
AI2 CH6 - mA INPUT		
AI2 CH1 - AI OFFSET	*0.0 (-20.0, 20.0)	
AI2 CH1 - AI SPAN	*100.0 (50.0, 200.0)	
AI2 CH2 - AI OFFSET	*0.0 (-20.0, 20.0)	
AI2 CH2 - AI SPAN	*100.0 (50.0, 200.0)	
AI2 CH3 - AI OFFSET	*0.0 (-20.0, 20.0)	
AI2 CH3 - AI SPAN	*100.0 (50.0, 200.0)	
AI2 CH4 - AI OFFSET	*0.0 (-20.0, 20.0)	
AI2 CH4 - AI SPAN	*100.0 (50.0, 200.0)	
AI2 CH5 - AI OFFSET	*0.0 (-20.0, 20.0)	
AI2 CH5 - AI SPAN	*100.0 (50.0, 200.0)	
AI2 CH6 - AI OFFSET	*0.0 (-20.0, 20.0)	
AI2 CH6 - AI SPAN	*100.0 (50.0, 200.0)	
DI MODULE 1	**Display Only**	
CH01 CONTACT CLOSED		
CH02 CONTACT CLOSED		
CH03 CONTACT CLOSED		
CH04 CONTACT CLOSED		
CH05 CONTACT CLOSED		
CH06 CONTACT CLOSED		
CH07 CONTACT CLOSED		
CH08 CONTACT CLOSED		
CH09 CONTACT CLOSED		
CH10 CONTACT CLOSED		
CH11 CONTACT CLOSED		
CH12 CONTACT CLOSED		
CH13 CONTACT CLOSED		
CH14 CONTACT CLOSED		
CH15 CONTACT CLOSED		
CH16 CONTACT CLOSED		
DI MODULE 2	**Display Only**	
CH01 CONTACT CLOSED		
CH02 CONTACT CLOSED		
CH03 CONTACT CLOSED		
CH04 CONTACT CLOSED		
CH05 CONTACT CLOSED		
CH06 CONTACT CLOSED		
CH07 CONTACT CLOSED		
CH08 CONTACT CLOSED		
CH09 CONTACT CLOSED		
CH10 CONTACT CLOSED		
CH11 CONTACT CLOSED		
CH12 CONTACT CLOSED		
CH13 CONTACT CLOSED		
CH14 CONTACT CLOSED		
CH15 CONTACT CLOSED		
CH16 CONTACT CLOSED		

DI MODULE 3	Display Only	
CH01 CONTACT CLOSED		
CH02 CONTACT CLOSED		
CH03 CONTACT CLOSED		
CH04 CONTACT CLOSED		
CH05 CONTACT CLOSED		
CH06 CONTACT CLOSED		
CH07 CONTACT CLOSED		
CH08 CONTACT CLOSED		
CH09 CONTACT CLOSED		
CH10 CONTACT CLOSED		
CH11 CONTACT CLOSED		
CH12 CONTACT CLOSED		
CH13 CONTACT CLOSED		
CH14 CONTACT CLOSED		
CH15 CONTACT CLOSED		
CH16 CONTACT CLOSED		
DI MODULE 4	**Display Only**	
CH01 CONTACT CLOSED		
CH02 CONTACT CLOSED		
CH03 CONTACT CLOSED		
CH04 CONTACT CLOSED		
CH05 CONTACT CLOSED		
CH06 CONTACT CLOSED		
CH07 CONTACT CLOSED		
CH08 CONTACT CLOSED		
CH09 CONTACT CLOSED		
CH10 CONTACT CLOSED		
CH11 CONTACT CLOSED		
CH12 CONTACT CLOSED		
CH13 CONTACT CLOSED		
CH14 CONTACT CLOSED		
CH15 CONTACT CLOSED		
CH16 CONTACT CLOSED		
DO MODULE 1	**Display Only**	
CH1 ENERGIZED		
CH2 ENERGIZED		
CH3 ENERGIZED		
CH4 ENERGIZED		
CH5 ENERGIZED		
CH6 ENERGIZED		
CH7 ENERGIZED		
CH8 ENERGIZED		
DO MODULE 2	**Display Only**	
CH1 ENERGIZED		
CH2 ENERGIZED		
CH3 ENERGIZED		
CH4 ENERGIZED		
CH5 ENERGIZED		
CH6 ENERGIZED		
CH7 ENERGIZED		
CH8 ENERGIZED		

