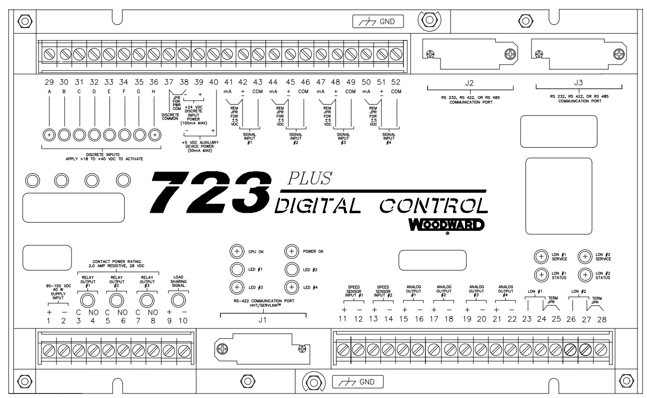
Product Manual 02879
(Revision B)
Original Instructions



723PLUS Digital Speed Control for Reciprocating Engines—Analog Load Sharing

8280-414, 8280-415, 8280-480, 8280-481

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:

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Proper Use

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

Translated Publications

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

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

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

⚠WARNING

Overspeed / Overtemperature / Overpressure

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

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

⚠WARNING

Personal Protective Equipment

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

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

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

⚠WARNING

Start-up

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

⚠WARNING

Automotive Applications

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

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

Electrostatic Discharge Awareness

NOTICE **Electrostatic Precautions**	**Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:** • **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).** • **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.** • **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.** **To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual *82715*, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.**

Follow these precautions when working with or near the control.

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

Chapter 1.
General Information

Introduction

This manual describes the Woodward 723PLUS Analog Load Sharing Digital Speed Control, models 8280-414 (low voltage), 8280-415 (high voltage), 8280-480 (low voltage, low speed), and 8280-481 (high voltage, low speed). The low speed versions are for engines rated at 130 rpm or less.

Declaration of Incorporation

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

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

Application

This 723PLUS Digital Speed Control controls the speed and load of reciprocating engines in generator set service, 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 kW sensor, an input for a synchronizer, an input for a remote speed or load setting, an input for output fuel limiting, and an internal speed reference for local control of speed. The control outputs include an actuator output, three configurable analog outputs, and three relay outputs. The relay outputs are for a shutdown, an alarm, and to open the generator breaker after unloading the generator. Connections for analog load sharing via an internal relay are also provided. These controls can be used with other Woodward controls and accessories which use standard analog load sharing.

LON® * channel #1 can be used to support Woodward LinkNet® input/output nodes for monitoring functions. LON channel #2 is not used.

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.

*—LON is a trademark of Echelon Corporation.
**—Modbus is a trademark of Schneider Automation Inc.

A typical 723PLUS control system is shown in Figure 1-6. The system shown is a genset with a flexible coupling between the engine and the generator. The generator is connected (along with other gensets) to an infinite bus and a plant load. While the utility is present, the on-line units will run in baseload or kW droop. The load can be controlled by the Remote Load Setpoint device. If the utility tie-line is lost, the on-line gensets will isochronously load share to control the system frequency as the system load changes. Off-line units can be brought on-line at any time with the SPM-A synchronizer. Protection is provided to the unit shown with the External Fuel Limiter and special torsional detection and filtering across the flexible coupling.

The 723PLUS control system includes:

- a 723PLUS Digital Speed Control
- ServLink Watch Window (Figure 1-3) or a hand held terminal (Figure 1-4)
- 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 synchronizing device
- an optional fuel limiting transducer
- three optional analog readout devices for display
- two optional relay-driven alarms and shutdowns
- optional Modbus devices for digital monitoring and control
- optional LinkNet Modules to provide additional I/O paths for the Modbus devices

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

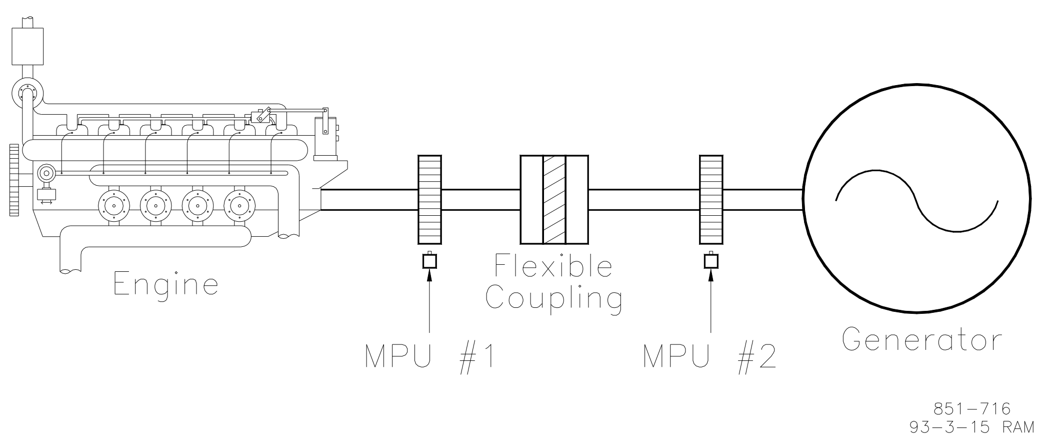


Figure 1-1. Flexible Coupled Generator Set

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.

A kW feedback device such as the Woodward Real Power Sensor (RPS) or commercial kW transducer can be used to provide the 723 control with a signal representing generator load. The generator load signal is used for a variety of automatic loading functions within the control. This signal is also required for baseloading against the grid or load sharing with other units. Signal Input #1 has been dedicated for this purpose.

An analog Speed and Phase Matching Synchronizer such as the Woodward SPM-A can be used to allow automatic synchronizing of the engine generator. Signal Input #2 has been dedicated to this purpose.

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 9 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 J Thermocouple In–Fail Low	4	24	1, 2, 3, or 4	9905-966 9905-967
100 Ω Am RTD Input	1	6	5	9905-970
4–20 mA Input	1	6	6	9905-968
Discrete Input	1	16	7	9905-971
Relay Output	1	8	8	9905-973
4–20 mA Output	1	6	9	9905-972
TOTAL	**9**	**66**		

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	4–20 mA Input	6	
7	Discrete Input	16	
8	Relay Output	8	
9	Analog Output	6	
Total		**66**	

Table 1-2. LinkNet Modules (Address)

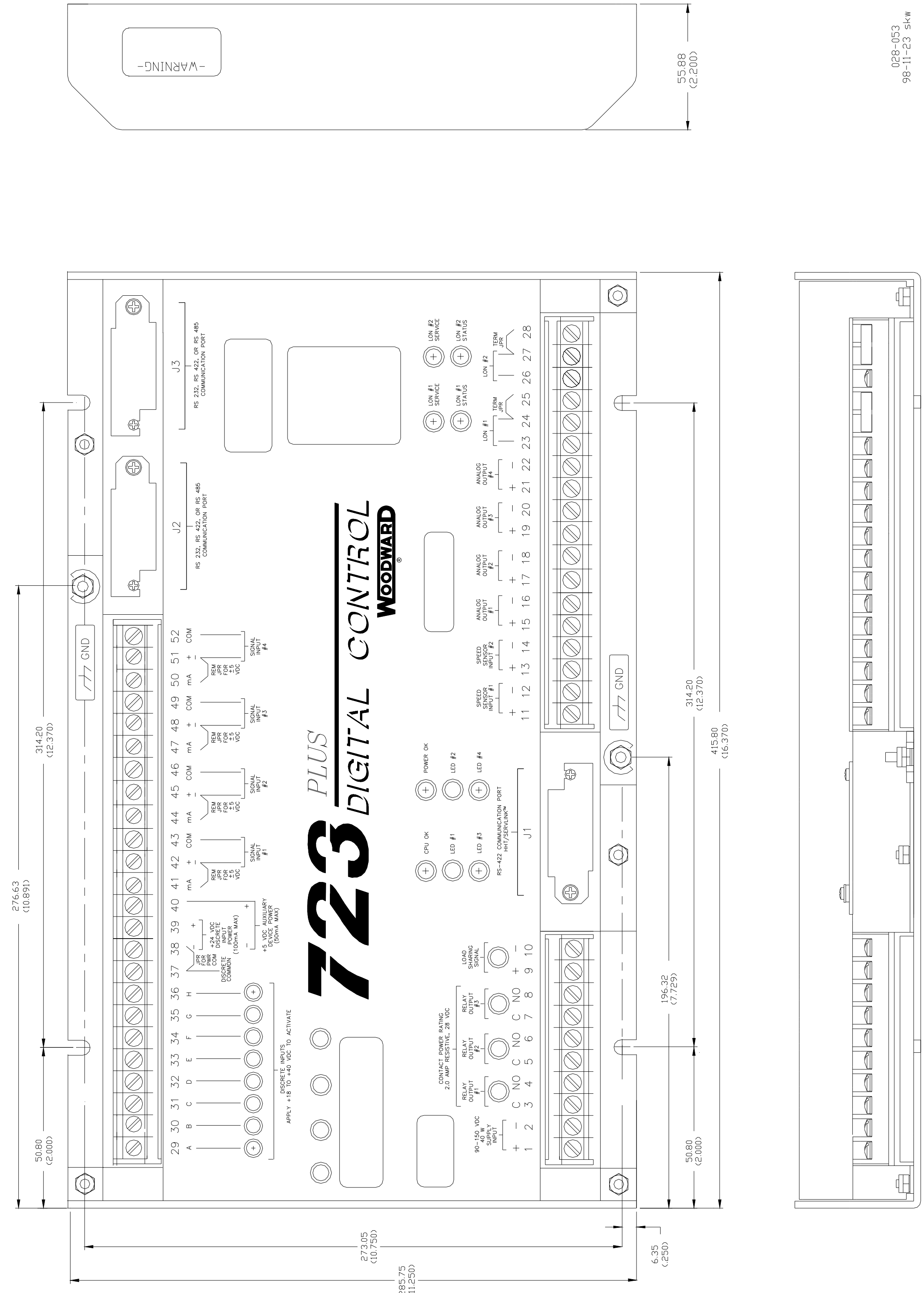


Figure 1-2. 723PLUS Digital Speed Control

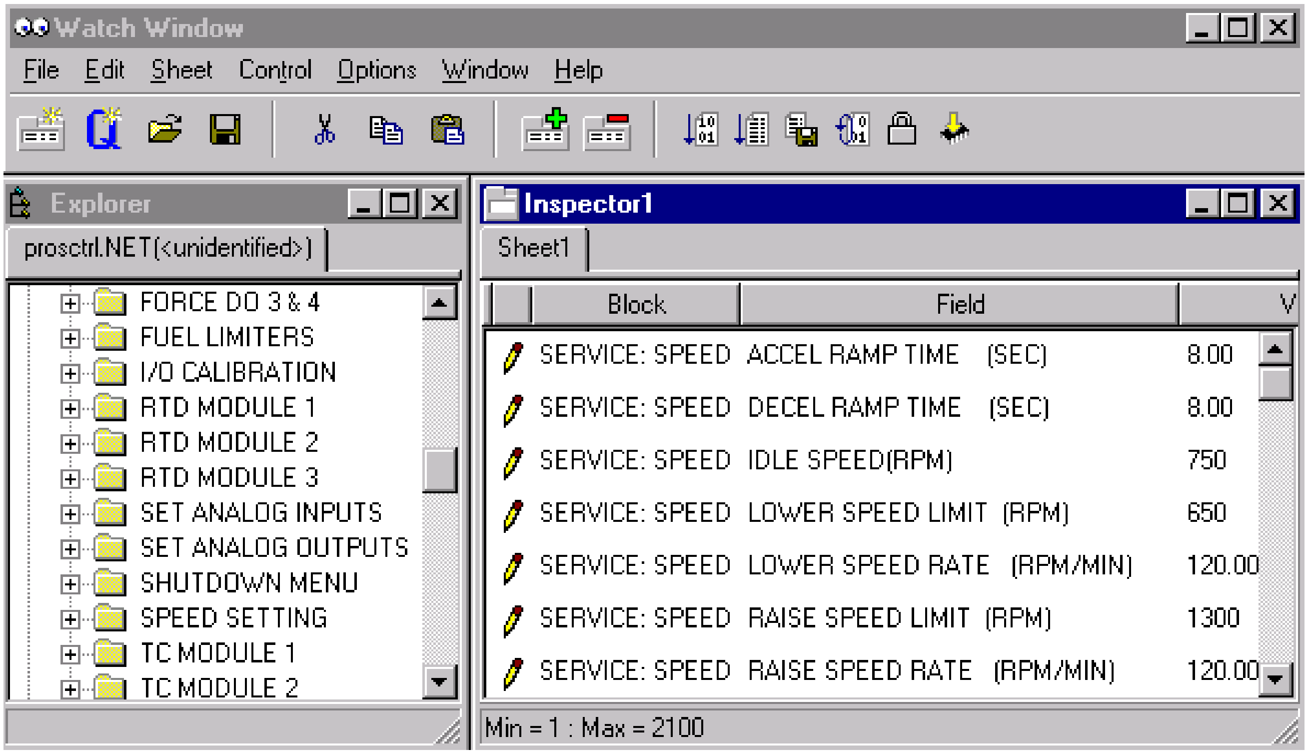
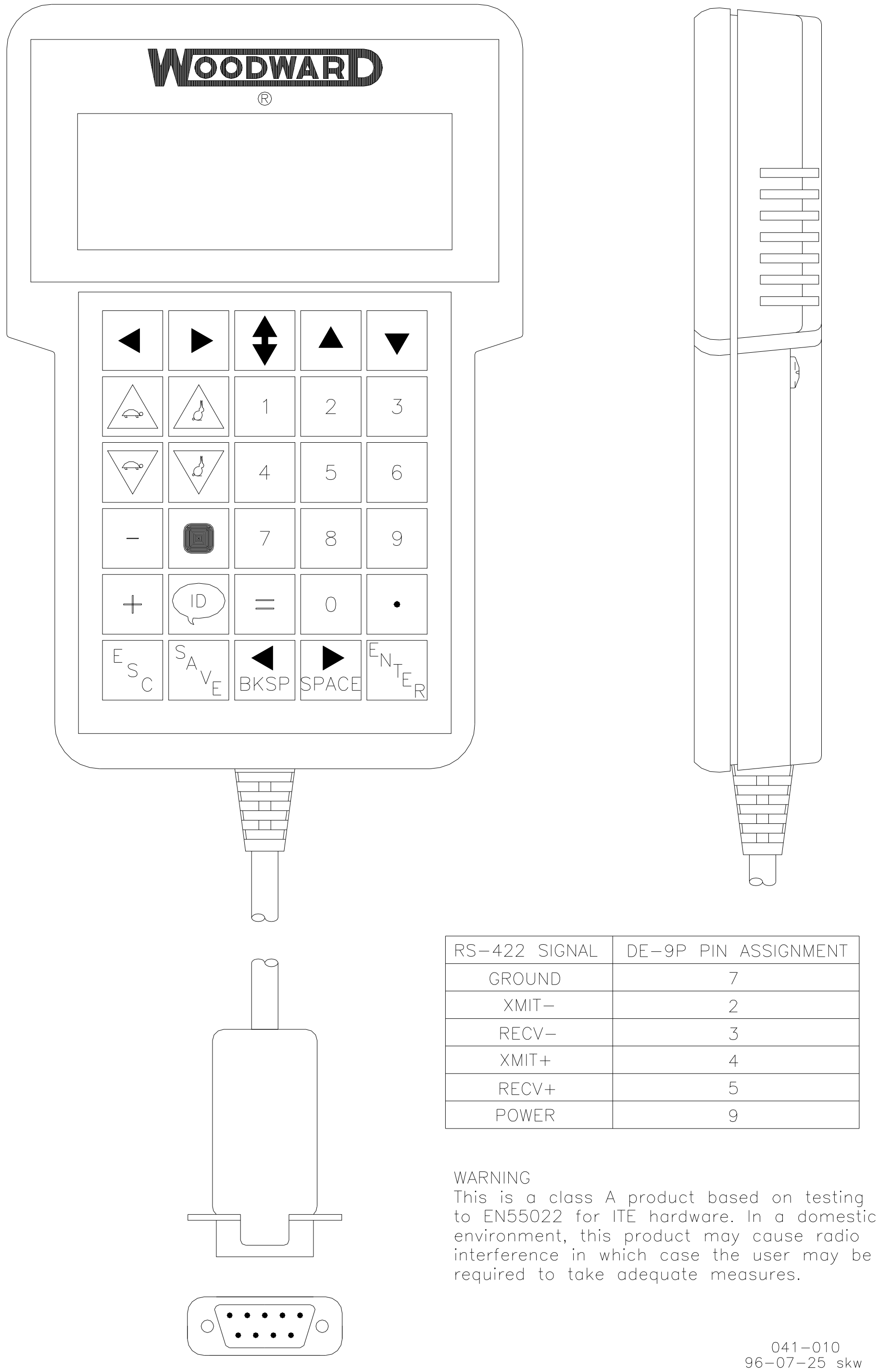


Figure 1-3. Watch Window Display



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.

Figure 1-4. Hand Held Programmer

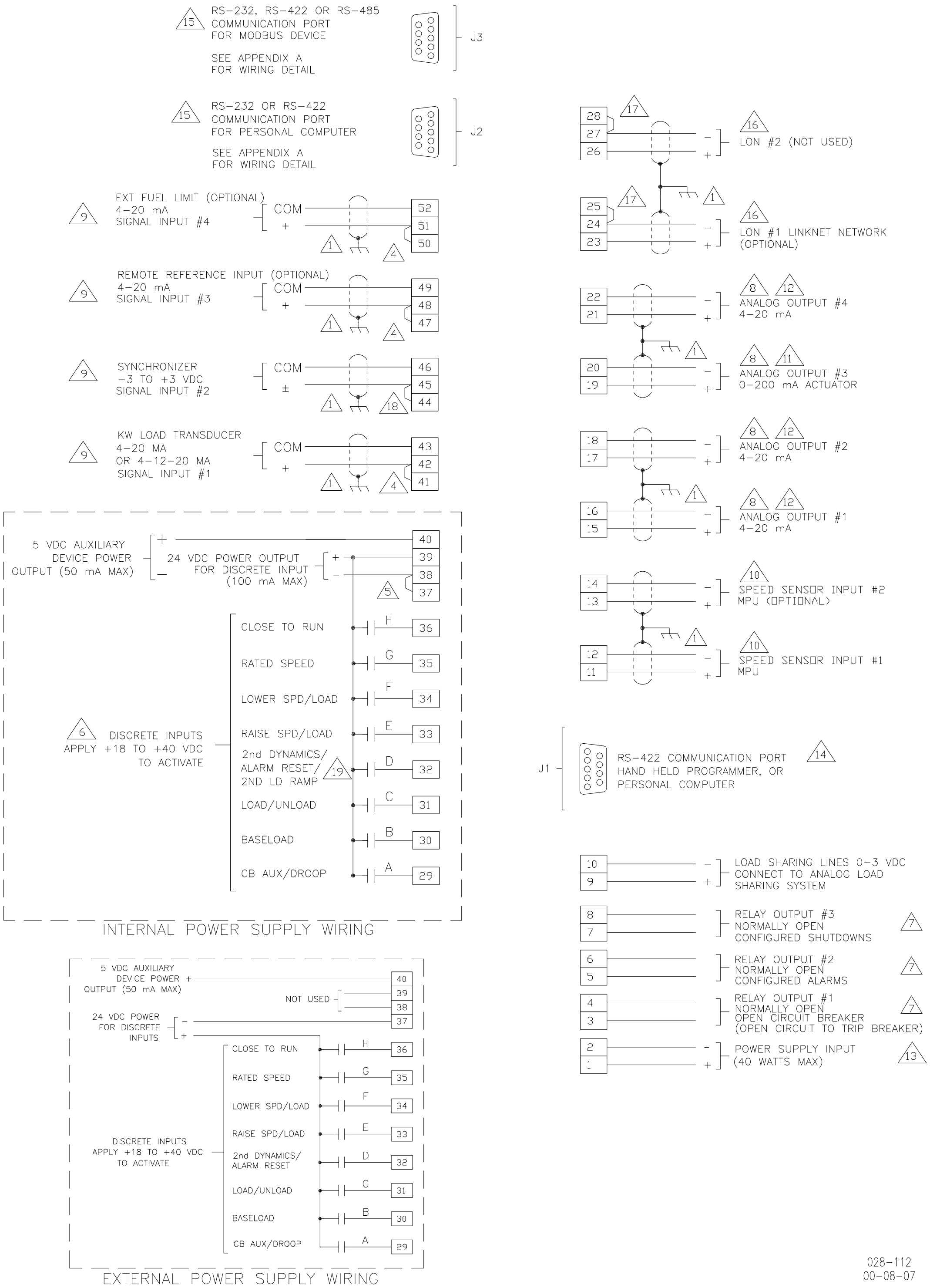


Figure 1-5a. Control Wiring Diagram

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. A. INTERNAL POWER SUPPLY – ADD JUMPER FROM TERMINAL 37 TO 38.
   B. EXTERNAL POWER SUPPLY – REMOVE JUMPER FROM TERMINAL 37 TO 38.

6. DISCRETE INPUTS ARE ISOLATED FROM OTHER CIRCUITS AND CAN BE POWERED BY TERMINAL 39 (+24 VDC) BY LEAVING THE JUMPER ACROSS TERMINALS 37 AND 38.

7. ALL RELAY OUTPUTS WILL OPEN ON LOSS OF CONTROL POWER.

8. ANALOG OUTPUT SIGNALS TO OTHER SYSTEMS MUST BE ISOLATED FROM GROUND EITHER BY DESIGN OR EMPLOYMENT OF ISOLATION AMPLIFIERS.

9. ANALOG INPUT SIGNALS FROM OTHER SYSTEMS MUST BE ISOLATED FROM GROUND EITHER BY DESIGN OR EMPLOYMENT OF ISOLATION AMPLIFIERS. INPUTS MUST BE EXTERNALLY POWERED.

10. FACTORY SET FOR MPU INPUT.

11. FACTORY SET FOR 0–200 mA OUTPUT. OUTPUTS ARE INTERNALLY POWERED. DO NOT PROVIDE EXTERNAL POWER.

12. FACTORY SET FOR 4–20 mA OUTPUT. OUTPUTS ARE INTERNALLY POWERED. DO NOT PROVIDE EXTERNAL POWER.

13. INTERNAL POWER SUPPLY PROVIDES DC ISOLATION BETWEEN THE POWER SOURCE AND ALL OTHER INPUTS AND OUTPUTS.

14. COMMUNICATION PORT J1:
   A. HAND HELD PROGRAMMER – REMOVE JUMPER BETWEEN TERMINALS 9 AND 10.
   B. PERSONAL COMPUTER – ADD JUMPER BETWEEN TERMINALS 9 AND 10.
      1. PERSONAL COMPUTER MUST HAVE WATCH WINDOW OR STANDARD DSLC CONTROL PC INTERFACE SOFTWARE INSTALLED.
      2. NEED DOWNLOAD CABLE #5416-870 TO CONNECT FROM J1 (RS-422) TO PERSONAL COMPUTER (RS-232).
   C. COMMUNICATION MODE CAN ALSO BE CHANGED WHEN THE ENGINE IS SHUT DOWN BY APPLYING DISCRETE INPUT COMBINATIONS. SEE CHAPTER4, "WATCH WINDOW PC INTERFACE", FOR DETAILS.
   D. POWER-UP MODE CAN BE CONFIGURED AT THE 'CFIG OPTION' MENU. SEE CHAPTER 4 FOR DETAILS.

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. 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.

18. THE SYNCHRONIZER AND OTHER WOODWARD ACCESSORIES PROVIDE +/– 5 VDC TO THE 723PLUS. REMOVE THE JUMPER IF USING WOODWARD ACCESSORIES INTO THIS INPUT.

19. SOFTWARE CONFIGURED. SEE CHAPTER 4, SERVICE AND CONFIGURE MENUS, FOR DETAILS.

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Figure 1-5b. Control Wiring Diagram (Notes)

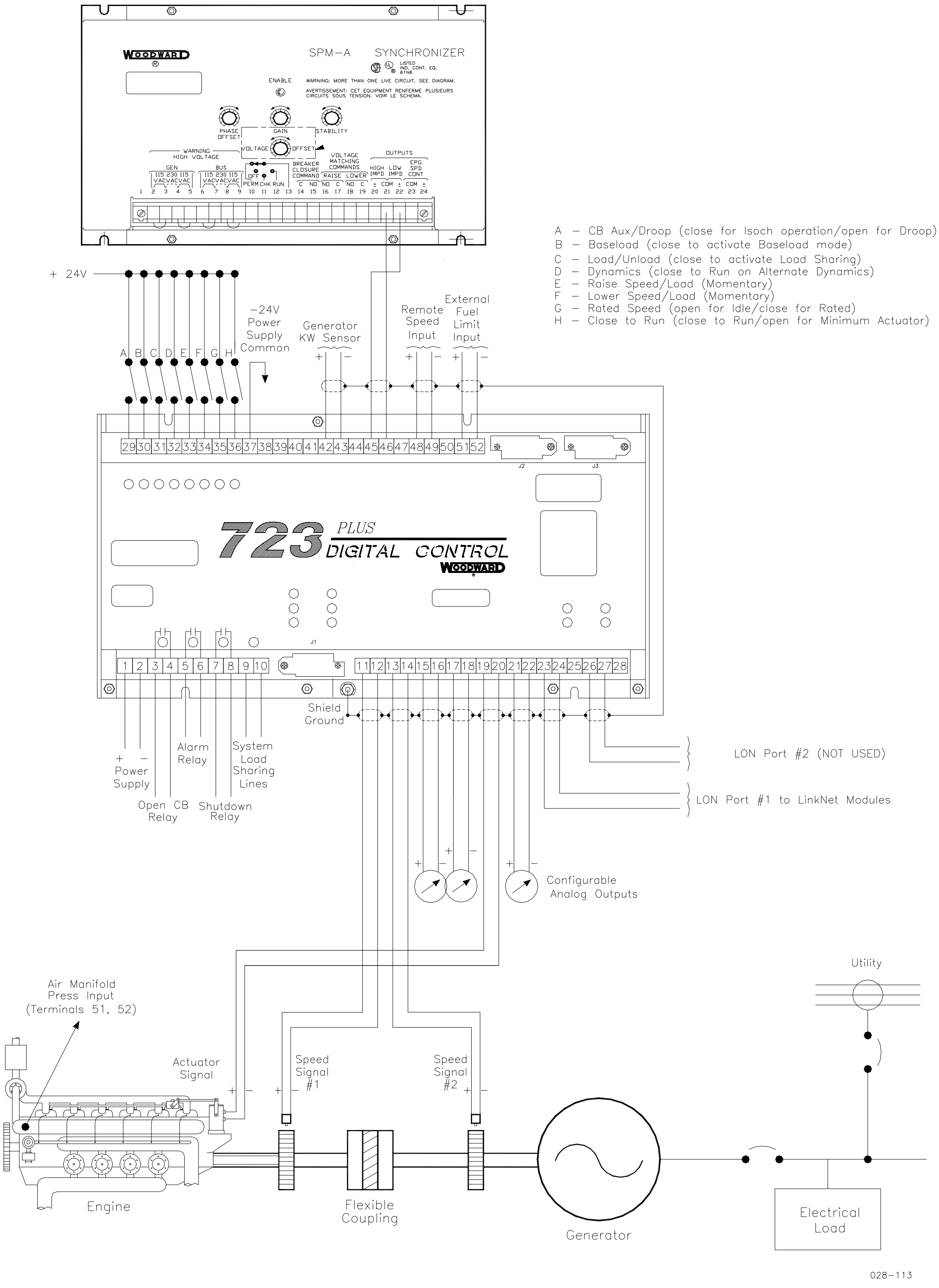


Figure 1-6. Typical 723PLUS Connections

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.v). 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 Speed 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.v), 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 2-1).

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

	JPR10	analog output #1	0–1 mA
*	JPR9	analog output #1	0–20 mA
	JPR12	analog output #2	0–1 mA
*	JPR11	analog output #2	0–20 mA
*	JPR13 & JPR2	actuator output #1	0–200 mA, single
	JPR13 & JPR1	actuator output #1	0–20 mA, single
&	JPR14 & JPR2	actuator output #1	0–160 mA, tandem
	JPR15 & JPR3	actuator output #2	0–200 mA, single
*	JPR15 & JPR4	actuator output #2	0–20 mA, single
&	JPR16 & JPR3	actuator output #2	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 1-6. The control wiring connections (Figure 1-5) 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.

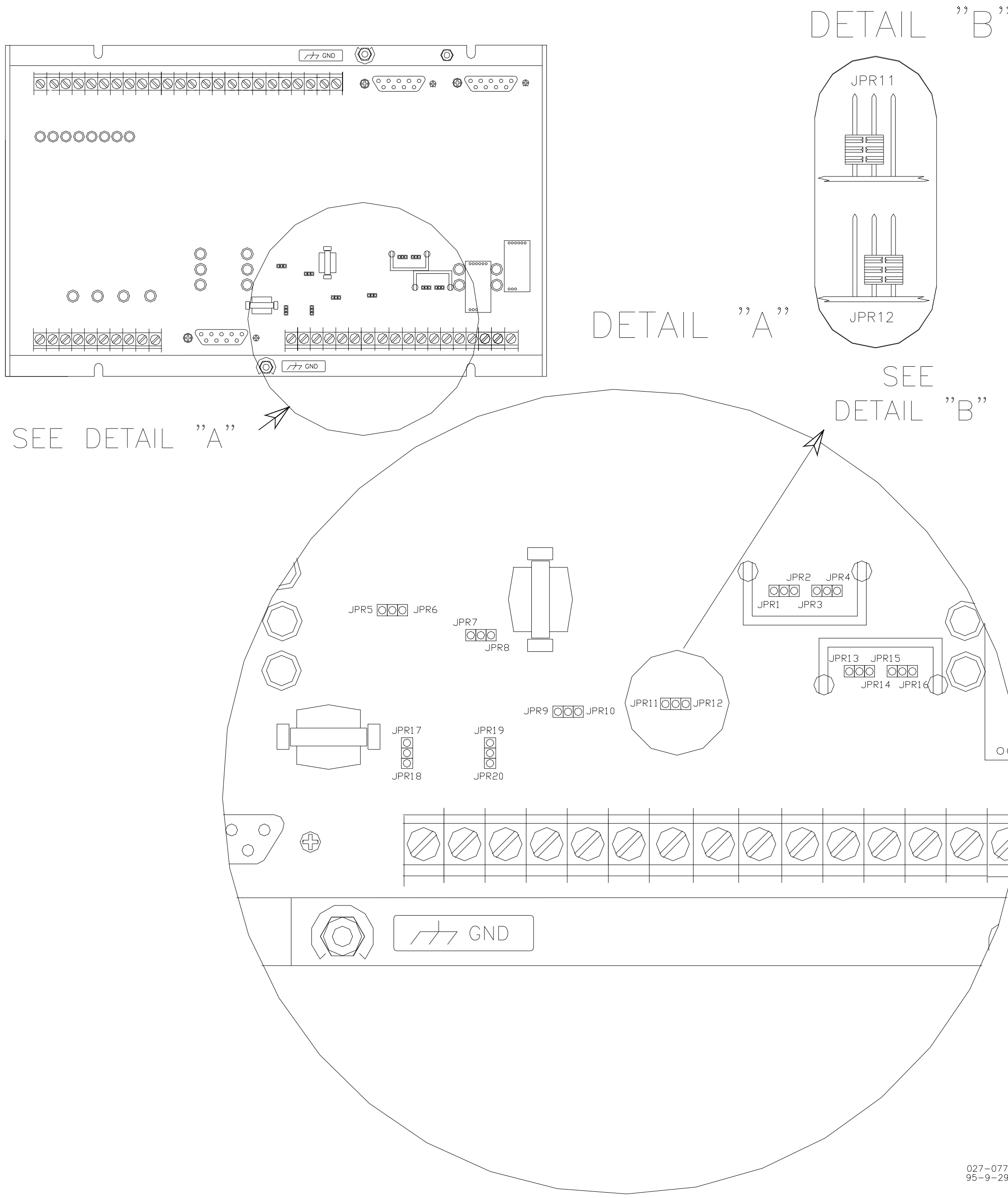


Figure 2-1. 723PLUS Control Internal Jumpers

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

1. Strip outer insulation from BOTH ENDS, exposing the braided or spiral wrapped shield. DO NOT CUT THE SHIELD.

2. Using a sharp, pointed tool, carefully spread the strands of the braided shield.

3. Pull 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.**

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 contact ratings are shown in the 723PLUS control specifications (inside back cover). 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 contacts on terminals 3/4 for Relay Output # 1 are used to open the generator circuit breaker. The circuit breaker should open when the load has been softly unloaded to minimum load. The relay will de-energize for one second (tunable) to open the breaker. The contacts will remain closed at all times when power is applied to the control, and will open only during the Open CB command pulse. 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 shutdown conditions are intended to externally shut down the engine. Relay Output #3 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.

