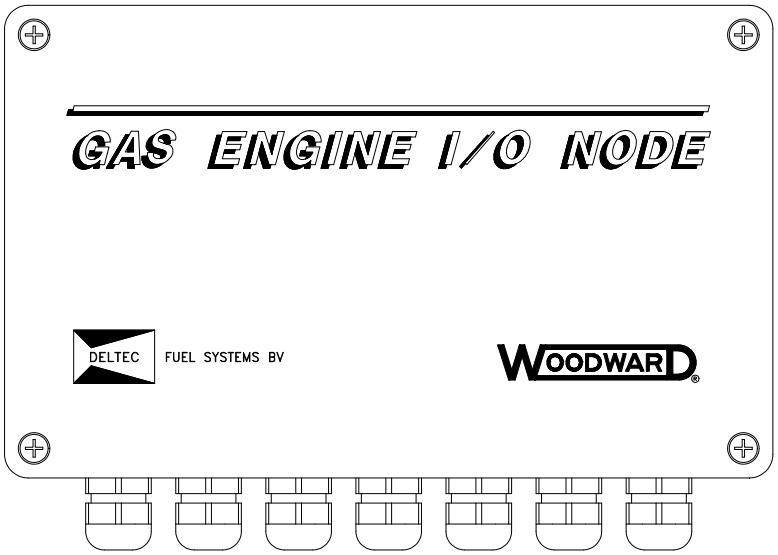
WOODWARD

Installation and Operation Manual



Gas Engine I/O Node

9906-129
Hardware Only

Manual 02765 (Revision A)

IMPORTANT

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

DEFINITIONS

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

WARNING

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

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

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

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

NOTICE

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

NOTICE

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

Contents

Illustrations and Tables

Electrostatic Discharge Awareness

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

Follow these precautions when working with or near the control.

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

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

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

4. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:

   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

NOTICE

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

Chapter 1.
General Information

Introduction

This manual describes the Woodward Gas Engine I/O Node, part number 9906-129. The combined use of this information will provide adequate information for the installation, operation and maintenance of the device, including its auxiliary hardware.

⚠WARNING

Use of this equipment by untrained or unqualified personnel could result in damage to the node or the installation's equipment and possible loss of life or personal injury. Make sure personnel using or working on this equipment are properly trained.

- Before operating the unit after installation verify the following:
- Check all wiring for proper connections (see the control wiring diagram in Appendix B).
- Check the power sources for proper voltages and proper connections (see Chapter 2).

Declaration of Incorporation

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

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

Hardware

The Gas Engine I/O Node (Figure 1-1) consists of a single printed circuit board in a metal chassis with seven water tight cable glands. Connections are via two terminal blocks. The Gas Engine I/O Node can be mounted in a control cabinet or in a convenient location in the vicinity of the gas engine that meets the temperature and vibration specifications.

The Gas Engine I/O Node requires a power supply input voltage, with 40 Watts as the nominal power consumption at rated voltage:

- 18-40 Vdc (24 Vdc nominal)

Application

The Gas Engine I/O Node 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 is receiving and sending air fuel ratio related parameters to the 723 DCS via the network using the LONTalk® protocol, an Echelon® Corporation LonWorks® network.

The engine skid mounting capability of the Gas Engine I/O Node makes it possible to mount it close to the engine, saving a lot of wiring installation. Only a twisted pair shielded cable is needed to communicate with the 723 DCS. Figure 1-2 shows a typical lay-out of the Gas Engine I/O Node with its auxiliary devices.

The Gas Engine I/O Node is programmed to suit air fuel ratio control applications requiring the following inputs and outputs:

- Relay output
- Aux. contact input
- Stepper motor output
- Lambda sensor and supply
- Potentiometer input (10kΩ 10 turns)
- Manifold Absolute Pressure (MAP) Sensor
- Manifold Absolute Temperature (MAT) Sensor
- RTD #2 or Analogue input #2 Sensor
- RTD #1 or Analogue input #1 Sensor
- The LON channel

