WOODWARD

723PLUS Digital Speed Control for Reciprocating Engines— Performance Control '424'

8280-424

Installation and Operation Manual

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

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

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

⚠ **Translated Publications**	If the cover of this publication states "Translation of the Original Instructions" please note: The original source of this publication may have been updated since this translation was made. Be sure to check manual *26311* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, to verify whether this translation is up to date. Out-of-date translations are marked with ⚠. Always compare with the original for technical specifications and for proper and safe installation and operation procedures.

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

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Important Definitions

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

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

⚠️**WARNING** **Overspeed / Overtemperature / Overpressure**	**The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.** **The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.**

⚠️**WARNING** **Personal Protective Equipment**	**The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:** • **Eye Protection** • **Hearing Protection** • **Hard Hat** • **Gloves** • **Safety Boots** • **Respirator** **Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.**

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

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

NOTICE

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 Digital Industrial Speed/ Performance Control '424', model 8280-424 (low voltage).

Declaration of Incorporation

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

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

Application

This 723PLUS Digital Industrial Speed/Performance Control '424' controls the speed, air/fuel ratio, and ignition timing of reciprocating engines in variable speed applications. The control includes inputs for two magnetic pickups (MPUs) or proximity switches for monitoring engine and turbocharger speed (or redundant engine speed sensing), a notch filter to attenuate the effect of flexible coupling torsionals, an input for a remote speed setting, inputs for air manifold pressure, and fuel gas header pressure or fuel gas flow fuel and an internal speed reference for local control of speed.

One LON®* channel can be used to support Woodward LINKnet™ input/output nodes for monitoring functions. One thermocouple LINKnet module is included with the control. The other LON channel is not used.

<div align="right">*—LON is a trademark of Echelon Corporation.</div>

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.

<div align="right">*—Modbus is a trademark of Schneider Autiomation Inc.</div>

The 723PLUS control system includes:
- a 723PLUS Digital Speed, Air/Fuel Ratio and Ignition Timing Control
- Servlink Watch Window (Figure 1-2) or an optional hand held terminal (Figure 1-3) for adjusting control parameters
- one proportional actuator output to position the fuel metering end device
- one proportional actuator output to position the air/fuel ratio end device
- one analog output to control the ignition timer setting
- an external power source
- one or two speed-sensing devices (two engine or one engine and one turbo)
- eight optional switch contacts to manage control functions
- one analog output for configurable turbocharger air assist PID control, pre-combustion chamber pressure control *or* display indication
- two optional relay-driven alarm and shutdown indicators
- one optional relay-driven automatic turbocharger air assist control
- optional Modbus devices for digital monitoring and control
- provision for one thermocouple LINKnet module (order separately) to make available temperature input signals required by the control
- optional LINKnet Modules to provide additional I/O paths for the Modbus devices

The 723PLUS control (Figure 1-1) 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 is possible. Acceptable input voltage range is 18 to 40 Vdc.

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

Other control options (on-board jumper configurations):
proximity switch input for speed signal frequencies below 1000 Hz
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 adjusting software parameters of the 723PLUS control, including the software options. The PC cable or Hand Held Programmer plug into communication port J1 of the control (see manual 26007 *Getting Started* for using the Watch Window software). [Hand Held Programmer part number 9905-292 can also be used.] See Figures 1-2 and 1-3.

Optional PC-based Performance '424' Control View (part number 8928-057) is a graphical user interface product used for monitoring and adjusting software parameters of the 723PLUS/Performance '424' control.

The two communication ports (J2 and J3) and the LON #1 data channel allow for digital communications between external Modbus compatible devices, Servlink devices, and Woodward LINKnet I/O modules. Port J2 is a dedicated port for Servlink clients like Watch Window and Control View. The LON #1 channel has been designated for use with up to 18 LINKnet modules. One thermocouple LINKnet module is required with the 723PLUS Performance '424' control. The inputs and outputs of these modules can be read and controlled with Modbus compatible devices connected to communication port J3. The number and types of LINKnet modules available:

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

Table 1-1. LINKnet Modules (Summary)

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

Table 1-2. LINKnet Modules (Address)
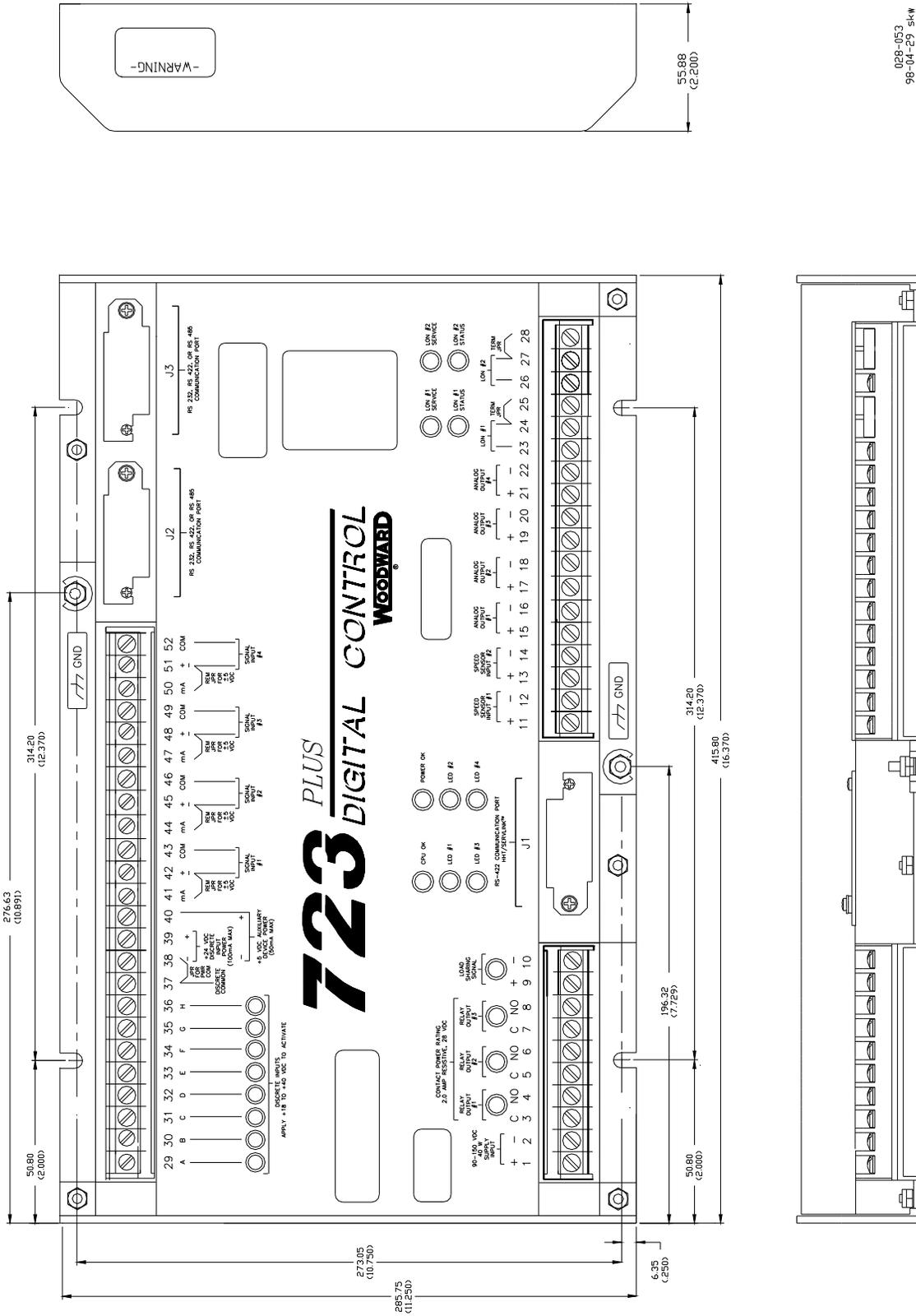
Figure 1-1. 723PLUS Digital Speed Control
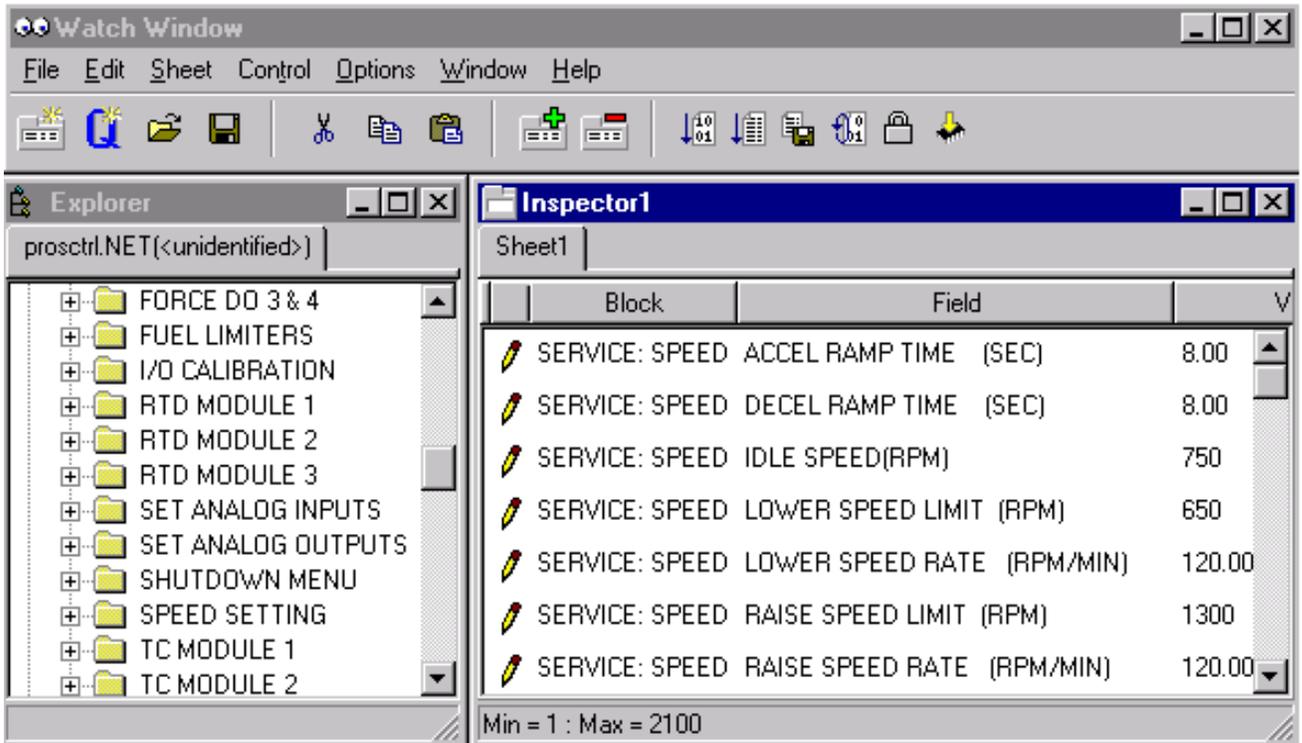
Figure 1-2. Watch Window Display

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

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

041-010
96-07-25 skw
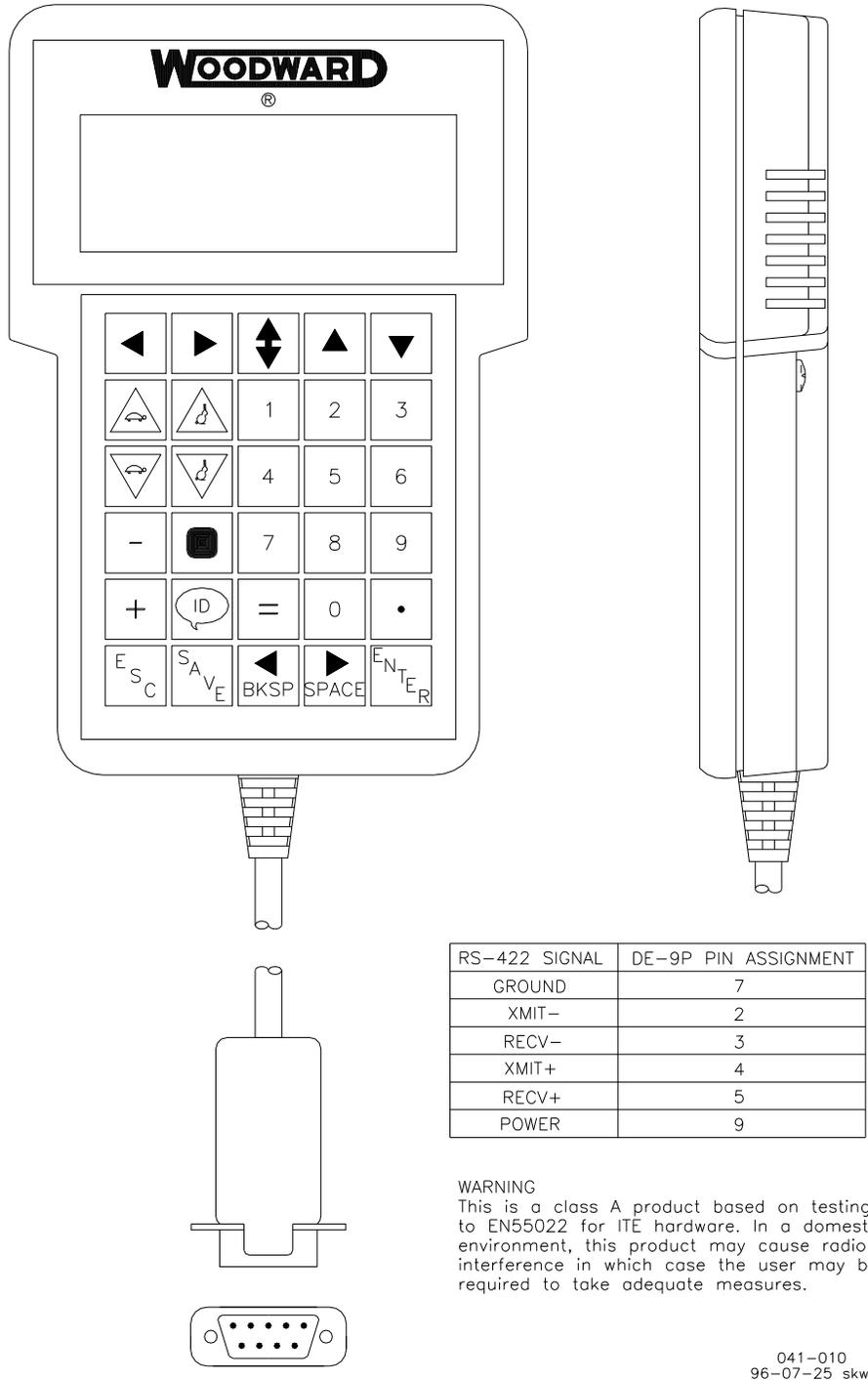
Figure 1-3. Hand Held Programmer

A – Remote Speed Control (maintain closed for remote)
B – Alarm Reset (momentarily close to reset)
C – Raise Air Manifold Pressure (momentarily)
D – Lower Air Manifold Pressure (momentarily)
E – Raise Speed (momentary)
F – Lower Speed (momentary)
G – Rated Speed (open for Idle/close for rated)
H – Close to run (close to run/open for minimum actuator)
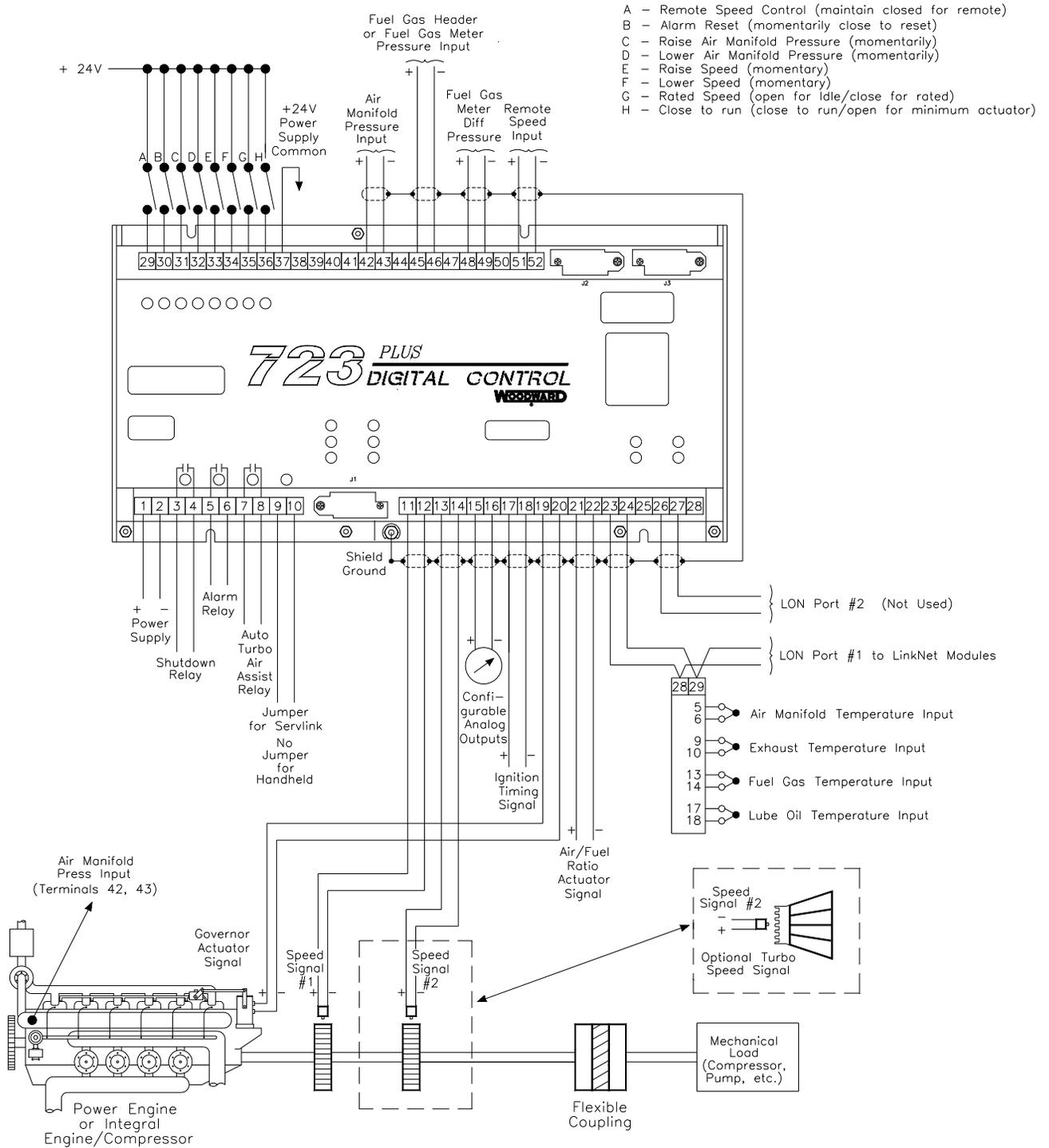
028-095
99-01-04 skw

Figure 1-4. Typical 723PLUS Connections
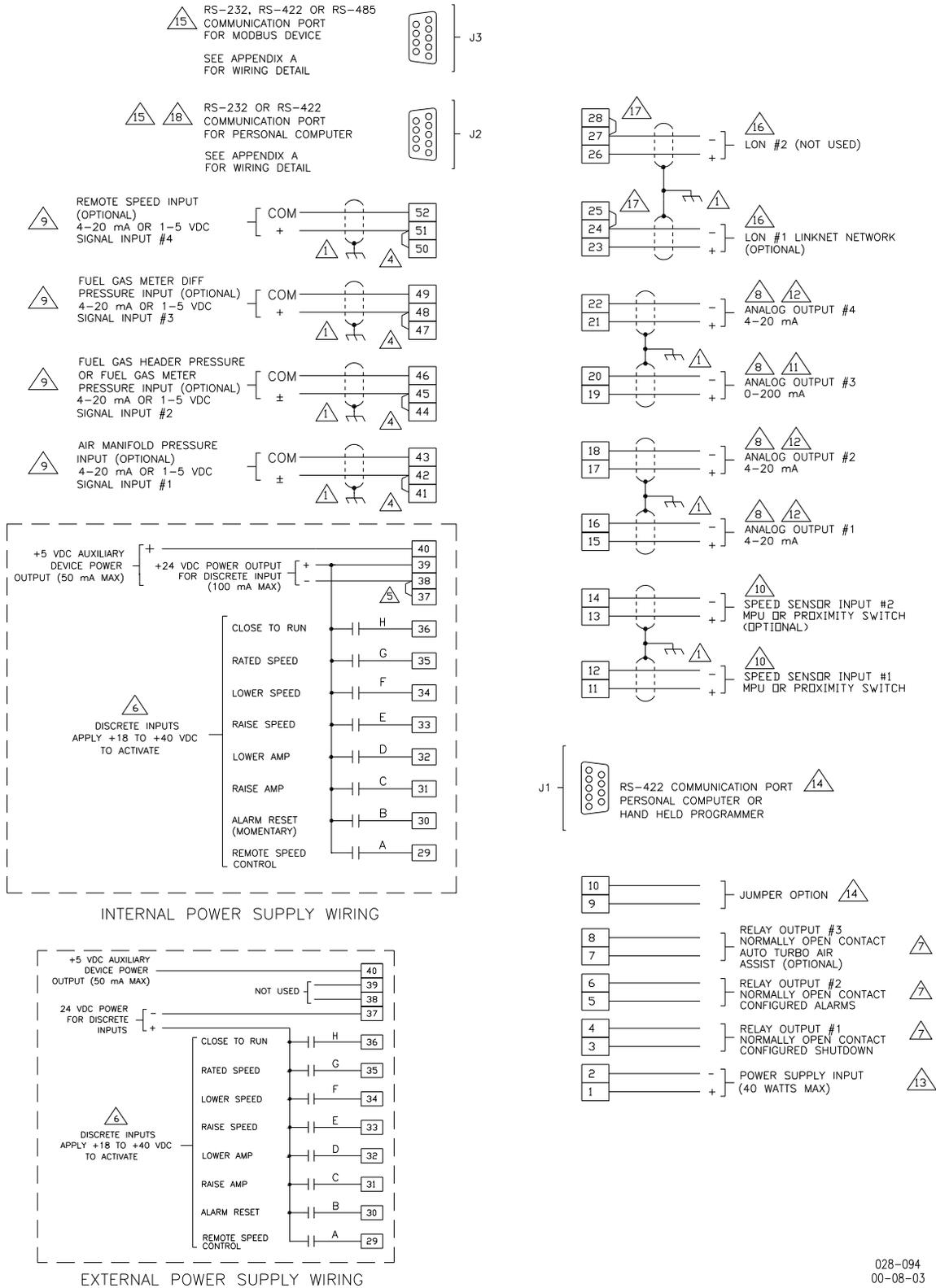
Figure 1-5a. Control Wiring Diagram

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 REMOVE JUMPER IF USING EXTERNAL DISCRETE INPUT POWER.

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

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

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

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

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

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

△10 FACTORY SET FOR MPU INPUT.

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

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

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

△14 COMMUNICATION PORT J1:
A. HAND HELD PROGRAMMER--REMOVE JUMPER BETWEEN TERMINALS 9 AND 10.
B. PERSONAL COMPUTER--ADD JUMPER BETWEEN TERMINALS 9 AND 10.
1. PERSONAL COMPUTER MUST HAVE WATCH WINDOW OR CONTROL VIEW SOFTWARE INSTALLED.
2. NEED DOWNLOAD CABLE #5416-870 TO CONNECT FROM J1 (RS-422) TO PERSONAL COMPUTER (RS-232).

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

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

△17 BOTH 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 WATCH WINDOW OR CONTROL VIEW SOFTWARE MUST BE INSTALLED ON THE PERSONAL COMPUTER.

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Figure 1-5b. Control Wiring Diagram

Chapter 2.
Installation

Introduction

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

Unpacking

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

Power Requirements

The low voltage version of the 723PLUS Digital Speed/Performance Control '424' requires a voltage source of 18 to 40 Vdc.

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

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

NOTICE	**To prevent damage to the control, make sure that the alternator or other battery-charging device is turned off or disconnected before disconnecting the battery from the control.**

Location Considerations

Consider these requirements when selecting the mounting location:
*   adequate ventilation for cooling;
*   space for servicing and repair;
*   protection from direct exposure to water or to a condensation-prone environment;
*   protection from high-voltage or high-current devices, or devices which produce electromagnetic interference;
*   avoidance of vibration;
*   selection of a location that will provide an operating temperature range of –40 to +70 °C (–40 to +158 °F).

The control must NOT be mounted on the engine.

Internal Jumpers

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

With the power off, remove the control cover. With a small pair of tweezers or needle-nose pliers, carefully remove the appropriate jumper and replace it securely over the proper two connectors (see Figure 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 1-4. 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.
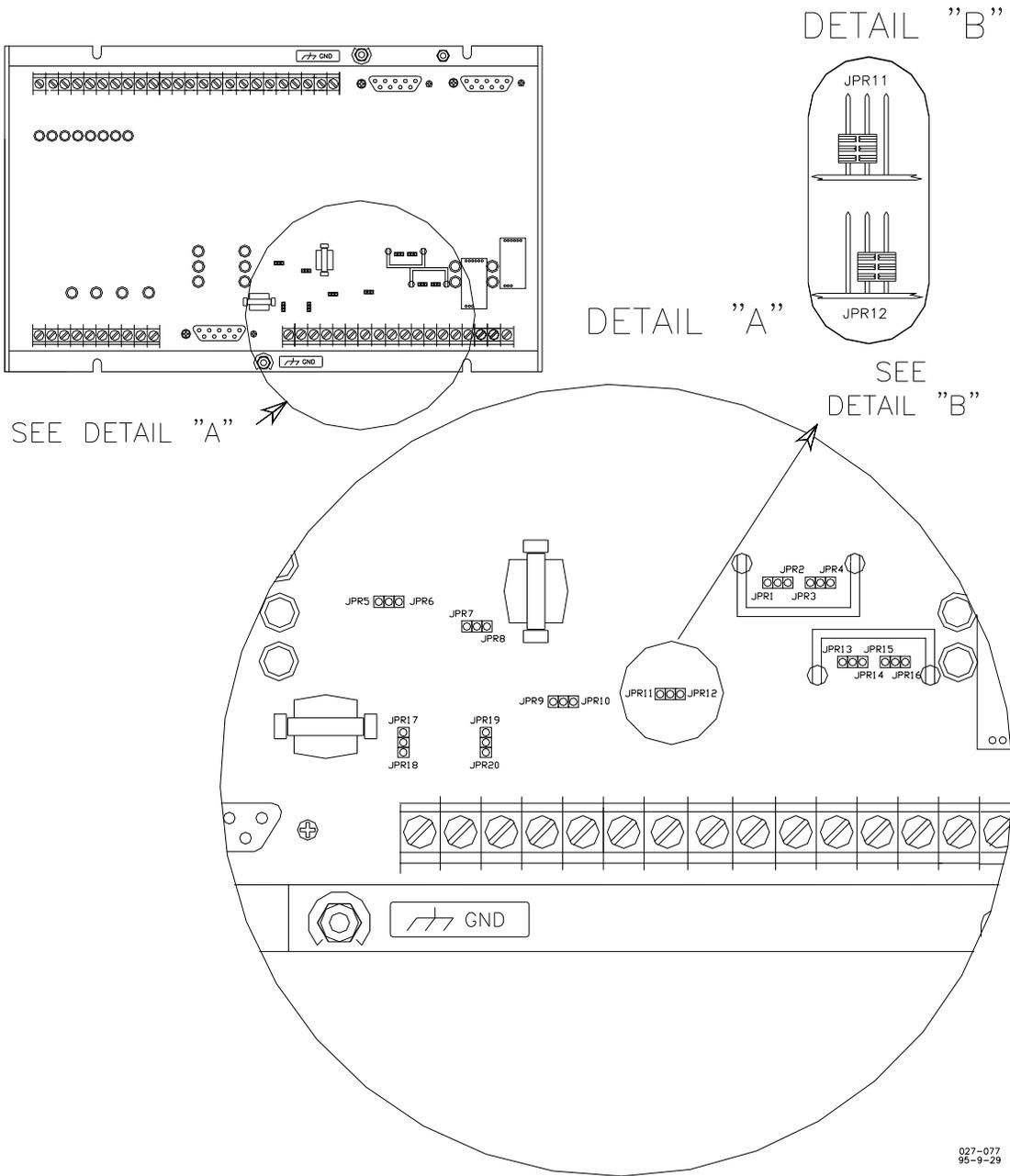
Figure 2-1. 723PLUS Control Internal Jumpers

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 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 three conditions which cause the relays to change state include a shutdown condition, an alarm condition, or an automatic turbocharger jet assist demand condition. The contact ratings are shown on the Control Wiring Diagram in Figure 1-5. Interposing relays should be used if the application exceeds these ratings. Each relay is energized when the green light above the respective terminals is illuminated.

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

The relay contact on terminals 5/6 for Relay Output #2 is used when internal alarm conditions are to be used by other devices in the application. No connection is required if the alarm function is not used in the application. The relay changes state if any configured alarm condition has occurred without being cleared or reset. The state of the contact can be configured as either close on alarm or open on alarm. If power to the control is lost, the contact will open.

The relay contact on terminals 7/8 for Relay Output #3 is used when a discrete turbocharger air assist end device is to be controlled automatically in the application. No connection is required if the turbocharger assist function is not used in the application. The relay changes state if air manifold pressure is at or falls below a tunable air manifold pressure set point after the engine is running. The engine running speed setting is also configurable. The state of the contact can be configured as either direct acting (close for assist) or reverse acting (open for assist). If power to the control is lost, the contact will open. Refer to analog output #1 for a configurable analog PID type of turbocharger air assist.

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

Connect a magnetic pickup (MPU) or proximity switch which senses engine speed only 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 redundant engine speed sensing or for monitoring turbocharger speed. The second engine speed sensing device will provide backup speed sensing in the event of a single engine speed sensor failure. If two engine speed sensors are used, they must both sense the exact same speed of rotation. If the second MPU/proximity switch connected to terminals 13 and 14 senses turbocharger speed rather than engine speed, the control must be configured to use the turbo MPU. Use shielded wire for all speed sensor connections. Connect the shield to the control 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 except at the control chassis ground connection.

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

> **NOTICE**   **To prevent possible damage to the control or poor control performance resulting from ground loop problems, we recommend using current-loop isolators if the 723PLUS control's analog inputs and outputs must both be used with non-isolated devices. A number of manufacturers offer 20 mA loop isolators.**

Analog Output #1 (Terminals 15/16)

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

The output can be software configured to one of several control parameters. These parameters include:
1—Engine Speed
2—Engine Speed Reference
3—Fuel Actuator Demand
4—J3 Modbus Analog Write Address 4:0002
5—Turbocharger Speed
6—Air Manifold Pressure
7—Fuel Gas Header Pressure **OR** Fuel Gas Meter Pressure
8—Air/Fuel Ratio Reference
9—Air/Fuel Ratio Actuator Position
10—Ignition Timing Reference
11—Air Manifold Temperature
12—Exhaust Stack Temperature
13—Fuel Gas Flow
14—Turbocharger Assist PID Control Signal
15—Pre-Combustion Chamber Control Signal
16—Remote Engine Speed Reference

Analog Output #1 is factory set for 4 to 20 mA representing the engine speed. Default range is 0 to 330 rpm. Software settings must be changed if the hardware is configured for 0 to 1 mA.

Analog Output #2 (Terminals 17/18)

Analog Output #2 provides a dedicated 4–20 mA current signal to the ignition timer for variable ignition timing control. This current signal is supplied to terminals 17(+) and 18(–). No connection is required if the variable ignition timing function is not used in the application.

Use shielded twisted-pair wires and install current-loop isolators to eliminate ground loops. A number of manufacturers offer 20 mA isolators. For input to the ignition timer, use the recommendations of the timer manufacturer. Make sure the shield has continuity the entire distance to the timer and make sure the shield is insulated from all other conducting surfaces except at a single ground point. Unless the timer manufacturer has a specific shield grounding recommendation, the shield should be grounded at the control end of the cable.

The control may be configured for 0–1 mA output. In the unlikely event the hardware jumper is changed, the software settings must also be changed.

Analog Output #3 (Terminals 19/20)

Analog Output #3 provides a dedicated 0–200 mA current signal to the fuel actuator for engine speed control. This current signal is supplied to terminals 19(+) and 20(−).

Use shielded twisted-pair wires with the shield connected to the chassis at the control.

The control may also be configured for 4–20 mA. If the hardware jumper is changed, the software settings must also be changed.

Analog Output #4 (Terminals 21/22)

Analog Output #4 provides a dedicated 4–20 mA current signal to the air/fuel actuator for air/fuel ratio control. This current signal is supplied to terminals 21(+) and 22(−). No connection is required if the air/fuel ratio function is not used in the application.

Use shielded twisted-pair wires with the shield connected to the chassis at the control.

The control may be configured for 0–200 mA output. In the unlikely event the hardware jumper is changed, the software settings must also be changed.

LON #1 and LON #2 (Terminals 23—28)

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

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

LON #2 is not used. DO NOT CONNECT.

Discrete Inputs (Terminals 29—36)

Discrete inputs are the switch input commands to the 723PLUS control. They interact in such a way as to allow engine control under a variety of conditions.

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

In systems which provide an external low voltage source to power the 723PLUS control (or other systems where external low voltage dc power is available), the discrete inputs may be powered by this external low voltage. The voltage source used must be capable of supplying 100 mA at a voltage level of 18 to 40 Vdc. Connect the external low voltage source negative to terminal 37(–). Connect the external low voltage source positive to the appropriate input switch or relay contact and connect the mated switch or relay contact to the corresponding discrete input terminal on the 723PLUS control.

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

In systems 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.

Remote Speed Control (Input A; Terminal 29)

The input switch or relay contact used to activate the Remote Speed Control function connects to terminal 29 (Discrete Input A). This discrete input changes the control state between discrete raise/lower control and remote speed reference control. When the contact is open, the control activates the discrete raise/lower control. With the contact closed (discrete input in the TRUE state), the remote speed reference is activated. During configuration the source of the discrete raise/lower and analog speed reference may be selected as either Hardware or Modbus. If the "USE REMOTE COMMANDS" is configured FALSE, the hardware inputs (discrete raise/lower and analog remote speed transmitter) are activated. If the "USE REMOTE COMMANDS" is configured TRUE, the Modbus inputs (BW raise/lower and AW remote speed reference) are activated. A BW Modbus switch is also provided to select the Hardware inputs over the Modbus inputs. The hardware selection may be partial (e.g., Discrete hardware only) or complete (e.g., Discrete and analog hardware).

Alarm Reset (Input B; Terminal 30)

The input switch or relay contact used to activate the Alarm Reset command connects to terminal 30 (Discrete Input B). This discrete input will issue a reset command to all parameters which can latch into an alarm state. Only those parameters which are in the normal state when the discrete input first goes TRUE will be reset to the no-alarm condition. When the external switch or relay contacts are closed (discrete input in the TRUE state), internal software will limit the command so that the reset condition will apply only for a short time within the control even if the external contact remains closed. With the contacts open (discrete input in the FALSE state), the control will again be ready to respond to the external contacts closing. The Alarm Reset command works in parallel with the command from Port J2, the command from Port J3, and a software switch from Watch Window, Control View, or the Hand Held Programmer.

Raise Air Manifold Pressure (Input C; Terminal 31)

The input switch or relay contact used to activate the Raise Air Manifold Pressure function connects to terminal 31 (Discrete Input C). This discrete input changes the control operation by increasing the air manifold pressure reference ramp. The ramp can only increase to a software adjusted RAISE AMP BIAS limit. The ramp will increase at a software adjusted rate. This command is normally used to temporarily raise air manifold pressure and establish the optimum air manifold pressure needed to meet regulatory emission limits, optimize engine fuel consumption or to quickly minimize an abnormal combustion phenomena (such as detonation).

If the Exhaust Temperature Air/Fuel Ratio control is selected instead of air manifold pressure control, and is active, the function of Discrete Input C is switched to increase the exhaust temperature reference ramp. The ramp can only increase to a software adjusted EXH TEMP RAISE limit. The ramp will increase at a software adjusted rate. This command is normally used to temporarily raise exhaust temperature and establish the optimum exhaust temperature needed to meet regulatory emission limits, optimize engine fuel consumption or to quickly minimize an abnormal combustion phenomena (such as misfiring). The input function switches back to raise air manifold pressure when the Exhaust Temperature Air/Fuel Ratio control is not active.

Lower Air Manifold Pressure (Input D; Terminal 32)

The input switch or relay contact used to activate the Lower Air Manifold Pressure function connects to terminal 32 (Discrete Input D). This discrete input changes the control operation by decreasing the air manifold pressure reference ramp. The ramp can only decrease to a software adjusted LOWER AMP BIAS limit. The ramp will decrease at a software adjusted rate. This command is normally used to temporarily lower air manifold pressure and establish the optimum air manifold pressure needed to meet regulatory emission limits, optimize engine fuel consumption or to quickly minimize an abnormal combustion phenomena (such as misfiring).

If the Exhaust Temperature Air/Fuel Ratio control is selected, instead of air manifold pressure control, and is active, the function of Discrete Input D is switched to decrease the exhaust temperature reference ramp. The ramp can only decrease to a software adjusted EXH TEMP LOWER limit. The ramp will decrease at a software adjusted rate. This command is normally used to temporarily lower exhaust temperature and establish the optimum exhaust temperature needed to meet regulatory emission limits, optimize engine fuel consumption or to quickly minimize an abnormal combustion phenomena (such as detonation). The input function switches back to lower air manifold pressure when the Exhaust Temperature Air/Fuel Ratio control is not active.

Raise Speed Contact (Input E; Terminal 33)

The input switch or relay contact used to activate the Raise Speed command connects to terminal 33 (Discrete Input E). This discrete input changes the control operation by increasing the speed reference ramp. The ramp can increase only to a software adjusted RAISE SPEED limit. The ramp will increase at a software adjusted rate. Command control can be configured for Modbus instead of this hardware input. The same raise speed limit and ramp rate apply to the Modbus BW Raise command. See "Remote Speed Control" above for description. The Raise input is not enabled if the Remote Speed Control input is TRUE. When the external switch or relay contacts are closed (discrete input in the TRUE state), the control will raise the speed reference. Raise is limited to the maximum speed limit. With the contacts open (discrete input in the FALSE state), the control will stop raising the speed reference.

Lower Speed Contact (Input F; Terminal 34)

The input switch or relay contact used to activate the Lower Speed command connects to terminal 34 (Discrete Input F). This discrete input changes the control operation by decreasing the speed reference ramp. The ramp can decrease only to a software adjusted LOWER SPEED limit. The ramp will decrease at a software adjusted rate. Command control can be configured for Modbus instead of this hardware input. The same lower speed limit and ramp rate apply to the Modbus BW Lower command. See "Remote Speed Control" above for description. The Lower input is not enabled if the Remote Speed Control input is TRUE. When the external switch or relay contacts are closed (discrete input in the TRUE state), the control will lower the speed reference. Lower is limited to the minimum speed limit. With the contacts open (discrete input in the FALSE state), the control will stop lowering the speed reference.

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), and rated speed is permissive, 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), or rated speed is not permissive, the speed reference will ramp for a time set by the Decel Time to the idle speed control point. Closing either the Raise, Lower, or Remote Speed Control input contacts will cancel the ramp to rated speed. The Rated Speed input contact must be opened and reclosed to restart the ramp to rated speed.

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), normal speed control function is enabled 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.**

Air Manifold Pressure Input (Signal Input #1; Terminals 42/43)

Connect an air manifold pressure transmitter to Signal Input #1. The input signal must be an isolated high-quality signal. By configuration, this input is used in the air/fuel ratio, ignition timing, turbocharger air assist, and pre-combustion chamber controls, and for speed control fuel limiting. Air manifold pressure is displayed in software adjustable engineering units on Watch Window, Control View, on an optional Hand Held Programmer, and as a Modbus AR address. No connection is required to this input if these functions are not needed by the application.

Use a shielded twisted-pair cable to connect a 4 to 20 mA current transmitter or 1 to 5 Vdc voltage transmitter to terminals 42(+) and 43(–). When using a voltage transmitter, remove the jumper between terminals 41 and 42. An input impedance of 255 Ω is present when the jumper is installed. Without the jumper installed, the input impedance will be greater than 10 MΩ. This input is not isolated from the other control inputs and outputs, and an isolation device must be installed if the transmitter output is not isolated. An out-of-range or failure of the input signal is detected for input values less than 2.0 mA (0.5 Vdc) or greater than 21 mA (5.25 Vdc). A detected failure will remain until the failure is repaired and an Alarm Reset is issued.

Fuel Gas Header OR Fuel Gas Meter Pressure Input (Signal Input #2; Terminals 45/46)

Connect a fuel gas header pressure **OR** a fuel gas meter pressure transmitter to Signal Input #2. The input signal must be an isolated high-quality signal. The application will determine whether the fuel gas header pressure or the fuel gas meter pressure transmitter is connected. By configuration, the fuel gas header pressure input can be used in the air/fuel ratio and pre-combustion chamber controls. Also by configuration, the fuel gas meter pressure input can be used to compute fuel flow for use in air/fuel ratio control and brake horsepower calculation. The connected pressure is displayed in software adjustable engineering units on Watch Window, Control View, on an optional Hand Held Programmer and as a Modbus AR address. Likewise, if the control is configured to compute fuel flow, flow is displayed in SCFM. No connection is required to this input if these functions are not needed by the application.

Use a shielded twisted-pair cable to connect a 4 to 20 mA current transmitter or 1 to 5 Vdc voltage transmitter to terminals 45(+) and 46(−). When using a voltage transmitter, remove the jumper between terminals 44 and 45. An input impedance of 255 Ω is present when the jumper is installed. Without the jumper installed, the input impedance will be greater than 10 MΩ. This input is not isolated from the other control inputs and outputs, and an isolation device must be installed if the transmitter output is not isolated. An out-of-range or failure of the input signal is detected for input values less than 2.0 mA (0.5 Vdc) or greater than 21 mA (5.25 Vdc). A detected failure will remain until the failure is repaired and an Alarm Reset is issued.

Fuel Gas Meter Differential Pressure Input (Signal Input #3; Terminals 48/49)

Connect a fuel gas meter differential pressure transmitter to Signal Input #3. The input signal must be an isolated high-quality signal. By configuration, this input is used to compute fuel flow for use in air/fuel ratio control and brake horsepower calculation. The fuel gas meter differential pressure is displayed in software adjustable engineering units on Watch Window, Control View, on an optional Hand Held Programmer and as a Modbus AR address. No connection is required to this input if this function is not needed by the application.

Use a shielded twisted-pair cable to connect a 4 to 20 mA current transmitter or 1 to 5 Vdc voltage transmitter to terminals 48(+) and 49(−). When using a voltage transmitter, remove the jumper between terminals 47 and 48. 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. An out of range or failure of the input signal is detected for input values less than 2.0 mA (0.5 Vdc) or greater than 21 mA (5.25 Vdc). A detected failure will remain until the failure is repaired and an Alarm Reset is issued.

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

Connect a remote speed reference transmitter to Signal Input #4. The input signal must be an isolated high-quality signal. The remote speed reference is displayed in rpm on Watch Window, Control View, on an optional Hand Held Programmer and as a Modbus AR address. No connection is required to this input if this function is not needed by the application.

Use a shielded twisted-pair cable to connect a 4 to 20 mA current transmitter or 1 to 5 Vdc voltage transmitter to terminals 51(+) and 52(–). When using a voltage transmitter, remove the jumper between terminals 50 and 51. 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. An out of range or failure of the input signal is detected for input values less than 2.0 mA (0.5 Vdc) or greater than 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 Performance '424' Control View software (part number 8928-057). The RS-232/RS-422 download cable (part number 5416-870) or Hand Held Programmer plug into communication port J1 of the control. These allow the user to configure software, adjust set points, and display parameters. A jumper switches the port J1 function. See Chapters 3 and 4 for the menu items available. Contact your local distributor for other options.

Communication Port J2

Communication Port J2 is an alternate Servlink connection for use with Watch Window software or Performance '424' 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 (part number 5416-614) may be used to connect port J2 to a personal computer. Watch Window or Performance '424' Control View can be used to display and modify tunable and configurable values in the control, to 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 two signals to the 723PLUS control. The two signals which can be sent to the 723PLUS are the remote speed reference and a source value for configured analog output #1. The commands which can be sent to the 723PLUS control are Alarm Reset, Raise Air Manifold Pressure, Lower Air Manifold Pressure, Raise Speed, Lower Speed, Close for Rated Speed, Close to Run, Use Raise Air Manifold Pressure Remote Command, Use Lower Air Manifold Pressure Remote Command, Use Raise Speed Remote Command, Use Lower Speed Remote Command, Use Rated/Idle Remote Command, Use Run/Stop Remote Command, and Use Remote Speed Reference. The Alarm Reset command works in parallel with the discrete input Alarm Reset command connected to terminal 30 (B), and a software switch from Watch Window, Control View, or the Hand Held Programmer. The Raise Speed and Lower Speed commands work independently (by configuration) from the discrete inputs Raise Speed (terminal 33/E) and Lower Speed (terminal 34/F) respectively. See Appendix C for complete listings of port addresses and description of values for Port J3.

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

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

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

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

Modbus Analog Write Address 0005 allows control of the speed reference. The signed 16-bit integer must be scaled as rpm for communication (that is, to produce a 330 rpm output from the 723PLUS, a value of 330 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.**

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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 menu system using Watch Window, Performance '424' Control View, or 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 Performance '424' control through ports J1 or J2. However, only port J1 can be used for loading the application software.

Port J1 is configured for RS-422 as a point-to-point only Servlink server and requires a special cable to convert from RS-422 to RS-232. The cable part number is 5416-870. RS-422 communications are less susceptible to noise than RS-232 and should be used when the control and computer are in noisy environments. When using port J1 with Watch Window or Performance '424' Control View, place a jumper across terminals 9 and 10. This tells the control that a computer is connected to J1. When using the Hand Held Programmer, remove the jumper.

