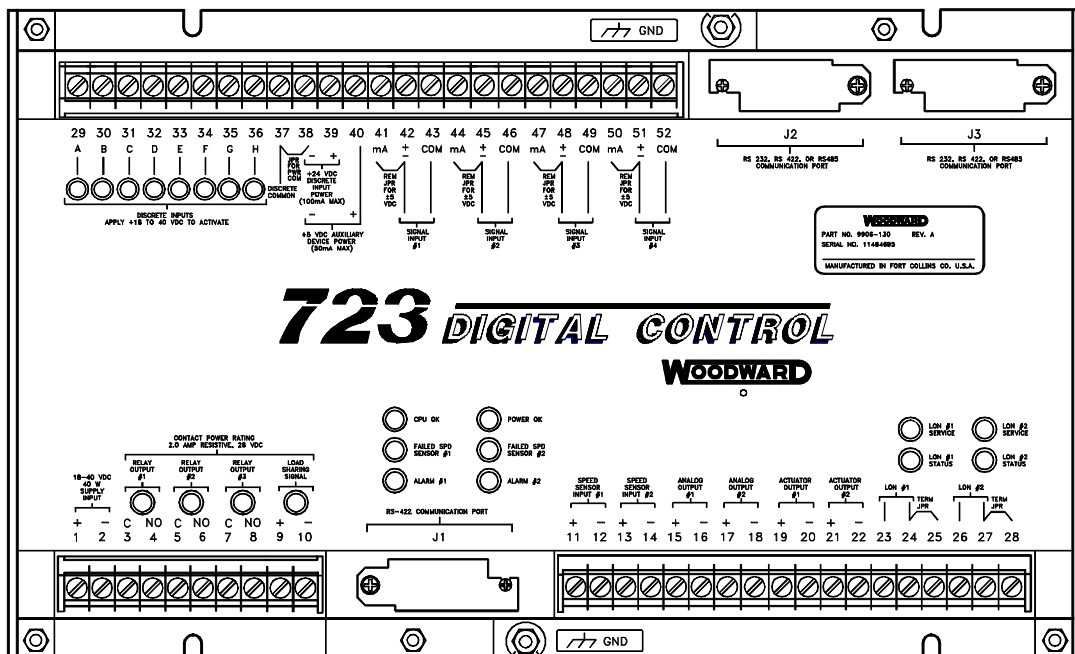




723 Generator Control

Application & Hardware Manual



P/N's 8280-153, 8280-154
8280-317, 8280-318
8280-322, 8280-323

WOODWARD GOVERNOR COMPANY

MANUAL 02755B

WARNING—DANGER OF DEATH OR PERSONAL INJURY



WARNING—FOLLOW INSTRUCTIONS

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.



WARNING—OUT-OF-DATE PUBLICATION

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, be sure to check the Woodward website:

www.woodward.com/pubs/current.pdf

The revision level is shown at the bottom of the front cover after the publication number. The latest version of most publications is available at:

www.woodward.com/publications

If your publication is not there, please contact your customer service representative to get the latest copy.



WARNING—OVERSPEED PROTECTION

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—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.

CAUTION—POSSIBLE DAMAGE TO EQUIPMENT OR PROPERTY



CAUTION—BATTERY CHARGING

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.



CAUTION—ELECTROSTATIC DISCHARGE

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.

IMPORTANT DEFINITIONS

- A **WARNING** indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
- A **CAUTION** indicates a potentially hazardous situation which, if not avoided, could result in damage to equipment or property.
- A **NOTE** provides other helpful information that does not fall under the warning or caution categories.

Woodward Governor Company reserves the right to update any portion of this publication at any time. Information provided by Woodward Governor Company is believed to be correct and reliable. However, no responsibility is assumed by Woodward Governor Company unless otherwise expressly undertaken.

© Woodward 1999
All Rights Reserved

Contents

CHAPTER 1	GENERAL INFORMATION.....	1
Introduction	.....	1
Application	.....	1
CHAPTER 2	723 DCS.....	3
723 Digital Control, Declaration of Incorporation	.....	3
723 Digital Speed Control Accessories	.....	3
723 Control Specifications	.....	3
CHAPTER 3	ELECTROSTATIC DISCHARGE AWARENESS.....	7
CHAPTER 4	723 INSTALLATION	9
Scope	.....	9
Unpacking	.....	9
Power Requirements	.....	9
Location Considerations	.....	10
Internal Jumpers	.....	10
Electrical Connections	.....	12
Shielded Wiring	.....	12
Power Supply	.....	12
Digital Relay Outputs	.....	13
Load Sharing Lines Input	.....	13
Speed Signal Inputs	.....	13
Analogue Outputs.....	.....	14
Actuator Output	.....	14
LON #1	.....	14
Discrete Inputs	.....	14
Analogue Inputs	.....	15
Serial Communications Ports.....	.....	15
Termination.....	.....	15
Grounding & Shielding	.....	17
Installation Checkout Procedure	.....	21
CHAPTER 5	SYSTEM DESCRIPTION	23
Engine Speed	.....	23
Speed Sensing	.....	23
Speed Filtering	.....	24
Speed Control & Synchronising	.....	24
Engine Start	.....	24
Synchronising to a Bus	.....	25
Synchronising to the Grid	.....	25
Droop Control	.....	25
Isochronous Load Sharing	.....	26
KW Control	.....	27

Operating Modes	28
Limiters & Load Rejection.....	29
Engine Shutdown Limiter.....	29
Start & Maximum Fuel Limiter	29
Frequency Load Limiter	29
Charge Air Pressure Limiter	29
Generator Breaker Load Rejection.....	29
Grid Breaker Load Rejection	29
PID Control & Actuator Output.....	30
Speed/Droop/Isochronous/Deadband KW Control.....	30
Direct KW Control.....	30
Actuator Hit	30
Run/Stop & Alarms	30
Modbus® Communications & Control.....	31
DSLC	32
Analogue Outputs	32
Control Options	32
Operator Interface	33
Configure Values List	34
Service Values List	36
Configure & Service Descriptions	43
Configure	43
Service	46
Modbus® Communications Address List.....	65
Boolean Writes 65	
Boolean Reads	65
Analogue Reads	66
Analogue Writes.....	66
 CHAPTER 6 APPLICATION PROGRAMMING	 69
Graphical Application Programmer	69
Run Time Performance 69	
System Support and Modification.....	70
GAP™ Process/Logic Blocks	70
 CHAPTER 7 POWER MANAGEMENT NETWORK	 73
Network Architecture	73
Hardware	73
 CHAPTER 8 MODBUS® COMMUNICATIONS.....	 77
 CHAPTER 9 SETPOINT PROGRAMMING.....	 83
Introduction	83
Hand Held Programmer and Menus	83
Hand Held Programmer Keys	84
Configure Menus.....	84

Service Menus	86
Adjusting Setpoints.....	86
PC Interface	87
Watch Window.....	87
Main Window	88
ServLink Explorer.....	88
ServLink Inspector.....	88
 CHAPTER 10 REPAIR & REPLACEMENT	91
Returning Equipment for Repair	91
Identification	91
Packing a Complete Control.....	91
Replacement Control Information.....	91
Address and Telephone/FAX Numbers	92
 Manual Revision History.....	Inside Back Cover
Ordering Manuals	Back Cover
Woodward Governor Company Locations	Back Cover

Diagrams, Drawings & Tables

2-1	723 Digital Speed Control.....	5
2-2	Hand Held Programmer	6
4-1	723 Control Internal Jumpers	11
4-2	RS-422 Terminator Locations.....	16
4-3	RS-485 Terminator Locations.....	16
4-4	723 RS-232 Connection	17
4-5	723 RS-422 Connection with optional termination at receiver.....	17
4-6	723 RS-485 Connections with optional termination.....	17
4-7	723 RS-422 Connections with optional termination at transmitter	17
4-8	Preferred multipoint wiring using shielded twisted-pair cable with separate signal ground wire	18
4-9	Alternate multipoint wiring using shielded twisted-pair cable without separate signal ground wire	18
4-10	723 Wiring Notes	19
4-11	723 Wiring	20
6-1	Process/Logic Program Blocks	71
7-1	Direct Wired Network.....	74
7-2	Network Wired Via Stubs	74
7-3	Typical LON Setup	75
8-1	Modbus® Transmission Modes	77
8-2	Modbus® Frame Definition	78
8-3	Modbus® Function Codes	78
8-4	Modbus® Function Codes	79
8-5	Modbus® Slave Exception Error Codes	79
8-6	Modbus® Master Exception Error Codes	79
8-7	Modbus® Messages.....	80
8-8	Communication Port Adjustments.....	80
9-1	Hand Held Programmer Functions.....	85

Chapter 1

General Information

Introduction

This manual describes the 723 Generator Control, p/n's 8280-153/154 (High & Low Voltage Control without GUI), 8280-317/318 (High & Low Voltage Control with GUI), 8280-322/323 (Low Voltage Marine Control with and without GUI).

Application

The control is intended for use in a variety of generator applications; for auxiliary generators and diesel electric propulsion in the marine market, and for island mode systems and for base loading against an infinite bus in the Power Plant market.

The KW Control mode is especially useful for applications where the grid is weak and large frequency excursions are expected. Under these circumstances, operating in droop mode is not practical, as large variations in load would be experienced, due to frequency shifts of the grid. In kW control, the speed of the engine is maintained by the grid, and the load on the generator remains constant throughout the frequency excursion.

The control provides closed loop speed control, with a torsional filter and a notch (band-stop) filter to help to eliminate the problems caused by low frequency oscillations due to engine & generator inertias and flexible couplings.

Three modes of operation are available:

- Droop control based on a 4-20mA **KW Transducer** input, or the actuator position.
- Isochronous load sharing with soft loading/unloading, and automatic generator breaker open command once the engine has unloaded.
- KW control with soft loading/unloading, and automatic generator breaker open command once the engine has unloaded. The reference may be adjusted by Increase/Decrease contacts or by analogue reference - 4-20mA or Modbus®. In addition an internally tunable kW reference value can be used.

Start and maximum fuel limiters are provided, as well as a charge air pressure limiter based on the 4-20mA **Charge Air Pressure** input (not available with all part numbers). A load limiter, enabled during KW control, will provide load de-rating during frequency excursions. Additional protection is offered to open the Grid Breaker or the Generator Breaker, should the frequency excursion become too large.

The control can be adjusted/biased for synchronising the generator to the bus by means of the **Increase/Decrease** contacts, or by the input provided for a Woodward **Unit Synchroniser** (SPM-A or DSLC - Digital Synchroniser & Load Control). The control may also be used for synchronising to the grid using the second synchroniser input (**System Synchroniser**), for an SPM-A or DSLC (not available with all part numbers).

One LON connection of the 723 may be connected to a DSLC, so that all of the generator parameters may be monitored within the 723, and then also via the Modbus®.

One serial port (J3) is available for Modbus® communications using RS232, RS422 or RS485. Engine and generator parameters can be monitored, and certain control functions sent to the control via the Modbus®.

4-20mA outputs are available for monitoring various control parameters.

Chapter 2

723 DCS

723 Digital Control

Declaration of Incorporation

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

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

723 Digital Speed Control Accessories

Hand Held Programmer (Figure 2-2), part number 9907-205, is used for adjusting the 723 control setpoints/parameters. It plugs into the serial port of the control.

Digital Synchroniser & Load Control (DSLCL) for synchronising the generator phase & voltage to that of the power bus. The DSLCL also provides dead bus closure facility and has real power load sensing using harmonic filtering algorithms. (DSLCL manual 02007)

SPM-A Synchroniser (9907-028 (without voltage matching) & 9907-029 (with voltage matching)) for synchronising the generator phase to that of the power bus. The synchroniser generates a generator breaker closure command to connect the unit in with the power bus.

Real Power Sensor (kW Transducer) for generator load monitoring. (p/n 8272-394)

723 Control Specifications

Part Numbers:

8280-153	High Voltage Control without GUI (Graphical User Interface)
8280-154	Low Voltage Control without GUI
8280-317	High Voltage Control with GUI
8280-318	Low Voltage Control with GUI
8280-322	Low Voltage Marine Control without GUI
8280-323	Low Voltage Marine Control with GUI
9907-205	Hand Held Programmer

Power Supply Rating

18-40 Vdc (24 or 32 Vdc nominal)
90-150 Vdc (125 Vdc nominal)

Power Consumption

40W nominal

Steady State Speed Band

magnetic pickup: 400 - 15000 Hz
proximity switch: 7.5 - 1000Hz

Digital Inputs (8)

8mA at 24Vdc

Analogue Inputs (4)

4-20 mA or 1-5 Vdc

Analogue Outputs (3)

4-20 mA or 0-1 mA to meter or computer (2)
20-160 mA or 4-20 mA (1)

Actuator Output (1)

20-160 mA or 4-20 mA

Programmer Communication Port (J1)

RS-422, 9-pin D connector, 1200 baud, full duplex

Communication Ports (J2 & J3)

RS-232, RS-422, or RS-485, 9-pin D connector, 1200 to 38400 baud, full duplex

Ambient Operating Temperature

-40 to +70 °C (-40 to +158 °F)

Storage Temperature

-55 to +105 °C (-67 to +221 °F)

Humidity

95% at 38 °C

EMI/RFI Susceptibility

US MIL-STD 461C (Parts 5 & 9)

Humidity

US MIL-STD 810D, Method 507.2, Procedure III

Mechanical Vibration

24-2000 Hz swept sine, 2.5 Gs constant acceleration, resonant dwells - 1 million cycles, total time $\frac{3}{4}$ 6 hours/axis

Mechanical Shock

US MIL-STD 810C, Method 526.2, Procedure I (basic design test). Procedure II (transit drop test, packaged). Procedure V (bench handling).

Salt Spray

ASTM B 117-73

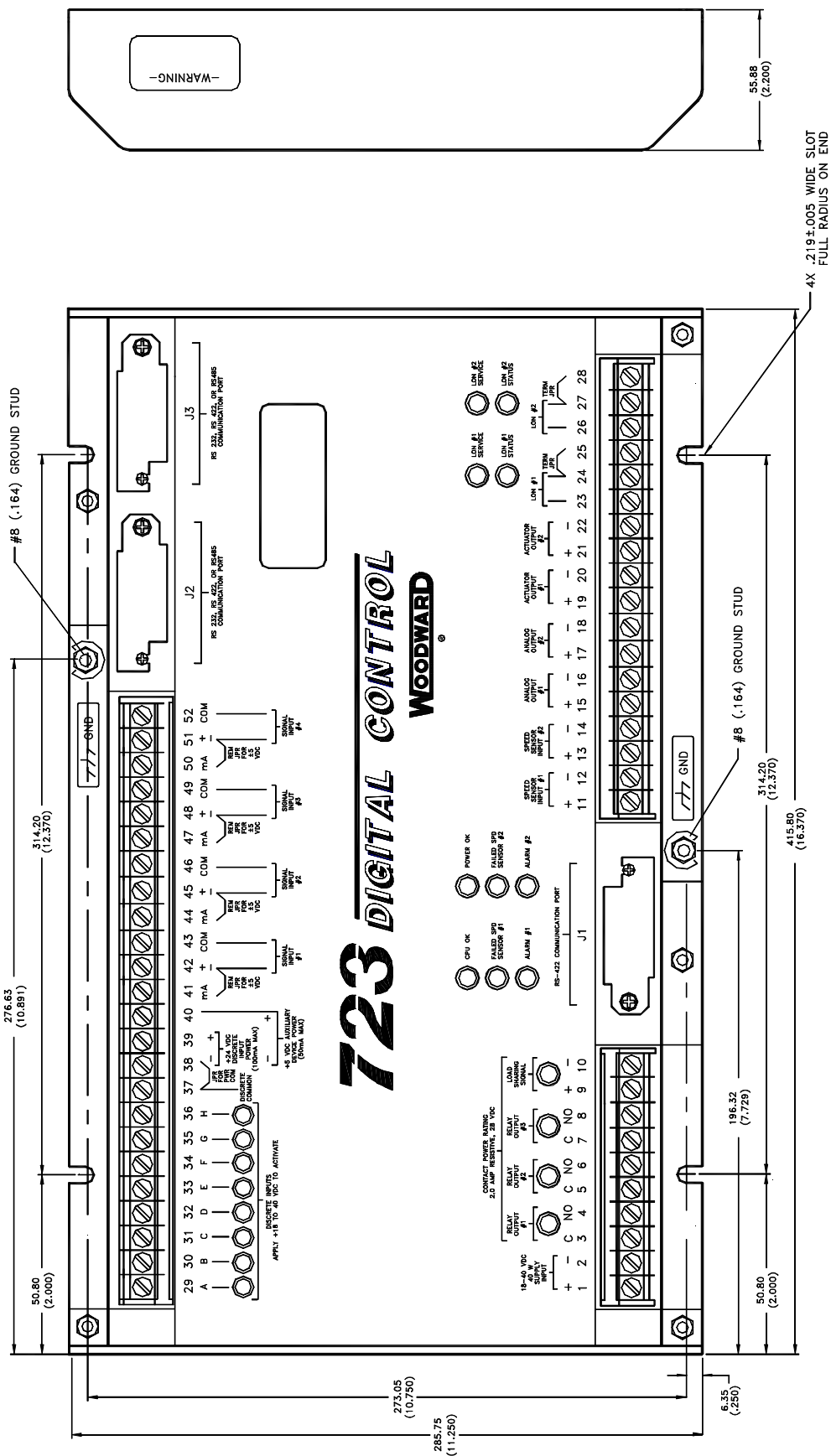
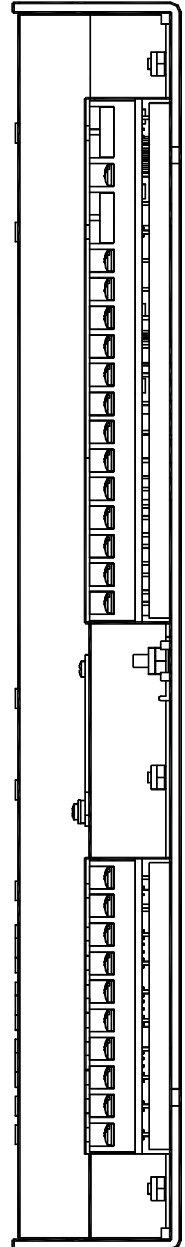


Figure 2-1. 723 Digital Speed Control

Dimensions in millimetres (Inches)

02752-01



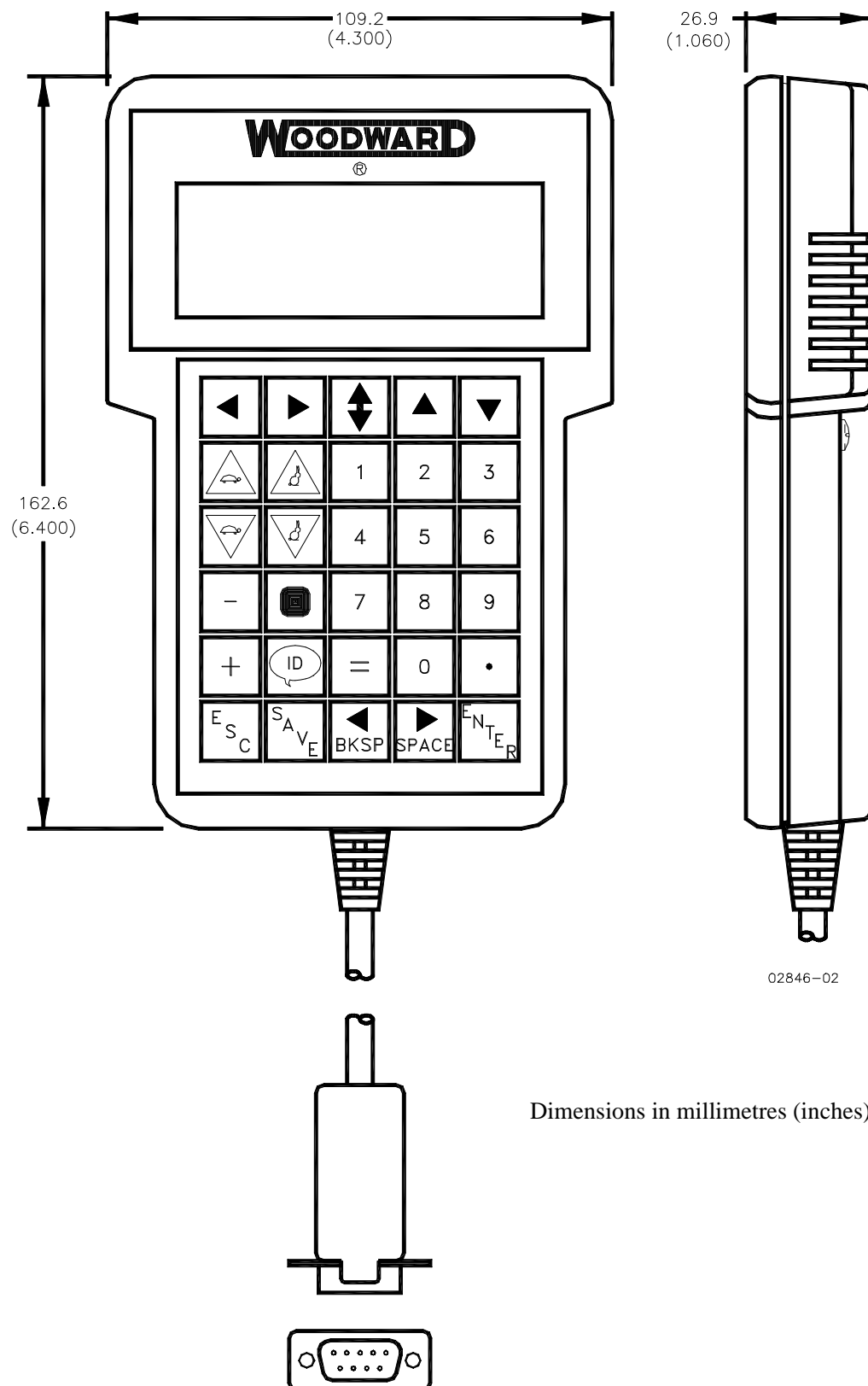


Figure 2-2. Hand Held Programmer

Chapter 3

Electrostatic Discharge Awareness

All electronic equipment is static-sensitive, some components more than others. To protect these components from static damage, you must take special precautions to minimise or eliminate electrostatic discharges.

Follow these precautions when working with or near the control.

1. Before doing maintenance on the electronic control, discharge the static electricity on your body to ground by touching and holding a grounded metal object (pipes, cabinets, equipment, etc.).
2. 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.
3. Keep plastic, vinyl, and styrofoam materials (such as plastic or styrofoam cups, cup holders, cigarette packages, cellophane wrappers, vinyl books or folders, plastic bottles, and plastic ash trays) away from the control, and the work area as much as possible.

Chapter 4

723 Installation

Scope

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

Unpacking

Before handling the control, read Chapter 3, Electrostatic Discharge Awareness. Be careful when unpacking the electronic control. Check the control for signs of damage such as bent panels, scratches, and loose or broken parts. If any damage is found, immediately notify the shipper.

Power Requirements

The high-voltage version of the 723 Digital Speed Control requires a voltage source of 90 to 150 Vdc. The low-voltage version requires a voltage source of 18 to 40 Vdc. Maximum power consumption is 40 Watts for both high & low voltage models.

