



733 Digital Speed Control

8301-1288
Oil India

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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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

Introduction

This manual describes the basic functions of the Woodward 733 based speed control for Oil India, model 8301-1288.

Application

This system controls the speed of engines in variable speed applications.

The serial channels provide for various control interfaces, such as Woodward Watch Window and ToolKit.

Chapter 2. Installation

Introduction

This chapter contains general installation instructions for the system. 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 the Electrostatic Discharge Awareness on 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 control requires a voltage source of (18 to 32) V (dc).

Location Considerations

Consider these requirements when selecting the mounting location:

- Adequate ventilation for cooling
- Space for servicing and repair
- Protection from direct exposure to water or to a condensation-prone environment
- Protection from high-voltage or high-current devices, or devices which produce electromagnetic interference
- Selection of a location that will provide an operating temperature range of (–40 to +70) °C / (–40 to +158) °F

Installation Checkout Procedure

With the installation complete as described in this chapter, do the following checkout procedure before beginning set point entry or initial start-up adjustments.

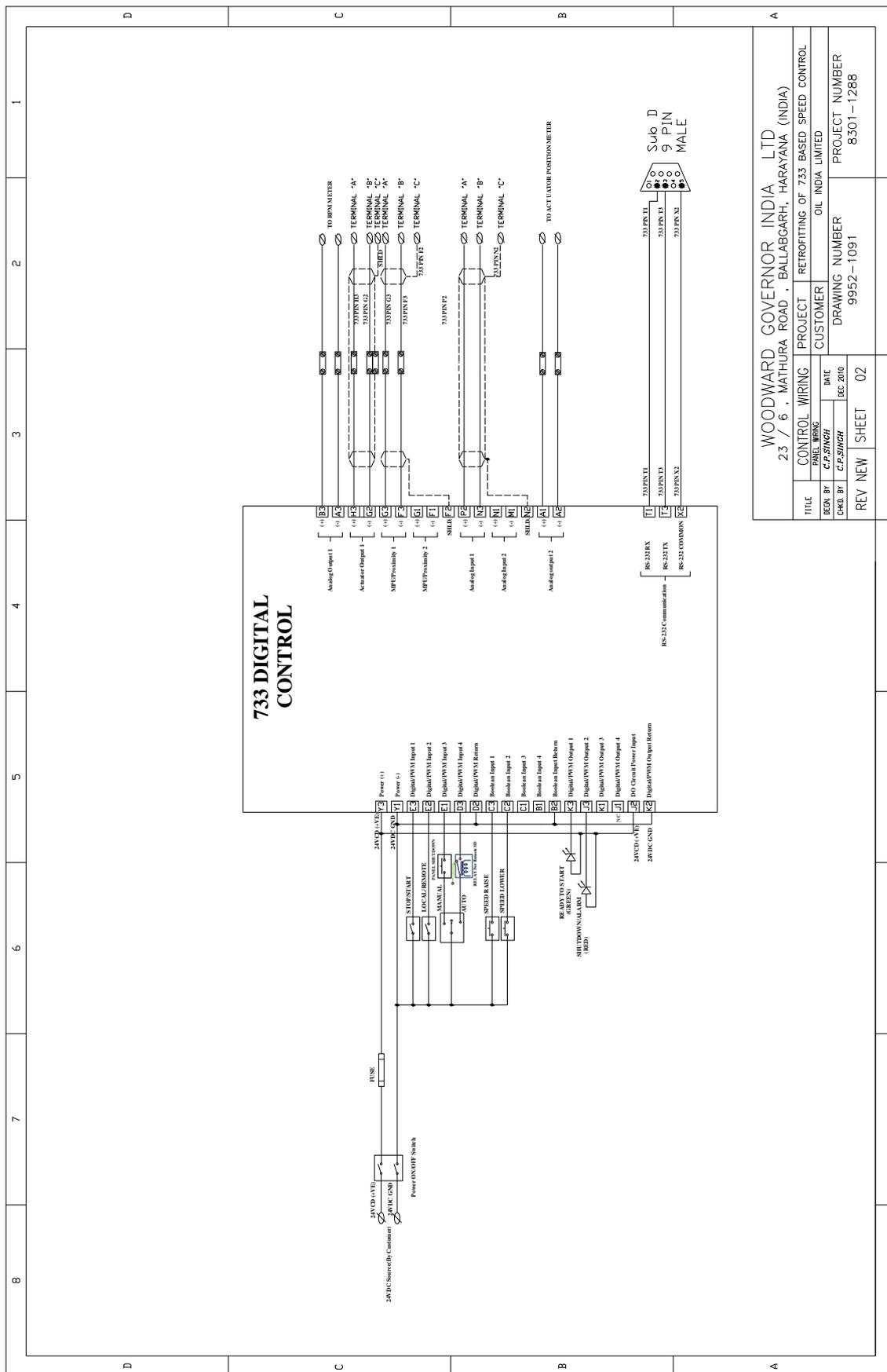
Visual Inspection

- Check the linkage between the actuator and fuel-metering device for looseness or binding.
- Check for correct wiring in accordance with the control wiring diagram, Figures 3-1 and 3-2.
- Check for broken terminals and loose terminal screws.
- 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 mm and 1.25 mm (0.010 inch and 0.050 inch) at the closest point. Make sure the gear run-out does not exceed the pickup gap.

Chapter 3.

System Wiring Diagram

This chapter provides the system wiring diagram.