Load Sharing Signal (Terminals 9/10)

Connect the system Load Sharing Signal lines to terminals 9(+) and 10(–). Use a shielded twisted-pair cable. The shield must be continuous for all units connected and should be connected to ground at only one location. The 723PLUS control provides an internal relay for connecting the Load Sharing Signal to the internal circuitry at the appropriate times. The relay is energized when the green light above terminals 9 and 10 is illuminated.

The Load Sharing Signal provides an analog communication path between separate 723PLUS controls and other compatible devices. The lines should be run continuously from control to control without devices for metering, load control, etc. The contacts of any relays must be designed for low-power signals. The Load Sharing Signal connection of the 723PLUS control is compatible with all other Woodward controls and accessories that use analog load sharing.

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 generator set, you must connect the first MPU (terminals 11/12) to detect engine speed, and the second MPU (terminals 13/14) to detect generator speed. 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.

LED Output #1, #2, #3, and #4 (Control Cover Mounted)

The four LED outputs are hard configured to provide specific status indications.

- LED #1 is illuminated if the MPU 1 input is failed. LED #1 also blinks (2 seconds) when the Hand Held interface is enabled.
- LED #2 is illuminated if the MPU 2 input is failed. LED #2 also blinks (2 seconds) when the ServLink/Watch Window interface is enabled.
- LED #3 is illuminated if any configured Alarm condition has occurred without being cleared or reset.
- LED #4 is illuminated if any configured Shutdown condition has occurred without being cleared or reset.

Analog Output #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 Baseload Setting
7– Remote Speed Set Point
8– J3 Modbus Analog Write Address
   4:0002 ANALOG OUTPUT #1
   4:0003 ANALOG OUTPUT #2
   4:0004 ANALOG OUTPUT #4
9– Generator Real Power (supplied by the kW Transducer)
10– Baseload Reference

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 generator load. Default range is 0 to 1100 kW. 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 unit may be configured for 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 nine 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. The Modbus device connected to Communication Port J3 drives these outputs.

LON #2 is not used.

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 and power management 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.

CB Aux/Droop Contact (Input A; Terminal 29)

The input switch or relay contact used to activate the Load Control connects to terminal 29 (Discrete Input A.) This discrete input is used to switch the control into isochronous mode, which allows the Load Control Function to operate. It is typically connected to an auxiliary contact on the generator circuit breaker. When the breaker closes, the input switch or relay contact should also close. When the external switch or relay contacts are open, the control will operate in Droop Mode. A switch in series with the auxiliary contact on the generator circuit breaker will allow manually selecting Droop Mode or Base Load/Isochronous Mode. Open this switch for Droop Mode. Close this switch for Base Load/Isochronous Modes.

Base Load (Input B; Terminal 30)

The input switch or relay contact used to activate the Base Load command connects to terminal 30 (Discrete Input B). This discrete input will cause the Load Control Function to operate in Base Load. In this mode of operation the governor will control the load on the generator. The infinite bus or a separate isochronous genset must control the plant frequency while in Base Load operation. With the state of this input TRUE, isochronous load sharing with other units is disabled. With the state of this contact FALSE, isochronous load sharing with other units can occur when loading is matched between units. The CB Aux/Droop Contact discrete input must be TRUE for the Base Load input to affect the control.

Load Generator (Input C; Terminal 31)

The input switch or relay contact used to activate the Load Generator command connects to terminal 31 (Discrete Input C). This discrete input will cause the Load Control Function to ramp to a distinct mode of operation. If the state of the input is TRUE, the Load Control Function will increase or decrease in order to achieve either Isochronous Load Sharing or Base Load operation. If the state of the input is FALSE (input switch or relay contact open), the Load Control Function will increase or decrease in order to achieve the Unload trip level. At the unload trip level, a momentary Breaker Open command will be issued. The CB Aux/Droop Contact discrete input must be TRUE for the Load Generator input to affect the control.

2nd Dynamics/2nd Ramp/Alarm Reset (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 circuit breaker open/closed or with dual-fuel engines. The contact input function may be configured for use as 2nd Dynamics, 2nd Load Ramp, or Alarm Reset. The contact function is determined by CFIG OPTION menu items USE CONT D AS RESET and USE 2nd DYNAMICS, as shown in Table 2-1.

Use Contact D as Reset	Use 2nd Dynamics	Use Contact D as 2nd Load Ramp	**2nd Speed Dynamics Function**	Contact D Function
FALSE	FALSE	FALSE	None	None
FALSE *	TRUE *	FALSE *	Contact D Input	2nd Dynamics
TRUE	FALSE	FALSE	None	Alarm Reset
TRUE	FALSE	TRUE	None	Alarm Reset
TRUE	TRUE	FALSE	CB Aux Input	Alarm Reset
TRUE	TRUE	TRUE	CB Aux Input	Alarm Reset
FALSE	FALSE	TRUE	None	2nd Load Ramp
FALSE	TRUE	TRUE	CB Aux Input	2nd Load Ramp

(Default Settings)*

Table 2-1. Contact D Options

Raise Speed/Load Contact (Input E; Terminal 33)

The input switch or relay contact used to activate the Raise Speed/Load command connects to terminal 33 (Discrete Input E). This discrete input changes the control operation by increasing the speed reference ramp when in droop or isochronous modes and by increasing the baseload reference when in baseload mode. The speed reference ramp can increase only to a software adjusted RAISE SPEED limit. The baseload reference ramp can increase only to a software adjusted RATED LOAD limit. Both ramps increase at software adjusted rates. De-selecting the Rated Speed command (described below) takes command control away from the Raise Speed/Load input and effectively disables the command.

When operating in isochronous mode, this command is normally used to raise the engine (or group of engines) speed for manually synchronizing and for testing high-speed operations such as overspeed. When operating in baseload mode, this command is used to increase the baseload reference and generator load. When operating in droop mode, this command is used to increase the fuel demand and generator load.

When the input switch or relay contacts are closed (discrete input in the TRUE state), the control will raise the speed or baseload reference depending on mode selection. Raise Speed is limited to the maximum speed limit. Raise Load is limited to the rated load limit. With the contacts open (discrete input in the FALSE state), the control will stop raising the speed or baseload reference. Maintained simultaneous closure of this Raise Speed/Load contact along with the Lower Speed/Load contact enables the Remote Reference Input. One Remote Reference Input is switched, by mode selection, between remote speed and remote baseload reference control.

Lower Speed/Load Contact (Input F; Terminal 34)

The input switch or relay contact used to activate the Lower Speed/Load command connects to terminal 34 (Discrete Input F). This discrete input changes the control operation by decreasing the speed reference ramp when in droop or isochronous modes and by decreasing the baseload reference when in baseload mode. The speed reference ramp can decrease only to a software adjusted LOWER SPEED limit. The baseload reference ramp can decrease only to a software adjusted UNLOAD TRIP LEVEL limit. Both ramps decrease at a software adjusted rate. De-selecting the Rated Speed command (described below) takes command control away from Lower Speed/Load input and effectively disables the command.

When operating in isochronous mode, this command is normally used to lower the engine (or group of engines) speed for manually synchronizing and testing low speed operations such as critical speeds. When operating in baseload mode, this command is used to decrease the baseload reference and generator load. When operating in droop mode, this command is used to decrease the fuel demand and generator load.

When the input switch or relay contacts are closed (discrete input in the TRUE state), the control will lower the speed or baseload reference depending on mode selection. Lower speed is limited to the minimum speed limit. Lower load is limited to the unload trip level limit. With the contacts open (discrete input in the FALSE state), the control will stop lowering the speed or baseload reference. Maintained simultaneous closure of this Lower Speed/Load contact along with the Raise Speed/Load contact enables the Remote Reference Input. One Remote Reference Input is switched, by mode selection, between remote speed and remote baseload reference control.

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. The Rated Speed input should be left in the TRUE state when the generator breaker is closed. If the application does not require an idle speed setting, the Rated Speed input can be left in the TRUE state at all times. This can be done by connecting the input directly to the positive Discrete Input Power source.

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.

KW Sensor (Signal Input #1; Terminals 42/43)

Connect a kW Sensor to Signal Input #1. The input signal must be an isolated high quality signal representing load on the generator. The 723PLUS control is designed to receive either 4 to 20 mA or 1 to 5 Vdc representing zero load to absolute maximum load. A 4–(12)–20 mA transducer where 12 mA equals zero generator load can also be used. The 4–(12)–20 transducer will allow the control to sense reverse-power, which will allow faster recovery when the generator is in a reverse-power condition. The input can be software calibrated for slight variations and to set the kW display value to match the actual kW. Because of the control nature of this input, no other device should be connected to the kW Sensor output. Failure of this input will force the control to operate in droop or, by configuration, continue isochronous mode with the feedback supplied from the Fuel Demand in place of kW.

Use a shielded twisted-pair cable to connect a 4 to 20 mA kW Sensor current transmitter or 1 to 5 Vdc kW Sensor voltage transmitter to terminals 42(+) and 43(–). When using a voltage transmitter, remove the jumper between terminals 42 and 41. 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.

SPM-A (Signal Input #2; Terminals 45/46)

Connect an SPM-A synchronizer or equivalent device to Signal Input #2. The input signal must be an isolated high quality signal. The 723PLUS control is designed to receive –5 to +5 Vdc into this input. At Rated Speed the speed of the engine will change by 0.667 (tunable) percent of rated per-volt input. The nominal input is zero. No connection is required to this input if this function is not needed by the application.

Use a shielded twisted-pair cable to connect the low impedance output from SPM-A terminal 22 to 723PLUS control terminal 45 (±) and SPM-A terminal 21 to 723PLUS control terminal 46 (com). Remove the factory installed jumper between terminals 45 and 44. Without the jumper installed, the input impedance will be greater than 10 MΩ. A failure of the SPM-A will not be detected by the 723PLUS control. However, the Sync Bias rpm is displayed to monitor the SPM-A effect.

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

Connect a Remote Speed/Load Setpoint transmitter to Signal Input #3. The input signal must be an isolated high quality signal representing the Remote Speed/Load Setpoint. When the Control is in remote Baseload mode, the Remote Speed/Load Setpoint moves the Load Ramp to the same value as the Remote Load Setpoint. When the control is in remote droop or isochronous mode, the Remote Speed/Load Setpoint moves the Speed Ramp to the same value as the Remote Speed/Load Setpoint. The Remote Speed/Load Setpoint could be an operator adjusted potentiometer, a computer generated setting, etc. No connection is required to this input if this function is not needed by the application.

The 723PLUS control is designed to receive either 4 to 20 mA or 1 to 5 Vdc, representing a minimum Remote Speed/Load Setpoint to a maximum Remote Speed/Load Setpoint. Separate software minimum and maximum settings are provided for remote speed (rpm) and remote load (kW). A software switch can be set which will allow the control to use the last valid value of this input if the input fails. Otherwise the value follows the failed input.

Use a shielded twisted-pair cable to connect a 4 to 20 mA Remote Speed/Load Setpoint current transmitter or 1 to 5 Vdc Remote Speed/Load Setpoint 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 input values exceeding 21 mA (5.25 Vdc). A detected failure will remain until 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 manifold air pressure or exhaust temperature. 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) 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.

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 8928-058). 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 software switch or a discrete input combination switches the port J1 function. See Chapter 3 for the available menu items and instructions for switching the port J1 function. 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 control parameters, read all connected LinkNet inputs, send commands and values to all connected LinkNet outputs, and send limited commands and four signals to the 723PLUS control. The four signals that can be sent to the 723PLUS are the remote speed/load reference and values that can be the source for the three configured analog outputs. The commands that can be sent to the 723PLUS control are CB Aux, Baseload, Load/Unload, Use 2nd Dynamics, Raise Speed, Lower Speed, Idle/Rated Speed, and Run/Stop. The Alarm Reset command works in parallel with the optional discrete input Alarm Reset command connected to terminal 32 (D), and a software switch from the Hand Held Programmer, Watch Window, or Control View. 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.

To activate the appropriate Discrete input via Modbus Boolean Write, you must assert the '723 Command Close "X"' (where "X" is replaced by "for Baseload", etc; e.g., 723 Command Close for Baseload), and you must also assert the 'Use "X" Remote Command' (where "X" is replaced by "Baseload", etc; e.g., Use Baseload Remote Command). This method allows you to choose which inputs you would like to have activated by hardware and which inputs you wish to ignore the hardware and use the Modbus Boolean Write command. Also be aware that you can read the hardware state of the Discrete Input using a Boolean Read Modbus command.

Optional LinkNet nodes provide system parameters which can be sent to and used by the Modbus devices connected to Communication Ports J2 and J3. The LinkNet nodes can provide temperature signals from 24 (type "J") thermocouples and 6 (3-wire, 100 Ω American curve) RTDs. Nodes can also provide 6 analog inputs in the form of 4 to 20 mA signals and 16 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 mA 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. This can occur only with the Modbus device connected to Communication Port J3. The LinkNet nodes can provide up to six 4 to 20 mA outputs and 8 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 (e.g., to produce a 12 mA output from the 723PLUS analog output #1, a value of 12000 must be applied to address 4:0002).

Modbus Analog Write Address 0005 allows control of the speed/load reference. The signed 16-bit integer must be scaled as rpm for communication (that is, to produce an 1800 rpm output from the 723PLUS, a value of 1800 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 1-5.
C. Check for broken terminals and loose terminal screws.
D. Check the speed sensor(s) for visible damage. If the sensor is a magnetic pickup, check the clearance between the gear and the sensor, and adjust if necessary. Clearance should be between 0.25 and 1.25 mm (0.010 and 0.050 inch) at the closest point. Make sure the gear runout does not exceed the pickup gap.

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. 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 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 10 ft (3 m) 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, it must be set for SERVLINK INTERFACE. To use the Hand Held Programmer, port J1 must be set HANDHELD INTERFACE.

By default Port J1 is set as a Hand Held Programmer interface. The interface for Port J1 can be switched to ServLink/Watch Window or Control View by one of two methods:

- One method, which may be made while the engine is running or stopped, involves using the Hand Held Programmer to open the I/O CALIBRATION menu item SERVLINK INTERFACE and setting this item TRUE. LED 2 will change state for two seconds to indicate the change was properly initiated. Five seconds later the control will switch Port J1 to a ServLink/Watch Window interface port. At this point communication with the Hand Held Programmer will be lost. The ServLink/Watch Window or Control View may be used to switch back to a Hand Held Programmer interface at the I/O CALIBRATION menu item HANDHELD INTERFACE by setting this item TRUE. LED 1 will change state for 2 seconds to indicate the change was properly initiated. Five seconds later the control will switch Port J1 to a Hand Held Programmer interface port.
- The other method, which may be made only while the engine is stopped, uses a combination of discrete inputs and an internal speed switch to set Port J1 as either a ServLink/Watch Window or Control View port, or as a Hand Held Programmer interface port. The following permissives must be set to change Port J1 mode:
  1. Engine must be stopped (speed < 5% rated).
  2. CB Aux discrete input A (term 29) must be FALSE.
  3. Run discrete input H (term 36) must be FALSE.
  4. 2nd Dynamics/Alarm Reset input D (term 32) must be TRUE.
  5. Raise input E (term 33) must be TRUE.
  6. Lower input F (term 34) must be TRUE.

To set Port J1 as a Hand Held Programmer interface, when the above permissives are completed, momentarily set the Baseload discrete input B (terminal 30) TRUE. LED 1 will change state for 2 seconds to indicate the change was properly initiated. Five seconds later the control will switch Port J1 to a Hand Held Programmer interface port.

To set Port J1 as a ServLink/Watch Window or Control View, when the above permissives are completed, momentarily set the Load discrete input C (terminal 31) TRUE. LED 2 will change state for 2 seconds to indicate the change was properly initiated. Five seconds later the control will switch Port J1 to a ServLink/Watch Window interface port.

The CFIG OPTION menu item PWRUP WITH HANDHELD sets the default power-up configuration of Port J1. Either interface may be used to change the default setting. Set this item TRUE to power-up in the Hand Held Interface mode. Set this item FALSE to power-up in the ServLink/Watch Window or Control View mode. Be sure to SAVE changes to this setting. The control will boot up to the saved port J1 mode.

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 most computer or electronics stores. Port J2 is a dedicated ServLink/Watch Window or Control View port. 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). More information about Watch Window can be found in manual 26007, Woodward Watch Window Software Getting Started.

723PLUS Analog Load Sharing Control View

Woodward has created Control View as a PC Interface for the 723PLUS Analog Load Sharing control. This custom graphical user interface is a ServLink client that has all 723PLUS Analog Load Sharing 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 Analog Load Sharing 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, it must be set for SERVLINK INTERFACE. This tells the control that a computer is connected to J1. When using the Hand Held Programmer, port J1 must be set for HANDHELD INTERFACE. Refer to Watch Window instructions above for detailed Port J1 interface settings.

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. Port J2 configuration may be set for RS-422 as a point-to-point or multidrop ServLink server.

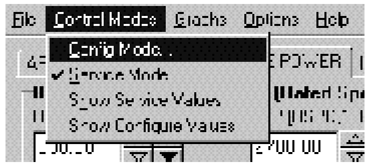
Read "Help About" to display the part number and revision letter of the software in the control. Refer to this number and revision level in any correspondence with Woodward (write this information in the programming checklist, Appendix D). Read the "Getting Started" notepad included with the Control 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 16 MB
- Communications: At least 1 free working COMM port

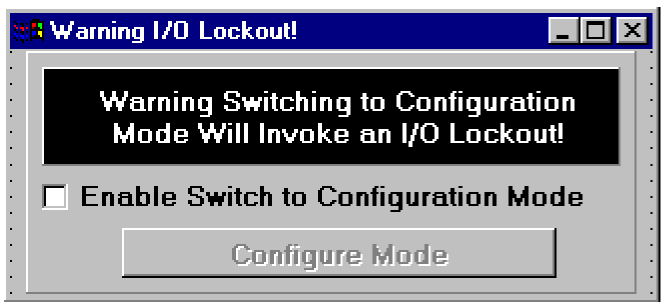
IMPORTANT	*** It is likely that this program would run fine on Windows 98 and Beta Versions Windows NT 5.0, but these have not been tested and will not be supported by Woodward.**

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.

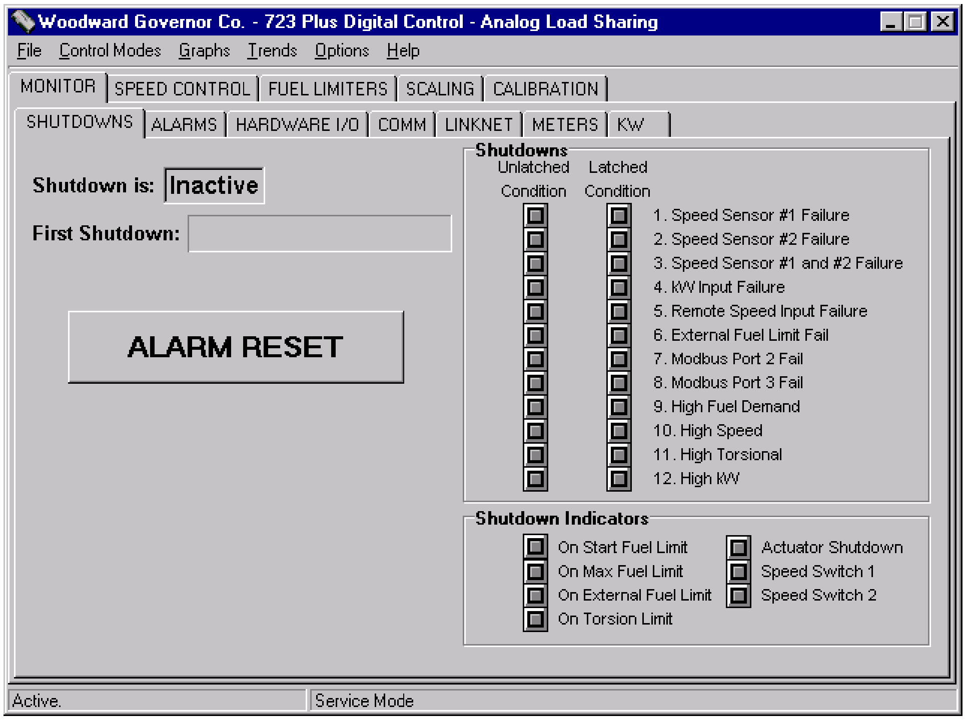
Show Service Values
This will bring the service values to the top so they can be adjusted. If the control is in configure mode, the values can be adjusted by any amount within their allowed maximum and minimum ranges.

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 interface is opened.

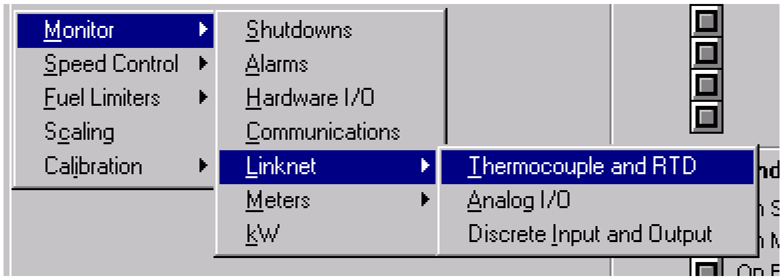


This shows the Monitor Shutdown screen and displays current status of all shutdowns. An Alarm Reset button is provided to reset any control alarms and shutdowns that have been cleared.

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 (if applicable) 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 may be hidden).



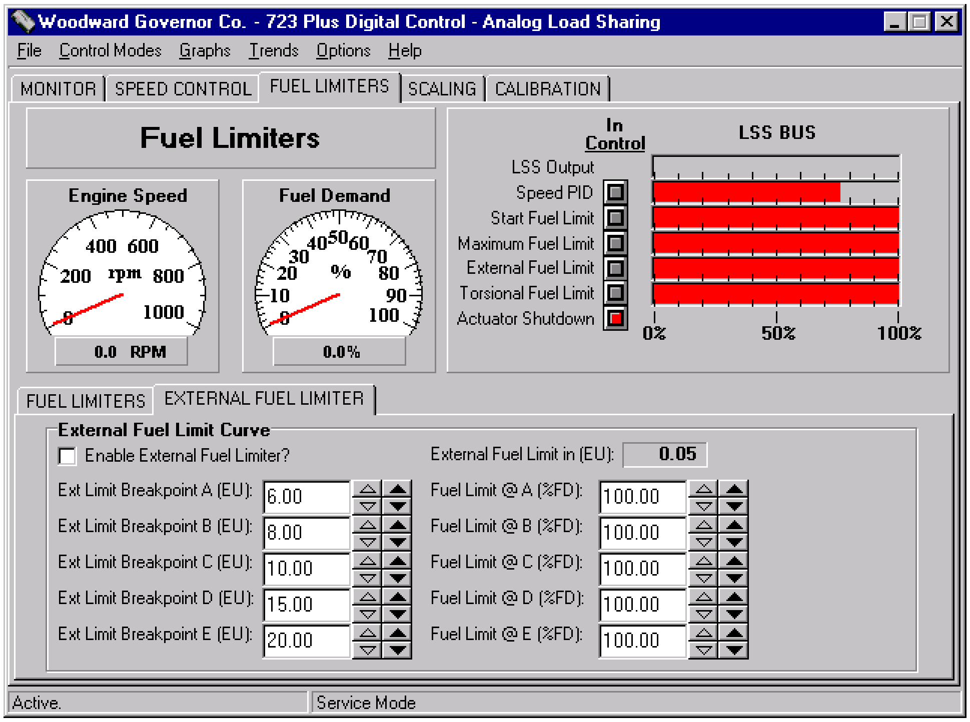
The Fuel Limiter screen, shown below, is typical of all screens except for the curve screens. You can see that the information is presented in various forms:

- 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 and External Fuel Limiter Settings.

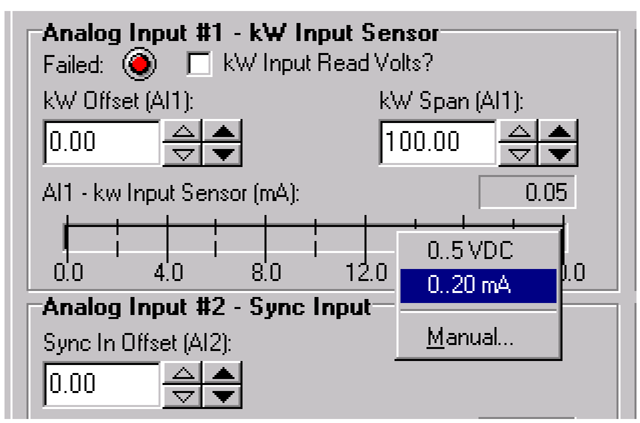
Two sets of raise/lower arrows accompany each tunable value. The hollow arrows produce "turtle" (slow) set point changes, and the solid arrows produce "rabbit" (fast) set point changes. Values may also be highlighted and typed in directly. This causes the raise/lower arrows to be replaced by an = sign. 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. This is a valuable setup feature since Control Mode "Show Service Values" can be enabled while in the Configuration Mode to permit typing in values without regard to the "10% of previous values" rule. Remember to change to the Service Mode and save settings once all values have been entered. 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 External Fuel Limiter sub-tab open.

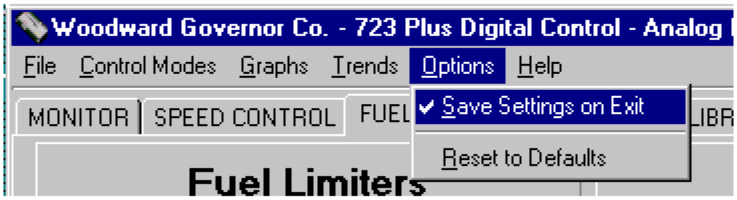
IMPORTANT **CFIG Option menu item 'Use External Fuel Limiter' must be set TRUE to make this sub-tab visible.**



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

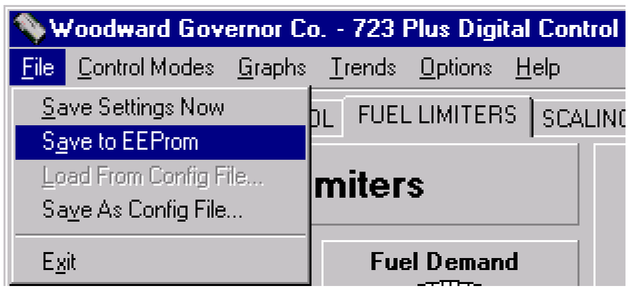


Saving Settings
The following shows how to set the program to save (or not save) gauge settings and screen position on close. Under the Options menu either check or uncheck Save Settings on Exit for the desired action on close. This save option will only save screen position and gauge settings on close.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



The other Options are:
- 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.



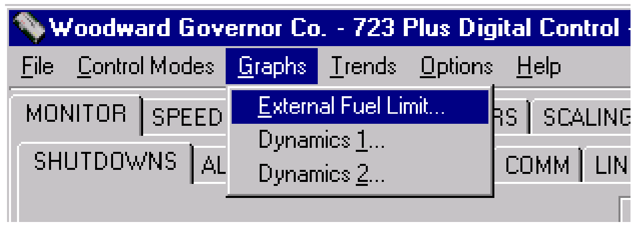
Select File from the menu bar, for the following choices:
- Save Settings Now will save the programs screen position and gauge settings.
- Save to EEPROM will save all configuration and service tunables in the 723PLUS EEPROM.
- Load Config File will load settings from a saved Configuration File into the 723PLUS EEPROM, overwriting all previous values. The Control mode must be set for 'Configure Mode' before this function is possible.
- Save As Config File will dump all settings from the 723PLUS controller EEPROM into a Configuration File.

NOTICE

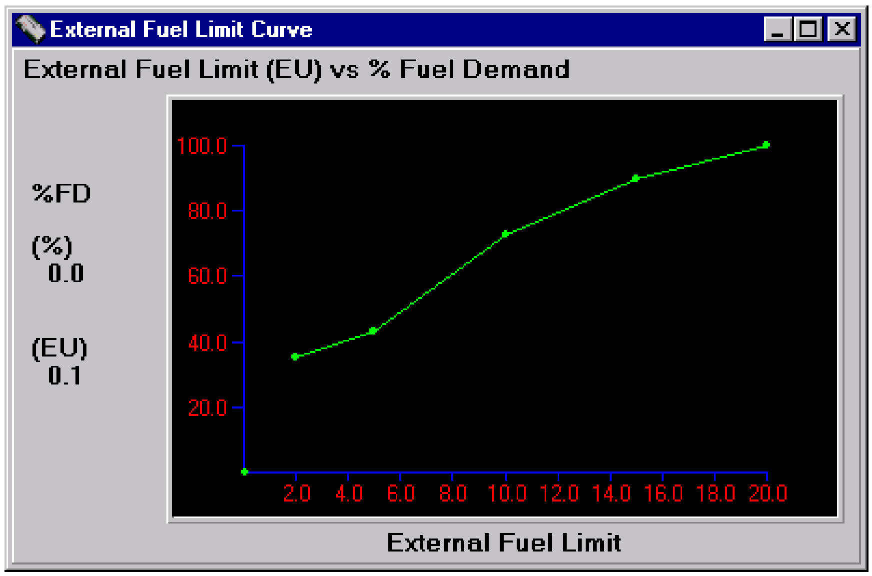
To prevent possible damage to the engine resulting from improper control settings, make sure you save the set points before removing power from the control. Failure to save the set points before removing power from the control causes them to revert to the previously saved settings.

2D Curves
The 2D curve screens are unique. The External Fuel Limiter Curve sub-screen with tabulated values and raise/lower arrows is shown above 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.

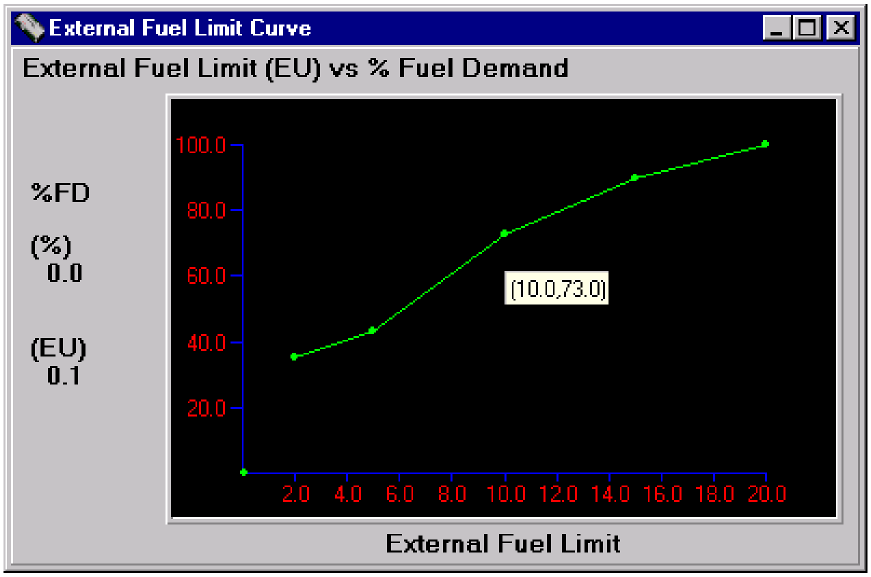


The following External Fuel Limit Curve screen, as well as screens for the other listed curves, are available for both viewing the curve graph and changing the curve set points.

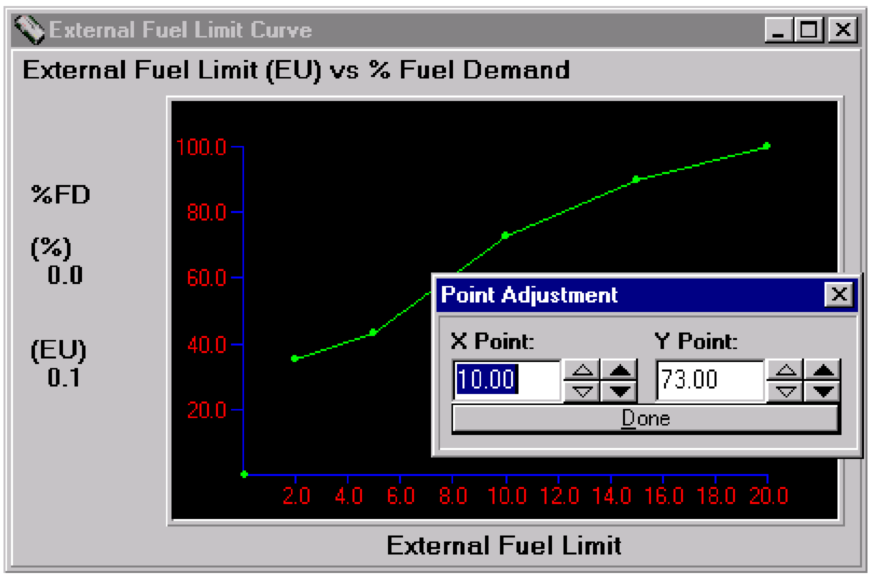


The above screen shows that the External Fuel Limit curve is a 2D curve with five breakpoints. It is set to limit maximum fuel demand at various External Fuel Limit inputs (e.g., Air Manifold Pressure). A digital display of the current x (curve input) and y (curve output) values in engineering units is included. Y in this example is the fuel limit (as a % fuel demand) based on External Fuel Limit X in engineering units.