CAUTION

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

NOTE

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

CAUTION

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

Location Considerations

Consider these requirements when selecting the mounting location:

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

The control must NOT be mounted on the engine.

Internal Jumpers

The 723 control has ten, two-position internal jumpers (JPR1 through JPR20) located on the top of the printed circuit board. If it is necessary to change any jumper to match the control requirements, and suits the nature of the software, be sure to read Chapter 3, Electrostatic Discharge Awareness.

Ensure that the power to the control is switched off, before removing the cover. Using a small pair of tweezers, carefully remove the appropriate jumper and replace it securely over the proper two connectors (see Figure 4-1).

The jumper connections are listed:

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

*--default jumper settings

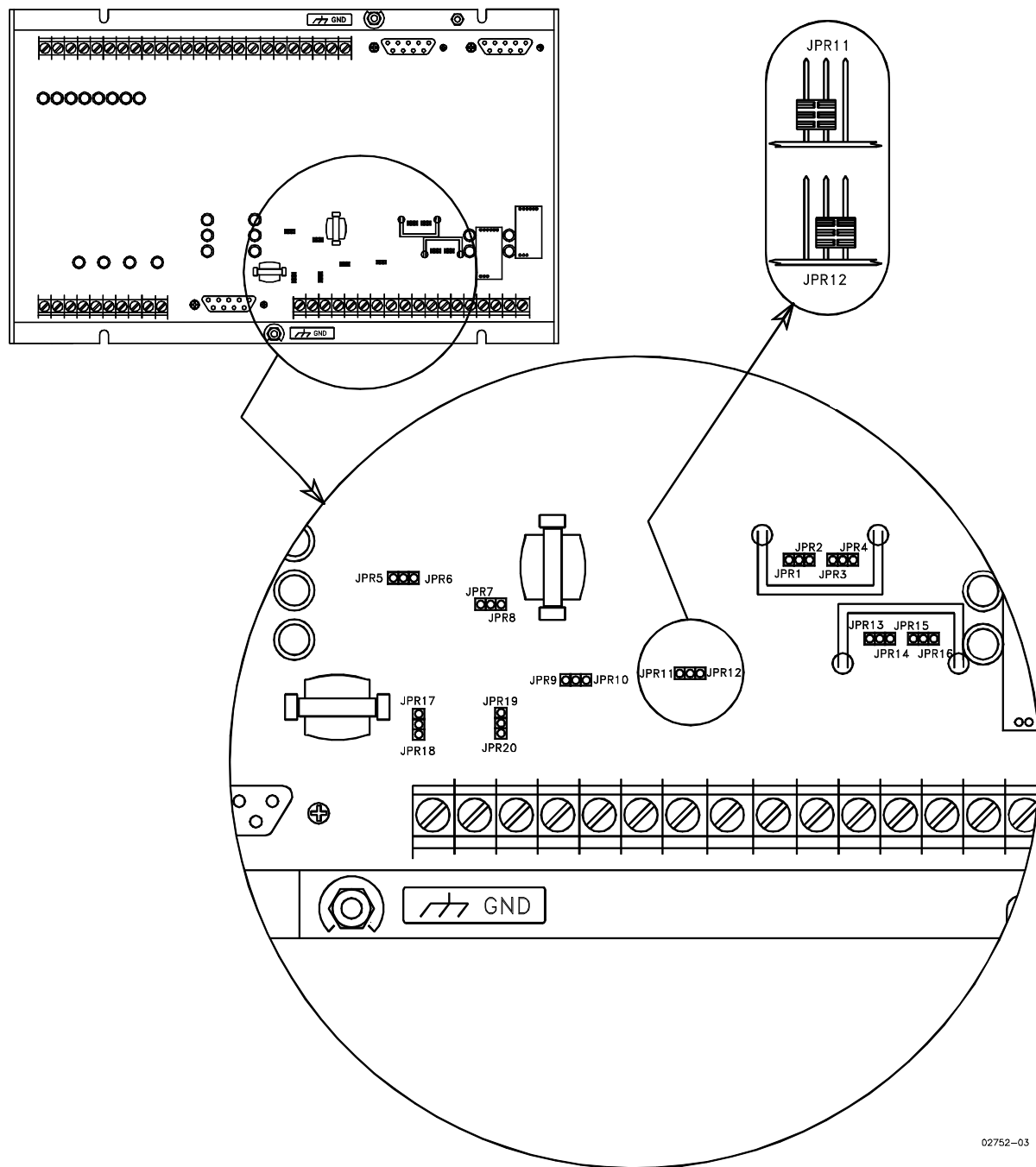


Figure 4-1. 723 Control Internal Jumpers

Electrical Connections

Shielded Wiring

All shielded cable must be twisted conductor pairs. Do not attempt to tin the braided shield. All signal lines should be shielded to prevent picking up stray signals from adjacent equipment. Connect the shields to the nearest chassis ground. Wire exposed beyond the shield should be as short as possible, not exceeding 50 mm (2 inches). The other end of the shields must be left open and insulated from any other conductor. **DO NOT** run shielded signal wires along with other wires carrying large currents. See Woodward application note 50532, *EMI Control in Electronic Governing Systems* for more information.

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

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

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

Power Supply (Terminals 1/2)

Power supply output must be low impedance (for example, directly from batteries). **DO NOT** power the control from high-voltage sources with resistors and zener diodes in series with the control power input. The 723 control contains a switching power supply which requires a current surge (around 1 Amp) to start properly.

CAUTION

To prevent damage to the control, do not power a low-voltage control from high-voltage sources, and do not power any control from high-voltage sources with resistors and zener diodes in series with the power input.

Run the power leads directly from the power source to the control. **DO NOT POWER OTHER DEVICES WITH LEADS COMMON TO THE CONTROL.** Avoid long wire lengths. Connect the positive (line) to terminal 1 and negative (common) to terminal 2. A protection device such as a fuse or MCB (rated 4 Amps for the Low-Voltage control and 2 Amps for the High-Voltage control) should be connected to prevent damage to the

control. If the power source is a battery, be sure the system includes an alternator or other battery-charging device.

If possible, do NOT turn off control power as part of a normal shutdown procedure. Leave the control powered except for service of the system and extended periods of disuse.

CAUTION

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

CAUTION

To prevent damage to the engine, apply power to the 723 control at least twenty five (25) seconds prior to starting the engine. The control must have time to complete its power up diagnostics and become operational. Do not start the engine unless both the green POWER OK and CPU OK indicators on the 723 control cover come on, because test failure turns off the output of the control.

Digital Relay Outputs

Major Alarm (Terminals 3 & 4)

Minor Alarm/Open Grid Breaker Command (Terminals 5 & 6)

Generator Breaker Open Command (Terminals 7 & 8)

Contact ratings for minimum 100,000 operations:

resistive - 2.0A at 28Vdc, 0.1A at 115Vac 50 to 400Hz

inductive - 0.75A at 28Vdc 0.2 Henry

Load Sharing Lines Input (Terminals 9/10)

Connect the load sharing lines directly to those of another 723 of the same designation, or to the appropriate terminals of another Woodward unit, for isochronous load sharing. Use a shielded twisted-pair cable. The shield should be connected continuously between controls, and grounded at one end only.

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

Connect a magnetic pickup (MPU) to terminals 11 and 12 (speed sensor #1). If required, connect a second MPU to terminals 13 and 14 (speed sensor #2). Use shielded wire for all speed sensor connections. Connect the shield to the chassis. Make sure the shield has continuity the entire distance to the speed sensor, and make sure the shield is insulated from all other conducting surfaces.

WARNING

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

Analogue Outputs (Terminals 15/16, 17/18, 19/20)**Actuator Position****Engine Speed****Engine Load****KW Reference****Speed Input #1****Speed Input #2**

Use shielded twisted-pair wires to connect to terminals 15(+) & 16(-), 17(+) & 18(-), and 19(+) & 20(-). For an electrically isolated input device such as a 4 to 20 mA input analogue meter, the shield should be grounded at the control end of the cable. For input to other devices, use the recommendation of the device manufacturer.

The analogue outputs will drive 4-20mA at 600 ohms maximum.

CAUTION

To prevent possible damage to the control or poor control performance resulting from ground loop problems, we recommend using current-loop isolators if the 723 control's analogue inputs and outputs are used with non-isolated devices (common ground system). A number of manufacturers offer 20 mA loop isolators. Consult Woodward Governor Company for further information.

Actuator Output (Terminals 21/22)

The actuator wires connect to terminals 21(+) and 22(-). Use shielded wires with the shield connected to chassis at the control.

LON #1 (Terminals 23/24/25)

Please read Chapter 7 for the wiring details of the LON networks.

Discrete Inputs (Terminals 29 - 36)

Discrete inputs are the switch input commands to the 723 control. The discrete inputs should be powered from the 723's own Discrete Input Power. In this case, terminals 37 & 38 should be jumpered. This connects the control's common to the discrete input common. Terminal 39 then supplies 24Vdc to the discrete inputs. Since this aux voltage is not isolated from other control circuits, use only isolated contacts (dry or signal

voltage rated) for the discrete circuits. **DO NOT POWER ANY OTHER DEVICES WITH THE DISCRETE INPUT AUX VOLTAGE SOURCE.**

If the discrete input voltage (24 Vdc) is supplied from an external source, connect the voltage source negative (–) to terminal 37. Then run the voltage source positive (+) to the appropriate switch or relay contact and then to the corresponding discrete input.

Note : There will be no connection to terminal 38 in this case.

Analogue Inputs

KW Transducer (Terminals 41/42/43)

KW Reference (Terminals 44/45/46)

Unit Synchroniser (Terminals 47/48/49)

System Synchroniser/Charge Air Pressure (Terminals 50/51/52)

Use shielded twisted-pair cable to connect to terminals 42(+) & 43(-), 45(+) & 46(-), 48(+) & 49(-) and 51(+) & 52(-). Ensure that jumpers are installed between terminals 41 & 42, 44 & 45 and 50 & 51 (only for p/n's 8280-322/323).

For 4-20mA inputs (jumper in), the internal burden resistance is 250 ohms.

CAUTION

To prevent possible damage to the control or poor control performance resulting from ground loop problems, we recommend using current-loop isolators if the 723 control's analogue inputs and outputs are used with non-isolated devices (common ground system). A number of manufacturers offer 20 mA loop isolators. Consult Woodward Governor Company for further information.

Serial Communications Ports

J2 - ServLink Server, RS232, RS422

J3 - Modbus®, RS232, RS422, RS485

Note: RS485 is not available for ServLink Server communications.

Termination

For RS-422, termination should be located at the receiver when one or more transmitters are connected to a single receiver. When a single transmitter is connected to one or more receivers, termination should be at the receiver farthest from the transmitter. Figure 4-2 is an example.

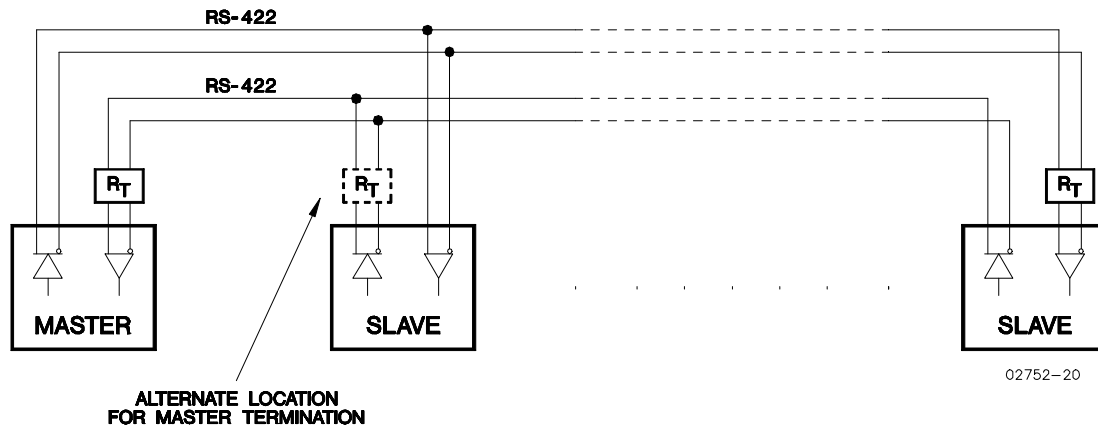


Figure 4-2. RS-422 Terminator Locations

For RS-485, termination should be at each end of the cable. If termination can't be located at the end of a cable, put it as close as possible to the ends. Figure 4-3 is an example.

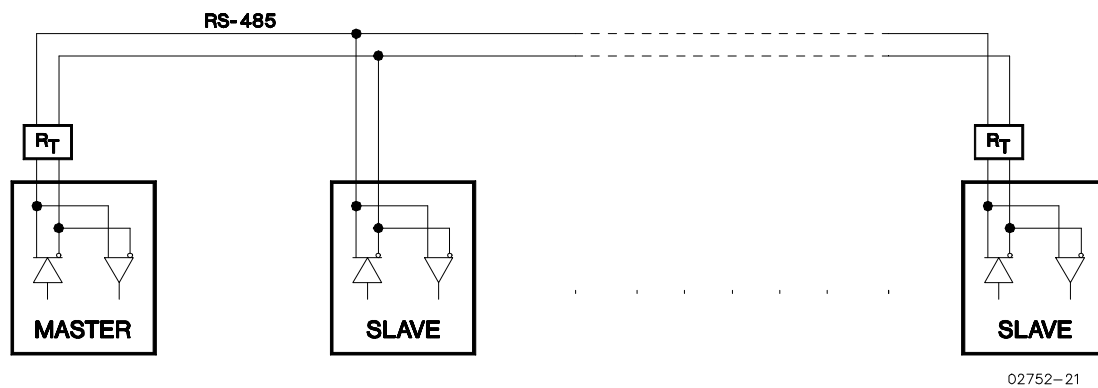


Figure 4-3. RS-485 Terminator Locations

Communicating with a HMI operator interface is a special case of Figure 4-1. Because the HMI master cannot put its transmitter into a high-impedance state, and the bit rate is less than 90k bits/sec, termination is not needed at the slave. Termination is needed at the HMI receiver, but because there is no way to locate it there, it has to be put at the alternate location.

If you don't know if a master can put its transmitter into a high-impedance state, terminate the line as shown in Figure 4-2. It does not hurt to terminate the line even when it's not needed as in the case of the HMI operator interface.

Termination is accomplished using a three-resistor voltage divider between a positive voltage and ground. The impedance of the resistor network should be equal to the characteristic impedance of the cable. This is usually about 100 to 120 ohms. The purpose is to maintain a voltage level between the two differential lines so that the receiver will be in a stable condition. The differential voltage can range between 0.2 and 6 volts; the maximum voltage between the receiver input and circuit ground must be less

than 10 volts. There is one termination resistor network for each J2 and J3 port located on the 723. Connection to this resistor network is made through the 9-pin connectors on pins 6 and 9.

See Figures 4-4 through 4-7 for termination and cable connection examples.

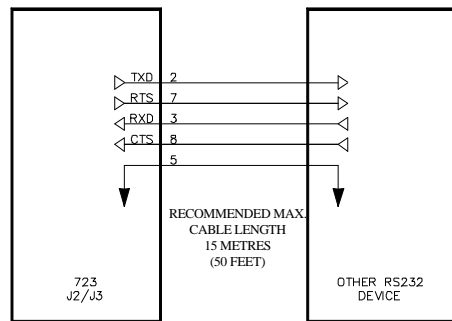
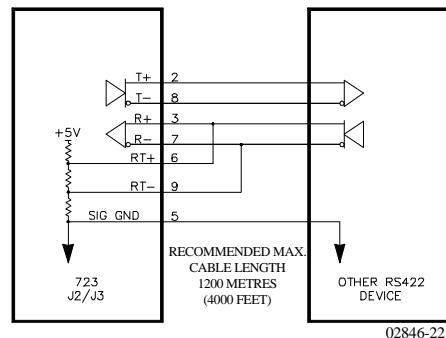


Figure 4-4. 723 RS-232 Connection



02846-22

Figure 4-5. 723 RS-422 Connections with optional termination at receiver

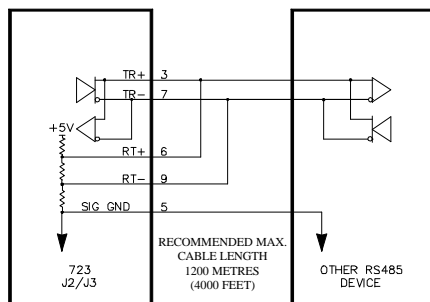
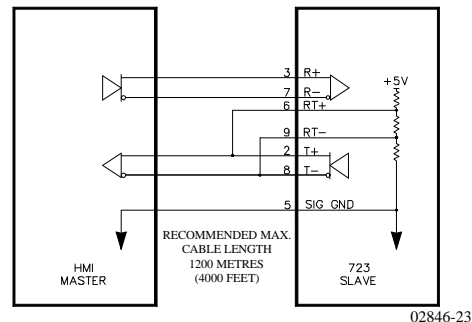


Figure 4-6. 723 RS-485 Connections with optional termination



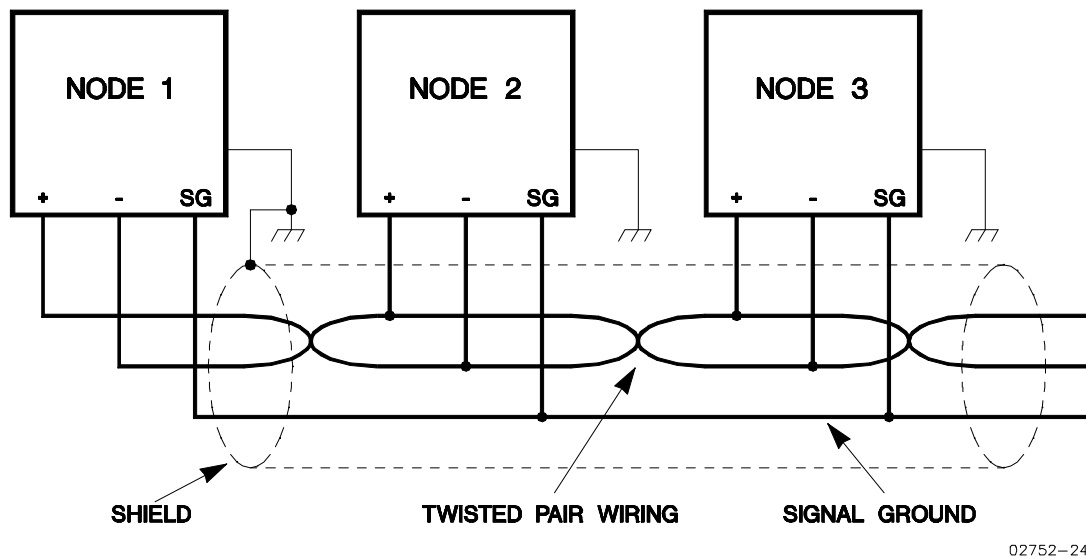
02846-23

Figure 4-7. 723 RS-422 Connections with optional termination at transmitter

Grounding and Shielding

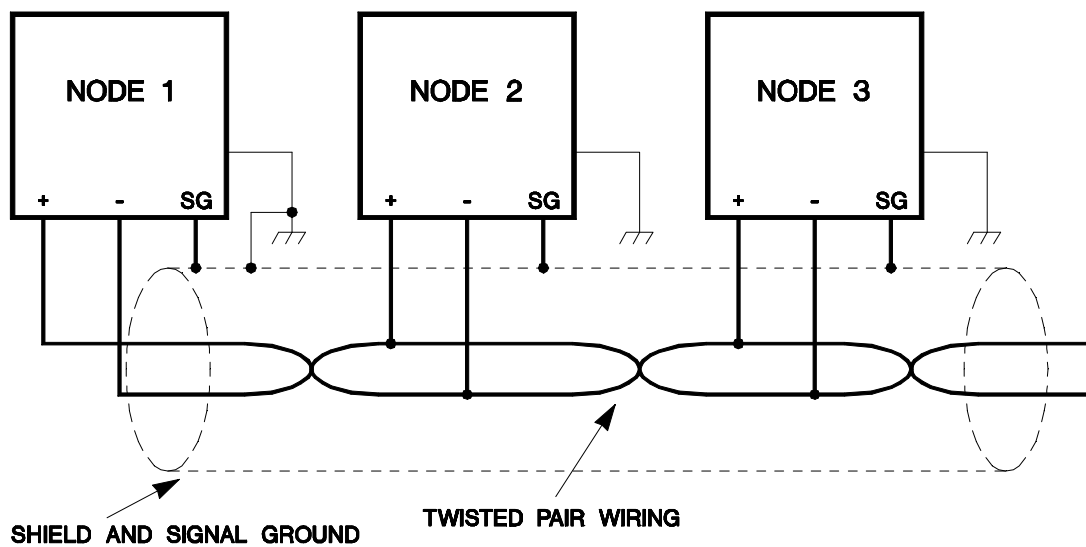
The RS-422 and RS-485 specifications state that a ground wire is needed if there is no other ground path between units. The preferred method to do this is to include a separate wire in the cable that connects the circuit grounds together. Connect the shield to earth ground at one point only. The alternate way is to connect all circuit grounds to the shield, and then connect the shield to earth ground at one point only. If the latter method is used, and there are non-isolated nodes on the party line, connect the shield to ground at a non-isolated node, not an isolated node. Figures 4-8 and 4-9 illustrate these cabling approaches.

Note: Non-isolated nodes may not have a signal ground available. If signal ground is not available, use the alternate wiring scheme in Figure 4-9 with the signal ground connection removed on those nodes only.



02752-24

Figure 4-8. Preferred multipoint wiring using shielded twisted-pair cable with separate signal ground wire.



02752-25

Figure 4-9. Alternate multipoint wiring using shielded twisted-pair cable without a separate signal ground wire.

Note: The signal ground connection is not required if signal ground is unavailable.

5

4

3

2

1

REVISION STATUS OF SHEETS

SHT	REV	SHT	REV	SHT	REV	SHT	REV	SHT	REV	SHT	REV	SHT	REV
1	NEW												
2	NEW												

REVISIONS

DESCRIPTION	LTR	ZONE	DATE	APPROVED
E/C503492	NEW		11.97	R.B.
E/C503492	NEW		11.97	R.B.

NOTES:

1. Shielded wire are twisted pairs, with shield grounded at one end only. When mounting control to bulkhead use the grounding stud to ensure proper grounding.

2. Shields must not be grounded at any external point unless otherwise noted.

3. All shields must be carried continuously through all terminal blocks and must not be tied to other shields except at the common ground point. The shields are tied together at the ground stud on the 723 chassis.

4. Remove jumper for voltage input.

5. Discrete inputs are isolated from other circuits and intended to be powered from terminal 39(24v dc) leaving the jumper in place. Input current is normally 10 milliampere per input into 2210 ohms.

6. Relay contact rating for minimum 100 000 operations:
resitive - 2.0 amperes at 28 Vdc
0.1 amperes at 115VAC 50to400Hz
inductive - 0.75 amperes at 28 Vdc 0.2 henry

7. Analogue output signals to other systems must be isolated from ground either by design or employment of isolation amplifiers.

8. Analogue input signals to other systems must be isolated from ground either by design or employment of isolation amplifiers.