Port J2 is configured by default for RS-232 and requires a widely available 9-pin 'null modem' cable. This cable should be available at almost any computer or electronics store. It does not matter if terminals 9 and 10 are jumpered or not when using port J2. Port J2 configuration may be set for RS-422 as a point-to-point or multidrop Servlink server.

Read 'Control Properties' to display the part number and revision level of the software in the control. Refer to this number and revision level in any correspondence with Woodward (write this information in the Programming Checklist, Appendix C).

723PLUS Performance '424' Control View

Woodward has created Control View as a PC Interface for the 723PLUS Performance '424' control. This custom graphical user interface is a Servlink client that has all 723PLUS Performance '424' 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 Performance '424' 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 Performance '424' Control View or Watch Window, place a jumper across terminals 9 and 10. This tells the control that a computer is connected to J1. When using the Hand Held Programmer, remove the jumper.

Port J2 is configured by default for RS-232 and requires a widely available 9-pin 'null modem' cable. This cable should be available at almost any computer or electronics store. It does not matter if terminals 9 and 10 are jumpered or not when using port J2. Port J2 configuration may be set for RS-422 as a point-to-point or multidrop Servlink server.

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

System Requirements

- Operating System: Windows 95 or Windows NT 4.0 *

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 supported by Woodward.**

- Processor: At Least a Pentium 166 MHz or equivalent.
- RAM: Recommended 32 MB (with Windows 95) and 64 MB (with Windows NT). Required 16 MB.
- Communications: At Least 1 Free Working COMM Port

Control Modes
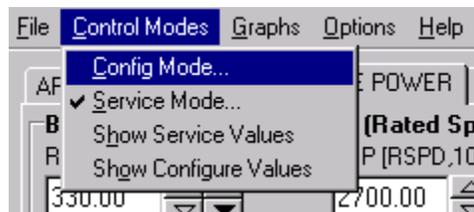
- **Service Mode**

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

- **Configure Mode**

This mode is used to setup 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 confirmation dialog box appears so that the control is not accidentally placed in configuration mode.
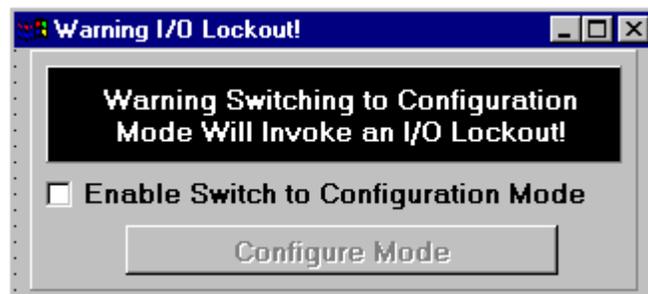
To continue and enter Configuration Mode, check the "Enable Switch to Configuration Mode" box, then press or click Configuration Mode. Close the window (click ⊠) to cancel.

- **Show Service Values**

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

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

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

Start-up Screen

The following Start-up Screen appears when the 723PLUS Performance '424'
Control View is opened.
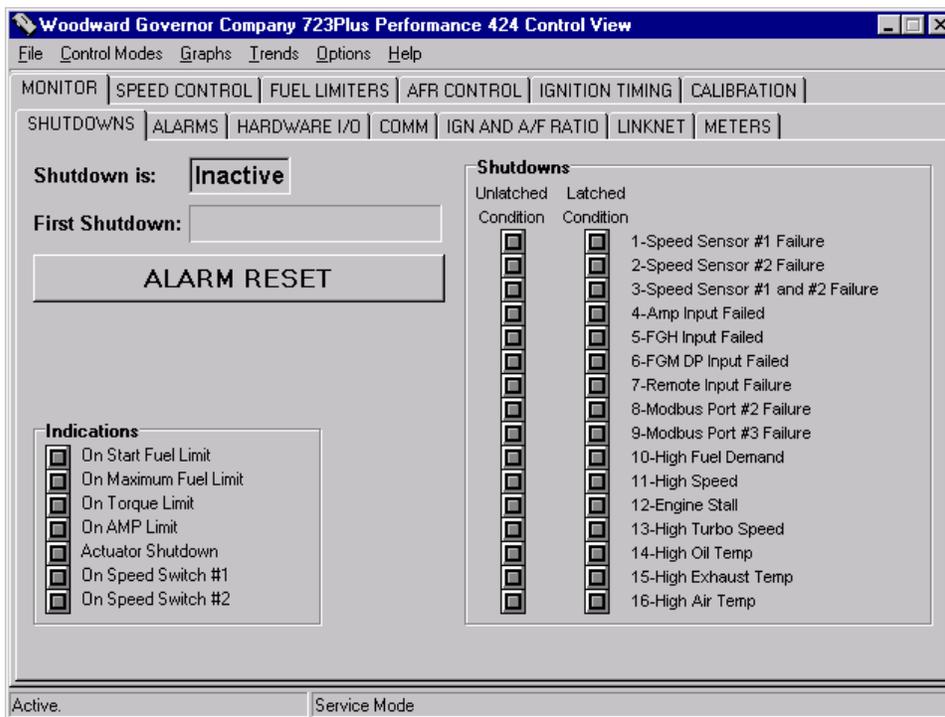
This shows the **Monitor Shutdown** screen and displays the current status of all
shutdowns. An **Alarm Reset** button is provided to reset any control alarms and
shutdowns that have been cleared.

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

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 movement to sub-screens.
Left click when the cursor is over the desired screen or sub-screen name to
move directly to that screen.

The following is an example of right clicking to select and move to the "Thermocouple" screen which is a sub-screen of "LINKnet" and "Monitor". It displays the full lists of other LINKnet sub-screens and Monitor sub-screens as well as all Main screens (including those that are hidden).
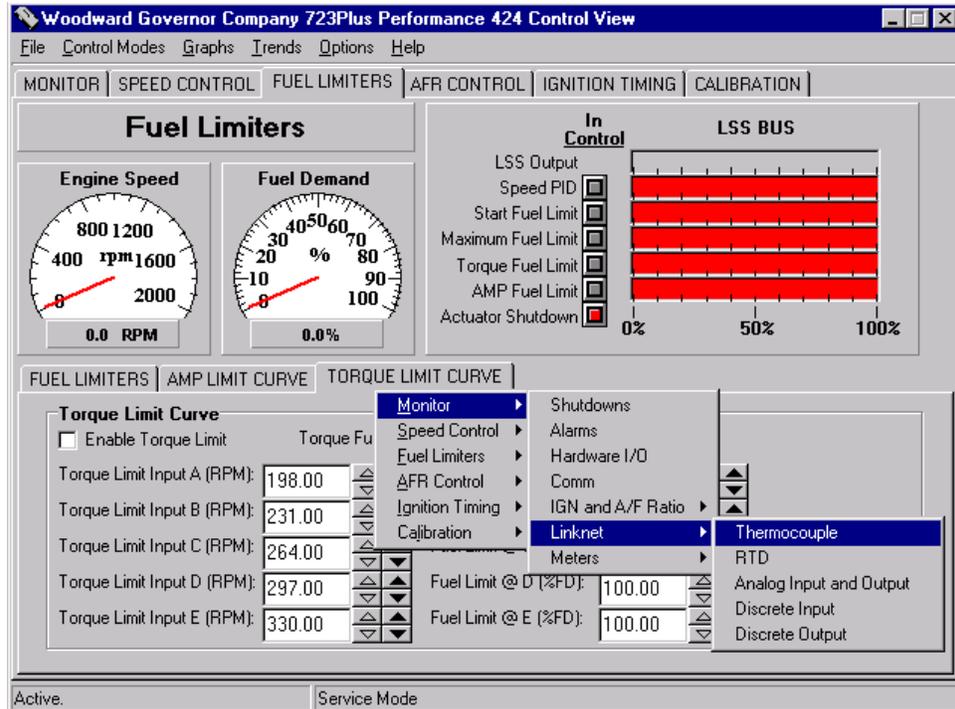
The Fuel Limiter screen, shown above, is typical of all screens, *except for the curve screens.* You can see that the information is presented in various forms:

- Analog and digital displays of Engine Speed and Fuel Demand
- LED display of the Fuel Limiter "In Control"
- Bar graph display of all Fuel Limiters on the fuel demand "LSS BUS"
- Sub-tabs for the Fuel Limiter Settings, Torque Limit Curve, and AMP Limit Curve. (The Torque Limit Curve sub-tab is shown open).

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

The following is the same Fuel Limiter screen with the Fuel Limiter Settings sub-tab open. The main portion of this screen remains the same. The sub-tab exposes specific Fuel Limiter setting values with a set of raise/lower arrows.
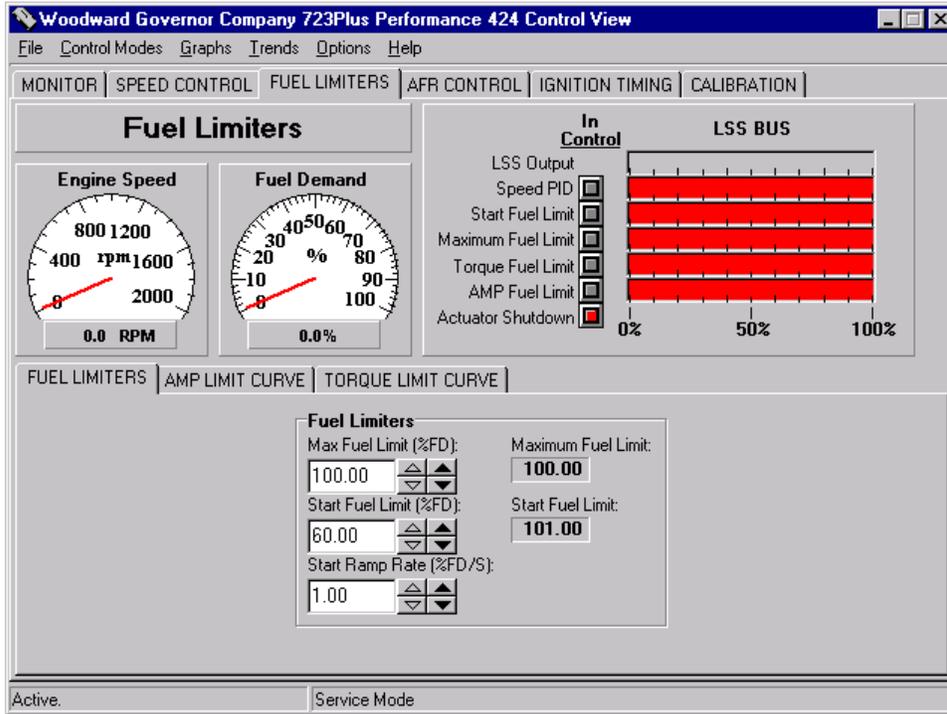
Right clicking on a gauge panel will bring up a different quick menu.
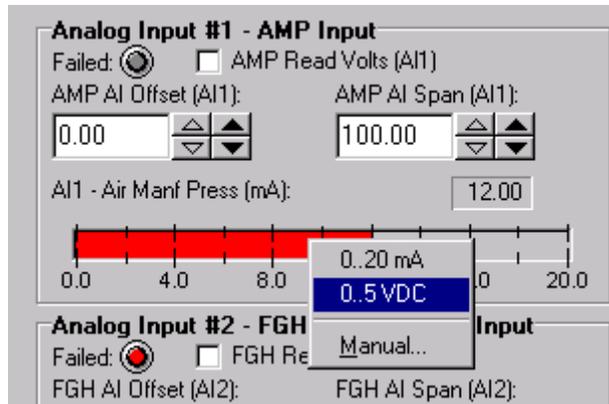
This quick menu will appear when you right click on a gauge (or a group of gauges) that has a changeable range. There are always multiple quick options and a manual option. If the program is set to save settings on close, new gauge settings will be saved automatically when the program is closed.

Saving Settings

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

The other Options are:
- **Load Settings on Open** automatically loads saved gauge settings on open.
- **Reset to Default Settings** will reset all the user options to their Default values.

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

Select File from the **menu bar, for the following choices:**
- **Save** Settings Now will save the programs screen position and gauge settings.
- **Save to EEPROM** will save all configuration and service tunables in the 723PLUS EEPROM.
- **Load Config File** will load all settings from a saved Configuration File into the 723PLUS EEPROM overwriting all previous values. Control Mode must be set for "Config Mode" for this function to be active. Exit Config Mode (by entering Service Mode) to save the control settings and to reset the control.
- **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 and 3D Curves

The 2D and 3D curve screens are unique. The Torque Limit Curve sub-screen with tabulated values and raise/lower arrows was shown earlier on the Fuel Limiter screen. The following shows a different way of viewing and changing this same curve *as a graph* instead of as tabulated settings.

To view a curve , select Graphs from the menu bar and a list of curves will pop up. Click the desired curve.
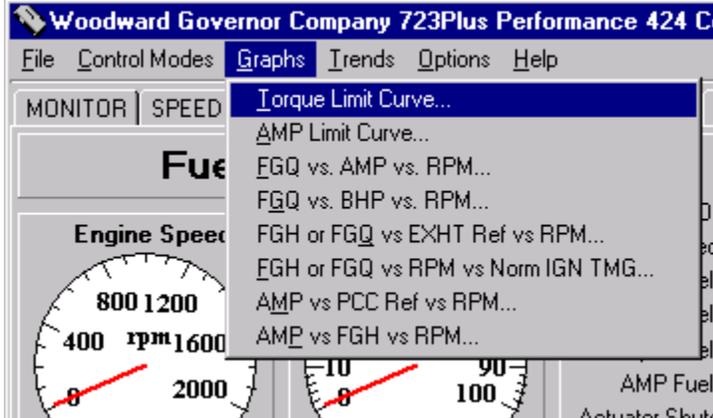
The following Torque Limit Curve screen, as well as screens for the other listed curves, are available for both viewing the curve graph and changing curve set points.
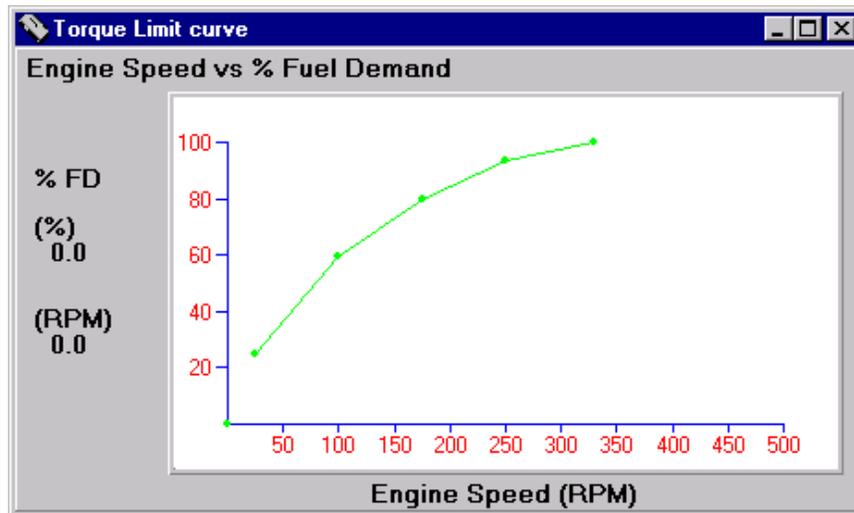
This screen shows that the Torque Limit curve is a 2D curve with 5 breakpoints. It is set to limit torque by limiting maximum fuel demand at various engine speeds. A digital display of the current x (curve input) and y (curve output) values in engineering units is included. Y in this example is the fuel limit (as a % fuel demand) based on engine speed. X is engine speed.

Holding the cursor over a curve breakpoint displays the coordinates, in (x,y) format, for that specific point as shown below.
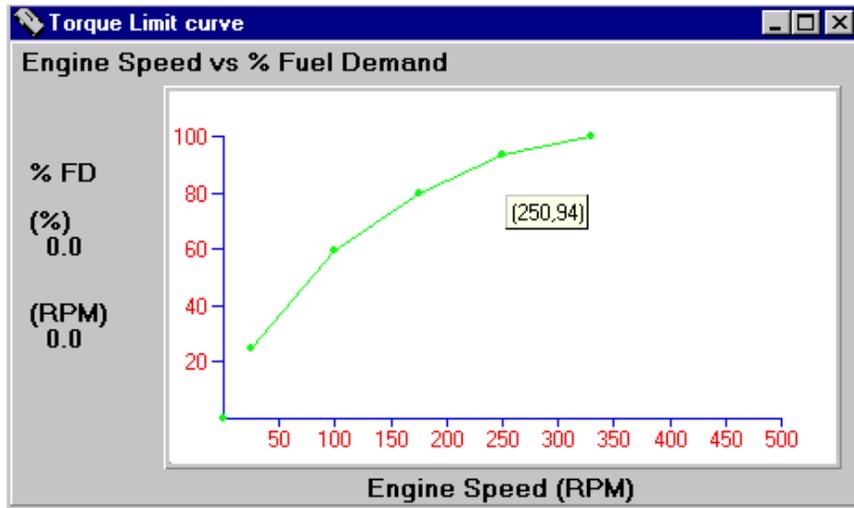
Right clicking on a breakpoint and selecting "properties" will pop up a "Point Adjustment" window for that point as shown below.
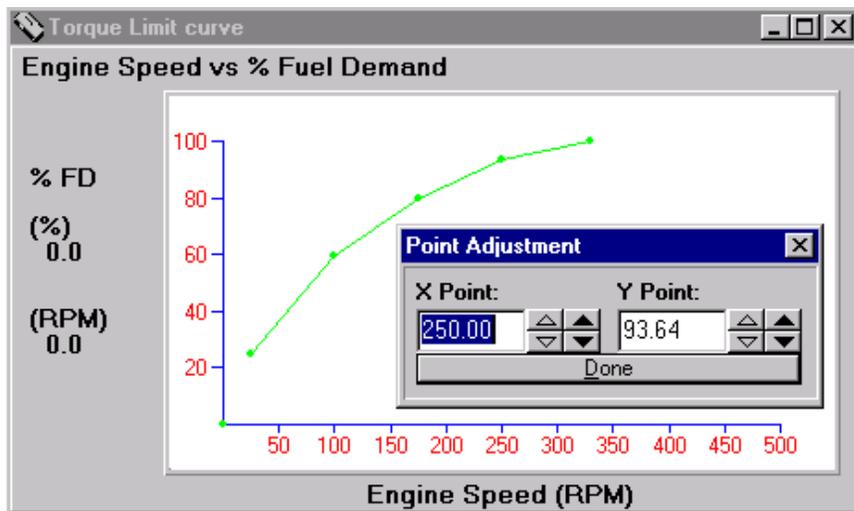
Adjustments to both the x and y breakpoint values can be made, as described earlier, by using the "turtle" and "rabbit" arrows or by typing in values and pressing the = key for the selected point. All breakpoints of all curves (2D and 3D) can be adjusted in this manner from the curve graph screens.

The following is an example of a 3D curve.
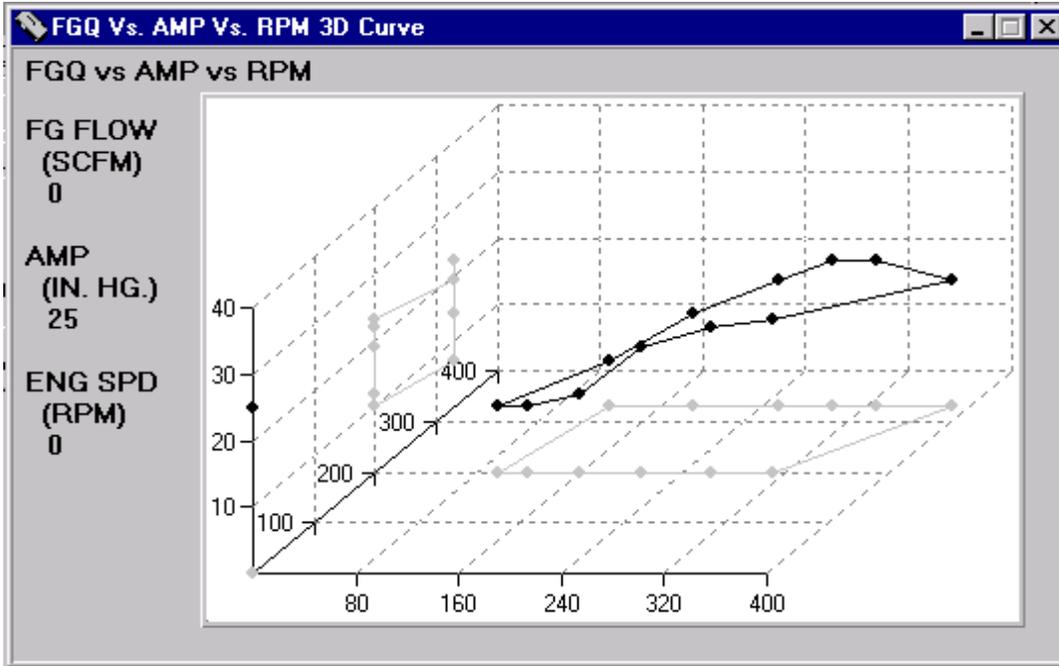
This is the fuel gas flow (FGQ) versus air manifold pressure (AMP) versus engine speed (RPM) curve in x, y, z format. X (FGQ) and Z (RPM) are curve inputs and Y (AMP) is the curve output. The x, y, z planes with grid lines are shown along with curve projections to the x and y planes. Digital displays of the present Fuel Gas Flow, Air Manifold Pressure and Engine Speed, in engineering units, are also provided.

The setup dialog for a 2D graph axes and colors is shown below.
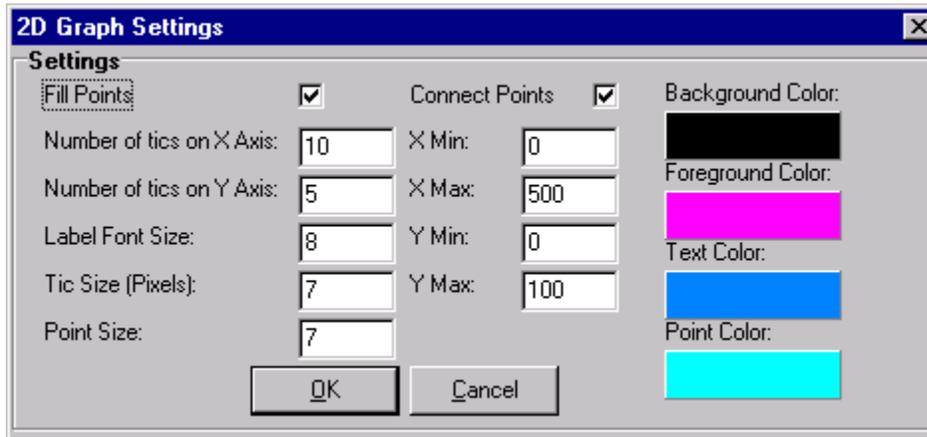
In addition, the following setup dialog for a 3D graph allows setting the angle of rotation and turning grid lines and plane projections on or off.
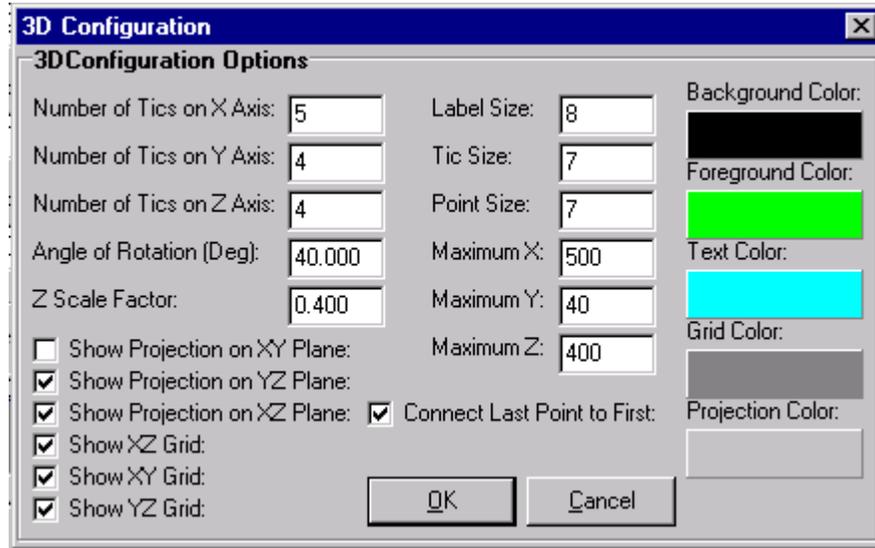
Trends
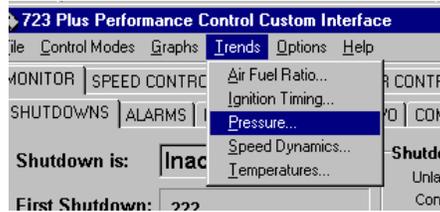
Purpose: The purpose of a Trend Graph is to provide a visual relational representation of data as it changes over time. This is especially useful when tuning an engine and when different fluctuations need to be seen and dealt with analytically.

Here is an example showing some analog inputs as well as a static value:
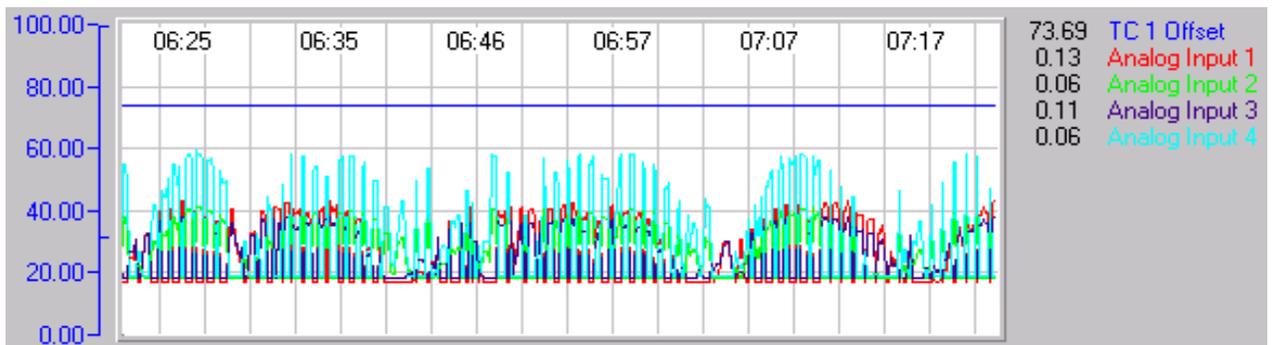
The Available Trends are listed below, with the items they contain:

Air Fuel Ratio
- Air Manifold Pressure (Hg)
- Air Manifold Pressure Reference (Hg)
- Air Fuel Ratio Valve Demand %
- Exhaust Temperature (Deg EU)
- Exhaust Temperature Reference (Deg EU)
- Exhaust Air Fuel Ratio Valve Demand %

Ignition Timing
- Ignition Timing (Deg)
- Ignition No Load Timing (Deg)
- Ignition Normal Timing (Deg)
- Ambient Torque Timing (Deg)
- Engine Speed (rpm)
- Air Manifold Pressure (EU)

Pressure
- Fuel Gas Header (EU)
- Fuel Gas Meter (EU)
- Assist Air Demand (%)
- Assist Air Reference (EU)
- Air Manifold Pressure (EU)
- Pre-Combustion Chamber Control (EU)

Speed Dynamics
- Engine Speed (rpm)
- Speed Reference (rpm)
- Turbo Speed (rpm)
- %Fuel Demand (rpm)

Temperature
- Exhaust Temperature (°F)
- Exhaust Temperature Reference (°F)
- Exhaust Stack Temperature (°F)
- Air Manifold Temperature (°F)
- Fuel Gas Meter Temperature (°F)
- Lube Oil Out Temperature (°F)

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 text description of a Trend Pen (e.g., "TC 1 Offset"), its axis will be shown on the left. Individual axis are available because different values need to be graphed on different ranges.
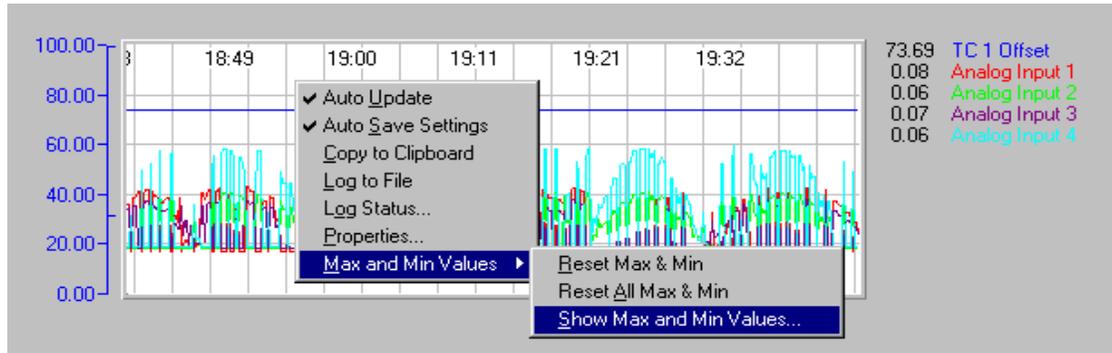
The axis provides another piece of information, the maximum and minimum value of its respective pen. This is indicated by two tic marks on the right side of the axis. When the program is first started, it initializes the values to 0, so it might be necessary to reset the Max and Min values once the program 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. The log path and file name is entered on the Trend "Properties" menu.

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

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

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

Log Status dialog:

Log Status: Inactive
Log File: e:\log2.log
Bytes a Line: 42

Lines a Second: 6.76   Bytes a Second: 284
Lines a Minute: 405.41   Bytes a Minute: 17,027
Lines an Hour: 24,324.32   Bytes an Hour: 1,021,622

Free Disk Space: 221,760K   Note: These values are
Time Elapsed: 00:14:42   estimates and are subject to
Time Available: ~222.28 Hours rounding error.

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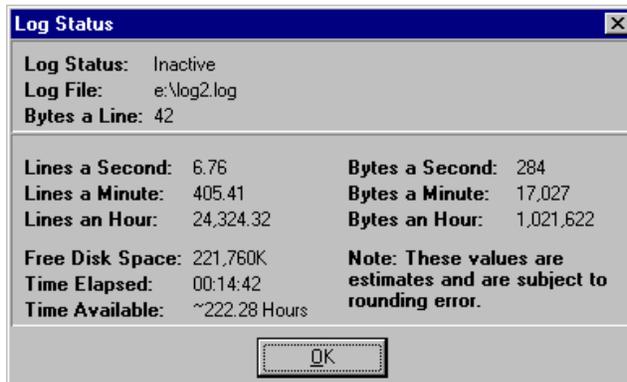
Properties: Will display this dialog.
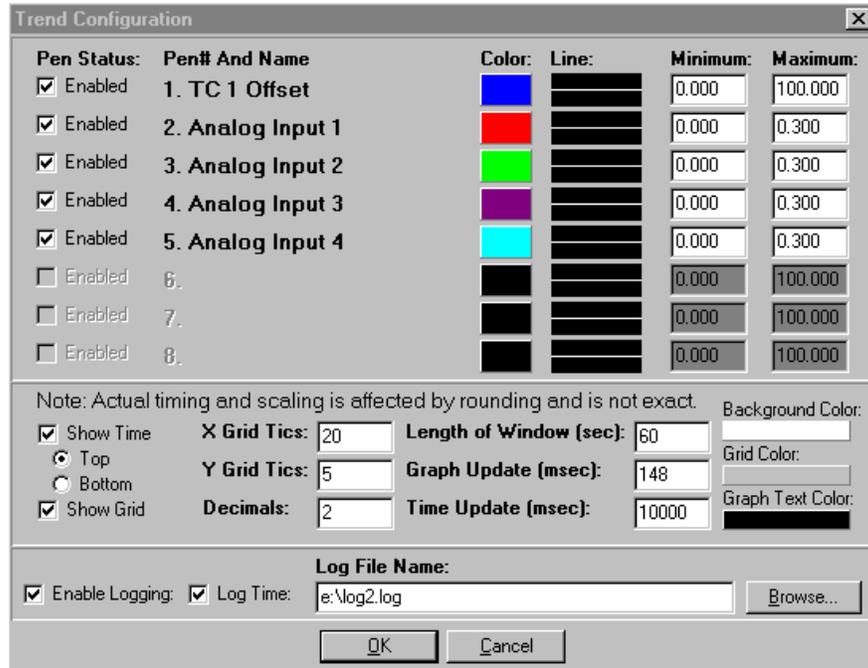
Pen X Enabled: Enables or disables graph of data for that pen. This is useful if pens are overlapping or only certain values need to be monitored or logged.

Pen X Color: Changes 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: This value and *Pen X Minimum* 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 whether 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 whether 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 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 tic 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 (the graph will not be moved at least one pixel per update) then 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 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.
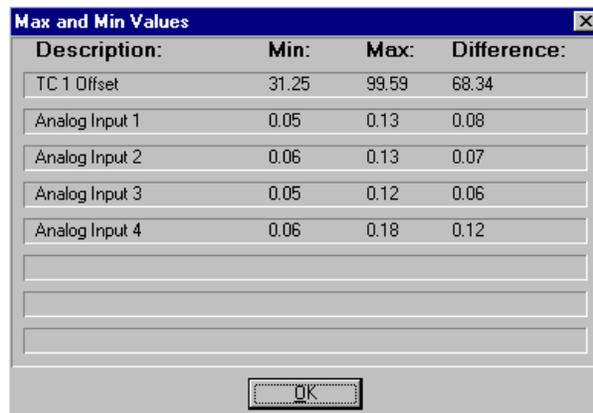
Max and Min Values			
Description:	Min:	Max:	Difference:
TC 1 Offset	31.25	99.59	68.34
Analog Input 1	0.05	0.13	0.08
Analog Input 2	0.06	0.13	0.07
Analog Input 3	0.05	0.12	0.06
Analog Input 4	0.06	0.18	0.12

OK

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):
Copyright and Disclaimer
System Requirements
Technical Support
Main Menu
- File
- Control Modes
- Graphs
- Trends
- Options
- Help
Other Menus
- Quick Menus
723 Plus Setup
- Defaults and Ranges
Troubleshooting
- Troubleshooting
Trends
- How To Setup a Trend
Graph Setup
- 2D Setup
- 3D Setup
Glossary
Default Start Screen (Graphic of Monitor Shutdown screen)

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.

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 A).

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 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.

TOGGLES BETWEEN UPPER
AND LOWER DISPLAYS

ADVANCES THROUGH
CONFIGURE OR SERVICE

MOVES BACKWARD THROUGH
CONFIGURE OR SERVICE

"TURTLE" (SLOW) KEYS —
INCREASE OR DECREASE THE
DISPLAYED SET POINT VALUE
SLOWLY.

"RABBIT" (FAST) KEYS —
INCREASE OR DECREASE THE
DISPLAYED SET POINT QUICKLY.

INCREASES OR DECREASES
SETPOINT BY ONE
STEP AT A TIME

DISPLAYS PART
NUMBER AND SOFTWARE
REVISION LEVEL.

RETURNS TO MENU HEADER
OR MAIN SCREEN

SAVES ENTERED VALUES
(SET POINTS)

MOVES BACKWARD
THROUGH EACH MENU,
ONE STEP AT A TIME.

ADVANCES THROUGH
EACH MENU, ONE
STEP AT A TIME.
ALSO SELECTS SERVICE MODE

NUMBER KEYS FOR
ENTERING EXACT
SETPOINT VALUES

SELECTS CONFIGURE MODE

FOR ENTERING EXACT
VALUES (WITHIN 10%)

FOR ACCESSING CONFIGURE
AND ENTERING SETPOINT VALUES

FOR SCROLLING LEFT AND RIGHT
THROUGH SCREEN DISPLAY

027-030
96-02-09

Figure 3-1. Hand Held Programmer Functions

Configuration Menu Descriptions

CFIG Options

1. **USE NOTCH FILTER** should be set TRUE to enable a notch filter on the speed input(s). Set FALSE to disable the notch filter.

2. **CALCULATE BHP** should be set TRUE to bring into view the service and Modbus displays of the Brake Horsepower (BHP) calculation. **Fuel flow is a required input for this calculation**. Set FALSE to disable display. Set FALSE if fuel flow is not a control input.

3. **USE PCC CONTROL** should be set TRUE to bring into view the PRECOMB SETTING menu. **Analog Output #1 must be connected and configured for PCC control**. Set FALSE if the Pre-Combustion Chamber control function is not used. **See NOTE below**.

4. **PCC LOAD INPUT SEL** determines whether Pre-Combustion Chamber pressure control is a function of the air manifold pressure or fuel gas header pressure input. Set at **1** to use the air manifold pressure input. Set at **2** to use the Fuel Gas Header Pressure input. Default is set at 1.

5. **USE TAC CONTROL** should be set TRUE to bring into view the TURBO ASSIST SETPT menu and to enable Automatic Turbocharger Air Assist Control. Two methods of control are offered. For Discrete on/off control, **Discrete Output #3 must be connected**. For Analog PID control, **Analog Output #1 must be connected and configured for TAC control**. Set FALSE to disable Automatic Turbocharger Air Assist Control and conceal the TURBO ASSIST SETPT menu. **See NOTE below.**

6. **TAC REVERSE ACTING** should be set FALSE if the Discrete Output #3 closes or the Analog Output #1 value *increases* to increase air manifold pressure. Set TRUE if the Discrete Output #3 opens or Analog Output #1 value *decreases* to increase air manifold pressure.

7. **USE IGN TMG CTRL** should be set TRUE to bring into view the Ignition Timing control configuration and service menus. Set FALSE if the Ignition Timing control function is not used.

8. **USE A/F RATIO CTRL** should be set TRUE to bring into view the Air/Fuel Ratio control configuration and service menus. Set FALSE if the Air/Fuel Ratio control function is not used.

9. **AFI START ENABLE—**Enter the engine speed (rpm) at which automatic A/F Ratio and Ignition Timing Control are activated. A/F Ratio and Ignition Timing starting settings are held at lower engine speeds.

10. **USE COMM PORT** should be set TRUE to bring into view the configuration and service menus for the Communication Ports 2 and 3. Set FALSE if the Communication Ports 2 and 3 are not used.

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

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

13. **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).

14. **MAX TORQUE (% RATED)** is set at the maximum allowable torque as a % rated. Normally this is set at 100%. However, ambient rated engines could require a higher setting. Refer to the engine nameplate to determine maximum engine torque rating.

15. **USE TORQUE LIMIT** is set TRUE to enable a Torque Fuel Limit curve. The curve applies a limit to the speed control actuator output (fuel demand) as a function of engine speed. Set FALSE to disable the Torque Fuel Limit curve.

16. **USE AMP LIMIT** is set TRUE to enable an Air Manifold Pressure Fuel Limit curve. The curve applies a limit to the speed control actuator output (fuel demand) as a function of air manifold pressure. Set FALSE to disable the AMP Fuel Limit curve.

> **IMPORTANT**   **Analog output #1 can be configured for either PCC control or TAC analog PID control, *but not both*.**

CFIG Speed Control

1. **RATED SPEED** sets the rated engine speed in rpm. Refer to the engine nameplate for the engine speed rating. This sets the Rated Speed reference selected when the Idle/Rated input switch is closed.

2. **DSPD #1 TEETH** is the number of teeth or holes in the gear or flywheel that engine speed sensor #1 is on. If the gear is running at a different speed than the engine, (e.g. one-half engine speed), then you must enter the gear ratio (e.g., one-half) times the number of teeth on the gear. The control requires the number of teeth seen by speed sensor #1 per engine revolution.

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

3. **DSPD #2 TEETH** is the number of teeth or holes in the gear or flywheel that engine speed sensor #2 is on. If the gear is running at a different speed than the engine, (e.g. one-half engine speed), then you must enter the gear ratio (e.g., one-half) times the number of teeth on the gear. The control requires the number of teeth seen by speed sensor #2 per engine revolution. ***See Turbocharger Speed detection exception NOTE below***.

4. **ASPD #2 TEETH** is the number of teeth or holes in the gear or flywheel that engine speed sensor #2 is on. If the gear is running at a different speed than the engine, (e.g. one-half engine speed), then you must enter the gear ratio (e.g., one-half) times the number of teeth on the gear. The control requires the number of teeth seen by speed sensor #2 per engine revolution. ***See Turbocharger Speed detection exception NOTE below***.

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

> **IMPORTANT**   **When MPU2 input is configured to detect Turbocharger Speed, always set ASPD #2 TEETH and DSPD #2 TEETH the same as DSPD #1 TEETH to prevent undesirable interaction between the MPU1 and MPU2 inputs. Turbocharger rpm is calculated *outside* the ASPD #2 and DMPU #2 input blocks and the relevant number of teeth are entered below.**

> **⚠WARNING** **The engine 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.**

5. **TURBO # TEETH** is the number of teeth or holes in the gear or slotted nut that the turbocharger speed sensor #2 is on. The control requires the number of teeth per turbocharger revolution.

> **IMPORTANT** **The turbocharger number of gear teeth is used by the control to convert pulses from the speed-sensing device to turbocharger rpm. Make sure the control is properly programmed to convert the gear-tooth count into turbocharger rpm for correct display and overspeed shutdown and alarm protection (if configured).**

6. **USE TURBO MPU** is set TRUE when the MPU2 input is connected as a turbocharger speed-sensing MPU. Set FALSE if the MPU2 is connected as an engine speed-sensing MPU or is not connected.

7. **RATED TURBO SPEED (RPM)** sets the turbocharger rated speed in rpm. Refer to the turbocharger nameplate for the rated turbo speed.

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

9. **TURBO SS CLEAR PRCNT** should be set to a percentage of rated turbocharger speed that will verify a valid turbocharger MPU signal exists.

10. **OIL TEMP RTD PERM (DEG F)** sets the oil warm-up temperature permissive, in °F, for rated speed. Oil temperature below this setting will block a rated speed or remote speed setting. Oil temperature above this setting permits a rated speed or remote speed setting.

11. **USE REMOTE REFERENCE** should be set TRUE to enable the remote speed reference (analog or Modbus as selected by USE REMOTE COMMANDS). Set FALSE to disable the remote speed reference.

12. **REMOTE LOCK IN LAST** is used to hold the last engine speed reference before failure when the Remote Speed input (analog or Modbus) fails. Set FALSE to disable REMOTE LOCK IN LAST. Set TRUE to enable REMOTE LOCK IN LAST.

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

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. **AMP INPUT FAILED** sets the condition which will occur when the Air Manifold Pressure 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. **FGH INPUT FAILED** sets the condition which will occur when the Fuel Gas Header OR Fuel Gas Meter Pressure input, whichever is configured and connected, 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. **FGM INPUT FAILED** sets the condition which will occur when the Fuel Gas Meter *Differential* Pressure 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. **REM INPUT FAIL** sets the condition which will occur when the Remote Speed Setting input drops below 2 mA or increases above 21 mA. This condition may be enabled as a Shutdown, Alarm, or both by selecting TRUE in the appropriate menu.

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

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

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

11. **ENGINE STALL** sets the condition which will occur when the engine speed drops below the STALL SETPOINT after achieving SS CLEAR PERCENTAGE for a tunable START TIME. This condition may be enabled as a Shutdown, Alarm, or both by selecting TRUE in the appropriate menu.

12. **HI TURBO SPD** sets the condition which will occur when the turbocharger speed rises above the HI TURBO SPD SETPT. This condition may be enabled as a Shutdown, Alarm, or both by selecting TRUE in the appropriate menu.

13. **HI OIL TEMP** sets the condition which will occur when the engine oil temperature rises above the HI OIL TEMP SETPT. This condition may be enabled as a Shutdown, Alarm, or both by selecting TRUE in the appropriate menu.

14. **HI EXH TEMP** sets the condition which will occur when the engine exhaust stack temperature rises above the HI EXH TEMP SETPT. This condition may be enabled as a Shutdown, Alarm, or both by selecting TRUE in the appropriate menu.

15. **HI AIR TEMP** sets the condition which will occur when the air manifold temperature rises above the HI AIR TEMP SETPT. This condition may be enabled as a Shutdown, Alarm, or both by selecting TRUE in the appropriate menu.

CFIG Indication

1. **ON START FUEL LIMIT** is set TRUE to display this fuel limit condition on the DISPLAY INDICATOR menu. Set FALSE to prevent display.

2. **ON MAX LIMIT** is set TRUE to display this fuel limit condition on the DISPLAY INDICATOR menu. Set FALSE to prevent display.

3. **ON TORQUE LIMIT** is set TRUE to display this fuel limit condition on the DISPLAY INDICATOR menu. Set FALSE to prevent display.

4. **ON AMP LIMIT** is set TRUE to display this fuel limit condition on the DISPLAY INDICATOR menu. Set FALSE to prevent display.

5. **ACTUATOR SHUTDOWN** is set TRUE to display this fuel limit condition on the DISPLAY INDICATOR menu. Set FALSE to prevent display.

6. **SPEED SWITCH 1** is set TRUE to display this speed switch 1 condition on the DISPLAY INDICATOR menu. Set FALSE to prevent display.

7. **SPEED SWITCH 2** is set TRUE to display this speed switch 2 condition on the DISPLAY INDICATOR menu. Set FALSE to prevent display.

Shutdown Setup

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

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

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

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

5.   **STALL SETPOINT**—Enter the engine speed stall level (rpm) required to trigger the ENGINE STALL shutdown.

6.   **STALL HYSTER**—Enter the engine speed hysteresis level (rpm above the stall level) required to clear the ENGINE STALL shutdown.

7.   **ENG STALL DELAY**—Enter the delay time (in seconds) to wait before the ENGINE STALL shutdown is issued after engine speed drops below the STALL SETPOINT.

8.   **HI TURBO SPD SETPT**—Enter the turbocharger speed fault level (rpm) required to trigger the HI TURBO SPD SD.

