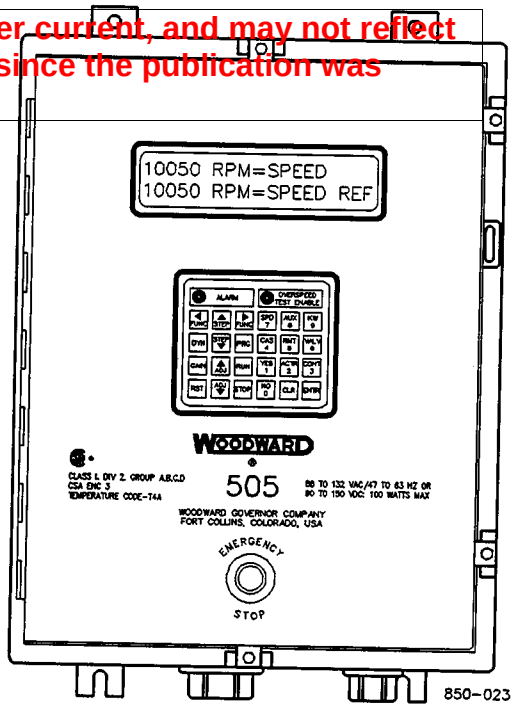
WOODWARD





# 505 DIGITAL GOVERNOR FOR STEAM TURBINES WITH SINGLE OR SPLIT-RANGE ACTUATORS




CSA CERTIFIED LR 85517

THIS EQUIPMENT IS SUITABLE FOR CLASS I, DIVISION 2, GROUP A, B, C, D, OR NON-HAZARDOUS LOCATIONS

English 8238-007, 8238-008, 8238-010, 8238-011, 8238-016, 8238-020, 8238-028, 8238-036, 8238-037, 8238-038 9903-296, 9903-297, 9903-298, 9903-299

Spanish 8238-031, 8238-032, 8238-033, 8238-034, 8238-035

INSTALLATION, CONFIGURATION, AND OPERATING PROCEDURES

**WOODWARD GOVERNOR COMPANY**

**WARNING**

**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.**

**The engine, turbine, or other type of prime mover should be equipped with an overspeed (overtemperature, or overpressure, where applicable) shutdown device(s), that operates totally independently of the prime mover control device(s) to protect against runaway or damage to the engine, turbine, or other type of prime mover with possible personal injury or loss of life should the mechanical-hydraulic governor(s) or electric control(s), the actuator(s), fuel control(s), the driving mechanism(s), the linkage(s), or the controlled device(s) fail.**

**CAUTION**

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 (PCBs) or modules.
- Do not touch the components or conductors on a PCB with your hands or with conductive devices.
- When not installed in a control, modules should be kept in a protective antistatic bag. 43027 modules and Position Control modules should also have a shunt bar placed over the module terminals before the module is placed in a storage bag. Refer to chart below for part numbers of bags and shunt bars.

| CONTROL NUMBER | ANTISTATIC BAG P/N | BAG SIZE IN INCHES | SHUNT BAR P/N |
|---|---|---|---|
| 43027 | 4951-039 | 10 x 12 | 4962-005 |
| 43027 Position Control | 4951-051 | 15 x 18 | 4962-005 (2 needed) |
| 100-Pin Modules (Westinghouse) | 4951-041 | 12 x 16 | 4962-011 |
| 301 | 4951-073 | 12 x 18 | N/A |
| 400 | 4951-069 | 10 x 14 | N/A |
| DCS | 4951-039 | 10 x 12 | N/A |
| NetCon 5000 | 4951-073 | 12 x 18 | N/A |
| Digital Remote Final Driver | 4951-051 | 15 x 18 | N/A |

The letter designation following the manual number is changed to the next letter in alphabetical order when an important change is made to the manual.

CHANGED AREAS ARE INDICATED BY A BLACK LINE IN THE MARGIN.

# TABLE OF CONTENTS

# TABLE OF CONTENTS (CONT.)

# TABLE OF CONTENTS (CONT.)

## LIST OF ILLUSTRATIONS

NOTES

## INTRODUCTION

This manual (85007) describes the Woodward 505 Digital Governor for steam turbines. English versions are (8238-007, 8238-008, 8238-010, 8238-011, 8238-016, 9903-296, 9903-297, 9903-298, and 9903-299. Stainless steel English versions are 8238-028, 8238-036, 8238-037, and 8238-038. Spanish versions are 8238-031, 8238-032, 8238-033, 8238-034, 8238-035. These controls are CSA Certified LR 85517. The option charts below show the differences between the part numbers. The manual gives the installation instructions, describes the control, and explains the configuration (programming) and operating procedures.

This manual does not contain instructions for the operation of the complete turbine system. For turbine- or plant-operating instructions, contact the plant-equipment manufacturer.

Manual 85006 describes the 505E Digital Governor for extraction steam turbines.

A software revision affects the programming of the 505. Your control has revised software if, while stepping through the "Shutdown Logic Block" of Section 4 of this manual, (CLR RESETS S/D RELAY) appears on your control's LCD display. If this item does NOT appear, your system has the original software and you should refer to Appendix B when instructed.

## OPTION CHARTS

COMMERCIAL APPLICATIONS (CSA APPROVED LR 85517)

| Control Number | Enclosure | Supply Voltage |
|---|---|---|
| English Version: 8238-007, 8238-016 (See Note 15 on Figure 2)<br><br>Spanish Version: 8238-032 | Standard | 110/120 Vac; 50/60 Hz or 125 Vdc |
| English Version: 8238-008<br><br>Spanish Version: 8238-033 | Flush Mounted | 110/120 Vac; 50/60 Hz or 125 Vdc |
| English Version: 8238-010<br><br>Spanish Version: 8238-034 | Standard | 18-32 Vdc |
| English Version: 8238-011<br><br>Spanish Version: 8238-035 | Flush Mounted | 18- 32 Vdc |

COMMERCIAL APPLICATIONS (CSA APPROVED LR 85517)

| Control Number | Enclosure | Supply Voltage |
|---|---|---|
| English Version: 8238-020<br><br>Spanish Version: 8238-031 | Standard (Has no EMERGENCY STOP button) | 110/120 Vac; 50/60 Hz or 125 Vdc |
| English Version 8238-028 | Standard Stainless Steel | 110/120 Vac; 50/60 Hz or 125 Vdc |
| English Version 8238-037 | Standard Stainless Steel | 18-32 Vdc |
| English Version 8238-036 | Flush Mounted Stainless Steel | 110/120 Vac; 50/60 Hz or 125 Vdc |
| English Version 8238-038 | Flush Mounted Stainless Steel | 18-32 Vdc |

NOTES

Part number 8238-021 is available but **DOES NOT** have CSA approval. Part number 8238-021 is the same as Part Number 8238-008 except that it has a 220/115 Vac input power transformer. **The 8238-021 control can not accept a dc input.**

Part number 9903-296 (CSA approved LR 85517) has been used in a nuclear application, but is not NRC approved

# CHAPTER 1
# 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 electro-static discharges.

1. Before performing 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. Do not remove the printed circuit boards (PCBs) from the control cabinet unless absolutely necessary. When handling a PCB, follow these instructions.

    - Do not touch any part of the PCB except the edges.
    - Do not touch the PCB, the connectors, or the components with conductive devices or with your hands.

4. Keep all plastic, vinyl, and styrofoam away from the control, the PCB, and the work area. Materials such as plastic/styrofoam coffee cups, coffee cup holders, cigarette packages, cellophane candy wrappers, vinyl books or folders, plastic bottles, and plastic ash trays tend to generate and store static electric charges.

NOTES

# CHAPTER 2
# INSTALLATION PROCEDURES

## MECHANICAL DATA AND HARDWARE INSTALLATION

### PACKAGING

Figure 1 shows 505 control layout. All 505 control components are contained in a single, NEMA Type 4 steel enclosure. The standard enclosure (Figure 1a) can be bulkhead-mounted. An optional enclosure is designed to be flush-mounted (Figure 1b). Access to internal components is through a left-hand-hinged door which is held closed by four screw-in clamps. A latch permits the door to be locked. The size of the enclosure allows the control to accommodate an internal heat rise of 20 degrees C. It also allows the enclosure to accommodate a large number of input and output connections (over a hundred wiring connections are available if all optional connections are made).

The enclosure has two openings in the bottom for wiring access. One hole is approximately 25 mm diameter, and the other is approximately 38 mm diameter. The holes are factory-fitted with English standard conduit hubs (1.0 inch and 1.5 inches), which can be replaced, if desired, by metric standard conduit hubs. The hubs accept threaded conduit.

All internal components are industrial grade. The components include the CPU (central processing unit), its memory, the switching power supply, all relays, all input/output circuitry, and all communications circuitry for the front door display, touch keypad, and the remote RS-232 communications.

If necessary the 505 enclosure can be purged to rid the enclosure of hazardous gases. See Figure 1 for recommended purge-hole sizes and locations.

**CAUTION**

**Maximum permitted purging pressure is 0.25 psi. A purging pressure greater than 0.25 psi will damage the keypad.**

A separate load sensor enclosure (if needed) houses the potential and current transformers and associated circuits.

### MOUNTING

The standard 505 enclosure must be vertically mounted on a wall or post, allowing sufficient room for lid opening and wiring access. Four welded flanges, two on top and two on bottom, permit secure mounting. An optional enclosure permits the control to be flush-mounted (see Figure 1b for cut-out dimensions).

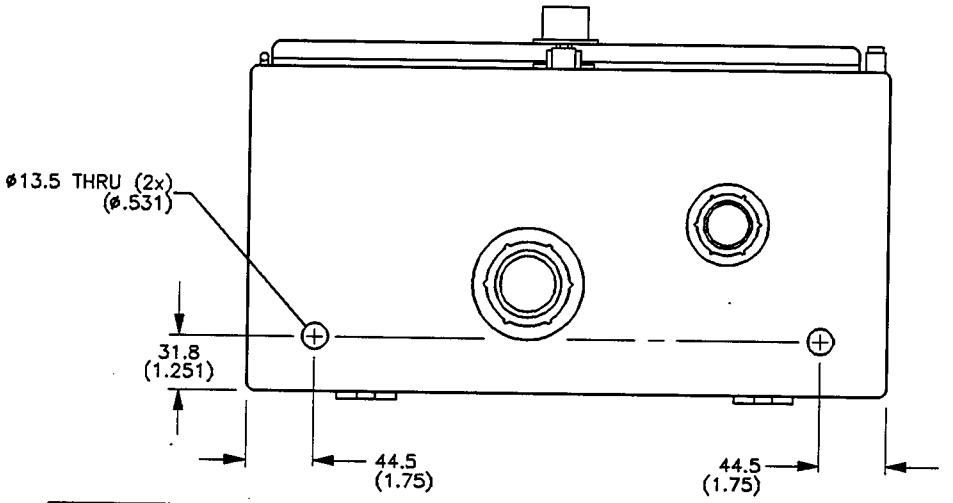
## ELECTRICAL CONNECTIONS

All electrical connections must be made through the two openings in the bottom of the enclosure to the terminal blocks inside the enclosure. Route all low-current lines (terminal blocks 1 through 96) through the large conduit hub. Route all high-current lines (terminal blocks 97 through 123) through the small conduit hub.

Wiring for each MPU and for each actuator must be separately shielded. We also recommend separate shielding for each mA input (terminal blocks 27 through 38). Contact inputs (terminal blocks 57 through 86) may be bundled together within a single multiconductor cable with one overall shield. Shields should be connected at one end only (usually the governor end). Relay and power supply wiring do not normally require shielding.

Make sure that all inputs and outputs, including all shields, are NOT grounded outside the 505 control box. Terminal block 123 (ground) is the only 505 connection that should be wired to external ground.

See Figure 2 for the plant wiring diagram and terminal block numbers.




METRIC/INCH CONVERSION

| MM | INCH |
|---|---|
| 13.5 | .531 |
| 31.8 | 1.251 |
| 44.5 | 1.75 |

## PURGING

**The maximum pressure permitted in the 505 enclosure is 0.25 psi. Damage to the keypad will result if internal pressure exceeds 0.25 psi.**

Figure 1. Recommended Purge Hole Sizes and Locations

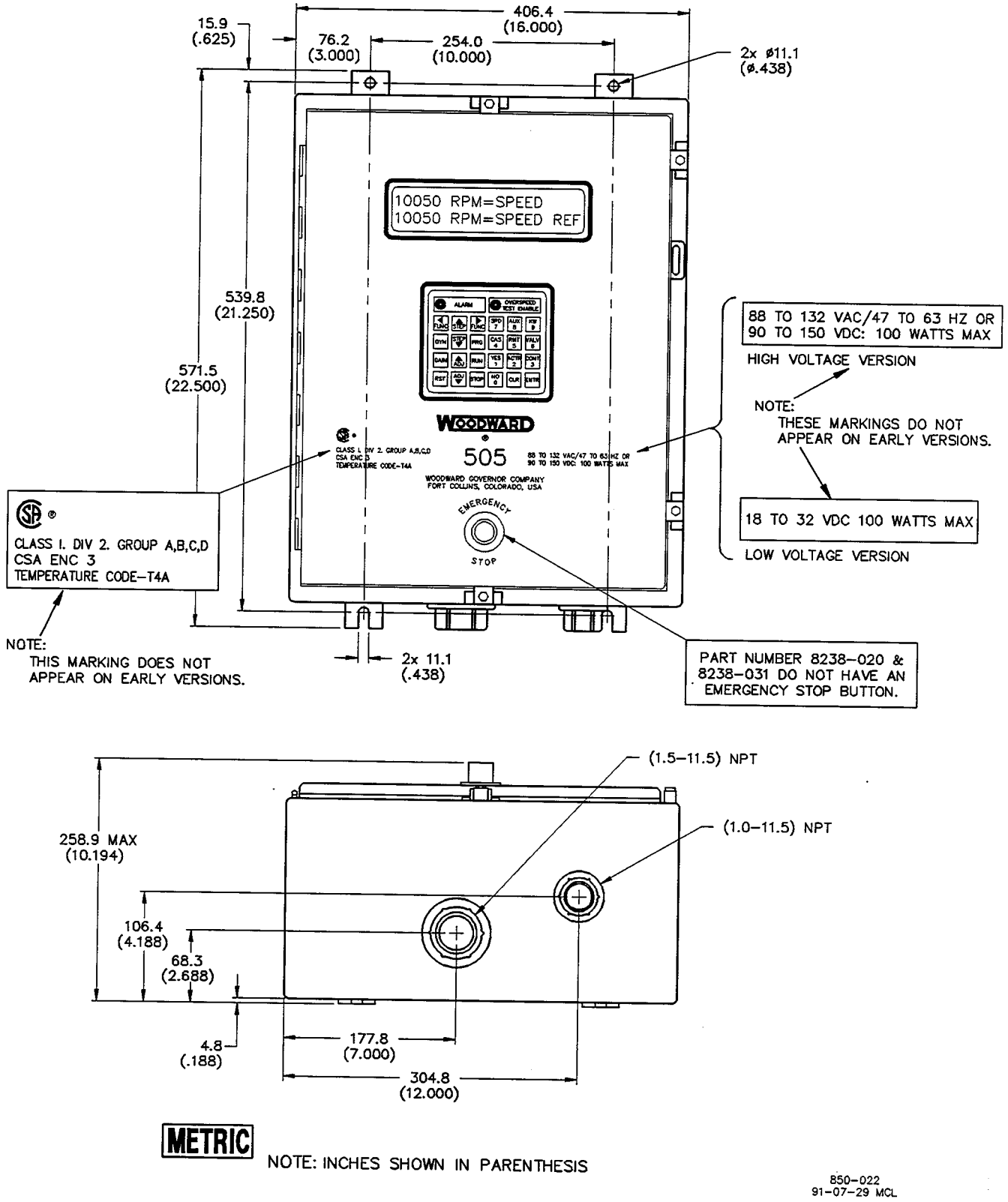



Figure 1a. 505 Control Layout (Standard Enclosure)

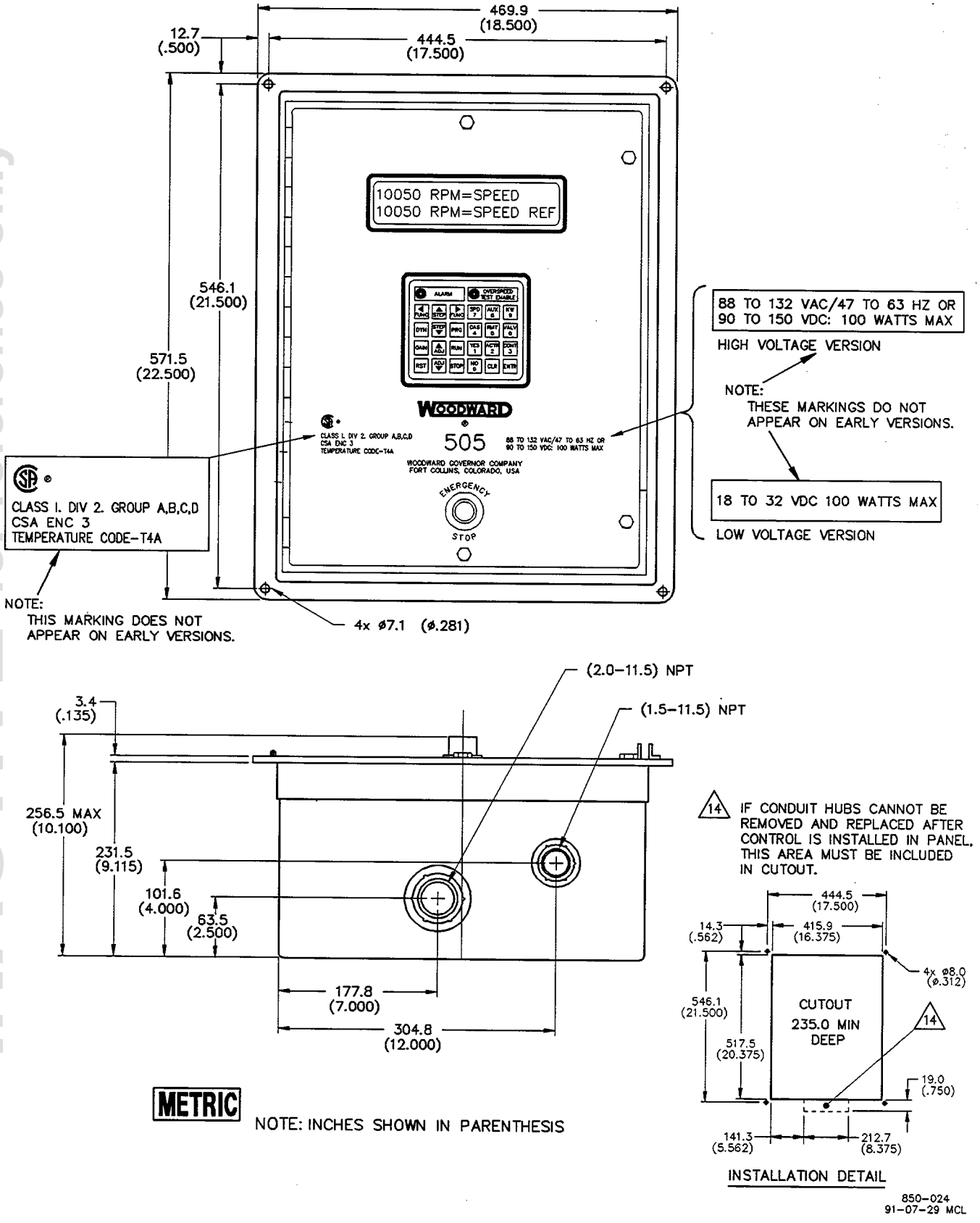
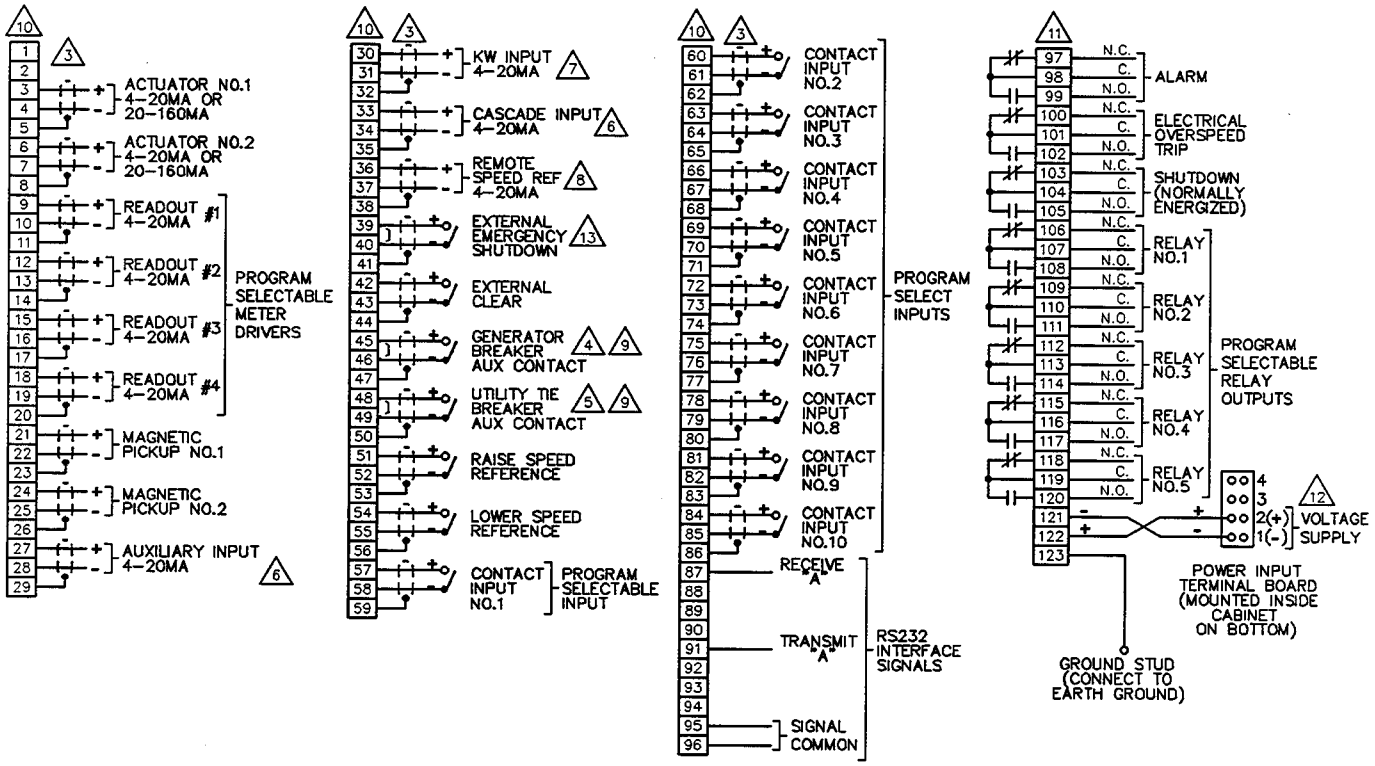



Figure 1b. 505 Control Layout (Flush-Mounted Enclosure)




NOTES:

1. UNLESS OTHERWISE SPECIFIED, SWITCHES CLOSE TO ACTIVATE FUNCTION.
2. UNLESS OTHERWISE SPECIFIED, RELAY CONTACTS ARE DE-ENERGIZED DURING OPERATING CONDITIONS.

△3 SHIELDED WIRES TO BE TWISTED PAIRS WITH SHIELD GROUNDED AT CONTROL END ONLY.

△4 CONTACT CLOSES WHEN GENERATOR BREAKER CLOSES.

△5 CONTACT CLOSES WHEN UTILITY TIE BREAKER CLOSES.

△6 TWO WIRES TRANSDUCER SYSTEM SHOWN. TRANSDUCER POWER IS SUPPLIED ON THE (+) TERMINAL.

