WOODWARD

Product Manual 02827
(Revision B, 2/1999)
Original Instructions

723 Digital Marine Control
Two-engine Mechanical Load Sharing

8280-208

Software 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 *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, 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 *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, 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 Out-of-date translations are marked with ⚠.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 723 Digital Marine Speed Control, 8280-208 (low voltage power supply). The 8280-208 is intended to be used where mechanical load sharing and unit clutching is required.

Application

The 8280-208 control is designed to regulate the speed and load of medium- and high-speed diesel engines in dual-engine marine applications that require mechanical load sharing. The applications include mechanically combined two-engine operation for main propulsion and dredge operation, including those with flexible couplings (see Figure 1-1).

Features include:

- Clutch control and permissive logic
- Soft loading and unloading
- Mechanical load sharing by matching fuel rack positions
- Advanced speed-sensing algorithms
- Firing torsional filtering
- Flexible coupling torsional filtering
- Torque fuel limiting
- Start fuel limiting
- Manifold or external fuel limiting
- Single-throttle operation for both engines during clutched operation

Inputs include:

- Two magnetic pickups (MPUs) or proximity switches for sensing engine speed, capable of filtering torsionals or providing redundant speed signals
- 4–20 mA remote speed-setting input
- 4–20 mA rack position feedback input
- 4–20 mA manifold or external fuel input
- ±5 Vdc auxiliary input
- Eight discrete inputs (contact inputs) for: Run/Stop, Clutch Request, Clutch Status, Idle/Rated, Raise Speed, Lower Speed, configurable contact for either Overspeed Test or Emergency Declutch, and configurable contact for either Alarm Reset or Dynamics 2.
- Load sharing lines for the mechanical load sharing
- Redundant communication ports J2 and J3 used for control status needed between controls for proper clutching and loading.

Outputs include:

- Three 4–20 mA outputs which are configurable for: engine speed, engine load, speed reference, actuator driver output, remote speed input, and PID output
- 0–200 mA actuator output compatible with most Woodward actuators
- One relay output for clutch permissive/close contact out
- Two Alarm relay outputs: each is user-configurable for normally open/ closed contact output. There are 13 status choices to choose among for these two alarms.
- Serial port for a hand-held programmer to monitor and program the 723 control

The 723 control provides several functions including speed governing, mechanical load sharing, clutching/declutching control logic including speed matching during clutching, and soft engine loading/unloading. Each engine requires a 723 control along with the associated I/O connections, transducers, and accessories (see Figure 1-2). The 723 controls use a master/slave relationship during clutching and load sharing operations. The master unit is the first unit to close its clutch. The slave unit is the last unit to close its clutch. The 723 control's primary job is speed control. When the engines are clutched together, the 723 control's job also becomes one of a load sharing control using the master's speed reference. The engine clutching process starts by matching (synchronizing) the engine speeds and then giving a clutch permissive command. Once clutched, the engine is soft-loaded until the loads are balanced mechanically (equal fuel-rack positions). The engines will maintain equal loads (load sharing) during clutched operation. During a declutching operation, the declutching engine is soft-unloaded and, when the unit is at the unload trip level, a declutch command is given. This is a simplified description, and several other items affect the 723 control's operation. See Chapter 3, Function Operation, for more details.

The 723 control consists of a single printed circuit board in a sheet metal chassis. Connections are via three terminal strips and three 9-pin subminiature D connectors. The 723 control should be located in a protected location. See Woodward manual 02758, 723 Digital Control Hardware Manual, for installation details.

IMPORTANT

This manual makes references to specific menu items or listings for adjustments or monitoring. Generally, the menu listings will follow the format of the mode you must be in first (Configure or Service), second will be the name of the Header (in capital letters) while in that mode, and finally the prompt (in capital letters) under that header. For example, in Service mode, under header (*SPD CONTROL*), at prompt ENGINE SPEED. All service headers are denoted by asterisks (*) and all configure headers are denoted by the absence of the (*).

723 Control Accessories

A hand-held programmer, part number 9907-205, is used to adjust and monitor the 723 control. The programmer plugs into the serial port J1 (9-pin D connector).

Woodward has several LVDT signal conditioners that we can recommend for fuel rack position transducer signal conditioning.

- 8272-824 (4–20 mA output, 24 Vdc input)
- 8272-834 (0–10 Vdc output, 24 Vdc input)

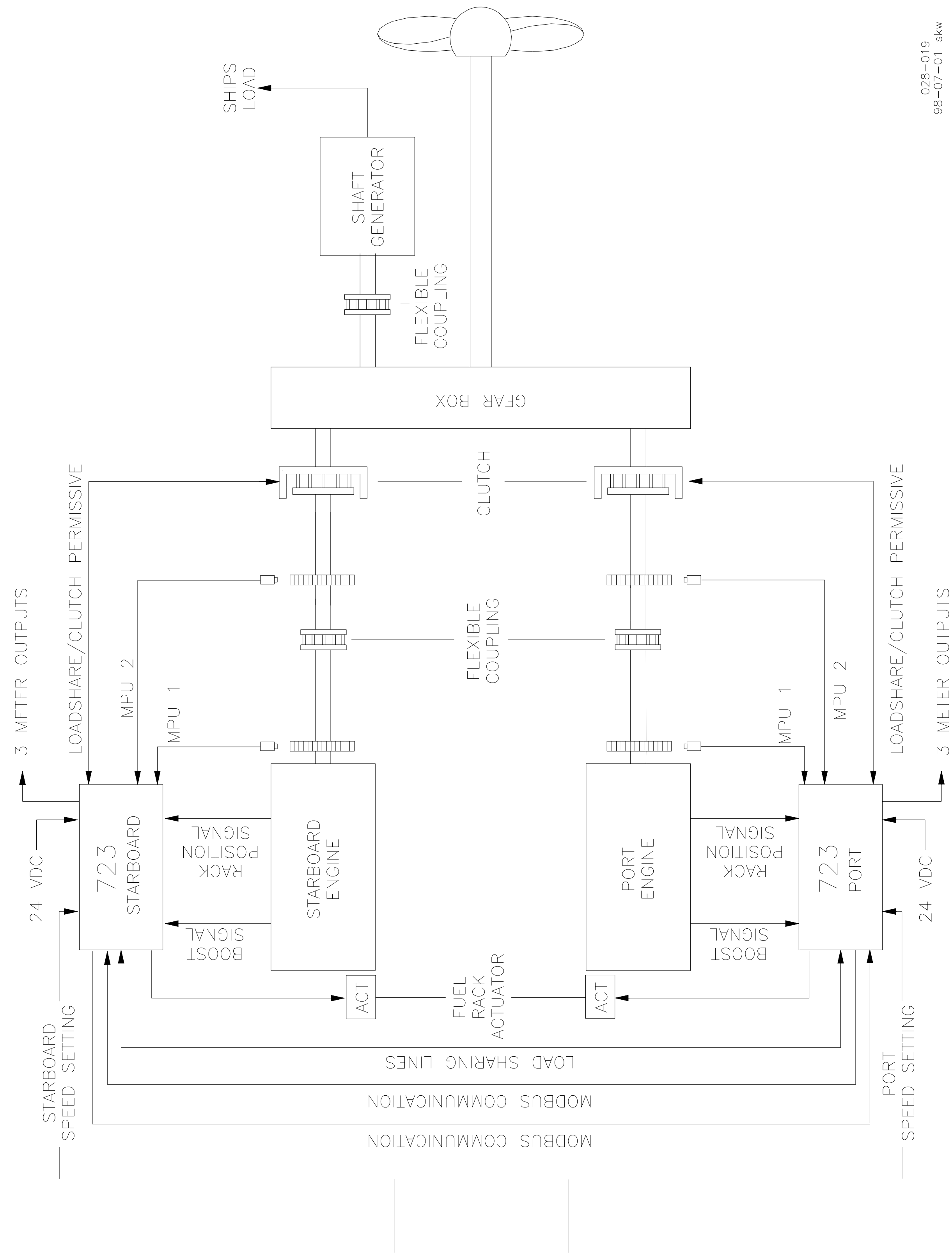


Figure 1-1. 723 Marine Load Sharing System

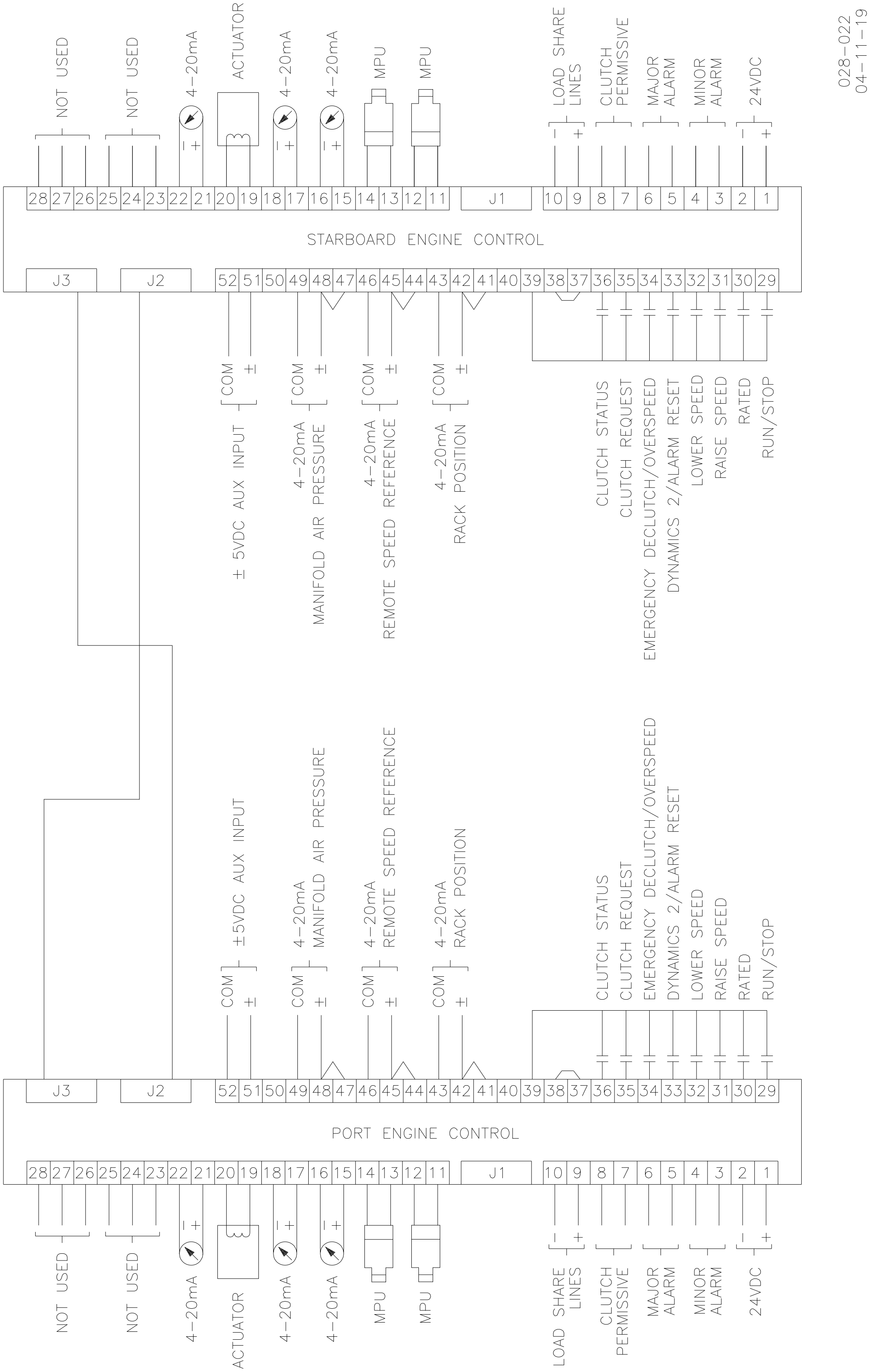


Figure 1-2. System Wiring Overview

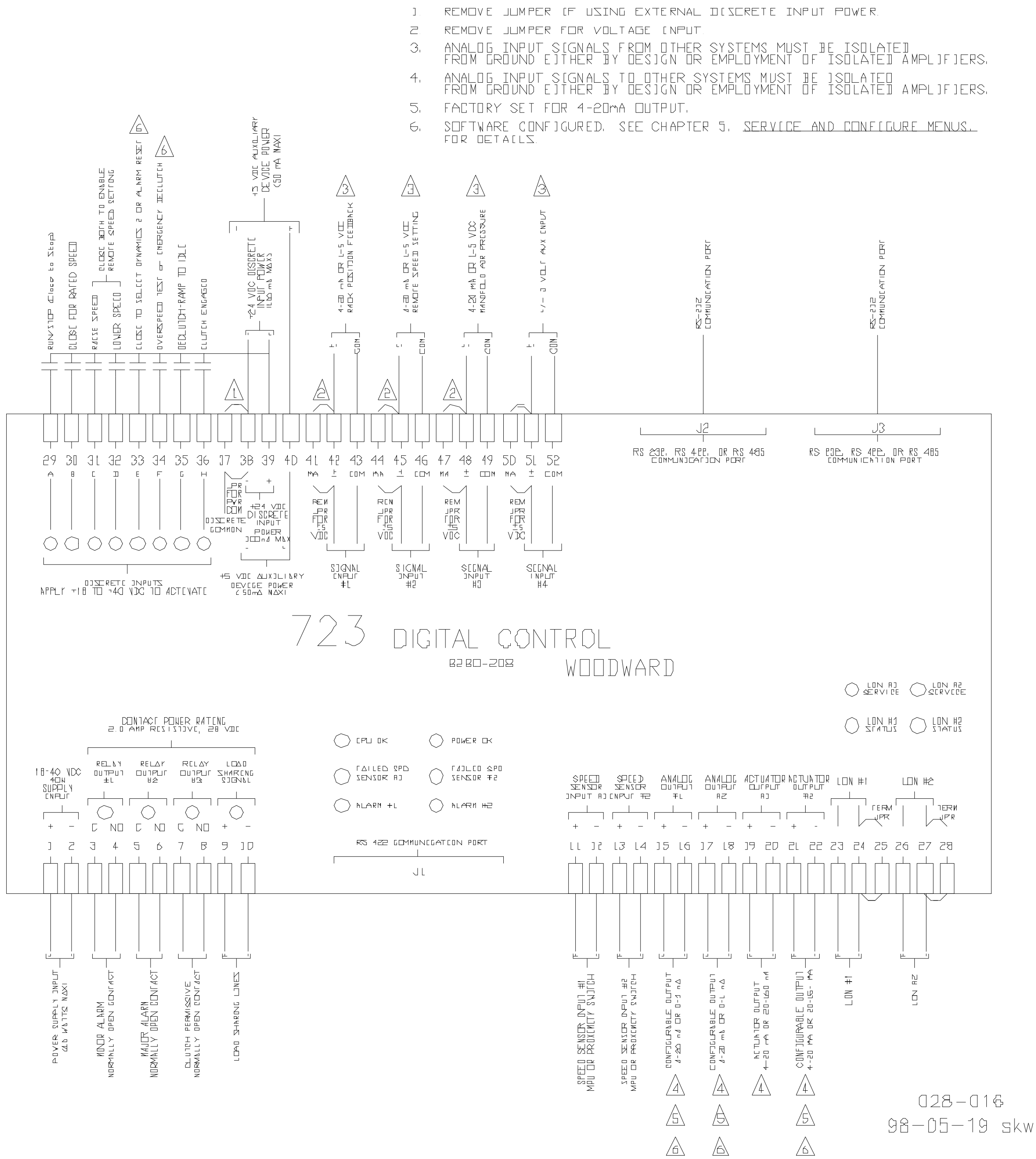
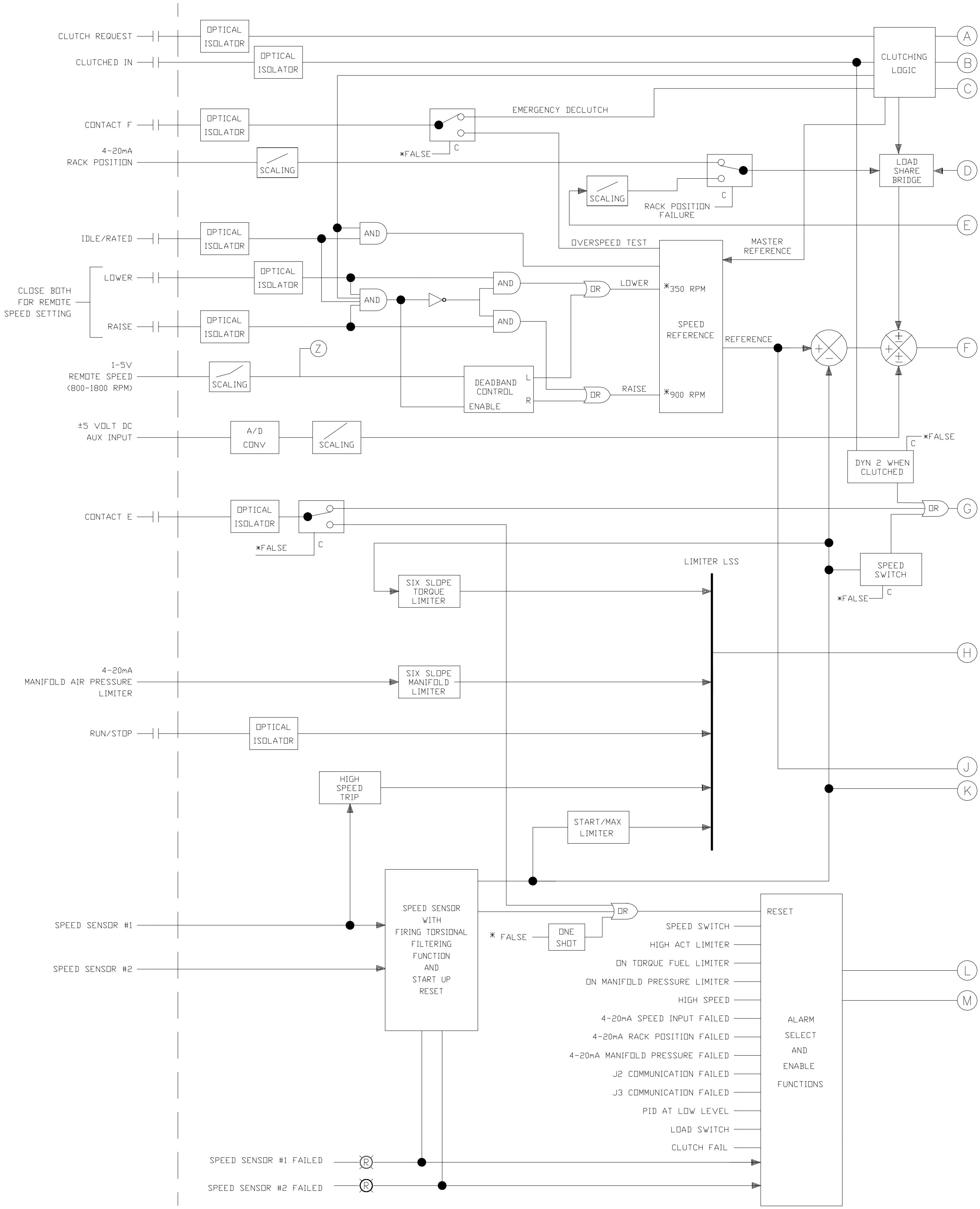


Figure 1-3. Control Wiring Inputs


CLUTCH REQUEST
CLUTCHED IN
OPTICAL ISOLATOR
CLUTCHING LOGIC
CONTACT F
EMERGENCY DECLUTCH
*FALSE
4-20mA RACK POSITION
SCALING
LOAD SHARE BRIDGE
RACK POSITION FAILURE
IDLE/RATED
AND
OVERSPEED TEST
MASTER REFERENCE
CLOSE BOTH FOR REMOTE SPEED SETTING
LOWER
RAISE
OR
*350 RPM
SPEED REFERENCE
*900 RPM
REFERENCE
1-5V REMOTE SPEED (800-1800 RPM)
DEADBAND CONTROL
ENABLE
±5 VOLT DC AUX INPUT
A/D CONV
DYN 2 WHEN CLUTCHED
CONTACT E
LIMITER LSS
SIX SLOPE TORQUE LIMITER
SPEED SWITCH
4-20mA MANIFOLD AIR PRESSURE LIMITER
SIX SLOPE MANIFOLD LIMITER
RUN/STOP
HIGH SPEED TRIP
START/MAX LIMITER
SPEED SENSOR WITH FIRING TORSIONAL FILTERING FUNCTION AND START UP RESET
SPEED SENSOR #1
SPEED SENSOR #2
* FALSE
ONE SHOT
RESET
HIGH ACT LIMITER
ON TORQUE FUEL LIMITER
ON MANIFOLD PRESSURE LIMITER
HIGH SPEED
4-20mA SPEED INPUT FAILED
4-20mA RACK POSITION FAILED
4-20mA MANIFOLD PRESSURE FAILED
J2 COMMUNICATION FAILED
J3 COMMUNICATION FAILED
PID AT LOW LEVEL
LOAD SWITCH
CLUTCH FAIL
ALARM SELECT AND ENABLE FUNCTIONS
SPEED SENSOR #1 FAILED
SPEED SENSOR #2 FAILED
A
B
C
D
E
F
G
H
J
K
L
M
Z
R

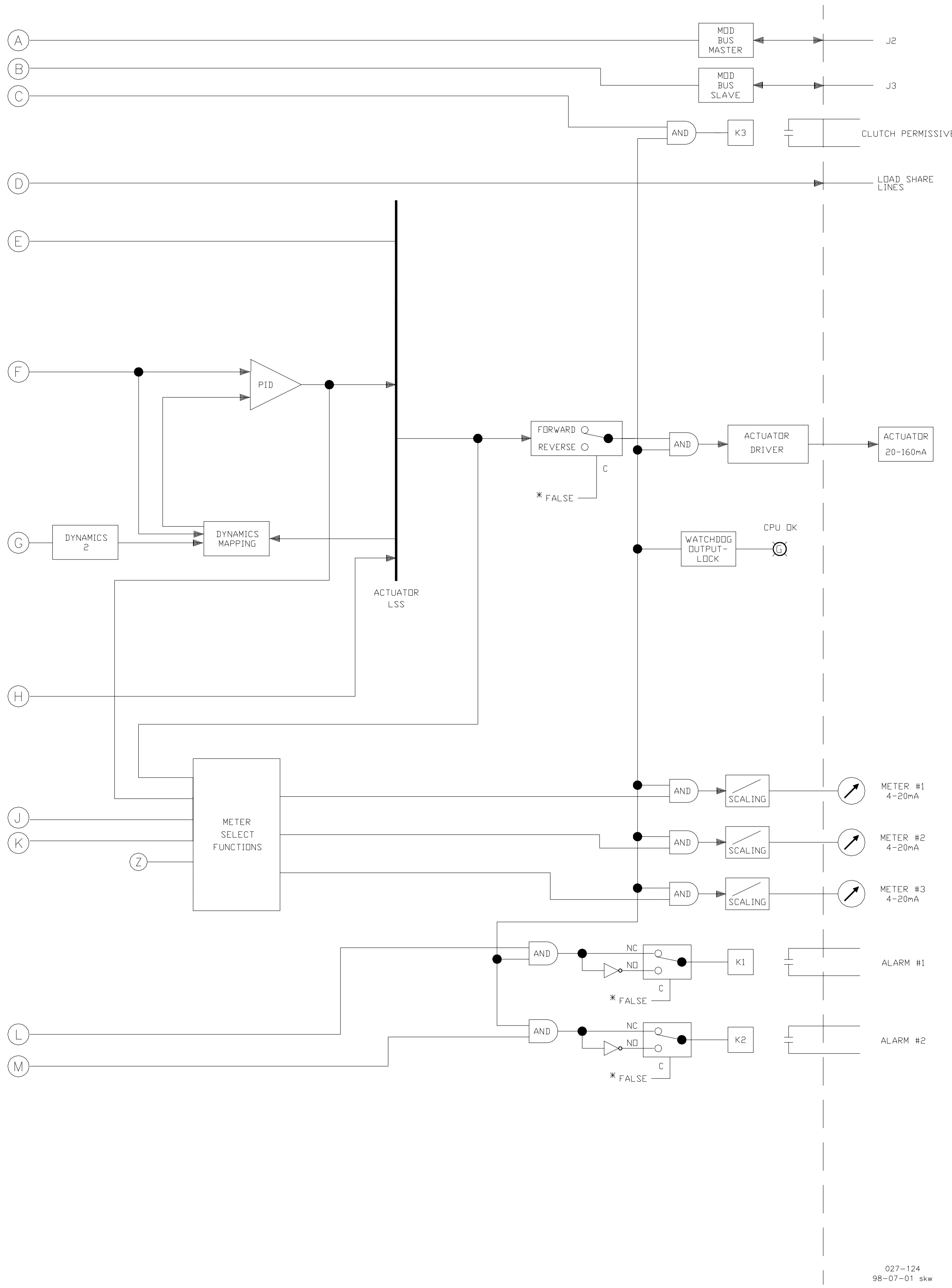


Figure 1-4. Functional Block Diagram

Chapter 2.
I/O Operation

Introduction

NOTICE

Before handling the 723 control, read page iii, Electrostatic Discharge Awareness.

The 723 control hardware is intended to be a generic control platform suitable for a wide range of applications. Each application is custom programmed including the I/O function, range, and calibration. The I/O hardware is fixed, and the wiring specifications for each 723 control remain the same; however the devices connected to I/O will vary.

Analog Output #1 (Terminal Block #15 and #16)

This analog output is a 4–20 mA signal. The signal can be changed to 0–1 mA (see hardware manual). What this output displays is selected in Configure Menu. The options are engine speed, engine load, speed reference, remote speed setting, actuator output, and PID output.

Analog Output #2 (Terminal Block #17 and #18)

This analog output is a 4–20 mA signal. The signal can be changed to 0–1 mA (see hardware manual). What this output displays is selected in Configure Menu. The options are engine speed, engine load, speed reference, remote speed setting, actuator output, and PID output.

Actuator Output #1 (Terminal Block # 19 and #20)

The actuator output can be set for either forward- or reverse-acting actuators in the Software Configure Menu. The hardware configuration (jumper configuration) for the actuator output can either be 0–200 mA (for 20–160 mA actuators) or 0–20 mA (for 4–20 mA actuators). See the hardware manual (02758) for more details about the hardware jumpers. The actuator terminal shaft position is proportional to the actuator output signal. The actuator output is compatible with most Woodward Governor actuators (hydraulic and electric) that accept 20–160 mA or 4–20 mA. See Chapter 3, Function Operation, for more information.

Actuator Output #2 (Terminal Block # 21 and #22)

This analog output is a 4–20 mA signal and is used for display. What this output displays is selected in Configure Menu. The options are engine speed, speed reference, remote speed setting, actuator output, and PID output.

Engine Speed Signal Input
(Speed Sensor Input #1, #2—TB11, TB12, TB13, TB14)

The two speed sensor inputs can be used with either a magnetic pickup (MPU) for high-speed signals (400–10 000 Hz) or proximity switch for medium-speed signals (7.5–1000 Hz). The inputs are determined by the hardware configuration (jumper configuration). See the hardware manual (02758) for more information. The maximum engine speed the 723 control can control is 2200 rpm.

There are three different speed sensing modes: single input speed sensing, redundant speed sensing, and torsional filtering of flexible couplings speed sensing. There is an adjustable low-pass speed sensor filter, called SPEED FILTER Hz, found in Service mode, under the header *DYNAMICS 1*, which is used to filter out firing torsionals on both speed signal inputs regardless of the speed sensing mode selected.

For single speed sensing, either input may be used. The unused speed signal input will be failed when the engine is running.

If redundant speed sensing is desired, both speed sensing inputs are used. The 723 will control using the signal that is the higher frequency.

If coupling torsional filtering is desired, both speed inputs are used. The coupling torsional filtering is enabled in Configure mode, under the header CONFIG SPD CONTROL, at the prompt called ENBLE TORSIONAL FLT. If ENBL TORSIONAL FLT is "TRUE", the torsional filtering is enabled and the redundant speed sensing is the back up mode should one of the speed sensors fail. For torsional filtering, SPEED SENSOR #1 MUST BE INSTALLED ON THE ENGINE SPEED-SENSING GEAR and speed sensor #2 must be installed on the opposite side of the flexible coupling. Both speed sensors must be installed on shafts rotating at the same speed for either dual speed sensing mode.

