



723PLUS Generator Control

8230-3011, 8230-3012

Application and Hardware Manual



General Precautions

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.

Practice all plant and safety instructions and precautions.

Failure to follow instructions can cause personal injury and/or property damage.



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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.



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Warnings and Notices

Important Definitions



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

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

WARNING

Overspeed / Overtemperature / Overpressure

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

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

WARNING

Personal Protective Equipment

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

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

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

WARNING

Start-up

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

WARNING

Automotive Applications

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

NOTICE

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

**Battery Charging
Device**

Electrostatic Discharge Awareness

NOTICE

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:

**Electrostatic
Precautions**

- Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).
- Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.
- Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.

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

Follow these precautions when working with or near the control.

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

Chapter 1.

General Information & Description

Introduction

This manual describes the 723PLUS Generator Control, P/N's 8280-3011/12 (High & Low Voltage Control)

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 MW 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 MW 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 4–20 mA **MW Transducer** input, or the actuator position.
- Isochronous load sharing with soft loading/unloading and automatic generator breaker open command once the engine has unloaded.
- MW control with soft loading/unloading and automatic generator breaker open command once the engine has unloaded. The reference may be adjusted locally (Increase/Decrease contacts) or remotely (analogue reference: 4–20 mA or Modbus[®] *).

*—Modbus is a trademark of Schneider Automation Inc.

Start and maximum fuel limiters are provided. 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.

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

One serial port (J3) is available for Modbus communications using RS-232, RS-422 or RS-485. Engine and generator parameters can be monitored and certain control functions sent to the control via the Modbus.

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

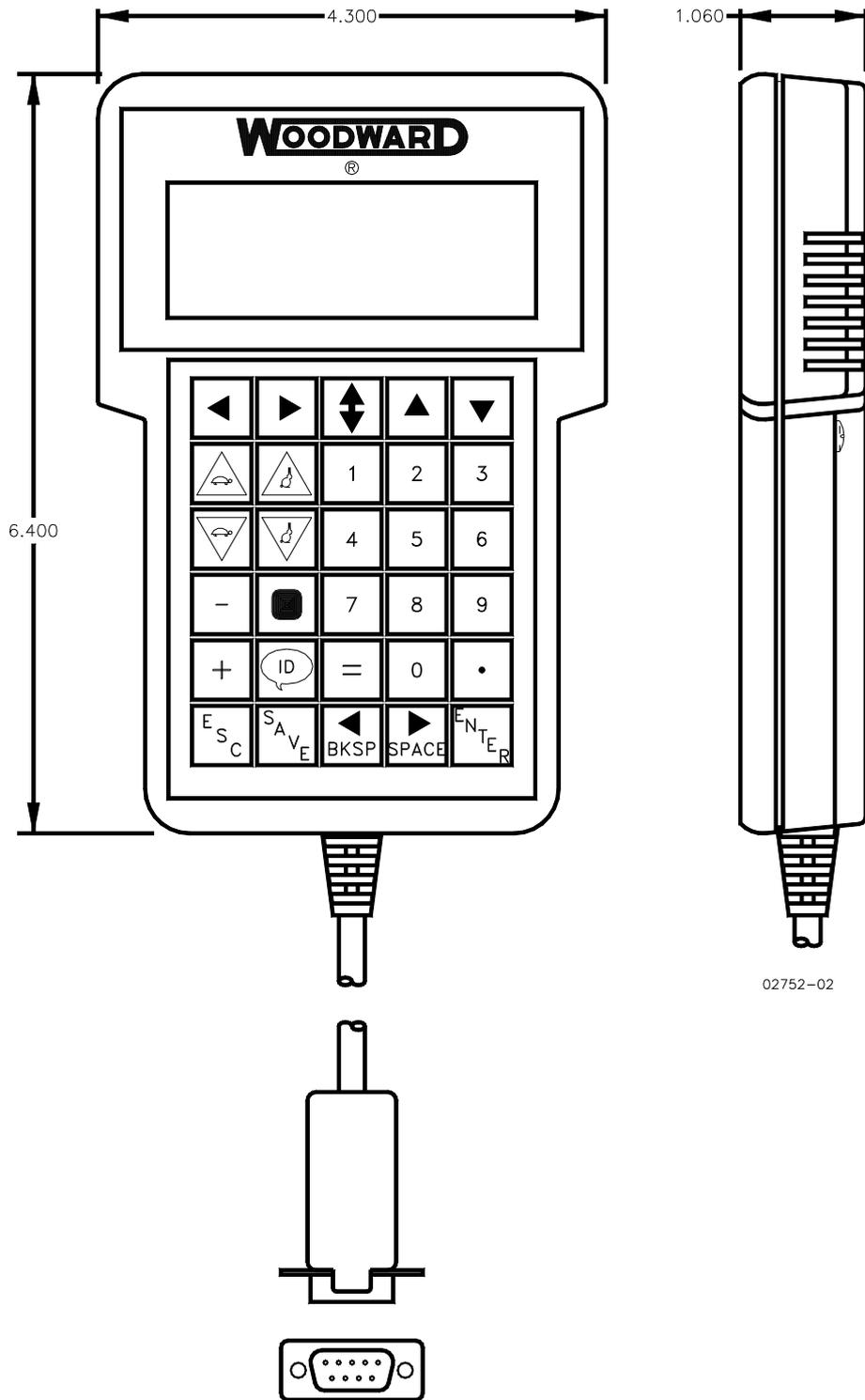
723PLUS Digital Control Accessories

Hand Held Programmer (Figure 1-2), part number 9907-205, is used for adjusting the 723 Plus 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 (MW Transducer) for generator load monitoring (P/N 8272-394).



02752-02

Figure 1-2. Hand Held Programmer

Chapter 2.

723PLUS Installation

Scope

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

Unpacking

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

NOTICE

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

IMPORTANT

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

NOTICE

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

Location Considerations

Consider these requirements when selecting the mounting location:

- Adequate ventilation for cooling
- Space for servicing and repair
- Protection from direct exposure to water or to a condensation-prone environment
- 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 from 40 to +70 °C (40 to 158 °F)

The control must NOT be mounted on the engine.

Internal Jumpers

The 723PLUS control has ten, two-position internal jumpers (JPR1 through JPR20) located on the top of the printed circuit board. If it is necessary to change any jumper to match the control requirements, and suits the nature of the software, be sure to read Chapter 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 2-1).

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

*--default jumper settings

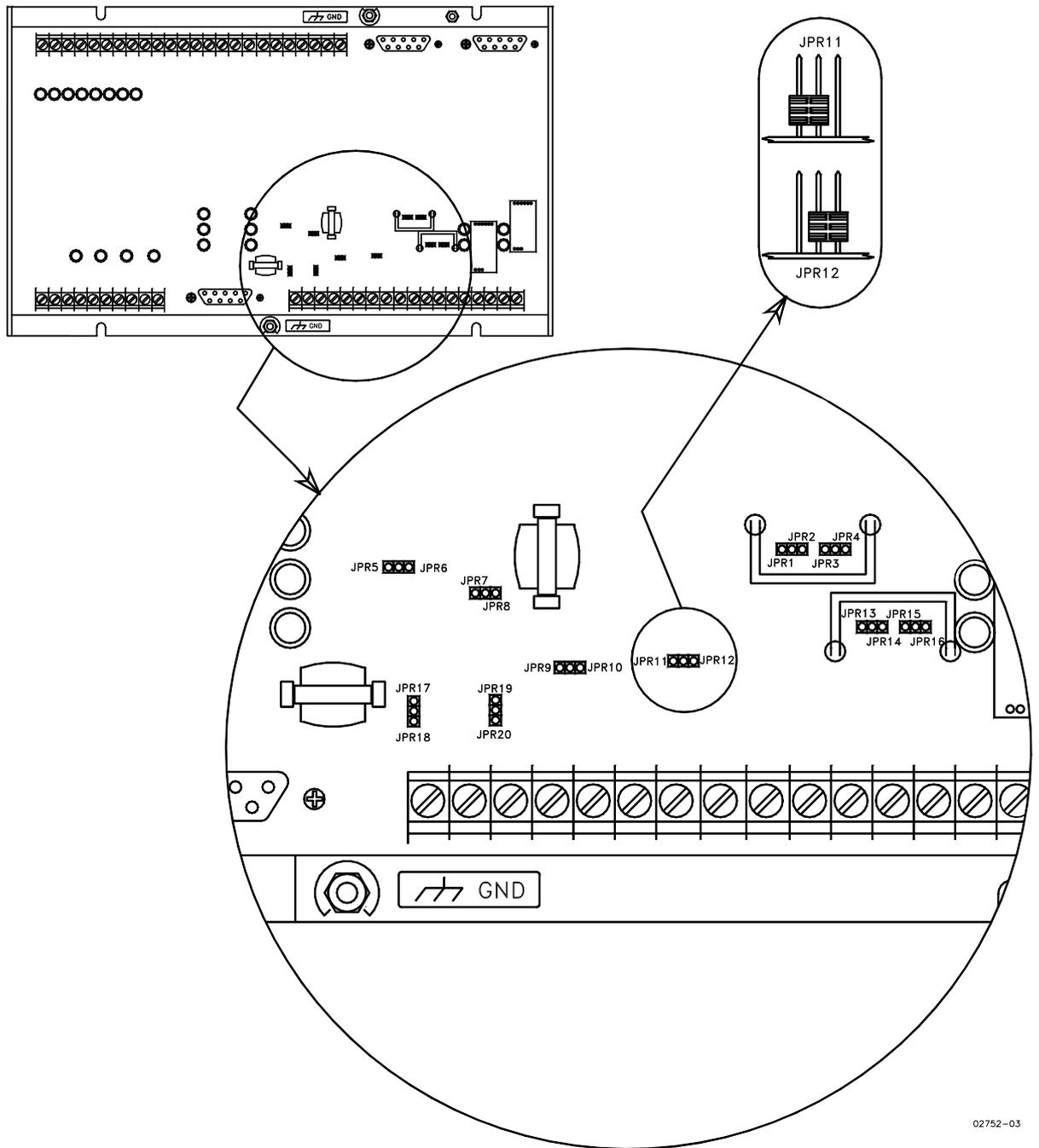


Figure 2-1. 723PLUS Control Internal Jumpers

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 for more information.