9.   **HI TURBO SPD DELAY**—Enter the delay time (in seconds) to wait before the HI TURBO SPD SD is issued after turbocharger speed exceeds the HI TURBO SPD SETPT.

10. **HI OIL TEMP SETPT**—Enter the engine oil temperature level (°F) required to trigger the HI OIL TEMP SD.

11. **HI OIL TEMP DELAY**—Enter the delay time (in seconds) to wait before the HI OIL TEMP SD is issued after engine oil temperature exceeds the HI OIL TEMP SETPT.

12. **HI EXH TEMP SETPT**—Enter the exhaust temperature level (°F) required to trigger the HI EXH TEMP SD.

13. **HI EXH TEMP DELAY**—Enter the delay time (in seconds) to wait before the HI EXH TEMP SD is issued after engine oil temperature exceeds the HI EXH TEMP SETPT.

14. **HI AIR TEMP SETPT**—Enter the air manifold temperature level (°F) required to trigger the HI AIR TEMP SD.

15. **HI AIR TEMP DELAY**—Enter the delay time (in seconds) to wait before the HI AIR TEMP SD is issued after air manifold temperature exceeds the HI AIR TEMP SETPT.

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

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

Alarm Setup

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

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

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

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

5. **STALL SETPOINT**—Enter the engine speed stall level (rpm) required to trigger the ENGINE STALL alarm.

6. **STALL HYSTER**—Enter the engine speed hysteresis level (rpm above the stall level) required to clear the ENGINE STALL alarm.

7. **ENG STALL DELAY**—Enter the delay time (in seconds) to wait before the ENGINE STALL alarm is issued after engine speed drops below the STALL SETPOINT.

8. **HI TURBO SPD SETPT**—Enter the turbocharger speed fault level (rpm) required to trigger the HI TURBO SPD ALARM.

9. **HI TURBO SPD DELAY**—Enter the delay time (in seconds) to wait before the HI TURBO SPD ALARM is issued after turbocharger speed exceeds the HI TURBO SPD SETPT.

10. **HI OIL TEMP SETPT**—Enter the engine oil temperature level (°F) required to trigger the HI OIL TEMP ALARM.

11. **HI OIL TEMP DELAY**—Enter the delay time (in seconds) to wait before the HI OIL TEMP ALARM is issued after engine oil temperature exceeds the HI OIL TEMP SETPT.

12. **HI EXH TEMP SETPT**—Enter the exhaust temperature level (°F) required to trigger the HI EXH TEMP ALARM.

13. **HI EXH TEMP DELAY**—Enter the delay time (in seconds) to wait before the HI EXH TEMP ALARM is issued after engine oil temperature exceeds the HI EXH TEMP SETPT.

14. **HI AIR TEMP SETPT**—Enter the air manifold temperature level (°F) required to trigger the HI AIR TEMP ALARM.

15. **HI AIR TEMP DELAY**—Enter the delay time (in seconds) to wait before the HI AIR TEMP ALARM is issued after air manifold temperature exceeds the HI AIR TEMP SETPT.

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

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

Indication Setup

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

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

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

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

IMPORTANT	**Setting Speed Switch Pickup above Dropout will set the output TRUE when speed is above the pickup setting and FALSE when below Dropout. Setting Speed Switch Dropout above Pickup will set the output FALSE when above Dropout and TRUE when speed is below the pickup setting.**

CFIG A/F Ratio

1. **A/F REV ACTING** is set TRUE for reverse acting Air/Fuel Ratio actuator action (i.e., *increasing* output *decreases* air manifold pressure). Set FALSE for direct acting Air/Fuel Ratio actuator action (i.e., *increasing* output *increases* air manifold pressure). Default is TRUE.

2. **USE FUEL FLOW A/F** is set TRUE for Fuel Flow sensing Air/Fuel Ratio control. Set FALSE for Fuel Gas Header Pressure sensing Air/Fuel Ratio control.

IMPORTANT	**Analog Inputs #2 and #3 must be connected to the correct transmitter types and sensing locations for the A/F Ratio configuration setting entered.**

IMPORTANT	**Fuel flow Configuration parameters are not applicable if USE FUEL FLOW A/F is set FALSE and may be ignored. All flow configuration parameters must be entered for proper operation if USE FUEL FLOW A/F is set TRUE.**

3. **ORIFICE COEFFICIENT**—Enter the Orifice Plate Flow Coefficient (if Fuel Flow is configured) based on the original Orifice Sizing calculation sheet. Coefficient must be set to calculate flow in SCFM. The flow coefficient is **C** in the following equation:

$$Q = C \sqrt{(P \times H_w / T)}$$

where: Q = Fuel Gas Flow (**SCFM**)

         P = Fuel Gas Meter run static pressure (**PSIA**)

         H_w = Orifice differential pressure (**inches of water**)

         T = Fuel Gas Meter run flowing temperature (**°R**)

All flow coefficients from the Orifice Sizing calculation sheet **must be included in C**.

4. **ABSOLUTE PRESS**—Enter the average site atmospheric pressure to convert the Fuel Gas Meter run static pressure from PSIG to PSIA. Enter zero if an absolute pressure transmitter is provided instead of a gauge pressure transmitter for the Fuel Gas Meter run static pressure input.

5. **ABSOLUTE TEMP—**Enter **459.7** to convert the Fuel Gas Meter run flowing temperature input from **°F** to **°R**. This value is tunable to allow the use of **°C** as the temperature input units for **custom software** adaptations, however, the control cannot be configured to read **°C** as the temperature input units for the **standard software** configuration.

6. **FUEL GAS BASE BTU**—Enter the base fuel gas BTU Low Heating Value dry (LHV_{dry}) used to establish Brake Specific Fuel Consumption (BSFC) during original engine production testing. This base fuel gas BTU LHV_{dry} is used to correct the fuel gas flow calculation (used in the A/F Ratio control and Torque computing) for actual site fuel gas BTU LHV_{dry}.

7. **NO FUEL MTR PR XMTR** is set TRUE if a Fuel Gas Meter run static pressure transmitter *is not* provided in the application. Set FALSE if a Fuel Gas Meter run static pressure transmitter *is* provided in the application.

8. **FUEL MTR PRESS**—If the NO FUEL MTR PR XMTR is set TRUE, enter the actual Fuel Gas Meter run static pressure (PSIG). Use an accurate test gauge to measure the Fuel Gas Meter run static pressure.

9. **NO FUEL MTR TMP T/C** is set TRUE if a Fuel Gas Meter run flowing temperature thermocouple input *is not* provided in the application. Set FALSE if a Fuel Gas Meter run flowing temperature thermocouple *is* provided in the application.

10. **FUEL MTR TEMP**—If the NO FUEL MTR TMP T/C is set TRUE, enter the actual Fuel Gas Meter run flowing temperature (°F). Use an accurate thermometer to measure the Fuel Gas Meter run flowing temperature.

11. **USE EXH TEMP A/F** is set TRUE to choose engine exhaust stack temperature Air/Fuel Ratio control. Air/ Fuel ratio is adjusted in this type of control to achieve a tunable exhaust temperature set point which varies with changes in engine speed and load. Increasing air manifold pressure decreases exhaust temperature and conversely decreasing air manifold pressure increases exhaust temperature. The set point is generated by a 3D curve. The normal Air/Fuel Ratio control (based on either fuel gas header pressure or fuel gas flow) acts as a low air manifold pressure limit and will override the exhaust temperature set point in the event it attempts to drive air manifold pressure too low. Set FALSE to disable exhaust stack temperature Air/Fuel Ratio control.

12. **LOCK IN LAST** is set TRUE to lock in the last Air/Fuel Ratio Reference upon failure of any reference input signal. Set FALSE to disable the lock in last which enables a tunable default Air/Fuel Ratio reference for manual reference control. Failure of the air manifold pressure input signal disables the lock in last function and sets the A/F Ratio control for maximum air (exhaust wastegate fully closed or air throttle fully open).

13. **AFV MIN TRVL** sets a low limit for the Air/Fuel Ratio valve (exhaust wastegate or air throttle) travel. NOTE: This low limit is reversed when A/F REV ACTING is TRUE. (e.g., a 10% min travel setting actually limits the travel to 100% – 10% = 90%). This setting limits valve travel toward the minimum air position regardless of the action setting.

14. **AFV MAX TRVL** sets a high limit for the Air/Fuel Ratio valve (exhaust wastegate or air throttle) travel. NOTE: This high limit is reversed when A/F REV ACTING is TRUE. (e.g., a 90% max travel setting actually limits the travel to 100% – 90% = 10%). This setting limits valve travel toward the maximum air position regardless of the action setting.

CFIG Ign Tmg

1. **IGN TMG REV ACTING** is set FALSE for direct acting Ignition Timing output action (i.e., *increasing* mA output *retards* ignition timing). Set TRUE for reverse acting Ignition Timing output action (i.e., *increasing* mA output *advances* ignition timing). Default is FALSE.

2. **START IGN TIMING**—Enter the required Ignition Timing to be used during engine starting in degrees before top dead center (°BTDC). A negative setting will set Ignition Timing after top dead center (°ATDC). Maximum ignition timing advance and retard limits will override settings outside these limits. The Start Ignition Timing setting is enabled below the AFI START ENABLE engine speed setting and disabled above this speed setting.

3. **MAX IGN ADVANCE**—Enter the maximum allowable ignition timing advance in degrees before top dead center (°BTDC). Refer to the Engine Builders Operating Manual for this setting. This sets the limit in the control for maximum ignition timing advance.

> **IMPORTANT**
>
> **The engine mounted ignition timer must be set to provide the correct ignition timing from full advance to full retard when the control calls for these settings. Always use a timing light to verify the actual engine ignition timing matches the controls ignition timing output signal.**

CFIG Communication

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

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

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

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

CFIG Analog Outputs

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

1. **AOUT 1 SELECT** determines which parameter controls Analog Output #1. The parameters which can be selected are:
    1–Engine Speed
    2–Engine Speed Reference
    3–Fuel Actuator Demand
    4–Customer Modbus Write (J3 Modbus Address 4:0011)
    5–Turbocharger Speed
    6–Air Manifold Pressure
    7–Fuel Gas Header Pressure **or** Fuel Gas Meter Pressure (whichever is connected to AI2)
    8–Air/Fuel Ratio Reference
    9–Air/Fuel Ratio Actuator Position
    10–Ignition Timing Reference
    11–Air Manifold Temperature
    12–Exhaust Temperature
    13–Fuel Gas Flow
    14–Turbo Assist PID Control Signal
    15–Pre-Combustion Chamber Control Signal
    16–Remote Engine Speed Reference

IMPORTANT	Only one Analog Output selection may be made. Do NOT attempt to configure the control for multiple control functions (such as Turbo Assist PID Control *and* Pre-Combustion Chamber Control). The choice is one or the other function and *not both*.

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

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

4. **ACT OUT 1 4–20 mA** scales the Analog Output #3 for 0 to 200 mA or 4 to 20 mA. A value of FALSE will scale the output for 0 to 200 mA. A value of TRUE will scale the output for 4 to 20 mA. Note that an internal hardware jumper must be configured if this item is changed.

5. **ACT OUT 2 4–20 mA** scales the Analog Output #4 for 0 to 200 mA or 4 to 20 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 200 mA. Note that an internal hardware 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 the 723PLUS Performance '424' 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/Alarm

These display menus are normally hidden and come into view when a shutdown or alarm condition exists. The display of first out status and faulted or normal condition of all configured shutdowns and alarms may then be viewed. Refer to the CFIG Shutdown/Alarms Menus for a listing of configurable shutdowns and alarms.

Speed Ctrl Dynamics

Dynamic adjustments are settings that affect the stability and transient performance of the engine. There is only one set of effective dynamics provided. The following descriptions of each menu item apply. Also see Figures 3-2, 3-3, and 3-4.

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

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

3. **SC 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. SC Reset is adjusted to prevent slow hunting and to minimize speed overshoot after a load disturbance.

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

5. **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 Min and Rated Gain set points 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.)

6. **WINDOW WIDTH** is the magnitude (in rpm) of a Compensated speed error (Ec) at which the control automatically switches to fast response. The control uses the absolute value of Compensated speed error (Ec) to make this switch. The absolute value is the difference between the speed reference (Nr) and the Compensated speed (Nc). A Window Width too narrow will result in cycling that always turns on the Gain Ratio. (See Figure 3-2.)

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

8. **GAIN SLOPE** changes Gain as a function of actuator output. Since actuator output is proportional to engine load, this adjustment 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.)

9. **SS1 SPEED FILTER** 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.**

---

10. **SS2 SPEED FILTER** adjusts the cutoff frequency of a low pass filter used on the turbo speed sensing input (see Figure 3-5). This filter is used to attenuate the turbo speed input separately from the engine speed input. The filter is activated during configuration by setting USE TURBO MPU to TRUE in the CFIG Speed Control menu. To use this feature set the cutoff frequency below 15.9 Hz. Normally attenuation of the turbo speed signal will not be necessary. However, some noise attenuation may be needed.
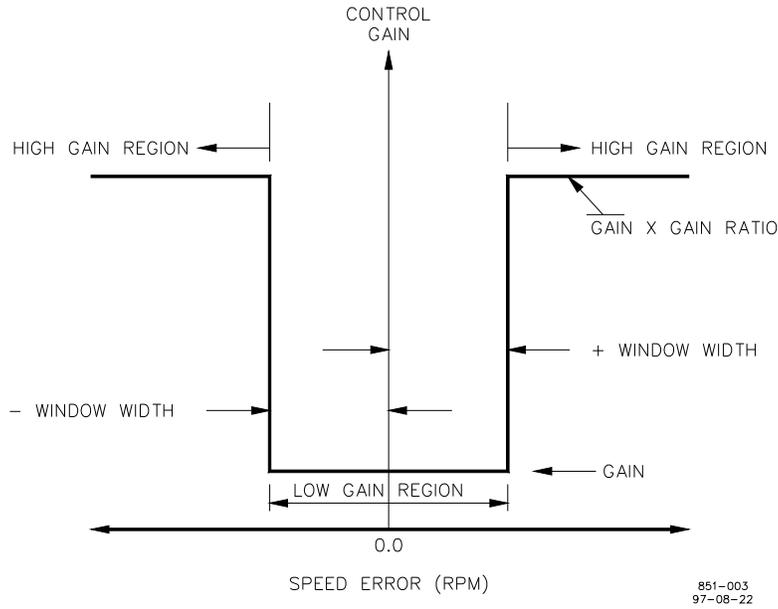

Figure 3-2. Control Gain as a Function of Speed Error
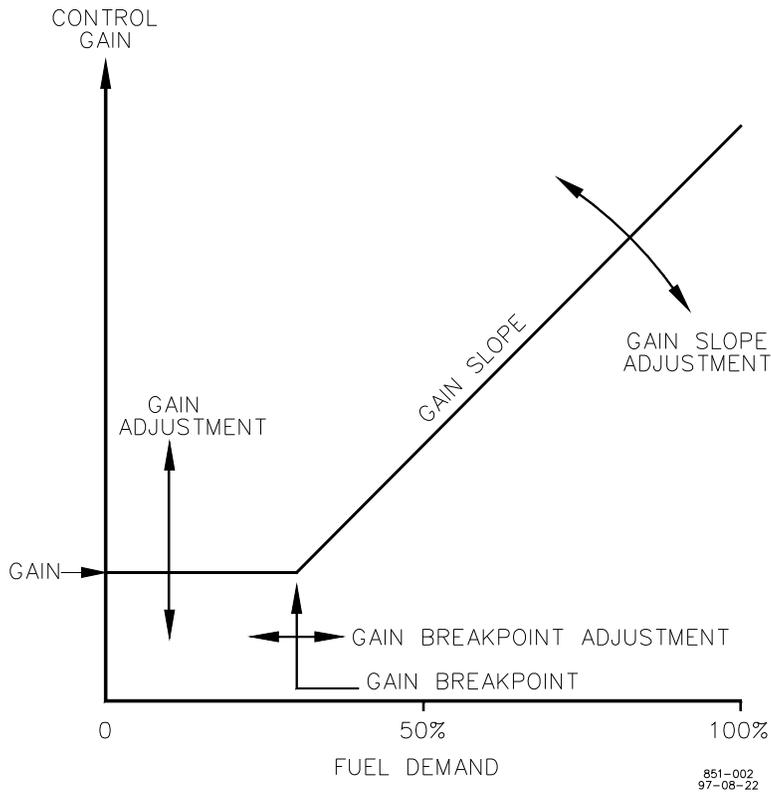
Figure 3-3. Control Gain as a Function of Control Output

RESULTS — GAIN AND RESET ADJUSTMENTS

SPEED   Gain is too high and reset too low. There are secondary
          overshoots on transients and large overshoots on starts.

SPEED   Gain is slightly high and reset is slightly too low. Optimum
          performance on load transients with slight overshoot on starts.

SPEED   Gain is slightly too low and reset is slightly high.
          Optimum performance on start with slight time
          extension of load transients.

SPEED   Gain is too low and reset is too high.
          Takes a long time to settle to rated speed.

IDEAL LOAD STEP RESPONSE
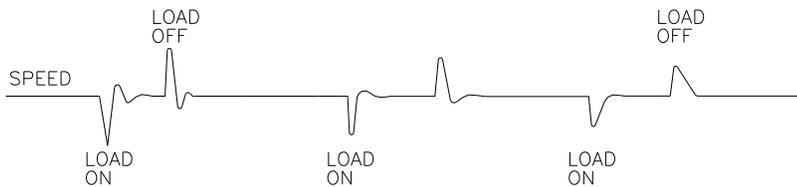
RESULTS — COMPENSATION ADJUSTMENT

NOTE: Increased actuator line width
       indicating a more active
       linkage as compensation
       is increased.

Use compensation to achieve most stable engine speed.
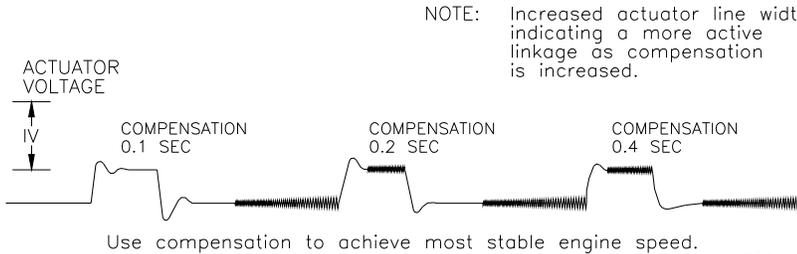
851—004c
97—12—19 skw

Figure 3-4. Typical Transient Response Curves
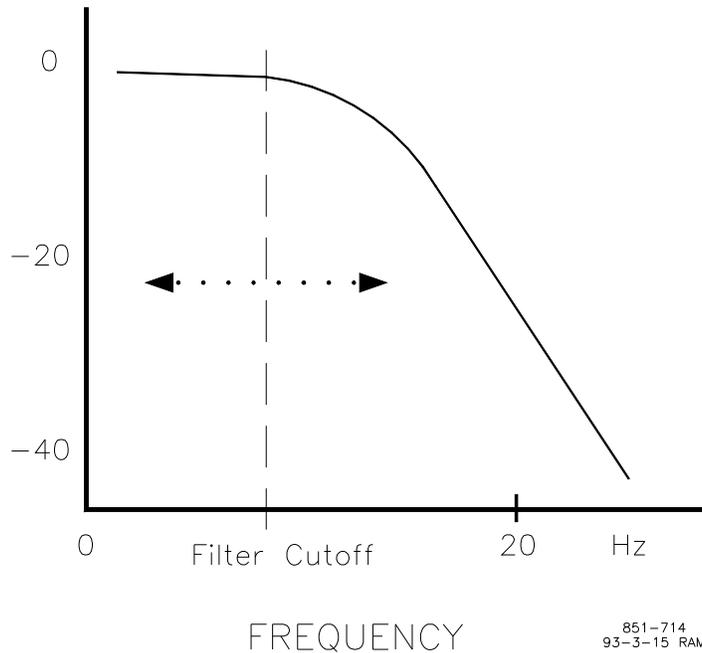
Figure 3-5. Speed Filter

Notch Filter

The notch filter is a bandstop filter. It rejects specific frequencies and allows 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 damp 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.

> ⚠️ **WARNING**   **To use the notch filter, make sure that the speed sensor(s) used are only on the engine side of the flexible coupling.**

There are two adjustments—**NOTCH FILT FREQ** and **NOTCH Q FACTOR**. (See Figure 3-6.)

11. **NOTCH FILT FREQ** is the center frequency of rejection in Hertz. The notch filter is activated by setting USE NOTCH FILTER to TRUE in the CFIG Options menu. In tuning the notch filter, the resonant frequency must be identified and entered. The allowed frequency range of the notch filter is 0.01 to 16.0 Hz.

12. **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 of 0.707, there is no attenuation of signal gain at the resonant frequency, and the filter gain equals one. At a value of 20.0, a maximum attenuation of the 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.
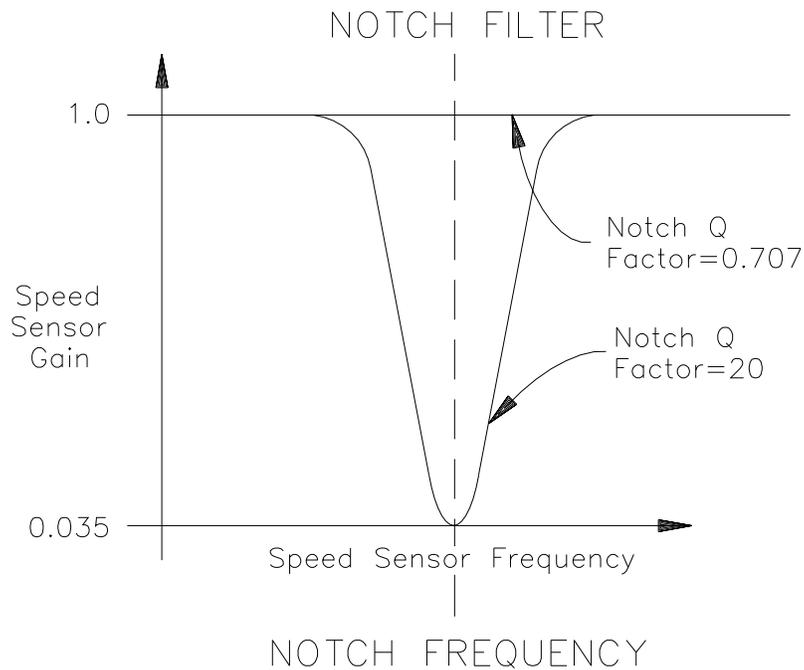
NOTCH FILTER

028-056
98-07-01 skw

Figure 3-6. Notch Filter

13. **DSPLY SPD FILTER** is a low-pass filter that is set to generate a delay in the Displayed Engine Speed only to smooth out the displayed value. Setting does not affect the speed control speed signal. Default setting is 1.0. A lower setting will be more responsive. A higher setting will be more stable.

14. **BUMP FUEL 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 FUEL ACTUATOR BUMP menu. To initiate an actuator bump, toggle Bump Fuel 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.

Speed Setting Menu

Speed adjustments are the settings that affect the speed reference.

1. **RAISE SPEED LIMIT** is the maximum speed reference setting. It is used to limit the Raise Speed and Remote Speed Setting inputs to a maximum. It is normally set at rated speed. Setting can be temporarily increased to test the overspeed trip device setting.

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

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

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

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

4. **START SPEED** is the initial speed reference for the speed control prior to starting. A ramp from the Start Speed to Idle or Rated, whichever is selected and permissive, begins when the engine accelerates, on starting fuel, to the Start Speed setting. The ramp time is the ACCEL RAMP TIME or the DECEL RAMP TIME setting as determined by the Idle/Rated selection and permissives.

5. **START TIME** is the time needed for the engine to reliably exceed the stall speed setting after the engine starts to crank (5% rated). Field set to prevent false stall shutdowns. Do not set too high since the stall shutdown is bypassed during this time.

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

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

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 inertia allows the engine to slow down. This condition is indicated by the control actuator output going to the minimum fuel position.**

8. **RAISE SPEED RATE** is the rate at which the speed reference is ramped when using the Raise Speed input or the Remote Speed Setting input to change speed 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.

9. **LOWER SPEED RATE** is the rate at which the speed reference is ramped when using the Lower Speed input or the Remote Speed Setting input to change speed 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.

10. **WARMUP TIME** is a *backup* delay time to wait for warm-up once the engine reaches running speed. Normally the lube oil temperature input is used to determine whether the engine is warm or not. However, the WARMUP TIME is used when the lube oil temperature input fails.

Fuel Limiters

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

1. **START FUEL LIMIT** limits the percent fuel demand when the engine is started. The limit is usually set at the fuel level required to start the engine. The limiter is disabled when the engine speed exceeds 95% of the speed reference and the Speed Control PID is in control for 1 second (see Figure 3-7).
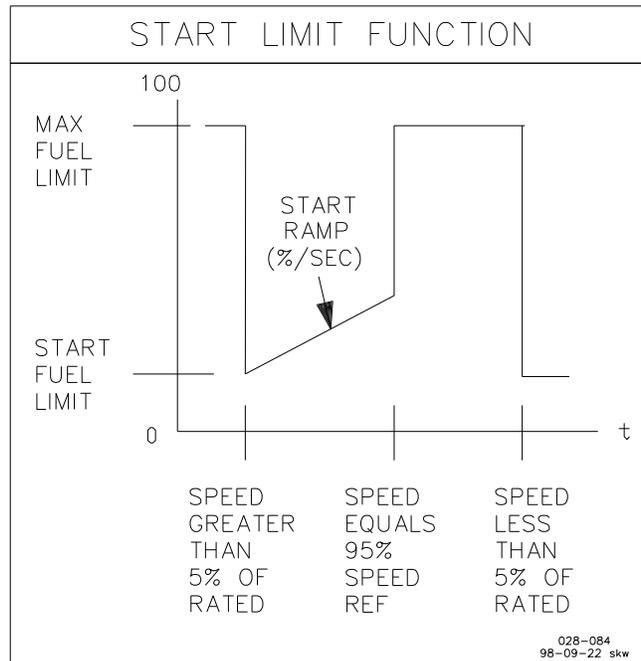

Figure 3-7. Start Limit Function

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

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

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 display value. The **span** should be adjusted so that the *maximum input* or *output* produces the correct mA value. Values are shown on the DISPLY I/O menu. 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. **AMP AI OFFSET** adjusts the min displayed AI1 Air Manifold Pressure mA.

2. **AMP AI SPAN** adjusts the max displayed AI1 Air Manifold Pressure mA.

3. **AMP READ VOLTS** when TRUE changes the displayed AI1 Air Manifold Pressure mA to read Volts instead.

4. **FGH AI OFFSET** adjusts the min displayed AI2 Fuel Gas Header *or* Fuel Gas Meter pressure mA.

5. **FGH AI SPAN** adjusts the max displayed AI2 Fuel Gas Header *or* Fuel Gas Meter pressure mA.

6. **FGH READ VOLTS** when TRUE changes the displayed AI1 Fuel Gas Header *or* Fuel Gas Meter pressure to read Volts instead.

7. **FGM AI OFFSET** adjusts the min displayed AI3 Fuel Gas Meter differential pressure mA.

8. **FGM AI SPAN** adjusts the max displayed AI3 Fuel Gas Meter differential pressure mA.

9. **FGM READ VOLTS** when TRUE changes the displayed AI1 Fuel Gas Meter differential pressure to read Volts instead.

10 **REM SPD REF OFFSET** adjusts the min displayed AI4 Remote Speed Ref mA.

11. **REM SPD REF SPAN** adjusts the max displayed AI4 Remote Speed Ref mA.

12. **REM READ VOLTS** when TRUE changes the displayed AI4 Remote Speed Ref mA to read Volts instead.

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

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

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

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

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

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

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

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

Fuel Actuator Bump

This menu allows activation and adjustment of the Fuel Actuator Bump Function. This function allows you to test your dynamics setting by putting a temporary limiter in the system, causing a speed/load disturbance. To activate the function the FUEL BUMP ENABLE must be set to TRUE and DYNAMICS - BUMP FUEL ACT must also be toggled to TRUE.

1. **FUEL BUMP ENABLE** enables the Actuator bump function for a period of 30 minutes.

2. **FUEL ACT BUMP LEVEL** sets the magnitude of the bump fuel limiter. A higher value will cutoff the fuel more, causing a larger 'bump'.

3. **FUEL ACT BUMP DURTN** sets the duration of the bump fuel limiter. A higher value will cutoff the fuel for a longer time, causing a longer 'bump'.

TORQUE LIMIT Curve

Torque Limiter limits the fuel demand based on a two-dimensional curve and an engine speed input. This fuel limit prevents overfueling and limits torque for up to five speed breakpoints. The input breakpoints units are in rpm. The fuel limits are in percent fuel demand. Fuel demand is generally set slightly above the fuel required to carry the allowable load for each specific breakpoint rpm. Too low a setting can degrade transient load performance.

A five-point curve is constructed for rpm versus Fuel Demand. Refer to Figure 3-8. The 'X' values are the Breakpoints and the 'Y' values are the Fuel Limit at the Breakpoints. All values between the designated breakpoints are interpolated.

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

2. **TORQUE LMT BRKPNT X** is the engine speed, in RPM, that designates that particular breakpoint (x-axis input in Figure 3-8).

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

AMP LMT Curve

Air Manifold Pressure Limiter limits the fuel demand based on a two-dimensional curve and an air manifold pressure 4–20 mA input. This function is mainly used to limit fuel demand during a sudden load increase to prevent overfueling due to turbocharger lag as sensed by the air manifold pressure. 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 builders recommended settings for AMP versus Fuel Demand. Refer to Figure 3-8. The 'X' values are the Breakpoints and the 'Y' values are the Fuel Limit at the Breakpoints. All values between the designated breakpoints are interpolated.

1. **ENABLE AMP FUEL LMT** enables and disables the fuel limiter, which uses the Air Manifold Pressure input to limit the actuator output. If the fuel limiter is disabled, the fuel limiter breakpoint settings will not be used.

2. **AMP LMT INPUT X** is the Air Manifold Pressure value, in engineering units, that designates that particular breakpoint (x-axis input in Figure 3-8).
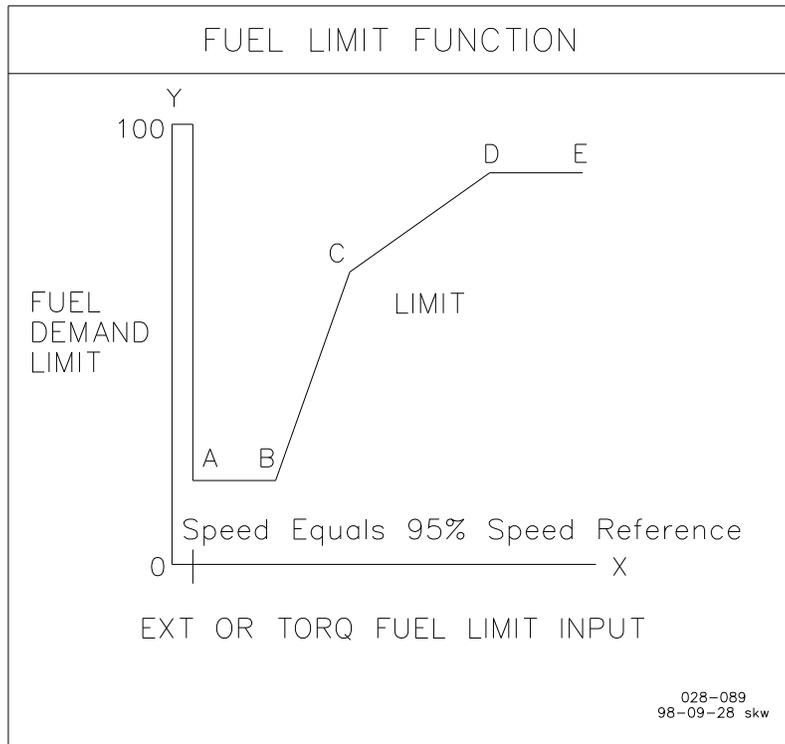
Figure 3-8. Fuel Limit Breakpoints

3. **FUEL LIMIT @ X** is the percent fuel demand allowed when the Air Manifold Pressure is at that respective Breakpoint (y-axis output in Figure 3-8).

AFR Ctrl Dynamics

1. **AFRC GAIN** determines how fast the control responds to an error in air manifold pressure from the air manifold pressure reference setting. The AFRC Gain is set to provide stable control of the air manifold pressure at all operating conditions.

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

3. **AFRC DERIVATIVE** is the time-derivative component of the PID response. This field is used only when derivative control action is desired. A default setting of .01 disables the derivative function (The Controller is Input Dominant). Increase setting to increase PID time-derivative.

4. **AFRC THRESHOLD** is the difference between air manifold pressure and the air manifold pressure reference which sets the PID output level to –1% when the PID is not in control. This threshold difference shifts the PID output out of the way of a higher limiting signal until the PID is back in control. Default setting is 0.1. A higher setting will keep the PID in control until the higher difference is reached.

5. **AMP FILTER** is a low-pass filter which is set to generate a delay in the Air Manifold pressure input to smooth out the signal by ignoring noise from the input. Default setting is 0.1. A lower setting will be more responsive but may be too unstable. A higher setting will be more stable but may be too unresponsive.

6. **FGH FILTER** is a low-pass filter which is set to generate a delay in the Fuel Gas Header pressure or the Fuel Gas Meter pressure input (whichever is configured and connected) to smooth out the signal by ignoring noise from the input. Default setting is 0.1. A lower setting will be more responsive but may be too unstable. A higher setting will be more stable but may be too unresponsive.

7. **FGM FILTER** is a low-pass filter which is set to generate a delay in the Fuel Gas Meter differential pressure input to smooth out the signal by ignoring noise from the input. Default setting is 0.3. A lower setting will be more responsive but may be too unstable. A higher setting will be more stable but may be too unresponsive.

8. **REM FILTER** is a low-pass filter which is set to generate a delay in the Remote Speed Reference input to smooth out the signal by ignoring noise from the input. Default setting is 0.1. A lower setting will be more responsive but may be too unstable. A higher setting will be more stable but may be too unresponsive.

9. **AMT FILTER** is a low-pass filter which is set to generate a delay in the Air Manifold temperature input to smooth out the signal by ignoring noise from the input. Default setting is 1.0. A lower setting will be more responsive but may be too unstable. A higher setting will be more stable but may be too unresponsive.

10. **FGQ FILTER** is a low-pass filter which is set to generate a delay in the Fuel Gas Flow calculated value to smooth out the calculated signal. Default setting is 0.1. A lower setting will be more responsive but may be too unstable. A higher setting will be more stable but may be too unresponsive.

11. **FGT FILTER** is a low-pass filter which is set to generate a delay in the Fuel Gas temperature input to smooth out the signal by ignoring noise from the input. Default setting is 2.0. A lower setting will be more responsive but may be too unstable. A higher setting will be more stable but may be too unresponsive.

12. **EXHT FILTER** is a low-pass filter which is set to generate a delay in the Exhaust Stack temperature input to smooth out the signal by ignoring noise from the input. Default setting is 2.0. A lower setting will be more responsive but may be too unstable. A higher setting will be more stable but may be too unresponsive.

13. **BUMP WSTGATE ACT** allows you to test your Air/Fuel Ratio dynamics settings by temporarily applying an increased air manifold pressure demand transient to stimulate a control response. Both the magnitude (AFR Act Bump Level) and duration (AFR Act Bump Duration) of the transient may be set. See the AFR ACTUATOR BUMP menu. To initiate an actuator bump, AFR BUMP ENABLE must be set TRUE, then toggle BUMP WSTGATE ACT to TRUE then back to FALSE while the engine is operating in a normal steady state loaded condition. Air/Fuel Ratio control is not active at low air manifold pressure. Some load is needed to achieve this minimum setting. Reset AFR BUMP ENABLE back to FALSE when dynamics are set.

AFR Actuator Bump

This menu provides a means of activating and adjusting the Air/Fuel Ratio (AFR) Actuator Bump Function. This function allows you to test your AFR dynamics setting by temporarily creating an increased air manifold pressure disturbance. To activate this function the BUMP ENABLE must be set to TRUE and Dynamics, BUMP WSTGATE ACT must also be toggled to TRUE.

1. **AFR BUMP ENABLE** enables the AFR Actuator bump function for a period of 30 minutes.

2. **AFR ACT BUMP LEVEL** sets the magnitude of the AFR Actuator demand (%). A higher value will move the actuator further and increase air manifold pressure more, causing a larger 'bump'.

3. **AFR ACT BUMP DURATN** sets the duration of the AFR Actuator demand. A higher value will increase air manifold pressure for a longer time, causing a longer 'bump'.

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. **REM SR @4mA EU (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.

2. **REM SR @20mA EU (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.

3. **AMP @4mA EU (in Hg)—**Enter the input pressure, in inches of mercury, at 4 mA from the air manifold pressure sensing device. If a voltage sensing device is provided, enter the input pressure at 1 Vdc.

4. **AMP @20mA EU (in Hg)—**Enter the input pressure, in inches of mercury, at 20 mA from the air manifold pressure sensing device. If a voltage sensing device is provided, enter the input pressure at 5 Vdc.

5. **FGH @4mA EU (PSI)—**Enter the input pressure, in psig, at 4 mA from the fuel gas header pressure *or* fuel gas meter pressure sensing device (whichever is configured and connected). If a voltage sensing device is provided, enter the input pressure at 1 Vdc.

6. **FGH @20mA EU (PSI)—**Enter the input pressure, in psig, at 20 mA from the fuel gas header pressure *or* fuel gas meter pressure sensing device (whichever is configured and connected). If a voltage sensing device is provided, enter the input pressure at 5 Vdc.

7. **FG DP @4mA EU (in Wat)—**Enter the input differential pressure, in inches of water, at 4 mA from the fuel gas meter differential pressure sensing device (if configured and connected). If a voltage sensing device is provided, enter the input pressure at 1 Vdc.

8.   **FG DP @20mA EU (in Wat)—**Enter the input differential pressure, in inches of water, at 20 mA from the fuel gas meter differential pressure sensing device (if configured and connected). If a voltage sensing device is provided, enter the input pressure at 5 Vdc.

Set Analog Outputs

This menu sets the Analog Outputs to allow the proper scaling of each output based on the engineering units of the software configured input and type of hardware configured output. The items below should be entered so that the MIN entry represents the configured value in engineering units at 4 mA (or 0 mA), and the MAX entry represents the configured value in engineering units at 20 mA (or 1 mA).

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

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

3.   **ANALOG OUTPUT 2 MIN** is adjusted to the full retard Ignition Timing in degrees ATC (– number) which will output 4 mA at Analog Output #2 when IGN TMG REV ACTING is configured FALSE and 20 mA when configured TRUE.

4.   **ANALOG OUTPUT 2 MAX** is adjusted to the full advance Ignition Timing in degrees BTC (+ number) which will output 20 mA at Analog Output #2 when IGN TMG REV ACTING is configured FALSE and 4 mA when configured TRUE.

> **IMPORTANT**   **Analog Output 3 Min is set for 0 mA output with the fuel demand at 0 percent and 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 OUTPUT 4 MIN** is adjusted to the Air/Fuel Actuator Output minimum position which will output 4 mA (or 0 mA if so configured) at Analog Output #4. It is factory set for 0 mA at the Actuator Output with the Air/Fuel actuator demand at 0 percent.

6.   **ANALOG OUTPUT 4 MAX** is adjusted to the Air/Fuel Actuator Output maximum position which will output 20 mA (or 200 mA if so configured) at Analog Output #4. It is factory set for 20 mA at the Actuator Output with the Air/Fuel actuator demand at 100 percent.

7   **AO FILTER FREQUENCY** adjusts the cutoff frequency of a low pass filter used on Analog outputs 1 and 2 **only** (see Figure 3-5). To use this feature set the cutoff frequency below 15.9 Hz. The filter is used to attenuate output signal noise.

Comm Port Setup

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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** error percentage is the exception error divided by the total communication transactions, and reflects the quality of the Port 3 communications.

AMP vs FGH

This menu is used to set the Air Manifold Pressure versus Fuel Gas Header pressure curve. The output of this three-dimensional curve is combined with an air manifold temperature compensation curve to produce the Air Manifold Pressure Reference for the Air/Fuel Ratio PID control. The inputs to this 3D curve are fuel gas header pressure and engine speed.

This menu comes into view and the curve function is active when USE A/F RATIO CTRL is configured TRUE, and USE FUEL FLOW A/F is configured FALSE on the CFIG OPTIONS and CFIG A/F Ratio menus. Otherwise, this curve function is inactive, and this menu is concealed.

The Air/Fuel Ratio function, based on this curve, is enabled when:
Engine speed is at or above the configured AFI START ENABLE rpm for 3 seconds.
The fuel gas header pressure and air manifold temperature inputs are connected and not failed.

This 3D curve provides broad flexibility for mapping the air/fuel ratio as needed to achieve emission compliance and fuel economy over a wide range of speed and load combinations. Intermediate engine speeds (between Rated and Min Speed) produce intermediate air/fuel ratio settings. **All values must be entered to complete the 3D curve function.** An air manifold temperature bias (±) is added to this curve value. This bias should be considered when deciding the final curve settings.

Initial settings should be based on original Engine Production Test Data *or* site emission and fuel test data **at 110 °F** air manifold temperature.

1. **RATED SPEED CURVE**—Enter the **Rated** Engine Speed (rpm).

2. **FUEL HDR (Rspd, HTq)**—Enter the fuel gas header pressure, in psi, for **rated** speed, high torque operation. Maximum rated torque operation is recommended for this point.

3. **AMP REF (Rspd HTq)**—Enter the optimum air manifold pressure, in inches of mercury, for **rated** speed, high torque operation.

4. **FUEL HDR (Rspd, LTq)**—Enter the fuel gas header pressure, in psi, for **rated** speed, low torque operation. Minimum rated torque operation is recommended for this point.

5. **AMP REF (Rspd LTq)**—Enter the optimum air manifold pressure, in inches of mercury, for **rated** speed, low torque operation.

6. **MIN SPEED CURVE**—Enter the **Minimum** Engine Speed (rpm).

7. **FUEL HDR (Lspd, HTq)**—Enter the fuel gas header pressure, in psi, for low (**min**) speed, high torque operation. Maximum allowable torque operation is recommended for this point.

8. **AMP REF (Lspd HTq)**—Enter the optimum air manifold pressure, in inches of mercury, for low (**min**) speed, high torque operation.

9. **FUEL HDR (Lspd, LTq)**—Enter the fuel gas header pressure, in psi, for low (**min**) speed, low torque operation. Minimum allowable torque operation is recommended for this point.

10. **AMP REF (Lspd LTq)**—Enter the optimum air manifold pressure setting, in inches of mercury, for low (**min**) speed, low torque operation.

11 **AFR VLV TRVL LMT** sets a limit for the Air/Fuel actuator output to limit the maximum exhaust bypass valve *or* air throttle valve travel. Set at 100% to allow full valve travel. Set below 100% to limit valve travel.

12 **MIN AMP LIMIT** sets the minimum air manifold pressure reference limit, in inches of mercury. This limit overrides the primary air manifold pressure reference when it is below the limit setting.

13 **DEFAULT AMP REF** sets a default air manifold reference which is used by the Air/Fuel Ratio PID control when any of the input devices fail *unless CFIG A/F RATIO item LOCK IN LAST is set TRUE.* **When LOCK IN LAST is TRUE, the last reference before the input device failed, is maintained until normal input device function is restored.** The DEFAULT AMP REF is tunable to allow manual adjustment of the air manifold reference when an input device fails and *LOCK IN LAST is set FALSE.*

14 **RESET ZERO R/L** is provided to reset the raise/lower air manifold pressure bias adjustments back to zero. The control provides Raise/Lower air manifold pressure bias adjustments for temporarily increasing and decreasing air manifold pressure during site emission or fuel tests to readily determine the optimum air manifold pressure reference. The raise/lower bias should not be used to make permanent air manifold pressure reference changes. Permanent changes should be made in the AMP VS FGH curve at Rated speed and minimum speed. Toggling TRUE then FALSE resets all temporary biases back to zero.

AMP Bias Settings

This menu is used to set the air manifold pressure (AMP) bias values and the limits for the air manifold temperature (AMT) and Raise/Lower inputs. The bias values (±) are added to the primary Air/Fuel Ratio reference value. The AMP bias is hard configured to be **zero at 110 °F**. Scaling changes this AMP bias value above or below zero as the AMT input varies above or below 110 °F. The AMP bias is varied as a ratio of actual load to rated load. This menu is concealed when use Air/Fuel Ratio control is configured FALSE.

IMPORTANT **The Raise/Lower inputs are also used to raise and lower exhaust temperature when Exhaust Temperature A/F Ratio is configured and enabled. The Exhaust Temperature Raise/Lower settings are made in the EXH TEMP SETUP menu.**

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1. **HI AMT, HF AMP BIAS**—Enter the air manifold pressure bias, in inches of mercury, to be added to the primary air manifold pressure reference at the rated load HI AIR MANF TEMP, HF temperature entered below. Setting is limited to a positive value and increases air manifold pressure as temperature increases above 110 °F.

2. **LO AMT, HF AMP BIAS**—Enter the amount of air manifold pressure bias, in inches of mercury, to be added to the primary air manifold pressure reference at the rated load LO AIR MANF TEMP, HF temperature entered below. Setting is limited to a negative value and decreases air manifold pressure as temperature decreases below 110 °F.

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3.   **HI AIR MANF TEMP, HF**—Enter the highest air manifold temperature, in °F, expected during normal operation at rated load.

4.   **LO AIR MANF TEMP, HF**—Enter the lowest air manifold temperature, in °F, expected during normal operation at rated load.

5.   **HI AIR MANF TEMP, LF**—Enter the highest air manifold temperature, in °F, expected during normal operation at minimum load.

6.   **FULL LD FUEL HDR**—Enter the Full Load Fuel Gas Header pressure (psig) *or* fuel gas flow (scfm) (whichever is configured and connected). This sets the rated load value which is used in conjunction with a load signal (fuel gas flow or header pressure) to ratio the AMT compensation of the AMP bias. (e.g., at 50% load the AMP bias is 50% of the rated load bias.)

