WOODWARD

Product Manual 26200
(Revision A)
Original Instructions

Gas Turbine/Compressor Control

MicroNet™ Part Number 8238-504
Designed as a Replacement for 511 DCS 8237-066

System Manual

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

Revisions	**This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual 26311 , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, on the *publications page* of the Woodward website:** **www.woodward.com/publications** **The latest version of most publications is available on the *publications page*. If your publication is not there, please contact your customer service representative to get the latest copy.**

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

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Revisions—Changes in this publication since the last revision are indicated by a black line alongside the text.

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Warnings and Notices

Important Definitions

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

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

WARNING

Overspeed / Overtemperature / Overpressure

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

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

WARNING

Personal Protective Equipment

The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:

- **Eye Protection**
- **Hearing Protection**
- **Hard Hat**
- **Gloves**
- **Safety Boots**
- **Respirator**

Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.

WARNING

Start-up

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

WARNING

Automotive Applications

On- and off-highway Mobile Applications: Unless Woodward's control functions as the supervisory control, customer should install a system totally independent of the prime mover control system that monitors for supervisory control of engine (and takes appropriate action if supervisory control is lost) to protect against loss of engine control with possible personal injury, loss of life, or property damage.

NOTICE **Battery Charging Device**	**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.**

Electrostatic Discharge Awareness

NOTICE **Electrostatic Precautions**	**Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:** • **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).** • **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.** • **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.** **To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual *82715*, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.**

Follow these precautions when working with or near the control.

1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
2. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

Chapter 1.
General Information

Introduction

This manual describes the Woodward MicroNet™ Digital Control System (part number 8238-504) designed to replace the 511 DCS controls designed for compressor and generator applications.

Electrical Scope of Supply

Qty	Description
1	MicroNet Simplex with simplex power supplies & Pentium CPU
1	Analog Combo Module (4 MPUs, 8 AI, 4 AO, 2 ACT)
1	High Density Discrete Module (48 DI, 24 DO)
2	High Density Analog Module utilizing DataForth signal converters (24 In/8 Out)
1	Moore Industries AD590 Ambient Temperature Signal Converter

General Description

The Woodward MicroNet Digital Control System is a programmable control system for gas turbines which can control speed, load, pressure, level, or flow. It can also control any other system parameter that can be sensed either by a transducer and converted to an analog signal, or by switches and contacts.

Inputs

This control can receive inputs from the following devices:
- 4 Magnetic pickups
- 12 Temperature sensors (J and K-type Thermocouples)
- 28 Analog Input Sensors (4 to 20 mA dc signals)
- 48 Discrete input contacts

Outputs

A MicroNet Digital Control System uses analog and discrete output modules to provide the following outputs. You can use more than one module of a particular type to increase the number of that same type of output channels if needed.
- 2 actuator driver channels (0 to 20 mA dc or 0 to 200 mA dc maximum range)
- 24 relay outputs
- 12 current outputs (4 to 20 mA dc)

Power Requirements

The MicroNet Digital Control System has both high and low voltage models available. The high voltage supply requires 90-150 Vdc or 88-132 Vac 50/60 Hz. The low voltage supply requires 18-32 Vdc.

Hardware

The MicroNet Digital Control System is housed in a standard six-slot chassis which should be bulkhead mounted in the control panel.

The card rack has six slots for modules. Slots 2 through 6 are for Input/Output (I/O) modules, and slot 1 must contain the CPU module.

There are two types of modules in a MicroNet control: the CPU (kernel) modules and the I/O (input/output) modules. The CPU module controls the system. The I/O modules interface the CPU module to the outside world, permitting it to sense digital and analog inputs and to issue analog and discrete outputs.

Each module is assigned to a specific slot, and the software will expect that specific I/O module always to be in its designated slot.

Physical Description

The modules slide into guide channels in the MicroNet chassis and plug into the motherboard. All modules have their circuitry on a single printed-circuit board. The top and bottom edges of the modules slide into guide channels in the card rack, and the connectors on the module back edges mate with connectors on the motherboard.

Each module has a strip on its front edge which serves as a pull handle when disengaging the connector on the module from the connector on the motherboard. The strip also serves as a handle to hold the module.

Relays are included in the system to isolate the system's discrete output circuits from the field wiring. The relay box is DIN rail mounted next to the High Density Discrete Field Termination Module (FTM).

Central Processor Unit (CPU) Module

The NT CPU module follows the instructions of the application program and controls all the circuits of the MicroNet control.

The NT CPU module has the following switch and indicators:

- **KEYBOARD PORT**

Not used.

- **MOUSE PORT**

Not used.

- **ABORT / FAIL LED**

Illuminates GREEN when the system is powered up or after a reset is issued. Illuminates RED when the CPU is initializing or when a problem is detected

- **RESET / PASS SWITCH**

Momentary switch to manually reset the CPU and the entire system. All modules are placed in I/O Lock until the CPU completes its initialization routine.

⚠WARNING **Do not press down on the Reset Switch when the turbine is running. Pressing down on this switch disables all I/O outputs and could cause loss of control of the turbine resulting in damage to equipment or personal injury or both.**

The CPU module has the following Communications Ports:

100BT
10/100 Base-TX Ethernet port used for Modbus®* communication and service tools. This port is not isolated and should only be accessed using the supplied Ethernet Filter module.

*—Modbus is a trademark of Schneider Automation Inc.

COM 1 and COM 2
The two serial ports can be used for RS-232 communications using ASCII or RTU.

- The COM 1 Serial Port is configured to use a standard Modbus communication protocol.
- The COM 2 Serial Port is configured as a 'ServLink' protocol port for service tools.

I/O Modules

Every I/O module has a FAULT LED which is controlled by the CPU. During every initialization of the system, the CPU turns these LEDs on. The CPU then individually tests each I/O module. If an I/O module fails any test, the FAULT LED remains on. The FAULT LED remaining on after the diagnostics have run may mean that the module has failed a test, or it may mean that the module is in the wrong slot.

Analog Combo Module
Please refer to manual 85584 (MicroNet/TMR Manual)

High Density Discrete Module
Please refer to manual 85584 (MicroNet/TMR Manual)

High Density Analog Module
Please refer to manual 85584 (MicroNet/TMR Manual)

Application Program

The application program is designed for a specific application by using the Woodward Graphical Application Program (GAP™). The GAP program, which runs on a standard PC (personal computer), builds and compiles the application program file. This application code is then processed by a program called the MicroNet Digital Control System Coder, which generates the application program code, which is then loaded into flash memory on the CPU module circuit board.

Chapter 2.
Description of Operation

Scope

This chapter describes the operation and features included in the MicroNet® Digital Control System for control of a gas turbine driving a compressor. The control has been divided into major functions for this description. Many of these functions have sub-functions, although not all of these may exist in your specific unit. The major functions of this MicroNet system include:
- Speed Control/Actuator
- Speed Sensing
- Speed Reference
- Start Ramp and Start Ramp Logic
- Ambient Temperature Sensor
- Exhaust Gas Temperature (EGT) Sensor
- CDP Sensor
- Analog and Digital Outputs
- Remote PT Control

Speed Control/Actuator

Speed control is responsible for setting the turbine fuel valve position to maintain the requested turbine speed. The sub-functions are:
- GG Control PID
- PT Control PID
- LSS Bus
- Accel Schedule
- Decel Schedule
- HSS Bus
- Actuator Driver

GG Control PID
The GG control PID (proportional-integral-derivative) function block compares the GG actual speed signal with the GG speed reference and calculates an appropriate output response. The GG control PID has three inputs:
- Actual speed input from the GG scaler
- GG speed reference input
- Feedback input from the jump and rate circuit output

PT Control PID
The PT control PID compares the PT actual speed signal with the PT speed reference and calculates an appropriate output response. The PT control PID has three inputs:
- Actual speed input from the PT scaler
- PT speed reference input
- Feedback input from the jump and rate circuit output

LSS Bus
The low signal select (LSS) bus selects the lowest of the GG PID, PT PID, EGT PID, start ramp, or the accel schedule signals, and passes it to the HSS bus. Whichever signal is calling for the lowest fuel is the one used for LSS bus output.

ACCEL Schedule

The accel schedule determines the maximum amount of fuel allowed during acceleration. It is based on either CDP (compressor discharge pressure) or the speed derivative. If the accel schedule is based on CDP, it will receive a signal from the CDP scaler and determines the maximum amount of fuel allowed for the current CDP. If the speed derivative accel is used, the maximum amount of fuel allowed is determined by a speed vs. speed derivative curve. This is programmed in the control. It then outputs this value to the LSS. If this value is the lowest on the LSS, the accel schedule controls the LSS.

DECEL Schedule

The decel schedule determines the minimum amount of fuel allowed during deceleration, based on CDP. It receives a signal from the CDP scaler and determines the minimum amount of fuel allowed for the current CDP. It then outputs this value to the HSS. If this value is the highest on the HSS, the decel schedule controls the HSS.

HSS Bus

The HSS bus receives the outputs of the LSS bus and the decel schedule as inputs. Whichever of these inputs is higher will be the signal sent to the jump and rate block by the HSS bus.

Actuator Driver

The actuator driver converts the 0-to-100% software control signal to a 10-to-200 mA drive signal. An input from the shutdown input can override the control signal and cause the actuator to go to minimum-fuel position or shut down. The shutdown circuit also has short and open coil fault detection. The actuator translates the signal from the electronic control into mechanical force to position the fuel valve.

Speed Sensing

The function of speed sensing is to monitor engine speed. The sub-functions are:

- Speed Sensors
- Sensor Fault Detection
- Speed Switches

Speed Sensors

There are four speed sensors in this system, two for GG and two for PT. The digital speed sensor I/O board receives input from the speed sensors on the turbine and converts this speed signal to a form usable by the control. The two speed signals from PT are high-signal selected with only the one indicating the higher speed being sent to the scaler (Hz to rpm). The output of this scaler goes to the PT control PID.

Sensor Fault Detection

Sensor fault detection is done in the application software. On detection of a sensor fault, a signal is generated for activation of associated indicators and alarms.

Speed Switches

There are three speed switches for GG and three speed switches for PT. These speed switches control relay drivers which can be used by the turbine system. There is also an overspeed switch for GG and one for PT. Each of these switches can be configured to activate at any speed. In addition, overspeed alarm switches are available for both GG and PT. Each switch also initiates a potential shutdown or alarm when activated.

Speed Reference

The speed reference produces the desired speed-setting signal and sends it to the speed controller. The sub-functions are:

- Speed Setting
- GG Ambient Bias
- Remote Speed Setting

Speed Setting

The GG and PT speed settings are raised or lowered by closing the associated contact. The rate at which the reference changes can also be selected. Each speed reference has both an upper and a lower limit position. The speed setting at each of these positions is a tunable value. Each speed reference also includes relay options to indicate when that speed reference is at the upper and lower limits.

GG Ambient Bias

The GG reference receives a reference input from the ambient temperature bias block. If the ambient temperature input fails, a fixed value (which is configurable) bias signal is input to the GG reference.

Remote Speed Setting

The PT speed setting can be controlled by a remote signal. The ENABLE contact enables remote speed setting. When enabled, the speed setting can be changed by varying a remote 4–20 mA signal. At this time all PT associated switch contacts (RAISE, LOWER, FAST, and INSTANT) must be open.

Start Mode

This control contains two options for start control, which is the initial control mode for the fuel. Both of these options are intended to provide a slow acceleration of the turbine, from turbine 'lite-off' up to closed loop N1 or N2 speed control. Once the fuel control has reached N1 or N2 control, the start mode demand signal is ramped out of the way (to 100%).

Once the Start Ramp Enabled discrete input contact is closed (TRUE), the fuel control will initiate a start. To achieve successful turbine 'lite-off', the unit must have been set up for either a mechanical lite-off or an electrical lite-off.