Power Supply (Terminals 1/2)

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

NOTICE

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

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

NOTICE

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

NOTICE

To prevent damage to the engine, apply power to the 723PLUS control at least 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 723PLUS 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 - 2.0 A at 28 Vdc, 0.1 A at 115 Vac 50 to 400 Hz

Inductive - 0.75 A at 28 Vdc 0.2 Henry

Load Sharing Lines Input (Terminals 9/10)

Connect the load sharing lines directly to those of another 723PLUS 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/proximity switch 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 4–20 mA at 600 Ω maximum.

NOTICE

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

Discrete Inputs (Terminals 29 - 36)

Discrete inputs are the switch input commands to the 723PLUS control. The discrete inputs should be powered from the 723PLUS'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 24 Vdc 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 that 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 (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.

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

NOTICE

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

Serial Communications Ports

J2—Servlink Server, RS-232, RS-422

J3—Modbus, RS-232, RS-422, RS-485

IMPORTANT

RS-485 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 2-2 is an example.

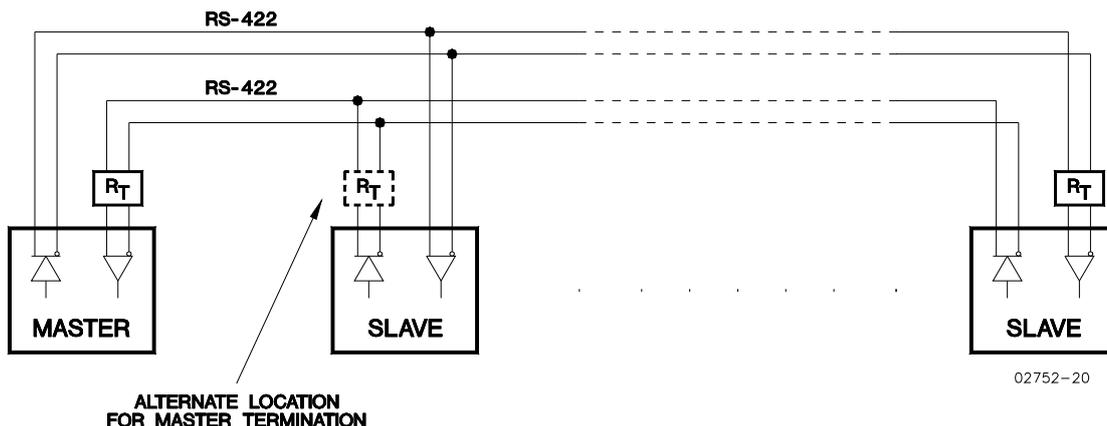


Figure 2-2. RS-422 Terminator Locations

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 2-3 is an example.

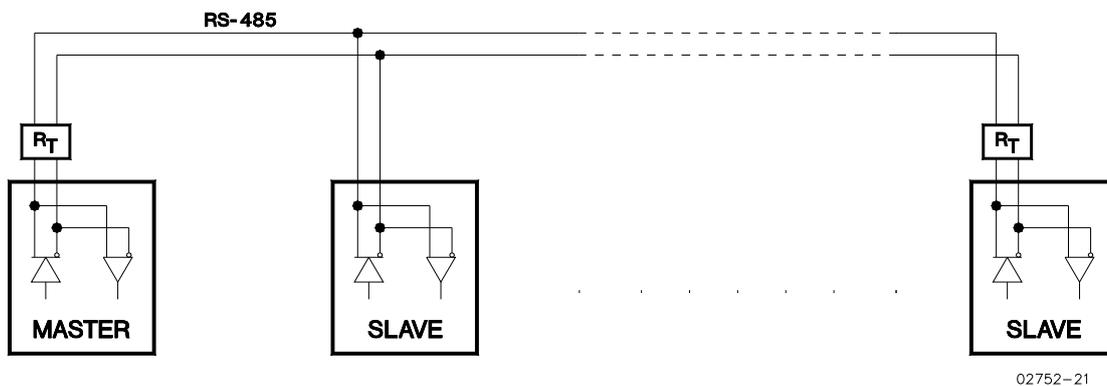


Figure 2-3. RS-485 Terminator Locations

Communicating with a HMI operator interface is a special case of Figure 2-4. Because the HMI master cannot put its transmitter into a high-impedance state, and the bit rate is less than 90 kbits/s, 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 2-4. 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 Ω. The purpose is to maintain a voltage level between the two differential

lines so that the receiver will be in a stable condition. The differential voltage can range between 0.2 and 6 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 723PLUS. Connection to this resistor network is made through the 9-pin connectors on pins 6 and 9.

See Figures 2-4 through 2-7 for termination and cable connection examples.

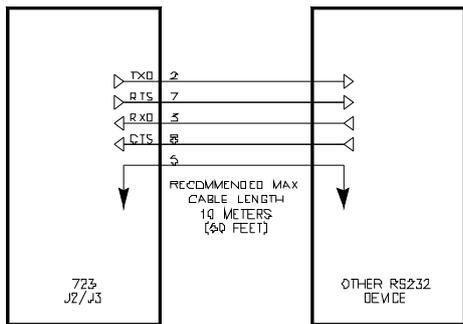
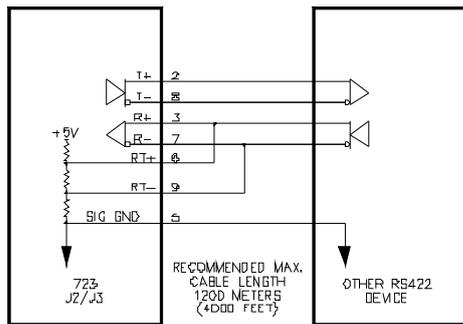


Figure 2-4. 723PLUS RS-232 Connection



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Figure 2-5. 723PLUS RS-422 Connections with Optional Termination at Receiver

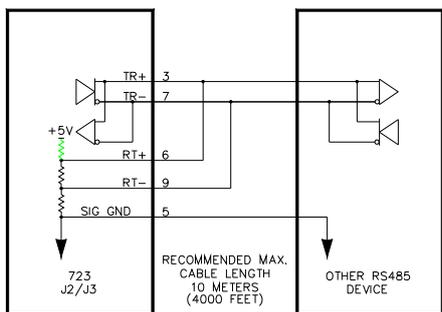
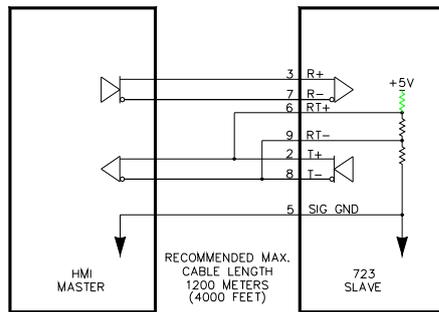


Figure 2-6. 723PLUS RS-485 Connections with Optional Termination



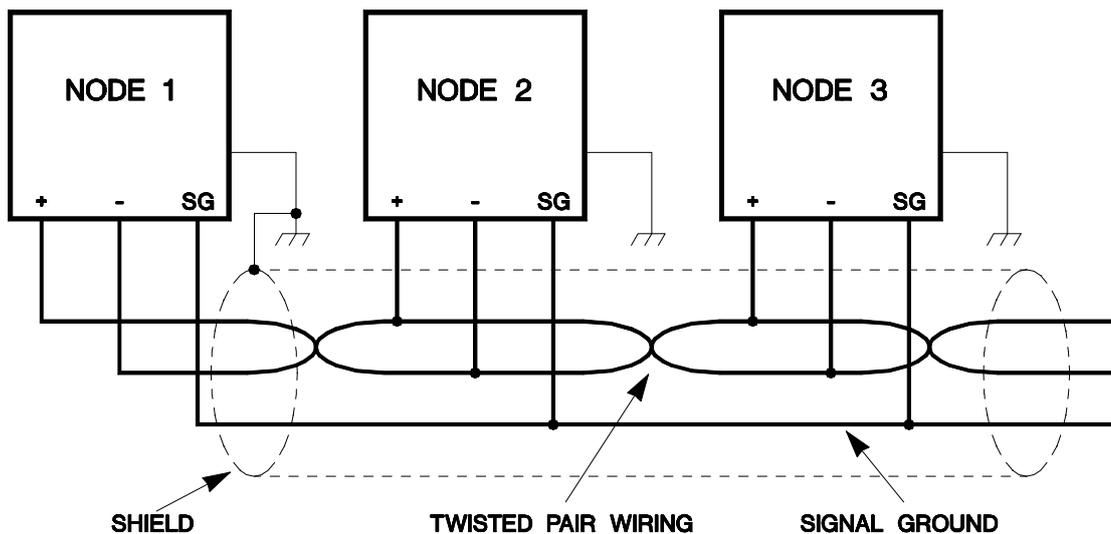
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Figure 2-7. 723PLUS RS-422 connections with Optional Termination at Transmitter