9. Internal power supply provides DC isolation between the power source and all other inputs and outputs.

10. Communication port J1 can only be used with the Woodward Hand held Programmer.

11. Communication ports J2 & J3 can be configured as RS-232, RS-422, OR RS-485 serial interface. Port configuration can be done in the application software only.

8280-153

8280-154

8280-317

8280-318

8280-322

8280-323

NEXT LEVEL

FINAL LEVEL

APPLICATION

UNLESS OTHERWISE SPECIFIED:
SURFACE FINISHES AND
GENERAL TOLERANCES ARE
TO BE AS SPECIFIED IN
SHOP STANDARD SS-112

MATERIAL:

THIRD ANGLE
PROJECTION

APPROVED

CHECKED

DRAWN

CAD OPR.

APPROVAL

WOODWARD GOVERNOR (U.K.) LTD

ENGINE AND TURBINE DIVISION

READING, BERKSHIRE, ENGLAND

DIAGRAM-PLANT WIRING

723 GENERATOR CONTROL

DROOP/ISOC/KW CONTROL

SIZE B

CODE IDENT NO. 9974-544

SCALE

WT.

SHEET 1:2

"THIS DRAWING OR ANY REPRODUCTION OF IT SHALL NOT BE USED FOR MANUFACTURE, PRODUCTION OR PROCUREMENT WITHOUT THE EXPRESS WRITTEN PERMISSION OF THE WOODWARD GOVERNOR COMPANY OR ONE OF ITS SUBSIDIARIES. USE OR REPRODUCTION FOR USE, IN A NORMAL MANNER ASSOCIATED WITH GOODS OR SERVICE FURNISHED OR TENDERED BY WOODWARD GOVERNOR COMPANY OR ONE OF ITS SUBSIDIARIES, IS APPROVED."

Figure 4-10. 723 Wiring Notes

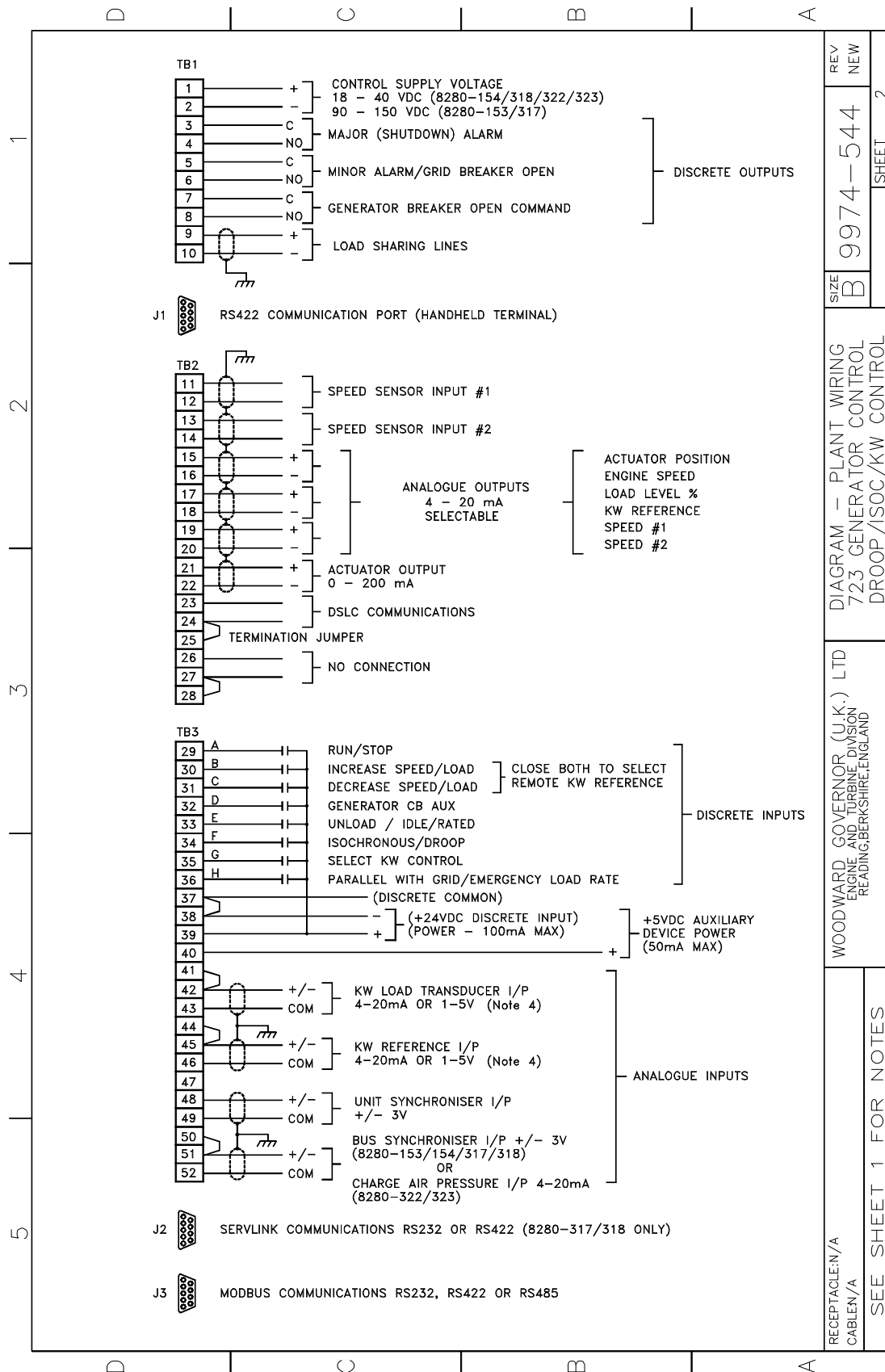


Figure 4-11. 723 Wiring

Installation Checkout Procedure

With the installation complete, carry out the following checkout procedure before beginning set point entry or initial start-up adjustments.

1. Visual inspection

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

WARNING

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

B. Check for correct wiring in accordance with the plant wiring diagram.

C. Check for broken terminals and loose terminal screws.

D. Check the speed sensor(s) for visible damage. If the sensor is a magnetic pickup, check the clearance between the gear and the sensor, and adjust if necessary. Clearance should be between 0.25 and 1.25 mm (0.010 and 0.050 inch) at the closest point. Make sure the gear runout does not exceed the pickup gap. Refer to the manual 82510 Magnetic Pickups And Proximity Switches For Electric Governors, for information.

2. Check for grounds

Check for grounds by measuring the resistance from all control terminals to chassis. All terminals except terminals 2 and 38 should measure infinite resistance (the resistance of terminals 2 and 38 depends on whether a floating or grounded power source is used). If a resistance less than infinite is obtained, remove the connections from each terminal one at a time until the resistance is infinite. Check the line that was removed last to locate the fault.

Chapter 5

System Description

Engine Speed

Speed Sensing

The control has two speed sensing inputs, and may be configured for torsional filtering, for smoother operation with soft couplings, or high signal select, giving speed sensing redundancy should one signal fail. If the torsional filter has been selected, the speed sensors should be positioned on either side of the coupling; sensor #1 on the engine side, and sensor #2 on the generator side. If the high signal select is utilised, then both speed sensing devices should be located on the same speed sensing disc.

Each speed sensor input has a failed speed detection device, with an override function which is active during engine start-up. The Failed Spd Sensor #1 and Failed Spd Sensor #2 LED's located on the 723 control, give indication when either input has failed. If a speed sensor fails, it will be switched out until the fault is rectified, and then reset during the next engine start ^{*F}.

When the torsional filter is selected, failure of either speed sensor will result in the activation of the Minor Alarm, and control will continue with one speed signal. If the **Generator CB Aux** contact input is closed, the *Propgain Multiplier* will be switched in to decrease the *Proportional Gain* value. If high signal select is chosen, failure of a speed sensor will also give continued control with one speed signal, and the Minor Alarm will be activated.

The option is available to disable the Minor Alarm if one speed sensor fails, for situations where only one speed sensor is utilised. The Failed Spd Sensor LED on the front panel of the 723 will still illuminate if no speed signal is sensed, but the Minor Alarm will not activate.

Failure of both speed sensors will initiate a shutdown, whereby the control will drive the actuator output to zero, and the Major Alarm will be activated.

WARNING

If the engine has been shutdown by the 723 control due to both speed sensors failing, do NOT attempt to start the engine until the faults have been located and rectified. Failure of the pickups can only be detected whilst the engine is running, i.e. the signal must already exist for the failure detection to operate. If the 723 cannot detect engine speed during start-up, the actuator output will go to maximum, possibly driving the engine into an overspeed condition. The engine should be equipped with an additional overspeed shutdown device that operates totally independently of this control, to protect against runaway or damage to the engine, with possible personal injury or loss of life.

Electronic overspeed detection and shutdown is integral to the control. The control will drive the actuator output to zero fuel, if the *Overspeed Trip* is exceeded.

WARNING

The engine should be equipped with an additional overspeed shutdown device, that operates totally independently of this control, to protect against runaway or damage to the engine, with possible personal injury or loss of life, should this control fail.

Speed Filtering

Each speed sensor input is fed through a low pass filter which should not need adjustment, but may be used to filter out any undesirable frequencies on the speed pickups.

If enabled, the torsional filter can be used to help prevent the control from reacting to torsionals across a flexible coupling. This works by ‘averaging’ out the speed sensing signals from either side of the coupling, although this can be weighted more heavily to one side than the other, by adjusting the *Sensor Weight*.

For systems with low frequency oscillatory modes due to engine and generator inertias, and flexible couplings, which can become difficult to control, the Notch/Band-Stop Filter is provided. This filter can reduce the signal transmission through the control, by reducing the signal gain at the resonant frequency, and hence preventing the control from reacting to these unwanted frequencies.

Speed Control & Synchronising

Engine Start

When the **Run/Stop** contact is closed, (or opened if the *Open DI#1 To Run* configureable is selected true^{*F}), the speed reference is at *Idle Speed*. The reference will then remain at idle, until the engine speed exceeds the *Idle/Rated Switch* speed, at which time the speed reference will ramp to *Rated Speed* at the *Accel/Decel Rate*. This ramp to rated may be interrupted by momentarily closing **Decrease** contact (so freezing the ramp).

If the **Idle/Rated** select contact is required, the *Enable I/R Select* parameter should be set true. When the **Run/Stop** contact is put in the ‘run’ position, the speed reference will be initially at *Idle Speed*. Once the engine has started, the control will remain at idle, if the contact is in the idle position, or will ramp to *Rated Speed*, at the *Accel/Decel Rate*, if/when the contact is closed. The idle-to-rated ramp may be interrupted by either opening the **Rated/Idle** contact (and so returning the reference back to *Idle Speed* at the *Accel/Decel Rate*), or by momentarily closing the **Decrease** contact (so freezing the ramp).

The rated-to-idle ramp may be interrupted similarly by either closing the **Rated/Idle** contact (and so returning the reference back to *Rated Speed*, at the *Accel/Decel Rate*), or by momentarily closing the **Increase** contact (so freezing the ramp).

The **Idle/Rated** contact input is only functional, whilst the **Generator CB Aux** contact input is open.

Synchronising to a Bus

When the engine reaches *Rated Speed*, and has remained within the *Ready to Synch Limits* for the *Sync OK Delay Time*, the control will issue a 'Run' command via the **LON** to the DSLC. If the DSLC is not connected using the **LON**, it will have to be enabled by the hardwired contact instead.

The **Unit Synchroniser** Input will bias the speed reference, based on the value of the bipolar voltage input. Once the **Generator CB Aux** contact is closed, the bias is either:

- switched out until the **Generator CB Aux** input is opened, if isoch mode is enabled.
- last value locked in until the **Generator CB Aux** input is opened, if droop mode is enabled.

Alternatively, the unit can be synchronised to the bus using the **Increase/Decrease** contacts, which will cause the speed reference to change at the *Inc/Dec Rate #1*. The *Maximum Speed* determines the limit to which the reference may be increased, and the *Minimum Speed* is the limit to which the reference may be decreased.

Opening the **Generator CB Aux** contact input will set the speed reference instantly to *Rated Speed*.

Synchronising to the Grid

Once the **Generator CB Aux** contact is closed, and the unit is either in droop mode or isochronous load sharing, the system may be synchronised to the utility. This can be done using a Woodward synchroniser (DSLC or SPM-A), via the bipolar **System Synchroniser** Input, (8280-153/154/317/318 only). If the control is in droop mode, the **Increase/Decrease** contact inputs may also be used.

Opening the **Parallel With Grid** (if used) contact input will set the speed reference instantly to *Rated Speed*.

Droop Control

To operate in Droop mode, the **Isochronous/Droop** contact input must be open, and the **Generator CB Aux** contact closed.

The speed droop value is calculated based on the Droop percentage, and the load on the engine. The engine load will be derived from the **KW Transducer** input. Should this signal fail, the load will be determined based on the position of the actuator output. Failure of the load signal input will activate the Minor Alarm, which will be reset once the signal is healthy. The speed droop will always be zero, whilst the CB Aux is open.

A 'Droop Pulse' function is provided to help prevent an engine being driven into reverse power, when connected to a bus in droop mode. When the **Generator CB Aux** contact is closed, the speed reference is immediately increased by the *Ref Bias Pulse*. This will cause the generator to immediately take on load from the other sets. This is a permanent bias, whilst the control remains in droop mode. This function can be disabled by tuning the *Ref Bias Pulse* parameter to zero.

Closure of the Increase contact will cause the speed reference to increase at the Inc/Dec Rate #2, therefore causing the engine to take on load (if available).

Closure of the Decrease contact will cause the speed reference to decrease at the Inc/Dec Rate #2, therefore causing the engine to shed load (if possible).

Isochronous Load Sharing

Isochronous load sharing is enabled by closing the **Isochronous/Droop** contact, provided that the **Generator CB Aux** contact is also closed, and the load input signal is healthy.

The first machine on-line will close its relay K4 contact on the load sharing lines instantly, connecting to the system load sharing lines, in preparation for isochronous load sharing with other units. Subsequent units selected to isochronous will increase/decrease load softly, according to the *Auto Load/Unload Rates*, until the load on the unit is within the defined *LS Error %*, of the other unit(s) which are already isochronously load sharing. At this time, the relay K4 will be closed to connect the load sharing lines to those of the other unit(s). The error between the system load and each individual unit's load will then be monitored, and the *Rated Speed* reference biased accordingly, to increase/decrease load, to achieve equal load sharing at *Rated Speed*.

The control provides a function for auto soft unloading of the engine. The **Unload** contact should be closed (momentarily) when the control is in isochronous load sharing. The engine load will then be ramped down at the *Auto Unload Rate*, until the *Unload Trip Level* is reached, at which time, the control will issue a **Generator Breaker Open Command**. This output will remain active, until the **Generator CB Aux** contact is opened.

Note: The **Generator Breaker Open Command** is a normally open contact, unless the *Brkr Open Cmd NC?* setpoint has been tuned to make the contact normally closed.

The unloading ramp may be stopped, if necessary, by momentarily closing the **Increase** contact. At this time, the control will be in droop mode, and will either remain so until the **Isochronous/Droop** contact is toggled open/closed to switch back into isochronous load sharing, or if the *Re-Load to Isoc* setpoint is tuned true, the control will automatically ramp back to isochronous load sharing.

The **Emergency Load Rate** input may be enabled for fast 'soft' loading/unloading of the engine.

If it is necessary that a machine is required on-line more quickly than usual (i.e. during an emergency situation), the contact should be closed, and once the **Generator CB Aux** contact is closed, the control will load the engine at the *Emergency Load Rate*, rather than the *Auto Load Rate*.

If the Unload function is used whilst the **Emergency Load Rate** contact is closed, the engine will be unloaded at the *Emergency Unload Rate*.

The *Emergency Load/Unload Rates* may be disabled at any time, by opening the contact.

If the **KW Transducer** input signal should fail whilst in isochronous load sharing, the control will switch back into droop control, with load based on the actuator output. Once the fault is rectified, and the signal fault reset (either automatically or by using the Modbus® Reset), the control will load/unload back into isochronous load sharing.

Whilst the control is operating in isochronous load sharing, the droop reference is continuously tracking, so that if the control is switched into droop mode, the transfer will be bumpless.

Switching into KW Control mode will also be bumpless.

KW Control

To operate in KW Control, the **Generator CB Aux, Parallel With Grid** (if used) and **KW Control** contact inputs must be closed.

Switching into KW Control from Isochronous Load Sharing or Droop mode will be bumpless. Once in KW Control, the kW reference can be adjusted by use of the **Increase/Decrease** contact inputs. Closing the **Increase** contact raises the kW reference towards the *Maximum Load* at the *Raise Load Rate*. Closing the **Decrease** contact lowers the kW reference towards the *Minimum Load* at the *Lower Load Rate*.

If the *Select Int kW Ref* parameter has been selected true in Configure, when the control switches into kW Control mode, and digital mode is selected (use of Increase/Decrease inputs to adjust load), the kW reference will automatically ramp to the *Internal kW Ref* at the *Int kW Ref Rate*. It will then remain at this level until the Increase/Decrease contact inputs are used to adjust the load, or if the control is switched into Remote/Analogue mode. *F

If both the **Increase** and **Decrease** contacts are closed (or Remote Reference selected via the Modbus®), the kW reference will ramp to the level determined by the **4-20mA Remote Reference** input (or Modbus® Remote reference), at the *Auto Load Rate*. Once this level has been reached, the reference will continue to follow the input, at the *Raise/Lower Load Rates*. If the remote reference input should fail (i.e. <2mA, >22mA), the kW reference will lock in the last healthy value. The control will then respond to the **Increase/Decrease** contacts, once the remote kW reference is de-selected.

If both the **Increase** and **Decrease** contacts are closed to select the remote reference, opening only one of the contacts will NOT de-select the remote reference. Both contacts must be opened to de-select the remote reference. This is to prevent the reference being driven high or low in the event of a single wire break.

Closing the **Unload** contact (momentarily) will cause the control to decrease the kW reference until the *Unload Trip Level* is reached, at which time the control will issue a **Generator Breaker Open Command**. This output will remain active until the **Generator CB Aux** contact is opened, indicating that the breaker has opened.

The unloading sequence can be interrupted by momentarily closing the **Increase** contact input. The load will then remain at the level it was interrupted at, if in local mode, or will ramp back to the remote reference level, if in remote mode.

Failure of the 4-20mA **kW Transducer** input (i.e. <1mA, >22mA) will switch the control into droop mode, with load calculated based on the actuator output. Once the fault is rectified, and the signal fault reset (either automatically or by using the Modbus® Reset), the control will load/unload back into kW Control.

During normal operation, transferring to droop or isochronous modes will be bumpless.

If the **Parallel With Grid** contact is opened, with the control selected to Isochronous, the load sharing lines relay K4 is closed immediately, to ensure that all units will switch instantly to isochronous load sharing. In this case, the transfer may not be completely bumpless, depending on the imported/exported load, before the grid breaker was opened.

Whilst operating in kW Control, provision is made for opening the Grid and Generator Breakers in the event that the grid frequency has risen too high or fallen too low. If the error between the *Rated Speed* and the actual engine speed exceeds the *Freq Error Setpoint #1*, the **Open Grid Breaker Command** will be issued (if this hardware option has been chosen). If the error exceeds the *Freq Error Setpoint #2*, the **Generator Breaker Open Command** will be issued.

Depending on which method of KW Control is preferred, either Direct KW Control or Compensated KW Control may be chosen.

Direct KW Control:

The PID compares the measured kW to the kW reference, and adjusts the actuator output accordingly.

Compensated KW Control:

The control is effectively in Droop mode. A deadband controller compares the measured kW with the kW reference, and then will increase/decrease the speed reference ramp, and hence increase/decrease the load on the engine.

Operating Modes

Whether the control is in Droop, Isochronous or kW Control mode, is dependent on the status of certain contact inputs, and whether or not certain analogue inputs are healthy. The table below indicates which mode of operation the control will select, based on the status of the relevant digital and analogue inputs.

MODE ⇒	Isoch	Droop	Droop	Droop	Droop	kW Control Analogue/Remote	kW Control Digital/Inc-Dec
I/O ↓							
Gen CB (DI)	X	X	X	X	X	X	X
Grid CB (DI)	O	O	X	O	X	X	X
Isoch/Droop (DI)	X	O	X/O	X	X/O	X/O	X/O
kW Control (DI)	X/O	X/O	O	X/O	X	X	X
kW Load (AI)	O	X/O	X/O	X	X	O	O
kW Reference (AI)	X/O	X/O	X/O	X/O	X/O	O	X/O

DI:

X = CLOSED

O = OPEN

X/O = STATUS IRRELEVANT

AI:

X = FAILED

O = HEALTHY

X/O = STATUS IRRELEVANT

Limiters & Load Rejection

The LED on the front of the 723, labelled 'Alarm #2', will illuminate if any of the Start, Maximum or Charge Air Pressure fuel limiters are controlling the fuel output, or if an engine shutdown has clamped the output to zero.

Engine Shutdown Limiter

If the control shuts down the engine, due to a major alarm condition, or because the stop command has been issued, the output to the actuator driver will be clamped at zero. A value of '0' will be displayed for the *Actuator Position* in the Service **Display Menu**.

Start & Maximum Fuel Limiter

The *Start Fuel Limit*, for limiting overfuelling or flooding during engine start-up is active when the engine is started. This limit is derived from a four point curve, to give flexibility of the limiting level at different engines speeds, as the engine is started.

When the PID takes control, the *Start Fuel Limit* is switched out until the engine is stopped, and the *Maximum Fuel Limit* is switched in.

Frequency Load Limiter

When operating in KW Control, a load limiter is provided to control the amount of load on the engine, when the grid frequency varies beyond the pre-set limits. A window is established, and within this window the limiter has no effect. Once this window is exceeded, the kW reference will be limited progressively, as the speed deviates further out of the window. If the *Unload Trip Level* is reached, the **Generator Breaker Open Command** will be issued. The purpose of this limiter is to ensure that control is maintained if the speed varies due to an unknown change to the system parameters.

Charge Air Pressure Fuel Limiter (8280-322/323 only)

A four point curve provides fuel limiting based on the 4-20mA **Charge Air Pressure** input signal. This limiter is only active once the **Generator CB Aux** contact is closed.

Generator Breaker Load Rejection

In the case of a load rejection due to the generator breaker opening, a load rejection algorithm will come into effect, giving reduced speed overshoot characteristics. This will be activated if the load was above a certain level before the breaker was opened. The actuator output will be driven to zero for a period dependent on the amount of load before the breaker was opened.

Grid Breaker Load Rejection

Similar to the Generator Breaker Load Rejection (above), this algorithm will come into effect when the Parallel With Grid contact is opened, with the load above a certain level.

PID Control & Actuator Output

Speed/Droop/Isochronous/ Deadband KW Control

The output has tuneable PID dynamics, a *Gain Slope* function (which adjusts *Proportional Gain* as the engine load changes), a *Gain Ratio* function (which multiplies the *Proportional Gain* as a function of the speed error), and *Derivative Dynamics*^{*F} (the PID dynamics are adjusted by a multiplier, as the rate of change of engine speed exceeds a certain level - see tuneable descriptions for more detail).

Two sets of dynamics (*Proportional Gain*, *Integral Gain* & *S.D.R.*) are provided:

- Set #1 is active when the **Generator CB Aux** contact is open.
- Set #2 is active when the **Generator CB Aux** contact is closed.