- **Mechanical Lite-off** = Minimum valve position mechanically set to yield correct lite-off fuel flow. If this is used, configure the MIN_FUEL position to zero (0.0).
- **Electrical Lite-off** = Minimum valve position set in software (MIN_FUEL) to yield correct valve demand position to yield lite-off fuel flow. If this is used, the valve should have the min stop set mechanically to zero degrees.

IMPORTANT **For information on setting MIN_FUEL, see Appendix C**

This contact is NOT a latched input, meaning that it must be held TRUE to activate fuel. If this signal is lost or drops out, the fuel control will chop fuel demand to the MIN Fuel Demand position.

NGG Derivative Control Start

This is the default start mode programmed for accelerating the turbine from Lite-off to speed control. This mode provides a PID control to raise the N1 speed at a defined acceleration rate of the N1 speed signal. The default rate for this is 50 rpm/s. This control loop will steadily increase fuel demand until a point at which a speed loop takes over control. The advantage of this mode is that it is closed loop around a parameter, while the start ramp mode simply opens the fuel valve with no feedback based on what is happening. The start ramp default rate (set in Appendix C) should be set high enough to just stay ahead of (greater than) the demand from this PID.

Start Ramp Control Start

An alternate start mode is simply to continue to ramp up the Start Ramp from the initial MIN_FUEL position to a point at which a speed loop takes over control of the fuel valve demand. The ramp will increase at the default rate, which is configured in Appendix C.

Ambient Temperature Sensor

The ambient temperature is sensed by an AD590. The AD590 microamp signal is converted to a milliamp signal through the Moore Industries device. This device has been programmed with a microamp-to-milliamp/temperature conversion chart that converts the value into a 4–20 mA signal. The ambient temperature sensor signal is converted to a digital signal in the MicroNet control and input to the GG reference and the EGT reference. If the ambient temperature input signal fails, a fixed-value signal (which can be changed using Woodward Watch Window II) is fed to the GG reference, and another fixed-value signal (which can also be changed using Watch Window II) is sent to the EGT reference.

Exhaust Gas Temperature (EGT)

The EGT section of this control includes the following sub-sections:
- EGT Sensing
- Temperature Control PID
- Temperature Reference

EGT Sensing
Two methods of sensing EGT are available, one thermocouple and multiple thermocouples. When the one-thermocouple method is selected (using the Watch Window tool), a single type K thermocouple senses EGT. The system feeds the temperature information from this thermocouple to the three temperature switches, the overtemp switch, and the EGT control PID. When the multiple-thermocouple method is used, the EGT is sensed by eleven type K thermocouples. The temp spread monitor block calculates the average reading of the eleven thermocouples (excluding any that are outside of the allowed spread or have failed). The temp spread monitor block and the subtract block calculate the difference between the highest and lowest readings (of the thermocouples that are included in the average). The average is sent to the three temperature switches, the overtemp switch, and the EGT control PID.

Temperature Control PID

The EGT PID block compares the actual EGT signal with the reference EGT signal and generates an appropriate output response signal. The EGT control PID receives a digital temperature signal from the selected sensing block, the EGT reference, and a feedback signal from the jump and rate block output.

Temperature Reference

The EGT Reference receives a reference input (programmable base, peak, or max.) selected by input, and a bias signal from the ambient bias block. If the ambient temperature input fails, a fixed value (also can be changed using the programmer) is selected for the bias signal.

Compressor Discharge Pressure (CDP)

Compressor discharge pressure (CDP) is sensed by a 4–20 mA pressure transducer. The 4–20 mA pressure signal is converted to a digital signal and used to bias the accel and decel schedules and as an input to the CDP readout driver.

Analog And Relay Driver Outputs

In addition to the actuator output, the control has outputs to indicate control operation and turbine parameters and conditions. The sub-functions are:

- Analog Outputs
- Relay Outputs
- Alarms
- Shutdowns
- Reset

Analog Outputs

The system includes the following analog outputs:

- Actuator drive signals. This system includes two actuator drivers, one for the gaseous-fuel actuator and one for the liquid-fuel actuator. Each of the two actuator drivers receives a fuel-demand signal from its associated scaler, and sends a 10–200 mA drive signal to its actuator. Each actuator, in turn, controls the flow of one type of fuel. If the unit is not dual fuel and is programmed for surge, the liquid actuator driver output controls the surge recycle valve.
- Readout signals (4 to 20 mA). The system includes the following 4–20 mA signals for driving readouts:
    - ❑GG (N1) Actual Speed Readout
    - ❑PT (N2) Actual Speed Readout
    - ❑EGT Readout
    - ❑CDP Readout
    - ❑Fuel Driver Demand Readout
    - ❑CIT (compressor inlet temperature or ambient temperature) Readout

Relay Driver Outputs

Twenty-four relay channels are available from the MicroNet control Field Terminal Module (with relays). These relays are driven by discrete outputs and used to indicate the function or status of the control or turbine. The relay outputs for ALARM and SHUTDOWN relays are normally energized. The relay signal outputs are programmed as follows:

1. Shutdown
2. Alarm
3. N1 Control
4. N2 Control
5. EGT Control
6. Accel Control
7. Start Ramp Control
8. N1 (GG) Reference Raise Limit
9. N1 (GG) Reference Lower Limit
10. N2 (PT) Reference Raise Limit
11. N2 (GG) Reference Lower Limit
12. N1 (GG) OVERSPEED Shutdown
13. N1 (GG) Input Failed
14. N2 (PT) OVERSPEED Shutdown
15. N2 (PT) Input Failed
16. OVERTEMP Shutdown
17. EGT Temp Signal Failed
18. N1 Speed Switch 1
19. N1 Speed Switch 2
20. N1 Speed Switch 3
21. N2 Speed Switch 1
22. N2 Speed Switch 2
23. N2 Speed Switch 3
24. EGT Temp Switch 1

Alarm List

(Consult Modbus Section for Modbus Address)

1. T/C #1 FAULT
2. T/C #2 FAULT
3. T/C #3 FAULT
4. T/C #4 FAULT
5. T/C #5 FAULT
6. T/C #6 FAULT
7. T/C #7 FAULT
8. T/C #8 FAULT
9. T/C #9 FAULT
10. T/C #10 FAULT
11. T/C #11 FAULT
12. N1 MPU SENSOR #1 FAILED
13. N1 MPU SENSOR #2 FAILED
14. N2 MPU SENSOR #1 FAILED
15. N2 MPU SENSOR #2 FAILED
16. * COMPRESSOR HEAD SENSOR FAILED
17. REMOTE PT REFERENCE INPUT FAILURE
18. * COMPRESSOR FLOW SENSOR FAILED
19. CDP SENSOR FAILED
20. AMBIENT TEMP SENSOR FAILED
21. EGT SUMMARY TEMP SIGNAL FAILED
22. * SPARE
23. * SPARE
24. T/C INPUTS EXCESSIVE SPREAD ALARM
25. NO. OF GOOD T/C INPUTS-ALARM

NOTE—* indicates optional alarm

When an alarm occurs, relay driver output turns on. The RESET will turn the alarm off if the alarm condition has been removed.

Shutdown List
(Consult Modbus Section for Modbus Address)

1. AMBIENT SENSOR FAILED
2. BOTH N1 SPEED SENSORS FAILED
3. BOTH N2 SPEED SENSORS FAILED
4. EGT SUMMARY SENSOR FAILED
5. NO. OF GOOD T/C INPUTS – SHUTDOWN
6. EGT OVERTEMP
7. EXCESSIVE NO. OF ADJ T/C FAILED
8. CDP SENSOR FAILED
9. REMOTE PT REF INPUT FAILED
10. ACTUATOR #1 FAILED
11. NO CONTROL CONFIGURATION FLAG
12. EXTERNAL SHUTDOWN INPUT

NOTE—* indicates optional alarm

When a shutdown occurs, the actuator signal goes to zero, and the turbine shuts down.

Watch Window II (WWII)

The Woodward Watch Window II (WWII) tool permits you to talk to the MicroNet control via the Ethernet port on the CPU. You can use WWII to monitor values, change parameters or set points, read fault messages, or issue instructions to the MicroNet Digital Control System.

The WWII tool is run on a laptop or desktop PC and uses standard Windows dialog boxes and Explorer windows to allow the user to create ‘Inspector’ files of any fields available in the application software.

Module Removal and Replacement

To prevent damaging to a MicroNet module or the system, follow these instructions when removing or replacing a module.

Removing MicroNet Modules

IMPORTANT

Before removing or working on a module, read the Electrostatic Discharge Awareness section on page ii, and read the information in Woodward manual 82715, *Guide For Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

NOTICE

Power must be turned off before removing any module from the control cabinet. Removing or installing a module with power on may damage that module or other parts of the control.

The following procedure describes the proper method for removing a MicroNet control module:

1. Disconnect FTM cables form the FTM by unlocking the retaining clip. Pull the cable off, being careful not to bend any of the cable connector pins.
2. Using the tabs on the modules push them away from the center of the module. The module will snap out
3. Place the module in a non-conductive plastic bag.

Module Fault

Module faults are indicated by a red LED on the module. If a red LED is on and the system is not initializing, the module is most likely bad. Reset the control by toggling the reset switch on the CPU module to see if the red LED will clear. If the LED remains on, the module should be replaced.

NOTICE	**Do not replace modules with power applied to the MicroNet Digital Control System. Removing and inserting modules with power applied could result in damage to the MicroNet control.**

Installing MicroNet Modules

When installing a module into the rack cabinet, keep two things in mind.

- First, the power to the control cabinet must be off. Removing the operating power prevents voltage transients from damaging the integrated circuits. Open the circuit breaker supplying operating power to the rack cabinet.
- Second, you must be very careful to install each module in the correct slot because there are no keys to keep a module from fitting in the wrong slot. To aid in proper module placement, the module slots are labeled with the slot number (1 on the left and 12 on the right) as well as the type of module allowed in that slot.

The following procedure describes the proper method for installing a MicroNet control module:

1. Push the module into the slot until the connector on the module and the connector on the motherboard make contact. When inserting the module make sure the PCB lines up with the guides designed to guide the module in.
2. With even pressure exerted at the top and bottom of the module, firmly push the module into place.
3. Replace the cables on the module. Be careful not to bend cable pins when putting the cables back on. Place the retaining clip back into the locked position.

NOTICE	**If resistance is encountered when installing a module, do not force the module. Remove the module and check the connectors for bent pins or obstructions. Forcing a connector may crack its insulator or break a pin.**

Initiating Ethernet Communications with the Control

Each CPU for this system will ship from Woodward with a default IP address of 190.14.98.116 (as a new unit) or 190.14.99.220 (as a spare). This means that the user must initially connect directly to the control with a PC that has had its IP changed to an address that is on this same first 3 octets within the subnet mask (for example 190.14.99. 221). Once the connecting PC is configured like this, the user can launch WWII by typing the IP address in the initial dialog box that opens when WWII is launched.

Changing the IP address of the Control

It is usually desirable to changed the fixed IP to an address available on the plant network, thus placing the control on the plant LAN. This is done via the AppManager program (supplied on SysDoc CD or from www.woodward.com). The user can change the control IP to any available IP on the plants local network.

IMPORTANT	**This is done from AppManager via a pull-down menu that is created by 'Right mouse Clicking' on the dialog box header bar "Change Network Settings".**

Control Problems

PID Controller Tuning

The majority of problems associated with the control of the turbine can be attributed to poor tuning of the PID control loops. These problems include overspeeding, overtemping, and flaming out, as well as many others. If the turbine control is hunting for example, the loop that is currently controlling the fuel valve is most likely incorrectly tuned and could cause sufficient overshoot to overspeed or overtemp the turbine. Some general tuning guidelines are outlined below.

⚠WARNING	**Tuning of PID loops should only be performed by qualified personnel who have a good understanding how the control should be performing. Improper tuning can result in overspeed or overtemp conditions which could cause damage to the turbine or possible injury or death to personnel.**

The quality of regulation obtained from an automatic control system depends upon the adjustments that are made to the various controller modes. Best results are obtained when the adjustment (tuning) is done systematically. Prior training and experience in controller tuning are desirable for effective application of this procedure.

