WOODWARD

Application Note

APECS 500 Electronic Controller

Quick Installation Guide

Manual 36725
(replaces SE-5768)

WARNING—DANGER OF DEATH OR PERSONAL INJURY

WARNING—FOLLOW INSTRUCTIONS

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

WARNING—OUT-OF-DATE PUBLICATION

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

www.woodward.com/pubs/current.pdf

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

www.woodward.com/publications

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

WARNING—OVERSPEED PROTECTION

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

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

WARNING—PROPER USE

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

CAUTION—POSSIBLE DAMAGE TO EQUIPMENT OR PROPERTY

CAUTION—BATTERY CHARGING

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

CAUTION—ELECTROSTATIC DISCHARGE

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

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

IMPORTANT DEFINITIONS

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

Revisions—Text changes are indicated by a black line alongside the text.

Contents

Illustrations and Tables

Electrostatic Discharge Awareness

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

Follow these precautions when working with or near the control.

1. Before doing maintenance on the electronic control, discharge the static electricity on your body to ground by touching and holding a grounded metal object (pipes, cabinets, equipment, etc.).

2. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.

3. Keep plastic, vinyl, and Styrofoam materials (such as plastic or Styrofoam cups, cup holders, cigarette packages, cellophane wrappers, vinyl books or folders, plastic bottles, and plastic ash trays) away from the control, the modules, and the work area as much as possible.

4. 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.

CAUTION—ELECTROSTATIC DISCHARGE

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*.

EMC Limitations

Power Bus

The power bus is intended to be a local bus and to have inductive load kickback events suppressed. Therefore, the control's power input is not designed to withstand a charging system load dump, heavy inductive kickbacks, or heavy surge type pulses. If the control is installed outside its intended usage, as described in this manual, centralized voltage pulse suppression should be implemented to help protect the control and other components on the bus.

COMM Port

The COMM port is intended to be a service port, with only temporary connection during service or initial configuration. The COMM port is susceptible to some EMC phenomena and possible unintentional battery return currents.

1. Battery return (B-) is also the communication signal common; typically PCs connect the communication signal's common to protective earth. The PC grounding can provide an unintended return path for B- currents. If B- and the PC are grounded to protective earth, a communication isolator should be used between the PC and the control. Damage to the PC or control, and/or unintended operation may result from a broken battery return wire or the parallel path.
2. The pins inside the COMM port plug are susceptible to damage by ESD discharges, static electricity arcs. Care should be taken not to touch them with tools or put fingers into the port. Always touch your hand or tool to a grounded piece of metal (discharge ESD) prior to coming in contact with the communication port.

The input is susceptible to RF noise such as switching transients and transmitter signals coupled into the communication cable. Cable orientation and short cable length may be used to eliminate these issues, depending on the severity of the environment

Chapter 1.
General Information

Introduction

The APECS 500 is a single-speed electronic engine governor that provides a means of controlling and limiting engine speed by adjusting the fuel control lever with a proportional actuator. APECS 500 will maintain fixed engine rpm regardless of load provided that the engine's available power is not exceeded (i.e., isochronous operation).

The APECS 500 controller has a multi-turn potentiometer for speed adjustment and a single turn potentiometer for gain adjustment. A serial interface is provided for additional adjustments with the All-purpose Calibration Tool (ACT).