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

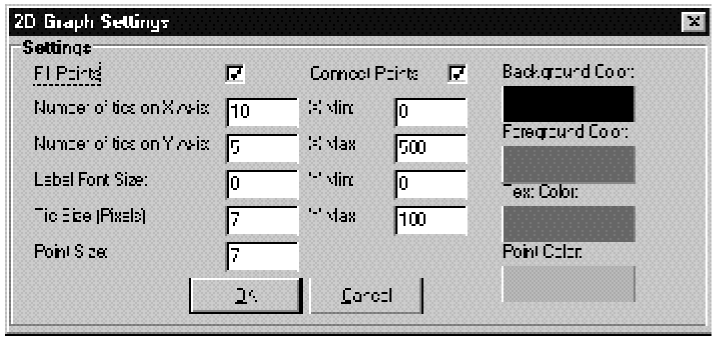


Right clicking on a breakpoint and selecting "properties" will pop-up a "Point Adjustment" window for that point as shown below.

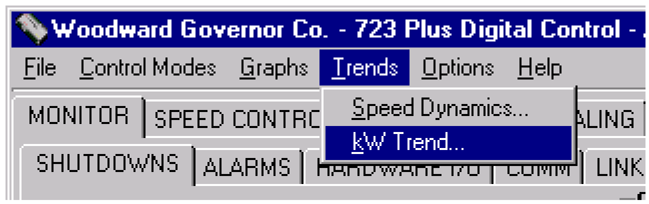


Adjustments to both the x and y breakpoint values can be made, as described earlier, by using the "turtle" and "rabbit" arrows or by typing in values and pressing the = key for the selected point. All breakpoints of all curves can be adjusted in this manner from the curve graph screens.

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

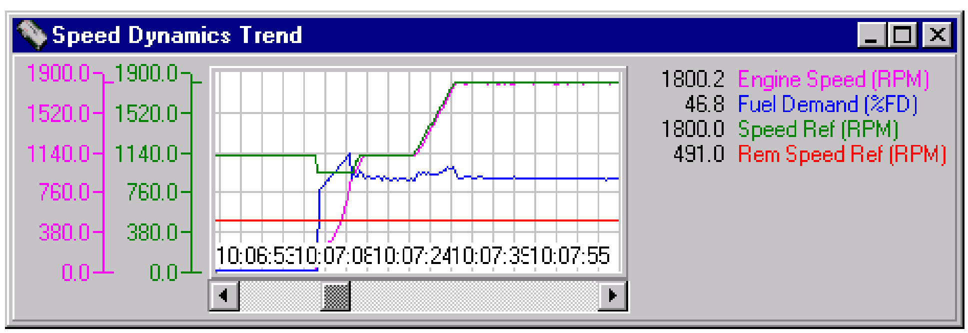


Trends



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 different fluctuations need to be seen and dealt with analytically. Multiple scales may be displayed or hidden. Scroll back and forth is also provided.

Here is an example showing the speed dynamics trend:



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

- Speed Dynamics

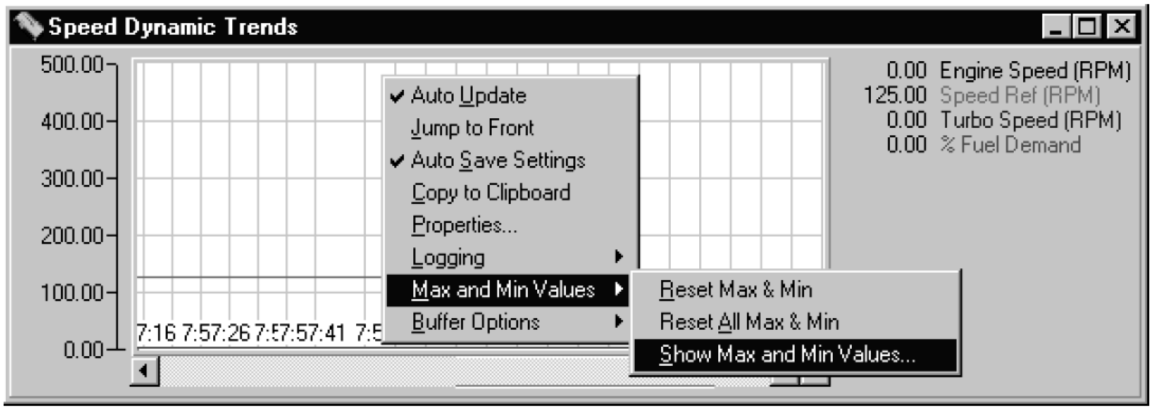
Remote Speed Reference (rpm)
Engine Speed (rpm)
Speed Reference (rpm)
%Fuel Demand

- KW Trend

Baseload Ref (kW)
Fuel Demand Representation (kW)
Generator Out (kW)
Load Reference (kW)
Remote Load Set Point (kW)

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*.

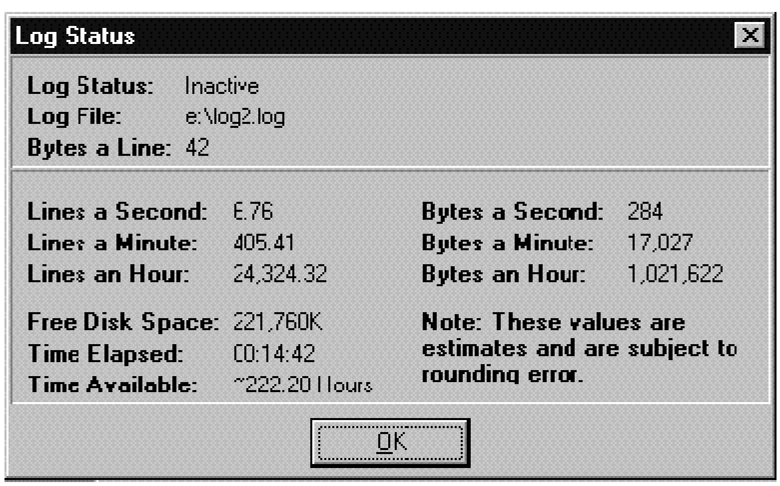
Auto Update: Will pause and unpause the graph motion, as well as pause and unpause logging.
Auto Save Settings: If checked this will automatically save all settings as they are changed.
Copy to Clipboard: Copies the whole graph (axis, graph window, descriptions, and values) to the clipboard so that it 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.

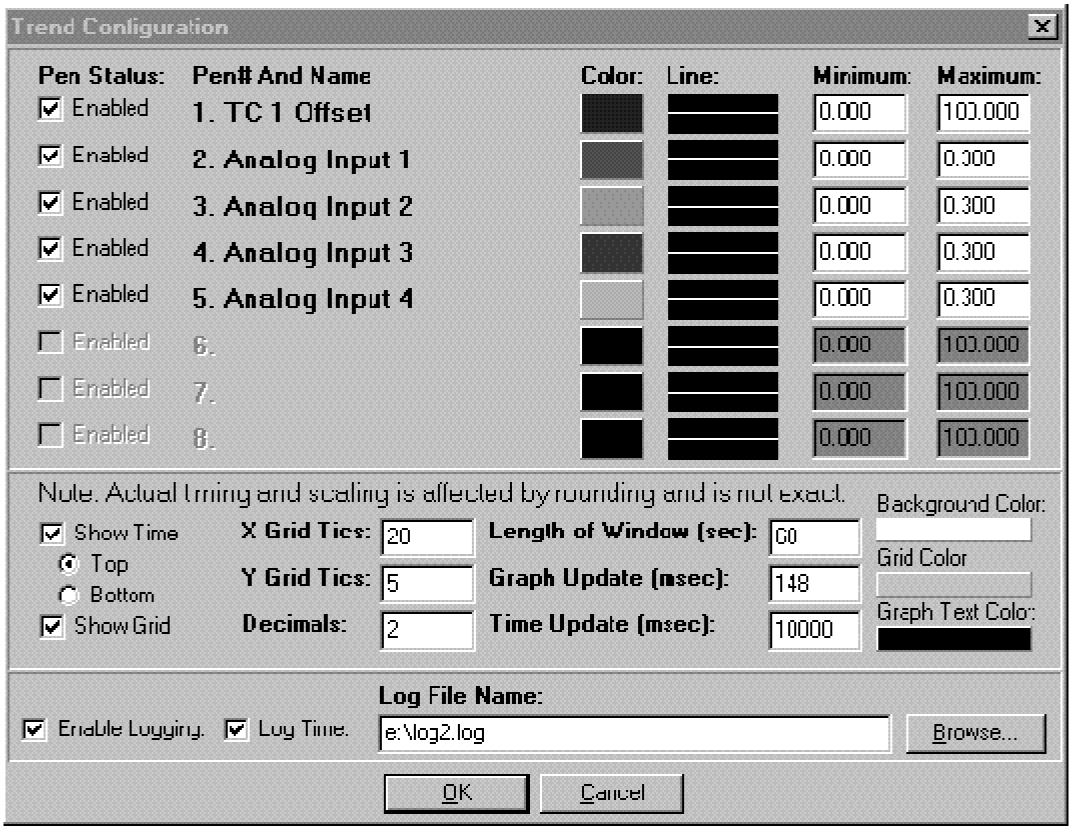
Log Creation Time: 2:56:31 PM on 7/31/98.

Time	TC 1 Offset	Analog Input 1	Analog Input 2	Analog Input 3	Analog 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 have 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.

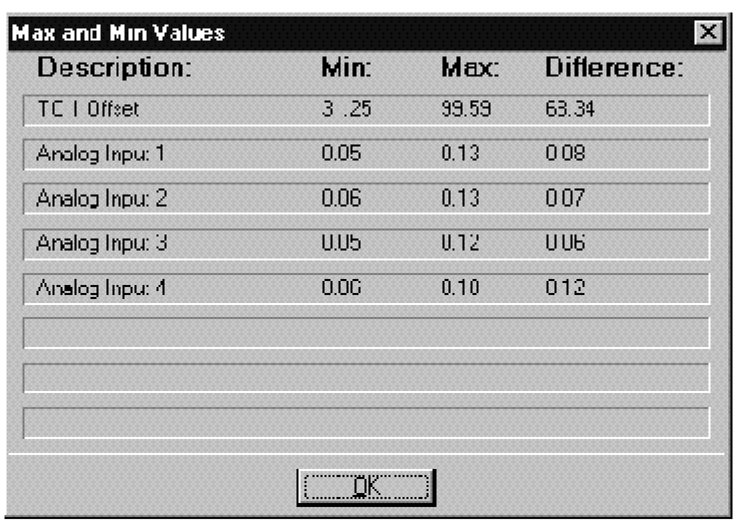
Log Time: Toggles whether or not the time stamp is placed with every data set in the log file. If a simple relational log is needed, it is not useful to log the time. However if you need to generate a scatter plot or perform more complex data analysis, a time stamp is necessary.

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.



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. Port J1 must be set for HAND HELD INTERFACE. Refer to the Watch Window instructions above for detailed port J1 interface settings.

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 3-1):

(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.

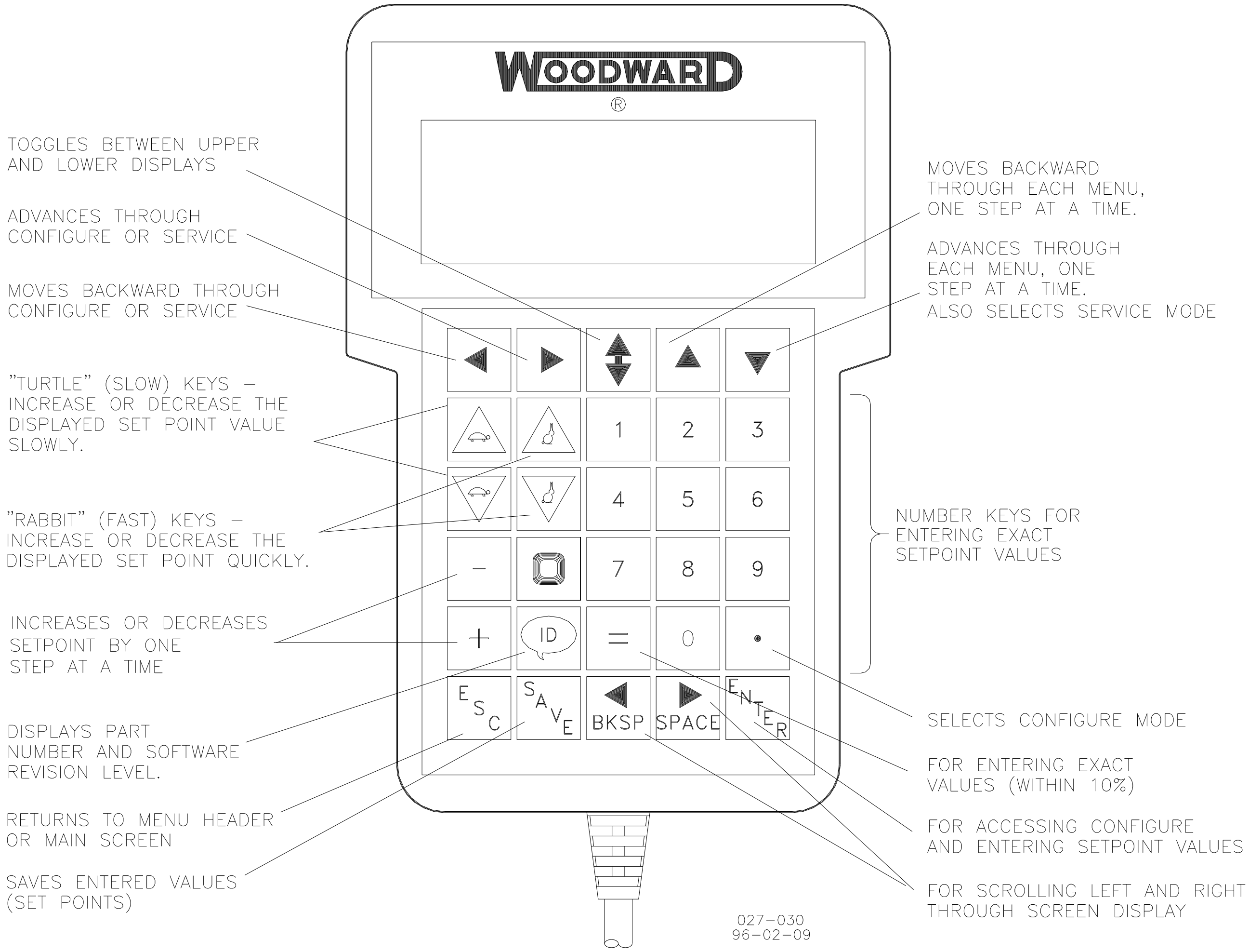


Figure 3-1. Hand Held Programmer Functions

Configuration Menu Descriptions

CFIG Option

1. **USE REV ACTUATOR** 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 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 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 Baseload Reference inputs fail. Set to FALSE to disable REMOTE LOCK IN LAST. Set to TRUE to enable REMOTE LOCK IN LAST.

9. **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).

10. **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.

11. **RESET ALM AT CB/RTD** is set to TRUE to issue an Alarm reset when the speed clears 90% speed reference or the CB Aux input is closed for a tunable delay time. Set to FALSE to block this alarm reset function. A FALSE setting does not block other types of alarm resets.

12. **USE CONT D AS RESET** is set to TRUE to make contact “D” an alarm reset input. See Table 2-1 for Contact D options.

13. **USE D AS 2nd LD RAMP** is set to TRUE to make contact “D” a second load ramp rate selector input. See Table 2-1 for Contact D options.

14. **USE FD ISOCH** is set to TRUE to activate Fuel Demand Isoch load sharing control when the kW transducer fails. Fuel Demand Isoch load sharing control uses the scaled actuator output as backup load feedback. Set to FALSE to fail to Fuel Demand Droop. See Table 5-2 for Droop/Isoch logic.

15. **USE FD DROOP ONLY** is set to TRUE to enable Fuel Demand Droop, blocking kW droop even though kW xducer is not failed. This allows setup of Fuel Demand Droop during commissioning. Set to FALSE to run in kW Droop when the CB AUX is open. See Table 5-2 for Droop/Isoch logic.

16. **USE BUMPLESS XFER** is set to TRUE to enable on-line bumpless transfer from isoch to droop mode when CB Aux contact opens. This may cause speed deviations at no-load when CB Aux actually does open. Set to FALSE to enable complete unloading when transferring from isoch to droop on-line.

17. **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.

18. **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.

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

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

21. **PWRUP WITH HANDHELD** is set to TRUE to set Port J1 default power-up mode as a Hand Held port. Set FALSE to set Port J1 default power-up mode as a ServLink/Watch Window port.

CFIG Speed Control

1. **RATED SPEED (RPM)** sets the normal operating speed of the engine. This must be the engine speed that represents the nominal system bus frequency. This is the speed that the Speed Reference will automatically ramp to when the Rated Speed discrete input is TRUE.

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. **[8280-414/-415 only]**

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 **[8280-414/-415 only]**

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. **[8280-414/-415 only]**

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 **[8280-414/-415 only]**

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. **[8280-414/-415 only]**

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. **OVERRIDE SPD FAIL** is set to TRUE only when a reverse-acting actuator is used and you want to run on the ballhead on speed sensor failure. Set to FALSE for all forward-acting systems.

11. **USE REMOTE AS SPEED** is set to FALSE to use the remote reference input as a baseload reference setting. Set TRUE to use the remote reference input as a speed reference setting.

12. **MPU ALARM ARM TIME** is the time delay to wait before latching armed the MPU failure alarm and 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.

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. **KW IN FAIL** sets the condition which will occur when the kW Load Transducer 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. **REMOTE INPUT FAIL** sets the condition which will occur when the Remote 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. **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.

7. **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.

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

9. **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.

10. **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.

11. **HIGH KW LEVEL** sets the condition which will occur when the kW level rises above the HI KW SETPT. This condition may be enabled as a Shutdown, Alarm,, or both, by selecting TRUE in the appropriate menu.

12. **ON START FUEL LIMIT** is set to TRUE to actuate the Relay Output when this fuel limit is in control. Set to FALSE to prevent Relay Output actuation. This indicator is non-latching.

13. **ON MAX LIMIT** is set to TRUE to actuate the Relay Output when this fuel limit is in control. Set to FALSE to prevent Relay Output actuation. This indicator is non-latching.

14. **ON EXT FUEL LIMIT** is set to TRUE to actuate the Relay Output when this fuel limit is in control. Set to FALSE to prevent Relay Output actuation. This indicator is non-latching.

15. **ON TORSION LIMIT** is set to TRUE to actuate the Relay Output when this fuel limit is in control. Set to FALSE to prevent Relay Output actuation. This indicator is non-latching.

16. **ACT SHUTDOWN** is set to TRUE to actuate the Relay Output when this fuel limit is in control. Set to FALSE to prevent Relay Output actuation. This indicator is non-latching.

17 **SPEED SWITCH** is set to TRUE to actuate Relay Output when this speed switch is triggered. Set to FALSE to prevent Relay Output actuation. This indicator is non-latching.

Shutdown Setup

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

2. **HI FUEL DEMND DELAY (SEC)—**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 (RPM)—**Enter the engine speed fault level (rpm) required to trigger the HI SPEED LEVEL shutdown.

4. **HI SPEED DELAY (SEC)—**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 (%RPM)—**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 (SEC)**—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. **KW HI LEVEL**—Enter the generator load fault level (kW) required to trigger the HI KW LEVEL shutdown.

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

9. **SPD SWITCH PICKUP (RPM)**—Enter the engine speed level (rpm) required to trigger SPEED SWITCH shutdown.

10. **SPD SWITCH DROPOUT (RPM)**—Enter the engine speed level (rpm) required to clear SPEED SWITCH shutdown.

> **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.**

11. **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.

12. **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 (%FD)—**Enter the % Fuel Demand fault level required to trigger the HI FUEL DEMND LEVEL alarm.

2. **HI FUEL DEMND DELAY (SEC)—**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 (RPM)—**Enter the engine speed fault level (rpm) required to trigger the HI SPEED LEVEL alarm.

4. **HI SPEED DELAY (SEC)—**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 (%RPM)—**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 (SEC)—**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. **KW HI LEVEL**—Enter the generator load fault level (kW) required to trigger the HI KW LEVEL alarm.

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

9. **SPD SWITCH PICKUP (RPM)**—Enter the engine speed level (rpm) required to trigger SPEED SWITCH alarm.

10. **SPD SWITCH DROPOUT (RPM)**—Enter the engine speed level (rpm) required to clear SPEED SWITCH alarm.

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.

11. **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.

12. **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.

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 PORTS found in menu CFIG OPTION must be set TRUE to bring this menu into view. This menu is concealed when USE COMM PORTS 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 Baseload Setting
   7. Remote Speed Reference
   8. J3 Modbus Address 4:0002
   9. Generator kW
   10. Baseload Reference

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. Default is TRUE. 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 Baseload Setting
   7. Remote Speed Reference
   8. J3 Modbus Address 4:0003
   9. Generator kW
   10. Baseload Reference

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. Default is TRUE. Note that an internal jumper must be configured if this item is changed.

5. **ACT OUT 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. Default is FALSE. 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. **AOUT 4 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 Baseload Setting
   7. Remote Speed Reference
   8. J3 Modbus Address 4:0004
   9. Generator kW
   10. Baseload Reference

7. **AOUT 4 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. Default is TRUE. 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 value 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-KW 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.

6. **5-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.

7. **6-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.

8. **7-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.

9. **8-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.

10. **9-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.

11. **10-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.

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

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

6. **5-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.

7. **6-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.

8. **7-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.

9. **8-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.

10. **9-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.

11. **10-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.

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

13. **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 D input or the CB Aux contact input (whichever is configured). See Table 2-1 for 2nd Speed Dynamics Function.

The control uses the 1st dynamics when the 2nd Dynamics contact or the CB Aux contact input (whichever is configured) is open, and it uses the 2nd dynamics when the configured contact is closed.

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

1. **GAIN** determines how fast the control responds to an error in engine speed from the speed-reference setting. The Gain is set to provide stable control of the engine at light or unloaded conditions.

2. **RESET** compensates for the lag time of the engine. It adjusts the time required for the control to return the speed to zero error after a disturbance. Reset is adjusted to prevent slow hunting and to minimize speed overshoot after a load disturbance.

3. **COMPENSATION** compensates for the actuator and fuel system time constant. Increasing Compensation increases actuator activity and transient performance.

4. **GAIN RATIO** is the ratio of the Gain setting at steady state to the Gain setting during transient conditions. The Gain Ratio operates in conjunction with the Window Width and Gain adjustments by multiplying the Gain set point by the Gain Ratio when the speed error is greater than the Window Width. This makes the control dynamics fast enough to minimize engine-speed overshoot on start-up and to reduce the magnitude of speed error when loads are changing. This allows a lower gain at steady state for better stability and reduced steady-state actuator linkage movement. (See Figure 3-2.)

5. **WINDOW WIDTH (RPM)** 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 3-2.)

6. **GAIN SLOPE BK PNT (%FD)** sets the percent output above which the Gain Slope becomes effective. It should usually be set just above the minimum load output. (See Figure 3-3.)

7. **GAIN SLOPE** changes Gain as a function of actuator output. Since actuator output is proportional to engine load, this makes Gain a function of engine load. Gain Slope operates in conjunction with the Gain Slope 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 3-3.)

8. **SPEED FILTER FREQ (HZ)** adjusts the cutoff frequency of a low pass filter used on the engine speed sensing input (see Figure 3-5). To use this feature set the cutoff frequency below 15.9 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 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.

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

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.**

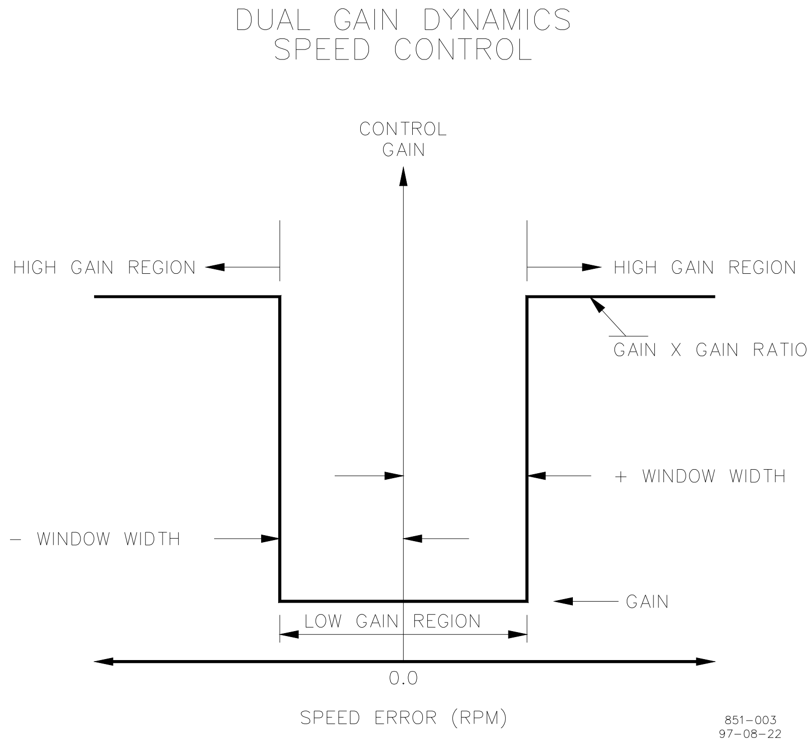


Figure 3-2. Control Gain as a Function of Speed Error

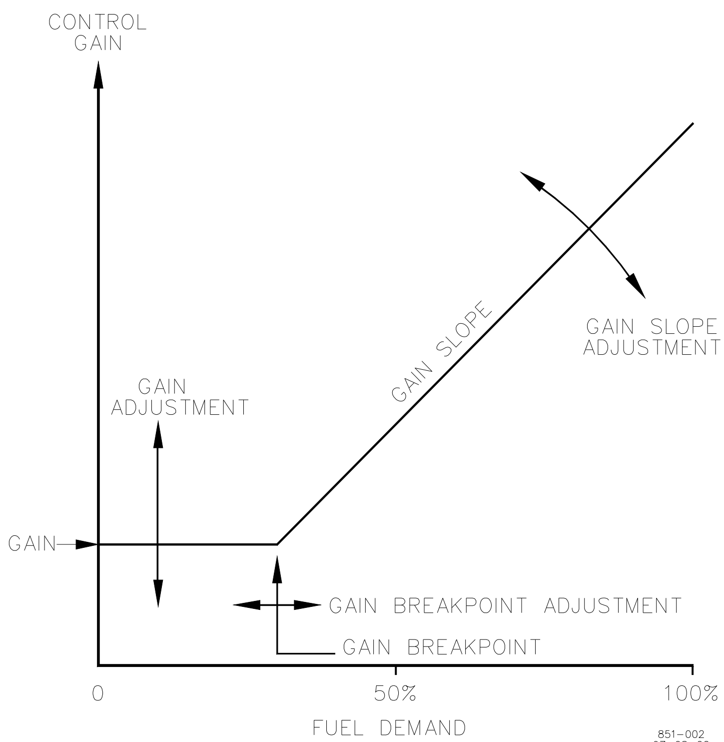


Figure 3-3. Control Gain as a Function of Control Output

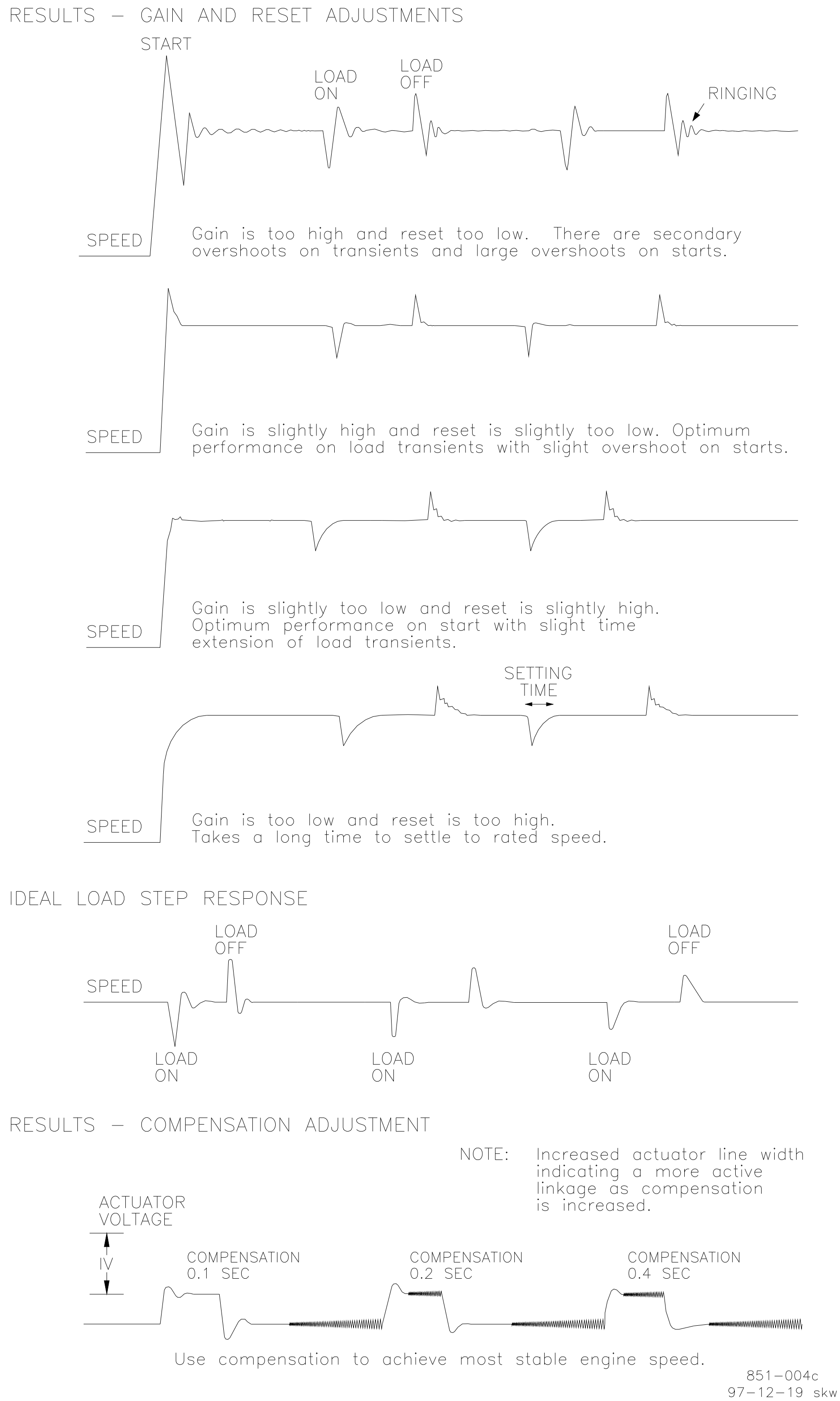


Figure 3-4. Typical Transient Response Curves

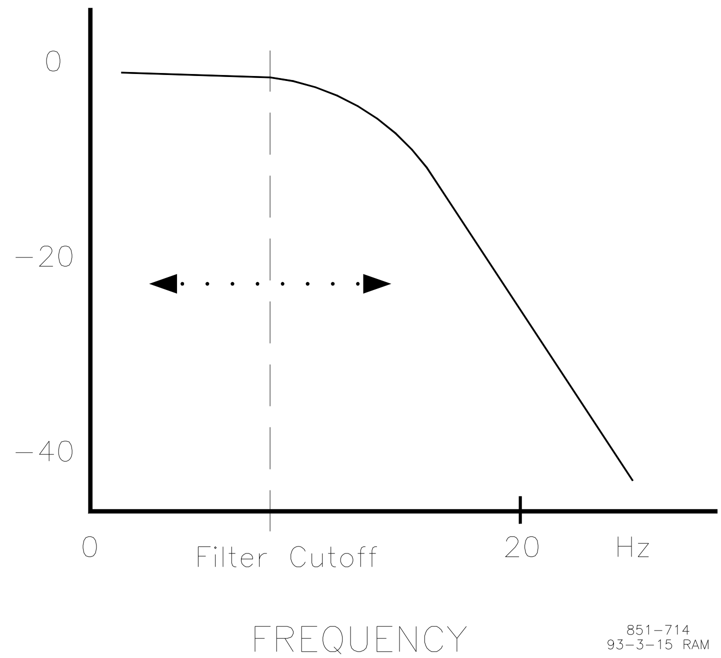


Figure 3-5. Speed Filter

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 (%FD)** is set at the no-load actuator 1 output % fuel demand.
2. **GAIN @ BREAKPOINT A** is the no-load GAIN setting.
3. **BREAKPOINT B (%FD)** is set at the 25 % load actuator 1 output % fuel demand.
4. **GAIN @ BREAKPOINT B** is the 25 % load GAIN setting.
5. **BREAKPOINT C (%FD)** is set at the 50 % load actuator 1 output % fuel demand.
6. **GAIN @ BREAKPOINT C** is the 50 % load GAIN setting.
7. **BREAKPOINT D (%FD)** is set at the 75 % load actuator 1 output % fuel demand.
8. **GAIN @ BREAKPOINT D** is the 75 % load GAIN setting.
9. **BREAKPOINT E (%FD)** 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 3-2).