This procedure will lead to controller settings which, after a load change, will provide:
- Process control without sustained cycling
- Process recovery in a minimum time

Controller settings derived for given operating conditions are valid over a narrow range of load change. The settings made for one operating set of conditions may result in excessive cycling or highly damped response at some other operating condition. This procedure should be applied under the most difficult operating conditions to assure conservative settings over the normal operating range.

There are several methods of controller tuning in use. The following procedure presents one which will be easiest to use, and at the same time, minimize process upset. This method is one of systematic trial and error.

The method given is based on the 1/4-ratio decay cycle. The peak of each cycle is 1/4 of the preceding one. The objective is to produce a trace as shown in Figure 2-1.

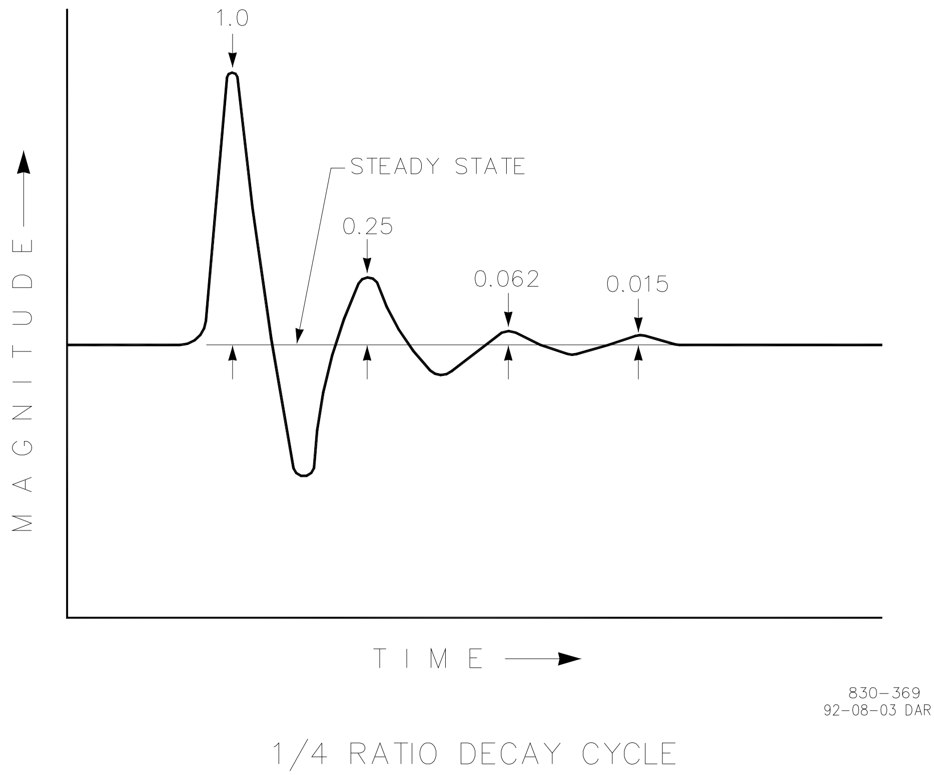

Figure 2-1. Ratio Decay Cycle

It is good practice to keep the average of the set point changes near the normal set point of the process to avoid excessive departure from normal operating level.

After each set point change, allow sufficient time to observe the effect of the last adjustment. It is wise to wait until approximately 90% of the change has been completed.

Controller Field Tuning Procedure

1. Have the process steady state on manual control at the normal set point. It is important that, for the duration of the controller tuning operation, no load changes take place. The occurrence of a load change may cause a misinterpretation of the recorder trace. Turn the integral adjustment to the position of low reset response, that is, place the reset adjustment at 0.02 repeats per minute (or 50 minutes per repeat). Adjust the Proportional Gain to a fairly low setting. (The actual value of the Proportional Gain will depend on the type of process variable being controlled.) Leave it this way until it is assured that the process has reached steady state.

2. Turn the Integral adjustment to minimum Reset effect; this will reduce or eliminate the Integral function. Check to see that Derivative adjustment is set for minimum Derivative, or in Woodward controllers at 100.

3. Switch to automatic control. Make a small change* in the set point and observe the response of the process to the Proportional Gain setting. If little or no cycling takes place, increase the Proportional Gain to 150% of its previous value and make another small change to the set point. After each set point change, increase the Proportional Gain to twice its previous value until an "Optimum Proportional" response curve (see below) is obtained. If a change in Proportional produces a "Proportional Too High" curve (see below), lower the Proportional Gain to its previous setting. The "Proportional Too Low" curve illustrates the condition in which the proportional is too low.

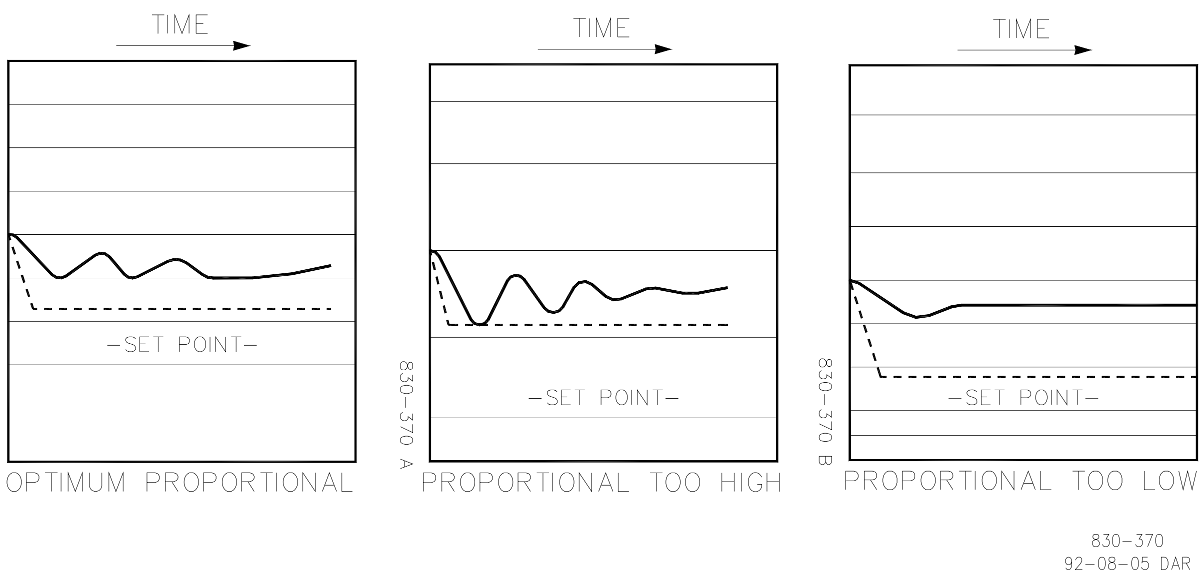

Figure 2-2. Proportional Gain Settings

**Set point changes can be made either up or down scale. The second change should return the set point to its original setting. Repeat this pattern through the tuning procedure.*

4. With the Proportional Gain at the setting previously obtained in step 3, make a change in set point and observe the recovery cycle. If there is no excessive cycling, increase the Integral to 0.04 repeats per minute (or 25 minutes per repeat). Make another set point change and observe results. After each set point change, make a change in the Integral adjustment to increase the Integral by 50% of the previous Integral effect. Continue in this manner until an acceptable response curve is obtained.

Poor Valve Response

What can appear as a tuning problem is often poor valve response. This can be due to a sticky actuator or inconsistent hydraulic pressure to the actuator. Changing hydraulic oil properties can also have an adverse affect to the control of the turbine.

The hydraulic supply to the actuator must be a consistent pressure over the entire operating range of the turbine.

The MicroNet control has logic built in to account for a sticky valve/actuator assembly. If you are having problems with the control of the turbine and the loops have been tuned and hydraulics verified, contact the Woodward for service.

Software Setup Procedure

Use of the WWII tool is required to access the application software tunable values of the MicroNet Digital Control System. Software setup for the MicroNet control begins with the software worksheet. When the worksheet is completed, the values are then entered into the MicroNet control with the WWII tool. This tool can also be used to upload (from the control to a file on the user PC) the tunable settings from the control. This file then can be downloaded (from the user PC to the control) into another control of the same part number and revision number. The site should keep this tunable file archived as it will simplify configuration of other spare units and aid technical support in commissioning troubleshooting.

WARNING — **The entry of incorrect values during the setup procedure can cause death, injury, and equipment damage. Be sure that the values to be entered are correct and have not been changed. If a value has been changed, cross out the old value and write the correct value in the software worksheet.**

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.

You can locate your nearest Woodward distributor, AISF, RER, or RTR on our website at:

www.woodward.com/directory

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 authorization 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: **www.woodward.com**.

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
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (0) 21 52 14 51
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (711) 78954-510
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
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
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

You can also locate your nearest Woodward distributor or service facility on our website at:

www.woodward.com/directory

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:

Your Name	
Site Location	
Phone Number	
Fax Number	
Engine/Turbine Model Number	
Manufacturer	
Number of Cylinders (if applicable)	
Type of Fuel (gas, gaseous, steam, etc)	
Rating	
Application	
Control/Governor #1	
Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	
Control/Governor #2	
Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	
Control/Governor #3	
Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	

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.
Modbus List

The following is the Modbus List generated from the Application software. This information is sent out from the control on serial port COM1 and on the Ethernet port on Port 5003.

WOODWARD GOVERNOR COMPANY
INDUSTRIAL CONTROLS DIVISION
FORT COLLINS, COLORADO, U.S.A.

Woodward Modbus Slave Address Information
File created on 09/27/02
FileName: 54181219.GAP
Project: 79779
P/N: 5418-1219
Rev: A
MICRONET REPLACEMENT
FOR 511 FUEL CONTROL/COMPRESSOR
SYSTEM P/N = 8238-504 (OLD = 8237-066)
GAP FILE NAME WGM_13C

MODBUS_S Block Name : COMM_HMI.DR_OI

Boolean Writes (RPTbw)

Addr	Input Description
0:0001	GG Setpoint Raise
0:0002	GG Setpoint Lower
0:0003	GG Setpoint Fast Rate
0:0004	PT Setpoint Raise
0:0005	PT Setpoint Lower
0:0006	PT Setpoint Fast Rate
0:0007	Enable Remote PT Control
0:0008	Disable Remote PT Control
0:0009	Start Command (Start Ramp)
0:0010	Trip Turbine
0:0011	Reset (Alarm & Shutdowns)
0:0012	Alarm Acknowledge

Boolean Reads (RPTbr)

Addr	Input Description
1:0001	COMM_HMI.PULSE.ONE_SHOT COMM Health (2 sec on/off)
1:0002	ALM_SD.SD_STACK.LATCH1 Summary Shutdown
1:0003	ALM_SD.SD_STACK.SEL_1 Ambient Temp Sensor Failed
1:0004	ALM_SD.SD_STACK.SEL_2 Both N1 Speed Sensors Failed
1:0005	ALM_SD.SD_STACK.SEL_3 Both N2 Speed Sensors Failed
1:0006	ALM_SD.SD_STACK.SEL_4 EGT Average Sensor Failed
1:0007	ALM_SD.SD_STACK.SEL_5 Too Many T/C signals failed SD
1:0008	ALM_SD.SD_STACK.SEL_6 3 Adjacent T/C Failed
1:0009	ALM_SD.SD_STACK.SEL_7 EGT Overtemp SD
1:0010	ALM_SD.SD_STACK.SEL_8 CDP Signal Failed
1:0011	ALM_SD.SD_STACK.SEL_9 Remote PT Ref Signal Failed
1:0012	ALM_SD.SD_STACK.SEL_10 Actuator Driver Failed
1:0013	ALM_SD.SD_STACK.SEL_11 Software Configuration Not Done

