

# E<sup>3</sup> Lean Burn Full Authority Control

## for Industrial Lean-Burn, Spark-ignited Engines

### Applications

Woodward's E<sup>3</sup> Lean Burn Full Authority control manages 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 helps customers meet regulated emission levels, while maintaining engine performance over a very large range of fuel qualities that may be found in landfill, digester, and other bio-fuel gases.

The E<sup>3</sup> Lean Burn Full Authority control is part of the Woodward line of E<sup>3</sup> All-Encompassing Engine and Emissions controls designed to meet the performance and reliability needs of gas engine manufacturers, owners, and operators.

### Control Overview

The E<sup>3</sup> Lean Burn Full Authority control is a fully integrated engine control solution that can have full authority over spark, fuel, and air, while remaining flexible enough to compensate for large variations in fuel quality. Additionally, diagnostics such as detonation and misfire as well as other health monitoring are integrated into the control.

The E<sup>3</sup> Lean Burn Full Authority control calculates and controls the air-to-fuel ratio required to keep the engine's exhaust emissions within compliance limits, and can also control engine speed and power for the driven load as well as controlling ignition timing. The control uses engine speed, air manifold absolute pressure (MAP), and air manifold air temperature (MAT) to calculate the required mass flow of gas to a single-point fuel-injection device to directly control the air-to-fuel ratio without measuring oxygen in the exhaust for generator applications.

The E<sup>3</sup> Lean Burn Full Authority control has two different lean-burn closed-loop algorithms:

- Gas Quality Closed Loop (GQCL) control (patents: US5657732 / EP0727574B1)—Uses engine efficiency and generator load measurement to eliminate the oxygen sensors. The E<sup>3</sup> Lean Burn Full Authority control calculates the amount of fuel required for a given emissions output and then commands the TecJet™ fuel control valve to deliver the optimum amount of fuel to the engine. In this manner, only the precise amount of fuel is delivered in order to have the highest achievable fuel economy without putting the engine into detonation or mis-firing conditions.
- UEGO closed-loop control—Uses exhaust oxygen measurement. In this mode, the E<sup>3</sup> Lean Burn Full Authority control operates as a standard Air Fuel Ratio controller.

The E<sup>3</sup> Lean Burn Full Authority control works in conjunction with Woodward's full range of gas engine components:

- Integrated throttle bodies ranging from 16 mm to 180 mm.
- TecJet fuel control valves of varying sizes to meet the application needs.
- IC-920 & IC-922 ignition controllers deliver ignition energy of up to 360 mJ for optimized combustion stability with complete control of ignition timing and ignition energy.

Engine health and diagnostics are integrated into the control to ensure the engine remains in a safe operating mode.