Grounding and Shielding

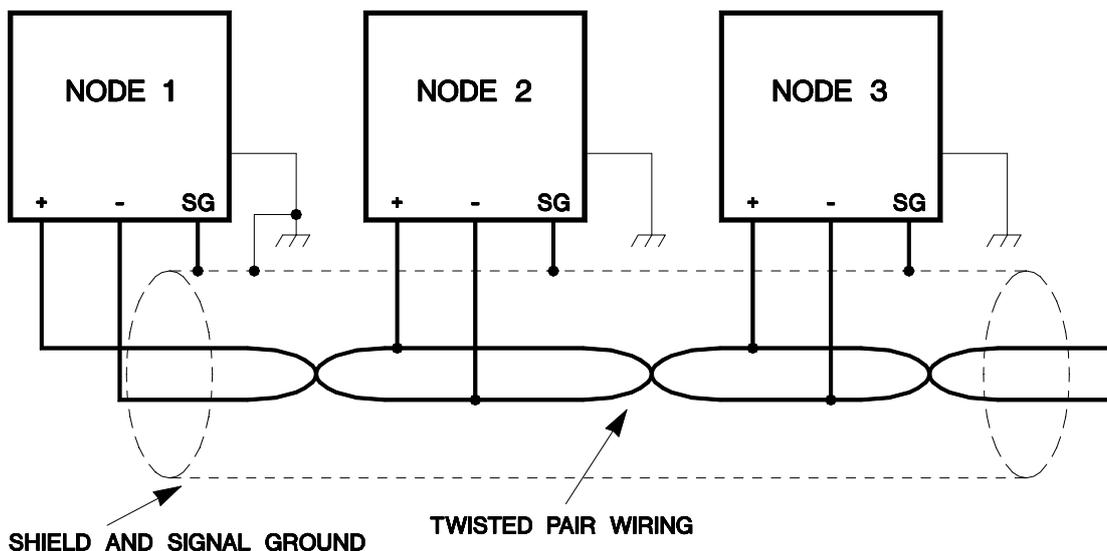
The RS-422 and RS-485 specifications state that a ground wire is needed if there is no other ground path between units. The preferred method to do this is to include a separate wire in the cable that connects the circuit grounds together. Connect the shield to earth ground at one point only. The alternate 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 2-8 and 2-9 illustrate these cabling approaches.

IMPORTANT Non-isolated nodes may not have a signal ground available. If signal ground is not available, use the alternate wiring scheme in Figure 2-9 with the signal ground connection removed on those nodes only.



02752-24

Figure 2-8. Preferred multipoint wiring using shielded twisted-pair cable with separate signal ground wire.



02752-25

Figure 2-9. Alternate multipoint wiring using shielded twisted-pair cable without a separate signal ground wire

IMPORTANT The signal ground connection is not required if signal ground is unavailable.

723PLUS Wiring Notes

1. Shielded wires are twisted pairs, with shield ground at one end only. When mounting control to be bulkhead use the grounding stud to ensure proper grounding.
2. Shield must not be grounded at any point unless otherwise noted.
3. All shield must be carried continuously through all terminal block and must not tied to other shields except at the common ground point, the shields are tied together at ground stud on the 723PLUS chassis.
4. Remove jumpers for voltage inputs.
5. Discrete inputs are isolated from other circuits and intended to be powered from terminal 39 (24 Vdc) leaving the jumpers in place. Input current is normally 10 mA per input at 2210 Ω .
6. Relay contact rating for minimum 100000 operations:
Resistive – 2.0 A at 28 Vdc
Amp at 115 Vac, 50 to 400 Hz
Inductive – 0.75 A at 28 Vdc, 0.2 Henry.
7. Analogue output signals to other system must be isolated from ground either by design or by implementation of isolation amplifiers.
8. Internal power supply provides DC isolation between the power source and all other inputs and outputs.
9. Communication port J1 can be configured for the use of Hand Held programmer and Servlink.
10. Communication port J2 and J3 can be configured as RS-232, RS-422, or RS-485 serial interface. Port configuration can be done in application software only.

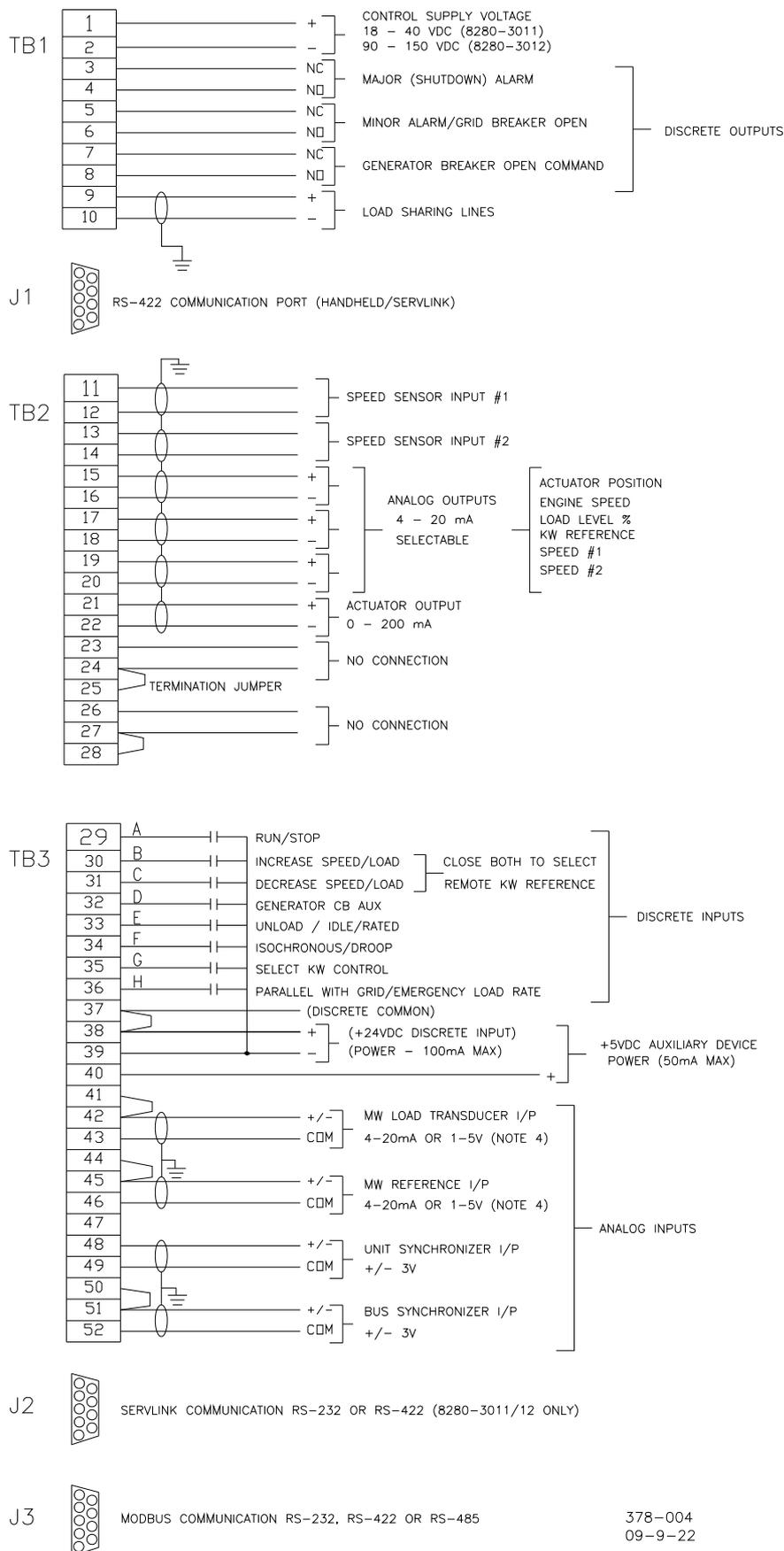


Figure 2-10. 723PLUS Wiring

Installation Checkout Procedure

With the installation complete, carry out the following checkout procedure before beginning setpoint 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.



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 3. 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 723PLUS 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.

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 Proppain 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 Alarm LED on the front panel of the 723PLUS 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 shut down by the 723PLUS 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 723PLUS 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* configurable is selected true), 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 either of the **Increase** or **Decrease** contacts (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 either of the **Increase** or **Decrease** contacts (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 analogue synchroniser (DSLCL or SPM-A), via the bipolar **System Synchroniser** Input. 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 **MW 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.

IMPORTANT

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 either the **Increase** or **Decrease** 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 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 **MW 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 MW Control mode will also be bumpless.

KW (MW) Control

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

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

If the *Select Int MW 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 MW reference will automatically ramp to the *Internal MW Ref* at the *Int MW 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.

If both the **Increase** and **Decrease** contacts are closed (and Remote Reference selected via the Modbus), the MW reference will ramp to the level determined by the **4–20 mA 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. <2 mA, >22 mA), the MW reference will lock in the last healthy value. The control will then respond to the **Increase/Decrease** contacts, once the remote MW 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 MW 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 4–20 mA **MW Transducer** input (i.e. <1 mA, >22 mA) 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 MW 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 MW 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 Set -point #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 MW Control is preferred, either Direct MW Control or Compensated KW Control may be chosen.

Direct MW Control:

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

Compensated MW Control:

The control is effectively in Droop mode. A dead band controller compares the measured MW with the MW 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 MW 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)	0	0	X	0	X	X	X
Isoch/Droop (DI)	X	0	X/O	X	X/O	X/O	X/O
kW Control (DI)	X/O	X/O	0	X/O	X	X	X
kW Load (AI)	0	X/O	X/O	X	X	0	0
kW Reference (AI)	X/O	X/O	X/O	X/O	X/O	0	X/O

Limiters & Load Rejection

The LED on the front of the 723PLUS, 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 over fuelling 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 MW 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 MW 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.

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* (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.

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 MW Control

A single set of dynamics (*Proportional Gain, Integral Gain & S.D.R.*) for operation in MW 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 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 723PLUS 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 350 Hz, and the *Rundown Time* period has elapsed.

Putting the **Run/Stop** contact 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 **MW Transducer** input fails - below 1 mA, above 22 mA
- if the **MW Reference** input fails - below 2 mA, above 22 mA
- if the **LON** communications to the DSLC fail
- if remote MW 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 MW 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 MW Reference
- Unload
- Idle Speed Select
- Rated Speed Select
- Droop Mode
- Isochronous Mode
- MW Control Mode
- Emergency Load Rate
- Reset
- Remote MW 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.

