



**Industrial Controls  
Product Line Catalog**

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## Technical Publications

Woodward technical product specifications and technical manuals are available in PDF (electronic) format on our website ([www.woodward.com/publications](http://www.woodward.com/publications)).

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# Leadership Through Experience and Innovation

Woodward is the world's largest independent designer and manufacturer of energy control solutions for aircraft and industrial engines, turbines, and power equipment.

The company's innovative controls and fuel delivery systems help manufacturers worldwide deliver cleaner, more efficient, and more reliable equipment to the global aerospace, power generation, oil and gas, and transportation markets.

Woodward is headquartered in Fort Collins, Colorado, USA, and serves global markets from locations worldwide.

Woodward's Aircraft Engine Systems customer business segment, headquartered in Rockford, Illinois, USA, provides aircraft engine systems and aircraft engine services to the global aerospace markets.

The company's Industrial Controls customer business segment, headquartered in Fort Collins, provides industrial turbine systems, industrial engine systems, power management systems, and process industry solutions worldwide. Our energy control solutions are based on the application of five core technologies into tightly integrated system solutions that control critical engine and turbine processes at a reasonable cost.

<b>Fluid Systems Technologies</b>	<ul style="list-style-type: none"> <li>• Valves</li> <li>• Actuators</li> <li>• Fuel Metering Units</li> <li>• Actuators</li> <li>• Pumps</li> <li>• Servo-components</li> </ul>
<b>Combustion Control</b>	<ul style="list-style-type: none"> <li>• Ignition Systems</li> <li>• Gas Turbine Fuel Nozzles</li> <li>• Gas Engine Fuel Admission</li> <li>• Diesel Fuel Injection</li> </ul>
<b>Electronic Controls and Software</b>	<ul style="list-style-type: none"> <li>• Diesel and Gas Engine Controls</li> <li>• Gas Turbine Controls</li> <li>• Steam Turbine Controls</li> <li>• Fuel Cell Controls</li> </ul>
<b>Systems Integration</b>	<ul style="list-style-type: none"> <li>• Integrated Control Components</li> <li>• Integrated Fuel Systems</li> <li>• Power Management Controls</li> <li>• Distributed Network Control</li> <li>• Application Engineering</li> </ul>
<b>Services</b>	<ul style="list-style-type: none"> <li>• Product Support</li> <li>• Repair and Overhaul</li> <li>• Global Distribution</li> </ul>

Woodward has the products, the training, and the technical support you need to be competitive in the global markets of tomorrow. Visit our website at [www.woodward.com](http://www.woodward.com).

# Product Lines

## Gas Engine Products

Tightening emissions standards, cost pressures, and dispersed application requirements have resulted in a more challenging business climate for the industrial gas engine industry. To meet these demands, Woodward offers comprehensive energy control system solutions for every size, type, and application of industrial gas engine made.

From the smallest spark-ignited engine in mobile equipment to the largest gas engine in power and compression applications, Woodward offers a tightly integrated control system solution that perfectly matches the requirements.

Based on four core technologies—Fuel and Air Delivery, Combustion Control, Electronic Controls and Software, and Systems Integration—Woodward system solutions are custom designed to maximize your engines' fuel economy and efficiency, and reduce engine emissions.



### Total Engine Control Systems

**The MI-04 control system** controls propane engines in forklifts and other alternative-fueled off-highway vehicles. The highly accurate closed-loop control system helps OEMs meet legislated TIER-2 emission levels, while maintaining excellent drivability and fuel economy. Woodward has a whole family of ECUs (engine control units) and continues to develop new applications as the market requirements change.

(product spec 03313)

**The OH1 control system** is designed to control heavy-duty, lean-burn natural gas engines in urban buses and trucks and other alternative-fueled on-highway vehicles. The highly accurate closed-loop control system helps OEMs meet legislated emission levels, while maintaining diesel-like drivability and excellent fuel economy.

(product spec 03224)

### Mixers, Carburetors, and Gaseous Fuel Systems



**Carburetors/mixers** are available for LPG and natural gas fueled engines, including dual-fueled engines, from 50 kW (67 hp) to 246 kW (330 hp).

(product specs 03262 [N-CA55], 03263 [N-CA70], 03264 [N-CA100], 03265 [N-CA125], 03266 [N-CA200], 03267 [N-CA225], 03268 [N-CA300/300-50], 03269 [N-CA475])



**Fixed-venturi Mixers** are available for a wide variety of naturally aspirated and turbocharged engines. Woodward mixers provide high homogeneity at very low resistance. All mixers feature robust, simple construction with no moving parts, and can be easily combined with Woodward air/fuel ratio control systems.



**Vapor Regulators / Vaporizer Regulators** offer improved vaporization. Liquid propane enters the regulator and then is vaporized using heat from the engine coolant. This is accomplished by spraying fuel against the regulator's thin heated walls. The diaphragm reacts to the fuel expansion due to vaporization, thus filling the expansion chamber and closing the high pressure valve.

When engine demand draws fuel from the low-pressure side, the high-pressure valve opens, letting liquid fuel into the high pressure chamber, continuing the vaporization process.

(product specs 03272 [N-51], 03275 [N-E], 03276 [N-H420], 36515 [N-H420-NG], 36580 [N-H420 Turbo], 03273 [N-J], 03271 [N-LPR], 03270 [N-PJ], 03274 [N-S])



**The N-2000/N-2001 Vaporizer/Regulators** for LPG-fueled engines combines in a single compact unit the vital carburetion functions of a lockoff (fuel lock)/filter and a vaporizer/regulator. It eliminates the inefficient approach of an individual lockoff and vaporizer with their multiple hoses, fitting, electrical connections, and brackets.

The precision die cast N-2000 meets the needs of the propane industry—ease of installation, lower cost, reduced parts inventory, and increased safety. The unit's small size and space-saving single bracket mounting enables installations in the most cramped engine compartments.

(product specs 03277 [N-2000], 36514 [N-2001])



**The LC-50** is designed for use on gaseous fueled industrial engines between 5 and 100 kW (7 and 134 hp). The throttle and venturi sizes are between 24 and 50 mm. Applications include power generation, refrigeration units, pumps, irrigation, and mobile industrial.

The mixer can be used with propane and natural gas and requires a zero pressure regulator. The throttle body incorporates the proven Woodward L-Series speed control, which operates the throttle plate. This modular design consists of a die-cast aluminum throttle body, mixer, plus a fully programmable integrated digital speed control and bi-directional actuator. This unique design includes a venturi style annular ring mixer with no moving parts for superior mixing.

(product spec 03222)

## Throttles



**The LCS ITB** integrated throttle body and speed control or actuator provides a building block approach to total engine management. This modular design consists of a die-cast aluminum throttle body plus a fully programmable integrated digital speed control and bi-directional actuator. The LCS ITB is a member of Woodward's *Integrated Throttle Body* family. Several throttle body size configurations (between 25 and 50 mm) are integrated with speed control or actuator options for use on gaseous fueled industrial engines between 5 and 100 kW (7 and 134 hp).

Applications include power generation, refrigeration units, pumps, irrigation, mobile industrial, and gas trim valves.

(product spec 03223)



**The APECS® Power Flow integrated valve actuator** is designed for throttling the intake of internal combustion engines. The APECS Power Flow system is designed to couple to standard market-available fuel mixer series and to standard SAE flanged intake manifolds. This integrated throttle body is adaptable to a fuel injected engine for air control.

(product spec 36505)



**The Flo-Tech™ ITB** integrated throttle body is designed for direct replacement of conventional throttle body with actuator and linkage. The throttle body will provide equivalent maximum flow rates of standard butterfly throttle bodies of the same diameter. The system contains a return spring to fully comply with DOT 571.124 specifications. The Flo-Tech integrated actuator/throttle body requires no actuator or linkage.

(product spec 04140)



The ProAct™ ITB integrated throttle bodies are butterfly valves electrically-actuated by ProAct Analog and ProAct Digital Plus actuators to control flow output. With bore sizes of 105 mm, 120 mm, and 135 mm, these ProAct ITBs are designed for use with engines in the 1–2 MW range. The ProAct actuators are electro-magnetic, 75 degree-of-travel devices, and therefore alleviate the problems associated with linkages on gas engines (such as setup, non-linearity, and wear).

(product spec 03305)

## Actuators



The L-Series Position Controller provides a building block approach to total engine management. The microprocessor-based bi-directional actuator design easily attaches to fuel pumps, mixers, or throttle bodies. The L-Series Position Controller accepts a position command and drives the 0–60 degree output shaft to the commanded position based on an internal shaft position sensor. The high-efficiency torque motor delivers 0.34 N·m (0.25 lb-ft) nominally over 60° travel range to operate fuel or air control devices.

(product spec 03328)



The ProAct™ Digital Plus actuator is intended to be mounted on-engine to control varying functions including (but not limited to): fuel rack positioning, timing control, throttle valve, and wastegate positioning. The actuator is effectively a positioner with an integral driver, which will accept a position command signal from another device in the system such as a speed control.

The ProAct Digital Plus actuator includes an integral digital driver capable of controlling the actuator, communicating with the outside control system, and containing on-board software and intelligence to realize monitoring and customizing functions.

(product spec 03231)



The UG-Actuator offers the advantages of electronic control and load sharing systems while using the convenient, existing UG8-type drives and linkages. The actuator provides the muscle for Woodward analog controls such as the 2301A, as well as Woodward digital controls such as the 2301D and the 723 Plus. The UG-Actuator can be used with diesel or natural gas engines, as well as with steam and industrial gas turbines. The UG-Actuator has a self-contained oil sump so a separate oil supply is not required.

(product spec 37511)



The PGPL Actuator/Driver is an electrohydraulic actuator with a proportional driver interface which can be used with electronic controls providing a 0 to 200 mA position signal. The actuator is designed for use with Woodward 2301A and D series, 700-series, Peak® 150, and 505 digital controls.

(product spec 37520)

## Air-Fuel Ratio Control Units



The L-Series Air/Fuel Ratio Control provides precise air/fuel ratio control for engines using three-way catalytic converters to reduce exhaust emissions. [A catalyst that simultaneously eliminates hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NO<sub>x</sub>) is referred to as a “three-way” catalyst.]

The L-Series is a microprocessor-based air/fuel ratio control for four-stroke, gaseous-fueled engines operating with a near-stoichiometric air/fuel ratio. It is designed to work in conjunction with a three-way catalytic converter to efficiently reduce exhaust emissions. By automatically maintaining an optimum air/fuel mixture, emissions compliance is achieved and catalyst life is maximized without operator supervision.

An LCS Aftermarket Kit can be applied on engines between 100 kW and 250 kW (134 and 340 hp). The aftermarket kit will accommodate the full range of fuel types and fuel qualities.

OEM air/fuel ratio control: (product spec 03255)

Aftermarket kit: (product spec 03257)





The **GEICO™ Stoichiometric Model 100** (GECO S100) was designed as an inexpensive, state-of-the-art air/fuel ratio control for natural gas engines in the aftermarket. The GECO S100 is an easy-to-install, low maintenance, and expandable solution for natural gas engines. Woodward is the only manufacturer offering a system for the stationary engine market combining air/fuel ratio with adaptive catalyst control and oxygen sensor health monitoring. The GECO S100's wide range of control authority quickly manages engine speed and load variations.