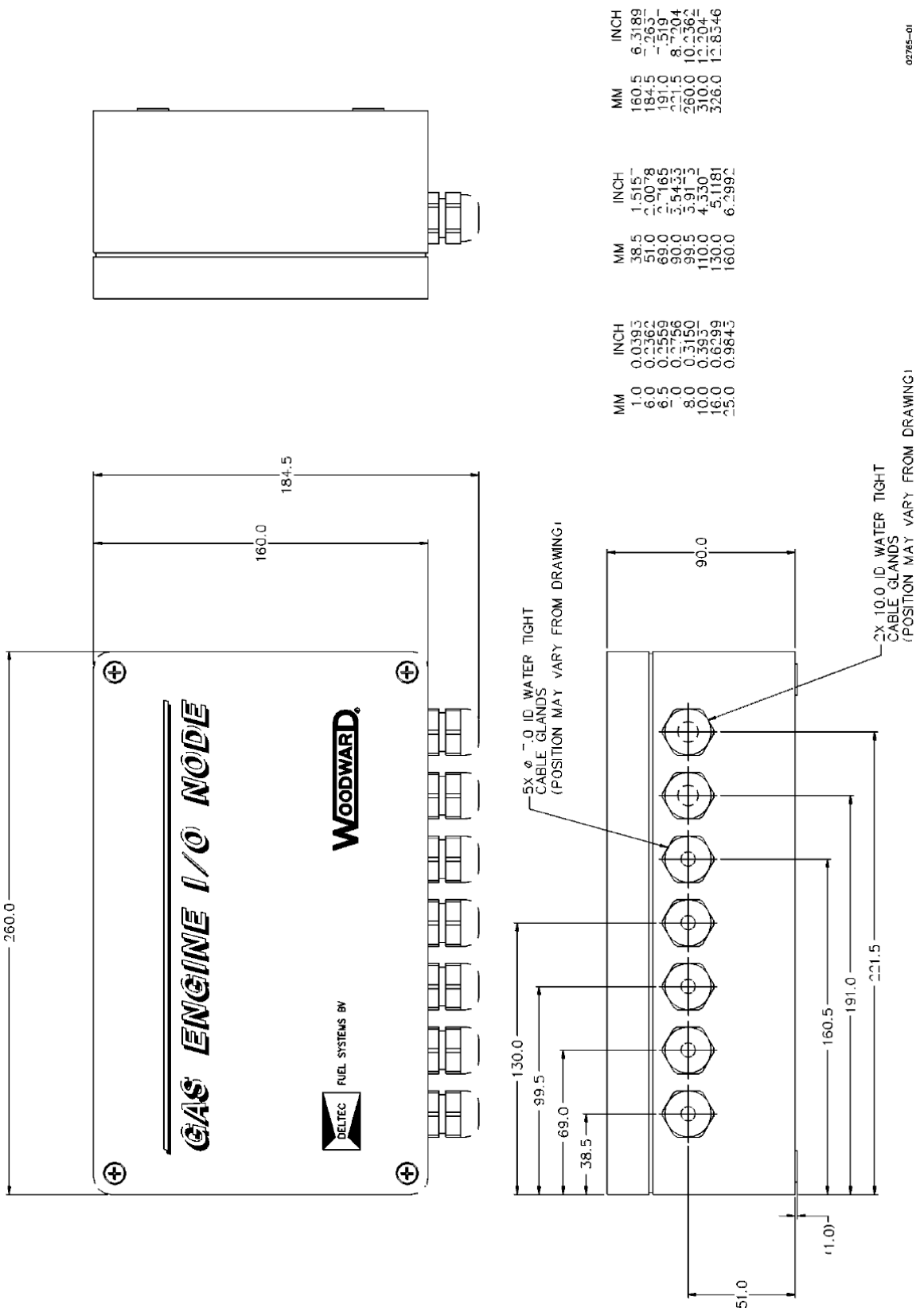

Figure 1-1. Outline Drawing of the Gas Engine I/O Node

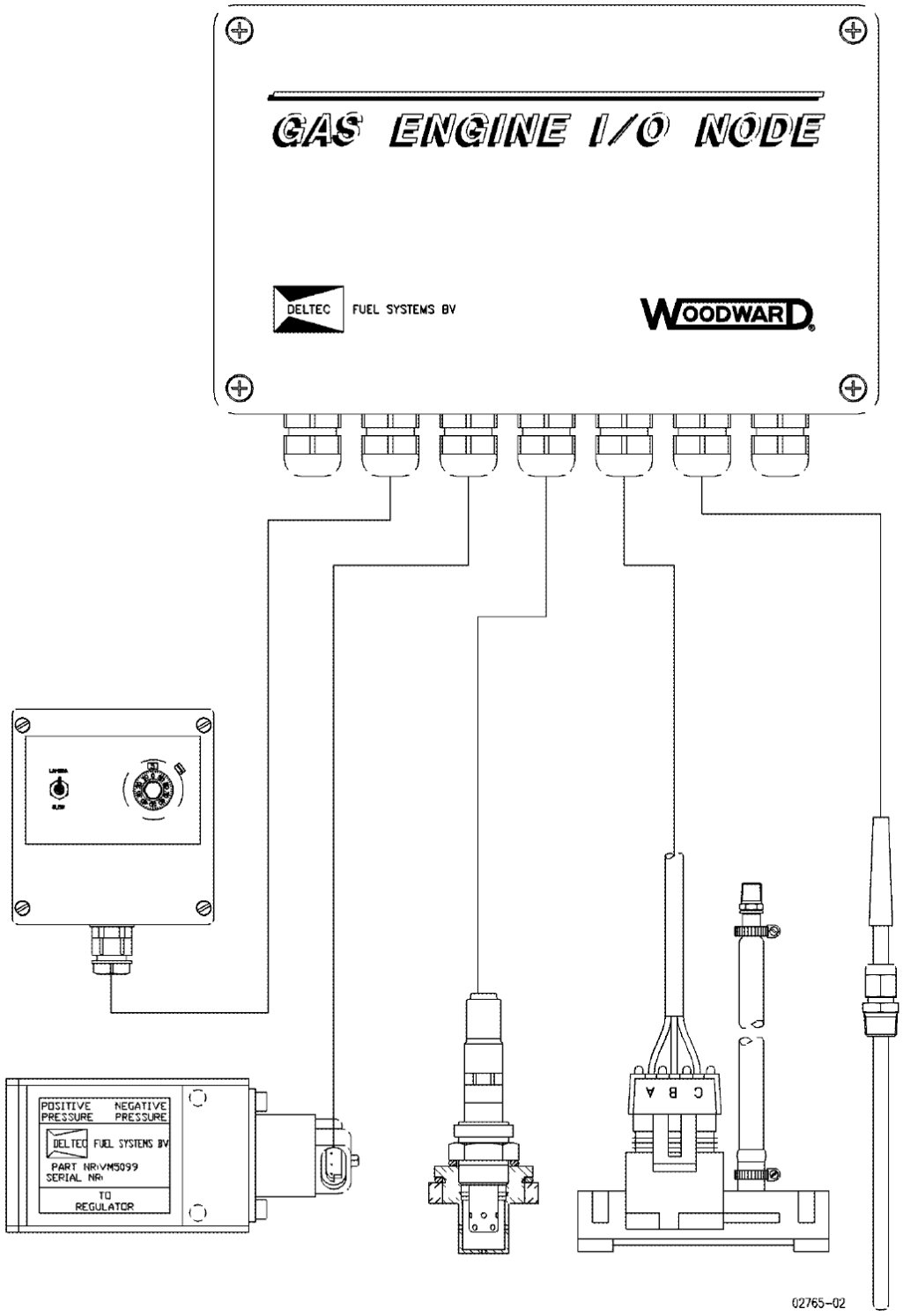

Figure 1-2. Typical Layout of the Gas Engine I/O Node and its Auxiliary Devices

Chapter 2. Installation

Unpacking

Before handling the control, read page iii, Electrostatic Discharge Awareness. Be careful when you unpack the electronic control. Check the Gas Engine I/O Node and its auxiliary hardware for signs of damage such as scratches, and loose or broken parts. If any damage is found, immediately notify the shipper.

Power Requirements

The Gas Engine I/O Node requires a voltage source of 18 to 40 Vdc.

NOTICE **To prevent damage to the node, do not exceed the input voltage range.**

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

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

Location Considerations

Consider these requirements when selecting the mounting location:

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

The node must NOT be mounted on the engine, only mounting on the engine skid is allowed.

Internal Jumpers

The Gas Engine I/O Node has six, two-position internal jumpers (JPR1 & JPR2, JPR3 & JPR4, JPR5 & JPR7, JPR6 & JPR8, JPR10 & JPR11, JPR13 & JPR14) located on the top of the printed circuit board. If it is necessary to change any jumper to match your control requirements, and this suits the nature of the software, be sure to read page iii, Electrostatic Discharge Awareness.

Remove the Gas Engine I/O Node cover, with the power off. Remove the five screws, to take the EMI shield off. Also carefully remove the appropriate jumper with your fingers or a small pair of tweezers. and replace it securely over the proper two connectors (see Figure 2-1).

The jumper connections are listed:

**	JPR6 & JPR5 & JPR14	RTD Input #1
**	JPR1 & JPR3 & JPR10	RTD Input #2
	JPR8 & JPR7 & JPR13	Analogue Input #1 0-5 Vdc
	JPR2 & JPR4 & JPR11	Analogue Input #2 0-5 Vdc

** default jumper setting

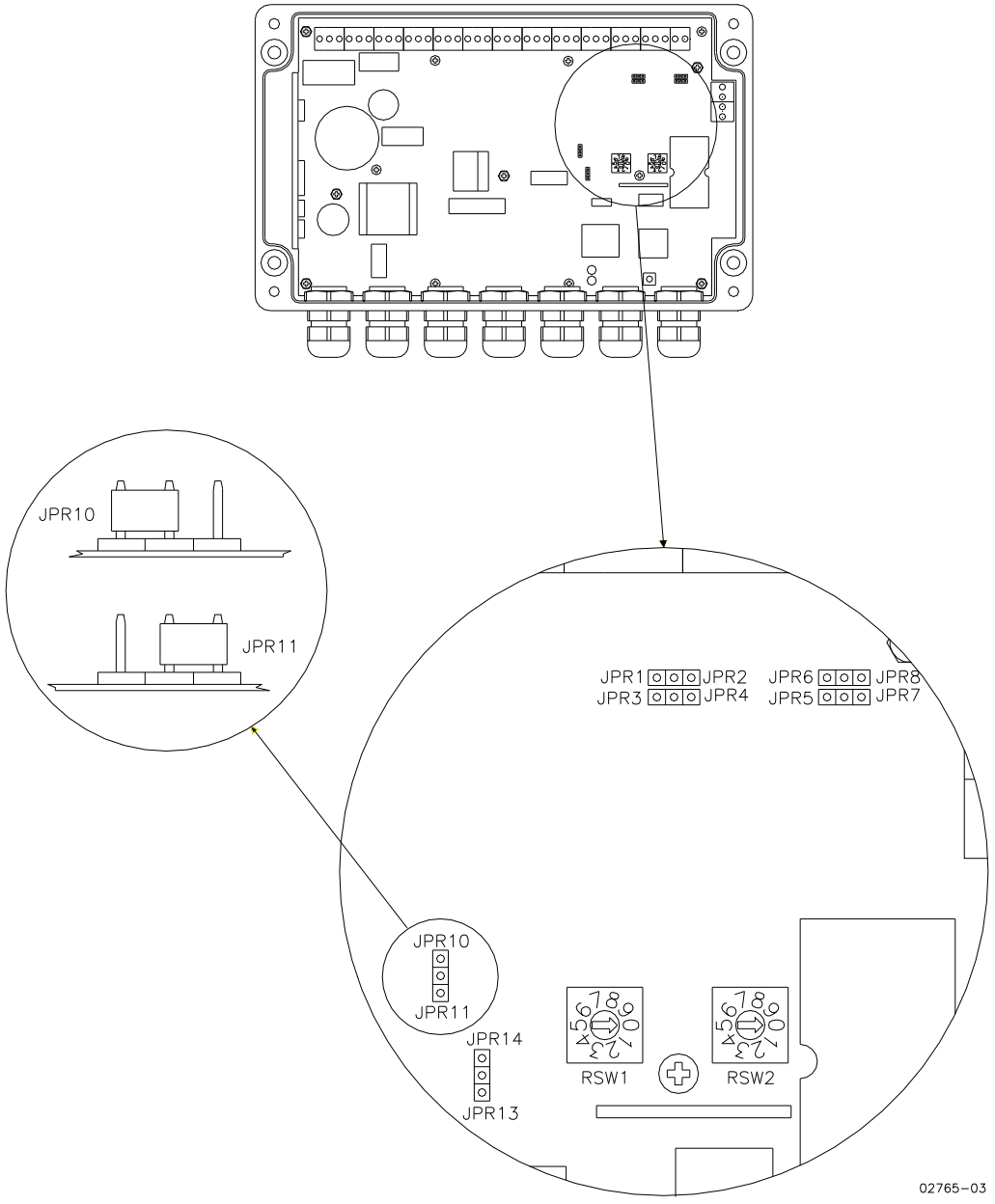

Figure 2-1. Gas Engine I/O Node Internal Jumpers and Rotary Switches

Rotary Switch Settings

The module address circuit reads the selected module address from the rotary switches on each node. This address should correspond to the address of the I/O module hardware in the application program. If these rotary switches are set incorrectly, the node will not communicate with the 723 DCS and a LON communication error will be annunciated through the application program. If the node address switches are changed, power to the module must be cycled before it will read the new module address and change its communication accordingly.