14. **WINDOW WIDTH (RPM)** 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 3-2).

15. **SPEED FILTER FREQ (HZ)** is the cutoff frequency of a low pass filter used on the speed sensing input (see Figure 3-5). To use this feature set the cutoff frequency below 15.9 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.

IMPORTANT — **If the calculated firing frequency is greater that 15.9 Hz, then disable the filter by setting the filter cutoff frequency at or above 15.9 Hz.**

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.

WARNING	**Be prepared to change the dynamics settings since the actuator bump transient may stimulate instability, which could result in an overspeed condition.**

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 (%FD)** is set in % fuel demand for the desired bump level.

3. **ACT BUMP DURATION (SEC)** 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.**

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).

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:

$$\frac{6}{(1200 \times 0.01)} = 50\%$$

   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 (%FD)** 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 (HZ)** 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.

8. **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.

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 (%FD)** 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 (%FD)** 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 3-6).

   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 (%FD/S)** establishes the start limiter ramping rate at which the fuel demand increases to assist starting in colder ambient conditions.

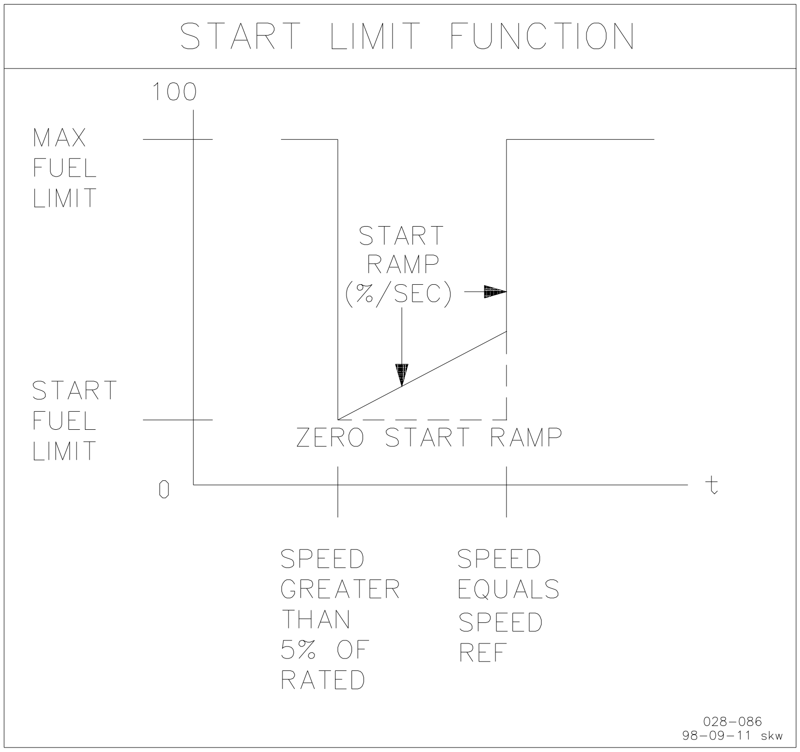


Figure 3-6. Start Limit Function

3. **MAX FUEL LIMIT (%FD)** 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.

Speed Setting Menu

Speed adjustments are the settings that affect the speed reference.

1. **START SPEED (RPM)** 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 (RPM)** 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 (RPM)** 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 (RPM)** 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 (SEC)** 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 (SEC)** 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 (RPM/MIN)** is the rate at which the speed reference is ramped when using the Raise Speed input, 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 (RPM/MIN)** 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.

9. **AI OVERRIDE LEVEL (%RATED)**—This is the speed level at which the analog inputs will be reset should they be failed during starting.

10. **AI OVERRIDE TIME (SEC)**—This is the delay time before the analog inputs will be reset after speed reaches the AI OVERRIDE LEVEL.

11. **AI CB CLS ARM DELAY (SEC)**—This is the delay time before arming the analog input failure alarm and shutdown functions after the CB AUX input closes. This allows voltage excitation and other sources for the inputs to stabilize before monitoring the inputs for failure. The alarm and shutdown bypass function is reset when speed drops below the AI OVERRIDE LEVEL.

KW Setting

KW settings affect parallel operation loading parameters.

1. **LOAD DROOP PERCENT** is the percentage of rated speed the speed reference will droop when the generator load is increased to maximum load. Set to desired droop percent.

2. **FUEL DEMAND @MIN LD (%FD)** must be set at the percentage of fuel demand when operating at rated speed/no-load. This establishes both the 0% internal load measurement for droop and the no-load fuel demand kW signal.

3. **FUEL DEMAND @MAX LD (%FD)** must be set at the percentage of fuel demand when operating at rated speed/rated-load. This establishes both the 100% internal load measurement for droop and the full load fuel demand kW signal.

4. **RATED LOAD (KW)**—Enter the maximum rated generator load.

IMPORTANT	**The fuel demand kW signal is a backup for the kW transducer input should it fail in either the kW droop or kW isochronous load sharing operating modes. Accurate fuel demand kW scaling is imperative for continued proper operation should the kW transducer input fail.**

5. **LOAD GAIN VOLTAGE**—Enter the load gain voltage of the control. A value of 6.0 is usually sufficient to allow load sharing with other units utilizing 0-3 Vdc analog load sharing lines. This value must be common with all other controls connected to the common Load Sharing Signal. If only 723PLUS controls are used in the load sharing scheme, leave this value set to 6.0 Vdc. This value represents 100% Rated generator load to the internal load sharing bridge.

6. **BASE LOAD REFERENCE (KW)**—Enter the internal Baseload set point. This sets the initial internal set point of the Baseload Reference Ramp when the Load Control enters Base Load mode.

7. **UNLOAD TRIP LEVEL (KW)**—Enter the unload trip level set point. This sets the load level at which the generator breaker opens (Relay Output #1) after the unit unloads following an Unload command. This also sets the minimum limit for the Load Control reference.

8. **LOADING RATE (KW/MIN)**—Enter the loading rate. This sets the rate at which the Load Reference Ramp will increase for soft loading and increasing load set points.

9. **UNLOADING RATE (KW/MIN)**—Enter the unloading rate. This sets the rate at which the Load Reference Ramp will decrease for soft unloading and decreasing load set points.

10. **2ND LOAD RATE (KW/SEC)**—Enter the second load ramp rate. Second load ramp rate is active when ‘USE CONT D AS RESET’ is set FALSE, ‘USE CONT D AS 2nd LOAD RAMP’ is set TRUE and Contact D is closed. See Table 2-1 for Contact D configurable functions.

11. **2ND UNLD RATE (KW/SEC)**—Enter the second unload ramp rate. Second unload ramp rate is active when 'USE CONT D AS RESET' is set FALSE, 'USE CONT D AS 2nd LOAD RAMP' is set TRUE and Contact D is closed. See Table 2-1 for Contact D configurable functions.

12. **BREAKER OPEN TIME (SEC)**—Enter the breaker open time in seconds. Determines how long the relay will open once the internal open breaker command is activated.

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. CFIG OPTION item 'USE EXT FUEL LIMIT' must be set TRUE to bring into view the EXT FUEL LIMIT CURVE menu. 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 3-7. 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.

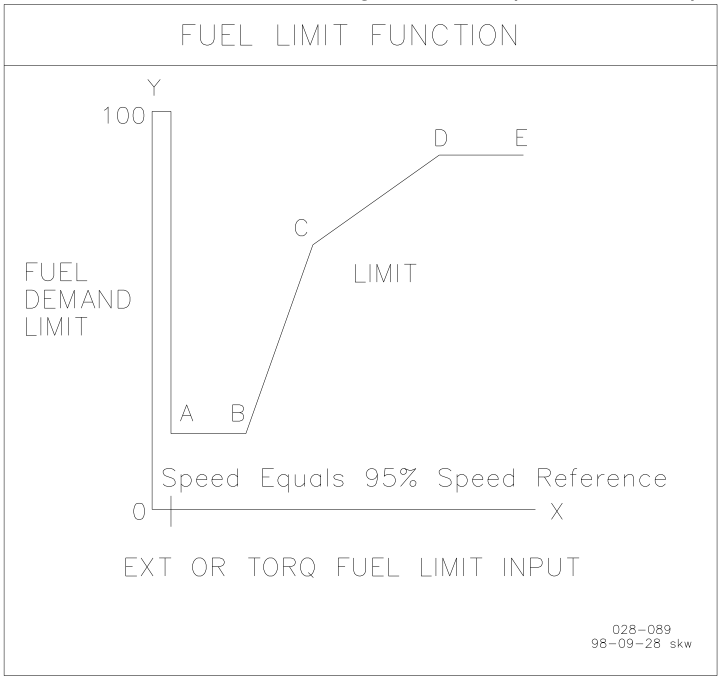


Figure 3-7. Torque Limit Curve

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 (EU)** is the External Fuel Limiter value that designates that particular breakpoint (x-axis input in Figure 3-7).

3. **FUEL LIMIT @ BRKPNT X (%FD)** is the percent fuel demand allowed when the External Fuel Limiter input is at that respective Breakpoint (y-axis output in Figure 3-7).

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. **KW SENSOR @4mA (KW)**—Enter the transducer kilowatt indication in kW when the device is delivering 4 mA to the 723PLUS input (it may be negative kW). If a voltage sensing device is provided, enter the input kW at 1 Vdc.

2. **KW SENSOR @20mA (KW)**—Enter the transducer kilowatt indication in kW when the device is delivering 20 mA to the 723PLUS input. If a voltage sensing device is provided, enter the input kW at 5 Vdc.

3. **REMOTE SPD @4mA (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.

4. **REMOTE SPD @20mA (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.

5. **REM LD SETPT @4mA (KW)**—Enter the preferred generator load reference set point in kW at 4 mA from the Remote Speed Reference input device. If a voltage sensing device is provided, enter the input kW at 1 Vdc.

6. **REM LD SETPT @20mA (KW)**—Enter the preferred generator load reference set point in kW at 20 mA from the Remote Speed Reference input device. If a voltage sensing device is provided, enter the input kW at 5 Vdc.

7. **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.

8. **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.

9. **SYNC IN SCALING (% PER VOLT)**—Enter the preferred percentage of rated speed the speed reference will change for a one volt synchronizer input change.

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

6. **ANALOG OUT 4 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 3-5). The filter is used to attenuate output signal noise. To use this feature, set the cutoff frequency below 15.9 Hz. To disable this filter, set the cutoff frequency at or above 15.9 Hz.

I/O Calibration

This menu allows exact calibration of the analog 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. **KW IN OFFSET (AI1)** adjusts the minimum displayed AI1 kW Transducer Input mA.

2. **KW INPUT SPAN (AI1)** adjusts the maximum displayed AI1 kW Transducer Input mA.

3. **KW READ VOLTS (AI1)** when TRUE changes the displayed AI1 kW Transducer Input to read Voltage instead of milliamps.

4. **SYNC OFFSET (AI2)** adjusts the displayed AI2 Synchronizer Input Voltage. Use this to calibrate for 0.0 volts input.

5. **REM IN OFFSET (AI3)** adjusts the minimum displayed AI3 Remote Reference Input.

6. **REM IN SPAN (AI3)** adjusts the maximum displayed AI3 Remote Reference Input mA.

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

8. **EXT LMT OFFSET (AI4)** adjusts the minimum displayed AI4 External Limiter Input mA.

9. **EXT LIMIT SPAN (AI4)** adjusts the maximum displayed AI4 External Limiter Input mA.

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

11. **DE-DROOP (mV)**—Allows for calibration of the load sharing bridge. With unit on-line no-load parallel, adjust until 'LOAD BIAS(RPM)' is close to zero RPM.

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

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

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

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

16. **AO 3 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.

17. **AO 3 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.

18. **AO 4 OFFSET** adjusts the Analog Output #4 mA minimum.

19. **AO 4 SPAN** adjusts the Analog Output #4 mA maximum.

20. **HANDHELD INTERFACE**—Set TRUE to set up port J1 as a Hand Held Programmer interface port.

IMPORTANT	**Five seconds after the HANDHELD INTERFACE is set TRUE, the control will switch Port J1 to a Hand Held Programmer interface port. At this point communication with ServLink/Watch Window will be lost.**

21. **SERVLINK INTERFACE**—Set TRUE to set up port J1 as a ServLink/Watch Window interface port.

IMPORTANT	**Five seconds after the SERVLINK INTERFACE is set TRUE, the control will switch Port J1 to a ServLink/Watch Window interface port. At this point communication with the Hand Held Programmer will be lost.**

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 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 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.

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

10. **PORT 3 EX ERR NUM** is the number of the exception error that occurred, based off the above table.

11. **PORT 3 EX ERR PCT** is the exception error divided by the total communication transactions, and reflects the quality of the port 3 communications.

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

This menu displays and allows calibration of LinkNet RTD input Module 1. 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 this menu 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

This menu displays and allows calibration of LinkNet Analog Input Module 1. 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 this menu 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

This is a **display only** menu which displays the state of LinkNet Discrete Inputs of Module 1. 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

This is a **display only** menu which displays the state of LinkNet Discrete Outputs of Module 1. 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. **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** menu.

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-CB AUX CONTACT** shows the state of the Isochronous/Droop contact (TRUE = CLOSED = ISOCHRONOUS, FALSE = OPEN = DROOP).

2. **B-BASE LOAD** shows the state of the Base Load contact (TRUE = CLOSED).

3. **C-LOAD GENERATOR** shows the state of the Load/Unload contact (TRUE = LOAD GENERATOR, FALSE = UNLOAD GENERATOR).

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

IMPORTANT	**D-2ND DYNAMICS contact may be configured as an Alarm Reset or 2nd Load/Unload rate. See Table 2-1 for Contact D configurable functions.**

5. **E-RAISE SPD/LOAD** shows the state of the Raise Speed/Load contact (TRUE = CLOSED).

6. **F-LOWER SPD/LOAD** shows the state of the Lower Speed/Load 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-OPEN GEN BRKR** shows the state of the Open Breaker 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-SHUTDOWN** shows the state of the Shutdown Relay Output #3. TRUE indicates the relay is energized.

12. **DO4-LD SHARE RELAY** shows the state of the Load Share Relay output. 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.

2. **SPD SENS IN #2** shows the frequency, in hertz, of the Speed Sensor #2 input signal.

3. **AI1-KW INPUT** shows the value, in mA, of the KW Transducer 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. **AI1-KW INPUT FAILED** shows the state of the KW Transducer Input #1 Signal. (TRUE = FAILED). This value is sent to Modbus.

5. **AI2-SYNC INPUT** shows the value, in Vdc, of the Synchronizer Input #2 signal. This value times 1000 is sent to Modbus. The Vdc value is after the effect of the offset in the I/O CALIBRATION menu.

6. **AI3-REMOTE IN** shows the value, in mA, of the Remote Speed/Load 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.

7. **AI3-REM IN FAILED** shows the state of the Remote Speed/Load Input #3 Signal. (TRUE = FAILED). This value is sent to Modbus.

8. **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.

9. **AI4-EXT LIM FAILED** shows the state of the External Fuel Limit Input #4 Signal (TRUE = FAILED). This value is sent to Modbus.

10. **LOAD SHARING LINES (Vdc)** shows the voltage present across the load sharing lines.

11. **LOAD SHARING ERROR (Vdc)** shows the voltage present across the load sharing bridge.

12. **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.

13. **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.

14. **ANALOG OUT 3** 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.

15. **ANALOG OUT 4** 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.

16. **LOAD SIGNAL** shows the internal voltage output, in Vdc, to the load sharing bridge.

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

Load Control Mode

This menu allows determination of 723PLUS load control mode. This menu can be very useful for troubleshooting. See Table 5-1 for general mode information.

1. **FD DROOP CONTROL**—Test mode for setting up fuel demand droop backup. Load control algorithm will use a scaled representation of the fuel demand as load feedback.

2. **KW DROOP CONTROL**—Operating mode when CB AUX contact is open and kW transducer is active.

3. **KW ISOCH LS CONTROL**—Normal Isochronous Load Sharing Control mode.

4. **FD ISOCH LS CONTROL**—Backup Isochronous Load Sharing Control mode for use only when the kW transducer fails. Load control algorithm will use a scaled representation of the fuel demand as load feedback.

5. **ISOCH LOADSHARING**—Unit has load sharing relay closed and is performing isochronous load sharing with other units.

6. **LOAD RAMP CONTROL**—Unit is currently ramping in or out of isochronous load sharing or baseload mode.

7. **BASE LOAD CONTROL**—Unit is currently in baseload control mode.

8. **REMOTE LOAD ENABLED**—Is TRUE when the Remote baseload set point is active.

9. **UNLOADED**—Is TRUE when the unit is controlling at the unload trip level.

LSS Control Mode

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

1. **SPEED IN CONTROL** will show TRUE when the fuel demand is being controlled by the Speed Control.
2. **ON START FUEL LIMIT** will show TRUE when the fuel demand is being limited by the START FUEL LIMIT.
3. **ON MAXIMUM LIMIT** will show TRUE when the fuel demand is being limited by the MAX FUEL LIMIT.
4. **ON EXTERNAL LIMIT** will show TRUE when the fuel demand is being limited by the EXT FUEL LMT CURVE.
5. **ON TORSIONAL LIMIT** will show TRUE when the fuel demand is being limited by the TORSNL FUEL LIMIT.
6. **ACTUATOR SHUTDOWN** will show TRUE when the fuel demand is being limited by the ACTUATOR SHUTDOWN LIMITER.
7. **REMOTE SPEED ENBLD** will show TRUE when the REMOTE SPEED REFERENCE is enabled (AI3 input device or Modbus AW).
8. **2nd DYNAMICS ENBLD** will show TRUE when 2nd Dynamics are enabled and used by the control.
9. **REAL GAIN SETTING** displays the actual gain value that is applied to the speed control PID. This is the gain value after all internal calculations and curves that may be applied to the entered gain setting are applied.
10. **SPD SENSOR 1 ACTIVE** will show TRUE when speed sensor input #1 is actively used by the control.
11. **SPD SENSOR 2 ACTIVE** will show TRUE when speed sensor input #2 is actively used by the control.
12. **PORT 1 ON HANDHELD** will show TRUE when Port 1 is setup to communicate with a handheld programmer.
13. **PORT 1 ON SERVLINK** will show TRUE when Port 1 is setup to communicate by ServLink with a PC.

Display Menu

This menu is for **display only**. It shows several control parameters which are often used to determine the operation of the engine.

1. **ENGINE SPEED** displays the present engine speed in rpm.
2. **BIASED SPD REF** displays the total output of the speed reference ramp, load sharing bias, droop bias, and synchronizer bias. This biased speed reference 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 configured for direct acting.

4. **SPEED REF** displays the output of the speed reference ramp before any biases are applied.

5. **LOAD BIAS** displays the value, in rpm, that the load control is biasing the speed reference.

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

7. **SYNC BIAS** displays the value, in rpm, that the synchronizer input is biasing the speed reference.

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

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

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

11. **FD REPRESENTATION (kW)** displays the present generator kW based on the fuel demand. This display value is established by the KW SETTING menu entries FUEL DEMAND @ MIN LD (%FD) for the 0 kW value, FUEL DEMAND @ MAX LD (%FD) and RATED LOAD (kW) for the rated load value. Intermediate %FD values will produce intermediate kW values.

12. **REM LD SETPT (kW)** displays the present remote load reference signal in kW.

13. **BASE LOAD REF (kW)** displays the present base load reference ramp output in kW.

14. **LOAD REFERENCE (kW)** displays the present load reference ramp output in kW.

15. **GENERATOR OUT (kW)** displays the present generator kW based on the kW transducer input. This display value is established by the SET ANALOG INPUTS menu entries KW SENSOR @ 4 mA (kW) and KW SENSOR @ 20 mA (kW). Intermediate mA values will produce intermediate kW values.

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.

4. **DO4 FORCE** is set TRUE to force the load sharing relay to the energized state. Set value FALSE to force the load sharing relay 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

This menu allows **LinkNet Discrete Outputs 1** 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.

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 or CB Aux contact open) and 2nd dynamics (2nd Dynamics or CB Aux contact closed).

Do the following adjustments first for 1st dynamics (2nd Dynamics or CB Aux 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 or CB Aux 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) and the Fuel Demand @ Min LD (KW SETTING 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 3-4.

⚠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.

IMPORTANT

When paralleled to the utility, speed error is created when corrective bias signals following load changes are applied to the speed reference by droop or the Load Sharing Control inputs. Speed errors are manifested as load transients instead of speed transients. An actuator bump is recommended to test dynamic settings when operating in parallel with the utility.

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. Set the Fuel Demand @ Max LD (KW SETTING menu) to this setting. 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 Speed 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 Speed 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 Analog Output 1 Min rpm set point for 4 mA set point output.

   Set engine speed to the speed desired for 20 mA output. Trim the Analog Output 1 Max 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.

Torsional Adjustments

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

1. Set the ENG SENSOR WEIGHT with the following procedure. The Torsional Level is the ratio between the engine inertia and the system inertia. If you know these values then set the initial value of Engine Sensor Weight equal to the engine inertia divided by the quantity (engine inertia + generator inertia) and follow the procedure outlined below. If you don't know the system inertia values, then start with the default value and follow the procedure outlined below.

2. It is important to know what speed or load (or combination of speed and load) causes the system to go into torsional instability. This is referred to here as the torsional point. The torsional point can be found by bumping the system using the Actuator Bump function in the dynamics menu. Be prepared to move the system away from the torsional point if it goes unstable. Bump the system at several different speeds and loads. If the system remains stable, slightly increase the dynamic Gain and again bump the system at several different speeds and loads. At some point, a torsional oscillation may begin to occur which can be corrected with the Engine Sensor Weight. Begin by reducing the value a small amount. After each adjustment, approach the torsional point and see if the performance is improving or degrading. If the performance is improving, continue making small reductions until you find the value where no further improvements are seen. If the performance is getting worse, begin increasing the value above the initial Engine Sensor Weight and determine if any improvement is observed. If the performance is improving, continue making small increases until you find the value where no further improvements are seen.

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

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

4. TORSNL LEVEL @LIMIT can be adjusted to the reading recorded above for the TORSIONAL LEVEL before the limit was reduced.

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

IMPORTANT

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

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 Speed and Load Control. Figures 5-1 and 5-2 show the control block diagram, for reference in the following descriptions.

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

The speed sensor inputs 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 the 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.

Fuel Control

The basic operation of the 723PLUS control is to provide a dynamically stable closed loop path between the engine fuel delivery system and feedback paths of engine speed and generator load. If generator load is not directly available, a second feedback path from the Fuel Demand is used to control load. The speed will be controlled at a reference set point which is the sum of the Speed Reference and the bias signals. The bias signals come from the Load Control or the Droop Function (depending on the position of the CB AUX Switch) and the Synchronizer Input. The closed loop path is interrupted by an LSS (Low Signal Selector) which will limit the Fuel Demand to the lowest value of all inputs. Inputs (other than the PID control signal) which can limit the Fuel Demand include a Min Fuel Function, a Max Fuel Function, a Start Limit Function, an External Fuel Limit Function, and a Torsional Limit Function. A very short duration Bump Actuator Function will also limit the Fuel Demand when it is applied. The Fuel Demand is a dimensionless value based on percentage of required fuel where 0 percent generally represents no fuel and 100 percent represents maximum fuel. The Fuel Demand is supplied to the Actuator Function to produce an Actuator Current. The Actuator Current is supplied to an Actuator which will control the fuel delivery system.

Control Dynamics

The control algorithms used in the 723PLUS Speed 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.

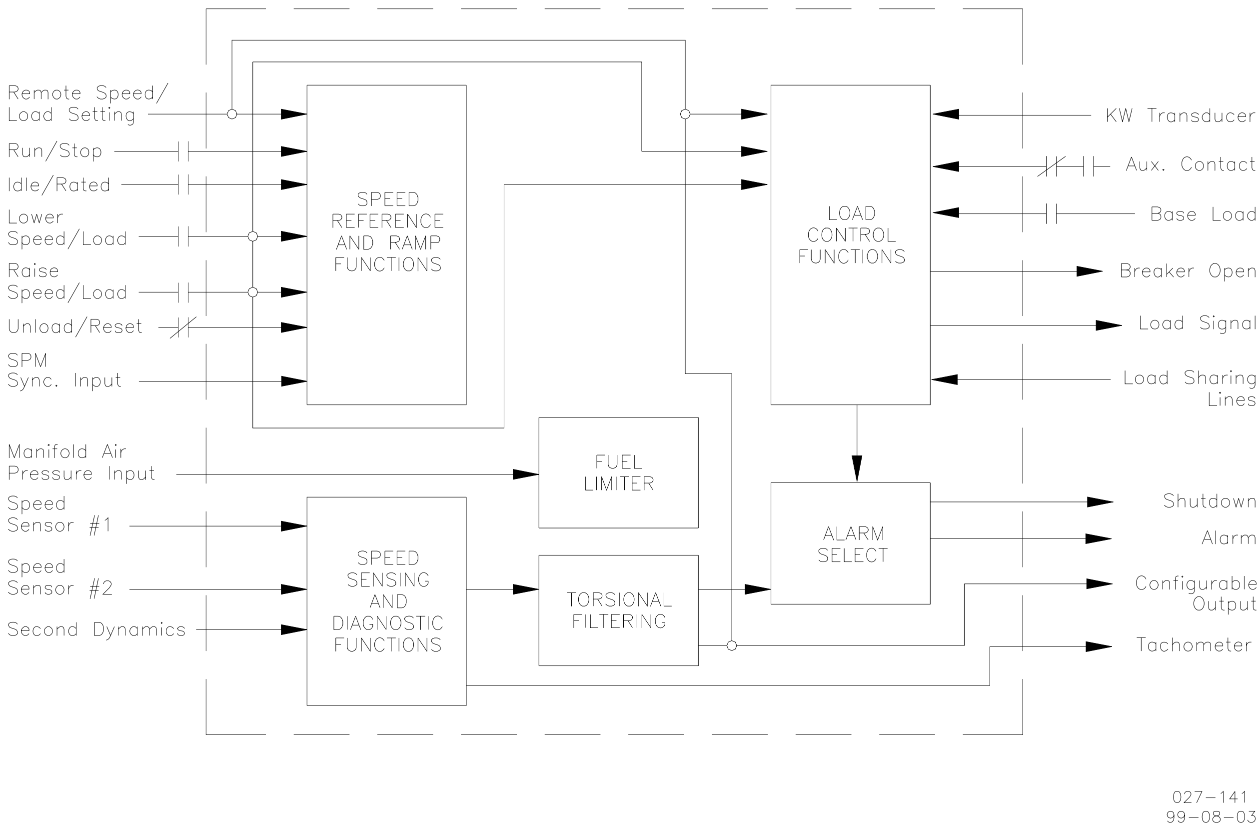


Figure 5-1. Simplified Block Diagram

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 (See Figure 3-3). 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. The control automatically increases gain by an adjustable ratio when a speed error exceeding an adjustable window occurs (See Figure 3-2). 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 reciprocating 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. Furthermore, this feature is active when paralleled to a utility grid. Although actual engine speed does not change, the speed reference is changed when corrective bias signals are applied by load sharing or droop during load transients. Large corrective bias signals will produce a large speed error to automatically increase gain.

The control also provides a second complete set of dynamic adjustments which are selected when the 2nd Dynamics or CB Aux (whichever is configured) discrete input is activated. Two sets of dynamics are useful where engine operating conditions change, such as in dual-fuel engines or in electrical power generation systems where the unit may be operated stand alone or in parallel with an infinite bus.

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.

A second speed sensing device may be used for redundancy or for torsional filtering on engines equipped with flexible couplings. 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.

However, if there is a flexible coupling between the engine and generator set, the first MPU (terminals 11/12) must detect engine speed, and the second MPU (terminals 13/14) must detect generator speed for proper functioning of the flexible coupling torsional filter.

The Speed Sensor Input is hardware-configured for an MPU when the control is shipped from the factory. In this configuration the impedance of the input could be as low as 200 Ω. An MPU used as a speed input device must provide a minimum amplitude signal of 1.0 Vrms at all times while the engine is being started and controlled. Refer to manual 82510 for complete details on MPU selection, location, and mounting.

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

The Speed Sensor Input is software-configurable for either a digital speed detection method or an analog speed detection method. The digital speed detection method samples at 1/16th of a revolution intervals and provides a new update to the program once per revolution. This method filters out engine firing torsionals. The Digital Speed Sensor frequency range is 400 to 15 000 Hz. The analog speed detection method uses a frequency-to-voltage converter and updates continuously. The analog method may allow for better transient response at the sacrifice of steady-state stability. A two-pole speed filter is available when the firing frequency is low enough to cause tuning problems. Analog Speed Sensor frequency range is 400 to 15 000 Hz.