(product spec 03553)



The **GEICO™ S100 Lean Burn** configuration is also available to further enhance emissions control.

(product spec 03251)

## Valves



The **TecJet™ 50 Plus, TecJet™ 50 Plus Precision Flow, and TecJet™ 110** are electronic gas metering valves for single-point injection. They have integrated sensors and electronics, which provide the correct gas flow under all specified conditions.

The microcomputer inside the TecJet valve converts the desired gas flow signal and gas parameter information into a valve position (which corresponds to the desired gas flow), depending on gas inlet pressure, gas temperature, and the pressure difference across the valve.

(product specs 03317 [50 Plus/110], 03330 [50 Plus Precision Flow])



The **SOGAV™** (Solenoid Operated Gas Admission Valve) family consist of several electrically actuated, high response gas admission valves for in-manifold (port) fuel admission. The SOGAV is designed for use on four-stroke, turbocharged gas engines of approximately 180 mm bore and larger. One SOGAV is required for each cylinder.

The SOGAV 36, 43 and 105 are main chamber port injection valves that control the fuel flow into the intake manifold. The numeric suffix is a constant used in the equation calculating the valve's flow. Due to the valves' extreme repeatability and fast response time it will provide excellent controllability of the gas engine.

(product spec 04151)

The SOGAV 0.8 and 2.2 are pre chamber injection valves that are designed to fuel the Pre-Chamber of engines with a cylinder size of 170–240 mm and 250–430 mm respectively. (For OEM applications only)

(product spec 04172)



The **Glo-Tech™** modulating, all electric wastegate/bypass valve is capable of handling hot (600 °C) exhaust gasses for gas engines. The Glo-Tech valve provides engine manufacturers a method to reduce emissions, increase efficiency and reliability. The Glo-Tech valve has a bore of 60 mm and is typically coupled with a ProAct actuator

(manual 26021)

## Engine Control Units



The **2301A Full Authority Speed Control** sets the speed or load of a diesel engine, gas engine, steam turbine, or gas turbine according to the demand of a process or a computer control signal of 4–20 mA or 1–5 Vdc.

The unit provides isochronous operation, with droop control available through an externally-wired potentiometer. The isochronous mode is used for constant speed of the controlled prime mover as long as it is able to provide power to satisfy the load. Droop control is provided when parallel-bus operation is required.

(product spec 02301)



The **2301A Load Sharing and Speed Controls** are designed for use in electric generator systems where multi-unit load sharing is desired. 2301A controls may be used with diesel, gas or gasoline engines, or steam or gas turbines.

Controls are available for applications requiring droop and/or isochronous speed control; in forward- or reverse-acting models; for single or tandem actuator installations; with accelerating or decelerating ramps; and in several speed ranges. Automatic, adjustable start fuel limiting regulates the maximum fuel setting while the engine is starting. This helps decrease pollution and engine wear.

Each 2301A control has a self-contained load sensor. Most models provide a 0–200 mA output signal; 0–20 mA output is available for special applications. The output signal is proportional to the fuel setting needed to attain the desired speed/load. Position feedback from the actuator is not required.

(product spec 82390)



The **2301D and 2301D-EC Digital Load Sharing and Speed Controls** are used in electric generator systems for which load sharing is desired. They can be used with diesel or gas engines, or steam or gas turbines. The control utilizes a digital based speed control and provides a single serial port for PC communications. The digital design eliminates the use of potentiometers for tuning and load control.

(product spec 03204)



The **723 Plus Digital Control** manages and controls reciprocating engines (gas, diesel, or dual fuel) used in power generation, marine propulsion, and gas compression/distribution. The control may also be used in cogeneration, power transmission/distribution, process management, pipeline pump stations, utility power generation, emergency standby power, and remote control station operation. The 723 Plus provides state-of-the-art control for new and retrofit situations.

Standard Applications: (product spec 03203)

Custom Applications: (product spec 02876)



The **723PLUS Compressor Performance Control**, based on Woodward's powerful 723PLUS/828 digital control platform, controls the speed, air/fuel ratio, and ignition timing of reciprocating engines in variable speed/load applications. The control includes inputs for two speed sensors (MPU or proximity) with firing torsional filters, for monitoring engine and turbocharger speed (or for redundant engine speed sensing), a notch filter to attenuate the effect of flexible coupling torsionals, a remote speed setting input, and inputs for air manifold pressure, fuel gas header pressure, and air manifold temperature with 3D curves for precisely mapping air/fuel ratio and ignition timing settings. Discrete raise/lower inputs are provided to adjust air manifold pressure and engine speed settings.

(product spec 03214)



The **733 Digital Control** manages and controls reciprocating engines (gas, diesel, or dual fuel) used in power generation, marine propulsion, locomotive and industrial engine, and process markets. The 733 has been specifically designed to enable it to be mounted directly on the engine, withstanding the high temperature and vibration environment. The 733 can also be mounted inside control cabinets if required.

The 733 is available as a standalone speed control with functions and configuration similar to other Woodward digital controls such as 723 (including plug-and-play network connectivity to the Woodward ProAct™ Digital Actuator family for an all-electric governing solution that can be engine mounted), and it is available as the main control unit within an engine management system. The control is designed for network connectivity to other Woodward or customer-selected devices, such as I/O modules (remote or integrated within the 733 package), actuators, ignition controls, air/exhaust and fuel flow control valves, power management controls, and EFI solenoid drivers. It may be programmed to perform all engine functions such as speed, air and fuel control, monitoring, alarms, engine protection and sequencing.

(product spec 03304)



The **EGS Control System** controls industrial gas engines used in power generation, pumping, and other stationary applications ranging from 300 kW to 2000 kW (400–2700 hp).

The highly accurate, closed-loop control system helps customers meet regulated emission levels, while maintaining engine performance over a very large range of fuel qualities.

(product spec 03336)



The **EGS-01** is a dedicated gas engine control unit that performs multiple typical gas engine control functions such as; A/F ratio control, speed control, load control and misfire detection. The EGS-01 supports detonation control, data and error logging, remote programming and monitoring and features CAN communication. The EGS-01 is highly integrated with the TecJet™ product; these products combined are designed to provide a highly accurate and flexible fuel admission system.

(product spec 36111)



The **Gas Engine I/O-Node (GEION)** in combination with 723 DCS can be used for lean-burn gas engines running in both "closed or open loop" air fuel ratio control and for stoichiometric gas engines, naturally aspirated or turbocharged, in the power range of 20 to 2000 kW. In case of a V-engine, air fuel ratio control per bank is possible using two Gas Engine I/O-Nodes and a 723 DCS, one for each bank. The Gas Engine I/O-Node itself is not suitable to do the air fuel ratio control. The Gas Engine I/O-node is specially designed to do the air fuel ratio control on carbureted turbocharged or non-turbocharged gas engines. The Gas Engine I/O-Node receives and sends air fuel ratio related parameters to the 723 DCS via the network.



The **In-Pulse™** system has been developed to control a range of Woodward electrical low pressure gas admission valves and electric-hydraulic high-pressure rail valves. These valves provide a means of injecting fuel or other fluids into engines operating within a speed range of 1 to 2100 rpm (range depends on the valve being driven). Plate type solenoid operated gas admission valves (SOGAVs) are suitable for in-manifold injection only, whereas the rail valve provides actuation of both in-cylinder and in-manifold type injection devices.

(product spec 03543)



The **In-Pulse™ II** fuel injection control manages and controls electronically fuel injected (EFI) reciprocating engines (gas, diesel, or dual fuel) used in power generation, marine propulsion, locomotive and industrial engine, and process markets. The In-Pulse II manages the core fuel system and injection events for many EFI fuel systems, including electronic unit injectors and pumps (EUI/EUP), common rail systems (C-R), SOGAV™ Solenoid Operated Gas Admission Valves, micro pilot injection systems, and electronic rail valves (ERV).

The In-Pulse II can mount directly on the engine, withstanding the high temperature and vibration environment. The In-Pulse II can also be mounted inside nearby control cabinets if required.

(product spec 03315)



The **FireFly™** control detects the occurrence of knock in gas engines and adjust the ignition timing to compensate. This provides protection from the harmful effects of knock and thereby increases efficiency. The FireFly uses knock sensors placed on the engine block. These sensors pick up vibration signals and the FireFly detects the specific vibrations associated with determining the knock condition. The FireFly ensures that only knock related vibration signals are acted upon, ignoring all usual vibration signals produced by a gas engine. Using the FireFly, each cylinder can be analyzed separately during individual cycles. This ensures that each cylinder is set to achieve optimum performance. Timing and/or load can be adjusted for individual cylinders, thus improving both emissions and performance. (For OEM applications only)

(product spec 36156)

## Ignition Control Products



The **IC-100** is a microprocessor controlled, spark capacitive discharge ignition system capable of supplying ignition energy for a wide range of gas engines with 1 to 8 cylinders. The IC-100 is user programmable utilizing either RS-232 or CAN communications.

(product spec 03229)



The **TIS-910, and the IC-900 and IC-910** consist of a 16-bit CPU and other CPU related peripherals, sensor signal conditioning circuitry, a high voltage power supply, plus either 20 outputs (TIS-910) or 24 outputs (IC-900/912). The system can be configured from 2 cylinders to a maximum of either 20 cylinders (TIS-910) or 24 cylinders (IC-900/910). The unit also has all required software to be configured for any type of industrial engine. There is never a requirement for factory reprogramming of software. All user programming/ configuring is accomplished via a terminal program that resides on a Personal computer or hand-held programmer using either RS-232 or CAN communications. The **IC-920 and IC-922** have ServLink capability.

TIS-910: (product spec 03246)

IC-900/912: (product spec 03230)

IC-920/922: (product spec 03331)

## Governors



The **SG governor** hydraulic speed droop type governor is designed for use on small diesel, gas, or gasoline engines where isochronous control is not required. The design of the speed droop governor is such that the governor operates at a slower speed as engine load increases. It is through this characteristic that stability of the system is achieved and division of load between paralleled units is made possible.



The **PSG governor** is a pressure compensated, speed-droop or isochronous governor for controlling the speed of small diesel, gas, and gasoline engines, or small steam or industrial gas turbines. The governor is used to control engines or turbines driving alternators, dc generators, pumps, or compressors.

(product spec 37010)



The **UG-25+ governor** is a microprocessor-controlled, mechanical-hydraulic amplified, governor for controlling diesel, gas, and dual fuel engines, and steam turbines. The UG-25+ offers enhanced control capabilities, such as start fuel and boost limiting schemes. The additional transient fuel limiting (jump-rate) improves the engine load acceptance and reduces transient emissions significantly. The UG-25+ concept offers a fast-acting and high-work-output governor, without the need for any auxiliary devices such as a start booster.

(product spec 03339)



The **3161 mechanical-hydraulic governor** is designed for speed control of diesel engines, gas engines, or steam turbines. The variety of standard features and available options makes the governor ideal for use in a wide variety of applications which require work capacity of up to 24 N·m (18 lb-ft). Applications include off-highway vehicles, industrial, marine, generator set, compressor, or pump drives.