DO MODULE 3	Display Only	
CH1 ENERGIZED		
CH2 ENERGIZED		
CH3 ENERGIZED		
CH4 ENERGIZED		
CH5 ENERGIZED		
CH6 ENERGIZED		
CH7 ENERGIZED		
CH8 ENERGIZED		
DO MODULE 4	**Display Only**	
CH1 ENERGIZED		
CH2 ENERGIZED		
CH3 ENERGIZED		
CH4 ENERGIZED		
CH5 ENERGIZED		
CH6 ENERGIZED		
CH7 ENERGIZED		
CH8 ENERGIZED		
AO MODULE 1	**Default (Low, High)**	
AO1 CH1 mA OUT		
AO1 CH2 mA OUT		
AO1 CH3 mA OUT		
AO1 CH4 mA OUT		
AO1 CH5 mA OUT		
AO1 CH6 mA OUT		
AO1 CH1 - OFFSET	*0.0 (-20.0, 20.0)	
AO1 CH1 - SPAN	*100.0 (50.0, 200.0)	
AO1 CH2 - OFFSET	*0.0 (-20.0, 20.0)	
AO1 CH2 - SPAN	*100.0 (50.0, 200.0)	
AO1 CH3 - OFFSET	*0.0 (-20.0, 20.0)	
AO1 CH3 - SPAN	*100.0 (50.0, 200.0)	
AO1 CH4 - OFFSET	*0.0 (-20.0, 20.0)	
AO1 CH4 - SPAN	*100.0 (50.0, 200.0)	
AO1 CH5 - OFFSET	*0.0 (-20.0, 20.0)	
AO1 CH5 - SPAN	*100.0 (50.0, 200.0)	
AO1 CH6 - OFFSET	*0.0 (-20.0, 20.0)	
AO1 CH6 - SPAN	*100.0 (50.0, 200.0)	
DISPLAY DIGITAL I/O	**Display Only**	
A-PROCESS ENABLE		
B-ALARM RESET		
C-SPEED FAIL OVRD		
D-2ND DYNAMICS		
E-RAISE SPEED		
F-LOWER SPEED		
G-RATED SPEED		
H-CLOSE TO RUN		
DO1-SHUTDOWN		
DO2-ALARM		
DO3-STAT INDICATOR		

DISPLAY ANALOG I/O	Default	
SPD SENS IN #1 (HZ)		
SPD SENS IN #2 (HZ)		
AI1-PROCESS IN #1		
AI2-PROCESS IN #2		
AI3-REMOTE IN		
AI4-EXT FUEL LIMIT		
AI1 FAILED		
AI2 FAILED		
AI3 FAILED		
AI4 FAILED		
ANALOG OUT 1(mA)		
ANALOG OUT 2(mA)		
ACTUATOR OUT 1(mA)		
ACTUATOR OUT 2(mA)		
ALARM RESET	*FALSE	
DISPLAY INDICATOR	**Display Only**	
ON START FUEL LIMIT		
ON MAX LIMIT		
ON EXT FUEL LIMIT		
ON TORSION LIMIT		
ON TORQUE LIMIT		
ACT SHUTDOWN		
SPEED SWITCH 1		
SPEED SWITCH 2		
CONTROL MODE	**Default**	
SPEED IN CONTROL		
ON START FUEL LIMIT		
ON MAXIMUM LIMIT		
ON EXTERNAL LIMIT		
ON TORSIONAL LIMIT		
ON TORQUE LIMIT		
ACTUATOR SHUTDOWN		
REMOTE SPEED ENBLD		
REM PROCESS ENBLD		
CASCADE RAMP ACTIVE		
CASCADE PID ACTIVE		
DB PROC CTRL ACTIVE		
SPD SENSOR 1 ACTIVE		
SPD SENSOR 2 ACTIVE		
PORT 1 ON HANDHELD		
PORT 1 ON SERVLINK		
RESET ALL ALARMS	*FALSE	

DISPLAY MENU	Display Only	
ENGINE SPEED(RPM)		
SPEED REF(RPM)		
FUEL DEMAND(%)		
DROOP BIAS(RPM)		
REMOTE SPEED REF (RPM)		
EXT FUEL LIMIT IN (EU)		
EXT FUEL LIMIT(%FD)		
PROCESS INPUT#1(EU)		
PROCESS INPUT#2(EU)		
PROCESS DIFFERENCE (EU)		
PROCESS REFERENCE (EU)		
FORCE 723 DO	**Default**	
DO1 FORCE	*FALSE	
DO2 FORCE	*FALSE	
DO3 FORCE	*FALSE	
FORCE DO 1 & 2	**Default**	
DO1 CH1 FORCE	*FALSE	
DO1 CH2 FORCE	*FALSE	
DO1 CH3 FORCE	*FALSE	
DO1 CH4 FORCE	*FALSE	
DO1 CH5 FORCE	*FALSE	
DO1 CH6 FORCE	*FALSE	
DO1 CH7 FORCE	*FALSE	
DO1 CH8 FORCE	*FALSE	
DO2 CH1 FORCE	*FALSE	
DO2 CH2 FORCE	*FALSE	
DO2 CH3 FORCE	*FALSE	
DO2 CH4 FORCE	*FALSE	
DO2 CH5 FORCE	*FALSE	
DO2 CH6 FORCE	*FALSE	
DO2 CH7 FORCE	*FALSE	
DO2 CH8 FORCE	*FALSE	
FORCE DO 3 & 4	**Default**	
DO3 CH1 FORCE	*FALSE	
DO3 CH2 FORCE	*FALSE	
DO3 CH3 FORCE	*FALSE	
DO3 CH4 FORCE	*FALSE	
DO3 CH5 FORCE	*FALSE	
DO3 CH6 FORCE	*FALSE	
DO3 CH7 FORCE	*FALSE	
DO3 CH8 FORCE	*FALSE	
DO4 CH1 FORCE	*FALSE	
DO4 CH2 FORCE	*FALSE	
DO4 CH3 FORCE	*FALSE	
DO4 CH4 FORCE	*FALSE	
DO4 CH5 FORCE	*FALSE	
DO4 CH6 FORCE	*FALSE	
DO4 CH7 FORCE	*FALSE	
DO4 CH8 FORCE	*FALSE	