Load Sharing Lines (TB9, TB10)

Because the load sharing line relay is contained in the control, no relay is required between the control and the load sharing line bus. Use shielded cable and connect the load sharing lines directly to terminals 9 (+) and 10 (–) of both controls. When the clutch request contact (terminal #35) and the clutch engaged contact (terminal #36) are high (+24 Vdc) and the LED above TB9 and TB10 is illuminated, the control is in the isochronous load sharing mode. In this mode, the internal load sharing line relay is energized and the load-matching circuit is connected to the load sharing lines. The load sharing line voltage range is 0–3 Vdc which represents no-load to full-load rack position. When the companion 723 control (slave) is clutching in, the companion senses the load sharing line voltage and (once it is clutched in) increases its load until the load sharing voltage is equal to the companion fuel rack position. Once the companion has soft loaded (loads are matched), the 723 control closes its internal load sharing-relay, and the two engines are in isochronous load sharing.

Contact Inputs (Discrete Inputs A–H—TB29–TB36)

Discrete Input A—Run/Stop: Close this contact to activate the stop mode in the 723 control. The 723 control will command minimum fuel to the engine.

Discrete Input B—Idle/Rated: When 24 Vdc is applied to terminal 30, the engine can be operated at a speed higher than idle. When +24 Vdc is removed from terminal 30, the engines speed immediately begins to decelerate to idle at the idle ramp time. The rated-to-idle ramp time is adjusted in Service mode, under the header *SPEED REFERENCE*, at prompt DECEL RAMP (SEC).

Discrete Input C—Raise Speed: When 24 Vdc is applied to terminal 31, the control raises speed at a rate determined by the raise speed rate. When 24 Vdc is removed, speed remains at its current value. Actuating the Raise Speed contact will cancel the ramps started by the Idle/Rated contact.

The raise speed rate ramp is adjusted in Service mode, under the header *SPEED REFERENCE*, at prompt RAISE SPEED RATE.

The Raise Speed contact input is disabled when the Remote Speed Setting mode is selected by closing both the Lower Speed and Raise Speed contacts.

Discrete Input D—Lower Speed: When 24 Vdc is applied to terminal 32, the control lowers speed at a rate determined by the lower speed rate. When 24 Vdc is removed, speed remains at its current value. Actuating the Lower Speed contact will cancel the ramps started by the Idle/Rated contact.

The lower speed rate ramp is adjusted in Service mode, under the header *SPEED REFERENCE*, at prompt LOWER SPEED RATE.
The Lower Speed contact input is disabled when the Remote Speed Setting mode is selected by closing both the Lower Speed and Raise Speed contacts.

Discrete Input E—Configurable Contact: This contact can be configured for one of two options: ALARM RESET or DYNAMICS 2. The selection is made in Configure mode, under the header CONFIG OPTION at prompt USE CONT E AS RESET.

Discrete Input F—Configurable Contact: This contact can be configured for one of two options: Overspeed Test or Emergency De-clutch. The selection is made in Configure mode, under the header CONFIG SPD CONTROL, at prompt CT F AS OVERSPD TEST.

If at the prompt CT F AS OVERSPD value is “TRUE”, Discrete Input F is enabled as an overspeed test contact and will have the following function. When 24 Vdc is applied to terminal 33, the control speed reference can be raised with the Raise Speed contact (terminal 31) to the HIGH SPEED SD point. Once 24 Vdc is removed from terminal 34, the speed reference ramp is once again limited by the Raise Speed Limit.

The adjustable high speed trip point value is found in Configure mode, under the header ALARM/SD CONFIGURE, at prompt HIGH SPEED SD. The Raise Speed Limit point is found in Service mode, prompt RAISE SPEED LIMIT, under the header *SPEED REFERENCE*.

If at the prompt CT F AS OVERSPD value is “FALSE”, then Discrete Input F is enabled as an Emergency Declutch contact and will have the following function. When 24 Vdc is applied to terminal 33, the control will immediately issue a de-clutch command and disable the unload ramp. The 24 Vdc must be removed from terminal 34 before the control will try and clutch again.

Discrete Input G—Clutch Request: When 24 Vdc is applied to terminal 35, the clutching sequence begins. First the control looks to see if the other engine is clutched in. If not, its speed ramps to idle and, after an adjustable dwell time at idle, the clutch permissive contact out (terminals #7 and #8) will close. The clutch permissive contact will open if the Clutch Engaged contact (Discrete Input H) does not go high within the adjustable CLUTCH IN TIME. The 1 to 120 second clutch-in time is set in Service mode, under the header *LOAD CONTROL*, at prompt CLUTCH IN TIME. If the other engine is already clutched in, the control will match (sync) its speed to the clutched-in unit and, after an adjustable dwell time, issue the clutch permissive contact out (terminals #7 and #8 close). Once the clutch has closed, the unit will soft load until loads are matched, and then it will go into isochronous load sharing. The soft loading time is set in Service mode, under the header *LOAD CONTROL*, at prompt LOAD RATE.

When 24 Vdc is removed from terminal 35, the de-clutching sequence begins. First the control looks to see if it is the only unit clutched in. If it is the only unit clutched in, it immediately opens the clutch permissive contacts (terminals #7 and #8). If both units are clutched in, the control asked to declutch will first soft unload and, once unloaded, will open the clutch permissive contacts (terminals #7 and #8). The soft unloading time is set in Service mode, under the header *LOAD CONTROL*, at prompt UNLOAD RATE.

Discrete Input H—Clutch Engaged: This contact in is used to tell the control the clutch status. When 24 Vdc is applied to terminal 36, the 723 assumes that its clutch is engaged (closed). If 24 Vdc is absent from terminal 36, the 723 assumes that the clutch is disengaged (open). This signal must be present for the unit to load share in either Manual mode or with a clutch request.

Fuel Rack Position Feedback (Analog Input #1—TB42–TB43)

The Fuel Rack Position Feedback input is used by the 723 for load sharing and fuel rack indication. The 4–20 mA (or 1–5 Vdc) vs load scaling is adjusted in Service. The fault levels for the input are hard-coded at 2 mA and 21 mA. If the input signal is outside the limits, the 723 control will default to using the actuator output for load sharing and the rack position indication. When using a 4 to 20 mA transmitter, you must install a jumper between terminals 41 and 42 to connect the internal 255 Ω resistor in the loop. If any other analog input or output is used in a common ground system, a current isolator must be installed.

Remote Speed Setting Input (Analog Input #2—TB45–TB46)

The remote speed setting input is used to set the speed reference for the 723 control during normal operation. The 4–20 mA vs rpm scaling is adjusted in Service. The remote speed reference will be proportional to the remote speed setting input as long as it is between 4 and 20 mA. The remote reference is limited so it cannot go below the LOWER SPEED LIMIT or above RAISE SPEED LIMIT. The fault levels for the input are hard-coded at 2 mA and 21 mA. If the input signal is outside the limits, the remote speed setting fault will be latched. When using a 4 to 20 mA transmitter, you must install a jumper between terminals 44 and 45 to connect the internal 255 Ω resistor in the loop. If any other analog input or output is used in a common ground system, an isolator must be installed. See remote speed input calibration in Chapter 5, Installation and Calibration, for more information.

Manifold Air or External Fuel Limit Input (Analog Input #3—TB48–TB49)

Connect a 4 to 20 mA current transmitter or 1 to 5 Vdc voltage transmitter to terminals 48 (+) and 49 (–) for the Manifold Air Pressure or External Fuel Limit Input (use turbo boost pressure, manifold pressure, or any other source that indicates engine load). The fault levels of the input are hard coded. Use a shielded, twisted-pair cable. When using a 4 to 20 mA transmitter, you must install a jumper between terminals 47 and 48 to connect the internal 255 Ω burden resistor in the loop. This input is not isolated from the other control inputs and outputs (except the power supply input and the discrete inputs). If any other analog input or output is used in a common ground system, an isolator must be installed. A number of manufacturers offer 20 mA loop isolators.

±5 Volt Aux Input (Analog Input #4—TB51– TB52)

This input was made for the rare occasion that a system might also have a DSLC™ control. This input is scaled to work with the Woodward DSLC.

Minor Alarm Contact Output (Relay Output #1— TB3, TB4)

The minor alarm output is a set of dry contacts, which is software configurable for either normally-open or normally-closed operation. When configured for normally-open operation, an alarm condition will cause the contacts to close (TB3 and TB4 will be shorted together). When configured for normally-closed operation, the contacts will be closed during normal operation and an alarm condition will cause the contacts to open (TB3 and TB4 will be separated from each other). The minor alarm can be configured to monitor any one or a combination of the following 15 alarms:

MPU 1 Failed
MPU 2 Failed
Manifold Air Failed
Remote Speed Failed
Rack Input Failed
Speed Switch
Torque Limiter
Manifold Limiter
High Act Alarm
Port 2 Link Error
Port 3 Link Error
Port 2&3 Link Error
PID @ Low Level
High Speed SW
Load Switch
Clutch Fail

Major Alarm Contact Output (Relay Output #2— TB5, TB6)

The major alarm output is a set of dry contacts, which is software configurable for either normally-open, or normally-closed operation. When configured for normally-open operation, an alarm condition will cause the contacts to close (TB5 and TB6 will be shorted together). When configured for normally-closed operation, the contacts will be closed during normal operation and an alarm condition will cause the contacts to open (TB5 and TB6 will be separated from each other). The major alarm can be configured to monitor any one or a combination of the following 15 alarms:

MPU 1 Failed
MPU 2 Failed
Manifold Air Failed
Remote Speed Failed
Rack Input Failed
Speed Switch
Torque Limiter
Manifold Limiter
High Act Alarm
Port 2 Link Error
Port 3 Link Error
Port 2&3 Link Error
PID @ Low Level
High Speed SW
Load Switch
Clutch Fail

Clutch Permissive Contact Output (Relay Output #3—TB7, TB8)

The clutch permissive contact is a normally-open dry set of contacts. If the power supply fails, the relay will de-energize and open its contacts.

There are two logic modes—auto and manual. Set Config Option – Manual Clutch Logic to TRUE for manual mode.

Manual Mode—This output acts as an indicator to start the clutch sequence. The clutch permissive contact closes when the speed is within the window for the clutch sync time.

Auto Mode—The 723 control issues a clutch closure permissive (if the necessary conditions have been met) by closing this set of contacts. There are two cases to be considered for automatic clutching. One is that no units are clutched in, and the second is that one unit is already clutched in. The following describes the conditions that must be met in each case before the contacts will close:

No Units are Clutched In (This unit will be the Master Speed Reference)
Close Clutch Request (Discrete Input G)
No Emergency De-clutch (if configured for that option [Discrete Input F])
If engine speed not at Idle, ramp to Idle
Engine speed at Idle for the CLUTCH SYNC TIME

Other Unit Already Clutched In (This unit's speed reference will be that of the unit that is already clutched in. [this one is considered the slave])
Clutch Request (Discrete Input G)
No Emergency De-clutch (if configured for that option [Discrete Input F])
This unit(slave) will match the clutched-in unit's (master) speed
Slave engine speed must be within the CLUTCH SPEED WINDOW (compared to Master) for the CLUTCH SYNC TIME (under *LOAD CONTROL*)

The Clutch Permissive Contact will open if a Clutch Engaged Contact is not received within the CLUTCH IN TIME (under *LOAD CONTROL*).

Power Supply Input (TB1, TB2)

The 8280-208 is a low voltage 723 control. 18–40 Vdc must be connected to terminals 1 (+) and 2 (–). The 723 control requires about 40 W. The power supply is reverse-voltage protected. The power supply output must be low impedance (for example, directly from batteries). DO NOT power the control from high-voltage sources with resistors and zener diodes in series with the control power input. The 723 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.**

+5 Vdc Auxiliary Device Power (TB38, TB40)

The 723 control can provide 5 Vdc power for external devices. The 5 Vdc auxiliary supply has a maximum current limit of 50 mA. The 5 Vdc can be used for the devices (typically potentiometers) connected to the analog inputs (typically speed-setting inputs).

J2 and J3

J2 and J3 are the digital communication ports for the 723, and values vital for proper control are passed over the cable connecting these two ports. J2 of one 723 must connect to J3 of the companion 723. Connecting only one set of communication ports (J2 of one and J3 of the other) is required. However, if redundancy in the communication is desired, connect both sets of ports. That is, J2 of the port 723 must connect to J3 of the starboard 723, and J2 of the starboard 723 must connect to J3 of the port 723. See Figure 2-1 for the pin-to-pin wiring diagram of the communication cable.

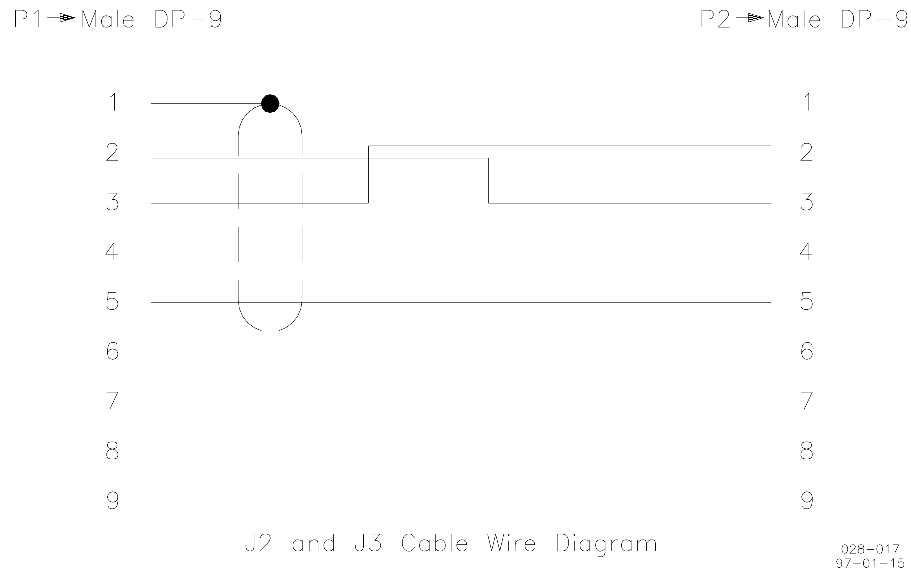


Figure 2-1. Communication Cable Wiring

POWER AND CPU OK LED

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

FAILED SPD SENSOR #1 and #2 LEDs

The FAILED SPD SENSOR #1 and #2 LEDs are red. The FAILED SPD SENSOR LEDs are programmed to illuminate if a speed sensor fault has been detected. FAILED SPD SENSOR #1 illuminates when a speed sensor 1 fault has been detected, and FAILED SPD SENSOR #2 illuminates when a speed sensor 2 fault has been detected. The speed sensor fault is activated if the sensed speed is below the failsafe speed setting. See Chapter 6, Faults and Troubleshooting, for more speed sensing fault details.

ALARM #1 LED

The ALARM #1 LED is programmed to light if both 723s on a common gear box were programmed to be either the port or starboard control. To select which control is either the port or starboard control, go to Configure mode, under the header CONFIG SPD CONTROL, at prompt PORT ENGINE. If at the prompt PORT ENGINE the value is set to "TRUE", that control will be considered the port engine. If at the prompt PORT ENGINE the value is set to "FALSE", that control will be considered the starboard engine.

⚠WARNING	**It is very important that both controls on a common gear box are NOT set to be the port engine, or that both controls on a common gear box are NOT set to be the starboard engine. Otherwise, the other engine could overspeed, causing serious personal injury or engine damage.**

ALARM #2 LED

The ALARM #2 LED is programmed to light if both J2 and J3 have a communication fault.

Chapter 3. Function Operation

Introduction

The three primary functions of this 723 control are speed control, fuel limiting, and load sharing. These functions will be broken down in this chapter as follows:

Speed Control	**Fuel Limiting**	**Load Sharing**
Speed Sensing	Rack Position	Load Sharing Lines
Speed Reference	Transient Overfuel	Fuel Rack Position
Dynamics	Manifold Air Pressure	
Actuator Output	Torque Fuel Limiting	
	Start Fuel Limiting	
	Maximum Fuel Limiting	

Speed Control

The primary job of the 723 control is to control the engine speed. The control compares the engine speed to the speed reference and then adjusts the actuator output to maintain a zero error between engine speed and the speed reference. This is done with a PID controller. There are several tunable variables (dynamics) available so the 723 control can be tuned for optimal performance over a wide range of engine operating conditions.

Speed Sensing

The speed sensors provide the feedback for the speed control PID. The 723 control has two speed sensor inputs that allow the application to sense engine speed in one of three ways: single speed sensing input, redundant speed sensing, or torsional filtering for flexible coupling speed sensing.

An adjustable low-pass speed sensor filter is provided, which is adjusted in Service mode, under the header *DYNAMICS 1*, at prompt SPEED FILTER HZ. The filter is used to attenuate engine firing frequencies. This filter is active on both speed signal inputs regardless of the speed sensing mode. The proper roll-off frequency setting can be found using the following formula:

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.

For single speed sensing, either input may be used. The unused speed signal input will be failed when the engine is running.

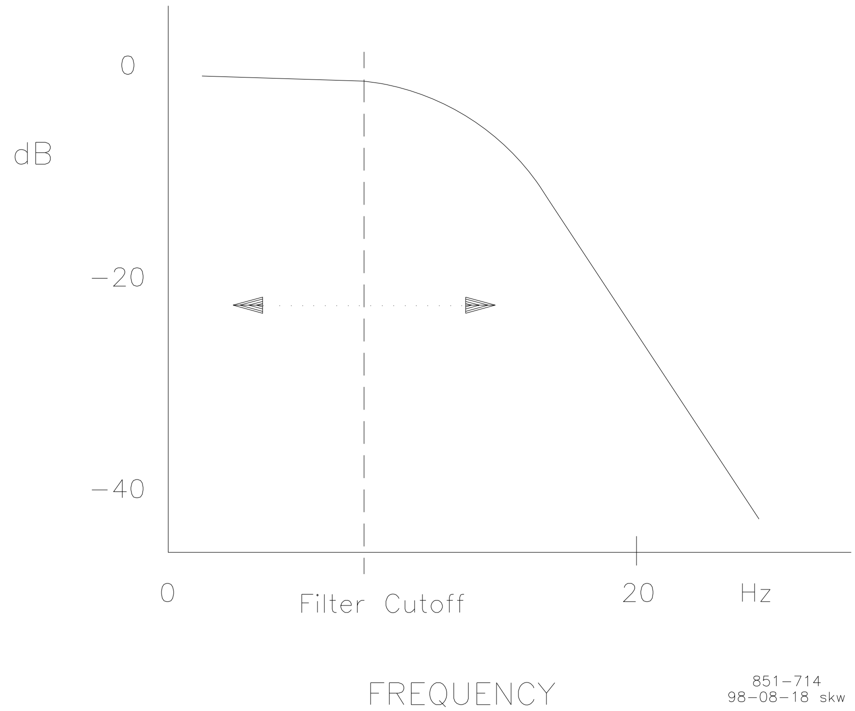


Figure 3-1. Speed Sensor Roll Off Filter

Notch Filter

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

The notch filter is a bandstop filter. It rejects specific frequencies and allows all others to pass. The idea is to reject the torsional (frequency on a frequency) frequencies that the coupling produces, so that the actuator will not respond to speed sensor changes it cannot control with the fuel. Systems with low frequency oscillatory modes due to engine and generator 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.

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

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

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

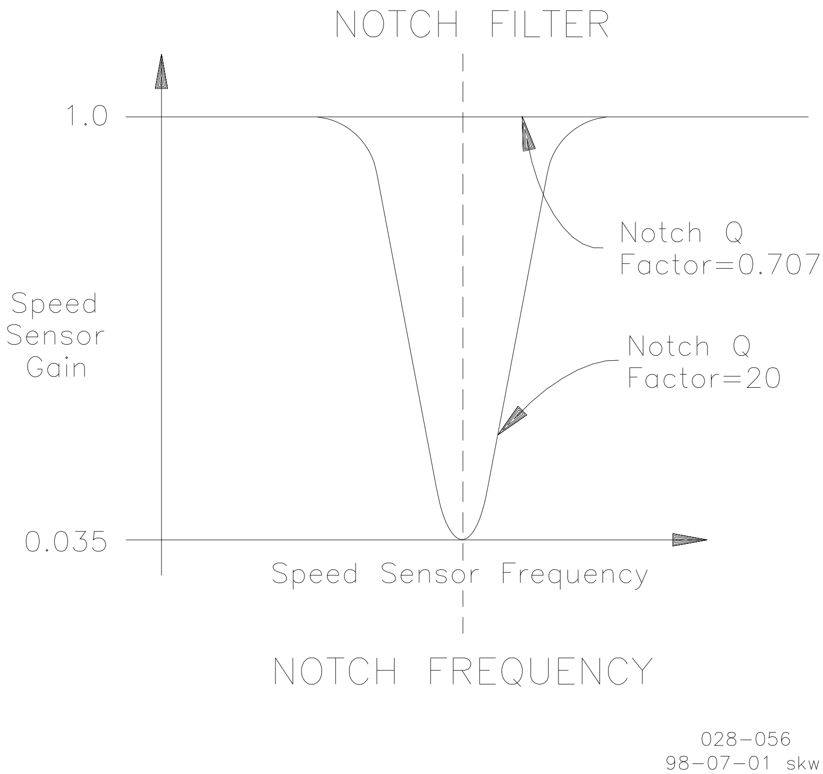


Figure 3-2. Notch Filter

Speed Sensing

If both speed sensing inputs are used, the speed sensing mode will be either redundant speed sensing or torsional filtering depending on the status of the ENBLE TORSIONAL FLT. ENBLE TORSIONAL FLT is found in Configure mode, under the header CONFIG SPD CONTROL, at prompt ENBLE TORSIONAL FLT. If ENBLE TORSIONAL FLT is “FALSE”, the torsional filtering is disabled and the redundant speed sensing is active. Redundant speed sensing uses the higher of the two speed signals (high-signal select) as the sensed engine speed. If ENBLE TORSIONAL FLT is “TRUE”, the torsional filtering is enabled and the redundant speed sensing is the back-up mode should one of the speed sensors fail.

For torsional filtering, speed sensor #1 must be installed on the engine speed sensing gear, and speed sensor #2 must be installed on the opposite side of the flexible coupling. Both speed sensors must be installed on shafts rotating at the same speed for either dual speed sensing mode. The torsional filter factor value, found in Service mode, under the header *TORSIONAL FILTER*, at prompt TORSIONAL FILTER, should be set according to the following formula:

Torsional Filter = Engine Rotating Inertia/Engine and Load Rotating Inertia
OR
Torsional Filter = Rotating Inertia on Engine Side of Coupling/Total Inertia

All the speed signal configurations are located in the CONFIG SPD CONTROL configure menu. GEAR #1 TEETH (under header, CONFIG SPD CONTROL) should be set to the number of gear teeth on the gear where speed sensor #1 is installed. If the gear is not rotating at the same speed as the crankshaft, the gear teeth must be adjusted accordingly. In this case, set the gear teeth equal to the number of teeth that will pass the MPU in one complete engine revolution.

Speed Signal (Hz) = Gear Teeth * Engine rpm / 60

GEAR #2 TEETH (under header, CONFIG SPD CONTROL) should be set to the number of gear teeth on the gear where speed sensor #2 is installed. If the gear is not rotating at the same speed as the crankshaft, the gear teeth must be adjusted accordingly. In this case, set the gear teeth equal to the number of teeth that will pass the MPU in one complete engine revolution. This gear must rotate at the same speed as the gear used for speed sensor #1.

⚠WARNING

The number of gear teeth is used by the 723 control to convert the 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 the engine to overspeed.

Should the engine speed fall below the failsafe speed, the 723 will consider the speed sensor failed and shut down the actuator output. The failsafe speed is automatically calculated and set to 5% of the value programmed in for rated engine speed. The speed sensors also have a failsafe voltage level. The 723 control must have at least 1 Vrms MPU voltage to operate. An amplitude less than 1 Vrms is considered to be a failed speed signal, and the 723 control will go to minimum fuel.

The 723 control also monitors the engine speed for an overspeed condition. The overspeed fault will latch, and actuator output will go to the minimum fuel position, if the engine speed is greater than the OVERSPEED TRIP value. This value is set in Configure mode, under the header LIMITERS/OVER SPEED, at prompt OVERSPEED TRIP. This fault is reset when the engine speed clears the failsafe speed like the other faults. The overspeed can be reset by restarting the engine or using the software reset, which can be found in Service mode, under either the header *MINOR ALARMS* or *MAJOR ALARMS*, at prompt RESET ALL ALARMS. Even though the overspeed fault will cause the actuator output to go to the minimum fuel position, ***IT SHOULD NOT BE USED AS THE OVERSPEED PROTECTION FOR THE ENGINE***.

⚠WARNING

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.

Speed Reference

The speed reference for the speed control PID is affected by several factors including: remote speed setting, master speed setting, load sharing, lower speed, raise speed and the idle/rated speed contact. The operation mode (clutching, declutching, etc.) of the 723 control determines which factor will bias the speed reference. The speed reference rate of change is limited by four adjustable ramp rates.

For the Remote 4–20 mA speed setting input to be active, the following conditions must be met: Idle/Rated contact closed, Lower contact closed, Raise contact closed, and this is the only engine clutched in (Master) or no engines are clutched in. When the Remote Speed Setting is active, the speed reference is proportional to the 4–20 mA Remote Speed Setting input signal. The lower limit speed set point is found in Service mode, under the header *SPEED RERERENCE*, at prompt REMOTE REF AT 4 mA. The Raise limit speed set point is found in Service mode, under the header *SPEED REFERENCE*, at prompt REMOTE REF AT 20 mA. The 4–20 mA input will detect a failure low if the 4–20 mA input signal drops below 2 mA, and a failure high if the input signal goes above 21 mA.

Because the 723's 4–20 mA input can actually read below and above the 4–20 mA set points, absolute lower limit and raise limit set points are required. The absolute lower limit speed set point is found in Service mode, under the header *SPEED REFERENCE*, at prompt LOWER SPEED LIMIT. The absolute raise limit speed set point is found in Service mode, under the header *SPEED REFERENCE*, at prompt RAISE SPEED LIMIT. In case of a Remote Speed Input failure, the 723 control is configurable to respond in one of two ways: go to absolute lower limit or Lock-in-Last. This selection is made in Configure mode, under the header CONFIG SPD CONTROL, at prompt LockOnLost REM SPD?. If LockOnLost REM SPD? is set "TRUE", when the Remote speed input goes either above 21 mA or below 2 mA, the speed reference will lock in the last position. If LockOnLost REM SPD? is set "FALSE", when the Remote speed input goes either above 21 mA or below 2 mA, the speed reference will ramp to the absolute lower limit set point. Once a failure of the Remote Speed Input is detected, the failure is latched. If the Remote Speed Setting has failed, the engine speed can be raised or lowered using the Raise/Lower Speed contacts (TB 31 and TB 32). Once the failure is fixed, the input failure latch can be reset in two different ways: either a shutdown and restart of engine, or by using the software reset, which can be found in Service mode, under either the header *MINOR ALARMS* or *MAJOR ALARMS*, at prompt RESET ALL ALARMS.

For proper operation, references for the 723 controls must be set the same on both units, as the speed signals are shared between the two 723 controls and are used for clutching, declutching, load sharing, and therefore they must be the same for both units.

If the Idle/Rated contact is open, the engine will ramp to, and run at, the idle speed set point. The idle speed is set in Service mode, under the header *SPEED REFERENCE*, at prompt IDLE SPEED (RPM). If the Idle/Rated contact is closed, the engine will ramp to and run at the rated speed set point (or the speed specified by the Remote Input when the Remote Speed Setting input is enabled). The Rated speed is set in Configure mode, under the header CONFIG SPD CONTROL, at prompt RATED SPEED (RPM). Opening the Idle/Rated contact will override the remote speed setting input, but it will not override the Master's speed setting in the Slave 723 control.

Two signals are capable of biasing the speed reference: the load bias signal from the load sharing lines and the ±5Vdc AUX input. The speed reference ramp, plus the ±5Vdc AUX or the load bias signal, can be found in Service mode, under the header *DISPLAY 1*, at prompt SPEED REF BIASED. Where load sharing is used, the 723 control speed reference is biased until the load error is zero. The amount of bias is proportional to the amount of load error. The ±5 Vdc Aux Speed Bias will change the speed only if Config Option – Enable Aux Input is set to TRUE.