1:0014 ALM_SD.SD_STACK.SEL_12 External Shutdown Initiated
1:0015 ALM_SD.SD_STACK.SEL_13 N1 Overspeed Trip
1:0016 ALM_SD.SD_STACK.SEL_14 N2 Overspeed Trip
1:0017
1:0018
1:0019
1:0020 ALM_SD.ALM_STACK.LATCH1 Summary Alarm
1:0021 ALM_SD.ALM_STACK.SEL_1 T/C 1 Failed/Out of Average
1:0022 ALM_SD.ALM_STACK.SEL_2 T/C 2 Failed/Out of Average
1:0023 ALM_SD.ALM_STACK.SEL_3 T/C 3 Failed/Out of Average
1:0024 ALM_SD.ALM_STACK.SEL_4 T/C 4 Failed/Out of Average
1:0025 ALM_SD.ALM_STACK.SEL_5 T/C 5 Failed/Out of Average
1:0026 ALM_SD.ALM_STACK.SEL_6 T/C 6 Failed/Out of Average
1:0027 ALM_SD.ALM_STACK.SEL_7 T/C 7 Failed/Out of Average
1:0028 ALM_SD.ALM_STACK.SEL_8 T/C 8 Failed/Out of Average
1:0029 ALM_SD.ALM_STACK.SEL_9 T/C 9 Failed/Out of Average
1:0030 ALM_SD.ALM_STACK.SEL_10 T/C 10 Failed/Out of Average
1:0031 ALM_SD.ALM_STACK.SEL_11 T/C 11 Failed/Out of Average
1:0032 ALM_SD.ALM_STACK.SEL_12 N1 Speed Sensor #1 Failed
1:0033 ALM_SD.ALM_STACK.SEL_13 N1 Speed Sensor #2 Failed
1:0034 ALM_SD.ALM_STACK.SEL_14 N2 Speed Sensor #1 Failed
1:0035 ALM_SD.ALM_STACK.SEL_15 N2 Speed Sensor #2 Failed
1:0036 ALM_SD.ALM_STACK.SEL_16 Compressor Head Sensor Failed
1:0037 ALM_SD.ALM_STACK.SEL_17 Remote PT Ref Signal Failed
1:0038 ALM_SD.ALM_STACK.SEL_18 Compressor Flow Sensor Failed
1:0039 ALM_SD.ALM_STACK.SEL_19 CDP Sensor Failed
1:0040 ALM_SD.ALM_STACK.SEL_20 Ambient Temp Sensor Failed
1:0041 ALM_SD.ALM_STACK.SEL_21 EGT Average Signal Failed
1:0042 ALM_SD.ALM_STACK.SEL_22 spare Alarm
1:0043 ALM_SD.ALM_STACK.SEL_23 spare Alarm
1:0044 ALM_SD.ALM_STACK.SEL_24 T/C Spread Alarm
1:0045 ALM_SD.ALM_STACK.SEL_25 4 T/C Sensors Failed
1:0046
1:0047
1:0048
1:0049
1:0050
1:0051 DRIVER.LSS.SEL_1 N1 Control
1:0052 DRIVER.LSS.SEL_2 N2 Control
1:0053 DRIVER.LSS.SEL_3 EGT Control
1:0054 DRIVER.LSS.SEL_4 Accel Control
1:0055 DRIVER.STRT_RAMP.AND Start Ramp Control
1:0056 DRIVER.STRT_NDOT.AND Start NDOT Control
1:0057
1:0058
1:0059
1:0060
1:0061
1:0062

Analog Reads (RPTar)

Addr Input Description Multiplier
3:0001 A1_A03_AIO.HEAD.AI_COMBO Compressor Head Pressure
3:0002 A1_A03_AIO.REM_CNT.AI_COMBO Remote Speed Reference
Setpoint
3:0003 A1_A03_AIO.FLOW.AI_COMBO Compressor Flow
3:0004 A1_A03_AIO.CDP.AI_COMBO CDP Input
3:0005 COMM_HMI.TEMPS_IN_C.OUT_13 Ambient Turbine Inlet Temp

3:0006 A1_A03_AIO.EXH_TMP.AI_COMBO EGT Average Exhaust Gas Temp
3:0007 A1_A03_AIO.AI_07.AI_COMBO spare
3:0008 A1_A03_AIO.AI_08.AI_COMBO spare
3:0009 A1_A03_AIO.MPU_N1_1.SS_COMBO N1 Speed Pickup #1
3:0010 A1_A03_AIO.MPU_N1_2.SS_COMBO N1 Speed Pickup #2
3:0011 A1_A03_AIO.MPU_N2_1.SS_COMBO N2 Speed Pickup #1
3:0012 A1_A03_AIO.MPU_N2_2.SS_COMBO N2 Speed Pickup #2
3:0013 COMM_HMI.TEMPS_IN_C.OUT_1 T/C Input #1
3:0014 COMM_HMI.TEMPS_IN_C.OUT_2 T/C Input #2
3:0015 COMM_HMI.TEMPS_IN_C.OUT_3 T/C Input #3
3:0016 COMM_HMI.TEMPS_IN_C.OUT_4 T/C Input #4
3:0017 COMM_HMI.TEMPS_IN_C.OUT_5 T/C Input #5
3:0018 COMM_HMI.TEMPS_IN_C.OUT_6 T/C Input #6
3:0019 COMM_HMI.TEMPS_IN_C.OUT_7 T/C Input #7
3:0020 COMM_HMI.TEMPS_IN_C.OUT_8 T/C Input #8
3:0021 COMM_HMI.TEMPS_IN_C.OUT_9 T/C Input #9
3:0022 COMM_HMI.TEMPS_IN_C.OUT_10 T/C Input #10
3:0023 COMM_HMI.TEMPS_IN_C.OUT_11 T/C Input #11
3:0024 ACCEL_DEC.CDP.A_NAME CDP Readout
3:0025 N1_CNTRL.N1_HSS.HSS_BUS N1 Selected Speed
3:0026 N2_CNTRL.N2_HSS.HSS_BUS N2 Selected Speed
3:0027 COMM_HMI.TEMPS_IN_C.OUT_12 EGT Temp
3:0028 DRIVER.ACT_OUT.A_SW Fuel Actuator Demand Output
3:0029 N1_CNTRL.CLAMP.LSS_BUS N1 Speed Reference Clamp
3:0030 N2_CNTRL.N2_REF.RAMP N2 Speed Reference

Analog Writes (RPTaw)

Addr Description Multiplier
4:0001

Appendix B.
Tunable List

Woodward Tunable List
File created on 09/27/02
FileName: 54181219.GAP
Project: 79779
P/N: 5418-1219
Rev: A
MICRONET REPLACEMENT
FOR 511 FUEL CONTROL/COMPRESSOR
SYSTEM P/N = 8238-504 (OLD = 8237-066)
GAP FILE NAME WGM_13C

Value Name	Nominal Value (Range)	New Value
A1_A01_CPU.COMM_01.BAUD	*8 (1, 11)	
A1_A01_CPU.COMM_01.BITS	*2 (1, 2)	
A1_A01_CPU.COMM_01.STOP	*1 (1, 3)	
A1_A01_CPU.COMM_01.PARITY	*1 (1, 3)	
A1_A01_CPU.COMM_01.MODE	*1 (1, 2)	
A1_A01_CPU.COMM_01.FLOW	*1 (1, 3)	
A1_A01_CPU.COMM_01.ECHO	*1 (1, 2)	
A1_A01_CPU.COMM_01.ENDLINE	*3 (1, 3)	
A1_A01_CPU.COMM_01.IGNCR	*2 (1, 2)	
A1_A01_CPU.COMM_02.BAUD	*8 (1, 11)	
A1_A01_CPU.COMM_02.BITS	*1 (1, 2)	
A1_A01_CPU.COMM_02.STOP	*1 (1, 3)	
A1_A01_CPU.COMM_02.PARITY	*1 (1, 3)	
A1_A01_CPU.COMM_02.MODE	*1 (1, 2)	
A1_A01_CPU.COMM_02.FLOW	*1 (1, 3)	
A1_A01_CPU.COMM_02.ECHO	*1 (1, 2)	
A1_A01_CPU.COMM_02.ENDLINE	*3 (1, 3)	
A1_A01_CPU.COMM_02.IGNCR	*2 (1, 2)	
A1_A01_CPU.RTCLOCK.SET_YEAR	*FALSE	
A1_A01_CPU.RTCLOCK.YEAR_IN	*2 (0, 99)	
A1_A01_CPU.RTCLOCK.SET_MONTH	*FALSE	
A1_A01_CPU.RTCLOCK.MONTH_IN	*9 (1, 12)	
A1_A01_CPU.RTCLOCK.SET_DAY	*FALSE	
A1_A01_CPU.RTCLOCK.DAY_IN	*18 (1, 31)	
A1_A01_CPU.RTCLOCK.SET_DOW	*FALSE	
A1_A01_CPU.RTCLOCK.DOW_IN	*1 (1, 7)	
A1_A01_CPU.RTCLOCK.SET_HOUR	*FALSE	
A1_A01_CPU.RTCLOCK.HOUR_IN	*2 (0, 23)	
A1_A01_CPU.RTCLOCK.SET_MIN	*FALSE	
A1_A01_CPU.RTCLOCK.MIN_IN	*1 (0, 59)	
A1_A01_CPU.RTCLOCK.SET_SEC	*FALSE	
A1_A01_CPU.RTCLOCK.SEC_IN	*1 (0, 59)	
A1_A03_AIO.ACT_FUEL.DITHER	*2.0 (0.0, 5.0)	
A1_A03_AIO.ACT_FUEL.MA_0	*20.0 (0.0, 100.0)	
A1_A03_AIO.ACT_FUEL.MA_100	*160.0 (20.0, 180.0)	
A1_A03_AIO.ACT_SURGE.IN	*0.0 (0.0, 100.0)	
A1_A03_AIO.ACT_SURGE.DITHER	*2.0 (0.0, 5.0)	