Appendix E. Menu Summary

Configure Menus

CFIG OPTION
USE REV ACTUATOR
USE 2nd DYNAMICS
USE 5-GAIN MAP
USE CONST DYNAMICS
USE EXT FUEL LIMIT
USE COMM PORTS
USE REMOTE COMMANDS
REMOTE LOCK IN LAST
RESET ALM ON CLEAR
FORCE DISCRETE OUTS
USE TORQUE LIMIT
PROCESS CTRL OPTION
USE CASCADE PROCESS
PROCESS REV ACTING
USE TORSION FILTER
USE NOTCH FILTER
ENABLE TORS LIMITER
USE START SPEED

CFIG SPEED CONTROL
RATED SPEED(RPM)
ASPD #1 TEETH
ASPD#1 MAX FREQ(Hz)
ASPD #2 TEETH
ASPD#2 MAX FREQ(Hz)
DSPD #1 TEETH
DSPD #2 TEETH
USE DIG SPD SENSOR
SS CLEAR PERCENTAGE
FORCE TO IDLE
MPU ALARM ARM TIME (SEC)
AI ALARM ARM TIME (SEC)

CFIG SHUTDOWN
SPEED #1 FAIL
SPEED #2 FAIL
SPD #1AND#2 FAIL
PROCESS #1 IN FAIL
PROCESS #2 IN FAIL
REMOTE INPUT FAIL
EXT FUEL LIMIT FAIL
MODBUS PORT3 FAIL
HI FUEL DEMND LEVEL
HIGH SPEED LEVEL
HI TORSIONAL LEVEL
PROCESS #1 HIGH
PROCESS #1 LOW
PROCESS #2 HIGH
PROCESS #2 LOW
PROCESS DIFF HIGH
PROCESS DIFF LOW

CFIG ALARM
SPEED #1 FAIL
SPEED #2 FAIL
SPD #1AND#2 FAIL
PROCESS #1 IN FAIL
PROCESS #2 IN FAIL
REMOTE INPUT FAIL
EXT FUEL LIMIT FAIL
MODBUS PORT3 FAIL
HI FUEL DEMND LEVEL
HIGH SPEED LEVEL
HI TORSIONAL LEVEL
PROCESS #1 HIGH
PROCESS #1 LOW
PROCESS #2 HIGH
PROCESS #2 LOW
PROCESS DIFF HIGH
PROCESS DIFF LOW

CFIG INDICATION
ON START FUEL LIMIT
ON MAX LIMIT
ON EXT FUEL LIMIT
ON TORSION LIMIT
ON TORQUE LIMIT
ACT SHUTDOWN
SPEED SWITCH 1
SPEED SWITCH 2

SHUTDOWN SETUP
HI FUEL DEMND SETPT(%FD)
HI FUEL DEMND DELAY(SEC)
HI SPEED SETPOINT (RPM)
HI SPEED DELAY(SEC)
TORSION LEVEL
SETPT(%RPM)
HI TORSION DELAY (SECS)
PROCESS 1 HI LEVEL
PROCESS 1 LOW LEVEL
PROCESS 1 DELAY
PROCESS 2 HI LEVEL
PROCESS 2 LOW LEVEL
PROCESS 2 DELAY
PROC DIFF HI LEVEL
PROC DIFF LO LEVEL
PROCESS DIFF DELAY
ENERGIZE FOR SHTDWN
SHUTDOWN ACT ON SD

ALARM SETUP
HI FUEL DEMND SETPT(%FD)
HI FUEL DEMND DELAY(SEC)
HI SPEED SETPOINT (RPM)
HI SPEED DELAY(SEC)
TORSION LEVEL
SETPT(%RPM)
HI TORSION DELAY (SECS)
PROCESS 1 HI LEVEL
PROCESS 1 LOW LEVEL
PROCESS 1 DELAY
PROCESS 2 HI LEVEL
PROCESS 2 LOW LEVEL
PROCESS 2 DELAY
PROC DIFF HI LEVEL
PROC DIFF LO LEVEL
PROCESS DIFF DELAY
ENERGIZE FOR ALARM
SHUTDOWN ACT ON ALM

INDICATION SETUP
SPD SWITCH1 PICKUP (RPM)
SPD SWITCH1
DROPOUT(RPM)
SPD SWITCH2 PICKUP (RPM)
SPD SWITCH2
DROPOUT(RPM)
ENRGIZE FOR INDICAT

CFIG COMMUNICATION
PORT 2 ADDRESS
PORT 3 ADDRESS
PORT 3 MODE

CFIG ANALOG OUTPUTS
AOUT 1 SELECT
AOUT 1 4-20 mA
AOUT 2 SELECT
AOUT 2 4-20 mA
ACT OUT 1 4-20 mA
ACT OUT 2 SELECT
ACT OUT 2 4-20 mA