There are four tunable (adjustable) rates at which the speed reference ramps to a new reference point (Accel Ramp, Decel Ramp, Raise Speed Limit, Lower Speed Limit). When the Idle/Rated contact is closed the speed reference will ramp to the Rated Speed set point at the ramp rate value set in Service mode, under the header *SPEED REFERENCE*, at prompt ACCEL RAMP (SEC). When the Idle/Rated contact is opened the speed reference will ramp to the idle speed set point at the ramp rate value set in Service mode, under the header *SPEED REFERENCE*, at prompt DECEL RAMP (SEC). When the Remote Speed Setting is enabled, and Remote Speed Setting input is increased, the ramp rate at which the speed reference will ramp to the new setting is found in Service mode, under the header *SPEED REFERENCE*, at prompt RAISE SPEED LIMIT. When the Remote Speed Setting is enabled, and Remote Speed Setting input is decreased, the ramp rate at which the speed reference will ramp to the new setting is found in Service mode, under the header *SPEED REFERENCE*, at prompt LOWER SPEED LIMIT.

If the 723 control is the second unit clutched-in (as Slave), all of its internal speed reference ramps will be ignored and the unit will follow the speed reference ramps as used in the Master.

The load sharing bias bypasses the ramp rate limiter so load sharing response is not limited by the speed reference ramp rate.

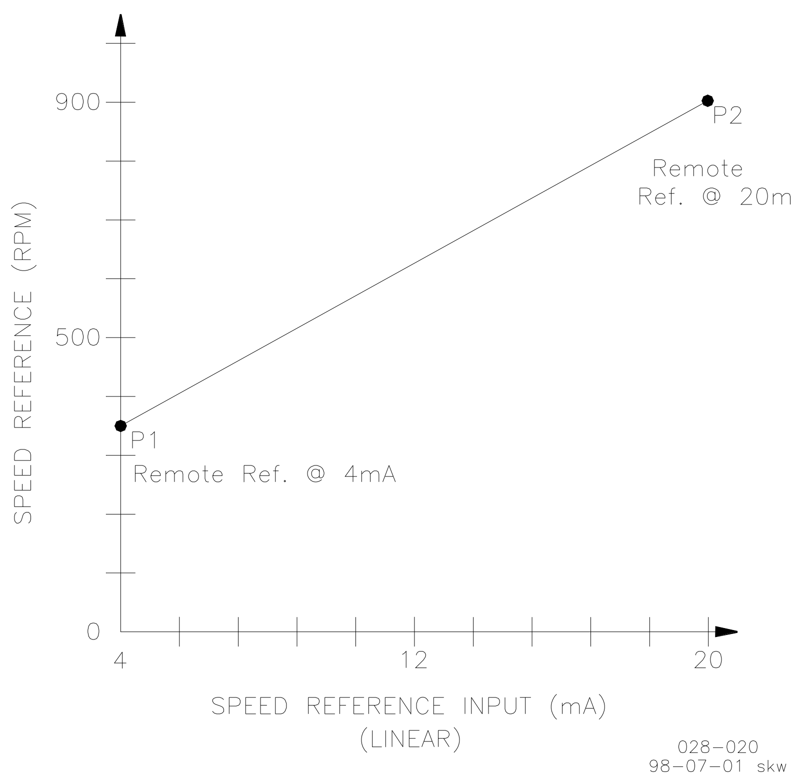


Figure 3-3. Speed Reference

Dynamics

Dynamic adjustments are the settings that affect the stability and transient performance of the engine. There are two sets of dynamics. The settings for Dynamics 1, are found in Service mode, under the header *DYNAMICS 1*. The settings for Dynamics 2, are found in Service mode, under the header *DYNAMICS 2*. The set being used is selected by the Dynamics 2 contact input, when clutched in or with the speed switch, depending on configuration. The following descriptions of each menu item apply to either set. Also see Figures 3-3, 3-4, and 3-5.

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

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

3. Act Comp compensates for the actuator time constant.

4. Gain Ratio is the ratio of the Gain setting at steady state to the setting during transient conditions. The Gain Ratio operates in conjunction with the Window Width and Gain adjustments by multiplying the Gain set point by the Gain Ratio when the speed error is greater than the Window Width. This makes the control dynamics fast enough to minimize engine-speed overshoot on start-up and to reduce the magnitude of speed error when loads are changing.

5. Window Width is the magnitude (in rpm) of a speed error at which the control automatically switches to fast response.

6. Gain Slope changes Gain as a function of actuator output. Since actuator output is proportional to engine load, this makes gain a function of engine load. Gain Slope operates in conjunction with the Gain 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.

7. Gain Breakpoint sets the percent output above which Gain Slope becomes effective. It should usually be set just above the minimum load output.

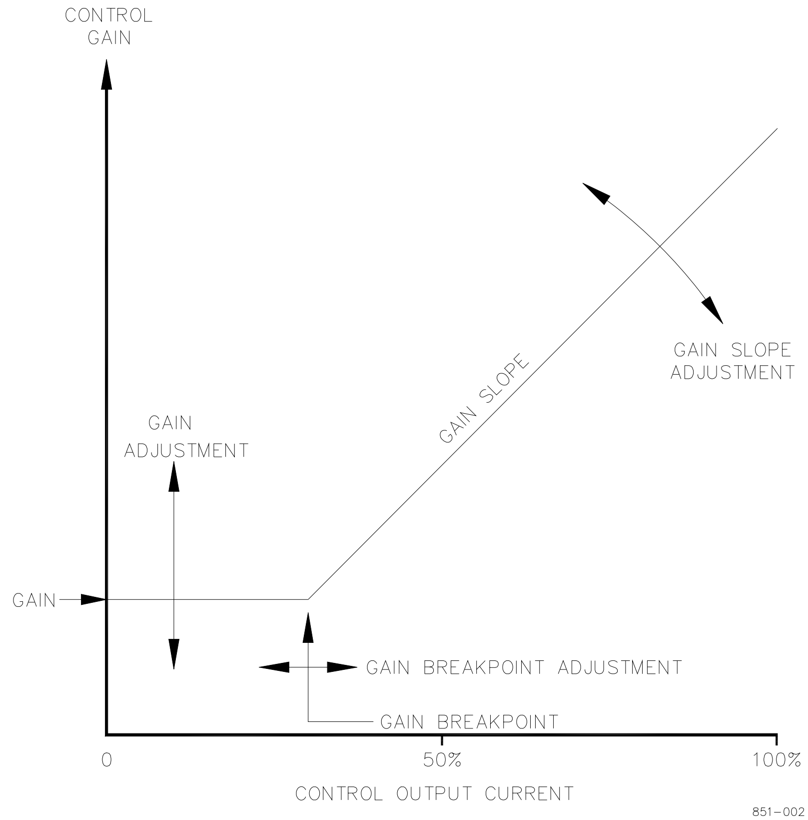


Figure 3-4. Gain Slope

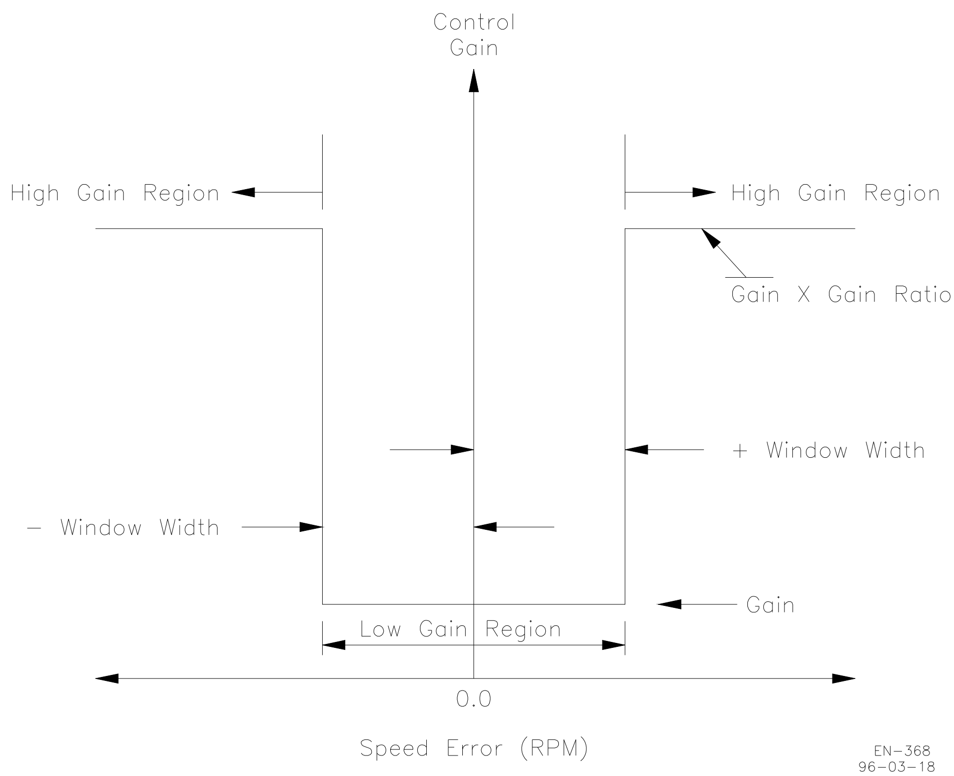


Figure 3-5. Gain Window

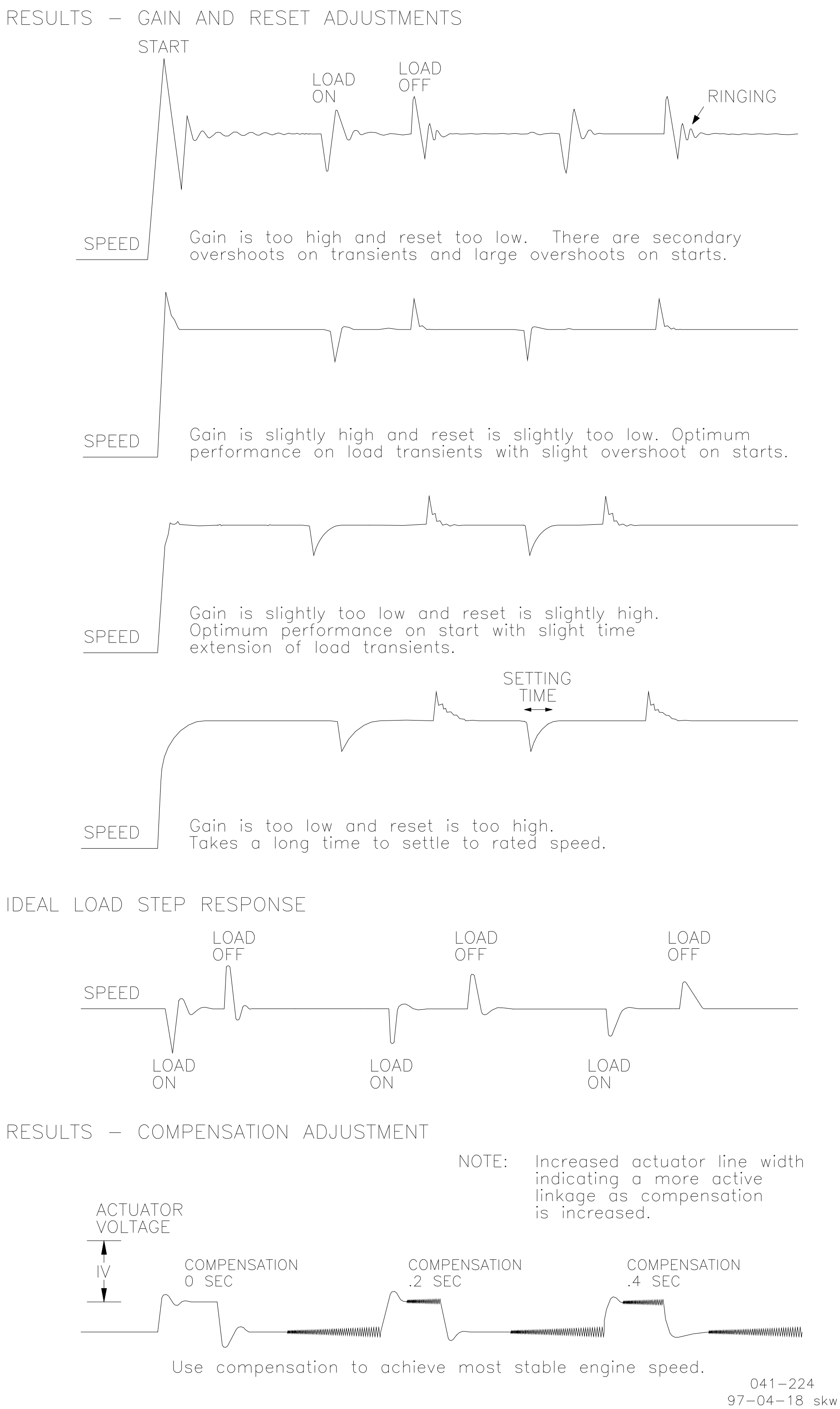


Figure 3-6. Typical Transient Response Curves

Actuator Output

The actuator output is the fuel command from the speed control PID. The amount and rate of change of the actuator output are determined by the dynamics settings. The 723 speed control actuator output can be programmed for either forward or reverse output. In a forward-acting application, the actuator output (TB 19 and TB 20) will be 0 mA when minimum fuel is asked for, and 200 mA when maximum fuel is asked for. In a reverse-acting application, the actuator output (TB 19 and TB 20) will be 200 mA when minimum fuel is asked for, and 0 mA when maximum fuel is asked for. The Forward/Reverse actuator output setting is found in Configure mode, under the header CONFIG SPD CONTROL, at prompt REVERSE ACTING ACT. “TRUE” will select the Reverse acting output. “FALSE” will select the Forward acting output. A mechanical ballhead back-up governor is required for reverse-acting applications. The mechanical ballhead back up is also available for forward-acting systems, however a manual override device must be used to activate the mechanical governor.

For most 723 control troubleshooting, it is recommended to monitor the actuator voltage and not the current. Take extreme care when using a current meter in the actuator wiring. If a lead falls off, an unexpected engine shutdown or overspeed will occur. A volt meter is a safer tool for troubleshooting. An open lead will not cause an unexpected shutdown or overspeed. In general, a Woodward Governor actuator voltage will be between 0–7 Vdc.

Fuel Limiting

The second primary function of the 723 control is to provide fuel rack limiting to protect the engine. All the fuel limiters and the PID output are connected to the actuator LSS (low-signal select) bus. The lowest input to the LSS bus is the input that is “In Control” of the output to the actuator. The inputs to the LSS bus are scaled from 0% to 100%. The output of the LSS bus goes directly to the actuator driver circuit and is also scaled from 0% to 100%. All the limiters are based on actuator driver output and not the Rack Position Feedback input.

Rack Position

The rack position input is optional, however should the rack position signal become faulted the fuel rack limiting will automatically switch to the default mode. In the default mode, the actuator low-signal select output is used as the rack position signal instead of the rack position input signal. The calibration of the fuel rack is done at only two positions, the unloaded rack position point and at the full load rack position point. The no-load or unloaded rack position point is defined as the actuator or rack position that requires the least amount of fuel rack to run the engine while it is unloaded. The engine speed that requires the least amount of fuel to run the engine at no load could be either idle or rated speed. The unloaded point should be determined while the engine is hot. The No Load Rack Position and the Actuator Output calibrations are found in Service mode, under the header *RACK CALIBRATION*, at prompts RACK OUT @ NO LOAD and ACT OUT @ NO LOAD respectively. Full load calibrations are found in Service mode, under the header *RACK CALIBRATION*, at prompts RACK OUT @ MAX LOAD and ACT OUT @ MAX LOAD respectively. See *RACK CALIBRATION* in Chapter 4.

Transient Overfuel

Transient Overfuel is a function that works in conjunction with the Manifold Air Pressure fuel limiter and the Torque Fuel Limiter. When either one or both of these fuel limiters are enabled, the *TRANSIENT OVR FUEL* Service header will automatically appear in the hand held programmer.

This function will allow the limiters to be exceeded for a short adjustable time, and by an adjustable amount. The overfuel time has a range of 0–1 seconds and is found in Service mode, under the header *TRANSIENT OVR FUEL*, at prompt OVER FUEL TIME. The overfuel bus units has a range of 0–100 units (% of actuator driver output), and is found in Service mode, under the header *TRANSIENT OVR FUEL*, at prompt OVER FUEL BUS UNITS.

Manifold Air Pressure/External Fuel Limiting

The Manifold Air Pressure/External Fuel Limiting fuel limit is an actuator driver output limit based on a 4–20 mA or 1–5 Vdc manifold air pressure or on an external fuel limit input. There are six tunable points on the Manifold Air Pressure fuel limit curve. The Manifold Air Pressure fuel limiter must first be enabled in Configure mode, under the header CONFIG OPTION, at prompt USE MANIFOLD LIMITR. If the value at USE MANIFOLD LIMITR is set to “TRUE”, the Manifold Air Pressure Fuel Limiter will be enabled, and if set to “FALSE”, it will be disabled. The six tunable points of the Manifold Air Pressure Fuel Limiter are found in Service mode, under the header *MAN PRESS LIMITER*, at prompt FUEL LIMIT BKP 1 through and including prompt FUEL LMT AT BKPT 6. These points limit the actuator output percent at selected manifold pressures. If the Manifold Air Pressure Fuel limit function is disabled, the Service header *MANIFOLD PRESS LMT* will not appear on the hand held, and the Manifold Air Pressure fuel limit is disabled.

Torque Fuel Limiting

The torque fuel limit is an actuator driver limit based on engine speed or engine speed reference. There are six tunable points on the torque fuel limit curve. The Torque Fuel Limiter must first be enabled in Configure mode, under the header CONFIG OPTION, at prompt USE TORQUE LIMITER. If the value at the prompt USE TORQUE LIMITER is set to “TRUE”, the Torque Fuel Limiter will be enabled, and if set to “FALSE”, it will be disabled. The six tunable points of the Torque Fuel Limiter are found in Service mode, under the header *TORQUE LIMITER*, at prompt TORQ LIMIT BKP 1 through and including prompt TORQ LMT AT BKPT 6. To select which torque fuel limit to use (either engine speed or the engine speed reference), go to Service mode, under the header *TORQUE LIMITER*, at prompt BASED ON SPD REF. If the value at the prompt BASED ON SPD REF is set to “TRUE”, the Torque Fuel Limiter will be based on engine speed reference, and if set to “FALSE”, it will be based on engine speed. If the Torque Fuel limit function is disabled, the Service header *TORQUE LIMITER* will not appear on the hand held, and the torque fuel limit is disabled. These points limit the actuator output percent at selected engine speeds.

Start Fuel Limiting

The start fuel limit is set to provide the desired maximum actuator driver output during starts. This will limit smoke, overfueling, flooding, or cylinder wash down during start-up. The start fuel limit will remain in effect until the engine speed reaches 95% of the speed reference set point. Once engine speed exceeds 95% of the speed reference and the PID is enabled for one second, the start fuel limit will be inactivated and remain inactive until the engine speed drops below 5% of the rated speed set point. The Start Fuel Limit set point is found in Service mode, under the header *START/MAX LIMITS*, at prompt START FUEL LIMIT.

Maximum Fuel Limiting

The maximum fuel limit is an absolute actuator driver output limit and is active at all times. This is the maximum actuator driver output the 723 control will allow under any conditions, and can be used to set the engine horsepower rating. It can also be used as a troubleshooting tool to block the fuel rack during unstable conditions. The Max Fuel Limit set point is found in Service mode, under the header *START/MAX LIMITS*, at prompt MAXIMUM FUEL LIMIT.

Load Sharing

The third primary function of the 723 control is to load share equally between two engines tied together mechanically through a common gear box. The load sharing is done electronically. The 723 controls communicate over the load sharing lines to maintain equal PERCENT LOAD. The 723 control compares the signal on the load sharing lines to its PERCENT LOAD and then biases its speed reference so the load sharing line signal and its load are equal.

Percent Load

The PERCENT LOAD value is the amount of engine load. It is calibrated to be 0% at minimum engine load and 100% at maximum engine load.

WARNING

It is imperative that the PERCENT LOAD be accurately calibrated at the minimum load and full load conditions. See Chapter 4, *RACK CALIBRATION*.

Load Sharing Lines

The load sharing lines provide the communications link for the 723 control loads. The signal on the load sharing lines is an analog voltage from 0–3 Vdc (no load to full load) based on PERCENT LOAD. The voltage signal is proportional to the total load on both units. The 723 control is capable of biasing the load sharing lines as well as reading the voltage signal on the load sharing lines. An internal relay isolates the 723 control from the load sharing lines until the unit is ready to begin load sharing. This is done shortly after a clutching operation begins. After the engine speeds are matched (synchronized), the clutch is closed. The 723 control then begins to soft load the engine until its load is equal to the load signal on the load sharing lines. Once the loads of the engines have been balanced, the internal load sharing relay is closed and the 723 control is in load sharing mode. In load sharing mode, both 723 controls will share load as one unit, using the master 723 control's speed reference.

Fuel Rack Position

The 723 control load sharing scheme is based on PERCENT LOAD. The 723 control uses the PERCENT LOAD under the *DISPLAY 1* service menu (which is the calibrated actuator driver output or rack position input signal) as the engine load, and biases the load sharing lines based on this signal. Load sharing can only be as accurate as is the engine's fuel rack calibrations. It is important to have as linear a relationship as possible between the fuel rack transducer output and the actual engine output (power). The engine's fuel rack or pump calibrations must be matched closely.

In single unit operation (one engine clutched), the voltage on the load sharing lines will be proportional to the fuel rack position. At 0 PERCENT LOAD, the load sharing line voltage should be 0 ±0.1 Vdc, and at 100 PERCENT LOAD, the load sharing voltage will be 3.0 ±0.1 Vdc. If the voltage on the load sharing lines does not match the given fuel rack position, verify the following: 1) The load sharing relay is closed (LED at terminals 9 and 10 lit), 2) Determine if the 723 control fuel rack position or the default fuel rack positions were calibrated properly.

Chapter 4. Service and Configure Menus

Hand Held Programmer and Menus

The Hand Held Programmer is a hand-held computer terminal that gets its power from the 723 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 terminal can be connected or disconnected at any time without affecting control operation.

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 relating to the application. Pressing the ID key will change the display to show the part number of the software and version letter.

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 723 has two sets of menus; the Service menus and Configure menus. The Service menus allow easy access and tuning while the engine is running. The Configure menus may only be entered if the I/O is shut down, and hence the engine stopped.

Configure Menus

To access Configure menus, the engine must be shut down. Open the Run/Stop contact. 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.

IMPORTANT	**If the engine is running during this process, it will be shut down due to shutting down the I/O of the control.**

To move between the menus, use the “Arrow Left” and “Arrow Right” keys. To move through the set points within a menu, use the “Arrow Up” and “Arrow Down” 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, and the control will automatically reboot itself.

Service Menus

To access the Service menus press the "Arrow Down" key from the master screen. To move between menus, and to move through set points within menus, follow the instructions as for the Configure menus. Also to return to the menu header, or to leave Service, follow the Configure instructions.

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 increase or decrease the value one unit at a time, use the "+" (PLUS) or "–" (MINUS) keys.

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

IMPORTANT	**This may be done only if the figure is within 10% of the existing value.**

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

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

Hand Held Programmer Keys

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

(left arrow)	Moves backward through Configure or Service, one menu at a time.
(right arrow)	Advances through Configure or Service, one menu at a time.
(up/down arrow)	Toggles between the two displayed items.
(up arrow)	Moves backward through each menu, one step at a time.
(down arrow)	Advances through each menu, one step at a time. Selects Service from Main Screen.
(turtle up)	Increases the displayed set point value slowly.
(turtle down)	Decreases the displayed set point value slowly.
(rabbit up)	Increases the displayed set point value quickly (about 10 times faster than the turtle keys).
(rabbit down)	Decreases the displayed set point value quickly (about 10 times faster than the turtle keys).
– (minus)	Increases set point values by one step at a time.
+ (plus)	Decreases set point values by one step at a time.
(solid square)	Not used.

ID	Displays the 723 control part number and software revision level.
ESC	To return to menu header or to main screen.
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.

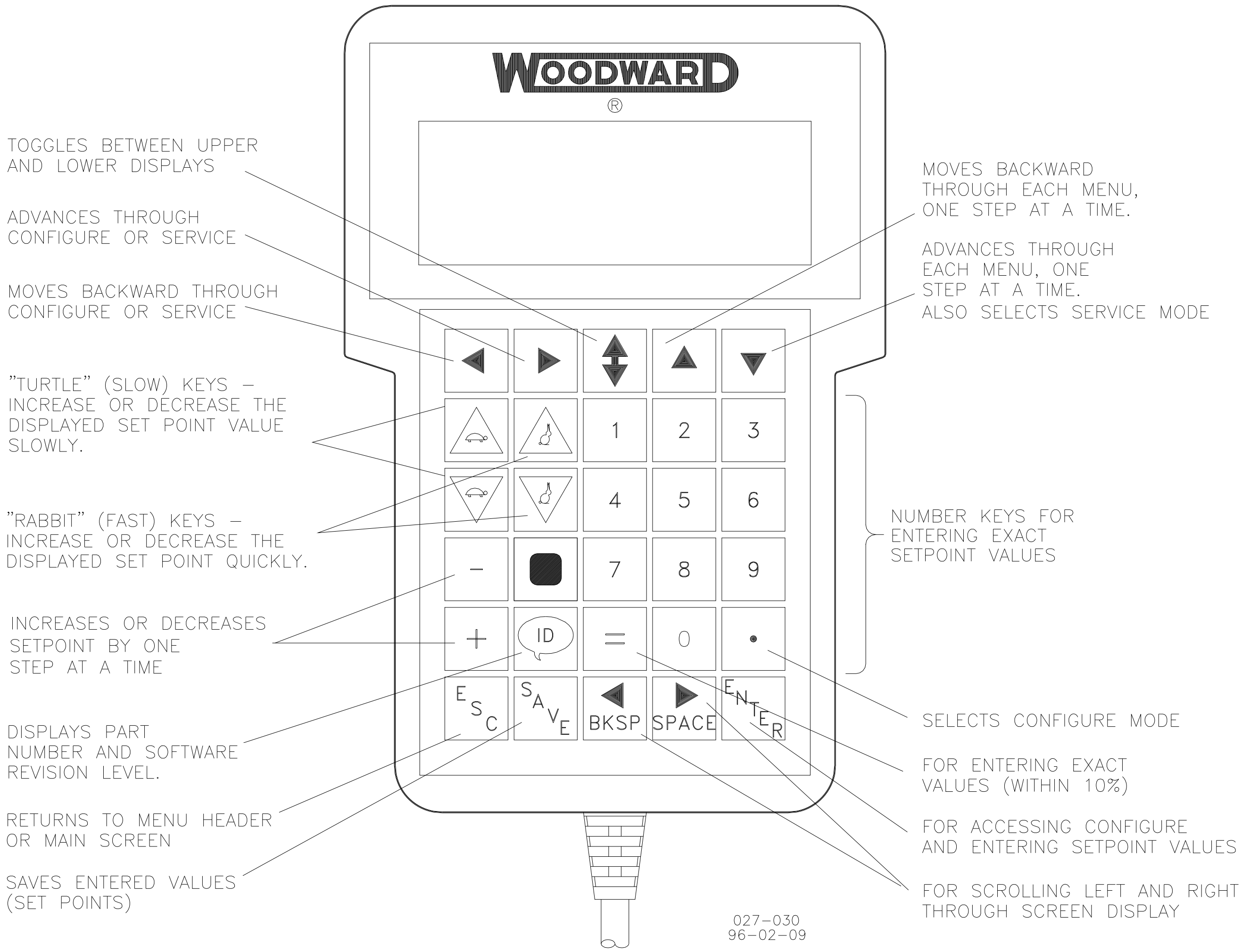


Figure 4-1. Hand Held Programmer Functions

NOTICE	**Any values that are adjusted or tuned must be saved prior to removing power to the 723 control, otherwise they will revert back to their original settings. Saving is done by pressing the SAVE key on the hand held programmer.**

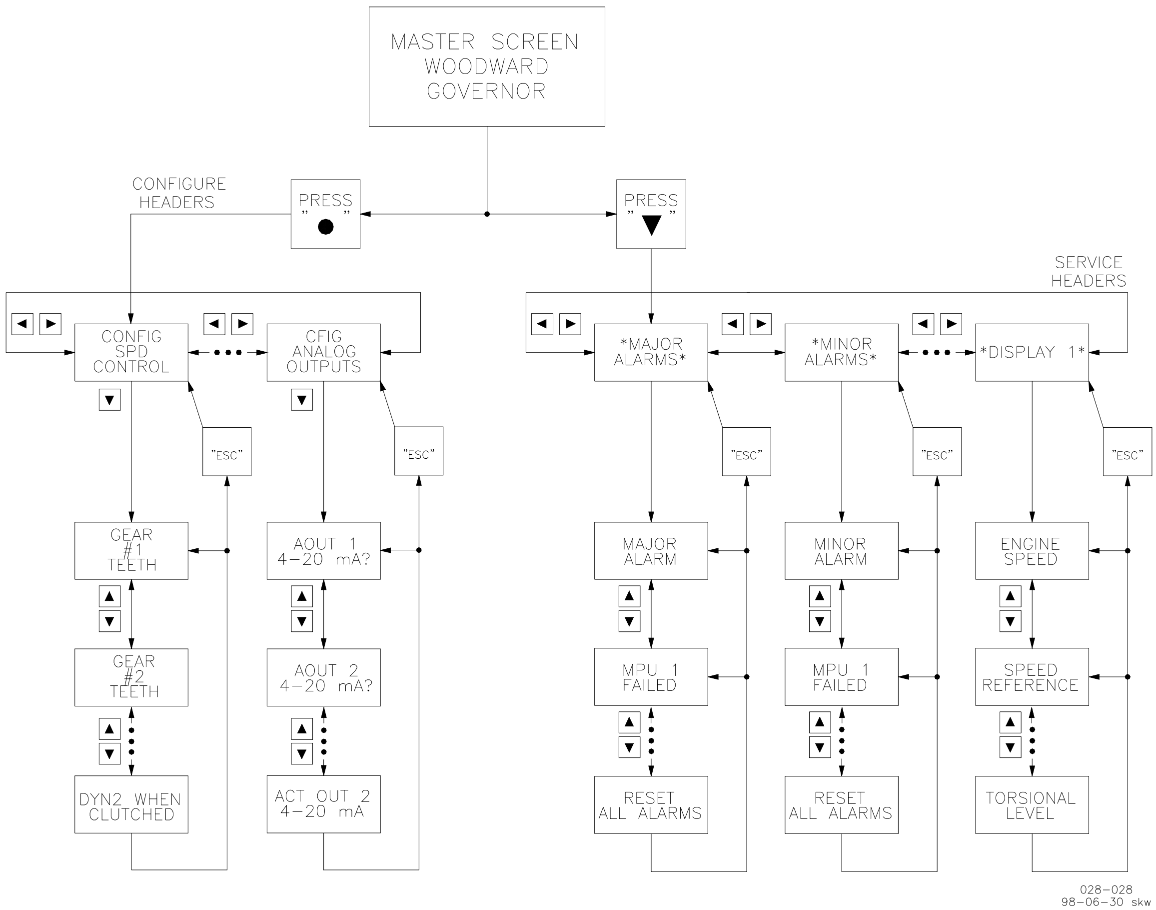


Figure 4-2. Service and Configure Headers

When the hand held programmer is not being used for extended periods, it is recommended that it be disconnected from the 723 control. The hand held programmer may provide an easier path for radio and other EMI signals to enter the 723 control and cause undesirable conditions. By removing the hand held programmer, undesirable, accidental, or tampered variable changes are avoided.