(product spec 03102)



The **PG-PL** is a pressure compensated, isochronous control type governor widely used for controlling speed for all types of diesel or gas engines and steam turbines, driving pumps and compressors. It produces output in the 12 to 58 ft-lb range.

(product spec 36700)



The **EG-3P (proportional)** and **EG-3PC (proportional with compensation)** actuators are designed for use on diesel, gas, and gasoline engines, or turbines, and are particularly well suited for use in control systems requiring a proportional mechanical output of a proportional electrical input.

(product spec 82516)

## Electric Governor Systems

APECS<sup>®</sup> is the Advanced Proportional Engine Control System.



The **APECS<sup>®</sup> 4500 Programmable Engine Controller** controls small spark-ignition engines. The control operates on 9–32 Vdc, and accepts inputs from magnetic pickup, coil-type spark ignition system, magneto spark ignition system, or Hall effect sensor. It offers user-selectable isochronous or droop governing and easy programmability, as well as an external analog input, two switched inputs, PTO switch input, idle verification switch input, engine protection switch input, a status LED, and a configurable auxiliary output.



The **APECS<sup>®</sup> 5000 Programmable Engine Controller** drives a stepper motor for throttle actuation. Designed for utility vehicle and other mobile applications, the APECS 5000 features ground speed and acceleration control to enhance personnel safety.



(product catalog 52132)



The **DPG Series** microprocessor-based digital controller governs diesel or gas-fueled engines. These programmable controls provide isochronous or droop speed control, isochronous load sharing, and precision frequency control. Work with APECS and Power Flow actuators.

- DPG 2100 series for generators (product spec 36502)
- DPG 2200 series for load-sharing generators (product spec 36503)
- DPG 2300 series for off-road vehicles (product spec 36504)
- DPG 2400 series for EFC valve applications (Cummins engines)



The **512/524 and 1712/1724 EPGs** are three-component governing systems for 12 or 24 Vdc operation. All EPG systems include an actuator, an electronic speed control, and magnetic pickup. Both isochronous and droop controls are available. The EPG is designed for precise speed control of diesel, gas, or gasoline engines, and gas turbines. The governor is especially suited to prime movers without a mechanical drive or hydraulic oil supply for the governor, and which have low-mass, low-friction fuel linkages.

(product spec 04106)



The **ProAct™ Integrated Speed Control (ISC)** is an electric actuator with an integrated electronic driver capable of diesel or gaseous engine speed control or positioning tasks. The ProAct ISC can be mounted on-engine to control a diesel fuel rack or gaseous throttle via linkage or integrated throttle body. The ProAct ISC accepts a speed input from an MPU and can accept a position command signal from another device in the system such as an engine control module.

Configured as a speed control, the ProAct ISC offers speed control with software-selectable speed set points, dynamics, fuel limiting, and start/stop behavior.

Configured as a positioner, the ProAct ISC offers position control with software-selectable CW/CCW operation and field calibration.

(product spec 03326)

## Diesel Engine Products

Tightening emissions standards, cost pressures, and dispersed application requirements have resulted in a more challenging business climate for the industrial diesel engine industry. To meet these demands, Woodward offers comprehensive energy control system solutions for every size, type, and application of industrial diesel engine made.

From the smallest diesel in mobile and stationary equipment to the largest heavy fuel engine in marine and power applications, Woodward offers a tightly integrated control system solution that perfectly matches the requirements.

Based on four core technologies—Fuel and Air Delivery, Combustion Control, Electronic Controls and Software, and Systems Integration—Woodward system solutions are custom designed to maximize your engines' fuel economy and efficiency, and reduce engine emissions.



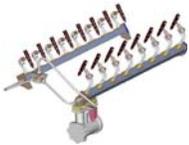
### Fuel Injection Systems



A full range of fuel injection **Nozzles**.



**Pumps** for diesel and heavy fuels that provide the high fuel injection pressures required to achieve the ultimate in high fuel efficiency, low emissions engine designs.



Woodward provides complete **Common Rail Fuel Injection** systems, including engine control unit (ECU), high-pressure fuel pump, high-pressure rails and pipes, flow control valve, and fuel injectors. The systems can use up to 1800 bar injection pressure in single and double wall piping and rail systems with integrated flow limiters. The modular pump has an integral flow control valve and pressure relief valve. The injector is capable of multiple injection events per cycle. The system is highly efficient and can match a wide range engine bores and speeds.

### Turbocharger Bypass and Wastegate Valves



**The Flo-Tech™** integrated actuator/butterfly valve body is designed for direct replacement of conventional turbocharger bypass valve with actuator and linkage. The valve body will provide equivalent maximum flow rates of standard butterfly valve bodies of the same diameter. The Flo-Tech integrated actuator/valve body requires no actuator or linkage.

(product spec 04140)



**The Glo-Tech™** modulating, all electric wastegate/bypass valve is capable of handling hot (600 °C) exhaust gasses for gas or diesel engines. The Glo-Tech valve provides engine manufacturers a method to reduce emissions, increase efficiency and reliability. The Glo-Tech valve has a bore of 60 mm and can accept an actuator case temperature of 100 °C.

(manual 26021)

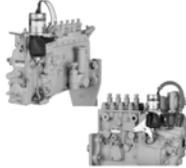
## Actuators



Woodward has numerous **solenoids**, both single-coil and dual-coil (allows the solenoid to remain energized for longer periods of time without overheating). Solenoids can be used to operate engine run/stop levers, throttles, chokes, valves, and clutches. They can also protect expensive diesel engines from overspeed, low lube pressure, and high temperature.

Woodward also has **solenoid shutdown kits** to fit a range of engines and fuel injection pump governors. The kits are designed for ease of installation and maintenance, and contain the solenoid plus all mounting hardware).

(product catalog 52132)



**APECS® actuators** work with APECS controls to provide proportional fuel control for construction, industrial, and agricultural equipment. Actuators are available with push or pull actuation, flange or base mount, 12 or 24 Vdc. Actuators come in 1.75" (44.5 mm), 2.50" (63.5 mm) and 3.00" (76.2 mm) diameter.

(product catalog 52132)



**The APECS® 2000 and APECS® 2500 linear actuators** provide accurate precise positioning with a minimal number of moving parts. Many of the moving parts normally associated with electric actuators are eliminated, prolonging the MTBF (mean time between failure).

These actuators are easy to install by mounting near the fuel system and direct connecting to the fuel control rod or lever. In most installations, the normal rotary-to-rotary connection is eliminated, resulting in a more trouble-free and accurate control system.

The actuator is suitable for installation on diesel, gasoline, or natural gas engines with fuel system force requirements of less than 13 pounds (58 N) of force.

(product spec 03324)



**The APECS® 70025 integrated actuator for Stanadyne "D" series injection pumps** is a proven all-electric, rotary actuator fully integrated into the cover of the Stanadyne pump. There are no brackets or external linkage, and the design is factory approved by Stanadyne. Installation is easy—simply remove the existing cover and install the new cover. Both a standard model and a completely sealed model are available.



**The APECS® 7000 all-electric rotary actuator** provides 70 degrees of rotation in a small package. The actuator is applicable to gasoline, natural gas, and diesel engines. A direct connection between the actuator shaft and butterfly shaft is possible on carburetor and throttle-body applications.

(product spec 36501)



The **L-Series Position Controller** provides a building block approach to total engine management. The microprocessor-based bi-directional actuator design easily attaches to fuel pumps, mixers, or throttle bodies. The L-Series Position Controller accepts a position command and drives the 0–60 degree output shaft to the commanded position based on an internal shaft position sensor. The high-efficiency torque motor delivers 0.34 N·m (0.25 lb-ft) nominally over 60° travel range to operate fuel or air control devices.

(product spec 03328)



The **ProAct™ Digital Plus actuator** is intended to be mounted on-engine to control varying functions including (but not limited to): fuel rack positioning, timing control, throttle valve, and wastegate positioning. The actuator is effectively a positioner with an integral driver, which will accept a position command signal from another device in the system such as a speed control.

The ProAct Digital Plus actuator includes an integral digital driver capable of controlling the actuator, communicating with the outside control system, and containing on-board software and intelligence to realize monitoring and customizing functions.

(product spec 03231)



The **EM-80 and EM-300 gear-motor actuators** are intended to be mounted on large diesel, gas, and gasoline engines, and on all types of turbines, to control the position of engine fuel racks, turbine fuel valves, turbine and turbocharger variable geometry, and to handle timing control. These systems are well suited for engines without a mechanical drive or hydraulic oil supply.

The EM-80 and EM-300 are all-electric actuator systems that provide 40 degrees of actuator output rotation. Each system consists of a three-phase brushless ac motor which drives a high-precision planetary reduction gear box. A dedicated driver controls the actuator position and allows monitoring of most features.

PC/Windows based software facilitates the system setup. The EM-80 and EM-300 are freely programmable to meet many customer requirements.

(product spec 36199)



The **UG-Actuator** offers the advantages of electronic control and load sharing systems while using the convenient, existing UG8-type drives and linkages. The actuator provides the muscle for Woodward analog controls such as the 2301A, as well as Woodward digital controls and engine management systems. The UG-Actuator can be used with diesel, gasoline, or natural gas engines, as well as with steam and industrial gas turbines. The UG-Actuator has a self-contained oil sump so a separate oil supply is not required.

(product spec 37511)



The **EG-3P (proportional) and EG-3PC (proportional with compensation)** actuators are designed for use on diesel, gas, and gasoline engines, or turbines, and are particularly well suited for use in control systems requiring a proportional mechanical output of a proportional electrical input.

(product spec 82516)



The **PGPL Actuator/Driver** is an electrohydraulic actuator with a proportional driver interface which can be used with electronic controls providing a 0 to 200 mA position signal. The actuator is designed for use with Woodward 2301A and D series, 700-series, Peak<sup>®</sup> 150, and 505 digital controls.

(product spec 37520)

## Engine Control Units



**ESS electronic speed switches** are used to protect against overspeed and underspeed, to detect starting speed and disconnect the cranking motor, to detect other critical speeds. These fully electronic switches can be applied to generator sets, starter motors, engines, conveyors, bus doors, PTO protection, magnetic brake retarders, transmissions, .... They can receive inputs from magnetic pickups, alternator output, ignition output, or the Mini-Gen<sup>®</sup> signal generator.

(product catalog 52132)



**The In-Pulse™** system has been developed to control a range of Woodward electrical low-pressure gas admission valves and electric-hydraulic high-pressure rail valves. These valves provide a means of injecting fuel or other fluids into engines operating within a speed range of 1 to 2100 rpm (range depends on the valve being driven). Plate type solenoid operated gas admission valves (SOGAVs) are suitable for in-manifold injection only, whereas the rail valve provides actuation of both in-cylinder and in-manifold type injection devices.

(product spec 03543)



**The In-Pulse™ II** fuel injection control manages and controls electronically fuel injected (EFI) reciprocating engines (gas, diesel, or dual fuel) used in power generation, marine propulsion, locomotive and industrial engine, and process markets. The In-Pulse II manages the core fuel system and injection events for many EFI fuel systems, including electronic unit injectors and pumps (EUI/EUP), common rail systems (C-R), SOGAV™ Solenoid Operated Gas Admission Valves, micro pilot injection systems, and electronic rail valves (ERV).