TITLE		WOODWARD GOVERNOR INDIA LTD 23 / 6 . MATHURA ROAD . BALLABGARH, HARAYANA (INDIA)	
CONTROL WIRING	PROJECT	RETROFITTING OF 733 BASED SPEED CONTROL	
DESIGN BY	CUSTOMER	OIL INDIA LIMITED	
CHECK BY	DATE	DEC 2010	
REV NEW	SHEET	DRAWING NUMBER	PROJECT NUMBER
02	02	9952-1091	8301-1288

Figure 3-1. Control Wiring Diagram

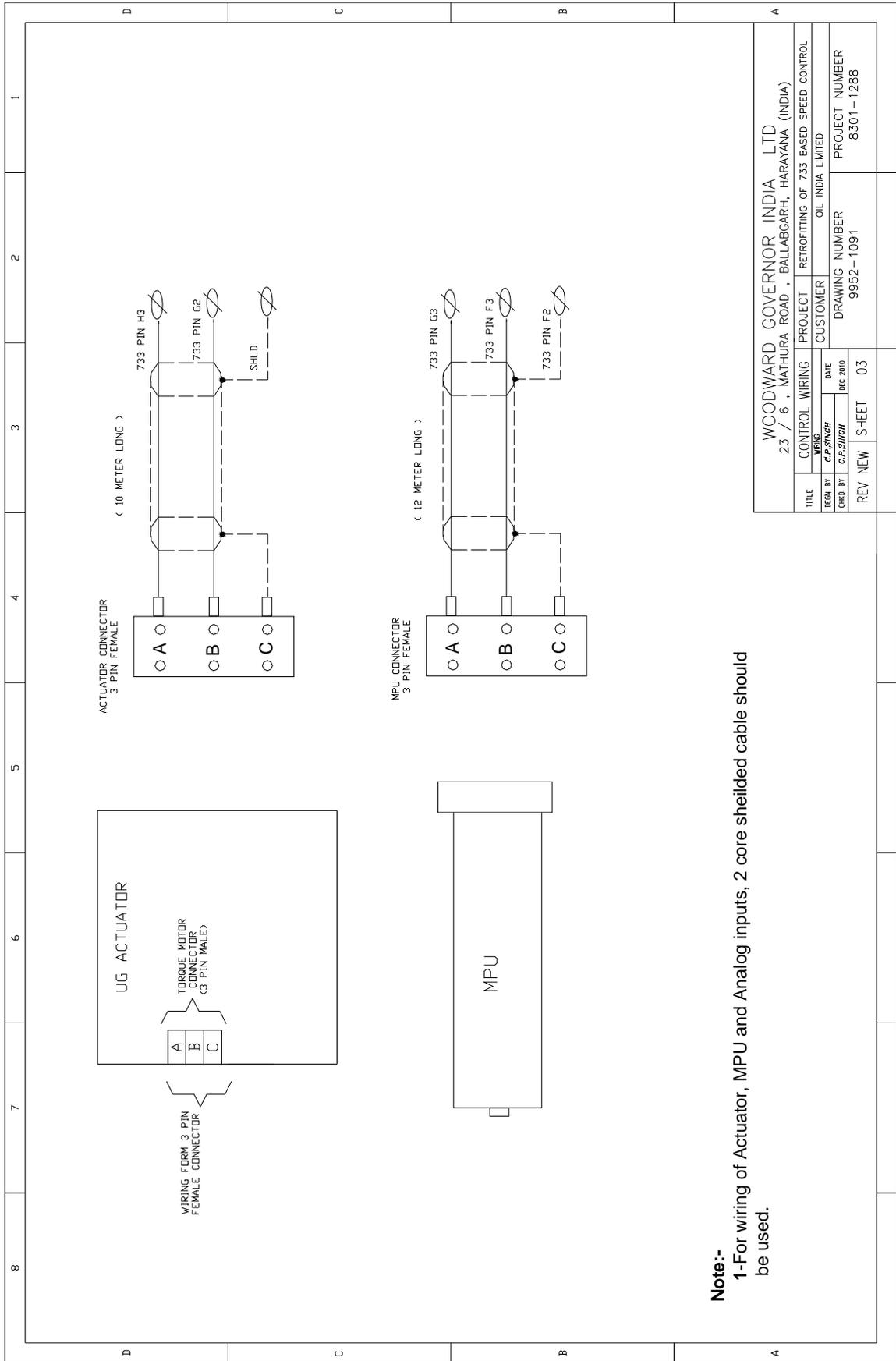


Figure 3-2. UG-Actuator Wiring & Interfacing Cables Detail

Chapter 4. System Hardware Description

Introduction

This chapter gives information about the type of components used in the system (8301-1288).

The Oil India system includes:

- A 733 Digital Control
- Servlink Watch Window for adjusting control parameters
- UG actuator to position the fuel metering
- Magnetic pickup for speed sensing
- Meters for speed and actuator position monitoring

733 Digital Control



The 733 control uses a GAP™ (Graphical Application Program) programmable processing core that provides all the necessary functions in a single CPU. The below listed specifications give some insight to the processor capability relative to other Woodward controls:

- Processor type: Motorola MPC565
- Clock frequency: 56 MHz
- Math support: Floating point CPU
- Real time clock built into CPU
- RTC accuracy: 1 minute / month
- Flash memory: 1 MByte
- RAM: 512 kBytes

Input/Output Arrangement

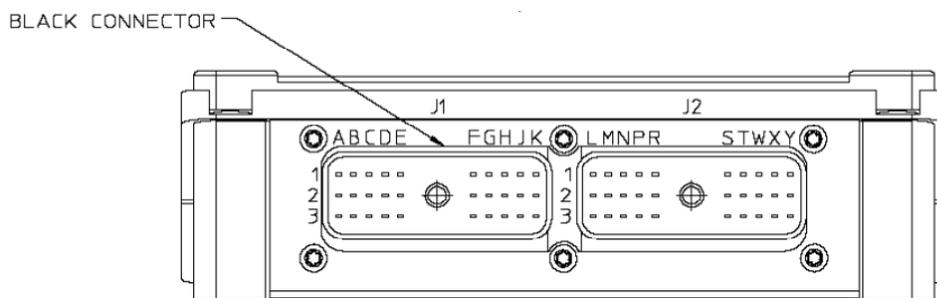
The standard I/O (input/output) for this product is:

Type of Input	# of Inputs	Options/Details
DC Power Input		
Power Input	1	18–32 Vdc, protected from reverse polarity
Analog Inputs		
Function Configurable Inputs	4	Current (4–20 mA)
MPU / Proximity Speed Sensor	2	10 –25000 Hz (general purpose use)
Analog Outputs		
Actuator Output	1	Current (either 4–20 mA or 20–160 mA)
Function Configurable outputs	3	Current (4–20 mA)
Discrete Inputs		
Configurable Switch, PWM, or Proxy inputs	4	Switch to return pins to activate
Configurable Switch or Contact inputs	4	Switch to return pins to activate
Discrete Outputs		
Configurable Relay Driver or PWM Outputs	4	Low side drivers
Communication Ports		
Serial Ports	2	(1)—RS-232, (1)—RS-485
CAN Ports	3	(1)—Isolated, (2)—On-Engine use

Temperature Specifications

The 733 control may be used in applications with an ambient temperature from –40 to +100 °C (–40 to +212 °F).