In case of a V-engine where the air fuel ratio per bank is controlled by means of two Gas Engine I/O Nodes and one 723 DCS, rotary switches RSW1 & RSW2 should be set differently. In this case the left bank of the V-engine will have its node address set on 00 (RSW1=0 & RSW2 = 0) and the right bank will have its node address set on 01 (RSW1=0 & RSW2 = 1). See Figure 2-1 for the rotary switch settings.

Shielded Wiring

All shielded cables must be twisted conductor pairs. Do not attempt to tin the braided shield. All signal lines should be shielded to prevent picking up stray signals from adjacent equipment. Connect the shields to the nearest chassis ground. Wire exposed beyond the shield itself should be as short as possible, not exceeding 50 mm (2 inches). The other end of the shields must be left open and insulated from any other conductor. DO NOT run shielded signal wires along with other wires carrying large currents. See Woodward application note 50532, *Interference Control in Electronic Governing Systems*, for more information.

Where shielded cable is required, cut the cable to the desired length and prepare the cable as instructed below.

- Strip outer insulation from one end, exposing the braided or spiral wrapped shield. DO NOT CUT THE SHIELD.
- Using a sharp, pointed tool, carefully spread the strands of the shield.
- Pull inner conductor(s) out of the shield. If the shield is the braided type, twist it to prevent fraying.
- Remove 6 mm (1/4 inch) of insulation from the inner conductors.

Installations with severe electromagnetic interference (EMI) may require additional shielding precautions. Contact Woodward Governor Company for more information.

IMPORTANT **Use a proper torque for assuring a rated seal for the glands. The compression nuts must be turned an additional half turn, beyond contact and hand tight, without allowing the fitting to move.**

Power Supply (Terminals 2/3)

Power supply output must be low impedance (for example, directly from batteries).The Gas Engine I/O Node contains a switching power supply which requires a current surge to start properly.

NOTICE

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

Run the power leads directly from the power source to the node. DO NOT POWER OTHER DEVICES WITH LEADS COMMON TO THE NODE. Avoid long wire lengths. Use shielded twisted-pair wires to connect the positive (line) to terminal 3 and negative (common) to terminal 2. If the power source is a battery, be sure the system includes an alternator or other battery-charging device.

If possible, do not turn off node power as part of a normal shutdown procedure. Leave the node powered except for service of the system and extended periods of disuse.

NOTICE

To prevent damage to the engine, apply power to the Gas Engine I/O Node at least 10 minutes prior to starting the engine. The UEGO sensor attached to the node must have time to finish its warming up cycle and become operational.

Relay Output (Terminals 4/5/6)

Use twisted-pair wires to connect to terminals 4 (normally open) & 5 (common) or 6 (normally closed) & 5 (common).The relay is energized when the application software reaches 25% of maximum load. The relay can be used to power up the UEGO burner lambda unit (optional device).

Aux Contact (Terminals 7/8)

Use twisted-pair wires to connect the single pole switch to terminals 7 & 8. The application software receives a boolean TRUE when terminal 7 is connected with terminal 8. This discrete input has got its own internal power supply, DO NOT POWER ANY OTHER DEVICES WITH THE AUX CONTACT INPUT.

The aux contact is used to switch the application software from Lambda to Slew mode. This input, like the potentiometer input, is connected to the Lambda/Slew box (see Figure 2-2). Use a miniature single pole switch for the Lambda/Slew switch.

Stepper Motor Driver (Terminals 10/11/12/13)

Electrical installation of the Gas Control Valve

Use a four core shielded cable to connect the Gas Control Valve to terminals 9 & 10 & 11 & 12 & 13. The special stepper motor connector (see Figure 2-3) is needed to make the connection to the Gas Engine I/O Node. The connector itself shows the letters A, B, C and D which should correspond with the terminals 10, 11, 12, and 13 on the node. A shield connection is provided at terminal 9. Make sure to connect A to A and B to B, etc. otherwise the Gas Control Valve does not function.

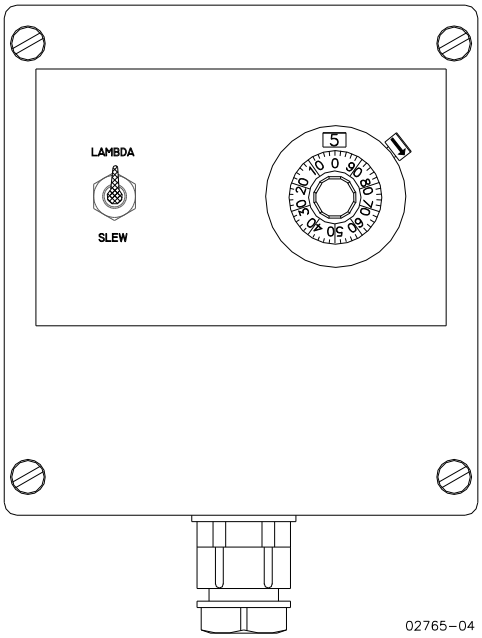

Figure 2-2. Lambda/Slew Box

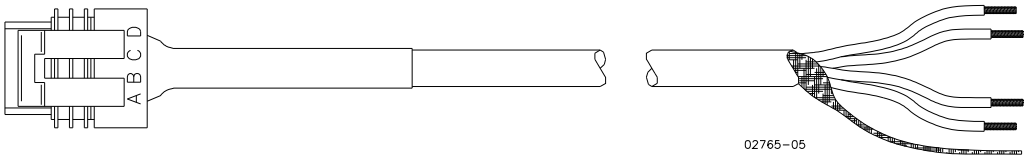

Figure 2-3. Gas Control Valve Connector with Shielded Cable

There are two ways to check the right connection between the Gas Control Valve and the node.

- Power up the Gas Engine I/O Node and watch the “positive pressure input” (disconnect the hose) of the Gas Control Valve. During power up, the plunger inside the Gas Control Valve will go to a minimum position, fully closing the “positive pressure” input.
- Set the Lambda/Slew switch in Slew mode and turn the potentiometer fully counter clock wise. This will result again in a fully closed “positive pressure” input. Put the potentiometer back in its original position.

Mechanical Installation of the Gas Control Valve

The Gas Control valve as shown in Figure 2-4 is used to control the gas supply to the mixer and therefore the air fuel ratio of the gas engine.

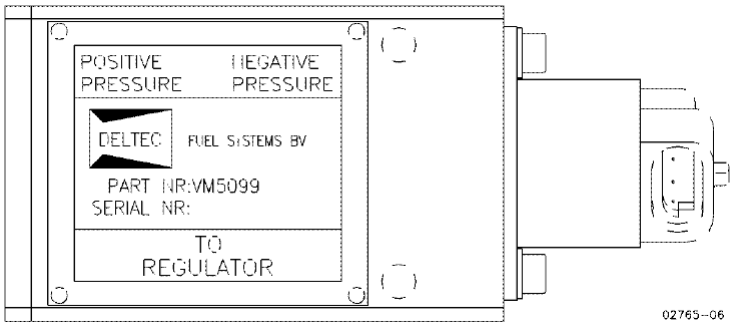

Figure 2-4. Gas Control Valve

The following points must be taken in account when mounting the Gas Control Valve on the engine:

- The output of the Gas Control Valve, marked with “TO REGULATOR”, must be connected to the sensing/impulse connection of the Zero Pressure Regulator (ZPR).Therefore the ZPR must be equipped with an external sensing/impulse connection.
- The “POSITIVE PRESSURE” input signal of the Gas Control Valve must be connected to the gas line between the ZPR and the Main Adjustment Screw (MAS).
- The “NEGATIVE PRESSURE” input signal of the Gas Control Valve must be connected to the gas line downstream of the MAS. This can be done directly after the MAS or to the prepared holes in the Deltec mixing unit on the gas connection of the Deltec mixer. Especially when the air fuel ratio control is used on landfill or bio-gas engines, the connection to the Deltec mixing unit points is advisable, to obtain a better response time.
- On V-engines with two mixing units an average negative pressure has to be connected to the Gas Control Valve.
- When the special delivered hose is not used make sure, that the hose which is used instead, has the same internal diameter. When the diameter is too small the response time is less and instability may occur.
- Due to the construction of the Gas Control Valve, the valve is not suitable for mounting on the engine. Heavy and enduring vibrations will damage the valve internally.
- The maximum allowable operating temperature is 80 °C.
- Avoid water inside the Gas Control Valve when the valve is used on landfill or bio-gas engines.
- H_2S in bio-gas or landfill gas will damage the stepper motor internally.