The In-Pulse II can mount directly on the engine, withstanding the high temperature and vibration environment. The In-Pulse II can also be mounted inside nearby control cabinets if required.

(product spec 03315)



**The 2301A Speed Control** controls the speed or load of diesel or gas engines, or steam or gas turbines. The unit provides control in the isochronous mode, with droop available through an externally wired potentiometer. The isochronous mode is used for constant speed of the controlled prime mover as long as it is able to provide power to satisfy the load.

(product spec 82021)



**The 2301A Load Sharing and Speed Controls** with temperature Limiting or Process Limiting are used in electric generator systems for which load sharing is desired. They can be used with diesel or gas engines, or steam or gas turbines and are compatible with all Woodward electronic controls.

(product spec 82047)



**The 2301D and 2301D-EC Digital Load Sharing and Speed Controls** are used in electric generator systems for which load sharing is desired. They can be used with diesel or gas engines, or steam or gas turbines and is compatible with all Woodward electronic controls. The control utilizes a 376 processor based speed control and provides a single serial port for PC communications. The digital design eliminates the use of potentiometers for tuning and load control.

(product spec 03204)



**The 723 Plus Digital Control** manages and controls reciprocating engines (gas, diesel, or dual fuel) used in power generation, marine propulsion, and gas compression/distribution. The control may also be used in cogeneration, power transmission/distribution, process management, pipeline pump stations, utility power generation, emergency standby power, and remote control station operation. The 723 Plus provides state-of-the-art control for new and retrofit situations.

Standard Applications: (product spec 03203)

Custom Applications: (product spec 02876)



**The 733 Digital Control** manages and controls reciprocating engines (gas, diesel, or dual fuel) used in power generation, marine propulsion, locomotive and industrial engine, and process markets. The 733 has been specifically designed to enable it to be mounted directly on the engine, withstanding the high temperature and vibration environment. The 733 can also be mounted inside control cabinets if required.

The 733 is available as a standalone speed control with functions and configuration similar to other Woodward digital controls such as 723 (including plug-and-play network connectivity to the Woodward ProAct™ Digital Actuator family for an all-electric governing solution that can be engine mounted), and it is available as the main control unit within an engine management system. The control is designed for network connectivity to other Woodward or customer-selected devices, such as I/O modules (remote or integrated within the 733 package), actuators, ignition controls, air/exhaust and fuel flow control valves, power management controls, and EFI solenoid drivers. It may be programmed to perform all engine functions such as speed, air and fuel control, monitoring, alarms, engine protection and sequencing.

(product spec 03304)

## Governors



**The SG governor** hydraulic speed droop type governor is designed for use on small diesel, gas, or gasoline engines where isochronous control is not required. The design of the speed droop governor is such that the governor operates at a slower speed as engine load increases. It is through this characteristic that stability of the system is achieved and division of load between paralleled units is made possible.



**The PSG governor** is a pressure compensated, speed-droop or isochronous governor for controlling the speed of small diesel, gas, and gasoline engines, or small steam or industrial gas turbines. The governor is used to control engines or turbines driving alternators, dc generators, pumps, or compressors.

(product spec 37010)



**The EGB Governor/Actuator** is used with Woodward analog or digital electronic controls that provide a proportional 20–160 mA signal to control dual fuel, diesel, and gasoline engines, and gas and steam turbines driving electrical or mechanical loads. The governor/actuator is available for outputs of 1, 2, 10, 13, 29, 35, 58, 200, and 300 ft-lb (1.4, 2.7, 14, 18, 39, 47, 79, 271, and 407 J) work capacity to position fuel racks or linkage.

During normal operation, the electronic control and actuator section of the EGB regulates fuel to the prime mover. Upon loss of electronic control signal, the standard EGB is adjusted to cause prime mover shutdown. An electronic, pneumatic, or manual starting device is then used to allow prime mover starting and operation under ballhead control. The ballhead section also regulates fuel if the control fails in such a manner as to call for maximum fuel. The EGB governor/ actuator can also be factory set to give maximum fuel (reverse action) on electronic control signal loss.

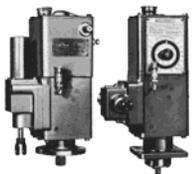
The self-contained hydraulic oil supply makes the governor easy to maintain in almost any installation environment.

EGB-1P/2P: (product spec 82575)

EGB-10P/13P/35P: (product spec 82543)

EGB-29P/58P: (product spec 82483)

EGB-200P/300P: (product spec 82473)



**The PG Dial and Lever governors** control the speed of diesel, gas, and dual-fuel engines in a variety of fields. Their applications include engines driving pumps, compressors, alternators, variable speed dc generators, marine propulsion units, and paper machines. Besides controlling speed, PG governors can also limit load and shut down the engine when the lubricating oil pressure fails. Woodward customizes each PG governor to meet the needs of the engine and the application.

(product spec 36010)



The **PG-PL** is a pressure compensated, isochronous control type governor widely used for controlling speed for all types of diesel or gas engines and steam turbines, driving pumps and compressors. It produces output in the 12 to 58 ft-lb range.  
(product spec 36700)



The **UG-25+ governor** is a microprocessor-controlled, mechanical-hydraulic amplified, governor for controlling diesel, gas, and dual fuel engines, and steam turbines. The UG-25+ offers enhanced control capabilities, such as start fuel and boost limiting schemes. The additional transient fuel limiting (jump-rate) improves the engine load acceptance and reduces transient emissions significantly. The UG-25+ concept offers a fast-acting and high-work-output governor, without the need for any auxiliary devices such as a start booster.  
(product spec 03339)



The **UG-5.7/8/10 governor** is a mechanical-hydraulic governor for controlling diesel, gas, or dual fuel engines, or steam turbines. UG-Dial governors are particularly suited for constant speed applications. Knob speed settings make synchronization easy for generator applications. Motor speed setting is available for remote synchronization. Adjustable droop makes load sharing between engines precise. UG Lever governors are widely used for variable speed control. Remote speed setting can be either mechanical through the speed setting lever or pneumatic with a special speed setting device. Special attachments are available for other applications.

UG-5.7/8/10 governor: (product spec 03029)

UG governor with pneumatic speed adjust: (product spec 03037)

### Electric Governor Systems



The **APECS<sup>®</sup> 4500 Programmable Engine Controller** controls small spark-ignition engines. The control operates on 9–32 Vdc, and accepts inputs from magnetic pickup, coil-type spark ignition system, magneto spark ignition system, or Hall effect sensor. It offers user-selectable isochronous or droop governing and easy programmability, as well as an external analog input, two switched inputs, PTO switch input, idle verification switch input, engine protection switch input, a status LED, and a configurable auxiliary output.

(product catalog 52132)



The **DPG Series** microprocessor-based digital controller governs diesel or gas-fueled engines. These programmable controls provide isochronous or droop speed control, isochronous load sharing, and precision frequency control. Work with APECS and Power Flow actuators.

- DPG 2100 series for generators (product spec 36502)
- DPG 2200 series for load-sharing generators (product spec 36503)
- DPG 2300 series for off-road vehicles (product spec 36504)
- DPG 2400 series for EFC valve applications (Cummins engines)



The **512/524 and 1712/1724 EPGs** are three-component governing systems for 12 or 24 Vdc operation. All EPG systems include an actuator, an electronic speed control, and magnetic pickup. Both isochronous and droop controls are available. The EPG is designed for precise speed control of diesel, gas, or gasoline engines, and gas turbines. The governor is especially suited to prime movers without a mechanical drive or hydraulic oil supply for the governor, and which have low-mass, low-friction fuel linkages.

(product spec 04106)



The **L-Series Integrated Engine Speed Control** is a microprocessor-based engine speed controller in a surprisingly small package. The L-Series can easily be programmed to match the operating parameters of every engine you produce. All it takes is a PC and a simple, plug-in download on your production line.

With many built-in functions, the L-Series speed control allows a high-volume OEM or packager to stock one part number, but implement a wide variety of engine control strategies by configuring the four auxiliary inputs at their factory.

Besides the traditional bracket mount using external linkage, the L-Series is available in a variety of mechanical configurations, including one integrated into a rotary diesel fuel pump and one integrated with a throttle body or a throttle body and mixer. The externally mounted systems can be configured for clockwise or counterclockwise (standard) shaft rotation for increasing fuel.

(product spec 03225)

## Gas Turbine Products

Tightening emissions standards, cost pressures, and dispersed application requirements have resulted in a more challenging business climate for the gas turbine industry. To meet these demands, Woodward offers comprehensive energy control system solutions for every size, type, and application of gas turbine made.

From the smallest turbine in distributed generation to the largest used in power generation applications, Woodward offers a tightly integrated control system solution that perfectly matches the requirements.

Based on four core technologies—Fuel and Air Delivery, Combustion Control, Electronic Controls and Software, and Systems Integration—Woodward system solutions are custom designed to maximize your engines' fuel efficiency and reliability, and reduce engine emissions.



### Gas Fuel Metering and Control



**The SonicFlo™ valve** controls the flow of gas fuel to the combustion system of an industrial or utility gas turbine. The unique design yields a linear flow characteristic unaffected by discharge pressure up to a pressure ratio ( $P2/P1$ ) of at least 0.8. The design also integrates the valve and actuator into a compact assembly. The key characteristics of this valve are a highly linear critical gas flow versus stroke relationship at constant upstream pressure. The integral actuator is a single-acting spring-loaded design for failsafe operation. The actuator includes an onboard hydraulic filter for last chance filtration of the fluid to ensure reliability of the servovalve and actuator. The servovalve is electrically redundant with triple coil design. Feedback for the actuator is provided by a dual coil, dual rod LVDT (linear variable differential transformer) directly coupled to the hydraulic piston.

Hydraulic: (product spec 03285)

Electric: (product spec 03287)



**The Woodward Gas Stop/Ratio Valve** performs a dual function for industrial or utility gas turbines. One function rapidly shuts off fuel to the turbine fuel control system. Another function provides accurate control of gas fuel pressure at the outlet of the stop/ratio valve. This pressure is applied to the inlets of the gas fuel control valve.

The Gas Stop/Ratio Valve features a modular design, and meets critical control characteristics while allowing the same valve design to accommodate a variety of stroke, force output, and mechanical interface arrangements. The electrical and mechanical interfaces have been designed for quick and easy assembly or removal of the valve, at the factory or in the field. The components include an on-board hydraulic filter, electrohydraulic servo valve, trip valve, single-acting hydraulic cylinder, and dual LVDTs.

(product manual 26093)



**The 3103 gas valve** is a stainless steel valve capable of metering gas flow between 23 and 18 144 kg/h (50 and 40 000 lb/h). It is designed to be corrosion resistant and self-cleaning, allowing it to operate in sour gas environments (high sulfur content gas) that can cause problems for other valves. When used in conjunction with an EM35MR electric actuator and EM 24 V digital driver, the 3103 valve delivers the demanding accuracy needed for DLE applications.

With EM35MR actuator: (product spec 03209)



**Woodward is a leader in fuel metering for Dry Low Emissions and Catalytic Combustion Control.** For applications requiring from 2 up to 5 parallel paths Woodward can provide the fuel metering system and the control. Our DLE fuel metering systems are capable of 2.0% of point, mass flow accuracy and our current programs cover multiple small industrial engines and aero-derivatives.