Configure Menus

CONFIG SPD CONTROL

⚠WARNING

All settings in the CONFIG SPD CONTROL configure header are critical engine operating parameters. Incorrectly set values could result in an engine overspeed and resulting injury or property damage.

⚠WARNING

When accessing the configuration menus the 723 control will activate an I/O lock on the hardware. All outputs will be turned off (zero current/volts, extinguished LEDs) or de-energized (open contacts). Do not attempt to run the engine when a configure menu is active.

GEAR #1 TEETH (*16–300 Teeth)—Set this to the number of teeth or holes on the speed sensing gear for speed sensor #1. If the speed sensing gear is not rotating at the same speed and the crankshaft, this is the number of gear teeth that will pass the speed sensor in one complete engine revolution.

GEAR #2 TEETH (*16–300 Teeth)—Set this to the number of teeth or holes on the speed sensing gear for speed sensor #2. If the speed sensing gear is not rotating at the same speed and the crankshaft, this is the number of gear teeth that will pass the speed sensor in one complete engine revolution.

RATED SPEED (*100–2200)—Set this value to the rated speed of the engine.

IDLE REF @ SHUTDOWN (*T/F)—If set to "TRUE", every time the engine is shut down (engine speed falls below 5% of rated speed) the speed reference will reset to the Idle set point (if remote speed setting is selected, the speed reference is reset to idle and, after one second, it will ramp to the remote speed setting). If set to "FALSE", the speed reference will stay at its present value when the engine is shut down.

POWER UP TO IDLE (*T/F)—If set to "TRUE", every time the 723 control power is turned on, the speed reference will reset to idle even though the rated contact is closed. If remote speed setting is selected during power-up, the speed reference is reset to idle and then after one second it will ramp to the remote speed setting. If set to "FALSE", the speed reference will immediately go to the selected speed reference point.

IDLE WHEN COMM FAIL (*T/F)—If set to "TRUE", a communications failure between the two 723s will cause the speed reference to reset to idle. Engine speed will remain at idle until communication is restored. If set to "FALSE", the speed references will lock in last.

LINEAR DYNAMIC MAP (*T/F)—Set this value "FALSE" to have constant Gain and Reset values over the entire engine speed reference range. Set this value "TRUE" to have Gain and Reset vary linearly with engine speed reference. See Figure 4-3 for these two dynamic maps.

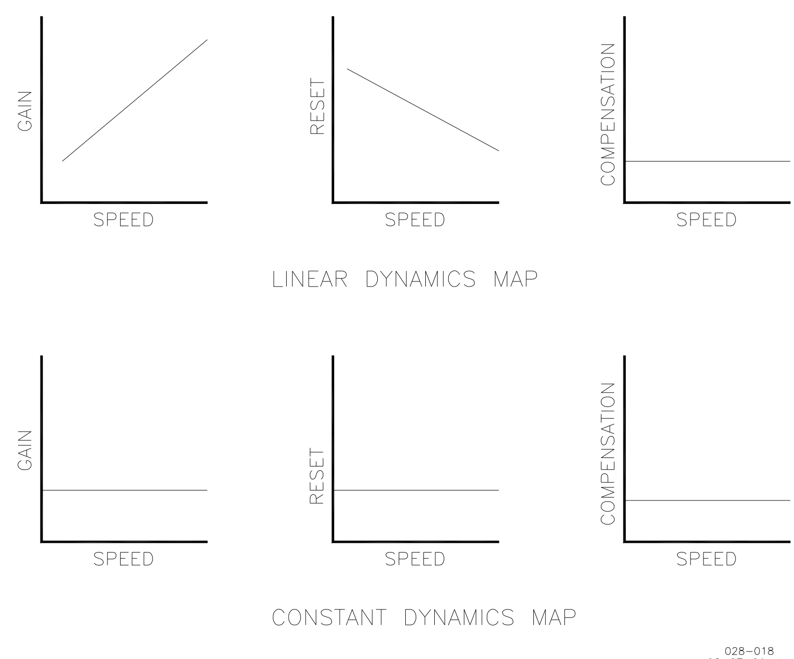


Figure 4-3. Dynamics Maps

DYN2 ON SPD SWITCH (*T/F)—If this value is set "TRUE", dynamics 2 will activate when the dynamics 2 contact is closed (contact E, if configured) and the engine speed is above the DYN2 ON SPD SWITCH value.

DYN2 WHEN CLUTCHED (*T/F)—If this value is set "TRUE", dynamics 2 will activate when the dynamics 2 contact is closed (contact E, if configured) and the engine is clutched in.

CONFIG OPTION

USE TORQUE LIMITER (*T/F)—Set this value "FALSE" if the Torque Limiter function is not required. Set this value "TRUE" if the Torque Limiter function is required. This also activates the *Torque Limiter* menu.

USE MANIFOLD LIMITR (*T/F)—Set this value "FALSE" if the Manifold Limiter function is not required. Set this value "TRUE" and connect a Manifold Pressure Transducer to the 723 if the Manifold Limiter function is required. This also activates the *Manifold Limiter* menu.

PORT ENGINE (*T/F)—Set this value "FALSE" for the 723 control that is on the starboard engine of the two engines on common gear box. Set this value "TRUE" for the 723 control that is on the port engine of the two engines on common gear box. The companion unit must have an opposite value.

ENBL COUPL TOR FILT (*T/F)—Set this value "TRUE" to enable the coupling torsional filter. Set this value "FALSE" to disable the coupling torsional filter. This also activates the *Torsional Filter* menu.

REM LOCK IN LAST (*T/F)—Set this value "TRUE" to enable the Lock-in-Last function of the remote speed setting input. When enabled, on a failed remote speed setting input, the speed reference will "lock" at the last remote speed setting input value. Set this value "FALSE" to disable the Lock-in-Last function of the remote speed setting input. When disabled, on a failed remote speed setting input, the speed reference will ramp to the Lower Limit speed value.

OVERRIDE FAILSAFE (*T/F)—Set this value "FALSE" to have the actuator output go to the MINIMUM fuel position on loss of engine speed input signal/ signals. Set this value "TRUE" to have the actuator output go to the MAXIMUM fuel position on loss of engine speed input signal(s). This function will activate only when Reverse Acting Act is also "TRUE".

REVERSE ACTING ACT (*T/F)—Set this value "FALSE" for forward (direct) acting actuators and "TRUE" for reverse (indirect) acting actuators.

ENABLE AUX INPUT (*T/F)—Set this value "FALSE" if the AUX Input is not being used. Set this value "TRUE" if the AUX Input function is required.

CT F AS OVRSPD TEST (*T/F)—Set this value "FALSE" for this discrete-in to be used as Emergency Declutch input. Set this value "TRUE" for this discrete-in to be used as Overspeed Test Enable input.

MANUAL CLUTCH LOGIC (*T/F)—Set this value "TRUE" to enable manual clutch logic. When manual clutch logic is selected, engine synchronizing must be done manually and a clutch permissive output will not be issued by the 723. Load sharing is initiated when a clutch engaged contact is sensed. Soft loading operates as normal, however soft unloading is not possible due to the absence of the clutch request function.

USE CONT E AS RESET (*T/F)—Set this value “TRUE” to use this contact to reset the major and minor alarms. When this value is set “FALSE”, this contact is used to enable Dynamics 2.

USE DSLC AS SYNC (*T/F)—Set this value “TRUE” if a DSLC (3%/volt) is used to synchronize a generator driven by a common gearbox. Set this value to “FALSE” if an SPM-A (0.667%/volt) is used to synchronize.

MAJOR ALM SD ACT (*T/F)—Set this value “TRUE” to have the control return to minimum fuel if a major alarm is detected.

USE NOTCH FILTER (*T/F)—Set this value “TRUE”: to enable the notch filter. The notch filter is useful for dampening otherwise uncontrollable system harmonics. It can be used as a flexible coupling torsional frequency filter if two speed sensors are not available.

MINOR ALARM TRIPS

Enabling any one or a combination of the following alarms is acceptable as they are linked together as logical “ORs”. This is relay output #1, 723 control terminals #3 and #4.

MPU 1 FAILED (*T/F)—Set this value “FALSE” if failure of MPU 1 input is not to be a minor alarm. Set this value “TRUE” if failure of MPU 1 input is to be alarmed as a minor alarm.

MPU 2 FAILED (*T/F)—Set this value “FALSE” if failure of MPU 2 input is not to be a minor alarm. Set this value “TRUE” if failure of MPU 2 input is to be alarmed as a minor alarm.

MANIFOLD AIR FAILED (*T/F)—Set this value “FALSE” if failure of Manifold Air Pressure Transducer input is not to be a minor alarm. Set this value “TRUE” if failure of Manifold Air Pressure Transducer input is to be alarmed as a minor alarm.

REMOTE SPEED FAILED (*T/F)—Set this value “FALSE” if failure of Remote Speed Setting input is not to be a minor alarm. Set this value “TRUE” if failure of Remote Speed Setting input is to be alarmed as a minor alarm.

RACK INPUT FAILED (*T/F)—Set this value “FALSE” if failure of Rack Position Feedback input is not to be a minor alarm. Set this value “TRUE” if failure of Rack Position Feedback input is to be alarmed as a minor alarm.

SPEED SWITCH (*T/F)—Set this value “FALSE” if no minor alarmed is desired once the Speed Switch set point is exceeded. Set this value “TRUE” if a Minor alarm is desired once the Speed Switch set point is exceeded. This alarm is non-latching.

TORQUE LIMITER (*T/F)—Set this value “FALSE” if no minor alarm output is desired when Torque Limiter is in control (limiting) of the actuator driver output. Set this value “TRUE” if a minor alarm output is desired when Torque Limiter is in control (limiting) of the actuator driver output. This alarm is non-latching.

MANIFOLD LIMITER (*T/F)—Set this value “FALSE” if no minor alarm output is desired when Manifold Pressure Limiter is in control (limiting) of the actuator driver output. Set this value “TRUE” if a minor alarm output is desired when Manifold Pressure Limiter is in control (limiting) of the actuator driver output. This alarm is non-latching.

HIGH ACT ALARM (*T/F)—Set this value “FALSE” if no minor alarm output is desired when Maximum Fuel Limiter is in control (limiting) of the actuator driver output. Set this value “TRUE” if a minor alarm output is desired when Maximum Fuel Limiter is in control (limiting) of the actuator driver output.

PORT 2 LINK ERROR (*T/F)—Set this value “FALSE” if no minor alarm output is desired when Port 2 detects an link or hardware error. Set this value “TRUE” if a minor alarm output is desired when Port 2 detects a link or hardware error.

PORT 3 LINK ERROR (*T/F)—Set this value “FALSE” if no minor alarm output is desired when Port 3 detects an link or hardware error. Set this value “TRUE” if a minor alarm output is desired when Port 3 detects a link or hardware error.

PORT 2&3 LINK ERROR (*T/F)—Set this value “FALSE” if no minor alarm output is desired when both Port2 and Port3 detect link or hardware errors. Set this value “TRUE” if a minor alarm output is desired when Port2 and Port3 detect a link or hardware error.

PID @ LOW LEVEL (*T/F)—Set this value “FALSE” if no minor alarm output is desired when PID At Zero Fault occurs. Set this value “TRUE” if a minor alarm output is desired when PID At Zero Fault occurs.

HIGH SPEED SW (*T/F)—Set this value “FALSE” if no minor alarm output is desired when engine overspeed occurs. Set this value “TRUE” if a minor alarm output is desired when engine overspeed occurs.

LOAD SWITCH (*T/F)—Set this value “FALSE” if no minor alarm output is desired when engine load exceeds LOAD SWITCH pickup (see *LOAD CONTROL*). Set this value “TRUE” if a minor alarm is desired when engine load exceeds LOAD SWITCH pickup. This alarm is non-latching.

CLUTCH FAIL (*T/F)—Set this value “FALSE” if no minor alarm output is desired when a clutch engaged contact is not received within the CLUTCH SYNC TIME. Set this value “TRUE” if a minor alarm is desired when the clutch engaged contact is not received within the CLUTCH SYNC TIME.

MAJOR ALARM TRIPS

Enabling any one or a combination of the following alarms is acceptable as they are linked together as logical “ORs”. This is relay output #1, 723 control terminals #3 and #4.

MPU 1 FAILED (*T/F)—Set this value “FALSE” if failure of MPU 1 input is not to be a major alarm. Set this value “TRUE” if failure of MPU 1 input is to be alarmed as a major alarm.

MPU 2 FAILED (*T/F)—Set this value “FALSE” if failure of MPU 2 input is not to be a major alarm. Set this value “TRUE” if failure of MPU 2 input is to be alarmed as a major alarm.

MANIFOLD AIR FAILED (*T/F)—Set this value “FALSE” if failure of Manifold Air Pressure Transducer input is not to be a major alarm. Set this value “TRUE” if failure of Manifold Air Pressure Transducer input is to be alarmed as a major alarm.

REMOTE SPEED FAILED (*T/F)—Set this value “FALSE” if failure of Remote Speed Setting input is not to be a major alarm. Set this value “TRUE” if failure of Remote Speed Setting input is to be alarmed as a major alarm.

RACK INPUT FAILED (*T/F)—Set this value “FALSE” if failure of Rack Position Feedback input is not to be a major alarm. Set this value “TRUE” if failure of Rack Position Feedback input is to be alarmed as a major alarm.

SPEED SWITCH (*T/F)—Set this value “FALSE” if no major alarmed is desired once the Speed Switch set point is exceeded. Set this value “TRUE” if a Major alarm is desired once the Speed Switch set point is exceeded. This alarm is non-latching.

TORQUE LIMITER (*T/F)—Set this value “FALSE” if no major alarm output is desired when Torque Limiter is in control (limiting) of the actuator driver output. Set this value “TRUE” if a major alarm output is desired when Torque Limiter is in control (limiting) of the actuator driver output. This alarm is non-latching.

MANIFOLD LIMITER (*T/F)—Set this value “FALSE” if no major alarm output is desired when Manifold Pressure Limiter is in control (limiting) of the actuator driver output. Set this value “TRUE” if a major alarm output is desired when Manifold Pressure Limiter is in control (limiting) of the actuator driver output. This alarm is non-latching.

HIGH ACT ALARM (*T/F)—Set this value “FALSE” if no major alarm output is desired when Maximum Fuel Limiter is in control (limiting) of the actuator driver output. Set this value “TRUE” if a major alarm output is desired when Maximum Fuel Limiter is in control (limiting) of the actuator driver output.

PORT 2 LINK ERROR (*T/F)—Set this value “FALSE” if no major alarm output is desired when Port 2 detects an link or hardware error. Set this value “TRUE” if a major alarm output is desired when Port 2 detects a link or hardware error.

PORT 3 LINK ERROR (*T/F)—Set this value “FALSE” if no major alarm output is desired when Port 3 detects an link or hardware error. Set this value “TRUE” if a major alarm output is desired when Port 3 detects a link or hardware error.

PORT 2&3 LINK ERROR (*T/F)—Set this value “FALSE” if no major alarm output is desired when both Port2 and Port3 detect link or hardware errors. Set this value “TRUE” if a major alarm output is desired when Port2 and Port3 detect a link or hardware error.

PID @ LOW LEVEL (*T/F)—Set this value “FALSE” if no major alarm output is desired when PID At Zero Fault occurs. Set this value “TRUE” if a major alarm output is desired when PID At Zero Fault occurs.

HIGH SPEED SW (*T/F)—Set this value “FALSE” if no major alarm output is desired when engine overspeed occurs. Set this value “TRUE” if a major alarm output is desired when engine overspeed occurs.

LOAD SWITCH (*T/F)—Set this value “FALSE” if no major alarm output is desired when engine load exceeds LOAD SWITCH pickup (see *LOAD CONTROL*). Set this value “TRUE” if a major alarm is desired when engine load exceeds LOAD SWITCH pickup. This alarm is non-latching.

CLUTCH FAIL (*T/F)—Set this value “FALSE” if no major alarm output is desired when a clutch engaged contact is not received within the CLUTCH SYNC TIME. Set this value “TRUE” if a major alarm is desired when the clutch engaged contact is not received within the CLUTCH SYNC TIME.

ALARM/SD CONFIGURE

ALARM DELAY TIME (*0.01–60.0)—Set this value for the duration that an analog input must be outside the normal operating range (below 2.0 mA for the low side or above 21 mA for the high side) before it is considered failed. The units for this value are seconds.

OPEN CNT ON MIN ALM (*T/F)—If this value is set “FALSE”, the minor alarm relay (relay #1) will energize, closing the contacts at terminals #3 and #4 when a minor alarm occurs. If this value is set “TRUE”, the minor alarm relay (relay #1) will de-energize, opening the contacts at terminals #3 and #4 when a minor alarm occurs. Remember that for any of the 15 minor alarms to be annunciated by the minor alarm output, it must first be enabled while under configure header MINOR ALARM TRIPS.

OPEN CNT ON MAJ ALM (*T/F)—If this value is set “FALSE”, the major alarm relay (relay #2) will energize, closing the contacts at terminals #5 and #6 when a major alarm occurs. If this value is set “TRUE”, the major alarm relay (relay #2) will de-energize, opening the contacts at terminals #5 and #6 when a major alarm occurs. Remember that for any of the 15 major alarms to be annunciated by the major alarm output, it must first be enabled while under configure header MAJOR ALARM TRIPS.

SHUTDOWN WHEN PID@0 (*T/F)—Set this value “FALSE” if no action is to be taken when the PID @ ZERO alarm occurs. Set this value “TRUE”, and a PID @ ZERO alarm will cause an Emergency Declutch.

PID @ ZERO LEVEL (*0.0–100.0)—The units for this value are percent of the actuator output driver. Set this value for the desired level that the PID output must be below before an alarm will occur.

PID @ ZERO TIME (*0.0–120.0)—The units for this value are seconds. Set this value for the duration that the PID output must be below the value set at prompt PID @ ZERO LEVEL before an alarm will occur.

HIGH ACT ALM LEVEL (%) (0.0–100.0)—The units for this value are percent of the actuator driver output. Set this value for the desired level that the PID output must be above before the HIGH ACT ALARM is tripped.

HIGH SPEED SD (1–2200 rpm)—The units for this value are rpm. Set this value to the desired high speed shutdown point.

CFIG ANALOG OUTPUTS

AOUT 1 4–20 mA? (*T/F)—Selects which output mA range is desired. TRUE selects 4–20 mA output, and FALSE selects 0–1 mA output. NOTE—The hardware jumpers must also be configured.

AOUT 2 4–20 mA? (*T/F)—Selects which output mA range is desired. TRUE selects 4–20 mA output, and FALSE selects 0–1 mA output. NOTE—The hardware jumpers must also be configured.

ACT OUT 2 4–20 mA? (*T/F)—Selects which output mA range is desired. TRUE selects 4–20 mA output, and FALSE selects 0–200 mA output. NOTE— The hardware jumpers must also be configured.

Service Menus

MAJOR ALARMS

IMPORTANT	**For any of the major alarms to be displayed, they must first be enabled while in Configure mode under header MAJOR ALARMS. Once the desired major alarms are enabled in Configure mode, any one or a combination of the enabled alarms may activate the Major Alarm output (terminals #5 and #6).**

MAJOR ALARM (T/F)—This is the major alarm indicator. A “TRUE” indicates that a major alarm has occurred or is active, and “FALSE” indicates that there are no major alarms. This will display “TRUE” if only one or any combination of the “enabled” Major alarms occur.

MPU 1 FAILED (T/F)—A “TRUE” displayed indicates that speed sensor input #1 (terminals #11 and #12) has failed. A “FALSE” displayed indicates that speed sensor input #1 is OK.

MPU 2 FAILED (T/F)—A “TRUE” displayed indicates that speed sensor input #2 (terminals #13 and #14) has failed. A “FALSE” displayed indicates that speed sensor input #2 is OK.

MANIFOLD AIR FAILED (T/F)—A “TRUE” displayed indicates that the Manifold Air Pressure input (analog input #3) has failed (either below 2 mA or above 21 mA). A “FALSE” displayed indicates that the Manifold Air Pressure input is within the 2–21 mA window.

REMOTE SPEED FAILED (T/F)—A “TRUE” displayed indicates that the Remote Speed input (analog input #2) has failed (either below 2 mA or above 21 mA). A “FALSE” displayed indicates that the Remote Speed input is within the 2–21 mA window.

RACK INPUT FAILED (T/F)—A “TRUE” displayed indicates that the Rack Position Feedback input (analog input #1) has failed (either below 2 mA or above 21.5 mA). A “FALSE” displayed indicates that Rack Position Feedback input is within the 2–21.5 mA window.

SPEED SWITCH ON (T/F)—A “TRUE” displayed indicates that the engine speed has exceeded the Speed Switch Pickup point. A “FALSE” displayed indicates that the engine speed has dropped below the Speed Switch Dropout point.

TORQUE LIMITER (T/F)—A “TRUE” displayed indicates that the Torque Fuel Limiter has control of, and is limiting, the actuator driver output. A “FALSE” displayed indicates that the Torque Fuel Limiter is not in control of the actuator driver output.

MANIFOLD LIMITER (T/F)—A “TRUE” displayed indicates that the Manifold Air Pressure Limiter has control of, and is limiting, the actuator driver output. A “FALSE” displayed indicates that the Manifold Air Pressure Limiter is not in control of the actuator driver output.

HIGH ACT ALARM (T/F)—A “TRUE” displayed indicates that the Maximum Fuel Limiter has control of, and is limiting, the actuator driver output. A “FALSE” displayed indicates that the Maximum Fuel Limiter is not in control of the actuator driver output.

PORT 2 LINK ERROR (T/F)—A "TRUE" displayed indicates that Port 2 has detected a link or hardware error. A "FALSE" displayed indicates Port 2 is functioning properly.

PORT 3 LINK ERROR (T/F)—A "TRUE" displayed indicates that Port 3 has detected a link or hardware error. A "FALSE" displayed indicates Port 3 is functioning properly.

PORT 2&3 LINK ERROR (T/F)—A "TRUE" displayed indicates that Port 2 and Port 3 have detected a link or hardware error. A "FALSE" displayed indicates Port 2 and Port 3 are functioning properly.

PID @ LOW LEVEL (T/F)—A "TRUE" displayed indicates that a PID @ Low Level alarm has occurred. A "FALSE" displayed indicates that the PID @ Low Level alarm has not been detected.

HIGH SPEED SW (T/F)—A "TRUE" displayed indicates that the engine speed has exceeded the 723 Engine Overspeed Trip point. A "FALSE" displayed indicates that the engine speed has not exceeded the 723 Engine Overspeed Trip point.

LOAD SWITCH (T/F)—A "TRUE" displayed indicates that the engine load is above the load switch pickup set point. A "FALSE" displayed indicates that the load switch is not activated.

CLUTCH FAIL (T/F)—A "TRUE" displayed indicates that a clutch engaged contact has not been received within the clutch sync time. A "FALSE" displayed indicates that a clutch engaged contact has been received.

RESET ALL ALARMS (T/F)—Toggle this value from "FALSE" to "TRUE" to reset any of the alarms once they have been cleared. This will also reset any minor alarms.

MINOR ALARMS

IMPORTANT

For any of the minor alarms to be displayed, they must first be enabled while in Configure mode under header MINOR ALARMS. Once the desired minor alarms are enabled in Configure mode, any one or a combination of the enabled alarms may activate the Minor Alarm output (terminals #3 and #4).

MINOR ALARM (T/F)—This is the minor alarm indicator. A "TRUE" indicates that a minor alarm has occurred or is active, and "FALSE" indicates that there are no minor alarms. This will display "TRUE" if only one or any combination of the "enabled" minor alarms occur.

MPU 1 FAILED (T/F)—A "TRUE" displayed indicates that speed sensor input #1 (terminals #11 and #12) has failed. A "FALSE" displayed indicates that speed sensor input #1 is OK.

MPU 2 FAILED (T/F)—A "TRUE" displayed indicates that speed sensor input #2 (terminals #13 and #14) has failed. A "FALSE" displayed indicates that speed sensor input #2 is OK.

MANIFOLD AIR FAILED (T/F)—A “TRUE” displayed indicates that the Manifold Air Pressure input (analog input #3) has failed (either below 2 mA or above 21.5 mA). A “FALSE” displayed indicates that the Manifold Air Pressure input is within the 2–21.5 mA window.

REMOTE SPEED FAILED (T/F)—A “TRUE” displayed indicates that the Remote Speed input (analog input #2) has failed (either below 2 mA or above 21.5 mA). A “FALSE” displayed indicates that the Remote Speed input is within the 2–21 mA window.

RACK INPUT FAILED (T/F)—A “TRUE” displayed indicates that the Rack Position Feedback input (analog input #1) has failed (either below 2 mA or above 21.5 mA). A “FALSE” displayed indicates that Rack Position Feedback input is within the 2–21 mA window.