△7 FOR EXCLUSIVE USE WITH WOODWARD GOVERNOR COMPANY REAL POWER SENSOR, P/N 8272-394.

△8 ISOLATED INPUT.

△9 IF THE APPLICATION DOES NOT USE GENERATOR OR TIE BREAKERS, A JUMPER MUST INSTALLED ACROSS TERMINALS 45 & 46 AND 48 & 49.

△10 EXTERNAL WIRING TO TERMINALS 1 THROUGH 96 (LOW CURRENT LINES) SHOULD BE ROUTED THROUGH THE LARGE CONDUIT HUB.

△11 EXTERNAL WIRING TO TERMINALS 97 THROUGH 123 (HIGH CURRENT LINES) SHOULD BE ROUTED THROUGH THE SMALL CONDUIT HUB.

△12 SEE OPTION CHART (PAGE 1 OF THIS MANUAL).

△13 FOR ALL PART NUMBERS EXCEPT 8238-020 AND 8238-031 A JUMPER OR EXTERNAL SHUTDOWN SWITCH MUST BE INSTALLED ACROSS TERMINALS 39 AND 40. PART NUMBERS 8238-020 AND 8238-031 REQUIRE A JUMPER ACROSS TERMINALS 39 AND 40.

△14 IF CONDUIT HUBS CANNOT BE REMOVED AND REPLACED AFTER CONTROL IS INSTALLED IN PANEL, THIS AREA MUST BE INCLUDED IN CUTOUT.

△15 8238-016 IS AN 8238-007 WITH SPECIAL SOFTWARE PROGRAMMING PER TSP-5529. SEE OPTION CHART (PAGE 1 OF THIS MANUAL).

85000-A-20
91-07-31 MCL

Figure 2. Plant Wiring Diagram

NOTES

# CHAPTER 3
# DESCRIPTION

## GENERAL DESCRIPTION

The 505 Digital Governor is a microprocessor-based control designed to control single-actuator or dual-actuator steam turbines (extraction steam turbines require the 505E version). A microprocessor-based digital control provides considerable flexibility in configuring the governor to your specific control requirements. This ability to configure your system in the field configurability allows a single design to be used in many different control applications, and it reduces both cost and delivery time.

The 505 control has two operating modes (the program mode and the run mode). Using the Program Mode, you select the options needed to configure the control to your turbine application.

Once the control has been configured, you will never again need to use the Program Mode, unless turbine options change. You then select Run Mode to operate the turbine from start-up through shutdown.

The 505 functions are shown in Figure 4. Use this block diagram to match the control features to your application.

## COMMUNICATION

You communicate with the 505 control through a 26-key membrane switch keypad located on the front of the control, or through remote switch contacts (field-wired to fit your needs), or through an RS-232 line and CRT display/keyboard. The control responds through an LCD (liquid crystal display) window located on the front of the control (which consists of two lines, each containing 20 half-inch-high characters), or through several meter readouts and relays, or through the RS-232 line.

The angle of view of the LCD window is adjustable. If your 505 is mounted in such a way that the LCD characters are not clear from the desired viewing angle, open the control door and slowly adjust the potentiometer on the back of the LCD circuit board until the characters are clear from the desired viewing angle.

## KEYPAD FUNCTIONS

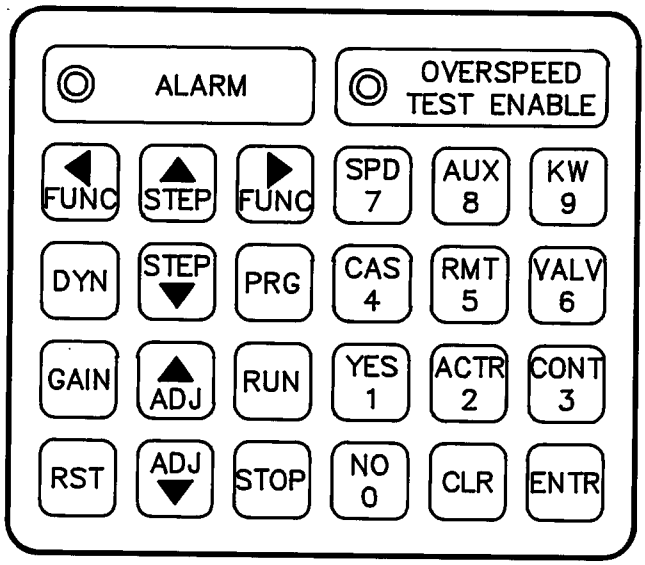



Figure 3. 505 Key Pad

A description of each key's function follows. Some descriptions refer to the function blocks contained in the programming and operating (run) flowcharts (see Figures 31 and 32).

FUNC left/FUNC right (function):
Moves the display left or right through the function blocks.

STEP up/STEP down:
Moves the display up or down within a function block.

ADJ up/ADJ down (adjust):
In the run mode, moves any adjustable parameter up (larger) or down (smaller).

DYN (dynamics):
Accesses the dynamic settings of the parameter controlling actuator position in the Run Mode.

GAIN:
Activates the dynamic gain setting of the displayed parameter in the Run Mode (you must press the DYN key, then step to the appropriate dynamic adjustment).

RST (reset):
Activates the dynamic reset setting of the displayed parameter in the Run Mode (you must press the DYN key, then step down to the appropriate dynamic adjustment).

PRG (program):
Puts the control into the Program Mode from the (CONTROLLING PARAM/PUSH RUN or PRG) state.

RUN:
Puts the control into the Run Mode from the (CONTROLLING PARAM/PUSH RUN or PRG) state.

STOP:
Returns the control to the ready status (Program Mode) or initiates a controlled turbine shutdown (Run Mode) once verification is given.

0/NO:
Enters 0/NO (Program Mode) or NO/Disable (Run Mode).

1/YES:
Enters 1/YES (Program Mode) or YES/Enable (Run Mode).

2/ACTR (actuator):
Enters 2 (Program Mode) or displays the actuator position (Run Mode).

3/CONT (control):
Enters 3 (Program Mode) or displays the parameter which is in control (Run Mode).

4/CAS (cascade):
Enters 4 (Program Mode) or displays the cascade control information (Run Mode).

5/RMT (remote):
Enters 5 (Program Mode) or displays the remote process control information (Run Mode).

6/VALV (valve):
Enters 6 (Program Mode) or displays the valve ramp information (Run Mode).

7/SPD (speed):
Enters 7 (Program Mode) or displays the speed control information (Run Mode).

8/AUX (Auxiliary)
Enters 8 (Program Mode) or displays the auxiliary control information (Run Mode).

9/KW:

Enters 9 (Program Mode) or displays the kW power control information (Run Mode).

CLR (clear):

Clears Program Mode entries or resets Run Mode alarms. Pressing the key also returns the control to the (CONTROLLING PARAM/PUSH RUN OR PRG) status after a shutdown.

ENTR (enter):

Enters new values in the Program Mode.

ALARM:

Displays the reason for any alarm condition when the key's LED indicator is illuminated.

OVERSPEED TEST ENABLE:

Permits the speed reference to be raised beyond the maximum controlling speed set point to test either the electrical or the mechanical overspeed trip.

In addition to the 26-key membrane switch panel, a large red mechanical button is mounted on the front of the enclosure. This is the emergency shutdown switch for the control.

## INPUTS AND OUTPUTS

All inputs and outputs to the 505 are made through terminal blocks inside the 505 enclosure. Wiring passes through two conduits on the bottom of the control.

The control monitors a change in the state of all external control contacts. Thus, the control does not react to a maintained level but only to a change (open to closed, closed to open). Contacts must be closed for a minimum of 14 milliseconds to register a change in state. At start-up, the control reviews all contact states, and reacts to any closed contact as a change in state.

Inputs to the control are: two MPU (magnetic pickup) inputs, one auxiliary input, one cascade input, one kW (load) input, one remote speed reference input, six hardwired contact inputs, and ten programmable contact inputs. Control outputs are: two actuator outputs, four 4 to 20 mA meter-drive outputs, and eight relay contact outputs.

Additional input and output occurs through an RS-232 line (see below). All inputs and outputs are shown in the plant wiring diagram, Figure 2, and in the block diagram, Figure 4. We do NOT recommend that any additional devices be connected into any control input or output circuit.

If your application uses two MPUs (magnetic pickups), the MPUs may be mounted on separate gears, but each gear must have the same number of teeth and rotate at the same speed, so that both MPUs record the same speed. The 505 control must receive a minimum MPU signal of 1.5 V rms, 12 kHz maximum. If you are using only one MPU, make sure it is connected to the terminal blocks for Magnetic Pickup No. 1.

NOTE

The speed signal that the 505 can accept must be within the following limits:

$\frac{T \times M \times R}{60}$ must be >500 y <12050

T = The number of teeth on the gear
M = The maximum setting of the speed reference
R = The gear ratio

If the signal is not within these limits, the 505 will respond with an MPU frequency error during programming.

The 4 to 20 mA auxiliary input and the 4 to 20 mA cascade input are each designed for a two-wire (ungrounded) transducer system (see Figure 7). Maximum external line resistance in each case is 25 ohms (wire resistance).

The 4 to 20 mA kW (load) input is designed for use with an isolated mA source, in particular the Woodward Real Power Sensor (8272-394). Maximum external line resistance is 300 ohms (wire resistance).

The 4 to 20 mA remote reference input is an isolated current-source input. The remote current source must be able to provide current sufficient for the 250 ohm internal control resistance plus any field wiring resistance (that is, ZL max of current source equal to or greater than 250 ohms + wire resistance).

The six hardwired contact inputs are:

External Emergency Shutdown
External Clear
Generator Breaker Auxiliary
Utility Tie Breaker Auxiliary
Raise Speed Reference
Lower Speed Reference

**Before starting, the External Emergency Shutdown contact must be jumpered closed or must have an external switch wired in and closed.** The control will initiate an emergency shutdown any time the contact is opened.

The Generator Breaker Auxiliary contact must be wired so it is closed when the generator breaker is closed; and the Utility Tie Breaker Auxiliary contact must be wired so it is closed when the utility tie breaker is closed. If your application does not use the breakers, you must jumper both contacts closed (terminal blocks 45 to 46 and 48 to 49).

NOTE

If using another manufacturer's real power sensor a lag response time may be necessary. Typically, 500 ms to 1 sec is needed, depending on total lag time of system.

The ten programmable contact inputs can be selected in the Program Mode from 13 options:

External Stop
External Run
Open Valve
Close Valve
Auxiliary Reference Raise
Auxiliary Reference Lower
MPU Failed Override
Overspeed Test
Idle/Rated
Cascade Reference Raise
Cascade Reference Lower
Enable Cascade Control
Enable Remote Process Control

Maximum external line resistance for contact inputs is 900 ohms (contact resistance + wire resistance).

The two actuator drive currents can be either: (1) both 20 to 160 mA signals for Woodward Governor Company hydromechanical or pneumatic actuators; or (2) both 4 to 20 mA signals for non-Woodward actuators. Actuator drive current is selected in the Program Mode. Maximum external line resistance for each 4 to 20 mA actuator output is 600 ohms (actuator impedance + wire resistance). Maximum external line resistance for each 20 to 160 mA actuator output is 45 ohms (actuator impedance + wire resistance).

If you are using only one actuator, make sure it is connected to the terminal blocks for actuator No. 1 (because the control is designed to let actuator No. 2 follow actuator No. 1). Do NOT place any resistor or jumper across the terminals for actuator No. 2.

The four 4 to 20 mA meter-drive outputs can be selected in the Program Mode from 12 analog output options:

Speed Input
Speed Reference
Auxiliary Input
Auxiliary Reference
Cascade Input
Cascade Reference
Remote Process Input
KW Input
Valve Ramp Position
Actuator 1 Position
Actuator 2 Position

Maximum external line resistance for meter outputs is 600 ohms (meter impedance + wire resistance).

Three of the eight relay outputs are dedicated:

Alarm relay
Electrical Overspeed Trip relay
Shutdown relay

The remaining five relay outputs can be selected in the Program Mode from eleven options:

Speed Reference Maximum
Speed Switch 1
Speed Switch 2
Remote Process Control
Auxiliary Input Switch
Valve Ramp Switch
Cascade In Control
Hand Valve 1
Hand Valve 2
Hand Valve 3
Hand Valve 4

The Form C type relay contacts are rated at:

5 amps of resistive load at 28 Vdc
1 amp of inductive load at 28 Vdc
250 mA of resistive load at 125 Vdc
500 mA of resistive load at 115 Vrms, 60 Hz
100 mA of inductive load at 115 Vrms, 60 Hz

**RS-232 COMMUNICATION**

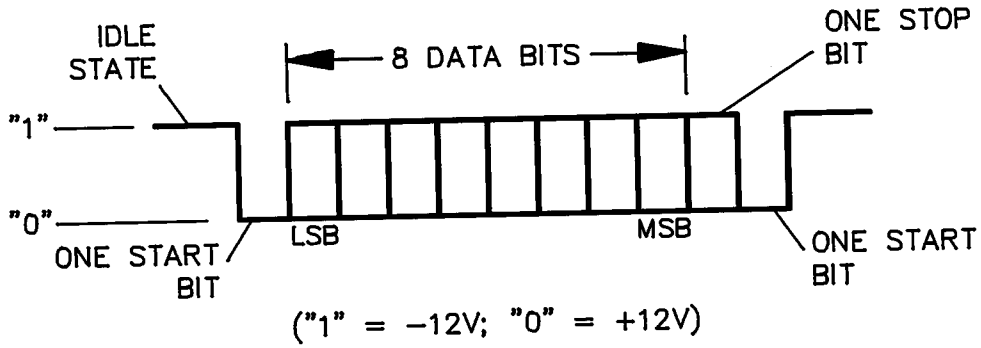
The control can communicate with a CRT (cathode-ray tube) terminal through an RS-232 line. The RS-232 protocol is asynchronous, eight bits/ character, no parity, one start bit, one stop bit (see Figure 5). Available baud rates (bits/second) are 300, 1200, or 2400. You select the RS-232 feature and the baud rate during control configuration in the Program Mode. If the RS-232 feature is not selected, the control does not put out any information on the RS-232 line.

You cannot access the Program Mode through the RS-232 line. Program configuration must be done from the keypad on the front of the control. When the control is in the Run Mode, you can access all Run Mode functions except overspeed test through the RS-232 line. An RS-232 line can be approximately 50 feet long (or longer if the line capacitance is held below 2500 picofarads).

You may select either manual or automatic RS-232 mode. Manual is the default mode. To select automatic RS-232 mode, type in AUTO, followed by a return. To return to manual RS-232 mode, type in MAN, followed by a return. In manual RS-232 mode, the control updates CRT information only when you press RETURN. In automatic RS-232 mode, the control updates the selected information (such as speed or pressure) automatically every second at 1200 or 2400 baud or every two seconds at 300 baud.

# RS–232 PROTOCOL

1. ASYNCHRONOUS
2. 8 BIT/CHARACTER
3. NO PARITY
4. 1 START BIT
5. 1 STOP BIT
6. 300, 1200 OR 2400 BAUD




# RS–232 INTERFACE

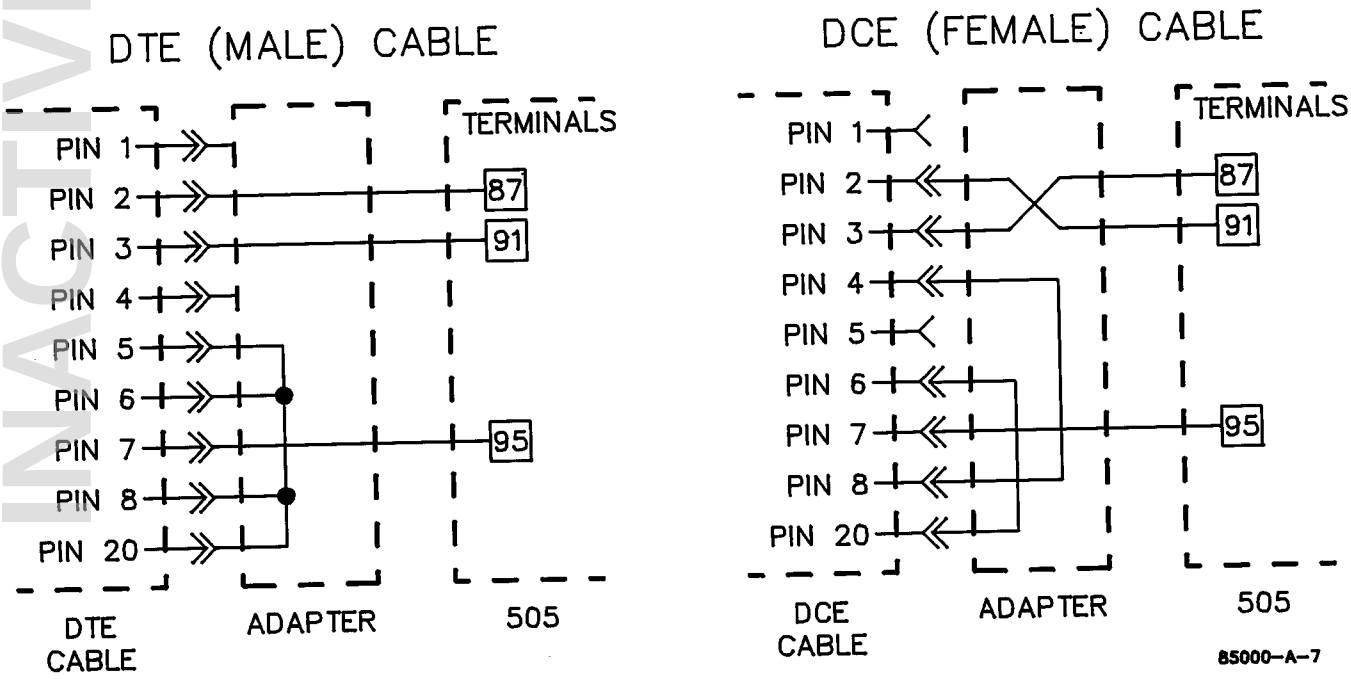



Figure 5. RS-232

To call up any function, either type in the same letter combinations shown on the control keypad (e.g., SPD for speed) or type in the function's full name (e.g., SPEED). For the arrow keys, enter the following two-letter codes:

AU = Adjust Up
AD = Adjust Down
FL = Function Left
FR = Function Right
SU = Step Up
SD = Step Down

When using the Adjust commands, repeatedly press the Return key to continue the adjustment; press any other key to stop the adjustment process. The CRT screen displays the same information as shown on the control's LCD readout.

To initiate an emergency shutdown through the RS-232 line, type in ESD (emergency shutdown), followed by a return.

## SPEED CONTROL

The speed control receives a turbine speed signal from one or two magnetic pickups. A frequency-to-voltage converter changes the speed frequency signal from each MPU into a proportional voltage signal. The PID (proportional, integrating, differentiating) control amplifier then compares this signal to the speed-reference set point to generate an output signal to the actuator driver(s) and valve actuator(s).

The speed control amplifier also can receive a programmable (optional) droop feedback signal to increase the stability of the turbine/governor system.

This can be direct feedback using a portion of the speed control amplifier output, or it can be load (kW) droop feedback. The 4 to 20 mA load droop signal comes from an isolated 4 to 20 mA source (in particular, the Woodward Real Power Sensor). An I/V (current-to-voltage) converter changes the load current signal to a proportional voltage. A percentage of that signal is then sent on to the control amplifier.

The speed reference is adjusted through the keypad on the front of the control. External contact closures also allow remote setting of the reference.

## AUXILIARY (KW/PRESSURE/TEMPERATURE) CONTROL

The auxiliary control can be used for kW (power) control, inlet pressure control, exhaust pressure control, temperature control, or other types of auxiliary control. The auxiliary input is a 4 to 20 mA current signal which the control converts to a proportional voltage. The PID control amplifier compares this voltage with the auxiliary reference to produce a control output to the digital LSS (low-signal select) bus. The LSS bus sends the lowest signal to the final driver circuitry.

The auxiliary control amplifier can also receive a programmable (optional) droop feedback signal to increase the stability of the turbine/governor system.

This is a direct feedback using a portion of the auxiliary control amplifier output.

The auxiliary reference is adjusted through the keypad on the front of the control. External contact closures also allow remote setting of the reference.



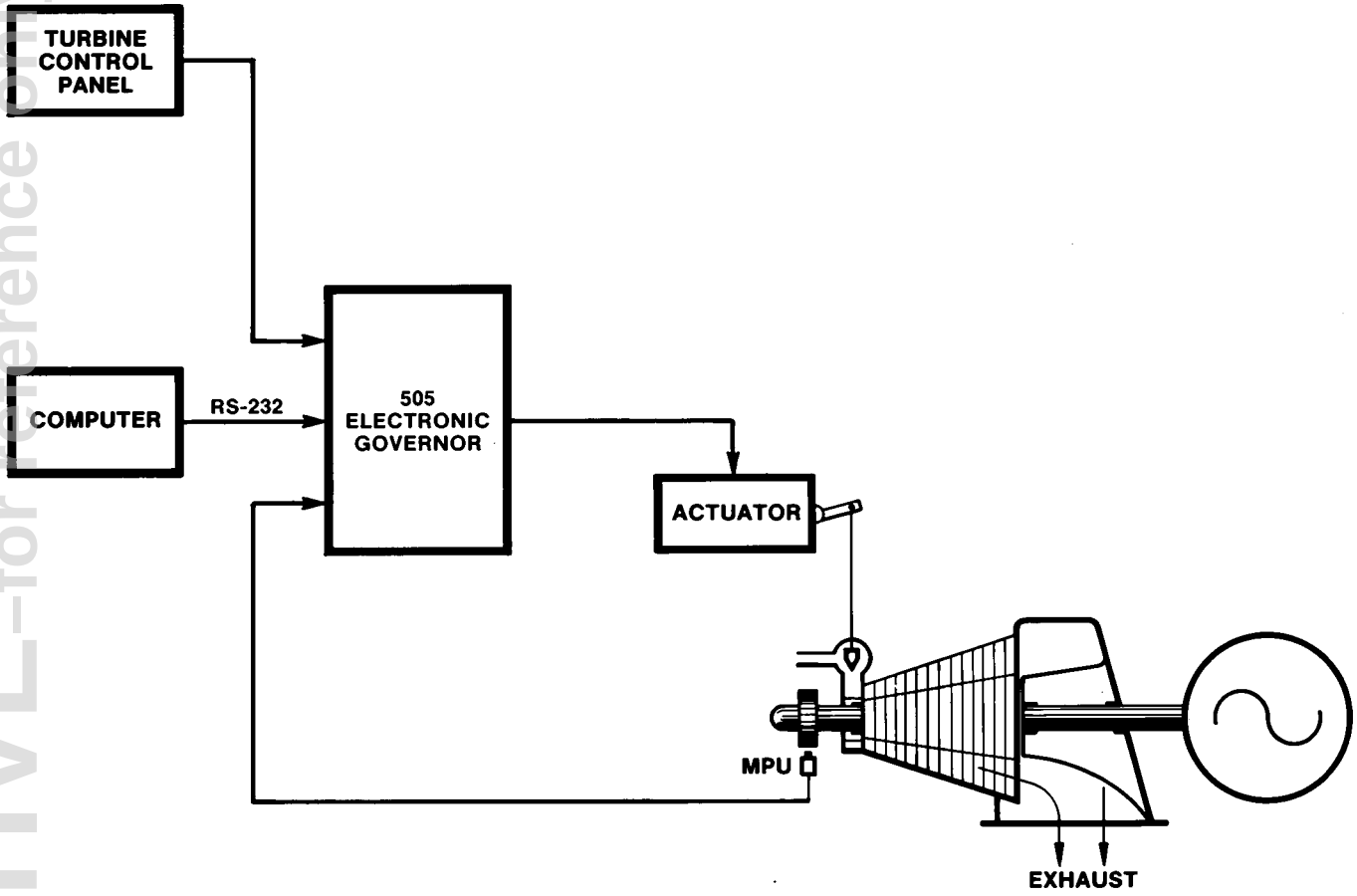



Figure 6. 505 Communication through an RS-232 Line

## REMOTE PROCESS CONTROL

The remote process control can control the speed-reference set point. A process control external to the 505 receives a 4 to 20 mA signal from a transducer. The external process control compares that signal with an external reference to generate an output to the remote process control portion of the 505. An I/V converter changes this current signal to a proportional voltage. The 505's internal process control compares this voltage to the output of the speed reference. If the incoming signal is greater than the speed-reference set point, the 505 raises the speed reference. If it is lower, the 505 lowers the speed reference.