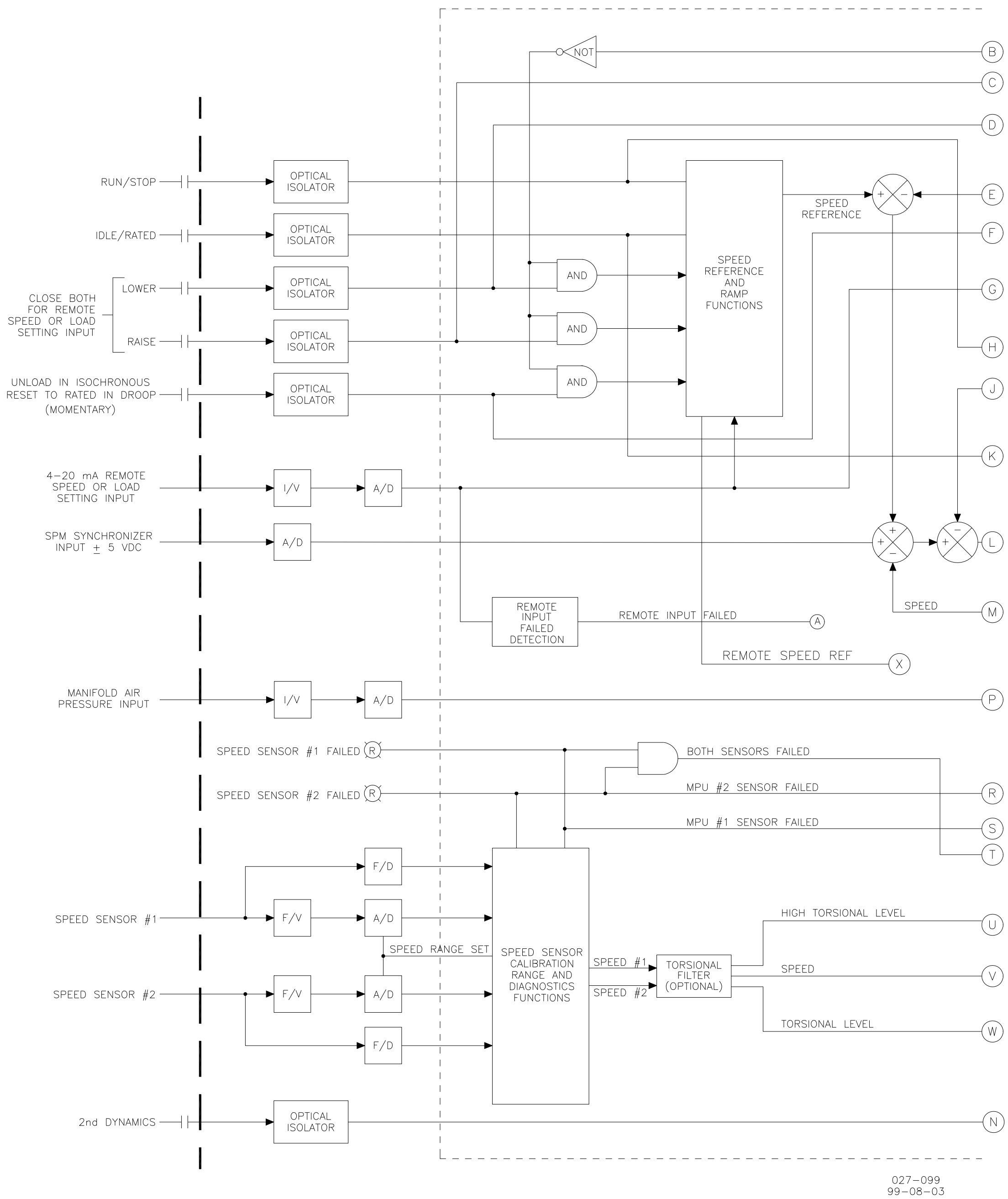


Figure 5-2a. Detailed Block Diagram

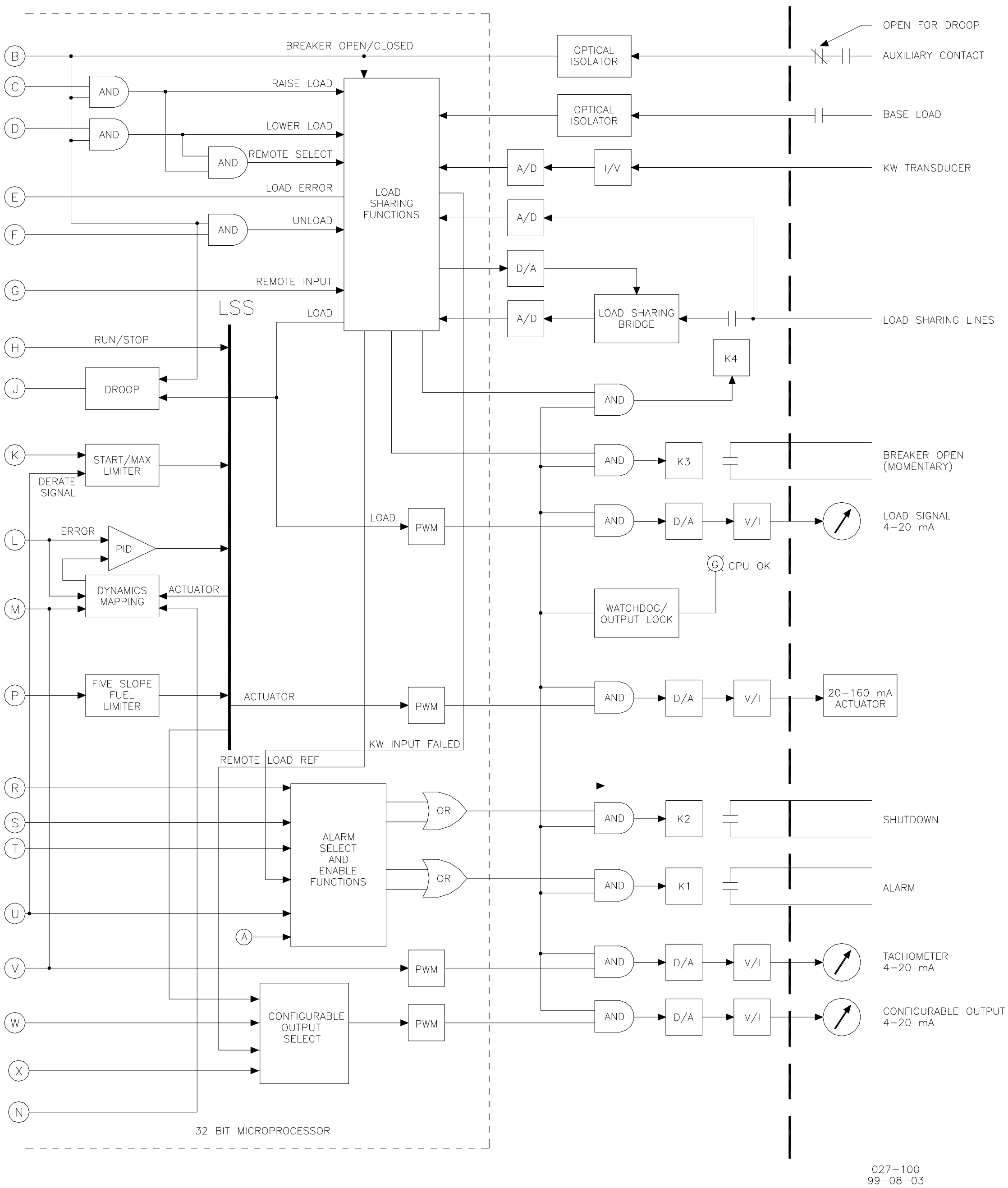


Figure 5-2b. Detailed Block Diagram

A Low RPM Speed-Sensing Algorithm is available as a separate part number. This algorithm is specially designed for less than 130 rpm rated engines (MAN B&W, Sulzer, etc.). The speed sensing frequency range of this particular controller is 5 to 976 Hz. The control will sense the speed above 976 Hz, but it loses measurement accuracy and is not recommended. A proximity switch is recommended for all low-rpm low-frequency applications.

Torsional Filter Function

When the "Use Torsional Filter" is configured FALSE, the speed control selects MPU #1 for use when both speed inputs are valid. Otherwise the valid input with the higher frequency is used.

When the "Use Torsional Filter" is configured TRUE, the torsional filter function is enabled, which allows 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 Alarm and Shutdown functions can be configured to activate if the torsional value gets too high.

As an alternative filtering means, a Notch Filter is also included for single speed sensor applications which require 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.

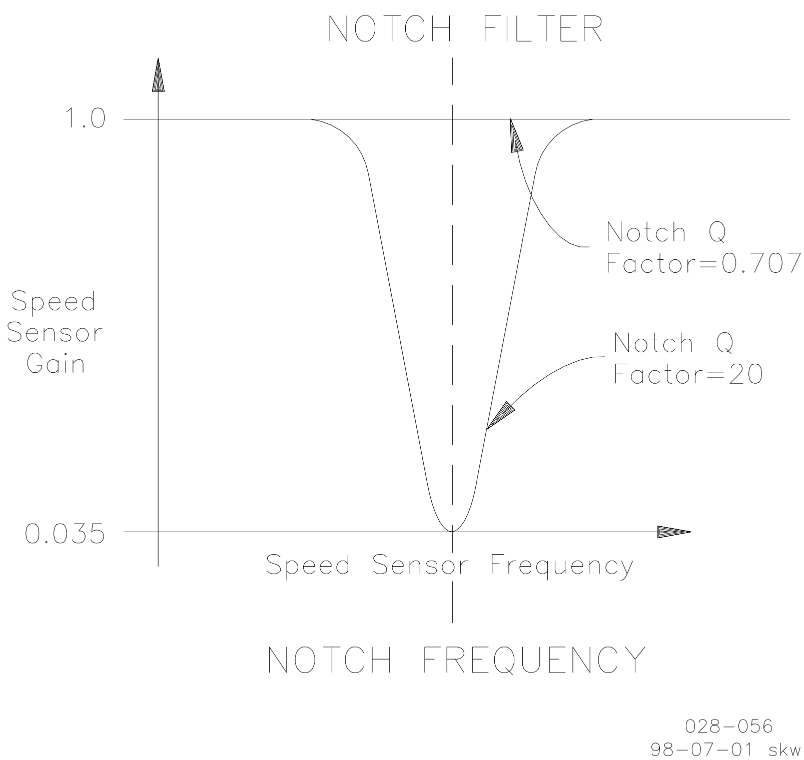


Figure 5-3. Notch Filter

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 Override Spd Fail is configured FALSE. 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 5-4). 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 disabled and re-armed for trigger during the next start. The start fuel limit function also works on reverse-acting systems. The function can be disabled by adjusting the Start Fuel Limit to a value of 100.

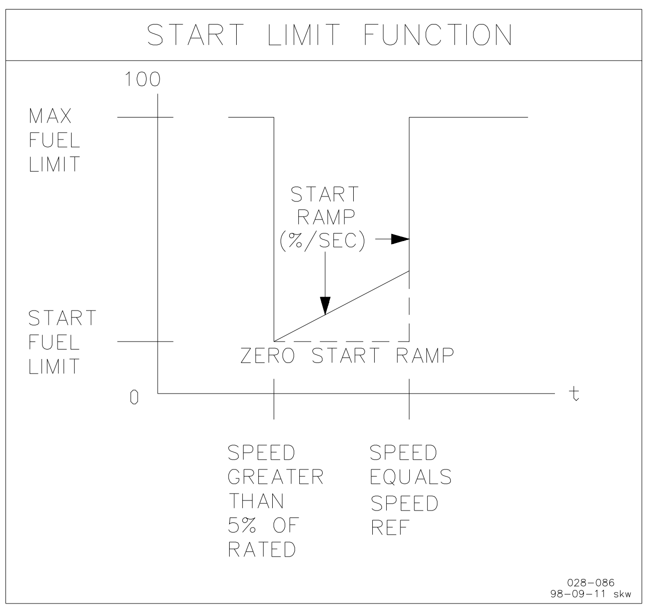


Figure 5-4. Start Limit Function

Fuel Limiting Function

The Fuel Limiting function prevents an overfuel condition by limiting fuel demand. The External Fuel Limiting Function provides one software adjustable five-breakpoint curve based on an external transmitter signal provided at Signal Input #4. The display value of the input signal can be scaled according to the engineering units desired. The output units for fuel demand limiting is in percent. The limiting value is linear from set point to set point as shown in Figure 5-5. The function is enabled when the engine speed first reaches 95 percent of the speed reference. It remains enabled until the engine is shut down. This function is disabled if the input signal is failed. This function can also be enabled or disabled by software at the EXT FUEL Limit Curve menu.

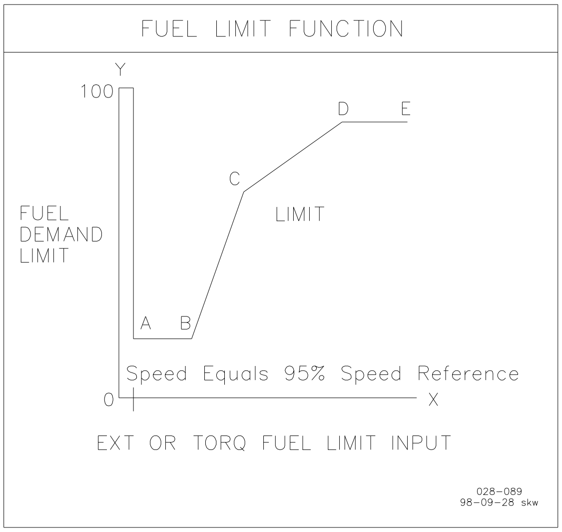


Figure 5-5. Fuel Limit Breakpoints

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 the failure threshold in percent of rated speed. The failure threshold can be adjusted in CFIG SPEED CONTROL - SS CLEAR PERCENTAGE. 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 OVERRIDE SPEED FAIL configuration setting. 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 input TRUE, then FALSE, issues the Alarm Reset command. In addition, an alarm reset is issued when the CLOSE TO RUN discrete input contact and, if CFIG OPTION - USE CONT D AS RESET is true, when discrete input D (term 32) contact is closed. 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/Load Reference and Ramps

The 723PLUS control provides local control with discrete inputs for raising and lowering speed/load. For remote speed/load 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. Input functions are enabled as follows:

- Local Speed/Load Reference Raise/Lower discrete inputs are enabled when remote speed/load setting is not enabled.
- Remote Speed/Load Reference setting is enabled when the Raise Speed/Load and Lower Speed/Load contacts are both closed, the Rated contact is closed, and Use Remote Commands is FALSE. The Remote Reference input is a Speed Reference setting when USE REMOTE AS SPEED is set true on the CFIG SPEED CONTROL menu. Otherwise the Remote input is a Baseload Reference setting.
- Modbus Speed/Load Reference setting is enabled when the Raise Speed/Load and Lower Speed/Load contacts are both closed, the Rated contact is closed, and Use Remote Commands is TRUE. The Modbus input is a Speed Reference setting when USE REMOTE AS SPEED is set true on the CFIG SPEED CONTROL menu. Otherwise the Modbus input is a Baseload Reference setting.

Speed Reference and Ramp Functions

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

The control provides 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 input.

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).

When configured TRUE, the Start reference is selected, at a very fast rate, by control power-up, engine not running, or engine cranking. The Start reference is given first priority over all other references and is the speed reference until the engine starts. The ramp to the reference selected by the Idle/Rated contact input begins after the engine speed exceeds the start speed setting. 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 internal software adjustment of the idle speed set point. The idle speed set point is selected when the Rated contact is open, if the start reference is removed either by configuration or engine speed above start speed.

Closing the Rated contact ramps the speed set point from idle to rated, if the start reference is removed.

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.

If remote speed operation is configured and 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 the Remote Reference input or the Modbus AW value is configured, 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 5-6). 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.

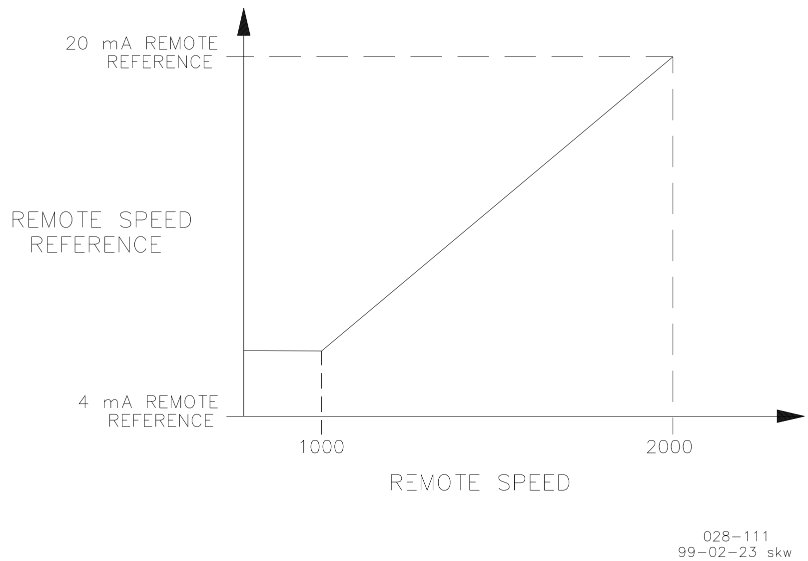


Figure 5-6. Remote Speed Reference

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.

Load Reference and Ramp Functions

This section describes the operation of the load reference and ramp functions and their relation to each other. Droop operating mode has no ramp functions and is not included here. Isochronous load sharing descriptions apply to two or more units paralleled on a common isolated bus or by accessory device with the utility. Baseload descriptions apply to a unit paralleled with the utility or with one or more units on an isolated bus. Read this section carefully to be sure your sequencing provides the proper operating modes.

The control provides an unload trip level set point, baseload set point, rated load set point, loading rate, unloading rate, 2nd load rate, and 2nd unload rate for local operation. Loading rate determines the kW per minute increase when the load input is closed. Unloading rate determines the kW per minute decrease when the load input is opened (unload). The 2nd load and unload rates (usually a fast kW/sec rate) are enabled by configuring USE 2nd LD RAMP true on the CFIG OPTION menu. Following configuration, closing discrete input D contact selects the 2nd load and unload rates. This mode could be useful in an emergency start situation where the generator set could be loaded at a fast rate. Opening discrete input D contact unselects the 2nd load and unload rates.

IMPORTANT **Discrete input D can only be configured for one function. If CFIG OPTION menu item USE D AS 2nd LD RAMP is configured true, the menu item USE CONT D AS RESET must be configured false and conversely.**

In the isochronous mode (CB Aux input closed), closing the load contact ramps the load set point from no-load to the load sharing setting. Opening the load contact (unload) ramps the load to the unload trip level setting. At the unload trip level a Circuit Breaker open signal is issued.

Closing the baseload contact ramps the load set point from no-load or the load sharing setting to the baseload reference. Opening the baseload contact ramps the load to the load sharing setting.

IMPORTANT **In isolated bus applications a brief speed transient may occur when the load sharing relay closes following transfer from baseload back into isochronous load sharing.**

Closing either the Raise or Lower contacts while in isochronous load sharing mode adjusts the speed reference (frequency) as described earlier. Normally the frequency is not adjusted in the isochronous load sharing mode. One exception, is if the synchronizer fails, or is not connected, and there is a need to manually synchronize the isochronous load sharing system back to the utility.

Closing either the raise or lower contacts while in baseload mode adjusts the unit load at the loading or unloading rate settings. The raise and lower commands will not increase the load above the rated load limit or below the unload trip level limit.

If remote speed operation is configured and selected while in isochronous load sharing mode the remote input adjusts the speed (frequency) to the reference value set by the Remote Reference milliamp input or the Modbus AW value, as configured and described earlier. Normally the frequency is not adjusted in the isochronous load sharing mode. One exception, is if the synchronizer fails, or is not connected, and there is a need to manually synchronize the isochronous load sharing system back to the utility.

If remote load operation is configured and selected while in baseload mode the remote input adjusts the unit load at the load and unload rate settings. The Remote Reference operates from 4 to 20 mA (1 to 5 Vdc). The kW values of the 4 mA and 20 mA remote load reference set points must be set between the rated load and unload trip level settings. The 4 mA Remote Reference set point may be set to a lower or higher load than the 20 mA set point, providing for either direct or reverse-acting remote load setting.

If the Remote Reference input or the Modbus AW value is present and selected when the Baseload contact is closed, the baseload reference will ramp to the kW load value set by the Remote Reference milliamp input or the Modbus AW value at the loading or unloading 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 baseload reference based on a straight line between the 4 mA and 20 mA Remote Reference set points (see Figure 5-6). If a difference is detected between the present baseload reference and the remote reference kW value, the present baseload reference is ramped up or down at the loading or unloading rate until the present baseload reference matches the remote baseload reference kW value. The remote reference will not increase/decrease the baseload reference above the rated load limit or below the unload trip level limit.

When operating in remote baseload 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 load 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 loading or unloading rate, until a rated load limit or unload trip level limit is reached.

Load Control

Isochronous load control is enabled when the CB Aux input contact is closed. In this mode actual load, as sensed by the kW sensor input, is compared to a load reference (load sharing or baseload) to produce a load bias. The load bias is summed with the speed reference to create a biased speed reference. A positive bias increases load and a negative bias decreases load. The load bias approaches zero as the actual load approaches the load reference. A load reference ramp allows soft loading into and out of isochronous load sharing or base load modes. During isochronous load sharing the load reference is made equal to the system load sharing signal. The system load sharing signal is input through the analog load sharing lines which allows isochronous load sharing with other Woodward products.

Droop control is enabled when the CB Aux input contact is opened.

Isochronous Load Sharing Operation

Isochronous load sharing is generally used to balance generator loads when two or more engines are supplying power to a bus which is isolated from the infinite bus. Accessory equipment, such as an Automatic Power Transfer and Load Control (APTL), can be used to achieve isochronous load sharing against an infinite bus but will not be discussed here. When a generator is carrying less load than its share, the load bias is positive and the closed loop path increases the fuel to the engine. When a generator is carrying more load than its share, the load bias is negative and the closed loop path decreases the fuel to the engine. As the fuel to the engine is changed, the load and/or speed changes until the engine speed exactly matches the biased speed reference. At this steady state isochronous load sharing condition, the load bias is virtually zero and the biased speed reference, rated speed reference, and engine speed are virtually equal.

The Rated Load item in the KW Settings menu affects the load sharing proportions. The rated load setting is the maximum capacity of the engine and a primary factor in balancing generator loads. As an example, consider two generators, one rated at 1200 kW and one rated at 600 kW. If the combined output of these generators in steady state isochronous load sharing is 750 kW, the 1200 kW generator will be carrying 500 kW and the 600 kW generator will be carrying 250 kW (both at 41.7% rated kW). At maximum load the 1200 kW generator will be carrying 1200 kW and the 600 kW engine will be carrying 600 kW (both at rated kW). The two engines will both carry their proportional share of load over the entire load range from zero load to rated load. In isochronous load sharing, no operator action is required as plant load increases or decreases, because the steady state system frequency will remain constant and load will be shared proportionally between all generators on-line. Note that if a single unit should be limited in load by any of the inputs to the LSS, that unit will stop load sharing with other units until its load can again share proportionally. The other units on line will continue isochronous load sharing at rated speed.

Load Sharing is only accurate if the kW Sensor provides an accurate signal to the 723PLUS control, and the values adjusted in the kW Settings menu for Load Gain Voltage, kW Sensor @4ma, and kW Sensor @20ma are correct and no other limiters are affecting the control. The value of the Load Gain Voltage should be the same value as other Load Gain Voltages in the system. This is generally a value of 6.00 representing six volts at maximum load in the exact same way that 6 Vdc represents the Load Gain Voltage at maximum load on other Woodward products.

Should the kW sensor input fail, the control can be configured to continue in a backup fuel demand (FD) isochronous load sharing mode. This backup load sharing mode is based on kW load scaled from the fuel demand. This method allows continued operation until the kW sensor can be repaired. It is strongly recommended that an alarm be triggered by kW sensor failure so that normal operation can be resumed as soon as possible. The FD isochronous load control method may not be very accurate since the actual kW is not sensed. Any real fuel demand vs kW non-linearity will appear as a generator load sharing error. It is not recommended to operate in this manner for extended periods of time.

Base Load Operation

Base load is used to load individual generators to an internal or external base load setting whenever the generator is paralleled with one or more generators or with the utility. Initially the load reference ramps to the internal default base load setting. The base load reference can be adjusted as previously described in the Load Reference and Ramp Functions section.

Closing the baseload input contact ramps the generator load from isochronous load sharing or no load into base load. Once in full base load operation, the base load reference determines the load on the generator without regard to other units connected to the same load. When the generator is carrying less load than the base load reference, the load bias is positive and the closed loop path increases the fuel to the engine. When the generator is carrying more load than the base load reference, the load bias is negative and the closed loop path will decrease the fuel to the engine. As the fuel to the engine is changed, the load and/or speed will change until the engine speed exactly matches the biased speed reference. At this steady state base load condition, the load bias is virtually zero and the biased speed reference, rated speed reference, and engine speed are virtually equal.

Opening the baseload input contact ramps the generator load from base load back into isochronous load sharing. However, opening the load input contact (unload) instead, ramps the generator load from the base load setting to the unload trip level where a breaker trip signal is issued after a tunable time delay.

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

It is possible for the control to be in base load control while supplying power to a load which is isolated from the infinite bus. The capability of the engine generator must be considered when operating this way. As an example again consider two generators, one capable of providing 1200 kW and one capable of providing 600 kW. If the combined load demand to these generators is 750 kW while the 1200 kW generator is in steady state isochronous load sharing and the 600 kW generator is in steady state base load with a set point of 250 kW, the 1200 kW generator will again be carrying 500 kW and the 600 kW generator will again be carrying 250 kW. However, now as the total load demand increases only the 1200 kW generator will respond to the increase. At a combined load demand of 1450 kW, the 1200 kW generator will carry 1200 kW while the 600 kW generator in base load will still be carrying 250 kW. If the load demand exceeds 1450 kW, the steady state frequency of the bus will decrease and the load supplied by each individual generator will increase.

Should the kW sensor input fail, the control can be configured to continue in a backup fuel demand (FD) base load mode. This backup base load mode is based on kW load scaled from the fuel demand. This method allows continued operation until the kW sensor can be repaired. It is strongly recommended that an alarm be triggered by kW sensor failure so that normal operation can be resumed as soon as possible. The FD base load control method may not be very accurate since the actual kW is not sensed. Any real fuel demand vs kW non-linearity will appear as a generator base load error. It is not recommended to operate in this manner for extended periods of time.

Soft Loading

The load command discrete input contact controls soft loading. If the load command discrete input is closed when the breaker (CB AUX) input contact closes, the generator will soft load to the reference level of the mode selected (load sharing or base load). If the load command discrete input is open (unload) when the breaker (CB AUX) closes, the generator will immediately load to the Unload Trip Level set in the KW Setting menu. When the load command discrete input is closed, the generator will soft load to the reference level of the mode selected (load sharing or base load). The ramp rate is adjustable. If configured, a 2nd ramp rate can be selected by discrete input D.

Soft Unloading and Open Generator Breaker Relay Output

If the load command discrete input contact is opened (unload) while the breaker (CB AUX) input contact is closed, the generator will soft unload from the present load level to the unload trip level. Once the generator load has reached the unload trip level or the reference has been there for 5 seconds, the Open Gen Breaker relay output will open for 1 second (tunable). The load command discrete input must be maintained OPEN to complete the unload sequence.

IMPORTANT

The Load Command discrete input must be maintained logic to operate the Soft Loading/Unloading sequence. The input must be OPEN to complete the Unload sequence and disconnect the generator. The input must be CLOSED to complete the Load sequence and operate the generator in Isochronous Load Sharing or Base Load operating mode.

CB AUX	Base Load	Load Gen	Lower Spd/Ld	Raise Spd/Ld	Operation of Load Control
F	X	X	X	X	Droop
F	X	X	T	F	Droop lower load
F	X	X	F	T	Droop raise load
F	X	X	T	T	Droop remote load ref
T	F	T	X	X	Isochronous load sharing
T	T	T	X	X	Base Load
T	T	T	F	F	Base Load ref will ramp to Internal Base Load Reference
T	T	T	F	T	Base Load ref will ramp toward Rated Load
T	T	T	T	F	Base Load ref will ramp toward the Unload Trip Level
T	T	T	T	T	Base Load ref will ramp to value of Remote Load Setpoint
T	X	F	X	X	Base Load control at the Unload Trip Level
T	X	T-F	X	X	Load will ramp to Unload Trip Level and Open Gen Breaker
Legend: F=False, T=True, X=Don't Care					

Table 5-1. Description of Discrete Inputs While in Load Control

Droop Function

The droop function is included on this control to provide conventional droop and also to provide another way for backup control in the event of a kW sensor failure. Bumpless transfer from normal load control to droop load control and from droop load control to normal load control can be configured. Load sharing and load control operations are not functional while in droop. The speed reference must be changed to increase or decrease the generator load while in droop. See Table 5-2 for a functional description of the speed reference while in droop. The base load and the load discrete inputs have no effect while operating in the droop mode. The CB Aux contact switches between load control and droop operation if the kW sensor value at signal input #1 is valid. If the kW sensor fails, the control will operate in fuel demand droop.

The droop function supplies a feedback path to bias the speed reference. The function of droop is to decrease the speed reference as the load increases. This is done by negatively biasing the output of the speed reference with the droop function. The CB Aux discrete input contact is used to switch the droop function on and off. When the discrete input is false, the droop function biases the speed reference, and the load bias is zero. When the discrete input is true, the droop bias is zero, and the load function biases the speed reference. The droop function can be permanently enabled by leaving the CB Aux contact discrete input false. A complete discussion of droop operation is included in the Power System Management Concepts section.

There are two types of droop feedback which occur within this control. The primary feedback is from kW load provided by the kW sensor. The secondary feedback is based on kW load scaled from the fuel demand. The droop feedback from the fuel demand is used when the kW sensor is failed and/or not reset. The fuel demand droop feedback uses the difference between the Fuel Demand @Min Ld and Fuel Demand @ Max Ld items in the KW Setting menu to determine the kW load. The kW sensor droop feedback is based on the Rated Load item in the KW Setting menu and the KW Sensor @ 4 mA and 20 mA load settings in the Set Analog Inputs menu.

CB AUX CLOSED	KW SENSOR FAILED	# USE FD DROOP ONLY	#USE FD ISOCH	MODE
F	F	F	X	KW DROOP
F	F	T	X	FD DROOP
F	T	X	X	FD DROOP
T	F	X	X	KW ISOCH
T	T	X	F	FD DROOP
T	T	X	T	FD ISOCH
Legend: F=False, T=True, X=Don’t Care				

Table 5-2. Droop/Isoch Mode Selection

Power System Management Concepts

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

Paralleling

There are two basic methods used for paralleling: droop, where speed decreases with load increase, and isochronous, where speed remains constant with load increase. The paralleling system shown in Figure 5-7 consists of a load matching circuit (1), a load scaling circuit (2), and a kW transducer (3).

An auxiliary contact on the generator breaker connected to terminal 29 is used to select isochronous load control operation. A contact in series with the auxiliary contact may be used to select either the droop or isochronous mode of operation.

When the input to the CB Aux contact is open, the control is in droop. When the CB Aux contact is closed, the control is in isochronous load control.

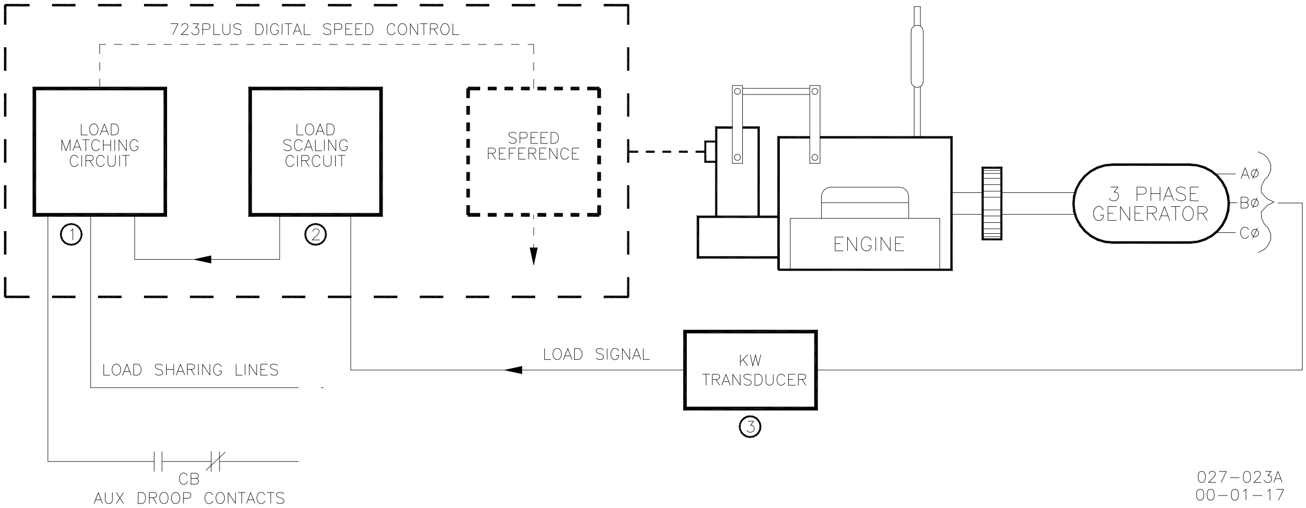


Figure 5-7. Paralleling System

With only one unit on line, the generator picks up the available load and remains at isochronous speed. If other units are on line and the load command discrete input is open, the load will immediately load to the Unload Trip Level setting. When the Load contact connected to terminal 31 is closed the load matching circuit corrects the fuel output to proportion load.

An amplifier in the kW transducer computes the load carried by each phase of the generator. The current load on each phase is multiplied by the cosine of the phase difference between the current and the voltage, and the three phases are added to determine the total load.

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

When the Baseload contact connected to terminal 30 is closed proportional load sharing is terminated and the load is ramped either up or down to the baseload reference setting.

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

Droop Mode

Droop is a decrease in speed or frequency, proportional to load. That is, as the load increases, the speed or frequency decreases, as illustrated in Figure 5-8. This reduction in speed is accomplished with negative feedback. The feedback increases as the system is loaded.

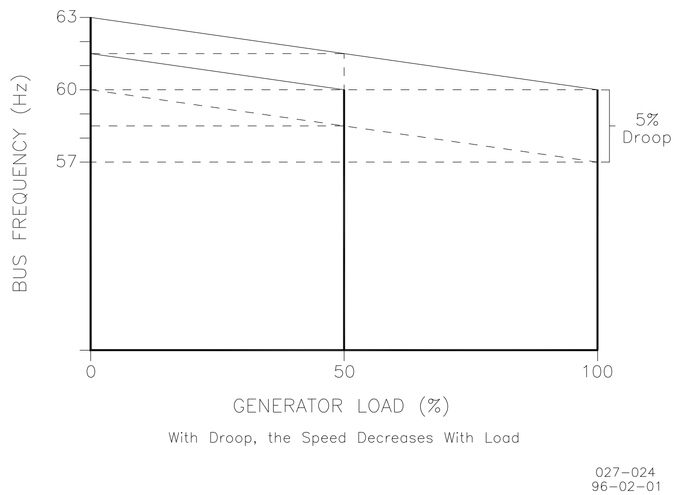


Figure 5-8. Droop Mode

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

Isochronous Mode

Isochronous means repeating at a single rate or having a fixed frequency or period. A generator set operating in the isochronous mode will operate at the same set frequency regardless of the load it is supplying, up to the full load capability of the generator set (see Figure 5-9). This mode can be used on one generator set running by itself in an isolated system.

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

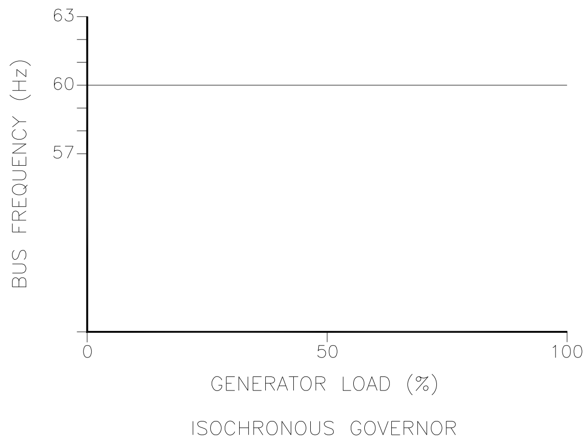


Figure 5-9. Isochronous Mode

Droop/Isochronous Load Sharing on an Isolated Bus

Droop/isochronous load sharing combines the first two modes. All generator sets in the system except one are operated in the droop mode. The one unit not in droop is operated in the isochronous mode. It is known as the swing machine. In this mode, the droop machines will run at the frequency of the isochronous unit. The droop and speed settings of each droop unit are adjusted so that each generates a fixed amount of power (see Figure 5-10). The output power of the swing machine will change to follow changes in the load demand. Maximum load for this type of system is limited to the combined output of the swing machine and the total set power of the droop machines. The minimum system load cannot be allowed to decrease below the output set for the droop machines. If it does, the system frequency will change, and the swing machine can be motored. The machine with the highest output capacity should be operated as the swing machine, so that the system will accept the largest load changes within its capacity.