SPEED SWITCH ON (T/F)—A “TRUE” displayed indicates that the engine speed has exceeded the Speed Switch Pickup point. A “FALSE” displayed indicates that the engine speed has dropped below the Speed Switch Dropout point.

TORQUE LIMITER (T/F)—A “TRUE” displayed indicates that the Torque Fuel Limiter has control of, and is limiting, the actuator driver output. A “FALSE” displayed indicates that the Torque Fuel Limiter is not in control of the actuator driver output.

MANIFOLD LIMITER (T/F)—A “TRUE” displayed indicates that the Manifold Air Pressure Limiter has control of, and is limiting, the actuator driver output. A “FALSE” displayed indicates that the Manifold Air Pressure Limiter is not in control of the actuator driver output.

HIGH ACT ALARM (T/F)—A “TRUE” displayed indicates that the Maximum Fuel Limiter has control of, and is limiting, the actuator driver output. A “FALSE” displayed indicates that the Maximum Fuel Limiter is not in control of the actuator driver output.

PORT 2 LINK ERROR (T/F)—A “TRUE” displayed indicates that Port 2 has detected a link or hardware error. A “FALSE” displayed indicates Port 2 is functioning properly.

PORT 3 LINK ERROR (T/F)—A “TRUE” displayed indicates that Port 3 has detected a link or hardware error. A “FALSE” displayed indicates Port 3 is functioning properly.

PORT 2&3 LINK ERROR (T/F)—A “TRUE” displayed indicates that Port 2 and Port 3 have detected a link or hardware error. A “FALSE” displayed indicates Port 2 and Port 3 are functioning properly.

PID @ LOW LEVEL (T/F)—A “TRUE” displayed indicates that a PID @ Low Level alarm has occurred. A “FALSE” displayed indicates that the PID @ Low Level alarm has not been detected.

HIGH SPEED SW (T/F)—A “TRUE” displayed indicates that the engine speed has exceeded the 723 Engine Overspeed Trip point. A “FALSE” displayed indicates that the engine speed has not exceeded the 723 Engine Overspeed Trip point.

LOAD SWITCH (T/F)—A “TRUE” displayed indicates that the engine load is above the load switch pickup set point. A “FALSE” displayed indicates that the load switch is not activated.

CLUTCH FAIL (T/F)—A “TRUE” displayed indicates that a clutch engaged contact has not been received within the clutch sync time. A “FALSE” displayed indicates that a clutch engaged contact has been received.

RESET ALL ALARMS (T/F)—Toggle this value from “FALSE” to “TRUE” to reset any of the alarms once they have been cleared. This will also reset any major alarms.

DYNAMICS 1

GAIN 1 (*0.01–150.0)—The gain is set to provide stable control of the engine at light unloaded conditions.

RESET 1 (*0.01–50.0 sec)—Reset compensates for the lag time of the engine. It adjusts the time required for the control to return the speed to zero error after a disturbance. Reset is adjusted to prevent slow hunting and to minimize speed overshoot after a load disturbance.

ACT COMP 1 (*0.01–1.0 sec)—Set this value for the time constant of the actuator and fuel system. Typical values are at 20–25% of the reset.

GAIN RATIO 1 (*1.0–20.0)—Set this value to the desired gain ratio multiplier when the speed error is outside of the window width.

WINDOW WIDTH 1 (*0.01–150.0 rpm)—Set this value for the desired speed error window (±) width.

GAIN SLOPE 1 (*0.01–20.0)—Set this value for the desired gain slope beyond the gain break point.

GAIN BKPT 1 (*0.01–100.0%)—Set this value for the desired percent output above which Gain Slope becomes effective.

SPEED FILTER HZ (*0.5–20.0 Hz)—Set this value to the cutoff frequency found by using the formula in Chapter 3. This is the roll-off frequency for the firing torsional filter. This filter is active regardless of which dynamic set is selected.

DYNAMICS 2

These settings are used only when dynamics 2 is selected.

GAIN 2 (*0.01–150.0)—The gain is set to provide stable control of the engine at the light unloaded conditions.

RESET 2 (*0.01–50.0 sec)—Reset compensates for the lag time of the engine. It adjusts the time required for the control to return the speed to zero error after a disturbance. Reset is adjusted to prevent slow hunting and to minimize speed overshoot after a load disturbance.

ACT COMP 2 (*0.01–1.0 sec)—Set this value for the time constant of the actuator and fuel system. Typical values are at 20–25% of the reset.

GAIN RATIO 2 (*1.0–20.0)—Set this value to the desired gain ratio multiplier when the speed error is outside of the window width.

WINDOW WIDTH 2 (*0.01–150.0 rpm)—Set this value for the desired speed error window (±) width.

GAIN SLOPE 2 (*0.01–20.0)—Set this value for the desired gain slope beyond the gain break point.

GAIN BKPT 2 (*0.01–100.0%)—Set this value for the desired percent output above which Gain Slope becomes effective.

DYN 2 SPD SW PU (*100.0–2200.0 rpm)—Set this to the desired rpm value that dynamics 2 will pick up.

DYN 2 SPD SW DO (*1.0–2200.0 rpm)—Set this to the desired rpm value that dynamics 2 will drop out. If the dropout is lower than the pickup, the switch is active above the pickup. If the dropout is higher than the pickup, the switch is inactive below the pickup.

SPEED REFERENCE

RAISE SPEED LIMIT (*100–2200 rpm)—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 the maximum rated engine speed.

LOWER SPEED LIMIT (*100–2200 rpm)—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 is normally set at the minimum operating speed of the engine.

IDLE SPEED (RPM) (*100–2200 rpm)—Idle Speed Reference sets the speed at which the engine is operated when the Idle/Rated contact (terminal #30) is open. It is also the Speed Reference set point that the control will go to if either IDLE REF @ SHUTDOWN or POWER UP TO IDLE functions are enabled in Configure mode. Always set the IDLE SPEED lower than rated speed.

ACCEL RAMP (SEC) (*0.0001–500.0 sec)—Accel Ramp 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.

DECEL RAMP (SEC) (*0.0001–500.0 sec)—Decel Ramp 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.

RAISE SPEED RATE (*1.0–10 000.0 rpm/sec)—Raise Speed Rate is the rate at which the speed reference is ramped when using the Raise command as well as when the Remote Speed Setting input is changed in the increase direction. A step change on the remote input does not cause an immediate change in the reference, which is ramped to the new setting at the Raise Speed Rate.

LOWER SPEED RATE (*1.0–10 000.0 rpm/sec)—Lower Speed Rate is the rate at which the speed reference is ramped when using the Lower command as well as when the Remote Speed Setting input is changed in the decrease direction. A step change on the remote input does not cause an immediate change in the reference, which is ramped to the new setting at the Lower Speed Rate.

SLV-MST RAMP RATE (*1.0–500.0 rpm/sec)—Slave-Master Ramp Rate is the rate at which the slave unit will ramp to synchronize with the master when its clutch request is activated.

REMOTE REF AT 4 mA (*–32 767.0–32 767.0 rpm)—Remote Reference at 4 mA is the engine speed desired when 4 mA is applied to the Remote Speed Setting input.

REMOTE REF AT 20 mA (*–32 767.0–32 767.0 rpm)—Remote Reference at 20 mA is the engine speed desired when 20 mA is applied to the Remote Speed Setting input.

SPD SWITCH PICKUP (*100.0–2200.0 rpm)—Speed Switch Pickup is the engine speed (rpm) at which the minor or major alarm will activate. This speed switch was designed to cause a minor alarm, major alarm, or both. It will cause a minor or major alarm only if enabled in Configure mode.

SPD SWITCH DROPOUT (*1.0–2200.0 rpm)—SPD Switch Dropout is the engine speed (rpm) at which the minor or major alarm will deactivate.

START/MAX LIMITS

START FUEL LIMIT (*0.0–100.0%)—Start Fuel Limit sets the maximum percent actuator output current when the engine is starting. Once the engine speed reaches 95% of the current speed reference set point (and the PID is in control for 1 second), the Start Fuel Limit is disabled until the engine is shut down. The limit is usually set at the fuel level required to start the engine under all normal operating conditions.

START RAMP RATE (%/SEC) (*0.01–10 000.0 %/sec)—Start Ramp Rate sets the rate at which the start limiter ramps once it reaches the START FUEL LIMIT.

MAXIMUM FUEL LIMIT (*0.0–101.0%)—Maximum Fuel Limit sets the maximum percent actuator output current under any conditions. Maximum (100%) is based on 200 mA. The limit is usually set just above the output at full load. The percent output is displayed in service, under header *DISPLAY 1*, at prompt ACTUATOR % OUT.

DISCRETE IN

IMPORTANT **For all discrete inputs, a "TRUE" value indicates the contact input is closed and a "FALSE" indicates the contact input is open.**

STOP CONTACT (T/F)—Shows the status of the Stop contact (terminal 29).

RATED CONTACT (T/F)—Shows the status of the Rated contact (terminal 30).

RAISE SPEED CONTACT (T/F)—Shows the status of the Raise Speed contact (terminal 31).

LOWER SPEED CONTACT (T/F)—Shows the status of the Lower Speed contact (terminal 32).

DYNAMICS 2 CONTACT (T/F)—Shows the status of the Dynamics 2 contact (terminal 33).

CONTACT F (T/F)—Shows the status of Contact Input F (terminal 34).

CLUTCH REQUEST (T/F)—Shows the status of the Clutch Request contact (terminal 35).

CLUTCH ENGAGED (T/F)—Shows the status of the Clutch Engaged contact (terminal 36).

REMOTE SPD SELECTED (T/F)—Shows the status of the Remote Speed Selected contacts. Raise Speed and Lower Speed contacts must both be closed for this status to display "TRUE".

TORQUE LIMITER

IMPORTANT **If the Torque Limiter is not enabled (while in Configure mode) this header will not appear and the Torque Limiter is not active. The Torque Limiter is a six-point curve.**

BASED ON SPD REF (*T/F)—Set this value "TRUE" to use the engine speed reference as the torque limit reference. Set the value "FALSE" to use actual engine speed as the torque fuel reference.

TORQ LIMIT BKPT 1 (*0.0–2200.0 rpm)—This value is the torque fuel limit speed input for point 1.

TORQ LMT AT BKPT 1 (*0.0–101.0%)—This value is the torque fuel limit in percent actuator output for point 1.

TORQ LIMIT BKPT 2 (*0.0–2200.0 rpm)—This value is the torque fuel limit speed input for point 2.

TORQ LMT AT BKPT 2 (*0.0–101.0%)—This value is the torque fuel limit in percent actuator output for point 2.

TORQ LIMIT BKPT 3 (*0.0–2200.0 rpm)—This value is the torque fuel limit speed input for point 3.

TORQ LMT AT BKPT 3 (*0.0–101.0%)—This value is the torque fuel limit in percent actuator output for point 3.

TORQ LIMIT BKPT 4 (*0.0–2200.0 rpm)—This value is the torque fuel limit speed input for point 4.

TORQ LMT AT BKPT 4 (*0.0–101.0%)—This value is the torque fuel limit in percent actuator output for point 4.

TORQ LIMIT BKPT 5 (*0.0–2200.0 rpm)—This value is the torque fuel limit speed input for point 5.

TORQ LMT AT BKPT 5 (*0.0–101.0%)—This value is the torque fuel limit in percent actuator output for point 5.

TORQ LIMIT BKPT 6 (*0.0–2200.0 rpm)—This value is the torque fuel limit speed input for point 6.

TORQ LMT AT BKPT 6 (*0.0–101.0%)—This value is the torque fuel limit in percent actuator output for point 6.

MAN PRESS LIMITER

IMPORTANT **If the Manifold Air Pressure Limiter is not enabled (while in Configure mode) this header will not appear and the Manifold Air Pressure Limiter is not active. The Manifold Air Pressure is a six-point curve.**

FUEL LIMIT BKPT 1 (*0.0–20.0 mA)—This value is the Manifold Air Pressure (mA) input for point 1.

FUEL LMT AT BKPT 1 (*0.0–101.0%)—This value is the fuel limit in percent actuator output for point 1.

FUEL LIMIT BKPT 2 (*0.0–20.0 mA)—This value is the Manifold Air Pressure (mA) input for point 2.

FUEL LMT AT BKPT 2 (*0.0–101.0%)—This value is the fuel limit in percent actuator output for point 2.

FUEL LIMIT BKPT 3 (*0.0–20.0 mA)—This value is the Manifold Air Pressure (mA) input for point 3.

FUEL LMT AT BKPT 3 (*0.0–101.0%)—This value is the fuel limit in percent actuator output for point 3.

FUEL LIMIT BKPT 4 (*0.0–20.0 mA)—This value is the Manifold Air Pressure (mA) input for point 4.

FUEL LMT AT BKPT 4 (*0.0–101.0%)—This value is the fuel limit in percent actuator output for point 4.

FUEL LIMIT BKPT 5 (*0.0–20.0 mA)—This value is the Manifold Air Pressure (mA) input for point 5.

FUEL LMT AT BKPT 5 (*0.0–101.0%)—This value is the fuel limit in percent actuator output for point 5.

FUEL LIMIT BKPT 6 (*0.0–20.0 mA)—This value is the Manifold Air Pressure (mA) input for point 6.

FUEL LMT AT BKPT 6 (*0.0–101.0%)—This value is the fuel limit in percent actuator output for point 6.

TRANSIENT OVR FUEL

IMPORTANT **If NEITHER the Manifold Air Pressure or the Torque Fuel Limiters is enabled (while in Configure mode) this header will not appear and the Transient Overfuel is not active. When active, the Transient Overfuel affects the Manifold Air Pressure Limiter and the Torque Limiter. It does NOT affect the Start Fuel Limiter or the Maximum Fuel Limiter.**

OVER FUEL TIME (*0.0–10.0 sec)—Sets the amount of time the Over Fuel Bus Units will be added to one or both of the Manifold Limiter or Torque Limiter curves.

OVER FUEL BUS UNITS (*0.0–100.0%)—Sets the amount added in percent actuator output that the limiters are allowed to go above their limit set point.

RESPONSE TESTING

IMPORTANT	**Response Testing is used for initial dynamic setup of the 723 governor.**

ACT BUMP DURATION (0.1–2.0 sec)—This is the time (in seconds) that the Actuator Bump will last once initiated.

ACT BUMP LEVEL (0.0–100.0%)—This value is the percent actuator output current to which the actuator driver LSS bus will be limited to once the bump is initiated.

INITIATE BUMP (*T/F)—Toggling this value “FALSE” to “TRUE” initiates the Actuator Bump function.

TORSIONAL FILTER

TORSIONAL FILTER (*0.0–1.0)—This is the setting for the flexible coupling torsional filter. Set this value to the inertia factor found by using the formula in Chapter 3. If the Torsional Filter is not enabled (while in Configure mode) this header will not appear and the filter is not active.

NOTCH FREQUENCY (HZ) (*0.5–16.0 Hz)—This is the center frequency of rejection, and the units are defined in Hertz. In tuning the notch filter, the resonant frequency must be identified and entered.

NOTCH Q FACTOR (*0.707–25.0)—This is the width about the NOTCH FREQUENCY that the filter rejects, and is dimensionless. At the minimum value 0.707, there is no attenuation of signal gain at the resonant frequency, and the filter gain equals one. At the maximum value 20.0, a maximum attenuation of signal gain occurs at the resonant frequency, and the filter gain equals 0.035. In general, the filter gain at the resonant frequency is 0.707/Q factor.

RACK CALIBRATION

IMPORTANT	**ACT OUT @ NO LOAD and ACT OUT @ MAX LOAD must always be calibrated, regardless of whether the Rack Position Feedback input is used or not. If the Rack Position Feedback input is not used, calibration of the RACK OUT @ NO LOAD and RACK OUT @ MAX LOAD values is not required.**

ACT OUT @ NO LOAD (0.0–100.0%)—Find the normal engine operating condition that requires the least amount of fuel to run. This operating condition is when the engine is unloaded and hot, and at either idle or rated speed. Adjust this value to match the ACTUATOR % OUT under *DISPLAY 1* when the engine is at minimum load.

ACT OUT @ MAX LOAD (0.0–100.0%)—Adjust this value to match the ACTUATOR % OUT under *DISPLAY 1* when the engine is at full load.

RACK OUT @ NO LOAD (–150.0–150.0%)—Find the normal engine operating condition that requires the least amount of fuel to run. This operating condition is when the engine is unloaded and hot, and at either idle or rated speed. Adjust this value until the PERCENT LOAD prompt under the *DISPLAY 1* header reads 1.5 ±1.0 when the engine is at this unloaded condition.

RACK OUT @ MAX LOAD (–150.0–150.0%)—Adjust this value until the PERCENT LOAD prompt under the *DISPLAY 1* header reads 100 when the engine is at full load.

Check rack calibration with rack position feedback connected (if used) at minimum load and maximum load. The PERCENT LOAD at these points should be 0% and 100% respectively. If there are discrepancies, re-calibrate RACK OUT @ NO LOAD and RACK OUT @ MAX LOAD. Disconnect the rack position feedback and check PERCENT LOAD at minimum load and maximum load. If there are discrepancies, re-calibrate ACT OUT @ NO LOAD and ACT OUT @ MAX LOAD.

CALIBRATION

IMPORTANT

The Analog Out Cal header contains all the calibrations for the three configurable analog outputs (Analog Output #1, Analog Output #2, and Actuator Output #2). Each analog output is configurable to output one of five different selections. The selections and their numbers are: 1=Actual Engine Speed, 2=Present Speed Reference value, 3=Remote Speed Setting input, 4=Percent Load (which is either the percent actuator output current or Rack Position Feedback input after their calibration point), 5=PID Output, and 6=Torsional Level (the absolute difference between the two MPU signals, in rpm).

AOUT1 1 SELECTION (*1–6)—Selects which item will be output to analog output #1 (terminals #15 and #16).

AOUT1 FILTER (Hz) (*0.1–20.0)—This value provides an adjustable lag time in the output.

ANALOG OUTPUT #1 MIN (*–30 000.0–30 000.0)—This is the value when Output #1 is 4 mA. Depending on which one is selected, this can be the Actual Engine Speed, Present Speed Reference value, Remote Speed Setting input, Percent Load, or PID output.

ANALOG OUTPUT #1 MAX (*–30 000.0–30 000.0)—This is the value when Output #1 is 20 mA. Depending on which one is selected, this can be the Actual Engine Speed, Present Speed Reference value, Remote Speed Setting input, Percent Load, or PID output.

AOUT 2 SELECTION (*1–6)—Selects which item will be output to analog output #2 (terminals #17 and #18).

AOUT2 FILTER (Hz) (*0.1–20.0)—This value provides an adjustable lag time in the output.

ANALOG OUTPUT#2 MIN (*–30 000.0–30 000.0)—This is the value when Output #2 is 4 mA. Depending on which one is selected, this can be the Actual Engine Speed, Present Speed Reference value, Remote Speed Setting input, Percent Load, or PID output.

ANALOG OUTPUT#2 MAX (*–30 000.0–30 000.0)—This is the value when Output #2 is 20 mA. Depending on which one is selected, this can be the Actual Engine Speed, Present Speed Reference value, Remote Speed Setting input, Percent Load, or PID output.

ACT OUT 2 SELECTION (*1–6)—Selects which item will be output to analog output #3 (terminals #21 and #22).

ACT OUT 2 FILTER (Hz) (*0.1–20.0)—This value provides an adjustable lag time in the output.

ACTUATOR OUT#2 MIN (*–30 000.0–30 000.0)—This is the value when Output #3 is 4 mA. Depending on which one is selected, this can be the Actual Engine Speed, Present Speed Reference value, Remote Speed Setting input, Percent Load, or PID output.

ACTUATOR OUT#2 MAX (*–30 000.0–30 000.0)—This is the value when Output #3 is 20 mA. Depending on which one is selected, this can be the Actual Engine Speed, Present Speed Reference value, Remote Speed Setting input, Percent Load, or PID output.

LOAD CONTROL

CLUTCH SYNC TIME (*0.0–120.0 sec)—Set this value for the time it takes to receive the clutch engaged signal.

UNLOAD RATE (*0.01–100.0%/sec)—Set this value to the desired engine unload rate in percent load per second.

LOAD RATE (*0.01–100.0%/sec)—Set this value to the desired engine load rate in percent load per second.

UNLOAD TRIP POINT (*0.0–100.0%)—Set this value to the desired amount of load on the engine at which the clutch open command (clutch permissive contacts TB#7 and #8 open) will be issued when engine unload has been selected by opening the Clutch Request contact. This is typically set near 0%.

GAIN % @ LIGHT LOAD (*10.0–100.0%)—Gain % @ Light Load is the percent of Gain that is required at light loads to maintain stable paralleled engine operation. This Gain percentage is only active when the engines are paralleled and affects whichever Gain is selected (Gain 1 or Gain 2). This is typically set at 50% and should not need adjusting.

LITE LD GAIN PU (*0.0–101.0%)—Lite Ld Gain PU is the percent of engine load at which the Gain % @ Light Load function becomes active (is turned on). This is typically set at 10% and should not need adjusting.

LITE LD GAIN DO (*0.0–101.0%)—Lite Ld Gain DO is the percent of engine load at which the Gain % @ Light Load function becomes inactive (is turned off). This is typically set at 15% and should not need adjusting.

LOAD SWITCH PU (*0.0–101.0%)—Set this value to the desired engine load that will enable the load switch.

LOAD SWITCH DO (*0.0–101.0%)—Set this value to the desired engine load that will disable the load switch.

CLUTCH IN TIME (*1.0–120.0 sec)—Set this value to the maximum time for the Clutch Permissive Contact to remain closed waiting to receive a Clutch Engaged Contact.

CLUTCH SPEED WINDOW (*0.1–100.0 rpm)—Set this value to the allowable absolute speed difference between the clutched in engine and the engine to be clutched in.

DISPLAY 2

ACT SHUTDOWN (T/F)—A “TRUE” displayed indicates that the 723 is asking the actuator driver output to go to the minimum fuel point. A “FALSE” displayed indicates that the 723 is not asking the actuator driver output to go to the minimum fuel point.

ON DYNAMICS 2 (T/F)—A “TRUE” displayed indicates that dynamics #2 is currently being used. A “FALSE” displayed indicates that dynamics #1 is currently being used.

SPEED CONTROL MODE (T/F)—A “TRUE” displayed indicates that the 723 speed control PID has control of the actuator driver output. A “FALSE” displayed indicates that the 723 speed control PID does not have control of the actuator driver output (something else has control).

ON MAX FUEL LIMIT (T/F)—A “TRUE” displayed indicates that the Maximum Fuel Limiter has control of the actuator driver output. A “FALSE” displayed indicates that the Maximum Fuel Limiter does not have control of the actuator driver output (something else has control).

ON START FUEL LIMIT (T/F)—A “TRUE” displayed indicates that the Start Fuel Limiter has control of the actuator driver output. A “FALSE” displayed indicates that the Start Fuel Limiter does not have control of the actuator driver output (something else has control).

BOOST LIMIT MODE (T/F)—A “TRUE” displayed indicates that the Manifold Air Pressure Limiter input has control of the actuator driver output. A “FALSE” displayed indicates that the Manifold Air Pressure Limiter input does not have control of the actuator driver output (something else has control).

TORQUE LIMIT MODE (T/F)—A “TRUE” displayed indicates that the Torque Fuel Limiter has control of the actuator driver output. A “FALSE” displayed indicates that the Torque Fuel Limiter does not have control of the actuator driver output (something else has control).

ENGINE OVER SPED? (T/F)—A “TRUE” displayed indicates that the engine has hit the 723 control overspeed trip point. This will be automatically reset each time the engine speed reaches 5% of rated speed during a start, or it can be reset by the software reset found in Service mode, at either headers “MINOR ALARM” or “MAJOR ALARM” at prompt RESET ALL ALARMS.

PORT 2 LINK ERROR (T/F)—A “TRUE” displayed indicates that a communications error has occurred on Port 2.

PORT 3 LINK ERROR (T/F)—A “TRUE” displayed indicates that a communications error has occurred on Port 3.

USE MASTER SPD REF (T/F)—A “TRUE” indicates that this control is currently a “slave” and is using the other control’s speed reference.

DISPLAY 1

ENGINE SPEED (0–2000 rpm)—This is the sensed engine speed after it has been processed by the flexible coupling and firing torsional filters.

SPEED REFERENCE (0–2000 rpm)—This is the present value of the engine speed reference.

SPEED REF BIASED (0–2000 rpm)—This is the engine speed reference value plus the bias value from either the load sharing bridge or the AUX input.

ACTUATOR % OUT (0–100%)—This is the actuator output command percentage to the actuator. This value is the output of the final driver and may be forward (direct) or reverse (indirect) acting. The percentage is proportional to the actuator current (0–200 mA or 0–20 mA).

PERCENT LOAD (0–100%)—This is the calibrated actuator driver signal or (if used and not failed) the Rack Position Input signal after it has been calibrated. The actuator driver signal or the Rack Position Input signal should be calibrated so that at no-load this reads 0%, and at full-load this reads 100%.

REMOTE SPD REF (RPM) (0–2000 rpm)—This is the Remote Speed Setting value from Analog Input #2.

RACK INPUT (mA)—This is the rack position sensor 4–20 mA input (Analog Input #1) signal value, displayed in milliamps.

REMOTE SPD INPUT (mA)—This is the Remote Speed Input (Analog Input #2) signal value, displayed in milliamps.

MANIFOLD PRESS(mA)—This is the Manifold Air Pressure input value from Analog Input #3, displayed in milliamps.

AUX INPUT (Volts)—This is the voltage value seen on the Aux input terminals (Analog Input #4).

TORSIONAL LEVEL—This is the absolute difference (in rpm) between the two MPUs (when used).