You can use the remote input signal for monitoring purposes without utilizing the remote control function, if desired. You must configure the remote control function and assign its analog output in the Program Mode (see block diagram, Figure 4). In the Run Mode, the remote control function must remain disabled when used strictly for monitoring.

## CASCADE CONTROL

The cascade control can control the speed-reference set point. It operates in the same manner as the remote process control. The cascade control contains a deadband comparator.

This compares a 4 to 20 mA process signal with an internal reference signal. If the two signals do not match, the comparator issues raise or lower commands to the speed reference until the error is less than the deadband.

The cascade control also can receive a programmable (optional) droop feedback signal to increase the stability of the turbine/governor system. This is a direct feedback using a portion of the speed control amplifier output.

You can use the cascade input signal for monitoring purposes without utilizing the cascade control function, if desired. You must configure the cascade control function and assign its analog output in the Program Mode (see block diagram, Figure 4). In the Run Mode, the cascade control function must remain disabled when used strictly for monitoring.

## VALVE RAMP CONTROL

The valve ramp control opens and closes the steam valve to aid in starting and shutting down the turbine. The ramp is adjusted through the keypad on the front of the control. External contact closures also allow remote setting of the ramp.

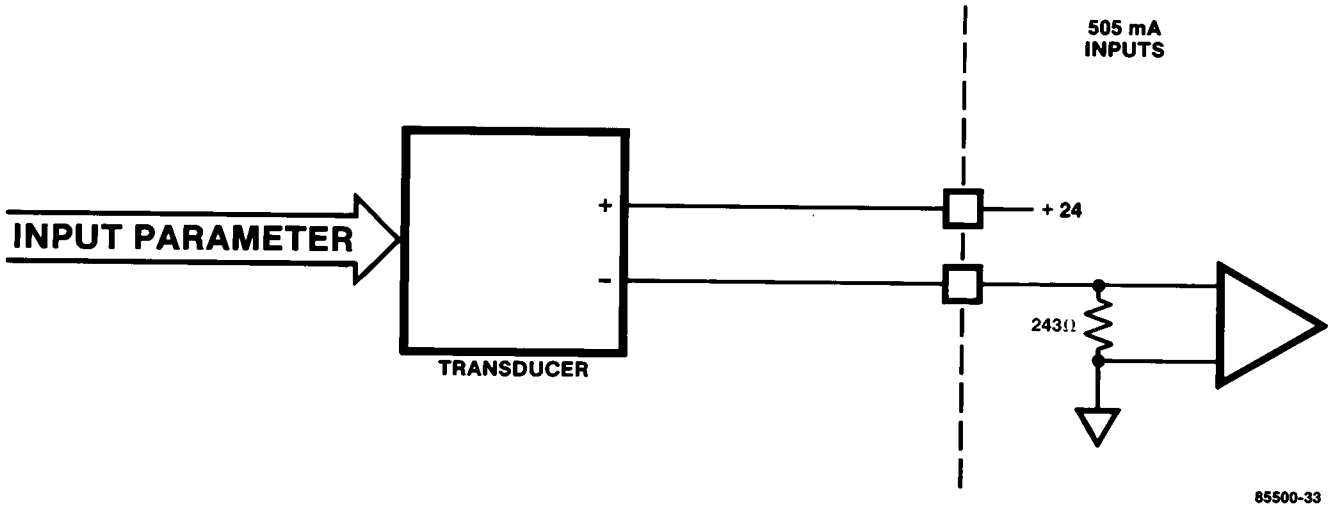



Figure 7. Two-Wire Transducer System

## CRITICAL SPEED AVOIDANCE

In many turbines, it is desirable to avoid certain speeds or speed ranges (or pass through them as quickly as possible) due to excessive turbine vibration or other factors. During 505 programming, you may identify up to two critical speed ranges. These may be any speed ranges below the minimum speed reference that are between idle speed and minimum speed. Within a critical speed range, the 505 control moves the speed reference at the fast rate and does not allow the speed reference to stop within the critical speed range. The operator can change direction of speed-reference movement through a critical speed range by pressing the ADJ down or ADJ up key.

## WATCHDOG TIMER/CPU FAULT CONTROL

A watchdog timer and CPU fault control circuit monitors the operation of the microprocessor and microprocessor memory. The microprocessor resets the watchdog timer every computing cycle. If the microprocessor fails to reset the timer within 30 milliseconds of the last reset, the CPU fault-control circuit initiates a shutdown.

## POWER SUPPLIES

The standard 505 power supply accepts 88 to 132 Vac at 47 to 63 Hz or 90 to 150 Vdc. An optional power supply accepts 18 to 32 Vdc. Either power supply can handle transient input-power losses of approximately 25 milliseconds (about 1.5 cycles at 60 Hz). Input-power losses longer than about 25 milliseconds will result in a shutdown from lost power. Control power consumption is less than 100 watts.

The power supply provides power for the control and for any external transducers. The 505 is designed to supply power to all transducers through a two-wire (ungrounded) system (Figure 7). The only exception is the 4 to 20 mA isolated input from the Woodward Real Power Sensor which has its own internal power supply.

The power supply (either standard or optional) is mounted inside the 505 box. External wiring to the supply is through the terminal block.

# CHAPTER 4
# CONFIGURATION PROCEDURES



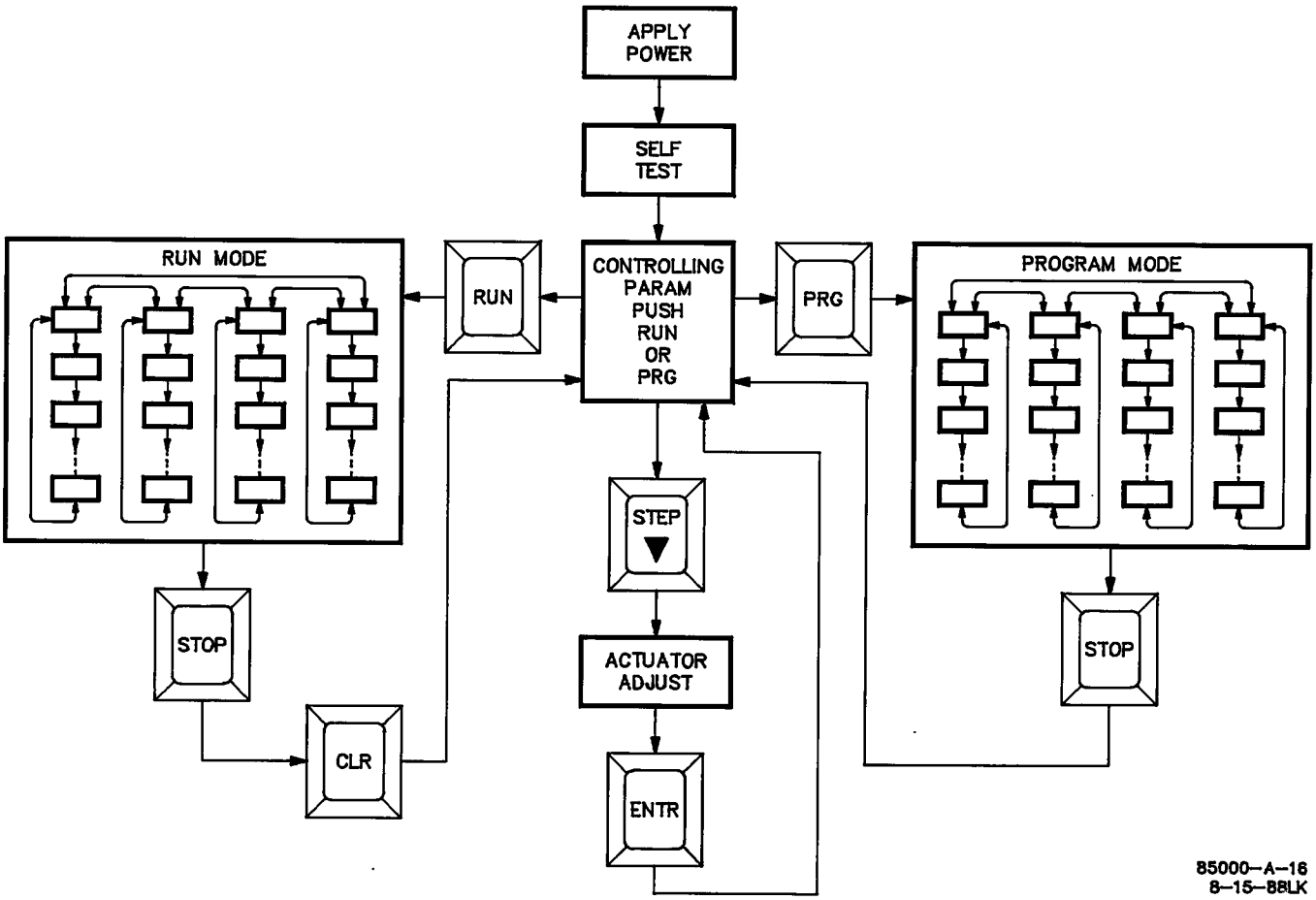



Figure 8. Basic Program Architecture

**PROGRAMMING**

The 505 is easy to program, due in large part to the menu-driven software.

Basic program architecture is illustrated in Figure 8.

When the control is powered up, and after the brief CPU self test has been completed, the control displays a ready status. You can then select either Run Mode or Program Mode.

Initial control procedures are shown in Figure 30.

The operating procedures are divided into two sections:
the Program Mode (Figure 31) and the Run Mode (Figure 32).

Once you have configured (programmed) the control, you may optionally lock out access to the Program Mode by moving the program jumper located inside the control box. To find the jumper, open the box and look at the keypad circuit board on the back of the open door.

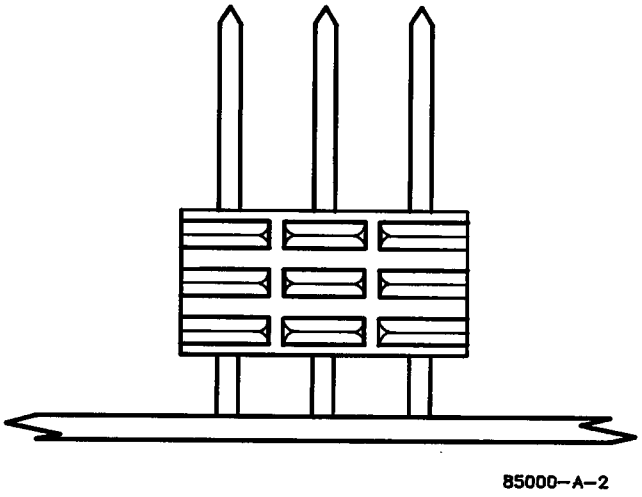



Figure 9. Program Mode Lockout Pins

You will see three small gold pins near the bottom of the keypad circuit board (see Figure 9). To enable access to the Program Mode, clip a metal jumper across all three pins. To disable access to the Program Mode, carefully slide the jumper off and replace it on only two adjacent pins (so it won't be lost). (The two outside pins are the connections for enabling the Program Mode.

The middle pin is not an electrical connection; it only provides a good mechanical connection for storing the jumper when the Program Mode is disabled.)

You cannot access the Program Mode while the turbine is running. This minimizes the possibility of introducing step disturbances into the system.

You can program and run the control using the LCD display and the touch keypad on the front of the control.

The touch keypad has several dual-function keys.

Pushing any dual-function key in the Program Mode enters the appropriate numeric or yes/no value printed on the key. Pushing the key in the Run Mode enters the operating parameter printed on the key.

The function keys (FUNC left, FUNC right) allow you to move right or left across the tops of the function blocks in both the Run and Program Modes.

The STEP up and STEP down keys allow you to move up or down the program columns. In the Program Mode, the control will not step down beyond the current step with an invalid entry (or with no entry). You must make a valid entry before you can step down to the next step.

The control displays previously entered values with each program step. If a displayed value is satisfactory, press the STEP up or STEP down key to continue. If a new value is required, enter it, then press ENTR. You must press the ENTR key to enter any new value. When you press ENTR, the control will automatically advance to the next step.

All steps immediately following a decision step (diamond shaped block in Figure 31) must contain valid entries. There are no default values. If an invalid entry is made, the control displays an invalid entry message. You must press CLR. The control then displays the program step again so a valid entry can be made.

In the Run Mode, functional blocks allow you to display operating parameters, both the actual incoming parameter and the parameter reference.

The functional blocks allow you to change set points or operating points and dynamic adjustments, and to enable or disable the remote process control and the cascade control.

## PROGRAM BLOCKS

Figure 31 shows the 17 program blocks. To program the control, simply step through the blocks as described above to match the control features to your installation. The first five program blocks must be programmed for every installation. The remaining 12 blocks contain optional features which must either be selected or rejected. The 17 blocks and their basic functions are described in detail below. Required Blocks:

1. Turbine Start -- to select manual, automatic, or semiautomatic turbine start-up;

2. Speed Control -- to select MPU information, number and type of actuators, and speed gain and reset;

3. Speed Reference -- to select reference set points and overspeed trip set point;

4. Contact Inputs -- to select desired contact inputs;

5. Shutdown Logic -- to select desired shutdown options.

Optional Blocks:

6. Auxiliary Control -- to select kW control, inlet/exhaust pressure control, or temperature control information.

7. Valve Ramp Control -- to select valve ramp and ramp rate;

8. Droop -- to select droop information;

9. Critical Speeds -- to select critical speed ranges;

10. Idle/Rated -- to select idle and rated set points;

11. Units -- to select desired pressure and temperature units for display;

12. Remote Process -- to select remote process information;

13. Cascade Control -- to select pressure or temperature control information;

14. Relay Output -- to select relay options;

15. Hand Valves -- to select hand valve relay outputs (your application may use other terms for "hand" valves, such as power, steam, or step valves);

16. Analog Readout -- to select analog readout options;

17. RS-232 -- to select RS-232 baud rate.

In each description below, the LCD display is shown first, followed by the action you should take. After you have configured a block, use the FUNC keys to select the next block to configure or check.

All control program questions will display on the top line of the LCD; all entries you make will display on the lower line of the LCD. At the beginning of each block, the control will display (FUNCTION) or (FUNCTION NOT USED) on the second LCD line.

This alerts you that you are at the beginning of a block. (FUNCTION) appears on mandatory program blocks and on any blocks that have already had values entered. (FUNCTION NOT USED) appears on any blocks that have not yet had values entered.

## TURBINE START BLOCK

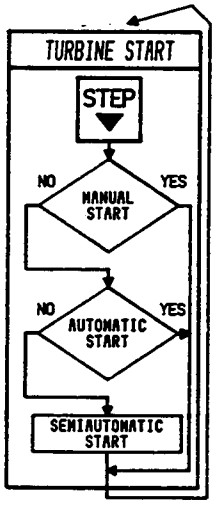



Figure 10. Turbine Start Block

TURBINE START FUNCTION -- When (TURBINE START) (FUNCTION) appears in the LCD display, press the STEP down key to configure this block or press a FUNC key to select another block to configure.

MANUAL START -- Press YES if you want manual start mode or NO if you want another start mode, then press ENTR. If you enter YES, the control will return to the beginning of this program block and display (TURBINE START) (FUNCTION). If you enter NO, the control will display (AUTOMATIC START).

AUTOMATIC START -- Press YES if you want automatic start mode or NO if you want semi-automatic start mode, then press ENTR. If you enter YES, the control will return to the beginning of this program block and display (TURBINE START) (FUNCTION). If you enter NO, the control will display (SEMIAUTOMATIC START).

SEMIAUTOMATIC START -- Press YES, followed by ENTR. The control will now return to the beginning of this program block and display (TURBINE START) (FUNCTION).

**SPEED CONTROL BLOCK**

SPEED CONTROL FUNCTION -- See Figure 11 below. When (SPEED CONTROL) (FUNCTION) appears in the LCD display, press the STEP down key to configure this block or press a FUNC key to select another block to configure.

TEETH SEEN BY MPU -- Enter the number of teeth on the gear being monitored by the magnetic pickup, then press ENTR.

MPU GEAR RATIO -- Enter the gear ratio, then press ENTR. The gear ratio is the result of dividing the speed of the MPU gear by the speed of the turbine shaft.

NUMBER OF MPU USED -- Enter 1 or 2, then press ENTR.

20-160 MA ACTUATOR -- If your actuators are 20-160 mA, press YES, followed by ENTR. If your actuators are 4-20 mA, press NO, followed by ENTR. If you enter YES, the control will display (ACTUATOR DITHER). If you enter NO, the control will display (4-20 MA ACTUATOR).

4-20 MA ACTUATOR -- Press YES, followed by ENTR.

ACTUATOR DITHER -- Press YES if you want actuator dither or NO if you don't want dither, then press ENTR. Dither applies a small, high-frequency signal (20 mA at about 60 Hz) to the actuator to overcome friction in Woodward TM-type actuators for quick response.

USE BOTH ACTUATORS -- Press YES if you are using both actuators or NO if you are using one actuator, then press ENTR. If you enter YES the control will display (ACTUATOR #2 OFFSET). If you enter NO, the control will display (SPEED GAIN).

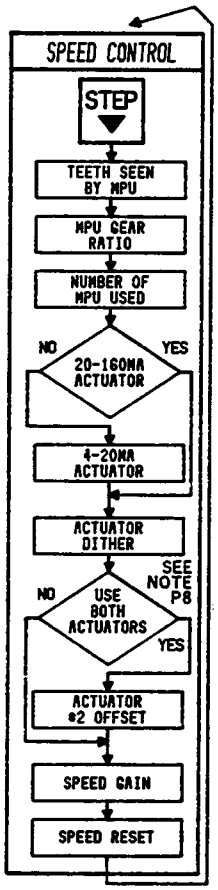



Figure 11. Speed Control Block

ACTUATOR #2 OFFSET -- Enter the percentage that actuator #1 is at when actuator #2 begins to open (if you enter 0, both actuators will open together).

SPEED GAIN -- Enter the gain percentage, then press ENTR. This value can later be changed in the Run Mode while the turbine is operating.

SPEED RESET -- Enter the reset percentage, then press ENTR. This value can later be changed in the Run Mode while the turbine is operating. The control will now return to the beginning of this program block and display (SPEED CONTROL) (FUNCTION).

**SPEED REFERENCE BLOCK**

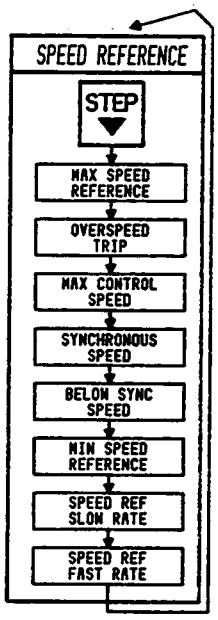



Figure 12. Speed Reference Block

SPEED REFERENCE FUNCTION -- When (SPEED REFERENCE) (FUNCTION) appears in the LCD display, press the STEP down key to configure this block or press a FUNC key to select another block to configure.

MAX SPEED REFERENCE -- Enter the maximum governor operating speed (rpm), then press ENTR.

This value should be greater than the overspeed trip.

OVERSPEED TRIP -- Enter the overspeed trip set point (rpm), then press ENTR. This value should be less than the maximum speed-reference value and less than the mechanical overspeed trip set point.

MAX CONTROL SPEED -- Enter the maximum normal governor controlling speed (rpm), then press ENTR. This value should be less than the overspeed trip value.

SYNCHRONOUS SPEED -- Enter the desired turbine speed (rpm) when the utility tie breaker opens, then press ENTR.

BELOW SYNC SPEED -- Enter the desired turbine speed (rpm) when the generator breaker opens, then press ENTR.

MIN SPEED REFERENCE -- Enter the minimum governor operating speed (rpm), then press ENTR.

SPEED REF SLOW RATE -- Enter the speed reference slow ramp rate (rpm/second), then press ENTR.

SPEED REF FAST RATE -- Enter the speed reference fast ramp rate (rpm/second), then press ENTR. The control will now return to the beginning of this program block and display (SPEED REFERENCE) (FUNCTION).

**CONTACT INPUTS BLOCK**

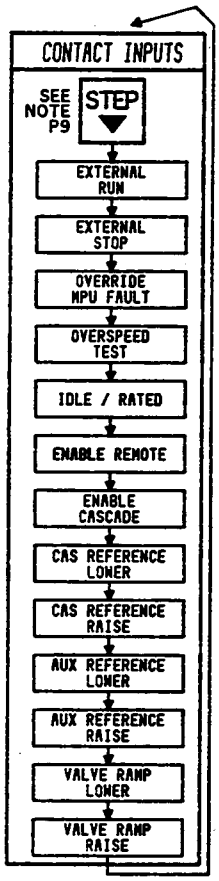



Figure 13. Contact Inputs Block

You may select up to ten contact inputs in addition to the six hardwired contact inputs (see the plant wiring diagram, Figure 2). Enter numbers 1 through 10 for the contact inputs you need. Enter 0/NO for those you don't need. The numbers correspond to the contact input numbers on the plant wiring diagram. The control will tell you if the number is presently being used. You must then select another number or press 0/NO.

CONTACT INPUTS FUNCTION -- When (CONTACT INPUTS) (FUNCTION) appears in the LCD display, press the STEP down key to configure this block or press a FUNC key to select another block to configure.

EXTERNAL RUN -- Enter a number (1 through 10), then press ENTR, if you want this contact input. Press 0/NO, followed by ENTR, if you don't want this contact input. (When closed, the contact initiates the governor's turbine start sequence.)
EXTERNAL STOP -- Enter a number (1 through 10), then press ENTR, if you want this contact input. Press 0/NO, followed by ENTR, if you don't want this contact input. (When closed, the contact initiates a controlled governor shutdown of the turbine.)

OVERRIDE MPU FAULT -- Enter a number (1 through 10), then press ENTR, if you want this contact input. Press 0/NO, followed by ENTR, if you don't want this contact input. (When closed, the contact disables the MPU signal-loss circuitry for turbine start-up. The contact must be open during normal turbine operation.)

OVERSPEED TEST -- Enter a number (1 through 10), then press ENTR, if you want this contact input. Press 0/NO, followed by ENTR, if you don't want this contact input. (When closed, the contact permits the Raise Speed Reference contact or the ADJ up key to raise the speed reference to the overspeed test limit.)

IDLE/RATED -- Enter a number (1 through 10), then press ENTR, if you want this contact input. Press 0/NO, followed by ENTR, if you don't want this contact input. (When closed, the contact selects the rated reference set point. When open, the contact selects the idle reference set point. The reference will ramp to these set points at the idle/rated reference rate. Pressing the ADJ up or ADJ down keys in the Run Mode will stop the reference.)

ENABLE REMOTE -- Enter a number (1 through 10), then press ENTR, if you want this contact input. Press 0/NO, followed by ENTR, if you don't want this contact input. (When closed, the contact enables the remote process control. When open, the contact disables the remote process control.)

ENABLE CASCADE -- Enter a number (1 through 10), then press ENTR, if you want this contact input. Press 0/NO, followed by ENTR, if you don't want this contact input. (When closed, the contact enables the cascade control. When open, the contact disables the cascade control.)