733 Wiring Pin Out



Speed Inputs

MPU/Proximity 1 (+)	G3	MPU/Proximity 2 (+)	G1
MPU/Proximity 1 (–)	F3	MPU/Proximity 2 (–)	F1
MPU/Proximity 1 shield	F2	MPU/Proximity 2 shield	F2

Digital Inputs

Digital / PWM Input 1	E3	Digital / PWM Input 3	E1
Digital / PWM Input 2	E2	Digital / PWM Input 4	D3
Digital / PWM Return	D2		
Boolean Input 1	C3	Boolean Input 2	C2
Boolean Input 3	C1	Boolean Input 4	B1
Boolean Input Return	B2		

Analog Outputs

Analog Output 1 (+)	B3	Analog Output 2 (+)	A1
Analog Output 1 (-)	A3	Analog Output 2 (-)	A2

Actuator Outputs

Actuator Output 1 (+)	H3	Actuator Output 2 (+)	H1
Actuator Output 1 (-)	G2	Actuator Output 2 (-)	H2

Power Outputs

Proximity Power (+)	D1
Proximity Power (-)	D2

Digital Outputs

Digital / PWM Output 1	K3	Digital / PWM Output 3	K1
Digital / PWM Output 2	J3	Digital / PWM Output 4	J1
DO Circuit Power Input	J2	Digital / PWM Output Return	K2

Analog Inputs

Analog Input 1 (+)	P2	Analog Input 3 (+)	L1
Analog Input 1 (-)	N3	Analog Input 3 (-)	M2
Analog Input 2 (+)	N1	Analog Input 4 (+)	M3
Analog Input 2 (-)	M1	Analog Input 4 (-)	L3
Analog Input 1&2 Shield	N2	Analog Input 3&4 Shield	L2

Power Input

Power (+)	Y3
Power (-)	Y1

CAN Communications

CAN 1 High	S1		
CAN 1 Low	S3		
CAN 1 Common	T2		
CAN 1 Shield	S2		
CAN 2 High	P3	CAN 3 High	P1
CAN 2 Low	R3	CAN 3 Low	R1
CAN 2&3 Shield	R2	CAN 2&3 Shield	R2

RS-485 Communications

RS-485 (+)	X3
RS-485 (-)	X1
RS-485 Common	Y2
RS-232/485 shield	W2
Termination Jumper (+)	W3
Termination Jumper (-)	W1

RS-232 Communications

RS-232 TX	T3
RS-232 RX	T1
RS-232 Common	X2
RS-232/485 Shield	W2

Analog Inputs

The function for Analog Input 1 AN1 is Remote Speed Set point. The remaining Analog Inputs are not used.

Actuator Outputs

The Actuator Output 1 is used to drive the UG Actuator (20–160 mA). If interfacing to a non-isolated device, the use of a loop isolator is required.

Analog Outputs

There are two analog outputs in addition to the actuator outputs for general use. Each output is a 4–20 mA current source.

The analog outputs are configured for:

1 = Engine Speed

2 = Fuel Demand

Discrete Inputs

There are 8 discrete inputs that can be used.

Closing an input switch or relay contact causes the input state for that discrete input to be “TRUE” (displayed as “CLOSED”). The input terminal will be open-circuited when the input switch or relay contact opens. This will cause the input state for that discrete input to be “FALSE” (displayed as “OPEN”).

Start/Stop System (DI - 1)

This discrete input changes the control operation by immediately decreasing the fuel demand to zero. When the switch or relay contacts are closed, the control is allowed to control the fuel in an attempt to control the speed. When the switch or relay contacts are open, the fuel demand immediately goes to zero.

Local/Remote Select (DI - 2)

This discrete input allows controlling the engine either from the local panel or remotely using remote speed signals. The local panel has the raise/lower switches for locally controlling the speed. If the local/remote switch is closed, then system can be controlled remotely and speed will follow the remote speed signal input. While if the switch is open, the raise/lower switches from the panel controls the engine speed.

Panel Shutdown Contact (DI - 3)

There is a switch for Engine Shutdown from panel. When switch is closed, the fuel demand is reduced to zero to cause system shutdown.

Remote Shutdown Contact (DI - 4)

This input is driven by the remote switch for shutdown of the engine.

Raise Speed Contact (DI - 5)

This discrete input changes the control operation by increasing the speed reference ramp. Closing the switch causes the speed reference to ramp up at specified ramp rate only up to a software adjusted RAISE SPEED limit. Opening the Rated Speed switch (described above) takes command control away from the Raise Speed input and effectively disables the command.

With the contacts open (discrete input in the “FALSE” state), the control will stop raising the speed.

Lower Speed Contact (DI - 6)

This discrete input changes the control operation by decreasing the speed reference ramp. The speed reference ramp can decrease only to a software adjusted LOWER SPEED limit. De-selecting the Rated Speed command (described above) takes command control away from Lower Speed input and effectively disables the command.

With the contacts open (discrete input in the "FALSE" state); the control will stop lowering the speed or base load reference.

Digital input 7 & 8

The Digital Input 7 & 8 is not used for the time.

Relay Driver Outputs

The outputs are configured for the below parameters:

1. Power On Indication
2. Alarm—the discrete output will activate when an Alarm is sensed.

Programming and Service Tools

Woodward Watch Window can be used to interface with the Servlink Server as a means for displaying the Service & Configure tunable/monitors, with the ability for tuning the parameters. Watch Window also offers the ability to upload the tunable 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).