7.   **RAISE AMP BIAS LMT**—Enter the Raise AMP Bias Limit, in inches of mercury, for the air manifold pressure Raise Discrete Input. This must be a positive value or zero. The default value is 3 inches of mercury.

8.   **LOWER AMP BIAS LMT**—Enter the Lower AMP Bias Limit, in inches of mercury, for the air manifold pressure Lower Discrete Input. This must be a negative value or zero. The default value is –3 inches of mercury.

9.   **R/L AMP RATE**—Enter the rate, in inches of mercury/second, for the air manifold pressure Raise/Lower Discrete Inputs.

10. **USE AMT BIAS**—Set TRUE to apply an AMT bias of the Air/Fuel ratio setting. Set FALSE to disable an AMT bias of the Air/Fuel ratio setting.

AMP Vs FGQ (Rtd Spd)

This menu is used to set the Air Manifold Pressure versus Fuel Gas Flow curve at **Rated Speed**. The output of this three-dimensional curve is combined with an air manifold temperature compensation curve to produce the Air Manifold Pressure Reference for the Air/Fuel Ratio PID control. The inputs to the 3D curve are fuel gas flow and engine speed.

This menu comes into view and the curve function is active when USE A/F RATIO CTRL is configured TRUE and USE FUEL FLOW A/F is configured TRUE on the CFIG OPTIONS and CFIG A/F Ratio menus. Otherwise, this curve function is inactive and this menu is concealed.

The Air/Fuel Ratio function, based on this curve, is enabled when:
Engine speed is at or above the configured AFI START ENABLE rpm for 3 seconds.
The fuel flow and air manifold temperature inputs are connected and not failed.

This 3D curve provides broad flexibility for mapping the air/fuel ratio as needed to achieve emission compliance and fuel economy over a wide range of speed and load combinations. Intermediate engine speeds (between these Rated speed settings and the Low Speed settings on the next menu) produce intermediate air/fuel ratio settings. **All values for rated speed and low speed must be entered to complete the 3D curve function**. An air manifold temperature bias (±) is added to this curve value. This bias should be considered when deciding the final curve settings.

Initial settings should be based on original Engine Production Test or reliable engine analyzer data *or* site emission and fuel test data **at 110 °F** air manifold temperature. Use this data to project points outside the normal operating range.

1. **RATED SPEED CURVE**—Enter the Rated Engine Speed (rpm).

2. **AMP REF (Max Tq)**—Enter the air manifold pressure, in inches of mercury, for rated speed, Maximum Torque (projected setting).

3. **AMP REF (Amb Tq)**—Enter the optimum air manifold pressure, in inches of mercury, for rated speed, Ambient Torque operation. Project this setting for non-ambient rated engines from the test data.

4. **AMP REF (100% Tq)**—Enter the optimum air manifold pressure, in inches of mercury, for the rated speed, 100% Torque operation.

5. **AMP REF (75% Tq)**—Enter the optimum air manifold pressure, in inches of mercury, for rated speed, 75% Torque operation.

6. **AMP REF (50% Tq)**—Enter the optimum air manifold pressure, in inches of mercury, for rated speed, 50% Torque operation.

7. **AMP REF (0% Tq)**—Enter the optimum air manifold pressure, in inches of mercury, for rated speed, 0% Torque operation.

8. **FUEL FLOW (Max Tq)**—Enter the Fuel Flow, in SCFM, for Rated Speed, Maximum Engine Torque. Maximum Engine Torque is some projected torque (e.g., 130% rated), above Ambient Rated Torque, which assures that overtorque conditions are recognized for shutdown and alarm purposes and to increase the Air Manifold Pressure setting no matter how briefly an overtorque condition exists. Project a Fuel Flow setting from a rated speed fuel flow versus torque curve (Based on Production Test or reliable engine analyzer data).

9. **FUEL FLOW (Amb Tq)**—Enter the Fuel Flow, in SCFM, for Rated Speed, Ambient Torque operation. This will be a projected flow for non-ambient rated engines.

10. **FUEL FLOW (100% Tq)**—Enter the Fuel Flow, in SCFM, for Rated Speed, 100% (Rated) Torque operation.

11. **FUEL FLOW (75% Tq)**—Enter the Fuel Flow, in SCFM, for Rated Speed, 75% Torque operation.

12. **FUEL FLOW (50% Tq)**—Enter the Fuel Flow, in SCFM, for Rated Speed, 50% Torque operation.

13. **FUEL FLOW (0% Tq)**—Enter the Fuel Flow, in SCFM, for Rated Speed, 0% Torque operation. This will be a projected flow.

14. **FUEL GAS SITE BTU**—Enter the site fuel gas BTU low heating value dry (LVH_{dry}). This value adjusts the fuel flow calculation to compensate for BTU differences between original engine production test data fuel flow and site fuel flow. **Be sure the Fuel Gas Base BTU ($LVH_{dry)}$ is configured in the CFIG A/F RATIO menu**.

15. **AFR VLV TRVL LMT** sets a limit for the Air/Fuel actuator output to limit the maximum exhaust bypass valve *or* air throttle valve travel. Set at 100% to allow full valve travel. Set below 100% to limit valve travel.

16. **MIN AMP LIMIT** sets the minimum air manifold pressure reference limit, in inches of mercury. This limit overrides the primary air manifold pressure reference when it is below the limit setting.

17. **DEFAULT AMP REF** sets a tunable air manifold reference which is used by the Air/Fuel Ratio PID control when any of the input devices fail *unless CFIG A/F RATIO item LOCK IN LAST is set TRUE.* **When LOCK IN LAST is TRUE, the last reference before the input device failed, is maintained until normal input device function is restored.** The DEFAULT AMP REF is tunable to allow manual adjustment of the air manifold reference when an input device fails and *LOCK IN LAST is set FALSE.*

18. **RESET ZERO R/L** is provided to reset the raise/lower air manifold pressure bias adjustments back to zero. The control provides Raise/Lower air manifold pressure bias adjustments for temporarily increasing and decreasing air manifold pressure during site emission or fuel tests to readily determine the optimum air manifold pressure reference. The raise/lower bias should not be used to make permanent air manifold pressure reference changes. Permanent changes should be made in the AMP VS FGQ curve at Rated speed and Low (Min) speed. Toggling TRUE then FALSE resets all temporary biases back to zero.

AMP Vs FGQ (Low Spd)

This menu is used to set the Air Manifold Pressure versus Fuel Gas Flow curve at **Low Speed** (minimum operating Speed). This menu is a continuation of the previous menu. Read the previous menu instructions and enter all settings as explained.

Initial settings should be based on original Engine Production Test or reliable engine analyzer data *or* site emission and fuel test data. Use this data to project points outside the normal operating range.

1. **LOW SPEED CURVE**—Enter the Low Engine Speed (rpm). Minimum speed operation is recommended for this data set.

2. **AMP REF (Max Tq)**—Enter the air manifold pressure, in inches of mercury, for low speed, Maximum Torque (projected setting).

3. **AMP REF (Amb Tq)**—Enter the optimum air manifold pressure, in inches of mercury, for low speed, Ambient Torque operation. Project this setting for non-ambient rated engines from the test data.

4. **AMP REF (100% Tq)**—Enter the optimum air manifold pressure, in inches of mercury, for low speed, 100% Torque operation.

5. **AMP REF (75% Tq)**—Enter the optimum air manifold pressure, in inches of mercury, for low speed, 75% Torque operation.

6. **AMP REF (50% Tq)**—Enter the optimum air manifold pressure, in inches of mercury, for low speed, 50% Torque operation.

7. **AMP REF (0% Tq)**—Enter the optimum air manifold pressure, in inches of mercury, for low speed, 0% Torque operation.

8. **FUEL FLOW (Max Tq)**—Enter the Fuel Flow, in SCFM, for Low Speed, Maximum Engine Torque. Maximum Engine Torque is some projected torque (e.g., 110% rated), above Ambient Rated Torque, which assures that overtorque conditions are recognized for shutdown and alarm purposes and to increase the Air Manifold Pressure setting no matter how briefly an overtorque condition exists. Project a Fuel Flow setting from a min speed fuel flow versus torque curve (Based on Production Test or reliable engine analyzer data).

9. **FUEL FLOW (Amb Tq)**—Enter the Fuel Flow, in SCFM, for Low Speed, Ambient Torque operation. This will be a projected flow for non-ambient rated engines.

10. **FUEL FLOW (100% Tq)**—Enter the Fuel Flow, in SCFM, for Low Speed, 100% (Rated) Torque operation.

11. **FUEL FLOW (75% Tq)**—Enter the Fuel Flow, in SCFM, for Low Speed, 75% Torque operation.

12. **FUEL FLOW (50% Tq)**—Enter the Fuel Flow, in SCFM, for Low Speed, 50% Torque operation.

13. **FUEL FLOW (0% Tq)**—Enter the Fuel Flow, in SCFM, for Low Speed, 0% Torque operation. This will be a projected flow.

Exh Temp (Rated Spd)

This menu is used to set the Exhaust Stack Temperature versus Load curve at **Rated Speed**. Load is scaled from the Fuel Gas Header Pressure *or* Fuel Gas Flow input (whichever is configured and connected). The output of this three-dimensional curve is the Exhaust temperature Reference for the Exhaust Temperature Air/Fuel Ratio PID control. The inputs to the 3D curve are fuel gas header pressure *or* fuel gas flow and engine speed.

This menu comes into view and the curve function is active when USE A/F RATIO CTRL is configured TRUE and USE EXH TEMP A/F is configured TRUE on the CFIG OPTIONS and CFIG A/F Ratio menus. Otherwise, this curve function is inactive and this menu is concealed.

The Air/Fuel Ratio function, based on this curve, is enabled when:
*   Exhaust temperature is below a tunable maximum temperature.
*   Engine speed is above a tunable minimum speed.
*   Air manifold pressure is above the AMP_VS_FGH *or* AMP_VS_FGQ curve setting. One of these curves must be active and properly setup as a **low limit** for the air manifold pressure reference.
*   The exhaust temperature input is connected and not failed.
*   The exhaust temperature is above a minimum tunable temperature for a tunable time delay.

This 3D curve provides broad flexibility for mapping the exhaust temperature Air/Fuel ratio settings as needed to achieve emission compliance and fuel economy over a wide range of speed and load combinations. Intermediate engine speeds (between Rated and Low Speed) produce intermediate exhaust temperature settings. **All values for rated speed and low speed must be entered to complete the 3D curve function.**

Initial settings should be based on original Engine Production Test or reliable engine analyzer data *or* site emission and fuel test data. Use this data to project points outside the normal operating range.

1. **RATED SPEED CURVE**—Enter the Rated Engine Speed (rpm).

2. **EXHT REF (Amb Tq)**—Enter the exhaust temperature set point, in °F, for rated speed, Ambient Torque operation. Set same as rated speed, 100% Torque for non-ambient rated engines.

3. **EXHT REF (100% Tq)**—Enter the exhaust temperature set point, in °F, for rated speed, 100% Torque operation.

4. **EXHT REF (75% Tq)**—Enter the exhaust temperature set point, in °F, for rated speed, 75% Torque.

5. **EXHT REF (50% Tq)**—Enter the exhaust temperature set point, in °F, for rated speed, 50% Torque operation.

6. **EXHT REF (0% Tq)**—Enter the exhaust temperature set point, in °F, for rated speed, 0% Torque operation.

7. **FUEL FLOW (Amb Tq)**—Enter the Fuel Flow, in scfm, *or* the Fuel Gas Header Pressure, in psig, (whichever is configured and connected) for Rated Speed, Ambient Torque operation. This will be a projected flow *or* pressure for non-ambient rated engines.

8. **FUEL FLOW (100% Tq)**—Enter the Fuel Flow, in scfm, *or* the Fuel Gas Header Pressure, in psig, (whichever is configured and connected) for Rated Speed, 100% (Rated) Torque operation.

9. **FUEL FLOW (75% Tq)**—Enter the Fuel Flow, in scfm, *or* the Fuel Gas Header Pressure, in psig, (whichever is configured and connected) for Rated Speed, 75% Torque operation.

10. **FUEL FLOW (50% Tq)**—Enter the Fuel Flow, in scfm, *or* the Fuel Gas Header Pressure, in psig, (whichever is configured and connected) for Rated Speed, 50% Torque operation.

11. **FUEL FLOW (0% Tq)**—Enter the Fuel Flow, in scfm, *or* the Fuel Gas Header Pressure, in psig, (whichever is configured and connected) for Rated Speed, 0% Torque operation. This will be a projected flow *or* pressure.

Exh Temp (Low Spd)

This menu is used to set the Exhaust Stack Temperature versus Load curve at **Low Speed**. This menu is a continuation of the previous menu. Read the previous menu instructions and enter all settings as explained.

Initial settings should be based on original Engine Production Test or reliable engine analyzer data *or* site emission and fuel test data. Use this data to project points outside the normal operating range.

1. **LOW SPEED CURVE**—Enter the Low Engine Speed (rpm). Minimum speed operation is recommended for this data set.

2. **EXHT REF (Amb Tq)**—Enter the exhaust temperature set point, in °F, for low speed, Ambient Torque operation. Set same as low speed, 100% Torque for non-ambient rated engines.

3. **EXHT REF (100% Tq)**—Enter the exhaust temperature set point, in °F, for low speed, 100% Torque operation.

4. **EXHT REF (75% Tq)**—Enter the exhaust temperature set point, in °F, for low speed, 75% Torque operation.

5. **EXHT REF (50% Tq)**—Enter the exhaust temperature set point, in °F, for low speed, 50% Torque operation.

6. **EXHT REF (0% Tq)**—Enter the exhaust temperature set point, in °F, for low speed, 0% Torque operation.

7. **FUEL FLOW (Amb Tq)**—Enter the Fuel Flow, in scfm, *or* the Fuel Gas Header Pressure, in psig, (whichever is configured and connected) for Minimum Speed, Ambient Torque operation. This will be a projected flow *or* pressure for non-ambient rated engines.

8. **FUEL FLOW (100% Tq)**—Enter the Fuel Flow, in scfm, *or* the Fuel Gas Header Pressure, in psig, (whichever is configured and connected) for Minimum Speed, 100% (Rated) Torque operation.

9. **FUEL FLOW (75% Tq)**—Enter the Fuel Flow, in scfm, *or* the Fuel Gas Header Pressure, in psig, (whichever is configured and connected) for Minimum Speed, 75% Torque operation.

10. **FUEL FLOW (50% Tq)**—Enter the Fuel Flow, in scfm, *or* the Fuel Gas Header Pressure, in psig, (whichever is configured and connected) for Minimum Speed, 50% Torque operation.

11. **FUEL FLOW (0% Tq)**—Enter the Fuel Flow, in scfm, *or* the Fuel Gas Header Pressure, in psig, (whichever is configured and connected) for Minimum Speed, 0% Torque operation. This will be a projected flow *or* pressure.

Exh Temp Setup

This menu is used to setup limits for the exhaust temperature and Raise/Lower inputs and to enable/disable the Exhaust Stack Temperature Air/Fuel (EXHT A/F) Ratio control. The Fuel Gas Header *or* Fuel Gas Flow Air/Fuel Ratio control (whichever is configured and connected) is enabled, as a substitute, when the EXHT A/F Ratio control is disabled (e.g., during start-up/warm-up).

This menu comes into view when USE A/F RATIO CTRL and USE EXH TEMP A/F are configured TRUE on the CFIG OPTIONS and CFIG A/F Ratio menus. Otherwise this menu is concealed.

| **IMPORTANT** | The Fuel Gas Header *or* Fuel Gas Flow Air/Fuel Ratio control (whichever is configured and connected) must be accurately set up to assume control whenever the EXHT A/F Ratio control is disabled (manually or automatically). |

IMPORTANT

The Raise/Lower inputs are also used to Raise/Lower air manifold pressure when Exhaust Temperature A/F Ratio is NOT configured or enabled. The Air Manifold Pressure Raise/Lower settings are made in the AMP Bias Settings menu.

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1. **USE EXH TEMP A/F** should be set TRUE to permit the EXHT A/F Ratio control to be enabled. Set FALSE to disable. Note that other settings must be met before the EXHT A/F Ratio control is actually enabled.

2. **MAX EXH TEMP** sets the Maximum allowable exhaust temperature as a limit for the exhaust temperature reference. The EXHT A/F Ratio control is disabled when exhaust temperature exceeds this setting.

3. **MIN EXH TEMP** sets the Minimum allowable exhaust temperature, in °F, as a limit for the exhaust temperature reference. Exhaust temperature must be at or above this minimum temperature for the duration of the EXH TEMP ENBL DELAY time before the EXHT A/F Ratio control is enabled.

4. **EXH TEMP ENBL DELAY** sets the time delay in seconds to wait before enabling the EXHT A/F Ratio control after the exhaust temperature is at or above the MIN EXH TEMP setting**.**

5. **EXH TEMP HYSTER** sets the exhaust temperature hysteresis, in °F, for the MIN EXH TEMP setting. Exhaust temperature below the MIN EXH TEMP - EXH TEMP HYSTER will disable the EXHT A/F Ratio control.

6. **EXH TEMP RAISE LMT—**Enter the Raise Limit, in °F, for the exhaust temperature Raise Discrete Input. The Discrete Input is switched, in the control, from Raise Air Manifold Pressure to Raise Exhaust Temperature when the EXHT A/F Ratio control is enabled. This must be a positive value or zero. The default value is 100 °F.

7. **EXH TEMP LOWER LMT—**Enter the Lower Limit, in °F, for the exhaust temperature Lower Discrete Input. The Discrete Input is switched, in the control, from Lower Air Manifold Pressure to Lower Exhaust Temperature when the EXHT A/F Ratio control is enabled. This must be a negative value or zero. The default value is –100 °F.

8. **EXH TMP R/L RATE**—Enter the rate, in °F/second, for the exhaust temperature Raise/Lower Discrete Inputs.

9. **RESET ZERO R/L** may be used to reset the raise/lower exhaust temperature bias adjustments back to zero. The control provides raise/lower exhaust temperature bias adjustments for temporarily increasing or decreasing the exhaust temperature during emission and fuel tests to readily determine the optimum exhaust temperature reference. This raise/lower should not be used to make permanent exhaust temperature reference changes. Permanent changes should be made in the EXH TEMP curve at Rated speed and Low (Min) speed. Toggling TRUE then FALSE resets all temporary biases back to zero.

BHP Vs FGQ (Rtd Spd)

This menu is used to set the Brake Horsepower versus Fuel Gas Flow curve at **Rated Speed**. The output of this 3D curve is the engine Brake Horsepower for local and Modbus display. The inputs to the curve are fuel gas flow and engine speed.

This curve is active when:
* CFIG Option menu item CALCULATE BHP is configured TRUE.
* The control has the fuel flow inputs connected and not failed.

This 3D curve provides broad flexibility for accurately computing Brake Horsepower over a wide range of speed and load combinations. Operation at intermediate engine speeds (between Rated Speed and Minimum Speed) produce intermediate BHP readings. **Values for both menus must be entered to complete the 3D curve.**

Initial settings should be based on original Engine Production Test or reliable engine analyzer data. The engine analyzer, if used, must be operated by a qualified technician, to verify BHP of an engine known to be in **"like-new"** operating condition. **DO NOT use an analyzer to verify fuel flow BHP of an engine which is NOT in top operating condition.** The fuel flow BHP of an impaired engine will be erroneously high because of imperfect combustion and a related increase in fuel consumption. The fuel flow BHP settings should not be reduced to match the analyzer BHP since it could lead to excessive loading of an impaired engine. **Refer to the Engine Nameplate for rated BHP**.

1. **BHP (Rspd, Max Tq)**—Enter the Brake Horsepower @ Rated Speed, Maximum Torque. This is a projected BHP (e.g., 1.3 x Rated BHP).

2. **BHP (Rspd, Amb Tq)**—Enter the Brake Horsepower @ Rated Speed, Ambient Torque.

3. **BHP (Rspd, 100% Tq)**—Enter the Brake Horsepower @ Rated Speed, 100% Torque.

4. **BHP (Rspd, 75% Tq)**—Enter the Brake Horsepower @ Rated Speed, 75% Torque.

5. **BHP (Rspd, 50% Tq)**—Enter the Brake Horsepower @ Rated Speed, 50% Torque.

6. **FUEL FLOW (Rspd, Max Tq)**—Enter the Fuel Flow, in SCFM, for Rated Speed, Maximum Engine Torque. Maximum Engine Torque is some projected torque (e.g., 130% rated), above Ambient Rated Torque, which assures that overtorque conditions are recognized for calculating BHP. Project a Fuel Flow setting from a rated speed, fuel flow versus torque curve (Based on Production Test or reliable engine analyzer data).

7. **FUEL FLOW (Rspd, Amb Tq)**—Enter the Fuel Flow, in SCFM, for Rated Speed, Ambient Torque operation. This will be a projected fuel flow for non-ambient rated engines.

8. **FUEL FLOW (Rspd, 100% Tq)**—Enter the Fuel Flow, in SCFM, for Rated Speed, 100% (Rated) Torque operation.

9. **FUEL FLOW (Rspd, 75% Tq)**—Enter the Fuel Flow, in SCFM, for Rated Speed, 75% Torque operation.

10. **FUEL FLOW (Rspd, 50% Tq)**—Enter the Fuel Flow, in SCFM, for Rated Speed, 50% Torque operation.

11. **FUEL FLOW (Rspd, 0% Tq)**—Enter the Fuel Flow, in SCFM, for Rated Speed, 0% Torque operation. This will be a projected flow.

12. **RATED SPEED CURVE**—Enter the Rated Engine Speed (rpm).

BHP Vs FGQ (Min Spd)

This menu is used to set the Brake Horsepower versus Fuel Gas Flow curve at **Min Speed**.

Initial settings should be based on original Engine Production Test or reliable engine analyzer data.

1. **BHP (MinSpd, Max Tq)**—Enter the Brake Horsepower @ Minimum Speed, Maximum Torque. This is a projected a BHP (e.g., 1.1 x min speed, 100% BHP).

2. **BHP (MinSpd, Amb Tq)**—Enter the Brake Horsepower @ Minimum Speed, Ambient Torque. This will be a projected BHP for non-ambient rated engines.

3. **BHP (MinSpd, 100% Tq)**—Enter the Brake Horsepower @ Minimum Speed, 100% Torque.

4. **BHP (MinSpd, 75% Tq)**—Enter the Brake Horsepower @ Minimum Speed, 75% Torque.

5. **BHP (MinSpd, 50% Tq)**—Enter the Brake Horsepower @ Minimum Speed, 50% Torque.

6. **FUEL FLOW (MinSpd, Max Tq)**—Enter the Fuel Flow, in SCFM, for Minimum Speed, Maximum Engine Torque. Maximum Engine Torque is some projected torque well above Ambient Rated Torque, which assures that overtorque conditions are recognized for calculating BHP. Project a Fuel Flow setting from a Minimum speed, fuel flow versus torque curve (Based on Production Test or reliable engine analyzer data).

7. **FUEL FLOW (MinSpd, Amb Tq)**—Enter the Fuel Flow, in SCFM, for Minimum Speed, Ambient Torque operation. This will be a projected fuel flow for non-ambient rated engines.

8. **FUEL FLOW (MinSpd, 100% Tq)**—Enter the Fuel Flow, in SCFM, for Minimum Speed, 100% (Rated) Torque operation.

9. **FUEL FLOW (MinSpd, 75% Tq)**—Enter the Fuel Flow, in SCFM, for Minimum Speed, 75% Torque operation.

10. **FUEL FLOW (MinSpd, 50% Tq)**—Enter the Fuel Flow, in SCFM, for Minimum Speed, 50% Torque operation.

11. **FUEL FLOW (MinSpd, 0% Tq)**—Enter the Fuel Flow, in SCFM, for Minimum Speed, 0% Torque. This will be a projected flow.

12. **MIN SPEED CURVE**—Enter the Minimum Engine Speed (rpm).

Ign Tmg Start Set

This menu is used to set the Ignition Timing Starting curve (IGN_VS_AMP) and limits.

At light-off, the Ignition Timing output is fixed at the START IGN TIMING setting in the CFIG IGN TMG menu.

This menu comes into view and the curve function is active when USE IGN TMG CTRL is configured TRUE on the CFIG OPTIONS menu. Otherwise, this curve function is inactive and this menu is concealed.

The Ignition Timing function, based on this curve, is enabled when:
- Engine speed is at or above the AFI START ENABLE rpm setting for the RETARD DELAY time setting.
- The Ignition Timing signal from this curve is lower (greater retard) than the normal and ambient Ignition Timing curve signals.

After the curve is enabled, the ignition timing will vary between the MAX IGN ADVANCE and the MAX RETARD LMT at the SLOW RETARD RATE based on the air manifold pressure input. The SLOW RETARD RATE is removed once air manifold pressure increases above the SLOW RETARD BRKPT.

Refer to the Engine Operating and Instruction Manual for the ignition timing full advance and full retard settings and the engine builders recommended ignition timing schedules.

1. **MAX RETARD LMT**—Enter the Maximum Ignition Retard Limit in degrees after top dead center (ATC) or before top dead center (BTC). A negative number represents degrees ATC (retarded timing) while a positive number represents degrees BTC (advanced timing). Zero is TDC.

2. **AMP 1**—Enter the air manifold pressure, in inches mercury, for point 1 ignition timing set below.

3. **AMP 2**—Enter the air manifold pressure, in inches mercury, for point 2 ignition timing set below.

4. **AMP 3**—Enter the air manifold pressure, in inches mercury, for point 3 ignition timing set below.

5. **AMP 4**—Enter the air manifold pressure, in inches mercury, for point 4 ignition timing set below.

6. **AMP 5**—Enter the air manifold pressure, in inches mercury, for point 5 ignition timing set below.

7. **AMP 1 TMG SET**—Enter the ignition timing, in degrees (– = ATC, + = BTC), for the AMP 1 input level.

8. **AMP 2 TMG SET**—Enter the ignition timing, in degrees (– = ATC, + = BTC), for the AMP 2 input level.

9. **AMP 3 TMG SET**—Enter the ignition timing, in degrees (– = ATC, + = BTC), for the AMP 3 input level.

10. **AMP 4 TMG SET**—Enter the ignition timing, in degrees (– = ATC, + = BTC), for the AMP 4 input level.

11. **AMP 5 TMG SET**—Enter the ignition timing, in degrees(– = ATC, + = BTC), for the AMP 5 input level.

12. **SLOW RETARD BRKPT**—Enter the air manifold pressure, in inches mercury, at which the starting ignition timing slow ramp rate is terminated.

13. **SLOW RETARD DBAND**—Enter the air manifold pressure deadband, in inches mercury, below the SLOW RETARD BRKPT setting at which the slow retard ramp rate is enabled.

14. **RETARD DELAY**—Enter the delay, in seconds, before the starting ignition timing retard is enabled, once the engine speed exceeds the AFI START ENABLE rpm setting.

15. **SLOW RETARD RATE**—Enter the ignition timing starting retard rate in degrees per seconds.

Ign Tmg Norm Set

This menu is used to set the Ignition Timing Normal curve (IGN_VS_RPM) and filter.

The output of this 3 dimensional curve is the Ignition Timing in degrees BTC (+) or ATC (–) for the Ignition Timing output signal. The inputs to the curve are fuel gas header pressure *or* fuel gas flow (whichever is configured and connected) and engine speed.

This menu comes into view and the curve function is active when USE IGN TMG CTRL is configured TRUE on the CFIG OPTIONS menu. Otherwise, this curve function is inactive and this menu is concealed.

The Ignition Timing function, based on this curve, is enabled when:
- Engine speed is at or above the AFI START ENABLE rpm setting for the RETARD DELAY time setting in the IGN TMG START SET menu.
- The Ignition Timing signal from this curve is lower (greater retard) than the starting Ignition Timing and ambient Ignition Timing curve signals.

After the curve is enabled, the ignition timing will vary between the MAX IGN ADVANCE and the MAX RETARD LMT at a tunable filter lag rate setting.

Refer to the Engine Operating and Instruction Manual for the ignition timing full advance and full retard settings and the engine builders recommended ignition timing schedules.

1. **FGH 1 RPM 1**—Enter the **minimum** engine Speed for setting the normal ignition timing **low** fuel gas header pressure or fuel gas flow input.

2. **FGH 1 RPM 2**—Enter the **Rated** engine Speed for setting the normal ignition timing **low** fuel gas header pressure or fuel gas flow input.

3. **FGH 2 RPM 1**—Enter the **minimum** engine Speed for setting the normal ignition timing **high** fuel gas header pressure or fuel gas flow input. Set same as FGH 1 RPM 1.

4. **FGH 2 RPM 2**—Enter the **Rated** engine Speed for setting the normal ignition timing **high** fuel gas header pressure or fuel gas flow input. Set same as FGH 1 RPM 2.

5. **FGH 1 RPM 1 TMG SET**—Enter the Ignition Timing in degrees (+ = BTC, – = ATC) for the normal ignition timing at **minimum** speed and **low** fuel gas header pressure or fuel gas flow input.

6. **FGH 1 RPM 2 TMG SET**—Enter the Ignition Timing in degrees (+ = BTC, – = ATC) for the normal ignition timing at **Rated** speed and **low** fuel gas header pressure or fuel gas flow input.

7. **FGH 2 RPM 1 TMG SET—**Enter the Ignition Timing in degrees (+ = BTC, – = ATC) for the normal ignition timing at **minimum** speed and **high** fuel gas header pressure or fuel gas flow input.

8. **FGH 2 RPM 2 TMG SET**—Enter the Ignition Timing in degrees (+ = BTC, – = ATC) for the normal ignition timing at **rated** speed and **high** fuel gas header pressure or fuel gas flow input.

9. **LO TORQ FGH**—Enter the Fuel Gas Header pressure in PSIG *or* Fuel Gas Flow in SCFM (whichever is configured and connected) for **Rated** speed, **minimum** Torque operation.

10. **FULL TORQ FGH**—Enter the Fuel Gas Header pressure in PSIG *or* Fuel Gas Flow in SCFM (whichever is configured and connected) for **Rated** speed, **100%** (Rated) Torque operation.

11. **NORM TMG FILTER** is a low-pass filter which is set to generate a delay in the Normal Ignition Timing calculated value to smooth out the calculated signal. Default setting is 0.1. A lower setting will be more responsive but may be too unstable. A higher setting will be more stable but may be too unresponsive.

12. **DEFAULT IGN TMG SET**—Enter the Default Ignition Timing, in degrees (+ = BTC, – = ATC), to be used for setting the ignition timing whenever failure of an essential input is detected.

Ign Tmg Ambtq Set

This menu is used to set the Ignition Timing Ambient Torque curve (IGN_VS_TORQ), Torque versus Actuator Output curve (TQ_VS_ACT1) and a torque signal filter.

This menu comes into view and the curve function is active when USE IGN TMG CTRL is configured TRUE on the CFIG OPTIONS menu. Otherwise, this curve function is inactive and this menu is concealed.

The Ignition Timing function, based on this curve, is enabled when:
*   Engine speed is at or above the AFI START ENABLE rpm setting for the RETARD DELAY time setting in the IGN TMG START SET menu.
*   The Ignition Timing signal from this curve is lower (greater retard) than the starting Ignition Timing and normal Ignition Timing curve signals.

After the curve is enabled, the ignition timing will vary between the MAX IGN ADVANCE and the MAX RETARD LMT at a tunable filter lag rate setting.

Refer to the Engine Operating and Instruction Manual for the ignition timing full advance and full retard settings and the engine builders recommended ignition timing schedules.

1. **100% TQ ACT OUT**—Enter the Actuator Output, Percent Fuel Demand, at Rated Speed, 100% Torque.

2. **MAX TQ ACT OUT**—Enter the Actuator Output, Percent Fuel Demand, at Rated Speed, Maximum Ambient Torque.

IMPORTANT	**If engines are not Ambient Rated, set the MAX TQ ACT OUT at the 100% TQ ACT OUT setting.**

3. **MAX TQ SET**—Enter the Maximum Ambient Torque as a percentage of Rated Torque. This setting converts MAX TQ ACT OUT % Fuel Demand into Torque.

IMPORTANT	**If engines are not Ambient Rated, set MAX TQ SET at 100%.**

4. **MAX TQ**—Enter the Maximum Ambient Torque as a percentage of Rated Torque.

IMPORTANT	**If engines are not Ambient Rated, set MAX TQ at 100%.**

5. **100% TQ TMG SET**—Enter the Ignition Timing in degrees (+ = BTC, – = ATC) for Rated Speed, 100% Torque operation.

6. **MAX TQ TMG SET**—Enter the Ignition Timing in degrees (+ = BTC, – = ATC) for Rated Speed, Maximum Ambient Torque operation.

IMPORTANT	**If engines are not Ambient Rated, set MAX TQ TMG SET at the 100% TQ TMG SET setting.**

7. **TORQ TMG FILTER** is a low-pass filter which is set to generate a delay in the Ambient Torque calculated value to smooth out the calculated signal. Default setting is 0.1. A lower setting will be more responsive but may be too unstable. A higher setting will be more stable but may be too unresponsive.

Turbo Assist Setpt

This menu is used to set the automatic Turbocharger Air Assist PID and Discrete Output control. This one menu sets both the PID and Discrete output control functions, even though only one of these is used by the control. The one used is connected. The other is not.

This menu comes into view and the control function is active when USE TAC CONTROL is configured TRUE on the CFIG OPTIONS menu. Otherwise, this control function is inactive and this menu is concealed.

The automatic Turbocharger Air Assist function is enabled when engine speed is at or above the AFI START ENABLE rpm setting in the CFIG OPTIONS menu for the RETARD DELAY time setting in the IGN TMG START SET menu.

Refer to the Engine Operating and Instruction Manual for the engine builders recommended Turbocharger Air Assist settings.

1. **TURBO ASSIST SET** is the air manifold pressure reference, in inches mercury, for the Turbocharger Air Assist PID and where Discrete Output 3 is switched on when air manifold pressure is below this reference setting.

2. **TURBO ASSIST HYST** is the hysteresis, in inches mercury, which is added to the TURBO ASSIST SET reference to set the air manifold pressure cutoff point for Discrete output 3. Increasing hysteresis increases the amount air manifold pressure must increase above the TURBO ASSIST SET reference before the Discrete output 3 is cutoff.

3. **TURBO ASSIST GAIN** determines how fast the PID control responds to an error in air manifold pressure from the air manifold pressure reference setting. The TURBO ASSIST GAIN is set to provide stable control of air manifold pressure and Analog Output 1 during automatic turbocharger air assist operation.

4. **TURBO ASSIST RESET** compensates for the lag time of the turbo assist piping system. It adjusts the time required for the PID control to return the air manifold pressure to zero error after a disturbance. TURBO ASSIST Reset is adjusted to prevent slow hunting during automatic turbocharger air assist operation.

5. **TURBO ASSIST DERIV** is the time-derivative component of the PID response. This field is only used when this component of PID control is desired. A default setting of .01 disables the derivative function (The Controller is Input Dominant). Increase setting to increase PID time-derivative.

6. **TURBO ASSIST THRESH** is the difference between air manifold pressure and the air manifold pressure reference which sets the PID output level to –1% when the PID is not in control. This threshold difference shifts the PID output out of the way of a higher limiting signal until the PID is back in control. Default threshold setting is 0.1. A higher threshold setting will shift the PID output to –1% at a higher difference.

7. **MAX VLV OPEN LMT** sets a maximum opening travel limit for the Turbo Air Assist valve connected to Analog Output 1. Set at 100% to allow full travel. Set below 100% to limit travel.

8. **PID BYPASS TIME** is the time, in seconds, the Turbocharger Air Assist PID is bypassed to allow quick opening of the Turbo Air Assist valve during engine starting. Set the bypass time for a duration which allows air manifold pressure to reach or exceed the TURBO ASSIST SET air manifold pressure reference. The Turbo Air Assist valve quickly opens to the MAX VLV OPEN LMT setting when engine speed is at or above the AFI START ENABLE rpm setting in the CFIG OPTIONS menu. After the PID BYPASS TIME expires the Turbocharger Air Assist PID is enabled. The Turbo Air Assist valve quickly closes when engine speed is below the AFI START ENABLE rpm.

PreComb Setting

This menu is used to set the Pre-Combustion Chamber Pressure, in psi, from either an Air Manifold Pressure *or* Fuel Gas Header Pressure versus Engine Speed curve. The output of this three-dimensional curve is the Pre-Combustion Chamber Pressure set point to the Pre-Combustion Chamber Pressure Analog Output 1 control. The inputs to the curve are air manifold pressure *or* fuel gas header pressure (whichever is configured) and engine speed.

This menu comes into view and the control function is active when CFIG OPTIONS menu item USE PCC CONTROL is configured TRUE.

Set PCC LOAD INPUT SEL on the CFIG OPTION menu at **1** to use the air manifold pressure input *or* at **2** to use the fuel gas header input for PCC Control.

IMPORTANT	**Do not set PCC Load Input Sel at 2 if a fuel gas header pressure transmitter is not connected to analog input 2.**

This 3D curve provides broad flexibility for mapping the correct pre-combustion chamber pressure over a wide range of speed and load combinations. Operation at intermediate engine speeds between the settings entered for Rated Speed and those entered for minimum speed, will produce an intermediate pre-combustion chamber pressure reference. **All values must be entered to complete the 3D curve function.**

Refer to the Engine Operating and Instruction Manual for the engine builders recommended Pre-Combustion Chamber settings.

1. **RATED SPEED CURVE**—Enter the **Rated** Engine Speed (rpm).

2. **PCC REF (100% Tq EU)**—Enter the optimum pre-combustion pressure reference, in psi, for **rated** speed, 100% torque operation.

3. **PCC REF (75% Tq EU)**—Enter the optimum pre-combustion pressure reference, in psi, for **rated** speed, 75% torque operation.

4. **PCC REF (50% Tq EU)**—Enter the optimum pre-combustion pressure reference, in psi, for **rated** speed, 50% torque operation.

5. **PCC REF (0% Tq EU)**—Enter the optimum pre-combustion pressure reference, in psi, for **rated** speed, 0% torque operation.

6. **LOAD IN (100% Tq EU)**—Enter the air manifold pressure, in inches mercury, *or* the fuel gas header pressure, in psi, (whichever is configured) for **rated** speed, 100% torque operation.

7. **LOAD IN (75% Tq EU)**—Enter the air manifold pressure, in inches mercury, *or* the fuel gas header pressure, in psi, (whichever is configured) for **rated** speed, 75% torque operation.

8. **LOAD IN (50% Tq EU)**—Enter the air manifold pressure, in inches mercury, *or* the fuel gas header pressure, in psi, (whichever is configured) for **rated** speed, 50% torque operation.

9. **LOAD IN (0% Tq EU)**—Enter the air manifold pressure, in inches mercury, *or* the fuel gas header pressure, in psi, (whichever is configured) for **rated** speed, 0% torque operation (Projected point).

10. **MIN SPEED CURVE**—Enter the **Minimum** Engine Speed (rpm).

11. **PCC REF (100% Tq EU)**—Enter the optimum pre-combustion pressure reference, in psi, for **minimum** speed, 100% torque operation.

12. **PCC REF (75% Tq EU)**—Enter the optimum pre-combustion pressure reference, in psi, for **minimum** speed, 75% torque operation.

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13. **PCC REF (50% Tq EU)**—Enter the optimum pre-combustion pressure reference, in psi, for **minimum** speed, 50% torque operation.

14. **PCC REF (0% Tq EU)**—Enter the optimum pre-combustion pressure reference, in psi, for **minimum** speed, 0% torque operation.

15. **LOAD IN (100% Tq EU)**—Enter the air manifold pressure, in inches mercury, *or* the fuel gas header pressure, in psi, (whichever is configured) for **minimum** speed, 100% torque operation.

16. **LOAD IN (75% Tq EU)**—Enter the air manifold pressure, in inches mercury, *or* the fuel gas header pressure, in psi, (whichever is configured) for **minimum** speed, 75% torque operation.

17. **LOAD IN (50% Tq EU)**—Enter the air manifold pressure, in inches mercury, *or* the fuel gas header pressure, in psi, (whichever is configured) for **minimum** speed, 50% torque operation.

18. **LOAD IN (0% Tq EU)**—Enter the air manifold pressure, in inches mercury, *or* the fuel gas header pressure, in psi, (whichever is configured) for **minimum** speed, 0% torque operation (Projected point).

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 produce the correct temperature display of the input temperature. The LINKnet Module must be connected and properly addressed for these menus to come into view.

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

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

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

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

RTD Module 1/3

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

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

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

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

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

AI Module 1/2

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

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

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

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

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

DI Module 1/4

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

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

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

DO Module 1/4

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

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

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

AO Module 1

This menu displays and allows calibration of LINKnet Analog Output Module 1. The **offset** and **span** should be adjusted to produce 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.**

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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–REMOTE SPEED REF** shows the state of the Remote Speed Reference Enable contact (TRUE = CLOSED).

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

3. **C–RAISE AIR MANF PRESS** shows the state of the Raise Air Manifold Pressure contact (TRUE = CLOSED).

4. **D–LOWER AIR MANF PRESS** shows the state of the Lower Air Manifold Pressure contact (TRUE = CLOSED).

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

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

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

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

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

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

11. **DO3–TURBO AIR ASSIST** shows the state of the Turbocharger Air Assist Relay Output #3. TRUE indicates the relay is energized.

Display Analog I/O

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

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

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

3. **AI1–AIR MANF PRESS** shows the value, in mA, of the Air Manifold Pressure Input #1 Signal. This value times 1000 is sent to Modbus. The mA value is after the effect of the offset and span in the I/O CALIBRATION menu.

4. **AI2–FUEL GAS HDR PRESS** shows the value, in mA, of the Fuel Gas Header Pressure signal *or* the Fuel Gas Meter Pressure Input #2 Signal (whichever is configured and connected). This value times 1000 is sent to Modbus. The mA value is after the effect of the offset and span in the I/O CALIBRATION menu.

5. **AI3–FUEL GAS MTR DP** shows the value, in mA, of the Fuel Gas Meter Pressure Differential Input #3. This value times 1000 is sent to Modbus. The mA value is after the effect of the offset and span in the I/O CALIBRATION menu.

6. **AI4–REMOTE SPD REF** shows the value, in mA, of the Remote Speed Reference Input #4 Signal. This value times 1000 is sent to Modbus. The mA value is after the effect of the offset and span in the I/O CALIBRATION menu.

7. **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.

8. **ANALOG OUT 2** shows the value, in mA, of the Ignition Timing signal at Analog Output #2. 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.

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

10. **ACTUATOR OUT 2** shows the value, in mA, of the Air/Fuel Ratio actuator signal at Analog Output #4. 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.

11. **ALARM RESET** is used to reset all latched alarms and shutdowns, including I/O faults, once the condition which triggered the alarm or shutdown has been cleared. Toggle TRUE then FALSE to activate the reset.

Display IGN TMG

This menu is for **display only**. It displays the Ignition Timing values and control modes. This menu comes into view when USE IGN TMG CTRL on the CFIG OPTIONS menu is configured TRUE. Otherwise, this menu is concealed.

1. **IGNITION TIMING (DEG)** shows the Ignition Timing in degrees. A positive number indicates degrees before top dead center (BTC). A negative number indicates degrees after top dead center (ATC). This value times 10 is sent to Modbus.

2. **NO LOAD TMG REF (DEG)** shows the Ignition Timing reference, in degrees, of the No Load Ignition Timing ramp. This value is sent to Modbus. This Ignition Timing reference is in control when ON NO LOAD TIMING is TRUE.

3. **NORMAL TMG REF (DEG)** shows the Ignition Timing reference, in degrees, of the Normal Ignition Timing curve. This value is sent to Modbus. This Ignition Timing reference is in control when ON NORMAL TIMING is TRUE.

4. **AMB TQ TMG REF (DEG)** shows the Ignition Timing reference, in degrees, of the Ambient Torque Ignition Timing curve. This value is sent to Modbus. This Ignition Timing reference is in control when ON AMB TORQ TIMING is TRUE.

5. **ON NO LOAD TIMING** is TRUE when the NO LOAD TMG REF is in control of the Ignition Timing Analog Output #2 as determined by a Low Signal Selector (LSS). This state is sent to Modbus.

6. **ON NORMAL TIMING** is TRUE when the NORMAL TMG REF is in control of the Ignition Timing Analog Output #2 as determined by a Low Signal Selector (LSS). This state is sent to Modbus.

7. **ON AMB TORQ TIMING** is TRUE when the AMB TQ TMG REF is in control of the Ignition Timing Analog Output #2 as determined by a Low Signal Selector (LSS). This state is sent to Modbus.

Display AMP AFR

This menu is for **display only**. It displays the Air Manifold Pressure Air/Fuel Ratio values and control modes. This menu comes into view when USE A/F RATIO CTRL on the CFIG OPTIONS menu is configured TRUE and USE EXH TEMP A/F is not enabled. Otherwise, this menu is concealed.

1. **AIR MANF PRESS (in Hg)** shows the Air Manifold Pressure, in inches of mercury. This value is sent to Modbus.

2. **AIR MANF PR REF (in Hg)** shows the Air Manifold Pressure Reference, in inches of mercury, for the Air/Fuel Ratio control. This value is sent to Modbus.

3. **AFR VLV DEMAND(%)** shows the Air/Fuel Ratio valve demand, as percent travel, when **direct acting** Air/Fuel Ratio control is configured. 0% travel is max air (exhaust bypass valve fully closed or air intake butterfly valve fully open). This value times 10 is sent to Modbus.

4. **REV AFR VLV DMND(%)** shows the Air/Fuel Ratio valve demand, as percent travel, when **reverse acting** Air/Fuel Ratio control is configured. 0% travel is max air (exhaust bypass valve fully closed or air intake butterfly valve fully open).

5. **IN A/F CONTROL** is TRUE when the Air/Fuel Ratio PID is in control of the Air/Fuel Actuator output (Analog Output #4). This state is sent to Modbus.