CAS REFERENCE LOWER -- Enter a number (1 through 10), then press ENTR, if you want this contact input. Press 0/NO, followed by ENTR, if you don't want this contact input. (When closed, the contact lowers the cascade reference. Pressing the ADJ up or ADJ down keys in the Run Mode will stop the reference.)

CAS REFERENCE RAISE -- Enter a number (1 through 10), then press ENTR, if you want this contact input. Press 0/NO, followed by ENTR, if you don't want this contact input. (When closed, the contact raises the cascade reference. Pressing the ADJ up or ADJ down keys in the Run Mode will stop the reference.)

AUX REFERENCE LOWER -- Enter a number (1 through 10), then press ENTR, if you want this contact input. Press 0/NO, followed by ENTR, if you don't want this contact input. (When closed, the contact lowers the auxiliary reference. Pressing the ADJ up or ADJ down keys in the Run Mode will stop the reference.)

AUX REFERENCE RAISE -- Enter a number (1 through 10), then press ENTR, if you want this contact input. Press 0/NO, followed by ENTR, if you don't want this contact input. (When closed, the contact raises the auxiliary reference. Pressing the ADJ up or ADJ down keys in the Run Mode will stop the reference.)

VALVE RAMP LOWER -- Enter a number (1 through 10), then press ENTR, if you want this contact input. Press 0/NO, followed by ENTR, if you don't want this contact input. (When closed, the contact lowers/closes the valve ramp. Pressing the ADJ up or ADJ down keys in the Run Mode will stop the ramp.)

VALVE RAMP RAISE -- Enter a number (1 through 10), then press ENTR, if you want this contact input. Press 0/NO, followed by ENTR, if you don't want this contact input. (When closed, the contact raises/opens the valve ramp. Pressing the ADJ up or ADJ down keys in the Run Mode will stop the ramp.) The control will now return to the beginning of this program block and display (CONTACT INPUTS) (FUNCTIONS).

**SHUTDOWN LOGIC BLOCK**

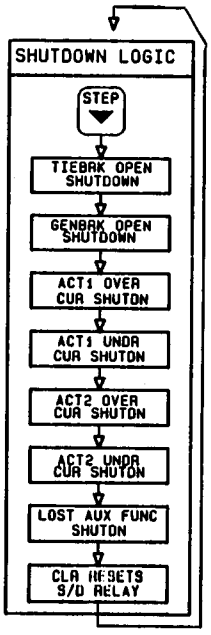



Figure 14. Shutdown Logic Block

SHUTDOWN LOGIC FUNCTION -- When (SHUTDOWN LOGIC) (FUNCTION) appears in the LCD display, press the STEP down key to configure this block or press a FUNC key to select another block to configure.

TIEBRK OPEN SHUTDOWN -- Press YES if you want the control to shut down the turbine if the tie breaker opens. Press NO if you do not want a shutdown on tie breaker opening. Then press ENTR.

GENBRK OPEN SHUTDOWN -- Press YES if you want the control to shut down the turbine if the generator breaker opens. Press NO if you do not want a shutdown on generator breaker opening. Then press ENTR.

ACT1 OVER CUR SHUTDN -- Press YES if you want the control to shut down the turbine on actuator 1 overcurrent. Press NO if you do not want a shutdown on actuator 1 overcurrent. Then press ENTR.

ACT1 UNDR CUR SHUTDN -- Press YES if you want the control to shut down the turbine on an actuator 1 undercurrent. Press NO if you do not want a shutdown on actuator 1 undercurrent. Then press ENTR.

ACT2 OVER CUR SHUTDN -- Press YES if you want the control to shut down the turbine on an actuator 2 overcurrent. Press NO if you do not want a shutdown on actuator 2 overcurrent. Then press ENTR.

ACT2 UNDR CUR SHUTDN -- Press YES if you want the control to shut down the turbine on an actuator 2 undercurrent. Press NO if you do not want a shutdown on actuator 2 undercurrent. Then press ENTR.

LOST AUX FUNC SHUTDN -- Press YES if you want the control to shut down the turbine when if the auxiliary (kW, pressure, or temperature) input is lost. Press NO if you do not want the control to shutdown the turbine on a lost auxiliary input. Then press ENTR. If your control has original software the control will return to the beginning of this program block and display (SHUTDOWN LOGIC) (FUNCTION). If your control has revised software the control will display (CLR RESETS S/D RELAY).

CLR RESETS S/D RELAY --

**NOTE**

The following question should be answered "NO" unless your control is a special case and you are absolutely certain that the question should be answered "YES."

Press NO if you want the shutdown relay to remain de-energized after a shutdown until the Run mode is entered. Press YES if you want the CLR contact to return the shutdown relay to its normally energized state after a shutdown. Then press ENTR. The control will return to the beginning of this program block and display (SHUTDOWN LOGIC) (FUNCTION).

**AUXILIARY CONTROL BLOCK**

AUXILIARY CONTROL FUNCTION -- When (AUXILIARY CONTROL) (FUNCTION) appears in the LCD display, press the STEP down key to select another block to configure.

AUXILIARY CONTROL -- Press YES if you want auxiliary control or NO if you do not want auxiliary control. Then press ENTR. If you enter YES, the control will display (INPUT IS KW). If you enter NO, the control will return to the beginning of this program block and display (AUXILIARY CONTROL) (FUNCTION).

INPUT IS KW -- Press YES if you want the auxiliary function to be kW (load) control or NO if you do not want it to be kW control. Then press ENTR. If you enter YES, the control will display (KW MAX LOAD). If you enter NO, the control will display (INPUT IS PRESSURE).

KW MAX LOAD -- Enter the maximum load (kW) the generator can carry, then press ENTR. This is the same value as the KW MAX LOAD entry in the Droop Block. When you change the entry in one place, the control automatically changes it in the other.

AUX MAX @ 20 MA -- Enter the maximum kW which will correspond to 20 mA input current (the control assumes 4 mA corresponds to zero input). Then press ENTR. This is the same value as the KW MAX LOAD entry in the Droop Block. When you change the entry in one place, the control automatically changes it in the other.

AUX REF LOWER LIMIT -- Enter the desired kW reference lower limit, then press ENTR.

AUX REF UPPER LIMIT -- Enter the desired kW reference upper limit, then press ENTR.

AUX REFERENCE RATE -- Enter the kW reference ramp rate (kW/second), then press ENTR. The control will now display (AUX DROOP).

INPUT IS PRESSURE -- Press YES if you want the auxiliary function to be inlet or exhaust pressure control or NO if you do not want it to be pressure control. Then press ENTR. If you enter YES, the control will display (INVERT AUX INPUT). If you enter NO, the control will display (INPUT IS TEMPERATURE).

INPUT IS TEMPERATURE -- Press YES followed by ENTR.

INVERT AUX INPUT -- When the controlled parameter is inverted, the actuator opens as the input increases. An inversion is normally required when inlet pressure is the controlled parameter.

When the controlled parameter is non-inverted, the actuator closes as the input increases. No inversion is normally required when exhaust pressure is the controlled parameter.

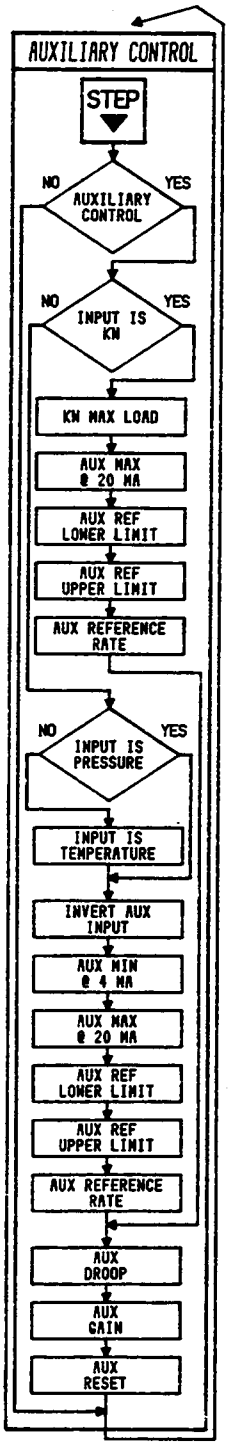



Figure 15. Auxiliary Control Block

Press YES if you want the control to invert the auxiliary input. Press NO if you do NOT want the control to invert the auxiliary input. Then press ENTR.

AUX MIN @ 4 mA -- Enter the minimum auxiliary value (pressure or temperature) which will correspond to 4 mA input current. Then press ENTR.

AUX MAX @ 20 mA -- Enter the maximum auxiliary value (pressure or temperature) which will correspond to 20 mA input current. Then press ENTR.

AUX REF LOWER LIMIT -- Enter the auxiliary reference lower limit (pressure or temperature), then press ENTR.

AUX REF UPPER LIMIT -- Enter the auxiliary reference upper limit (pressure or temperature), then press ENTR.

AUX REFERENCE RATE -- Enter the auxiliary reference ramp rate (units/second), then press ENTR.

AUX DROOP -- Enter the desired auxiliary droop (%), then press ENTR.

AUX GAIN -- Enter the gain percentage, then press ENTR. This value can later be changed in the Run Mode, while the turbine is operating.

AUX RESET -- Enter the reset percentage, then press ENTR. This value can later be changed in the Run Mode, while the turbine is operating. The control will now return to the beginning of this program block and display (AUXILIARY CONTROL) (FUNCTION).

**VALVE RAMP CONTROL BLOCK**

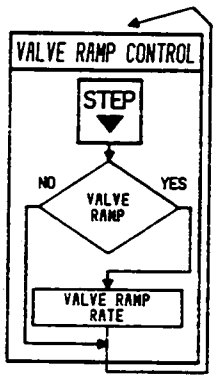



Figure 16. Valve Ramp Control Block

VALVE RAMP CONTROL FUNCTION -- When (VALVE RAMP CONTROL) (FUNCTION) appears in the LCD display, press the STEP down key to configure this block or press a FUNC key to select another block to configure.

VALVE RAMP -- Press YES if you want to use the valve ramp or NO if you do not want a valve ramp. Then press ENTR. If you enter YES, the control will display (VALVE RAMP RATE). If you enter NO, the control will return to the beginning of this program block and display (VALVE RAMP CONTROL) (FUNCTION).

VALVE RAMP RATE -- Enter the valve ramp rate (%/second), then press ENTR.

VALVE RAMP -- Press YES if you want to use the valve ramp or NO if you do not want an valve ramp. Then press ENTR. If you enter YES, the control will display (VALVE RAMP RATE). If you enter NO, the control will return to the beginning of this program block and display (VALVE RAMP CONTROL) (FUNCTION).

VALVE RAMP RATE -- Enter the valve ramp rate (%/second), then press ENTR. The control will return to the beginning of this program block and display (VALVE RAMP CONTROL) (FUNCTION).

NOTE

Information in the following "DROOP BLOCK" applies only to revised software. See Introduction Section of this manual. If your control has original software, refer to Appendix B for information on the "DROOP BLOCK".

If the droop block is going to be used, synchronous speed must be greater than zero.

**DROOP BLOCK**

DROOP FUNCTION -- When (DROOP) (FUNCTION) appears in the LCD display, press the STEP down key to configure this block or press a FUNC key to select another block to configure.

SPEED DROOP -- Press YES if you want speed droop or NO if you do not want speed droop. Then press ENTR. If you enter YES, the control will display (SPEED DROOP). If you enter NO, the control will display (KW DROOP).

SPEED DROOP -- Enter the desired speed droop (%), then press ENTR. The control will now display (DROOP/ISOCH SWITCH).

KW DROOP -- Press YES if you want kW droop or NO if you do not want kW droop. Then press ENTR. If you enter YES, the control will display (KW MAX LOAD). If you enter NO, the control will return to the beginning of this program block and display (DROOP) (FUNCTION).

KW MAX LOAD -- Enter the maximum load (kW) the generator can carry, then press ENTR. This is the same value as the KW MAX LOAD entry in the Auxiliary Control Block. When you change the entry in one place, the control automatically changes it in the other.

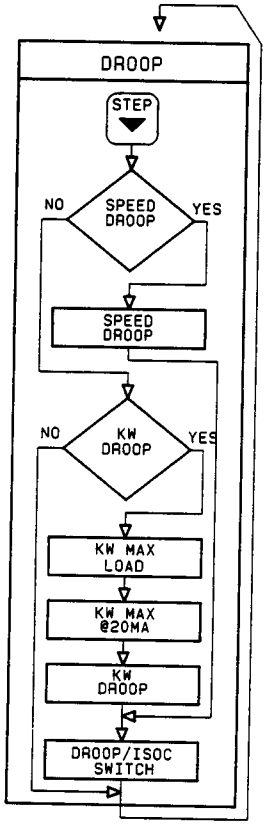



Figure 17. Droop Block

KW MAX @ 20 MA -- Enter the maximum kW which will correspond to 20 mA input current (the control assumes 4 mA corresponds to zero input). Then press ENTR. This is the same value as the AUX MAX @ 20 MA entry in the Auxiliary Control Block. When you change the entry in one place, the control automatically changes it in the other.

KW DROOP -- Enter the desired kW droop (%), then press ENTR.

DROOP/ISOCH SWITCH -- Press YES if you want the control to run in droop when the utility tie breaker is closed and in isochronous when the utility tie breaker is open. Press NO if you want the control to run in droop at all times. Press ENTR. Control will now return to the beginning of this program block and display (DROOP) (FUNCTION).

## CRITICAL SPEEDS BLOCK

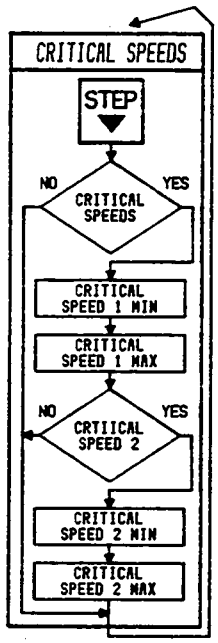



Figure 18. Critical Speeds Block

CRITICAL SPEEDS FUNCTION -- When (CRITICAL SPEEDS) (FUNCTION) appears in the LCD display, press the STEP down key to configure this block or press a FUNC key to select another block to configure.

CRITICAL SPEEDS -- Press YES if you want to select one or two critical speed ranges or NO if you do not want this function. Then press ENTR.

If you enter YES, the control will display (CRITICAL SPEED 1 MIN). If you enter NO, the control will return to the beginning of this program block and display (CRITICAL SPEEDS) (FUNCTION).

CRITICAL SPEED 1 MIN -- Enter the lower value for the first critical speed range (rpm), then press ENTR. This value must be greater than or equal to the idle speed.

CRITICAL SPEED 1 MAX -- Enter the upper value for the first critical speed range (rpm), then press ENTR. This value must be less than the (MIN SPEED REFERENCE).

CRITICAL SPEED 2 -- Press YES if you want a second critical speed range or NO if you do not want a second range. Then press ENTR. If you enter YES, the control will display (CRITICAL SPEED 2 MIN). If you enter NO, the control will return to the beginning of this program block and display (CRITICAL SPEEDS) (FUNCTION).

CRITICAL SPEED 2 MIN -- Enter the lower value for the second critical speed range (rpm), then press ENTR. This value must be greater than the idle speed.

CRITICAL SPEED 2 MAX -- Enter the upper value for the second critical speed range (rpm), then press ENTR. This value must be less than (MIN SPEED REFERENCE). The control will now return to the beginning of this program block and display (CRITICAL SPEEDS) (FUNCTION).

**IDLE/RATED BLOCK**

IDLE/RATED FUNCTION -- When (IDLE/RATED) (FUNCTION) appears in the LCD display, press the STEP down key to configure this block or press a FUNC key to select another block to configure.

IDLE/RATED -- Press YES if you want the idle/rated function or NO if you do not want the function. Then press ENTR. If you enter YES, the control will display (IDLE SPEED). If you enter NO, the control will return to the beginning of this program block and display (IDLE/RATED) (FUNCTION).

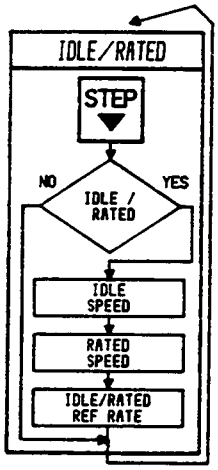



Figure 19. Idle/Rated Block

IDLE SPEED -- Enter the turbine idle speed (rpm), then press ENTR. This value must be less than lowest critical speed minimum.

RATED SPEED -- Enter the turbine rated speed (rpm), then press ENTR. This value must be greater than or equal to the minimum speed reference.

IDLE/RATED REF RATE -- Enter the idle/rated reference ramp rate (rpm/second), then press ENTR. The control will now return to the beginning of this program block and display (IDLE/RATED) (FUNCTION).

## UNITS BLOCK

Default units for pressure and temperature are psi (pounds per square inch) and degrees C (degrees Celsius).

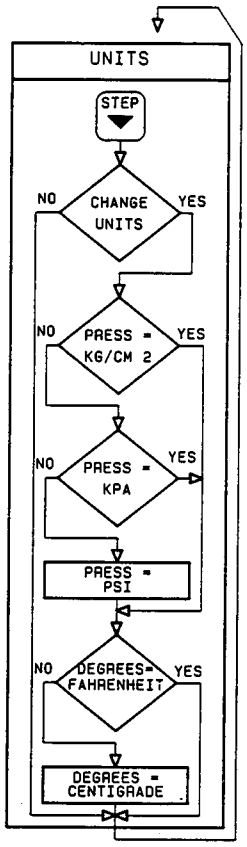



Figure 20. Units Block

UNITS FUNCTION -- When (UNITS) (FUNCTION) appears in the LCD display, press the STEP down key to configure this block or press a FUNC key to select another block to configure.

CHANGE UNITS -- Press YES if you want to change units for pressure or temperature. Press NO if you do not want to change units. Then press ENTR. If you enter YES, the control will display (PRESS = KGF/CM**2). If you enter NO, the control will return to the beginning of this program block and display (UNITS) (FUNCTION).

PRESS = KGF/CM**2 -- Press YES if you want the control to display pressure in kilograms (force) per square centimeter or NO if you want another option. Then press ENTR. If you enter YES, the control will display (TEMP = degrees F) If you enter NO, the control will display (PRESS = KPA).

PRESS = KPA -- Press YES if you want the control to display pressure in kilopascals or NO if you want another option. Then press ENTR. If you enter YES, the control will display (TEMP = degrees F). If you enter NO, the control will display (PRESS = PSI).

PRESS = PSI -- Press YES, followed by ENTR.

TEMP = ° F -- Press YES if you want the control to display temperature in degrees Fahrenheit or NO if you want another option. Then press ENTR. If you enter YES, the control will return to the beginning of this program block and display (UNITS) (FUNCTION). If you enter NO, the control will display (TEMP = ° C).

TEMP = ° C -- Press YES, followed by ENTR. The control will now return to the beginning of this program block and display (UNITS) (FUNCTION).

**REMOTE PROCESS BLOCK**

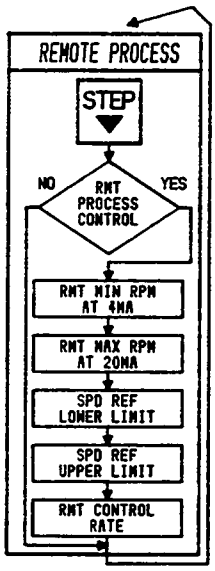



Figure 21. Remote Process Block

REMOTE PROCESS FUNCTION -- When (REMOTE PROCESS) (FUNCTION) appears in the LCD display, press the STEP down key to configure this block or press a FUNC key to select another block to configure.

RMT PROCESS CONTROL -- Press YES if you want remote process control or NO if you do not want remote process control. If you enter YES, the control will display (RMT MIN RPM AT 4MA). If you enter NO, the control will return to the beginning of this program block and display (REMOTE PROCESS) (FUNCTION).

RMT MIN RPM AT 4MA -- Enter the minimum rpm which corresponds to the 4 mA input signal from the remote process controller, then press ENTR.

RMT MAX RPM AT 20MA -- Enter the maximum rpm which corresponds to the 20 mA input signal from the remote process controller, then press ENTR.

SPD REF LOWER LIMIT -- Enter the minimum speed reference in rpm which you want to correspond to the remote lower limit, then press ENTR. This value must be greater than or equal to (MIN SPEED REFERENCE).

SPD REF UPPER LIMIT -- Enter the maximum speed reference in rpm which you want to correspond to the remote upper limit, then press ENTR. This value must be less than or equal to the (MAX CONTROL SPEED).

RMT CONTROL RATE -- Enter the ramp rate at which the remote control will raise or lower the speed reference (rpm/second), then press ENTR. The control will now return to the beginning of this program block and display (REMOTE PROCESS) (FUNCTION).

**CASCADE CONTROL BLOCK**

CASCADE CONTROL FUNCTION -- When (CASCADE CONTROL) (FUNCTION) appears in the LCD display, press the STEP down key to configure this block or press a FUNC key to select another block to configure.

CASCADE CONTROL -- Press YES if you want cascade control or NO if you do not want cascade control. Then press ENTR. If you enter YES, the control will display (INPUT IS PRESSURE). If you enter NO, the control will return to the beginning of this program block and display (CASCADE CONTROL) (FUNCTION).

INPUT IS PRESSURE -- Press YES if you want the cascade function to be pressure control or NO if you do not want it to be pressure control. Then press ENTR. If you enter YES, the control will display (INVERT CAS INPUT). If you enter NO, the control will display (INPUT IS TEMP).
INPUT IS TEMP -- Press YES, followed by ENTR.

INVERT CAS INPUT -- When the controlled parameter is inverted, the actuator opens as the input increases. An inversion is normally required when inlet pressure is the controlled parameter.

When the controlled parameter is non-inverted the actuator closes as the input increases. No inversion is normally required when exhaust pressure is the controlled parameter.

Press YES if you want the control to invert the cascade input, or press NO if you do not want the control to invert the cascade input. Then press ENTR. (The input would normally need to be inverted for inlet pressure control.)

CAS MIN @ 4 MA -- Enter the minimum cascade value (pressure, temperature) which will correspond to 4 mA input current. Then press ENTR.

CAS MAX @ 20 MA -- Enter the maximum cascade value (pressure, temperature) which will correspond to 20 mA input current. Then press ENTR.

CAS REF LOWER LIMIT -- Enter the desired cascade reference lower limit (pressure, temperature), then press ENTR.

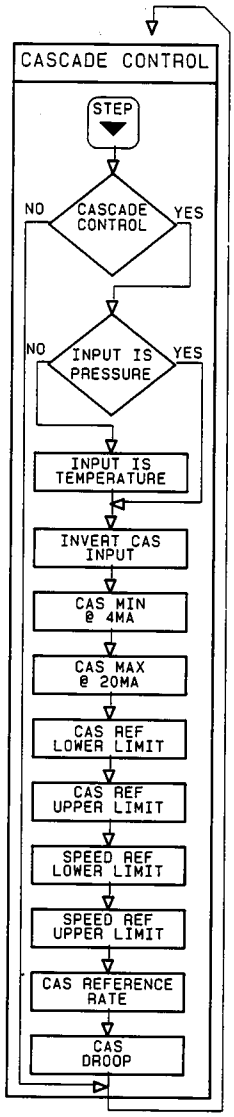



Figure 22. Cascade Control Block

CAS REF UPPER LIMIT -- Enter the desired cascade reference upper limit (pressure, temperature), then press ENTR.

SPD REF LOWER LIMIT -- Enter the minimum speed reference rpm which you want to correspond to the cascade lower limit, then press ENTR. This value must be greater than or equal to the minimum speed reference speed.

SPD REF UPPER LIMIT -- Enter the maximum speed reference rpm which you want to correspond to the cascade upper limit, then press ENTR. This value must be less than or equal to the maximum control speed.

CAS REFERENCE RATE -- Enter the cascade reference ramp rate (units/second), then press ENTR.

CAS DROOP -- Enter the desired cascade droop (%), then press ENTR. The control will now return to the beginning of this program block and display (CASCADE CONTROL) (FUNCTION).