Maintenance of the Gas Control Valve

The Gas Control Valve is the only moving part of the complete system that requires maintenance. The Gas Control Valve needs to be cleaned and greased every 8000 engine running hours for natural gas, and every 4000 hours for landfill or bio-gas. Use silicone spray to grease the moving parts in the Gas Control Valve.

NOTICE

Take care when disassembling the Gas Control Valve. When assembling and disassembling the stepper motor and the plunger, make sure NOT TO ROTATE the stepper motor or plunger. Rotating one of those items will break down the flexible linkage between the stepper motor and the plunger. A broken flexible linkage will not be replaced under warranty.

Lambda Sensor Input (Terminals 15/16)

General Information

The Universal Exhaust Gas Oxygen (UEGO) sensor operates with a controller which controls the temperature of the sensor and converts the sensor pumping current into an analogue signal from 2.5 Vdc to 4.5 Vdc.

The complete UEGO sensor kit (see Figure 2-5) with part number 1680-447 consists of:

- the UEGO sensor
- the UEGO controller
- the wiring harness

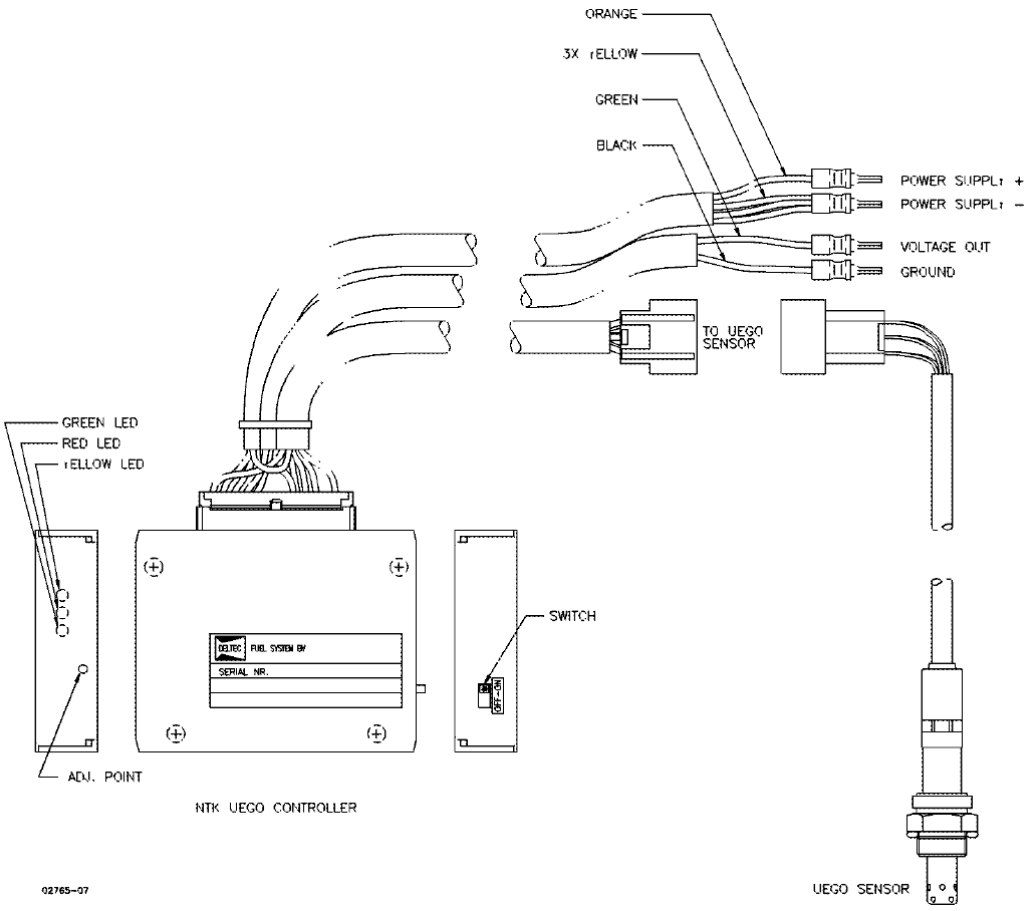

Figure 2-5. UEGO Sensor Kit

The UEGO sensor is used as a feedback signal for the closed loop air fuel ratio control. The application software uses this signal to trim the Gas Control Valve in order to run the gas engine on the right lambda.

Electrical Installation of the UEGO Sensor

Use shielded twisted-pair wires to connect the lambda signal to terminals 15 & 16. For connection between the UEGO sensor and the controller use the original wiring harness. The four wires from UEGO wiring harness must be connected to the Gas Engine I/O Node as follows:

UEGO		**Gas Engine I/O Node**
Black	lambda sensor (–)	terminal 15
Green	lambda sensor (+)	terminal 16
Yellow	lambda sensor supply (–)	terminal 17
Orange	lambda sensor supply (+)	terminal 18

A shield connection is provided at terminal 14.

Mechanical Installation of the UEGO Sensor

1. Mount the sensor close to the engine to increase the response time of the UEGO sensor.

2. Mount the sensor in a horizontal position to use the air flow around the engine for cooling the outer side of the sensor.

3. Do not mount the sensor at the top or at the bottom of the exhaust pipe.

4. ALWAYS use a heat shield around the sensor to prevent the sensor housing from heating up by radiation (see Figure 2-6).

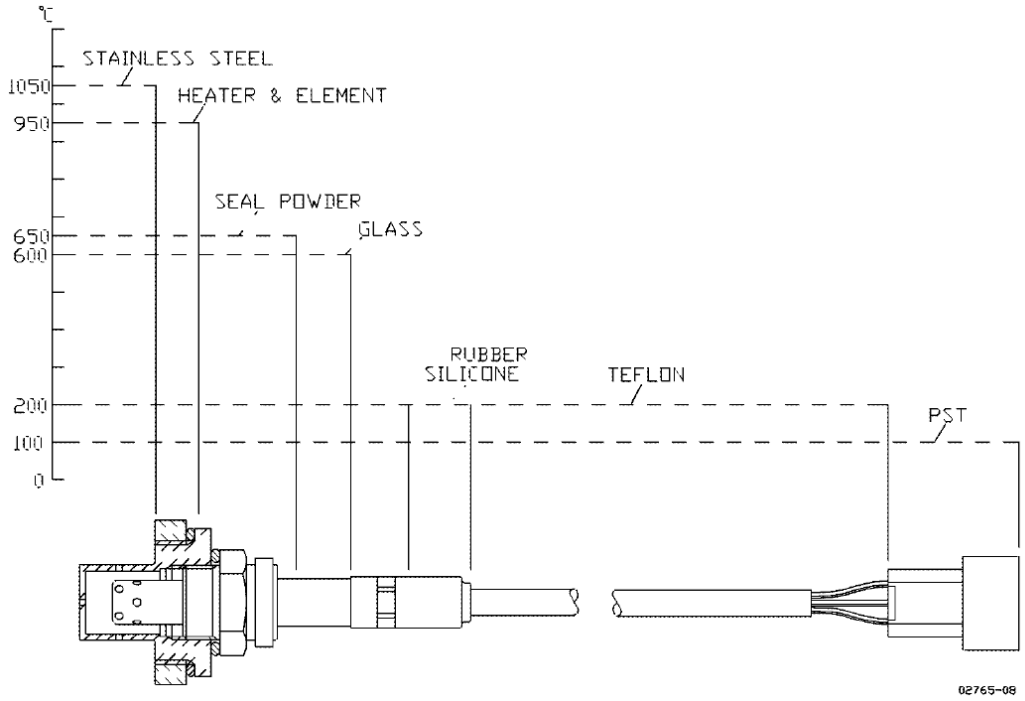

Figure 2-6. Thermal Characteristics of the UEGO Sensor

5. Measure the sensor housing temperatures at full load to be sure that the maximum temperatures are not reached.

6. Always use the special protection cover and welding ring for mounting the sensor (see Figure 2-7).

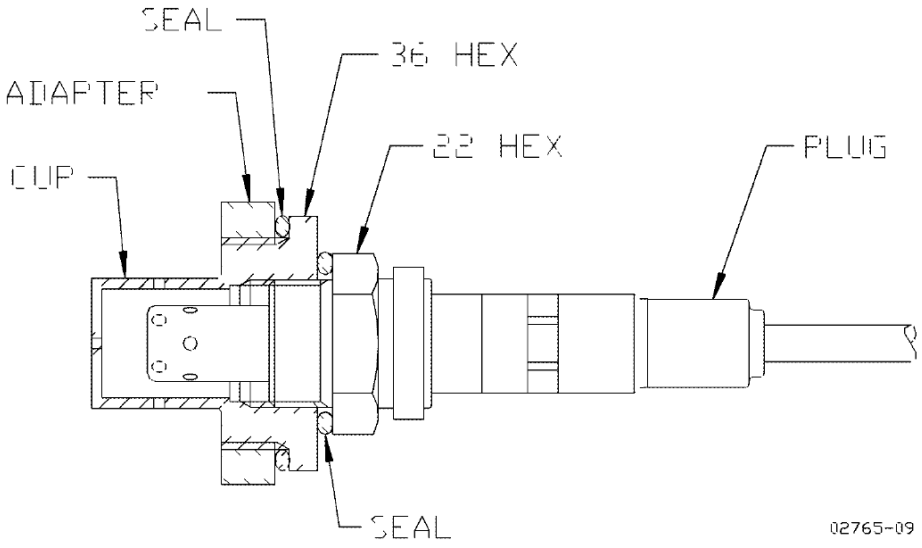

Figure 2-7. UEGO Sensor

NOTICE

For mounting the protection cover into the welding ring and the UEGO sensor into the protection cover, always use Loctite Nickel Anti-Seize (Cat Number 76777). See Figure 2-8.