Analogue Outputs

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

- Actuator Position (0–100%)
- Engine Speed (rpm - 4 mA & 20 mA setpoints configurable)
- Engine Load (0–100%)
- KW Reference (kW - 4 mA & 20 mA setpoints configurable)
- Speed Input #1 (rpm - 4 mA & 20 mA setpoints configurable)
- Speed Input #2 (rpm - 4 mA & 20 mA 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 723PLUS Generator Control:

- Bus Synchroniser Input
- 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.
- MW Control configurable as Direct (default) or Deadband - Configured using Operator Interface, all P/N's.
- Ability to select DSLC as load controller instead of 723PLUS - 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.
- 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 and closed to Stop, instead of the default, close to Run, open to Stop.
- Woodward Servlink Server.

Operator Interface

The parameters within the control may be configured and monitored using either a Hand Held Programmer, or using the Servlink Server.

Configure Values List

Configure Prompt	Default Value	Range	Final Value
SPEED SENSORS			
PULSE/REV #1	155	60 TO 360	_____
MAXIMUM HZ #1	2500	500 TO 10000	_____
PULSE/REV #2	155	60 TO 360	_____
MAXIMUM HZ #2	2500	500 TO 10000	_____
ENGINE SPEED			
IDLE SPEED (rpm)	400.000	0.00 TO 2000.00	_____
RATED SPEED (rpm)	750.000	0.00 TO 2000.00	_____
OVERSPEED TRIP (rpm)	860.000	0.00 TO 2500.00	_____
TORSIONAL FILTER?	FALSE	TRUE TO FALSE	_____
MW CONTROL			
REMOTE REF @ 4mA (MW)	0.000	0.00 TO 60.00	_____
REMOTE REF 20mA (MW)	8.00	0.00 TO 60.00	_____
SELECT INT kW REF	FALSE	TRUE TO FALSE	_____
FINAL DRIVER			
REVERSE ACTING?	FALSE	TRUE TO FALSE	_____
ACTUATOR mA @ 0%	10.000	0.00 TO 200.00	_____
ACTUATOR mA @ 100%	180.000	20.00 TO 200.00	_____
ENABLE ACTUATOR HIT	FALSE	TRUE TO FALSE	_____
STROKE ACTUATOR	FALSE	TRUE TO FALSE	_____
ENGINE LOAD			
RATED LOAD (MW)	6.52	0.00 TO 60.0	_____
MW @ 4mA	0.000	-60 TO +60	_____
MW @ 20mA	8.00	0 TO 60	_____
MODBUS PORT SETUP			
MODE	2	1 TO 2	_____
SLAVE ADDRESS	1	1 TO 247	_____
CONFIGURE			
ENABLE SETPOINTS	TRUE	TRUE TO FALSE	_____
ENABLE CALIBRATION	FALSE	TRUE TO FALSE	_____

CONF MODBUS I/P'S			
START/STOP	FALSE	TRUE TO FALSE	_____
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	FALSE	TRUE TO FALSE	_____
DO#1 NC?	FALSE	TRUE TO FALSE	_____

Service Values List

Service Prompt	Default Range	Range	Final Value
DISPLAY MENU			
ENGINE SPEED (rpm)	(Monitor)		
SPEED REFERENCE (rpm)	(Monitor)		
MW 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)		
ISOCHRONOUS MODE	(Monitor)		
% LOAD	(Monitor)		
LS LINES %	(Monitor)		
LOAD SHARE ERROR	(Monitor)		
KW CONTROL MODE	(Monitor)		
LOAD REFERENCE (MW)	(Monitor)		
REMOTE REF SELECTED	(Monitor)		
REMOTE REFERENCE (MW)	(Monitor)		
MW LIMIT			
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	_____
S.D.R. #1	10.00	0.01 TO 100.00	_____
DYN SELECT DELAY (s)	2.500	0.00 TO 10.00	_____
ENABLE DERIV DYN	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	_____
S.D.R. #2	14.550	0.01 TO 100.00	_____
PROPGAIN MULTIPLIER	1.000	0.01 TO 10.00	_____

KW DYNAMICS

PROPORTIONAL GAIN	0.010	0.01 TO 10.00	_____
INTEGRAL GAIN (1/s)	1.300	0.01 TO 5.00	_____

S.D.R.

S.D.R.	20.00	0.01 TO 100.00	_____
USE LOWER PROP BAND	FALSE	TRUE TO FALSE	_____

GAIN SLOPE

LOAD BKPT #1 (%)	0.000	0.00 TO 110.00	_____
MULTIPLIER #1	1.000	0.01 TO 10.00	_____
LOAD BKPT #2 (%)	100.00	00.0 TO 110.00	_____
MULTIPLIER #2	1.000	0.01 TO 10.00	_____

GAIN RATIO

ERROR WINDOW #1 (rpm)	100.00	0.00 TO 100.00	_____
GAIN RATIO #1	1.00	0.00 TO 10.00	_____
ERROR WINDOW #2 (rpm)	10.00	0.00 TO 100.00	_____
GAIN RATIO #2	2.00	0.00 TO 10.00	_____

DERIV DYNAMICS

P DERIV BKPT #1 (rpm/s)	50.00	0.01 TO 500.00	_____
P MULTIPLIER #1	1.000	0.01 TO 10.00	_____
P DERIV BKPT #2 (rpm/s)	500.00	0.01 TO 500.00	_____
P MULTIPLIER #2	2.000	0.01 TO 10.00	_____
I DERIV BKPT #1 (rpm/s)	50.00	0.01 TO 500.00	_____
I MULTIPLIER #1	1.000	0.01 TO 10.00	_____
I DERIV BKPT #2 (rpm/s)	500.00	0.01 TO 500.00	_____
I MULTIPLIER #2	1.000	0.01 TO 10.00	_____
D DERIV BKPT #1 (rpm/s)	50.00	0.01 TO 500.00	_____
D MULTIPLIER #1	1.000	0.01 TO 10.00	_____
D DERIV BKPT #2 (rpm/s)	500.00	0.01 TO 500.00	_____
D MULTIPLIER #2	1.000	0.01 TO 10.00	_____

ENGINE SPEED

SPEED FILTER (Hz)	10.00	0.01 TO 16.00	_____
FILTER FREQUENCY (Hz)	16.00	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)	150.00	0.00 TO 2500.00	_____
TWO SPEED SENSORS?	TRUE	TRUE TO FALSE	_____
DIS NOTCH FILTER	FALSE	TRUE TO FALSE	_____

SPEED REFERENCE

MINIMUM SPEED (rpm)	700.0	0.00 TO 2000.0	_____
MAXIMUM SPEED (rpm)	800.0	0.00 TO 2000.0	_____
ACCEL/DECEL RATE (rpm)	10.00	0.00 TO 2000.0	_____
IDLE/RATED SWITCH (rpm)	400.0	0.00 TO 2500.0	_____
INC/DEC RATE #1 (rpm/s)	1.00	0.00 TO 2000.0	_____
INC/DEC RATE #2 (rpm/s)	1.00	0.00 TO 2000.0	_____

START/STOP

RUNDOWN TIME (s)	0.00	0.00 TO 300.00	_____
PULSE/CONT ALARM?	FALSE	TRUE TO FALSE	_____
ALARM PULSE TIME (s)	1.00	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)	4.00	0.00 TO 20.00	_____
SYNC OK DLY TIME (s)	2.00	0.00 TO 30.00	_____
UNIT SYNC GAIN	2.00	0.00 TO 100.00	_____
REF BIAS PULSE (rpm)	0.00	0.00 TO 10.00	_____
SYS SYNC GAIN	2.00	0.00 TO 100.00	_____
DISABLE UNIT SYNCH	FALSE	TRUE TO FALSE	_____
DISABLE SYS SYNCH	FALSE	TRUE TO FALSE	_____
SYNC FILTER	10.00	0.01 TO 16.00	_____

LOAD SHARING

LS ERROR %	4.00	1.00 TO 100.00	_____
LOAD GAIN	5.00	0.01 TO 100.00	_____
AUTO LOAD RATE (KW/s)	50.00	0.00 TO 20000.0	_____
EMGNCY LOAD RATE (KW/s)	50.00	0.00 TO 20000.0	_____
AUTO UNLOAD RATE (KW/s)	5.00	0.00 TO 20000.0	_____
EMGNCY UNLD RATE (KW/s)	50.00	0.00 TO 20000.0	_____
RE-LOAD TO ISOC?	FALSE	TRUE TO FALSE	_____

MW CONTROL

AUTO LOAD RATE (KW/s)	30.00	0.00 TO 30000.0	_____
AUTO UNLOAD RATE (KW/s)	50.00	0.00 TO 30000.0	_____
RAISE LOAD RATE (KW/s)	30.00	0.00 TO 30000.0	_____
LOWER LOAD RATE (KW/s)	30.00	0.00 TO 30000.0	_____
ENABLE INSTANT RATE	FALSE	TRUE TO FALSE	_____
INSTNT RATE WINDOW (KW)	3000.00	0.00 TO 30000.0	_____
OVRD REMOTE IP FAIL	FALSE	TRUE TO FALSE	_____
DEDBND WINDOW (KW)	50.00	0.00 TO 1000.00	_____
D/B CTRL RAMP RATE (KW/s)	50.00	0.10 TO 5000.00	_____
INTRNL MW REF RATE (KW)	1000	0.00 TO 30000.0	_____
INTRNL MW REF	3	0.00 TO 110.00	_____

ENGINE LOAD

DROOP (%)	5.00	0.00 TO 15.00	_____
FULL LOAD ACT %	80.00	0.00 TO 100.00	_____
KW FILTER (Hz)	2.00	1.00 TO 10.00	_____
LOAD FILTER (Hz)	2.00	1.00 TO 10.00	_____
UNLOAD TRIP LEVEL (KW)	100.00	-1000.0 TO 30000.0	_____
OVRD LOAD I/P FAIL	FALSE	TRUE TO FALSE	_____