Dimensions

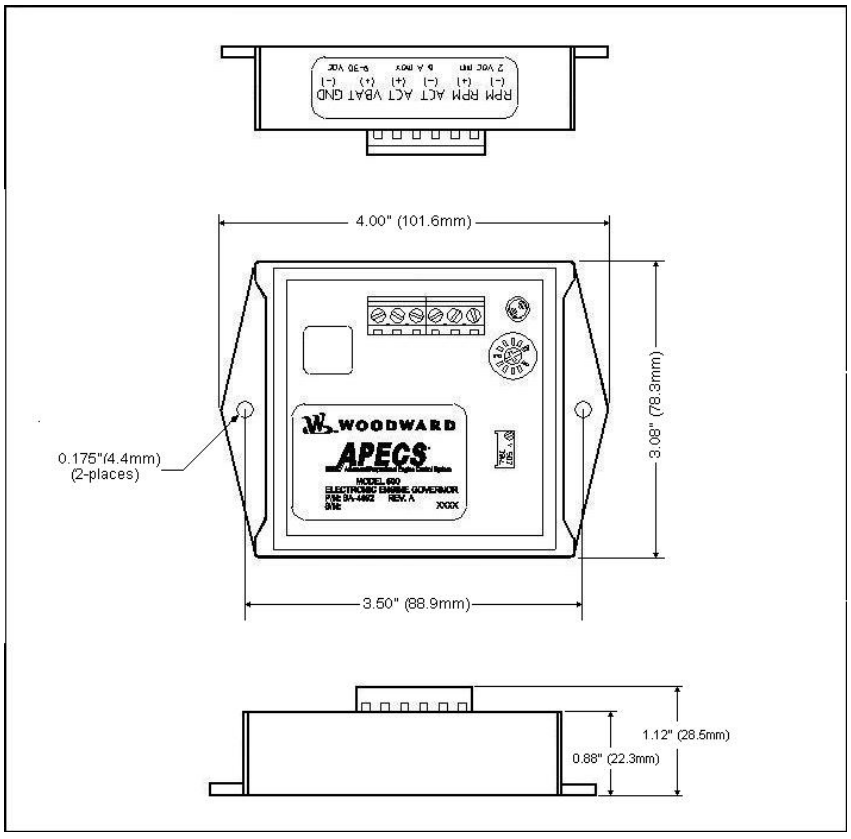

Figure 1. APECS 500 Dimensions

Chapter 2.
Wiring & Calibration

Wiring

Refer to **Figure 2** to connect your APECS controller to battery power, the magnetic pickup, actuator, and the All-purpose Calibration Tool (ACT).

Use insulated, automotive grade wiring (minimum18 AWG or 1 mm^2) for all connections. Shielded wiring is recommended for the magnetic pickup.

The controller has six Euro-style screw terminals:

- *Battery Positive and Negative* (9-30 Vdc). Reverse voltage protected
- *Actuator Positive and Negative* (6A continuous). Short circuit protected. This output is compatible with all Woodward 0175, 0250, 0300, and integral proportional actuators.
- *Magnetic Pickup (MPU) Positive and Negative* (2 Vac minimum at 1000 Hz). The controller is factory programmed for 2500 to 5000 Hz. This range may be modified with the ACT to cover 200-15,000 Hz.

Calibration

MANUAL CALIBRATION

Provided that the MPU frequency is compatible with the engine application, setup consists of the following:

1. Set gain potentiometer to center of travel (5). The speed set potentiometer should be set to the minimum speed (fully counterclockwise) position.
2. Apply power to controller. The status LED should turn on for one second indicating normal operation.
3. Crank engine. The status LED should turn on continuously, indicating a good speed signal from the MPU. If not, check the MPU installation and wiring. If LED immediately begins to flash a two code (indicating engine overspeed) increase the desired speed setting by turning the multi-turn speed set potentiometer several turns clockwise. Repeat this crank and adjust process until the engine starts.
4. Adjust speed setpoint until desired speed is achieved. If engine speed will not settle down, turn gain potentiometer counterclockwise until stable performance results.
5. Once the desired speed setpoint is achieved, adjust gain for optimal performance at all loads. In general, this amounts to increasing the gain as much as possible without inducing oscillation under any load.