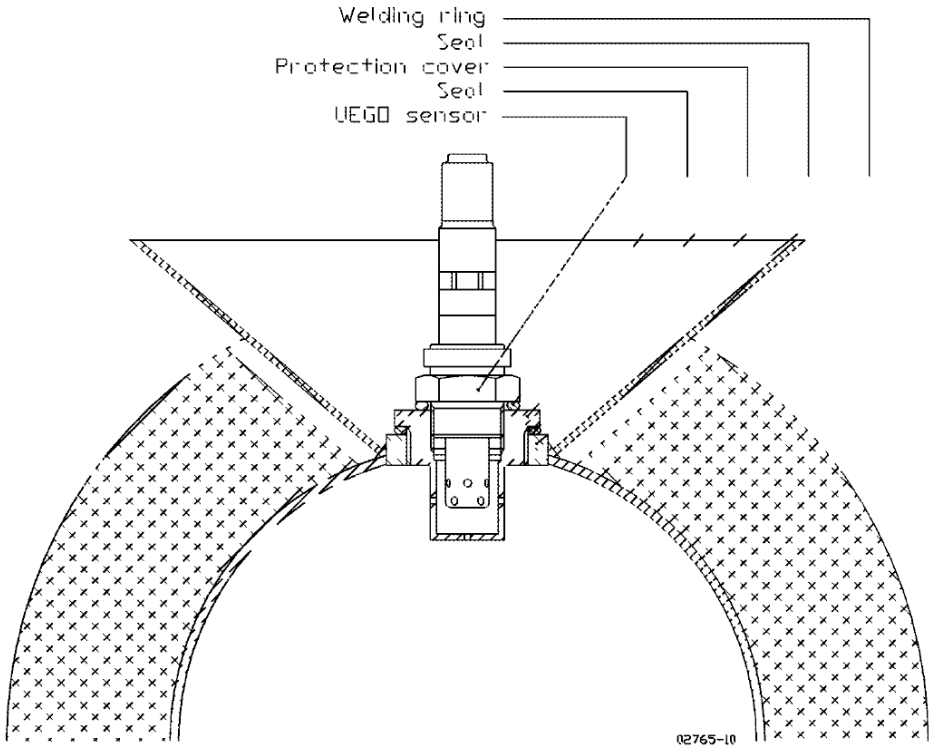

Figure 2-8. Mounting of the UEGO Sensor in the Exhaust Pipe

7. The sensor should never be mounted in the exhaust pipe when the Gas Engine I/O Node is powered down. The sensor is not heated then.

NOTICE

Running the engine with an unheated sensor will damage the sensor. Remove the UEGO sensor if not used. The hole can be plugged off with an old spark plug (thread M18 x 1.5).

8. Before running the engine, the Gas Engine I/O Node should be powered up and the UEGO controller should be switched on at least 10 minutes prior to starting the engine

Calibration of the UEGO Sensor

If the power on/off switch is turned on, the yellow power on LED will start to flash, this means that the power supply of the controller is functioning correctly. The controller starts immediately with its warm up cycle. After 30 seconds the red sensor error LED turns off, at the same time the green sensor OK LED turns on.

If the red sensor error LED is burning during operation then the sensor is misreading the right lambda value. This can be caused by overheating the sensor.

The UEGO controllers normally have about the same output voltages. The output at lambda = 1.00 shall always be around 3.00 Vdc. At a lambda = ±1.55 (this is approximately 8.5% O_2 with natural gas) the output voltage should be between 3.49 and 3.54 Vdc.

Lambda sensors are more or less sensitive to aging, which means that the output voltage may drift a little over a certain time period. Therefore the output voltage needs to be checked every service interval of the engine. The following procedure can be used:

- Stop the engine.
- Turn off the power of the controller using the power on/off switch (see Figure 2-9).
- Dismount the UEGO sensor from the exhaust and let it hang free in the open air.
- Turn on the power of the controller and let the sensor clean itself with fresh air during the service interval.
- Before mounting the sensor back to the exhaust, make sure you check the output voltage with a multimeter.
- The output voltage should be exactly 4.50 Vdc at 20.9% oxygen.
- If necessary, trim the adjustment point (see Figure 2-9) so that the multimeter is reading exactly 4.50 Vdc
- Remount the UEGO sensor back in the exhaust.

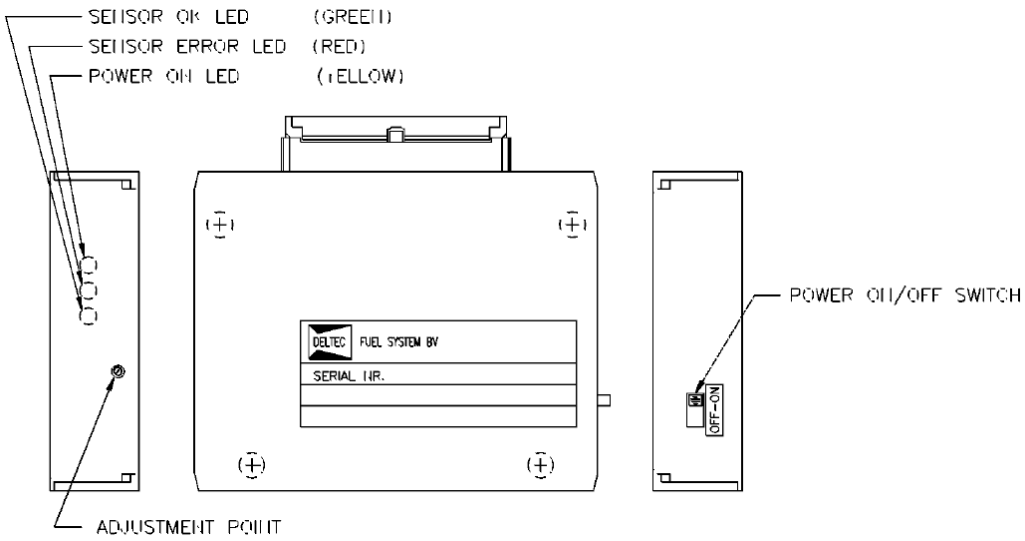

Figure 2-9. UEGO Controller

Lambda Sensor Supply (Terminals 17/18)

Use shielded twisted-pair wires to connect the UEGO controller to terminals 17 & 18. A shield connection is provided at terminal 19.

For connection between the UEGO sensor and the controller use the original wiring harness. The two power supply lines from UEGO wiring harness must be connected on the Gas Engine I/O Node as follows:

UEGO		**Gas Engine I/O Node**
Yellow	lambda sensor supply (–)	terminal 17
Orange	lambda sensor supply (+)	terminal 18

Potentiometer Input (Terminals 20/21/22)

Use a three core shielded cable to connect the potentiometer to terminals 20, 21, & 22. A shield connection is provided at terminal 19. Use a 10-turns 10 kΩ potentiometer (see Figure 2-2). Put the runner in the mid position (potentiometer dial showing 5) so that the potentiometer dial range works from 5 to 10 and from 5 to 0. Turning the dial clock wise (from 5 to 10) the voltage between terminal 20 (GND) and terminal 21 (SIGNAL INPUT) should increase from 2.5 Vdc to 5.04 Vdc. Turning the dial counter clock wise (from 5 to 0) the voltage between terminal 20 (GND) and terminal 21 (SIGNAL INPUT) should decrease from 2.5 Vdc to 0 Vdc. Between terminal 22 (POWER) and terminal 20 (GND) the power supply voltage of 5.04 Vdc can be measured.