FREQUENCY LIMITER

BUS FRQ	60.00	45.00 TO 65.00	_____
KW LMTER HZ #1	00.0	0.00 TO 60.0	_____
KW LMTER HZ #2	10.00	10.00 TO 60.0	_____
MAX LOAD (1) (MW)	10.00	0.00 TO 50.00	_____
KW LMTER HZ #3	90.00	0.00 TO 100.0	_____
MAX LOAD (2) (MW)	10.00	0.00 TO 50.00	_____
KW LMTER HZ #4	100.00	50.00 TO 100.00	_____
FRQ ERROR SP#1 (HZ)	5.00	0.00 TO 10.00	_____
FRQ ERROR SP#2 (HZ)	5.00	0.00 TO 10.00	_____
TRIP DLY (s)	0.100	0.00 TO 3.00	_____

FUEL LIMITERS

START FUEL LMT X1 (rpm)	0.00	0.00 TO 2000.00	_____
START FUEL LMT Y1 (%)	80.00	0.00 TO 100.00	_____
START FUEL LMT X2 (rpm)	100.00	0.00 TO 2000.00	_____
START FUEL LMT Y2 (%)	80.00	0.00 TO 100.00	_____
START FUEL LMT X3 (rpm)	100.00	0.00 TO 2000.00	_____
START FUEL LMT Y3 (%)	50.00	0.00 TO 100.00	_____
START FUEL LMT X4 (rpm)	750.00	0.00 TO 2000.00	_____
START FUEL LMT Y4 (%)	50.00	0.00 TO 100.00	_____
MAX FUEL LMT (%)	100.0	0.00 TO 100.0	_____

FINAL DRIVER

HIT ACTUATOR	FALSE	TRUE TO FALSE	_____
ACTUATOR HIT PULSE	0.100	0.00 TO 2.00	_____
ACTUATOR HIT VALUE	0.00	0.00 TO 100.00	_____
STROKE ACTUATOR (%)	0.00	0.00 TO 100.00	_____

GEN BRKR LOAD REJ

LOAD REJ LEVEL (%)	60.00	0.00 TO 100.00	_____
LOAD LEVEL 1 (%)	0.00	0.00 TO 100.00	_____
REJECTION PERIOD1 (s)	0.00	0.00 TO 5.000	_____
LOAD LEVEL 2 (%)	100.00	0.00 TO 100.00	_____
REJECTION PERIOD2 (s)	0.50	0.00 TO 5.000	_____

GRD BRKR LOAD REJ

LOAD REJ LEVEL (%)	60.00	0.00 TO 110.00	_____
LOAD LEVEL 1 (%)	0.00	0.00 TO 100.00	_____
REJECTION PERIOD1 (s)	0.00	0.00 TO 5.000	_____
LOAD LEVEL 2 (%)	100.00	0.00 TO 100.00	_____
REJECTION PERIOD2 (s)	0.50	0.00 TO 5.000	_____
ENABLE LOAD REJ	FALSE	TRUE TO FALSE	_____

CALIBRATION

REMOTE I/P OFFSET	0.00	-10.00 TO 10.00	_____
REMOTE I/P GAIN	1.00	0.00 TO 10.00	_____
LOAD I/P OFFSET	0.00	-10.00 TO 10.00	_____
LOAD I/P GAIN	1.00	0.00 TO 10.00	_____
LS LINE OFFSET	0	0 TO 32767	_____
LS LINE GAIN	21845	0 TO 32767	_____
LS LOAD OFFSET	2028	0 TO 32767	_____
LS LOAD GAIN	8083	0 TO 32767	_____
AN O/P#1 OFFSET	0.00	-1000.0 TO 100.0	_____
AN O/P#1 GAIN	1.00	0.5 TO 1.5	_____
AN O/P#2 OFFSET	0.00	-1000.0 TO 100.0	_____
AN O/P#2 GAIN	1.00	0.5 TO 1.5	_____
AN O/P#3 OFFSET	0.00	-1000.0 TO 100.0	_____
AN O/P#3 GAIN	1.00	0.5 TO 1.5	_____
AN O/P CALIBRATION	4.00	0.00 TO 20.00	_____

MODBUS PORT SETUP

H/W CONFIGURE	1	1 TO 3	_____
BAUD RATE	6	1 TO 7	_____
STOP BITS	1	1 TO 3	_____
PARITY	1	1 TO 3	_____
TIME OUT	1.00	0.00 TO 10.00	_____
ENABLE MODBUS ALARMS	FALSE	TRUE TO FALSE	_____

SERVLINK SETUP			
H/W CONFIGURE	1	1 TO 2	_____
BAUD RATE	9	1 TO 12	_____
ANALOG O/P CONFIG			
ANALOG O/P #1	1	1 TO 7	_____
ANALOG O/P #2	1	1 TO 7	_____
ANALOG O/P #3	1	1 TO 7	_____
ENG SPD O/P @ 4mA	0.00	0.00 to 2000.0	_____
ENG SPD O/P @ 20mA	750.0	0.00 to 2000.0	_____
KW REF O/P @ 4mA	0.00	0.00 to 30000.0	_____
KW REF O/P @ 4mA	10000.0	0.00 to 30000.0	_____
SPEED 1 O/P @ 4mA	0.00	0.00 to 2000.0	_____
SPEED 1 O/P @ 20mA	750.0	0.00 to 2000.0	_____
SPEED 2 O/P @ 4mA	0.00	0.00 to 2000.0	_____
SPEED 2 O/P @ 20mA	0.00	0.00 to 2000.0	_____
MAJOR ALARM			
OVERSPEED	(Monitor)		
BOTH SPD SENS 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)		

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 723PLUS. 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 are adhered to.

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

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

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

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

If $\mathbf{B} < \mathbf{A}$ then use \mathbf{B} as the *Maximum Hz*, provided that \mathbf{B} is greater than $1.1 \times \text{Overspeed Trip Frequency}$. If not, then contact Woodward for further assistance.

ENGINE SPEED

<i>Idle Speed (rpm)</i>	is provided for engine start-up or cool down. It is independent of the minimum speed setpoint and may be set to a lower value. <i>Idle Speed</i> is selected when the Rated/Idle contact is opened, if this function is enabled.
<i>Rated Speed (rpm)</i>	is the nominal engine speed.
<i>Overspeed Trip (rpm)</i>	is the speed at which a shutdown is initiated, to prevent over-speed. Please see Engine Manufacturer's recommendation for the value of this parameter.
<i>Torsional Filter?</i>	will enable the torsional filter if selected true.

MW CONTROL

<i>Remote Ref @ 4mA, Remote Ref @ 20mA (MW)</i>	is the MW reference required at 4 mA and 20 mA by the remote reference input.
<i>Select Int kW Ref</i>	if selected true, will enable the use of an internal MW reference value (if the remote reference is not selected.)

FINAL DRIVER

<i>Reverse Acting?</i>	if selected true, will reverse the actuator output signal to 200–0 mA for 0–100%.
<i>Actuator mA @ 0%</i>	sets the mA output required to the actuator at 0% control (PID) output.
<i>Actuator mA @100%</i>	sets the mA output required to the actuator at 100% control (PID) output.
<i>Enable Actuator Hit</i>	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.
<i>Stroke Actuator</i>	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

<i>Rated Load (MW)</i>	is the rated generator load.
<i>MW @ 4mA, MW @ 20mA</i>	is the value of the MW transducer input at 4 mA & 20 mA.

MODBUS PORT SETUP

<i>Mode</i>	sets the communications protocol of the J3 port. 1=ASCII, 2=RTU.
<i>Slave Address</i>	sets the network address of the control. This will always be set to 1 for Point-to-Point communications.

CONFIGURE

<i>Enable Setpoints</i>	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.
<i>Enable Calibration</i>	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

<i>Grid Brkr Open Cmd?</i>	if selected true, digital output #2 will be configured as the Grid Breaker Open Command output, instead of the Minor Alarm.
<i>Emergency Rate I/P?</i>	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.
<i>KW Deadband Control</i>	if selected true, kW control will be as compensated droop via the speed reference (see description in system description text).
<i>Enable DSLC PM</i>	if selected true, disables the power management of the 723, and allows the 723PLUS 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.
<i>Enable I/R Select</i>	if selected true, allows the Unload contact input to be utilised as an Idle/Rated contact whilst the CB Aux input is open.

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>MW Load</i>	is the generator load in MW.
<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 350 Hz.
<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 MW Control mode.
<i>Load Reference (MW)</i>	is the MW reference value.
<i>Remote Ref Selected</i>	indicates that the remote MW reference has been selected.

<i>Remote Reference (MW)</i>	is the MW reference demanded by the remote reference input.
<i>MW Limit</i>	is the MW limit as determined by the frequency limiter curve.

SPD DYNAMICS #1

<i>Proportional Gain #1</i>	PID proportional gain adjustment for the dynamics gain. 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 kW recovery rate after a transient. 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>S.D.R. #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

<i>Proportional Gain #2</i>	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.
<i>Integral Gain #2 (1/s)</i>	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.

S.D.R. #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.

Proppgain 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. $\text{Gain Value} = \text{Proppgain Multiplier} * \text{Proportional}$

KW DYNAMICS

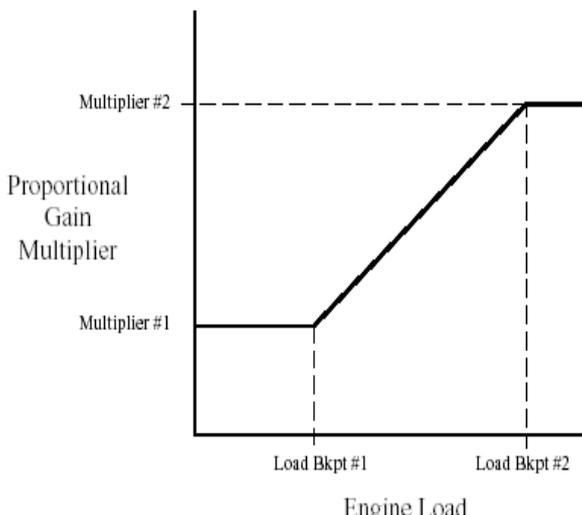
(For MW control) Proportional Gain PID proportional gain adjustment for the dynamics gain, when in MW control mode. Increasing the P term increases the gain, a value for P that is too large will cause oscillation, if P is too small the offset from a transient will be too large.