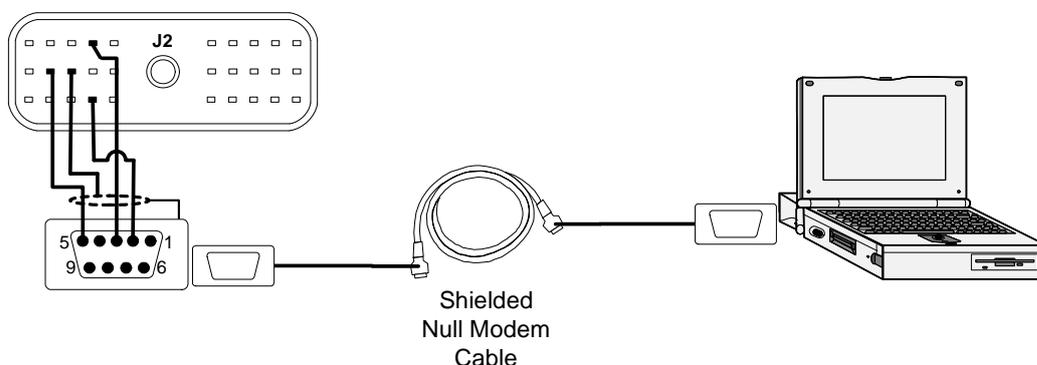
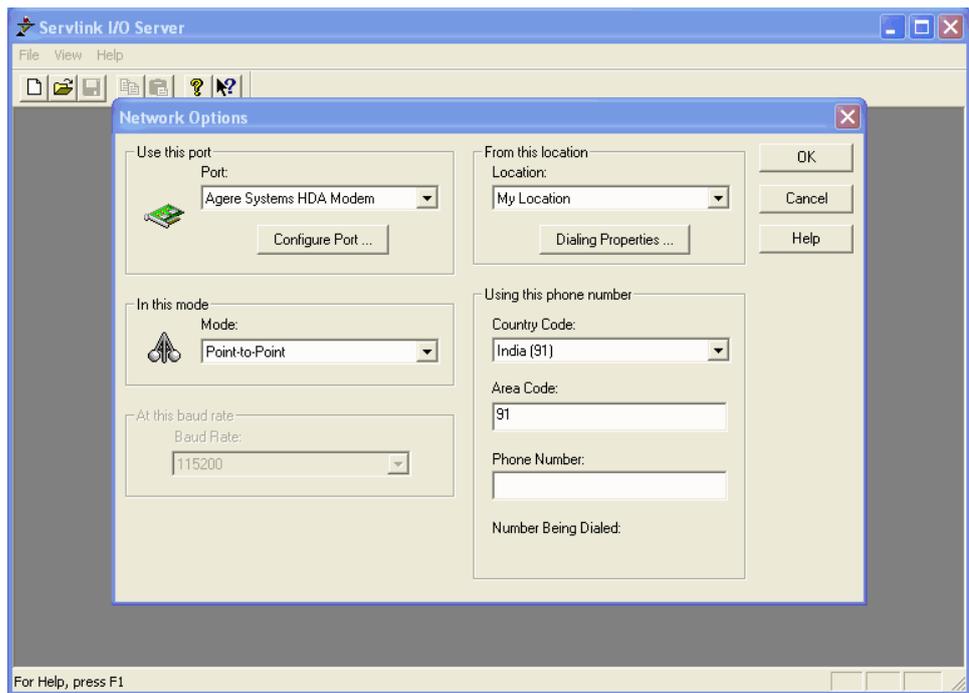
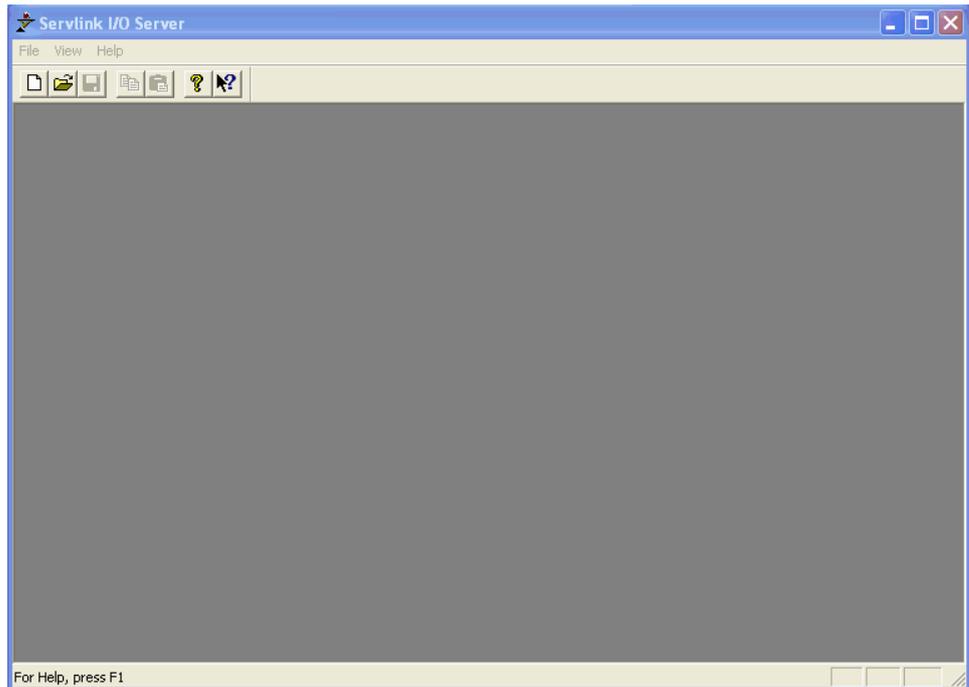