The dynamics can be multiplied individually by a multiplier, which is based on the speed derivative. As the absolute value of the derivative exceeds a set level (according to a two-point curve), the P, I & D terms can be increased/decreased, as the derivative value further increases. This option can be chosen instead of the *Gain Ratio* function, but may be used in conjunction with the *Gain Slope* function.^{*F}

When the torsional filter is operational, if one of the speed sensors should fail, the *Proportional Gain* is multiplied by the *PropGain Multiplier*, in order to attempt to slow the control down, and prevent it responding to torsionals, for which the torsional filter was enabled to help minimise.

Direct KW Control

A single set of dynamics (*Proportional Gain*, *Integral Gain* & *S.D.R.*) for operation in KW Control mode.

Actuator Hit

An 'Actuator Hit' function is provided for testing the dynamics of the control during commissioning of the system. This function can be enabled in Configure mode, and once the control has reset itself, the function is only available for a 30 minute period. When the appropriate parameter is toggled true using the Operator Interface (HHT or PC-based), a tuneable value is subtracted from the actuator output, for a tuneable period of time. This will enable the operator to check that the dynamic settings are suitable. This is a better alternative to physically disturbing the fuel rack to check the response of an engine, as it will provide a consistent means of test.

Run/Stop & Alarms

Closure of the **Run/Stop** contact (or open if the option is selected^{*F}) will release the actuator output from zero to the *Start Fuel Limit* level. The 'Run' signal will also act as a reset to any speed sensor faults, and the 723 electronic overspeed trip latch (unless the Modbus® Reset has been enabled).

The **Run/Stop** will only be effective for engine starting, provided that the engine speed has fallen below 350Hz, and the *Rundown Time* period has elapsed.

Putting the **Run/Stop** contact in the 'stop' position will cause the control to limit the actuator output to zero. If the **Generator CB Aux** is closed at this time, the control will also issue a **Generator Breaker Open Command**.

Major Alarm:

The Major Alarm will be activated:

- if the *Overspeed Trip* level is exceeded
- if both speed sensor inputs should fail

The relay contact will be opened continuously, unless the option for *Pulse Alarm* is selected, in which case, the contact will be opened for the *Pulse Alarm Time*, and will then be re-closed.

Minor Alarm:

The Minor Alarm will be activated:

- if one speed signal fails
- if the **KW Transducer** input fails - below 1mA, above 22mA
- if the **Charge Air Pressure** input fails - below 2mA, above 22mA
- if the **KW Reference** input fails - below 2mA, above 22mA
- if the **LON** communications to the DSLC fail
- if remote kW reference is selected using the **Increase/Decrease** contacts, and a single signal is lost (wire-break)
- if the **Modbus®** serial communications have failed
- if in KW Control, and the Frequency Limiter has come into effect

Rectification and reset of the fault, will reset the Minor Alarm.

Modbus® Communications & Control

Instead of the hardwired inputs, the Modbus® communication can deliver the following signals from another system, e.g. Power Management

- Run
- Stop
- Increase Speed/Load
- Decrease Speed/Load
- Select Remote KW Reference
- Unload
- Idle Speed Select
- Rated Speed Select
- Droop Mode
- Isochronous Mode
- KW Control Mode
- Emergency Load Rate
- Reset
- Remote KW Reference

In Configure mode, each input which is required via the Modbus® instead, should be individually selected.

In addition to the control signals, a number of parameters can also be monitored via the Modbus®. A full listing including addresses can be found at the end of this chapter.

DSLC

The 723 can be interface to the Woodward Digital Synchroniser & Load Control (DSLC), via the **LON** (Local Operator Network), and via the **Unit and/or Bus Synchroniser** inputs.

The only command given to the DSLC via the **LON** is the 'Run' synchroniser command. However, via the **LON**, the 723 reads in all of the available generator parameters, measured by the DSLC. These Boolean and analogue values can be read via the 723 Modbus®, or at the Operator Interface.

The speed bias from the DSLC should be fed into the **Unit Synchroniser** input (or the **Bus Synchroniser** input if used).

The 723 may be configured so that the DSLC will control all load functions. In this case, once the **Generator CB Aux** contact is closed, the 723 will be switched into speed control mode (zero droop), with the speed reference biased by the DSLC input (via the **Unit Synchroniser** input) in order to increase/decrease actuator output to control the load on the engine.

Analogue Outputs

Through the 723 4-20mA analogue outputs, it is possible to monitor any three of the following:

- Actuator Position (0-100%)
- Engine Speed (rpm - 4mA & 20mA setpoints configurable)
- Engine Load (0-100%)
- KW Reference (kW - 4mA & 20mA setpoints configurable)
- Speed Input #1 (rpm - 4mA & 20mA setpoints configurable)
- Speed Input #2 (rpm - 4mA & 20mA setpoints configurable)

The analogue outputs are configured under the **ANALOG O/P CONFIG** menu in Service.

Control Options

The following options are available with the 723 Generator Control:

- Bus Synchroniser Input - p/n's 8280-153/154/317/318 only.
- Charge Air Pressure Fuel Limiter - p/n's 8280-322/323 Marine Control only.
- Digital O/P #2 configurable for **Minor Alarm** (default) or **Grid Breaker Open Command** - Configured using Operator Interface, all p/n's.
- Digital I/P #8 configurable for **Parallel With Grid** (default) or **Emergency Load Rate** - Configured using Operator Interface, all p/n's.

- KW Control configurable as Direct (default) or Deadband - Configured using Operator Interface, all p/n's.
- Ability to select DSLC as load controller instead of 723 - Configured using Operator Interface, all p/n's.
- Ability to enable the Unload contact input for Idle/Rated selection whilst breaker is open - Configured using Operator Interface, all p/n's.
- Digital O/P #1 (Major Alarm) configurable for normally open or normally closed (default) contact - Configured using Operator Interface. ^{*F}
- Digital O/P #2 (Minor Alarm or Grid Breaker Open Command) configurable for normally open (default) or normally closed contact - Configured using Operator Interface, all p/n's.
- The **Run/Stop** contact input may be configured such that the contact is opened to Run, and closed to Stop, instead of the default, close to Run, open to Stop. ^{*F}
- Woodward ServLink Server & Graphical User Interface for tuning and monitoring - p/n's 8280-317/318/323 only.

Operator Interface

The parameters within the control may be configured and monitored using either a Hand Held Programmer, or using the ServLink Server and Graphical User Interface (more details of this can be found in Chapter 9 - Setpoint Programming).

Configure Values List

Configure Prompt	Default Value	Range	Final Value
SPEED SENSORS			
PULSE/REV #1	155	60 TO 360	<input type="text"/>
MAXIMUM HZ #1	2500	500 TO 10000	<input type="text"/>
PULSE/REV #2	155	60 TO 360	<input type="text"/>
MAXIMUM HZ #2	2500	500 TO 10000	<input type="text"/>
ENGINE SPEED			
IDLE SPEED (rpm)	400.000	0.00 TO 2000.00	<input type="text"/>
RATED SPEED (rpm)	750.000	0.00 TO 2000.00	<input type="text"/>
OVERSPEED TRIP (rpm)	860.000	0.00 TO 2500.00	<input type="text"/>
TORSIONAL FILTER?	FALSE	TRUE TO FALSE	<input type="text"/>
KW CONTROL			
REMOTE REF @ 4mA	0.000	0.00 TO 20000.00	<input type="text"/>
REMOTE REF 20mA	10000.000	0.00 TO 20000.00	<input type="text"/>
SELECT INT KW REF	FALSE	TRUE TO FALSE	<input type="text"/>
FINAL DRIVER			
REVERSE ACTING?	FALSE	TRUE TO FALSE	<input type="text"/>
ACTUATOR mA @ 0%	10.000	0.00 TO 200.00	<input type="text"/>
ACTUATOR mA @ 100%	180.000	20.00 TO 200.00	<input type="text"/>
ENABLE ACTUATOR HIT	FALSE	TRUE TO FALSE	<input type="text"/>
CHARGE AIR @ 20mA	4.000	0.00 TO 10.00	<input type="text"/>
STROKE ACTUATOR ^{*F}	FALSE	TRUE TO FALSE	<input type="text"/>
ENGINE LOAD			
RATED LOAD (kW)	10000.000	0.00 TO 20000.00	<input type="text"/>
KW @ 4mA	0.000	-20000.00 TO 20000.00	<input type="text"/>
KW @ 20mA	10000.000	-20000.00 TO 20000.00	<input type="text"/>
MODBUS PORT SETUP			
MODE	2	1 TO 2	<input type="text"/>
SLAVE ADDRESS	1	1 TO 247	<input type="text"/>
CONFIGURE			
ENABLE SETPOINTS	TRUE	TRUE TO FALSE	<input type="text"/>
ENABLE CALIBRATION	FALSE	TRUE TO FALSE	<input type="text"/>
CONF MODBUS I/P'S			
START/STOP	FALSE	TRUE TO FALSE	<input type="text"/>

INC/DEC/SEL REMOTE	FALSE	TRUE TO FALSE	_____
UNLOAD & IDLE/RATED	FALSE	TRUE TO FALSE	_____
DROOP/ISOCHRONOUS	FALSE	TRUE TO FALSE	_____
SELECT KW CONTROL	FALSE	TRUE TO FALSE	_____
EMERGENCY LOAD RATE	FALSE	TRUE TO FALSE	_____
RESET	FALSE	TRUE TO FALSE	_____
REMOTE KW REFERENCE	FALSE	TRUE TO FALSE	_____
CONTROL OPTIONS			
GRID BRKR OPEN CMD?	FALSE	TRUE TO FALSE	_____
EMERGENCY RATE I/P?	FALSE	TRUE TO FALSE	_____
KW DEADBAND CONTROL	FALSE	TRUE TO FALSE	_____
ENABLE DSLC PM	FALSE	TRUE TO FALSE	_____
ENABLE I/R SELECT	FALSE	TRUE TO FALSE	_____
OPEN DI#1 TO RUN *F	FALSE	TRUE TO FALSE	_____
DO#1 NC? *F	TRUE	TRUE TO FALSE	_____

Service Values List

Service Prompt	Default Value	Range	Final Value
DISPLAY MENU			
ENGINE SPEED (rpm)	(Monitor)		
SPEED REFERENCE (rpm)	(Monitor)		
KW LOAD	(Monitor)		
ACTUATOR POSITION (%)	(Monitor)		
FUEL LIMIT	(Monitor)		
PID OUTPUT	(Monitor)		
ENGINE STOPPED	(Monitor)		
ENGINE RUNNING	(Monitor)		
READY TO SYNC	(Monitor)		
UNIT SYNC BIAS	(Monitor)		
SYS SYNC BIAS	(Monitor)		
DROOP BIAS	(Monitor)		
REF BEFORE BIAS (rpm)	(Monitor)		
GEN BREAKER CLOSED	(Monitor)		
ISOCRONOUS MODE	(Monitor)		
% LOAD	(Monitor)		
LS LINES %	(Monitor)		
LOAD SHARE ERROR	(Monitor)		
KW CONTROL MODE	(Monitor)		
LOAD REFERENCE (kW)	(Monitor)		
REMOTE REF SELECTED	(Monitor)		
REMOTE REFERENCE (kW)	(Monitor)		
KW LIMIT	(Monitor)		
CHARGE AIR PRESSURE (bar)	(Monitor)		
SPD DYNAMICS #1			
PROPORTIONAL GAIN #1	0.250	0.01 TO 10.00	
INTEGRAL GAIN #1 (1/s)	0.500	0.01 TO 5.00	
SDR #1	10.000	0.01 TO 100.00	
DYN SELECT DELAY (s)	2.500	0.00 TO 10.00	
ENABLE DERIV DYN ^{*F}	FALSE	TRUE TO FALSE	
SPD DYNAMICS #2			
PROPORTIONAL GAIN #2	0.350	0.01 TO 10.00	
INTEGRAL GAIN #2 (1/s)	0.630	0.01 TO 5.00	
SDR #2	14.550	0.01 TO 100.00	
PROPGAIN MULTIPLIER	1.000	0.01 TO 1.00	
KW DYNAMICS			
PROPORTIONAL GAIN	0.010	0.01 TO 10.00	
INTEGRAL GAIN (1/s)	0.300	0.01 TO 5.00	
SDR	20.000	0.01 TO 100.00	

***GAIN SLOPE* *F**

LOAD BKPT #1 (%)	0.000	0.00 TO 110.00	_____
MULTIPLIER #1	1.000	0.01 TO 10.00	_____
LOAD BKPT #2 (%)	100.000	0.00 TO 110.00	_____
MULTIPLIER #2	1.000	0.01 TO 10.00	_____

***GAIN RATIO* *F**

ERROR WINDOW #1 (rpm)	100.000	0.00 TO 100.00	_____
GAIN RATIO #1	1.000	0.00 TO 10.00	_____
ERROR WINDOW #2 (rpm)	10.000	0.00 TO 100.00	_____
GAIN RATIO #2	2.000	0.00 TO 10.00	_____

***DERIV DYNAMICS* *F**

P DERIV BKPT #1 (rpm/s)	50.000	0.01 TO 500.00	_____
P MULTIPLIER #1	1.000	0.01 TO 10.00	_____
P DERIV BKPT #2 (rpm/s)	500.000	0.01 TO 500.00	_____
P MULTIPLIER #2	2.000	0.01 TO 10.00	_____
I DERIV BKPT #1 (rpm/s)	50.000	0.01 TO 500.00	_____
I MULTIPLIER #1	1.000	0.01 TO 10.00	_____
I DERIV BKPT #2 (rpm/s)	500.000	0.01 TO 500.00	_____
I MULTIPLIER #2	1.000	0.01 TO 10.00	_____
D DERIV BKPT #1 (rpm/s)	50.000	0.01 TO 500.00	_____
D MULTIPLIER #1	1.000	0.01 TO 10.00	_____
D DERIV BKPT #2 (rpm/s)	500.000	0.01 TO 500.00	_____
D MULTIPLIER #2	1.000	0.01 TO 10.00	_____

ENGINE SPEED

SPEED FILTER (Hz)	10.000	0.01 TO 16.00	_____
FILTER FREQUENCY (Hz)	16.000	0.01 TO 16.00	_____
FILTER Q FACTOR	0.707	0.707 TO 25.00	_____
SENSOR WEIGHT	0.500	0.00 TO 1.00	_____
ENGINE RUNNING (rpm)	150.000	0.00 TO 2500.00	_____
TWO SPEED SENSORS?	TRUE	TRUE TO FALSE	_____
DIS NOTCH FILTER	FALSE	TRUE TO FALSE	_____

SPEED REFERENCE

MINIMUM SPEED (rpm)	700.000	0.00 TO 2000.00	_____
MAXIMUM SPEED (rpm)	800.000	0.00 TO 2000.00	_____
ACCEL/DECEL RATE (rpm/s)	10.000	0.00 TO 2000.00	_____
IDLE/RATED SWITCH (rpm)	400.000	0.00 TO 2500.00	_____
INC/DEC RATE #1 (rpm/s)	1.000	0.00 TO 2000.00	_____
INC/DEC RATE #2 (rpm/s)	1.000	0.00 TO 2000.00	_____

START/STOP

RUNDOWN TIME (s)	0.000	0.00 TO 300.00	_____
PULSE/CONT ALARM?	FALSE	TRUE TO FALSE	_____
ALARM PULSE TIME (s)	1.000	1.00 TO 30.00	_____

BRKR OPEN CMD NC?	FALSE	TRUE TO FALSE	
DIG O/P #2 NC?	FALSE	TRUE TO FALSE	
SYNCHRONISING			
RDY TO SYNC LIMITS (rpm)	4.000	0.00 TO 20.00	
SYNC OK DLY TIME (s)	2.000	0.00 TO 30.00	
UNIT SYNCH GAIN	2.000	0.00 TO 100.00	
REF BIAS PULSE (rpm)	0.000	0.00 TO 10.00	
SYS SYNCH GAIN	2.000	0.00 TO 100.00	
DISABLE UNIT SYNCH	FALSE	TRUE TO FALSE	
DISABLE SYS SYNCH	FALSE	TRUE TO FALSE	
SYNC FILTER	10.000	0.01 TO 16.00	
LOAD SHARING			
LS ERROR %	4.000	1.00 TO 100.00	
LOAD GAIN	5.000	0.01 TO 100.00	
AUTO LOAD RATE (kW/s)	50.000	0.00 TO 20000.00	
EMERGENCY LOAD RATE(kW/s)	50.000	0.00 TO 20000.00	
AUTO UNLOAD RATE (kW/s)	5.000	0.00 TO 20000.00	
EMRGNCY UNLOAD RATE (kW/s)	50.000	0.00 TO 2000.00	
RE-LOAD TO ISOC?	FALSE	TRUE TO FALSE	
KW CONTROL			
AUTO LOAD RATE (kW/s)	50.000	0.00 TO 20000.00	
AUTO UNLOAD RATE (kW/s)	50.000	0.00 TO 20000.00	
RAISE LOAD RATE (kW/s)	50.000	0.00 TO 20000.00	
LOWER LOAD RATE (kW/s)	50.000	0.00 TO 20000.00	
ENABLE INSTANT RATE	FALSE	TRUE TO FALSE	
INSTANT RATE WINDOW (kW)	0.000	0.00 TO 20000.00	
OVRD REMOTE IP FAIL	FALSE	TRUE TO FALSE	
DEADBAND WINDOW (kW)	50.000	0.00 TO 1000.00	
D/B CTRL RAMP RATE (kW/s)	50.000	0.10 TO 5000.00	
INTERNAL KW REF (kW)	800.000	0.00 TO 20000.00	
INT KW REF RATE (kW/s) *F	200.000	0.00 TO 20000.00	
ENGINE LOAD			
DROOP (%)	5.000	0.00 TO 15.00	
FULL LOAD ACT %	80.000	0.00 TO 100.00	
KW FILTER (Hz)	2.000	1.00 TO 10.00	
LOAD FILTER (Hz)	2.000	1.00 TO 10.00	
UNLOAD TRIP LEVEL (kW)	100.000	-1000.00 TO 20000.00	
OVRD LOAD I/P FAIL	FALSE	TRUE TO FALSE	
FREQUENCY LIMITER			
BUS FREQUENCY	60.000	45.00 TO 65.00	
KW LIMITER HZ #1	0.000	0.00 TO 60.00	
KW LIMITER HZ #2	10.000	10.00 TO 60.00	

MAXIMUM LOAD (1) (MW)	10.000	0.00 TO 50.00	
KW LIMITER HZ #3	90.000	0.00 TO 100.00	
MAXIMUM LOAD (2) (MW)	10.000	0.00 TO 50.00	
KW LIMITER HZ #4	100.000	50.00 TO 100.00	
FREQ ERROR SP#1 (Hz)	5.000	0.00 TO 10.00	
FREQ ERROR SP#2 (Hz)	5.000	0.00 TO 10.00	
TRIP DELAY (s)	0.100	0.00 TO 3.00	
FUEL LIMITERS			
START FUEL LIMIT X1 (rpm)	0.000	0.00 TO 2000.00	
START FUEL LIMIT Y1 (%)	80.000	0.00 TO 100.00	
START FUEL LIMIT X2 (rpm)	100.000	0.00 TO 2000.00	
START FUEL LIMIT Y2 (%)	80.000	0.00 TO 100.00	
START FUEL LIMIT X3 (rpm)	100.000	0.00 TO 2000.00	
START FUEL LIMIT Y3 (%)	50.000	0.00 TO 100.00	
START FUEL LIMIT X4 (rpm)	750.000	0.00 TO 2000.00	
START FUEL LIMIT Y4 (%)	50.000	0.00 TO 100.00	
MAXIMUM FUEL LIMIT (%)	100.000	0.00 TO 100.00	
CHARGE AIR LIMIT			
MANIFOLD PRESSURE A	0.000	0.00 TO 6.00	
ACTUATOR % A	50.000	0.00 TO 100.00	
MANIFOLD PRESSURE B	1.000	0.00 TO 6.00	
ACTUATOR % B	50.000	0.00 TO 100.00	
MANIFOLD PRESSURE C	3.000	0.00 TO 6.00	
ACTUATOR % C	100.000	0.00 TO 100.00	
MANIFOLD PRESSURE D	4.000	0.00 TO 6.00	
ACTUATOR % D	100.000	0.00 TO 100.00	
OVRD AIR I/P FAIL	FALSE	TRUE TO FALSE	
FINAL DRIVER			
HIT ACTUATOR	FALSE	TRUE TO FALSE	
ACTUATOR HIT PULSE	0.100	0.00 TO 2.00	
ACTUATOR HIT VALUE	0.000	0.00 TO 100.00	
STROKE ACTUATOR (%) ^{*F}	0.000	0.00 TO 100.00	
GEN BRKR LOAD REJ			
LOAD REJ LEVEL (%)	60.000	0.00 TO 100.00	
LOAD LEVEL 1 (%)	0.000	0.00 TO 100.00	
REJECTION PERIOD 1 (s)	0.000	0.00 TO 5.00	
LOAD LEVEL 2 (%)	100.000	0.00 TO 100.00	
REJECTION PERIOD 2 (s)	0.500	0.00 TO 5.00	
GRD BRKR LOAD REJ			
LOAD REJ LEVEL (%)	60.000	0.00 TO 110.00	
LOAD LEVEL 1 (%)	0.000	0.00 TO 100.00	
REJECTION PERIOD 1 (s)	0.000	0.00 TO 5.00	

LOAD LEVEL 2 (%)	100.000	0.00 TO 100.00	
REJECTION PERIOD 2 (s)	0.500	0.00 TO 5.00	
ENABLE LOAD REJ	FALSE	TRUE TO FALSE	
CALIBRATION			
REMOTE I/P OFFSET	0.000	-10.00 TO 10.00	
REMOTE I/P GAIN	1.000	0.00 TO 10.00	
LOAD I/P OFFSET	0.000	-10.00 TO 10.00	
LOAD I/P GAIN	1.000	0.00 TO 10.00	
LS LINES OFFSET	0	0 TO 32767	
LS LINES GAIN	21845	0 TO 32767	
LS LOAD OFFSET	2028	0 TO 32767	
LS LOAD GAIN	8083	0 TO 32767	
AIR I/P OFFSET	0.000	-10.00 TO 10.00	
AIR I/P GAIN	1.000	0.00 TO 10.00	
AN O/P #1 OFFSET *F	0.000	-1000.00 TO 100.00	
AN O/P #1 GAIN *F	1.000	0.5 TO 1.5	
AN O/P #2 OFFSET *F	0.000	-1000.00 TO 100.00	
AN O/P #2 GAIN *F	1.000	0.5 TO 1.5	
AN O/P #3 OFFSET *F	0.000	-1000.00 TO 100.00	
AN O/P #3 GAIN *F	1.000	0.5 TO 1.5	
AN O/P CALIBRATION *F	4.000	0.00 TO 20.00	
MODBUS PORT SETUP			
HARDWARE CONFIG	1	1 TO 3	
BAUD RATE	6	1 TO 7	
STOP BITS	1	1 TO 3	
PARITY	1	1 TO 3	
TIMEOUT	1.000	0.00 TO 10.00	
ENABLE MODBUS ALMS	FALSE	TRUE TO FALSE	
SERVLINK SETUP			
HARDWARE CONFIG	1	1 TO 2	
BAUD RATE	9	1 TO 12	
DSLC COMMS SETUP			
DSLC SERVICE PIN	FALSE	TRUE TO FALSE	
DSLC TIMEOUT (s)	5.000	0.00 TO 100.00	
DSLC XMIT TIME (s)	0.500	0.05 TO 100.00	
RESET LON	FALSE	TRUE TO FALSE	
ANALOG O/P CONFIG			
ANALOGUE OUTPUT #1	1	1 TO 6	
ANALOGUE OUTPUT #2	1	1 TO 6	
ANALOGUE OUTPUT #3	1	1 TO 6	
ENG SPEED O/P @4mA	0.000	0.00 TO 2000.00	
ENG SPEED O/P @20mA	750.000	0.00 TO 2000.00	