**The Gas Shutoff Valve** is designed to provide extremely fast shutoff to gaseous flow and to be used for emergency and normal shutdown operation. The valve operates at pressures up to 900 psia and its all stainless steel construction assures availability of the valve under all operating conditions. The valve design allows minimum pressure drop by utilizing a straight through flow, this also keeps all critical moving parts and seals out of the flow stream.

GSOV25: (product spec 40176)  
GSOV25T: (product spec 03286)



**Woodward GS series gas fuel metering systems** are designed for use on industrial gas turbines in the 200 kW to 50 MW output power range. The assemblies provide reliable, cost effective interfaces between electronic engine control systems and gas turbines used in power generation, compressor, and mechanical drive applications.

GS3/GS10: (product spec 45021)  
GS6: (product spec 03256)  
GS16: (product spec 03284)

## Liquid Fuel Metering



**The Three-way Fuel Oil Bypass Control Valve** is used to control the flow of liquid fuel to a gas turbine. The valve contains no feedback device, so it relies on external flow measurement as a form of feedback to control the flow of fuel to the turbine. Upon loss of electrical command signal or hydraulic pressure, the valve will divert fuel to the bypass port for a safe turbine shutdown. The valve utilizes a fully integrated valve and actuator design. The design is equivalent to a dual acting electrohydraulic actuator and a three-way bypassing valve.



**The Three-way Fuel Oil Stop Valve** is a two position valve used to shut off the flow of liquid fuel to the turbine and divert it to the fuel pump suction. The valve position is controlled by a low level trip pressure acting on the pilot operated trip circuit integrated into the valve. The valve uses a failsafe spring to ensure the shutoff of fuel from the turbine on loss of hydraulic control pressure or hydraulic actuation pressure. The valve utilizes a fully integrated valve and actuator design. This design is equivalent to a single acting hydraulic actuator and a three-way shut-off valve.



Woodward is leading the way in controls and fuel metering systems for the next generation of Dry Low Emission Engines—Dual Fuel DLE. The first of these engines to go to market is the LM6000 PD engine. Woodward is supplying the controls and fuel system for the first engine to go to the field.

**In the Liquid DLE Fuel system** a single positive displacement pump is used to provide fuel to the system. The Bypass Valve (BPV) is used to provide the normal system bypass and also serves to provide closed loop control of the system pressure to the three throttling valves. Each of the three throttling valves meter fuel independently to the engine manifolds. Fuel flow accuracy of better than 2.5% of point mass flow is achieved by the fuel metering valves without expensive transducers or individual valve characterizations.

(product spec 40179)



**The Liquid Shutoff Valve 25** is a three-way valve designed to rapidly shut off all liquid fuel flow and prevent leakage to the turbine. In the de-energized state, the valve diverts inlet flow to bypass ports, preventing pressure damage to positive displacement fluid systems. Normal installation of the 21.5 lb (9.8 kg) valve is in the fuel line between the fuel regulating valve and the turbine. The valve diverts flows from the discharge to bypass ports any time the operating electrical signal is lost.  
(product spec 40169)



**The 1907 large liquid fuel valve** accurately meters liquid fuel to a gas turbine during acceleration, steady-state operation, and deceleration. The valve may be used for almost any liquid-fueled industrial gas turbine application within its range of fuel flow (70 to 340 kg/h; 150 to 25 000 lb/h). The 1907 valve is typically operated with a hydro-mechanical actuator.  
(product spec 40125)



**The LQ series of liquid fuel metering valves** are designed for use on industrial and aero-derivative gas turbine engines in the 1000 kW to 42 000 kW output power range. The assemblies provide reliable, cost-effective interfaces between electronic engine control systems and gas turbines used in power generation, mechanical drive, and marine applications. The LQ valves utilize corrosion resistant, shear-type metering components that are positioned by high torque electric actuators to assure extended operation in all types of liquid fuel service.  
LQ25: (product spec 40174)  
LQ25T: (product spec 40179)

### Specialty Valves



**The 3151A Water Valve/EML100 Actuator assembly** is used as part of a gas-turbine nitrous oxide emission-reduction system. The unit meters water injected into an industrial gas turbine's combustion chamber, lowering combustion temperature. This assembly is designed to be used with the Woodward EM Digital Driver.  
(product spec 40187)

### Standard Controls



**The 2301D-GT** is a microprocessor-based control with integral application software designed for single-shaft gas turbine applications. Like Woodward's 2301A line of controls, this control is housed in a sheet-metal chassis and consists of a single printed circuit board. To facilitate unit retrofits, the 2301D-GT's I/O terminals are located in the same general location as Woodward's 2301A line of controls.



This control is designed to perform the core fuel control functions of a small gas turbine package. The application software is field configurable, allowing it to be configured and modified to meet site-specific requirements.

Standard: (product spec 03236)  
For Dresser-Rand KG2 gas turbines: (product spec 91346)



**The GTC100 and GTC200** industrial controllers offer robust, low-cost control for a wide variety of dual-fuel gas turbine applications. The GTC100 controls single-shaft turbines, and the GTC200 controls two-shaft machines. Industrial microprocessor technology is coupled with a proven real time operating system to provide reliable and deterministic performance that is required for recursion-rate-sensitive applications. Dedicated inputs and outputs (I/O) are available onboard for key control signals, while expansion I/O is used for other less sensitive parameters.  
(product spec 03319)



The **GTC190** control system is a new generation of turbine control that provides the power of PC technology in a rugged and deterministic system. The flexible and powerful software tools and exceptional computational power make the GTC190 control an ideal solution for controlling a single-shaft large industrial gas turbine. Typical large industrial gas turbine control loops (speed, load, EGT, etc.) come standard within the core system. Both single and dual fuel capabilities are available with the GTC190.

(product spec 03294)



The **GCT250** control is an industrial platform that offers robust, low-cost control for a wide variety of aero-derivative gas turbine applications. Most importantly, this control is designed to be a true “network based platform” that interfaces seamlessly with a wide variety of modern communication and field bus architectures. The GTC250 couples state-of-the-art PC technology with a proven real time operating system to provide reliable and deterministic performance that is required for recursion-rate sensitive applications. Dedicated inputs and outputs (I/O) are available onboard for key control signals while distributed I/O can be used for other less critical parameters.

(product spec 03303)

### Turbine Exciter Systems



The **STExcite™** high-energy ignition driver interfaces with flexible ignition leads and igniters to provide the ignition system of industrial gas turbines. The unit is compatible with existing high-energy turbine ignition systems. Versions are available with single (STExcite 2010) and dual (STExcite 2020) outputs. The use of digital circuitry allows for advanced diagnostics, improved reliability, and network communication options. In addition, the unit is UL Listed and CE approved.

(product spec 03308)

### Fuel Nozzles



Woodward offers one of the widest ranges of technology options available for fuel spray components, including gas injection, liquid injection, dual fuel, and dry low emissions. These FST product lines incorporate an unmatched combination of products, technologies and application expertise:

- Pressure Atomizing Nozzles
- Airblast and Air Assist Nozzles
- Hybrid Airblast Nozzles
- Industrial Nozzles (standard and DLE)
- Augmentor Spray Manifolds
- Augmentor Spraybars
- Fuel Metering and Distribution Valves

### Custom Control Systems



The **AtlasPC™** control system is a new generation of turbine and engine control that provides the power of PC technology in a rugged and deterministic system. The flexible and powerful software tools and exceptional computational power make the AtlasPC control an ideal solution for controlling a variety of Prime Movers:

- Industrial Gas Turbines (large and small)
- Aero-derivative Gas Turbines
- Gas and Diesel Engines
- Steam Turbines
- Hydro Turbines

(product spec 03213)



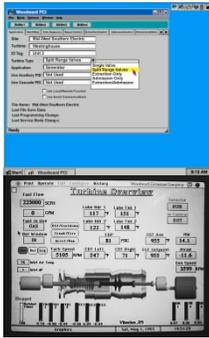
The AtlasSC™ control is a powerful and rugged industrial control with embedded microprocessor technology and dedicated I/O for real time control of engines and turbines. At the heart of the small and powerful AtlasSC platform is an industrial processor with Real Time Operating System (RTOS). The AtlasSC platform utilizes the industry-standard PC/104 bus structure to leverage “PC Economics,” resulting in lower costs and greater feature flexibility.

(product spec 03253)



The MicroNet™ and MicroNet™ Plus Controllers are state-of-the-art, programmable, digital controllers. They can be programmed to control any prime mover and its associated processes, as well as system sequencing, high speed system monitoring, surge control, vibration monitoring and station control. The MicroNet™ digital control is available in both simplex and triple modular redundant (TMR) configurations. The MicroNet Plus is the next-generation MicroNet, with flexibility that allows it to be configured with one or two CPUs; one or two power supplies; and simplex, duplex, or triplex I/O modules.

(product spec 85583 [MicroNet], 03333 [MicroNet Plus])



The many decades of Woodward experience with controlling engines and turbines, has been translated into a **sophisticated suite of software tools** specially tailored to prime mover applications.

- GAP™—Graphical Application Programmer is an IEC 1131-3 graphical programming environment with function blocks that are specialized for turbine and engine control applications.
- Real Time Operating System (RTOS)—Provides the software architecture to meet the real-time requirements of the most complex turbine control problems.
- NetSim™—GAP can be compiled directly for PC Simulation with NetSim against engine models in ACSL, MATRIXx, Simulink or Matlab.
- Service Tools—A range of options from on control displays for local control and service, debug, and configuration functions, to PC based windows software programs for advanced troubleshooting and maintenance (both locally and remotely).



**HMI (Human Machine Interface)** for Woodward electronic controls is primarily Windows based PC software. Utilizing proven Intellution® 32-bit software that is compatible with both Windows 95 and NT operating systems, customers can do on-line configuration, trending, reporting, statistical process control, alarming and alarm management, remote monitoring, and supervisory control and data acquisition. The interface is very intuitive; it features on-line help and offers true plug and play hardware compatibility.

### Accessories and Fuel Skids



The **H-Spring Actuator** is a modular, high-pressure, hydraulic actuator designed for high-force linear or rotary valve control applications requiring failsafe functionality. Optionally, the actuator can be configured for either modulating or on/off services. Both custom and standard configurations are available to match the required application. H-Spring actuators are designed for use in utility steam turbine control valves and stop valves, gas turbine steam admission valves and bypass air valves, and in general process applications.

(product spec 03343)



Woodward provides a variety of actuators, pumps, servovalves, and hydraulic control units to deal with variable geometry needs on the engine. Typical applications control variable stator vanes, inlet guide vanes, variable bleed valves, thrust balance, etc.



**Fuel Skids**—Woodward works with OEMs to determine the best system design and components to meet the fuel metering requirements for all types and sizes of gas turbine fuel systems. Working at the system level, the design is optimized for maximum performance and minimum cost in the areas of fuel metering, skid design, manufacture, assembly, and test.

## Steam Turbine Products

Tightening reliability, safety, total cost of ownership, and plant-wide communications requirements are changing the face of the steam turbine controls industry. To meet these demands, Woodward offers comprehensive energy control system solutions for every size, type, and application of steam turbine made. From the smallest turbine to the largest, Woodward offers a tightly integrated control system solution that perfectly matches the requirements.