CALIBRATION WITH ACT

With the addition of the All-purpose Calibration Tool (ACT) computer interface (Woodward P/N: SA-5206), the user can adjust the following features:

- Frequency Range – factory set to 200-15,000 Hz.
- Proportional, Integral and Derivative gains (Gain potentiometer affects all three.)
- Overspeed shutdown and delay – factory set to 25% overshoot
- Underspeed shutdown and delay –factory set to disabled
- Crank-to-run transition speed – factory set to 90% of setspeed
- Warmup speed and time – factory set to disabled
- Offset to actuator command – can correct start-up overshoot and undershoot

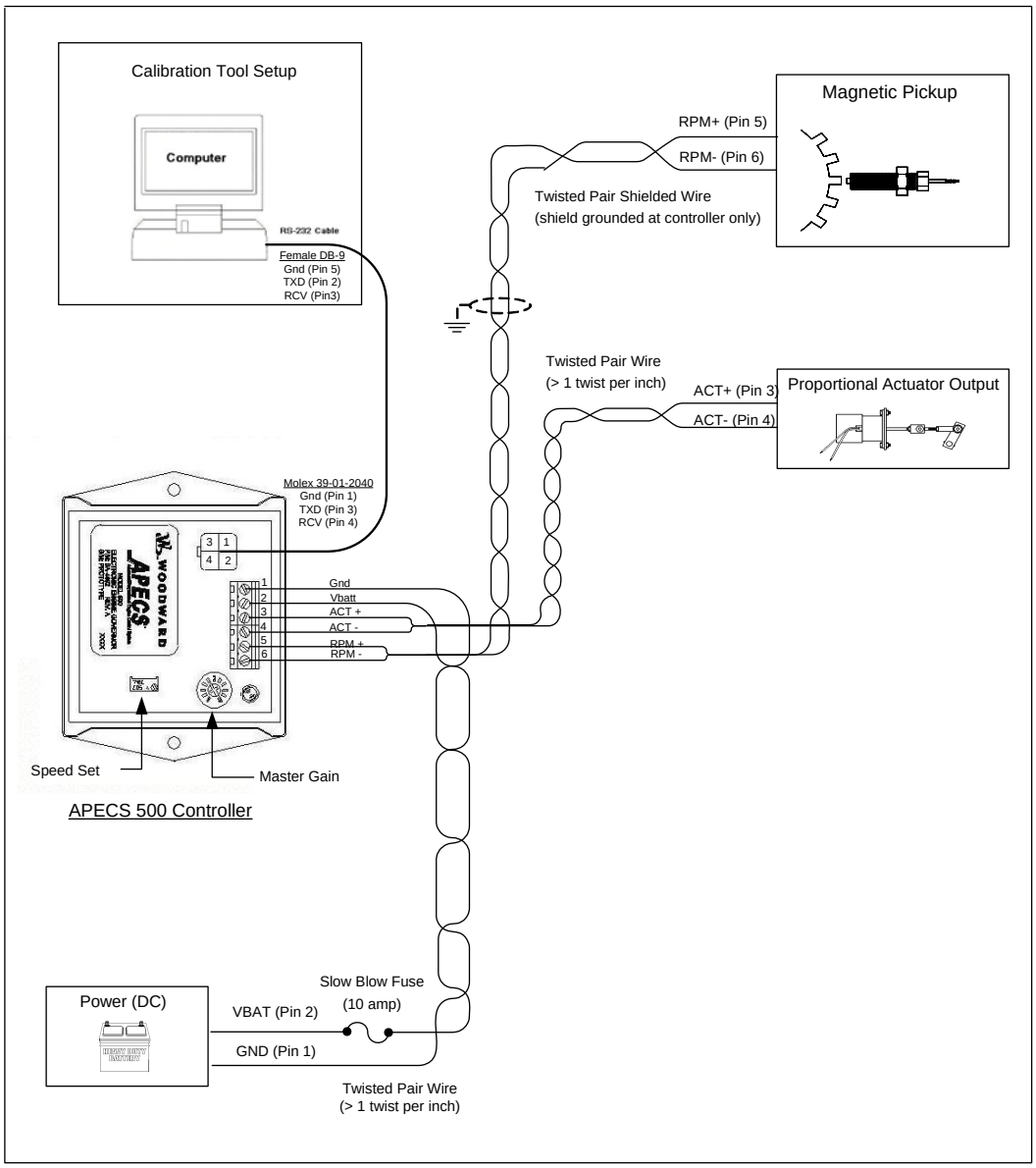

Figure 2. APECS 500 Wiring Diagram

List of Parameters

With the All-purpose Calibration Tool (ACT), the following parameters can be accessed to optimize performance of the APECS 500. ACT can also be used to monitor governor data (rpm, actuator command, etc.).