Make sure that the potentiometer clock wise function is connected according to control wiring diagram, as seen in figure 7-16, of the Gas Engine I/O Node. This means that in Slew mode, turning the potentiometer clock wise, the air fuel ratio of the engine should increase, making the engine leaner.

The potentiometer works in conjunction with the Lambda/Slew switch. In Lambda mode the potentiometer can be used for increasing or decreasing the lambda reference of the application software making the engine run leaner or richer. In slew mode the potentiometer can be used to for moving the plunger manually in the Gas Control Valve for the set up of the air fuel ratio application software.

MAP Sensor Input (Terminals 24/25/26)

Electrical Installation of the MAP Sensor

Use a three core shielded cable to connect the MAP sensor to terminals 24 , 25, & 26. A shield connection is provided at terminal 23.

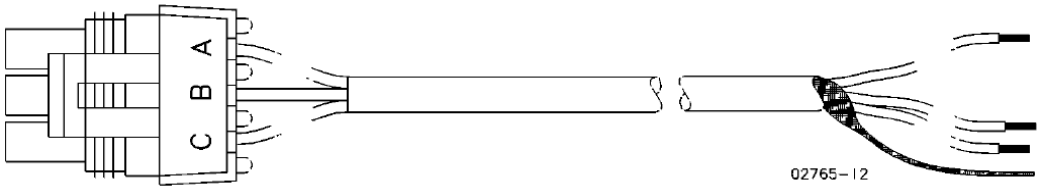

Figure 2-10. MAP Sensor Connector with Shielded Cable

The special MAP connector (see Figure 2-10) is needed to make the connection to the Gas Engine I/O Node. The connector itself shows the letters A, B, and C which should correspond with the terminals 24, 25, and 26 on the node. Make sure to connect A to A and B to B, etc. otherwise the MAP sensor does not function.

Mechanical Installation of the MAP Sensor

The Manifold Absolute Pressure sensor is used to measure the pressure of the mixture in the manifold of the gas engine. Together with the generator load signal and the reference MAP settings a reliable engine protection system can be achieved. The following points must be taken in account when mounting the MAP sensor (see Figure 2-11) on the engine:

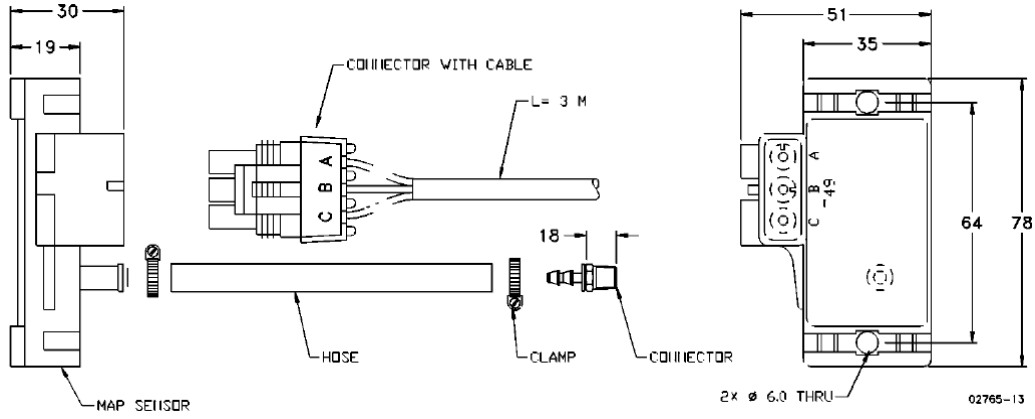

Figure 2-11. Manifold Absolute Temperature Sensor

- The MAP sensor must be connected to the intake manifold, downstream the throttle valve and aftercooler.
- The MAP sensor can be mounted directly on the engine using two M6 bolts. The maximum allowable operating temperature is 80 ºC.
- Use the special rubber hose and hose connectors which are part of the MAP sensor kit
- On stationary engines the maximum length of the MAP hose is not very important, however for a reasonably quick response time of the sensor,
- a maximum length of one meter is preferred.
- The MAP cable is not high temperature resistance, physical contact with high temperature parts of the engine is not allowed and can damage the cable.

MAP Sensor Checkout Procedure

The following checkout procedure can be used to see if the MAP sensor itself is functioning properly:

Measure the voltage between the signal wire (B) and the sensor common wire (A), using a multimeter. At an ambient pressure of ±100 kPa, the multimeter should read a voltage depending on the pressure range of the MAP sensor.

The following voltages can be seen:

pressure range	part number	signal out
0-100 kPa	P/N 1680-439	4.559 Vdc
0-200 kPa	P/N 1680-441	2.398 Vdc
0-300 kPa	P/N 1680-443	1.625 Vdc

MAT Sensor Input (Terminals 28/29/30)

Electrical Installation of the MAT Sensor

Use a three core shielded cable to connect the MAT sensor to terminals 28 , 29, & 30. A shield connection is provided at terminal 27. The MAT sensor is a Resistance Temperature Device, a PT100 type of RTD sensor. The RTD sensor provides one connection to one end and two to the other end of the sensor. Connected to the terminals 28, 29, & 30, designed to accept three wire input, compensation is achieved for lead resistance and temperature change in lead resistance. See figure 4-12 for the MAT connection on the node.

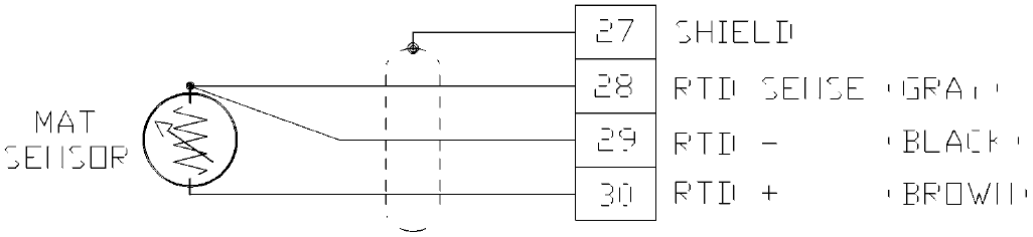

Figure 2-12. MAT Connection on the Terminals

Mechanical Installation of the MAT Sensor

The Manifold Absolute Temperature sensor is used to measure the temperature of the mixture in the manifold of the gas engine. The MAT signal is needed to correct the lambda reference value of the air fuel ratio control, to keep the NO_x level constant.

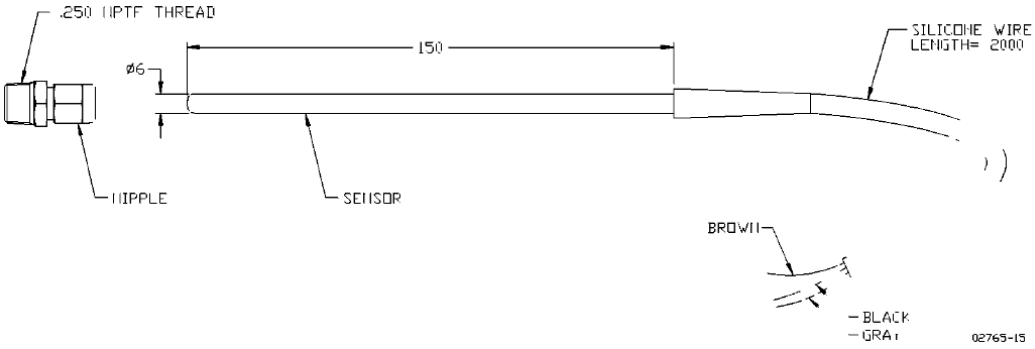

Figure 2-13. Manifold Absolute Temperature Sensor

The following points must be taken in account when mounting the MAT sensor (see Figure 2-13) on the engine:

- The MAT sensor must be mounted on the intake manifold, downstream the throttle valve where the average temperature of the mixture, can be measured.
- The MAT sensor tip must be located in the middle of the mixture flow, otherwise the temperature measurement is less accurate, due to the influence radiation of the manifold.
- Use the special supplied MAT nipple for connection.
- The MAT sensor cable is high temperature resistant up to 100 ºC.

MAT Sensor Checkout Procedure

The following checkout procedure can be used to see if the MAT sensor itself is functioning properly:

Measure the resistance between the brown and the black wire, using a multimeter. At 0 °C, the resistance between the brown and the black wire should be exactly 100 Ω.

Example: at 20 °C, the resistance is 107.79 Ω.

RTD #2 or Analog Input #2 (Terminals 32/33/34)

Use a two or three conductor shielded wire depending on the configuration of this input A shield connection is provided at terminal 31 for both configurations. The default jumper setting of this input is set for a RTD sensor. This input can be used to connect an Air Temperature Sensor to the node if this is required by the application. The same requirements as for a MAT sensor are applied if a PT100 type of sensor is being used for air temperature measurement. In case of an analog input, see Chapter 2 for the right jumper setting of this input.