### Standard Digital Controls



**The 505 and 505E** are microprocessor-based controls designed to operate steam turbines of all sizes. The 505 is designed to operate steam turbines using one or two (split-stage) actuators to drive inlet steam valves. The 505E is designed to operate single extraction and/or admission steam turbines. These digital controls are field programmable. They use menu-driven software to instruct site engineers on programming the control to a specific generator or mechanical drive application. The 505 or 505E can be configured to operate as a stand-alone unit or in conjunction with a plant's Distributed Control System.

(product spec 85005)



**The Peak® 150** digital control is designed to control a steam turbine driving a mechanical load. It provides tight control of speed (NEMA D) and includes an input for a 4–20 mA remote speed control signal, which can be used for a process-generated input to control the speed setting. Other features include dual speed control dynamics and overspeed trip test capabilities.

(product spec 85549)



**The ProTech® 203** Overspeed Protection System monitors three individual magnetic pickups (MPUs) to provide overspeed protection for steam and gas turbines and other prime movers. The system replaces mechanical overspeed devices, especially in high-speed applications (above 10,000 rpm) when a mechanical overspeed device becomes unreliable.

(product spec 85562)



**The 5009** control is designed to provide highly reliable control on critical steam turbine applications. It can be configured to control condensing, backpressure, and single automatic extraction/admission turbines. The 5009 is field programmable and uses Windows™ menu-driven software to guide site engineers on configuring the control to a specific generator or mechanical drive application. The 5009 can be configured to operate as a stand-alone unit or in conjunction with a plant's Distributed Control System.

(product spec 85578)



**The 505DE** is a microprocessor-based control with integral application software that is designed to control double automatic extraction/admission steam turbines. The turbine control architecture is patterned after the popular 505E Single Extraction/Admission Steam Turbine Control. Like the 505E, the 505DE uses configurable software for maximum field flexibility.

The control hardware consists of four plug-together modules housed in a rugged metal chassis. The SmartCore module and the Analog I/O module contain the I/O required for double extraction turbine control. The main processor and the Ethernet port are located on the Pentium CPU module. The Power Supply module (24 Vdc) is provided to power the entire control assembly. The control also contains 12 relay drivers for external use.

(product spec 03312)





The **505CC-2** is a microprocessor-based control with integral application software designed to control a single-valve or two-valve steam turbine and its one- or two-stage compressor load. The turbine control architecture is patterned after the popular 505 and 505E turbine controls. The anti-surge control provides the user with a choice between two algorithms—the standard Woodward anti-surge algorithm or a special ‘minimum transducer’ design that adapts to variable molecular weights. Like the 505, the 505CC-2 uses configurable software for maximum field flexibility.

The control hardware consists of four plug-together modules housed in a rugged metal chassis. The SmartCore module contains the basic I/O for turbine control. An Analog I/O module interfaces with the signal I/O associated with the one- or two-stage load compressor. The main processor and an Ethernet port are located on the Pentium CPU module. In addition, a Power Supply module (24 Vdc) is provided to power the entire control assembly. The modules are stacked into a PC/104 configuration that eliminates the need for a costly motherboard. Connections between the modules are made with plug-together on-board connectors that are environmentally rated for industrial service in adverse conditions.

(product spec 03298)



The **Servo Position Controller (SPC)** is a servo-valve driver that accepts a DeviceNet™ \* or 4–20 mA based position demand signal from a system controller, and accurately positions proportional or integrating servo-valves. The SPC has the required accuracy, responsiveness, and redundancy required for steam or gas turbine fuel valve control. For valve position sensing, the SPC accepts feedback signals from one or two (redundant) ac devices or one dc device.

A Windows based software program is used to configure the SPC, adjust tunables, and monitor parameters via a personal computer. For ease of service, SPC configurations can be done while connected or disconnected to the unit. Once a configuration has been created, this program allows configurations to be uploaded and downloaded to other SPCs as desired.

\*—DeviceNet is a trademark of Open DeviceNet Vendor Association, Inc.  
(product spec 03254)

## Custom Digital Controls



The **MicroNet™** and **MicroNet™ Plus Controllers** are state-of-the-art, programmable, digital controllers. They can be programmed to control any prime mover and its associated processes, as well as system sequencing, high speed system monitoring, surge control, vibration monitoring and station control. The MicroNet™ digital control is available in both simplex and triple modular redundant (TMR) configurations. The MicroNet Plus is the next-generation MicroNet, with flexibility that allows it to be configured with one or two CPUs; one or two power supplies; and simplex, duplex, or triplex I/O modules.

(product spec 85583 [MicroNet], 03333 [MicroNet Plus])



The **AtlasPC™** control system is a new generation of turbine and engine control that provides the power of PC technology in a rugged and deterministic system. The flexible and powerful software tools and exceptional computational power make the AtlasPC control an ideal solution for controlling a variety of prime movers:

- Steam Turbines
- Industrial Gas Turbines (large and small)
- Aero-derivative Gas Turbines
- Gas and Diesel Engines
- Hydro Turbines

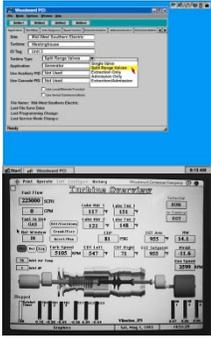
(product spec 03213)



The **2301D-ST** is a microprocessor based control with integral application software designed for single-valve steam turbine applications. Like Woodward's 2301A line of controls, this control is housed in a sheet-metal chassis and consists of a single printed circuit board. To facilitate unit retrofits, the 2301D-ST's I/O terminals are located in the same general location as Woodward's 2301A line of controls.

This control is designed to perform the core control functions of a small steam turbine package. The application software is field configurable, allowing it to be configured and modified to meet site-specific requirements.

(product spec 03297)



The many decades of Woodward experience with controlling engines and turbines, has been translated into a **sophisticated suite of software tools** specially tailored to prime mover applications.

- **GAP™**—Graphical Application Programmer is an IEC 1131-3 graphical programming environment with function blocks that are specialized for turbine and engine control applications.
- **Real Time Operating System (RTOS)**—Provides the software architecture to meet the real-time requirements of the most complex turbine control problems.
- **NetSim™**—GAP can be compiled directly for PC Simulation with NetSim against engine models in ACSL, MATRIXx, Simulink or Matlab.
- **Service Tools**—A range of options from on control displays for local control and service, debug, and configuration functions, to PC based windows software programs for advanced troubleshooting and maintenance.

### Actuation



The **TG-13E and TG-17E proportional actuators** are self-contained electrohydraulic actuators for use on steam turbines where isochronous control, load sharing, or other functions are required. They can be used with all available Woodward electronic governor controls and accessories. The TG actuators convert an electrical signal to a corresponding proportional output shaft position to position the valve which controls the flow of steam or energy medium to the turbine. They are intended for controlling small steam turbines driving such loads as alternators, dc generators pumps, compressors, fans or paper-making machines.

(product spec 04044)



The **Electrohydraulic Power Cylinder (EHPC)** provides the force to operate the control valves of a steam turbine. The EHPC is intended for use on mechanical drives or generator driven turbines. The EHPC integrates the actuator, pilot valve, electronic feedback device, final driver and the power cylinder into a single package, eliminating linkage and reducing hydraulic plumbing and wiring.

(product spec 85189)



The **Electrohydraulic Power Servo (EHPS)** is a fully integrated three-stage servo valve designed to drive low-pressure steam turbine control valve cylinders. The EHPS, in conjunction with a new or already installed steam valve cylinder, provides the linear actuation force to operate steam turbine control valves or valve racks. This servo can be configured to drive single or double acting actuators, and to use the system's turbine lube oil supply, or a separate oil source (5.5–17.2 bar, 80–250 psi).

(product spec 03342)



The **TM-25LP and TM-200LP** actuators are electrohydraulic, proportional actuators for positioning steam and fuel-control valves requiring low/high force linear inputs.

(product spec 82451)



The **ProAct™ Digital Plus actuator** is intended to be mounted on-engine to control varying functions including (but not limited to): fuel rack positioning, timing control, throttle valve, and wastegate positioning. The actuator is effectively a positioner with an integral driver, which will accept a position command signal from another device in the system such as a speed control.

The ProAct Digital Plus actuator includes an integral digital driver capable of controlling the actuator, communicating with the outside control system, and containing on-board software and intelligence to realize monitoring and customizing functions.

(product spec 03231)



The electrically controlled **Hydraulic Amplifier** is a pilot operated, linear servo actuator used in conjunction with the Woodward 2301, 505 Series or MicroNet™ electronic controls. The amplifier contains a Woodward EG-3P actuator which converts the electric control signal to a rotary output which controls the servo output position taken by the amplifier. The amplifier is capable of operating the control mechanisms for steam turbines or large engines which require relatively large forces and work capacity.

(product spec 89007)



The Woodward **CPC Current to Pressure Converter** is designed for positioning steam and fuel valves and/or the associated servos. A 4–20 mA in/out signal is linearly and proportionally converted into a hydraulic output pressure. The CPC can thus interface with any electronic control, such as Woodward MicroNet™ systems and the Woodward 505 Control. It connects to pressure-operated servo systems and single-acting power cylinders. The CPC is suited for new as well as retrofit applications.

(product spec 85202)



The **H-Spring Actuator** is a modular, high-pressure, hydraulic actuator designed for high-force linear or rotary valve control applications requiring failsafe functionality. Optionally, the actuator can be configured for either modulating or on/off services. Both custom and standard configurations are available to match the required application. H-Spring actuators are designed for use in utility steam turbine control valves and stop valves, gas turbine steam admission valves and bypass air valves, and in general process applications.

(product spec 03343)

## Governors



The **UG-25+ governor** is a microprocessor-controlled, mechanical-hydraulic amplified, governor for controlling diesel, gas, and dual fuel engines, and steam turbines. The UG-25+ offers enhanced control capabilities, such as start fuel and boost limiting schemes. The additional transient fuel limiting (jump-rate) improves the engine load acceptance and reduces transient emissions significantly. The UG-25+ concept offers a fast-acting and high-work-output governor, without the need for any auxiliary devices such as a start booster.

(product spec 03339)



The **TG Governors** are self-contained mechanical-hydraulic speed droop governors for use on small steam turbines where isochronous (constant speed) operation is not required.

(product spec 04038)

## Power Management Products

From the very simplest power generation applications to the most complex, Woodward has the power management control to meet your needs. Based on decades of experience with genset control, load/VAR sharing, synchronization and power protection technologies, Woodward's power management product line is unsurpassed in the world.



Woodward's fully integrated generator set control panels are designed to control, monitor, and protect the complete generator system, including the engine, generator, switchgear, and utility power. This product range spans the full range of generator set applications—from the simple, low-cost easYgen™ controls for stand-alone or emergency generators, up to the EGCP-3 controls for complex, multiple generator, multiple utility feed systems.

In addition to the protective relaying functions built into the GCP and EGCP genset controls, Woodward offers a line of multi-function protective relays that protect the generator or utility for numerous ANSI-standard faults in a single, compact and low-cost unit.

Other Woodward analog and digital controls provide discrete functionality, including synchronization, load sharing, generator load sensing and loading, and import/expert control.