Service Menus

SHUTDOWN MENU
FIRST SHUTDOWN
1-SPEED #1FAIL
2-SPEED #2 FAIL
3-SPD #1AND#2 FAIL
4-PROCESS #1 FAIL
5-PROCESS #2 FAIL
6-REMOTE INPUT FAIL
7-EXT FUEL LMT FAIL
8-MODBUS 3 FAIL
9-HI FUEL DEMAND
10-HIGH SPEED
11-HIGH TORSIONAL
12-PROCESS #1 HIGH
13-PROCESS #1 LOW
14-PROCESS #2 HIGH
15-PROCESS #2 LOW
16-PROCESS DIFF HI
17-PROCESS DIFF LOW
ALARM RESET

ALARM MENU
FIRST ALARM
1-SPEED #1FAIL
2-SPEED #2 FAIL
3-SPD #1AND#2 FAIL
4-PROCESS #1 FAIL
5-PROCESS #2 FAIL
6-REMOTE INPUT FAIL
7-EXT FUEL LMT FAIL
8-MODBUS 3 FAIL
9-HI FUEL DEMAND
10-HIGH SPEED
11-HIGH TORSIONAL
12-PROCESS #1 HIGH
13-PROCESS #1 LOW
14-PROCESS #2 HIGH
15-PROCESS #2 LOW
16-PROCESS DIFF HI
17-PROCESS DIFF LOW
ALARM RESET

1st SPEED DYNAMICS
GAIN 1
RESET 1
COMPENSATION 1
GAIN RATIO 1
WINDOW WIDTH 1(RPM)
GAIN SLOPE BK PNT 1(%FD)
GAIN SLOPE 1
SPEED FILTER FREQ 1(HZ)
BUMP ACT

2nd SPEED DYNAMICS
GAIN 2
RESET 2
COMPENSATION 2
GAIN RATIO 2
WINDOW WIDTH 2(RPM)
GAIN SLOPE BK PNT 2(%FD)
GAIN SLOPE 2
SPEED FILTER FREQ 2(HZ)
BUMP ACT

1st DYNAMICS-5 GAIN
BREAKPOINT 1A (%FD)
GAIN @BREAKPOINT 1A
BREAKPOINT 1B (%FD)
GAIN @BREAKPOINT 1B
BREAKPOINT 1C (%FD)
GAIN @BREAKPOINT 1C
BREAKPOINT 1D (%FD)
GAIN @BREAKPOINT 1D
BREAKPOINT 1E (%FD)
GAIN @BREAKPOINT 1E
RESET 1
COMPENSATION 1
GAIN RATIO 1
WINDOW WIDTH 1(RPM)
SPEED FILTER FREQ 1(HZ)
BUMP ACT

2nd DYNAMICS-5 GAIN
BREAKPOINT 2A (%FD)
GAIN @BREAKPOINT 2A
BREAKPOINT 2B (%FD)
GAIN @BREAKPOINT 2B
BREAKPOINT 2C (%FD)
GAIN @BREAKPOINT 2C
BREAKPOINT 2D (%FD)
GAIN @BREAKPOINT 2D
BREAKPOINT 2E (%FD)
GAIN @BREAKPOINT 2E
RESET 2
COMPENSATION 2
GAIN RATIO 2
WINDOW WIDTH 2(RPM)
SPEED FILTER FREQ 2(HZ)
BUMP ACT

ACTUATOR BUMP
BUMP ENABLE
ACT BUMP LEVEL(%FD)
ACT BUMP DURATION (SEC)

TORSIONAL FILTER
ENABLE TORS FILTER
ENG SENSOR WEIGHT
TORS SCALE (%RATED)
TORSNL FUEL LIMIT (%FD)
TORSNL LEVEL @LIMIT(%)
TORSNL LEVEL @CLEAR(%)
NOTCH FREQUENCY (HZ)
NOTCH Q FACTOR
TORSIONAL LEVEL(%)
TORSNL FILTR ACTIVE
TORSIONAL LIMIT LVL(%FD)

FUEL LIMITERS
START FUEL LIMIT (%FD)
START RAMP RATE (%FD/S)
MAX FUEL LIMIT(%FD)

SPEED SETTING
START SPEED
RAISE SPEED LIMIT (RPM)
LOWER SPEED LIMIT (RPM)
IDLE SPEED(RPM)
ACCEL RAMP TIME (SEC)
DECEL RAMP TIME (SEC)
RAISE SPEED RATE
(RPM/MIN)
LOWER SPEED RATE
(RPM/MIN)

DB PROCESS CONTROL
DEFAULT PROC STPT (EU)
PROCESS DEADBAND (EU)
DB INCR RATE (RPM/MIN)
DB DECR RATE (RPM/MIN)
PROC RAISE LIMIT (EU)
PROC LOWER LIMIT (EU)
PROC RAISE RATE (EU/MIN)
PROC LOWER RATE
(EU/MIN)
PROCESS #1 FILTER (HZ)
PROCESS #2 FILTER (HZ)
PROCESS INPUT#1(EU)
PROCESS INPUT#2(EU)
PROCESS DIFFERENCE (EU)
PROCESS REFERENCE (EU)
PROCESS REM REF(EU)