Integral Gain (1/s) PID integrator rate adjustment for the dynamics, affects recovery rate after a transient, when in MW 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 over damped response. If I is too large, the actuator current will move too fast and speed will overshoot and response will be under damped.

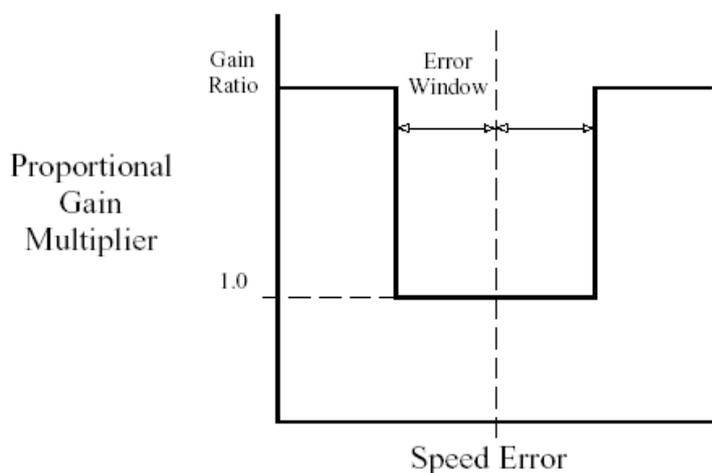
S.D.R. PID derivative ratio adjustment for the dynamics when in MW Control mode. Set the amount of derivative (or lead) action the control will have. Increasing the derivative ratio value above 1 will decrease the derivative function giving the control a PI type action. A value too large will make the 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.

Use Lower Prop. Band If selected true proportional value of kW dynamics is divided by 10 internally.

GAIN SLOPE



<i>Load Bkpt #1 (%)</i>	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'.
<i>Multiplier #1</i>	This is the multiplier, associated with 'Load Bkpt #1', for the calculation of the gain multiplier.
<i>Load Bkpt #2 (%)</i>	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'.
<i>Multiplier #2</i>	This is the multiplier, associated with 'Load Bkpt #2', for the calculation of the gain multiplier.

GAIN RATIO

<i>Error Window #1 (rpm)</i>	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.
<i>Gain Ratio #1</i>	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.

<i>Error Window #2</i> (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 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.
<i>Gain Ratio #2</i>	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.

DERIV DYNAMICS

<i>P Deriv Bkpt #1</i> (rpm/s)	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)
<i>P Multiplier #1</i>	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).
<i>P Deriv Bkpt #2</i> (rpm/s)	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)
<i>P Multiplier #2</i>	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).
<i>I Deriv Bkpt #1</i> (rpm/s)	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)
<i>I Multiplier #1</i>	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).
<i>I Deriv Bkpt #2</i> (rpm/s)	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)
<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</i> (rpm/s)	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 15.9 Hz, 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 Alarm LED on the front of the 723PLUS 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.
<i>Dis Notch Filter</i>	if selected true will disable the Notch Filter.

SPEED REFERENCE

<i>Minimum Speed (rpm)</i>	is the lowest rpm value to which the speed reference may be driven by closing the Decrease Speed/Load contact input.
<i>Maximum Speed (rpm)</i>	is the maximum value to which the speed reference may be driven by closing the Increase Speed/Load contact input.
<i>Accel/Decel Rate (rpm/s)</i>	is the rate at which the speed reference ramps from <i>Idle Speed</i> to <i>Rated Speed</i> , and from <i>Rated Speed</i> to <i>Idle Speed</i> .

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 350 Hz, 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

Rdy To Sync Limits (rpm) is the synchronising speed window that the engine speed must be within.

Sync OK Dly Time (s) is the time duration that the engine must be running within the synchronising speed window before the ready to synchronise command is given.

Unit Synch Gain Adjustment of this value will increase or decrease the effect of the analogue unit synchroniser input to the speed reference.

Ref Bias Pulse (rpm) 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.

Sys Synch Gain Adjustment of this value will increase or decrease the effect of the analogue bus tie synchroniser input to the speed reference.

Disable Unit Synch Select true if not using a Woodward Analogue synchroniser for synchronisation between the generator and the bus.

Disable Sys Synch Select true if not using a Woodward Analogue synchroniser for bus synchronisation.

Sync Filter (Hz) is for filtering the unit synchroniser input to the control.

LOAD SHARING

LS Error % 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.

Load Gain sets the sensitivity to the load share error.

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

Emergency Load Rate (kW/s) is the rate at which load is increased when soft loading into isochronous load sharing, with the Emergency Loading Rate contact closed.

Auto Unload Rate (kW/s) 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.

Emergency 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.

MW 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 useful 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.

<i>Ovrđ Remote I/P Fail</i>	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.
<i>Deadband Window (kW)</i>	If the kW error is within this window, and Deadband KW Control is enabled; no action will be taken to correct the error.
<i>D/B Ctrl Ramp Rate (kW/s)</i>	If Deadband KW Control is enabled, this is the rate at which the speed reference is increased/decreased to control the MW level.
<i>Int MW Ref Rate (kW/s)</i>	If the internal MW reference is selected, this is the rate at which the reference is ramped to the ' <i>Internal MW Ref</i> ' level.
<i>Internal MW Ref (%)</i>	This is the level to which the MW reference will ramp, when the control is switched into MW Control mode, and the remote reference is not selected, if the option has been selected in Configure.

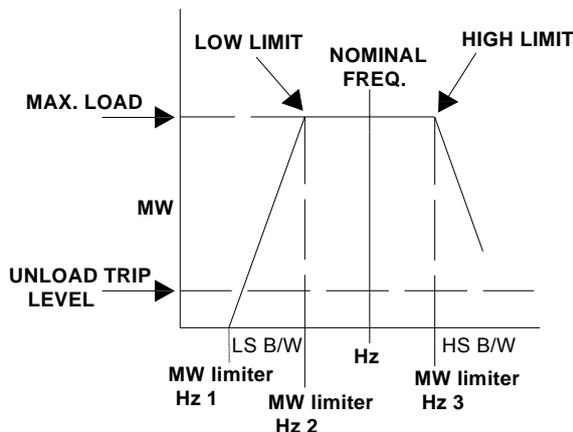
ENGINE LOAD

<i>Droop (%)</i>	is the % of rated speed by which the speed reference is drooped at zero to full load.
<i>Full Load Act %</i>	is the actuator % output at full load.
<i>KW Filter (Hz)</i>	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 MW transducer.
<i>Load Filter (Hz)</i>	is the filter value. This value should not need to be adjusted, but can be used to filter the internally derived position feedback.
<i>Unload Trip Level (kW)</i>	When the control is in isochronous load sharing or MW control mode, and the Unload command is given, the load will be decreased to this level before the generator breaker open command is issued.
<i>Ovrđ Load I/P Fail</i>	if selected true, will override the failed signal detection of the MW 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

<i>Bus Frequency (Hz)</i>	selects the frequency of the bus, normally set at 50 or 60 Hz.
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KW Lmt These tuneable set-ups the curve for the frequency limiter. See diagram below:
Hz #1, #2, #3 & #4, Maximum Load 1 & 2 (MW).



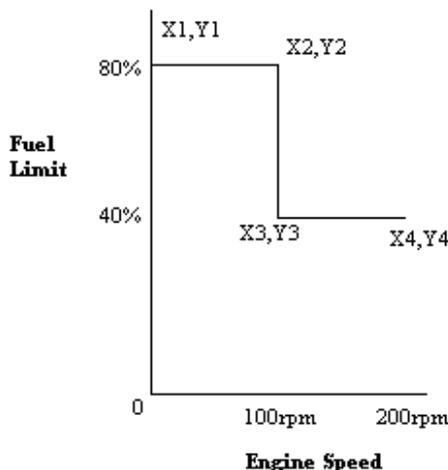
Freq Error SP#1 is the frequency error (difference between actual bus frequency and normal bus frequency) above which the Grid Breaker Open command is issued.

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 over fuelling. 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.

FINAL DRIVER

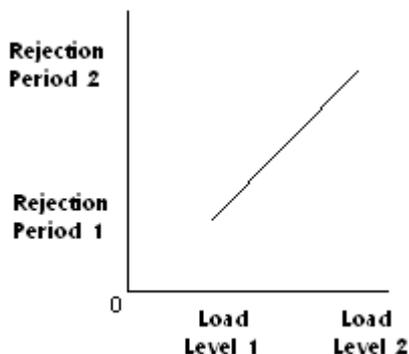
Hit Actuator, Actuator Hit Pulse (s), Actuator Hit Value (%) If the Actuator Hit has been enabled, when the *Hit Actuator* parameter is tuned TRUE, the *Actuator Hit Value* will be subtracted from the % actuator output, for a period of time (*Actuator Hit Pulse*). This function is available for the purpose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

Stroke Actuator (%) If the configurable *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 Rejection Period*, as determined by the curve set-up below.