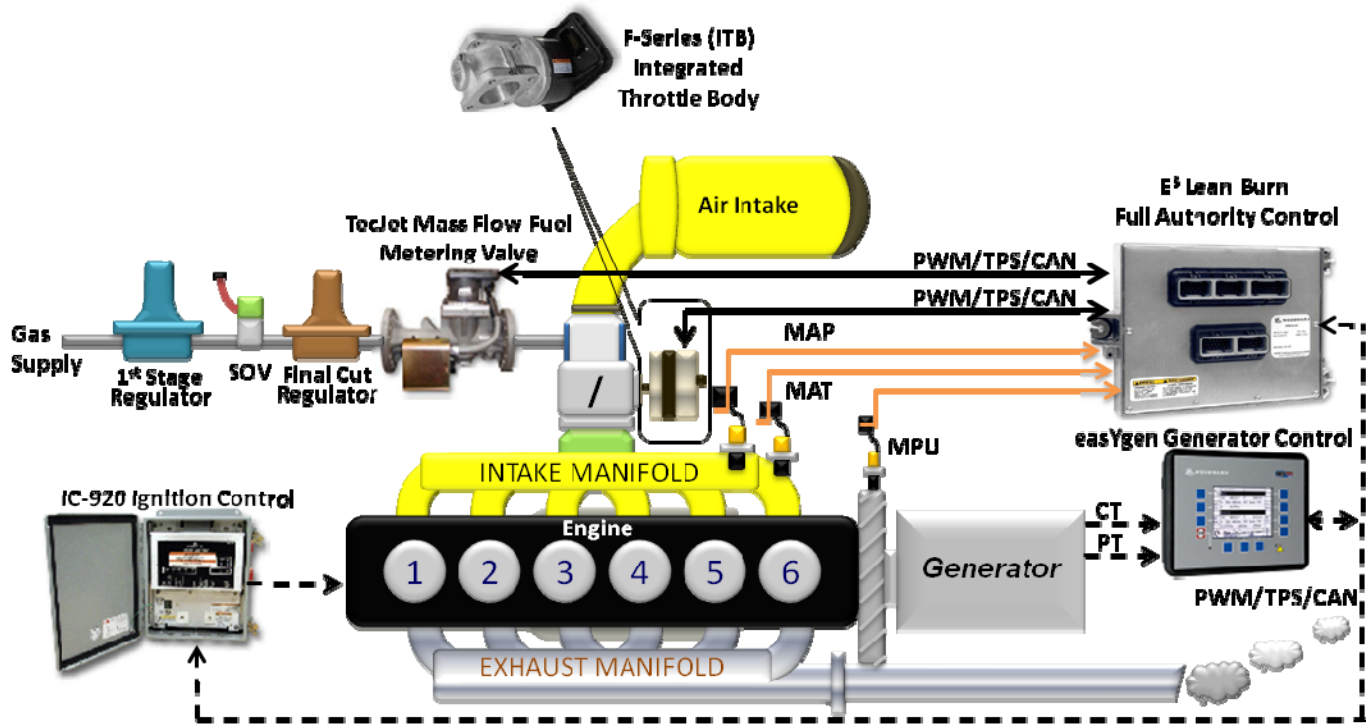


- Allows engine to operate on different fuels while maintaining engine efficiency
- Integrated approach reduces system complexity and reduces overall cost
- Speed-density-based Air Fuel Ratio controller
- Can handle gas quality changes of  $\pm 10\%$  CH<sub>4</sub> without a gas quality sensor
- Can handle gas quality changes between 100 & 2500 BTU/scf (3.7–93.1 mJ/m<sup>3</sup>) with use of External Gas Quality Analyzer
- Flexible Configuration

The E<sup>3</sup> Lean Burn Full Authority control works with the easYgen™ power management products for generator load control, load sharing, and synchronization, and can form the gateway to external systems while also displaying information available from the E<sup>3</sup> Lean Burn Full Authority control.

The E<sup>3</sup> Lean Burn Full Authority control uses Woodward's GAP™ software and allows multiple password protection with the ability to perform custom software routines in addition to standard Woodward software allow the customer complete authority over the applications.

The following functional diagram shows how all the components are integrated into a system:



E<sup>3</sup> Lean Burn Full Authority Control System Configuration

## Environmental Specifications

### Operating Temperature:

−40 °C to +85 °C (−40 °F to +185 °F)

### Storage Temperature:

−40 °C to +105 °C (−40 °F to +221 °F)

### Mechanical Vibration:

Woodward Vibration Test RV2 (Procedure 3-04-6231): 0.1 G<sup>2</sup>/Hz, 10 Hz to 2000 Hz, 12.8 Grms, 3 h/axis w/vibration isolation dampeners

### Mechanical Shock:

50 G, 11 ms, half-sine wave, 4 shocks in each direction (24 total shocks)

### Ingress Protection:

IP66 per EN60529

### EMC Specifications:

EN61000-6-2: Immunity for Industrial Environments  
EN61000-6-4: Emissions for Industrial Environments

For environmental specifications of other system components, please refer to the applicable product specifications.

## Regulatory Compliance

**European Compliance for CE Marking**—These listings are limited only to those units bearing the CE Marking.

**EMC Directive:** Declared to 2004/108/EC COUNCIL DIRECTIVE of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and all applicable amendments.

**North American Compliance**—These listings are limited only to those units bearing the CSA agency identification.

**CSA:** CSA Certified for Class I, Division 2, Groups A, B, C, D, T4 at 85 °C ambient. For use in Canada and the United States. Certificate 1604047.



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