Isochronous Load Sharing on an Isolated Bus

Isochronous load sharing operates all generator sets in a system in the isochronous mode. Load sharing is accomplished by adding a load sensor to each electric isochronous governor. The load sensors are interconnected by the load sharing lines. Any imbalance in load between units will cause a change to the regulating circuit in each governor. While each unit continues to run at isochronous speed, these changes force each machine to supply a proportional share of power to meet the total load demand on the system (see Figure 5-11).

Base Load on an Isolated Bus

Base Load is a method of setting a base or fixed load on a machine operating in parallel with an isolated bus. This is accomplished by using an isochronous load control and providing a reference at which to control the load. The governor will force the generator output to increase or decrease until the output of the load sensor is equal to the reference setting. At this point, the system is in balance. This method can only be used where other generator sets are producing enough power to meet the changes in load demand. This operating mode is ideal for either soft loading additional units into an isochronous system, or for derating or unloading a machine (see Figure 5-12).

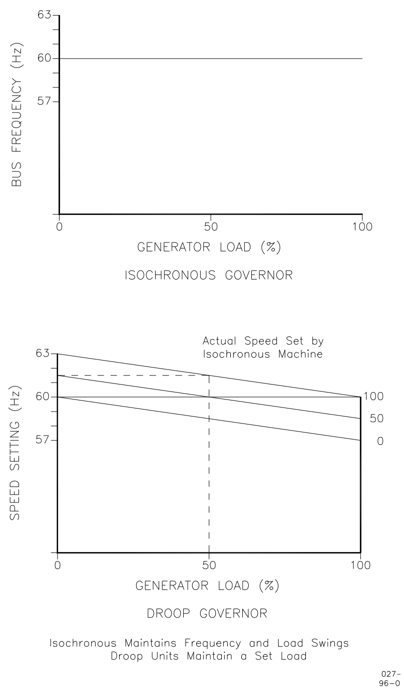


Figure 5-10. Droop/Isochronous Load Sharing

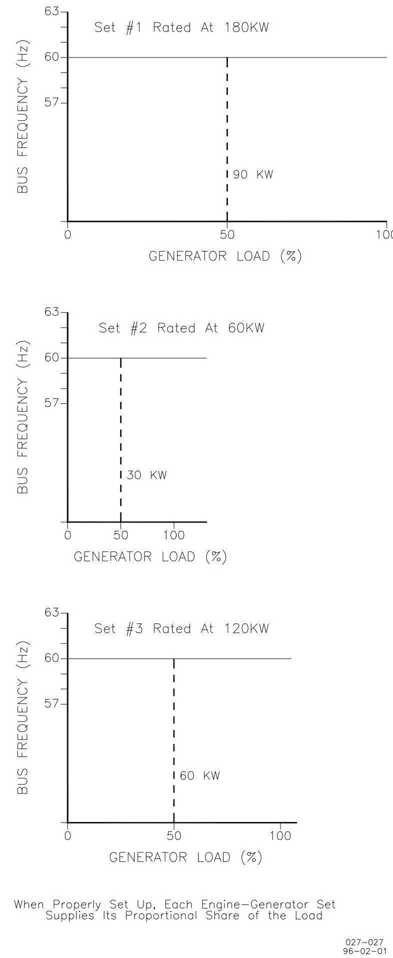


Figure 5-11. Isochronous Load Sharing

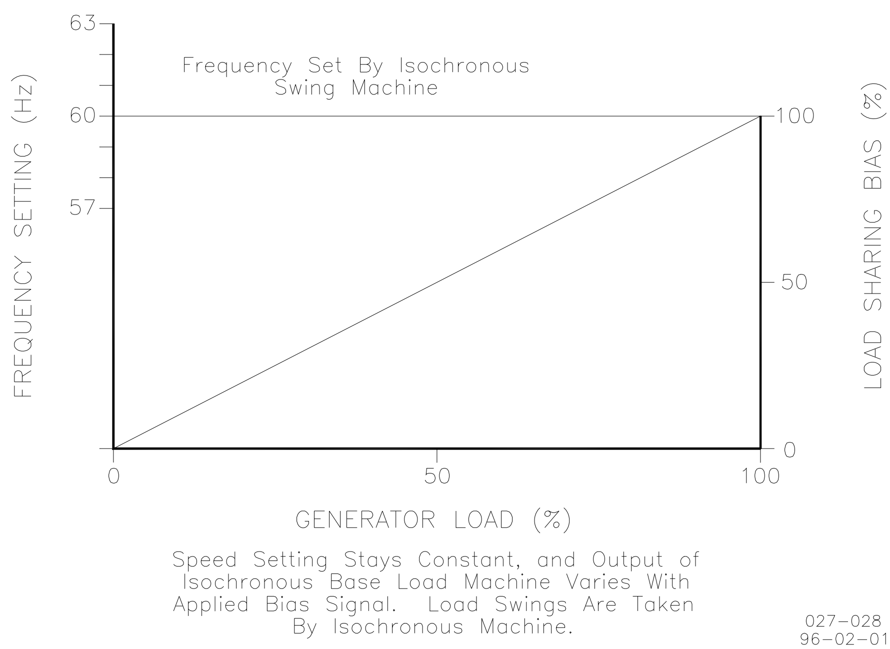


Figure 5-12. Isochronous Base Load on an Isolated Bus

Base Load

Base Load for a system paralleled to an infinite bus or utility is the same as base load in an isolated system. The advantage of base loading over droop is that when separating from a utility, there is no frequency change. Simply removing the bias signal on breaking from the utility returns the system to isochronous.

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). 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 on 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 “5413-917” (or “5414-726” for low speed controls) 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.

KW Sensor Input

Perform the following steps to calibrate and test Analog 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 1.0 Vdc (4.0 mA) on the meter. Select DISPLAY ANALOG I/O on the Hand Held Programmer or Watch Window. Select AI1-KW INPUT.

3. The AI1-KW INPUT value should be equal to the input value. If it isn’t, adjust I/O CALIBRATION - KW IN OFFSET(AI1) until they are about equal.

4. Set the source for 5.0 Vdc (20.0 mA) on the meter.

5. The AI1-KW INPUT value should be equal to the input value. If it isn’t, adjust I/O CALIBRATION - KW IN SPAN(AI1) until they are about equal.

6. Repeat steps 2–5 until no further adjustments are required.

Synchronizer Input

Perform the following steps to calibrate and test Analog Input 2.

1. Connect a –5 to +5 Vdc source to terminals 45(+) and 46(–).Verify that no jumper is installed across terminals 44 and 45. Connect a dc voltmeter across terminals 45(+) and 46(–).

2. Set the source for 0.0 Vdc on the meter. Select DISPLAY ANALOG I/O on the Hand Held Programmer or Watch Window. Select AI2-SYNCH INPUT.

3. The AI2-SYNCH INPUT value should be equal to the input value. If it isn't, adjust I/O CALIBRATION - SYNC OFFSET(AI2) until they are about equal.

4. Set the source for +3.0 Vdc on the meter.

5. The AI2-SYNCH INPUT value should be equal to the input value within 0.2 Vdc.

6. Set the source for -3.0 Vdc on the meter.

7. The AI2-SYNCH INPUT value should be equal to the input value within 0.2 Vdc.

Remote Input

Perform the following steps to calibrate and test Analog 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 1.0 Vdc (4.0 mA) on the meter. Select DISPLAY ANALOG I/O on the Hand Held Programmer or Watch Window. Select AI3-REMOTE IN.

3. The AI3-REMOTE IN value should be equal to the input value. If it isn't, adjust I/O CALIBRATION - REM IN OFFSET(AI3) until they are about equal.

4. Set the source for 5.0 Vdc (20.0 mA) on the meter.

5. The AI3-REMOTE IN value should be equal to the input value. If it isn't, adjust I/O CALIBRATION - REM IN SPAN(AI3) until they are about equal.

6. Repeat steps 2—5 until no adjustments are required.

External Limiter Input

Perform the following steps to calibrate and test Analog 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 1.0 Vdc (4.0 mA) on the meter. Select DISPLAY ANALOG I/O on the Hand Held Programmer or Watch Window. Select AI4-EXT FUEL LIMIT.

3. The AI4-EXT FUEL LIMIT value should be equal to the input value. If it isn't, adjust I/O CALIBRATION - EXT LMT OFFSET(AI4) until they are about equal.

4. Set the source for 5.0 Vdc (20.0 mA) on the meter.

5. The AI4-EXT FUEL LIMIT value should be equal to the input value. If it isn’t, adjust I/O CALIBRATION - EXT LIMIT SPAN(AI4) until they are about equal.

6. Repeat steps 2—5 until no adjustments are required.

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.

2. Set the signal generator to 400 Hz. Read DISPLAY ANALOG I/O - SPD SENS IN#1 (HZ) value of 400 Hz. Increase the signal generator frequency to 2000 Hz. The value read should follow the signal generator frequency.

3. Repeat steps 1–2 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 the connection is removed.

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

Chapter 7. Product Support and Service Options

Product Support Options

If you are experiencing problems with the installation, or unsatisfactory performance of a Woodward product, the following options are available:
1. Consult the troubleshooting guide in the manual.
2. Contact the **OE Manufacturer or Packager** of your system.
3. Contact the **Woodward Business Partner** serving your area.
4. Contact Woodward technical assistance via email (**EngineHelpDesk@Woodward.com**) 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).

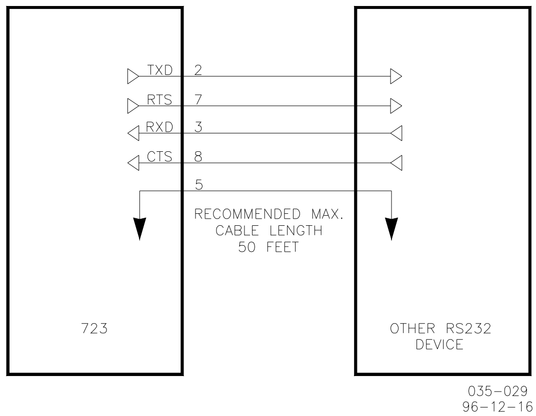


Figure A-1. 723PLUS RS-232 Connections

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).

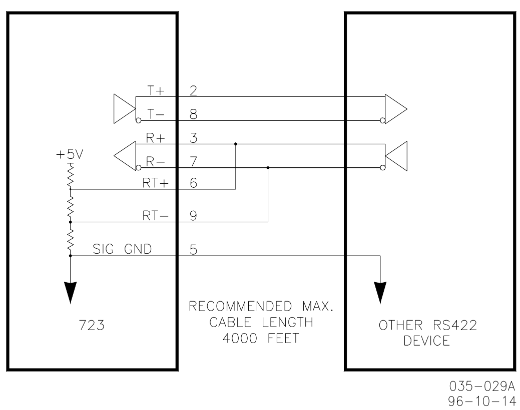


Figure A-2. 723PLUS RS-422 Connections with Optional Termination at Receiver

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).

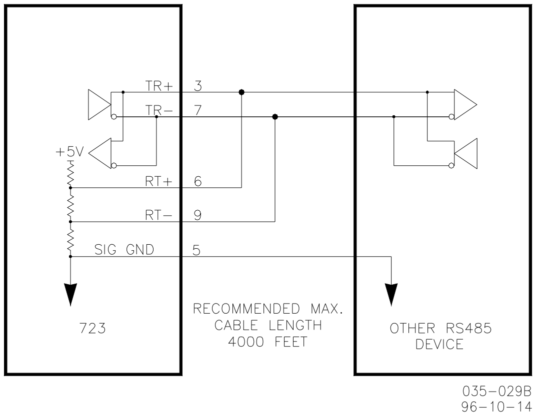


Figure A-3. 723PLUS RS-485 Connections with Optional Termination

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.

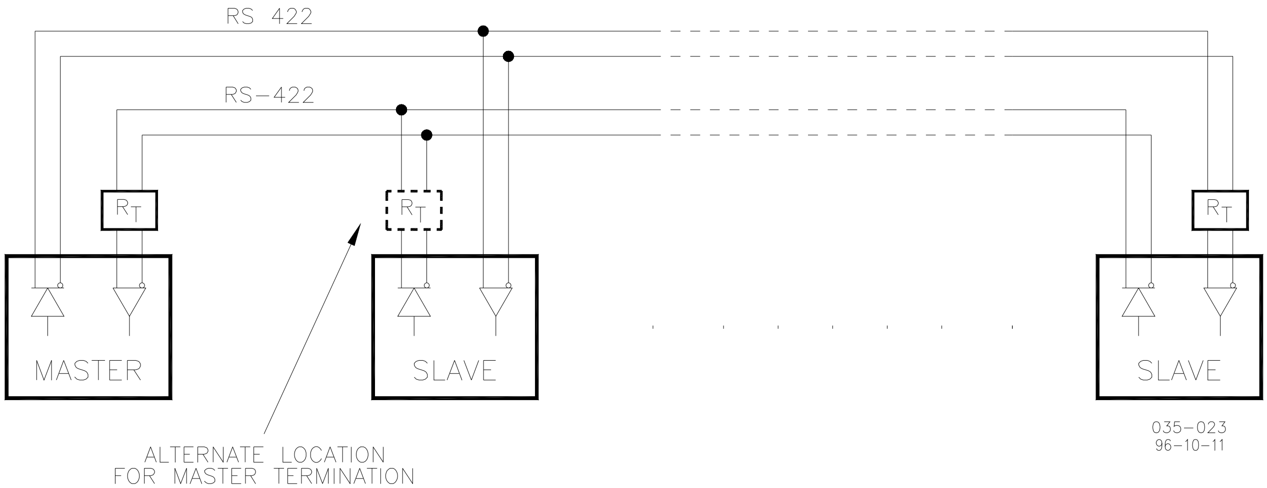


Figure A-4. RS-422 Terminator Locations

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.**

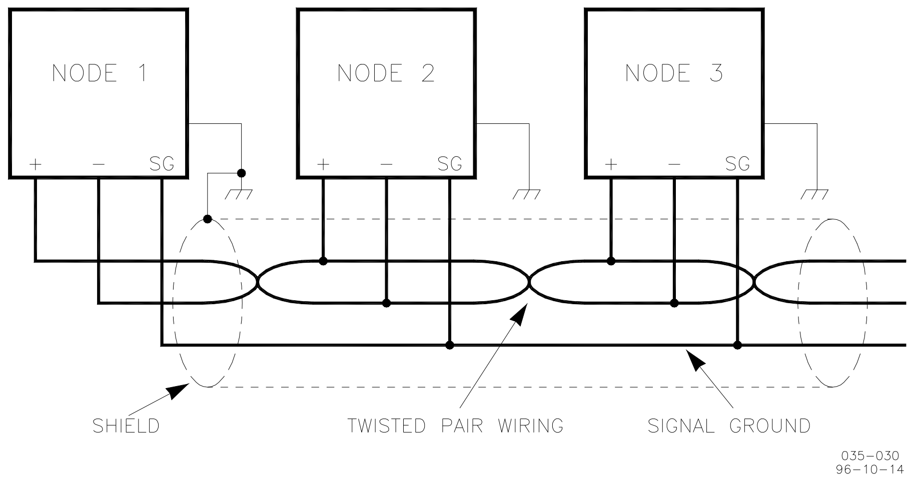


Figure A-5. Preferred Multipoint Wiring Using Shielded Twisted-pair Cable with a Separate Signal Ground Wire

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

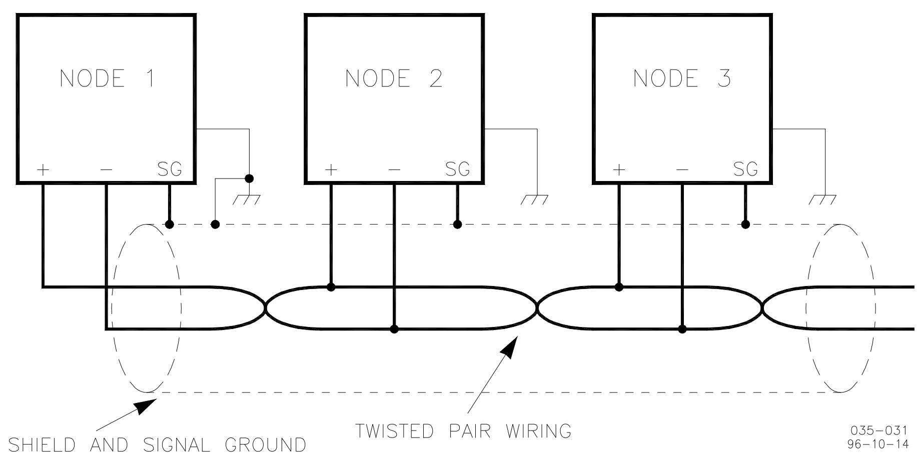


Figure A-6. Alternate Multipoint Wiring Using Shielded Twisted-pair Cable without a Separate Signal Ground Wire

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 9 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

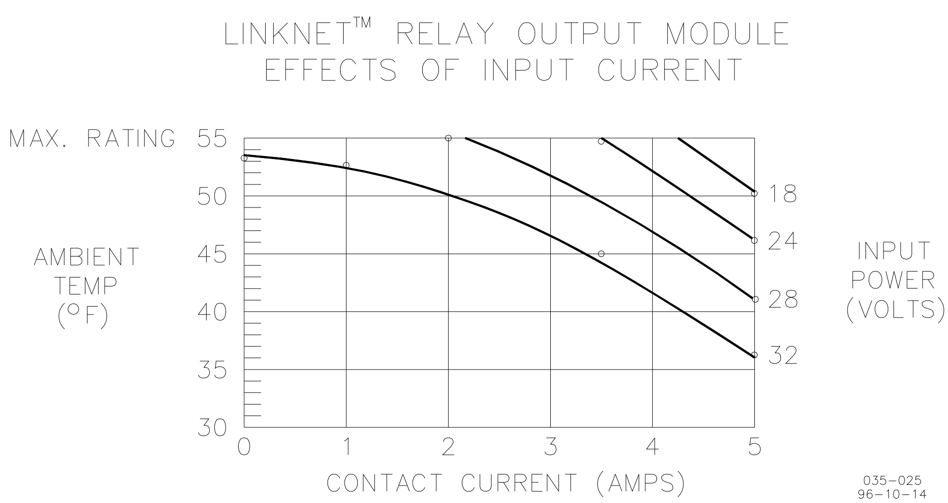


Figure B-1. LinkNet Relay Contacts

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.

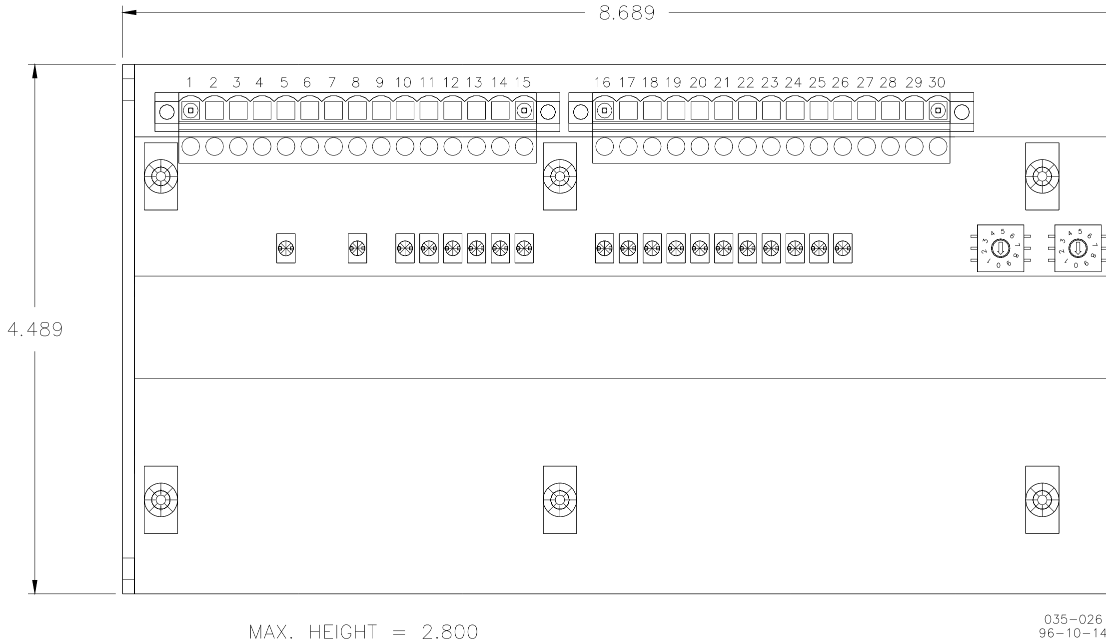


Figure B-2. Outline Drawing of I/O Module

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.

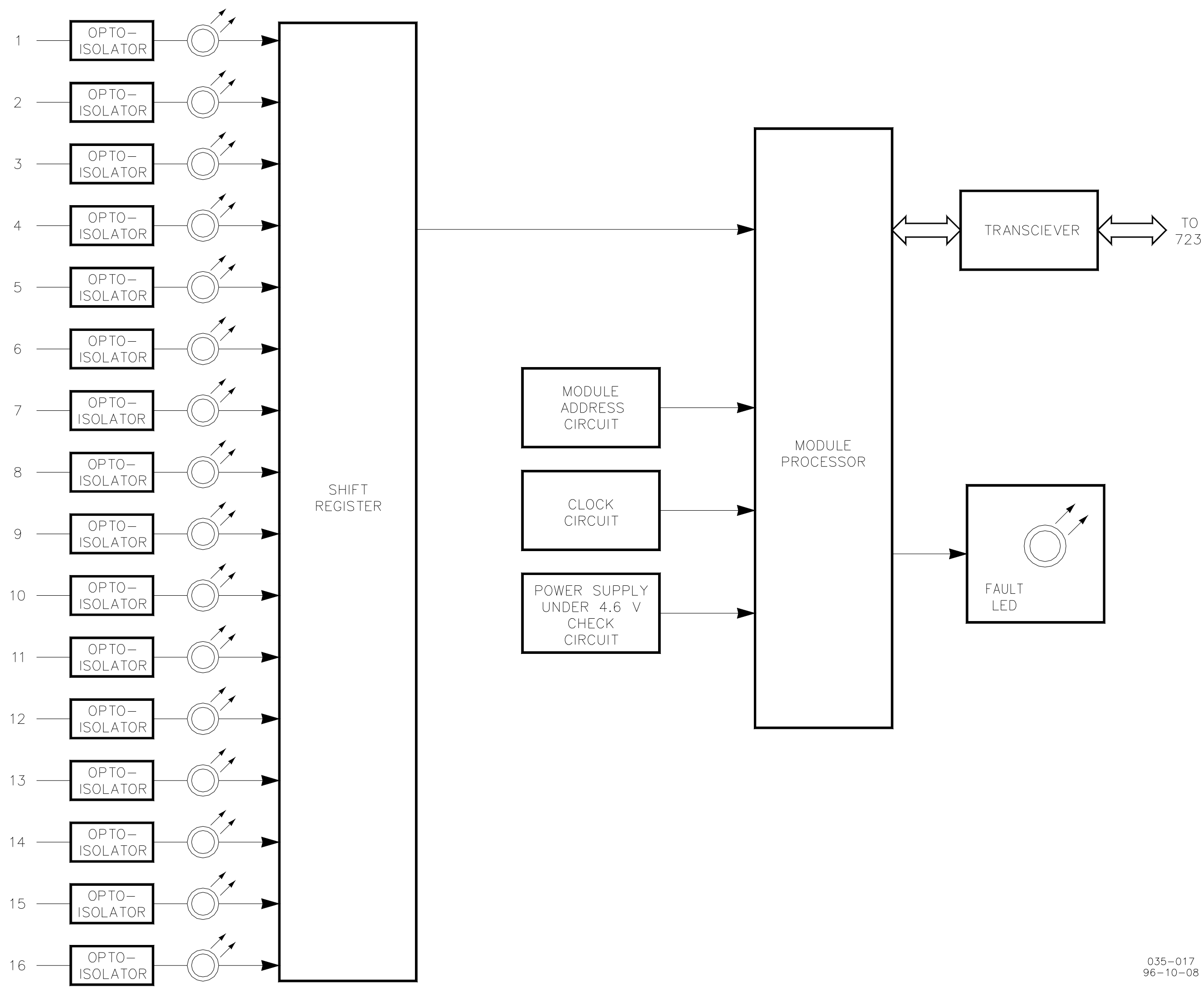


Figure B-3. Discrete Input Module Block Diagram

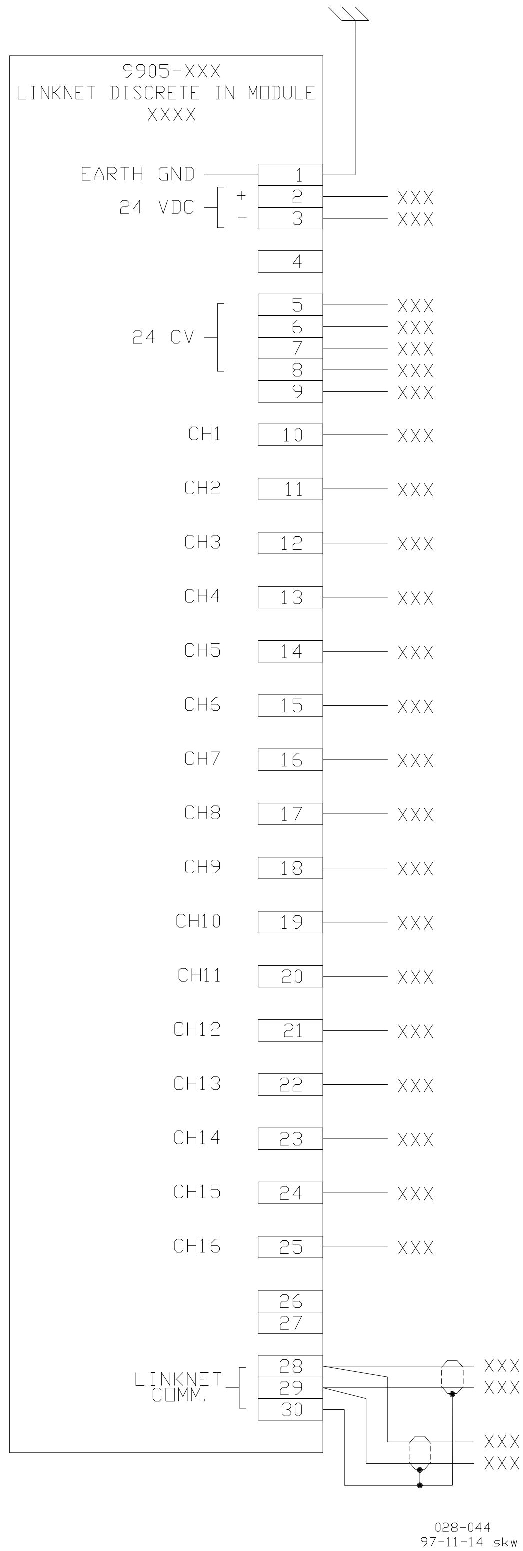


Figure B-4. Discrete Input Module Wiring Diagram

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.

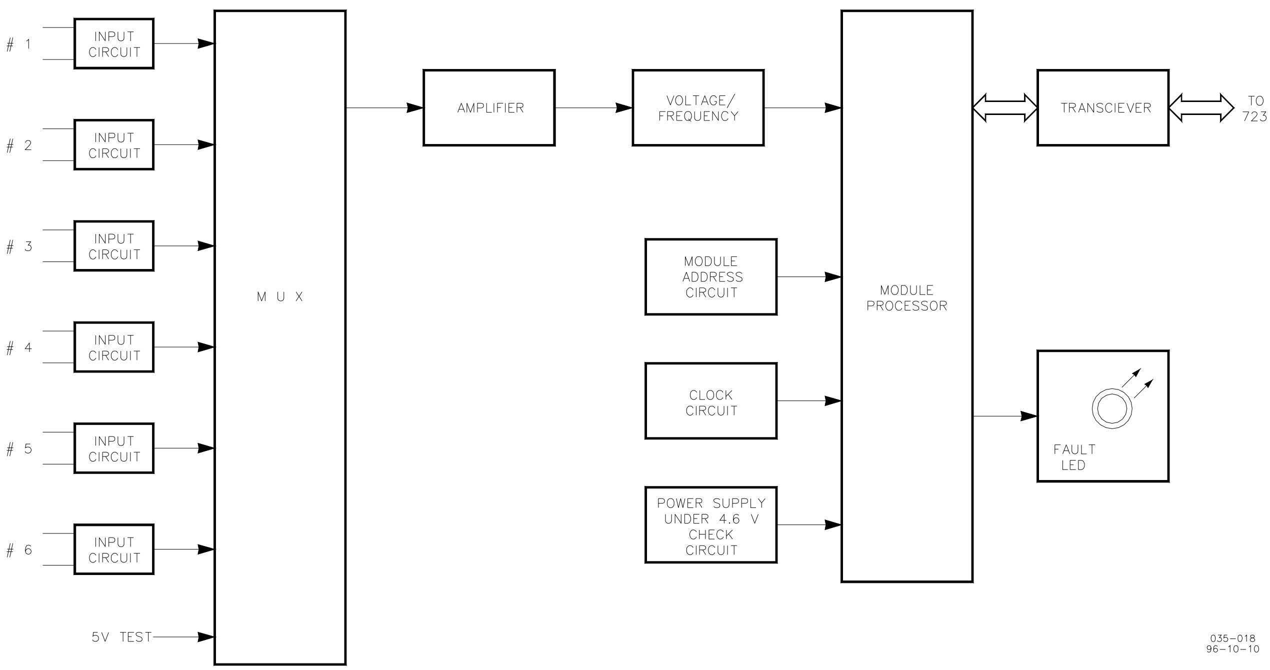


Figure B-5. 4–20 mA Input Module Block Diagram

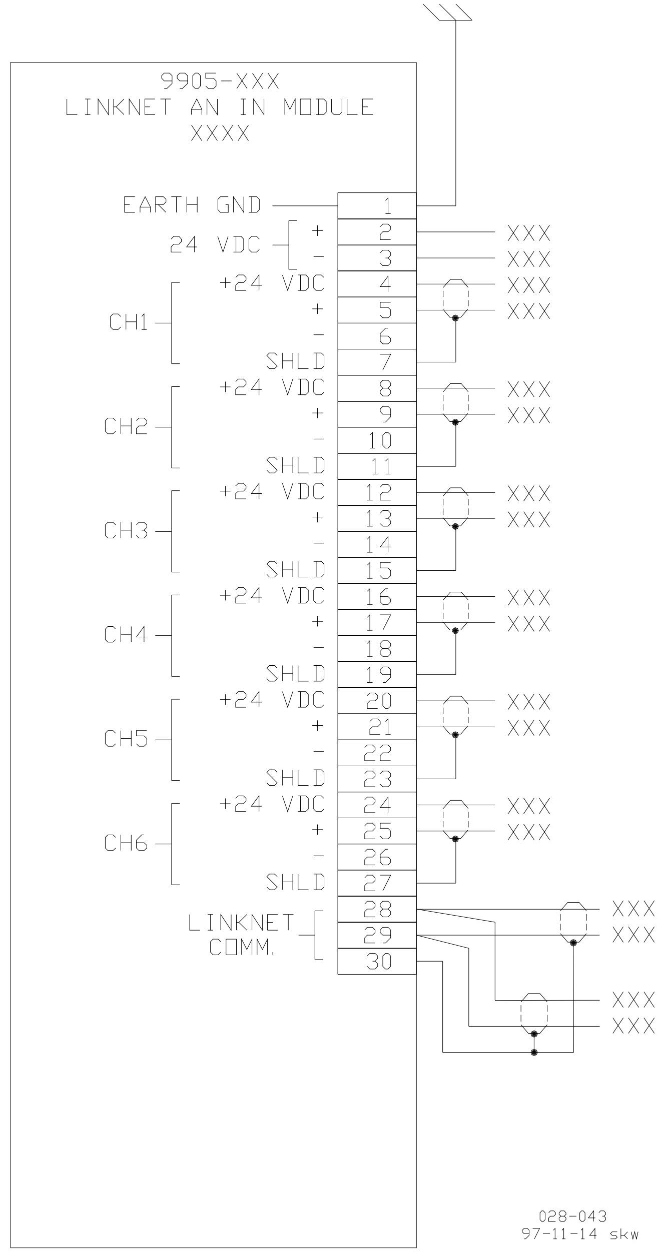


Figure B-6. 4–20 mA Input Module Wiring Diagram

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.