Regardless of your application, Woodward has a cost-effective control solution that perfectly matches the requirements.

## Genset Controls

Woodward's fully integrated generator set control panels are designed to control, monitor, and protect the complete generator system, including the engine, generator, switchgear, and utility power supply. This product range spans the full range of generator set applications—from the simple, low-cost GCP-10 Series controls for stand-alone or emergency generators up to the GCP-30 Series / EGCP-3 controls for complex, multiple generator, multiple utility feed systems.



For isolated power units, the new GCP-11 genset control provides complete engine and generator control, as well as control logic for one power circuit breaker. The GCP-11 unit provides engine start-stop control, and also protects the engine and generator for speed, temperature, pressure, voltage, current, frequency, overload or other faults. The control includes a total of 12 discrete alarm inputs, 2 analog engine signal inputs, 1 switching/magnetic pickup input, and 9 freely configurable relay outputs.

(product spec 03242)



For emergency and stand-by power applications, the **GCP-12** genset control with control logic for two power circuit breakers could be used. The GCP-12 unit provides engine start-stop control, ATS transfer switch control (open transition), and also protects the engine and generator for speed, temperature, pressure, voltage, frequency, or other faults. The control includes a total of 12 discrete alarm inputs, 2 analog engine signal inputs, 1 switching/magnetic pickup input, and 8 freely configurable relay outputs.

(product spec 03242)



The **easYgen™-1000** is a second-generation genset control designed to provide a maximum of flexibility in a user friendly, easy-to-use, and intuitive design with a big graphical display for simple applications. This controller is one of a large series of new and powerful genset controls (**easYgen**). This sophisticated trend-setting technology offers a maximum of flexibility for each user. New technologies included are: **FlexApp™** (This intelligent and flexible feature provides the tool for simple adjustment of multiple applications); **DynamicsLCD™** (The graphical LCD provides softkeys that vary depending on application and operation); **FlexIn™** (The included two analog inputs can be freely configured through the user); **FlexCAN™** (Flexible CAN bus for multiple use. Selectable during configuration); **LogicsManager™** (A large number of measuring values, inputs, internal states or constant values can be combined logically to operate a relay contact or an internal function); **FlexRange™** (The true rms voltage measuring combines both rated 120 Vac and rated 480 Vac). Users need to keep only one unit in stock.

Woodward also offers the **easYgen™ 300** for auto start and transfer switch operation, and the **easYgen™ 3000** for multiple unit operation.

easYgen 300 (product spec 37217)

easYgen 1000 (product spec 37180)

easYgen 3000 (product spec 37258)



The **GCP-20** is also designed for emergency and stand-by power applications, but controls the speed governor and voltage regulator to provide no-break transfer (closed transition) to and from the utility. The GCP-20 monitors the generator and the utility and protects for voltage, current, frequency, active and reverse power, load imbalance, and overload faults. The engine is monitored for speed, temperature and pressure.

The control includes a total of 14 discrete alarm inputs, 4 analog engine signal inputs, 1 switching/magnetic Pickup input, and 4 freely configurable relay outputs. Additional external units interfering with the control, remote control and analog speed/voltage bias signals are available as options.

→ **Please request special versions from our sales department.**

(product spec 03243)



The **GCP-21** incorporates control and synchronizing logic for one circuit breaker and is well suited for isolated and mains parallel operation in stand-by, combined heat and power, and peak shaving applications. A soft loading feature is included in this control unit.

Additional protection features include phase/vector shift and reduced power faults as well as a quick mains failure detection for permanent operation in parallel with the utility (no separate utility protection device necessary).

The GCP-21 control includes a total of 14 discrete alarm inputs, 4 analog engine signal inputs, 1 switching/magnetic Pickup input, and 4 freely configurable relay outputs. Additional external units interfering with the control, remote control and analog speed/voltage bias signals are available as options.

→ **Please request special versions from our sales department.**

(product spec 03243)



The **GCP-22** adds control logic for two circuit breakers, providing mains failure detection, ATS transfer switch control (open transition), no-break transfer (closed transition), and soft loading feature for both directions utility to generator and generator to utility.

→ **Please request special versions from our sales department.**

(product spec 03243)



The most powerful of the new genset control panels — the **GCP-31** and **GCP-32** units — are similar in function to the GCP-21 and GCP-22 controls, but add load sharing and VAR sharing capabilities for multiple unit operation. They also incorporate a synchroscope on the front panel.

Standard I/O include 16 discrete alarm inputs, 7 analog engine or generator signal inputs, 1 switching/magnetic Pickup input, and 7 freely configurable relay outputs. Additional external units interfering with the control, additional inputs/outputs, remote control and analog speed/voltage bias signals are available as options. A real-time clock and event recorder is also available.

→ **Please request special versions from our sales department.**

(product specs 03240 [GCP-30 Series], 37316 [GCP-31 RPQ-SC08])



The **EGCP-2** is a microprocessor based complete generator control and engine management package. It is designed for use with an automatic voltage regulator and a Woodward or other speed control to automate and protect diesel or gas engine based generator sets. Designed for small to medium size generator sets, the EGCP-2 can be configured to operate stand-alone or utility paralleled sets. A network of EGCP-2 controls is capable of controlling up to eight unmanned generator sets for base-load, peak shaving or backup power generation.

(product spec 03219)



Designed for medium- and large-sized generators, the **EGCP-3** adds to the powerful EGCP-2 product with advanced IEEE protection algorithms, utility-grade metering, individual control of utility and inter-tie breakers, added input/output capabilities and backward compatibility with Woodward DSLC/MSLC synchronizers. A network of up to 16 EGCP-3 controls can handle your most sophisticated base-load, peak shaving or backup power generation applications.

Based on Woodward's powerful GAP™ application programming tools, the EGCP-3 can be easily customized by Woodward, your Woodward distributor or, with a GAP license and minimal training, by OEM customers.

(product specs 03300, 03301)

## Synchronizers

Analog and digital synchronizers from Woodward span the full range of synchronizer capabilities, providing precise voltage and phase matching capabilities for every application, from the simplest to the most demanding.



The **SPM-D10** digital synchronizer incorporates control logic for one circuit breaker (including a two-phase synchronization), display of ac data on the front panel, a user keypad, a built-in synchroscope, and easy configuration. Also available is built-in utility protection for over-/under-voltage, over-/under-frequency, phase/vector shift; generator protection for over-/under-voltage, over-/under-frequency, and for reverse/reduce power and overload.

The **SPM-D10/YB** is a three-phase synchronizer that includes the complete control logic for one power circuit breaker. An additional expanded function logic to couple synchronous networks and different de-energized (black) busses completes this unit to a complete and powerful solution.

The **SPM-D11** provides load sharing, and the **SPM-D21** adds two-breaker synchronizing and load control.

(product specs 37297 [SPM-D10], 37298 [SPM-D10YB], 37292 [SPM-D11], 37293 [SPM-D21])



The **DSLCTM** control is a microprocessor-based synchronizer and load control designed for use on three-phase ac generators equipped with Woodward or other compatible speed controls and compatible automatic voltage regulators. The DSLC control is a synchronizer, a load sensor, a load control, a dead bus closing system, and optionally a VAR/PF and process control, all integrated into one powerful, yet convenient package.

(product spec 02006)



The **MSLC** control is a microprocessor-based load control designed for three-phase electric power generation sites equipped with Woodward DSLC Digital Synchronizer and Load Control units which operate in parallel with the utility. The MSLC is a synchronizer, a utility load sensor, an import/export load level control, a power factor control, and a master process control.

(product spec 02021)

## Multi Function Relays

MFR Multi Function Relays provide monitoring and protection for a wide range of power generation and distribution applications. Each of the MFR series protects for the designated faults, monitors and displays the generator or utility ac signals, includes one ANSI 74 alarm relay and 3 output relays, and is easily configured via the service interface.



The **MFR 11** provides voltage protection only, and different packages are available for different applications:

- MFR 11/MP package includes protection for over-/under-voltage, over-/under-frequency, and voltage asymmetry faults.
- MFR 11/NU package adds a wide range power supply.
- MFR 11/VDEW package includes protection for over-/under-voltage, over-/under-frequency, voltage asymmetry faults and protection for phase/vector shift.
- MFR 11/G59 package adds protection for  $df/dt$  (ROCOF) faults, and five additional relay outputs.
- MFR 11/G59N package adds a wide range power supply to the G59 package.
- MFR 11/SC package was made for synch-check and zero-voltage monitoring.  
(product spec 03244)

The **MFR 12** provides current protection only, and different packages are available for different applications:

- MFR 12/CP package includes protection for time-overcurrent (TOC) and calculated ground faults.
- MFR 12/51V package includes protection for time-overcurrent (TOC), calculated ground faults and voltage restraint time overcurrent.
- MFR 12/IvIkR package includes protection for ground faults via measurement of the displacement voltage.
- MFR 12/50-51GN package includes protection for directional ground faults.  
(product spec 03249)

The **MFR 13** provides voltage, current and power protection, and different packages are available for different applications:

- MFR 13/GP package includes protection for over-/under-voltage, over-/under-frequency, voltage asymmetry, time-overcurrent (TOC), overload, reduced/reverse load, load imbalance, re-active power (loss of excitation), and power factor  $\cos\phi$  as well as monitoring for zero-voltage.
- MFR 13/GPX package adds five additional configurable relay outputs and a synch-check relay function.
- MFR 13/GPX-I package additionally offers a MOD bus RTU slave interface.  
(product spec 03245)

→ Please request special versions from our sales department.

Other Woodward multi-function relays—such as the MFR 2/3 and ESDR units—provide specialized protection, synchronization and monitoring functions.



The **MFR 15** provides voltage, current and power protection as well as automatic control and synchronization. Different packages are available for different applications:

- **MFR 15/SY package** includes similar protection as the MFR 13/GP except monitoring for zero-voltage plus synchronization for one power circuit breaker, automatic control for real power and power factor cosphi. An 0/4–20 mA analog signal could be used to feed an external power set point value to the control. Three freely configurable analog outputs and an pulse output for kWh complete this package:
- **MFR 15/SYN package** adds load sharing.
- **MFR 15/SYN-I package** adds a MOD bus RTU slave interface.

→ **Please request special versions from our sales department.**

(product spec 03247)



The **MFR 2** control combines protection for both the generator and the utility with synchronization logic for two circuit breakers. It controls frequency, voltage, real generator power, power factor (cosphi), and load/VAR sharing. It also displays kWh, kVARh, operating hours, number of starts and maintenance calls.

The MFR 2 includes 4 discrete alarm inputs, 4 freely configurable relay outputs, and features a synchroscope on the front panel. Two different packages offer flexibility.

→ **Please request special versions from our sales department.**

(product spec 03248)



The **MFR 3** adds additional I/O's and a soft loading feature as well as push-buttons for direct control on the front panel.

The MFR 3 includes 12 discrete alarm inputs, 7 freely configurable relay outputs, and features a synchroscope on the front panel. Two different packages offer flexibility.

→ **Please request special versions from our sales department.**

(product spec 37166)



The **ESDR 4** and **ESDR 4T** are three-phase current differential protection relays for generators, motors and, with the ESDR 4T, even transformers in unit connection.