CASCADE PROC CTRL
DEFAULT PROC STPT (EU)
PROC GAIN
PROC INTEGRAL GAIN
PROC S D R
SPEED REF@0% PID (RPM)
SPEED REF@100% PID (RPM)
CASC NOT MATCHED
RT(RPM/MIN)
PROC RAISE LIMIT (EU)
PROC LOWER LIMIT (EU)
PROC RAISE RATE (EU/MIN)
PROC LOWER RATE
(EU/MIN)
PROCESS #1 FILTER (HZ)
PROCESS #2 FILTER (HZ)
PROCESS INPUT#1(EU)
PROCESS INPUT#2(EU)
PROCESS DIFFERENCE (EU)
PROCESS REFERENCE (EU)
PROCESS REM REF(EU)

TORQUE LIMIT CURVE
ENABLE TORQUE LIMIT
TORQUE LMT BRKPNT A(RPM)
FUEL LIMIT@BRKPNT A(%FD)
TORQUE LMT BRKPNT B(RPM)
FUEL LIMIT@BRKPNT B(%FD)
TORQUE LMT BRKPNT C(RPM)
FUEL LIMIT@BRKPNT C(%FD)
TORQUE LMT BRKPNT D(RPM)
FUEL LIMIT@BRKPNT D(%FD)
TORQUE LMT BRKPNT E(RPM)
FUEL LIMIT@BRKPNT E(%FD)

DROOP
LOAD DROOP PERCENT
FUEL DEMAND @MIN LD(%FD)
FUEL DEMAND @MAX LD(%FD)

EXT FUEL LMT CURVE
ENABLE EXT FUEL LMT
EXT LIMIT BRKPNT A (EU)
FUEL LIMIT@BRKPNT A(%FD)
EXT LIMIT BRKPNT B (EU)
FUEL LIMIT@BRKPNT B(%FD)
EXT LIMIT BRKPNT C (EU)
FUEL LIMIT@BRKPNT C(%FD)
EXT LIMIT BRKPNT D (EU)
FUEL LIMIT@BRKPNT D(%FD)
EXT LIMIT BRKPNT E (EU)
FUEL LIMIT@BRKPNT E(%FD)

SET ANALOG INPUTS
PROCESS #1@4mA(EU)
PROCESS #1@20mA(EU)
PROCESS #2@4mA(EU)
PROCESS #2@20mA(EU)
REMOTE SPD @4mA (RPM)
REMOTE SPD @20mA (RPM)
REM PROC@4mA(EU)
REM PROC@20mA(EU)
EXT FUEL LMT@4mA (EU)
EXT FUEL LMT@20mA (EU)

SET ANALOG OUTPUTS
ANALOG OUTPUT 1 MIN(EU)
ANALOG OUTPUT 1 MAX(EU)
ANALOG OUTPUT 2 MIN(EU)
ANALOG OUTPUT 2 MAX(EU)
ACTUATOR OUT 2 MIN (EU)
ACTUATOR OUT 2 MAX (EU)
AO FILTER FREQUENCY(HZ)

I/O CALIBRATION
PROC#1 OFFSET(AI1)
PROC#1 IN SPAN(AI1)
PROC#1 READ VOLTS (AI1)
PROC#2 OFFSET(AI2)
PROC#2 IN SPAN(AI2)
PROC#2 READ VOLTS (AI2)
REM IN OFFSET(AI3)
REM IN SPAN(AI3)
REM IN READ VOLTS (AI3)
EXT LMT OFFSET(AI4)
EXT LIMIT SPAN(AI4)
EXT LMT READ VOLTS (AI4)
AO 1 OFFSET
AO 1 SPAN
AO 2 OFFSET
AO 2 SPAN
ACT 1 OFFSET
ACT 1 SPAN
ACT 2 OFFSET
ACT 2 SPAN

COMM PORT SETUP
PORT2 HARDWARE CFIG
PORT 2 BAUD RATE
PORT3 HARDWARE CFIG
PORT 3 BAUD RATE
PORT 3 STOP BITS
PORT 3 PARITY
PORT 3 TIMEOUT(SEC)
PORT3 LINK ERROR
PORT3 EXCEPTION ERR

TC MODULE 1
CH1 - TC DEGREES F
CH2 - TC DEGREES F
CH3 - TC DEGREES F
CH4 - TC DEGREES F
CH5 - TC DEGREES F
CH6 - TC DEGREES F
CH1 - TC OFFSET
CH1 - TC SPAN
CH2 - TC OFFSET
CH2 - TC SPAN
CH3 - TC OFFSET
CH3 - TC SPAN
CH4 - TC OFFSET
CH4 - TC SPAN
CH5 - TC OFFSET
CH5 - TC SPAN
CH6 - TC OFFSET
CH6 - TC SPAN