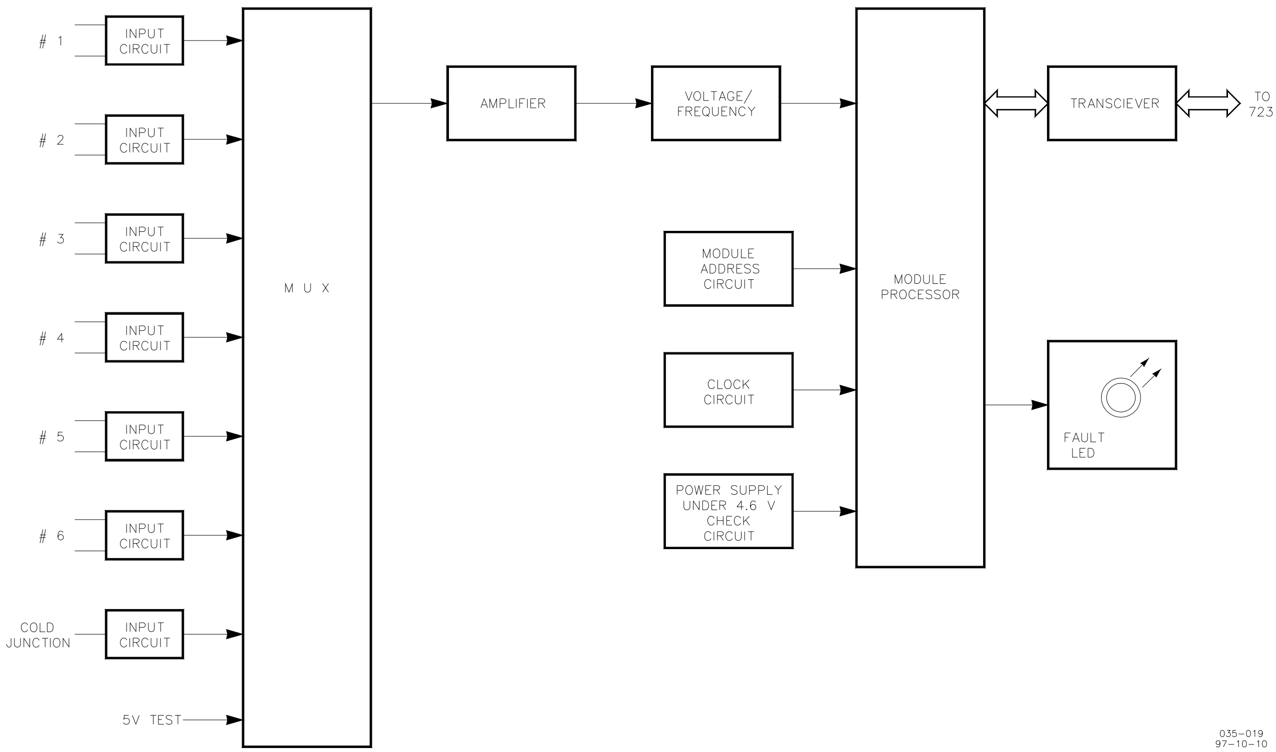


Figure B-7. Thermocouple Input Module Block Diagram

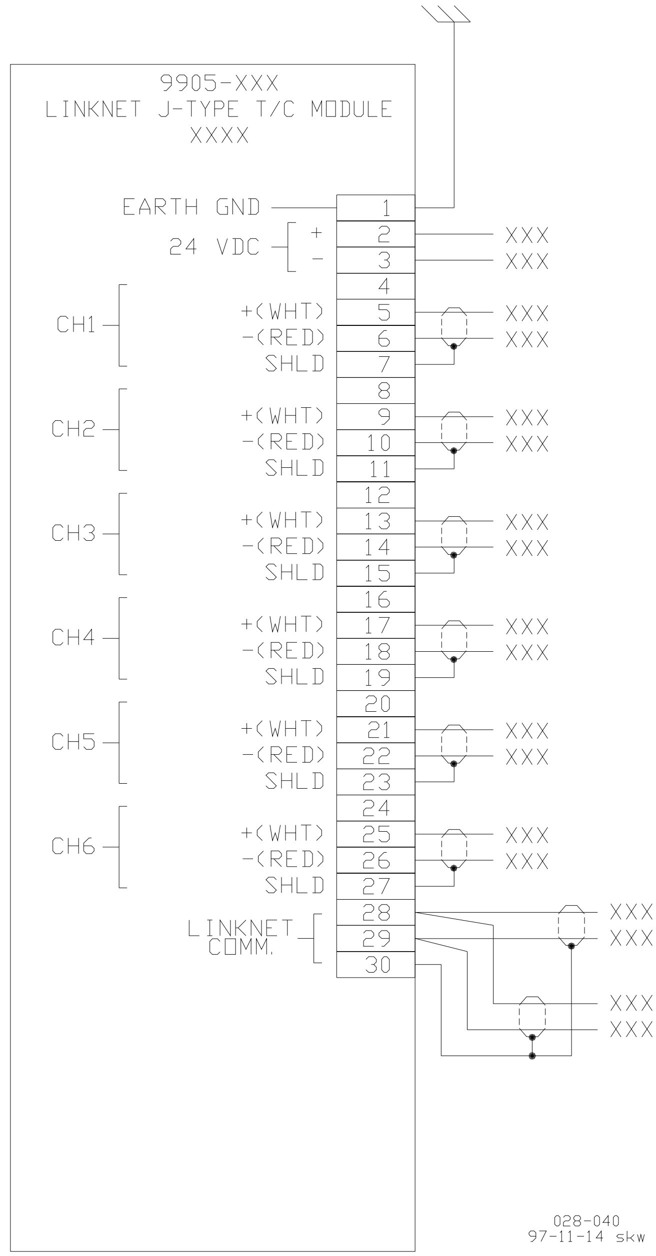


Figure B-8. Thermocouple Input Module Wiring Diagram

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 Ω, 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.

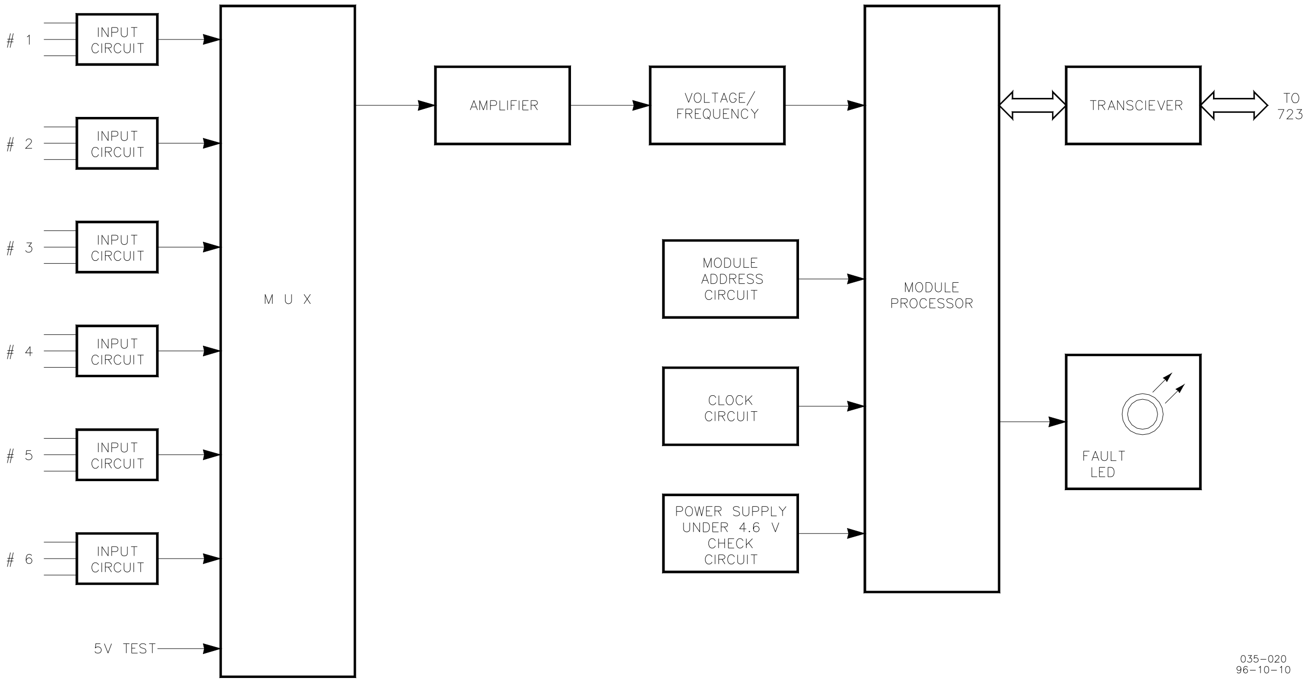


Figure B-9. RTD Input Module Block Diagram

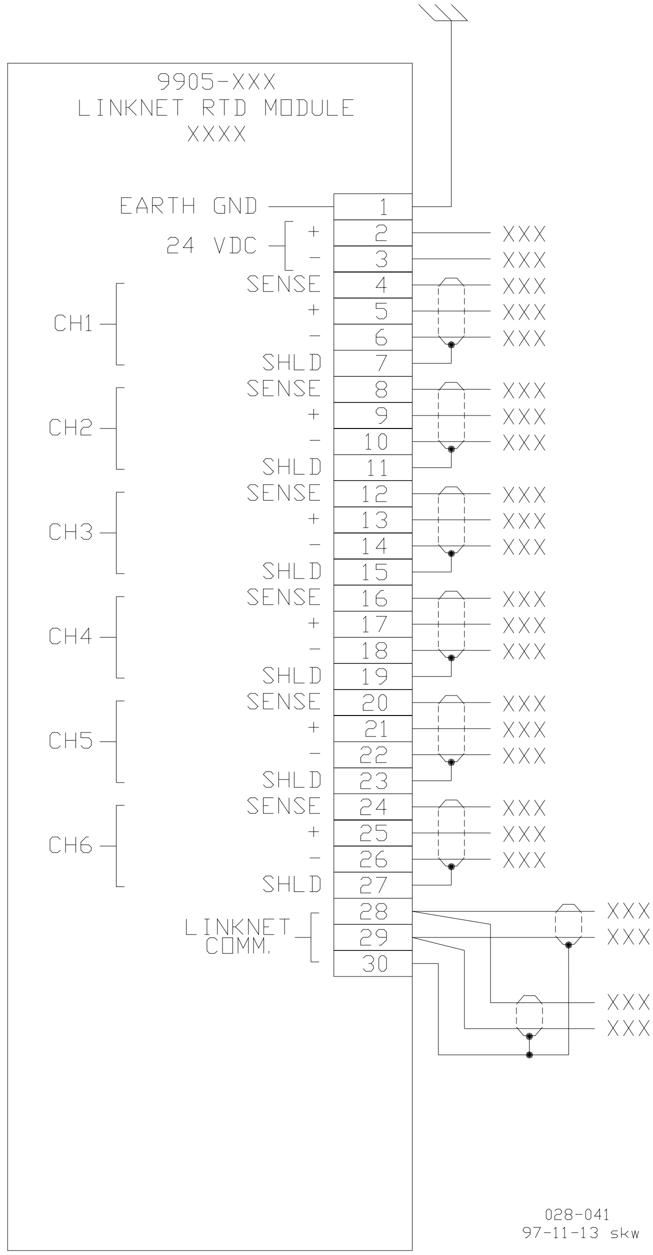


Figure B-10. RTD Input Module Wiring Diagram

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.

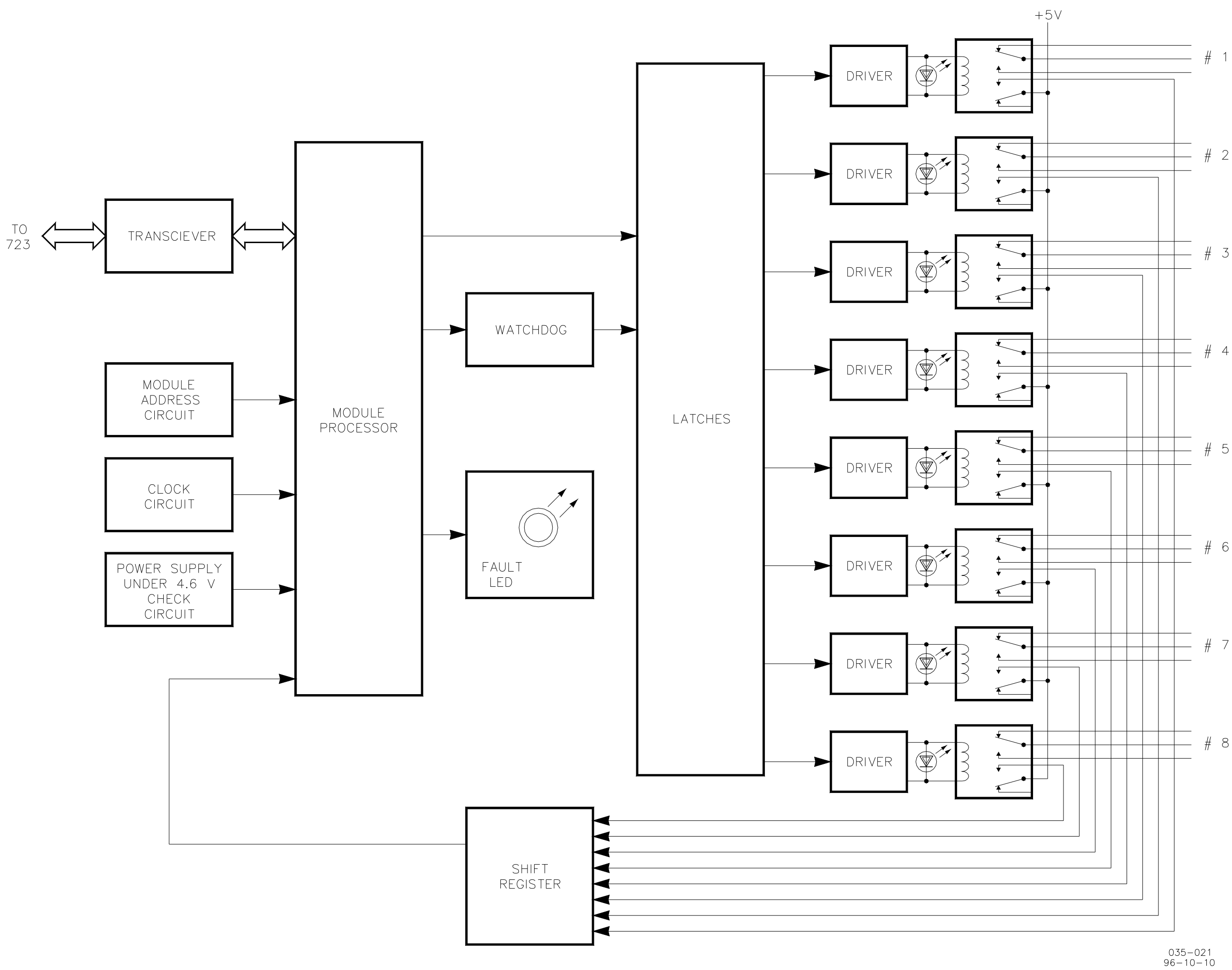


Figure B-11. Relay Output Module Block Diagram

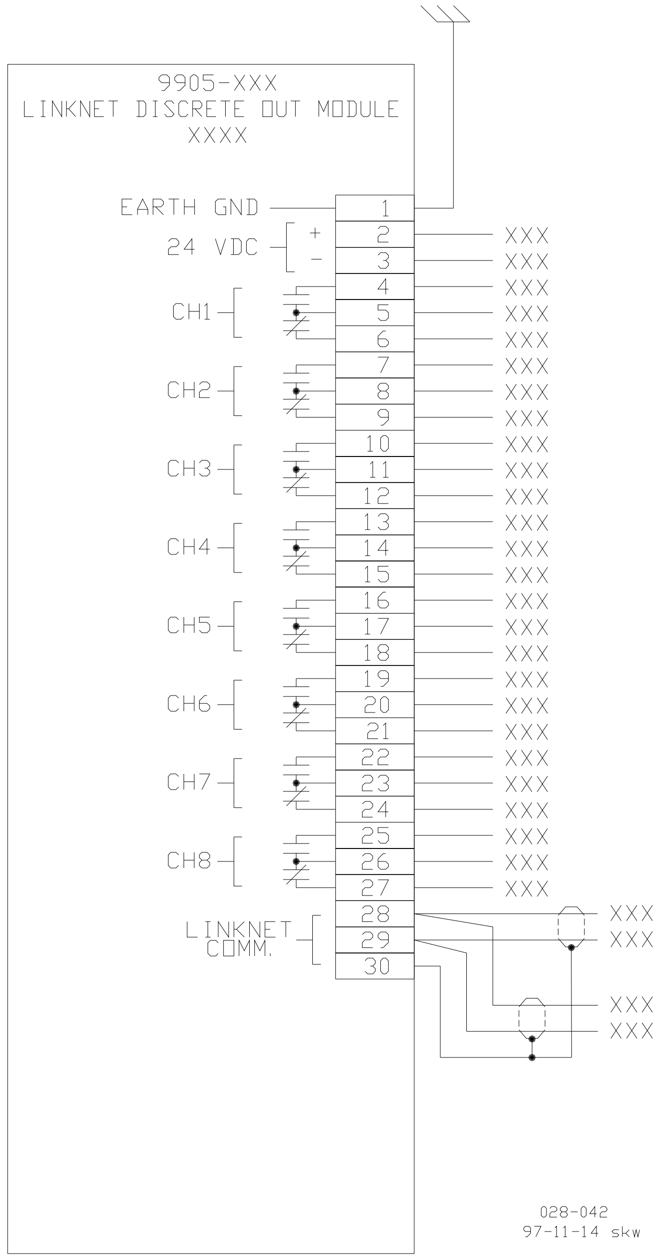


Figure B-12. Relay Output Module Wiring Diagram

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.

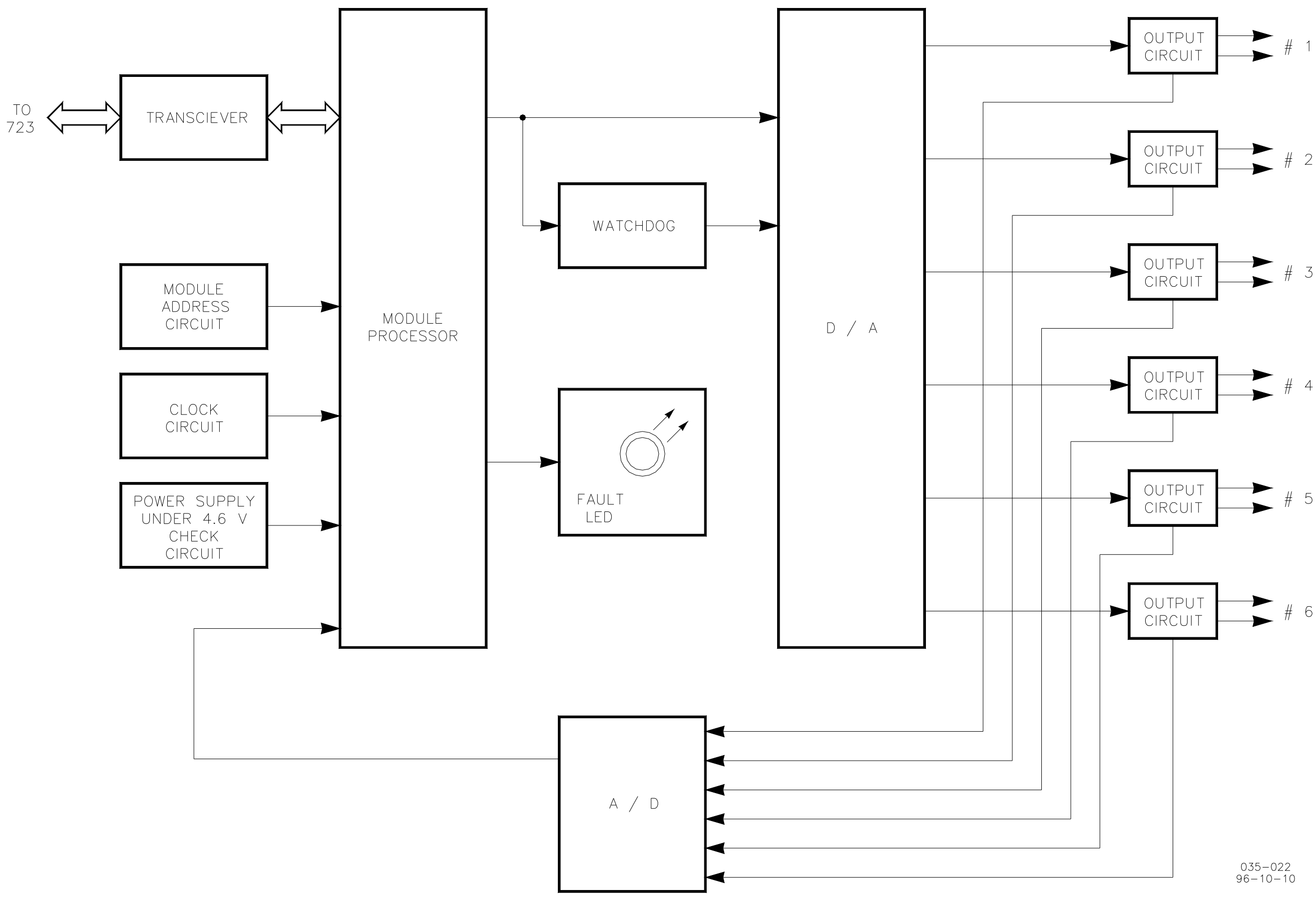


Figure B-13. 4–20 mA Output Module Block Diagram

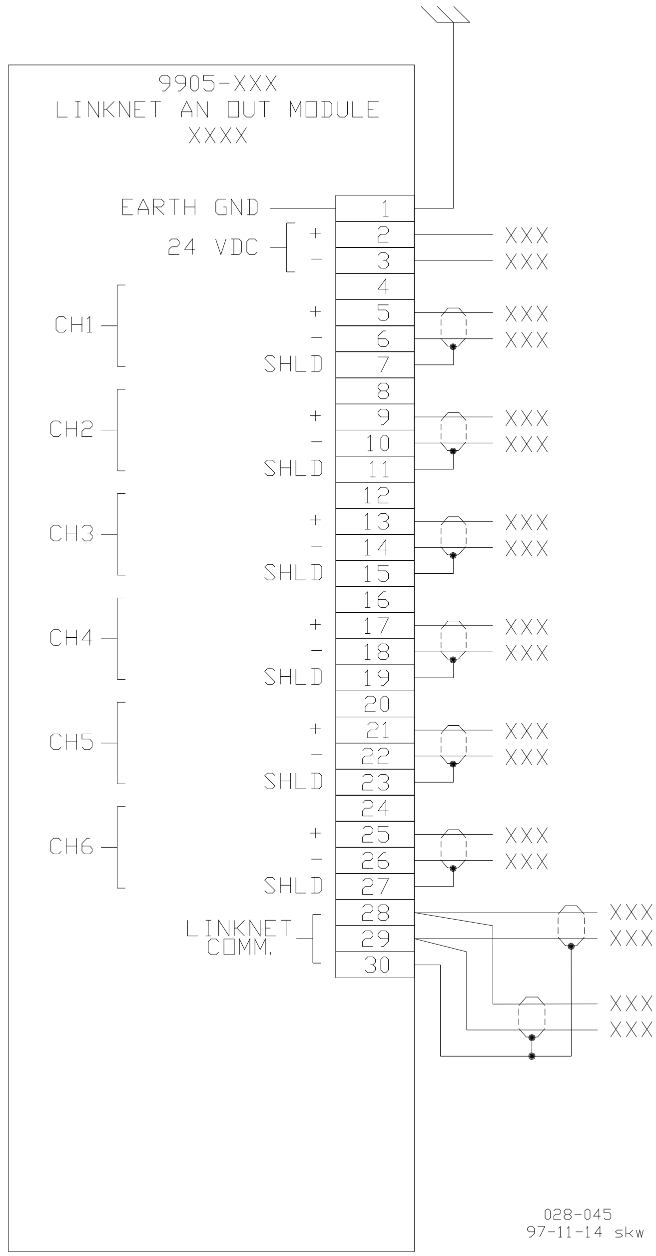


Figure B-14. 4–20 mA Output Module Wiring Diagram

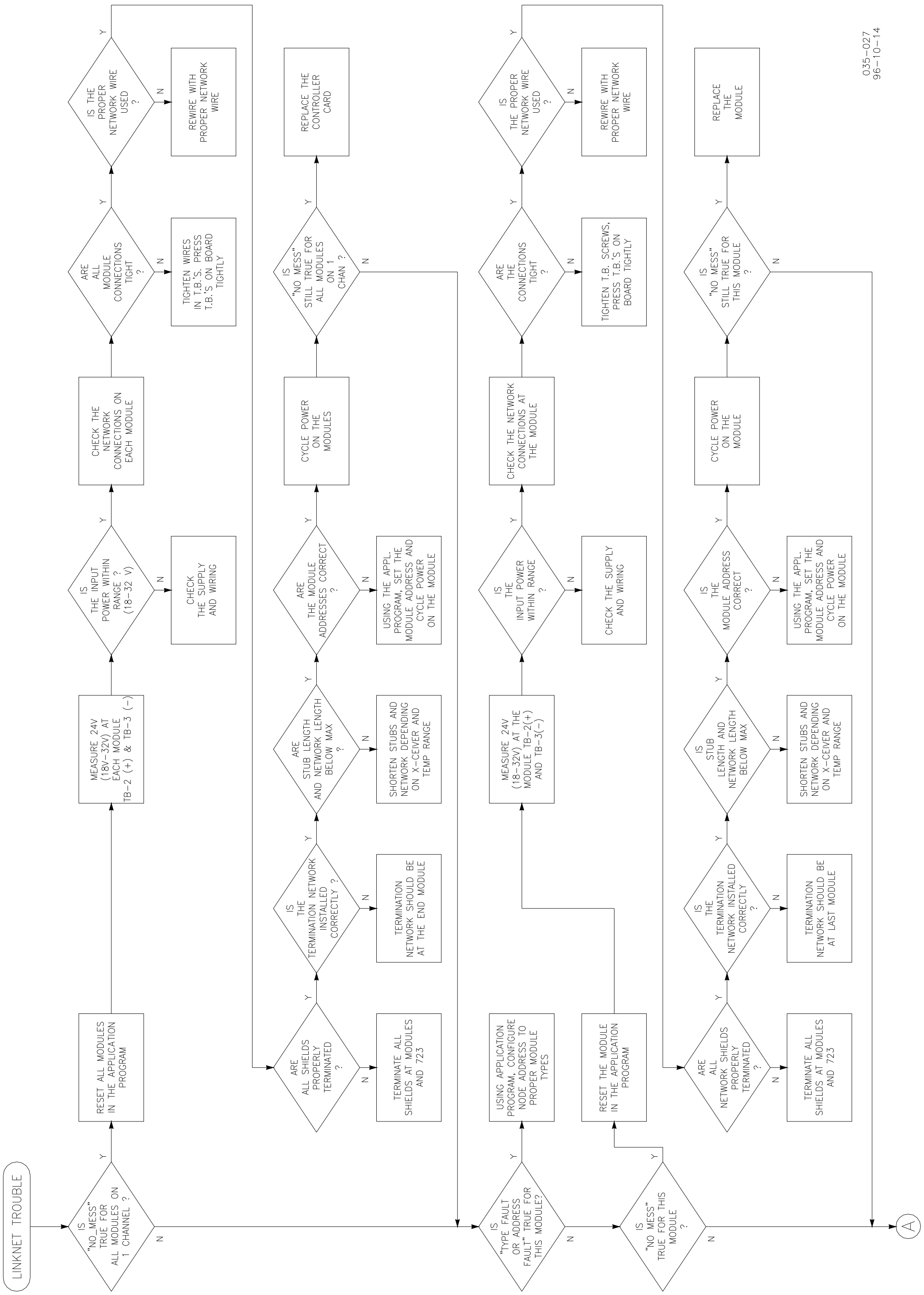


Figure B-15a. Troubleshooting Flowchart (1 of 2)

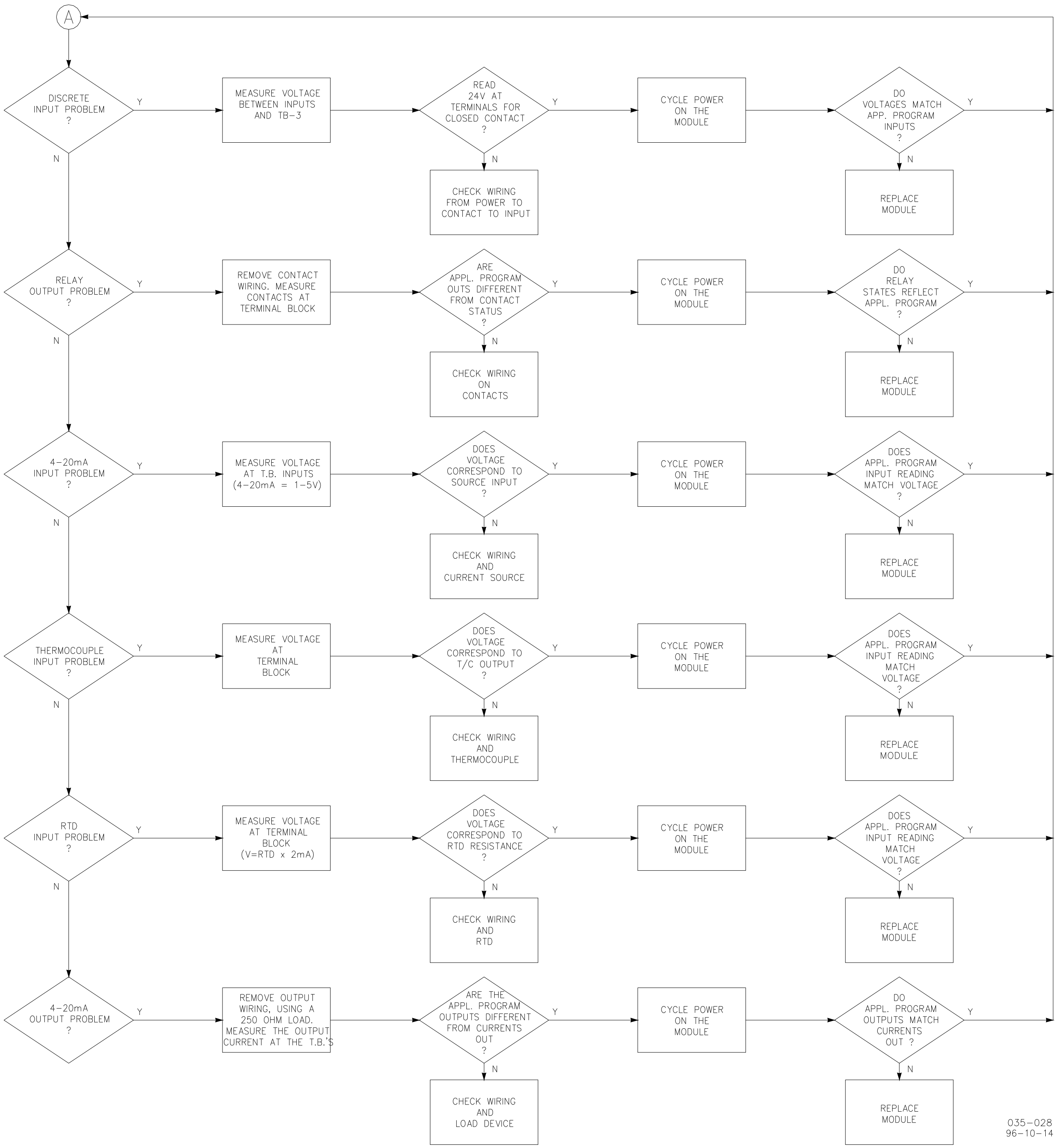


Figure B-15b. Troubleshooting Flowchart (2 of 2)

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 v 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