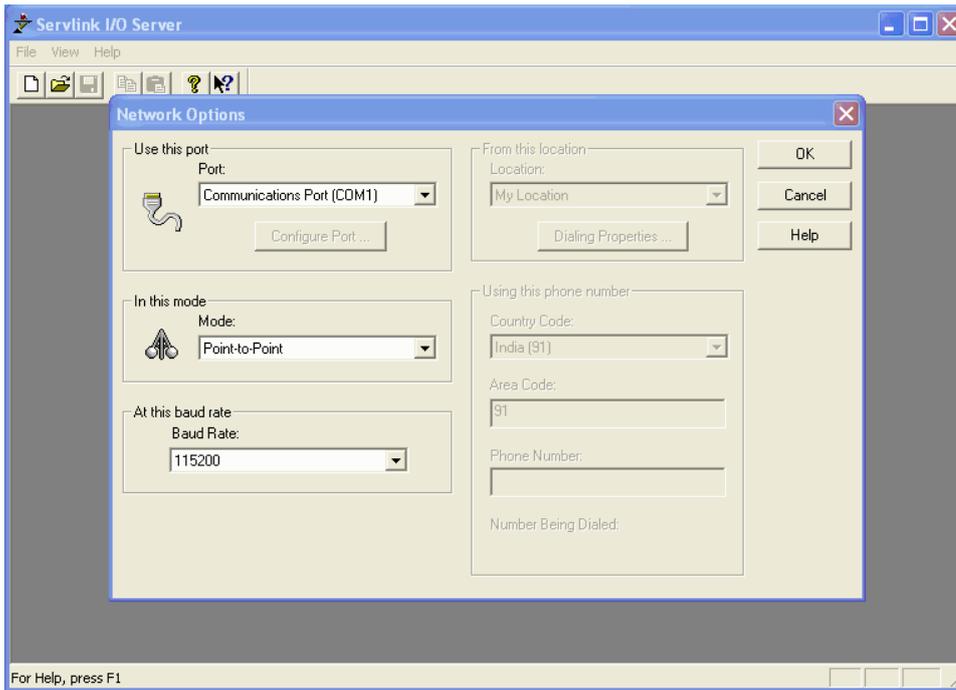
Figure 4-1. Connecting the 733 to a PC

Using Watch Window

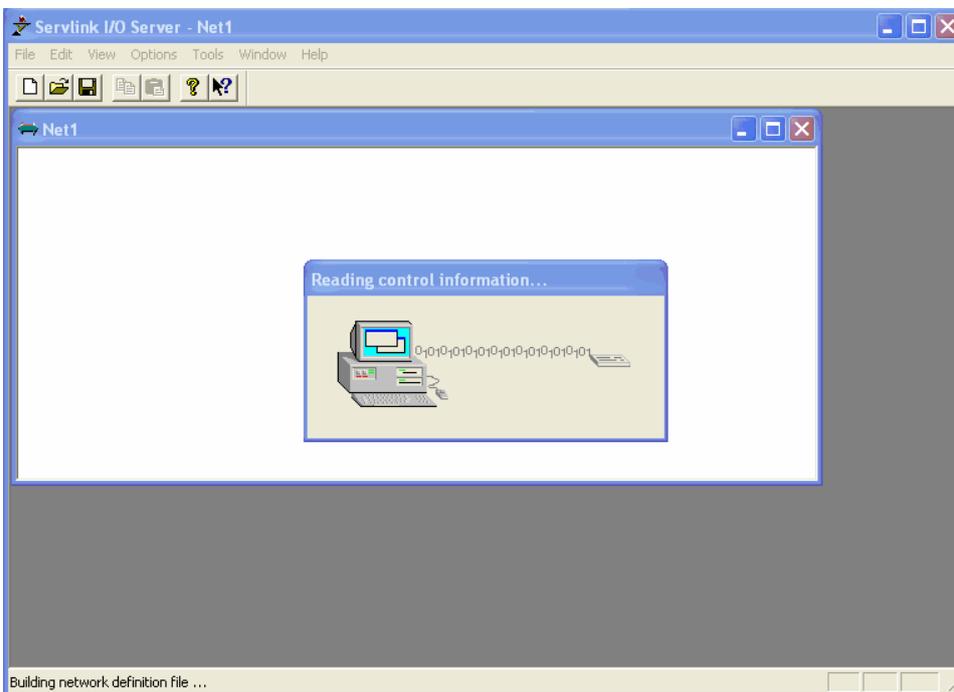
Here are brief instructions for using Watch Window in conjunction with Servlink to view the control variables on a PC (Personal Computer). These instructions are meant to be introductory only. Full on-line help is available in each application. It is assumed that you already have Servlink and Watch Window installed. The default location can be found by clicking the START icon on the main menu bar and then clicking the PROGRAMS menu item. Look for an icon called WOODWARD WATCH WINDOW.

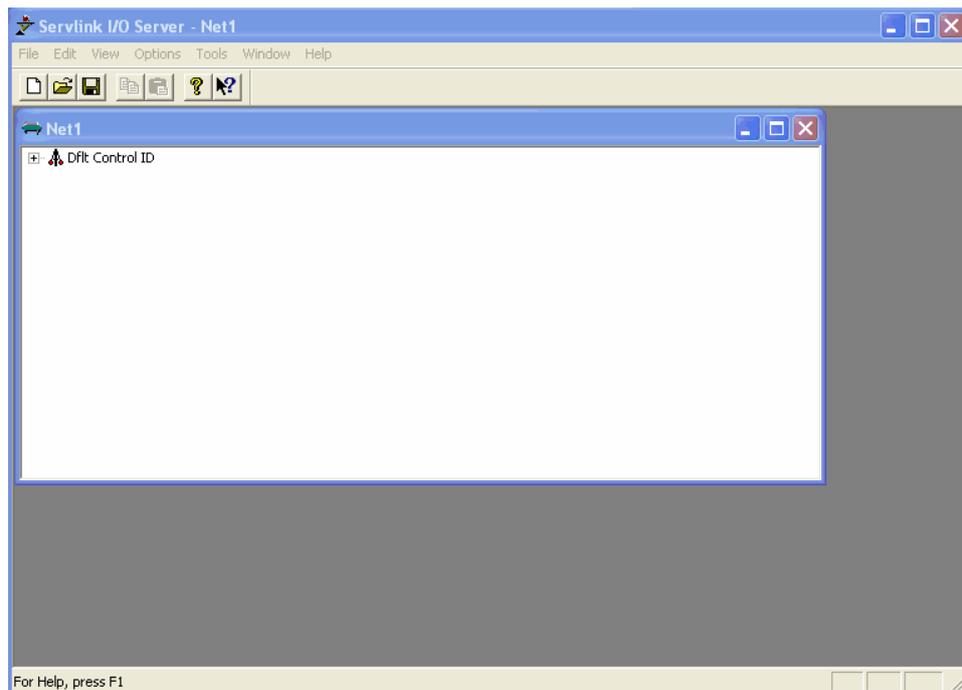
1. Make sure that all other programs that may access your computer communication ports are shut down.
2. Get the RS-232 cross cable to talk from your PC to the control
3. Start the Servlink server and open a new file. Select the proper com port for your PC, verify that POINT-TO-POINT communication mode is selected, and verify that the baud rate is 115200.





4. Select OK. If everything is working right, you should see an animated picture of a string of 1's and 0's flying from the control to the PC on your screen. You now have a network definition file whose default name is NET1.