TC MODULE 2
CH1 - TC DEGREES F
CH2 - TC DEGREES F
CH3 - TC DEGREES F
CH4 - TC DEGREES F
CH5 - TC DEGREES F
CH6 - TC DEGREES F
CH1 - TC OFFSET
CH1 - TC SPAN
CH2 - TC OFFSET
CH2 - TC SPAN
CH3 - TC OFFSET
CH3 - TC SPAN
CH4 - TC OFFSET
CH4 - TC SPAN
CH5 - TC OFFSET
CH5 - TC SPAN
CH6 - TC OFFSET
CH6 - TC SPAN

TC MODULE 3
CH1 - TC DEGREES F
CH2 - TC DEGREES F
CH3 - TC DEGREES F
CH4 - TC DEGREES F
CH5 - TC DEGREES F
CH6 - TC DEGREES F
CH1 - TC OFFSET
CH1 - TC SPAN
CH2 - TC OFFSET
CH2 - TC SPAN
CH3 - TC OFFSET
CH3 - TC SPAN
CH4 - TC OFFSET
CH4 - TC SPAN
CH5 - TC OFFSET
CH5 - TC SPAN
CH6 - TC OFFSET
CH6 - TC SPAN

TC MODULE 4
CH1 - TC DEGREES F
CH2 - TC DEGREES F
CH3 - TC DEGREES F
CH4 - TC DEGREES F
CH5 - TC DEGREES F
CH6 - TC DEGREES F
CH1 - TC OFFSET
CH1 - TC SPAN
CH2 - TC OFFSET
CH2 - TC SPAN
CH3 - TC OFFSET
CH3 - TC SPAN
CH4 - TC OFFSET
CH4 - TC SPAN
CH5 - TC OFFSET
CH5 - TC SPAN
CH6 - TC OFFSET
CH6 - TC SPAN

RTD MODULE 1
CH1 - RTD DEGREES F
CH2 - RTD DEGREES F
CH3 - RTD DEGREES F
CH4 - RTD DEGREES F
CH5 - RTD DEGREES F
CH6 - RTD DEGREES F
CH1 - RTD OFFSET
CH1 - RTD SPAN
CH2 - RTD OFFSET
CH2 - RTD SPAN
CH3 - RTD OFFSET
CH3 - RTD SPAN
CH4 - RTD OFFSET
CH4 - RTD SPAN
CH5 - RTD OFFSET
CH5 - RTD SPAN
CH6 - RTD OFFSET
CH6 - RTD SPAN

RTD MODULE 2
CH1 - RTD DEGREES F
CH2 - RTD DEGREES F
CH3 - RTD DEGREES F
CH4 - RTD DEGREES F
CH5 - RTD DEGREES F
CH6 - RTD DEGREES F
CH1 - RTD OFFSET
CH1 - RTD SPAN
CH2 - RTD OFFSET
CH2 - RTD SPAN
CH3 - RTD OFFSET
CH3 - RTD SPAN
CH4 - RTD OFFSET
CH4 - RTD SPAN
CH5 - RTD OFFSET
CH5 - RTD SPAN
CH6 - RTD OFFSET
CH6 - RTD SPAN

RTD MODULE 3
CH1 - RTD DEGREES F
CH2 - RTD DEGREES F
CH3 - RTD DEGREES F
CH4 - RTD DEGREES F
CH5 - RTD DEGREES F
CH6 - RTD DEGREES F
CH1 - RTD OFFSET
CH1 - RTD SPAN
CH2 - RTD OFFSET
CH2 - RTD SPAN
CH3 - RTD OFFSET
CH3 - RTD SPAN
CH4 - RTD OFFSET
CH4 - RTD SPAN
CH5 - RTD OFFSET
CH5 - RTD SPAN
CH6 - RTD OFFSET
CH6 - RTD SPAN

AI MODULE 1
AI1 CH1 - mA INPUT
AI1 CH2 - mA INPUT
AI1 CH3 - mA INPUT
AI1 CH4 - mA INPUT
AI1 CH5 - mA INPUT
AI1 CH6 - mA INPUT
AI1 CH1 - AI OFFSET
AI1 CH1 - AI SPAN
AI1 CH2 - AI OFFSET
AI1 CH2 - AI SPAN
AI1 CH3 - AI OFFSET
AI1 CH3 - AI SPAN
AI1 CH4 - AI OFFSET
AI1 CH4 - AI SPAN
AI1 CH5 - AI OFFSET
AI1 CH5 - AI SPAN
AI1 CH6 - AI OFFSET
AI1 CH6 - AI SPAN

AI MODULE 2
AI2 CH1 - mA INPUT
AI2 CH2 - mA INPUT
AI2 CH3 - mA INPUT
AI2 CH4 - mA INPUT
AI2 CH5 - mA INPUT
AI2 CH6 - mA INPUT
AI2 CH1 - AI OFFSET
AI2 CH1 - AI SPAN
AI2 CH2 - AI OFFSET
AI2 CH2 - AI SPAN
AI2 CH3 - AI OFFSET
AI2 CH3 - AI SPAN
AI2 CH4 - AI OFFSET
AI2 CH4 - AI SPAN
AI2 CH5 - AI OFFSET
AI2 CH5 - AI SPAN
AI2 CH6 - AI OFFSET
AI2 CH6 - AI SPAN