KW REF O/P @ 4mA	0.000	0.00 TO 20000.00	
KW REF O/P @ 20mA	10000.000	0.00 TO 20000.00	
SPEED 1 O/P @ 4mA	0.000	0.00 TO 2000.00	
SPEED 1 O/P @ 20mA	750.000	0.00 TO 2000.00	
SPEED 2 O/P @ 4mA	0.000	0.00 TO 2000.00	
SPEED 2 O/P @ 20mA	750.000	0.00 TO 2000.00	

MAJOR ALARM

OVERSPEED	(Monitor)
BOTH SPD SEN FAILED	(Monitor)

MINOR ALARM

KW SENSOR FAILURE	(Monitor)
REM REF FAILURE	(Monitor)
SPEED SENSOR FAULT	(Monitor)
MODBUS COMMS	(Monitor)
KW LIMITING	(Monitor)
REM SEL WIRE BREAK	(Monitor)
DSLCL COMMS FAULT	(Monitor)
CHARGE AIR I/P FAIL	(Monitor)

DSLCL ANALOGUES

GEN A-PHASE VOLTAGE (Volts)	(Monitor)
GEN B-PHASE VOLTAGE (Volts)	(Monitor)
GEN C-PHASE VOLTAGE (Volts)	(Monitor)
BUS A-PHASE VOLTAGE (Volts)	(Monitor)
GEN A-PHASE CURRENT (Amps)	(Monitor)
GEN B-PHASE CURRENT (Amps)	(Monitor)
GEN C-PHASE CURRENT (Amps)	(Monitor)
POWER FACTOR	(Monitor)
REAL POWER (kW)	(Monitor)
REACTIVE POWER (kVAR)	(Monitor)
APPARANT POWER (kVA)	(Monitor)
GENERATOR FREQUENCY (Hz)	(Monitor)
BUS FREQUENCY (Hz)	(Monitor)

DSLCL BOOLEANS

DSLCL ALARM OUTPUT	(Monitor)
VOLTAGE LOWER OUTPUT	(Monitor)
VOLTAGE RAISE OUTPUT	(Monitor)
BREAKER CLOSE O/P	(Monitor)
SYNC TIMEOUT ACTIVE	(Monitor)
SYNC RECLOSE ACTIVE	(Monitor)
LOAD HIGH LIMIT	(Monitor)
LOAD LOW LIMIT	(Monitor)
VOLTAGE RANGE	(Monitor)
VOLTAGE LOW LIMIT	(Monitor)
VOLTAGE HIGH LIMIT	(Monitor)
SS OFF	(Monitor)
SS CHECK	(Monitor)

SS PERMISSIVE	(Monitor)
SS RUN	(Monitor)
SS CLOSE TIMER	(Monitor)
SS SYNC TIMER	(Monitor)
SS SYNCHRONISED	(Monitor)
SYNCH CHECK I/P	(Monitor)
SYNCH PERM I/P	(Monitor)
SYNCH RUN I/P	(Monitor)
CB AUX I/P	(Monitor)
VOLTS RAISE I/P	(Monitor)
VOLTS LOWER I/P	(Monitor)

Configure & Service Descriptions

Configure

SPEED SENSORS

Pulse/Rev #1 & #2

is the number of teeth (or holes) on the speed sensing disc, for the speed sensors connected to the 723. If the torsional filter is enabled, #1 refers to the speed sensor on the engine side of the flexible coupling, and #2 refers to the speed sensor on the generator side.

Maximum Hz #1 & #2

allows tuning of the speed sensing algorithm, to obtain the optimum resolution for sensing speed. It is important that the following instructions for tuning these parameters is adhered to.

The *Maximum Hz* should be calculated based on both the minimum and maximum controlling speeds:

$$\frac{\text{Maximum Speed} \times \text{Pulse/Rev} \times 1.3}{60} = A$$

$$\frac{\text{Minimum Speed} \times \text{Pulse/Rev} \times 4}{60} = B$$

If **B** > **A** then use **A** as the *Maximum Hz*. Calculate separately for each speed sensor input, if *Pulse/Rev #1* & *Pulse/Rev #2* are different.

If **B** < **A** then use **B** as the *Maximum Hz*, provided that **B** is greater than **1.1 x Overspeed Trip Frequency**. If not, then contact Woodward Governor for further assistance.

ENGINE SPEED

Idle Speed (rpm)

is provided for engine start-up or cooldown. It is independent of the minimum speed setpoint and may be set to a lower value. *Idle Speed* is selected when the Rated/Idle contact is opened, if this function is enabled.

Rated Speed (rpm)

is the nominal engine speed.

Overspeed Trip (rpm)

is the speed at which a shutdown is initiated, to prevent overspeed. Please see Engine Manufacturer's recommendation for the value of this parameter.

Torsional Filter?

will enable the torsional filter if selected true.

KW CONTROL

Remote Ref @ 4mA, Remote Ref @ 20mA

is the kW reference required at 4mA and 20mA by the remote reference input.

Select Int kW Ref if selected true, will enable the use of an internal kW reference value (if the remote reference is not selected.)

FINAL DRIVER

Reverse Acting? if selected true, will reverse the actuator output signal to 200-0mA for 0-100%.

Actuator mA @ 0% sets the mA output required to the actuator at 0% control (PID) output.

Actuator mA @ 100% sets the mA output required to the actuator at 100% control (PID) output.

Enable Actuator Hit if selected true, will enable the function to hit the actuator down by a certain amount, for a certain period of time. This is for testing and proving the dynamic set-up of the control. Once this parameter has been selected true, it will only remain activated for 30 minutes. After this time, to re-enable the function, the parameter will have to be re-set to true.

Charge Air @ 20mA is the value, in bar, of the charge air pressure input, at 20mA.

Stroke Actuator if true, allows the actuator output to be driven by adjusting the service tuneable Stroke Actuator, whilst the engine is stopped, and the Run/Stop contact is in the Stop position. This will enable the calibration and testing of an electric actuator.

ENGINE LOAD

Rated Load (kW) is the rated generator load.

KW @ 4mA, KW @ 20mA is the value of the kW transducer input at 4mA & 20mA.

MODBUS PORT SETUP

Mode sets the communications protocol of the J3 port. 1= ASCII, 2= RTU.

Slave Address sets the network address of the control. This will always be set to 1 for Point-to-Point communications.

CONFIGURE

Enable Setpoints if selected false, will prevent all Service setpoint menus from being displayed, and therefore prevents adjustment. This

parameter would normally be set false, once the control has been commissioned.

Enable Calibration

if selected true, the *CALIBRATION* menu will be displayed under Service.

CONF MODBUS I/P'S

this menu is for configuring whether certain control inputs are received via the standard hardware, or via the Modbus®. To select that they are received via the Modbus®, set the parameter true.

*Start/Stop, Inc/Dec/Sel
Remote, Unload &
Idle/Rated,
Droop/Isochronous, Select
KW Control Emergency Load
Rate, Reset, Remote KW
Reference*

CONTROL OPTIONS

Grid Brkr Open Cmd?

if selected true, digital output #2 will be configured as the Grid Breaker Open Command output, instead of the Minor Alarm.

Emergency Rate I/P?

if selected true, digital input #8 (H) will be configured as the Emergency Load Rate selection input, instead of the Parallel with Grid breaker status.

KW Deadband Control

if selected true, kW control will be as compensated droop via the speed reference (see description in system description text).

Enable DSLC PM

if selected true, disables the power management of the 723, and allows the 723 to follow the 'Unit Synchroniser' input after the breaker has closed. This will enable the DSLC to handle the isochronous load sharing and base loading of the system, without interference from the 723.

Enable I/R Select

if selected true, allows the Unload contact input to be utilised as an Idle/Rated contact whilst the CB Aux input is open.

Open DI#1 to Run

if true, digital input #1 is configured Open to Run, Close to Stop.

DO#1 NC?

if true, digital output #1 will be normally closed, i.e. contact will open when a major alarm occurs.

Service

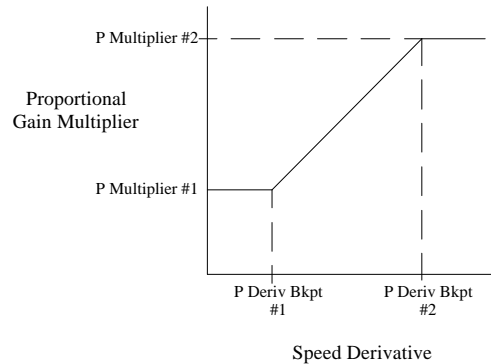
DISPLAY MENU

<i>Engine Speed (rpm)</i>	displays the current speed of the engine.
<i>Speed Reference (rpm)</i>	is the rpm reference, after the droop has been taken into account, if in droop mode, or taking into account the error bias if in isochronous mode.
<i>KW Load</i>	is the generator load in kW.
<i>Actuator Position (%)</i>	is the % actuator output demanded by the control.
<i>Fuel Limit (%)</i>	is the % level of the closest fuel limiter.
<i>PID Output</i>	is the % level output from the PID.
<i>Engine Stopped</i>	indicates that the engine speed is below 350Hz.
<i>Engine Running</i>	indicates that the engine speed is above the <i>Engine Running</i> speed switch.
<i>Ready To Sync</i>	indicates that the engine has reached <i>Rated Speed</i> and has remained within the window for the required time.
<i>Unit Sync Bias</i>	is the rpm bias from the unit synchroniser input.
<i>Sys Sync Bias</i>	is the rpm bias from the system synchroniser input.
<i>Droop Bias</i>	is the rpm bias calculated for droop.
<i>Ref Before Bias (rpm)</i>	is the rpm speed reference before any biases (synch or droop) are taken into account.
<i>Gen Breaker Closed</i>	indicates that the Generator CB Aux input is closed.
<i>Isochronous Mode</i>	displays the status of the load sharing lines relay, which connects the unit load sharing lines to the system load sharing lines. If true is displayed, the control is in Isochronous mode.
<i>% Load</i>	is the engine load, expressed as a % of the <i>Rated Load</i> .
<i>LS Lines %</i>	is the % load represented on the load sharing lines.
<i>Load Share Error</i>	is the error calculated between the % load on the load sharing lines, and the % unit load.
<i>KW Control Mode</i>	indicates that the control is in KW Control mode.

<i>Load Reference (kW)</i>	is the kW reference value.
<i>Remote Ref Selected</i>	indicates that the remote kW reference has been selected.
<i>Remote Reference (kW)</i>	is the kW reference demanded by the remote reference input.
<i>KW Limit</i>	is the kW limit as determined by the frequency limiter curve.
<i>Charge Air Pressure (bar)</i>	is the manifold air pressure in bar.

SPD DYNAMICS #1

<i>Proportional Gain #1</i>	PID proportional gain adjustment for the dynamics gain, when the Generator CB Aux input is open. Increasing the P term increases the gain, a value for P that is too large will cause oscillation, if P is too small the offset from a transient will be too large.
<i>Integral Gain #1 (1/s)</i>	PID integrator rate adjustment for the dynamics, affects recovery rate after a transient, when the Generator CB Aux input is open. A value for I that is too small will change the actuator current slowly and speed will take a long time to return to set speed after a transient, giving overdamped response. If I is too large the actuator current will move too fast and speed will overshoot and response will be underdamped.
<i>SDR #1</i>	PID derivative ratio adjustment for the dynamics, when the Generator CB Aux input is open. Set the amount of derivative (or lead) action the control will have. Increasing the derivative ratio value above 1 will decrease the derivative function giving the control a PI type action. A value too large will make the system less responsive. A value too small will make the system oscillate, and cannot be compensated for with the proportional gain or the integrator rate.
<i>Dyn Select Delay (s)</i>	is the delay period for switching from Dynamics #2 to Dynamics #1, after the Generator CB Aux contact input is opened.
<i>Enable Deriv Dyn</i>	If true, the Gain Ratio function will be switched out, and the Derivative Dynamics function will be switched in. Both functions are multiplying, and will work on whichever dynamics is switched in at the time (#1 or #2). The Gain Ratio multiplies the Proportional Gain, based on the speed error, whilst the Derivative Dynamics multiplies all three PID terms (individually tuneable), based on the rate of change of engine speed. Example:



SPD DYNAMICS #2

Proportional Gain #2

PID proportional gain adjustment for the dynamics gain, when the Generator CB Aux input is closed. Increasing the P term increases the gain, a value for P that is too large will cause oscillation, if P is too small the offset from a transient will be too large.

Integral Gain #2 (1/s)

PID integrator rate adjustment for the dynamics, affects recovery rate after a transient, when the Generator CB Aux input is closed. A value for I that is too small will change the actuator current slowly and speed will take a long time to return to set speed after a transient, giving overdamped response. If I is too large the actuator current will move too fast and speed will overshoot and response will be underdamped.

SDR #2

PID derivative ratio adjustment for the dynamics, when the Generator CB Aux input is closed. Set the amount of derivative (or lead) action the control will have. Increasing the derivative ratio value above 1 will decrease the derivative function giving the control a PI type action. A value too large will make the system less responsive. A value too small will make the system oscillate, and cannot be compensated for with the proportional gain or the integrator rate.

Propgain Multiplier

This value of this parameter determines the value of gain in the control, should a speed sensor fail when the torsional filter is enabled, and the Generator CB Aux input closed. The purpose of this parameter is to slow the PID down in the event of the torsional filter being disabled, when a speed sensor fails.

$$\text{Gain Value} = \text{Propgain Multiplier} * \text{Proportional Gain \#2}$$

KW DYNAMICS

Proportional Gain

PID proportional gain adjustment for the dynamics gain, when in kW Control mode. Increasing the P term increases the gain, a value for P that is too large will cause oscillation, if P is too

small the offset from a transient will be too large.

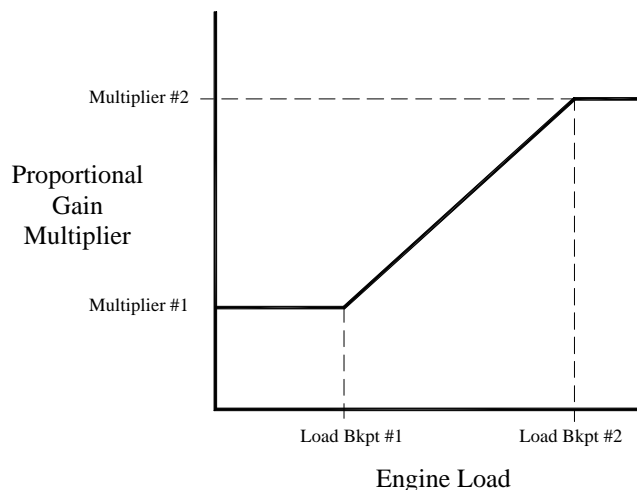
Integral Gain (1/s)

PID integrator rate adjustment for the dynamics, affects recovery rate after a transient, when in kW Control mode. A value for I that is too small will change the actuator current slowly and speed will take a long time to return to set speed after a transient, giving overdamped response. If I is too large the actuator current will move too fast and speed will overshoot and response will be underdamped.

SDR

PID derivative ratio adjustment for the dynamics when in kW Control mode. Set the amount of derivative (or lead) action the control will have. Increasing the derivative ratio value above 1 will decrease the derivative function giving the control a PI type action. A value too large will make the system less responsive. A value too small will make the system oscillate, and cannot be compensated for with the proportional gain or the integrator rate.

GAIN SLOPE



Load Bkpt #1 (%)

This is the load breakpoint associated with 'Multiplier #1', for the curve set up to calculate a proportional gain multiplier, which is dependent on the engine load. At loads between points #1 & #2, the multiplier is increased/decreased linearly between these two points.

For values of load at, or less than, breakpoint #1, the multiplier will be 'Multiplier #1'.

Multiplier #1

This is the multiplier, associated with 'Load Bkpt #1', for the calculation of the gain multiplier.

Load Bkpt #2 (%)

This is the load breakpoint associated with 'Multiplier #2', for the curve set up to calculate a proportional gain multiplier, which is dependent on the engine load. At loads between points #1 & #2,

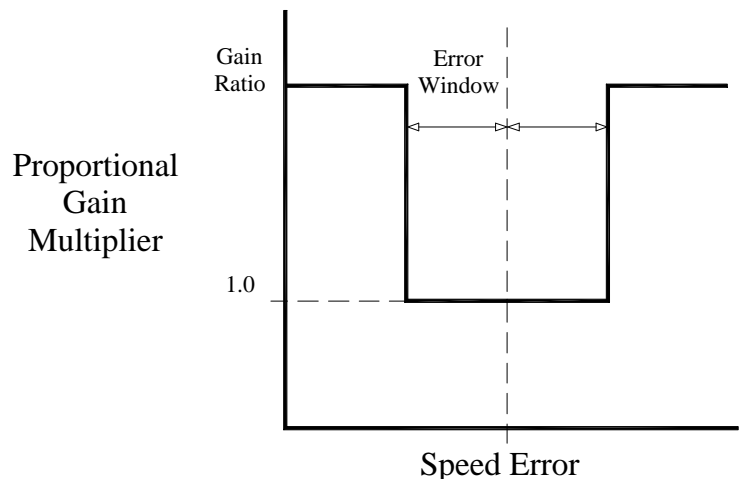
the multiplier is increased/decreased linearly between these two points.

For values of load at, or greater than, breakpoint #2, the multiplier will be 'Multiplier #2'.

Multiplier #2

This is the multiplier, associated with 'Load Bkpt #2', for the calculation of the gain multiplier.

GAIN RATIO



Error Window #1 (rpm)

This value is the magnitude of a speed error at which the control automatically switches to fast response, whilst the Generator CB Aux input is open. The control does not use the absolute value of speed error, but 'anticipated' speed error to make this switch. This method provides for quick switching to the low gain value when recovering from the speed transient. This provides smoother switching than if the absolute speed error was used for the window.

Gain Ratio #1

This sets the ratio of the gain setting at steady state to the gain setting during transient conditions, whilst the Generator CB Aux input is open. The Gain Ratio operates in conjunction with the Error Window and Proportional Gain adjustments, by multiplying the Proportional Gain setpoint by the Gain Ratio when the speed error is greater than the Error Window. This makes the control dynamics fast enough to minimise engine speed overshoot on start-up and to reduce the magnitude of speed error when loads are changing. This allows a lower gain at steady state for better stability and reduced steady-state actuator linkage movement. The Gain Ratio function is disabled, if the Derivative Dynamics are enabled, and vice versa.

Error Window #2 (rpm)

This value is the magnitude of a speed error at which the control automatically switches to fast response, whilst the Generator CB

	<p>Aux input is closed. The control does not use the absolute value of speed error, but 'anticipated' speed error to make this switch. This method provides for quick switching to the low gain value when recovering from the speed transient. This provides smoother switching than if the absolute speed error was used for the window.</p>
<i>Gain Ratio #2</i>	<p>This sets the ratio of the gain setting at steady state to the gain setting during transient conditions, whilst the Generator CB Aux input is closed. The Gain Ratio operates in conjunction with the Error Window and Proportional Gain adjustments, by multiplying the Proportional Gain setpoint by the Gain Ratio when the speed error is greater than the Error Window. This makes the control dynamics fast enough to minimise engine speed overshoot on start-up and to reduce the magnitude of speed error when loads are changing. This allows a lower gain at steady state for better stability and reduced steady-state actuator linkage movement. The Gain Ratio function is disabled, if the Derivative Dynamics are enabled, and vice versa.</p>
DERIV DYNAMICS	
<i>P Deriv Bkpt #1 (rpm/s)</i>	<p>This value is breakpoint #1 which relates to 'P Multiplier #1' of the curve to determine the Proportional Gain multiplier, based on the engine speed derivative (rate of change of speed). (rpm/s)</p>
<i>P Multiplier #1</i>	<p>This value is the multiplier #1 which relates to 'P Deriv Bkpt #1' of the curve to determine the Proportional Gain multiplier, based on the engine speed derivative (rate of change of speed).</p>
<i>P Deriv Bkpt #2 (rpm/s)</i>	<p>This value is the breakpoint #2 which relates to 'P Multiplier #2' of the curve to determine the Proportional Gain multiplier, based on the engine speed derivative (rate of change of speed). (rpm/s)</p>
<i>P Multiplier #2</i>	<p>This value is the multiplier #2 which relates to 'P Deriv Bkpt #2' of the curve to determine the Proportional Gain multiplier, based on the engine speed derivative (rate of change of speed).</p>
<i>I Deriv Bkpt #1 (rpm/s)</i>	<p>This value is breakpoint #1 which relates to 'I Multiplier #1' of the curve to determine the Integral Gain multiplier, based on the engine speed derivative (rate of change of speed). (rpm/s)</p>
<i>I Multiplier #1</i>	<p>This value is the multiplier #1 which relates to 'I Deriv Bkpt #1' of the curve to determine the Integral Gain multiplier, based on the engine speed derivative (rate of change of speed).</p>
<i>I Deriv Bkpt #2 (rpm/s)</i>	<p>This value is the breakpoint #2 which relates to 'I Multiplier #2' of the curve to determine the Integral Gain multiplier, based on the engine speed derivative (rate of change of speed). (rpm/s)</p>

<i>I Multiplier #2</i>	This value is the multiplier #2 which relates to 'I Deriv Bkpt #2' of the curve to determine the Integral Gain multiplier, based on the engine speed derivative (rate of change of speed).
<i>D Deriv Bkpt #1 (rpm/s)</i>	This value is breakpoint #1 which relates to 'D Multiplier #1' of the curve to determine the S.D.R. multiplier, based on the engine speed derivative (rate of change of speed). (rpm/s)
<i>D Multiplier #1</i>	This value is the multiplier #1 which relates to 'D Deriv Bkpt #1' of the curve to determine the S.D.R. multiplier, based on the engine speed derivative (rate of change of speed).
<i>D Deriv Bkpt #2 (rpm/s)</i>	This value is the breakpoint #2 which relates to 'D Multiplier #2' of the curve to determine the S.D.R. multiplier, based on the engine speed derivative (rate of change of speed). (rpm/s)
<i>D Multiplier #2</i>	This value is the multiplier #2 which relates to 'D Deriv Bkpt #2' of the curve to determine the S.D.R. multiplier, based on the engine speed derivative (rate of change of speed).