	Port Unit	Starboard Unit
Hardware P/N:		
Hardware S/N:		
Software P/N:		

Date:

Vessel:

Menu Default Values

	CONFIGURE		
Menu Item	**Default (Low, High)**	**As Left Port**	**As Left Starboard**
CONFIG SPD CONTROL			
GEAR #1 TEETH	#60 (16, 300)		
GEAR #2 TEETH	#60 (16, 300)		
RATED SPEED	#900 (100, 2200)		
IDLE REF @ SHUTDOWN	#TRUE		
POWER UP TO IDLE	#TRUE		
IDLE WHEN COMM FAIL	#TRUE		
LINEAR DYNAMIC MAP	#FALSE		
DYN2 ON SPD SWITCH	#FALSE		
DYN2 WHEN CLUTCHED	#FALSE		
CONFIG OPTION			
USE TORQUE LIMITER	#FALSE		
USE MANIFOLD LIMITR	#FALSE		
PORT ENGINE	#FALSE		
ENBL COUPL TOR FILT	#FALSE		
REM LOCK IN LAST	#FALSE		
OVERRIDE FAILSAFE	#FALSE		
REVERSE ACTING ACT	#FALSE		
ENABLE AUX INPUT	#FALSE		
CT F AS OVRSPD TEST	#FALSE		
MANUAL CLUTCH LOGIC	#FALSE		
USE CONT E AS RESET	#FALSE		
USE DSLC AS SYNC	#TRUE		
MAJOR ALM SD ACT	#FALSE		
USE NOTCH FILTER	#FALSE		
MINOR ALARM TRIPS			
MPU 1 FAILED	#FALSE		
MPU 2 FAILED	#FALSE		
MANIFOLD AIR FAILED	#FALSE		
REMOTE SPEED FAILED	#FALSE		
RACK INPUT FAILED	#FALSE		
SPEED SWITCH	#FALSE		
TORQUE LIMITER	#FALSE		
MANIFOLD LIMITER	#FALSE		
HIGH ACT ALARM	#FALSE		
PORT 2 LINK ERROR	#FALSE		
PORT 3 LINK ERROR	#FALSE		
PORT 2&3 LINK ERROR	#FALSE		
PID @ LOW LEVEL	#FALSE		
HIGH SPEED SW	#FALSE		
LOAD SWITCH	#FALSE		
CLUTCH FAIL	#FALSE		
MAJOR ALARM TRIPS			
MPU 1 FAILED	#FALSE		
MPU 2 FAILED	#FALSE		
MANIFOLD AIR FAILED	#FALSE		
REMOTE SPEED FAILED	#FALSE		
RACK INPUT FAILED	#FALSE		
SPEED SWITCH	#FALSE		
TORQUE LIMITER	#FALSE		
MANIFOLD LIMITER	#FALSE		
HIGH ACT ALARM	#FALSE		
PORT 2 LINK ERROR	#FALSE		
PORT 3 LINK ERROR	#FALSE		
PORT 2&3 LINK ERROR	#FALSE		
PID @ LOW LEVEL	#FALSE		
HIGH SPEED SW	#FALSE		

LOAD SWITCH	#FALSE		
CLUTCH FAIL	#FALSE		
ALARM/SD CONFIGURE			
ALARM DELAY TIME	#0.5 (0.01, 60.0)		
OPEN CNT ON MIN ALM	#FALSE		
OPEN CNT ON MAJ ALM	#FALSE		
SHUTDOWN WHEN PID@0	#FALSE		
PID @ ZERO LEVEL	#0.0 (0.0, 100.0)		
PID @ ZERO TIME	#10.0 (0.0, 120.0)		
HIGH ACT ALM LEVEL (%)	#100.0 (0.0, 100.0)		
HIGH SPEED SD	#1000 (1, 2200)		
CFIG ANALOG OUTPUTS			
AOUT 1 4-20 mA?	#TRUE		
AOUT 2 4-20 mA?	#TRUE		
ACT OUT 2 4-20 mA?	#TRUE		
	SERVICE		
Menu Item	**Default (Low, High)**	**As Left Port**	**As Left Starboard**
MAJOR ALARMS			
MAJOR ALARM			
MPU 1 FAILED			
MPU 2 FAILED			
MANIFOLD AIR FAILED			
REMOTE SPEED FAILED			
RACK INPUT FAILED			
SPEED SWITCH ON			
TORQUE LIMITER			
MANIFOLD LIMITER			
HIGH ACT ALARM			
PORT 2 LINK ERROR			
PORT 3 LINK ERROR			
PORT 2&3 LINK ERROR			
PID @ LOW LEVEL			
HIGH SPEED SW			
LOAD SWITCH			
CLUTCH FAIL			
RESET ALL ALARMS	*FALSE		
MINOR ALARMS			
MINOR ALARM			
MPU 1 FAILED			
MPU 2 FAILED			
MANIFOLD AIR FAILED			
REMOTE SPEED FAILED			
RACK INPUT FAILED			
SPEED SWITCH ON			
TORQUE LIMITER			
MANIFOLD LIMITER			
HIGH ACT ALARM			
PORT 2 LINK ERROR			
PORT 3 LINK ERROR			
PORT 2&3 LINK ERROR			
PID @ LOW LEVEL			
HIGH SPEED SW			
LOAD SWITCH			
CLUTCH FAIL			
RESET ALL ALARMS	*FALSE		
DYNAMICS 1			
GAIN 1	*1.0 (0.01, 150.0)		
RESET 1	*1.0 (0.01, 50.0)		
ACT COMP 1	*0.2 (0.01, 1.0)		
GAIN RATIO 1	*1.0 (1.0, 20.0)		

WINDOW WIDTH 1	*25.0 (0.01, 150.0)		
GAIN SLOPE 1	*0.01 (0.01, 20.0)		
GAIN BKPT 1	*50.0 (0.01, 100.0)		
SPEED FILTER HZ	*20.0 (0.5, 20.0)		
DYNAMICS 2			
GAIN 2	*1.0 (0.01, 150.0)		
RESET 2	*1.0 (0.01, 50.0)		
ACT COMP 2	*0.2 (0.01, 1.0)		
GAIN RATIO 2	*1.0 (1.0, 20.0)		
WINDOW WIDTH 2	*25.0 (0.01, 150.0)		
GAIN SLOPE 2	*0.01 (0.01, 20.0)		
GAIN BKPT 2	*50.0 (0.01, 100.0)		
DYN 2 SPD SW PU	*500.0 (100.0, 2200.0)		
DYN 2 SPD SW DO	*400.0 (1.0, 2200.0)		
SPEED REFERENCE			
RAISE SPEED LIMIT	*900 (100, 2200)		
LOWER SPEED LIMIT	*300 (100, 2200)		
IDLE SPEED (RPM)	*350 (100, 2200)		
ACCEL RAMP (SEC)	*4.0 (0.0001, 500.0)		
DECEL RAMP (SEC)	*4.0 (0.0001, 500.0)		
RAISE SPEED RATE	*10.0 (1.0, 10000.0)		
LOWER SPEED RATE	*10.0 (1.0, 10000.0)		
SLV-MST RAMP RATE	*30.0 (1.0, 500.0)		
REMOTE REF AT 4 mA	*250.0 (-32767.0, 32767.0)		
REMOTE REF AT 20 mA	*900.0 (-32767.0, 32767.0)		
SPD SWITCH PICKUP	*500.0 (100.0, 2200.0)		
SPD SWITCH DROPOUT	*400.0 (1.0, 2200.0)		
START/MAX LIMITS			
START FUEL LIMIT	*40.0 (0.0, 100.0)		
START RAMP RATE (%/SEC)	*1.0 (0.01, 10000.0)		
MAXIMUM FUEL LIMIT	*70.0 (0.0, 101.0)		
DISCRETE IN			
STOP CONTACT			
RATED CONTACT			
RAISE SPEED CONTACT			
LOWER SPEED CONTACT			
DYNAMICS 2 CONTACT			
CONTACT F			
CLUTCH REQUEST			
CLUTCH ENGAGED			
REMOTE SPD SELECTED			
TORQUE LIMITER			
BASED ON SPD REF	*FALSE		
TORQ LIMIT BKPT 1	*600.0 (0.0, 2200.0)		
TORQ LMT AT BKPT 1	*101.0 (0.0, 101.0)		
TORQ LIMIT BKPT 2	*700.0 (0.0, 2200.0)		
TORQ LMT AT BKPT 2	*101.0 (0.0, 101.0)		
TORQ LIMIT BKPT 3	*800.0 (0.0, 2200.0)		
TORQ LMT AT BKPT 3	*101.0 (0.0, 101.0)		
TORQ LIMIT BKPT 4	*900.0 (0.0, 2200.0)		
TORQ LMT AT BKPT 4	*101.0 (0.0, 101.0)		
TORQ LIMIT BKPT 5	*1000.0 (0.0, 2200.0)		
TORQ LMT AT BKPT 5	*101.0 (0.0, 101.0)		
TORQ LIMIT BKPT 6	*1100.0 (0.0, 2200.0)		
TORQ LMT AT BKPT 6	*101.0 (0.0, 101.0)		
MAN PRESS LIMITER			
FUEL LIMIT BKPT 1	*4.0 (0.0, 20.0)		
FUEL LMT AT BKPT 1	*101.0 (0.0, 101.0)		
FUEL LIMIT BKPT 2	*8.0 (0.0, 20.0)		
FUEL LMT AT BKPT 2	*101.0 (0.0, 101.0)		
FUEL LIMIT BKPT 3	*12.0 (0.0, 20.0)		

FUEL LMT AT BKPT 3	*101.0 (0.0, 101.0)		
FUEL LIMIT BKPT 4	*16.0 (0.0, 20.0)		
FUEL LMT AT BKPT 4	*101.0 (0.0, 101.0)		
FUEL LIMIT BKPT 5	*18.0 (0.0, 20.0)		
FUEL LMT AT BKPT 5	*101.0 (0.0, 101.0)		
FUEL LIMIT BKPT 6	*20.0 (0.0, 20.0)		
FUEL LMT AT BKPT 6	*101.0 (0.0, 101.0)		
TRANSIENT OVR FUEL			
OVER FUEL TIME	*0.0 (0.0, 10.0)		
OVER FUEL BUS UNITS	*0.0 (0.0, 100.0)		
RESPONSE TESTING			
ACT BUMP DURATION	*0.1 (0.1, 2.0)		
ACT BUMP LEVEL	*100.0 (0.0, 100.0)		
INITIATE BUMP	*FALSE		
TORSIONAL FILTER			
TORSIONAL FILTER	*0.5 (0.0, 1.0)		
NOTCH FREQUENCY (HZ)	*15.9 (0.5, 16.0)		
NOTCH Q FACTOR	*0.707 (0.707, 25.0)		
RACK CALIBRATION			
ACT OUT @ NO LOAD	*15.0 (0.0, 100.0)		
ACT OUT @ MAX LOAD	*70.0 (0.0, 100.0)		
RACK OUT @ NO LOAD	*0.0 (-150.0, 150.0)		
RACK OUT @ MAX LOAD	*100.0 (-150.0, 150.0)		
CALIBRATION			
AOUT 1 SELECTION	*1 (1, 6)		
AOUT 1 FILTER (Hz)	*20.0 (0.1, 20.0)		
ANALOG OUTPUT#1 MIN	*0.0 (-30000.0, 30000.0)		
ANALOG OUTPUT#1 MAX	*1800.0 (-30000.0, 30000.0)		
AOUT 2 SELECTION	*4 (1, 6)		
AOUT 2 FILTER (Hz)	*20.0 (0.1, 20.0)		
ANALOG OUTPUT#2 MIN	*0.0 (-30000.0, 30000.0)		
ANALOG OUTPUT#2 MAX	*100.0 (-30000.0, 30000.0)		
ACT OUT 2 SELECTION	*5 (1, 6)		
ACT OUT 2 FILTER(Hz)	*20.0 (0.1, 20.0)		
ACTUATOR OUT#2 MIN	*0.0 (-30000.0, 30000.0)		
ACTUATOR OUT#2 MAX	*100.0 (-30000.0, 30000.0)		
LOAD CONTROL			
CLUTCH SYNC TIME	*2.0 (0.0, 120.0)		
UNLOAD RATE	*2.0 (0.01, 100.0)		
LOAD RATE	*2.0 (0.01, 100.0)		
UNLOAD TRIP POINT	*0.0 (0.0, 100.0)		
GAIN % @ LIGHT LOAD	*50.0 (10.0, 100.0)		
LITE LD GAIN PU	*10.0 (0.0, 101.0)		
LITE LD GAIN DO	*15.0 (0.0, 101.0)		
LOAD SWITCH PU	*101.0 (0.0, 101.0)		
LOAD SWITCH DO	*100.0 (0.0, 101.0)		
CLUTCH IN TIME	*5.0 (1.0, 120.0)		
CLUTCH SPEED WINDOW	*20.0 (0.1, 100.0)		
DISPLAY 2			
ACT SHUTDOWN			
ON DYNAMICS 2			
SPEED CONTROL MODE			
ON MAX FUEL LIMIT			
ON START FUEL LIMIT			
BOOST LIMIT MODE			
TORQUE LIMIT MODE			
ENGINE OVER SPED?			
PORT 2 LINK ERROR			
PORT 3 LINK ERROR			
USE MASTER SPD REF			
RESET ALL ALARMS	*FALSE		

DISPLAY 1			
ENGINE SPEED			
SPEED REFERENCE			
SPEED REF BIASED			
ACTUATOR % OUT			
PERCENT LOAD			
REMOTE SPD REF(RPM)			
RACK INPUT (mA)			
REMOTE SPD INPUT(mA)			
MANIFOLD PRESS(mA)			
AUX INPUT (Volts)			
TORSIONAL LEVEL			

Chapter 5. Installation and Calibration

Introduction

Read through this chapter entirely before proceeding with the I/O verification and calibration.

For the hardware installation and wiring information, refer to the 723 Hardware Manual, 02758. The hardware manual contains the specific installation information including wire gauge and shielding requirements.

Do not run the engines during the following calibration except where noted.

Should any of the transducers, sensor, companion 723 control, or field devices connected to the 723 control's inputs be changed at a later time, the corresponding input calibration will need to be performed before returning the engine to normal operation.

The "Companion Control" or "Companion 723 Control" refers to the other 723 control. If you are working on the port 723 control, the starboard 723 control is the "companion". If you are working on the starboard 723 control, the port 723 control is the "companion".

The following calibration procedure uses the default hardware settings for the analog I/O. Wherever 4–20 mA is mentioned, the appropriate equivalent 0–1 mA or 1–5 Vdc signal can be used instead. For example, if Analog Input #1 has been configured for 0–1 mA, then 0 mA can be used in place of 4 mA, and 1 mA can be used in place of 20 mA. The same applies if the milliamp jumper is removed for 1–5 Vdc input. Then 1 Vdc can be used in place of 4 mA, and 5 Vdc can be used in place of 20 mA.

If the 723 control response or the hand held readout do not agree with the information listed, stop and correct the problem before continuing with the next step. For optional I/O that is not used in the application, the respective installation and calibration can be skipped. Complete the I/O Verification before proceeding to the I/O Calibration and running the engine.

Do NOT start the engine(s) at this point. Lock the engine(s) out so they will not start or attempt to start during the I/O Verification.

I/O Verification

Apply 18–40 Vdc power supply [TB1 (+) and TB2 (–)] to the 723 control. After approximately 20 seconds, the green CPU LED should illuminate. Once the CPU LED is illuminated, plug the hand held programmer into J1. The hand held programmer will be used during the I/O verification and calibration.

RUN/STOP Switch (Discrete Input A)

Place the Run/Stop switch in the stop position (closed). The prompt STOP CONTACT, under the header *DISCRETE IN*, should read “TRUE”. Place the Run/Stop switch in the run position (open). The STOP CONTACT prompt should read “FALSE”. Do not allow the engine to start during this step.

⚠WARNING **The Run/Stop switch should be used in conjunction with the normal shutdown devices. The Run/Stop should NOT be used as the emergency shutdown for the engine.**

CLOSE FOR RATED SPEED Switch (Discrete Input B)

Place the Close For Rated Speed switch in the Rated Speed position (closed). The prompt RATED CONTACT, under the header *DISCRETE IN*, should read “TRUE”. Place the Close For Rated Speed switch in the Idle Speed position (open). The RATED CONTACT prompt should read “FALSE”.

RAISE SPEED Switch (Discrete Input C)

Place the Raise Speed switch in the Raise Speed position (closed). The prompt RAISE SPEED CONTACT, under the header *DISCRETE IN*, should read “TRUE”. Place the Raise Speed switch in the open position. The RAISE SPEED CONTACT prompt should read “FALSE”.

LOWER SPEED Switch (Discrete Input D)

Place the Lower Speed switch in the Lower Speed position (closed). The prompt LOWER SPEED CONTACT, under the header *DISCRETE IN*, should read “TRUE”. Place the Lower Speed switch in the open position. The LOWER SPEED CONTACT prompt should read “FALSE”.

DYNAMICS 2 Switch (Discrete Input E)

Place the Dynamics 2 switch in the Dynamics Set 2 select position (closed). The prompt DYNAMICS 2 CONTACT, under the header *DISCRETE IN*, should read “TRUE”. Place the Dynamics 2 switch in the Dynamics Set 1 selected position (open). The DYNAMICS 2 CONTACT prompt should read “FALSE”.

Contact F— OVERSPEED/ EMERGENCY DECLUTCH Switch (Discrete Input F)

Place the Contact F switch in the ON position (closed). The prompt CONTACT F, under the header *DISCRETE IN*, should read “TRUE”. Place the Contact F switch in the OFF position (open). The CONTACT F prompt should read “FALSE”.

CLUTCH REQUEST Switch (Discrete Input G)

Place the Clutch Request switch in the Clutch Request position (closed). The prompt CLUTCH REQUEST, under the header *DISCRETE IN*, should read “TRUE”. Place the Clutch Request switch in the Declutch position (open). The CLUTCH REQUEST prompt should read “FALSE”.

CLUTCH ENGAGED Switch (Discrete Input H)

Place the Clutch Engaged switch in the Clutch Engaged position (closed). The prompt CLUTCH ENGAGED, under the header *DISCRETE IN*, should read “TRUE”. Place the Clutch Engaged switch in the Clutch is NOT Engaged position (open). The CLUTCH ENGAGED prompt should read “FALSE”.

Minor Alarm Relay (Relay Output #1)

A minor alarm may or may not be active at this time. The MINOR ALARM prompt at header *MINOR ALARMS* will be "TRUE" when a minor alarm is active and "FALSE" if there are no minor alarms. The position of the contacts on terminals 3 and 4 (Relay #1 energized or de-energized) when a minor alarm is active depends on the selection made in Configure mode, under header ALARM CONFIGURE, at prompt OPEN CNT ON MIN ALM.

If at prompt OPEN CNT ON MIN ALM, the value is set "FALSE", then closed contacts (Relay #1 energized) on terminals 3 & 4 indicate a minor alarm is active, and open contacts (Relay #1 de-energized) indicate no minor alarm. If at prompt OPEN CNT ON MIN ALM, the value is set "TRUE", then open contacts (Relay #1 de-energized) on terminals 3 & 4 indicate a minor alarm is active, and closed contacts (Relay #1 energized) indicate no minor alarm.

Verify that Relay #1 contacts are configured for the desired logic, closed or open, upon active Minor Alarm. Verify that the current contact status matches the MINOR ALARM prompt and is correctly indicated by the necessary monitoring, shutdown, and alarm equipment.

Major Alarm Relay (Relay Output #2)

A major alarm may or may not be active at this time. The MAJOR ALARM prompt at header *MAJOR ALARMS* will be "TRUE" when a major alarm is active and "FALSE" if there are no major alarms. The position of the contacts on terminal 5 & 6 (Relay #2 energized or de-energized) when a major alarm is active depends on the selection made in Configure mode, under header ALARM CONFIGURE, at prompt OPEN CNT ON MAJ ALM.

If at prompt OPEN CNT ON MAJ ALM, the value is set "FALSE", then closed contacts (Relay #2 energized) on terminals 5 & 6 indicate a major alarm is active, and open contacts (Relay #2 de-energized) indicate no major alarm. If at prompt OPEN CNT ON MAJ ALM, the value is set "TRUE", then open contacts (Relay #2 de-energized) on terminals 5 & 6 indicate a major alarm is active, and closed contacts (Relay #2 energized) indicate no major alarm.

Verify that Relay #2 contacts are configured for the desired logic, closed or open, upon active Major Alarm. Verify that the current contact status matches the MAJOR ALARM prompt and is correctly indicated by the necessary monitoring, shutdown, and alarm equipment.

CLUTCH COMMAND Contacts (Relay Output #3)

The contacts at terminals 7 & 8 will be closed when clutched in, or when requested to clutch in and all the clutching permissives have been met. The contacts at terminals 7 & 8 will be open once asked to declutch, and the engine load is ramped to the Unload Trip Point. The contacts at terminals 7 & 8 will open immediately if Contact F is configured as an Emergency Declutch contact and Contact F is closed. Jumper terminals 7 & 8 and verify that the respective clutch relay picks up. Remove the jumper and verify that the relay drops out.

FAILED SPD SENSOR #1 LED

The failed speed sensor #1 LED is a visual indication that speed sensor 1 has gone below the failsafe speed while the 723 control was in run mode.

FAILED SPD SENSOR #2 LED

The failed speed sensor #2 LED is a visual indication that speed sensor 2 has gone below the failsafe speed while the 723 control was in run mode.

ALARM #1 LED

This LED is a visual indication that two 723 controls on a common gear box (companion controls) were both programmed as either PORT or STARBOARD engine control. Do not parallel engines until this LED has been extinguished.

ALARM #2 LED

This LED is programmed to illuminate when both J2 and J3 have a communication fault. If this LED is illuminated, the controls will act as if they are in a single engine system. All engine synchronizing (speed matching) must be done manually. For proper operation this LED must be OFF!

Speed Sensor 1 (Speed Sensor Input #1)

Verify the MPU shield is tied only to the 723 control ground and nowhere else in the system. If an MPU is used, measure the resistance across terminals 11 & 12. The resistance depends on the MPU used but should be less than 250 Ω. Disconnect the MPU connector at the MPU and the resistance value should be greater than 250 Ω. The typical input resistance for an MPU speed sensor is 250 ±50 Ω. Check the resistance of the MPU and verify it is within the manufacturer’s specifications. Reconnect the MPU connector.

A proximity probe cannot be tested using this manner. For a proximity probe, verify the wiring to the proximity probe including the power supply wiring. The MPU or proximity probe will be tested prior to running the engine.

Speed Sensor 2 (Speed Sensor Input #2)

Speed Sensor 2 is an optional input. Verify the MPU shield is tied only to the 723 control ground and nowhere else in the system. If an MPU is used for the speed sensor, measure the resistance across terminals 13 & 14. The resistance depends on the MPU used, but should be less than 250 A. Disconnect the MPU connector at the MPU and the resistance value should be greater than 250 Ω. The typical input resistance for an MPU speed sensor is 250 ±50 Ω. Check the resistance of the MPU and verify it is within the manufacture’s specifications. Reconnect the MPU connector.

A proximity probe cannot be tested using this manner. For a proximity probe, verify the wiring to the proximity probe including the power supply wiring. The MPU or proximity probe will be tested prior to running the engine.

Actuator Output

Verify the actuator wiring from the 723 control to the actuator. Verify proper polarity as well as shield continuity. The shield should be connected only at the 723 control and nowhere else in the system. Verify the actuator output current (0– 200 mA or 4–20 mA) matches the actuator input. Refer to the actuator manual for proper wiring connections and signal input. The 723 control, actuator, and actuator wiring will be tested prior to starting the engine.

RACK POSITION (Analog Input #1)

The fuel Rack Position input signal comes from a transducer located on the engine fuel rack. For best results the input signal should be linear when compared to the actual fuel rack position. The input signal must be direct acting (increasing fuel rack position with increasing fuel). To verify the fuel rack transducer, view the Rack Position input in Service mode, under header *DISPLAY 1*, at prompt RACK INPUT (mA). Release any mechanical stops on the engine fuel rack and take any necessary precautions (shut off fuel, starting air, etc.) to prevent the engine from starting or being started at this time. Install a current meter in the wiring between the transducer and the 723 control. Move the fuel rack from minimum to maximum fuel position and verify the current meter tracks the RACK INPUT within ±10%. Verify the advertised output of the rack position transducer matches the current meter as well. The input will be calibrated later, so the accuracy is not critical at this time. Remove the current meter and return the wiring to its original condition.

Remote Speed Setting (Analog Input #2)

The remote speed input is intended to be used with only one speed setting device, typically the bridge controller. However, some applications may require that two or more speed devices be used. Ideally the two speed setting devices need to be matched very closely. The calibration of the remote speed setting input will be covered later. At this point, verify the wiring and any relay logic that may be used to switch between multiple speed setting devices. With the hand held programmer, view the Remote Speed Setting (in rpm), in Service mode, under header *DISPLAY 1*, at prompt REMOTE SPEED REF. Set the remote speed setting device to its idle speed position (4 mA). Verify the REMOTE SPEED REF prompt reads at or near the desired engine idle rpm. Move the remote speed setting device to its rated speed position (20 mA). Verify the REMOTE SPEED REF prompt reads at or near the desired engine rated rpm. If multiple speed devices are used, repeat this process for all devices to verify proper wiring. It may be useful to record the different signal input ranges for all devices for the remote speed calibration. Verify the shield is connected only to the 723 control and nowhere else in the system.

MANIFOLD AIR PRESSURE (Analog Input #3)

This is an optional input and can be skipped if the function is disabled. The Manifold Air Pressure fuel limit is an input signal from a sensor (pressure, temperature, etc.) to limit fuel rack position based on the input signal. To verify the input, the field sensor or device needs to be monitored. Install a current meter in the wiring. With the hand held programmer one can view the Manifold Pressure input (it is displayed in mA), in Service mode, under header *DISPLAY 1*, at prompt MANIFOLD PRESS (mA). Set the MANIFOLD PRESSURE device to its 4 mA position. Verify the MANIFOLD PRESS (mA) matches (±1.0%) the milliamp reading on the current meter. Set the MANIFOLD PRESSURE device to its 20 mA position. Verify the MANIFOLD PRESS (mA) matches (±1.0%) the milliamp reading on the current meter. The input will be calibrated later, so the accuracy is not critical at this time. Also compare the current meter reading with the advertised output for the field sensor or device and verify that they agree. If possible, exercise the field sensor or device and verify that the MANIFOLD PRESS (mA) reading and current meter track each other throughout the range. Remove the current meter and return the wiring to its original state. Verify shield wire is connected only to the 723 control and nowhere else in the system.

±5 Vdc Auxiliary Input (Analog Input #4)

The ±5 Vdc Auxiliary input is programmed to be used with the Woodward DSLC™ Digital Synchronizer and Load Control or SPM-A synchronizer. Verify the wiring between the synchronizer unit and the 723 control at this time. Verify that the jumper on terminals 50 and 51 is removed. Verify the shield is connected at the 723 control.

Load Sharing Lines

Verify the wiring between the 723 controls for the load sharing lines. The load sharing line shield must be connected only at one of the 723 controls. The load sharing line signals will be tested after the engine is running.

I/O Calibration

In some applications, it may not be possible or practical to achieve 4–20 mA full range for the Manifold Air Pressure, Rack Position, or Remote Speed Setting analog inputs. All of these inputs can be calibrated, or scaled, to use almost any range within the 4 mA and 20 mA limits. If the input signal falls outside of the 4 mA and 20 mA limits, proper fault detection cannot be guaranteed.

At this point the engine still has not been started. Do not attempt the start the engine until told to do so during the I/O calibration. All precautions to keep the engine from starting should remain in place.

Configure and Service Menu Preset

The first step in the calibration process is to go through the applicable configure and service menus and preset as many menu items as possible. See Chapter 4 for menu item definitions and details. If a preset is unknown for a menu item, leave it at its default setting.

With the hand held programmer, access the configuration headers (see Chapter 4). View the CONFIG SPD CONTROL configure header. Step through the menu items and adjust the values to match the critical engine configurations. After completing the configuring of the items under the CONFIG SPD CONTROL configure header, continue in the same manner with the other five configure headers (CONFIG OPTION, MINOR ALARM TRIPS, MAJOR ALARM TRIPS, ALARM/SD CONFIGURE, and CONFIG ANALOG OUTPUTS), enabling/ disabling functions and setting the tunable values until all items are set as desired. See Chapter 4 for menu item definitions. Upon completion of adjusting all configuration menu items, save the settings by pressing the SAVE button on the hand held programmer. Exit the configuration headers. The 723 control will reboot before returning to normal operation. Reboot takes about 20 to 30 seconds.

With the hand held programmer, go through the service menus and preset any applicable menu items. Several of the service menus do not have any adjustments available and can be skipped. Several of the menu items are calibrations that will be fine tuned later but can be preset at this time.

Minor Alarm (Discrete Output #1)

Configurable for normally open (relay #1 de-energized) or normally closed contacts (relay #1 energized). No calibration needed.

Major Alarm (Discrete Output #2)

Configurable for normally open (relay #2 de-energized) or normally closed contacts (relay #2 energized). No calibration needed.

Clutch Permissive Output (Discrete Output #3)

No configuration needed.

Load Sharing Lines

No calibration available.

Analog Output #1

Analog output #1 is configurable to output one of six different selections. This selection is made in Service mode, under header *CALIBRATION* at the prompt AOUT 1 SELECTION. The selections and their numbers are: 1=Actual Engine Speed, 2=Present Speed Reference value, 3=Remote Speed Setting input, 4=Percent Load (which is based on actuator output current or Rack Position Feedback input), 5=Actuator Output, and 6=Torsional Level.

The first thing to be decided is which one of the six selections is to be displayed as a 4–20 mA output. Once the decision is made, calibrate the analog output by programming at two places, the minimum point (4 mA) and the maximum point (20 mA). For example, if selection 1 was made (Actual Engine Speed) and the meter being driven by this analog output is designed to display 0 rpm at 4 mA and 1000 rpm at 20 mA, then 0 rpm/4 mA is the first point and 1000 rpm/20 mA is the second point. To calibrate these two points, enter Service mode and find header *CALIBRATION*. At prompt ANALOG OUTPUT #1 MIN, adjust the value viewed to the desired engine speed (in engine rpm) for 4 mA output. Move to the next menu item in that header, which will be a prompt that reads ANALOG OUTPUT #1 MAX, and adjust the value viewed to the desired engine speed (in engine rpm) for 20 mA output (see Figure 5-1).

The prompts ANALOG OUTPUT #1 MIN and ANALOG OUTPUT #1 MAX do not display the engineering units of the value being displayed, so you will have to remember which selection was made while at the AOUT 1 SELECTION prompt. If “1”, “2”, “3”, or “6” were selected, the units are engine rpm. If “4” or “5” were selected, the units will be percent.