6. **ON DFLT A/F RATIO** is TRUE when the primary Air/Fuel Ratio reference has failed and the default reference *or* the 'lock in last' reference is being used by the Air/Fuel Ratio control.

7. **ON MIN AIR LIMIT is TRUE** when the primary Air/Fuel Ratio reference is overridden by the MIN AMP LMT setting (minimum air manifold pressure reference limit). This state is sent to Modbus.

8. **ON START LIMIT** is TRUE when the primary Air/Fuel Ratio control output is overridden by the Starting Air/Fuel Ratio Valve Travel Limit Setting. This is normally set at the 'maximum air' valve position. This state is sent to Modbus.

9. **AFRR CURVE OUTPUT** is the present primary Air/Fuel Ratio reference, in inches of mercury, at the AMP vs FGH curve output (before any biases are applied). This value is sent to Modbus.

10. **AMP R/L BIAS** is the present bias, in inches of mercury, applied to the primary Air/Fuel Ratio reference by the Raise/Lower Air manifold pressure discrete inputs. This value is sent to Modbus.

11. **AMT BIAS** is the present bias, in inches of mercury, applied to the primary Air/Fuel Ratio reference by the air manifold thermocouple input. This value is sent to Modbus.

12. **AMT BIAS ENABLED** is the present status of the AMT Bias. Value is TRUE when Air Manifold Temperature bias is enabled.

Display EXHT AFR

This menu is for **display only**. It displays the Exhaust Temperature Air/Fuel Ratio values and control modes. This menu comes into view when USE A/F RATIO CTRL on the CFIG OPTIONS menu is configured TRUE and USE EXH TEMP A/F is enabled. Otherwise, this menu is concealed.

1. **EXHAUST TEMP(DEG F)** shows the Exhaust Temperature (stack), in °F. This value (before filtering) is sent to Modbus.

2. **EXH TEMP REF (in Hg)** shows the Exhaust Temperature Reference, in °F, for the Air/Fuel Ratio control. This value is sent to Modbus.

3. **AFR VLV DEMAND(%)** shows the Air/Fuel Ratio output valve demand, as percent travel, when **direct acting** Air/Fuel Ratio control is configured. 0% travel is max air (exhaust bypass valve fully closed or air intake butterfly valve fully open). This value times 10 is sent to Modbus.

4. **REV AFR VLV DMND(%)** shows the Air/Fuel Ratio output valve demand, as percent travel, when **reverse acting** Air/Fuel Ratio control is configured. 0% travel is max air (exhaust bypass valve fully closed or air intake butterfly valve fully open).

5. **IN A/F CONTROL** is TRUE when the Air/Fuel Ratio PID is in control of the Air/Fuel Actuator output (Analog Output #4). This state is sent to Modbus.

6. **ON START LIMIT** is TRUE when the primary Air/Fuel Ratio control output is overridden by the Starting Air/Fuel Ratio Valve Travel Limit Setting. This is normally set at the 'maximum air' valve position. This state is sent to Modbus.

7. **EXH TEMP R/L BIAS** is the present bias, in °F, applied to the primary Exhaust Temperature Reference by the Raise/Lower 'air manifold pressure' discrete inputs. The discrete input function is internally switched from 'air manifold pressure' Raise/Lower to 'exhaust temperature' Raise/Lower when Exhaust Temperature A/F is enabled. This value is sent to Modbus.

Display Indicator

This menu is for **display only**. It displays the configured Status Indication states in the 723PLUS control.

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

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

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

4. **ON AMP LIMIT** will show TRUE when the fuel demand is being limited by the Air Manifold Pressure Fuel Limit.

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

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

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

8. **PORT 1 ON HANDHELD** will show TRUE when Port 1 is setup to communicate with a handheld programmer.

9. **PORT 1 ON SERVLINK** will show TRUE when Port 1 is setup to communicate by Servlink with a PC.

A/F Ratio Ctrl Mode

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

1. **ON FG HDR A/F CTRL** will show TRUE when the Air/Fuel Ratio based on the fuel gas header pressure input is in control.

2. **ON FG FLOW A/F CTRL** will show TRUE when the Air/Fuel Ratio based on the fuel gas flow inputs is in control.

3. **ON EXH TMP A/F CTRL** will show TRUE when the Air/Fuel Ratio based on the exhaust temperature thermocouple input is in control.

4. **ON LOCK IN LAST A/F** will show TRUE when the Air/Fuel Ratio based on the last valid air manifold pressure reference is in control. This indicates that one or more of the inputs needed for normal Air/Fuel Ratio control have failed. Failed inputs have to be repaired and an alarm reset issued to restore normal Air/Fuel Ratio control.

5. **ON DEFAULT AMP A/F** will show TRUE when the Air/Fuel Ratio based on the default air manifold pressure reference is in control. This indicates that one or more of the inputs needed for normal Air/Fuel Ratio control have failed. The default air manifold pressure reference is tunable for manual air manifold pressure control during input failure. Failed inputs have to be repaired and an alarm reset issued to restore normal Air/Fuel Ratio control.

Speed Control Mode

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

1. **SPEED IN CONTROL** will show TRUE when the fuel demand is being controlled by the Speed Control. This state is sent to Modbus.

2. **ON START FUEL LMT** will show TRUE when the fuel demand is being limited by the START FUEL LIMIT. This state is sent to Modbus.

3. **ON MAXIMUM LIMIT** will show TRUE when the fuel demand is being limited by the MAX FUEL LIMIT. This state is sent to Modbus.

4. **ON TORQUE LIMIT** will show TRUE when the fuel demand is being limited by the TORQUE LIMIT CURVE. This state is sent to Modbus.

5. **ON AMP LIMIT (LSS)** will show TRUE when the fuel demand is being limited by the AMP LMT CURVE. This state is sent to Modbus.

6. **ACTUATOR SHUTDOWN** will show TRUE when an Actuator Shutdown has been applied. This state is sent to Modbus.

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

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

Display Menu

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

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

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

3. **FUEL DEMAND** displays the percent fuel demand. This is the same as the actuator output which is configured for direct acting.

4. **TURBO SPEED** displays the present turbocharger speed in rpm (if configured).

5. **START FUEL LIMIT** displays the output value of the start fuel limit ramp.

6. **TORQUE FUEL LIMIT** displays the torque fuel limit setting as a percent fuel demand.

7. **AMP FUEL LIMIT** displays the air manifold pressure fuel limit setting as a percent fuel demand.

8. **AIR MANF PRESS** displays the present air manifold pressure, in inches of mercury.

9. **FUEL GAS HEADER** displays the present fuel gas header pressure or fuel gas meter pressure (whichever is configured and connected), in psig.

10. **FUEL GAS METER** displays the present fuel gas meter differential pressure, in inches of water.

11. **REMOTE SPD REF** displays the present remote speed reference signal in rpm.

12. **ASSIST AIR REF** displays the turbocharger air assist reference, in inches of mercury.

13. **ASSIST AIR DEMAND** displays the turbocharger assist air valve demand in percent. This is NOT the same as the turbocharger assist output, if configured for reverse acting. This is the same, if configured for direct acting.

14. **PRECOMB CHAM CTRL** displays the Pre-Combustion Chamber control curve output signal, in psig.

15. **BRAKE HORSEPOWER** displays the present engine brake horsepower.

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. <u>BE AWARE</u> that incorrect wiring may inadvertently actuate the wrong end device.

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

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

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

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

FORCE DO 1 & 2

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

FORCE DO 3 & 4

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Chapter 4.
Initial Adjustments

Introduction

This chapter contains information on control calibration. It includes initial prestart-up and start-up settings and adjustments.

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

Start-up Adjustments

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

2. Close the Run/Stop contact. Be sure the Idle/Rated contact is in idle (open). Apply power to the control. Do NOT proceed unless the green POWER OK and CPU OK indicators on the front of the control are on.

3. Check the engine speed sensor.

    Minimum voltage required from the engine 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 the 723PLUS Performance '424' 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.

Speed Control Dynamic Adjustments

The objective of these dynamic adjustments is to obtain the optimum, stable engine speed response from minimum speed/load to full speed and load.

1.   Minimum Speed and Load Adjustments

Do this adjustment at minimum speed with minimum load applied.

Slowly increase the Min 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 minimum speed & minimum load, record the Actuator Output as read on the Display Menu. Set the Gain Slope Breakpoint to this reading.

Observe the movement of the actuator. If the activity of the actuator is excessive, reduce the Min 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:

•   Min Gain is too high and Reset is too low. Reduce the Min 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.

- Min 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 Min 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 Min 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. Rated Speed, Full Load Adjustment

Do these adjustments at rated speed and full load (or at the maximum available load if full load is not available).

Slowly increase the Rated Gain set point until the actuator output or engine speed becomes slightly unstable, then reduce the Rated Gain as necessary to stabilize the engine.

Observe the movement of the actuator. If the activity of the actuator is excessive, reduce the Rated Gain set point slightly to achieve an acceptable actuator movement level.

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 Rated 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 Rated Gain set point slightly. 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.

4. Verify that performance at all speed and load conditions is satisfactory and repeat the above procedures if necessary. Full load rejection testing is recommended as part of the performance testing.

5. While operating at full load, record the Actuator Output on the Display Menu. Select the Maximum Fuel Limit set point on the Fuel Limiter Menu. Set at approximately 10% over the full load output if desired, otherwise leave at 100%.

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

Air/Fuel Ratio Dynamic Adjustments

The objective of these dynamic adjustments is to obtain the optimum, stable air manifold pressure (AMP) *or* exhaust temperature (EXHT) response. The process (AMP or EXHT) used by the control is selected by A/F Ratio configuration. These adjustments are not required if the Air/Fuel Ratio function is not used.

These adjustments can be made at any speed and load combination which places the Air/Fuel Ratio control into a control mode (verify In A/F Control is TRUE). The trend screen included with Control View is a useful tool for monitoring the control response to engine load changes and to Air/Fuel Ratio dynamic setting changes.

Slowly increase the AFRC Gain set point until the Air/Fuel actuator output or process (AMP or EXHT) become slightly unstable, then reduce the AFRC Gain, as necessary, to stabilize the output and process.

Observe the movement of the Air/Fuel actuator. If the activity of the actuator is excessive, reduce the AFRC Gain set point slightly to achieve an acceptable actuator movement level.

If there is a slow periodic cycling of the process above and below the process reference, reduce the AFRC Gain by 50% and increase AFRC Reset slightly. Observe the movement of the Air/Fuel actuator or actuator output. Continue to increase AFRC Reset until the movement is active and acceptable but not rapid or excessive.

Check final dynamic settings during load changes or by issuing an A/F actuator bump. The Air/Fuel actuator output should quickly stabilize with minimal disturbance following an engine load or actuator bump transient.

Turbo Assist Dynamic Adjustments

The objective of these dynamic adjustments is to obtain the optimum, stable Turbo Air Assist control valve response during automatic turbocharger air assist PID control operation. These adjustments are not required if the Turbo Air Assist function is not used.

These adjustments can be only made at start-up when Turbo Assist is operational. The trend screen included with the Performance '424' Control View software is a useful tool for monitoring the Turbo Air Assist control valve response during start-up.

Slowly increase the Turbo Assist Gain set point until the Assist Air Demand output signal become slightly unstable, then reduce the Turbo Assist Gain, as necessary, to stabilize the output.

Observe the Assist Air Demand output signal. If the activity of the output signal is excessive, reduce the Turbo Assist Gain set point slightly to achieve an acceptable signal movement level.

If there is a slow periodic cycling of the air manifold pressure above and below the Turbo Assist Set reference, reduce the Turbo Assist Gain by 50% and increase Turbo Assist Reset slightly. Observe the movement of the Assist Air Demand output signal. Continue to increase Turbo Assist Reset until the movement is active and acceptable but not rapid or excessive.

Check final dynamic settings during start-up. The Assist Air Demand output signal should increase quickly to the maximum open valve position, for 3 seconds (setting is tunable), then slowly close to control air manifold pressure at the Turbo Assist reference setting. The Assist Air Demand output signal should not overshoot the final position required to regulate air manifold pressure at the Turbo Assist Set reference. Refer to Figure 4-1.
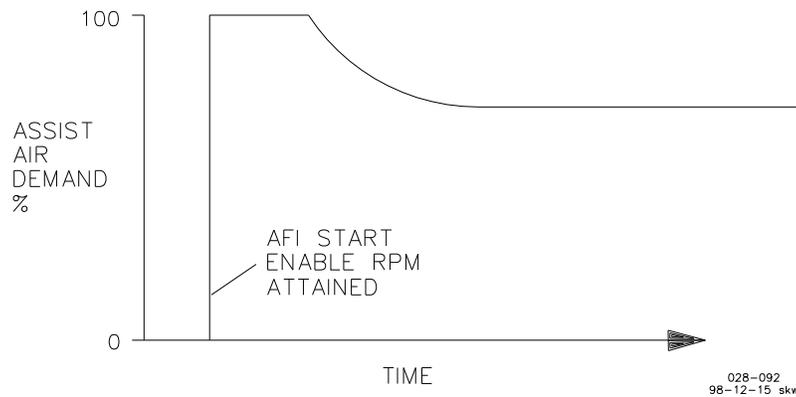
Figure 4-1. Assist Air Demand

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 (Remote Speed contact closed). If the engine rpm is lower or higher than desired, increase or decrease the 4 mA Remote Reference set point to obtain the correct speed. There may be a small difference between the set point and actual speed which compensates for the inaccuracies in the analog circuits.

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

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

2.   4 to 20 mA Tachometer Output

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

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

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

Conclusion of Setup Procedures

This completes the adjustment chapter. Save the set points by pressing the "SAVE" key on the Hand Held Programmer or save settings using the 723PLUS Performance '424' 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 the 723PLUS Performance '424' 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). The 723PLUS Performance '424' Control View or Watch Window may remain connected or removed from the control at the end user's discretion. Close the cover over J1 and re-tighten the retaining screw if connection is removed.

Chapter 5.
Description of Operation

General

This chapter provides an overview of the features and operation of the 723PLUS Digital Industrial Speed/Performance Control '424'. Figure 5-1 shows the control block diagram for reference in the following descriptions.

The 723PLUS Digital Industrial Speed/Performance Control '424' uses a 32-bit microprocessor for all control functions. All control adjustments are made with a hand-held terminal/display, the 723PLUS Performance '424' Control View, or Watch Window that communicates with the control via a serial port. The hand-held terminal/display is disconnected from the control when not in service, to provide security against tampering. The 723PLUS Performance '424' Control View or Watch Window may remain installed or disconnected 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 one configurable output. This output may be used for an analog meter, recorder, or as an input to a computer.

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

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

Speed Control Dynamics

The control algorithms used in the 723PLUS Industrial Speed/Performance Control '424' are designed specifically for reciprocating engine applications. The control offers an effective set of dynamics for variable speed, variable load operation.
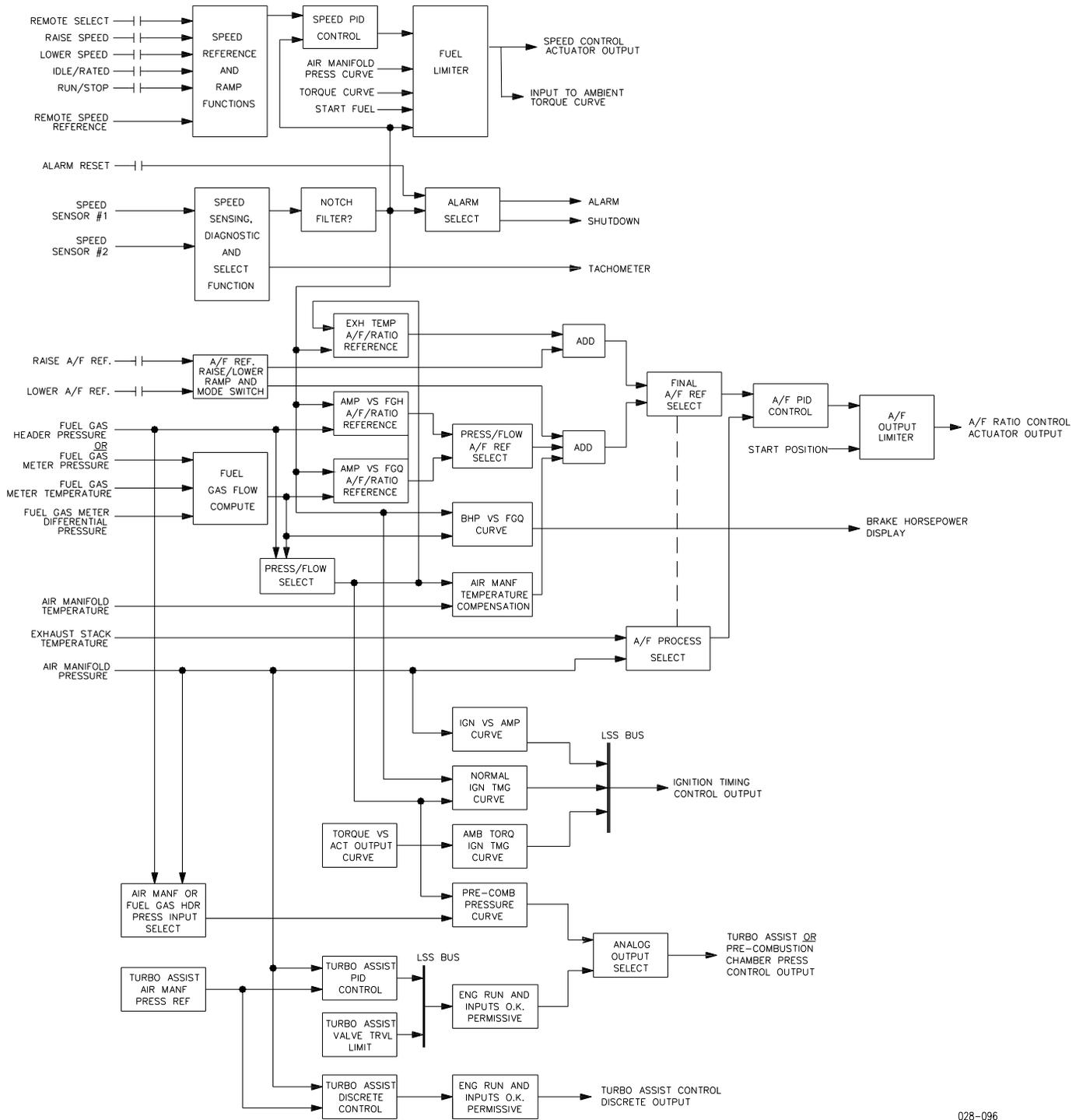
Figure 5-1. Simplified Block Diagram

Min Gain and Rated Gain provide independent gain settings for minimum speed and rated speed to obtain stability and response over the entire variable speed operating range. Independent gain settings are useful for reciprocating engines that tend to be less stable at reduced speed operation.

Gain slope and gain breakpoint vary the gain linearly as a function of fuel demand (load). This provides the flexibility to increase or decrease gain as load increases. Gain slope and gain breakpoint are useful for fuel systems and processes that tend to be less stable at reduced or increased load operation. This function may be disabled by setting the gain slope at zero.

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

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

Speed Input

One or two speed sensors provide an engine speed signal to the control. The method used to detect speed is a digital type of detection for the engine or an analog type of detection for the turbocharger. The digital detection method senses speed very quickly and can respond to speed changes very quickly.

Notch Filter Function

When "Use Notch Filter" is configured FALSE, the notch filter function is disabled. When "Use Notch Filter" is configured TRUE, a notch filter is enabled for single speed sensor applications that will benefit from torsional filtering. In the notch filter approach, no attempt is made to map the oscillatory modes, but an effort is made to reduce the signal transmission through the controller by a filter that drastically reduces the signal gain at the resonant frequency.

Minimum Fuel Function

The Minimum Fuel Function brings the fuel demand to zero. This occurs when the Close to Run discrete input goes FALSE. It also occurs if both speed sensor inputs have failed, or if one speed sensor input fails when MPU2 is configured as a Turbo Speed input. 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 5-2). During start-up, when engine speed reaches five percent of rated speed, the Start Limit Function is momentarily triggered to immediately limit the fuel demand to a software-adjustable start fuel limit. The start ramp begins increasing the fuel demand at a software-adjustable rate shortly after the start fuel limit is triggered. The rate can be set at zero to eliminate the start ramp function. When engine speed reaches 95% of the speed reference, and the PID is in control of the fuel demand for 1 second, the Start Limit Function will immediately increase to a maximum value of 100 percent. When engine speed decreases below five percent of rated speed from a shutdown, the Start Fuel Limit Function is re-armed for trigger during the next start. The start fuel limit function also works on reverse-acting systems. The function can be disabled by adjusting the Start Fuel Limit to a value of 100.
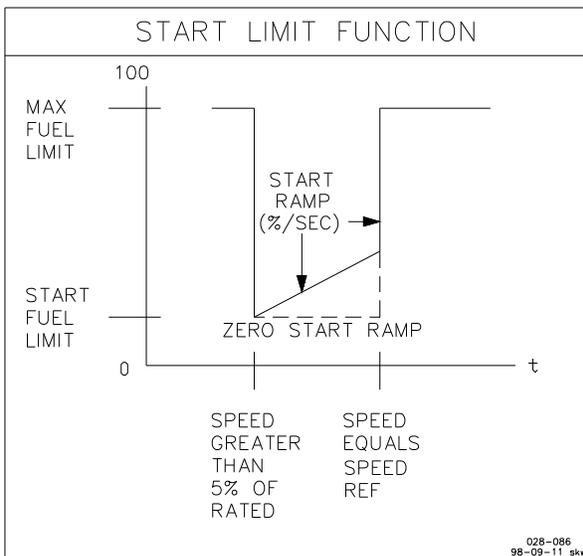
Figure 5-2. Start Limit Function

Fuel Limiting Function

Two separate Fuel Limiting Functions (AMP LIMIT curve and TORQUE LIMIT curve) provide limits to the fuel demand which prevents overfuel conditions. One function is based on an air manifold pressure transmitter signal provided at Signal Input #1. The other is based on the engine speed provided at the speed inputs. These Fuel Limiting Functions provide two software adjustable five-breakpoint curves based on each signal. The display value of the input signal can be scaled according to the engineering units desired. The output used for fuel demand limiting is in percent. The limiting value is linear from set point to set point as shown in Figure 5-3. The functions are enabled when the engine speed first reaches 95 percent of the speed reference. They remain enabled until the engine is shut down. These functions are also disabled if the input signal is failed. These functions can also be enabled or disabled by software at the AMP Limit Curve menu and the Torque Limit Curve menu.
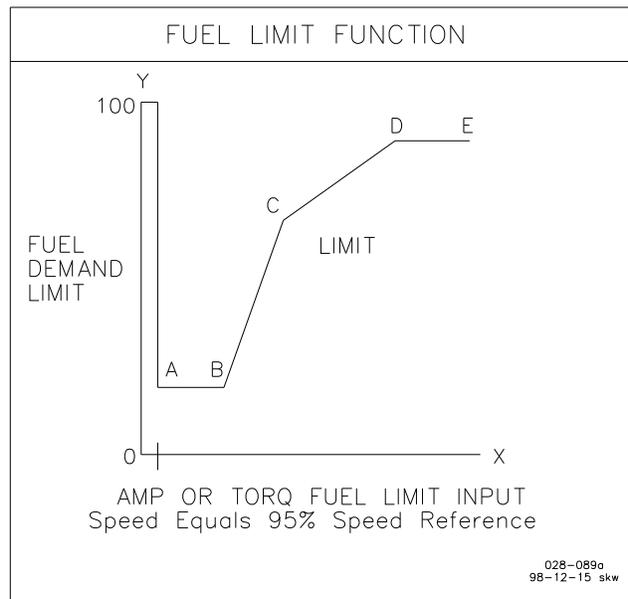
Figure 5-3. Fuel Limit Breakpoints

Actuator Function

The Actuator Function changes the fuel demand into a signal which can be used by Analog Output #3. This allows for a direct-acting actuator only. A direct-acting fuel system is one where the signal to the actuator increases as the fuel demand increases. Standard actuators use effective signals of 20 to 160 mA to travel from minimum position to maximum position. The fuel demand is scaled from 0 to 100 percent for an output of 0 to 200 mA. This results in a fuel demand with a value of ten percent when the actuator is effectively at minimum and a fuel demand of 80 percent when the actuator is effectively at maximum. An output of 4 to 20 mA instead of 0 to 200 mA is a configuration option.

Speed Failures

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

Alarm Reset

The Alarm Reset command can be issued from several different points. The command is a momentary true which resets any parameters which were latched in a failed state and are now valid when the reset occurs. The command can be issued from the Shutdown menu, Alarm menu, or the Display Analog I/O menu using Watch Window, Control View, or with the Hand Held programmer. Toggling the Alarm Reset discrete input TRUE, then FALSE, issues the Alarm Reset command. An Alarm Reset can be issued by Modbus Boolean Write (BW) address 0:0001. An Alarm Reset is also issued when power is applied to the 723PLUS. And finally, the control issues an Alarm Reset during start-up (when configured).

Speed Reference and Ramps

The 723PLUS Performance Control '424' provides local control with discrete inputs for raising and lowering speed. For remote speed setting, the control provides a 4 to 20 mA or 1 to 5 Vdc Remote Reference input and a Modbus analog write (AW) address 4:0005. Input functions are enabled as follows:

Local Speed Reference Raise/Lower discrete inputs are enabled when the Remote Speed Control discrete input contact is open.

Remote Speed Reference setting is enabled when the Remote Speed control discrete input contact is closed, the Rated contact is closed, Use Remote Reference is configured TRUE, and Use Remote Commands is configured FALSE.

Modbus Speed Reference setting is enabled when the Remote Speed control discrete input contact is closed, the Rated contact is closed, Use Remote Reference is configured TRUE, and Use Remote Commands is configured TRUE.

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, 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 idle to rated speed. This rate is also used to ramp from start to idle 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, the remote reference input, and the Modbus AW value.

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 configuration has this function disabled. It can be enabled for applications which need this function (e.g., spark gas reciprocating engines). This Start reference is selected, at a very fast rate, by control power-up or engine not running. When configured TRUE, the Start reference is given first priority over all other references.

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

Closing the Rated contact ramps the speed set point from idle to rated *if* the oil temperature is above the rated speed permissive oil temperature setting or if the backup warm-up timer expires.

The oil temperature permissive setting is configurable, and the control will hold idle speed until the oil temperature has warmed to the oil temperature setting. The control input is a type J thermocouple installed in the engine lube oil outlet piping and connected to a thermocouple LINKnet node. If preferred, this thermocouple may be installed in another location (e.g., jacket water outlet piping) which indicates adequate engine warm-up before permitting acceleration to rated speed. A warm-up timer is provided as a backup to the temperature permissive should the thermocouple input fail or be left unconnected.

The oil temperature permissive input does not inhibit loading. The engine may be loaded during idle warm-up operation. In fact, loading is recommended since the engine will be doing useful work and will warm up faster. Two-cycle engines also run better and get off turbocharger air assist operation when some load is applied to the engine. A low temperature setting disables this function to allow acceleration of a cold engine to rated speed.

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

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

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

If a Remote Speed Reference input or Modbus AW value is present and selected when the Idle/Rated contact is closed or during the idle to rated ramp, the speed reference will ramp to the speed set by the milliamps on the Remote Speed Reference input or the Modbus AW value, based on the raise rate set point, *if* the oil temperature is above the rated speed permissive setting. 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 5-4). If a difference is detected between the present speed reference and the remote reference rpm value, the present speed reference is ramped up or down at the raise or lower rate until the present speed reference matches the remote speed reference rpm value. The remote reference will not increase/decrease the speed reference above the raise limit or below the lower limit.
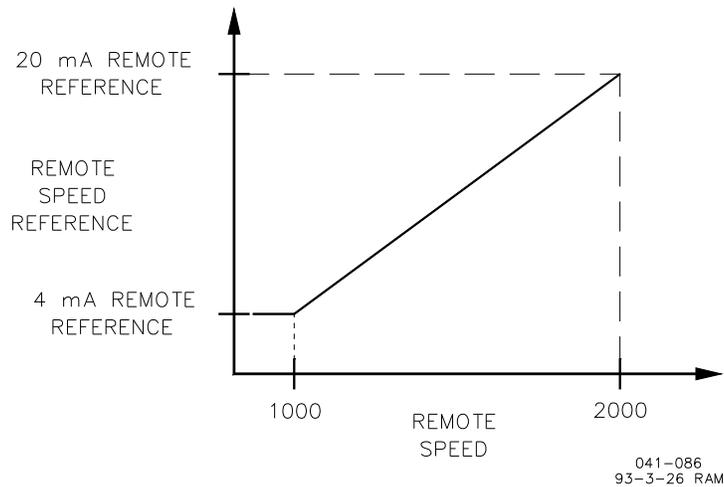
Figure 5-4. Remote Speed Reference

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

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

Air/Fuel Ratio Reference

The 723PLUS control provides three configurable Air/Fuel Ratio control reference types and discrete inputs for temporarily raising and lowering the air manifold pressure or exhaust temperature reference. Reference type is selected and enabled as follows:

Air manifold pressure reference based on fuel gas header pressure, engine speed, and air manifold temperature inputs, is enabled when Use Air/Fuel Ratio is TRUE and Use Fuel Flow A/F is FALSE. The Raise/Lower air manifold pressure discrete inputs are also enabled.

Air manifold pressure reference based on fuel gas flow, engine speed, and air manifold temperature inputs, is enabled when Use Air/Fuel Ratio is TRUE and Use Fuel Flow A/F is TRUE. The Raise/Lower air manifold pressure discrete inputs are also enabled.

Exhaust temperature reference based on fuel gas header pressure *or* fuel flow (whichever is configured and connected) and engine speed inputs is enabled when Use Air/Fuel Ratio is TRUE, Use Exh Temp A/F is TRUE, air manifold pressure is above the override air manifold pressure reference, engine is running at minimum speed or higher, and exhaust temperature is above a minimum setting for a predetermined delay time and below a maximum exhaust temperature setting. The Raise/Lower air manifold pressure discrete input functions are switched to become Raise/Lower exhaust temperature discrete inputs. The Raise/Lower limits and rates are also switched to exhaust temperature limits and rates.

This section describes the operation of the Air/Fuel Ratio reference functions. Read this section carefully to be sure your Air/Fuel Ratio control provides the correct operating mode.

A/F Ratio—Fuel Gas Header Pressure Type

A three-dimensional curve sets the air manifold pressure reference as a function of speed and load. The fuel gas header pressure input provides the load variable, and the speed sensor input provides the speed variable.

The 3D curve has two breakpoints each for fuel gas header pressure and engine speed, for a combined total of four breakpoints. The curve output is combined with an air manifold temperature bias curve output to produce the final air manifold pressure reference for the A/F Ratio PID control. In addition, raise/lower air manifold pressure discrete inputs also combine with the curve output to temporarily increase or decrease the air manifold pressure reference during testing to establish optimum settings.

The A/F Ratio PID control adjusts the A/F Ratio actuator control output to regulate the air manifold pressure at the air manifold pressure reference setting. Dynamic A/F Ratio adjustments are provided to tune the PID control for optimum air manifold pressure stability and response during variable speed and load operation.

A/F Ratio—Fuel Gas Flow Type

A three-dimensional curve sets the air manifold pressure reference as a function of speed and load. The fuel gas flow inputs provide the load variable and the speed sensor input provides the speed variable.

Fuel flow is computed from the fuel gas meter run pressure, temperature, and orifice plate differential pressure inputs. Constants can be entered for one or both of the fuel gas meter run pressure and temperature inputs when these are constant by nature or regulation. Differential pressure is a required input.

The 3D curve has six breakpoints for fuel gas flow and two breakpoints for engine speed, for a combined total of twelve breakpoints. The curve output is combined with an air manifold temperature bias curve output to produce the final air manifold pressure reference for the A/F Ratio PID control. In addition, raise/lower air manifold pressure discrete inputs also combine with the curve output to temporarily increase or decrease the air manifold pressure reference during testing to establish optimum settings. Figure 5-5 is an example of this 3D curve. Each breakpoint is individually set independently of the other breakpoints.

The A/F Ratio PID control adjusts the A/F Ratio actuator control output to regulate the air manifold pressure at the air manifold pressure reference setting. Dynamic A/F Ratio adjustments are provided to tune the PID control for optimum air manifold pressure stability and response during variable speed and load operation.

A/F Ratio—Exhaust Temperature Type

A three-dimensional curve sets the exhaust temperature reference as a function of speed and load. The fuel gas header pressure *or* fuel gas flow inputs provides the load variable and the speed sensor input provides the speed variable.
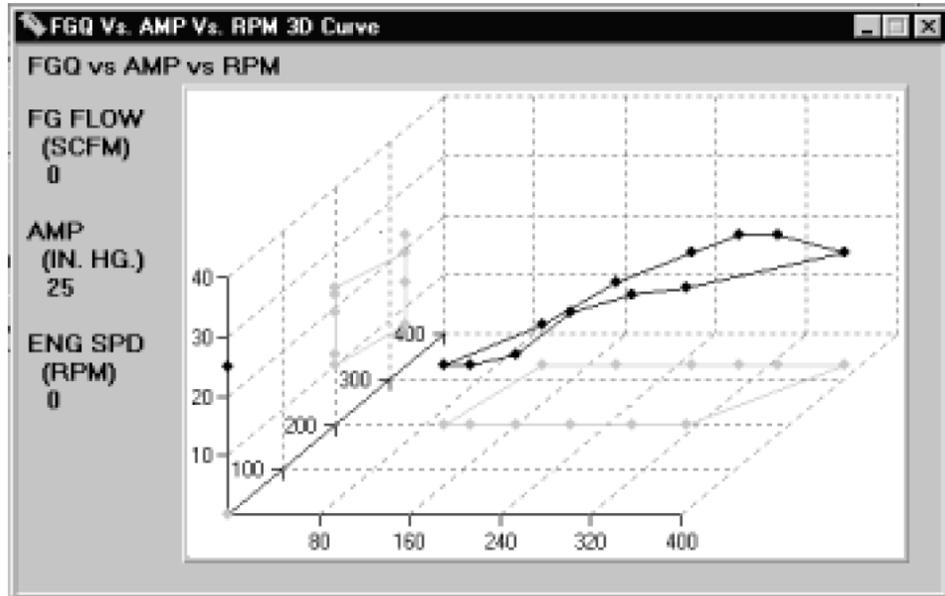
Figure 5-5. Air Manifold Pressure Reference vs Speed and Fuel Flow

The 3D curve has five breakpoints for fuel gas header pressure *or* fuel gas flow and two breakpoints for engine speed, for a combined total of ten breakpoints. The raise/lower exhaust temperature discrete inputs combine with the curve output to temporarily increase or decrease the exhaust temperature reference during testing to establish optimum settings.

The A/F Ratio PID control adjusts the A/F Ratio actuator control output to regulate the exhaust stack temperature at the exhaust temperature reference setting. Dynamic A/F Ratio adjustments are provided to tune the PID control for optimum exhaust temperature stability and response during variable speed and load operation.

Either the fuel gas header pressure *or* fuel gas flow type A/F Ratio control (whichever is configured and connected) will assume A/F Ratio control when the exhaust temperature A/F Ratio control is disabled for any reason (e.g., at start-up, an air manifold pressure override condition exists, etc.).

A/F Ratio—Air Manifold Temperature Bias

A three-dimensional curve sets a bias for the air manifold pressure reference as a function of air manifold temperature and load. The fuel gas header pressure *or* fuel gas flow input (whichever is configured and connected) provides the load variable, and an air manifold thermocouple input provides the temperature variable.

The curve bias setting (±) is added to either the Fuel Gas Header Pressure *or* the Fuel Gas Flow reference value. It is not used with the Exhaust Temperature reference. The air manifold pressure bias setting is hard configured to be zero at 110 °F air manifold temperature. Bias settings are limited to positive values for temperatures above 110 °F and negative values for temperatures below 110 °F.

The 3D curve has two breakpoints each for fuel gas header pressure *or* fuel gas flow and air manifold temperature, for a combined total of four breakpoints. The zero load breakpoints are hard configured for zero bias regardless of air manifold temperature.

A/F Ratio Actuator

The Actuator Function changes the A/F Ratio PID demand into a signal which can be used by Analog Output #4. This allows for either a direct-acting actuator or a reverse-acting actuator. A direct-acting A/F Ratio system is one where the signal to the actuator increases as the A/F Ratio PID demand increases. A reverse-acting A/F Ratio system is one where the signal to the actuator decreases as the A/F Ratio PID demand increases. In either system, the air manifold pressure to the engine increases as the A/F Ratio PID demand increases. A reverse-acting system allows for using actuators which fail to the maximum air position on loss of control output. Reverse actuators use effective signals of 4 to 20 mA to travel from **maximum** air position to **minimum** air position. Direct actuators use effective signals of 4 to 20 mA to travel from **minimum** air position to **maximum** air position. The A/F Ratio PID demand is scaled from 0 to 100 percent for an output of 4 to 20 mA when Direct Acting is selected (or 20 to 4 mA when Reverse Acting is selected). The actuator normally controls a turbocharger exhaust bypass valve, an intake air throttle valve, or an air dump valve to regulate air manifold pressure. The 723PLUS A/F Ratio control is compatible with these valve types, with appropriate actuators, for all the configurations provided.

Air/Fuel Ratio Input Failures

The Air/Fuel Ratio control handles input failures in distinct manners based on the A/F Ratio configuration since configuration determines which inputs are used by the control.

The Exhaust Temperature A/F Ratio control is disabled and the primary override A/F Ratio control (Fuel Gas Header *or* Fuel Gas Flow) is enabled when the exhaust thermocouple input fails.

The Fuel Gas Flow A/F Ratio control has two different failure modes based on the CFIG A/F Ratio Lock in Last setting:

When Lock in Last is set TRUE, the air manifold pressure reference will lock in the last valid setting when a failure of the fuel gas meter pressure, fuel gas meter temperature, fuel gas meter orifice differential pressure, or air manifold temperature input is detected. The A/F Ratio control continues to regulate air manifold pressure at the 'lock in last' reference until normal operation of the failed input is restored. Failure of the air manifold pressure input switches the air manifold pressure reference and process inputs of the A/F Ratio PID to the last valid air manifold pressure. This effectively locks the A/F Ratio actuator signal at its last valid output level when a failure of the air manifold pressure is detected. Configuring an input failed alarm for all (pressure and temperature) of the A/F Ratio control inputs is recommended.

When Lock in Last is set FALSE, the air manifold pressure reference will switch to a Default reference setting when a failure of the fuel gas meter pressure, fuel gas meter temperature, fuel gas meter orifice differential pressure, or air manifold temperature input is detected. The A/F Ratio control continues to regulate air manifold pressure at the Default reference until normal operation of the failed input is restored. This Default reference (DEFAULT AMP REF) is tunable for manual air manifold pressure control during input failure. The Raise/Lower discrete input functions are disabled. Failure of the air manifold pressure input also switches the air manifold pressure reference to a Default air manifold pressure reference. However, the A/F Ratio control is incapacitated without the air manifold pressure input and manual air manifold pressure control is ineffective. This sets the A/F actuator output at the maximum air position. Configuring an air manifold pressure input failed alarm or shutdown is recommended.

The Fuel Gas Header Pressure A/F Ratio control has two distinct failure modes based on the CFIG A/F Ratio Lock in Last setting:

When Lock in Last is set TRUE, the air manifold pressure reference will lock in the last valid setting when a failure of the fuel gas header pressure or of the air manifold temperature input is detected. The A/F Ratio control continues to regulate air manifold pressure at the 'lock in last' reference until normal operation of the failed input is restored. Failure of the air manifold pressure input switches the air manifold pressure reference and process inputs of the A/F Ratio PID to the last valid air manifold pressure. This effectively locks the A/F Ratio actuator signal at its last valid output level when a failure of the air manifold pressure is detected. Configuring an input failed alarm for all (pressure and temperature) of the A/F Ratio control inputs is recommended.

When Lock in Last is set FALSE, the air manifold pressure reference will switch to a Default reference setting when a failure of the fuel gas header pressure or air manifold temperature input is detected. The A/F Ratio control continues to regulate air manifold pressure at the Default reference until normal operation of the failed input is restored. This Default reference is tunable for manual air manifold pressure control during input failure. Failure of the air manifold pressure input also switches the air manifold pressure reference to a Default air manifold pressure reference. However, the A/F Ratio control is incapacitated without the air manifold pressure input, and manual air manifold pressure control is ineffective. This sets the A/F actuator output at the maximum air position. Configuring an air manifold pressure input failed alarm or shutdown is recommended.

Ignition Timing Reference

The 723PLUS control provides three tunable ignition timing reference curves and one configurable starting ignition timing setting. Settings are also provided to limit maximum advance and maximum retard. A low signal selector determines which ignition timing signal is applied to the ignition timing output.

This section describes the operation of the ignition timing reference function. Read this section carefully to be sure your ignition timing control provides the correct operating mode.

Starting Ignition Timing

The Starting Ignition Timing is a configurable setting and is in control of the ignition timing output when engine speed is below the Air/Fuel Ratio and Ignition (AFI) START ENABLE rpm setting. A positive value sets the Starting Ignition Timing as °BTC, and a negative value sets the Starting Ignition Timing as °ATC. The Starting Ignition Timing must be set between the maximum advance and maximum retard limit settings. The Starting Ignition Timing is removed once the engine starts and is running above the AFI START ENABLE speed for a tunable retard delay setting.

The purpose of the Starting Ignition Timing setting is to set the ignition timing, during starting, at the correct crank angle, relative to Top Dead Center (TDC), as required for reliable starting. Set per the engine manufacturers recommendation.

Start-up Ignition Timing

A two-dimensional curve sets the Start-up Ignition Timing reference as a function of air manifold pressure. Curve function is enabled when the engine is running above the AFI START ENABLE speed for a tunable retard delay setting. A ramp function is provided for stability.

The primary purpose of this reference is to set an ignition timing retard for turbocharged engines, to boost turbocharger speed, and minimize turbocharger assist air consumption following engine start-up while operating at light load. A tunable ramp rate is enabled at a tunable air manifold pressure setting to effect ignition timing stability. Set per the engine manufacturers recommendation.

This curve can also be set to control the Normal Ignition Timing of turbocharged and non-turbocharged engines as a function of air manifold pressure. Set per the engine manufacturers recommendation.

This 2D curve has five breakpoints for setting the ignition timing versus air manifold pressure. The ignition timing reference is linear between breakpoints.

Normal Ignition Timing

A three-dimensional curve sets the Normal Ignition Timing reference as a function of speed and load. The fuel gas header pressure *or* fuel gas flow input (whichever is configured and connected) provides the load variable and the speed sensor input provides the speed variable.

The primary purpose of this reference is to control ignition timing during normal loaded operation. Set per the engine manufacturers recommendation.

This 3D curve has two breakpoints for setting the ignition timing versus fuel gas header pressure *or* fuel gas flow, at two speeds, for a combined total of four breakpoints. The ignition timing reference is linear between breakpoints.

Ambient Torque Ignition Timing

A two-dimensional curve sets the Ambient Torque Ignition Timing reference as a function of ambient torque. The ambient torque input is scaled by a second 2D curve as a function of fuel demand.

The primary purpose of the Ambient Torque Ignition Timing curve is to retard ignition timing, during ambient torque operation, to limit peak firing pressure. Set per the engine manufacturer recommendations.

The purpose of the ambient torque curve is to produce an ambient torque signal, based on fuel demand. The fuel demand must be measured at rated speed/ambient torque and rated speed/100% torque to determine the curve breakpoint settings.

The 2D Ambient Torque Ignition Timing curve has two breakpoints for setting the ignition timing versus ambient torque. The ignition timing reference is linear between breakpoints.

This 2D ambient torque curve has two breakpoints for setting the ambient torque versus fuel demand. Torque is linear between breakpoints.

To disable the Ambient Torque Ignition Timing function for non-ambient rated engines, set the configurable rated speed maximum allowable torque at 100%.

Ignition Timing LSS

The ignition timing reference signals from the Start-up Ignition Timing, Normal Ignition Timing, and Ambient Ignition Timing curves are inputs to an Ignition Timing Low Signal Selector (LSS). The maximum ignition timing advance and retard limits are used as the LSS bus high and low limits.

The Ignition Timing LSS applies the lowest ignition timing signal input (highest retard), to the ignition timing output. The signal must be between the maximum advance and maximum retard limit settings. When all signals exceed either the maximum advance or the maximum retard limit settings, the applicable limit setting is applied to the ignition timing output.

Turbocharger Air Assist Control

The 723PLUS control provides two choices for automatic turbocharger air assist control:
- Discrete relay
- Analog PID

The choice is made by connecting to the preferred output type. Connection is not necessary if this function is not used by the application.

One air manifold pressure set point is provided for both types.

With the discrete type (relay), the output contact is closed after the engine is running, while air manifold pressure is below the set point, and opens while air manifold pressure is above the set point plus a tunable hysteresis set point *for direct acting configuration.* The contact action is configurable as either direct acting (close for assist) or reverse acting (open for assist). If power to the control is lost, the contact will open.

With the analog PID type, a "rapid on" signal is output after the engine is running, for a tunable PID Bypass Time. PID control is enabled after the PID Bypass Time expires, to regulate air manifold pressure at the air manifold pressure set point. The PID control action is configurable as direct acting (increasing output increases air manifold pressure) or reverse acting (decreasing output increases air manifold pressure). The PID output is applied to Analog Out #1 which must be configured for turbocharger air assist control and connected to a 4–20 mA turbocharger assist valve actuator.

The AFI Start Enable speed set point, in rpm, is used by both types as the engine running set point.

> **IMPORTANT**   **Analog output #1 can be configured for either PCC control or TAC analog PID control, _but not both_.**

Pre-Combustion Chamber Pressure Control

The 723PLUS control provides one three-dimensional curve for pre-combustion chamber pressure control.