ENGINE SPEED

<i>Speed Filter (Hz)</i>	Normally, this value should not need to be adjusted, but can be used to filter any undesirable frequencies on the speed pickups. If tuned above 15.9Hz, the filter will automatically be disabled.
<i>Filter Frequency (Hz)</i>	should be set to the resonant frequency of the speed signal which requires filtering by the band-stop (notch) filter.
<i>Filter Q Factor</i>	adjusts the attenuation of the signal frequency, filtered by the band-stop filter. The minimum value of 0.707 results in zero attenuation, and as the value is increased, the attenuation is increased, and the range of frequencies affected broadens.
<i>Sensor Weight</i>	When using the torsional filter, it is possible to weight one speed sensor input more heavily than the other. If this value is set between 0.5 and 1, sensor #1 will be weighted more heavily than sensor #2. Between 0 and 0.5, sensor #2 will be more heavily weighted.
<i>Engine Running (rpm)</i>	is the speed above which the engine is assumed to be running, for monitoring purposes.
<i>Two Speed Sensors?</i>	if selected false, the minor alarm relay will not be activated, should a speed sensor input fail. The <i>Failed Spd Sensor</i> LED on the front of the 723 however, will still illuminate, as the failure is continuously detected. The purpose of this parameter, is to prevent the minor alarm activating, when only one speed

pickup is used.

Dis Notch Filter

if selected true will disable the Notch Filter.

SPEED REFERENCE

Minimum Speed (rpm)

is the lowest rpm value to which the speed reference may be driven by closing the Decrease Speed/Load contact input.

Maximum Speed (rpm)

is the maximum value to which the speed reference may be driven by closing the Increase Speed/Load contact input.

Accel/Decel Rate (rpm/s)

is the rate at which the speed reference ramps from *Idle Speed* to *Rated Speed*, and from *Rated Speed* to *Idle Speed*.

Idle/Rated Switch (rpm)

The speed reference will start to ramp to the *Rated Speed* when this switch speed is exceeded. It is recommended that this parameter is tuned to a value slightly lower than the *Idle Speed*.

Inc/Dec Rate #1 (rpm/s)

is the rate at which the speed reference is increased/decreased using the Increase/Decrease contacts, when the Generator CB Aux contact is open.

Inc/Dec Rate #2 (rpm/s)

is the rate at which the speed reference is increased/decreased using the Increase/Decrease contacts, when the Generator CB Aux contact is closed.

START/STOP

Rundown Time (s)

After a shutdown, this is the period for which the engine speed must be below 350Hz, before the control will recognise the 'run' command.

Pulse/Cont Alarm?

if selected true, the major alarm relay will de-energise for the *Alarm Pulse Time* if a shutdown condition occurs. If false, the alarm will remain latched, until the next 'run' command is received.

Alarm Pulse Time (s)

If the above option is selected true, this is the period for which the major alarm relay output is de-energised.

Brkr Open Cmd NC?

if selected true will set the output relay for the Breaker Open Command as normally energised, and so when the breaker open command is issued by the control, the relay is de-energised and hence the contact opened.

Dig O/P #2 NC?

if selected true will set the Digital Relay Output #2 as normally energised, and so when the function for this output is activated

(Minor Alarm or Open Grid Breaker) by the control, the relay is de-energised and hence the contact opened.

SYNCHRONISING

<i>Rdy To Sync Limits (rpm)</i>	is the synchronising speed window that the engine speed must be within.
<i>Sync OK Dly Time (s)</i>	is the time duration that the engine must be running within the synchronising speed window before the ready to synchronise command is given.
<i>Unit Synch Gain</i>	Adjustment of this value will increase or decrease the effect of the analogue unit synchroniser input to the speed reference.
<i>Ref Bias Pulse (rpm)</i>	is the value added to the speed reference, instantly, when the generator breaker is closed. This is for a droop system, to ensure that the generator is not driven into reverse power as soon as the breaker is closed.
<i>Sys Synch Gain</i>	Adjustment of this value will increase or decrease the effect of the analogue bus tie synchroniser input to the speed reference.
<i>Disable Unit Synch</i>	Select true if not using a Woodward Analogue synchroniser for synchronisation between the generator and the bus.
<i>Disable Sys Synch</i>	Select true if not using a Woodward Analogue synchroniser for bus synchronisation.
<i>Sync Filter (Hz)</i>	is for filtering the unit synchroniser input to the control.

LOAD SHARING

<i>LS Error %</i>	When soft loading/unloading into isochronous load sharing, the control will not establish isochronous load sharing, until the load share error is within the limits determined by this parameter.
<i>Load Gain</i>	sets the sensitivity to the load share error.
<i>Auto Load Rate (kW/s)</i>	is the rate at which load is increased when soft loading into isochronous load sharing.
<i>Emergency Load Rate (kW/s)</i>	is the rate at which load is increased when soft loading into isochronous load sharing, with the Emergency Loading Rate contact closed.
<i>Auto Unload Rate (kW/s)</i>	is the rate at which load is decreased when soft unloading into

isochronous load sharing, from droop control. Also when using the Unload feature to shed load and open the generator breaker.

Emrgncy Unload Rate (kW/s) is the rate at which load is decreased when soft unloading into isochronous load sharing, from droop control, with the Emergency Loading Rate contact closed. Also using the Unload feature to shed load, with the Emergency Loading Rate contact closed.

Re-Load To Isoc? When operating in Isochronous Load Sharing mode, if the Raise/Lower contacts are momentarily closed following the Unload command (to abort the unload sequence), the setting of this value will determine the course of action. If it is set true, the control will re-load back into Isoch mode. If it is set false, the control will remain at the load level it was aborted at, and remain in Droop mode.

KW CONTROL

Auto Load Rate (kW/s) is the rate at which load is increased when soft loading into remote kW control.

Auto Unload Rate (kW/s) is the rate at which load is decreased when the Unload function is used to shed load and open the generator breaker.

Raise Load Rate (kW/s) is the rate at which the kW reference is increased when in kW control.

Lower Load Rate (kW/s) is the rate at which the kW reference is decreased when in kW control.

Enable Instant Rate if selected true, when using the remote kW reference, once the error between the kW and the kW reference is within the window, the kW reference will change instantly as the remote reference changes, all ramp rates will be overridden. This is seful when the remote reference input is utilised to adjust the kW reference to control Import/Export levels.

Instant Rate Window (kW) is the window applied to the *Instant Rate* function above.

Ovrd Remote I/P Fail if selected true, will override the failed signal detection of the remote kW reference input. When the remote reference input is disabled, it is not possible to select remote reference kW control.

Deadband Window (kW) If the kW error is within this window, and Deadband KW Control is enabled, no action will be taken to correct the error.

D/B Ctrl Ramp Rate (kW/s) If Deadband KW Control is enabled, this is the rate at which

the speed reference is increased/decreased to control the kW level.

Internal kW Ref (kW)

This is the level to which the kW reference will ramp, when the control is switched into kW Control mode, and the remote reference is not selected, if the option has been selected in Configure.

Int kW Ref Rate (kW/s)

If the internal kW reference is selected, this is the rate at which the reference is ramped to the '*Internal kW Ref*' level.

ENGINE LOAD

Droop (%)

is the % of rated speed by which the speed reference is drooped at zero to full load.

Full Load Act %

is the actuator % output at full load.

KW Filter (Hz)

is the filter value. This value should not need to be adjusted, but can be used to filter any undesirable frequencies picked up by the kW transducer.

Load Filter (Hz)

is the filter value. This value should not need to be adjusted, but can be used to filter the internally derived position feedback.

Unload Trip Level (kW)

When the control is in isochronous load sharing or kW control mode, and the Unload command is given, the load will be decreased to this level before the generator breaker open command is issued.

Ovrd Load I/P Fail

if selected true, will override the failed signal detection of the kW transducer input. When the load input is disabled, isochronous load sharing is not possible, and droop control is based on the actuator position.

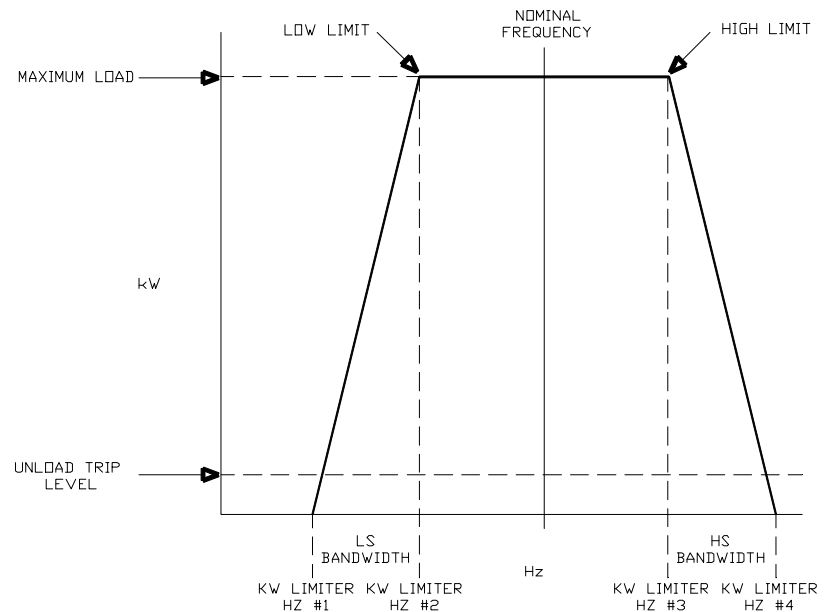
FREQUENCY LIMITER

Bus Frequency (Hz)

selects the frequency of the bus, normally set at 50 or 60Hz.

KW Limiter Hz #1, #2, #3 & #4, Maximum Load 1 & 2 (MW).

These tuneables set-up the curve for the frequency limiter. See diagram below:



Freq Error SP#1

is the frequency error (difference between actual bus frequency and normal bus frequency) above which the Grid Breaker Open command is issued.

Freq Error SP#2

is the frequency error (difference between actual bus frequency and normal bus frequency) above which the Generator Breaker Open command is issued.

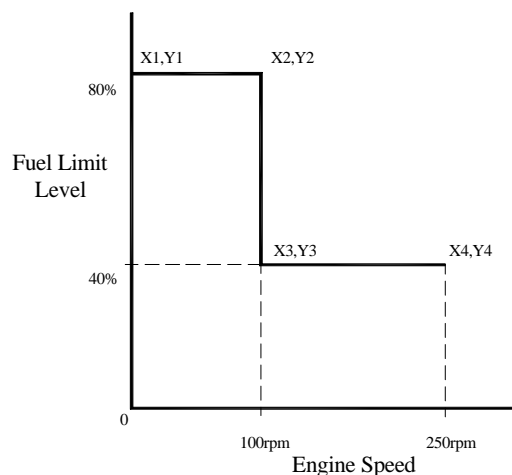
Trip Delay (s)

is the period of delay between detection and breaker open command, if *Freq Error SP#2* is exceeded.

FUEL LIMITERS

Start Fuel Limit X1..X4 (rpm),
Start Fuel Limit Y1..Y4 (%)

is the maximum % actuator output during engine start-up. This should be set to value which gives optimum start characteristics, while minimising smoke emissions due to overfuelling. A four point curve is provided to allow different fuel limiting levels at different speeds. e.g.

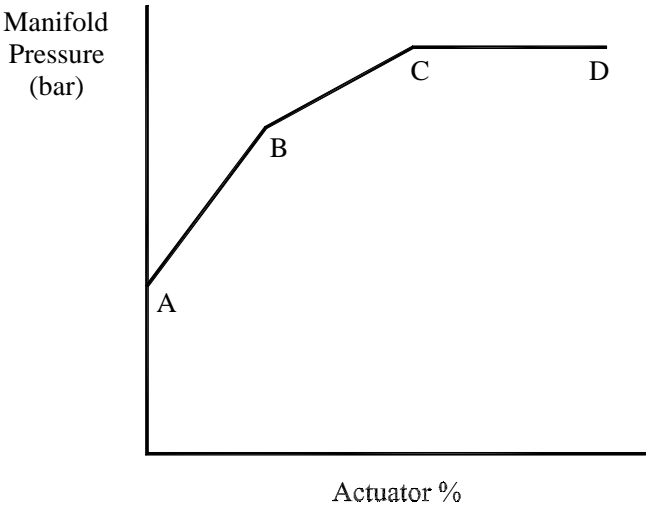


Maximum Fuel Limit (%) is the maximum % actuator output during normal engine operation. This limit should normally be set just above the output at full load.

CHARGE AIR LIMIT

Manifold Pressure A (bar)
Actuator % A
Manifold Pressure B (bar)
Actuator % B
Manifold Pressure C (bar)
Actuator % C
Manifold Pressure D (bar)
Actuator % D

The charge air pressure limiter is determined by a four-point curve of actuator position (%) versus manifold air pressure (bar). These setpoints determine the form of the curve. Please refer to the engine manufacturer for details of the curve.



Ovrd Air I/P Fail if selected true, will override the failed signal detection of the kW transducer input. When the charge air pressure input is disabled, the fuel limiter based on this signal is also disabled.

FINAL DRIVER

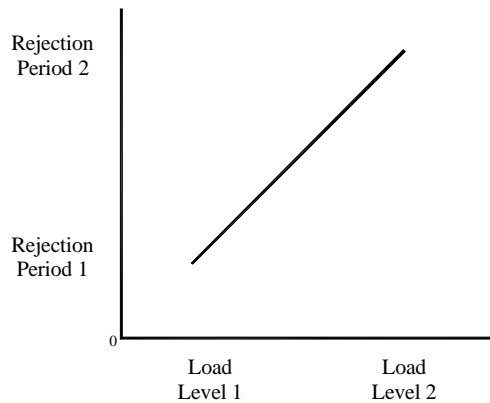
Hit Actuator, Actuator Hit Pulse (s), Actuator Hit Value (%) If the Actuator Hit has been enabled, when the *Hit Actuator* parameter is tuned TRUE, the *Actuator Hit Value* will be subtracted from the % actuator output, for a period of time (*Actuator Hit Pulse*). This function is available for the purpose of testing and proving dynamic set-up.

Stroke Actuator (%) If the configureable *Stroke Actuator* has been selected true, the engine is stopped, and the Run/Stop contact is in the Stop position, by adjusting this value, the actuator output can be increased and decreased in order to calibrate an electric actuator.

GEN BRKR LOAD REJ*Load Rej Level (%)*

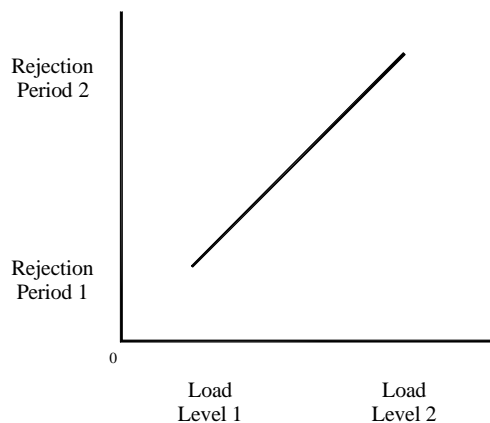
If the CB Aux contact is opened whilst the load is above this value, the actuator will be forced to 0% for the *Load Rej Period*, as determined by the curve set-up below.

Load Level 1..2 (%),
Rejection Period 1..2 (s)

***GRD BRKR LOAD REJ****Load Rej Level (%)*

If the Parallel with Grid contact is opened whilst the load is above this value, the actuator will be forced to 0% for the *Load Rej Period*, as determined by the curve set-up below.

Load Level 1..2 (%),
Rejection Period 1..2 (s)

*Enable Load Rej*

if selected true, will enable the load rejection pulse function, caused by the grid breaker opening.

CALIBRATION*Remote I/P Offset*

If it is necessary to calibrate the Remote Analogue input, adjustment of this parameter will alter the offset.

To calibrate the input, set the mA to zero, and ensure that the control is measuring zero. If not, adjust the offset until it does. Then set the mA input to 20mA. Ensure that the control is

	measuring 20. If not, adjust the gain until it does. Return the mA input to zero, and check that the control is still measuring zero. If not, repeat the calibration process.
<i>Remote I/P Gain</i>	If it is necessary to calibrate the Remote Analogue input, adjustment of this parameter will alter the gain.
<i>Load I/P Offset</i>	<p>If it is necessary to calibrate the kW transducer input, adjustment of this parameter will alter the offset.</p> <p>To calibrate the input, set the mA to zero, and ensure that the control is measuring zero. If not, adjust the offset until it does. Then set the mA input to 20mA. Ensure that the control is measuring 20. If not, adjust the gain until it does. Return the mA input to zero, and check that the control is still measuring zero. If not, repeat the calibration process.</p>
<i>Load I/P Gain</i>	If it is necessary to calibrate the kW transducer input, adjustment of this parameter will alter the gain.
<i>LS Lines Offset</i>	<p>If it is necessary to calibrate Load Share Lines input, adjustment of this parameter will alter the offset.</p> <p>To calibrate the load sharing lines, contact Woodward Governor for further information.</p>
<i>LS Lines Gain</i>	If it is necessary to calibrate the Load Share Lines input, adjustment of this parameter will alter the gain.
<i>LS Load Offset</i>	<p>If it is necessary to calibrate load output to the load sharing lines, adjustment of this parameter will alter the offset.</p> <p>To calibrate the load output to the load sharing lines, contact Woodward Governor for further information.</p>
<i>LS Load Gain</i>	If it is necessary to calibrate the load output to the load sharing lines, adjustment of this parameter will alter the gain.
<i>Air I/P Offset</i>	<p>If it is necessary to calibrate the Charge Air Pressure input, adjustment of this parameter will alter the offset.</p> <p>To calibrate the input, set the mA to zero, and ensure that the control is measuring zero. If not, adjust the offset until it does. Then set the mA input to 20mA. Ensure that the control is measuring 20. If not, adjust the gain until it does. Return the mA input to zero, and check that the control is still measuring zero. If not, repeat the calibration process.</p>
<i>Air I/P Gain</i>	If it is necessary to calibrate the Charge Air Pressure input, adjustment of this parameter will alter the gain.
<i>An O/P #1 Offset</i>	<p>This parameter is the offset term, for calibration of analogue output #1 (terminals 15 & 16).</p> <p>If it is necessary to calibrate the output, set the parameter</p>

	<p>'Analogue Output #1' (in menu *ANALOG O/P CONFIG*) to 7. Then adjust the 'An O/P Calibration' term to zero, and measure the current from output #1. If it is not zero, then adjust the offset term. Then adjust the 'An O/P Calibration' term to 20, and check the current again. If it does not read 20, then adjust the gain term. Return to zero, and check again, and work through the calibration process again if necessary.</p>
<i>An O/P #1 Gain</i>	This parameter is the gain term, for calibration of analogue output #1 (terminals 15 & 16).
<i>An O/P #2 Offset</i>	<p>This parameter is the offset term, for calibration of analogue output #2 (terminals 17 & 18).</p> <p>If it is necessary to calibrate the output, set the parameter 'Analogue Output #2' (in menu *ANALOG O/P CONFIG*) to 7. Then adjust the 'An O/P Calibration' term to zero, and measure the current from output #2. If it is not zero, then adjust the offset term. Then adjust the 'An O/P Calibration' term to 20, and check the current again. If it does not read 20, then adjust the gain term. Return to zero, and check again, and work through the calibration process again if necessary.</p>
<i>An O/P #2 Gain</i>	This parameter is the gain term, for calibration of analogue output #2 (terminals 17 & 18).
<i>An O/P #3 Offset</i>	<p>This parameter is the offset term, for calibration of analogue output #3 (terminals 19 & 20).</p> <p>If it is necessary to calibrate the output, set the parameter 'Analogue Output #3' (in menu *ANALOG O/P CONFIG*) to 7. Then adjust the 'An O/P Calibration' term to zero, and measure the current from output #3. If it is not zero, then adjust the offset term. Then adjust the 'An O/P Calibration' term to 20, and check the current again. If it does not read 20, then adjust the gain term. Return to zero, and check again, and work through the calibration process again if necessary.</p>
<i>An O/P #3 Gain</i>	This parameter is the gain term, for calibration of analogue output #3 (terminals 19 & 20).
<i>An O/P Calibration</i>	For any analogue output selected to Option 7 (calibration), adjustment of this value between 0 & 20 will allow checking and adjustment of the calibration of the output/metering device, between 0 and 20 mA.

***MODBUS PORT SETUP* (J3 Port)**

Hardware Config sets the communications hardware configuration, 1= RS232, 2= RS422, 3= RS485

<i>Baud Rate</i>	sets the desired baud rate, an integer number in the range 1 to 7 is to be used representing: 1= 1200, 2= 1800, 3= 2400, 4= 4800, 5= 9600, 6= 19200, 7= 38400. The preferred baud rate is 9600. If the chosen baud rate is 38400, then both J2 and J3 must be set identical.
<i>Stop Bits</i>	sets the desired number of stop bits, an integer number in the range 1 to 3 is to be used representing: 1= 1, 2= 1.5, 3= 2
<i>Parity</i>	sets the desired parity, an integer number in the range 1 to 3 is to be used representing: 1= OFF, 2= ODD, 3= EVEN
<i>Timeout (s)</i>	If no communication is received within the Timeout period, a communications error will occur.
<i>Enable Modbus Alms</i>	If set false, communications errors are ignored by the control.

SERVLINK SETUP**(J2 Port)**

<i>Hardware Config</i>	sets the communications hardware configuration, 1= RS232, 2= RS422, 3= RS485
<i>Baud Rate</i>	sets the desired baud rate, an integer number in the range 1 to 10 is to be used representing: 1= 110, 2= 300, 3= 600, 4= 1200, 5= 1800, 6= 2400, 7= 4800, 8= 9600, 9= 19200, 10= 38400. The preferred baud rates are 9600 and 19200.

DSLC COMMS SETUP

<i>DSLC Service Pin</i>	must be toggled true/false when prompted, during LON binding procedure. This should only be required during initial commissioning.
<i>DSLC Timeout</i>	If no communication is received within the Timeout period, a communications error will occur.
<i>DSLC Xmit Time</i>	is the time period between transmissions from the 723 to the DSLC.
<i>Reset LON</i>	is available for manually re-setting the LON in the event that it becomes necessary.

ANALOG O/P CONFIG*Analogue Output #1..#3*

These will select the parameters which are output through the three analogue output channels of the 723. 1= Actuator Position, 2= Engine Speed, 3= Percentage Load, 4= KW Reference, 5= Speed #1, 6= Speed #2, 7= Calibration Output

Eng Speed O/P @4mA, Eng Speed O/P @ 20mA, KW Ref O/P @ 4mA, KW Ref O/P @ 20mA, Speed 1 O/P @4mA, Speed 1 O/P @20mA, Speed 2 O/P @ 4mA, Speed 2 O/P @ 20mA

are for scaling the parameters output via the analogue 4-20mA outputs.

MAJOR ALARM*Overspeed*

this menu will only be displayed, if a Major Alarm has occurred.

if true, the engine speed has reached the *Overspeed Trip* level.

Both Spd Sen Failed

if true, both speed sensors have failed, i.e. below the *Low Setpoint*.

MINOR ALARM*KW Sensor Failure*

this menu will only be displayed, if a Minor Alarm has occurred.

if true, the analogue load input has failed, i.e. below 1mA, above 22mA.

Rem Ref Failure

if true, the analogue remote reference input has failed, below 2mA, above 22mA

Speed Sensor Fault

if true, a speed sensor has failed, i.e. below the 250Hz

Modbus Comms

if true, a communications failure has occurred with Modbus.

KW Limiting

if true, the kW reference is being limited by the frequency limiter curve.

Rem Sel Wire Break

if true, following the selection of remote kW reference (closure of both Increase & Decrease contacts), a single wire has been disconnected or broken. Both contacts must be broken to de-select remote kW reference.

DSLC Comms Fault

if true, there has been a communications failure between the 723 and the DSLC.