**NOTE**

Information in the following "RELAY OUTPUT BLOCK" applies only to revised software. See Introduction Section of this manual. If your control has original software, refer to Appendix B for information on the "RELAY OUTPUT BLOCK."

**RELAY OUTPUT BLOCK**

Three relay outputs are always provided by the control (Alarm, Electrical Overspeed Trip, and Shutdown). In addition, you may select up to five more (optional) relay outputs. Enter numbers 1 through 5 for the relay outputs you need. Enter 0/NO for those you don't need. The numbers correspond to the relay numbers on the plant wiring diagram (see Figure 2). The control will tell you if the number is presently being used. You must then select another number or press 0/NO.

Seven of the optional relays are contained in this block (Relay Output), and four more are contained in the next block (Hand Valves). The relay numbers can be used only once in either block.

RELAY OUTPUT FUNCTION -- When (RELAY OUTPUT) (FUNCTION) appears in the LCD display, press the STEP down key to configure this block or press a FUNC key to select another block to configure.

RELAY OUTPUT -- Press YES if you want optional relay outputs or 0/NO if you do not want any optional relay outputs. Then press ENTR. If you enter YES, the control will display (SPEED REF MAX RELAY). If you enter 0/NO, the control will return to the beginning of this program block and display (RELAY OUTPUT) (FUNCTION).

SPD AT MAX REF RELAY -- Enter a number (1 through 5), then press ENTR, if you want this relay. Press 0/NO, followed by ENTR, if you don't want this relay. (The relay energizes when the speed reference is at maximum.)

SPEED SWITCH 1 RELAY -- Enter a number (1 through 5), then press ENTR, if you want this relay. Press 0/NO, followed by ENTR, if you don't want this relay. (The relay energizes when turbine speed is at or above the set point for speed switch 1.) If you select this relay, the control will display (SPEED SWITCH 1 RPM). If you enter 0/NO, the control will display (SPEED SWITCH 2 RELAY).

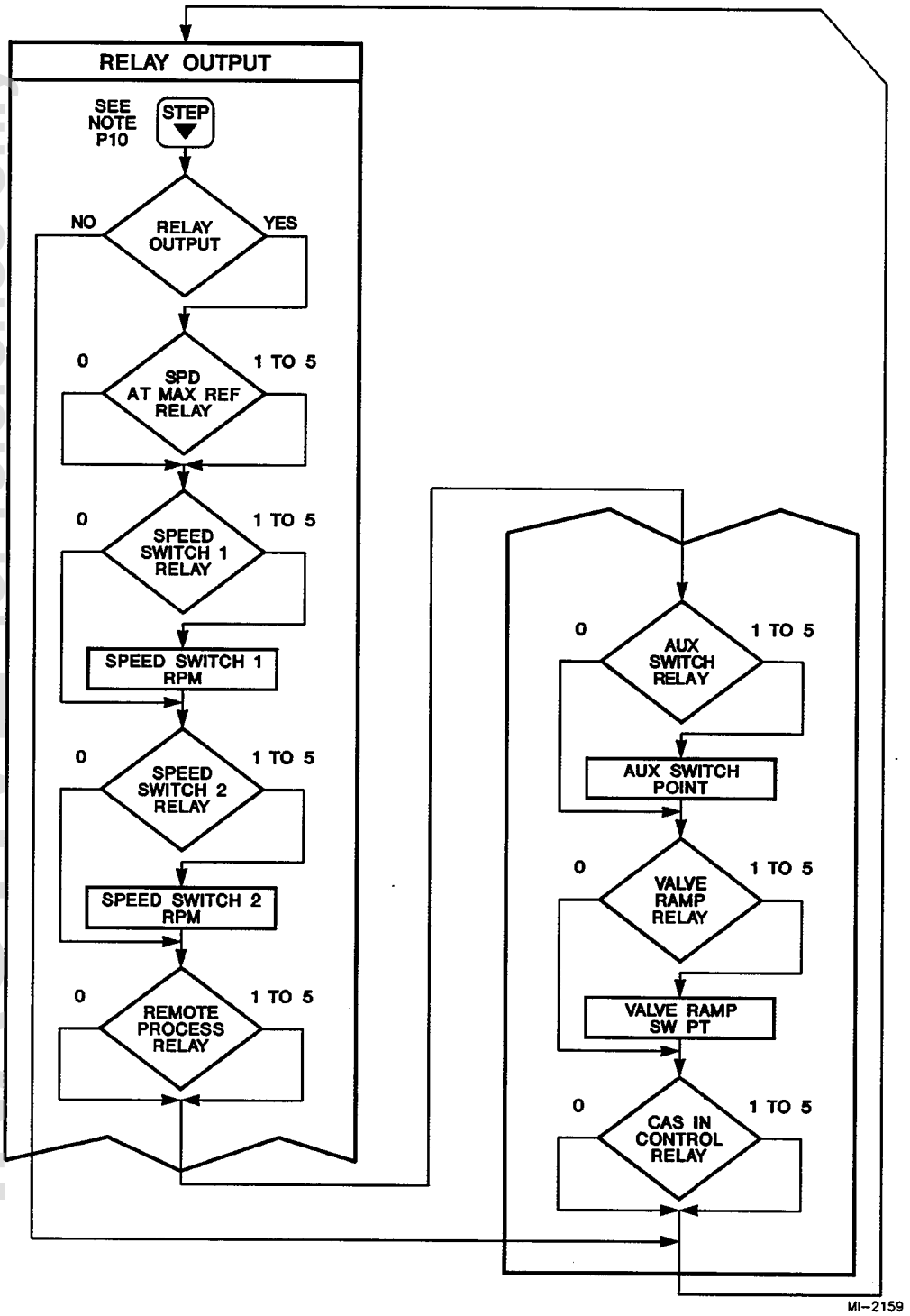



Figure 23. Relay Output Block

SPEED SWITCH 1 RPM -- Enter the speed set point for speed switch 1 (rpm), then press ENTR.

SPEED SWITCH 2 RELAY -- Enter a number (1 through 5), then press ENTR, if you want this relay. Press 0/NO, followed by ENTR, if you don't want this relay. (The relay energizes when turbine speed is at or above the set point for speed switch 2.) If you select this relay, the control will display (SPEED SWITCH 2 RPM). If you enter 0/NO, the control will display (REMOTE PROCESS RELAY).

SPEED SWITCH 2 RPM -- Enter the speed set point for speed switch 2 (rpm), then press ENTR.
REMOTE PROCESS RELAY -- Enter a number (1 through 5), then press ENTR, if you want this relay. Press 0/NO, followed by ENTR, if you don't want this relay. (The relay energizes when the remote process control is in control of the speed reference.)

AUX SWITCH RELAY -- Enter a number (1 through 5), then press ENTR, if you want this relay. Press 0/NO, followed by ENTR, if you don't want this relay. (The relay energizes when the auxiliary input is at or above the auxiliary switch set point). If you select this relay, the control will display (AUX SWITCH POINT). If you enter 0/NO, the control will display (VALVE RAMP RELAY).

AUX SWITCH POINT -- Enter the auxiliary switch set point (kW, pressure, or temperature), then press ENTR.

VALVE RAMP RELAY -- Enter a number (1 through 5), then press ENTR, if you want this relay. Press 0/NO, followed by ENTR, if you don't want this relay. (The relay energizes when the valve ramp is at or above the valve ramp switch point.) If you select this relay, the control will display (VALVE RAMP SW POINT). If you enter 0/NO, the control will display (CAS IN CONTROL RELAY).

VALVE RAMP SW POINT -- Enter the valve ramp switch point (%), then press ENTR. The control will display (CAS IN CONTROL RELAY).

CAS IN CONTROL RELAY -- Enter a number 1 through 5, then press ENTR, if you want this relay. Press 0/NO, followed by ENTR, if you don't want this relay. (The relay energizes when the cascade control is in control of the speed reference). The control will now return to the beginning of this program block and display (RELAY OUTPUT) (FUNCTION).

## HAND VALVES BLOCK

See the two paragraphs at the beginning of the previous block (Relay Output).

Your application may use other terms for "hand" valves, such as power or steam valves. Some manufacturers refer to them as part-load or dual-steam hand valves. These valves increase turbine efficiency by providing steam to additional input nozzles of turbine at selected levels of actuator current. Hand valve relays energize at a certain percentage of actuator position (hand valve open) and de-energizes at another percentage of actuator position (hand valve close).

If your turbine does not use hand valves as described above, the hand valve block may be used to operate case drain valves or other valves that are required to operate as a function of actuator position (steam flow).

HAND VALVES FUNCTION -- When (HAND VALVES) (FUNCTION) appears in the LCD display, press the STEP down key to configure this block or press a FUNC key to select another block to configure.

HAND STEAM VALVE -- Press YES if you want optional hand steam valve relay outputs or 0/NO if you do not want any hand steam valve relay outputs. Then press ENTR. If you enter YES, the control will display (HAND VALVE 1 RELAY). If you enter NO, the control will return to the beginning of this program block and display (HAND VALVES) (FUNCTION).

HAND VALVE 1 RELAY -- Enter a number (1 through 5), then press ENTR, if you want this relay. Press NO, followed by ENTR, if you don't want this relay. (The relay energizes at a selected percentage of actuator position and de-energizes at another selected percentage of actuator position.) If you select this relay, the control will display (HAND VALVE 1 OPEN). If you enter NO, the control will display (HAND VALVE 2 RELAY).

HAND VALVE 1 OPEN -- Enter the percentage of actuator travel at which you wish the Hand Valve 1 relay to energize.

HAND VALVE 1 CLOSE -- Enter the percentage of actuator travel at which you wish the Hand Valve 1 relay to de-energize. This must be less than or equal to the value for HAND VALVE 1 OPEN.

HAND VALVE 2 RELAY -- Enter a number (1 through 5), then press ENTR, if you want this relay. Press NO, followed by ENTR, if you don't want this relay. (The relay energizes at a selected percentage of actuator position and de-energizes at another selected percentage of actuator position.) If you select this relay, the control will display (HAND VALVE 2 OPEN). If you enter NO, the control will display (HAND VALVE 3 RELAY).

HAND VALVE 2 OPEN -- Enter the percentage of actuator travel at which you wish the Hand Valve 2 relay to energize.

HAND VALVE 2 CLOSE -- Enter the percentage of actuator travel at which you wish the Hand Valve 2 relay to de-energize. This must be less than or equal to the value for HAND VALVE 2 OPEN.

HAND VALVE 3 RELAY -- Enter a number (1 through 5), then press ENTR, if you want this relay. Press NO, followed by ENTR, if you don't want this relay. (The relay energizes at a selected percentage of actuator position and de-energizes at another selected percentage of actuator position.) If you select this relay, the control will display (HAND VALVE 3 OPEN). If you enter NO, the control will display (HAND VALVE 4 RELAY).

HAND VALVE 3 OPEN -- Enter the percentage of actuator travel at which you wish the Hand Valve 3 relay to energize.

HAND VALVE 3 CLOSE -- Enter the percentage of actuator travel at which you wish the Hand Valve 3 relay to de-energize. This must be less than or equal to the value for HAND VALVE 3 OPEN.

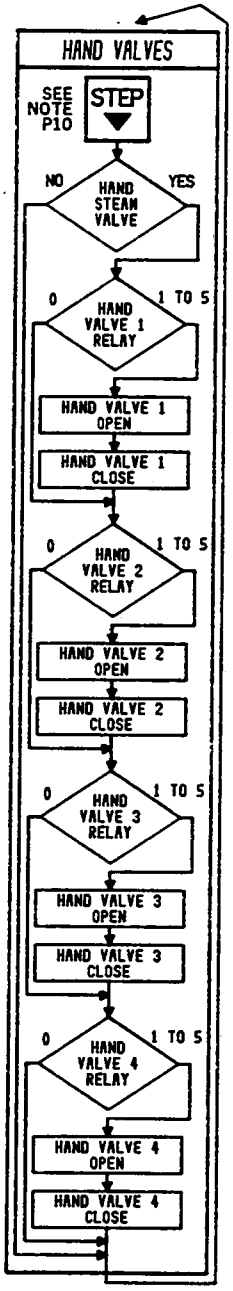



Figure 24. Hand Valves Block

HAND VALVE 4 RELAY -- Enter a number (1 through 5), then press ENTR, if you want this relay. Press NO, followed by ENTR, if you don't want this relay. (The relay energizes at a selected percentage of actuator position and de-energizes at another selected percentage of actuator position.) If you select this relay, the control will display (HAND VALVE 4 OPEN). If you enter NO, the control will return to the beginning of this program block and display (HAND VALVES) (FUNCTION).

HAND VALVE 4 OPEN -- Enter the percentage of actuator travel at which you wish the Hand Valve 4 relay to energize.

HAND VALVE 4 CLOSE -- Enter the percentage of actuator travel at which you wish the Hand Valve 4 relay to de-energize. This must be less than or equal to the value for HAND VALVE 4 OPEN. The control will now return to the beginning of this program block and display (HAND VALVES) (FUNCTION).

### ANALOG READOUT BLOCK

You may select up to four analog readouts. Enter numbers 1 through 4 for the analog readouts you need. Enter 0/NO for those you don't need. The numbers correspond to the readout numbers on the plant wiring diagram (see Figure 2). The control will tell you if the number is presently being used. You must then select another number or press 0/NO. All readouts are 4 to 20 mA, where 4 mA corresponds to the minimum value and 20 mA corresponds to the maximum value.

ANALOG READOUT FUNCTION -- When (ANALOG READOUT) (FUNCTION) appears in the LCD display, press the STEP down key to configure this block or press a FUNC key to select another block to configure.

ANALOG READOUT -- Press YES if you want optional analog readouts or 0/NO if you do not want any analog readouts. Then press ENTR. If you enter YES, the control will display (SPEED INPUT READOUT). If you enter NO, the control will return to the beginning of this program block and display (ANALOG READOUT) (FUNCTION).

SPEED INPUT READOUT -- Enter a number (1 through 4), then press ENTR, if you want this readout. Press NO, followed by ENTR, if you don't want this readout. If you enter YES, the control will display (SPEED MIN RPM @ 4 MA). If you enter NO, the control will display (SPEED REFERENCE READOUT).

SPEED MIN RPM @ 4 MA -- Enter the minimum input speed (rpm) which corresponds to 4 mA readout.

SPEED MAX RPM @ 20 MA -- Enter the maximum input speed (rpm) which corresponds to 20 mA readout.

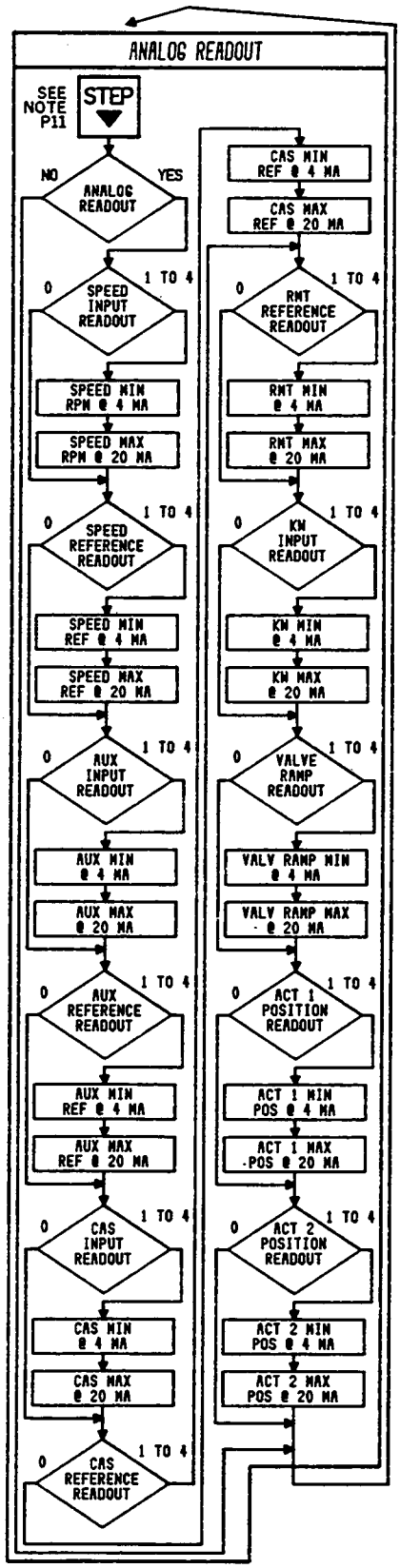



Figure 25. Analog Readout Block

SPEED REFERENCE READOUT -- Enter a number (1 through 4), then press ENTR, if you want this readout. Press NO, followed by ENTR, if you don't want this readout. If you enter YES, the control will display (SPEED MIN REF @ 4 MA). If you enter NO, the control will display (AUX INPUT READOUT).

SPEED MIN REF @ 4 MA -- Enter the minimum speed reference set point (rpm) which corresponds to 4 mA readout.

SPEED MAX REF @ 20 MA -- Enter the maximum speed reference set point (rpm) which corresponds to 20 mA readout.

AUX INPUT READOUT -- Enter a number (1 through 4), then press ENTR, if you want this readout. Press NO, followed by ENTR, if you don't want this readout. If you enter YES, the control will display (AUX MIN @ 4 MA). If you enter NO, the control will display (AUX REFERENCE READOUT).

AUX MIN @ 4 MA -- Enter the minimum auxiliary input (kW, pressure, or temperature) which corresponds to 4 mA readout.

AUX MAX @ 20 MA -- Enter the maximum auxiliary input (kW, pressure, or temperature) which corresponds to 20 mA readout.

AUX REFERENCE READOUT -- Enter a number (1 through 4), then press ENTR, if you want this readout. Press NO, followed by ENTR, if you don't want this readout. If you enter YES, the control will display (AUX MIN REF @ 4 MA). If you enter NO, the control will display (CAS INPUT READOUT).

AUX MIN REF @ 4 MA -- Enter the minimum auxiliary reference set point which corresponds to 4 mA readout.

AUX MAX REF @ 20 MA -- Enter the maximum auxiliary reference set point which corresponds to 20 mA readout.

CAS INPUT READOUT -- Enter a number (1 through 4), then press ENTR, if you want this readout. Press NO, followed by ENTR, if you don't want this readout. If you enter YES, the control will display (CAS MIN @ 4 MA). If you enter NO, the control will display (CAS REFERENCE READOUT).

CAS MIN @ 4 MA -- Enter the minimum cascade input (pressure, temperature) which corresponds to 4 mA readout.

CAS MAX @ 20 MA -- Enter the maximum cascade input (pressure, temperature) which corresponds to 20 mA readout.

CAS REFERENCE READOUT -- Enter a number (1 through 4), then press ENTR, if you want this readout. Press NO, followed by ENTR, if you don't want this readout. If you enter YES, the control will display (CAS MIN REF @ 4 MA). If you enter NO, the control will display (RMT REFERENCE READOUT).

CAS MIN REF @ 4 MA -- Enter the minimum cascade reference set point (pressure, temperature) which corresponds to 4 mA readout.

CAS MAX REF @ 20 MA -- Enter the maximum cascade reference set point (pressure, temperature) which corresponds to 20 mA readout.

RMT REFERENCE READOUT -- Enter a number (1 through 4), then press ENTR, if you want this readout. Press NO, followed by ENTR, if you don't want this readout. If you enter YES, the control will display (RMT MIN @ 4 MA). If you enter NO, the control will display (KW INPUT READOUT).

RMT MIN @ 4 MA -- Enter the minimum remote process input (rpm) which corresponds to 4 mA readout.

RMT MAX @ 20 MA -- Enter the maximum remote process input (rpm) which corresponds to 20 mA readout.

KW INPUT READOUT -- Enter a number (1 through 4), then press ENTR, if you want this readout. Press NO, followed by ENTR, if you don't want this readout. If you enter YES, the control will display (KW MIN @ 4 MA). If you enter NO, the control will display (VALV RAMP READOUT).

KW MIN @ 4 MA -- Enter the minimum kW (load) input which corresponds to 4 mA readout.

KW MAX @ 20 MA -- Enter the maximum kW (load) input which corresponds to 20 mA readout.

VALV RAMP READOUT -- Enter a number (1 through 4), then press ENTR, if you want this readout. Press NO, followed by ENTR, if you don't want this readout. If you enter YES, the control will display (VALV RAMP MIN @ 4 MA). If you enter NO, the control will display (VALV RAMP READOUT).

VALV RAMP MIN @ 4 MA -- Enter the minimum valve ramp position (%) which corresponds to 4 mA readout.

VALV RAMP MAX @ 20 MA -- Enter the maximum valve ramp position (%) which corresponds to 20 mA readout.

ACT 1 POS READOUT -- Enter a number (1 through 4), then press ENTR, if you want this readout. Press NO, followed by ENTR, if you don't want this readout. Use actuator 1 if you only have one actuator. If you enter YES, the control will display (ACT 1 MIN POS @ 4 MA). If you enter NO, the control will display (ACT 2 POS READOUT).

ACT 1 MIN POS @ 4 MA -- Enter the minimum actuator position (%) which corresponds to 4 mA readout. Use actuator 1 if you only have one actuator.

ACT 1 MAX POS @ 20 MA -- Enter the maximum actuator 1 position (%) which corresponds to 20 mA readout. Use actuator 1 if you only have one actuator.

ACT 2 POS READOUT -- Enter a number (1 through 4), then press ENTR, if you want this readout. Press NO, followed by ENTR, if you don't want this readout. If you enter YES, the control will display (ACT 2 MIN POS @ 4 MA). If you enter NO, the control will return to the beginning of this program block and display (ANALOG READOUT) FUNCTION).

ACT 2 MIN POS @ 4 MA -- Enter the minimum actuator position (%) which corresponds to 4 mA readout.

ACT 2 MAX POS @ 20 MA -- Enter the maximum actuator position (%) which corresponds to 20 mA readout. The control will return to the beginning of this program block and display (ANALOG READOUT) FUNCTION).

**RS-232 BLOCK**

RS-232 FUNCTION -- When (RS-232) (FUNCTION) appears in the LCD display, press the STEP down key to configure this block or press a FUNC key to select another block to configure.

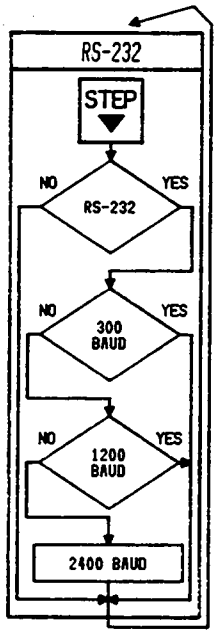



Figure 26. RS-232 Block

RS-232 -- Press YES if you want to use the RS-232 communication line or NO if you do not want to use the RS-232, then press ENTR. If you enter YES, the control will display (300 BAUD). If you enter NO, the control will return to the beginning of this program block and display (RS-232) (FUNCTION).

300 BAUD -- Press YES if you want to operate the RS-232 line at 300 baud or NO if you want another baud rate, then press ENTR. If you enter YES, the control will return to the beginning of this program block and display (RS-232) (FUNCTION). If you enter NO, the control will display (1200 BAUD).
1200 BAUD -- Press YES if you want to operate the RS-232 line at 1200 baud or NO if you want another baud rate, then press ENTR. If you enter YES, the control will return to the beginning of this program block and display (RS-232) (FUNCTION). If you enter NO, the control will display (2400 BAUD).

2400 BAUD -- Press YES, followed by ENTR. The control will now return to the beginning of this program block and display (RS-232) (FUNCTION).

## PROGRAM CONFIGURATION COMPLETENESS CHECK

After the program is configured, push STOP to exit the Program Mode. The control then automatically performs a completeness check on the configured program to assure that required program blocks have values loaded into them. This check cannot determine if the values entered are realistic, but it makes sure that values have been loaded into required blocks. After the completeness check is finished, the control returns to the ready status and displays (CONTROLLING PARAM) (PUSH RUN OR PRG). This occurs almost instantly, unless an error is found.