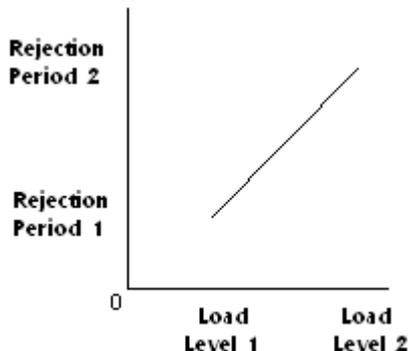
Load Level 1..2 (%), Rejection Period 1..2 (s)



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

<i>Remote I/P Offset</i>	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 20 mA. Ensure that the control 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>	If it is necessary to calibrate the MW transducer 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 20 mA. Ensure that the control is measuring 20. If not, adjust the gain until it does. Return them A input to zero, and check that the control is still measuring zero. If not, repeat the calibration process.
<i>Load I/P Gain</i>	If it is necessary to calibrate the MW transducer input, adjustment of this parameter will alter the gain.
<i>LS Lines Offset</i>	If it is necessary to calibrate Load Share Lines input, adjustment of this parameter will alter the offset. To calibrate the load sharing lines, contact Woodward for further information.
<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>	If it is necessary to calibrate load output to the load sharing lines, adjustment of this parameter will alter the offset. To calibrate the load output to the load sharing lines, contact Woodward for further information.
<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>	If it is necessary to calibrate the 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 20 mA. 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>Air I/P Gain</i>	If it is necessary to calibrate the input, adjustment of this parameter will alter the gain.
<i>An O/P #1 Offset</i>	This parameter is the offset term, for calibration of analogue output #1 (terminals 15 & 16). If it is necessary to calibrate the output, set the parameter '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.
<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>	This parameter is the offset term, for calibration of analogue output #2 (terminals 17 & 18). 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.
<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>	This parameter is the offset term, for calibration of analogue output #3 (terminals 19 & 20). 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.
<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

<i>Hardware Config</i>	sets the communications hardware configuration, 1=RS-232, 2=RS-422, 3=RS-485
<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 19200. 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

<i>Hardware Config</i>	sets the communications hardware configuration, 1=RS-232, 2=RS-422, 3=RS-485
<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.

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.

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 These are for scaling the parameters output via the analogue 4–20 mA 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 Set - point*.

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 1 mA, above 22 mA.

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

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

Modbus Comms if true, a communications failure has occurred with Modbus.

KW Limiting if true, the MW reference is being limited by the frequency limiter curve.

Rem Sel Wire Break if true, following the selection of remote MW 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.

NOTICE

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	DSL 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	

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	
3:0020	
3:0021	
3:0022	

Analogue Writes

<u>Address</u>	<u>Description</u>
4:0001	Remote KW Reference (kW)

Chapter 4.

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. Woodward have 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 723PLUS, 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 10 ms, 20 ms, 40 ms, and 80 ms. 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 make 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 4-1. Process/Logic Program Blocks

Chapter 5. Modbus Communication

Introduction

The 723PLUS Digital Control utilises Schneider Automation'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 5-1). The 723PLUS DCS uses either the ASCII or the RTU transmission mode.

CODING SYSTEM	ASCII	RTU
	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)

Table 5-1. 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 723PLUS. 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 meters (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 723PLUS 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 723PLUS will communicate as a slave with a Modbus Master device utilising a separate link to each device. However, if multi dropping is used, one or two 723PLUS's can be connected to one Master device on a single link.

The data is passed between the Master and the 723PLUS in the form of message frames (see Table 5-2). On any single multi drop 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

Table 5-2. Modbus Frame Definition

The function code portion of the message frame tells the addressed slave what function to perform. Table 5-3 and Figure 5-1 define and list the function codes supported by the 723PLUS.

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	Loop back test - returns the query (Sub function 0 only)	
15	Write digital outputs	0XXXX
16	Write analogue outputs	4XXXX

Table 5-3. Modbus Function Codes

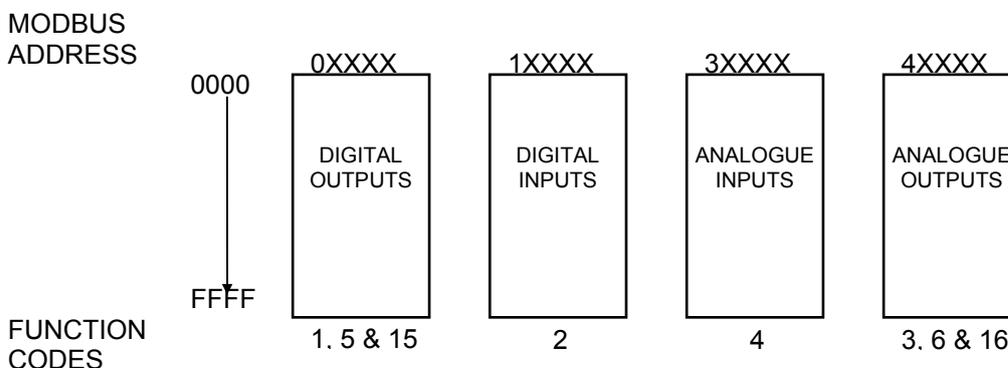


Figure 5-1. Modbus Function Codes

Table 5-6 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 (Tables 5-4 & 5-5) list the exception errors displayed by the 723PLUS 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

Table 5-4. 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

Table 5-5. Modbus Master Exception Error Codes

Function Code	Message Type							
1,2,3,4	Query	<table border="1"> <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 border="1"> <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 border="1"> <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 border="1"> <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 border="1"> <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 border="1"> <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					

Table 5-6. Modbus Messages

The pertinent serial port 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, 1.5

Table 5-7. Communication Port Adjustments

The Modbus communication ports in the 723PLUS 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 discrete are a 1 bit binary, on or off value and the numeric's are 16 bit values. Registers are interpreted by the 723PLUS 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 723PLUS. 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 723PLUS 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 723PLUS. An example of a Boolean read value would be an alarm indication. The '1:' term in the address identifies an input coil. The 723PLUS 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 723PLUS. 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 723PLUS 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 723PLUS. An example of an analogue write value would be a kW load reference. The value of the holding registers is also stored in the control as numbers representing engineering units. The 723PLUS 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 6.

Setpoint Programming

Introduction

Due to the differences between installations, plus system and component tolerances, the 723PLUS 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).



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 723PLUS has two types of tuneable; the Service tuneable and the Configure tuneable. The Service tuneable allows tuning while the engine is running. The Configure tuneable 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 723PLUS control will contain a list of each tuneable parameter, with its 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 723PLUS control. The terminal connects to the RS-232 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, back lighted LCD display. The display permits you to look at two separate functions or menu items at the same time. Use the ⤴ "Up/Down Arrow" key to toggle between the two displayed items. The BKSP and SPACE keys will scroll through the display to show the remainder of a prompt if it is longer than the display screen's 19 characters.

The 723PLUS has two sets of menus; the Service menus and the Configure menus. The Service menus allow easy access and tuning while the engine is running. The Configure menus may 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 6-1):

◀ (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 setpoint value slowly.
(Turtle down)	Decreases the displayed setpoint value slowly.
(Rabbit up)	Increases the displayed setpoint value quickly (about 10 times faster than the turtle keys).
(Rabbit down)	Decreases the displayed setpoint 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 (setpoints).
◀ 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.

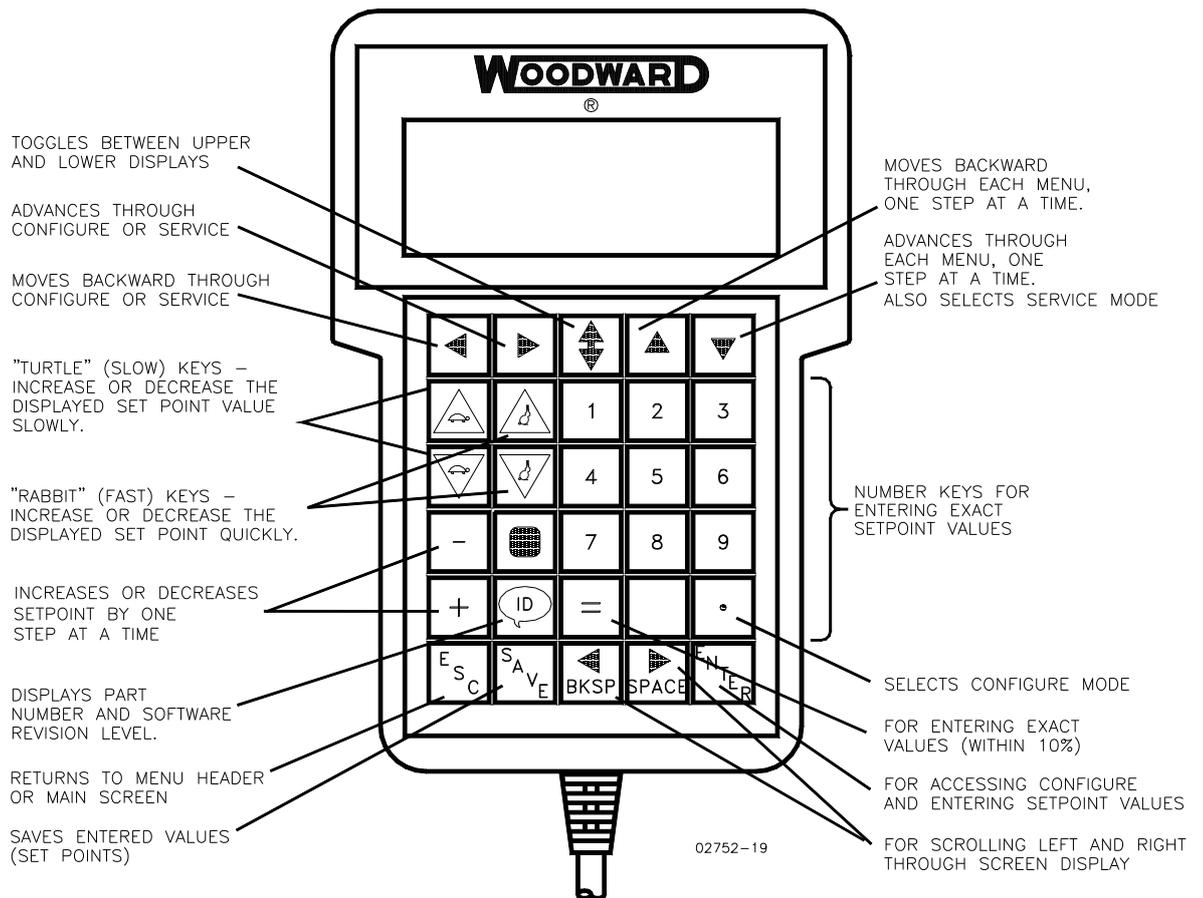


Figure 6-1. Hand Held Programmer Functions

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 setpoint, 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.