Charge Air I/P Fail

if true, the charge air pressure input has failed, below 2mA, above 22mA

DSLC ANALOGUES

this menu will display all of the necessary and relevant analogue parameters, read in from the DSLC.

DSLC BOOLEANS

this menu will display all of the necessary and relevant Boolean parameters, read in from the DSLC.

CAUTION

Failure to save setpoints prior to removing power from the control will cause them to revert to the previously saved settings.

Modbus® Communications Address List

Boolean Writes

<u>Address</u>	<u>Description</u>
0:0001	RUN/START ENGINE
0:0002	STOP ENGINE
0:0003	INCREASE SPEED/LOAD
0:0004	DECREASE SPEED/LOAD
0:0005	SELECT REMOTE REFERENCE
0:0006	UNLOAD
0:0007	DROOP
0:0008	ISOCHRONOUS
0:0009	EMERGENCY LOADING RATE
0:0010	RESET
0:0011	SELECT KW CONTROL
0:0012	VOLTAGE RAISE
0:0013	VOLTAGE LOWER
0:0014	SELECT RATED SPEED
0:0015	SELECT IDLE SPEED

Boolean Reads

<u>Address</u>	<u>Description</u>
1:0001	*MAJOR/SHUTDOWN ALARM*
1:0002	*MINOR ALARM*
1:0003	
1:0004	
1:0005	
1:0006	OVERSPEED - SD
1:0007	BOTH SPEED SENSORS FAILED - SD
1:0008	
1:0009	
1:0010	KW SENSOR FAILURE - MINOR
1:0011	REMOTE REFERENCE FAILURE - MINOR
1:0012	SPEED SENSOR FAILURE - MINOR
1:0013	KW LIMITING - MINOR
1:0014	REMOTE SELECT, WIRE BREAK - MINOR
1:0015	DSLC COMMS FAULT
1:0016	
1:0017	
1:0018	
1:0019	ENGINE STOPPED
1:0020	ENGINE RUNNING
1:0021	READY TO SYNCHRONISE
1:0022	GENERATOR BREAKER CLOSED
1:0023	ISOCHRONOUS MODE
1:0024	KW CONTROL MODE

1:0025	REMOTE REFERENCE SELECTED
1:0026	
1:0027	
1:0028	
1:0029	DSLC ALARM OUTPUT
1:0030	DSLC VOLTAGE LOWER OUTPUT
1:0031	DSLC VOLTAGE RAISE OUTPUT
1:0032	DSLC BREAKER CLOSE OUTPUT
1:0033	DSLC SYNC TIMEOUT ACTIVE
1:0034	DSLC SYNC RECLOSE ACTIVE
1:0035	DSLC LOAD HIGH LIMIT
1:0036	DSLC LOAD LOW LIMIT
1:0037	DSLC VOLTAGE RANGE
1:0038	DSLC VOLTAGE LOW LIMIT
1:0039	DSLC VOLTAGE HIGH LIMIT
1:0040	DSLC SYNCH STATE OFF
1:0041	DSLC SYNCH STATE CHECK
1:0042	DSLC SYNCH STATE PERMISSIVE
1:0043	DSLC SYNCH STATE RUN
1:0044	DSLC SYNCH STATE CLOSE TIMER
1:0045	DSLC SYNCH STATE SYNC TIMER
1:0046	DSLC SYNCH STATE SYNCHRONISED
1:0047	DSLC SYNCH CHECK I/P
1:0048	DSLC SYNCH PERM I/P
1:0049	DSLC SYNCH RUN I/P
1:0050	DSLC CB AUX I/P
1:0051	DSLC VOLTS RAISE I/P
1:0052	DSLC VOLTS LOWER I/P

Analogue Reads

<u>Address</u>	<u>Description</u>
3:0001	ENGINE SPEED (rpm)
3:0002	ENGINE SPEED #1 (rpm)
3:0003	ENGINE SPEED #2 (rpm)
3:0004	SPEED REFERENCE (rpm)
3:0005	KW LOAD
3:0006	ACTUATOR POSITION (%)
3:0007	FUEL LIMIT
3:0008	PID OUTPUT
3:0009	% LOAD
3:0010	LS LINES %
3:0011	LOAD SHARE ERROR
3:0012	LOAD REFERENCE (kW)
3:0013	REMOTE REFERENCE (kW)
3:0014	KW LIMIT
3:0015	UNIT SYNCH BIAS (rpm)
3:0016	SYSTEM SYNCH BIAS (rpm)
3:0017	DROOP BIAS (rpm)
3:0018	SPEED REFERENCE BEFORE BIASES

3:0019	CHARGE AIR PRESSURE (bar)
3:0020	
3:0021	
3:0022	
3:0023	DSLCL GENERATOR A-PHASE VOLTAGE (Volts)
3:0024	DSLCL GENERATOR B-PHASE VOLTAGE (Volts)
3:0025	DSLCL GENERATOR C-PHASE VOLTAGE (Volts)
3:0026	DSLCL BUS A-PHASE VOLTAGE (Volts)
3:0027	DSLCL GENERATOR A-PHASE CURRENT (Amps)
3:0028	DSLCL GENERATOR B-PHASE CURRENT (Amps)
3:0029	DSLCL GENERATOR C-PHASE CURRENT (Amps)
3:0030	DSLCL POWER FACTOR
3:0031	DSLCL REAL POWER (kW)
3:0032	DSLCL REACTIVE POWER (kVAR)
3:0033	DSLCL APPARANT POWER (kVA)
3:0034	DSLCL GENERATOR FREQUENCY (Hz)
3:0035	DSLCL BUS FREQUENCY (Hz)

Analogue Writes

<u>Address</u>	<u>Description</u>
4:0001	REMOTE KW REFERENCE (kW)

Chapter 6

Application Programming

Graphical Application Programmer

When designing a new control system, much time may be spent re-writing, re-testing and re-drawing documentation for software which has already been proven in a similar application. The Woodward Governor Company has developed a Graphical Application Programmer (GAP™) which allows the applications engineer to efficiently re-use existing software with a minimum of re-writing, re-testing and re-generating documentation. This application software generating system is self-documenting so that the engineer who develops the application will not be the only person who is able to efficiently modify the software.

The GAP™ software allows the applications engineer to design the control system logic with an integrated drawing package which runs on a PC under the Windows™ environment. Once the control software has been graphically entered, the GAP™/PC system automatically generates code which is loaded into the 723, to control the engine.

The GAP™ software blocks are written in C, a transportable language, which means that it can be used on different hardware platforms. Because of this, the same proven blocks which have been utilised in the past in various applications, with different control platforms, will be used in future controls, without introducing system bugs.

Similarly, just as the same blocks are re-used, the applications engineers using the GAP™ software, build on a Woodward library of GAP™ software functions which may be re-used from control to control, with little code generation and testing time, and again, without introducing errors.

All changes and additions to the GAP™ software are generated, tested and documented by an integrated team of software experts, so that the improvement of the GAP™ software is an ongoing process. This process minimises the amount of time spent re-writing specific control functions, whilst giving the applications engineer flexibility for design changes or special requirements.

Run Time Performance

When more and more complex algorithms are implemented in a digital control, the result can be a less than robust controller. One of the main advantages of the GAP™ software is that all the blocks have been written as efficiently as possible without jeopardising code stability. Blocks are written in one standard language, and the interface between blocks is well defined. Unwanted interactions between unrelated pieces of software have virtually been eliminated with the GAP™ software.

The timing requirements of the code generated by the GAP™ software have also been rigidly defined and adhered to. Variable execution time blocks have been avoided. The non-variability in the execution times of the blocks means that a control that runs efficiently during

testing, is currently exercising the entire control program. The user does not have to worry that under an unanticipated set of conditions, the processor will become overburdened, and will not have enough time to complete its assigned tasks. Only with predictable execution times, can a multi-tasking operating system have a guaranteed update rate. Software tasks may be programmed to run every 10ms, 20ms, 40ms and 80ms. The GAP™ software guarantees that a task programmed to run every 10 milliseconds will run exactly every 10 milliseconds, regardless of what other functions the control system is presently exercising.

System Support and Modification

During system support and modification, the advantages of the GAP™ software become readily apparent. Because of the structure of the GAP™ software, and because it generates its own documentation, changes to the control software can be easily supported by field service personnel, and the original engineer is not necessarily required for system support, or further modifications to the software. If the control software were written with only the aid of a software compiler like C or Pascal, any errors introduced in this code, might be almost impossible to identify and repair. The GAP™ system generates its own documentation that is guaranteed to match the control code generated.

The GAP™ system, because of its rigidly defined nature, allows Woodward to exercise the same engineering change and revision control system procedures used to control the manufacture of any control system part. This ISO 9001 approved engineering change system guarantees software compatibility, as well as documentation that makes it possible to reproduce, diagnose, and repair control logic bugs. If any bugs do escape, they will be well documented, and the affected systems will be readily located and fixed.

GAP™ Process/Logic Blocks

The following table shows the range of process/logic blocks which are available for application programming. Some of the blocks represent Woodward defined functions (e.g. PID_ENGA), while others may be recognised as standard logic functions (e.g. NOT).

ABSOLUTE	B_FEEDBACK	LAG	PID_2
ADD	B_FIRST	LAG_2	PID_ENGA
AND	B_MUX_N_1	LAG_3	PID_ENGALG
A_2_RM	B_NAME	LATCH	PID_RECIP
A_3_RM	B_SW	LATCH1	PID_SAMPLE
A_COMPARE	B_SW_REV	LEAD	PROP
A_FEEDBACK	B_TO_INT	LEADLAG_2	RAMP
A_FIRST	CMD_TRIM	LEAD_2	SAMP_HOLD
A_MONITOR	CURVE_2D	LEAD_LAG	SQRT
A_MUX_N_1	CURVE_3D	LSS_BUS	SUBTRACT
A_MUX_S_N	CURVE_OD	MANCAL_AI	SW_TIMER
A_NAME	DEADBAND	MANCAL_AO	SYS_PERF
A_SW	DELAY	MULTIPLY	TC_MON
A_SW_REV	DIVIDE	NAND	T_FLIPFLOP
A_TO_INT	EVENT_CORR	NEGATE	T_NAME
A_TO_TIME	FLT_DIAG	NOR	T_TO_AN
BG_TESTS	HSS_BUS	NOT	WGSPL
B_2_RM	I_NAME	ONE_SHOT	XNOR
B_3_RM	I_TO_AN	OR	XOR
B_ALARM	JMP_RATE	PID	

Figure 6.1 Process/Logic Program Blocks

Chapter 7

Power Management Network

Network Architecture

A special Serial LonTalk® Adapter (SLTA) is needed to make a network 'binding' between the DSLC and the 723 DCS.

An SLTA is a network interface that enables any PC to connect to a LonWorks network. An SLTA enables the attached PC to act as an application node on a LonWorks network. When used with a PC and the LonManager LonMaker Installation Tool, the SLTA can also be used to build sophisticated network management, monitoring and control tools for the LonWorks network.

Note: Once a DSLC has been 'bound' to a 723, the DSLC is no longer able to automatically communicate via the LON, to other DSLC's. If it is required for the DSLC's to communicate with each other, as well as a 723, the whole network will have to be taken into consideration. Each 723 and DSLC on the network will have to be entered into a database, and identified and bound individually, therefore becoming part of the communicating network.

Hardware

The network consists of one channel of the 723 and a DSLC.

More information regarding the DSLC (Digital Synchroniser & Load Control) may be found in the manual number 02007.

The DSLC communicates with the 723 through shielded twisted pair wiring. The specifications for the system require that listed level V type cable be used. For systems where more than one 723/DSLC pair are installed, the network may be wired directly from unit to unit, as shown in Figure 7-1, or each unit may be connected to the network via stubs as in Figure 7-2. The network must be terminated at both ends; Each end is terminated by placing a jumper between terminals 24 & 25 (723), and/or 41 & 42 (DSLC). There is no polarity associated with the network wiring.

For optimum EMC performance, the network cable shield should be landed at each unit, and the exposed wire length limited to 25mm. At each end, the outer insulation should be stripped and the bare shield tie-wrapped to the chassis.

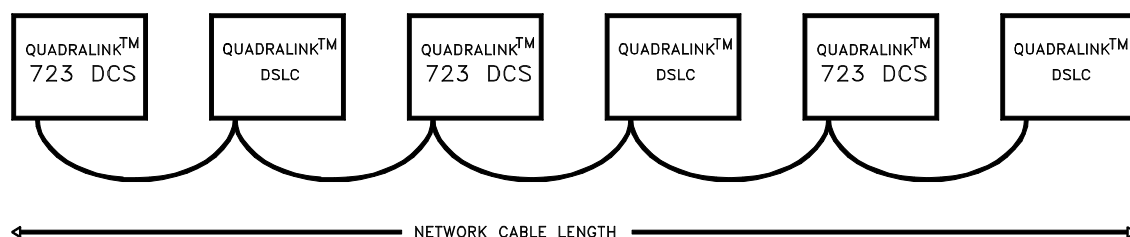


Figure 7-1. Direct Wired Network

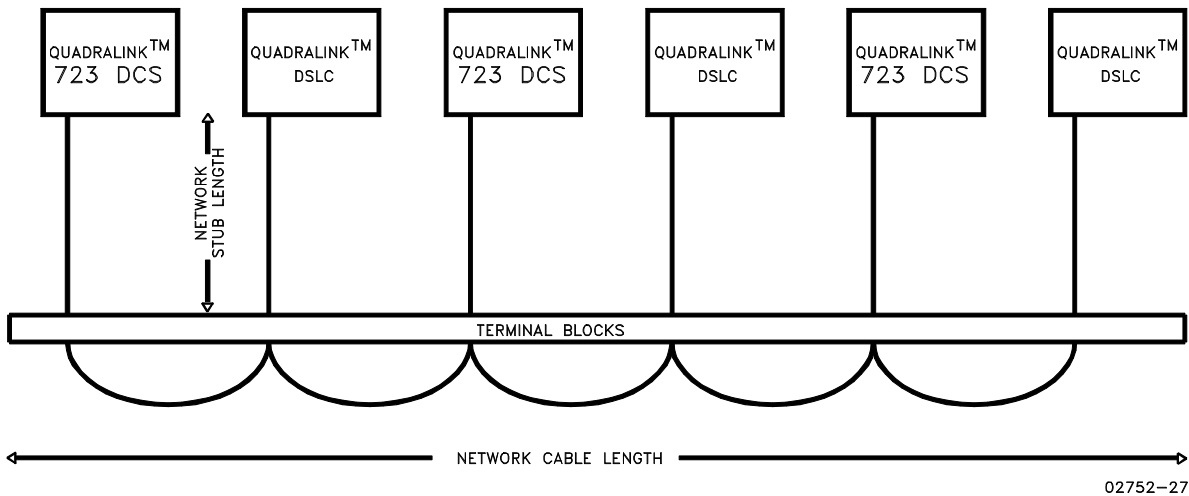


Figure 7-2. Network Wired Via Stubs

The cable used for the network will affect the overall system performance with respect to distance, stub length, and total number of nodes supported on a single channel. Echelon® recommends the use of UL Level IV, 0.325 mm² (22 AWG) twisted pair cable for the network bus as defined in UL’s LAN Cable Certification Program, UL document number 200-120 20 M/11/91

Proper LonWorks™ network wiring is critical to assure that the network operates correctly. Figure 7-3 illustrates an example typical system. The system may include other LonWorks™ compatible devices, such as a DSLC, Digital Synchroniser & Load Control. The following requirements must be met:

1. Use only recommended shielded twisted pair cabling for the LonWorks™ network. Correct cable is available from Woodward, Belden, or other suppliers providing an equivalent cable.

Woodward part number **2008-349**

Belden
PO Box 1980
Richmond, IN 47375
(1) 317 983 5200

Belden part number

P/N	Description
9207	PVC 0.52 mm ² (20 AWG) shielded. NC Type CL2, CSA Cert. PCC FT 1.
89027	Teflon 0.52 mm ² (20 AWG) shielded, Plenum version. NEC Type CMP,

	CSA Cert. FT 4.
YR28867	PVC 0.325 mm ² (22 AWG) shielded.
YQ28863	Plenum 0.325 mm ² (22 AWG) shielded.

- For maximum cable length see the table on page 25, as it is dependent on temperature.
- Stubs, or wiring drops, connecting intermediate devices to the main cable are limited to 300 mm in length.
- Shields must be carried through all breakout boxes to provide a continuous shield throughout the network.
- The network must be properly terminated at each end of the cable. Internal components are provided in the 723 DCS & DSLC, which provide proper network termination with the installation of a jumper on the controls at each end of the cable. Intermediate nodes should not have the termination jumper installed.

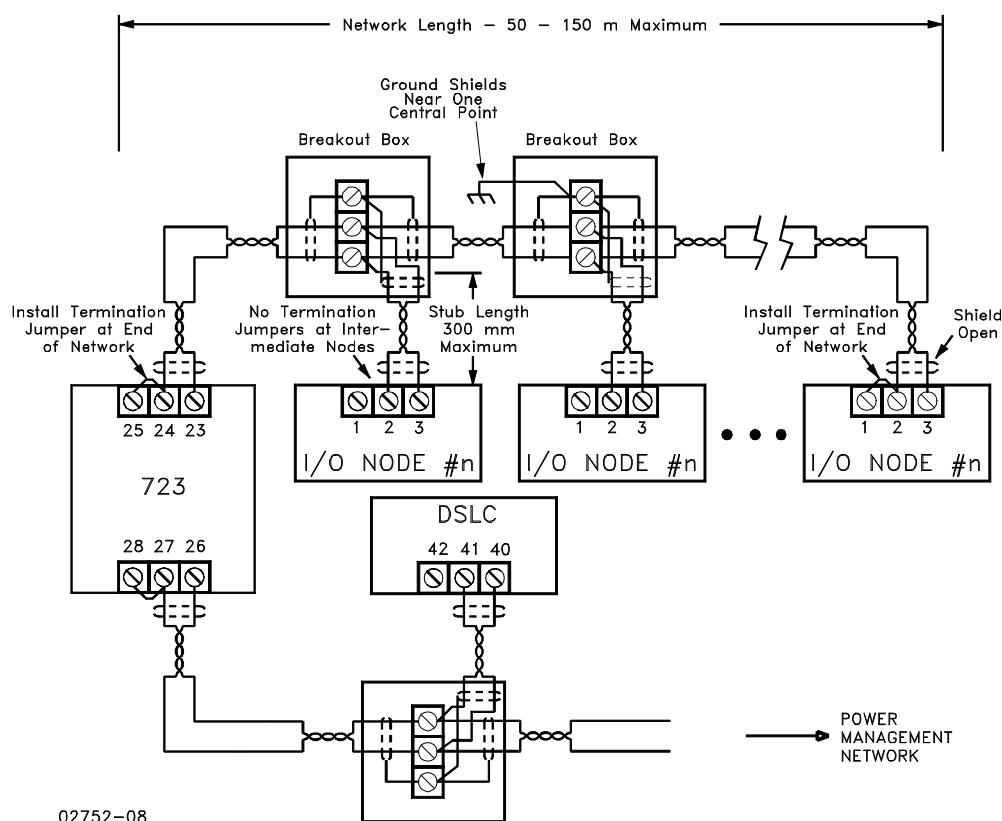


Figure 7-3. Typical LON Set-up

Chapter 8

MODBUS® Communications

The 723 Digital Control utilises AEG-Modicon Inc's MODBUS® protocol. The Modbus® protocol determines how the master and slaves establish and break off contact, how the sender and receiver are identified, how messages are exchanged in an orderly manner, and how errors are detected. The protocol also controls the query and response cycle which takes place between the master and slave devices.

The protocol provides for one master and up to 247 slaves on a common line. Each slave is assigned a fixed unique device address in the range of 1 to 247. Only the master can initiate a transaction. A transaction consists of a message from the master to one of the slaves and a response from that slave to the master.

The control supports two modes of transmission for Modbus®. The mode defines the individual units of information within a message, and the numbering system used to transmit the data. Only one mode of transmission may be used per Modbus® system; mixing of modes is not possible. The two transmission modes are ASCII (American Standard Code for Information Interchange) and RTU (Remote Terminal Unit). The modes are defined in the table below (Table 8.1). The 723 DCS uses either the ASCII or the RTU transmission mode.

	ASCII	RTU
CODING SYSTEM	HEXADECIMAL	8 BIT BINARY
BITS PER CHARACTER	7	8
PARITY	EVEN, ODD, NONE	EVEN, ODD, NONE
STOP BITS	1 OR 2	1 OR 2
DATA TRANSMITTED PER CHARACTER	4 BITS	8 BITS
ERROR CHECKING	LRC (LONGITUDINAL REDUNDANCY CHECK)	CRC (CYCLICAL REDUNDANCY CHECK)

Figure 8.1 Modbus® Transmission Modes

In RTU mode, the data is sent in 8-bit binary characters. In ASCII mode, each RTU character is first divided into two 4-bit parts (high order and low order) and then represented by their hexadecimal equivalent. The ASCII characters representing the hexadecimal characters are used to construct the message. ASCII mode uses twice as many characters as RTU mode. Additionally, in RTU mode, message characters must be transmitted in a continuous stream. In ASCII mode, breaks of up to 1 second can occur between characters.

There are two communication ports available in the 723. Both ports may be configured for RS-232, RS-422 or RS-485 communications. If the communication utilises an RS-232 link, the distance between devices is limited to a maximum distance of 15 metres (50 feet). It should be noted that the J3 port can communicate using either ASCII or RTU mode, whereas the J2 port is only able to communicate using ASCII.

The 723 can be programmed as either a master or slave unit. When programmed as a slave unit, it responds only after being asked for a set of parameters. Typically the 723 will communicate as a slave with a Modbus® Master device utilising a separate link to each device. However, if multidropping is used, one or two 723's can be connected to one Master device on a single link.

The data is passed between the Master and the 723 in the form of message frames (see Table 8.2). On any single multidrop link, each slave address must be unique.

BEGINNING OF FRAME	SLAVE ADDRESS	FUNCTION CODE	DATA	ERROR CHECK CODE	END OF FRAME
:	2 CHARS 8 BITS	2 CHARS 8 BITS	4 BITS DATA PER CHAR	2 CHAR 8 BITS	CR LF
3-CHAR DEAD TIME	1 CHAR 8 BITS	1 CHAR 8 BITS	8 BITS DATA PER CHAR	2 CHAR 16 BITS	3 CHAR DEAD TIME

Figure 8.2 Modbus® Frame Definition

The function code portion of the message frame tells the addressed slave what function to perform. Table 8.3 and Figure 8.1 define and list the function codes supported by the 723.