One error message alerts you that additional information is required before the configured program can operate the turbine.

The control displays the message (INCOMPLETE PRG) (PUSH CLR KEY). Pushing the CLR key causes the control to display the Program Mode step that requires more information. You must enter the additional information, then attempt to exit the Program Mode by pushing STOP. The completeness check will continue to fail until the control is satisfied that the configured program is complete.

Another error message ties the automatic or semi-automatic start together with the need to have the Valve Ramp Control block configured. If automatic or semiautomatic start is selected, the valve ramp control must be configured. If it has not been configured, the control displays the message (START/VRAMP ERROR) (PUSH CLR KEY). Pushing the CLR key causes the control to display the beginning of the Turbine Start function block. You must then review the starting procedure.

The last two error messages deal with critical speed ranges. Control logic does not permit the idle speed to exist within a critical speed range. If idle is greater than a minimum critical speed, the control displays the message (IDLE = to CRIT MIN) (PUSH CLR KEY). Pushing the CLR key causes the control to display the (CRITICAL SPEEDS) message. You also may wish to review the critical speed ranges selected.

Control logic also prevents a critical speed from being above the minimum control speed. The secondary speed-setting functions, the remote process control, and the cascade control operate within a range defined by the minimum and maximum control speeds. The maximum control speed must be less than the maximum speed reference and overspeed trip settings. This prevents the secondary speed-setting functions from attempting to operate within a critical speed range. If a critical speed is found above the minimum control speed, the control displays the message (CRIT SPD = MIN SPD) (PUSH CLR KEY). Pushing the CLR key causes the control to display the (CRITICAL SPEEDS) message. You may want to review the critical speed ranges as well.

## ACTUATOR MIN AND MAX POSITION CALIBRATION

After a valid program is inserted, if needed, the actuator minimum and maximum positions can be adjusted. This readjustment strokes the actuator from minimum to maximum.

The actuator position is determined by the drive current. The maximum actuator current can not be adjusted lower than the minimum actuator current. The minimum actuator current can not be adjusted higher than the maximum actuator current.

If readjusted, sufficient actuator overtravel at the minimum stop must be provided so that the actuator can fully close the steam valve completely to shut off the steam flow to the turbine.

**CAUTION**

Before calibrating, jumper terminals 39 and 40. Insert ammeter in series with actuator.

**WARNING**

**Overspeed sensing and its relay are disabled during this process. Overspeeding of the turbine will cause damage to turbine and can cause severe injury or death to personnel. STEAM TO THE TURBINE MUST BE SHUT OFF BY OTHER MEANS DURING THIS PROCESS.**

From the (Controlling Param-Push Run or Prg) display, push the Step Down key.

ADJ ACTUATOR STOPS ? - PRESS ENTER/NO -- Press NO to return to (Controlling Param-Push Run or Prg) display. Press ENTR to configure block.

STEAM MUST BE OFF!!! - PRESS ENTER/NO -- Press NO to return to Controlling Param-Push Run or Prg) display. Press ENTR to configure block.

ACT 1 MIN STOP ADJ - PRESS ENTR/ADJ -- Press the (ADJ) UP or DOWN keys to set new position. Then press ENTER to make change.

ACT 1 MAX STOP ADJ - PRESS ENTR/ADJ -- Press the (ADJ) UP or DOWN keys to set new position. Then press ENTER to make change.

ACT 2 MIN STOP ADJ - PRESS ENTR/ADJ -- Press the (ADJ) UP or DOWN keys to set new position. Then press ENTER to make change.

ACT 2 MAX STOP ADJ - PRESS ENTR/ADJ -- Press the (ADJ) UP or DOWN keys to set new position. Then press ENTER to make change. The control now returns to (Controlling Param-Push Run or Prg) display.

# CHAPTER 5
# OPERATING PROCEDURES

## OPERATING FUNCTIONS

There are four operating functions (see Figure 32). You can move from function to function by pushing the FUNC keys, and you can move up and down within a function block by pushing the STEP keys. The four blocks and their basic functions are:

1. Controlling Param (parameter) -- to display the parameter currently controlling actuator position;
2. Display/Adjust -- to display or adjust all inputs, outputs, and references;
3. Alarm -- to display all control alarms;
4. Dynamic Adjustment -- to display or adjust dynamic adjustments for all control channels.

## STARTING PROCEDURES

**NOTE**

Refer to the turbine manufacturer's operating procedures for complete information on turbine start-up.

To enter the Run Mode, push RUN when the (CONTROLLING PARAM) (PUSH RUN OR PRG) status is displayed.

Immediately after RUN is pushed, the Shutdown relay energizes. The upper LCD readout displays (CONTROLLING PARAM), and the lower readout displays the parameter controlling the actuator position.

The external emergency shutdown contact must be closed (by jumper or switch) before starting. If not, the control will shut down as soon as RUN is pushed and display (SHUTDN/EMERGENCY).

If either the generator breaker contact or the utility tie breaker contact is open during start-up, the control will alarm when RUN is pushed. This is NOT a problem, but serves to alert you that the breakers are open. You may acknowledge the alarm by pushing CLR to de-energize the Alarm relay. Then continue the normal starting procedure.

If your application does not use generator or tie breakers, you must install a jumper across their terminal blocks (45 to 46 and 48 to 49).

The control has three starting modes: automatic, semiautomatic, and manual, one of which must have been configured during control programming.

**NOTE**

**When starting the turbine using any of the following starting modes, monitor the speed readout to ensure you have a good speed signal.**

## AUTOMATIC START MODE

After pushing RUN, you must manually open the trip-and-throttle valve. The control provides a prompt to indicate when you should open the trip-and-throttle valve. Then push RUN again, and the control automatically begins moving the valve ramp from minimum position (valve closed) toward maximum position (valve open).

You can monitor speed and valve ramp position by pushing VALV. When turbine speed increases to either the minimum speed set point or idle speed (if used), the speed governor takes control of actuator position. The control continues to move the valve ramp toward its maximum position while speed remains controlled at minimum governor or idle speed. You may then move the speed reference to another operating speed by pushing SPD followed by the ADJ up key.

You can abort the automatic start at any time by taking manual control of the valve ramp by pushing the ADJ up or ADJ down key while speed and valve ramp position are displayed.

Pushing the STOP key or the Emergency Stop button also overrides the automatic start feature.

## SEMIAUTOMATIC START MODE

After pushing RUN, you must manually open the valve ramp. Pushing VALV displays both speed and valve ramp position, and it activates the ADJ up and ADJ down keys. You can then open the valve ramp manually by pressing the ADJ up key.

When turbine speed increases to the minimum or idle speed set point, the speed governor takes control of actuator position.

You must continue moving the valve ramp toward its maximum position after the speed governor takes control (to ensure that the valve ramp is out of the way). You may then move the speed reference to another operating speed by pushing SPD followed by the ADJ up key.

## MANUAL START MODE

**WARNING**

**The trip-and-throttle valve must be closed before pushing RUN in Manual Start mode. If RUN is pushed while the trip-and-throttle valve is open, there exists a possibility of turbine runaway with resultant serious injury or loss of life.**

After RUN is pushed, the trip-and-throttle valve must remain closed. The speed governor then senses zero speed and opens both the actuator to its maximum position. You must then manually open the trip-and-throttle valve to admit steam to the turbine. When turbine speed increases to the minimum or idle speed set point, the speed governor takes control of actuator position and the trip-and-throttle valve can be fully opened.

Speed remains controlled at minimum governor or idle speed. You may monitor speed by pushing SPD at any time. After the speed governor is in control, you may control the speed set point position by pushing the ADJ keys (while the SPD screen is displayed).

## ZERO SPEED SIGNAL OVERRIDE

**WARNING**

**The engine, turbine, or other type of prime mover should be equipped with a separate overspeed shutdown device(s) that operate totally independently of the prime mover control device(s) to protect against runaway or damage to the engine, turbine, or other type of prime mover with possible personal injury or loss of life when the zero-speed signal detection circuits are disabled (Zero-Speed Signal Override turned on) for starting, or if the zero-speed signal detection circuits remain disabled (due to equipment failure or human error) after the prime mover is started.**

At start-up, the 505 control automatically overrides the zero-speed signal detection circuit until turbine speed exceeds 500 rpm. Above 500 rpm, the control shuts down the turbine if all speed signals are lost. Redundant MPUs (magnetic pickups) are recommended when starting in the automatic mode. During program configuration, you can select the MPU Failed Override contact to use instead of the automatic override. The MPU fault detector is overridden as long as the contact is closed. Open the contact to rearm the MPU fault detector.

## IDLE/RATED

The 505 is equipped with an idle/rated function which can be initiated only from external contacts. There are no keypad controls for this function. The feature must be configured in the Program Mode or the control ignores the idle/rated contacts. Manual raise speed reference and lower speed reference commands from the keypad, external contacts, or RS-232 have priority over the idle/rated function and cancel its operation.

When the external idle/rated contacts are open, the 505 controls at idle speed. When the idle/rated contacts are closed, the control automatically ramps from its current speed to rated speed. The speed reference moves at the idle/rated reference rate. The control maintains speed control as a function of the moving speed reference. Once the speed stops at rated speed, or is stopped by using the ADJ up or ADJ down keys, the speed reference may be moved to another operating point.

When the idle/rated contacts are again opened, the control moves back to idle speed at the same idle/rated reference rate. If rated is selected when the speed reference is above rated speed, the reference does not return to rated speed. Idle may be selected regardless of the speed reference position. Rated speed may be equal to or greater than the minimum control speed, but it must be less than or equal to the maximum control speed.

The idle/rated contacts can be either open or closed when the turbine is started. With the idle/rated contacts open, the governor takes control at idle. Then, when the idle/rated contacts are closed, the governor ramps up speed at the idle/rated reference rate to rated speed. If on start-up the idle/rated contacts are closed (rated selected), the governor takes control at rated speed.

When the turbine is used for mechanical drive, rated speed may be set at minimum governor speed. When the turbine is used for generator drive, rated speed may be set either at minimum governor speed or at synchronous speed.

## REFERENCES

You select a reference rate during control programming for each ramp or reference. This rate determines how fast each reference will change.

The LCD readout displays the reference values on the lower line and the actual turbine operating point on the upper line. The control automatically updates both values within the update time constant of the display.

The speed reference can operate at several rates. The slow rate is determined in the Program Mode. External contacts such as the external raise and lower functions or the overspeed test function can move a reference/ramp only at the slow rate.
Within any critical speed range, the speed reference always moves at the fast rate. The control does not allow the reference to stop within the critical range.

The cascade control can move the speed reference at a variable rate up to the fast rate. When the error between the pressure or temperature requested by the cascade control and the cascade reference is small, the speed reference moves at a very slow rate. As the error between the requested pressure or temperature and the cascade reference increases, the speed reference moves at a variable rate dependent on the amount of error. For very large errors it moves at the fast rate.

You also can select reference rates by the length of time you hold down the ADJ up and ADJ down keys. If you hold down the ADJ key longer than the time specified below, the reference moves five times faster than the slow rate.

The overspeed test function and external contacts never move any faster than the speed reference slow rate. The points in time at which the dynamics, parameters, and valve ramp rates change are listed below.

For the parameter reference adjustments, holding the ADJ key down for 0 to 3 seconds moves the set point at the slow rate. Holding the key down longer than 3 seconds moves the set point at five times the slow rate. The smallest rate increment is a quarter of the slow rate.

The valve ramp adjustments always moves at the valve ramp rate. The smallest increment the valve ramp can move is a quarter of the valve ramp rate.

**NOTE**

**Information in the following "DROOP/ISOCH" description applies only to revised software. See Introduction Section of this manual. If your control has original software, refer to Appendix B for information on the "DROOP/ISOCH" description.**

## DROOP/ISOCH

The 505 Speed Control can be configured to operate in one of five droop/isoch modes. See Figure 28 below. These modes are:

Isochronous;
Speed Droop;
Kw (Load) Droop;
Droop/Isoch Switch with Speed Droop;
Droop/Isoch Switch with Kw Droop.

You must select one of these five options during control configuration. The auxiliary control block and the cascade control block also have optional droop feedback which you must reject or select during control configuration. If you select a droop option, the control will not permit a droop of greater than 10%.



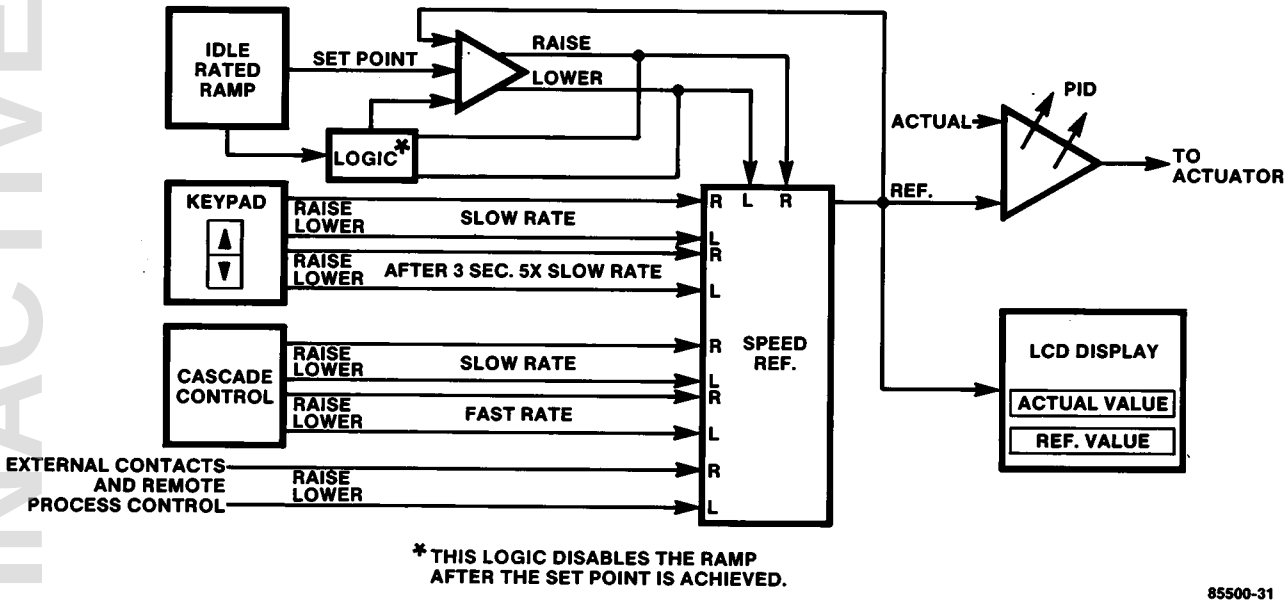



Figure 27. Speed Reference Rates

If you have configured your control for droop, the turbine speed will always be less than the speed reference set point when speed droop is selected. The difference will depend on the amount (%) of droop selected during programming.

When configuring a maximum speed-reference set point, remember that it must be above the turbine overspeed value by the amount of droop if you want to be able to reach overspeed using the Overspeed Test Enable pushbutton (max speed reference = overspeed rpm + overspeed rpm times %droop). For example, if overspeed is 5000 rpm and droop is set at 5%, max speed reference should be 5000 + (5000) (0.05) = 5000 + 250 = 5250 rpm.

See Figure 28. If one of the first three options is selected, the control is designed to reset the speed reference to some predetermined speed if either the generator or utility tie breaker opens. If the generator breaker opens on a loaded generator, the overshoot caused by the load loss could overspeed the turbine. To prevent this, the control automatically resets the speed reference to the programmed below-synchronous-speed set point established when the control was configured.

See figure 28. If you have selected one of the first three options and the utility tie breaker opens, the control automatically resets the speed reference to the programmed synch-speed set point.

This may be synchronous speed or, if plant frequency needs to be maintained after separating from the utility, the synch speed must be above turbine synchronous speed. This speed is determined from the amount of droop (speed or kW) programmed into the control and the amount of load the generator is expected to carry. In a droop system, plant frequency varies with generator load. The speed set point can be adjusted manually to compensate for these load changes.

When the control is configured for isochronous speed control on an isolated bus (first option of figure 28), both synchronous-speed and below-synchronous-speed set points could be set at the turbine's synchronous speed.

See Figure 28. If one of the last two options is selected, the control switches between droop and isoch based on the position of the utility breaker. When the tie breaker is open the control is in isochronous operation. When the tie breaker closes the control switches to droop (either kW or speed) and the speed reference is automatically adjusted to maintain speed. When the tie breaker opens, the control returns to isochronous operation and the speed reference is again automatically adjusted to maintain speed.

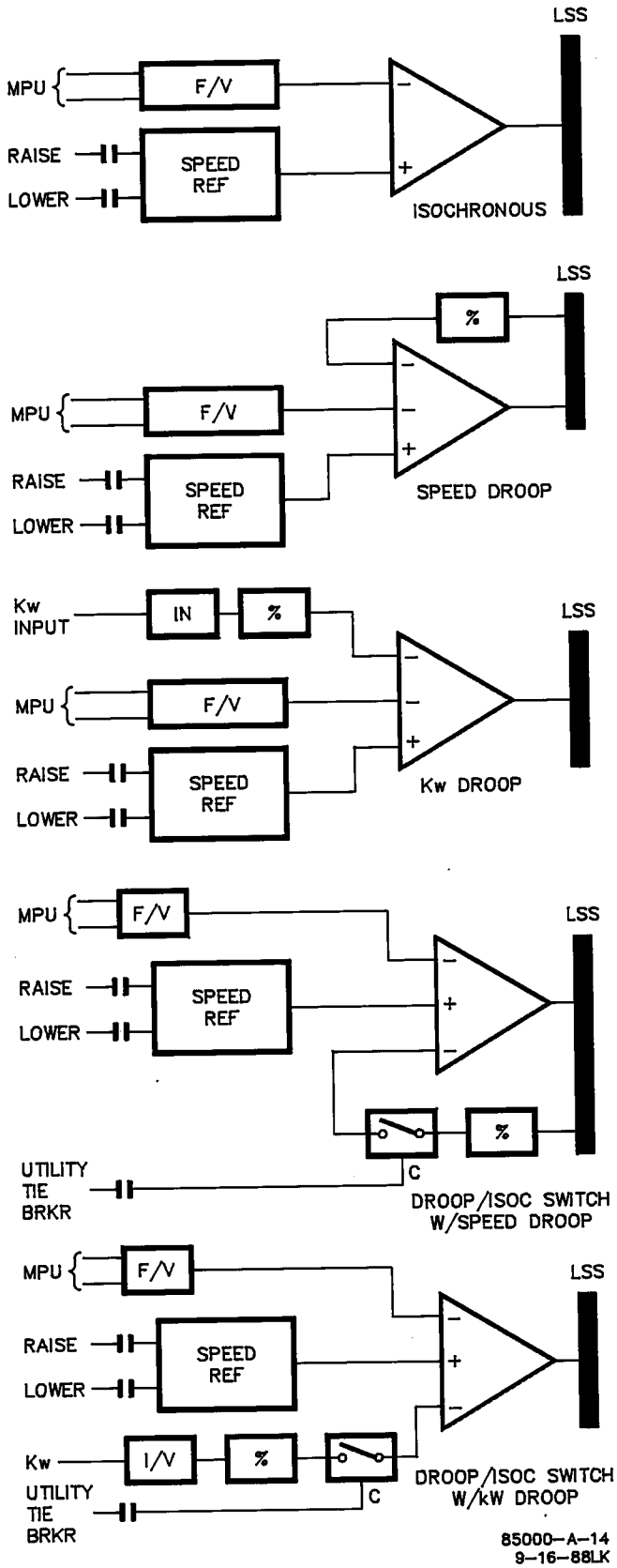



Figure 28. Droop/Isoch

## SPEED LIMITS

All normal control operations occur between the maximum and minimum control speeds. To obtain a speed greater than the maximum control speed requires using the overspeed test enable function.

To obtain a speed less than the minimum control speed requires opening the external idle/rated contact. The speed reference then begins ramping to the idle speed at the idle/rated rate. Once the reference drops below the minimum control speed, you can take manual control of the reference with the ADJ up and ADJ down keys.

## PRIORITIES

The 505 has an internal priority scheme to sort out incoming commands. Listed below are the priorities, from the highest to the lowest.

Emergency Shutdown: Any type

Low Signal Select (LSS) Bus (this is an internal function to which there is only indirect access through the control channels)

Internal Priority of the Speed Reference:
- -- Manual Shutdown
- -- Reset to Synchronous Speed/Below Synchronous Speed
- -- Min/Max Clamps
- -- Critical Speed Avoidance
- -- Remote Process Control
- -- Cascade Control
- -- Speed-Lower
- -- Speed-Raise
- -- Idle/Rated

## DYNAMIC ADJUSTMENTS

Dynamic adjustments are made in the RUN mode. Pressing the DYN key calls up the dynamic adjustments of the parameter in control. Pressing one of the STEP keys causes each parameter's dynamics to appear in turn. An asterisk appearing on the edge of the LCD display line indicates that the displayed parameter is controlling actuator position.

For the speed control channel and auxiliary control channel, the LCD display shows gain on the upper line and reset on the lower line. Pressing the GAIN or RST key places an arrow by that parameter on the display and activates the ADJ keys. The ADJ keys can then be used to adjust the function pointed to by the arrow.

Gain and reset (stability) are interacting parameters. They correspond to the P (proportional) and I (integral) terms as follows:

Gain (%) = P
Reset (%) = I

You must adjust gain and reset to match the response of the turbine. To obtain a faster transient response, slowly increase the gain setting until the actuator or final driver output begins to oscillate or waver. Then adjust the reset as necessary to stabilize the output. If stability cannot be obtained with the reset adjustment, reduce the gain setting.

If necessary, for stability, slightly increase the speed/Kw droop setting (if droop is used) and then repeat the gain and reset adjustments.

The secondary speed-setting functions (Remote Process Control and Cascade Control) may be treated as analog deadband controllers. For Remote Process Control, the dynamics function displays a blank upper line and the remote process control deadband parameter on the lower line. Pressing the RST key causes an arrow to appear by the remote deadband display. Use the ADJ keys to adjust the deadband value. The cascade control dynamics displays the cascade rate on the upper line and the cascade deadband on the lower line. Pressing the GAIN or RST keys causes an arrow to appear by the rate or deadband adjustment respectively. Use the ADJ keys to adjust the function pointed to by the arrow.

The dynamics are adjusted as a percent of the existing value. Holding the ADJ key down for 0 to 0.25 seconds moves the dynamics parameter 1% of its value. Holding the key down for longer than 0.25 seconds moves the dynamics at a rate of 5% of its value for each 0.25 seconds of hold down time.

## REMOTE PROCESS CONTROL AND CASCADE CONTROL

The remote process control and the cascade control are secondary speed-setting functions. Both functions may have values loaded into them in the Program Mode. Each function must be enabled to be used and disabled when not used. Attempting to enable both functions simultaneously causes neither to control and activates the alarm function.

Both functions can adjust the speed reference only from the minimum speed reference to the maximum controlling speed. If the mA input signal to either function drops below approximately 3 mA or exceeds approximately 21 mA, the function ceases to influence the speed reference, the speed set point remains at its last setting, and an alarm is issued. No alarm occurs if the function is not enabled. Before either function can be enabled, the generator breaker and the utility tie breaker both must be closed. If either breaker opens, the secondary speed-setting functions cease to influence the speed reference. You can configure the control to shut down the turbine or to alarm on a breaker opening, if either secondary speed-setting function is enabled.

You also can configure the control to alarm on a breaker opening, if both secondary speed-setting functions are disabled.You can enable either the remote process control or the cascade control once the turbine is up to speed and a load is established.

## REMOTE PROCESS CONTROL

The remote process controller is external to the 505 control. When remote process control is enabled, the speed reference is controlled by the remote process controller output signal. The remote process controller compares its input signal to a reference setting to generate a 4 to 20 mA output signal. This output signal is applied to the 505.