A1_A03_AIO.ACT_SURGE.MA_0	*20.0 (0.0, 100.0)	
A1_A03_AIO.ACT_SURGE.MA_100	*160.0 (20.0, 180.0)	
A1_A03_AIO.AI_07.LATCH_DLY	*100.0 (0.0, 500.0)	
A1_A03_AIO.AI_08.LATCH_DLY	*100.0 (0.0, 500.0)	
A1_A03_AIO.AMBIENT.LATCH_DLY	*100.0 (0.0, 500.0)	
A1_A03_AIO.CDP.LATCH_DLY	*100.0 (0.0, 500.0)	
A1_A03_AIO.EXH_TMP.LATCH_DLY	*100.0 (0.0, 500.0)	
A1_A03_AIO.FLOW.LATCH_DLY	*100.0 (0.0, 500.0)	
A1_A03_AIO.HEAD.LATCH_DLY	*100.0 (0.0, 500.0)	
A1_A03_AIO.REM_CNT.LATCH_DLY	*100.0 (0.0, 500.0)	
A1_A05_AIO.ACT_RDOUT.OFFSET	*0.0 (-10.0, 10.0)	
A1_A05_AIO.ACT_RDOUT.GAIN	*1.0 (0.8, 1.2)	
A1_A05_AIO.AO_03.IN	*0.0 (0.0, 10.0)	
A1_A05_AIO.AO_03.OFFSET	*0.0 (-10.0, 10.0)	
A1_A05_AIO.AO_03.GAIN	*1.0 (0.8, 1.2)	
A1_A05_AIO.AO_04.IN	*0.0 (0.0, 10.0)	
A1_A05_AIO.AO_04.OFFSET	*0.0 (-10.0, 10.0)	
A1_A05_AIO.AO_04.GAIN	*1.0 (0.8, 1.2)	
A1_A05_AIO.CIT_RDOUT.OFFSET	*0.0 (-10.0, 10.0)	
A1_A05_AIO.CIT_RDOUT.GAIN	*1.0 (0.8, 1.2)	
A1_A05_AIO.TC_01.OFFSET	*0.0 (-200.0, 200.0)	
A1_A05_AIO.TC_01.GAIN	*1.0 (0.8, 1.2)	
A1_A05_AIO.TC_01.LATCH_DLY	*500.0 (0.0, 5000.0)	
A1_A05_AIO.TC_02.OFFSET	*0.0 (-200.0, 200.0)	
A1_A05_AIO.TC_02.GAIN	*1.0 (0.8, 1.2)	
A1_A05_AIO.TC_02.LATCH_DLY	*500.0 (0.0, 5000.0)	
A1_A05_AIO.TC_03.OFFSET	*0.0 (-200.0, 200.0)	
A1_A05_AIO.TC_03.GAIN	*1.0 (0.8, 1.2)	
A1_A05_AIO.TC_03.LATCH_DLY	*500.0 (0.0, 5000.0)	
A1_A05_AIO.TC_04.OFFSET	*0.0 (-200.0, 200.0)	
A1_A05_AIO.TC_04.GAIN	*1.0 (0.8, 1.2)	
A1_A05_AIO.TC_04.LATCH_DLY	*500.0 (0.0, 5000.0)	
A1_A05_AIO.TC_05.OFFSET	*0.0 (-200.0, 200.0)	
A1_A05_AIO.TC_05.GAIN	*1.0 (0.8, 1.2)	
A1_A05_AIO.TC_05.LATCH_DLY	*500.0 (0.0, 5000.0)	
A1_A05_AIO.TC_06.OFFSET	*0.0 (-200.0, 200.0)	
A1_A05_AIO.TC_06.GAIN	*1.0 (0.8, 1.2)	
A1_A05_AIO.TC_06.LATCH_DLY	*500.0 (0.0, 5000.0)	
A1_A05_AIO.TC_07.OFFSET	*0.0 (-200.0, 200.0)	
A1_A05_AIO.TC_07.GAIN	*1.0 (0.8, 1.2)	
A1_A05_AIO.TC_07.LATCH_DLY	*500.0 (0.0, 5000.0)	
A1_A05_AIO.TC_08.OFFSET	*0.0 (-200.0, 200.0)	
A1_A05_AIO.TC_08.GAIN	*1.0 (0.8, 1.2)	
A1_A05_AIO.TC_08.LATCH_DLY	*500.0 (0.0, 5000.0)	
A1_A05_AIO.TC_09.OFFSET	*0.0 (-200.0, 200.0)	
A1_A05_AIO.TC_09.GAIN	*1.0 (0.8, 1.2)	
A1_A05_AIO.TC_09.LATCH_DLY	*500.0 (0.0, 5000.0)	
A1_A05_AIO.TC_10.OFFSET	*0.0 (-200.0, 200.0)	
A1_A05_AIO.TC_10.GAIN	*1.0 (0.8, 1.2)	
A1_A05_AIO.TC_10.LATCH_DLY	*500.0 (0.0, 5000.0)	
A1_A05_AIO.TC_11.OFFSET	*0.0 (-200.0, 200.0)	
A1_A05_AIO.TC_11.GAIN	*1.0 (0.8, 1.2)	
A1_A05_AIO.TC_11.LATCH_DLY	*500.0 (0.0, 5000.0)	
A1_A05_AIO.TC_12.OFFSET	*0.0 (-200.0, 200.0)	
A1_A05_AIO.TC_12.GAIN	*1.0 (0.8, 1.2)	
A1_A05_AIO.TC_12.LATCH_DLY	*500.0 (0.0, 5000.0)	

AA.SIMULATE.IN	*FALSE	
ACCEL_DEC.ACCEL_OUT.X_1	*2.0 (0.0, 1000.0)	
ACCEL_DEC.ACCEL_OUT.Y_1	*0.0 (0.0, 1000.0)	
ACCEL_DEC.ACCEL_OUT.X_2	*10.0 (0.0, 1000.0)	
ACCEL_DEC.ACCEL_OUT.Y_2	*11.46 (0.0, 1000.0)	
ACCEL_DEC.ACCEL_OUT.X_3	*165.0 (0.0, 1000.0)	
ACCEL_DEC.ACCEL_OUT.Y_3	*64.81 (0.0, 1000.0)	
ACCEL_DEC.ACCEL_OUT.X_4	*225.0 (0.0, 1000.0)	
ACCEL_DEC.ACCEL_OUT.Y_4	*90.0 (0.0, 1000.0)	
ACCEL_DEC.DECEL.X_1	*35.0 (0.0, 1000.0)	
ACCEL_DEC.DECEL.Y_1	*0.0 (0.0, 1000.0)	
ACCEL_DEC.DECEL.X_2	*100.0 (0.0, 1000.0)	
ACCEL_DEC.DECEL.Y_2	*13.22 (0.0, 1000.0)	
ACCEL_DEC.DECEL.X_3	*240.0 (0.0, 1000.0)	
ACCEL_DEC.DECEL.Y_3	*30.0 (0.0, 1000.0)	
ACCEL_DEC.USE_RAMP.IN	*FALSE	
COMM_HMI.AMB_RDOUT.CTRL	*TRUE	
COMM_HMI.DR_OI.ASCII_RTU	*2 (1, 2)	
COMM_HMI.DR_OI.INIT_MOD	*FALSE	
COMM_HMI.DR_OI.TIME_OUT	*3.0 (1.0, 30.0)	
COMM_HMI.DR_OI.NET_ADDR	*1 (1, 247)	
CONFIGUR.ANINPUTS.IN_1	*0.0 (-20000.0, 20000.0)	
CONFIGUR.ANINPUTS.IN_2	*100.0 (-20000.0, 20000.0)	
CONFIGUR.ANINPUTS.IN_3	*3850.0 (-20000.0, 20000.0)	
CONFIGUR.ANINPUTS.IN_4	*5775.0 (-20000.0, 20000.0)	
CONFIGUR.ANINPUTS.IN_5	*0.0 (-20000.0, 20000.0)	
CONFIGUR.ANINPUTS.IN_6	*100.0 (-20000.0, 20000.0)	
CONFIGUR.ANINPUTS.IN_7	*0.0 (-20000.0, 20000.0)	
CONFIGUR.ANINPUTS.IN_8	*300.0 (-20000.0, 20000.0)	
CONFIGUR.ANINPUTS.IN_9	*-40.0 (-20000.0, 20000.0)	
CONFIGUR.ANINPUTS.IN_10	*150.0 (-20000.0, 20000.0)	
CONFIGUR.ANINPUTS.IN_11	*0.0 (-20000.0, 20000.0)	
CONFIGUR.ANINPUTS.IN_12	*100.0 (-20000.0, 20000.0)	
CONFIGUR.ANINPUTS.IN_13	*0.0 (-20000.0, 20000.0)	
CONFIGUR.ANINPUTS.IN_14	*100.0 (-20000.0, 20000.0)	
CONFIGUR.ANINPUTS.IN_15	*0.0 (-20000.0, 20000.0)	
CONFIGUR.ANINPUTS.IN_16	*100.0 (-20000.0, 20000.0)	
CONFIGUR.ANIN_USED.IN_1	*TRUE	
CONFIGUR.ANIN_USED.IN_2	*FALSE	
CONFIGUR.ANIN_USED.IN_3	*TRUE	
CONFIGUR.ANIN_USED.IN_4	*FALSE	
CONFIGUR.ANIN_USED.IN_5	*FALSE	
CONFIGUR.ANIN_USED.IN_6	*TRUE	
CONFIGUR.ANIN_USED.IN_7	*TRUE	
CONFIGUR.ANIN_USED.IN_8	*TRUE	
CONFIGUR.ANOUTPUTS.IN_1	*0.0 (-20000.0, 20000.0)	
CONFIGUR.ANOUTPUTS.IN_2	*300.0 (-20000.0, 20000.0)	
CONFIGUR.ANOUTPUTS.IN_3	*0.0 (-20000.0, 20000.0)	
CONFIGUR.ANOUTPUTS.IN_4	*12000.0 (-20000.0, 20000.0)	
CONFIGUR.ANOUTPUTS.IN_5	*0.0 (-20000.0, 20000.0)	
CONFIGUR.ANOUTPUTS.IN_6	*7000.0 (-20000.0, 20000.0)	
CONFIGUR.ANOUTPUTS.IN_7	*0.0 (-20000.0, 20000.0)	
CONFIGUR.ANOUTPUTS.IN_8	*1093.0 (-20000.0, 20000.0)	
CONFIGUR.ANOUTPUTS.IN_9	*-40.0 (-20000.0, 20000.0)	
CONFIGUR.ANOUTPUTS.IN_10	*150.0 (-20000.0, 20000.0)	
CONFIGUR.ANOUTPUTS.IN_11	*0.0 (-20000.0, 20000.0)	

CONFIGUR.ANOUTPUTS.IN_12	*100.0 (-20000.0, 20000.0)	
CONFIGUR.ANOUTPUTS.IN_13	*0.0 (-20000.0, 20000.0)	
CONFIGUR.ANOUTPUTS.IN_14	*100.0 (-20000.0, 20000.0)	
CONFIGUR.ANOUTPUTS.IN_15	*0.0 (-20000.0, 20000.0)	
CONFIGUR.ANOUTPUTS.IN_16	*100.0 (-20000.0, 20000.0)	
CONFIGUR.CNFIG_DONE.IN_1	*TRUE	
CONFIGUR.EGT_CNFG1.IN_1	*TRUE	
CONFIGUR.EGT_CNFG1.IN_2	*TRUE	
CONFIGUR.ENA_CNFIG.IN_3	*FALSE	
CONFIGUR.SIG_FAIL.IN_1	*FALSE	
CONFIGUR.SIG_FAIL.IN_2	*TRUE	
CONFIGUR.SIG_FAIL.IN_3	*FALSE	
CONFIGUR.SIG_FAIL.IN_4	*TRUE	
CONFIGUR.SIG_FAIL.IN_5	*TRUE	
CONFIGUR.SIG_FAIL.IN_6	*FALSE	
CONFIGUR.SIG_FAIL.IN_7	*TRUE	
CONFIGUR.SIG_FAIL.IN_8	*FALSE	
CONFIGUR.SIG_FAIL.IN_9	*TRUE	
CONFIGUR.SPDINPUTS.IN_1	*12000.0 (0.0, 30000.0)	
CONFIGUR.SPDINPUTS.IN_2	*1.0 (0.01, 100.0)	
CONFIGUR.SPDINPUTS.IN_3	*500.0 (0.0, 30000.0)	
CONFIGUR.SPDINPUTS.IN_4	*10100.0 (0.0, 30000.0)	
CONFIGUR.SPDINPUTS.IN_5	*12000.0 (0.0, 30000.0)	
CONFIGUR.SPDINPUTS.IN_6	*1.0 (0.01, 100.0)	
CONFIGUR.SPDINPUTS.IN_7	*500.0 (0.0, 30000.0)	
CONFIGUR.SPDINPUTS.IN_8	*10100.0 (0.0, 30000.0)	
CONFIGUR.SPDINPUTS.IN_9	*7000.0 (0.0, 30000.0)	
CONFIGUR.SPDINPUTS.IN_10	*1.0 (0.01, 100.0)	
CONFIGUR.SPDINPUTS.IN_11	*400.0 (0.0, 30000.0)	
CONFIGUR.SPDINPUTS.IN_12	*6060.0 (0.0, 30000.0)	
CONFIGUR.SPDINPUTS.IN_13	*7000.0 (0.0, 30000.0)	
CONFIGUR.SPDINPUTS.IN_14	*1.0 (0.01, 100.0)	
CONFIGUR.SPDINPUTS.IN_15	*400.0 (0.0, 30000.0)	
CONFIGUR.SPDINPUTS.IN_16	*6060.0 (0.0, 30000.0)	
CONFIGUR.START_RAMP.IN_1	*2.0 (0.0, 10.0)	
CONFIGUR.START_RAMP.IN_2	*0.26 (0.0, 5.0)	
CONFIGUR.TCNUM_AL.IN	*4 (1, 11)	
CONFIGUR.TCNUM_SD.IN	*5 (1, 11)	
CONFIGUR.TC_CNFG.IN_1	*200.0 (0.0, 2000.0)	
CONFIGUR.TC_CNFG.IN_2	*2000.0 (0.0, 2000.0)	
CONFIGUR.TC_CNFG.IN_3	*200.0 (0.0, 2000.0)	
CONFIGUR.TC_CNFG.IN_4	*200.0 (0.0, 2000.0)	
CONFIGUR.TC_CNFG.IN_5	*1495.0 (0.0, 2000.0)	
CONFIGUR.TC_CNFG.IN_6	*350.0 (0.0, 2000.0)	
CONFIGUR.TC_CNFG.IN_7	*400.0 (0.0, 2000.0)	
CONFIGUR.TC_CNFG.IN_8	*1600.0 (0.0, 2000.0)	
CONFIGUR.TC_CNFG.IN_9	*1600.0 (0.0, 2000.0)	
CONFIGUR.TC_CNFG.IN_10	*1575.0 (0.0, 2000.0)	
CONFIGUR.TC_CNFG.IN_11	*200.0 (0.0, 2000.0)	
C_ANIN1.GAIN.IN	*1.0 (0.0, 2.0)	
C_ANIN1.OFFSET.IN	*0.0 (-487500.0, 487500.0)	
C_ANIN2.GAIN.IN	*1.0 (0.0, 2.0)	
C_ANIN2.OFFSET.IN	*0.0 (-487500.0, 487500.0)	
C_ANIN3.GAIN.IN	*1.0 (0.0, 2.0)	
C_ANIN3.OFFSET.IN	*0.0 (-487500.0, 487500.0)	
C_ANIN4.GAIN.IN	*1.0 (0.0, 2.0)	