DI MODULE 1
CH01 CONTACT CLOSED
CH02 CONTACT CLOSED
CH03 CONTACT CLOSED
CH04 CONTACT CLOSED
CH05 CONTACT CLOSED
CH06 CONTACT CLOSED
CH07 CONTACT CLOSED
CH08 CONTACT CLOSED
CH09 CONTACT CLOSED
CH10 CONTACT CLOSED
CH11 CONTACT CLOSED
CH12 CONTACT CLOSED
CH13 CONTACT CLOSED
CH14 CONTACT CLOSED
CH15 CONTACT CLOSED
CH16 CONTACT CLOSED

DI MODULE 2
CH01 CONTACT CLOSED
CH02 CONTACT CLOSED
CH03 CONTACT CLOSED
CH04 CONTACT CLOSED
CH05 CONTACT CLOSED
CH06 CONTACT CLOSED
CH07 CONTACT CLOSED
CH08 CONTACT CLOSED
CH09 CONTACT CLOSED
CH10 CONTACT CLOSED
CH11 CONTACT CLOSED
CH12 CONTACT CLOSED
CH13 CONTACT CLOSED
CH14 CONTACT CLOSED
CH15 CONTACT CLOSED
CH16 CONTACT CLOSED

DI MODULE 3
CH01 CONTACT CLOSED
CH02 CONTACT CLOSED
CH03 CONTACT CLOSED
CH04 CONTACT CLOSED
CH05 CONTACT CLOSED
CH06 CONTACT CLOSED
CH07 CONTACT CLOSED
CH08 CONTACT CLOSED
CH09 CONTACT CLOSED
CH10 CONTACT CLOSED
CH11 CONTACT CLOSED
CH12 CONTACT CLOSED
CH13 CONTACT CLOSED
CH14 CONTACT CLOSED
CH15 CONTACT CLOSED
CH16 CONTACT CLOSED

DI MODULE 4
CH01 CONTACT CLOSED
CH02 CONTACT CLOSED
CH03 CONTACT CLOSED
CH04 CONTACT CLOSED
CH05 CONTACT CLOSED
CH06 CONTACT CLOSED
CH07 CONTACT CLOSED
CH08 CONTACT CLOSED
CH09 CONTACT CLOSED
CH10 CONTACT CLOSED
CH11 CONTACT CLOSED
CH12 CONTACT CLOSED
CH13 CONTACT CLOSED
CH14 CONTACT CLOSED
CH15 CONTACT CLOSED
CH16 CONTACT CLOSED

DO MODULE 1
CH1 ENERGIZED
CH2 ENERGIZED
CH3 ENERGIZED
CH4 ENERGIZED
CH5 ENERGIZED
CH6 ENERGIZED
CH7 ENERGIZED
CH8 ENERGIZED

DO MODULE 2
CH1 ENERGIZED
CH2 ENERGIZED
CH3 ENERGIZED
CH4 ENERGIZED
CH5 ENERGIZED
CH6 ENERGIZED
CH7 ENERGIZED
CH8 ENERGIZED

DO MODULE 3
CH1 ENERGIZED
CH2 ENERGIZED
CH3 ENERGIZED
CH4 ENERGIZED
CH5 ENERGIZED
CH6 ENERGIZED
CH7 ENERGIZED
CH8 ENERGIZED

DO MODULE 4
CH1 ENERGIZED
CH2 ENERGIZED
CH3 ENERGIZED
CH4 ENERGIZED
CH5 ENERGIZED
CH6 ENERGIZED
CH7 ENERGIZED
CH8 ENERGIZED

AO MODULE 1
AO1 CH1 mA OUT
AO1 CH2 mA OUT
AO1 CH3 mA OUT
AO1 CH4 mA OUT
AO1 CH5 mA OUT
AO1 CH6 mA OUT
AO1 CH1 - OFFSET
AO1 CH1 - SPAN
AO1 CH2 - OFFSET
AO1 CH2 - SPAN
AO1 CH3 - OFFSET
AO1 CH3 - SPAN
AO1 CH4 - OFFSET
AO1 CH4 - SPAN
AO1 CH5 - OFFSET
AO1 CH5 - SPAN
AO1 CH6 - OFFSET
AO1 CH6 - SPAN

DISPLAY DIGITAL I/O
A-PROCESS ENABLE
B-ALARM RESET
C-SPEED FAIL OVRD
D-2ND DYNAMICS
E-RAISE SPEED
F-LOWER SPEED
G-RATED SPEED
H-CLOSE TO RUN
DO1-SHUTDOWN
DO2-ALARM
DO3-STAT INDICATOR

DISPLAY ANALOG I/O
SPD SENS IN #1 (HZ)
SPD SENS IN #2 (HZ)
AI1-PROCESS IN #1
AI2-PROCESS IN #2
AI3-REMOTE IN
AI4-EXT FUEL LIMIT
AI1 FAILED
AI2 FAILED
AI3 FAILED
AI4 FAILED
ANALOG OUT 1(mA)
ANALOG OUT 2(mA)
ACTUATOR OUT 1(mA)
ACTUATOR OUT 2(mA)
ALARM RESET