RTD #1 or Analog Input #1 (Terminals 36/37/38)

Use a two or three conductor shielded wire depending on the configuration of this input. A shield connection is provided at terminal 35 for both configurations. The default jumper setting of this input is set for a RTD sensor. This input can be used to connect a Gas Temperature Sensor to the node if this is required by the application. The same requirements as for a MAT sensor are applied if a PT100 type of sensor is being used for gas temperature measurement. In case of an analogue input see Chapter 2 for the right jumper setting of this input.

LON Communication Channel (Terminals 40/41/42)

The communications network used by the Gas Engine I/O Node is Echelon® Corporation's LonWorks® technology. An Echelon Neuron® chip operates as a slave processor to the 723 control main processor. LonWorks provides the interconnection between all controls over which I/O (input/output) information passes (see Figure 2-14). There is no polarity for the LON wiring and the shield connection is available at terminal 39.

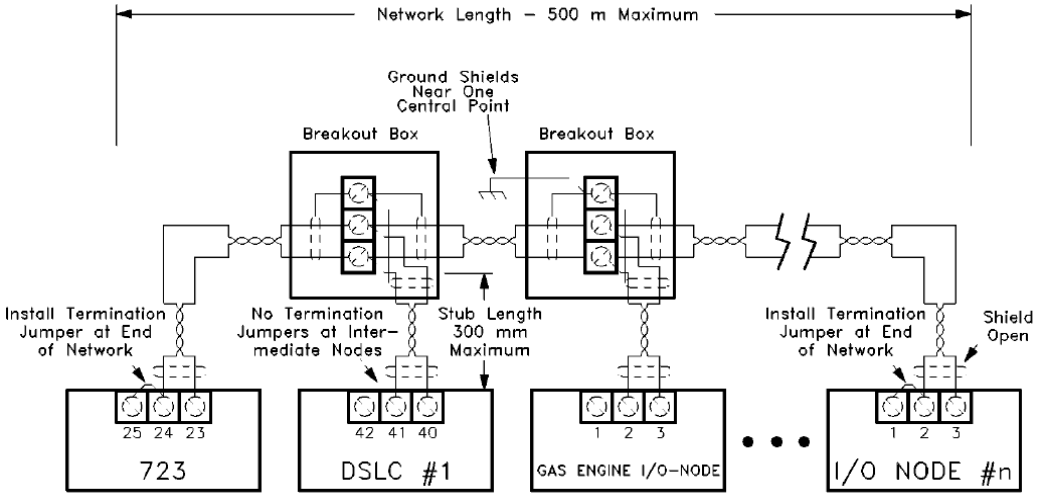

Figure 2-14. Typical LON Setup

The cable used for the network will affect the overall system performance with respect to distance, stub length. and total number of nodes supported on a single channel. Echelon recommends the use of UL Level IV, 0.325 mm² (22 AWG) twisted pair cable for the network bus as defined in UL's LAN Cable Certification Program, UL document number 200-120 20 M/11/91.

Proper LonWorks network wiring is critical to assure that the network (and thus the air fuel ratio control system) operates correctly. Figure 2-14 illustrates a typical system with a Gas Engine I/O Node. The system may include other LonWorks-compatible devices, such as a Woodward DSLC™, Digital Synchronizer and Load Control. The following requirements must be met:

1. Use only recommended shielded twisted pair cabling for the LonWorks network. Correct cable is available from Woodward, Belden, or other suppliers providing an equivalent cable.

   Woodward part number 2008-349

Belden
PO Box 1980
Richmond, IN 47375
(317) 983-5200

Belden part number

P/N	Description
9207	PVC 0.52 mm² (20 AWG) shielded. NC Type CL2, CSA Cert. PCC FT 1
89207	Teflon 0.52 mm² (20 AWG) shielded, Plenum version. NEC Type CMP, CSA Cert. FT 4
YR28867	PVC 0.325 mm² (22 AWG) shielded.
YQ28863	Plenum 0.325 mm² (22 AWG) shielded.

2. Maximum cable length for a LonWorks 1.25 MBEs network is 500 m (1640 ft).

3. Stubs, or wiring drops, connecting intermediate devices to the main cable are limited to 300 mm in length.

4. Shields must be carried through all breakout boxes to provide a continuous shield throughout the network.

5. The network must be properly terminated at each end of the cable. Internal components are provided in all Woodward 723 DCS, Gas Engine I/O Node or DSLC which provide proper network termination with installation of a jumper on the controls at each end of the cable. Intermediate nodes should not have the termination jumper installed.

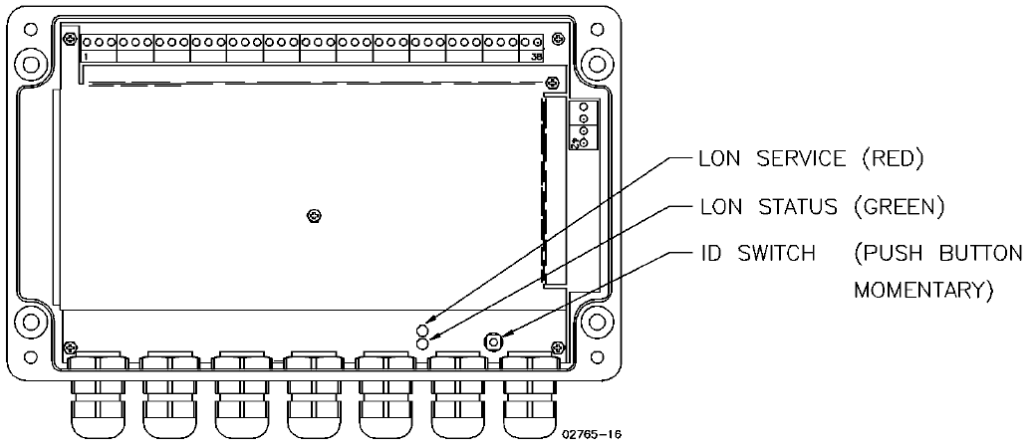

Figure 2-15. Location of the Network LEDs and ID Switch

A special Serial LonTalk Adapter (SLTA) is needed to make a network “binding” between the Gas Engine I/O Node and the 723 DCS.

An SLTA is a network interface that enables any PC to connect to a LonWorks network. An SLTA enables the attached PC to act as an application node on a LonWorks network. When used with a PC and the LonManager LonMaker Installation Tool, the SLTA can also be used to build sophisticated network management, monitoring and control tools for the LonWorks network.

The red service LED, as seen in Figure 2-15, will reflect the network status of the Gas Engine I/O Node:

- **blinking** means Gas Engine I/O Node is unconfigured
- **off** means Gas Engine I/O Node is configured
- **on** means Gas Engine I/O Node is applicationless

The green status LED, as seen in Figure 2-15, can be used to check with the LonManager LonMaker Installation Tool if the network is functioning correctly. With the LonManager LonMaker Installation Tool a “wink” command can be transmitted via the network. After receiving the “wink” command the green LED will start to blink. It stops after 15 minutes, or when it receives a second “wink” command.

The identification push-button switch (ID switch), as seen in figure 4-15, must be used during installation to broadcast the unique 48-bit Neuron ID on the network.

Chapter 3.
Service Options

Product Service Options

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

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

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

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

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

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

Woodward Factory Servicing Options

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

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

Replacement/Exchange: Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime. This is a flat-rate program and includes the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205).

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

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

Flat Rate Repair: Flat Rate Repair is available for the majority of standard products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be. All repair work carries the standard Woodward service warranty (Woodward Product and Service Warranty 5-01-1205) on replaced parts and labor.

Flat Rate Remanufacture: Flat Rate Remanufacture is very similar to the Flat Rate Repair option with the exception that the unit will be returned to you in “like-new” condition and carry with it the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205). This option is applicable to mechanical products only.

Returning Equipment for Repair

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

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

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

Packing a Control

Use the following materials when returning a complete control:

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

NOTICE

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

Replacement Parts

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

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

Engineering Services

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

- Technical Support
- Product Training
- Field Service

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

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

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

For information on these services, please contact us via telephone, email us, or use our website and reference **www.woodward.com/support**, and then ***Customer Support***.