C_ANIN4.OFFSET.IN	*0.0 (-487500.0, 487500.0)	
C_ANIN5.GAIN.IN	*1.0 (0.0, 2.0)	
C_ANIN5.OFFSET.IN	*0.0 (-487500.0, 487500.0)	
C_ANIN6.GAIN.IN	*1.0 (0.0, 2.0)	
C_ANIN6.OFFSET.IN	*0.0 (-487500.0, 487500.0)	
C_ANIN7.GAIN.IN	*1.0 (0.0, 2.0)	
C_ANIN7.OFFSET.IN	*0.0 (-487500.0, 487500.0)	
C_ANIN8.GAIN.IN	*1.0 (0.0, 2.0)	
C_ANIN8.OFFSET.IN	*0.0 (-487500.0, 487500.0)	
C_SPDIN1.NUM_TEETH.IN	*47 (1, 1000)	
C_SPDIN2.NUM_TEETH.IN	*47 (1, 1000)	
C_SPDIN3.NUM_TEETH.IN	*83 (1, 1000)	
C_SPDIN4.NUM_TEETH.IN	*83 (1, 1000)	
EGT.AMBIAS_EGT.X_1	*-50.0 (-300.0, 300.0)	
EGT.AMBIAS_EGT.Y_1	*0.89 (0.0, 10.0)	
EGT.AMBIAS_EGT.X_2	*-50.0 (-300.0, 300.0)	
EGT.AMBIAS_EGT.Y_2	*0.89 (0.0, 10.0)	
EGT.AMBIAS_EGT.X_3	*59.0 (-300.0, 300.0)	
EGT.AMBIAS_EGT.Y_3	*1.0 (0.0, 10.0)	
EGT.AMBIAS_EGT.X_4	*140.0 (-300.0, 300.0)	
EGT.AMBIAS_EGT.Y_4	*1.0 (0.0, 10.0)	
EGT.EGT_PID.PROP_GN	*0.1 (0.01, 100.0)	
EGT.EGT_PID.INT_GN	*2.0 (0.0, 50.0)	
EGT.EGT_PID.S_D_R	*5.0 (0.01, 100.0)	
EGT.EGT_PID.THRESH	*25.0 (10.0, 1500.0)	
EGT.INDIVID_TC.IN_1	*TRUE	
EGT.NO_BIAS.NO	*1.0 (0.0, 1.1)	
EGT.RESET_OR.IN_4	*FALSE	
N1_CNTRL.CHCK4_SD.IN_1	*2000.0 (300.0, 2500.0)	
N1_CNTRL.N1_PID.PROP_GN	*0.1 (0.001, 100.0)	
N1_CNTRL.N1_PID.INT_GN	*0.8 (0.001, 50.0)	
N1_CNTRL.N1_PID.S_D_R	*5.0 (0.01, 100.0)	
N1_CNTRL.N1_PID.THRESH	*20.0 (0.0, 20000.0)	
N2_CNTRL.N2_PID.PROP_GN	*0.1 (0.001, 100.0)	
N2_CNTRL.N2_PID.INT_GN	*0.8 (0.001, 50.0)	
N2_CNTRL.N2_PID.S_D_R	*5.0 (0.01, 100.0)	
N2_CNTRL.N2_PID.THRESH	*10.0 (0.0, 20000.0)	
NGGDT.ACEL_SCHD.Y_1	*50.0 (0.0, 2000.0)	
NGGDT.ACEL_SCHD.X_2	*6500.0 (2000.0, 10000.0)	
NGGDT.ACEL_SCHD.Y_2	*50.0 (0.0, 2000.0)	
NGGDT.ACEL_SCHD.X_3	*8130.0 (2000.0, 12000.0)	
NGGDT.ACEL_SCHD.Y_3	*1545.0 (0.0, 2000.0)	
NGGDT.ACEL_SCHD.X_4	*9530.0 (2000.0, 12000.0)	
NGGDT.ACEL_SCHD.Y_4	*725.0 (0.0, 2000.0)	
NGGDT.ACEL_SCHD.X_5	*10200.0 (2000.0, 12000.0)	
NGGDT.ACEL_SCHD.Y_5	*725.0 (0.0, 2000.0)	
NGGDT.NGGDT_STRT.PROP_GN	*0.004 (0.0, 1.0)	
NGGDT.NGGDT_STRT.INT_GN	*20.0 (0.0, 50.0)	
NGGDT.NGGDT_STRT.S_D_R	*100.0 (0.01, 100.0)	
NGGDT.NGGDT_STRT.THRESH	*4000.0 (50.0, 5000.0)	
NGGDT.NGG_DERV.LAG_TAU	*1.0 (0.01, 3.0)	
SERVICE.AMB_DFLT.IN	*80.0 (-200.0, 200.0)	
SERVICE.AUTO_ENA.IN	*FALSE	
SERVICE.N1VAL_SW1.IN	*500.0 (0.0, 20000.0)	
SERVICE.N1VAL_SW2.IN	*1200.0 (0.0, 20000.0)	
SERVICE.N1VAL_SW3.IN	*1700.0 (0.0, 20000.0)	

SERVICE.N1_CORRLMT.IN	*10050.0 (0.0, 20000.0)	
SERVICE.N1_DFLT.IN	*30.0 (0.0, 1000.0)	
SERVICE.N1_FAST.IN	*400.0 (0.0, 1000.0)	
SERVICE.N1_LOWER.IN	*5000.0 (0.0, 20000.0)	
SERVICE.N1_OVRIDE.IN	*2000.0 (0.0, 5000.0)	
SERVICE.N1_UPPER.IN	*10000.0 (0.0, 20000.0)	
SERVICE.N2VAL_SW1.IN	*500.0 (0.0, 20000.0)	
SERVICE.N2VAL_SW2.IN	*1600.0 (0.0, 20000.0)	
SERVICE.N2VAL_SW3.IN	*3700.0 (0.0, 20000.0)	
SERVICE.N2_DFLT.IN	*11.0 (0.0, 1000.0)	
SERVICE.N2_FAST.IN	*65.0 (0.0, 1000.0)	
SERVICE.N2_LOWER.IN	*3850.0 (0.0, 20000.0)	
SERVICE.N2_UPPER.IN	*5775.0 (0.0, 20000.0)	
SERVICE.RC_FAST.IN	*11.0 (0.0, 1000.0)	
SERVICE.RC_FWINSIZ.IN	*10.0 (0.0, 1000.0)	
SERVICE.RC_LOWER.IN	*3850.0 (0.0, 20000.0)	
SERVICE.RC_UPPER.IN	*5775.0 (0.0, 20000.0)	
SERVICE.RC_WINSIZ.IN	*5.0 (0.0, 1000.0)	
SERVICE.VLV_PRCT.IN	*0.0 (0.0, 100.0)	
SERVICE.VLV_STROK.IN	*FALSE	
TUNE_VAR.TUNE_UDP.SL_ADDR_1	*0 (0, 15)	

Appendix C.
Application Worksheet

Worksheet for MicroNet Control Application

The following worksheet is used to select the values used in the tunable blocks of the GAP™ for the MicroNet® Digital Control System application. On the lines provided, enter the values used for your control. If values are changed, enter the new values. Use a separate worksheet for each control when more than one control is used at each site. To assist users of the 511 DCS systems in understanding the new MicroNet Digital Control System, two Watch Window II (WWII) Inspector files were created.

IMPORTANT **This appendix will only match the original inspector files that were created at the time of control shipment. It is expected that as users get familiar with the system, they will customize these inspector files.**

The CONFIG.WWI file should be used once, at initial installation, to establish the correct turbine package configuration details for correct operation of the fuel control. The turbine must be shut down (in a non-running state) during control setup with this WWII inspector file.

The SERVICE.WWI file should be used anytime calibration, tuning, or monitoring of the control system is required. The turbine may be operational during the use of this WWII inspector file; however, it may or may not be running (that is, during valve calibration, the unit should be shut down).

WORKSHEET
software / revision – 5418-1219 A

Control Part Number ______________________

Control Serial Number ___________________

I/O CONFIGURATION NOTES

MPUs:
GG MPUs: Maximum frequency sensing = 25000 Hz
PT MPUs: Maximum frequency sensing = 25000 Hz

TEMPERATURE INPUT (single sensor):
EGT: display in Deg. F, "K" type thermocouple only

TEMPERATURE INPUT (Optional):
T/C #1-11: display in Deg. F, "K" type thermocouple only

AMBIENT SENSOR:
AMBIENT TEMP: display in Deg. F, type sensor = AD59O through a converter

CONFIGURE EXPLANATION

The following worksheet is used with the MicroNet control to explain the Configure portion of the application software. The default value and range are shown for each tunable.

****
** LIST OF CONFIGURE SHEET TAB HEADERS IN ORDER **
****

1. ** Inputs Used **
2. ** Analog Ranges **
3. ** Speed Signal Ranges **
4. ** Failed Signals **
5. ** T/C Monitor **
6. ** Analog Output Ranges **
7. ** Relay Outputs **
8. ** Control Dynamics **
9. ** Service 1 **
10. ** Service 2 **
11. ** Turbine Parameters **

****
** INPUTS USED **
****

To allow any of the CONFIGURE tunables to be used by the control, you must first enter I/O Lock by 'right mouse clicking' on the CPU icon in the Explorer window. Once this is done the CNFIG_MODE block on this inspector sheet will show a TRUE value.

This section contains the parameters required to configure start ramp functions. The start ramp is initiated by closure of the start ramp contact. Opening of the contact causes an immediate reset of the start ramp output to zero and immediate setting of the actuator output to the minimum fuel limit.

1. Configuration Complete? FALSE (T/F) __________
   This needs to be tuned TRUE once configuration is complete.

2. Gas Min Fuel Limit 2.00 (0.00 to 10.00) __________
   - Start ramp minimum fuel limit in % of valve travel. This sets an "electrical" light off fuel flow. If the fuel valve mechanical minimum stop is set for light-off flow then set this value to zero. After closure of the Start Ramp contact and the Start Ramp output becomes greater than the Decel Schedule (CDP based deceleration rate limiter) output the Start Ramp Min Fuel Limit is defeated so the Decel Schedule can command actuator position to be below this point.