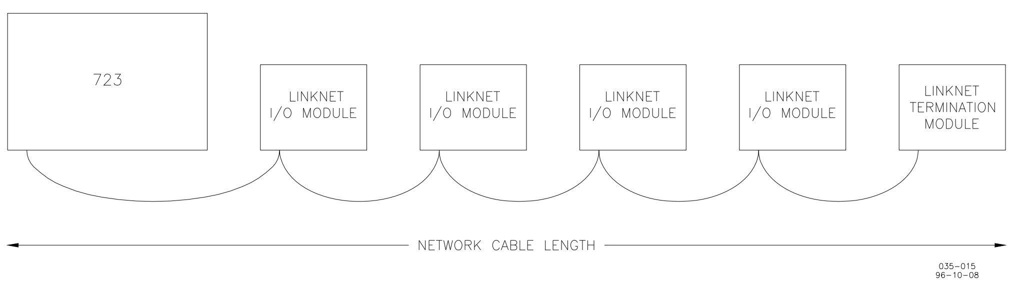


Figure B-16. Direct Wired Network

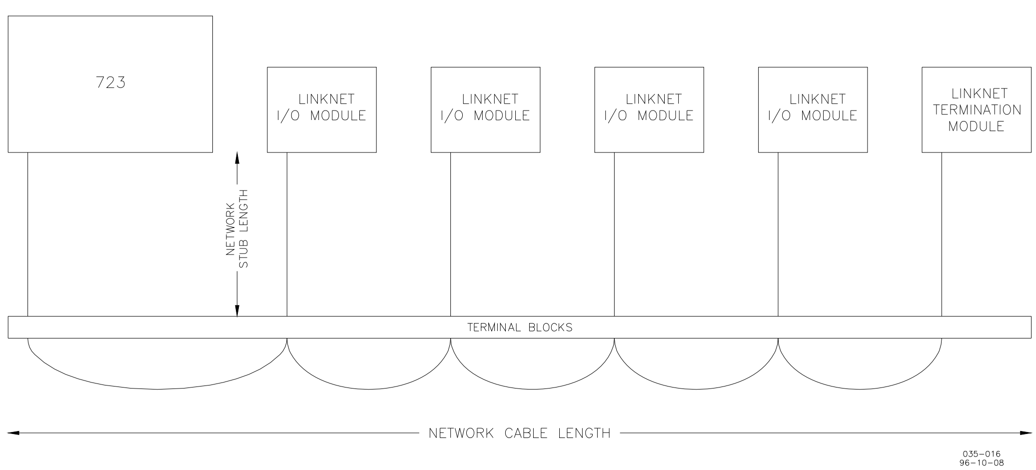


Figure B-17. Network Wired Via Stubs

Appendix C. Modbus Slave Address Information

Part Numbers 8280-414/-415/-480/-481

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 CIRCUIT BREAKER AUX REMOTE COMMAND
0:0012	USE BASELOAD REMOTE COMMAND
0:0013	USE LOAD REMOTE COMMAND
0:0014	USE SECOND DYNAMICS REMOTE COMMAND
0:0015	USE RAISE SPEED/LOAD REMOTE COMMAND
0:0016	USE LOWER SPEED/LOAD 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 CIRCUIT BREAKER AUXILIARY
0:0022	723 COMMAND CLOSE FOR BASELOAD
0:0023	723 COMMAND CLOSE TO LOAD GENERATOR
0:0024	723 COMMAND CLOSE FOR SECOND DYNAMICS
0:0025	723 COMMAND CLOSE FOR RAISE SPEED/LOAD
0:0026	723 COMMAND CLOSE FOR LOWER SPEED/LOAD
0:0027	723 COMMAND CLOSE FOR RATED SPEED
0:0028	723 COMMAND CLOSE FOR 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

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 LOAD RAMP CONTACT
1:0006	C-LOAD GENERATOR CONTACT
1:0007	B-BASE LOAD CONTACT
1:0008	A-CB AUX CONTACT
1:0009	DO1-OPEN GEN BREAKER
1:0010	DO2-ALARM RELAY
1:0011	DO3-SHUTDOWN RELAY
1:0012	DO4-LOAD SHARE RELAY

1:0013	MPU 1 FAILED
1:0014	MPU 2 FAILED
1:0015	KW SENSOR INPUT FAILED
1:0016	
1:0017	REMOTE LOAD REF 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 #1AND#2 FAIL SHUTDOWN
1:0025	4-KW SENSOR FAIL SHUTDOWN
1:0026	5-REM LD SETPT FAIL SHUTDOWN
1:0027	6-EXT FUEL LIMIT FAIL SHUTDOWN
1:0028	7-MODBUS 3 FAIL SHUTDOWN
1:0029	8-HI FUEL DEMAND SHUTDOWN
1:0030	9-HI SPEED SHUTDOWN
1:0031	10-HIGH TORSIONAL LVL SHUTDOWN
1:0032	11-HIGH KW SHUTDOWN
1:0033	ON START FUEL LIMIT SHUTDOWN
1:0034	ON MAX FUEL LIMIT SHUTDOWN
1:0035	ON EXT FUEL LIMIT SHUTDOWN
1:0036	ON TORSIONAL FUEL LIMIT SHUTDOWN
1:0037	ACT SHUTDOWN
1:0038	SPEED SWITCH 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 #1 FAIL ALARM
1:0063	2-SPEED #2 FAIL ALARM
1:0064	3-SPD #1AND#2 FAIL ALARM
1:0065	4-KW SENSOR FAIL ALARM
1:0066	5-REM LD SETPT FAIL ALARM
1:0067	6-EXT FUEL LIMIT FAIL ALARM
1:0068	7-MODBUS 3 FAIL ALARM
1:0069	8-HI FUEL DEMAND ALARM
1:0070	9-HI SPEED ALARM
1:0071	10-HIGH TORSIONAL LVL ALARM
1:0072	11-HIGH KW ALARM
1:0073	ON START FUEL LIMIT ALARM
1:0074	ON MAX FUEL LIMIT ALARM
1:0075	ON EXT FUEL LIMIT ALARM
1:0076	ON TORSIONAL FUEL LIMIT ALARM
1:0077	ACT SHUTDOWN ALARM
1:0078	SPEED SWITCH 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	ON EXT FUEL LIMIT (LSS)
1:0105	ON TORSIONAL LIMIT (LSS)
1:0106	ACT SHUTDOWN (LSS)
1:0107	TORSIONAL FILTER ACTIVE
1:0108	SPEED SWITCH #1
1:0109	SPEED SWITCH #2
1:0110	PRIMARY SPEED INPUT ACTIVE
1:0111	STANDBY SPEED INPUT ACTIVE
1:0112	KW ISOCH LOAD CONTROL
1:0113	FUEL DEMAND ISOCH LOAD CONTROL
1:0114	KW DROOP CONTROL
1:0115	FD DROOP CONTROL
1:0116	ISOCHRONOUS LOAD SHARING
1:0117	BASE LOAD CONTROL
1:0118	LOAD RAMP CONTROL
1:0119	UNLOADED
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

Analog Reads

Addr	Description
3:0001	AI1-KW TRANSDUCER IN (uA)
3:0002	AI2-SYNCH INPUT (millivolts)
3:0003	AI3-REMOTE REF SETPOINT (uA)
3:0004	AI4-EXT FUEL LIMIT INPUT (uA)
3:0005	LS LINE VOLTAGE (millivolts)
3:0006	LS LOAD SIGNAL (millivolts)
3:0007	AO1-CONFIGURED ANALOG OUTPUT(uA)
3:0008	AO2-CONFIGURED ANALOG OUTPUT(uA)
3:0009	AO3- OUTPUT TO ACTUATOR (uA,mAx100)
3:0010	AO4-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	LOAD BIAS(rpm)
3:0017	DROOP BIAS(rpm)
3:0018	SYNC BIAS(rpm)
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(%RATED RPM)
3:0034	EXT FUEL LIMIT(%fd)
3:0035	BASE LOAD REFERENCE(kw)
3:0036	LOAD REFERENCE(kw)
3:0037	FUEL DEMAND KW REPRESENTATION
3:0038	
3:0039	
3:0040	
3:0041	AI1-GENERATOR OUTPUT (kw)
3:0042	AI3-REMOTE SPEED SETPOINT(rpm)
3:0043	AI3-REMOTE LOAD SETPOINT (kw)
3:0044	AI4-EXT FUEL LIMIT INPUT (EU)
3:0045	AO1-CONFIGURED ANALOG OUTPUT(engr)
3:0046	AO2-CONFIGURED ANALOG OUTPUT(engr)
3:0047	AO3- OUTPUT TO ACTUATOR (%)
3:0048	AO4-CONFIGURED ANALOG OUTPUT(engr)
3:0049	
3:0050	
3:0051	FIRST OUT ALARM
3:0052	FIRST OUT SHUTDOWN
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	AI 1 CHANNEL 1 (uA)
3:0092	AI 1 CHANNEL 2 (uA)
3:0093	AI 1 CHANNEL 3 (uA)
3:0094	AI 1 CHANNEL 4 (uA)

3:0095	AI 1 CHANNEL 5 (uA)
3:0096	AI 1 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 hand held Main Menu Header press ‘ID’, or from Watch Window or the STD PC interface, select “Help About” 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	#TRUE	
USE 5-GAIN MAP	#FALSE	
USE CONST DYNAMICS	#TRUE	
USE EXT FUEL LIMIT	#FALSE	
USE COMM PORTS	#FALSE	
USE REMOTE COMMANDS	#FALSE	
REMOTE LOCK IN LAST	#FALSE	
FORCE DISCRETE OUTS	#FALSE	
RESET ALM ON CLEAR	#FALSE	
RESET ALM AT CB/RTD	#FALSE	
USE CONT D AS RESET	#FALSE	
USE D AS 2nd LD RAMP	#FALSE	
USE FD ISOCH	#FALSE	
USE FD DROOP ONLY	#FALSE	
USE BUMPLESS XFER	#FALSE	
USE TORSION FILTER	#FALSE	
USE NOTCH FILTER	#FALSE	
ENABLE TORS LIMITER	#FALSE	
USE START SPEED	#FALSE	
PWRUP WITH HANDHELD	#TRUE	
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)	
OVERRIDE SPD FAIL	#FALSE	
USE REMOTE AS SPEED	#FALSE	
MPU ALARM ARM TIME (SEC)	#10.0 (0.0, 120.0)	

CFIG SHUTDOWN	Default	
SPEED #1 FAIL	#FALSE	
SPEED #2 FAIL	#FALSE	
SPD #1AND#2 FAIL	#FALSE	
KW IN FAIL	#FALSE	
REMOTE INPUT FAIL	#FALSE	
EXT FUEL LIMIT FAIL	#FALSE	
MODBUS PORT3 FAIL	#FALSE	
HI FUEL DEMND LEVEL	#FALSE	
HI SPEED LEVEL	#FALSE	
HI TORSIONAL LEVEL	#FALSE	
HIGH KW LEVEL	#FALSE	
ON START FUEL LIMIT	#FALSE	
ON MAX LIMIT	#FALSE	
ON EXT FUEL LIMIT	#FALSE	
ON TORSION LIMIT	#FALSE	
ACT SHUTDOWN	#FALSE	
SPEED SWITCH	#FALSE	

CFIG ALARM	Default	
SPEED #1 FAIL	#FALSE	
SPEED #2 FAIL	#FALSE	
SPD #1AND#2 FAIL	#FALSE	
KW IN FAIL	#FALSE	
REMOTE INPUT FAIL	#FALSE	
EXT FUEL LIMIT FAIL	#FALSE	
MODBUS PORT 3 FAIL	#FALSE	
HI FUEL DEMND LEVEL	#FALSE	
HI SPEED LEVEL	#FALSE	
HI TORSIONAL LEVEL	#FALSE	
HIGH KW LEVEL	#FALSE	
ON START FUEL LIMIT	#FALSE	
ON MAX LIMIT	#FALSE	
ON EXT FUEL LIMIT	#FALSE	
ON TORSION LIMIT	#FALSE	
ACT SHUTDOWN	#FALSE	
SPEED SWITCH	#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)	
KW HI LEVEL	#1100.0 (0.0, 16384.0)	
KW DELAY	#10.0 (0.0, 10800.0)	
SPD SWITCH PICKUP (RPM)	#500.0 (0.0, 2200.0)	
SPD SWITCH DROPOUT (RPM)	#400.0 (0.0, 2200.0)	
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)	
KW HI LEVEL	#1100.0 (0.0, 16384.0)	
KW DELAY	#10.0 (0.0, 10800.0)	
SPD SWITCH PICKUP (RPM)	#500.0 (0.0, 2200.0)	
SPD SWITCH DROPOUT (RPM)	#400.0 (0.0, 2200.0)	
ENERGIZE FOR ALARM	#TRUE	
SHUTDOWN ACT ON ALM	#FALSE	

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	#9 (1, 10)	
AOUT 2 4-20 mA	#TRUE	
ACT OUT 4-20 mA	#FALSE	
AOUT 4 SELECT	#3 (1, 10)	
AOUT 4 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-KW INPUT FAIL		
5-REMOTE INPUT FAIL		
6-EXT FUEL LMT FAIL		
7-MODBUS PORT3 FAIL		
8-HIGH FUEL DEMAND		
9-HIGH SPEED		
10-HIGH TORSIONAL		
11-HIGH KW		
ALARM RESET	*FALSE	

ALARM MENU	Default	
FIRST ALARM		
1-SPEED #1FAIL		
2-SPEED #2 FAIL		
3-SPD #1AND#2 FAIL		
4-KW INPUT FAIL		
5-REMOTE INPUT FAIL		
6-EXT FUEL LMT FAIL		
7-MODBUS PORT3 FAIL		
8-HIGH FUEL DEMAND		
9-HIGH SPEED		
10-HIGH TORSIONAL		
11-HIGH KW		
ALARM RESET	*FALSE	
1st 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 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 (0.10, 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 (0.001, 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 (0.01, 1000.0)	
MAX FUEL LIMIT(%FD)	*100.0 (0.0, 100.0)	
SPEED SETTING	Default (Low, High)	
START SPEED (RPM)	*125 (1, 2100)	
RAISE SPEED LIMIT (RPM)	*1300 (1, 2100)	
LOWER SPEED LIMIT (RPM)	*1100 (1, 2100)	
IDLE SPEED(RPM)	*750 (1, 2100)	
ACCEL RAMP TIME (SEC)	*8.0 (0.0, 10800.0)	
DECEL RAMP TIME (SEC)	*8.0 (0.0, 10800.0)	
RAISE SPEED RATE (RPM/MIN)	*120.0 (0.01, 32767.0)	
LOWER SPEED RATE (RPM/MIN)	*120.0 (0.01, 32767.0)	
AI OVERRIDE LEVEL (%RATED)	*90.0 (1.0, 100.0)	
AI OVERRIDE TIME (SEC)	*1.0 (1.0, 300.0)	
AI CB CLS ARM DELAY(SEC)	*1.0 (0.0, 120.0)	

KW SETTING	Default (Low, High)	
LOAD DROOP PERCENT	*0.0 (0.0, 10.0)	
FUEL DEMAND @MIN LD(%FD)	*27.0 (0.0, 100.0)	
FUEL DEMAND @MAX LD(%FD)	*73.0 (0.0, 100.0)	
RATED LOAD(KW)	*1000 (1, 16384)	
LOAD GAIN VOLTAGE	*6.0 (3.0, 7.0)	
BASE LOAD REFERENCE(KW)	*200 (0, 16384)	
UNLOAD TRIP LEVEL (KW)	*50 (0, 16384)	
LOADING RATE (KW/MIN)	*100 (0, 32767)	
UNLOADING RATE (KW/MIN)	*100 (0, 32767)	
2ND LOAD RATE (KW/SEC)	*5 (0, 32767)	
2ND UNLD RATE (KW/SEC)	*5 (0, 32767)	
BREAKER OPEN TIME (SEC)	*1.0 (0.8, 60.0)	

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)	
KW SENSOR @4mA(KW)	*0.0 (-16384.0, 16384.0)	
KW SENSOR @20mA(KW)	*1200.0 (-16384.0, 16384.0)	
REMOTE SPD @4mA (RPM)	*750.0 (-16384.0, 16384.0)	
REMOTE SPD @20mA (RPM)	*1300.0 (-16384.0, 16384.0)	
REM LD SETPT @4mA(KW)	*0.0 (0.0, 16384.0)	
REM LD SETPT @20mA(KW)	*1000.0 (0.0, 16384.0)	
EXT FUEL LMT@4mA (EU)	*4.0 (-16384.0, 16384.0)	
EXT FUEL LMT@20mA (EU)	*20.0 (-16384.0, 16384.0)	
SYNC IN SCALING (% PER VOLT)	*0.66667 (0.0, 10.0)	

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)	*1100.0 (-32767.0, 32767.0)	
ANALOG OUTPUT 4 MIN (EU)	*0.0 (-32767.0, 32767.0)	
ANALOG OUTPUT 4 MAX (EU)	*100.0 (-32767.0, 32767.0)	
AO FILTER FREQUENCY(HZ)	*20.0 (0.01, 20.0)	

I/O CALIBRATION	Default (Low, High)	
KW IN OFFSET(AI1)	*0.0 (-20.0, 20.0)	
KW INPUT SPAN(AI1)	*100.0 (50.0, 200.0)	
KW READ VOLTS (AI1)	*FALSE	
SYNC OFFSET(AI2)	*0.0 (-5000.0, 5000.0)	
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	
DE-DROOP(mV)	*0.0 (-5000.0, 5000.0)	
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)	
AO 3 OFFSET	*0.0 (-4095.0, 4095.0)	
AO 3 SPAN	*100.0 (50.0, 200.0)	
AO 4 OFFSET	*0.0 (-4095.0, 4095.0)	
AO 4 SPAN	*100.0 (50.0, 200.0)	
HANDHELD INTERFACE	*FALSE	
SERVLINK INTERFACE	*FALSE	
COMM PORT SETUP	Default (Low, High)	
PORT2 HARDWARE CFIG	*1 (1, 2)	
PORT 2 BAUD RATE	*10 (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 EXCEPTION ERR		
PORT3 LINK ERROR		
PORT3 EX ERR NUM		
PORT3 EX ERR PCT		
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)	

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)	
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		
DO MODULE 1	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-CB AUX CONTACT		
B-BASE LOAD		
C-LOAD GENERATOR		
D-2ND DYNAMICS		
E-RAISE SPD/LOAD		
F-LOWER SPD/LOAD		
G-RATED SPEED		
H-CLOSE TO RUN		
DO1-OPEN GEN BRKR		
DO2-ALARM		
DO3-SHUTDOWN		
DO4-LD SHARE RELAY		
DISPLAY ANALOG I/O	Default	
SPD SENS IN #1 (HZ)		
SPD SENS IN #2 (HZ)		
AI1-KW INPUT		
AI1-KW INPUT FAILED		
AI2-SYNCH INPUT		
AI3-REMOTE IN		
AI3-REM IN FAILED		
AI4-EXT FUEL LIMIT		
AI4-EXT LIM FAILED		
LOAD SHARING LINES (Vdc)		
LOAD SHARING ERROR (Vdc)		
ANALOG OUT 1(mA)		
ANALOG OUT 2(mA)		
ANALOG OUT 3(mA)		
ANALOG OUT 4(mA)		
LOAD SIGNAL(Vdc)		
ALARM RESET	*FALSE	

LOAD CONTROL MODE	Display Only	
FD DROOP CONTROL		
KW DROOP CONTROL		
KW ISOCH LS CONTROL		
FD ISOCH LS CONTROL		
ISOCH LOADSHARING		
LOAD RAMP CONTROL		
BASE LOAD CONTROL		
REMOTE LOAD ENABLED		
UNLOADED		
LSS CONTROL MODE	Display Only	
SPEED IN CONTROL		
ON START FUEL LIMIT		
ON MAXIMUM LIMIT		
ON EXTERNAL LIMIT		
ON TORSIONAL LIMIT		
ACTUATOR SHUTDOWN		
REMOTE SPEED ENBLD		
2nd DYNAMICS ENBLD		
REAL GAIN SETTING		
SPD SENSOR 1 ACTIVE		
SPD SENSOR 2 ACTIVE		
PORT 1 ON HANDHELD		
PORT 1 ON SERVLINK		
DISPLAY MENU	Display Only	
ENGINE SPEED(RPM)		
BIASED SPD REF(RPM)		
FUEL DEMAND(%)		
SPEED REF(RPM)		
LOAD BIAS(RPM)		
DROOP BIAS(RPM)		
SYNC BIAS(RPM)		
REMOTE SPEED REF (RPM)		
EXT FUEL LIMIT IN (EU)		
EXT FUEL LIMIT(%FD)		
FD REPRESENTATION (KW)		
REM LD SETPT(KW)		
BASE LOAD REF(KW)		
LOAD REFERENCE(KW)		
GENERATOR OUT(KW)		
FORCE 723 DO	Default	
DO1 FORCE	*FALSE	
DO2 FORCE	*FALSE	
DO3 FORCE	*FALSE	
DO4 FORCE	*FALSE	

FORCE DO 1	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	

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
FORCE DISCRETE OUTS
RESET ALM ON CLEAR
RESET ALM AT CB/RTD
USE CONT D AS RESET
USE D AS 2nd LD RAMP
USE FD ISOCH
USE FD DROOP ONLY
USE BUMPLESS XFER
USE TORSION FILTER
USE NOTCH FILTER
ENABLE TORS LIMITER
USE START SPEED
PWRUP WITH HANDHELD

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
OVERRIDE SPD FAIL
USE REMOTE AS SPEED
MPU ALARM ARM TIME (SEC)

CFIG SHUTDOWN
SPEED #1 FAIL
SPEED #2 FAIL
SPD #1AND #2 FAIL
KW IN FAIL
REMOTE INPUT FAIL
EXT FUEL LIMIT FAIL
MODBUS PORT3 FAIL
HI FUEL DEMND LEVEL
HI SPEED LEVEL
HI TORSIONAL LEVEL
HIGH KW LEVEL
ON START FUEL LIMIT
ON MAX LIMIT
ON EXT FUEL LIMIT
ON TORSION LIMIT
ACT SHUTDOWN
SPEED SWITCH

CFIG ALARM
SPEED #1 FAIL
SPEED #2 FAIL
SPD #1AND #2 FAIL
KW IN FAIL
REMOTE INPUT FAIL
EXT FUEL LIMIT FAIL
MODBUS PORT 3 FAIL
HI FUEL DEMND LEVEL
HI SPEED LEVEL
HI TORSIONAL LEVEL
HIGH KW LEVEL
ON START FUEL LIMIT
ON MAX LIMIT
ON EXT FUEL LIMIT
ON TORSION LIMIT
ACT SHUTDOWN
SPEED SWITCH

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)
KW HI LEVEL
KW DELAY
SPD SWITCH PICKUP (RPM)
SPD SWITCH DROPOUT (RPM)
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 (SEC)
KW HI LEVEL
KW DELAY
SPD SWITCH PICKUP (RPM)
SPD SWITCH DROPOUT (RPM)
ENERGIZE FOR ALARM
SHUTDOWN ACT ON ALM

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 4-20 mA
AOUT 4 SELECT
AOUT 4 4-20 mA

Service Menus

SHUTDOWN MENU
FIRST SHUTDOWN
1-SPEED #1FAIL
2-SPEED #2 FAIL
3-SPD #1AND #2 FAIL
4-KW INPUT FAIL
5-REMOTE INPUT FAIL
6-EXT FUEL LMT FAIL
7-MODBUS PORT3 FAIL
8-HIGH FUEL DEMAND
9-HIGH SPEED
10-HIGH TORSIONAL
11-HIGH KW
ALARM RESET

ALARM MENU
FIRST ALARM
1-SPEED #1FAIL
2-SPEED #2 FAIL
3-SPD #1AND #2 FAIL
4-KW INPUT FAIL
5-REMOTE INPUT FAIL
6-EXT FUEL LMT FAIL
7-MODBUS PORT3 FAIL
8-HIGH FUEL DEMAND
9-HIGH SPEED
10-HIGH TORSIONAL
11-HIGH KW
ALARM RESET

1st 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 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 (%FD/S)
MAX FUEL LIMIT (%FD)

SPEED SETTING
START SPEED (RPM)
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)
AI OVERRIDE LEVEL (%RATED)
AI OVERRIDE TIME (SEC)
AI CB CLS ARM DELAY (SEC)

KW SETTING
LOAD DROOP PERCENT
FUEL DEMAND @MIN LD (%FD)
FUEL DEMAND @MAX LD (%FD)
RATED LOAD (KW)
LOAD GAIN VOLTAGE
BASE LOAD REFERENCE (KW)
UNLOAD TRIP LEVEL (KW)
LOADING RATE (KW/MIN)
UNLOADING RATE (KW/MIN)
2ND LOAD RATE (KW/SEC)
2ND UNLD RATE (KW/SEC)
BREAKER OPEN TIME (SEC)

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
KW SENSOR @4mA (KW)
KW SENSOR @20mA (KW)
REMOTE SPD @4mA (RPM)
REMOTE SPD @20mA (RPM)
REM LD SETPT @4mA (KW)
REM LD SETPT @20mA (KW)
EXT FUEL LMT@4mA (EU)
EXT FUEL LMT@20mA (EU)
SYNC IN SCALING (% PER VOLT)

SET ANALOG OUTPUTS
ANALOG OUTPUT 1 MIN (EU)
ANALOG OUTPUT 1 MAX (EU)
ANALOG OUTPUT 2 MIN (EU)
ANALOG OUTPUT 2 MAX (EU)
ANALOG OUT 4 MIN (EU)
ANALOG OUT 4 MAX (EU)
AO FILTER FREQUENCY (HZ)

I/O CALIBRATION
KW IN OFFSET (AI1)
KW INPUT SPAN (AI1)
KW READ VOLTS (AI1)
SYNC OFFSET (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)
DE-DROOP (mV)
AO 1 OFFSET
AO 1 SPAN
AO 2 OFFSET
AO 2 SPAN
AO 3 OFFSET
AO 3 SPAN
AO 4 OFFSET
AO 4 SPAN
HANDHELD INTERFACE
SERVLINK INTERFACE

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)
PORT 3 EXCEPTION ERR
PORT 3 LINK ERROR
PORT 3 EX ERR NUM
PORT 3 EX ERR PCT

TC MODULE 1
CH 1 - TC DEGREES F
CH 2 - TC DEGREES F
CH 3 - TC DEGREES F
CH 4 - TC DEGREES F
CH 5 - TC DEGREES F
CH 6 - TC DEGREES F
CH 1 - TC OFFSET
CH 1 - TC SPAN
CH 2 - TC OFFSET
CH 2 - TC SPAN
CH 3 - TC OFFSET
CH 3 - TC SPAN
CH 4 - TC OFFSET
CH 4 - TC SPAN
CH 5 - TC OFFSET
CH 5 - TC SPAN
CH 6 - TC OFFSET
CH 6 - TC SPAN

TC MODULE 2
CH 1 - TC DEGREES F
CH 2 - TC DEGREES F
CH 3 - TC DEGREES F
CH 4 - TC DEGREES F
CH 5 - TC DEGREES F
CH 6 - TC DEGREES F
CH 1 - TC OFFSET
CH 1 - TC SPAN
CH 2 - TC OFFSET
CH 2 - TC SPAN
CH 3 - TC OFFSET
CH 3 - TC SPAN
CH 4 - TC OFFSET
CH 4 - TC SPAN
CH 5 - TC OFFSET
CH 5 - TC SPAN
CH 6 - TC OFFSET
CH 6 - TC SPAN

TC MODULE 3
CH 1 - TC DEGREES F
CH 2 - TC DEGREES F
CH 3 - TC DEGREES F
CH 4 - TC DEGREES F
CH 5 - TC DEGREES F
CH 6 - TC DEGREES F
CH 1 - TC OFFSET
CH 1 - TC SPAN
CH 2 - TC OFFSET
CH 2 - TC SPAN
CH 3 - TC OFFSET
CH 3 - TC SPAN
CH 4 - TC OFFSET
CH 4 - TC SPAN
CH 5 - TC OFFSET
CH 5 - TC SPAN
CH 6 - TC OFFSET
CH 6 - TC SPAN

TC MODULE 4
CH 1 - TC DEGREES F
CH 2 - TC DEGREES F
CH 3 - TC DEGREES F
CH 4 - TC DEGREES F
CH 5 - TC DEGREES F
CH 6 - TC DEGREES F
CH 1 - TC OFFSET
CH 1 - TC SPAN
CH 2 - TC OFFSET
CH 2 - TC SPAN
CH 3 - TC OFFSET
CH 3 - TC SPAN
CH 4 - TC OFFSET
CH 4 - TC SPAN
CH 5 - TC OFFSET
CH 5 - TC SPAN
CH 6 - TC OFFSET
CH 6 - TC SPAN

RTD MODULE 1
CH 1 - RTD DEGREES F
CH 2 - RTD DEGREES F
CH 3 - RTD DEGREES F
CH 4 - RTD DEGREES F
CH 5 - RTD DEGREES F
CH 6 - RTD DEGREES F
CH 1 - RTD OFFSET
CH 1 - RTD SPAN
CH 2 - RTD OFFSET
CH 2 - RTD SPAN
CH 3 - RTD OFFSET
CH 3 - RTD SPAN
CH 4 - RTD OFFSET
CH 4 - RTD SPAN
CH 5 - RTD OFFSET
CH 5 - RTD SPAN
CH 6 - RTD OFFSET
CH 6 - 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

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

DO MODULE 1
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-CB AUX CONTACT
B-BASE LOAD
C-LOAD GENERATOR
D-2ND DYNAMICS
E-RAISE SPD/LOAD
F-LOWER SPD/LOAD
G-RATED SPEED
H-CLOSE TO RUN
DO1-OPEN GEN BRKR
DO2-ALARM
DO3-SHUTDOWN
DO4-LD SHARE RELAY

DISPLAY ANALOG I/O
SPD SENS IN #1 (HZ)
SPD SENS IN #2 (HZ)
AI1-KW INPUT
AI1-KW INPUT FAILED
AI2-SYNC INPUT
AI3-REMOTE IN
AI3-REM IN FAILED
AI4-EXT FUEL LIMIT
AI4-EXT LIM FAILED
LOAD SHARING LINES (Vdc)
LOAD SHARING ERROR (Vdc)
ANALOG OUT 1 (mA)
ANALOG OUT 2 (mA)
ANALOG OUT 3 (mA)
ANALOG OUT 4 (mA)
LOAD SIGNAL (Vdc)
ALARM RESET

LOAD CONTROL MODE
FD DROOP CONTROL
KW DROOP CONTROL
KW ISOCH LS CONTROL
FD ISOCH LS CONTROL
ISOCH LOADSARING
LOAD RAMP CONTROL
BASE LOAD CONTROL
REMOTE LOAD ENABLED
UNLOADED

LSS CONTROL MODE
SPEED IN CONTROL
ON START FUEL LIMIT
ON MAXIMUM LIMIT
ON EXTERNAL LIMIT
ON TORSIONAL LIMIT
ACTUATOR SHUTDOWN
REMOTE SPEED ENBLD
2nd DYNAMICS ENBLD
REAL GAIN SETTING
SPD SENSOR 1 ACTIVE
SPD SENSOR 2 ACTIVE
PORT 1 ON HANDHELD
PORT 1 ON SERVLINK

DISPLAY MENU
ENGINE SPEED (RPM)
BIASED SPD REF (RPM)
FUEL DEMAND (%)
SPEED REF (RPM)
LOAD BIAS (RPM)
DROOP BIAS (RPM)
SYNC BIAS (RPM)
REMOTE SPEED REF (RPM)
EXT FUEL LIMIT IN (EU)
EXT FUEL LIMIT (%FD)
FD REPRESENTATION (KW)
REM LD SETPT (KW)
BASE LOAD REF (KW)
LOAD REFERENCE (KW)
GENERATOR OUT (KW)

FORCE 723 DO
DO1 FORCE
DO2 FORCE
DO3 FORCE
DO4 FORCE

FORCE DO 1
DO1 CH1 FORCE
DO1 CH2 FORCE
DO1 CH3 FORCE
DO1 CH4 FORCE
DO1 CH5 FORCE
DO1 CH6 FORCE
DO1 CH7 FORCE
DO1 CH8 FORCE

723PLUS Control Specifications

Woodward Part Numbers:	
8280-414	723PLUS with low-voltage power supply
8280-415	723PLUS with high-voltage power supply
8280-480	723PLUS Low Speed with low-voltage power supply
8280-481	723PLUS Low Speed with high-voltage power supply
9907-205	Hand Held Programmer
8923-932	Watch Window Installation
8923-058	Analog Load Sharing Control View Installation

Input Power

Low Voltage Model	18–40 Vdc (24 or 32 Vdc nominal)
High Voltage Model	90–150 Vdc (125 Vdc nominal)
Power Consumption	40 W nominal
Inrush Current (Low Voltage Model)	7 A for 0.1 ms
Inrush Current (High Voltage Model)	22 A for 15 ms

Inputs

Speed Signal Inputs (2)

Speed Input Voltage	1.0–50.0 Vrms
Speed Input Frequency	Magnetic Pickup: 400 Hz to 15 kHz; Proximity Switch: 30 Hz to 15 kHz
Speed Input Impedance	10 kΩ ±15%

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

Discrete Inputs (8)

Discrete Input	24 Vdc, 10 mA nominal, 18–40 Vdc range
Response Time	10 ms ±15%
Impedance	2.3 kΩ

NOTE—For Lloyd's Register applications, use only control-supplied power.

Analog Inputs (4)

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

Load Sharing Input

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

Outputs

Analog Outputs 0–1 or 4–20 mA (2)

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

Analog Outputs 0–20 or 0–200 mA (2)

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

Relay Contact Outputs (3)

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

Environment

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

Compliance

UL/cUL Listing	Class 1, Division 2, Groups A, B, C, D
Lloyd's Register of Shipping	Certification Pending
American Bureau of Shipping (ABS)	Certification Pending
European Union (EU)	Compliant with EMC Directive 89/336/EEC (Low Voltage Model Only)

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

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