The 3D curve sets the pre-combustion chamber pressure reference as a function of speed and load. Either the air manifold pressure input _or_ fuel gas header pressure input can be configured to provide the load variable, and the speed sensor input provides the speed variable. The curve output is applied to Analog Out #1 which must be configured for pre-combustion chamber control and connected to a 4–20 mA pressure control actuator.

This 3D curve has four breakpoints for setting the pre-combustion chamber pressure versus air manifold pressure _or_ fuel gas header pressure, at two speeds, for a combined total of eight breakpoints. The pre-combustion chamber pressure is linear between breakpoints.

Brake Horsepower

The 723PLUS control provides one three-dimensional curve for fuel flow based brake horsepower calculation and **display only**. No control functions are provided with this curve.

The 3D curve sets the brake horsepower display value as a function of speed and load. The fuel gas flow inputs provide the load variable, and the speed sensor input provides the speed variable. The curve output is applied to the Display Menu and made available over Modbus.

This 3D curve has six breakpoints for setting the brake horsepower versus fuel flow, at two speeds, for a combined total of twelve breakpoints. The brake horsepower is linear between breakpoints.

Initial settings should be based on the original engine production test or reliable engine analyzer data. The engine analyzer, if used, must be operated by a qualified technician, to verify brake horsepower of an engine known to be in **"like-new"** operating condition. ***DO NOT* use an analyzer to verify fuel flow brake horsepower of an engine which is *NOT* in top operating condition.** The fuel flow brake horsepower of an impaired engine will be erroneously high because of imperfect combustion and a related increase in fuel consumption. This is expected and desirable since an erroneously high brake horsepower reading generally results in some unloading of an impaired engine. The fuel flow brake horsepower settings of an impaired engine should not be reduced to match the analyzer brake horsepower since it could lead to excessive loading. **Refer to the engine nameplate for rated brake horsepower**.

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, the 723PLUS Performance '424' Control View, or Watch Window to the control in accordance with the instructions in Chapter 3. Verify that correct voltage and polarity are applied to the control. Verify that the programmer does its power-up tests (if applicable). **Be sure the jumper between terminals 9 and 10 is removed to use the Hand Held Programmer** (do note remove the jumper to use Watch Window or the 723PLUS Performance '424' Control View). Failure to do the power up test indicates that either the control or the Hand Held Programmer has failed. If so, try this step with another Hand Held Programmer. If the test still fails, replace the 723PLUS control. If the test passes with the second Hand Held Programmer, replace the Hand Held Programmer.

2. Verify the controller ID on the 723PLUS Performance '424' Control View by clicking "help" then "about". Verify the controller ID on the Hand Held Programmer by pressing the "ID" key. Verify the controller ID in Watch Window by reading 'Control Properties'. The Application ID message "5414-146" 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 Speed Ctrl 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 the 723PLUS Performance '424' 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.

Air Manifold Pressure Xdcr Input

The following tests calibrate and verify the function of the Air Manifold Pressure Xdcr input (Signal Input #1).

1. Connect a 4 to 20 mA or 1 to 5 Vdc source to terminals 42(+) and 43(–). If a mA source is used, a jumper must be installed across terminals 41 and 42. Connect a dc voltmeter across terminals 42(+) and 43(–). Optionally, a mA meter may be installed in series with the 4 to 20 mA source.

2. Set the source for 5.0 Vdc (20.0 mA) on the meter. Select DISPLAY MENU on the Hand Held Programmer, the 723PLUS Performance '424' Control View or Watch Window. Select AIR MANF PRESS.

3. The AIR MANF PRESS value should be equal to the AMP @20mA value set previously in the SET ANALOG INPUTS menu.

4. Set the source for 1.0 Vdc (4.0 mA). The AIR MANF PRESS value should be equal to the AMP @4mA value set previously in the SET ANALOG INPUTS menu. If the meter indicates proper voltages (or currents) are present on Signal Input #1, but readings on the Hand Held Programmer, the 723PLUS Performance '424' Control View or Watch Window are incorrect, the 723PLUS control is defective and should be replaced.

Fuel Gas Header Press or Fuel Gas Meter Press Input

The following tests calibrate and verify the function of the Fuel Gas Header Press or Fuel Gas Meter Press Xdcr input (Signal Input #2).

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

2. Set the source for 5.0 Vdc (20.0 mA) on the meter. Select DISPLAY MENU on the Hand Held Programmer, the 723PLUS Performance '424' Control View or Watch Window. Select FUEL GAS HEADER.

3. The FUEL GAS HEADER PRESS value should be equal to the FGH @20mA value set previously in the SET ANALOG INPUTS menu.

4. Set the source for 1.0 Vdc (4.0 mA). The FUEL GAS HEADER PRESS value should be equal to the FGH @4mA value set previously in the SET ANALOG INPUTS menu. If the meter indicates proper voltages (or currents) are present on Signal Input #2, but readings on the Hand Held Programmer, the 723PLUS Performance '424' Control View or Watch Window are incorrect, the 723PLUS control is defective and should be replaced.

Fuel Gas Meter Diff Press Xdcr Input

The following tests calibrate and verify the function of the Fuel Gas Meter Diff Press Xdcr input (Signal Input #3).

1. Connect a 4 to 20 mA or 1 to 5 Vdc source to terminals 48(+) and 49(–). If a mA source is used, a jumper must be installed across terminals 47 and 48. Connect a dc voltmeter across terminals 48(+) and 49(–). Optionally, a mA meter may be installed in series with the 4 to 20 mA source.

2. Set the source for 5.0 Vdc (20.0 mA) on the meter. Select DISPLAY MENU on the Hand Held Programmer, the 723PLUS Performance '424' Control View or Watch Window. Select FUEL GAS METER.

3. The FUEL GAS METER value should be equal to the FG DP @20mA value set previously in the SET ANALOG INPUTS menu.

4. Set the source for 1.0 Vdc (4.0 mA). The FUEL GAS METER value should be equal to the FG DP @4mA value set previously in the SET ANALOG INPUTS menu. If the meter indicates proper voltages (or currents) are present on Signal Input #3, but readings on the Hand Held Programmer, the 723PLUS Performance '424' Control View or Watch Window are incorrect, the 723PLUS control is defective and should be replaced.

Remote Speed Ref Xdcr Input

The following tests calibrate and verify the function of the Remote Speed Ref Xdcr input (Signal Input #4).

1. Connect a 4 to 20 mA or 1 to 5 Vdc source to terminals 51(+) and 52(–). If a mA source is used, a jumper must be installed across terminals 50 and 51. Connect a dc voltmeter across terminals 51(+) and 52(–). Optionally, a mA meter may be installed in series with the 4 to 20 mA source.

2. Set the source for 5.0 Vdc (20.0 mA) on the meter. Select DISPLAY MENU on the Hand Held Programmer, the 723PLUS Performance '424' Control View or Watch Window. Select REMOTE SPEED REF.

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

4. Set the source for 1.0 Vdc (4.0 mA). The REMOTE SPEED REF input value should be equal to the REM SR @ 4mA value set previously in the SET ANALOG INPUTS menu. If the meter indicates proper voltages (or currents) are present on Signal Input #4, but readings on the Hand Held Programmer, the 723PLUS Performance '424' Control View or Watch Window are incorrect, the 723PLUS control is defective and should be replaced.

Actuator Output

The following tests verify the actuator output of the control.

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

2. Close the Run contact (terminal 36). Connect a milliamp meter across terminals 19(+) and 20(–) if no actuator is connected. Connect the milliamp meter in series with the actuator if one is connected to the control. (Alternately, a dc voltmeter may be connected across the output when an actuator is connected. The correct output currents must be computed using the voltage measured and the input resistance of the actuator.)

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

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

5. Set the Start Fuel Limit and Max Fuel Limit to the values as recorded during installation.

Speed Inputs

The following tests verify the operation of the speed inputs.

1. Connect a frequency signal generator to Speed Sensor Input #1 (terminal 11/12). Set the output level above 1.0 Vrms. Record the DSPD #1 TEETH set point from the CFIG SPEED CONTROL Menu. Temporarily set to 60 (this causes the rpm values and Hertz values to be the same, to make doing the tests easier).

2. Set the signal generator to 400 Hz. Read Engine Speed value of 400 rpm on Display Menu. Increase the signal generator frequency to 2000 Hz. The value read should follow the signal generator frequency.

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

4. Repeat steps 1–3 for Speed Sensor Input #2 (terminal 13/14), except also temporarily set ASPD #2 TEETH to 60.

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 the 723PLUS Performance '424' 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). The 723PLUS Performance '424' Control View or Watch Window may remain connected or removed from the control as desired. Close the cover over J1 and re-tighten the retaining screw if connection is removed.

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

Chapter 7.
Product Support and Service Options

Product Support Options

If you are experiencing problems with the installation, or unsatisfactory performance of a Woodward product, the following options are available:
1. Consult the troubleshooting guide in the manual.
2. Contact the **OE Manufacturer or Packager** of your system.
3. Contact the **Woodward Business Partner** serving your area.
4. Contact Woodward technical assistance via email (**EngineHelpDesk@Woodward.com**) with detailed information on the product, application, and symptoms. Your email will be forwarded to an appropriate expert on the product and application to respond by telephone or return email.
5. If the issue cannot be resolved, you can select a further course of action to pursue based on the available services listed in this chapter.

OEM or Packager Support: Many Woodward controls and control devices are installed into the equipment system and programmed by an Original Equipment Manufacturer (OEM) or Equipment Packager at their factory. In some cases, the programming is password-protected by the OEM or packager, and they are the best source for product service and support. Warranty service for Woodward products shipped with an equipment system should also be handled through the OEM or Packager. Please review your equipment system documentation for details.

Woodward Business Partner Support: Woodward works with and supports a global network of independent business partners whose mission is to serve the users of Woodward controls, as described here:

*   A **Full-Service Distributor** has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.

*   An **Authorized Independent Service Facility (AISF)** provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.

*   A **Recognized Engine Retrofitter (RER)** is an independent company that does retrofits and upgrades on reciprocating gas engines and dual-fuel conversions, and can provide the full line of Woodward systems and components for the retrofits and overhauls, emission compliance upgrades, long term service contracts, emergency repairs, etc.

A current list of Woodward Business Partners is available at **www.woodward.com/directory**.

Product Service Options

Depending on the type of product, the following options for servicing Woodward products may be available through your local Full-Service Distributor or the OEM or Packager of the equipment system.
*   Replacement/Exchange (24-hour service)
*   Flat Rate Repair
*   Flat Rate Remanufacture

Replacement/Exchange: Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime.

This option allows you to call your Full-Service Distributor in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Full-Service Distributor.

Flat Rate Repair: Flat Rate Repair is available for many of the standard mechanical products and some of the electronic products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be.

Flat Rate Remanufacture: Flat Rate Remanufacture is very similar to the Flat Rate Repair option, with the exception that the unit will be returned to you in "like-new" condition. This option is applicable to mechanical products only.

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned for repair, please contact your Full-Service Distributor in advance to obtain Return Authorization and shipping instructions.

When shipping the item(s), attach a tag with the following information:
- return number;
- name and location where the control is installed;
- name and phone number of contact person;
- complete Woodward part number(s) and serial number(s);
- description of the problem;
- instructions describing the desired type of repair.

Packing a Control

Use the following materials when returning a complete control:
- protective caps on any connectors;
- antistatic protective bags on all electronic modules;
- packing materials that will not damage the surface of the unit;
- at least 100 mm (4 inches) of tightly packed, industry-approved packing material;
- a packing carton with double walls;
- a strong tape around the outside of the carton for increased strength.

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

Replacement Parts

When ordering replacement parts for controls, include the following information:
- the part number(s) (XXXX-XXXX) that is on the enclosure nameplate;
- the unit serial number, which is also on the nameplate.

Engineering Services

Woodward's Full-Service Distributors offer various Engineering Services for our products. For these services, you can contact the Distributor by telephone or by email.

- Technical Support
- Product Training
- Field Service

Technical Support is available from your equipment system supplier, your local Full-Service Distributor, or from many of Woodward's worldwide locations, depending upon the product and application. This service can assist you with technical questions or problem solving during the normal business hours of the Woodward location you contact.

Product Training is available as standard classes at many Distributor locations. Customized classes are also available, which can be tailored to your needs and held at one of our Distributor locations or at your site. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability.

Field Service engineering on-site support is available, depending on the product and location, from one of our Full-Service Distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface.

For information on these services, please contact one of the Full-Service Distributors listed at **www.woodward.com/directory**.

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory published at **www.woodward.com/directory**.

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

Products Used In Electrical Power Systems	Products Used In Engine Systems	Products Used In Industrial Turbomachinery Systems
Facility---------------Phone Number	**Facility---------------Phone Number**	**Facility---------------Phone Number**
Brazil ------------ +55 (19) 3708 4800	Brazil ------------ +55 (19) 3708 4800	Brazil ------------ +55 (19) 3708 4800
China ----------- +86 (512) 6762 6727	China ----------- +86 (512) 6762 6727	China ----------- +86 (512) 6762 6727
Germany:	Germany------- +49 (711) 78954-510	India ---------------+91 (129) 4097100
Kempen----+49 (0) 21 52 14 51	India ---------------+91 (129) 4097100	Japan-------------- +81 (43) 213-2191
Stuttgart-- +49 (711) 78954-510	Japan-------------- +81 (43) 213-2191	Korea-------------- +82 (51) 636-7080
India ---------------+91 (129) 4097100	Korea-------------- +82 (51) 636-7080	The Netherlands- +31 (23) 5661111
Japan-------------- +81 (43) 213-2191	The Netherlands- +31 (23) 5661111	Poland---------------+48 12 295 13 00
Korea-------------- +82 (51) 636-7080	United States ---- +1 (970) 482-5811	United States ---- +1 (970) 482-5811
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).
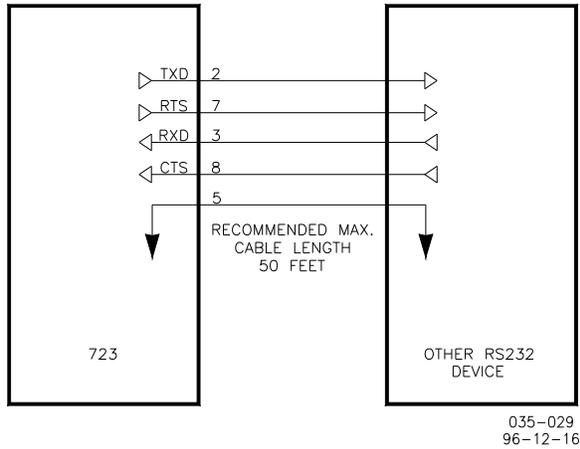
Figure A-1. 723PLUS RS-232 Connections

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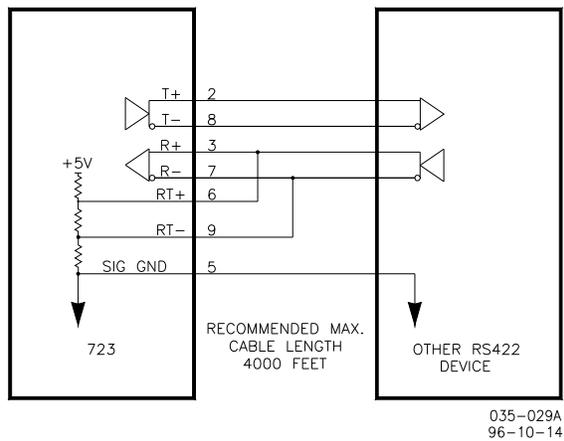
Figure A-2. 723PLUS RS-422 Connections with Optional Termination at Receiver

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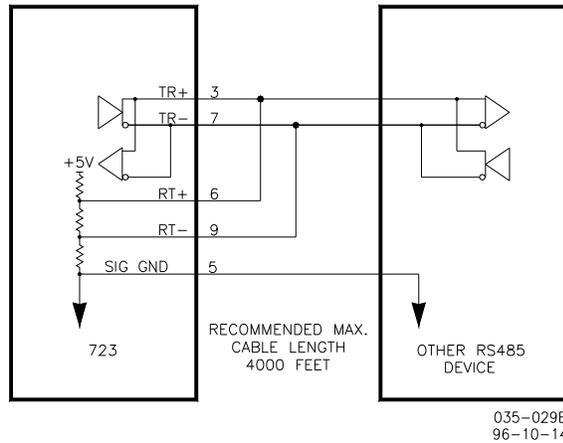
Figure A-3. 723PLUS RS-485 Connections with Optional Termination

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.
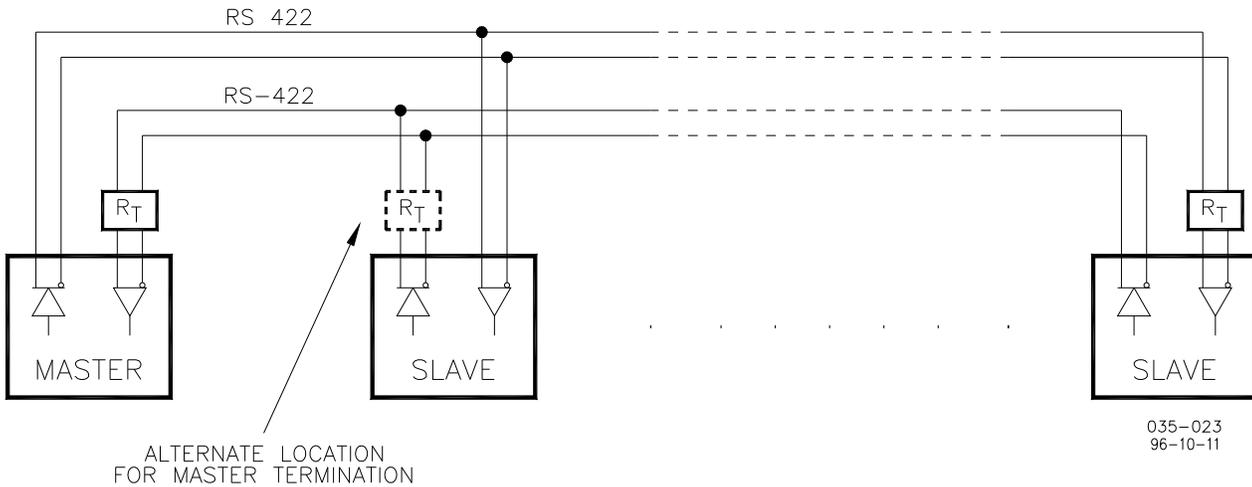
Figure A-4. RS-422 Terminator Locations

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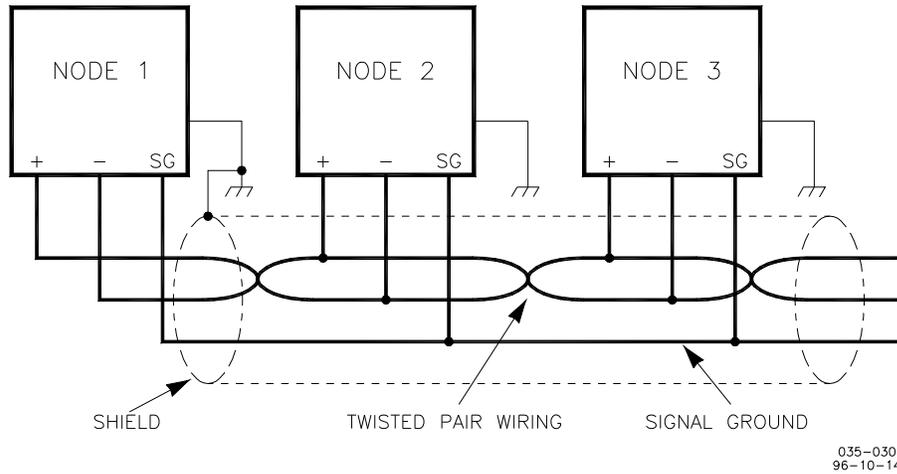
Figure A-5. Preferred Multipoint Wiring Using Shielded Twisted-pair Cable with a Separate Signal Ground Wire

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IMPORTANT   **The SG (signal ground) connection is not required if signal ground is unavailable.**
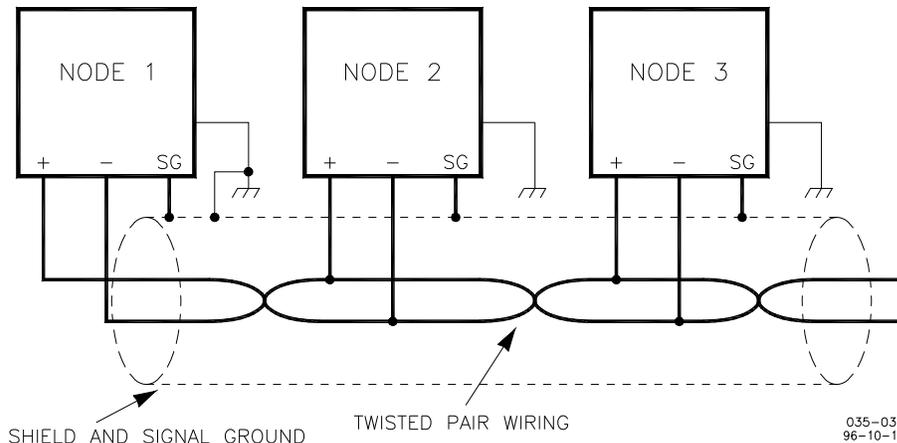
Figure A-6. Alternate Multipoint Wiring Using Shielded Twisted-pair Cable without a Separate Signal Ground Wire

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Appendix B.
LINKnet™ I/O Network

Introduction

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

Network Architecture

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

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

Hardware

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

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

I/O Module Specifications

Accuracy
     1% at 25 °C without field calibration

Power Supply Input
     18 to 32 Vdc

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

Scan Rate
Less than 7 output modules:
   (# of I/O modules x 6 + 75) ms typical
   (# of I/O modules x 6 + 100) ms max
7 or more output modules:
   (# of I/O modules x 6 + # of output modules x 3 + 55) ms typical
   (# of I/O modules x 6 + # of output modules x 3 + 80) ms max

Field Wiring
2 mm^2 (14 AWG) maximum wire size

Temperature Range
–40 to +55 °C

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

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

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

Discrete Input Current
13.1 mA per channel when "on" (@ 24 V)

Relay Contacts
Ratings: 5.0 A @ 28 Vdc resistive
            0.5 A @ 115 Vac resistive
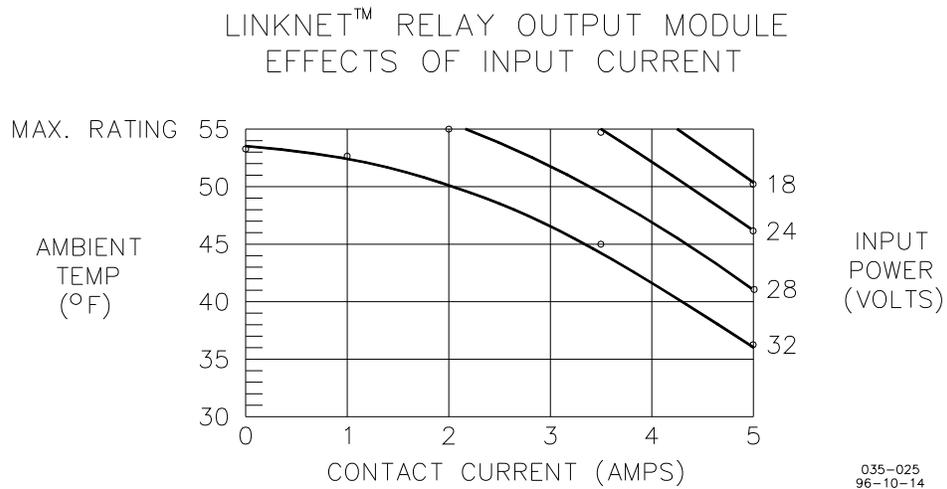
Figure B-1. LINKnet Relay Contacts

Individual I/O Module Specifications

I/O Module Type	Number of Channels	Resolution (bits)	Temp Coefficient (ppm/°C)	Input Impedance	Power Required at 24 V input
Discrete Input	16	N/A	N/A	N/A	6.5 W
Relay Output	8	N/A	N/A	N/A	5.0 W
4-20 mA Input with 24 V	6	12	235	255 Ω	5.3 W
4-20 mA Input	6	12	235	255 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.
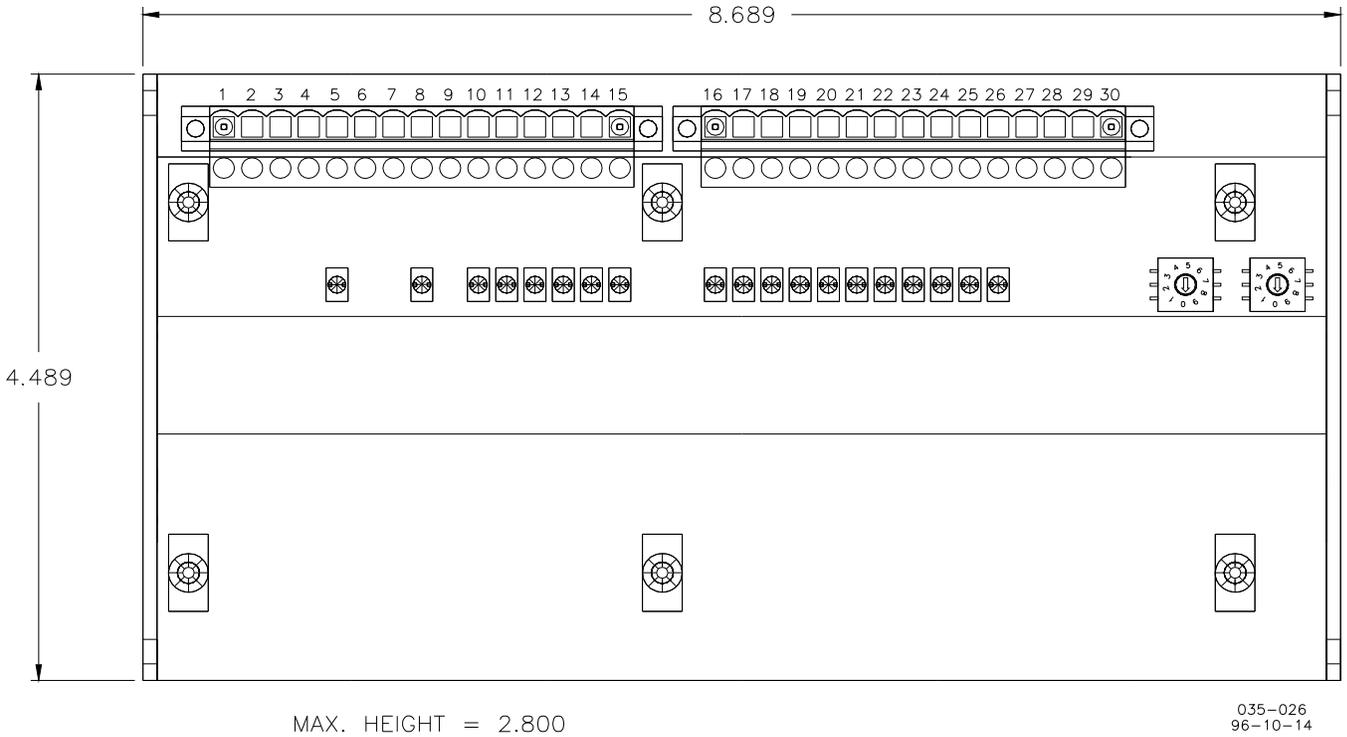
Figure B-2. Outline Drawing of I/O Module

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.
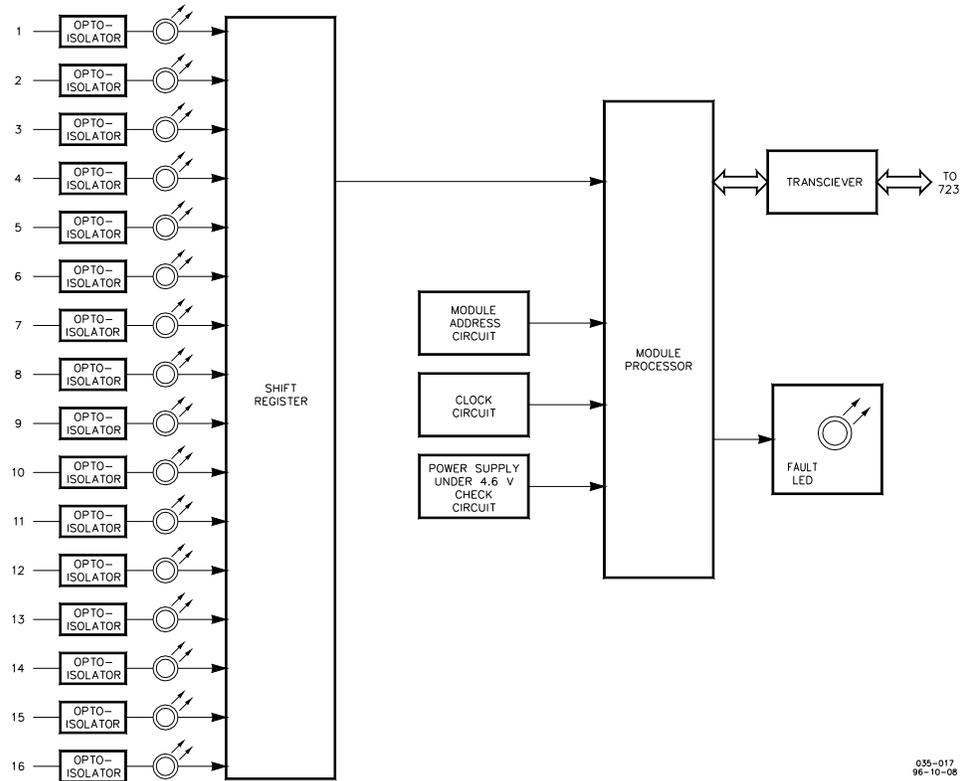
Figure B-3. Discrete Input Module Block Diagram
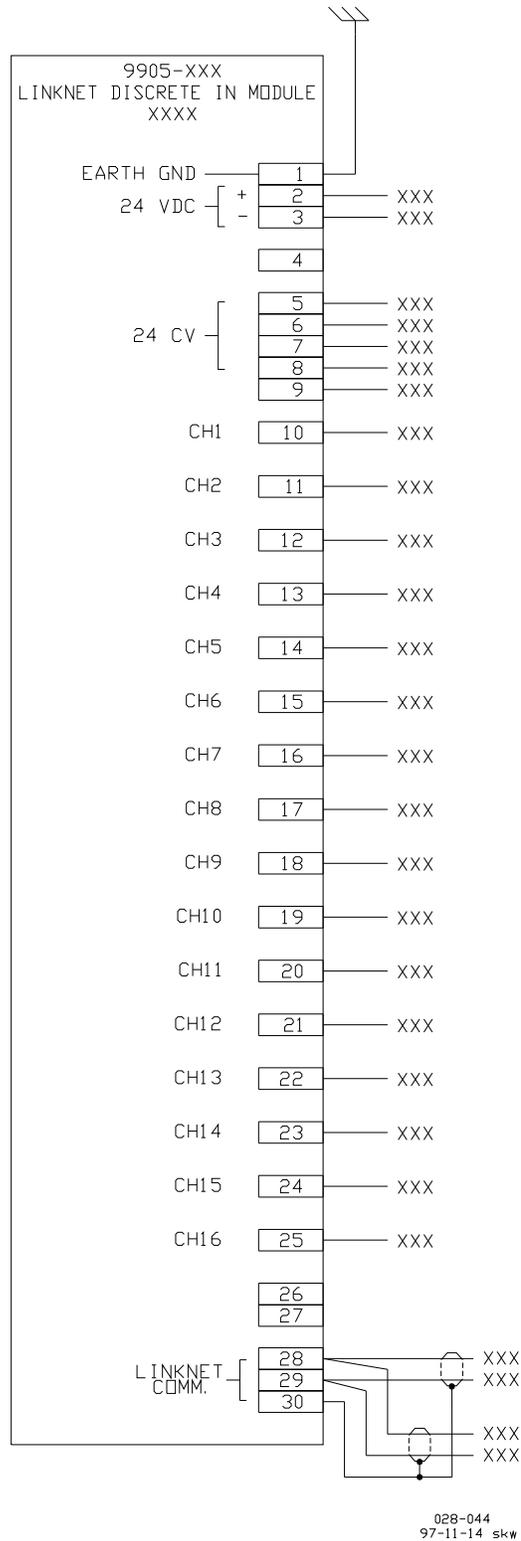
Figure B-4. Discrete Input Module Wiring Diagram

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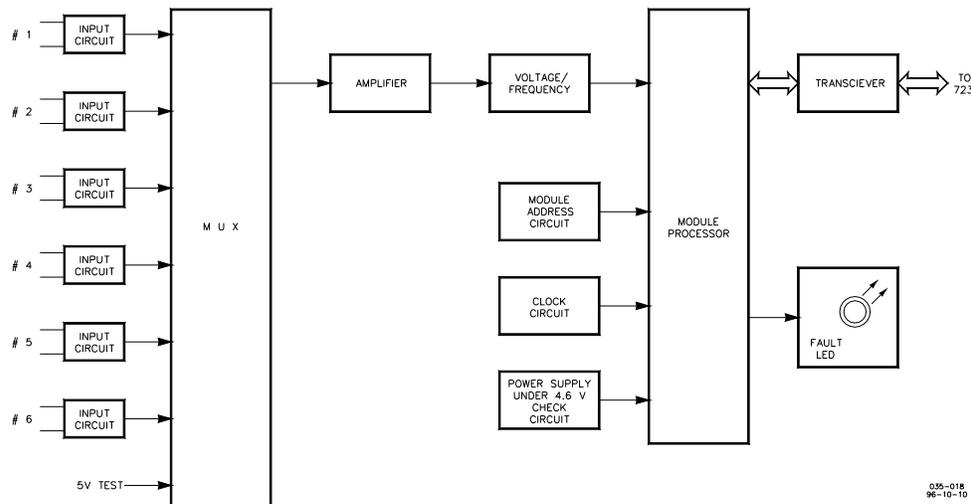
Figure B-5. 4–20 mA Input Module Block Diagram

```
                              9905-XXX
                        LINKNET AN IN MODULE
                              XXXX


              EARTH GND ─────────┤   1   │
                             + ──┤   2   │──── XXX
                 24 VDC ┤    − ──┤   3   │──── XXX
                       +24 VDC ──┤   4   │──── XXX
                             + ──┤   5   │──── XXX
            CH1 ┤                │   6   │
                       SHLD ─────┤   7   │
                       +24 VDC ──┤   8   │──── XXX
                             + ──┤   9   │──── XXX
            CH2 ┤                │  10   │
                       SHLD ─────┤  11   │
                       +24 VDC ──┤  12   │──── XXX
                             + ──┤  13   │──── XXX
            CH3 ┤                │  14   │
                       SHLD ─────┤  15   │
                       +24 VDC ──┤  16   │──── XXX
                             + ──┤  17   │──── XXX
            CH4 ┤                │  18   │
                       SHLD ─────┤  19   │
                       +24 VDC ──┤  20   │──── XXX
                             + ──┤  21   │──── XXX
            CH5 ┤                │  22   │
                       SHLD ─────┤  23   │
                       +24 VDC ──┤  24   │──── XXX
                             + ──┤  25   │──── XXX
            CH6 ┤                │  26   │
                       SHLD ─────┤  27   │
                    LINKNET ┤    │  28   │──── XXX
                    COMM.   ┤    │  29   │──── XXX
                                 │  30   │
                                                  XXX
                                                  XXX

                                         028-043
                                         97-11-14 skw
```
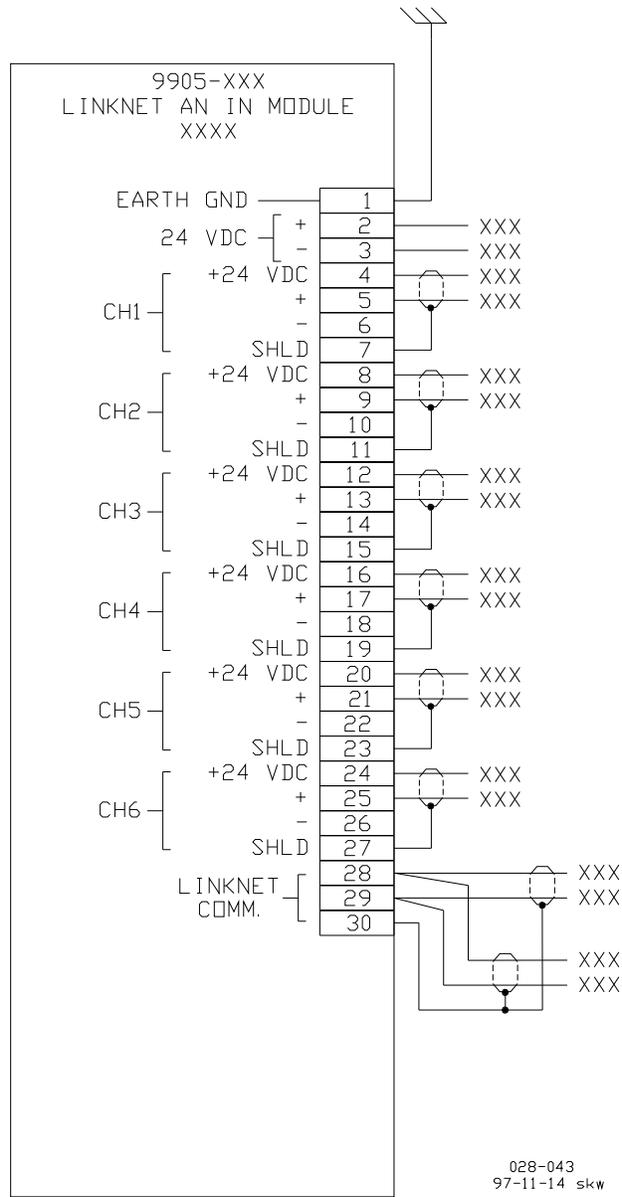
Figure B-6. 4–20 mA Input Module Wiring Diagram

Thermocouple Input Module

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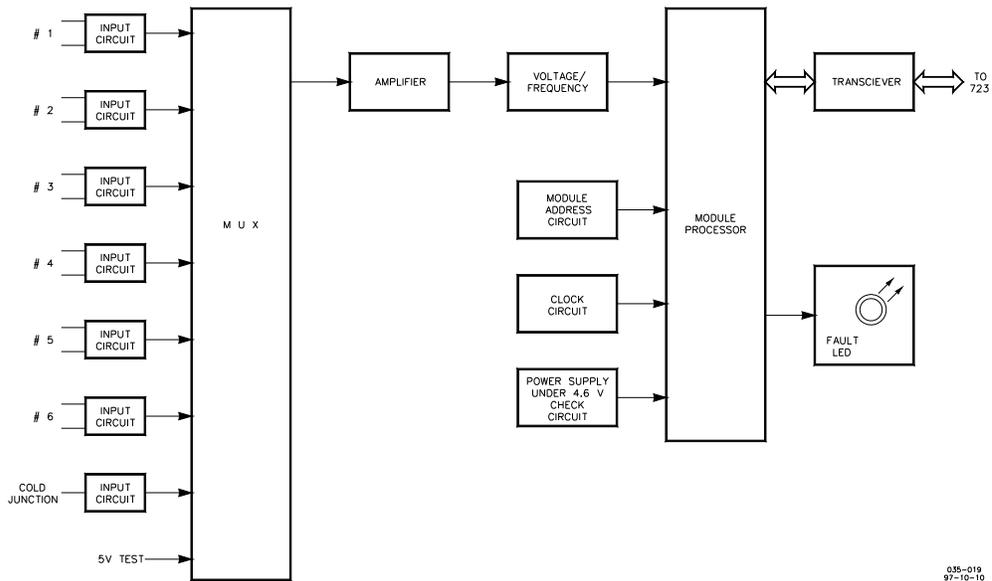
Figure B-7. Thermocouple Input Module Block Diagram
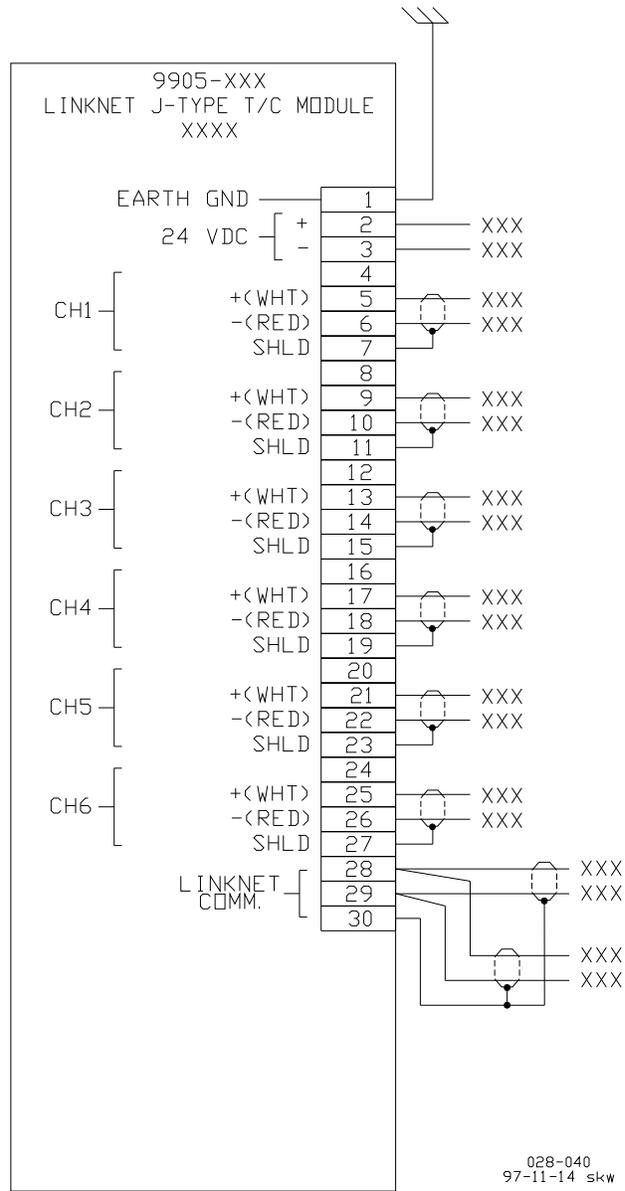
Figure B-8. Thermocouple Input Module Wiring Diagram

RTD Input Module

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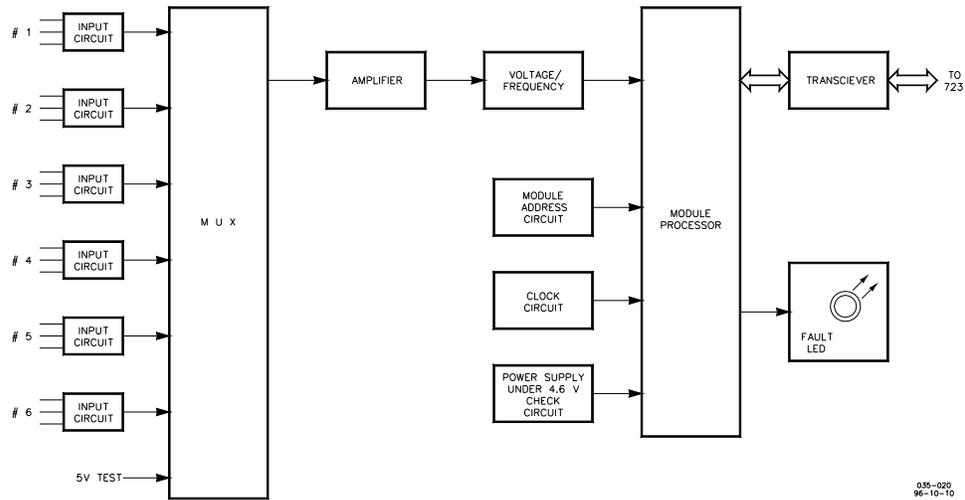
Figure B-9. RTD Input Module Block Diagram
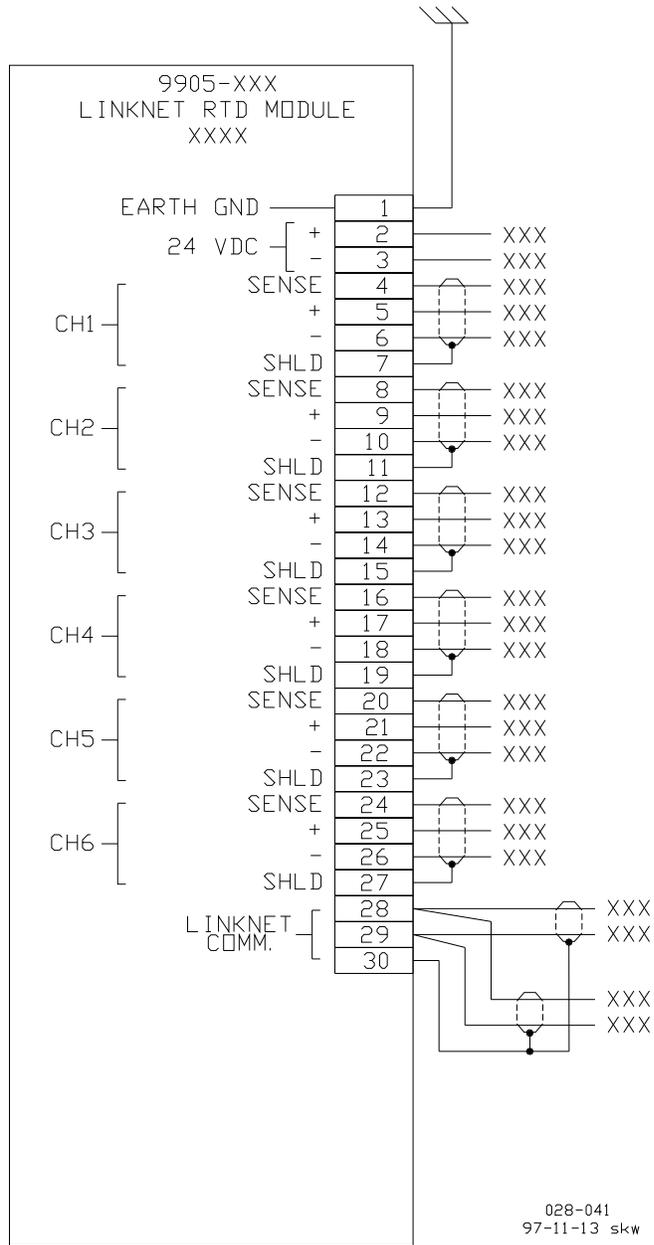
Figure B-10. RTD Input Module Wiring Diagram