3. Gas Start Ramp Rate 0.26 (0.00 to 5.00) __________
   - Timed start ramp transfer rate in % actuator travel per second.

4. Use Individual T/C Monitor ? TRUE (TRUE to FALSE) __________
   - Temperature monitoring option—if answered TRUE, allows temperature spread monitoring with alarms or trips on adjustable spreads. Up to 11 thermocouples can be monitored.

IMPORTANT **If not using spread monitor functions, the relative alarms and trips will be disabled.**

5. Auto Override of T/C Signals (During start) TRUE? ___________ (TRUE to FALSE)

6. Number of Failed T/C's = Alarm 4 (1 to 11) ___________

7. Number of Failed T/C's = Shutdown 5 (1 to 11) ___________

8. Use Remote PT Speed Reference Input TRUE? ___________ (TRUE to FALSE)

9. Use Compressor Discharge Pressure Input TRUE? ___________ (TRUE to FALSE)

10. Use Ambient Turbine Inlet Temp Input TRUE? ___________ (TRUE to FALSE)

11. Use Average EGT Temp Input FALSE? ___________ (TRUE to FALSE)

****
** ANALOG RANGES **
****

1. Value of Remote Ref Signal at 4 mA 3850.0 ___________ (–20000.0 to 20000.0)

2. Value of Remote Ref Signal at 20 mA 5775.0 ___________ (–20000.0 to 20000.0)

   This section sets up CDP (Compressor Discharge Pressure) signal scaling and maximum CDP based or DN/DT based acceleration and deceleration rates. Turbine manufacturer specifications should be followed to prevent damage to the turbine.

3. Value of CDP Signal at 4 mA 0.0 ___________ (–20000.0 to 20000.0)

4. Value of CDP Signal at 20 mA 300.0 ___________ (–20000.0 to 20000.0)

5. Value of Ambient Turbine Inlet Temp at 4 mA –40.0 ___________ (–20000.0 to 20000.0)

6. Value of Ambient Turbine Inlet Temp at 20 mA 150.0 ___________ (–20000.0 to 20000.0)

7. Value of Average EGT Temp at 4 mA –40.0 ___________ (–20000.0 to 20000.0)

8. Value of Average EGT Temp at 20 mA –40.0 ___________ (–20000.0 to 20000.0)

****
** SPEED SIGNAL RANGES **
****

1. Speed Input #1 – Max Speed 12000.0 (0, 30000) __________
2. Speed Input #1 – Gear Ratio 1.0 (0.01, 100.0) __________
3. Speed Input #1 – Number of Gear Teeth 47 (1, 1000) __________
4. Speed Input #1 – Low Speed Setpoint 500.0 (0.0, 30000.0) __________
5. Speed Input #1 – Hi Speed Setpoint 10100.0 (0.0, 30000.0) __________
6. Speed Input #2 – Max Speed 12000.0 (0, 30000) __________
7. Speed Input #2 – Gear Ratio 1.0 (0.01, 100.0) __________
8. Speed Input #2 – Number of Gear Teeth 47 (1, 1000) __________
9. Speed Input #2 – Low Speed Setpoint 500.0 (0.0, 30000.0) __________
10. Speed Input #2 – Hi Speed Setpoint 10100.0 (0.0, 30000.0) __________
11. Speed Input #3 – Max Speed 7000.0 (0, 30000) __________
12. Speed Input #3 – Gear Ratio 1.0 (0.01, 100.0) __________
13. Speed Input #3 – Number of Gear Teeth 83 (1, 1000) __________
14. Speed Input #3 – Low Speed Setpoint 400.0 (0.0, 30000.0) __________
15. Speed Input #3 – Hi Speed Setpoint 6060.0 (0.0, 30000.0) __________
16. Speed Input #4 – Max Speed 7000.0 (0, 30000) __________
17. Speed Input #4 – Gear Ratio 1.0 (0.01, 100.0) __________
18. Speed Input #4 – Number of Gear Teeth 83 (1, 1000) __________
19. Speed Input #4 – Low Speed Setpoint 400.0 (0.0, 30000.0) __________
20. Speed Input #4 – Hi Speed Setpoint 6060.0 (0.0, 30000.0) __________

****
** FAILED SIGNALS**
****

1. Tune TRUE to have the selected signal failure initiate a Shutdown.
2. Ambient Temp Signal Failed FALSE (TRUE to FALSE)? ___________
3. CDP Signal Failed TRUE (TRUE to FALSE)? ___________
4. EGT Average Temp Signal Failed FALSE (TRUE to FALSE)? ___________
5. Both N1 Speed Signals Failed TRUE (TRUE to FALSE)? ___________
6. Excessive # of T/C Signals Failed TRUE (TRUE to FALSE)? ___________
7. 3 Adjacent T/C Signals Failed TRUE (TRUE to FALSE)? ___________
8. Remote Reference Signal Failed FALSE (TRUE to FALSE)? ___________
9. Actuator Output Signal Failed TRUE (TRUE to FALSE)? ___________

****
** T/C MONITOR**
****

1. T/C Monitor Spread Alarm Value 200.0 (0.0, 2000.0) ___________
2. T/C Monitor-High Delta 200.0 (0.0 to 2000.0) ___________
   - Difference (degrees F) between highest and lowest valid A2 thermocouple readings before producing an output to the alarm logic. Greatest amount an individual A2 thermocouple can read above the averaged readings to remain in the average calculation. A thermocouple reading is not included in the average if:
   - Individual T/C temp > average T/C temp + HIGH DELTA VALUE
3. T/C Monitor-Low Delta 200.0 (0.0 to 2000. 0) ___________
   - Smallest amount an individual A2 thermocouple can read below the averaged readings to remain in the average calculation. A thermocouple reading is not included in the average if:
   - Individual T/C temp < average T/C temp – LOW DELTA VALUE
4. EGT Temp Topping Control Setpoint 1495.0 (0.0, 2000.0) ___________
5. EGT Override Temp Switch Setpoint 350.0 (0.0, 2000.0) ___________
6. EGT Temp Switch #1 Setpoint 400.0 (0.0, 2000.0) ___________
7. EGT Temp Switch #2 Setpoint 1600.0 (0.0, 2000.0) ___________
8. EGT Temp Switch #3 Setpoint 1600.0 (0.0, 2000.0) ___________
9. EGT Over Temp Switch Setpoint 1575.0 (0.0, 2000.0) ___________
10. EGT T/C Signal Failed Low Setpoint 200.0 (0.0, 2000.0) ___________

****
** ANALOG OUTPUT RANGES **
****

1. Value of Analog Output #1 Signal at 4 mA 0.0 ___________ (–20000.0 to 20000.0)
2. Value of Analog Output #1 Signal at 20 mA 300.0 ___________ (–20000.0 to 20000.0)
3. Value of Analog Output #2 Signal at 4 mA 0.0 ___________ (–20000.0 to 20000.0)
4. Value of Analog Output #2 Signal at 20 mA 12000.0 ___________ (–20000.0 to 20000.0)
5. Value of Analog Output #3 Signal at 4 mA 0.0 ___________ (–20000.0 to 20000.0)
6. Value of Analog Output #3 Signal at 20 mA 7000.0 ___________ (–20000.0 to 20000.0)
7. Value of Analog Output #4 Signal at 4 mA 0.0 ___________ (–20000.0 to 20000.0)
8. Value of Analog Output #4 Signal at 20 mA 1093.0 ___________ (–20000.0 to 20000.0)
9. Value of Analog Output #5 Signal at 4 mA -40.0 ___________ (–20000.0 to 20000.0)
10. Value of Analog Output #5 Signal at 20 mA 150.0 ___________ (–20000.0 to 20000.0)
11. Value of Analog Output #6 Signal at 4 mA 0.0 ___________ (–20000.0 to 20000.0)
12. Value of Analog Output #6 Signal at 20 mA 100.0 ___________ (–20000.0 to 20000.0)

****
** RELAY OUTPUTS **
****

1. Shutdown (TRUE = None present)
2. Alarm (TRUE = None present)
3. N1 Control
4. N2 Control
5. EGT Control
6. Acceleration Limit Control
7. Start Ramp Control

8. N1 Reference Upper Limit
9. N1 Reference Lower Limit
10. N2 Reference Upper Limit
11. N2 Reference Lower Limit
12. N1 Overspeed Shutdown
13. N1 Speed Input Failed
14. N2 Overspeed Shutdown
15. N2 Speed Input Failed
16. EGT Overtemp Shutdown
17. EGT Temp Signal Failed
18. N1 Speed Switch #1
19. N1 Speed Switch #2
20. N1 Speed Switch #3
21. N2 Speed Switch #1
22. N2 Speed Switch #2
23. N2 Speed Switch #3
24. EGT Temp Switch #1

The following section outlines optional configurations that can be adjusted in this standard control. These should be checked at the site to be sure they are correct for the turbine being controlled; however the default settings for this unit should be valid for replacing the Woodward 8237-066 control.

CDP ACCEL SCHEDULE—Three-slope acceleration rate limiter based on CDP scaled in the same units as above. Outputs are scaled from 0 to 100% of valve travel. Since gas flow is not proportional to actuator current or valve angle, the Accel Schedule breakpoints should be calculated based on fuel flow, and then fuel flow converted to actuator current using valve test data.

Note on completing Accel and Decel Schedules—Gas flow in pph or BTU/hr vs. actuator current data is required. Also required is the turbine manufacturers acceleration and deceleration specifications.

1. Plot a piece-wise linear approximation to the required accel and decel schedules with three slopes maximum for accel and two for decel. This plot determines the breakpoints in the schedules entered into the MicroNet control. Note that line slopes established by the schedule points do not change to zero at endpoints. If actuator current is to be held constant for varying CDP, then a zero slope line segment must be created in the schedule.

2. Rescale the dependent variable (gas mass flow or heat consumption) to match the units used in the gas flow data.

3. Now plot the valve test data with the dependent variable scaled as above vs. actuator current. For greatest accuracy, a non-linear curve fit of the data should be used; however a piece-wise linear plot is generally acceptable.

4. Using the Y axis (gas flow) values of the endpoints and breakpoints from the plot of step 1, determine the corresponding actuator current values which produce those flows in the plot of step 3.

5. Find the X axis (CDP) values of the endpoints and breakpoints from the plot of step 1.

6. Rescale the actuator current values of step 4 on a scale of 0 to 100 corresponding to min. to max. stops on the valve. If desired, plot this normalized actuator current as a function of CDP. This is the schedule to be entered in the MicroNet control.
 For example:
 See the linearized sample manufacturers specification in Figure C-1 and the valve test data example in Table C-1.