5. Start the Watch Window application. When Watch Window executes, you will have a screen displaying three windows entitled Watch Window, Explorer, and Inspector.
6. The explorer window will have two groups displayed, SERVICE and CONFIGURE. Double clicking on either of these will expand them to show groups of values. Explorer is used only to locate a tunable or monitor value. **In order to change a value or monitor a value, you must drag and drop a value from the explorer window into the Inspector window.** Once a value is displayed in the Inspector, you can see several blocks of information. The most important blocks for a tunable value are the FIELD and VALUE blocks. The FIELD block is used to identify a particular value, and the VALUE block displays the current value of a variable. There are two types of values available in Watch Window. One is a monitor value, which is marked in the INSPECTOR window with a **pair of glasses**. This means it may only be looked at. The other value is read/write value, which is marked with a pencil. The read/write type may be modified using the up and down arrows in the value block.

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 labeled 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 tunable, or service tunable (or debug tunable if relevant):

- @@: Service Tunable
- @@: Monitor Value
- @@: Configure Tunable

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.
- 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 tunable or configurable the status bar will display the minimum and maximum value for that variable.

Magnetic Speed Pickup

The magnetic speed pickup (MPU) is used to detect the speed of the prime mover. It is necessary when the prime mover drives something other than an alternator, and is often used where an alternator is driven directly by the prime mover and when a control signal is necessary before the alternator comes up to its proper output voltage. A speed sensor circuit, either a section on the governor amplifier chassis or a separate unit, is needed to convert the MPU's output signal to one usable by the governor amplifier.

The magnetic pickup produces a voltage output when any magnetic material moves through the magnetic field at the end of the pickup. Since most engines and turbines have flywheels or other large gears made of magnetic material (usually iron or steel), magnetic pickups can usually be installed without adding attachments to gear or shaft. Nonmagnetic material such as aluminum, brass and some stainless steels will not excite the magnetic pickup.

The output of a magnetic pickup is affected by three factors:

- Voltage increases with increases of the surface speed of the monitored magnetic material.
- Voltage decreases as the air gap between the magnetic pickup and the surface of the gear tooth is increased.
- Voltage waveform is determined by the size and shape of the gear tooth in relation to the size and shape of the pole piece.

With any given speed and clearance conditions, a maximum power output will result when the field is filled with a relatively infinite mass of magnetic material at one instant and a complete absence of such material the next. A reasonable approach to these conditions exists when the cross-section of the exciting masses is equal to or greater than that of the pole piece and the space between is equal to or greater than three times the diameter of the pole piece.

As the magnetic pickup-gear relationship begins to deviate from the specifications listed above, the MPU output waveform may deteriorate to an unacceptable shape. Because the speed sensor detects zero-crossings, the waveform should cross zero only twice for each tooth (once going positive and once going negative).

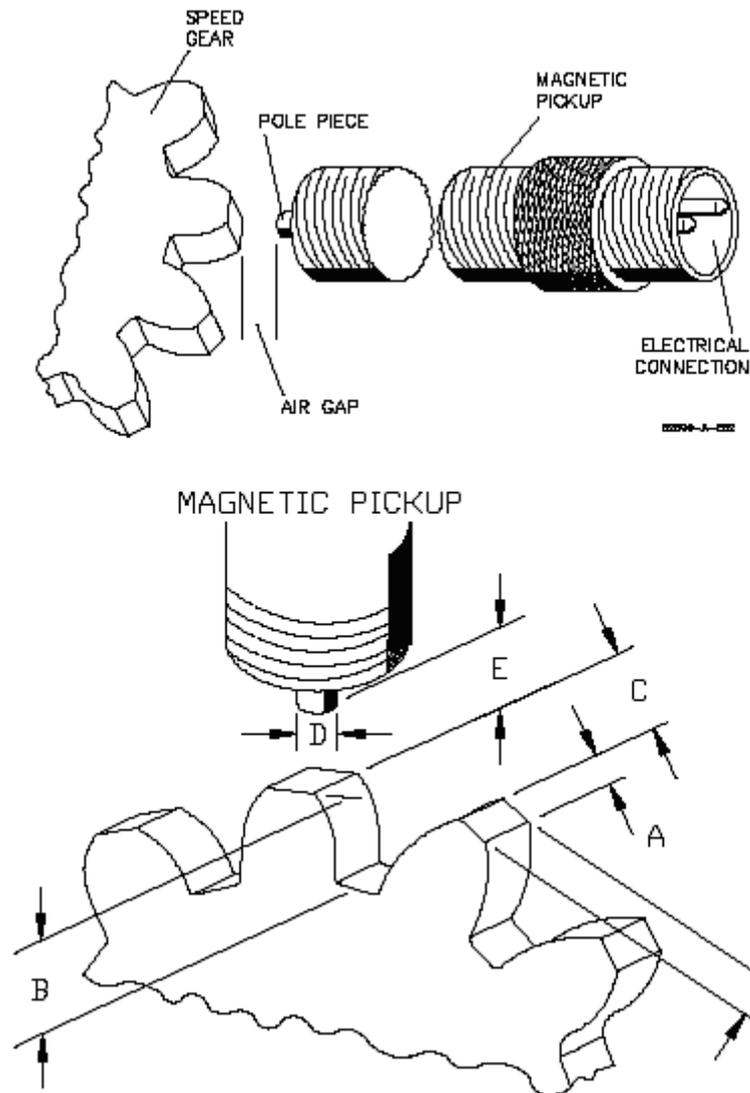


Figure 4-2. Magnetic Pickup Dimensions

In Figure 4-2, the optimum dimensions of A, B, C, and F are given as they relate to D, the diameter of the pole piece of the magnetic pickup. The optimum relationship for maximum output is as follows:

- A is equal to or greater than D
- B is equal to or greater than C
- C is equal to or greater than three times D
- F is equal to or greater than D

Mount the magnetic pickup radially to the outside diameter of the desired gear either through housing or on a rigid bracket. Make sure the gear is of magnetic material. The gap between the pickup and the outside diameter of the gear should be set normally between 0.25 and 1.02 mm (0.010 and 0.040 inch) at the closest point [make sure the gear has less than 0.51 mm (0.020 inch) diametric run-out. Since the signal strength is inversely proportional to gap distance, a weak signal may be generated with more than 1.02 mm (0.040 inch) gap. A shield of non-magnetic material may be installed between the gear and the pickup if necessary for physical shielding. Since the material spaces the pickup face farther from the gear, and since an electromagnetic force may be generated by enough to operate the speed signal circuit.