The currents flowing into the individual conductors are measured by means of current transformers at both sides of the protection object(s).

Any two-phase or three phase short circuits and ground leakage's are recognized by the ESDR 4 and ESDR 4T as fault currents.

(product spec 03250)



The **TUG 4** is a protection relay for separate two-step protection of up to 16 measuring inputs. Included functions are conversion of measured values of dc signals from generator/prime mover, protective functions for temperature (two levels of alarm/monitoring), and 4 relay outputs for user configuration.

(product spec 37169)

## Discrete-Function Controls and Accessories

To complete your power management system, Woodward offers the most complete range of analog and digital controls available in the industry.



The **GW 4** is an extension to many of the GCP genset control units, providing the communications interface from the GCP network to a variety of external buses. Available communication buses include RS-232, RS-485, Modbus<sup>®</sup> \*, Profibus, the Leonhard-Data-Protocol, and even an external modem. All the secondary interface/bus systems receive/send data from/to the Guidance Level CAN bus network used for the GCP Series. Upon request, more protocols will be available.

\*—Modbus is a trademark of Modicon, Inc.  
(product spec 37170)



The **LS 4** is a power circuit breaker control for complex applications where additional section switches (such as bus-couplers) exist. The measurement value logging and the "switch-in-order" for the power circuit breakers are put into effect in the LS 4. The set value for the synchronization is transmitted from the LS 4 via the CAN bus to the genset controller (such as GCP).

(product spec 37167)



The **UMT 1** is a digital multi measuring transducer that measures true rms via three-phase measuring of voltage and current. Three analog outputs - 20/0/4→20 mA and an analog output manager offers the flexibility to output every measured and calculated value. The impulse output can be configured to output kWh/h or kVARh/h.



The **ST 2** Lambda Control is a digital Lambda control used to achieve low exhaust emission values in gas powered machines. The Lambda voltage is directly measured and evaluated in the ST 2. The regulating signals given to the gas regulating path may for instance be transmitted via a stepper motor or an analog output.



The **IKD 1** is an external I/O expansion board. If the digital inputs and outputs in the controller are not sufficient, 8 digital inputs and outputs can be connected via the CAN bus with this extension card. It is possible to connect two IKD 1 to the controller in parallel.

(product spec 37171)



The **IKN 1** is an external 20 channel NiCrNi temperature scanner. It is an Intelligent Terminal NiCrNi to measure up to 20 different temperatures, including mean-value generation and limit-value monitoring. The measured data is transmitted via the CAN bus to the controller, where they can be displayed. Configuration via CAN bus is also possible.



The **Real Power Sensor** is a solid-state electronic device housed in a metal chassis intended for installation in a prime mover control cabinet. The unit contains its own power supply and is powered separately from the speed control. The Real Power Sensor constantly monitors the generator output voltage and current with transformers. These transformers are selected to provide potential voltage of 115 Vac or 230 Vac at nominal generator voltage. The current transformers are selected to provide a 5-amp secondary current at full generator output. The Real Power Sensor provides a signal to the speed control that is proportional to the output power of the generator. The Real Power Sensor is used with Woodward speed controls to measure generator output power and provide a kilowatt signal to the speed control.

(product specs 02012 & 82011)



The **Digital Reference Unit** generates a precise voltage that may be used wherever a very accurate reference signal is required. Typical use combines the Digital Reference Unit with other Woodward controls for regulation of speed or load. This device provides precise electronic control of the reference-signal voltage. The level of the reference signal can be manually or automatically selected from maximum to minimum with an additional adjustable intermediate set point.

(product spec 03218)



The **Generator Load Sensor** adds droop or isochronous load sharing for paralleling generator sets having Woodward speed control systems. It has an SPM-A Synchronizer input and shares load with all other Woodward load-sharing systems. This unit is used with the EPG system and the Woodward 2301A and 701A Speed Controls. The Generator Load Sensor uses paralleling lines to ensure proportional load sharing when generators are isochronously paralleled.

(product spec 82314)



**Woodward Process and Import/ Export Controls**, with Woodward load or speed controls, give you process control of an engine system. Process controls will control any process where the controlled parameter is determined by the load or speed of a engine and where the controlled parameter can be monitored as a 1 to 5Vdc,  $\pm 5$  Vdc, 4 to 20 mAdc or  $\pm 20$  mAdc input signal, depending on your specific process control needs. A process input signal of 0 to 10Vdc is optional if you use an external control-point potentiometer. Process and Import/ Export controls are available for a wide range of process configurations. This control compares process transducer input signals to operator-set references. The difference between each input and the reference setting is sent to a circuit which is sent, as an operating voltage, to a speed or load control. The load or speed control then changes or maintains the engine load or speed and in turn, maintains a constant process setting.

(product spec 02013)

## Distributed Generation Systems

### Miniturbine, Microturbine, and Fuel Cell Products

New distributed generation technologies deserve new control system solutions. And Woodward delivers with tightly integrated fuel, air, combustion, and electronic control solutions to meet the cost, reliability, and performance needs of the emerging distributed generation industries.



**AtlasPC™ Control System**—Representing a new generation of control that provides the power of PC technology in a rugged system, the AtlasPC Control System offers flexible and powerful software tools and exceptional computational power for micro/miniturbine and fuel cells greater than 150 kW.

(product spec 03213)



**The AtlasSC™ control** is a powerful and rugged industrial control with embedded microprocessor technology and dedicated I/O for real time control of engines and turbines. At the heart of the small and powerful AtlasSC platform is an industrial processor with Real Time Operating System (RTOS). The AtlasSC platform utilizes the industry-standard PC/104 bus structure to leverage “PC Economics,” resulting in lower costs and greater feature flexibility.

(product spec 03253)



**Swift Gas Metering System**—The Swift Gas Metering System has been developed for microturbines, miniturbines, small industrial turbines (up to 2 MW), and high-pressure fuel cells. The Swift system has four valve sizes with maximum fuel flows between 6.3 and 88.9 g/s (50 and 695 lb/h) of standard natural gas, depending on system pressures. The system is designed for installation in the engine enclosure and can accommodate gas temperatures up to 121 °C (250 °F).

(product spec 03252)



**Purge Valve**—During liquid fuel operation, microturbine nozzle performance can degrade due to coking at the nozzle tips. Woodward has adapted and cost-reduced one of its patented aircraft turbine products to allow microturbine nozzles to operate without coking and experience much longer life prior to required maintenance.



**Butterfly Valves (Low Temperature)**—The LCS-ITB was originally designed to provide speed control for small diesel engines. However, the high performance and low cost of these butterfly valves have made them very useful in reducing the cost of fuel cell systems.

(product spec 03223)

**Systems**—Based on Woodward's experience in developing complete systems, customers are increasingly relying on Woodward to design and build complete systems. Woodward integrates key components developed in-house with off-the-shelf components to deliver the most cost effective solution to meet the customer's needs.

# Woodward Services

## How to Contact Woodward

For assistance, call one of the following international Woodward facilities. You can also contact the Woodward Customer Service Department or consult our worldwide directory on Woodward's website ([www.woodward.com](http://www.woodward.com)) for the name of your nearest Woodward distributor or service facility. [For worldwide directory information, including full address, phone, fax, and e-mail information, go to [www.woodward.com/corp/locations/locations.cfm](http://www.woodward.com/corp/locations/locations.cfm).]

<u>Facility</u>	<u>Phone Number</u>
Brazil (Campinas)	+55 (19) 3708 4800
China (Suzhou)	+86 (512) 6762 6727
China (Tianjin)	+86 (22) 2621 3120/1/2
Germany (Stuttgart)	+49 (711) 78954-0
India (Ballabgarh)	+91 (129) 230 7111
Japan (Tomisato)	+81 (476) 93-4661
The Netherlands (Hoofddorp)	+31 (23) 5661111
United Kingdom (Cheltenham)	+44 (0) 1242 277000
United States (Fort Collins)	+1 (970) 482-5811 OR (800) 523-2831
United States (Niles)	+1 (847) 967-7730

## Engineering Services

Woodward Industrial Controls Engineering Services offers the following after-sales support for Woodward products. For these services, you can contact us by telephone, by e-mail, or through the Woodward website.

- Technical Support
- Product Training
- Field Service

Use the contact information above (How to Contact Woodward) or below (under Sales Support), or visit the Woodward website ([www.woodward.com](http://www.woodward.com)).

**Technical Support** is available through our many worldwide locations or our authorized distributors, depending upon the product. This service can assist you with technical questions or problem solving during normal business hours. Emergency assistance is also available during non-business hours by phoning our toll-free number and stating the urgency of your problem. For technical support, please contact us via telephone, e-mail us, or use our website and reference **Customer Services** and then **Technical Support**.

**Product Training** is available at many of our worldwide locations (standard classes). 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. For information concerning training, please contact us via telephone, e-mail us, or use our website and reference **Customer Services** and then **Product Training**.

Customer Services has also created the first of several planned CBT (computer based training) modules, available on CD-ROM from Woodward or from any Woodward authorized Distributor. Currently available is part number 8928-358, **Basic Governing and Control Theory**. Further information is also available in product specification 03221.

**Field Service** engineering on-site support is available, depending on the product and location, from one of our many worldwide locations or from one of our authorized 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 field service engineering assistance, please contact us via telephone, e-mail us, or use our website and reference **Customer Services** and then **Technical Support**.

## Sales Support

To request sales assistance (order status, price & delivery, order entry, including 24-hour emergency support), please contact the Woodward agency listed for your area.

### North America

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For fastest service, contact your local distributor or office. But if all else fails, contact the Industrial Controls 24-hour emergency number (for emergency and/or down situations to provide delivery of available parts or technical assistance): 800-523-2831 (toll-free in North America) or +1-970-482-5811.

**Repair Services**

The following factory options are available for servicing Woodward equipment, based on the standard Woodward Product and Service Warranty (5-01-1205) that is in effect at the time the product is purchased from Woodward or the service is performed:

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

If you are experiencing problems with installation or unsatisfactory performance of an installed system, the following options are available:

- Consult the troubleshooting guide in the manual.
- Contact Woodward technical assistance (see “How to Contact Woodward” later in this chapter) and discuss your problem. In most cases, your problem can be resolved over the phone. If not, you can select which course of action you wish to pursue based on the available services listed in this section.

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

This option allows you to call 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 Woodward facility as explained below (see “Returning Equipment for Repair” later in this chapter).

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 to Woodward within 60 days, Woodward will issue a credit for the core charge. [The core charge is the average difference between the flat rate replacement/exchange charge and the current list price of a new unit.]

**Return Shipment Authorization Label.** To ensure prompt receipt of the core, and avoid additional charges, the package must be properly marked. A return authorization label is included with every Replacement/Exchange unit that leaves Woodward. The core should be repackaged and the return authorization label affixed to the outside of the package. Without the authorization label, receipt of the returned core could be delayed and cause additional charges to be applied.

## 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.

## Woodward Distributor Network

Woodward service and sales are available throughout the world from Woodward plants and offices, from Woodward Distributors, and from other Woodward authorized agents. The latest listing of every Woodward location, including address, phone, fax, and e-mail, is contained in our worldwide directory, which is available on the Woodward website ([www.woodward.com](http://www.woodward.com)).

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