Relay Output Module

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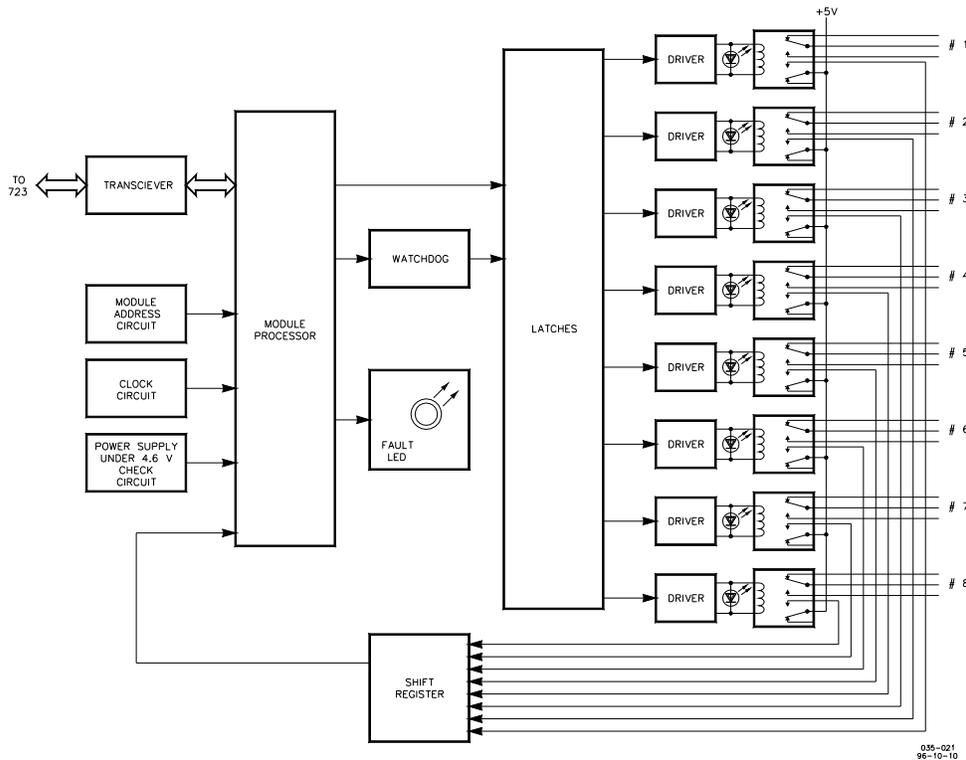
Figure B-11. Relay Output Module Block Diagram

```
9905-XXX
LINKNET DISCRETE OUT MODULE
XXXX

EARTH GND ── 1
24 VDC  [+ 2          XXX
         - 3          XXX
           4          XXX
CH1    [   5          XXX
           6          XXX
           7          XXX
CH2    [   8          XXX
           9          XXX
           10         XXX
CH3    [   11         XXX
           12         XXX
           13         XXX
CH4    [   14         XXX
           15         XXX
           16         XXX
CH5    [   17         XXX
           18         XXX
           19         XXX
CH6    [   20         XXX
           21         XXX
           22         XXX
CH7    [   23         XXX
           24         XXX
           25         XXX
CH8    [   26         XXX
           27         XXX
           28         XXX
LINKNET [  29         XXX
COMM.      30

028-042
97-11-14 skw
```
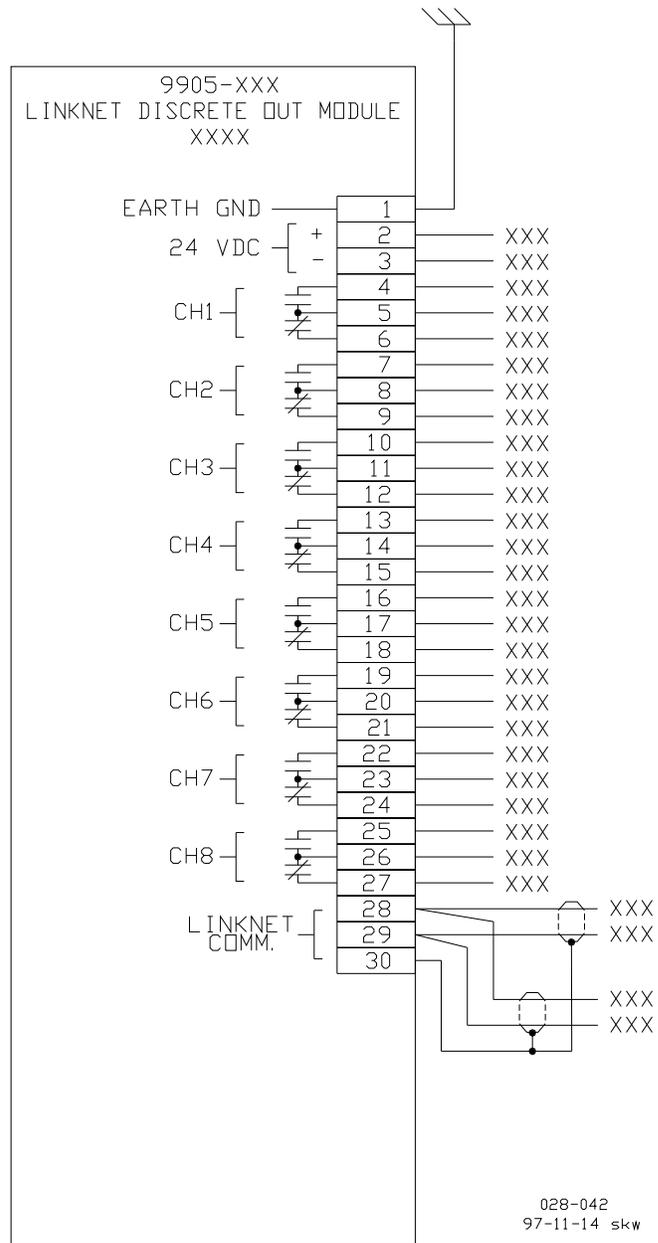
Figure B-12. Relay Output Module Wiring Diagram

4–20 mA Output Module

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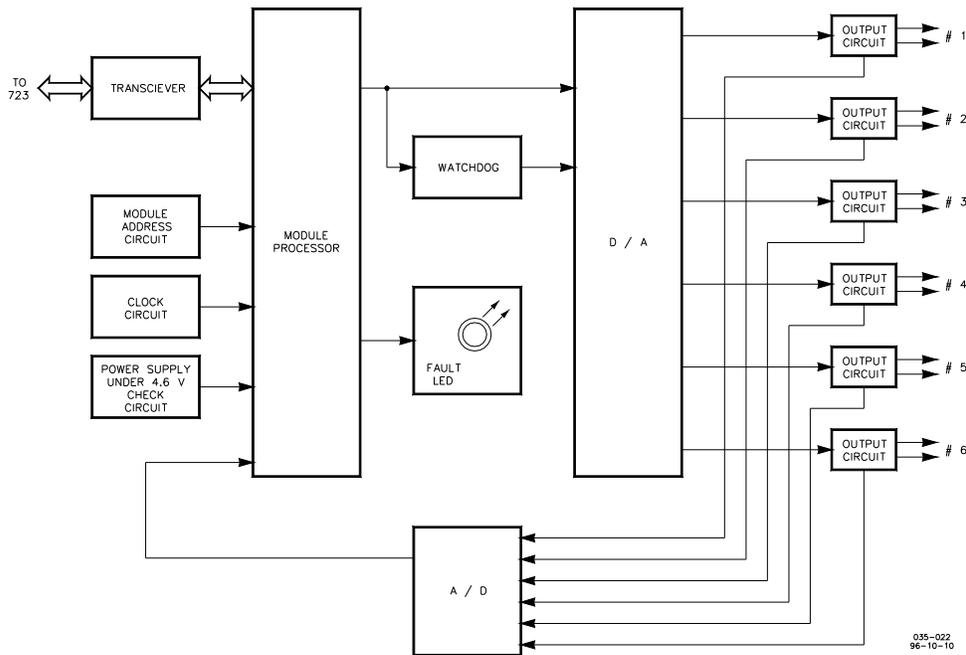
Figure B-13. 4–20 mA Output Module Block Diagram
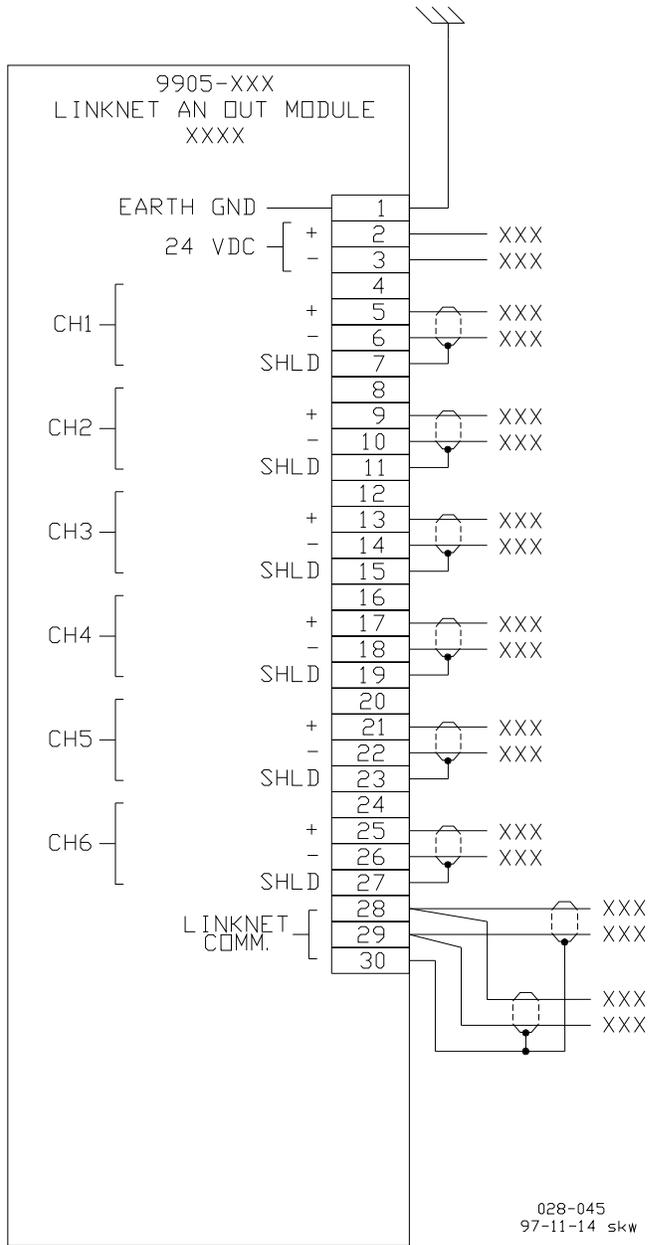
Figure B-14. 4–20 mA Output Module Wiring Diagram

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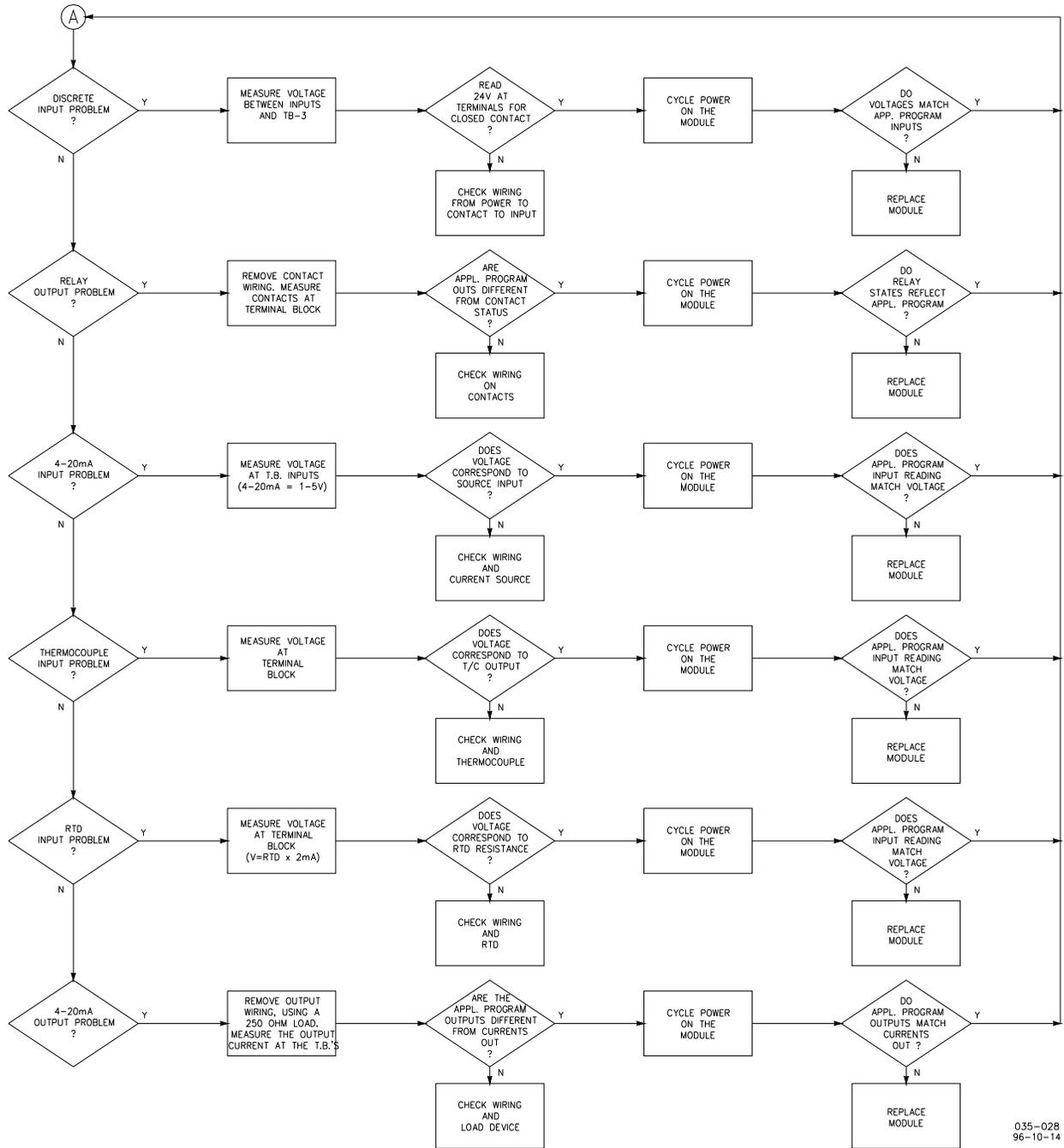
Figure B-15b. Troubleshooting Flowchart (2 of 2)

Troubleshooting Flowchart

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

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

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

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

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

Wiring and Proper Cable

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

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

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

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

Woodward part number 2008-349

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

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

Cable Length and Number of LINKnet I/O Modules

Specification	0 to 55 °C	–20 to +55 °C	–40 to +55 °C
Maximum network cable length	150 m	150 m	50 m
Maximum number of I/O modules	60	32	20
Maximum stub length	300 mm	300 mm	300 mm
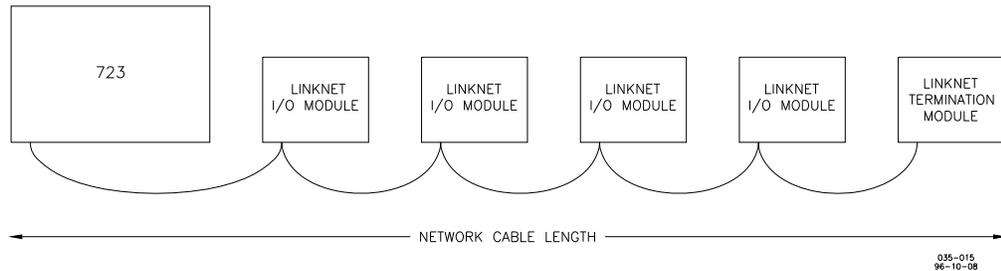
Figure B-16. Direct Wired Network
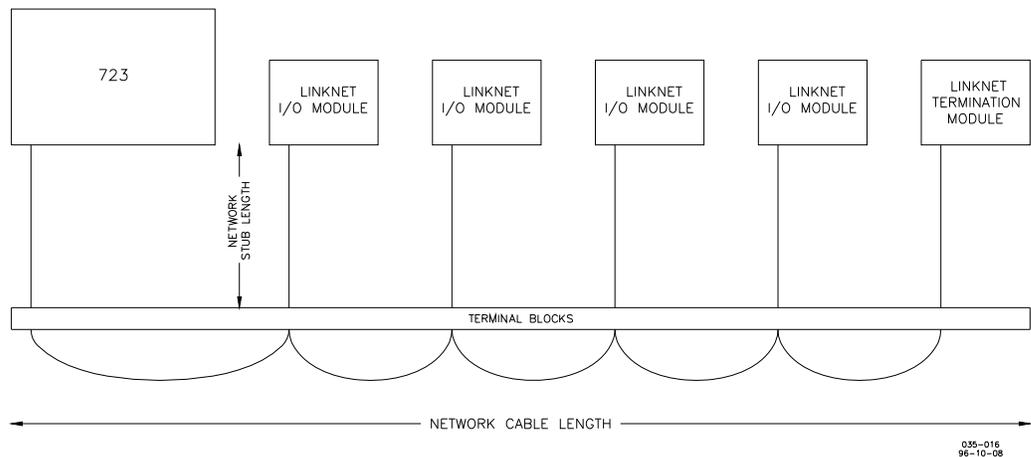
Figure B-17. Network Wired Via Stubs

Appendix C.
Modbus Slave Address Information

Part Number 8280-424

This appendix contains the Modbus slave address information for 723PLUS part number 8280-424.

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	USE RAISE AMP REMOTE COMMAND
0:0010	USE LOWER AMP REMOTE COMMAND
0:0011	USE RAISE SPEED REMOTE COMMAND
0:0012	USE LOWER SPEED REMOTE COMMAND
0:0013	USE RATED/IDLE REMOTE COMMAND
0:0014	USE RUN/STOP REMOTE COMMAND
0:0015	USE REMOTE SPEED REFERENCE
0:0016	
0:0017	
0:0018	
0:0019	723 COMMAND CLOSE FOR RAISE AMP
0:0020	723 COMMAND CLOSE FOR LOWER AMP
0:0021	723 COMMAND CLOSE FOR RAISE SPEED
0:0022	723 COMMAND CLOSE FOR LOWER SPEED
0:0023	723 COMMAND CLOSE FOR RATED SPEED
0:0024	723 COMMAND CLOSE FOR RUN
0:0025	
0:0026	
0:0027	
0:0028	
0:0029	
0:0030	
0:0031	CHANNEL 1 DISCRETE OUTPUT MODULE 1
0:0032	CHANNEL 2 DISCRETE OUTPUT MODULE 1
0:0033	CHANNEL 3 DISCRETE OUTPUT MODULE 1
0:0034	CHANNEL 4 DISCRETE OUTPUT MODULE 1
0:0035	CHANNEL 5 DISCRETE OUTPUT MODULE 1
0:0036	CHANNEL 6 DISCRETE OUTPUT MODULE 1
0:0037	CHANNEL 7 DISCRETE OUTPUT MODULE 1
0:0038	CHANNEL 8 DISCRETE OUTPUT MODULE 1
0:0039	CHANNEL 1 DISCRETE OUTPUT MODULE 2
0:0040	CHANNEL 2 DISCRETE OUTPUT MODULE 2
0:0041	CHANNEL 3 DISCRETE OUTPUT MODULE 2
0:0042	CHANNEL 4 DISCRETE OUTPUT MODULE 2
0:0043	CHANNEL 5 DISCRETE OUTPUT MODULE 2
0:0044	CHANNEL 6 DISCRETE OUTPUT MODULE 2
0:0045	CHANNEL 7 DISCRETE OUTPUT MODULE 2
0:0046	CHANNEL 8 DISCRETE OUTPUT MODULE 2
0:0047	CHANNEL 1 DISCRETE OUTPUT MODULE 3
0:0048	CHANNEL 2 DISCRETE OUTPUT MODULE 3
0:0049	CHANNEL 3 DISCRETE OUTPUT MODULE 3
0:0050	CHANNEL 4 DISCRETE OUTPUT MODULE 3
0:0051	CHANNEL 5 DISCRETE OUTPUT MODULE 3
0:0052	CHANNEL 6 DISCRETE OUTPUT MODULE 3
0:0053	CHANNEL 7 DISCRETE OUTPUT MODULE 3
0:0054	CHANNEL 8 DISCRETE OUTPUT MODULE 3

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

Boolean Reads

Addr	Description
1:0001	H-CLOSE TO RUN CONTACT
1:0002	G-RATED CONTACT
1:0003	F-LOWER SPEED CONTACT
1:0004	E-RAISE SPEED CONTACT
1:0005	D-LOWER AIR MANF PRESS CONTACT
1:0006	C-RAISE AIR MANF PRESS CONTACT
1:0007	B-ALARM RESET
1:0008	A-REMOTE SPEED SELECT CONTACT
1:0009	DO1-SHUTDOWN RELAY
1:0010	DO2-ALARM RELAY
1:0011	DO3-AUTO TURBO AIR ASSIST
1:0012	
1:0013	MPU 1 FAILED
1:0014	MPU 2 FAILED
1:0015	AIR MANF PRESS INPUT FAILED
1:0016	FUEL GAS HEADER PRESS INPUT FAILED
1:0017	FUEL GAS METER DIFF PR INPUT FAILED
1:0018	REMOTE SPEED SETPOINT INPUT FAILED
1:0019	HANDHELD SELECTED
1:0020	LAPTOP SELECTED
1:0021	SHUTDOWN IS ACTIVE
1:0022	1-SPEED #1FAIL SHUTDOWN
1:0023	2-SPEED #2 FAIL SHUTDOWN
1:0024	3-SPD #1 AND #2 FAIL SHUTDOWN
1:0025	4-AMP INPUT FAILED SHUTDOWN
1:0026	5-FGH INPUT FAILED SHUTDOWN
1:0027	6-FGM INPUT FAILED SHUTDOWN
1:0028	7-REM INPUT FAILED SHUTDOWN
1:0029	8-MODBUS 3 FAIL SHUTDOWN
1:0030	9-HIGH FUEL DEMAND SHUTDOWN
1:0031	10-HIGH SPEED SHUTDOWN
1:0032	11-ENGINE STALL MINOR ALARM
1:0033	12-HIGH TURBO SPEED SHUTDOWN
1:0034	13-HIGH OIL TEMP SHUTDOWN
1:0035	14-HIGH EXHAUST TEMP SHUTDOWN
1:0036	15-HIGH COMB AIR TEMP SHUTDOWN
1:0037	
1:0038	
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 #1 AND #2 FAIL ALARM
1:0065	4-AMP INPUT FAILED ALARM
1:0066	5-FGH INPUT FAILED ALARM
1:0067	6-FGM INPUT FAILED ALARM
1:0068	7-REM INPUT FAILED ALARM
1:0069	8-MODBUS 3 FAIL ALARM
1:0070	9-HIGH FUEL DEMAND ALARM
1:0071	10-HIGH SPEED ALARM
1:0072	11-ENGINE STALL ALARM
1:0073	12-HIGH TURBO SPEED ALARM
1:0074	13-HIGH OIL TEMP ALARM
1:0075	14-HIGH EXHAUST TEMP ALARM
1:0076	15-HIGH COMB AIR TEMP ALARM
1:0077	
1:0078	
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	AT MIN FUEL (LSS)
1:0105	ON TORQUE LIMIT (LSS)
1:0106	ON AMP LIMIT (LSS)
1:0107	ACT SHUTDOWN (LSS)
1:0108	SPEED SWITCH #1 ACTIVE
1:0109	SPEED SWITCH #2 ACTIVE
1:0110	AIR/FUEL RATIO IN CONTROL (LSS)
1:0111	ON A/F RATIO START LIMIT (LSS)
1:0112	ON A/F RATIO HI LIMIT (LSS)
1:0113	ON MIN AMP REF LIMIT (HSS)
1:0114	NORMAL IGN TMG IN CONTROL (LSS)
1:0115	ON START IGN TMG CONTROL (LSS)
1:0116	ON AMBIENT LOAD IGN TMG CTRL (LSS)
1:0117	PRIMARY SPEED INPUT ACTIVE
1:0118	STANDBY SPEED INPUT ACTIVE
1:0119	
1:0120	
1:0121	DISCRETE IN MOD 1 CHANNEL 1
1:0122	DISCRETE IN MOD 1 CHANNEL 2
1:0123	DISCRETE IN MOD 1 CHANNEL 3
1:0124	DISCRETE IN MOD 1 CHANNEL 4
1:0125	DISCRETE IN MOD 1 CHANNEL 5
1:0126	DISCRETE IN MOD 1 CHANNEL 6
1:0127	DISCRETE IN MOD 1 CHANNEL 7
1:0128	DISCRETE IN MOD 1 CHANNEL 8
1:0129	DISCRETE IN MOD 1 CHANNEL 9
1:0130	DISCRETE IN MOD 1 CHANNEL 10
1:0131	DISCRETE IN MOD 1 CHANNEL 11
1:0132	DISCRETE IN MOD 1 CHANNEL 12
1:0133	DISCRETE IN MOD 1 CHANNEL 13
1:0134	DISCRETE IN MOD 1 CHANNEL 14
1:0135	DISCRETE IN MOD 1 CHANNEL 15
1:0136	DISCRETE IN MOD 1 CHANNEL 16

```
1:0137    DISCRETE IN MOD 2 CHANNEL 1
1:0138    DISCRETE IN MOD 2 CHANNEL 2
1:0139    DISCRETE IN MOD 2 CHANNEL 3
1:0140    DISCRETE IN MOD 2 CHANNEL 4
1:0141    DISCRETE IN MOD 2 CHANNEL 5
1:0142    DISCRETE IN MOD 2 CHANNEL 6
1:0143    DISCRETE IN MOD 2 CHANNEL 7
1:0144    DISCRETE IN MOD 2 CHANNEL 8
1:0145    DISCRETE IN MOD 2 CHANNEL 9
1:0146    DISCRETE IN MOD 2 CHANNEL 10
1:0147    DISCRETE IN MOD 2 CHANNEL 11
1:0148    DISCRETE IN MOD 2 CHANNEL 12
1:0149    DISCRETE IN MOD 2 CHANNEL 13
1:0150    DISCRETE IN MOD 2 CHANNEL 14
1:0151    DISCRETE IN MOD 2 CHANNEL 15
1:0152    DISCRETE IN MOD 2 CHANNEL 16
1:0153    DISCRETE IN MOD 3 CHANNEL 1
1:0154    DISCRETE IN MOD 3 CHANNEL 2
1:0155    DISCRETE IN MOD 3 CHANNEL 3
1:0156    DISCRETE IN MOD 3 CHANNEL 4
1:0157    DISCRETE IN MOD 3 CHANNEL 5
1:0158    DISCRETE IN MOD 3 CHANNEL 6
1:0159    DISCRETE IN MOD 3 CHANNEL 7
1:0160    DISCRETE IN MOD 3 CHANNEL 8
1:0161    DISCRETE IN MOD 3 CHANNEL 9
1:0162    DISCRETE IN MOD 3 CHANNEL 10
1:0163    DISCRETE IN MOD 3 CHANNEL 11
1:0164    DISCRETE IN MOD 3 CHANNEL 12
1:0165    DISCRETE IN MOD 3 CHANNEL 13
1:0166    DISCRETE IN MOD 3 CHANNEL 14
1:0167    DISCRETE IN MOD 3 CHANNEL 15
1:0168    DISCRETE IN MOD 3 CHANNEL 16
1:0169    DISCRETE IN MOD 4 CHANNEL 1
1:0170    DISCRETE IN MOD 4 CHANNEL 2
1:0171    DISCRETE IN MOD 4 CHANNEL 3
1:0172    DISCRETE IN MOD 4 CHANNEL 4
1:0173    DISCRETE IN MOD 4 CHANNEL 5
1:0174    DISCRETE IN MOD 4 CHANNEL 6
1:0175    DISCRETE IN MOD 4 CHANNEL 7
1:0176    DISCRETE IN MOD 4 CHANNEL 8
1:0177    DISCRETE IN MOD 4 CHANNEL 9
1:0178    DISCRETE IN MOD 4 CHANNEL 10
1:0179    DISCRETE IN MOD 4 CHANNEL 11
1:0180    DISCRETE IN MOD 4 CHANNEL 12
1:0181    DISCRETE IN MOD 4 CHANNEL 13
1:0182    DISCRETE IN MOD 4 CHANNEL 14
1:0183    DISCRETE IN MOD 4 CHANNEL 15
1:0184    DISCRETE IN MOD 4 CHANNEL 16
```

Analog Reads

Addr	Description
3:0001	AI1-AIR MANF PRESS (uA)
3:0002	A12-FUEL GAS HEADER PRESS (uA)
3:0003	AI3-FUEL GAS METER DP (uA)
3:0004	AI4-REMOTE SPEED SETPOINT (uA)
3:0005	
3:0006	
3:0007	AO1-CONFIGURED ANALOG OUTPUT (uA)
3:0008	AO2-IGNITION TIMING ANALOG OUTPUT (uA)
3:0009	ACT1- FUEL ACTUATOR OUTPUT (uA,mAx100)
3:0010	ACT2-A/F RATIO ACT OUTPUT (uA,mAx100))
3:0011	SPEED INPUT #1 (rpm)
3:0012	SPEED INPUT #2 (rpm)
3:0013	ENGINE SPEED (rpm)
3:0014	SPEED REFERENCE (rpm)
3:0015	FUEL DEMAND (%fd * 10)
3:0016	START FUEL LIMIT
3:0017	TORQUE LIMIT (%fd)
3:0018	AMP LIMIT (%fd)
3:0019	A/F RATIO PID REF (EU x 10)
3:0020	A/F EXH TEMP REF (EU x 10)
3:0021	A/F VALVE DEMAND (%afvd x 10)
3:0022	A/F FGH BIAS AMP REF (EU x 10)

3:0023	A/F FGQ BIAS AMP REF (EU x 10)
3:0024	A/F AMT BIAS AMP REF (EU x 10)
3:0025	A/F AMP R/L REF (EU x 10)
3:0026	A/F EXH TEMP R/L REF (EU)
3:0027	IGNITION TIMING REF (DEG BTC x 10)
3:0028	STARTUP TIMING REF (DEG BTC)
3:0029	NORMAL TIMING REF (DEG BTC)
3:0030	AMB TORQ TIMING REF (DEG BTC)
3:0031	FUEL GAS FLOW (SCFM x 10)
3:0032	FUEL METER PRESS (PSIA)
3:0033	FUEL METER TEMP (DEG R)
3:0034	AIR ASSIST REFERENCE (EU)
3:0035	AIR ASSIST DEMAND (%AAD x 10)
3:0036	PRECOMB CHAM SIGNAL (EU x 10)
3:0037	BRAKE HORSEPOWER
3:0038	
3:0039	
3:0040	
3:0041	AI1-AIR MANF PRESS (EU x 10)
3:0042	A12-FUEL GAS HEADER PRESS (EU x 10)
3:0043	AI3-FUEL GAS METER DP (EU x 10)
3:0044	AI4-REMOTE SPEED SETPOINT (RPM)
3:0045	AO1-CONFIGURED ANALOG OUTPUT(%EU X 10)
3:0046	AO2-OUTPUT TO IGN TIMER (%EU X 10)
3:0047	ACT1-OUTPUT TO ACTUATOR (%EU)
3:0048	ACT2-OUTPUT TO AFR ACTUATOR (%EU)
3:0049	FIRST OUT SHUTDOWN
3:0050	FIRST OUT ALARM
3:0051	
3:0052	
3:0053	
3:0054	
3:0055	
3:0056	
3:0057	
3:0058	
3:0059	
3:0060	
3:0061	TC 1 CHANNEL 1 (deg F)
3:0062	TC 1 CHANNEL 2 (deg F)
3:0063	TC 1 CHANNEL 3 (deg F)
3:0064	TC 1 CHANNEL 4 (deg F)
3:0065	TC 1 CHANNEL 5 (deg F)
3:0066	TC 1 CHANNEL 6 (deg F)
3:0067	TC 2 CHANNEL 1 (deg F)
3:0068	TC 2 CHANNEL 2 (deg F)
3:0069	TC 2 CHANNEL 3 (deg F)
3:0070	TC 2 CHANNEL 4 (deg F)
3:0071	TC 2 CHANNEL 5 (deg F)
3:0072	TC 2 CHANNEL 6 (deg F)
3:0073	TC 3 CHANNEL 1 (deg F)
3:0074	TC 3 CHANNEL 2 (deg F)
3:0075	TC 3 CHANNEL 3 (deg F)
3:0076	TC 3 CHANNEL 4 (deg F)
3:0077	TC 3 CHANNEL 5 (deg F)
3:0078	TC 3 CHANNEL 6 (deg F)
3:0079	TC 4 CHANNEL 1 (deg F)
3:0080	TC 4 CHANNEL 2 (deg F)
3:0081	TC 4 CHANNEL 3 (deg F)
3:0082	TC 4 CHANNEL 4 (deg F)
3:0083	TC 4 CHANNEL 5 (deg F)
3:0084	TC 4 CHANNEL 6 (deg F)
3:0085	RTD 1 CHANNEL 1 (deg F)
3:0086	RTD 1 CHANNEL 2 (deg F)
3:0087	RTD 1 CHANNEL 3 (deg F)
3:0088	RTD 1 CHANNEL 4 (deg F)
3:0089	RTD 1 CHANNEL 5 (deg F)
3:0090	RTD 1 CHANNEL 6 (deg F)
3:0091	RTD 2 CHANNEL 1 (deg F)
3:0092	RTD 2 CHANNEL 2 (deg F)
3:0093	RTD 2 CHANNEL 3 (deg F)
3:0094	RTD 2 CHANNEL 4 (deg F)
3:0095	RTD 2 CHANNEL 5 (deg F)
3:0096	RTD 2 CHANNEL 6 (deg F)

3:0097   RTD 3 CHANNEL 1 (deg F)
3:0098   RTD 3 CHANNEL 2 (deg F)
3:0099   RTD 3 CHANNEL 3 (deg F)
3:0100   RTD 3 CHANNEL 4 (deg F)
3:0101   RTD 3 CHANNEL 5 (deg F)
3:0102   RTD 3 CHANNEL 6 (deg F)
3:0103   AI 1 CHANNEL 1 (uA)
3:0104   AI 1 CHANNEL 2 (uA)
3:0105   AI 1 CHANNEL 3 (uA)
3:0106   AI 1 CHANNEL 4 (uA)
3:0107   AI 1 CHANNEL 5 (uA)
3:0108   AI 1 CHANNEL 6 (uA)
3:0109   AI 2 CHANNEL 1 (uA)
3:0110   AI 2 CHANNEL 2 (uA)
3:0111   AI 2 CHANNEL 3 (uA)
3:0112   AI 2 CHANNEL 4 (uA)
3:0113   AI 2 CHANNEL 5 (uA)
3:0114   AI 2 CHANNEL 6 (uA)

Analog Writes

Addr	Description
4:0001	
4:0002	723 ANALOG OUTPUT #1
4:0003	723 ANALOG OUTPUT #2
4:0004	723 ACTUATOR OUTPUT #2
4:0005	723 REMOTE SPEED REFERENCE
4:0006	
4:0007	
4:0008	
4:0009	
4:0010	
4:0011	ANALOG OUT CHANNEL 1
4:0012	ANALOG OUT CHANNEL 2
4:0013	ANALOG OUT CHANNEL 3
4:0014	ANALOG OUT CHANNEL 4
4:0015	ANALOG OUT CHANNEL 5
4:0016	ANALOG OUT CHANNEL 6

Appendix D.
Programming Checklist

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

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

Configure Menus

CFIG OPTIONS	Default (Low, High)	Field Settings
USE NOTCH FILTER	#FALSE	
CALCULATE BHP	#FALSE	
USE PCC CONTROL	#FALSE	
PCC LOAD INPUT SEL	#1 (1, 2)	
USE TAC CONTROL	#FALSE	
TAC REVERSE ACTING	#FALSE	
USE IGN TMG CTRL	#FALSE	
USE A/F RATIO CTRL	#FALSE	
AFI START ENABLE (RPM)	#120.0 (50.0, 700.0)	
USE COMM PORT	#FALSE	
RESET ALM ON CLEAR	#FALSE	
USE REMOTE COMMANDS	#FALSE	
FORCE DISCRETE OUTS	#FALSE	
MAX TORQUE (%RATED)	#100 (80, 125)	
USE TORQUE LIMIT	#TRUE	
USE AMP LIMIT	#TRUE	
CFIG SPEED CONTROL	**Default (Low, High)**	
RATED SPEED(RPM)	#330 (1, 2100)	
DSPD #1 TEETH	#16 (16, 500)	
DSPD #2 TEETH	#16 (16, 500)	
ASPD #2 TEETH	#16 (16, 500)	
TURBO # TEETH	#6.0 (1.0, 500.0)	
USE TURBO MPU	#FALSE	
RATED TURBO SPEED(RPM)	#1000 (0, 32767)	
SS CLEAR PERCENTAGE	#5.0 (1.0, 10.0)	
TURBO SS CLEAR PRCNT	#3.0 (0.0, 100.0)	
OIL TEMP RTD PERM (DEG F)	#120.0 (40.0, 200.0)	
USE REMOTE REFERENCE	#FALSE	
REMOTE LOCK IN LAST	#FALSE	
MPU ALARM ARM TIME (SEC)	#10.0 (0.0, 120.0)	

CFIG SHUTDOWNS	Default	
SPEED #1 FAIL	#FALSE	
SPEED #2 FAIL	#FALSE	
SPD #1 AND #2 FAIL	#FALSE	
AMP INPUT FAILED	#FALSE	
FGH INPUT FAILED	#FALSE	
FGM INPUT FAILED	#FALSE	
REM INPUT FAILED	#FALSE	
MODBUS PORT3 FAIL	#FALSE	
HI FUEL DEMND SHTDN	#FALSE	
HI SPEED SHTDN	#FALSE	
ENGINE STALL	#FALSE	
HI TURBO SPD SHTDN	#FALSE	
HI OIL TEMP SHTDN	#FALSE	
HI EXH TEMP SHTDN	#FALSE	
HI AIR TEMP SHTDN	#FALSE	
CFIG ALARMS	Default	
SPEED #1 FAIL	#FALSE	
SPEED #2 FAIL	#FALSE	
SPD #1 AND #2 FAIL	#FALSE	
AMP INPUT FAILED	#FALSE	
FGH INPUT FAILED	#FALSE	
FGM INPUT FAILED	#FALSE	
REM INPUT FAILED	#FALSE	
MODBUS PORT3 FAIL	#FALSE	
HI FUEL DEMND ALARM	#FALSE	
HI SPEED ALARM	#FALSE	
ENGINE STALL	#FALSE	
HI TURBO SPD ALARM	#FALSE	
HI OIL TEMP ALARM	#FALSE	
HI EXH TEMP ALARM	#FALSE	
HI AIR TEMP ALARM	#FALSE	
CFIG INDICATION	Default	
ON START FUEL LIMIT	#FALSE	
ON MAX LIMIT	#FALSE	
ON TORQUE LIMIT	#FALSE	
ON AMP LIMIT	#FALSE	
ACTUATOR SHUTDOWN	#FALSE	
SPEED SWITCH 1	#FALSE	
SPEED SWITCH 2	#FALSE	

SHUTDOWN SETUP	Default (Low, High)	
HI FUEL DEMND SETPT(%FD)	#100.0 (0.0, 100.0)	
HI FUEL DEMND DELAY(SEC)	#10.0 (0.0, 10800.0)	
HI SPEED SETPOINT (RPM)	#1320.0 (0.0, 2500.0)	
HI SPEED DELAY(SEC)	#0.2 (0.0, 10800.0)	
STALL SETPOINT(RPM)	#25.0 (0.0, 100.0)	
STALL HYSTER(RPM)	#11.1 (0.0, 100.0)	
ENG STALL DELAY(SEC)	#10.0 (0.0, 10800.0)	
HI TURBO SPD SETPT (RPM)	#10000.0 (0.0, 20000.0)	
HI TURBO SPD DELAY (SEC)	#0.2 (0.0, 10800.0)	
HI OIL TEMP SETPT (DEG F)	#185.0 (0.0, 250.0)	
HI OIL TEMP DELAY(SEC)	#0.2 (0.0, 10800.0)	
HI EXH TEMP SETPT(DEG F)	#1200.0 (0.0, 2000.0)	
HI EXH TEMP DELAY (SEC)	#0.2 (0.0, 10800.0)	
HI AIR TEMP SETPT (DEG F)	#135.0 (0.0, 200.0)	
HI AIR TEMP DELAY(SEC)	#0.2 (0.0, 10800.0)	
ENERGIZE FOR SHTDWN	#TRUE	
SHUTDOWN ACT ON SD	#TRUE	
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)	
STALL SETPOINT(RPM)	#25.0 (0.0, 100.0)	
STALL HYSTER(RPM)	#11.1 (0.0, 100.0)	
ENG STALL DELAY(SEC)	#10.0 (0.0, 10800.0)	
HI TURBO SPD SETPT (RPM)	#9500.0 (0.0, 20000.0)	
HI TURBO SPD DELAY (SEC)	#0.2 (0.0, 10800.0)	
HI OIL TEMP SETPT (DEG F)	#180.0 (0.0, 250.0)	
HI OIL TEMP DELAY (SEC)	#0.2 (0.0, 10800.0)	
HI EXH TEMP SETPT (DEG F)	#1150.0 (0.0, 2000.0)	
HI EXH TEMP DELAY (SEC)	#0.2 (0.0, 10800.0)	
HI AIR TEMP SETPT (DEG F)	#130.0 (0.0, 200.0)	
HI AIR TEMP DELAY (SEC)	#0.2 (0.0, 10800.0)	
ENERGIZE FOR ALARM	#TRUE	
SHUTDOWN ACT ON ALM	#FALSE	
INDICATION SETUP	**Default (Low, High)**	
SPD SWITCH 1 PICKUP (RPM)	#500.0 (0.0, 2200.0)	
SPD SWITCH 1 DROPOUT (RPM)	#400.0 (0.0, 2200.0)	
SPD SWITCH 2 PICKUP (RPM)	#500.0 (0.0, 2200.0)	
SPD SWITCH 2 DROPOUT (RPM)	#400.0 (0.0, 2200.0)	

CFIG A/F RATIO	Default (Low, High)	
A/F REV ACTING	#TRUE	
USE FUEL FLOW A/F	#FALSE	
ORIFICE COEFFICIENT	#0.0 (0.0, 32000.0)	
ABSOLUTE PRESS	#14.7 (0.0, 32000.0)	
ABSOLUTE TEMP	#459.7 (0.0, 32000.0)	
FUEL GAS BASE BTU (LHV dry)	#925.0 (550.0, 1100.0)	
NO FUEL MTR PR XMTR	#FALSE	
FUEL MTR PRESS (PSIG)	#1.0 (-100.0, 32000.0)	
NO FUEL MTR TMP T/C	#FALSE	
FUEL MTR TEMP (DEG F)	#1.0 (-100.0, 32000.0)	
USE EXH TEMP A/F	#FALSE	
LOCK IN LAST	#FALSE	
AFV MIN TRVL	#0.0 (0.0, 100.0)	
AFV MAX TRVL	#100.0 (0.0, 100.0)	
CFIG IGN TMG	**Default (Low, High)**	
IGN TMG REV ACTING	#FALSE	
START IGN TIMING (DEG BTC)	#4.0 (-40.0, 45.0)	
MAX IGN ADVANCE(DEG BTC)	#4.0 (0.0, 45.0)	
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, 17)	
AOUT 1 4-20 mA	#TRUE	
AOUT 2 4-20 mA	#TRUE	
ACT OUT 1 4-20mA	#FALSE	
ACT OUT 2 4-20 mA	#TRUE	

Service Menus

SHUTDOWN MENU	Default	Field Settings
FIRST SHUTDOWN		
1-SPEED #1FAIL		
2-SPEED #2 FAIL		
3-SPD #1AND#2 FAIL		
4-AMP INPUT FAILED		
5-FGH INPUT FAILED		
6-FGM DP INPUT FAILED		
7-REM INPUT FAILED		
8-MODBUS 3 FAIL		
9-HI FUEL DEMND SHTDN		
10-HI SPEED SHTDN		
11-ENGINE STALL		
12-HI TURBO SPD SHTDN		
13-HI OIL TEMP SHTDN		
14-HI EXH TEMP SHTDN		
15-HI AIR TEMP SHTDN		
ALARM RESET	*FALSE	