Analog Output #2

Analog output #2 is configurable to output one of six different selections. This selection is made in Service mode, under header *CALIBRATION* at the prompt AOUT 2 SELECTION. The selections and their numbers are: 1=Actual Engine Speed, 2=Present Speed Reference value, 3=Remote Speed Setting input, 4=Percent Load (which is based on actuator output current or Rack Position Feedback input), 5=Actuator Output, and 6=Torsional Level.

The first thing to be decided is which one of the six selections is to be displayed as a 4–20 mA output. Once the decision is made, calibrate the analog output by programming at two places, the minimum point (4 mA) and the maximum point (20 mA). For example, if selection 1 was made (Actual Engine Speed) and the meter being driven by this analog output is designed to display 0 rpm at 4 mA and 1000 rpm at 20 mA, then 0 rpm/4 mA is the first point and 1000 rpm/20 mA is the second point. To calibrate these two points, enter Service mode and find header *CALIBRATION*. At prompt ANALOG OUTPUT #2 MIN, adjust the value viewed to the desired engine speed (in engine rpm) for 4 mA output. Move to the next menu item in that header, which will be a prompt that reads ANALOG OUTPUT #2 MAX, and adjust the value viewed, to the desired engine speed (in engine rpm) for 20 mA output (see Figure 5-1).

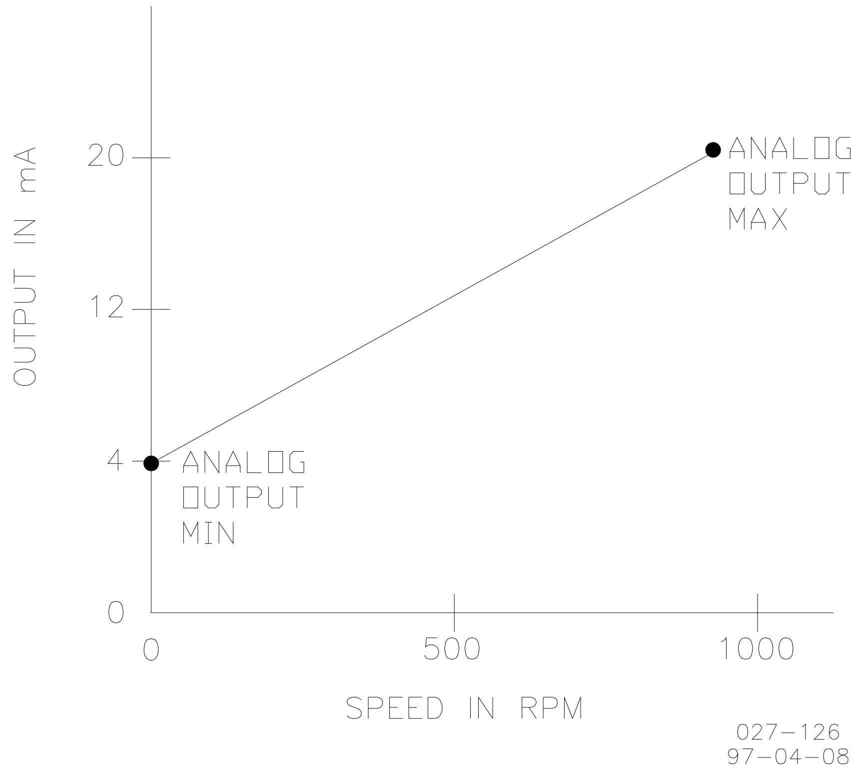


Figure 5-1. Analog Output Calibration Example

The prompts ANALOG OUTPUT #2 MIN and ANALOG OUTPUT #2 MAX do not display the engineering units of the value being displayed, so you will have to remember which selection was made while at the AOUT 2 SELECTION prompt. If “1”, “2”, “3”, or “6” were selected, the units are engine rpm. If “4” or “5” were selected, the units will be percent.

Speed Sensor #1 (Speed Sensor Input #1)

No calibration needed.

Speed Sensor #2 (Speed Sensor Input #2)

No calibration needed.

Actuator Output #1

No calibration needed.

Actuator Output #2

Actuator Output #2 is configurable to output one of six different selections. This selection is made in Service mode, under header *CALIBRATION* at the prompt ACT OUT 2 SELECTION. The selections and their numbers are: 1=Actual Engine Speed, 2=Present Speed Reference value, 3=Remote Speed Setting input, 4=Percent Load (which is based on actuator output current or Rack Position Feedback input), 5=Actuator Output, and 6=Torsional Level.

The first thing to be decided is which one of the six selections is to be displayed as a 4–20 mA output. Once the decision is made, calibrate the analog output by programming at two places, the minimum point (4 mA) and the maximum point (20 mA). For example, if selection 1 was made (Actual Engine Speed) and the meter being driven by this analog output is designed to display 0 rpm at 4 mA and 1000 rpm at 20 mA, then 0 rpm/4 mA is the first point and 1000 rpm/20 mA is the second point. To calibrate these two points, enter Service mode and find header *CALIBRATION*. At prompt ACTUATOR OUT #2 MIN, adjust the value viewed to the desired engine speed (in engine rpm) for 4 mA output. Move to the next menu item in that header, which will be a prompt that reads ACTUATOR OUT #2 MAX, and adjust the value viewed to the desired engine speed (in engine rpm) for 20 mA output (see Figure 5-1).

The prompts ACTUATOR OUT #2 MIN and ACTUATOR OUT #2 MAX do not display the engineering units of the value being displayed, so you will have to remember which selection was made while at the OUTPUT #3 SELECT prompt. If “1”, “2”, “3”, or “6” were selected, the units are engine rpm. If “4” or “5” were selected, the units will be percent.

Discrete Inputs A–H

No calibration needed.

Rack Position Input (Analog Input #1)

The Rack Position Input is optional. If it is not used or fails, the 723 control will default to using the actuator driver output to indicate engine load.

IMPORTANT — **Since the percent actuator driver signal is used for the default condition, it must always be calibrated.**

The fuel rack position transducer setup is done by adjusting two known points of the rack position transducer output: the minimum mechanical stop and the maximum mechanical stop. The rack transducer setup should be done with the engine shut down. The rack shutdown device(s) must be released so the fuel rack can be moved from stop to stop by hand. The input signal can be direct acting (increase fuel to increase milliamps) or indirect acting (decrease fuel to increase milliamps). Most Woodward integral actuator/LVDTs are indirect acting. With a milliamp meter connected in series with the rack position input, and the rack held at its minimum mechanical stop, verify that the meter reads 4.0 mA for direct acting and 20.0 mA for indirect acting. Next, move the fuel rack to its maximum mechanical stop and verify that the meter reads 20.0 mA for direct acting and 4.0 mA for indirect acting. If the calibration of the signal conditioner is not correct, then calibration adjustments are required. For non-Woodward signal conditioners follow the calibration instructions provided with the equipment. For the Woodward signal conditioner with the Woodward integral actuator/LVDT:

1. Connect actuator LVDT wiring (see Figure 1-3).

2. All potentiometers should be initially set at 12.5 turns from the CCW (counterclockwise) end (approximately centered).

3. With the rack at the maximum stop, adjust the Offset Potentiometer approximately to the required output level (4 mA).

4. With the rack at the minimum stop, adjust the Gain potentiometer approximately to the required output level (20 mA).

5. While remaining at the minimum stop, adjust the Phase Compensation potentiometer for the maximum output level (until it peaks).

6. Continue to adjust only the Offset and Gain potentiometers to obtain the correct output levels at the corresponding fuel rack positions.

To set up the 723 rack calibration inputs for direct acting, set 723 menu item **RACK CALIBRATION - RACK OUT @ NO LOAD** = 0% and **RACK CALIBRATION - RACK OUT @ MAX LOAD** = 100%.

To set up the 723 rack calibration inputs for indirect acting, set 723 menu item **RACK CALIBRATION - RACK OUT @ NO LOAD** = 100% and **RACK CALIBRATION - RACK OUT @ MAX LOAD** = 0%.

These adjustments should get you fairly close, and you may have to do some fine tuning, but **DISPLAY 1 - PERCENT LOAD** should always (direct or indirect) be 0% at min rack and 100% at max rack.

Remote Speed Setting Input (Analog Input #2)

The remote speed setting milliamp input signal must be calibrated for acceptable system performance. Verify with a milliamp meter that the remote speed setting device outputs 4 mA at the minimum position to the 723 and 20 mA to the 723 at the maximum position. With the hand held programmer, go in Service mode, go to the header *DISPLAY 1*, and at prompt REMOTE SPEED REF, view the remote speed setting input (it is displayed in rpm). This is the milliamp input signal after it has been converted to rpm. While leaving the REMOTE SPEED REF displayed on one line of the hand held programmer, find and display the prompt REMOTE REF @ 4 mA (it is under header *SPEED REFERENCE*) on the other line of the hand held programmer. Set the remote speed setting device for its minimum speed position. Adjust the REMOTE REF @ 4 mA value until the REMOTE SPEED REF prompt value displays the desired speed reference setting (in rpm) for this position. Set the remote speed setting device for its maximum speed position. Adjust the REMOTE REF @ 20 mA value until the REMOTE SPEED REF prompt value displays the desired speed reference setting (rpm) for this position. Move the remote speed setting device for between its minimum speed position and its maximum speed position to verify the desired speed settings at each position. The remote speed setting input is now calibrated.

The remote speed input is intended to be used with only one speed setting device, typically the bridge controller. However, some applications may require two or more speed devices be used. Due to the differences in the output signal from the multiple speed setting devices, the remote speed setting input calibration may have to be compromised to achieve acceptable results. For example, if one speed setting device output signal is 3.80 mA to 19.80 mA and the other speed device is 4.20 mA to 20.20 mA, it will only be possible to accurately calibrate one of the devices. If device one is calibrated accurately, then the second device will not function properly. Due to the offset in the second device, it will not be possible to reach the idle speed (4.20 mA). The second device may also trigger the high signal fault for the remote speed input at its rated speed position (20.20 mA). And conversely if the second speed setting device is calibrated accurately then similar problems may occur when using the first speed setting device. When speed setting device one is at its idle position (3.80 mA), the low signal fault for the remote speed input may be triggered, and it will not be possible to reach rated speed (19.80 mA).

There are two choices to correct this problem. First, calibrate both speed devices so the output signals are very close to each other. The range and offset of the output signal do not matter as long as they are identical. The second option is to calibrate the remote speed setting using a combination of the two speed setting signals. The device with the lower idle speed signal would be used for the low end calibration (REMOTE REF @ 4 mA). The device with the higher rated speed signal would be used for the high end calibration (REMOTE REF @ 20 mA). From the above example, use the first speed setting device for the low end (Idle Speed) calibration (3.80 mA) and use the second speed setting device for the high end (Rated Speed) calibration (20.20 mA). The resulting calibration will not cause any remote speed input faults, however there will be some deadband on the respective speed setting devices. One unit will not be able to reach its idle speed (device two in our example) and the other device will not be able to reach its rated speed (device one in our example). The deadband will be proportional to the error between the two devices. Ideally the two speed setting devices need to be matched very closely.

Manifold Air Pressure Input (Analog Input #3)

The manifold air pressure fuel limit is an optional input, and this section may be skipped if the function is not enabled. The calibration is done with the input scaling and fuel limiting curve.

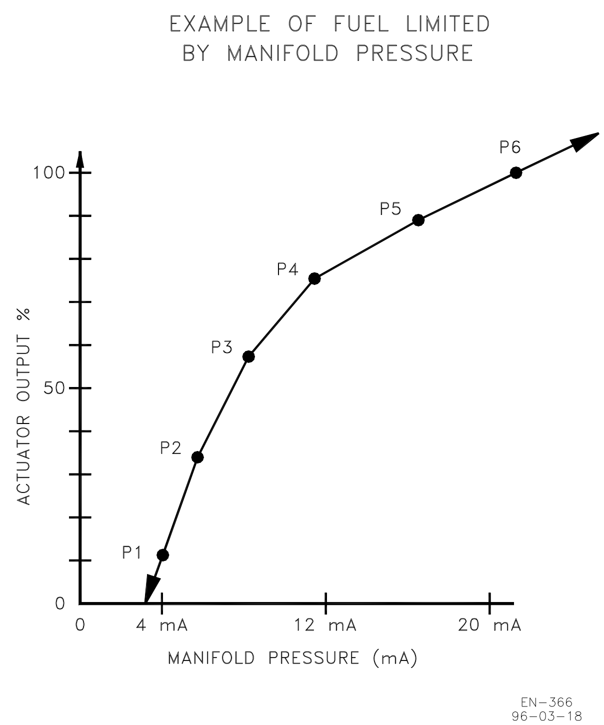


Figure 5-2. External Fuel Limit Calibration and Scaling

The Manifold Air Pressure fuel limit is a percent actuator driver output limit based on manifold air pressure. There are six tunable points on the Manifold Air Pressure fuel limit curve. The six tunable points of the Manifold Air Pressure Fuel Limiter are found in Service mode, under the header *MANIFOLD PRESS LMT*, at prompt FUEL LIMIT BKP 1 through and including prompt FUEL LMT AT BKPT 6. Each point has a FUEL LIMIT BKP which is the milliamp input value. And each point has a FUEL LMT AT BKPT value which is the percent actuator driver output at the corresponding milliamp input value. The manifold air pressure fuel limit curve is generally provided by the engine manufacturer (see Figure 5-2).

±5 Volt Auxiliary Input (Analog Input #4)
No calibration needed.

J2 and J3
All values are preset. No calibration needed.

Torque Fuel Limit Adjustment
The torque fuel limit is optional and, if it is not enabled, its header will not appear in Service mode. If the torque fuel limit is enabled, the Torque Limiter header will appear in Service mode, called *TORQUE LIMITER*. The torque fuel limiter should be set up using the engine manufacturer's torque fuel limit curve. The torque fuel limit can be based on either the actual engine speed or the engine speed reference. This selection is made in Service mode, at header *TORQUE LIMITER* at prompt BASED ON SPD REF. By setting the BASED ON SPD REF value to "TRUE", the torque fuel limiting will be based on the engine speed reference. If the value is "FALSE", the torque fuel limiting will be based on the actual engine speed. Six adjustable points are available to create the torque fuel limit curve (see Figure 5-3) and are located in the *TORQUE LIMITER* service header. Each point has an rpm (engine speed or engine speed reference) and percent actuator driver output at that rpm. The torque fuel limit curve is generally provided by the engine manufacturer.

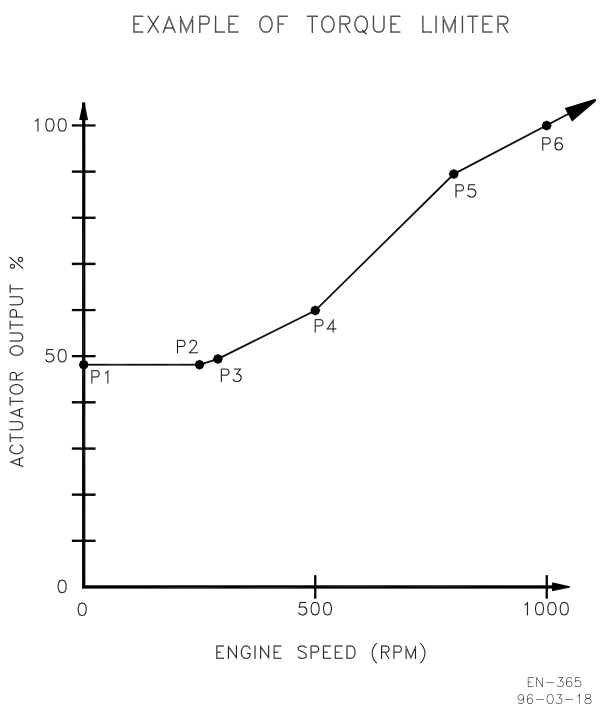


Figure 5-3. Torque Fuel Limit Curve

Start Fuel Limit Calibration
The start fuel limit is set to provide the desired maximum percent actuator driver output during starts. The start fuel limit should be set to provide consistent starting during hot and cold starts. Once it is felt that the start fuel limit is properly set, it is a good idea to test it under all required starting conditions so that consistent starting can be expected. The Start Fuel Limit set point is found in Service mode, under the header *START/MAX LIMITS*, at prompt START FUEL LIMIT (see Figure 5-4).

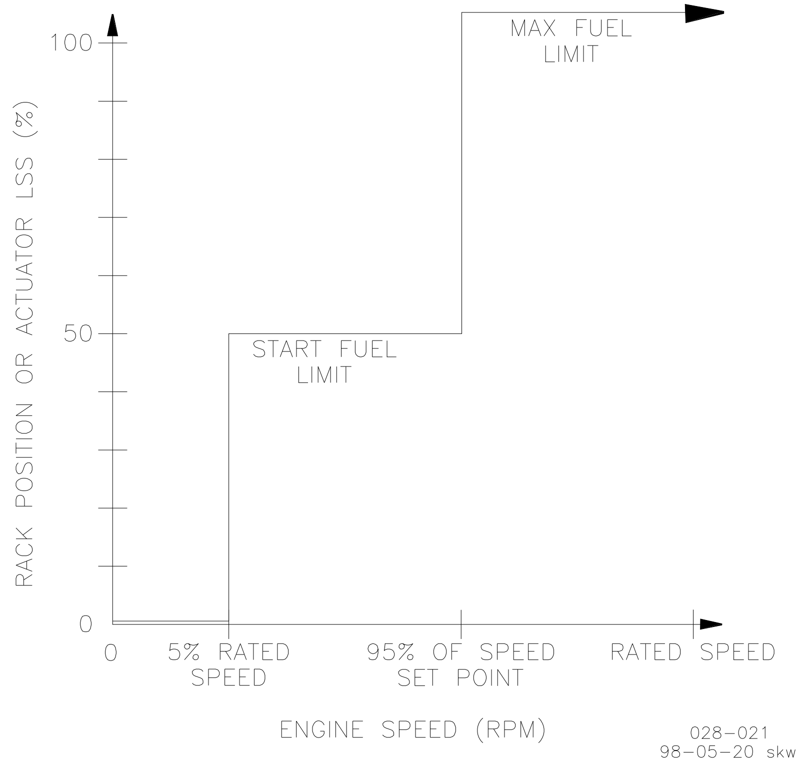


Figure 5-4. Start Fuel Limit

Engine Start Up

The 723 control pre-calibration is now complete and the engine is ready to be started. The first attempt to start the engine should be done with the fuel shut off to prevent the engine from starting. This will allow the 723 control, actuator, and actuator wiring to be checked prior to actually running the engine. Begin by measuring the dc voltage at terminal 19 & 20. With the engine stopped, the voltage should be 0.0 Vdc (forward acting), or 7.0 Vdc (reverse acting). Begin cranking the engine and verify the voltage on terminals 19 & 20 increases, or decreases for reverse acting, to approximately 3.50 Vdc (assuming 50% start fuel limit). The voltage will vary depending on actuators as well as the start fuel limit setting. The voltage will be proportional to the start fuel limit. While the engine is cranking, verify the actuator movement on the engine is in the increase-fuel direction. This test can be done at the same time the speed sensors are being tested.

For electric actuators, make sure power is applied to the electrical actuator driver module. While the engine is cranking, the speed sensors can be tested also. To test the MPU or proximity probe, disconnect the speed sensor from speed sensor input #2 and crank the engine without starting the engine. Verify speed sensor 1 is mounted on the engine side of any couplings. Verify the fuel is shut off to prevent the engine from running. The value viewed in Service mode under header *DISPLAY 1* at the prompt ENGINE SPEED should increase to the engine cranking rpm. To check speed sensor #1 input signal strength, measure the RMS voltage at terminals 11 & 12. The voltage must be 1.0 Vrms or greater during cranking. Proceed to the next section if the second speed sensor is not used. Reconnect speed sensor #2. To test the second MPU or proximity probe, disconnect the first speed sensor and crank the engine without starting the engine. Verify the fuel is shut off to prevent the engine from running. The value viewed in Service mode under header *DISPLAY 1* at the prompt ENGINE SPEED should increase to the engine cranking rpm. To check speed sensor #2 input signal strength, measure the RMS voltage at terminals 13 & 14. For an MPU, measure the RMS voltage at terminals 13 & 14. The voltage must be 1.0 Vrms or greater during cranking. Reconnect the speed sensor #1. Speed sensor #2 can be mounted on either side of the coupling.

Prepare the engine for a normal start (restore all shut off fuel, start air, etc.). Be prepared to shut down the engine should a problem arise during the start. Verify the proper engine overspeed devices function.

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.**

Select the idle speed position from the speed setting device. Attempt to start the engine. If the engine does not start or hesitates, increase the start fuel limit. Once the engine has started and is running, the dynamics can be adjusted for optimal performance. If the engine does not start, proceed to Chapter 6 for troubleshooting. If necessary, on new or rebuilt engines, stabilize the engine as soon a possible and allow the engine to run for some break-in period as specified by the engine manufacturer.

Dynamics Adjustments

The objective of the dynamic adjustments is to obtain the optimum, stable engine speed response from minimum speed and load to full speed and load. All adjustments apply to both sets of standard dynamics (*DYNAMICS 1* or *DYNAMICS 2*).

Do the following adjustments first for dynamics 1 adjustments. Use menu or (header) *DYNAMICS 1* to set the first set of dynamics, if changes are needed.

Then repeat the adjustments for the second set of dynamics. Use menu or (header) *DYNAMICS 2* to set the second set of dynamics, if changes are needed.

1. No-Load Adjustments

   Do this adjustment without load applied.

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

After acceptable performance at no load, record the Actuator Output as read in menu *DISPLAY 1*. Set the Gain Slope Breakpoint (*DYNAMICS 1* menu) to this reading.

2. Minimum Load Adjustment

Do this adjustment at the minimum speed and load conditions at which the engine is operated. Speed may be set either with the Raise and Lower commands in local control or with the 4 to 20 mA Remote Speed Setting input in remote mode.

Observe the movement of the actuator. If the activity of the actuator is excessive, reduce the Gain set point slightly to get the actuator movement to an acceptable level.

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

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

Gain is too low. If the preceding procedure does not improve the slow periodic cycling of the engine speed, the control may be limiting cycling through the low gain control region set by the Window Width set point. Increase the Gain set point to minimize the cycling. If actuator movement becomes excessive, reduce the Compensation set point until movement is acceptable. In some cases, Compensation may be reduced to zero and only the Gain and Stability 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.

3. Full Load Adjustment

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

If operation in this range is satisfactory, no further dynamic adjustments are necessary. If during changes in speed or load, excessive speed errors occur, increase the Gain Slope adjustment until engine performance is satisfactory. If excessive actuator movement again occurs, do procedure 4, then repeat procedure 3. If the settling time after a speed or load change is too long, reduce the Stability set point slightly and increase the Gain slightly. If slow-speed hunting occurs after a load or speed change but decreases or stops in time, increase the Stability set point slightly and reduce the Gain set point (see Figure 5-5).

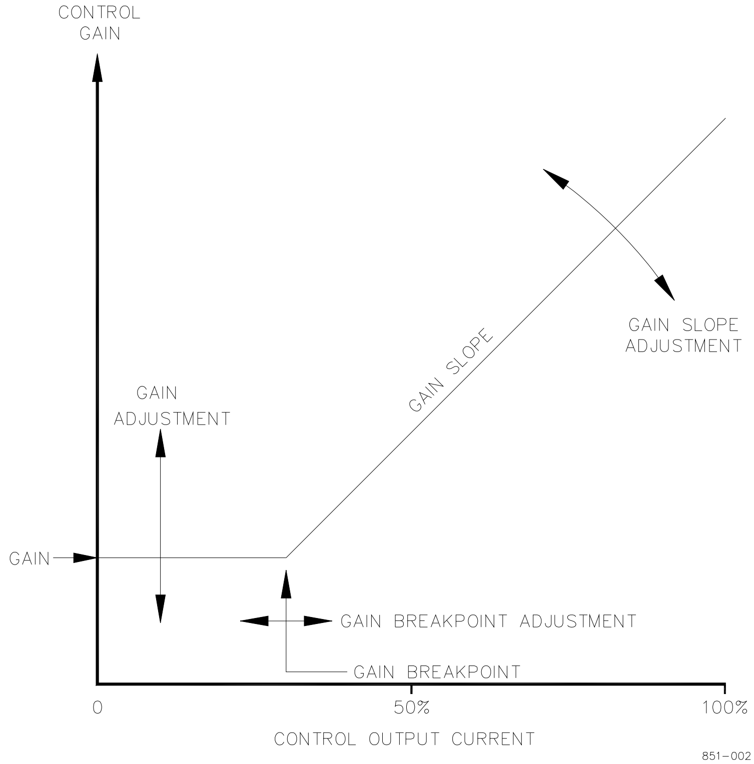


Figure 5-5. Gain Slope

4. When speed and load changes occur, the control should switch automatically to high gain to reduce the amplitude of the offspeeds. 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.

5. Verify that the performance at all speed and load conditions is satisfactory and repeat the above procedures if necessary.

6. While operating at minimum speed and load, record the Actuator Output in the *DISPLAY 1* menu. Select the Start Fuel Limit in the *START/MAX LIMITS* menu. Set at approximately 5% over the recorded value.

7. While operating at full load, record the Actuator Output in the *DISPLAY 1* menu. Select the Maximum Fuel Limit set point in the *START/MAX LIMITS* menu. Set at approximately 10% over the full load output 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.

If needed, calculate the roll-off frequency for the firing torsional speed filter and adjust the value at the prompt SPEED FILTER HZ (under *DYNAMICS 1* header) to the calculated number. If the speed filter is not needed, adjust SPEED FILTER HZ to 20 Hz to disable the speed filter. If the flexible coupling filter is being used, calculate the inertia factor for the system. Adjust the TORSIONAL FILTER (under *TORSIONAL FILTER* header) to match the calculated inertia factor. If only one speed sensor is being used, the inertia factor has no effect on the speed sensing.

Always try to use the maximum frequency for best response.

IMPORTANT **See Woodward Application Note 01304, *700 Series Controls, Dynamic Adjustment Procedure*, for more information on the dynamics adjustments.**

Load Sharing Calibration

There are no load sharing calibrations available to field personnel.

In single-unit operation (one engine running and clutched in), the voltage on the load sharing lines will be proportional to the calibrated fuel rack position [PERCENT LOAD (*DISPLAY 1*)]. At 0% load, the load sharing line voltage will be 0 ±0.1 Vdc, and at 100% load, the load sharing voltage will be 3.0 ±0.2 Vdc. If the voltage on the load sharing lines does match the given fuel rack position, verify the following: 1) The load sharing relay LED must be illuminated (this indicates that the load sharing relay is closed). 2) Verify whether the 723 control is using actual fuel rack position or the default fuel rack mode for engine load value. In either case, the fuel rack or default fuel rack must be properly calibrated. The voltage on the load sharing lines will be proportional to the engine fuel rack position (after the calibration block in the software): 0% rack=0 Vdc, 50% rack=1.5 Vdc, 100%=3.0 Vdc. Test both engines separately.

Synchronizing, Clutching, and Loading Adjustments

Prior to testing the clutching and declutching of the 723 control, the I/O calibration, and engine start-up, and load sharing calibration procedures must be completed.

⚠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.**

Start the engine and prepare to clutch in the engine by itself. The first engine to close its clutch becomes the master 723 control. Before the master can clutch in, the engine speed must be within the idle check window (configurable; ±20 rpm of the idle set point) for 2 seconds (configurable). Clutch the engine in by itself. This is done by closing the Clutch Request contact. Adjust the dynamics set, if necessary. Declutch the engine. This is done by opening the Clutch Request contact. Increase the engine speed so it is outside of the idle check window and attempt to clutch the engine by closing the Clutch Request contact. The engine speed should ramp to idle and, once the engine speed is within the idle check window for 2 seconds, the clutch permissive contact (Relay Output #3) should close. Repeat for both engines separately.

Once both engines have been tested individually for clutching operations, both units can be tested together. When clutching two engines together, it is useful to have one hand held for each 723 control. When clutching two units together for the first time, monitor the calibrated fuel rack position, PERCENT LOAD (*DISPLAY 1*). If two hand held programmers are not available, monitor one engine with the hand held programmer and the other engine by visually watching the actuator terminal shaft. Clutch in one engine (this unit becomes the master). Clutch in the other engine as the slave unit. When the slave unit is clutched in, monitor the rack positions. Both units should attempt to share load. If either unit integrates to maximum fuel or to minimum fuel, declutch one engine and troubleshoot the system. Verify PERCENT LOAD (*DISPLAY 1*) are close (±5%) with the hand held programmers. The actual engine load may not be close, and typically one unit slightly motorizes the other unit at very low loads. This is due to the differences between engine calibrations, including the fuel racks/ pumps, and fuel rack position transducers.