DISPLAY INDICATOR
ON START FUEL LIMIT
ON MAX LIMIT
ON EXT FUEL LIMIT
ON TORSION LIMIT
ON TORQUE LIMIT
ACT SHUTDOWN
SPEED SWITCH 1
SPEED SWITCH 2

CONTROL MODE
SPEED IN CONTROL
ON START FUEL LIMIT
ON MAXIMUM LIMIT
ON EXTERNAL LIMIT
ON TORSIONAL LIMIT
ON TORQUE LIMIT
ACTUATOR SHUTDOWN
REMOTE SPEED ENBLD
REM PROCESS ENBLD
CASCADE RAMP ACTIVE
CASCADE PID ACTIVE
DB PROC CTRL ACTIVE
SPD SENSOR 1 ACTIVE
SPD SENSOR 2 ACTIVE
PORT 1 ON HANDHELD
PORT 1 ON SERVLINK
RESET ALL ALARMS

DISPLAY MENU
ENGINE SPEED(RPM)
SPEED REF(RPM)
FUEL DEMAND(%)
DROOP BIAS(RPM)
REMOTE SPEED REF (RPM)
EXT FUEL LIMIT IN (EU)
EXT FUEL LIMIT(%FD)
PROCESS INPUT#1(EU)
PROCESS INPUT#2(EU)
PROCESS DIFFERENCE (EU)
PROCESS REFERENCE (EU)

FORCE 723 DO
DO1 FORCE
DO2 FORCE
DO3 FORCE

FORCE DO 1 & 2
DO1 CH1 FORCE
DO1 CH2 FORCE
DO1 CH3 FORCE
DO1 CH4 FORCE
DO1 CH5 FORCE
DO1 CH6 FORCE
DO1 CH7 FORCE
DO1 CH8 FORCE
DO2 CH1 FORCE
DO2 CH2 FORCE
DO2 CH3 FORCE
DO2 CH4 FORCE
DO2 CH5 FORCE
DO2 CH6 FORCE
DO2 CH7 FORCE
DO2 CH8 FORCE

FORCE DO 3 & 4
DO3 CH1 FORCE
DO3 CH2 FORCE
DO3 CH3 FORCE
DO3 CH4 FORCE
DO3 CH5 FORCE
DO3 CH6 FORCE
DO3 CH7 FORCE
DO3 CH8 FORCE
DO4 CH1 FORCE
DO4 CH2 FORCE
DO4 CH3 FORCE
DO4 CH4 FORCE
DO4 CH5 FORCE
DO4 CH6 FORCE
DO4 CH7 FORCE
DO4 CH8 FORCE

723PLUS Control Specifications

Woodward Part Numbers:	
8280-464	723PLUS with low-voltage power supply
8280-465	723PLUS with high-voltage power supply
9907-205	Hand Held Programmer
8923-932	Watch Window Installation
8928-056	Process Control View Installation
Power Supply Rating	18–40 Vdc (24 or 32 Vdc nominal) 90–150 Vdc (125 Vdc nominal)
Power Consumption	40 W nominal
Inrush Current:	7 A for 0.1 ms (low-voltage model)
Inrush Current:	22 A for 15 ms (high-voltage model)
Steady State Speed Band	±0.25% of rated speed
Magnetic Pickup	400–15 000 Hz (200–2100 rpm)
Proximity Switch	30–15 000 Hz (200–2100 rpm)
Discrete Inputs (8)	10 mA at 24 Vdc, impedance 2.3 kΩ
Remote Load Setting Input	4–20 mA or 1–5 Vdc, externally powered
Process Input #1	4–20 mA or 1–5 Vdc, externally powered
Process Input #2	4–20 mA or 1–5 Vdc, externally powered
Analog Outputs #1 & #2	4–20 or 0–1 mA to meter or computer, internally (configurable) powered
Analog Output #3	0–200 or 4–20 mA to Actuator, internally powered
Analog Output #4	4–20 or 0–200 mA to meter, computer, or second (configurable) actuator, internally powered
Relay Outputs	Shutdown, Alarm, Status Indicator
Relay Contact Ratings	Resistive—2.0 A at 28 Vdc, 0.1 A at 115 Vac 50 to 400 Hz Inductive—0.75 A at 28 Vdc 0.2 Henry, 0.1 A at 28 Vdc Lamp
Programmer Serial Port (J1)	RS-422, 9-pin D connector, 1200 baud, full duplex
Communication Port (J2)	RS-232, RS-422, 9-pin connector, 110 to 38 400 baud, full duplex
Communication Port (J3)	RS-232, RS-422, RS-485, 9-pin connector, 1200 to 38 400 baud, full duplex
Ambient 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 Specification Humidity Test 1
EMI/RFI Susceptibility	Lloyd's Register of Shipping, EN50081-2 and EN50082-2
Mechanical Vibration	Lloyd's Register of Shipping Specification Vibration Test 1
Mechanical Shock	US MIL-STD 810C, Method 516.2, Procedure I (basic design test), Procedure II (transit drop test, packaged), Procedure V (bench handling)

We appreciate your comments about the content of our publications.

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