ALARM MENU	Default	
FIRST ALARM		
1-SPEED #1FAIL		
2-SPEED #2 FAIL		
3-SPD #1AND#2 FAIL		
4-AMP INPUT FAILED		
5-FGH INPUT FAILED		
6-FGM DP INPUT FAILED		
7-REM INPUT FAILED		
8-MODBUS 3 FAIL		
9-HI FUEL DEMND ALM		
10-HI SPEED ALARM		
11-ENGINE STALL		
12-HI TURBO SPD ALM		
13-HI OIL TEMP ALM		
14-HI EXH TEMP ALM		
15-HI AIR TEMP ALM		
ALARM RESET	*FALSE	
SPEED CTRL DYNAMICS	**Default (Low, High)**	
MIN GAIN	*1.0 (0.01, 100.0)	
RATED GAIN	*2.25 (0.01, 100.0)	
SC RESET	*1.0 (0.01, 50.0)	
COMPENSATION	*0.25 (0.01, 1.0)	
GAIN RATIO	*1.0 (0.0, 10.0)	
WINDOW WIDTH (RPM)	*60.0 (1.0, 60.0)	
GAIN SLOPE BK PNT (%FD)	*100.0 (0.0, 100.0)	
GAIN SLOPE	*0.0 (-20.0, 20.0)	
SS1 SPD FILTER (HZ)	*15.9 (0.01, 20.0)	
SS2 SPD FILTER (HZ)	*0.66 (0.01, 20.0)	
NOTCH FILT FREQ(HZ)	*15.9 (0.01, 16.0)	
NOTCH Q FACTOR	*0.707 (0.707, 25.0)	
DSPLY SPD FILTER	*1.0 (0.01, 100.0)	
BUMP FUEL ACT	*FALSE	
SPEED SETTING	**Default (Low, High)**	
RAISE SPEED LIMIT (RPM)	*330 (1, 2100)	
LOWER SPEED LIMIT (RPM)	*198 (1, 2100)	
IDLE SPEED (RPM)	*220 (1, 2100)	
START SPEED (RPM)	*125 (1, 2100)	
START TIME (SEC)	*14.0 (0.0, 60.0)	
ACCEL RAMP TIME (SEC)	*25.0 (15.0, 500.0)	
DECEL RAMP TIME (SEC)	*25.0 (15.0, 500.0)	
RAISE SPEED RATE (RPM/MIN)	*180.0 (6.0, 32767.0)	
LOWER SPEED RATE (RPM/MIN)	*180.0 (6.0, 32767.0)	
WARMUP TIME	*300.0 (0.0, 1800.0)	
FUEL LIMITERS	**Default (Low, High)**	
START FUEL LIMIT (%FD)	*1.0 (0.1, 100.0)	
START RAMP RATE (%FD/S)	*1.0 (0.0, 1000.0)	
MAX FUEL LIMIT (%FD)	*100.0 (0.0, 100.0)	

I/O CALIBRATION	Default (Low, High)	
AMP AI OFFSET(AI1)	*0.0 (-200.0, 200.0)	
AMP AI SPAN(AI1)	*100.0 (50.0, 200.0)	
AMP READ VOLTS (AI1)	*FALSE	
FGH AI OFFSET(AI2)	*0.0 (-200.0, 200.0)	
FGH AI SPAN(AI2)	*100.0 (50.0, 200.0)	
FGH READ VOLTS (AI2)	*FALSE	
FGM AI OFFSET(AI3)	*0.0 (-200.0, 200.0)	
FGM AI SPAN(AI3)	*100.0 (50.0, 200.0)	
FGM READ VOLTS (AI3)	*FALSE	
REM SPD REF OFFSET(AI4)	*0.0 (-200.0, 200.0)	
REM SPD REF SPAN (AI4)	*100.0 (50.0, 200.0)	
REM READ VOLTS (AI4)	*FALSE	
AO 1 OFFSET	*0.0 (-4095.0, 4095.0)	
AO 1 SPAN	*100.0 (50.0, 200.0)	
AO 2 OFFSET	*0.0 (-4095.0, 4095.0)	
AO 2 SPAN	*100.0 (50.0, 200.0)	
ACT 1 OFFSET	*0.0 (-4095.0, 4095.0)	
ACT 1 SPAN	*100.0 (50.0, 200.0)	
ACT 2 OFFSET	*0.0 (-4095.0, 4095.0)	
ACT 2 SPAN	*100.0 (50.0, 200.0)	
FUEL ACTUATOR BUMP	**Default (Low, High)**	
FUEL BUMP ENABLE	*FALSE	
FUEL ACT BUMP LEVEL (%FD)	*1.0 (0.0, 100.0)	
FUEL ACT BUMP DURTN(SEC)	*0.1 (0.01, 2.0)	
TORQUE LIMIT CURVE	**Default (Low, High)**	
ENABLE TORQUE LIMIT	*FALSE	
TORQUE LMT BRKPNT A(RPM)	*198.0 (1.0, 2100.0)	
FUEL LMT @ BRKPNT A (%FD)	*100.0 (0.0, 100.0)	
TORQUE LMT BRKPNT B(RPM)	*231.0 (1.0, 2100.0)	
FUEL LMT @ BRKPNT B (%FD)	*100.0 (0.0, 100.0)	
TORQUE LMT BRKPNT C(RPM)	*264.0 (1.0, 2100.0)	
FUEL LMT @ BRKPNT C (%FD)	*100.0 (0.0, 100.0)	
TORQUE LMT BRKPNT D(RPM)	*297.0 (1.0, 2100.0)	
FUEL LMT @ BRKPNT D (%FD)	*100.0 (0.0, 100.0)	
TORQUE LMT BRKPNT E(RPM)	*330.0 (1.0, 2100.0)	
FUEL LMT @ BRKPNT E (%FD)	*100.0 (0.0, 100.0)	
AMP LMT CURVE	**Default (Low, High)**	
ENABLE AMP FUEL LMT	*FALSE	
AMP LMT INPUT A(EU)	*0.0 (0.0, 100.0)	
FUEL LIMIT @ A(%FD)	*100.0 (0.0, 100.0)	
AMP LMT INPUT B(EU)	*10.0 (0.0, 100.0)	
FUEL LIMIT @ B(%FD)	*100.0 (0.0, 100.0)	
AMP LMT INPUT C(EU)	*20.0 (0.0, 100.0)	
FUEL LIMIT @ C(%FD)	*100.0 (0.0, 100.0)	
AMP LMT INPUT D(EU)	*30.0 (0.0, 100.0)	
FUEL LIMIT @ D(%FD)	*100.0 (0.0, 100.0)	
AMP LMT INPUT E(EU)	*40.0 (0.0, 100.0)	
FUEL LIMIT @ E(%FD)	*100.0 (0.0, 100.0)	

AFR CTRL DYNAMICS	Default (Low, High)	
AFRC GAIN	*0.1 (0.01, 3.0)	
AFRC RESET	*0.2 (0.01, 32767.0)	
AFRC DERIVATIVE	*0.01 (0.01, 100.0)	
AFRC THRESHOLD	*0.1 (0.1, 1200.0)	
AMP FILTER(LAG)	*0.1 (0.01, 100.0)	
FGH FILTER(LAG)	*0.1 (0.01, 100.0)	
FGM FILTER(LAG)	*0.3 (0.01, 100.0)	
REM FILTER(LAG)	*0.1 (0.01, 100.0)	
AMT FILTER(LAG)	*1.0 (0.01, 10.0)	
FGQ FILTER(LAG)	*0.1 (0.01, 10.0)	
FGT FILTER(LAG)	*2.0 (0.0, 10.0)	
EXHT FILTER(LAG)	*2.0 (0.01, 10.0)	
BUMP WSTGATE ACT	*FALSE	
AFR ACTUATOR BUMP	**Default (Low, High)**	
AFR BUMP ENABLE	*FALSE	
AFR ACT BUMP LVL (%AFVP)	*1.0 (0.0, 100.0)	
AFR ACT BUMP DURATN(SEC)	*0.1 (0.01, 2.0)	
SET ANALOG INPUTS	**Default (Low, High)**	
REM SR @4mA EU (RPM)	*198.0 (-16384.0, 16384.0)	
REM SR @20mA EU (RPM)	*330.0 (-16384.0, 16384.0)	
AMP @4mA EU (in Hg)	*0.0 (-16384.0, 16384.0)	
AMP @20mA EU (in Hg)	*50.0 (-16384.0, 16384.0)	
FGH @4mA EU (PSI)	*0.0 (-16384.0, 16384.0)	
FGH @20mA EU (PSI)	*100.0 (-16384.0, 16384.0)	
FG DP @4mA EU(IN WAT)	*0.0 (-16384.0, 16384.0)	
FG DP @20mA EU (IN WAT)	*100.0 (-16384.0, 16384.0)	
SET ANALOG OUTPUTS	**Default (Low, High)**	
ANALOG OUTPUT 1 MIN(EU)	*0.0 (-32767.0, 32767.0)	
ANALOG OUTPUT 1 MAX(EU)	*330.0 (-32767.0, 32767.0)	
ANALOG OUTPUT 2 MIN(EU)	*-32.0 (-36.0, 45.0)	
ANALOG OUTPUT 2 MAX(EU)	*4.0 (0.0, 45.0)	
ANALOG OUTPUT 4 MIN (%)	*0.0 (-20.0, 135.0)	
ANALOG OUTPUT 4 MAX (%)	*100.0 (-20.0, 135.0)	
AO FILTER FREQUENCY(HZ)	*20.0 (0.01, 20.0)	
COMM PORT SETUP	**Default (Low, High)**	
PORT2 HARDWARE CFIG	*1 (1, 2)	
PORT 2 BAUD RATE	*9 (1, 10)	
PORT3 HARDWARE CFIG	*1 (1, 3)	
PORT 3 BAUD RATE	*6 (1, 7)	
PORT 3 STOP BITS	*1 (1, 3)	
PORT 3 PARITY	*1 (1, 3)	
PORT 3 TIMEOUT(SEC)	*10.0 (0.5, 30.0)	
PORT 3 LINK ERROR		
PORT 3 EXCEPTION ERR		
PORT 3 EX ERR NUM		
PORT 3 EX ERR PCT		

AMP VS FGH	Default (Low, High)	
RATED SPEED CURVE (RPM)	*330.0 (0.0, 2100.0)	
FUEL HDR[RSPD,HTQ](PSI)	*56.0 (0.0, 16384.0)	
AMP REF[RSPD,HTQ] (in Hg)	*31.0 (0.0, 750.0)	
FUEL HDR[RSPD,LTQ](PSI)	*24.5 (0.0, 16384.0)	
AMP REF[RSPD,LTQ] (in Hg)	*7.0 (0.0, 750.0)	
MIN SPEED CURVE(RPM)	*198.0 (0.0, 2100.0)	
FUEL HDR[LSPD,HTQ](PSI)	*28.0 (0.0, 16384.0)	
AMP REF[LSPD,HTQ] (in Hg)	*15.5 (0.0, 750.0)	
FUEL HDR[LSPD,LTQ](PSI)	*15.0 (0.0, 16384.0)	
AMP REF[LSPD,LTQ] (in Hg)	*5.0 (0.0, 750.0)	
AFR VLV TRVL LMT (%)	*100.0 (0.0, 100.0)	
MIN AMP LIMIT(in Hg)	*7.0 (1.0, 10.0)	
DEFAULT AMP REF	*50.0 (0.0, 100.0)	
RESET ZERO R/L	*FALSE	
AMP BIAS SETTINGS	**Default (Low, High)**	
HI AMT,HF AMP BIAS(in Hg)	*1.8 (0.0, 100.0)	
LO AMT,HF AMP BIAS(in Hg)	*-6.6 (-100.0, 0.0)	
HI AIR MANF TEMP,HF(F)	*140.0 (0.0, 1000.0)	
LO AIR MANF TEMP,HF(F)	*0.0 (-100.0, 100.0)	
HI AIR MANF TEMP,LF(F)	*140.0 (0.0, 1000.0)	
FULL LD FUEL HDR (PSI)	*56.0 (0.0, 1500.0)	
RAISE AMP BIAS LMT(in Hg)	*3.0 (0.1, 80.0)	
LOWER AMP BIAS LMT(in Hg)	*-3.0 (-80.0, -0.1)	
R/L AMP RATE(in Hg/SEC)	*0.2 (0.1, 7.0)	
USE AMT BIAS	*TRUE	
AMP VS FGQ(RTD SPD)	**Default (Low, High)**	
RATED SPEED CURVE (RPM)	*330.0 (0.0, 2100.0)	
AMP REF(MAXTQ in Hg)	*36.0 (0.0, 40.0)	
AMP REF(AMBTQ in Hg)	*33.5 (0.0, 40.0)	
AMP REF (100%TQ in Hg)	*31.0 (0.0, 40.0)	
AMP REF(75%TQ in Hg)	*19.1 (0.0, 30.0)	
AMP REF(50%TQ in Hg)	*7.1 (0.0, 20.0)	
AMP REF (0%TQ in Hg)	*7.0 (0.0, 10.0)	
FUEL FLOW (MAXTQ SCFM)	*422.2 (0.0, 1500.0)	
FUEL FLOW (AMBTQ SCFM)	*390.5 (0.0, 1500.0)	
FUEL FLOW (100%TQ SCFM)	*328.1 (0.0, 1300.0)	
FUEL FLOW (75%TQ SCFM)	*253.3 (0.0, 1100.0)	
FUEL FLOW (50%TQ SCFM)	*186.4 (0.0, 700.0)	
FUEL FLOW(0%TQ SCFM)	*120.0 (0.0, 700.0)	
FUEL GAS SITE BTU (LHVdry)	*925.0 (550.0, 1100.0)	
AFR VLV TRVL LMT(%)	*100.0 (0.0, 100.0)	
MIN AMP LIMIT(in Hg)	*7.0 (1.0, 10.0)	
DEFAULT AMP REF	*50.0 (0.0, 100.0)	
RESET ZERO R/L	*FALSE	

AMP VS FGQ(LOW SPD)	Default (Low, High)	
LOW SPEED CURVE(RPM)	*198.0 (0.0, 2100.0)	
AMP REF(MAXTQ in Hg)	*18.5 (0.0, 40.0)	
AMP REF(AMBTQ in Hg)	*17.0 (0.0, 40.0)	
AMP REF (100%TQ in Hg)	*15.5 (0.0, 40.0)	
AMP REF(75%TQ in Hg)	*8.0 (0.0, 40.0)	
AMP REF(50%TQ in Hg)	*5.5 (0.0, 30.0)	
AMP REF (0%TQ in Hg)	*5.0 (0.0, 10.0)	
FUEL FLOW (MAXTQ SCFM)	*256.4 (0.0, 700.0)	
FUEL FLOW (AMBTQ SCFM)	*239.4 (0.0, 700.0)	
FUEL FLOW (100%TQ SCFM)	*209.2 (0.0, 700.0)	
FUEL FLOW (75%TQ SCFM)	*162.0 (0.0, 700.0)	
FUEL FLOW (50%TQ SCFM)	*112.7 (0.0, 700.0)	
FUEL FLOW(0%TQ SCFM)	*83.3 (0.0, 700.0)	
EXH TEMP(RATED SPD)	Default (Low, High)	
RATED SPEED CURVE(RPM)	*330.0 (100.0, 2100.0)	
EXHT REF (AMBTQ DEG F)	*500.0 (100.0, 1500.0)	
EXHT REF (100%TQ DEG F)	*500.0 (100.0, 1500.0)	
EXHT REF (75%TQ DEG F)	*500.0 (100.0, 1500.0)	
EXHT REF (50%TQ DEG F)	*500.0 (100.0, 1500.0)	
EXHT REF (0%TQ DEG F)	*500.0 (100.0, 1500.0)	
FUEL FLOW (AMBTQ SCFM)	*60.0 (0.0, 900.0)	
FUEL FLOW (100%TQ SCFM)	*50.0 (0.0, 900.0)	
FUEL FLOW (75%TQ SCFM)	*40.0 (0.0, 900.0)	
FUEL FLOW (50%TQ SCFM)	*30.0 (0.0, 900.0)	
FUEL FLOW (0%TQ SCFM)	*20.0 (0.0, 900.0)	
EXH TEMP(LOW SPD)	Default (Low, High)	
LOW SPEED CURVE(RPM)	*198.0 (100.0, 2100.0)	
EXHT REF (AMBTQ DEG F)	*500.0 (100.0, 1500.0)	
EXHT REF (100%TQ DEG F)	*500.0 (100.0, 1500.0)	
EXHT REF (75%TQ DEG F)	*500.0 (100.0, 1500.0)	
EXHT REF (50%TQ DEG F)	*500.0 (100.0, 1500.0)	
EXHT REF (0%TQ DEG F)	*500.0 (100.0, 1500.0)	
FUEL FLOW (AMBTQ SCFM)	*31.0 (0.0, 900.0)	
FUEL FLOW (100%TQ SCFM)	*27.0 (0.0, 900.0)	
FUEL FLOW (75%TQ SCFM)	*23.0 (0.0, 900.0)	
FUEL FLOW (50%TQ SCFM)	*19.0 (0.0, 900.0)	
FUEL FLOW (0%TQ SCFM)	*15.0 (0.0, 900.0)	
EXH TEMP SETUP	Default (Low, High)	
USE EXH TEMP A/F	*FALSE	
MAX EXHAUST TEMP(DEG F)	*600.0 (100.0, 1500.0)	
MIN EXHAUST TEMP(DEG F)	*500.0 (100.0, 1500.0)	
EXH TEMP ENBL DELAY(SEC)	*600.0 (0.0, 3600.0)	
EXH TEMP HYSTER(DEG F)	*100.0 (0.0, 1200.0)	
EXH TEMP RAISE LMT(DEG F)	*100.0 (0.0, 500.0)	
EXH TEMP LOWER LMT(DEG F)	*-100.0 (-500.0, 0.0)	
EXH TMP R/L RATE(DEG F/SEC)	*3.3 (0.01, 100.0)	
RESET ZERO R/L	*TRUE	

BHP VS FGQ(RTD SPD)	Default (Low, High)	
BHP [RSPD,MAXTQ]	*3375.0 (0.0, 15000.0)	
BHP [RSPD,AMBTQ]	*3132.0 (0.0, 15000.0)	
BHP [RSPD,100%TQ]	*2700.0 (0.0, 15000.0)	
BHP [RSPD,75%TQ]	*2025.0 (0.0, 15000.0)	
BHP [RSPD,50%TQ]	*1350.0 (0.0, 15000.0)	
FUEL FLOW[RSPD,MAXTQ](PSI)	*422.2 (0.0, 1500.0)	
FUEL FLOW[RSPD,AMBTQ](PSI)	*390.5 (0.0, 1500.0)	
FUEL FLOW[RSPD,100%TQ](PSI)	*328.1 (0.0, 1300.0)	
FUEL FLOW[RSPD,75%TQ](PSI)	*253.3 (0.0, 1100.0)	
FUEL FLOW[RSPD,50%TQ](PSI)	*186.4 (0.0, 700.0)	
FUEL FLOW[RSPD,0%TQ](PSI)	*120.0 (0.0, 700.0)	
RATED SPEED CURVE (RPM)	*330.0 (0.0, 2100.0)	
BHP VS FGQ(MIN SPD)	Default (Low, High)	
BHP [MINSPD,MAXTQ]	*2025.0 (0.0, 15000.0)	
BHP [MINSPD,AMBTQ]	*1879.0 (0.0, 15000.0)	
BHP [MINSPD,100%TQ]	*1620.0 (0.0, 15000.0)	
BHP [MINSPD,75%TQ]	*1215.0 (0.0, 15000.0)	
BHP [MINSPD,50%TQ]	*810.0 (0.0, 15000.0)	
FUEL FLOW[MSPD,MAXTQ](PSI)	*256.4 (0.0, 700.0)	
FUEL FLOW[MSPD,AMBTQ](PSI)	*239.4 (0.0, 700.0)	
FUEL FLOW[MSPD,100%TQ](PSI)	*209.2 (0.0, 700.0)	
FUEL FLOW[MSPD,75%TQ](PSI)	*162.0 (0.0, 700.0)	
FUEL FLOW[MSPD,50%TQ](PSI)	*112.7 (0.0, 700.0)	
FUEL FLOW[MSPD,0%TQ](PSI)	*83.3 (0.0, 700.0)	
MIN SPEED CURVE(RPM)	*198.0 (0.0, 2100.0)	
IGN TMG START SET	Default (Low, High)	
MAX RETARD LMT(DEG)	*-25.0 (-40.0, 45.0)	
AMP 1 (in Hg)	*0.0 (-0.1, 0.0)	
AMP 2 (in Hg)	*5.0 (0.0, 50.0)	
AMP 3 (in Hg)	*7.0 (0.0, 50.0)	
AMP 4 (in Hg)	*40.0 (0.0, 50.0)	
AMP 5 (in Hg)	*50.0 (0.0, 50.0)	
AMP 1 TMG SET(DEG)	*-32.0 (-35.0, 45.0)	
AMP 2 TMG SET(DEG)	*-25.0 (-35.0, 45.0)	
AMP 3 TMG SET(DEG)	*4.0 (-35.0, 45.0)	
AMP 4 TMG SET(DEG)	*4.0 (-35.0, 45.0)	
AMP 5 TMG SET(DEG)	*4.0 (-35.0, 45.0)	
SLOW RETARD BRKPT (in Hg)	*7.0 (0.0, 10.0)	
SLOW RETARD DBAND (in Hg)	*-0.2 (-1.0, -0.01)	
RETARD DELAY(SEC)	*3.0 (0.0, 10.0)	
SLOW RETARD RATE (DEG/s)	*0.2 (0.01, 3.0)	

IGN TMG NORM SET	Default (Low, High)	
FGH 1 RPM 1 (RPM)	*198.0 (50.0, 2100.0)	
FGH 1 RPM 2 (RPM)	*330.0 (50.0, 2100.0)	
FGH 2 RPM 1 (RPM)	*198.0 (50.0, 2100.0)	
FGH 2 RPM 2 (RPM)	*330.0 (50.0, 2100.0)	
FGH1 RPM1 TMG SET (DEG)	*0.0 (-20.0, 45.0)	
FGH1 RPM2 TMG SET (DEG)	*4.0 (-20.0, 45.0)	
FGH2 RPM1 TMG SET (DEG)	*0.0 (-20.0, 45.0)	
FGH2 RPM2 TMG SET (DEG)	*4.0 (-20.0, 45.0)	
LO TORQ FGH 1(PSI)	*20.0 (0.0, 100.0)	
FULL TORQ FGH 2(PSI)	*56.0 (0.0, 100.0)	
NORM TMG FILTER(LAG)	*0.1 (0.01, 15.9)	
DEFAULT IGN TMG SET (DEG)	*2.0 (-30.0, 45.0)	
IGN TMG AMBTQ SET	**Default (Low, High)**	
100% TQ ACT OUT(%FD)	*75.0 (40.0, 100.0)	
MAX TQ ACT OUT (%FD)	*95.0 (40.0, 100.0)	
MAX TQ SET (%RATED)	*116.0 (100.0, 130.0)	
MAX TQ (%RATED)	*116.0 (100.0, 125.0)	
100% TQ TMG SET(DEG)	*4.0 (-20.0, 45.0)	
MAX TQ TMG SET(DEG)	*2.0 (-20.0, 45.0)	
TORQ TMG FILTER(LAG)	*0.1 (0.01, 15.9)	
TURBO ASSIST SETPT	**Default (Low, High)**	
TURBO ASSIST SET (in Hg)	*5.5 (2.0, 10.0)	
TURBO ASSIST HYST (in Hg)	*-0.2 (-1.0, 0.0)	
TURBO ASSIST GAIN	*5.0 (0.01, 20.0)	
TURBO ASSIST RESET	*0.1 (0.01, 32767.0)	
TURBO ASSIST DERIV	*0.01 (0.01, 100.0)	
TURBO ASSIST THRESH	*101.0 (0.0, 101.0)	
MAX VALVE OPEN LMT	*100.0 (-1.0, 100.0)	
PID BYPASS TIME(SEC)	*3.0 (0.0, 10.0)	
PRECOMB SETTING	**Default (Low, High)**	
RATED SPEED CURVE (RPM)	*330.0 (1.0, 2100.0)	
PCC REF (RS,100%TQ EU)	*40.0 (0.0, 40.0)	
PCC REF (RS,75%TQ EU)	*25.0 (0.0, 30.0)	
PCC REF (RS,50%TQ EU)	*10.0 (0.0, 20.0)	
PCC REF (RS,0%TQ EU)	*5.0 (0.0, 10.0)	
LOAD IN (RS,100%TQ EU)	*40.0 (0.0, 100.0)	
LOAD IN (RS,75%TQ EU)	*30.0 (0.0, 100.0)	
LOAD IN (RS,50%TQ EU)	*20.0 (0.0, 100.0)	
LOAD IN (RS,0%TQ EU)	*10.0 (0.0, 100.0)	
MIN SPEED CURVE(RPM)	*198.0 (1.0, 2100.0)	
PCC REF (MS,100%TQ EU)	*15.0 (0.0, 40.0)	
PCC REF (MS,75%TQ EU)	*10.0 (0.0, 40.0)	
PCC REF (MS,50%TQ EU)	*5.0 (0.0, 30.0)	
PCC REF (MS,0%TQ EU)	*1.0 (0.0, 100.0)	
LOAD IN(MS,100%TQ EU)	*30.0 (0.0, 100.0)	
LOAD IN(MS,75%TQ EU)	*20.0 (0.0, 100.0)	
LOAD IN(MS,50%TQ EU)	*10.0 (0.0, 100.0)	
LOAD IN(MS,0%TQ EU)	*0.0 (0.0, 100.0)	

TC MODULE 1	Default (Low, High)	
CH1 - AIR MANIFOLD (DEG F)		
CH2 - EXHAUST STACK (DEG F)		
CH3 - FUEL GAS MTR (DEG F)		
CH4 - LUBE OIL OUT (DEG F)		
CH5 - TC DEGREES F		
CH6 - TC DEGREES F		
CH1 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH1 - TC SPAN	*100.0 (50.0, 200.0)	
CH2 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH2 - TC SPAN	*100.0 (50.0, 200.0)	
CH3 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH3 - TC SPAN	*100.0 (50.0, 200.0)	
CH4 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH4 - TC SPAN	*100.0 (50.0, 200.0)	
CH5 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH5 - TC SPAN	*100.0 (50.0, 200.0)	
CH6 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH6 - TC SPAN	*100.0 (50.0, 200.0)	
TC MODULE 2	**Default (Low, High)**	
CH1 - TC DEGREES F		
CH2 - TC DEGREES F		
CH3 - TC DEGREES F		
CH4 - TC DEGREES F		
CH5 - TC DEGREES F		
CH6 - TC DEGREES F		
CH1 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH1 - TC SPAN	*100.0 (50.0, 200.0)	
CH2 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH2 - TC SPAN	*100.0 (50.0, 200.0)	
CH3 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH3 - TC SPAN	*100.0 (50.0, 200.0)	
CH4 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH4 - TC SPAN	*100.0 (50.0, 200.0)	
CH5 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH5 - TC SPAN	*100.0 (50.0, 200.0)	
CH6 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH6 - TC SPAN	*100.0 (50.0, 200.0)	

TC MODULE 3	Default (Low, High)	
CH1 - TC DEGREES F		
CH2 - TC DEGREES F		
CH3 - TC DEGREES F		
CH4 - TC DEGREES F		
CH5 - TC DEGREES F		
CH6 - TC DEGREES F		
CH1 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH1 - TC SPAN	*100.0 (50.0, 200.0)	
CH2 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH2 - TC SPAN	*100.0 (50.0, 200.0)	
CH3 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH3 - TC SPAN	*100.0 (50.0, 200.0)	
CH4 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH4 - TC SPAN	*100.0 (50.0, 200.0)	
CH5 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH5 - TC SPAN	*100.0 (50.0, 200.0)	
CH6 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH6 - TC SPAN	*100.0 (50.0, 200.0)	
TC MODULE 4	Default (Low, High)	
CH1 - TC DEGREES F		
CH2 - TC DEGREES F		
CH3 - TC DEGREES F		
CH4 - TC DEGREES F		
CH5 - TC DEGREES F		
CH6 - TC DEGREES F		
CH1 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH1 - TC SPAN	*100.0 (50.0, 200.0)	
CH2 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH2 - TC SPAN	*100.0 (50.0, 200.0)	
CH3 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH3 - TC SPAN	*100.0 (50.0, 200.0)	
CH4 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH4 - TC SPAN	*100.0 (50.0, 200.0)	
CH5 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH5 - TC SPAN	*100.0 (50.0, 200.0)	
CH6 - TC OFFSET	*0.0 (-500.0, 500.0)	
CH6 - TC SPAN	*100.0 (50.0, 200.0)	

RTD MODULE 1	Default (Low, High)	
CH1 - RTD DEGREES F		
CH2 - RTD DEGREES F		
CH3 - RTD DEGREES F		
CH4 - RTD DEGREES F		
CH5 - RTD DEGREES F		
CH6 - RTD DEGREES F		
CH1 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH1 - RTD SPAN	*100.0 (50.0, 200.0)	
CH2 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH2 - RTD SPAN	*100.0 (50.0, 200.0)	
CH3 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH3 - RTD SPAN	*100.0 (50.0, 200.0)	
CH4 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH4 - RTD SPAN	*100.0 (50.0, 200.0)	
CH5 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH5 - RTD SPAN	*100.0 (50.0, 200.0)	
CH6 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH6 - RTD SPAN	*100.0 (50.0, 200.0)	
RTD MODULE 2	Default (Low, High)	
CH1 - RTD DEGREES F		
CH2 - RTD DEGREES F		
CH3 - RTD DEGREES F		
CH4 - RTD DEGREES F		
CH5 - RTD DEGREES F		
CH6 - RTD DEGREES F		
CH1 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH1 - RTD SPAN	*100.0 (50.0, 200.0)	
CH2 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH2 - RTD SPAN	*100.0 (50.0, 200.0)	
CH3 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH3 - RTD SPAN	*100.0 (50.0, 200.0)	
CH4 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH4 - RTD SPAN	*100.0 (50.0, 200.0)	
CH5 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH5 - RTD SPAN	*100.0 (50.0, 200.0)	
CH6 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH6 - RTD SPAN	*100.0 (50.0, 200.0)	

RTD MODULE 3	Default (Low, High)	
CH1 - RTD DEGREES F		
CH2 - RTD DEGREES F		
CH3 - RTD DEGREES F		
CH4 - RTD DEGREES F		
CH5 - RTD DEGREES F		
CH6 - RTD DEGREES F		
CH1 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH1 - RTD SPAN	*100.0 (50.0, 200.0)	
CH2 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH2 - RTD SPAN	*100.0 (50.0, 200.0)	
CH3 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH3 - RTD SPAN	*100.0 (50.0, 200.0)	
CH4 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH4 - RTD SPAN	*100.0 (50.0, 200.0)	
CH5 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH5 - RTD SPAN	*100.0 (50.0, 200.0)	
CH6 - RTD OFFSET	*0.0 (-500.0, 500.0)	
CH6 - RTD SPAN	*100.0 (50.0, 200.0)	
AI MODULE 1	**Default (Low, High)**	
AI1 CH1 - mA INPUT		
AI1 CH2 - mA INPUT		
AI1 CH3 - mA INPUT		
AI1 CH4 - mA INPUT		
AI1 CH5 - mA INPUT		
AI1 CH6 - mA INPUT		
AI1 CH1 - AI OFFSET	*0.0 (-20.0, 20.0)	
AI1 CH1 - AI SPAN	*100.0 (50.0, 200.0)	
AI1 CH2 - AI OFFSET	*0.0 (-20.0, 20.0)	
AI1 CH2 - AI SPAN	*100.0 (50.0, 200.0)	
AI1 CH3 - AI OFFSET	*0.0 (-20.0, 20.0)	
AI1 CH3 - AI SPAN	*100.0 (50.0, 200.0)	
AI1 CH4 - AI OFFSET	*0.0 (-20.0, 20.0)	
AI1 CH4 - AI SPAN	*100.0 (50.0, 200.0)	
AI1 CH5 - AI OFFSET	*0.0 (-20.0, 20.0)	
AI1 CH5 - AI SPAN	*100.0 (50.0, 200.0)	
AI1 CH6 - AI OFFSET	*0.0 (-20.0, 20.0)	
AI1 CH6 - AI SPAN	*100.0 (50.0, 200.0)	

AI MODULE 2	Default (Low, High)	
AI2 CH1 - mA INPUT		
AI2 CH2 - mA INPUT		
AI2 CH3 - mA INPUT		
AI2 CH4 - mA INPUT		
AI2 CH5 - mA INPUT		
AI2 CH6 - mA INPUT		
AI2 CH1 - AI OFFSET	*0.0 (-20.0, 20.0)	
AI2 CH1 - AI SPAN	*100.0 (50.0, 200.0)	
AI2 CH2 - AI OFFSET	*0.0 (-20.0, 20.0)	
AI2 CH2 - AI SPAN	*100.0 (50.0, 200.0)	
AI2 CH3 - AI OFFSET	*0.0 (-20.0, 20.0)	
AI2 CH3 - AI SPAN	*100.0 (50.0, 200.0)	
AI2 CH4 - AI OFFSET	*0.0 (-20.0, 20.0)	
AI2 CH4 - AI SPAN	*100.0 (50.0, 200.0)	
AI2 CH5 - AI OFFSET	*0.0 (-20.0, 20.0)	
AI2 CH5 - AI SPAN	*100.0 (50.0, 200.0)	
AI2 CH6 - AI OFFSET	*0.0 (-20.0, 20.0)	
AI2 CH6 - AI SPAN	*100.0 (50.0, 200.0)	
DI MODULE 1	Display Only	
CH01 CONTACT CLOSED		
CH02 CONTACT CLOSED		
CH03 CONTACT CLOSED		
CH04 CONTACT CLOSED		
CH05 CONTACT CLOSED		
CH06 CONTACT CLOSED		
CH07 CONTACT CLOSED		
CH08 CONTACT CLOSED		
CH09 CONTACT CLOSED		
CH10 CONTACT CLOSED		
CH11 CONTACT CLOSED		
CH12 CONTACT CLOSED		
CH13 CONTACT CLOSED		
CH14 CONTACT CLOSED		
CH15 CONTACT CLOSED		
CH16 CONTACT CLOSED		
DI MODULE 2	Display Only	
CH01 CONTACT CLOSED		
CH02 CONTACT CLOSED		
CH03 CONTACT CLOSED		
CH04 CONTACT CLOSED		
CH05 CONTACT CLOSED		
CH06 CONTACT CLOSED		
CH07 CONTACT CLOSED		
CH08 CONTACT CLOSED		
CH09 CONTACT CLOSED		
CH10 CONTACT CLOSED		
CH11 CONTACT CLOSED		
CH12 CONTACT CLOSED		
CH13 CONTACT CLOSED		
CH14 CONTACT CLOSED		
CH15 CONTACT CLOSED		
CH16 CONTACT CLOSED		

DI MODULE 3	Display Only	
CH01 CONTACT CLOSED		
CH02 CONTACT CLOSED		
CH03 CONTACT CLOSED		
CH04 CONTACT CLOSED		
CH05 CONTACT CLOSED		
CH06 CONTACT CLOSED		
CH07 CONTACT CLOSED		
CH08 CONTACT CLOSED		
CH09 CONTACT CLOSED		
CH10 CONTACT CLOSED		
CH11 CONTACT CLOSED		
CH12 CONTACT CLOSED		
CH13 CONTACT CLOSED		
CH14 CONTACT CLOSED		
CH15 CONTACT CLOSED		
CH16 CONTACT CLOSED		
DI MODULE 4	Display Only	
CH01 CONTACT CLOSED		
CH02 CONTACT CLOSED		
CH03 CONTACT CLOSED		
CH04 CONTACT CLOSED		
CH05 CONTACT CLOSED		
CH06 CONTACT CLOSED		
CH07 CONTACT CLOSED		
CH08 CONTACT CLOSED		
CH09 CONTACT CLOSED		
CH10 CONTACT CLOSED		
CH11 CONTACT CLOSED		
CH12 CONTACT CLOSED		
CH13 CONTACT CLOSED		
CH14 CONTACT CLOSED		
CH15 CONTACT CLOSED		
CH16 CONTACT CLOSED		
DO MODULE 1	Display Only	
CH1 ENERGIZED		
CH2 ENERGIZED		
CH3 ENERGIZED		
CH4 ENERGIZED		
CH5 ENERGIZED		
CH6 ENERGIZED		
CH7 ENERGIZED		
CH8 ENERGIZED		
DO MODULE 2	Display Only	
CH1 ENERGIZED		
CH2 ENERGIZED		
CH3 ENERGIZED		
CH4 ENERGIZED		
CH5 ENERGIZED		
CH6 ENERGIZED		
CH7 ENERGIZED		
CH8 ENERGIZED		

DO MODULE 3	Display Only	
CH1 ENERGIZED		
CH2 ENERGIZED		
CH3 ENERGIZED		
CH4 ENERGIZED		
CH5 ENERGIZED		
CH6 ENERGIZED		
CH7 ENERGIZED		
CH8 ENERGIZED		
DO MODULE 4	Display Only	
CH1 ENERGIZED		
CH2 ENERGIZED		
CH3 ENERGIZED		
CH4 ENERGIZED		
CH5 ENERGIZED		
CH6 ENERGIZED		
CH7 ENERGIZED		
CH8 ENERGIZED		
AO MODULE 1	Default (Low, High)	
AO1 CH1 mA OUT		
AO1 CH2 mA OUT		
AO1 CH3 mA OUT		
AO1 CH4 mA OUT		
AO1 CH5 mA OUT		
AO1 CH6 mA OUT		
AO1 CH1 - AO OFFSET	*0.0 (-20.0, 20.0)	
AO1 CH1 - AO SPAN	*100.0 (50.0, 200.0)	
AO1 CH2 - AO OFFSET	*0.0 (-20.0, 20.0)	
AO1 CH2 - AO SPAN	*100.0 (50.0, 200.0)	
AO1 CH3 - AO OFFSET	*0.0 (-20.0, 20.0)	
AO1 CH3 - AO SPAN	*100.0 (50.0, 200.0)	
AO1 CH4 - AO OFFSET	*0.0 (-20.0, 20.0)	
AO1 CH4 - AO SPAN	*100.0 (50.0, 200.0)	
AO1 CH5 - AO OFFSET	*0.0 (-20.0, 20.0)	
AO1 CH5 - AO SPAN	*100.0 (50.0, 200.0)	
AO1 CH6 - AO OFFSET	*0.0 (-20.0, 20.0)	
AO1 CH6 - AO SPAN	*100.0 (50.0, 200.0)	
DISPLAY DIGITAL I/O	Display Only	
A-REMOTE SPEED REF		
B-ALARM RESET		
C-RAISE AIR MANF PRESS		
D-LOWER AIR MANF PRESS		
E-RAISE SPEED		
F-LOWER SPEED		
G-RATED SPEED		
H-CLOSE TO RUN		
DO1-SHUTDOWN		
DO2-ALARM		
DO3-TURBO AIR ASIST		

DISPLAY ANALOG I/O	Default	
SPD SENS IN #1(HZ)		
SPD SENS IN #2(HZ)		
AI1-AIR MANF PRESS (mA)		
AI2-FUEL GAS HDR PRESS(mA)		
AI3-FUEL GAS MTR DP(mA)		
AI4-REMOTE SPEED REF(mA)		
ANALOG OUT 1(mA)		
ANALOG OUT 2(mA)		
ACTUATOR OUT 1(mA)		
ACTUATOR OUT 2(mA)		
ALARM RESET	*FALSE	
DISPLAY IGN TMG	**Display Only**	
IGNITION TIMING(DEG)		
NO LOAD TMG REF(DEG)		
NORMAL TMG REF(DEG)		
AMB TQ TMG REF(DEG)		
ON NO LOAD TIMING		
ON NORMAL TIMING		
ON AMB TORQ TIMING		
DISPLAY AMP AFR	**Display Only**	
AIR MANF PRESS (in Hg)		
AIR MANF PR REF (in Hg)		
AFR VLV DEMAND(%)		
REV AFR VLV DMND(%)		
IN A/F CONTROL (LSS)		
ON DFLT A/F RATIO		
ON MIN AIR LIMIT		
ON START LIMIT		
AFRR CURVE OUTPUT		
AMP R/L BIAS(in Hg)		
AMT BIAS (in Hg)		
AMT BIAS ENABLED		
DISPLAY EXHT AFR	**Display Only**	
EXHAUST TEMP(DEG F)		
EXH TEMP REF (DEG F)		
AFR VLV DEMAND(%)		
REV AFR VLV DMND(%)		
IN A/F CONTROL (LSS)		
ON START LIMIT		
EXH TEMP R/L BIAS (EU)		
DISPLAY INDICATOR	**Display Only**	
ON START FUEL LMT		
ON MAXIMUM LIMIT		
ON TORQUE LIMIT		
ON AMP LIMIT		
ACTUATOR SHUTDOWN		
SPEED SWITCH 1		
SPEED SWITCH 2		
PORT 1 ON HANDHELD		
PORT 1 ON SERVLINK		

A/F RATIO CTRL MODE	Display Only	
ON FG HDR A/F CTRL		
ON FG FLOW A/F CTRL		
ON EXH TMP A/F CTRL		
ON LOCK IN LAST A/F		
ON DEFAULT AMP A/F		
SPEED CONTROL MODE	**Display Only**	
SPEED IN CONTROL		
ON START FUEL LMT		
ON MAXIMUM LIMIT		
ON TORQUE LIMIT		
ON AMP LIMIT		
ACTUATOR SHUTDOWN		
SPD SENSOR 1 ACTIVE		
SPD SENSOR 2 ACTIVE		
DISPLAY MENU	**Display Only**	
ENGINE SPEED (RPM)		
SPEED REF (RPM)		
FUEL DEMAND (%)		
TURBO SPEED (RPM)		
START FUEL LIMIT		
TORQUE FUEL LIMIT		
AMP FUEL LIMIT		
AIR MANF PRESS (EU)		
FUEL GAS HEADER(EU)		
FUEL GAS METER (EU)		
REMOTE SPD REF (RPM)		
ASSIST AIR REF (EU)		
ASSIST AIR DEMAND(%)		
PRECOMB CHAM CTRL (EU)		
BRAKE HORSEPOWER		
FORCE 723 DO	**Default**	
DO1 FORCE	*FALSE	
DO2 FORCE	*FALSE	
DO3 FORCE	*FALSE	

FORCE DO 1 & 2	Default	
DO1 CH1 FORCE	*FALSE	
DO1 CH2 FORCE	*FALSE	
DO1 CH3 FORCE	*FALSE	
DO1 CH4 FORCE	*FALSE	
DO1 CH5 FORCE	*FALSE	
DO1 CH6 FORCE	*FALSE	
DO1 CH7 FORCE	*FALSE	
DO1 CH8 FORCE	*FALSE	
DO2 CH1 FORCE	*FALSE	
DO2 CH2 FORCE	*FALSE	
DO2 CH3 FORCE	*FALSE	
DO2 CH4 FORCE	*FALSE	
DO2 CH5 FORCE	*FALSE	
DO2 CH6 FORCE	*FALSE	
DO2 CH7 FORCE	*FALSE	
DO2 CH8 FORCE	*FALSE	
FORCE DO 3 & 4	Default	
DO3 CH1 FORCE	*FALSE	
DO3 CH2 FORCE	*FALSE	
DO3 CH3 FORCE	*FALSE	
DO3 CH4 FORCE	*FALSE	
DO3 CH5 FORCE	*FALSE	
DO3 CH6 FORCE	*FALSE	
DO3 CH7 FORCE	*FALSE	
DO3 CH8 FORCE	*FALSE	
DO4 CH1 FORCE	*FALSE	
DO4 CH2 FORCE	*FALSE	
DO4 CH3 FORCE	*FALSE	
DO4 CH4 FORCE	*FALSE	
DO4 CH5 FORCE	*FALSE	
DO4 CH6 FORCE	*FALSE	
DO4 CH7 FORCE	*FALSE	
DO4 CH8 FORCE	*FALSE	

723PLUS Control Specifications

Woodward Part Numbers:

8280-424	723PLUS with low-voltage power supply
9907-205	Hand Held Programmer
8923-932	Watch Window Installation
8928-057	Performance '424' Control View Installation

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

Steady State Speed Band	±0.25% of rated speed
Magnetic Pickup	400–15 000 Hz (200–2100 rpm)
Proximity Switch	30–15 000 Hz (200–2100 rpm)

Discrete Inputs (8)	10 mA at 24 Vdc, impedance 2.3 kΩ
Air Manifold Pressure	4–20 mA or 1–5 Vdc, externally powered
Fuel Gas Header OR	
Meter Pressure	4–20 mA or 1–5 Vdc, externally powered
Fuel Gas Meter Diff Pressure	4–20 mA or 1–5 Vdc, externally powered
Remote Load Setting Input	4–20 mA or 1–5 Vdc, externally powered

Analog Output #1 (configurable)	4–20 mA to meter, computer, or second actuator, internally powered
Analog Output #2	4–20 mA to ignition timer, internally powered
Analog Output #3	0–200 mA to governor actuator, internally powered
Analog Output #4	4–20 mA to air/fuel ratio actuator, internally powered

Relay Outputs	Shutdown, Alarm, Turbo Air Assist
Relay Contact Ratings	Resistive—2.0 A at 28 Vdc, 0.1 A at 115 Vac 50 to 400 Hz Inductive—0.75 A at 28 Vdc 0.2 Henry, 0.1 A at 28 Vdc Lamp

Programmer Serial Port (J1)	RS-422, 9-pin D connector, for use with PC or hand held interface
Communication Port (J2)	RS-232, RS-422, 9-pin connector, 110 to 38400 baud, full duplex, for use with Servlink clients (e.g., Watch Window, Control View)
Communication Port (J3)	RS-232, RS-422, RS-485, 9-pin connector, 1200 to 38400 baud, full duplex, for use with Modbus master

Ambient Operating Temperature	–40 to +70 °C (–40 to +158 °F)
Storage Temperature	–55 to +105 °C (–67 to +221 °F)
Humidity	95% at +20 to +55 °C (+68 to +131 °F) Lloyd's Register of Shipping Specification Humidity Test 1

EMI/RFI Susceptibility	Lloyd's Register of Shipping, EN50081-2 and EN50082-2
Mechanical Vibration	Lloyd's Register of Shipping Specification Vibration Test 1
Mechanical Shock	US MIL-STD 810C, Method 516.2, Procedure I (basic design test), Procedure II (transit drop test, packaged), Procedure V (bench handling)

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