Most electronic controls require a minimum output of 1.5 Vac (rms) from the magnetic speed pickup at the lowest controlling speed. Above figure shows the maximum air gap allowed for each surface speed and diametric pitch or gear module to produce this maximum required voltage.

$$\text{MPU Hertz} = \frac{\text{No. Teeth} \times \text{Gear RPM} \times \text{Gear Ratio}}{60}$$

$$\text{Example: MPU Hertz} = \frac{120 \text{ Teeth} \times 1800 \text{ RPM} \times 1}{60}$$

$$\text{MPU Hertz} = 3600 \text{ Hertz}$$

How to Mount Magnetic Pickup on the Cam Gear Cover

With the prime mover shut down, turn the pickup in until it just touches the outside diameter of the gear. One 360° turn counterclockwise will move the pickup out 1.41 mm (0.0555 inch). Screw out the amount required for the desired gap. If possible, run the gear slowly through 360° rotation to check the clearance of the pickup. When the gap is set, tighten the jam nut securely against the housing or bracket so the pickup cannot turn in or out.

UG-Actuator

The UG-Actuator provides the muscle power required to control the engine fuel rack. It has a self-contained oil sump so a separate oil supply is not required. The UG-Actuator takes a given electrical input signal and converts it to a proportional hydraulic output-shaft position to control engine fuel flow. The standard UG-Actuator produces approximately 20 J (15 ft-lb) of work over 42 degrees of rotary output. The oil pump is the proven high-output Gerotor, designed to provide long life with minimal maintenance. The actuator's electric to hydraulic transducer uses a Woodward built torque motor which converts the 20–160 mA control signal to a given output position.

Terminal Shaft and Drive Shafts

Terminal Shaft - .500-36 Serrated

Drive Shaft – 1.125-48 Serrated

Hydraulic Pump

The UG-Actuator is equipped with a Gerotor pump. High speed and low speed pumps are available, depending on the drive speed from the engine. The pump uses oil from the self-contained UG-Actuator sump to provide 1172 kPa (170 psi) internal operating pressure. The direction of rotation is selected by pump housing alignment. The pump operates in one direction only. The drive uses a maximum of 375 W (0.5 hp). If the actuator oil pump is rotated in the wrong direction, oil pressure will not be generated in the actuator.



Figure 4-3. UG Actuator

Control Linkage

The terminal shaft rotates 42 degrees. Use $\frac{2}{3}$ of the total rotation between no load and full load. The additional “overtravel” should be split and used at both ends to provide maximum fuel when required and to assure shutdown at minimum-fuel actuator position.

Many control problems are related to the linkage between the actuator and the engine. Use only first-quality rod ends for the linkage, rod ends that will last under the nearly constant motion associated with precise control. The linkage must be stiff, not subject to engine-caused vibration. The linkage must be as light as possible and still maintain the attributes of stiffness. Linkage which is too heavy can damage the actuator as well as make it difficult to achieve steady control.

The installed linkage must operate smoothly, be free of binding, and free of lost motion due to worn parts. If there is a collapsible member in the linkage, be sure it does not yield each time the actuator moves the linkage rapidly. Use a linear linkage. Linear linkage moves the fuel-setting shaft in direct proportion to the movement of the actuator output.

Design the linkage so the power output of the engine is proportional to the position of the actuator output shaft.



Figure 4-4. Linkage

Chapter 5.

Description of Operation

Introduction

This chapter provides an overview of the features and operation of the 733 Speed Control.

The 733 Speed Control uses a 32 bit microprocessor for all control functions. All control adjustments are made with an external computer that communicates with the control via a serial port. The external computer can be disconnected from the control during normal operation, to provide security against tampering.

Speed Control

A speed-sensing device, such as a magnetic pickup, senses the speed of the prime mover, and converts it to an ac signal with a frequency proportional to prime mover speed. The frequency-to-software block (GAP Block) receives the ac signal from the speed sensor and changes it to a digital number representing prime mover rpm.

The digital control compares the numeric output of the speed sensor to the numeric number of the speed reference at the summing junction. If the speed is lower or higher than the reference, a response calculated by the PID (Proportional-Integral-Derivative control) is sent to the actuator driver calling for an increase or decrease in actuator current.

The actuator responds to the signal from the actuator driver by repositioning the fuel or steam rack, changing the speed of the prime mover until the speed signal and the reference are equal.

A failed speed signal circuit monitors the speed signal input. When no signal is detected, it calls for minimum fuel. The minimum fuel signal is sufficient to cause the actuator to go to the minimum position if not restricted.

Remote Speed Setting

There are two control options local control and remote control. Close the Local/Remote switch to put the control into the remote speed setting input mode. One of the Analog inputs must be configured to Remote Speed Set Point. When the control is in remote, the Remote Speed set point moves the Speed Ramp to the same value as the Remote Speed set point. Here analog AN1 is configured for remote speed signal. The signal type is (4 to 20) mA.

Even if the Local/Remote switch is closed (Remote Selection), there are some software conditions to enable the Remote Speed Control. These conditions are:

- Any one of the analog Input must be assigned to Remote speed signal
- No fault related to remote speed input
- Both Raise and Lower Switches open

If any of the above mentioned conditions is false, the software will not enable the remote speed sensing, but will hold the set point value.

Local Speed Setting

Open the Local/Remote switch to enable the Local control. There are two switches on the panel, Raise Speed and Lower Speed, to control the speed locally. If the Raise switch is closed, the speed set point will start ramping up at defined rate. Similarly, if the Lower switch is closed, the speed set point will start ramping down at defined rate. If both inputs are closed, then the rpm set point will hold the previous value.

Control Dynamics

RESET, GAIN, and ACTUATOR COMPENSATION adjust the control to accommodate various types of prime mover systems. The RESET adjustment affects prime mover reaction time when recovering after a sudden load change. The magnitude of the speed change resulting from a sudden change in load is controlled by adjusting the GAIN. ACTUATOR COMPENSATION compensates for the time the actuator and prime mover fuel system takes to react to signals from the control. Idle Proportional Gain and Rated Proportional Gain are used to stabilize the engine at idle speed and rated speed settings.