During programming, the 505 is told that a 4 mA input signal from the process controller corresponds to a specific turbine speed in rpm and that a 20 mA input signal corresponds to another turbine speed in rpm.

The remote process controller applies a speed signal to the 505 that is at or between these settings. The speed signal setting depends on the setting of the remote control reference. The remote process controller can move the speed reference between the programmed 4 to 20 mA speeds.

When remote process control is enabled, the remote process controller sets turbine speed by controlling the 505 speed reference. The 505 compares the speed called for by the remote process controller with the speed called for by the present speed reference setting. If the two speeds do not match, the 505 increases or decreases the speed reference setting until the speeds match.

If it is desired to obtain a "bumpless" transfer to process control, the remote process controller and speed reference signals must be matched before remote process control is enabled. If it is desired to do this without disturbing the turbine speed/load, the process control signal is matched to the speed reference before enabling process control. If maintaining a specific turbine speed/load is NOT an important factor, the process speed reference can be matched to the process control signal before enabling process control.

Process control can be also enabled without matching signals. In this case, as soon as process control is enabled, the speed reference moves at a set rate to the setting called for by the process control signal.

Remote process control is monitored by pressing the RMT/5 key to call up the remote display. The upper LCD displays turbine speed in rpm.

The bottom LCD displays process control signal in mA. Pressing the 1/YES key or closing the external remote process control enable contacts now enables process control.

When enabled, remote process control can decrease the speed reference at any time. However, it can increase the speed reference setting only when the speed loop is in control of the actuator. This keeps the remote process controller from pushing the speed reference to its maximum position while the speed loop is not in control. This prevents the speed loop from trying to control speed at some unacceptably high speed after it regains control of the actuator.

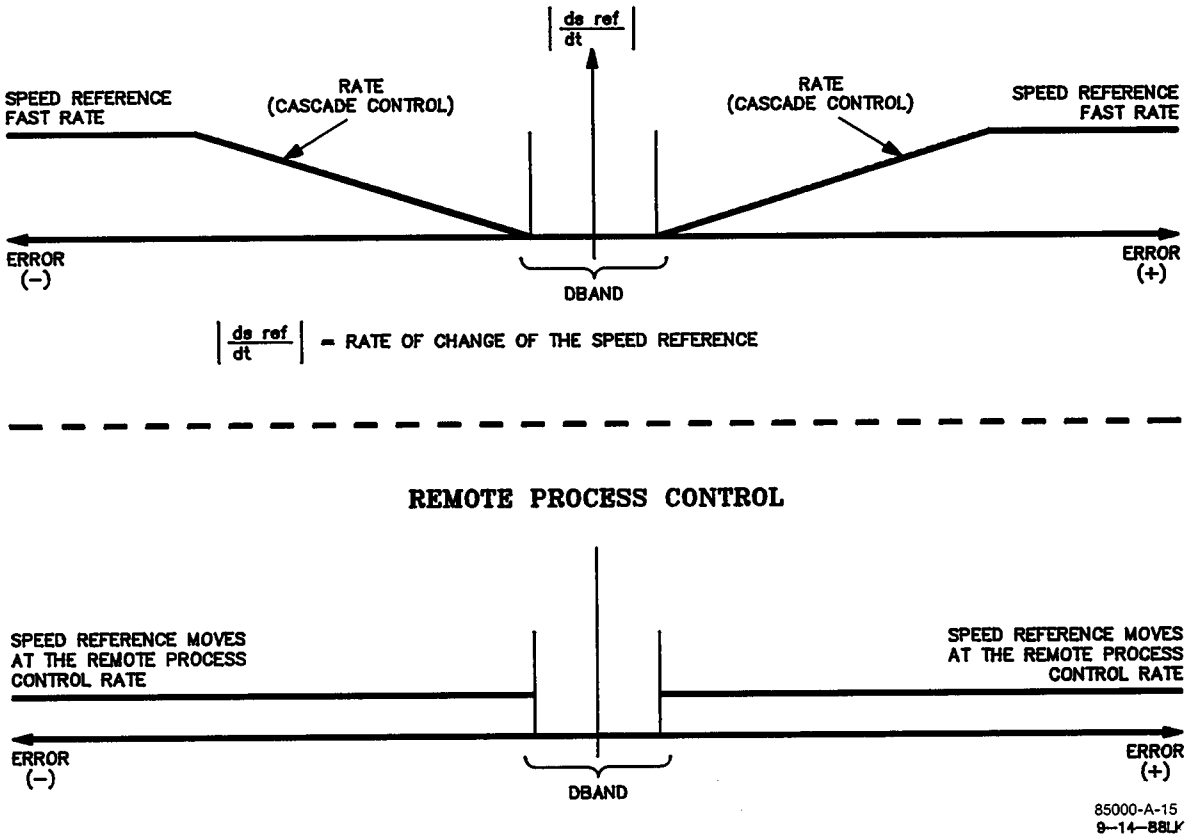



Figure 29. Control Function Adjustment Rates

Remote process control is disabled by first pressing the RMT/5 key to bring up the remote display and then pressing the 0/NO key or by opening the external remote process control enable contacts.

## CASCADE CONTROL

The cascade control is a secondary speed-setting function internal to the 505. It operates in a manner similar to the remote process control in the automatic mode.

The cascade control receives a 4 to 20 mA signal from a transducer (such as temperature or pressure). A digital deadband comparator circuit compares this incoming parameter with an internal reference. If a difference exists between the two signals, the circuitry adjusts the speed-reference set point to eliminate the difference (within the limits of the deadband).

Pushing the CAS/4 key displays the actual value of the controlled parameter (temperature or pressure) in the upper LCD and the value of the cascade reference in the lower LCD. To enable the cascade control, push the 1/YES key or close the external enable contacts. This displays (ENBL) in the top LCD. You can disable the function at any time by pushing the CAS/4 key, then pushing the 0/NO key or opening the external enable contacts.

The cascade control can decrease the speed-reference set point at any time while it is enabled. However, it can increase the speed-reference set point only while the speed loop is controlling the actuator. This keeps the cascade control from pushing the speed reference to its maximum position while the speed loop is not in control. This prevents the speed loop from trying to control speed at some unacceptably high speed after it regains control of the actuator.
Unlike the remote process control, the cascade control can move the speed reference at a variable rate up to the fast rate. Once enabled, the cascade control adjusts the speed reference to reduce the error between the input and the cascade reference to within its deadband window. The further the incoming signal drifts from the cascade control set point, the faster an adjustment is made to the speed set point, up to the speed-reference fast rate.

**ADJUSTMENT RATES**

**NOTE**

Adjustment rates have the following default values set in:

RMT Deadband = 10%.
CAS Rate = 10%.
CAS Deadband = 10%.

**These rates have to be adjusted only if default values are NOT satisfactory for your control's operation.**

You can adjust the deadband windows for both the cascade control and the remote process control in the Run Mode. The cascade control has both rate adjustment (the slope of the error versus the correction rate line) and a deadband adjustment (the size of the deadband window). The remote process control has only a deadband adjustment.

Errors from the remote process control greater than the deadband cause the speed reference to move at only the remote process control rate. Figure 29 depicts the rate of adjustment made to the speed reference by the two control functions.

ERROR = the difference between the actual cascade input signal and the cascade reference or the difference between the remote process control and the speed reference set point.

DBAND = the deadband established for the deadband comparator. Maximum (100%) deadband is equal to 10% of the cascade input at 20 mA. The maximum deadband for the remote process control is defined as 10% of the maximum speed reference. In both cases, the 10% is measured from the (ds ref/dt) axis. This gives a total deadband window of 20% maximum for both the cascade control and the remote process control.

RATE = the change to the speed-reference ramp rate proportional to the amount of error. Only the cascade control has a rate adjustment.

**OVERSPEED TEST**

The 505 control allows you to test both the turbine electrical and mechanical overspeed trips. You can perform an overspeed test only while the 505 is displaying the actual speed and speed reference.
Pressing the OVERSPEED TEST ENABLE key immediately displays the actual speed and speed reference. Both the cascade control and the remote process control must be disabled.

To perform an overspeed test, raise the speed reference set point to the maximum controlling speed using the ADJ up key. When the speed reference set point reaches the maximum controlling speed,the speed set point cannot be increased further by pushing the ADJ up key alone. To continue press and hold the OVERSPEED TEST ENABLE key. Then press and hold the ADJ UP key. The red LED on the OVERSPEED TEST ENABLE key illuminates when the actual speed is above the maximum controlling speed.

Pushing both keys causes the speed set point to increase at the slow rate until the control reaches the electrical overspeed trip point, at which point the red overspeed test LED begins flashing. There are three options at this point.

If the OVERSPEED TEST ENABLE key is released, the control trips the turbine due to an overspeed condition. The Shutdown relay deactivates and the Overspeed relay activates. The actuator current immediately drops to less than one milliampere. The message (SHUTDN/OVERSPEED) appears in the lower LCD while (CONTROLLING PARAM) appears in the upper LCD display.

After the LED starts flashing, another option is to continue pushing both keys to increase speed beyond the overspeed trip point. If a mechanical turbine trip or a separate electrical trip exists above the electrical overspeed trip, but at a speed less than the maximum speed-reference speed, the turbine trips due to the mechanical overspeed trip. If the mechanical trip is set above the maximum speed-reference speed, or does not exist, the speed-reference set point continues to increase until it reaches the maximum speed-reference speed, at which point the red LED starts flashing at twice the previous rate.

The final option after reaching the electrical overspeed trip speed is to continue pushing the OVERSPEED TEST ENABLE key and release the ADJ up key and push the ADJ down key to decrease the speed-reference set point. The red overspeed test LED stops flashing when the speed set point is below the overspeed trip speed.

Any time the OVERSPEED TEST ENABLE key is released while the speed-reference set point is above the maximum controlling speed and below the electrical overspeed trip speed, the speed-reference set point automatically moves down toward the maximum controlling speed at the slow rate. Releasing the ADJ keys at any time while the OVERSPEED TEST ENABLE key is held down causes the speed reference to stop moving.

**ALARMS**

When an alarm condition exists, the red alarm LED illuminates and the Alarm relay activates. Pushing ALARM displays the reason for the alarm. If there is more than one cause for an alarm, pushing the STEP keys displays these additional causes.

The alarm function is latching. The alarm LED stays on and the Alarm relay stays activated if all alarm causes disappear. Once the cause of an alarm is corrected, you must push CLR to clear the alarm. To deactivate the Alarm relay while an alarm condition is still present, push the CLR button. Any additional alarm condition causes the Alarm relay to activate, and each time it must be cleared. The red Alarm LED remains illuminated until all causes for the alarm condition have been corrected.

The alarm conditions and their LCD displays are:

LOST MPU 1 SIGNAL -- Loss of number 1 MPU signal.

LOST MPU 2 SIGNAL -- Loss of number 2 MPU signal.

LOST CAS SIGNAL -- The input current to the cascade control is less than approximately 3 mA. The cascade control ceases to influence the speed reference. The speed set point remains at its last setting. No alarm occurs if the function is not enabled.

HIGH CAS SIGNAL -- The input current to the cascade control is greater than approximately 21 mA. The cascade control ceases to influence the speed reference. The speed set point remains at its last setting. No alarm occurs if the function is not enabled.

LOST RMT SIGNAL -- The input current to the remote process control is less than approximately 3 mA. The remote process control ceases to influence the speed reference. The speed set point remains at its last setting. No alarm occurs if the function is not enabled.

HIGH RMT SIGNAL -- The input current to the remote process control is greater than approximately 21 mA. The remote process control ceases to influence the speed reference. The speed set point remains at its last setting. No alarm occurs if the function is not enabled.

LOST KW SIGNAL -- The input current to the auxiliary power (kW) control is less than approximately 3 mA, when it is not in control of the actuator position.

HIGH KW SIGNAL -- The input current to the auxiliary power (kW) control is greater than approximately 21 mA. The function may or may not be in control of the actuator position.

LOST AUX SIGNAL -- The input current to the auxiliary control is less than approximately 3 mA.

HIGH AUX SIGNAL -- The input current to the auxiliary control is greater than approximately 21 mA.

TIE BREAKER OPEN -- The utility tie breaker is open.
This alarm is only active after the breaker has been closed for the first time after start-up.

GEN BREAKER OPEN -- The generator breaker is open.
This alarm is only active after the breaker has been closed for the first time after start-up.

TIE BRKR OPEN/NO CAS -- The utility tie breaker is open, and the cascade control has ceased to influence the speed reference (the cascade control will again influence the speed reference as soon as the tie breaker is closed). You may clear this alarm without reclosing the breaker by pushing CLR.

GEN BRKR OPEN/NO CAS -- The generator breaker is open, and the cascade control has ceased to influence the speed reference (the cascade control will again influence the speed reference as soon as the generator breaker is closed). You may clear this alarm without reclosing the breaker by pushing CLR.

TIE BRKR OPEN/NO RMT -- The utility tie breaker is open, and the remote process control has ceased to influence the speed reference (the remote process control will again influence the speed reference as soon as the tie breaker is closed). You may clear this alarm without reclosing the breaker by pushing CLR.

GEN BRKR OPEN/NO RMT -- The generator breaker is open, and the remote process control has ceased to influence the speed reference (the remote process control will again influence the speed reference as soon as the generator breaker is closed). You may clear this alarm without reclosing the breaker by pushing CLR.

CAS & RMT ENBL -- Both the remote process control and the cascade control are enabled at the same time. Neither function gains control.

## SHUTDOWNS

Listed below are all the shutdown conditions and their LCD displays. When a shutdown condition occurs, the shutdown cause is displayed in the bottom LCD while (CONTROLLING PARAM) is displayed in the top LCD.

There are two types of shutdown:
a controlled (normal) shutdown and an emergency shutdown.

You can initiate a controlled shutdown while the 505 is controlling the turbine in the Run Mode. Pressing the STOP key and giving verification places the control in speed control and moves the speed reference to its minimum set point at the slow rate. Once the speed reference is at the minimum-speed set point, the valve ramp (if used) moves to its minimum position, the shutdown relay de-activates, and the actuator is at minimum. (If the valve ramp is not configured, the actuator goes completely closed after the speed reference reaches its minimum position).

After a controlled shutdown, the top LCD displays (CONTROLLING PARAM) and the bottom LCD displays (SHUTDN COMPLETE). Note that the control remains in the Run Mode. You must push the CLR key (or close the external clear contact) to return to (CONTROLLING PARAM) (PUSH RUN OR PRG).

The verification feature prevents an unwanted shut-down should you accidentally push the STOP key. When STOP is pushed, the LCD displays (MANUAL SHUTDOWN) (PUSH YES OR NO). At this point, you can push 1/YES to stop the turbine in an orderly fashion. Pushing 0/NO causes the LCD to return to the (CONTROLLING PARAM) display.

In an emergency shutdown, the control automatically goes to minimum actuator position. The Shutdown relay deactivates. The control displays the reason for the shutdown in the bottom LCD and (CONTROLLING PARAM) in the top LCD.

In a shutdown, the control saves all prior operating values, including the references and valve ramp positions. The control remains in the Run Mode with the Shutdown relay deactivated and the actuator current at minimum. You can review these reference and ramp values as if the turbine were operating with the Run Mode function blocks. To exit the Run Mode and return to the (CONTROLLING PARAM) (PUSH RUN OR PRG) display, push the CLR key or close the external clear contact.

The controlled (normal) shutdown LCD display is:

SHUTDN/MANUAL -- Operator-initiated manual shutdown. The operator has pressed the STOP key. When normal shutdown is complete, the control displays (SHUTDN COMPLETE).

Emergency shutdown causes and their LCD displays are:

SHUTDN/EMERGENCY -- Operator-initiated emergency shutdown. The operator has pressed the Emergency Stop button or opened the external shutdown command contacts. The external shutdown command contacts (normally closed) are tied in series with the Emergency Stop button on the front of the control. When they are opened, the control responds the same as if the red Emergency Stop button had been pushed.

SHUTDN/NO MPU -- All MPU signals have been lost.

SHUTDN/NO KW INPUT -- The power (kW) input signal has dropped below approximately 3 mA. Shutdown occurs only if the function was controlling the actuator position or power (kW) droop is used.

SHUTDN/NO AUX IN -- The auxiliary input (kW/power, inlet/exhaust pressure, or temperature) has been lost. Shutdown occurs only if the function was controlling the actuator position. Shutdown on a loss of auxiliary input is a programmable (optional) feature.

SHUTDN/BRKR OPEN -- The tie breaker or the generator breaker has opened. Shutdown when either the utility breaker opens or the generator breaker opens is a programmable (optional) feature. This shutdown is only active after the breaker has been closed for the first time after start-up.

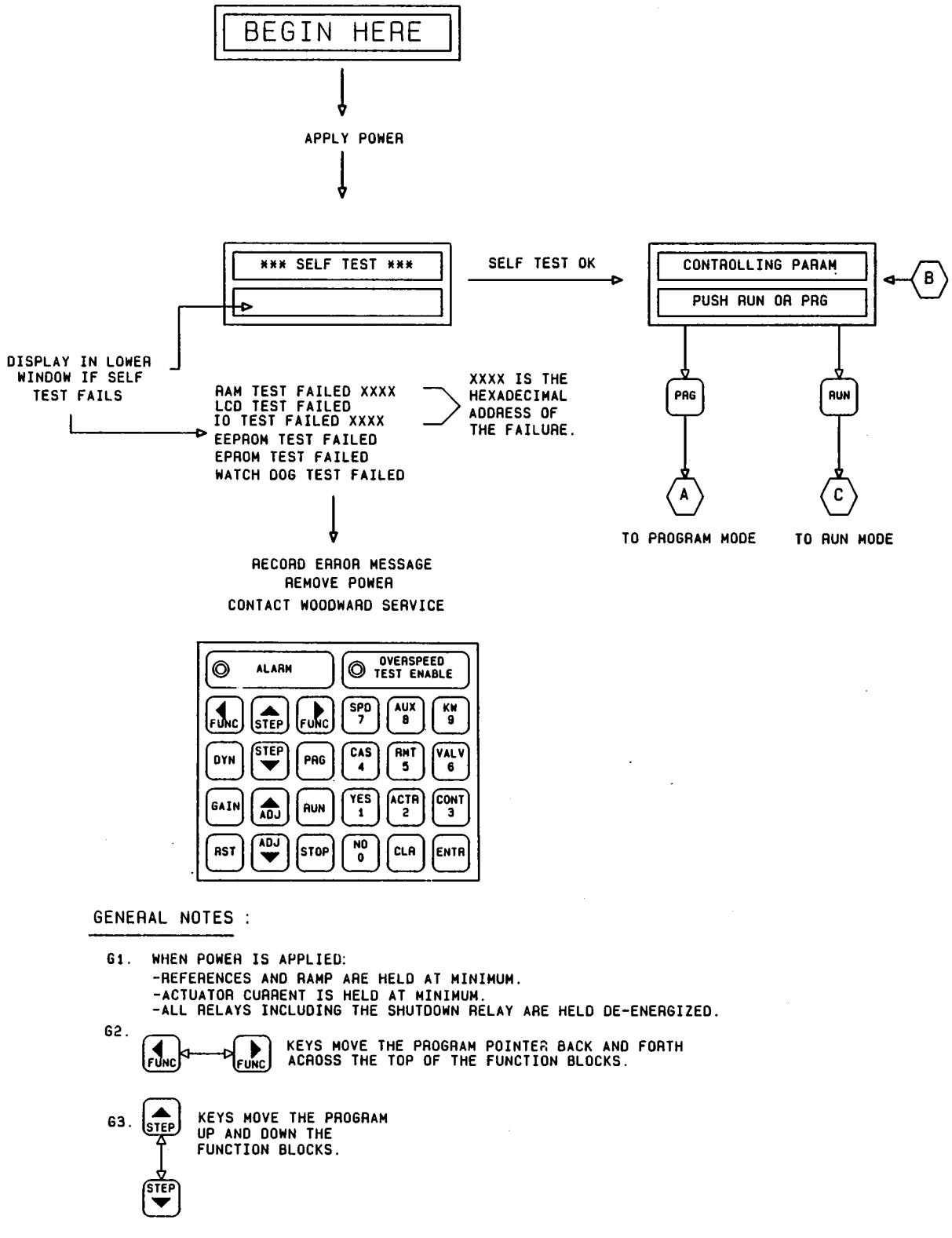
SHUTDN/OVERSPEED -- There is an overspeed condition. When an overspeed condition exists, both the Overspeed relay and the Shutdown relay change state.

SHUTDN/ ACT 1 OVER CUR -- There is an actuator 1 overcurrent. Shutdown on actuator 1 overcurrent is a programmable (optional) feature.

SHUTDN/ ACT 1 UNDR CUR -- There is an actuator 1 undercurrent. Shutdown on actuator 1 undercurrent is a programmable (optional) feature.

SHUTDN/ ACT 2 OVER CUR -- There is an actuator 2 overcurrent. Shutdown on actuator 2 overcurrent is a programmable (optional) feature.

SHUTDN/ ACT 2 UNDR CUR -- There is an actuator 2 undercurrent. Shutdown on actuator 2 undercurrent is a programmable (optional) feature.




GENERAL NOTES :

G1. WHEN POWER IS APPLIED:
-REFERENCES AND RAMP ARE HELD AT MINIMUM.
-ACTUATOR CURRENT IS HELD AT MINIMUM.
-ALL RELAYS INCLUDING THE SHUTDOWN RELAY ARE HELD DE-ENERGIZED.

G2. FUNC ↔ FUNC KEYS MOVE THE PROGRAM POINTER BACK AND FORTH ACROSS THE TOP OF THE FUNCTION BLOCKS.

G3. STEP / STEP KEYS MOVE THE PROGRAM UP AND DOWN THE FUNCTION BLOCKS.

Figure 30. Initial Procedures

# PROGRAM MODE PROCEDURES (PRG)

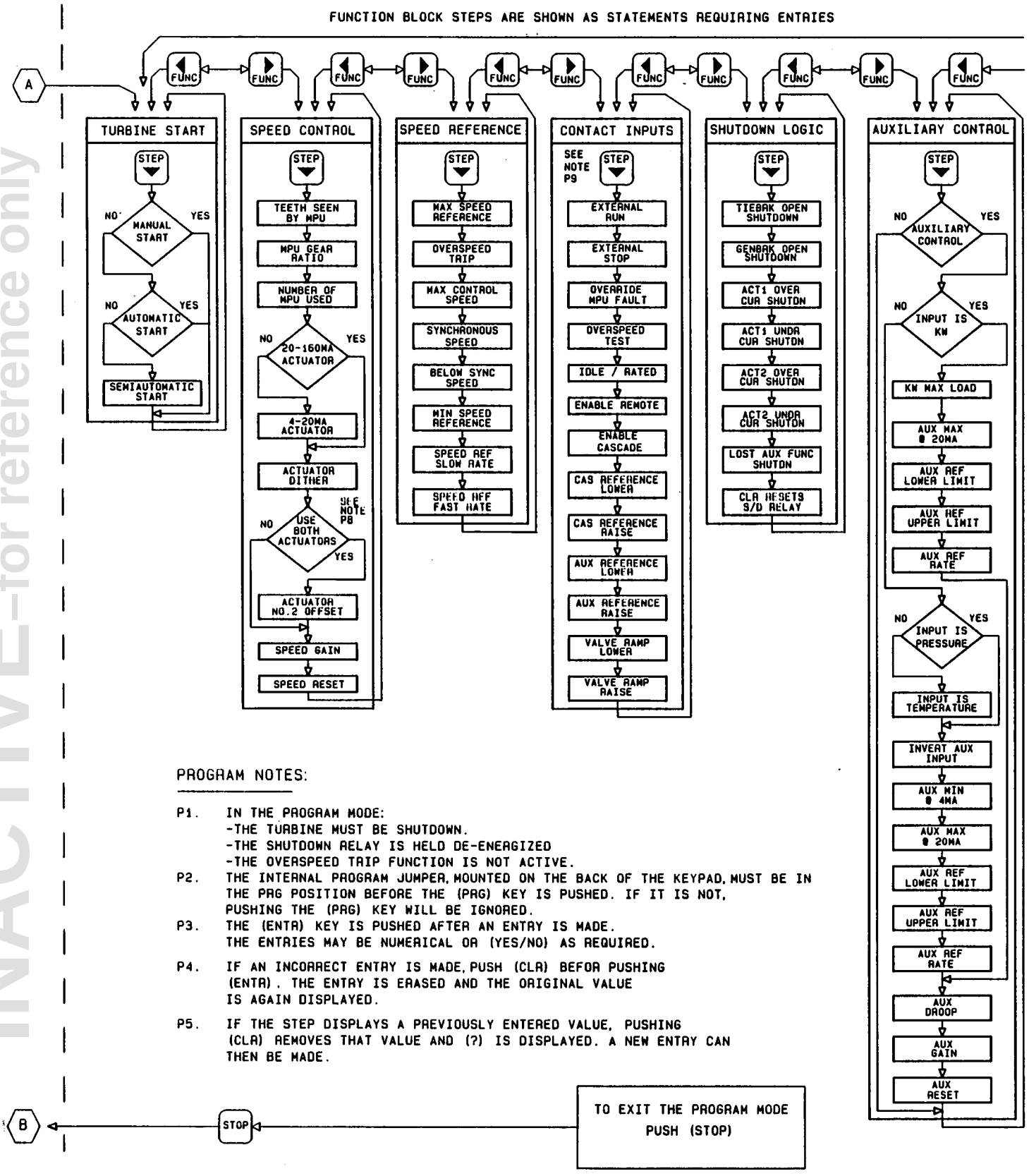



Figure 31. Program Mode Procedures

# CHAPTER 6
# 505 TROUBLESHOOTING

## GENERAL

Most problems you will encounter are covered in the manual. Use the index to locate the sections of the manual that may describe your problem. This troubleshooting section contains a few guidelines that our field service technicians and engineers have suggested.