Code	Description	Modbus® Reference Address
1	Read digital outputs	0XXXX
2	Read digital inputs	1XXXX
3	Read analogue outputs	4XXXX
4	Read analogue inputs	3XXXX
5	Write single digital output	0XXXX
6	Write single analogue input	4XXXX
8	Loopback test - returns the query (subfunction 0 only)	
15	Write digital outputs	0XXXX
16	Write analogue outputs	4XXXX

Figure 8.3 Modbus® Function Codes

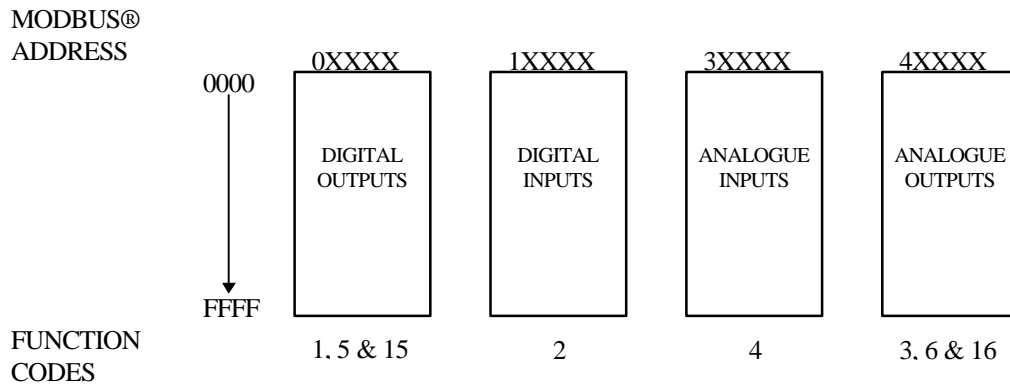


Figure 8.4 Modbus® Function Codes

Figure 8.7 shows typical Modbus® frames for the various function codes. If a slave detects an error in a message, it will not act on or respond to that message. For any requested data that is undefined, the slave will respond with a value of zero. The slave will respond with an exception response if it detects illegal data in a message. The following tables (Figure 8.5 & 8.6) lists the exception errors displayed by the 723 control.

Code	Name	Meaning
1	Illegal Function	The message function is not an allowable action
2	Illegal Data Address	The message start address is not allowable address
9	Checksum Error	The received message had an incorrect error check code
10	Garbled Message	The received message could not be decoded

Figure 8.5 Modbus® Slave Exception Error Codes

Code	Name	Meaning
1	Illegal Function	This exception response received from a slave
2	Illegal Data Address	This exception response received from a slave
9	Checksum Error	The received message had an incorrect error check code
10	Garbled Message	The received message could not be decoded
20	Unsolicited Message	A message was received without being requested
21	Function Mismatch	Received message had a function code different from the command
22	Slave Address Mismatch	Received message had an address different from the command
23	No Response	The slave did not respond within 1.5 seconds

Figure 8.6 Modbus® Master Exception Error Codes

Function Code	Message Type							
1,2,3,4	Query	<table><tr><td>SLAVE ADDRESS</td><td>FUNCTION CODE</td><td>START ADDRESS</td><td>NUMBER OF POINTS</td><td>ERROR CHECK</td></tr></table>	SLAVE ADDRESS	FUNCTION CODE	START ADDRESS	NUMBER OF POINTS	ERROR CHECK	
SLAVE ADDRESS	FUNCTION CODE	START ADDRESS	NUMBER OF POINTS	ERROR CHECK				
1,2,3,4	Response	<table><tr><td>SLAVE ADDRESS</td><td>FUNCTION CODE</td><td>BYTE COUNT</td><td>ANALOGUE OR DIGITAL DATA</td><td>ERROR CHECK</td></tr></table>	SLAVE ADDRESS	FUNCTION CODE	BYTE COUNT	ANALOGUE OR DIGITAL DATA	ERROR CHECK	
SLAVE ADDRESS	FUNCTION CODE	BYTE COUNT	ANALOGUE OR DIGITAL DATA	ERROR CHECK				
5,6	Query or Response	<table><tr><td>SLAVE ADDRESS</td><td>FUNCTION CODE</td><td>DATA ADDRESS</td><td>ANALOGUE OR DIGITAL VALUE</td><td>ERROR CHECK</td></tr></table>	SLAVE ADDRESS	FUNCTION CODE	DATA ADDRESS	ANALOGUE OR DIGITAL VALUE	ERROR CHECK	
SLAVE ADDRESS	FUNCTION CODE	DATA ADDRESS	ANALOGUE OR DIGITAL VALUE	ERROR CHECK				
15,16	Query	<table><tr><td>SLAVE ADDRESS</td><td>FUNCTION CODE</td><td>START ADDRESS</td><td>NUMBER OF POINTS</td><td>ANALOGUE OR DIGITAL DATA</td><td>ERROR CHECK</td></tr></table>	SLAVE ADDRESS	FUNCTION CODE	START ADDRESS	NUMBER OF POINTS	ANALOGUE OR DIGITAL DATA	ERROR CHECK
SLAVE ADDRESS	FUNCTION CODE	START ADDRESS	NUMBER OF POINTS	ANALOGUE OR DIGITAL DATA	ERROR CHECK			
15,16	Response	<table><tr><td>SLAVE ADDRESS</td><td>FUNCTION CODE</td><td>START ADDRESS</td><td>NUMBER OF POINTS</td><td>ERROR CHECK</td></tr></table>	SLAVE ADDRESS	FUNCTION CODE	START ADDRESS	NUMBER OF POINTS	ERROR CHECK	
SLAVE ADDRESS	FUNCTION CODE	START ADDRESS	NUMBER OF POINTS	ERROR CHECK				
ALL	Response	<table><tr><td>SLAVE ADDRESS</td><td>FUNCTION CODE</td><td>ERROR CODE</td><td>ERROR CHECK</td></tr></table>	SLAVE ADDRESS	FUNCTION CODE	ERROR CODE	ERROR CHECK		
SLAVE ADDRESS	FUNCTION CODE	ERROR CODE	ERROR CHECK					

Figure 8.7 Modbus® Messages

The pertinent serialport communications parameters are adjustable. The following table defines these parameters, and their ranges.

Parameter	Typical Value	Adjustment Range
Baud Rate	9600	1200 to 38400
Parity	None	None, Odd, Even
Stop Bits	1	1, 1.5, 2

Figure 8.8 Communication Port Adjustments

The Modbus® communication ports in the 723 are custom programmed for each application, and have unique Modbus® addresses. The Modbus® address listing consists of Boolean Writes, Boolean Reads, Analogue Reads, and Analogue Writes. The Boolean reads and writes are also referred to as input and holding coils. The analogue reads and writes are also referred to as input registers and holding registers.

All values that can be addressed by Modbus® are considered to be discrete and numeric. The discretess are a 1 bit binary, on or off value and the numerics are 16 bit values. Registers are interpreted by the 723 as signed 16 bit integers. The maximum number of analogues in a single message is 59 for ASCII mode and 118 for RTU mode. The maximum number of digitals in a single message is 944 for ASCII mode and 1888 for RTU mode.

Boolean Writes (Holding Coils)

Holding coils are logical signals that are both readable from and writable to the 723. An example of a Boolean write value would be 'raise' or 'lower' commands. A logical true denoted by the value 1 will cause the command listed in the description to be executed. The 723 control supports function codes 1, 5 and 15. These correspond to reading selected holding coils, writing to a single holding coil, and writing to a multiple holding coils, respectively.

Boolean Reads (Input Coils)

Input Coils are logical signals that are readable from, but not writable to, the 723. An example of a Boolean read value would be an alarm indication. The '1:' term in the address identifies an input coil. The 723 supports Modbus® function code 2, which involves reading selected input coils.

Analogue Reads (Input Registers)

Input registers are analogue values that are readable from, but not writable to, the 723. An example of an analogue read value would be engine speed. The value of the input registers are stored internal to the control as floating point numbers representing engineering units (i.e. rpm or Hz). The values that are transmitted are integer values ranging from -32767 to +32767. Since Modbus® can only handle integers, values that have a decimal point should be multiplied by a constant before being sent by Modbus®. The 723 supports Modbus® function code 4, which involves reading selected input registers.

Analogue Writes (Holding Registers)

Holding registers are analogue values that are writable to, but not readable from, the 723. An example of an analogue write value would be a kW load reference. The value of the holding registers are also stored in the control as numbers representing engineering units. The 723 supports Modbus® function codes 3, 6 and 16. These correspond to reading selected holding registers, writing to a single holding register, and writing to multiple holding registers, respectively.

Chapter 9

Setpoint Programming

Introduction

Due to the differences between installations, plus system and component tolerances, the 723 control must be tuned to each system for optimum performance.

This chapter contains information on how to enter control setpoints, using either a Hand Held Programmer or a PC Interface, (whichever is provided for the application).

WARNING

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

The 723 has two types of tuneable; the Service tuneable and the Configure tuneable. The Service tuneables allow tuning while the engine is running. The Configure tuneables may only be adjusted if the control (and hence the I/O) is shutdown, and therefore, the engine stopped.

The System Description for each type of 723 control will contain a list of each tuneable parameter, with it's default value and range of adjustment. A second list will provide an individual description of each tuneable.

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 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. This is information relating to the application. Pressing the 'ID' key will change the display to show the part number of the control.

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 the 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 shutdown, and hence the engine stopped.

Hand Held Programmer Keys

The programmer keys do the following functions (see Figure 9-1):

(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)	Decreases setpoint values by one step at a time.
+ (plus)	Increases setpoint 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.

Configure Menus

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

To exit the Configure menus press the ESC key. The setpoints will be automatically saved when leaving Configure.

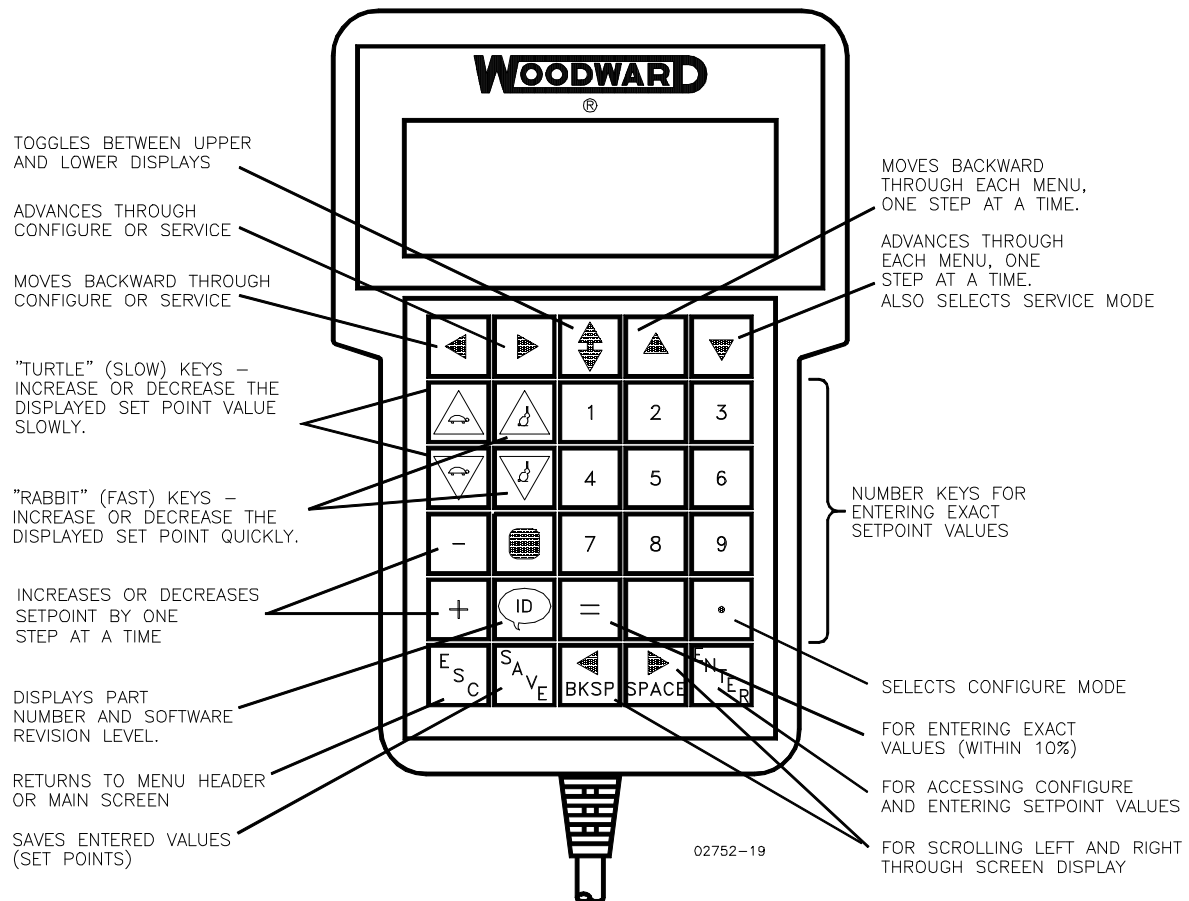


Figure 9-1. Hand Held Programmer Functions

Service Menus

To access the Service menus press the **key**. To move between menus, and to move through setpoints 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 Setpoints

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 set-up where a value may need to be changed significantly. Where necessary, to select TRUE, use either the “Turtle Up” or the “Rabbit Up” keys, and to select FALSE, use the “Turtle Down” or “Rabbit Down” keys.

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

Note: This may only be done if the figure is within 10% of the existing value, or for any adjustments made in Configure.

To save setpoints 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.

CAUTION

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.

PC Interface

A PC Interface may be provided for tuning parameters, instead of the Hand Held Programmer. This will consist of the ServLink Server, which acts as the interface between the PC and the 723. The hardware communication link is configurable for RS232 or RS422 (RS422 only if using the 723 J1 port), and the communications protocol is the Woodward developed ServLink.

The Woodward Watch Window can be used to interface with the ServLink Server, as a means for displaying the Service & Configure tuneables/monitors, with the ability for tuning the parameters. Watch Window also offers the ability to upload the tuneable parameters from the control, into a file, and also to download the parameters stored in the file, into a control (of the same type/application).

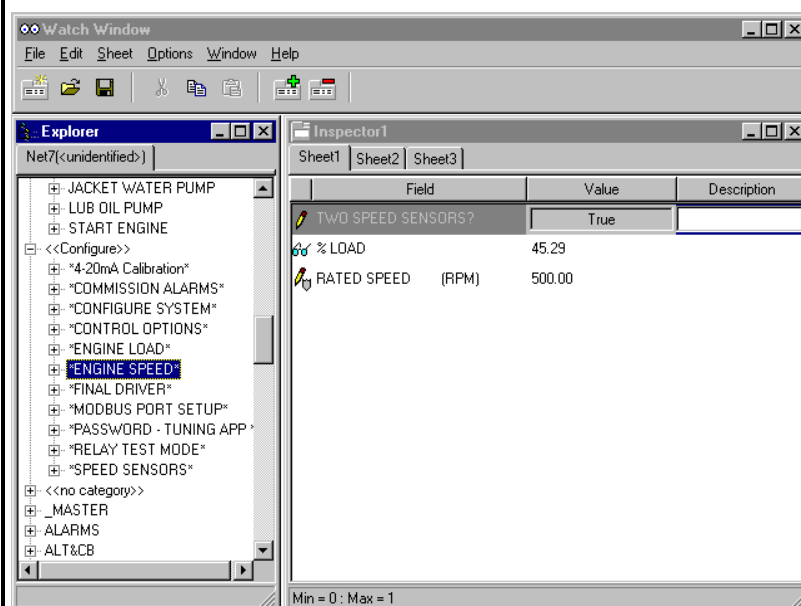
With each application manual, a list of each of the tuneable parameters will be provided along with a description of each. Also, a listing of each of the tuneables with the default values and the range of adjustment will be included.

The PC Interface should be installed on a PC running a Windows 32 bit operating system (e.g. Windows 95 or NT).

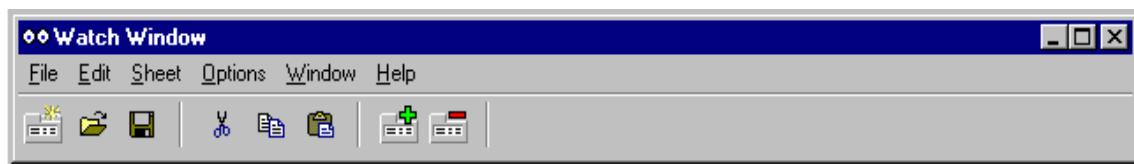
Watch Window

The Watch Window is a tool for viewing and adjusting the parameters of the 723PLUS Control. An application can be quickly and easily developed by the user, by assembling a number of tabbed sheets, onto which are 'dropped', the parameters that are required for monitoring/adjusting. The Watch Window is made up of three types of window; Main Window, ServLink Explorer and ServLink Inspector.

Following is an example of the Watch Window:

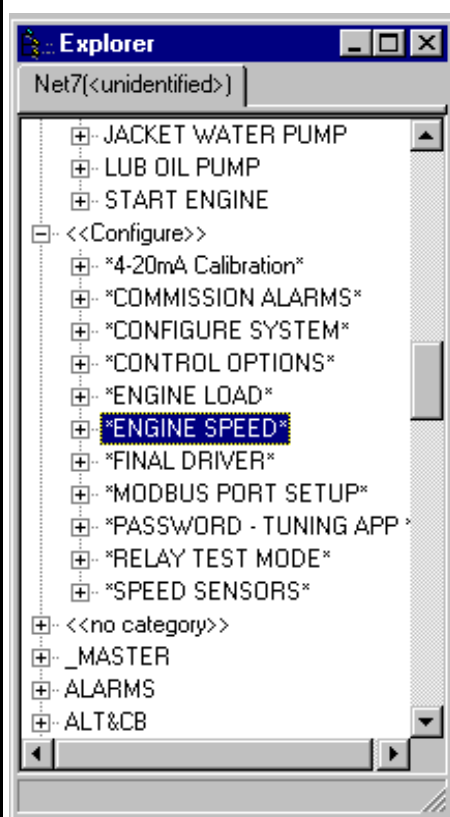


Main Window



The Main Window is the application controlling window, and provides the standard menus for opening/closing/saving files, Cut/Copy/Paste of parameters, and also for adding/removing/rename tabbed sheets to the application.

ServLink Explorer



The Explorer is used to browse the set of variables available through the Servlink Server.

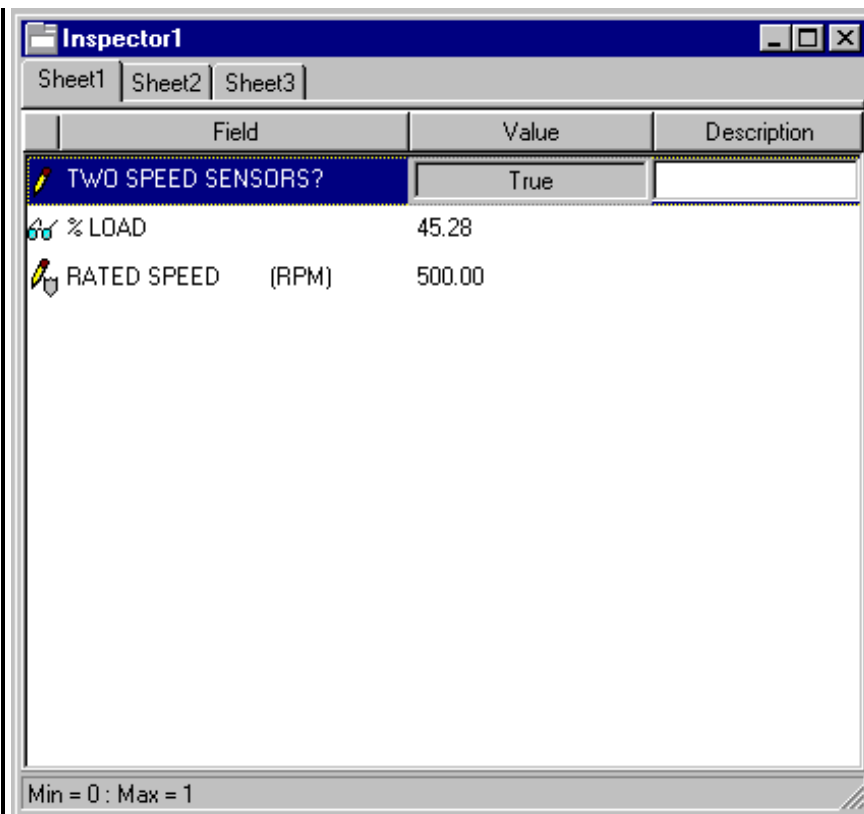
The Explorer is composed a set of tabbed sheets. Each sheet is associated with a single control from a Servlink network. The sheet's tab is labelled with the associated control's identifier.

Each sheet contains a tree view. The tree view displays the names of the categories and blocks in a control's application program in a hierarchical structure. The names at each level in the tree are listed in alphabetical order. The Watch Window which is normally supplied will display the Configure and Service menu's only.

Selected variables can be used in Copy & Paste or Drag & Drop operations in order to add a variable to an Inspector. Variables can be selected using the mouse (left click) or keyboard (arrow keys). Selecting categories or blocks selects all of the fields underneath them.

ServLink Inspector

The Inspector is used to monitor and edit variables available through the Servlink Server. The Inspector is composed of a set of tabbed sheets. Each sheet contains a grid (the grid shown in the following example is reduced - other fields headers are available to define which control a variable relates to, and if relevant, which category and blockname. Each sheet's tab is labelled with a user-definable name. The user has the ability to add and remove sheets using menu items and/or tool bar buttons in the Main Window.



An icon to the left of the variable defines whether it is a monitor value, configure tuneable or service tuneable (or debug tuneable if relevant)

- : Service Tuneable
- : Monitor Value
- : Configure Tuneable

One or more variables can be selected using the mouse (left click) or keyboard (arrow keys). If the user wishes to select multiple variables, they can do so by performing one of these sequences:

- Select a variable, hold down the shift key, and arrow up or down until all of the variables are selected.
- Click on a variable, hold down the shift key, and click on the last variable in the series that the user wishes to select.

Selected variables can be used in Cut, Copy & Paste or Drag & Drop operations in order to add a variable to an Inspector. If the selected variable is tuneable or configurable the status bar will display the minimum and maximum value for that variable. If multiple variables are selected, the minimum and maximum will not be displayed for any of the selected variables.

The Inspector can have its configuration saved and restored. The Inspector can be closed by using the Main Window or by clicking the standard windows close button.

Chapter 10

Repair & Replacement

Returning Equipment for Repair

Identification

If any part of the electronic control is to be returned to Woodward Governor Company for repair, attach a tag to the part with the following information:

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

CAUTION

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

Packing a Complete Control

Use the following materials when returning a complete control:

- 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.

Replacement Control Information

When ordering a replacement (or spare) electronic control, include the following information:

- the part number(s) that is on the enclosure nameplate, plus any prefixes or suffixes;
- the unit serial number, which is also on the nameplate.

Address and Telephone/FAX Numbers

Use the following addresses when shipping or corresponding:

Woodward Governor (U.K.) Ltd.
Engine Controls
350 Basingstoke Road
Reading
Berkshire
RG2 0NY
England

TELEPHONE: 44 (0)118 9752727 (24 hours a day)
FAX: 44 (0)118 9751599

Woodward Governor Nederland B.V.
Hoofdweg 601
PO Box 34
2130 AA
Hoofddorp
The Netherlands

TELEPHONE: 31 (0)23 5661111
FAX: 31 (0)23 5636529

Woodward Governor Company
1000 East Drake Road
PO Box 1519
Fort Collins, CO 80522-1519
USA

TELEPHONE: 1 970 4825811
FAX: 1 970 4983047

Manual Revision History

All modifications made to this manual, since the last revision of the manual are marked to the left hand side by a thick black line.

1. This manual (revision B) has been revised to incorporate changes made to the GAP software to rev F. All items which are relevant only to rev F software, not to any previous versions, are marked ^{*F}. (10th February 1999)

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please include the manual number from the front cover of this publication.



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.