Speed Reference and Ramps

The 733 control provides local control with discrete inputs for raising and lowering speed. For remote speed setting, the control provides a remote reference analog input. Input functions are enabled as follows:

- Local Speed Reference Raise/Lower discrete inputs control the speed ramp inputs when the Local/Remote switch is open (Local).
- Remote Speed Reference setting is enabled when the when the Local/Remote switch is closed (Remote).

Speed Reference and Ramp Functions

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

The control provides start, lower limit, raise limit, and raise and lower rates for local operation. Raise and lower rates determine how fast speed is increased or decreased by the raise and lower discrete input commands.

The raise and lower commands increase and decrease engine speed based on the raise and lower rate settings. The raise and lower commands will not increase the speed reference above the raise limit or below the lower limit. The raise and lower commands can be used as speed trim inputs for manual synchronization.

If remote speed setting operation is configured and enabled, the control will ramp speed to the reference value set by the Remote Reference input at the Remote Reference increase or decrease time settings provided that Local/Remote switch is in closed mode. The Remote Reference range is configured for a range from 4 to 20 mA. The minimum input value (4 mA) Remote Reference set point may be set to a lower or higher speed than the high input (20 mA) set point, providing for either direct- or reverse-acting remote speed setting.

If a difference is detected between the present speed reference and the remote reference rpm value, the present speed reference is ramped up or down at the increase or decrease rate until the present speed reference matches the remote speed reference rpm value. The remote reference will not increase/decrease the speed reference above the maximum input value or below the minimum input value. (see Figure 5-1).

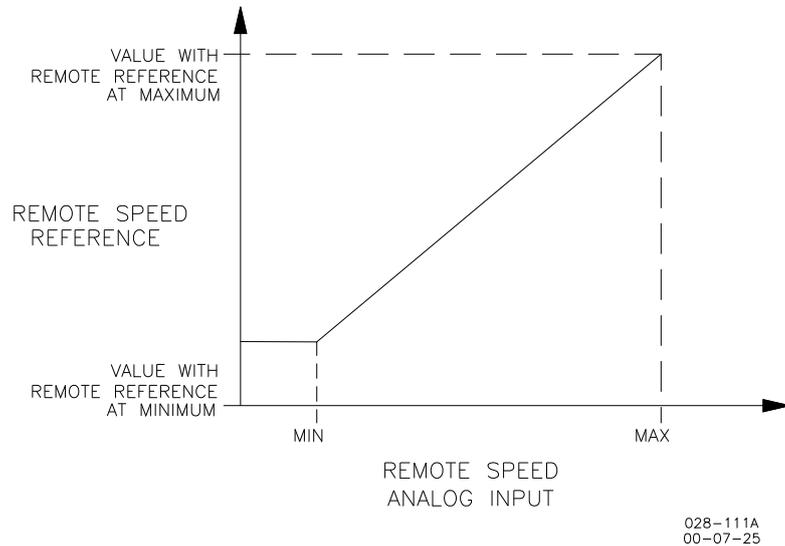


Figure 5-1. Remote Speed Reference

Shutdown

The control provides a Remote Shutdown Switch. From the panel, a shutdown can be initiated using the panel Shutdown switch. In order to select between Local or Remote Shutdown, the panel also provides an Auto/Manual Switch. Set the Auto/Manual Switch to Auto to enable Remote Shutdown. Set the Auto/Manual switch to Manual to enable Local Shutdown.

Chapter 6.

Control Tunables & Setpoints

Introduction

This chapter contains information on control calibration. It includes initial prestart-up and start-up settings and adjustments. Because of the variety of installations, plus system and component tolerances, the 733 control must be tuned and configured for each system to obtain optimum performance.

1. MAINIO.MPU.NUM_TEETH : No of encoder teeth
Default Value: 60
2. MAINIO.ACTUATOR.MA_0 : mA o/p value at 0 % I/P to actuator
Default value: 20 mA
3. MAINIO.ACTUATOR.MA_100: mA o/p value at 100 % I/P to actuator
Default value: 180 mA
4. SPEED.OUT.VAL_4: Speed output corresponding to 4 mA signal
Default value: 0
5. SPEED.OUT.VAL_20: Speed output corresponding to 20 mA signal
Default value: 950

Speed Set points

1. SPEED.REF.P_SP_1 : Remote latch set point
Default value: 300
2. SPEED.REF.R_SP_1: Ramp rate for remote latch
Default value: 10
3. SPEED.REF.P_SP_2 : Local raise set point
Default value: 520
4. SPEED.REF.R_SP_2: Ramp rate for Local Raise
Default value: 5
5. SPEED.REF.P_SP_3 : Local Lower set point
Default value: 300
6. SPEED.REF.R_SP_3: Ramp rate for Local Lower
Default value: 5
7. SPEED.REF.P_SP_4 : Remote Raise set point
Default value: 520
8. SPEED.REF.R_SP_4: Ramp rate for remote Raise
Default value: 10
9. SPEED.REF.P_SP_5 : Remote Lower set point
Default value: 300
10. SPEED.REF.R_SP_5: Ramp rate for remote Lower
Default value: 5

PID Control

1. SPEED.PID.PROP_GN: Proportional gain for speed PID
Default Value: 0.20
2. SPEED.PID.INT_GN: Integral gain for speed PID
Default Value: 0.05
3. SPEED.PID.S_D_R: Derivative ratio for speed PID
Default value: 0.45

Chapter 7. Troubleshooting

The following troubleshooting guide is an aid in isolating trouble to the control or actuator.

IMPORTANT

The control can be damaged with the wrong voltage. When replacing a control, check the power supply, battery, etc., for the correct voltage.

SYMPTOM	CAUSE	REMEDY
Ready to start indication is not coming on door	Switch may be in off position	Turn on the switch.
	LED may be defective.	Check the LED wiring. Verify that the voltage across the LED is 24 V (dc).
	733 control is not power on.	Remove the 733 control connectors and measure the voltage across terminals Y1 and Y3. The multimeter should read 24 V (dc). If voltage is present, the 733 control is defective. Replace the control.
No speed sensing	Magnetic pickup could be defective	Check that the resistance across the magnetic pickup terminals is (190 to 215) Ω .
		Check the speed sensor wiring.
		Check the clearance between the sensor tip and gear teeth.
Speed sensor signal fault	Magnetic pickup could be defective	Repeat the above process.

Chapter 8.

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.

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication **26613**.



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

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