CATEGORY	PARAMETER	DESCRIPTION	FACTORY CAL
Governor Gain Calibration	DERIVATIVE_GAIN	Speed stability	0.25
	INTEGRAL GAIN	Steady state speed	5
	PROPORTIONAL_GAIN	Transient response	2
Engine Set Speed Calibration	RAMP_DOWN_RATE	Engine speed ramp down rate (rpm/sec)	1000
	RAMP_UP_RATE	Engine speed ramp up rate (rpm/sec)	1000
	SET_SPEED_MAX	Maximum engine speed possible with speed pot	5000
	SET_SPEED_MIN	Minimum engine speed possible with speed pot	2500
	WARMUP_PCNT	Engine warm up speed, % of set speed	0.8
	WARM_UP_TIME	Time spent at warm up speed (sec)	0
Speed Input Configuration	PULSES_PER_REV	No. of pulses per engine revolution (if set to 60, rpm = Hz)	60
	PULSES_PER_UPDATE	No. of pulses until next engine speed update	0
Engine Start Calibration	CRANK_DUTY_CYCLE	Kickoff duty cycle for open-loop cranking	0.945
	CRANK_2_RUN_PCNT	Percentage of set speed where crank-to-run transition occurs	0.9
Diagnostics Calibration	OVERSPEED_PCNT	Overspeed shutdown, % of setspeed (max)	0
	OVERSPEED_TIME	Time in msec before setting overspeed fault	250
	UNDERSPEED_PCNT	Underspeed shutdown, % of setpoint (min)	0
	UNDERSPEED_TIME	Time in msec before setting underspeed fault	2500
	UNDERSPEED_RUN_TIME	Run time (sec) before underspeed is checked	10
Actuator Output Calibration	DUTYCYCLE_OFFSET	Initial value for duty cycle – adjust for improved startup	0.25

Chapter 3. Diagnostics

The status LED on the APECS 500 can diagnose a variety of conditions:

- When the APECS 500 is powered up, the LED will turn on for one second then turn off. If it does not, the APECS 500 is either not receiving power or it is totally non-functional.
- If a fault condition exists, the status LED will flash a code that indicates the nature of the fault. Refer to the table below. The ACT can also be used to look up current and historic faults.
- If there are no faults, the status LED will turn on continuously when the APECS 500 receives a valid signal from the magnetic pickup. If it does not, then there is not a valid signal.

FLASH CODE	FAULT	ENGINE SHUTDOWN	CORRECTIVE ACTION
1	APECS unit not calibrated	Yes	Connect ACT and set PULSES_PER_REV to a non-zero number.
2	Engine speed excessive	Yes	Check parameter settings. Overspeed criteria may be too sensitive. Check for electrical noise entering controller. Check wiring and connections. Make sure linkage moves freely, without backlash. Check tip of speed sensor.
3	Engine speed unusually low	Yes	Check parameter settings. Underspeed criteria may be too sensitive. Check linkage and the actuator travel. Ensure that load is not greater than engine capacity. Check for other engine-related problems: clogged fuel filter, clogged air filter, lack of fuel.
4	Actuator disconnected, open circuit or short circuit	Yes	Check actuator wiring and actuator resistance. Resistance should be less than 10 ohms but greater than 1 ohm.
5	Factory settings lost	Yes	If calibration file is available, download calibration file and cycle power again. If controller still does not work or if no calibration file is available, consult factory.
6	Speed Set Pot out-of-range	Defaults to minimum speed	Consult factory.
7	Gain Set Pot out-of-range	Yes	Consult factory.
8	Controller unit failed	Yes	Electrical noise may be entering controller. Check wiring, shielding and connections to controller. Cycle power to engine. If controller still does not work, consult factory.