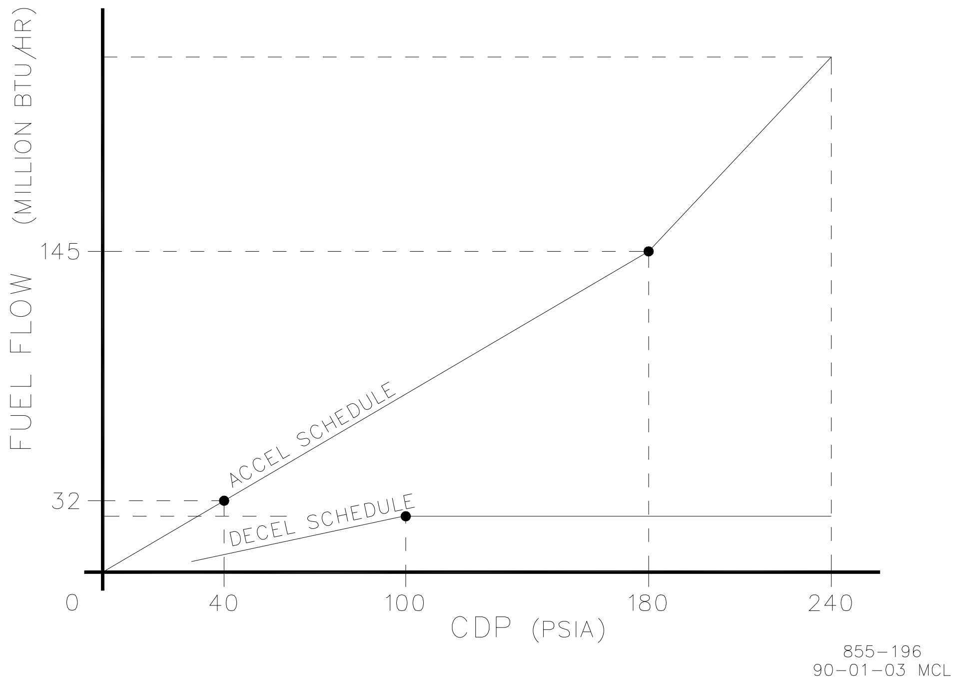

Figure C-1. Linearized Flow Schedule

Valve Angle (deg)	Actuator Current (mA)	Gas Flow (pph)
9.0	32.8	435
9.8	35.0	515
16.5	54.7	1580
22.6	72.1	3060
28.0	86.3	4689
34.9	107.2	7059
41.8	127.7	9378
51.5	155.1	12488

Table C-1. Valve Test Data

Given the gas lower heating value of 20 000 BTU/lbm, flow in million BTU/hr can be rescaled for pph as in the valve test data. The accel schedule breakpoint is at 7250 pph (145 million BTU/hr) fuel flow and 180 psia CDP. From the valve test data, this point corresponds to 108.9 mA of actuator current. For this example a linear interpolation between valve test data points was used to find the actuator current (step 3 above), however better accuracy will result using a non-linear curve fit. Two more points are required to establish the two-slope accel schedule. The first is (40 psia,1600 pph) which corresponds to 54.9 mA. The second endpoint is (240 psia, 10500 pph) which corresponds to an actuator current of 137.6 mA. Now rescale actuator current for 0 to 100 for min. to max. travel of the valve. From the valve data, min. travel is at 35.0 mA and max travel is at 155.1 mA. This gives:

CDP (psia)	**Act. Current (mA)**	**Act. Signal (0 to 100)**
40	54.9	16.6
180	108.9	61.5
240	137.6	85.4

where CDP is the Accel Schedule input value to be entered and ACT. SIGNAL is the output value to be entered. The same procedure is followed for the Decel Schedule.

DN/DT Accel Schedule is biased by GG speed derivative. When DN/DT PID control is used, the acceleration (or deceleration) schedule values must be in terms of GG speed (for inputs) and GG derivative (for outputs).

****
** CONTROL DYNAMICS **
****

1. GG Proportional Gain: 0.10 (0.00 to 100.00) ___________
   GG PID proportional gain adjustment.

2. GG Integral Gain: 0.80 (0.00 to 100.00) ___________
   GG PID integral gain adjustment.

3. PT Proportional Gain: 0.10 (0.00 to 100.00) ___________
   PT PID proportional gain adjustment.

4. PT Integral Gain: 0.80 (0.00 to 100.00) ___________
   PT PID integral gain adjustment.

5. EGT Proportional Gain: 0.10 (0.00 to 100.00) ___________
   EGT PID proportional gain adjustment.

6. EGT Integral Gain: 2.00 (0.00 to 100.00) ___________
   EGT PID integral gain adjustment.

CDP ACCEL SCHEDULE biased by CDP as scaled above. Output of curves block will limit LSS bus in scale of 0-100%, i.e. if output is 50, for a given input, then fuel flow will not be able to increase above 50%.

1.	GAS-Accel Pt #1 Input	2.00 (0.00 to 1000.00)	___________
2.	GAS-Accel Pt #1 Output	0.00 (0.00 to 1000.00)	___________
3.	GAS-Accel Pt #2 Input	10.00 (0.00 to 1000.00)	___________
4.	GAS-Accel Pt #2 Output	11.46 (0.00 to 1000.00)	___________
5.	GAS-Accel Pt #3 Input	165.0 (0.00 to 1000.00)	___________
6.	GAS-Accel Pt #3 Output	64.81 (0.00 to 1000.00)	___________
7.	GAS-Accel Pt #4 Input	225.0 (0.00 to 1000.00)	___________
8.	GAS-Accel Pt #4 Output	90.00 (0.00 to 1000.00)	___________

DECEL SCHEDULE biased by CDP as scaled above. Output of curves block will limit LSS bus in scale of 0-100%, i.e. if output is 50, for a given input, then fuel flow will not be able to decrease below 50%.

9.	GAS-Decel Pt #1 Input	35.00 (0.00 to 1000.00)	___________
10.	GAS-Decel Pt #1 Output	0.00 (0.00 to 1000.00)	___________
11.	GAS-Decel Pt #2 Input	100.00 (0.00 to 1000.00)	___________
12.	GAS-Decel Pt #2 Output	13.22 (0.00 to 1000.00)	___________
13.	GAS-Decel Pt #3 Input	240.00 (0.00 to 1000.00)	___________
14.	GAS-Decel Pt #3 Output	30.00 (0.00 to 1000.00)	___________

The Ambient Temperature Sensor will Bias the EGT temp with a multiplier that comes from the EGT.AMBIAS_EGT.CURVE_2D block.

15.	Amb Bias - Point #1 Input	-50.00 (-300.00 to 300.00)	___________
16.	Amb Bias - Point #1 Output	0.89 (0.00 to 10.00)	___________
17.	Amb Bias - Point #2 Input	-50.00 (-300.00 to 300.00)	___________
18.	Amb Bias - Point #2 Output	0.89 (0.00 to 10.00)	___________
19.	Amb Bias - Point #3 Input	59.00 (-300.00 to 300.00)	___________
20.	Amb Bias - Point #3 Output	1.00 (0.00 to 10.00)	___________
21.	Amb Bias - Point #4 Input	140.0 (-300.00 to 300.00)	___________
22.	Amb Bias - Point #4 Output	1.00 (0.00 to 10.00)	___________

The remaining three headers (Service 1, Service 2, Turb Parameters) are described in the next section.

Service Explanation

The following list shows the sheet available in the SERVICE.WWI inspector file. The default value and range are shown for each tunable. The user is encouraged to enhance this inspector file by adding sheets with additional information and tunables for which easy access is desired.

IMPORTANT **These are values which can be adjusted in the Service mode without shutting down the engine.**

****
** LIST OF SERVICE SHEET TAB HEADERS IN ORDER **
****

1. ** Service 1 **
2. ** Service 2 **
3. ** Turbine Parameters **
4. ** Driver Status **
5. ** Gas Fuel Valve Calibration **

****
** SERVICE 1 **
****

1. Auto Enable N1 MPU Override FALSE (TRUE/FALSE) ___________
2. N1 Corrected Speed Max Limiter 10050.0 (0.0, 20000.0) ___________
3. Ambient Default Temp 80.0 (-200.0, 200.0) ___________
4. N1 Low Override Speed Switch 200.0 (0.0, 2000.0) ___________
5. N1 Reference Default Ramp Rate 30.0 (0.0, 1000.0) ___________
6. N1 Reference Fast Ramp Rate 400.0 (0.0, 1000.0) ___________
7. N1 Reference Upper Limit 10000.0 (0.0, 20000.0) ___________
8. N1 Reference Lower Limit 5000.0 (0.0, 20000.0) ___________
9. N1 Speed Switch #1 Setpoint 500.0 (0.0, 20000.0) ___________
10. N1 Speed Switch #2 Setpoint 1200.0 (0.0, 20000.0) ___________
11. N1 Speed Switch #3 Setpoint 1700.0 (0.0, 20000.0) ___________
12. N2 Reference Default Ramp Rate 11.0 (0.0, 1000.0) ___________
13. N2 Reference Fast Ramp Rate 65.0 (0.0, 1000.0) ___________
14. N2 Reference Upper Limit 5775.0 (0.0, 20000.0) ___________
15. N2 Reference Lower Limit 3850.0 (0.0, 20000.0) ___________
16. N2 Speed Switch #1 Setpoint 500.0 (0.0, 20000.0) ___________

17. N2 Speed Switch #2 Setpoint 1600.0 (0.0, 20000.0) ____________

18. N2 Speed Switch #3 Setpoint 3700.0 (0.0, 20000.0) ____________

****
** SERVICE 2 **
****

1. Remote Speed Reference 11.0 (0.0, 1000) ____________
2. Remote Reference Deadband Window Size 5.0 (0.0, 1000) ____________
3. Remote Reference Deadband Fast Window Size 10.0 ____________ (0.0, 1000)
4. Remote Reference Setpoint Upper Limit 5775.0 (0.0, 20000) ____________
5. Remote Reference Setpoint Lower Limit 3850.0 (0.0, 20000) ____________

****
** TURBINE PARAMETERS **
****

1. Fuel Control Start Command Status
2. Reset Input *FALSE
   Toggle this tunable to send the control a reset command.
3. Shutdown Stack Status
4. Alarm Stack Status
5. Fuel Metering Valve Output Demand
6. Fuel Demand
7. CDP Input Sensor
8. EGT Reference Temperature
9. EGT Temperature
10. N1 (GG) Reference
11. N1 Speed
12. N2 (PT) Reference
13. N2 (PT) Speed

****
** DRIVER STATUS **
****

1. LSS Bus Position [%] = LSS bus output scaled in percent actuator demand.

2. HSS Bus Position [%] = HSS bus output scaled in percent actuator demand.

3. Fuel Valve Demand (%) = Fuel valve actuator demand, in percent.

4. Fuel Valve Calibration Mode = TRUE indicates valve is in calibrate mode.

****
** GAS FUEL VALVE CALIBRATION **
****

IMPORTANT **To enable Actuator Calibration, EGT TEMP must be less than 400 °F (204 °C), have no trips existing on unit, and Enable Actuator Calibration must be tuned TRUE. See note above on determining fuel valve actuator calibration minimum & maximum current settings.**

1. Enable Actuator Calibration FALSE (TRUE to FALSE) ___________

2. Valve Percent Act Stroke 0.00 (0.00 to 100.00) ___________
Adjusting this value strokes the fuel valve actuator, scaled in percent actuator demand.

3. Gas Actuator Minimum Current 20.00 (0.00 to 100.00) ___________
Current of GAS fuel act driver at zero demand.

4. Gas Actuator Maximum Current 160.00 (20.00 to 180.00) ___________
Offset calibration for GAS fuel act driver.

5. Gas Act. Dither Amplitude 2.00 (0.00 to 5.00) ___________
This value adjusts the amplitude of the AC component of the actuator signal. Adjust this value in the increasing direction until vibration is noticeable at the terminal shaft of the actuator and decrease the amplitude until the vibration is no longer perceptible.

Tunable Upload/Download Function

The TUNABLE UPLOAD & DOWNLOAD functionality is used for downloading or uploading tunables into or out of the control. The tunables may be downloaded from the control to a PC anytime, however the turbine must be shutdown while using the TUNABLE DOWNLOAD FUNCTION mode.

NOTICE **Entering into I/O Lock mode while the turbine is running will cause an automatic shutdown of the turbine with resulting process stoppage. Do not enter the I/O Lock to upload tunables into the control while the turbine is running.**

From WWII—Go to the Explorer window and 'right-mouse' click on the control (top level). A pull-down menu will appear, and the App Settings selection will allow you to Save to File or Load from File.

SAVE = Download the tunables in the control to a file on the user PC
LOAD = Upload tunable settings from a user PC into the control

Loading tunables into the control will cause the unit to Lock the I/O and shut down the turbine.

A complete list of tunables can be found in Appendix B.

We appreciate your comments about the content of our publications.

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