Verify the speeds of the engines are the same as the master unit's reference. If the hand held programmers indicate good load sharing, but the actual fuel racks are not balanced, the rack calibrations need to be re-verified. The actuator commands may be different, but neither unit should be at or near 0% or 100% actuator command. Apply load to the engines and verify that the engines pick up load and load share equally. Unload the engines and de-clutch the master unit. The slave unit will now become the master unit. Increase the master engine load to approximately 50% or as much as is possible or practical. Clutch in the slave unit. First, the slave will match speed with the master. When the slave unit's speed is within ±20 rpm of the Master's speed for 2 seconds, the slave 723 control will issue a clutch permissive (Relay Output #3). Once the slave clutch has closed, the slave unit will load, and the master unit will unload at the slave's load rate in percent of rack position per second. The rates at which the units load and unload are determined by values in the LOAD RATE (*LOAD CONTROL*) value. Adjust the value as necessary to achieve the desired loading results.

Once the units have reached equal loads, the slave unit will close its internal load sharing relay and begin isochronous load sharing with the master. The load difference between the two units must be 5% or less before the load sharing relay will close and isochronous load sharing can begin. Declutch the slave by opening the Clutch Request contact. The slave unit will unload and the master unit will load at the slave's unload rate. When the slave reaches its unload level, UNLOAD TRIP POINT (*LOAD CONTROL*), the clutch permissive contacts (Relay Output #3) will open and the unit should declutch. Different combinations of master and slave units as well as declutching combinations can be attempted to verify proper system operation. See Chapter 6, Faults and Troubleshooting, if there are any problems.

Conclusion

The 723 control is now calibrated and adjusted for normal operation. If any problems are experienced during the calibration or adjustments, see Chapter 6 for troubleshooting. We recommend you check the system operation under all conditions to verify proper setup and calibration of the 723 controls. If any accessories, including transducers, are replaced, the respective input needs to be calibrated again for the new accessory.

Chapter 6.
Faults and Troubleshooting

Introduction

This chapter covers the major and minor alarms, CPU OK LED, POWER OK LED, FAILED SPD SENSOR #1 LED, FAILED SPD SENSOR #2 LED, ALARM #1 LED, ALARM #2 LED, and the most common problems and their causes. The possible causes of the alarms or faults and common problems will be covered as well as some brief troubleshooting.

Major Alarm and Minor Alarm

The faults or conditions that cause an activation of the major or minor alarm relays are selectable in Configure mode. As shipped, none of the alarms are selected. The selection of which faults or conditions activate the alarm relays is up to the operator. The major and minor alarm selection options are identical. See the description of operation in Chapter 3 for the different selections.

Both Speed Sensors Failed

Both speed sensors faulted at the same time will cause the 723 to go to the minimum fuel position. The speed sensor faults are latching faults (latching means the fault/alarm condition remains in effect even if the problem disappears, until the control is reset—see Alarm/Fault Resets below). Intermittent problems with the speed sensors may cause the speed sensor faults to latch during normal operation and trigger the actuator driver to go to the minimum fuel position. Therefore, both speed sensors do not have to fail at the same time to cause shutdown (actuator driver to the minimum fuel position). As long as one speed sensor is functioning, the engine may still run properly with the 723 control even though it is indicating that one of the speed sensors has failed.

CPU Watchdog Fault

The CPU watchdog fault is caused by a CPU failure. A CPU failure will cause the hardware watchdog monitor to time out. When the watchdog times out, the green CPU OK LED will turn off and the hardware I/O lock will be activated. The I/O lock will de-energize all discrete outputs (and all analog outputs will go to zero current). The hand held programmer may or may not work depending on the type of CPU failure. The CPU failure can be caused by several things including a failed CPU, corrupt memory, intermittent input power supply, or a bad or incorrectly installed program. Generally, if a CPU watchdog fault occurs, the 723 control will need to be replaced.

POWER SUPPLY OK LED

If the power supply fails, the POWER OK LED will not illuminate. The failed power supply can be either an internal or external power supply problem. One cause can be no voltage or improper voltage applied to terminal 1 & 2 (blown fuse, open wire, etc.). If the proper voltage is applied to terminals 1 & 2, and the CPU OK LED is still not illuminated, replace the 723 control.

Alarm Delay Time

The analog input failed alarms are delayed before the actual fault is triggered. The fault must be present for the entire delay time before the fault is activated. This delay time is adjustable and is useful when dealing with intermittent or noisy signals. The alarm delay time, ALARM DELAY TIME (ALARM CONFIGURE), can be set to delay the fault from 0.1 to 2.0 seconds.

Alarm/Fault Resets

All of the alarms/faults detected by the 723 control are latching faults. Therefore, the alarms/faults may be true even though the alarm/faulted condition has been cleared. Unless otherwise mentioned, there are three ways to reset the latched (inactive) faults. If the faulted condition is still present when the reset is attempted the fault will not clear. A fault reset is triggered when the engine speed clears 5% of the rated speed set point during cranking. Another fault reset is triggered from the hand held programmer. The reset is triggered by toggling the RESET ALL ALARMS (*MINOR ALARM* or *MAJOR ALARM*) from "FALSE" to "TRUE". The reset only occurs on the transition from false to true. The third fault reset is with contact E, if it is configured to be ALARM RESET.

Speed Sensor 1 & 2 Fault

The speed sensor faults are latched when the sensed speed falls below the failsafe speed while the unit has been running (run mode). The FAILED SPD SENSOR #1 LED and #2 LED are used to display the status of the speed sensor faults. The respective LED will illuminate if the corresponding speed sensor fault is latched. There are no delays in the speed sensor fault detection, so an intermittent signal will latch a fault. When the engine is in stop mode, the speed sensor fault is overridden. When the 723 control is powered up or re-booted by exiting Configuration, the speed sensor faults may be active. As soon as the engine attempts to start, the speed sensor faults should clear. If one of the speed sensors inputs is not used, the respective fault will latch once the engine starts. A failed speed sensor will cause the 723 control to disable the flexible coupling filtering and switch to redundant (high signal select) speed sensing mode. If both speed sensors faults are latched at the same time, the control will go to minimum output. Most speed sensor problems are caused by loose wires, improper MPU gap, poor MPU location, or by dirt, oil, or metal filings on the end of the probe.

ALARM #1 LED

The Alarm #1 LED is used to indicate if both 723s are configured to be the same unit (both Port or both Starboard).

ALARM #2 LED

The Alarm #1 LED is used to indicate that both J2 and J3 have a communication error. The three causes are: 1.) J2 and J3 have a hardware fault (replace control). 2.) The communication line between J2 and J3 is broken. 3.) Wire connections between J2 and J3 are not correct.

Overspeed Trip

The overspeed fault is latched when either one of the speed sensor signals goes above the adjustable overspeed set point. The status of the overspeed fault is ENGINE OVER SPED? (*DISPLAY 2*). There are no delays in the overspeed fault, so an intermittent signal will cause the fault to latch. An overspeed trip will cause the actuator output to go to minimum position, which should shut down the engine. The overspeed trip can be reset using the hand held programmer with the software reset [found under either header (*MINOR ALARM* or *MAJOR ALARM*)] or once the engine rpm goes above 5% of the rated speed set point during a restart. It can also be reset with contact E, if contact E has been configured to be ALARM RESET.

The minor and major alarms can be configured to alarm when an overspeed trip has occurred.

Remote Speed Input Fault

The remote speed input fault is latched when the sensed input signal goes outside the 2.0 mA and 21.0 mA range. The status of the fault is found at prompt REMOTE SPEED FAIL in either the *MINOR ALARMS* or *MAJOR ALARMS* header if the Remote Speed Input Fault has been selected as one of these alarms. If the Remote Speed Setting Input is used, we recommend that the Remote Speed Input Fault be configured to activate one of the alarms.

Rack Position Input Fault

The Rack Position input fault is latched when the sensed input signal goes outside of the 2 mA and 21.0 mA range. The status of the fault is found at prompt RACK INPUT FAILED in either the *MINOR ALARMS* or *MAJOR ALARMS* header, if the Rack Position Input Fault has been selected as one of these alarms. If the Rack Position Input is used, we recommend that the Rack Position Fault be configured to activate one of the alarms.

When the rack position fault is latched, the 723 control automatically switches to the default rack calibration based on the percent actuator driver output. The 723 control will function normally (load sharing, fuel limiting, etc.) when using the default rack calibration (if it was set up properly). The accuracy of the default rack calibration will not be as good as the rack position transducer, so the fault should be corrected as soon as possible.

Manifold Air Pressure Input Fault

The Manifold Air Pressure input fault is latched when the sensed input signal goes outside of the 2 mA and 21.0 mA range. The status of the fault is found at prompt MANIFOLD INPUT FAIL in either the *MINOR ALARMS* or *MAJOR ALARMS* header, if the Manifold Air Pressure Input Fault has been selected as one of these alarms. If the Manifold Air Pressure Input is used, we recommend that the Manifold Air Pressure Fault be configured to activate one of the alarms.

PID at Zero Fault

The speed control PID at zero fault is latched when the speed control PID output has integrated to the minimum fuel level. The PID at zero fault is an indication that the engine is being motored by the other unit. The fault has its own fault delay time. The delay time is set at the prompt PID @ ZERO TIME. The minimum fuel level is also adjustable. The PID @ ZERO LEVEL is the actuator LSS percent used to determine where “minimum” fuel is. PID @ ZERO TIME and PID @ ZERO LEVEL are found in ALARM/SD CONFIGURE. Depending on the linkage arrangement, the PID @ ZERO LEVEL should be set near minimum fuel and lower than the lowest actuator LSS command for normal operation. The status of the fault is found at prompt PID @ LOW LEVEL in either the *MINOR ALARMS* or *MAJOR ALARMS* header, if the PID at Zero Fault has been selected as one of these alarms. If the PID at Zero is used, we recommend that the PID at Zero fault be configured to activate one of the alarms.

Troubleshooting Procedure

Table 7-1 is a general guideline for isolating system problems. The service personnel should be thoroughly familiar with the contents of this manual as well as governor theory involving precise control of engine speed. This guide assumes the system wiring, soldering connections, switch and relay contacts, and input and output connections are correct and in good working order. Make the checks in the order indicated. Various system checks assume that the prior check have been properly done.

⚠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.**

Table 7-1. Troubleshooting Procedure

Symptom	Cause	Test/Remedy
Engine will not start (actuator not moving to start fuel position).	1. CPU OK LED not illuminated.	1a. No or incorrect power supply voltage. Power supply fuse may be open. Power supply may be dropping out, especially if the cranking batteries are being used to power the 723 control. The power supply polarity may be reversed (dc units only). Replace the hardware as necessary. 1b. Watchdog fault caused by hardware faults or software faults. Replace hardware.
	2. Actuator voltage remains at 0 Vdc (forward acting) or 7 Vdc (reverse acting) during cranking.	2a. 723 control in STOP mode. With hand held programmer verify that RUN/STOP contact status is false (Discrete Input A open) during cranking. 2b. Verify actuator voltage output from 723 control during cranking. Voltage should be between 0 Vdc & 7 Vdc. The voltage will be proportional (forward acting actuator), or inversely proportional (reverse acting actuator), to the actuator command percentage viewed on the hand held programmer. Proceed to next section if actuator voltage is correct. If voltage is higher than 7.0 Vdc, check for open actuator circuit (wiring, actuator coil, etc.). If actuator voltage is not proportional to command, check that 723 control hardware is configured for desired actuator output (0–200 mA or4–20 mA). 2c. Shorted actuator output. Check for actuator wires shorted to ground. 2d. Speed signal not clearing failsafe levels. View the engine speed with the hand held programmer. Engine speed must be greater than 5% of the rated speed set point before actuator is allowed to move from minimum fuel. Check for proper MPU clearance. Check speed signal amplitude (> 1Vrms) during cranking. Verify proper gear teeth calibration. See Chapter 5, speed sensor. 2e. Start fuel limit set too low. View start fuel limit with hand held programmer. Increase start fuel limit if necessary. 2f. Fuel limiter not functioning properly. Incorrect rack position transducer calibration may cause the actuator output to minimum fuel. See rack calibration procedure for testing. **IMPORTANT** **Hydraulic actuators must have oil pressure and proper drive rotation to operate. Electric actuators must have power applied to their respective electronic driver module. See the actuator manual for more information.**
	3. Actuator not responding to actuator voltage signal from 723 control.	3a. Verify actuator linkage is not binding. Check for sticking fuel rack, fuel rack shutdown solenoid active, or properly functioning collapsible link. 3b. The actuator does not track the actuator voltage, refer to the specific actuator manual troubleshooting. 3b. Actuator tracks actuator voltage, but engine still does not start. Proceed to next section.

Symptom	Cause	Test/Remedy
Engine will not start (actuator moving to start fuel position).	1. Actuator linkage not connected. 2. Start fuel limit too low. 3. Engine problem.	1. Verify the linkage from actuator to fuel rack is properly connected. Verify collapsible link functioning properly, if used. 2. Check the start fuel limit level. Increase start fuel limit as necessary. 3. Engine fuel, air, ignition, etc. problem. Engine fuel and/ or air solenoid(s) may still be shutdown from calibration procedure. Troubleshoot engine as recommended by manufacturer.
Engine overspeeds on start.	1. Actuator and/or linkage problem. 2. Speed control dynamics adjustment.	1a. Verify that fuel rack is not binding and linkage is properly adjusted. 1b. Actuator drive rotation incorrect. 1c. Verify the actuator and 723 control are the same action (forward or reverse). Verify that as the 723 control actuator command goes to maximum fuel, the fuel rack is moved in the increase fuel direction. Actuator terminal shaft position should be proportional to the actuator command. 2. Speed control PID dynamics may be adjusted for sluggish operation. Attempt to start engine by controlling fuel rack manually or by reducing the speed reference. Adjust dynamics for better response.
Engine overspeeds on start or causes excessive smoke on start.	1. Start fuel limit set too high.	1. Reduce start fuel limit to some level slightly above (10%–20%) the percent actuator driver level needed to run the engine at idle speed.
Engine speed not regulated.	1. Improper linkage adjustment. 2. 723 control problem. 3. Mechanical governor in control.	1. Verify actuator is capable of reaching the minimum and maximum fuel rack positions. 2a. 723 control is not powered up. Verify proper power supply operation. 2b. Verify proper CPU status (CPU LED illuminated). 2c. 723 control is STOP or shutdown mode. View actuator shutdown mode with hand held programmer. 2d. Fuel limiter in control. View fuel limiter control status with hand held programmer. 3a. Engine may be running on ballhead back up if used. Verify by attempting to change engine speed with speed setting input for mechanical governor. Manual override device on actuator may be active. 3b. Actuator load limit setting on actuator set too low. Increase load limit so 723 control takes control of engine speed. 3c. Actuator wiring may be open. Check wiring and continuity from 723 control to actuator.

Symptom	Cause	Test/Remedy
Engine does not accelerate and/or decelerate when remote reference moved.	1. Idle speed mode selected.	1. Verify with hand held programmer that Idle/Rated speed contact is true (Closed). An open Idle/Rated speed contact will override the remote speed setting input.
	2. Unit is clutched in as slave or appears to be clutched in as slave.	2a. If unit is clutched in last, it becomes the slave unit. The slave unit will use the master speed reference set point. 2b. Unit is attempting to clutch in as the slave unit. The speed reference will be determined by the master unit again.
	3. Remote speed setting input not functioning.	3. Remote speed setting device not functioning. View the remote speed setting input and verify proper operation. See the remote speed setting calibration for troubleshooting. The 723 control will not track the remote above or below the rated and idle speed settings.
	4. Slow speed reference ramp rate.	4. Speed reference ramp rate set too low. Increase the speed reference ramp rate to desired rate for acceleration or deceleration.
	5. Communications with companion failed.	5. Unit will run at idle speed when communications with the companion are lost if CONFIG SPD CONTROL – IDLE WHEN COMM FAIL is set to TRUE.
	6. Mechanical governor in control.	6a. Mechanical governor in control of the engine speed. 723 control not in control of speed. Manual override device may be active. Verify actuator command is at 0% or 100%. See actuator manual for more information. 6b. Actuator wires may be open. Check continuity from 723 control to actuator.

Symptom	Cause	Test/Remedy
Engine will not stabilize. Control may be erratic or vary with load.	1. Speed control dynamics adjustments.	1. A dynamics adjustment problem generally appears as a sinusoidal hunt or oscillation. There are several dynamics adjustments that take effect during loaded or unloaded conditions at different speeds. Verify the proper dynamics are being adjusted at the proper time. Disable gain slope and/or gain ratio functions to isolate problem. See dynamics adjustments to correctly adjust 723 control response.
	2. Improper linkage adjustments.	2a. Make sure the actuator terminal shaft movement is approximately 2/3 of the total actuator movement from no load to full load. For most diesels, turbines, and fuel injected prime movers, the actuator linkage should be linear. For the other prime movers, a non-linear linkage should be used. See the actuator manual regarding linkage arrangements. 2b. Make sure the linkage, ball-ends, and associated fuel rack links are in good condition and not worn. Make sure the fuel rack is not binding.
	3. Faulty dynamics #2 contact.	3. Dynamics #2 contact may be intermittently open or closing, causing the dynamics selection to be intermittent. This is especially true if an oil pressure or speed switch is used to select between the two dynamics.
	4. Erratic speed setting devices.	4. The speed setting device signal may be erratic, causing the speed reference to move around erratically. The 723 control will attempt to follow the changing the speed reference. View the speed setting input in control and verify that the speed reference is stable.
	5. Mechanical governor interference/problem.	5a. Often referred to as ballhead interference. The mechanical ballhead governor and 723 control speed settings are too close to each other. The speed control governors (electrical and mechanical) are attempting to control the engine speed at the same time. Separate the two speed settings, lower 723 control speed setting, or increase the mechanical speed setting. There must be at least a 1.7% difference in speed setting between the 723 and the mechanical governor. 5b. Possible actuator stability problem. Check actuator drive rotation and actuator hydraulic pressure. Check condition of actuator oil and supply system. For electric actuators, check electronic driver module power supply, and associated wiring. See the actuator manual for troubleshooting.
	6. Poor engine speed signal.	6a. MPU speed signal problem. Verify MPU probe is in good condition (free of dirt, oil, grease, or metal filings). Verify the gear is in good condition (no missing teeth, gear run out with tolerance, etc.). If possible view speed signal to 723 control with an oscilloscope. MPU speed signal should be a sine wave with a relatively fixed amplitude. There should be no major wave form distortions. 6b. Possible engine firing torsionals or flexible coupling torsionals. Attempt to re-adjust the inertia factor and/or speed filter.

Symptom	Cause	Test/Remedy
Engine will not stabilize. Control may be erratic or vary with load. [continued]	7. Engine fuel delivery or other mechanical problem.	7. Attempt to isolate engine and governors. If possible, slowly reduce mechanical load limit until actuator terminal shaft is controlled by load limit setting. The fuel rack can also be blocked by using the maximum fuel limiter in the 723 control. **⚠WARNING** **Do not lower load limit rapidly or any lower than necessary to prevent unwanted engine shutdowns under severe load conditions. This is especially true at low speed. If the engine is still unstable when the actuator/fuel rack is blocked, the problem is most likely an engine problem.**
	8. Improper wiring and installation. Possible shielding or ground loop problems.	8a. Verify all shields are grounded at 723 control only and not at any other points. Verify shields are carried continuously through any terminal blocks throughout their length. 8b. If possible begin to remove one input wiring section at a time until stability is corrected. Remove as many inputs a possible until only the minimum connections (power supply, MPU, & actuator) exist. An external current or voltage source may be needed to simulate input signal when the field device wiring is removed to run the engine. Correct the possible ground loop, shield problem. See 8c below. 8c. Verify 723 control wiring (power supply, MPU, actuator, etc.) is not routed through conduit containing high voltages or currents. Route suspect wiring outside of conduit and verify engine instability goes away. 8d. If 723 control wiring is isolated down to power supply, MPU, and actuator, check condition of solder joints at MPU and actuator connectors. Check all terminal connections for tightness.
Engines do not share load equally.	1. Improper rack transducer or default percent actuator calibration.	1. The 723 control can only share load as well as the rack transducers, actuator linkages, and engine fuel rack(s) or pump(s) are calibrated. With the hand held programmer, verify the engine fuel rack positions are equal (+/– 2.5%). A small rack position error between units is common and will never be zero. If 723 control indicates balanced load sharing (rack positions on hand held programmer equal), the control is functioning properly and the problem is with the fuel rack transducer calibrations or engine fuel system. If engine fuel rack positions are balanced, the problem exists in the engine (fuel pumps, etc.). See the appropriate engine manufacturer's recommendations for balancing the engine's fuel racks. Verify the fuel racks have been properly calibrated for their full load and no load conditions. Verify the same approximate fuel rack setting corresponds to similar rack position percent between the 723 controls.
	2. Fuel limiter active.	2. An active fuel limit will override the load sharing and de-rate the engine. Verify no fuel limiters are active.
	3. Actuator linkage problem.	3. Verify the actuator linkage is capable of controlling engine fuel rack at that position.
	4. Load sharing line.	4. There are no load sharing line calibrations available to field personnel. Verify load sharing line voltages (see Chapter 5). Verify the load sharing polarity is correct between the two units. Verify the load sharing signal voltage is positive. The correct range is 0–3 Vdc (0% rack position to 100% rack position).

Symptom	Cause	Test/Remedy
Engine does not share load with other unit (one unit takes all of the load).	1. Improper rack transducer calibration.	1. Verify the rack position percent increases as the engine fuel rack is moved in the increase fuel direction.
	2. Clutch contacts.	2. Verify that when both engines are clutched together, both port and starboard clutch contact inputs are closed. When both contacts are closed, the 723 controls begin load sharing as indicated by a closed internal load sharing relay (load sharing relay LED will be illuminated).
	3. Load sharing lines.	3. Verify the load sharing polarity is correct between the two units. Verify the load sharing signal voltage is positive. The correct range is 0–3 Vdc (0% rack position to 100% rack position). The individual engine load sharing line output can be tested by simulating the parallel operation of the engines.
	4. ALARM LED #1 illuminated.	4. Verify the ALARM LED #1 is not illuminated. If it is, and both 723s are powered up and one or both of the Modbus® * ports are connected (J2 and J3), verify that the communication line or communication lines are working. If they are OK, then the units are both configured as either the Port or Starboard engine. If this is the case, then one of them needs to be configured as the Port engine and one needs to be configured as the Starboard engine. *–Modbus is a trademark of Schneider Automation Inc.
	5. Mechanical governor in control.	5. Both engines must be under control of the 723 control. If one of the engines is in mechanical governor control, the load will not be shared unless the mechanical speed setting is corrected and the mechanical governor is in droop.
Engine does not maintain constant speed (isochronous).	1. Fuel limiter in control.	1. Verify speed control is in control and no fuel limiter becomes active.
	2. Mechanical governor in control.	2. Most mechanical governors have some amount of droop built into the governor. Verify engine does not droop using 723 control.
	3. Actuator linkage.	3. Engine speed droops off near rated speed (full load). Verify actuator or fuel rack is not at its maximum fuel position.

Chapter 7.
Product Support and Service Options

Product Support Options

If you are experiencing problems with the installation, or unsatisfactory performance of a Woodward product, the following options are available:

1. Consult the troubleshooting guide in the manual.
2. Contact the **OE Manufacturer or Packager** of your system.
3. Contact the **Woodward Business Partner** serving your area.
4. Contact Woodward technical assistance via email (**EngineHelpDesk@Woodward.com**) with detailed information on the product, application, and symptoms. Your email will be forwarded to an appropriate expert on the product and application to respond by telephone or return email.
5. If the issue cannot be resolved, you can select a further course of action to pursue based on the available services listed in this chapter.

OEM or Packager Support: Many Woodward controls and control devices are installed into the equipment system and programmed by an Original Equipment Manufacturer (OEM) or Equipment Packager at their factory. In some cases, the programming is password-protected by the OEM or packager, and they are the best source for product service and support. Warranty service for Woodward products shipped with an equipment system should also be handled through the OEM or Packager. Please review your equipment system documentation for details.

Woodward Business Partner Support: Woodward works with and supports a global network of independent business partners whose mission is to serve the users of Woodward controls, as described here:

- A **Full-Service Distributor** has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.
- An **Authorized Independent Service Facility (AISF)** provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.
- A **Recognized Engine Retrofitter (RER)** is an independent company that does retrofits and upgrades on reciprocating gas engines and dual-fuel conversions, and can provide the full line of Woodward systems and components for the retrofits and overhauls, emission compliance upgrades, long term service contracts, emergency repairs, etc.

A current list of Woodward Business Partners is available at **www.woodward.com/directory**.

Product Service Options

Depending on the type of product, the following options for servicing Woodward products may be available through your local Full-Service Distributor or the OEM or Packager of the equipment system.

- Replacement/Exchange (24-hour service)
- Flat Rate Repair
- Flat Rate Remanufacture

Replacement/Exchange: Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime.

This option allows you to call your Full-Service Distributor in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Full-Service Distributor.

Flat Rate Repair: Flat Rate Repair is available for many of the standard mechanical products and some of the electronic products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be.

Flat Rate Remanufacture: Flat Rate Remanufacture is very similar to the Flat Rate Repair option, with the exception that the unit will be returned to you in "like-new" condition. This option is applicable to mechanical products only.

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned for repair, please contact your Full-Service Distributor in advance to obtain Return Authorization and shipping instructions.

When shipping the item(s), attach a tag with the following information:

- return number;
- name and location where the control is installed;
- name and phone number of contact person;
- complete Woodward part number(s) and serial number(s);
- description of the problem;
- instructions describing the desired type of repair.

Packing a Control

Use the following materials when returning a complete control:

- protective caps on any connectors;
- antistatic protective bags on all electronic modules;
- packing materials that will not damage the surface of the unit;
- at least 100 mm (4 inches) of tightly packed, industry-approved packing material;
- a packing carton with double walls;
- a strong tape around the outside of the carton for increased strength.

NOTICE

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

Replacement Parts

When ordering replacement parts for controls, include the following information:

- the part number(s) (XXXX-XXXX) that is on the enclosure nameplate;
- the unit serial number, which is also on the nameplate.

Engineering Services

Woodward's Full-Service Distributors offer various Engineering Services for our products. For these services, you can contact the Distributor by telephone or by email.

- Technical Support
- Product Training
- Field Service

Technical Support is available from your equipment system supplier, your local Full-Service Distributor, or from many of Woodward's worldwide locations, depending upon the product and application. This service can assist you with technical questions or problem solving during the normal business hours of the Woodward location you contact.

Product Training is available as standard classes at many Distributor locations. Customized classes are also available, which can be tailored to your needs and held at one of our Distributor locations or at your site. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability.

Field Service engineering on-site support is available, depending on the product and location, from one of our Full-Service Distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface.

For information on these services, please contact one of the Full-Service Distributors listed at **www.woodward.com/directory**.

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory published at **www.woodward.com/directory**.

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

Products Used In Electrical Power Systems

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

Products Used In Engine Systems

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

Products Used In Industrial Turbomachinery Systems

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

For the most current product support and contact information, please visit our website directory at **www.woodward.com/directory**.

Technical Assistance

If you need to contact technical assistance, you will need to provide the following information. Please write it down here before contacting the Engine OEM, the Packager, a Woodward Business Partner, or the Woodward factory:

General

Your Name	
Site Location	
Phone Number	
Fax Number	

Prime Mover Information

Manufacturer	
Engine Model Number	
Number of Cylinders	
Type of Fuel (gas, gaseous, diesel, dual-fuel, etc.)	
Power Output Rating	
Application (power generation, marine, etc.)	

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	

Control/Governor #2

Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	

Control/Governor #3

Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	

Symptoms

Description	

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

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 02827B.

PO Box 1519, Fort Collins CO 80522-1519, USA
1000 East Drake Road, Fort Collins CO 80525, USA
Phone +1 (970) 482-5811 • Fax +1 (970) 498-3058

Email and Website—www.woodward.com

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

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