Chapter 4.
Service Options

Product Service Options

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

- Consult the troubleshooting guide in the manual.
- Contact the manufacturer or packager of your system.
- Contact the Woodward Full Service Distributor serving your area.
- Contact Woodward technical assistance (see "How to Contact Woodward" later in this chapter) and discuss your problem. In many cases, your problem can be resolved over the phone. If not, you can select which course of action to pursue based on the available services listed in this chapter.

OEM and 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 **Recognized Turbine Retrofitter (RTR)** is an independent company that does both steam and gas turbine control retrofits and upgrades globally, and can provide the full line of Woodward systems and components for the retrofits and overhauls, long term service contracts, emergency repairs, etc.

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

Woodward Factory Servicing Options

The following factory options for servicing Woodward products are available through your local Full-Service Distributor or the OEM or Packager of the equipment system, based on the standard Woodward Product and Service Warranty (5-01-1205) that is in effect at the time the product is originally shipped from Woodward or a service is performed:

- 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 is a flat-rate program and includes the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205).

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.

Charges for the Replacement/Exchange service are based on a flat rate plus shipping expenses. You are invoiced the flat rate replacement/exchange charge plus a core charge at the time the replacement unit is shipped. If the core (field unit) is returned within 60 days, a credit for the core charge will be issued.

Flat Rate Repair: Flat Rate Repair is available for the majority of standard 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. All repair work carries the standard Woodward service warranty (Woodward Product and Service Warranty 5-01-1205) on replaced parts and labor.

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 and carry with it the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205). 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.

CAUTION—ELECTROSTATIC DISCHARGE

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 offers various Engineering Services for our products. For these services, you can contact us by telephone, by email, or through the Woodward website.

- 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. Emergency assistance is also available during non-business hours by phoning Woodward and stating the urgency of your problem.

Product Training is available as standard classes at many of our worldwide locations. We also offer customized classes, which can be tailored to your needs and can be held at one of our 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 many or our worldwide locations or 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 us via telephone, email us, or use our website and reference **www.woodward.com/support**, and then ***Customer Support***.

How to Contact Woodward

For assistance, call one of the following Woodward facilities to obtain the address and phone number of the facility nearest your location where you will be able to get information and service.

Electrical Power Systems

Facility	Phone Number
Australia	+61 (2) 9758 2322
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany:	
Kempen	+49 (0) 21 52 14 51
Stuttgart	+49 (711) 78954-0
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
Poland	+48 12 618 92 00
United States	+1 (970) 482-5811

Engine Systems

Facility	Phone Number
Australia	+61 (2) 9758 2322
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany:	
Stuttgart	+49 (711) 78954-0
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Turbine Systems

Facility	Phone Number
Australia	+61 (2) 9758 2322
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

You can also contact the Woodward Customer Service Department or consult our worldwide directory on Woodward's website (**www.woodward.com/support**) for the name of your nearest Woodward distributor or service facility.

For the most current product support and contact information, please refer to the lastest version of publication **51337** at **www.woodward.com/publications**.

Technical Assistance

If you need to telephone for technical assistance, you will need to provide the following information. Please write it down here before phoning:

General

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

Prime Mover Information

Engine/Turbine Model Number _____
Manufacturer _____
Number of Cylinders (if applicable) _____
Type of Fuel (gas, gaseous, steam, etc) _____
Rating _____
Application _____

Control/Governor Information

Please list all Woodward governors, actuators, and electronic controls in your system:

Woodward Part Number and Revision Letter _____
Control Description or Governor Type _____
Serial Number _____

Woodward Part Number and Revision Letter _____
Control Description or Governor Type _____
Serial Number _____

Woodward Part Number and Revision Letter _____
Control Description or Governor Type _____
Serial Number _____

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

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Email and Website—www.woodward.com

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

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

2008/8/Lincolnshire