IMPORTANT

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 setpoint values into the EEPROM memory. The EEPROM retains all setpoints when power is removed from the control.

NOTICE

To prevent possible damage to the engine resulting from improper control settings, make sure you save the setpoints before removing power from the control. Failure to save the setpoints 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 723PLUS. The hardware communication link is configurable for RS-232 or RS-422 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 tuneable/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).

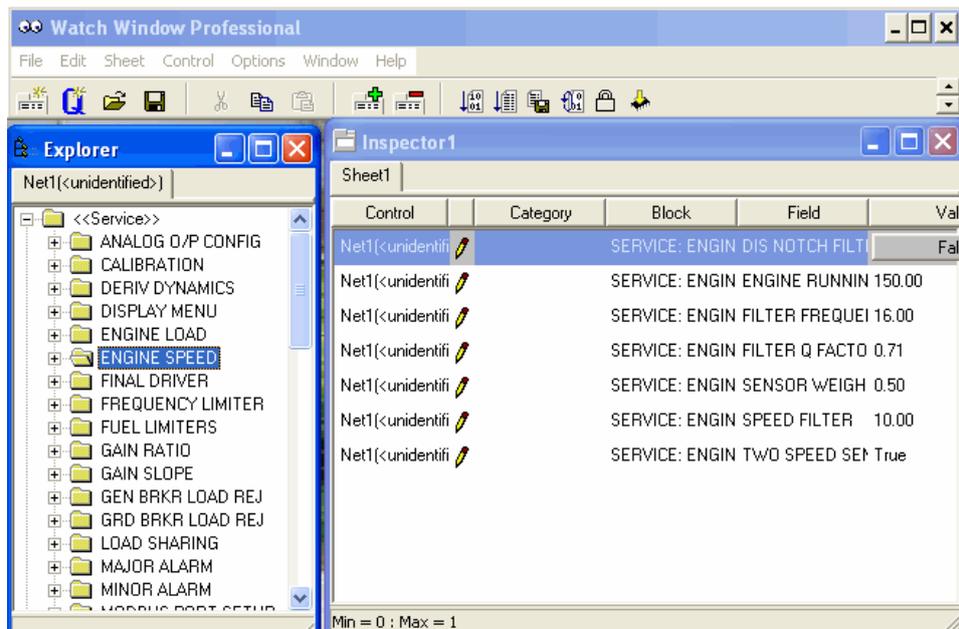
With each application manual, a list of each of the tuneable parameters will be provided along with a description of each. Also, a listing of each of the tuneable with the default values and the range of adjustment will be included.

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

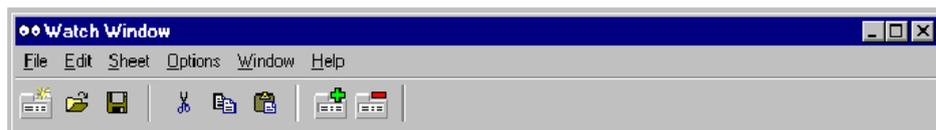
Watch Window

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. Watch Window is made up of three types of window; Main Window, Servlink Explorer and Servlink Inspector.

Here is an example of Watch Window:

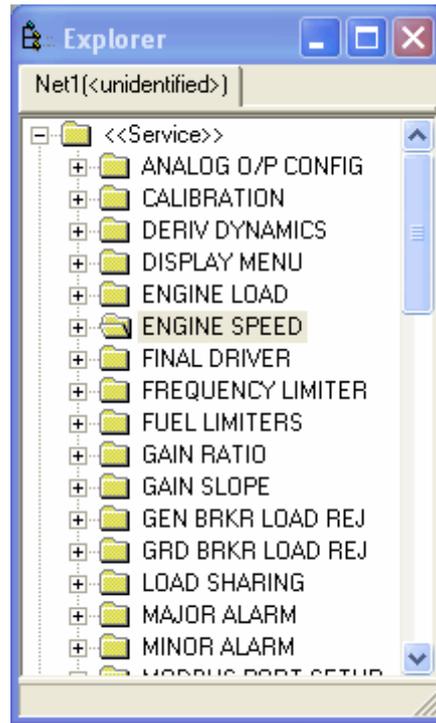


Main Window



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/renameing tabbed sheets to the application.

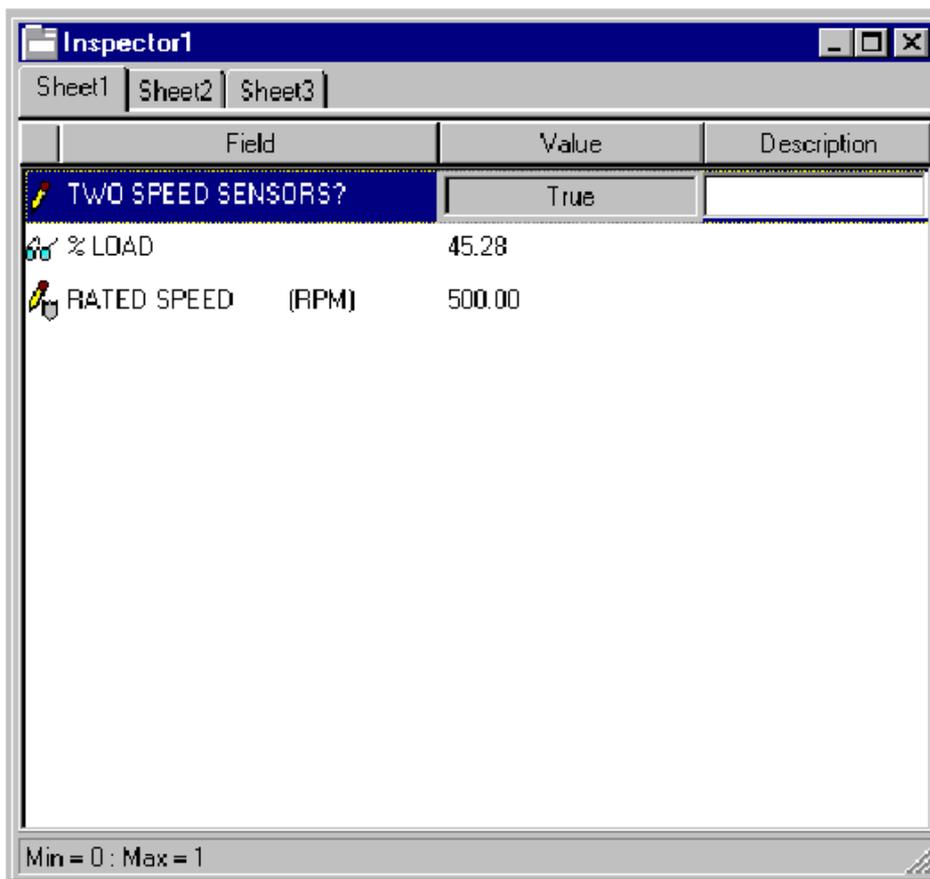
Servlink Explorer



The Explorer is used to browse the set of variables available through the Servlink Server. The Explorer is composed a set of tabbed sheet. Each sheet contains a tree view. The tree view displays the names of the categories & blocks in the control application program in a hierarchical structure.

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 block name. 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 7.

Product Support and Service Options

Product Support Options

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

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

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

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

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

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

Product Service Options

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

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

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

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

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

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

Returning Equipment for Repair

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

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

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

Packing a Control

Use the following materials when returning a complete control:

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

NOTICE

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

Replacement Parts

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

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

Engineering Services

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

- Technical Support
- Product Training
- Field Service

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

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

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

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

Contacting Woodward's Support Organization

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

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

Products Used In Electrical Power Systems		Products Used In Engine Systems		Products Used In Industrial Turbomachinery Systems	
<u>Facility</u>	<u>Phone Number</u>	<u>Facility</u>	<u>Phone Number</u>	<u>Facility</u>	<u>Phone Number</u>
Brazil	+55 (19) 3708 4800	Brazil	+55 (19) 3708 4800	Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727	China	+86 (512) 6762 6727	China	+86 (512) 6762 6727
Germany:		Germany	+49 (711) 78954-510	India	+91 (129) 4097100
Kempen	+49 (0) 21 52 14 51	India	+91 (129) 4097100	Japan	+81 (43) 213-2191
Stuttgart	+49 (711) 78954-510	Japan	+81 (43) 213-2191	Korea	+82 (51) 636-7080
India	+91 (129) 4097100	Korea	+82 (51) 636-7080	The Netherlands	+31 (23) 5661111
Japan	+81 (43) 213-2191	The Netherlands	+31 (23) 5661111	Poland	+48 12 295 13 00
Korea	+82 (51) 636-7080	United States	+1 (970) 482-5811	United States	+1 (970) 482-5811
Poland	+48 12 295 13 00				
United States	+1 (970) 482-5811				

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

Technical Assistance

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

General

Your Name _____
Site Location _____
Phone Number _____
Fax Number _____

Prime Mover Information

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

Control/Governor Information

Control/Governor #1

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

Control/Governor #2

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

Control/Governor #3

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

Symptoms

Description _____

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

723PLUS Control Specifications

Woodward Part Numbers	8280-3011 High Voltage Control 8280-3012 Low Voltage Control
Power Supply Rating	18-40 Vdc (24 or 32 Vdc nominal) 90-150 Vdc (125 Vdc nominal)
Power Consumption	40 W nominal
Steady State Speed Band	Magnetic pickup: 400—15 000 Hz Proximity switch: 30—15 000 Hz
Digital Inputs (8)	10 mA at 24 Vdc
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-232, 9-pin D connector, 19200 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 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

Declarations

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

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

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

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