How to Contact Woodward

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

Electrical Power Systems

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

Engine Systems

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

Turbine Systems

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

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

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

Technical Assistance

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

General

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

Prime Mover Information

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

Control/Governor Information

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

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

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

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

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

Appendix A.
Part Number List

Description	Woodward Part Number
Sensor	
MAP 0-1 bar absolute	1680-439
MAP 0-2 bar absolute	1680-441
MAP 0-3 bar absolute	1680-443
Oxygen “Lambda” sensor	1680-445
UEGO sensor kit	1680-447
MAT PT100 sensor	1680-449
Air Temperature PT100 sensor	1680-449
Gas Temperature PT100 sensor	1680-449
Valve	
Gas Control Valve	1314-023
Potentiometer	
10-turns 10 kΩ Potentiometer	1657-659
Dial 15-turns	1659-609

Appendix B.
Control Wiring Diagram

Control wiring is shown on the next two pages.

NOTES:

1. SHIELDED WIRES ARE TWISTED PAIRS, WITH SHIELD GROUNDED AT ONE END ONLY WHEN MOUNTING CONTROL TO BULKHEAD. USE THE GROUNDING STUD AND HARDWARE SUPPLIED WITH THE CHASSIS TO ENSURE PROPER GROUNDING.

2. SHIELDS MUST NOT BE GROUNDED AT ANY EXTERNAL POINT UNLESS OTHERWISE NOTED.

3. ALL SHIELDS MUST BE CARRIED CONTINUOUSLY TROUGH ALL TERMINAL BLOCKS AND MUST NOT BE TIED TO OTHER SHIELDS EXCEPT AT THE COMMON GROUND POINT. THE SHIELDS ARE TIED TOGETHER AT THE GROUND STUD

4. LON TERMINATION JUMPER.

5. INTERNAL POWER SUPPLY PROVIDES DC ISOLATION BETWEEN THE POWER SOURCE AND ALL OTHER INPUTS AND OUTPUTS.

6. UNLESS OTHERWISE SPECIFIED:
   A. RELAYS SHOWN DE-ENERGIZED
   B. RELAYS ENERGIZE FOR FUNCTION
   C. RELAY CONTACT RATINGS FOR MINIMUM 100 000 OPERATIONS:
   RESISTIVE- 2.0 AMPERES AT 28 VDC
   0.1 AMPERES AT 115 VAC 50 TO 400 Hz
   INDUCTIVE- 0.75 AMPERES AT 28 VDC 0.2 HENRY
   0.1 AMPERES AT 28 VDC LAMP

7. CONTACT OPEN FOR LAMBDA MODE, CLOSED FOR SLEW MODE.

8. USE THE DelTec GAS CONTROL VALVE WITH THE PART NUMBER 1314-025.

9. FOR LEAN-BURN APPLICATIONS USE UEGO SENSOR WITH PART NUMBER 1680-447.
   FOR STOICHIOMETRIC APPLICATIONS USE OXYGEN "LAMBDA" SENSOR WITH PART NUMBER 1680-445

10. FOR DETAILED INSTALLATION INSTRUCTIONS SEE CHAPTER 4.13

11. USE A 10-TURNS 10 KOHM POTENTIOMETER.

12. THE MANIFOLD ABSOLUTE PRESSURE SENSOR IS AVIALABLE IN THREE PRESSURE RANGES :
    0 to 100 kPa WITH PART NUMBER 1680-439
    0 to 200 kPa WITH PART NUMBER 1680-441
    0 to 300 kPa WITH PART NUMBER 1680-443

13. USE PT100 RTD TYPE OF TEMPERATURE SENSOR WITH PART NUMBER 1680-449.

14. SEE CHAPTER 4.5 FOR JUMPER SETTING IF THE ANALOGUE INPUTS ARE USED.

15. FACTORY SET FOR RTD INPUT.

16. USE TWISTED PAIR SHIELDED WIRE ONLY. SEE CHAPTER 4.19.

02765-18

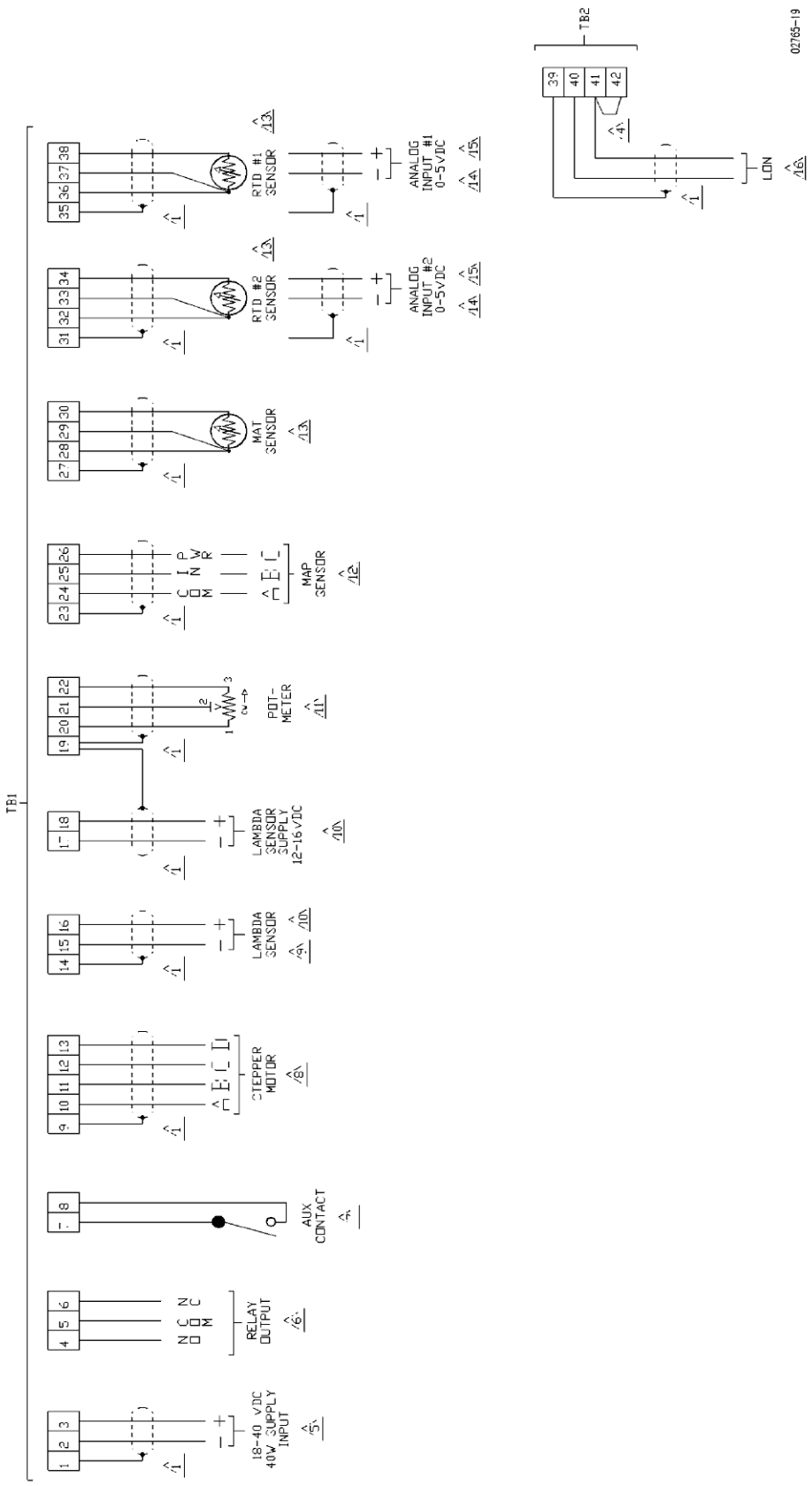

Figure A-1. Gas Engine I/O Node Control Wiring Diagram

Appendix C.
Gas Engine I/O Node Specification

Woodward Part Number:	9906-129, Gas Engine I/O Node
Power Supply Rating	18–40 Vdc (24 or 32 Vdc nominal)
Power Consumption	40 W nominal

Test	Spec	Level
Vibration	US MIL-STD-810C, Method 514.2, Procedure 8	Curve W
Shock	US MIL-STD-810C, Method 516.2, Procedure 1	40 g, 11 ms Terminal-peak Sawtooth Pulse
Storage Temperature		
	US MIL-STD-810D, Method 501.2, Procedure 1	105 °C
	US MIL-STD-810D, Method 502.2, Procedure 1	–50 °C
Operating Temperature		
	US MIL-STD-810D, Method 501.2, Procedure 2	70 °C
	US MIL-STD-810D, Method 502.2, Procedure 2	–40 °C
Humidity	US MIL-STD-810D, Method 507.2, Procedure 3	
Salt Fog	US MIL-STD-810D, Method 509.2, Procedure 1	
Enclosure	IEC 529	IP56
CE EMC Emissions		
	EN50081-2	
CE EMC Immunity		
	EN50082-2	

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 02765A.

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Email and Website—www.woodward.com

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

2009/3/Fort Collins