## ALARMS/SHUTDOWNS

If the LCD display says alarm but the Alarm LED is not illuminated, press the 3/CONT key. If an alarm condition occurs then goes away, the Alarm LED will turn off but the LCD display may still indicate an alarm.

If the control shuts down due to a CPU fault, watchdog timer failure, or power loss, you must turn off control power then turn the power back on. Until you do, you cannot step through any functions in the Run or Program Modes.

If an emergency shutdown is tripped while the LCD display indicates (PUSH RUN OR PRG), (TURBINE TURNING), or (OPEN T&T VALVE), and the RUN is still attempted, the control will stop on an emergency shutdown as the Run Mode is entered. Press the CLR key and try to start again. After any emergency stop, always press the CLR key, and this problem will not occur.

After any shutdown, the Shutdown relay contacts should be reset to ensure proper start-up.

## WIRING/COMPONENT PROBLEMS

Most 505 problems are caused by wiring problems. Carefully and thoroughly check all wiring connections at both ends. Be very careful when installing wires into the 505 control terminal blocks. Check all shields for proper grounding at the control end only.

You can measure all inputs and outputs directly at the terminal strips. The LCD display will show what the 505 measures. This comparison will tell you if the 505 is interpreting the input signal correctly.

Never disconnect or reconnect the LCD with the power on.

Be very careful when reconnecting any ribbon cable inside the control. If you install the connector upside down or off by a pin, you can damage components or cause incorrect LCD indications and incorrect operation of the keypad.

## ACTUATORS/CONTROL ADJUSTMENTS

If the RS-232 line is not working, check the wiring first. Then check the Program Mode entries for matching baud rates.

If you are trying to adjust the speed reference dynamics in the Run Mode and the ADJ up and ADJ down keys will not work, check to make sure that CAS (cascade control) and RMT (remote control) are both disabled.

If the LCD screen characters are garbled, there is a possible failure of a PROM. Call Woodward.

If the actuator output is unsteady or hunts, try blocking the steam valve by closing the valve ramp. If you block the steam valve in this manner and the actuator output is steady but the turbine still hunts, then the problem is outside the governor. If an actuator hunts, it may need dither (especially TM type).

If the 505 control is not able to fully close or open the actuator, check to make sure that the actuator is calibrated correctly. If the 505 control is not able to control speed above or below a certain speed, the steam valve may not be adjusted correctly. An indication of this is if the control is calling for minimum actuator but the speed is still climbing or staying the same, or if the control is calling for maximum actuator but the speed will not increase. Shut down the control and verify that the actuator is closed. If it is, then partially open the T&T valve and verify that the turbine does not turn.

If the T&T valve allows the turbine to turn, then the steam valve is not seated.

## OTHER OPERATING PROBLEMS

When CAS (cascade control) or RMT (remote control) is enabled, and the deadband is greater than 0%, the actual speed will not match the requested speed due to the nature of the deadband operation.

If CAS or RMT will not work, check that generator and tie breakers are both closed.

From the (MANUAL SHUTDOWN) (PUSH YES OR NO) display, you cannot initiate an overspeed test. You must select or reject the manual shutdown option first.

If actual speed is less than the speed called for by the speed reference, check for droop (kW or speed). Droop causes the actual speed to be less than the speed reference.

If the STOP, RUN, or PRG keys will not work in the Run Mode, the turbine may not be running. Push the 3/CONT key to check for the (PUSH RUN OR PRG) display. From there the control will start or enter the program mode.

If the kW, CAS, RMT, or AUX input values are reading incorrectly, check that the input wire shielding is properly grounded at the 505 control end only.

# CHAPTER 7
# REPAIR AND REPLACEMENT PROCEDURES

## INSTRUCTIONS FOR RETURNING EQUIPMENT FOR REPAIR

Do not attempt to service internal electronic components nor attempt to remove any of the circuit boards. If the control requires repair, contact Woodward Governor Company, Engine and Turbine Controls Division, PO Box 1519, Fort Collins, Colorado 80522-9990, USA. Telephone (303) 482-5811, or contact your nearest Woodward Governor Company service facility.

If you need to return the control to Woodward Governor Company for repair, attach a tag to the control with the following information:

Name and location where the control is installed;

Complete Woodward Governor Company part number(s) and serial number(s);

Description of the problem;

Instructions describing the desired type of repair.

**CAUTION**

**Before handling any electronic component, read Manual 82715, "Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules" and Section 1 of this manual.**

Use the following materials when returning a control:

Protective caps on the connectors on the bottom of the unit;

Packing materials that will not damage the surface of the unit;

At least four inches of tightly packed, industry-approved packing material;

A packing carton with double walls;

A strong tape around the outside of the carton for increased strength.

**CAUTION**

**The field-configured portion of the program will be zeroed out after factory repair. to prevent damage to your equipment, you must reconfigure the Program Mode before the unit is put back into service.**

## REPLACEMENT PARTS INFORMÁTION

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

The part number (8238-XXX) that is on the enclosure nameplate;

The unit serial number, which is also on the nameplate;

The part numbers of any separate components to be replaced.

# INDEX

# INDEX (cont.)

# INDEX (cont.)

NOTES

## APPENDIX A

## 505 PROGRAM MODE WORKSHEETS

The 505 Program Mode Worksheets provide a step-by-step guide for programming (configuring) the 505 control. You may copy the worksheet or order extra copies from Woodward Governor Company, Engine and Turbine Controls Division, PO Box 1519, Fort Collins, Colorado 80522-9990, USA; telephone (303) 482-5811 (ask for Supplement S85007).

Use the worksheets along with the Program Mode flowchart (Figure 31). See Section 4 for a detailed description of the configuration (programming) procedures.

A note alerts reader when information applies to only one version of software. Your control has **revised software** if, while stepping through the "Shutdown Logic Block" of Section 4 of this manual, (CLR RESETS S/D RELAY) appears on your control's LCD display. If this item does NOT appear, your system has the **original software.**

S85007

## 505 PROGRAM MODE WORKSHEET

**GOVERNOR SERIAL NUMBER** _____
**APPLICATION** _____

### TURBINE START

**MANUAL START**
Yes____ No____
Push RUN. Actuator moves to max position, operator opens T&T valve manually until governor takes control.

**AUTOMATIC START**
Yes____ No____
Open T&T valve, then push RUN. Control valve opens at the valve ramp rate until the governor takes control.

**SEMIAUTOMATIC START**
Yes____ No____
Open T&T valve, then push RUN. Actuator remains at min position. Operator controls actuator position using valve ramp feature until governor takes control.

### SPEED CONTROL

**TEETH SEEN BY MPU** _____
(Number of teeth on gear).

**MPU GEAR RATIO** _____
(Relationship to turbine shaft).

**NUMBER OF MPU USED**
1_____ 2_____

**20-160MA ACTUATOR**
Yes____ No____
All Woodward actuators are 20-160 mA.

**4-20MA ACTUATOR**
Yes____ No____
For actuators other than Woodward.

**ACTUATOR DITHER**
Yes____ No____
Recommended for Woodward TM-type actuators.

**USE BOTH ACTUATORS**
Yes_____ NO_____

**ACTUATOR #2**
**OFFSET** _____% The % actuator #1 is at when actuator #2 begins to open (enter 0 if both actuators open together).

**SPEED GAIN** _____%
If value unknown, set at 10% for start.

**SPEED RESET** _____%
If value unknown, set at 10% for start.

**SPEED REFERENCE**

**MAX SPEED REFERENCE** _____ rpm
Absolute max speed governor will control at.

**OVERSPEED TRIP** _____ rpm
Governor only. Not to be used as ultimate protection.

**MAX CONTROL SPEED** _____ rpm
Normal governor operation upper limit.

**SYNCHRONOUS SPEED** _____ rpm
Turbine generator 50 or 60 Hz speed in rpm. Control resets to this speed if utility tie breaker opens.

**BELOW SYNC SPEED** _____ rpm
Slightly less than sync speed that governor resets to when the generator breaker opens.

**MIN SPEED REFERENCE** _____ rpm
Normal governor operation lower limit.

**SPEED REF SLOW RATE** _____ rpm/sec
Rate of speed change for normal operation.

**SPEED REF FAST RATE** _____ rpm/sec
Rate of speed change for critical speed ranges and cascade control during large changes.

**CONTACT INPUTS**

You may configure up to ten contact inputs in addition to the six hardwired inputs.

**EXTERNAL RUN**
#____ No____
Enter number (1 to 10) or enter 0/NO for this contact.

**EXTERNAL STOP**
#____ No____
Enter number (1 to 10) or enter 0/NO for this contact.

**OVERRIDE MPU FAULT**
#____ No____
Enter number (1 to 10) or enter 0/NO for this contact.

**OVERSPEED TEST**
#____ No____
Enter number (1 to 10) or enter 0/NO for this contact.

**IDLE/RATED**
#____ No____
Enter number (1 to 10) or enter 0/NO for this contact.

**ENABLE REMOTE**
#____ No____
Enter number (1 to 10) or enter 0/NO for this contact.

**ENABLE CASCADE**
#____ No____
Enter number (1 to 10) or enter 0/NO for this contact.

**CAS REFERENCE LOWER**
#____ No____
Enter number (1 to 10) or enter 0/NO for this contact.

**CAS REFERENCE RAISE**
#____ No____
Enter number (1 to 10) or enter 0/NO for this contact.

**AUX REFERENCE LOWER**
#____ No____
Enter number (1 to 10) or enter 0/NO for this contact.

**AUX REFERENCE RAISE**
#____ No____
Enter number (1 to 10) or enter 0/NO for this contact.

**VALVE RAMP LOWER**
#____ No____
Enter number (1 to 10) or enter 0/NO for this contact.

**VALVE RAMP RAISE**
#____ No____
Enter number (1 to 10) or enter 0/NO for this contact.

**SHUTDOWN LOGIC**

**TIEBRK OPEN SHUTDOWN**
Yes____ No____

**GENBRK OPEN SHUTDOWN**
Yes____ No____

**ACT 1 OVER CUR SHUTDN**
Yes____ No____

**ACT 1 UNDR CUR SHUTDN**
Yes____ No____

**ACT 2 OVER CUR SHUTDN**
Yes____ No____

**ACT 2 UNDR CUR SHUTDN**
Yes____ No____

**LOST AUX FUNC SHUTDN**
Yes____ No____
If Yes, skip next question

**NOTE**

**Step "CLR RESETS S/D RELAY" below item applies only to controls with revised software. If your control has original software, the following item does NOT apply.**

**CLR RESETS S/D RELAY**
Yes____ No____
Almost always should be "No".

**AUXILIARY CONTROL**

**AUXILIARY CONTROL**
Yes_____ No_____

**INPUT IS KW**
Yes_____ No_____
If No, skip to input is pressure.

**KW MAX LOAD**
_____ kW
Max kW generator can carry. Same as KW MAX LOAD in Droop section.

**AUX MAX @ 20 MA**
_____ kW
Max kW which will correspond to 20 mA input. 4 mA is zero kW. Same as kW MAX @ 20 mA in Droop section.

**AUX REF LOWER LIMIT**
_____ kW
Lower limit of governor kW range.

**AUX REF UPPER LIMIT**
_____ kW
Upper limit of governor kW range.

**AUX REFERENCE RATE**
_____ kW/sec
Rate at which kW reference set point can be changed.

**INPUT IS PRESSURE**
Yes_____ No_____
If No, input is temperature.

**INPUT IS TEMPERATURE**
Yes_____ No_____

**INVERT AUX INPUT**
Yes_____ No_____

**AUX MIN @ 4 MA**
_____ Units
Min pressure/temperature which will correspond to 4 mA input.

**AUX MAX @ 20MA**
_____ Units
Max pressure/temperature which will correspond to 20 mA input.

**AUX REF LOWER LIMIT**
_____ Units
Lower limit of governor pressure/temperature range.

**AUX REF UPPER LIMIT**
_____ Units
Upper limit of governor pressure/temperature range.

**AUX REFERENCE RATE**
_____ Units/sec
Rate at which pressure/temperature reference set point can be changed.

**AUX DROOP**
_____ %
Not more than 10 %.

**AUX GAIN**
_____ %
If value unknown, set at 10% for start.

**AUX RESET**
_____ %
If value unknown, set at 10% for start.

**VALVE RAMP CONTROL**

**VALVE RAMP**
Yes___ No___
Used to move actuator from min to max. Required for auto and semi-auto start.

**VALVE RAMP RATE** _____ %/sec
Rate at which the valve ramp moves the actuator.

**DROOP**

**SPEED DROOP**
Yes___ No___
If NO, skip to KW DROOP.

**NOTE**

**Step "ACTUATOR TRAVEL" below applies only to controls with original software. See Introduction Section of this manual to determine your control's software status. If your control has revised software, the following item does NOT apply.**

**ACTUATOR TRAVEL** _____ %
Percent of actuator travel from no load to full load.

**SPEED DROOP** _____ %
Not more than 10%.

**KW DROOP**
Yes___ No___

**KW MAX LOAD** _____ kW
Max kW generator can carry.

**KW MAX @ 20 MA** _____ kW
Max kW which will correspond to 20 mA input. 4 mA is zero kW.

**KW DROOP** _____ %
Not more than 10%. 4-20 mA input from external kW sensor required.

**NOTE**

**Step "DROOP/ISOCH SWITCH" below item applies only to controls with revised software. See Introduction section of this manual. If your control has original software, the following item does NOT apply.**

**DROOP/ISOCH SWITCH**
Yes____ No____
If "Yes", control runs in droop when utility tie breaker is closed and isoch when utility tie breaker is open. If "No", control runs in droop at all times.

**CRITICAL SPEEDS**

**CRITICAL SPEEDS**
Yes____ No____

**CRITICAL SPEED 1 MIN** _____ rpm

**CRITICAL SPEED 1 MAX** _____ rpm

**CRITICAL SPEED 2**
Yes____ No____

**CRITICAL SPEED 2 MIN** _____ rpm

**CRITICAL SPEED 2 MAX** _____ rpm

**IDLE/RATED**

**IDLE/RATED**
Yes____ No____
Ramp from selected low speed to selected high speed, actuated by external switch.

**IDLE SPEED** _____ rpm

**RATED SPEED** _____ rpm

**IDLE/RATED REF RATE** _____ rpm/sec
Rate at which ramp travels from idle to rated.

**UNITS**

**CHANGE UNITS**
Yes____ No____
Factory default units are pounds per square inch (psi) for pressure and degrees Celsius (degrees C) for temperature.

**PRESS = KGF/CM**2**
Yes____ No____
Kilograms (force) per square centimeter.

**PRESS = KPA**
Yes____ No____
Kilopascals.

**PRESS = PSI**
Yes____ No____
Pounds per square inch.

**TEMP = ° F**
Yes____ No____
Degrees Fahrenheit.

**TEMP = ° C**
Yes____ No____
Degrees Celsius.

## REMOTE PROCESS

**RMT PROCESS CONTROL**
Yes____ No____

**RMT MIN RPM AT 4MA** _____ rpm
Min rpm which will correspond to 4 mA input.

**RMT MAX RPM AT 20MA** _____ rpm
Max rpm which will correspond to 20 mA input.

**SPD REF LOWER LIMIT** _____ rpm
Min speed reference rpm which will correspond to the remote lower limit.

**SPD REF UPPER LIMIT** _____ rpm
Max speed reference rpm which will correspond to the remote upper limit.

**RMT CONTROL RATE** _____ rpm/sec
Rate at which the remote control will raise or lower the speed reference.

## CASCADE CONTROL

**CASCADE CONTROL**
Yes____ No____

**INPUT IS PRESSURE**
Yes____ No____

**INPUT IS TEMP**
Yes____ No____

**INVERT CAS INPUT**
Yes____ No____

**CAS MIN @ 4 MA** _____ Units
Min pressure/temperature which will correspond to 4 mA input.

**CAS MAX @ 20 MA** _____ Units
Max pressure/temperature which will correspond to 20 mA input.

**CAS REF LOWER LIMIT** _____ Units

**CAS REF UPPER LIMIT** _____ Units

**SPEED REF LOWER LIMIT** _____ rpm
Min speed reference rpm which will correspond to the cascade lower limit.

**SPEED REF UPPER LIMIT** _____ rpm
Max speed reference rpm which will correspond to the cascade upper limit.

**CAS REFERENCE RATE** _____Units/sec
Rate at which the cascade reference will raise or lower.

**CAS DROOP** _____ %
Not more than 10%.

**RELAY OUTPUT**

**RELAY OUTPUT**
Yes___ No___
You may configure up to five relays, including hand valve relays, other than the three pre-assigned relays (Alarm, Electrical Overspeed Trip, Shutdown).

**SPEED REF MAX RELAY**
#___ No___
Enter number (1 to 5) or enter 0/NO for this relay.

**SPEED SWITCH 1 RELAY**
#___ No___
Enter number (1 to 5) or enter 0/NO for this relay.

**SPEED SWITCH 1 RPM** _____ rpm

**SPEED SWITCH 2 RELAY**
#___ No___
Enter number (1 to 5) or enter 0/NO for this relay.

**SPEED SWITCH 2 RPM** _____ rpm

**REMOTE PROCESS RELAY**
#___ No___
Enter number (1 to 5) or enter 0/NO for this relay.

**AUX SWITCH RELAY**
#____ No____
Enter number (1 to 5) or enter 0/NO for this relay.

**AUX SW POINT** _____ %

**VALVE RAMP RELAY**
#____ No____
Enter number (1 to 5) or enter 0/NO for this relay.

**VALVE RAMP SW POINT** _____ %

**NOTE**

**Step "CAS IN CONTROL RELAY" below item applies only to controls with revised software. See Introduction Section of this manual. If your control has original software, the following item does NOT apply.**

**CAS IN CONTROL RELAY**
#___ No___

**HAND VALVES**

**HAND STEAM VALVE**
Yes____ No____
Used to configure hand valve relays.

**HAND VALVE 1 RELAY**
#____ No____
Enter number (1 to 5) or enter 0/NO for this relay.

**HAND VALVE 1 OPEN** _____ %
Percent of actuator stroke at which valve is to open (relay energizes).

**HAND VALVE 1 CLOSE** _____ %
Percent of actuator stroke at which valve is to close (relay de-energizes).

**HAND VALVE 2 RELAY**
#____ No____
Enter number (1 to 5) or enter 0/NO for this relay.

**HAND VALVE 2 OPEN** _____ %
Percent of actuator stroke at which valve is to open (relay energizes).

**HAND VALVE 2 CLOSE** _____ %
Percent of actuator stroke at which valve is to close (relay de-energizes).

**HAND VALVE 3 RELAY**
#____ No____
Enter number (1 to 5) or enter 0/NO for this relay.

**HAND VALVE 3 OPEN** _____ %
Percent of actuator stroke at which valve is to open (relay energizes).

**HAND VALVE 3 CLOSE** _____ %
Percent of actuator stroke at which valve is to close (relay de-energizes).

**HAND VALVE 4 RELAY**
#____ No____
Enter number (1 to 5) or enter 0/NO for this relay.

**HAND VALVE 4 OPEN** _____ %
Percent of actuator stroke at which valve is to open (relay energizes).

**HAND VALVE 4 CLOSE** _____ %
Percent of actuator stroke at which valve is to close (relay de-energizes).

**ANALOG READOUT**
You may configure up to four 4-20 mA analog readouts.

**ANALOG READOUT**
Yes____ No____

**SPEED INPUT READOUT**
#____ No____
Enter number (1 to 4) or enter 0/NO for this readout.

**SPEED MIN RPM @ 4 MA** _____ rpm
Min rpm which will correspond to 4 mA readout.

**SPEED MAX RPM @ 20 MA** _____ rpm
Max rpm which will correspond to 20 mA readout.

**SPEED REFERENCE READOUT**
#____ No____
Enter number (1 to 4) or enter 0/NO for this readout.

**SPEED MIN REF @ 4 MA** _____ rpm
Min rpm which will correspond to 4 mA readout.

**SPEED MAX REF @ 20 MA** _____ rpm
Max rpm which will correspond to 20 mA readout.

**AUX INPUT READOUT**
#____ No____
Enter number (1 to 4) or enter 0/NO for this readout.

**AUX MIN @ 4 MA** _____
Units Min value which will correspond to 4 mA readout.

**AUX MAX @ 20 MA** _____
Units Max value which will correspond to 20 mA readout.

**AUX REFERENCE READOUT**
#____ No____
Enter number (1 to 4) or enter 0/NO for this readout.

**AUX MIN REF @ 4 MA** _____
Units Min value which will correspond to 4 mA readout.

**AUX MAX REF @ 20 MA** _____
Units Max value which will correspond to 20 mA readout.

**CAS INPUT READOUT**
#____ No____
Enter number (1 to 4) or enter 0/NO for this readout.

**CAS MIN @ 4 MA** _____ Units
Min value which will correspond to 4 mA readout.

**CAS MAX @ 20 MA** _____ Units
Max value which will correspond to 20 mA readout.

**CAS REFERENCE READOUT**
#____ No____
Enter number (1 to 4) or enter 0/NO for this readout.

**CAS MIN REF @ 4 MA** _____ Units
Min value which will correspond to 4 mA readout.

**CAS MAX REF @ 20 MA** _____ Units
Max value which will correspond to 20 mA readout.

**RMT REFERENCE READOUT**
#____ No____
Enter number (1 to 4) or enter 0/NO for this readout.

**RMT MIN @ 4 MA** _____ rpm
Min value which will correspond to 4 mA readout.

**RMT MAX @ 20 MA** _____ rpm
Max value which will correspond to 20 mA readout.

**KW INPUT READOUT**
#____ No____

Enter number (1 to 4) or enter 0/NO for this readout.

**KW MIN @ 4 MA** _____ kW
Min kW which will correspond to 4 mA readout.

**KW MAX @ 20 MA** _____ kW
Max kW which will correspond to 20 mA readout.

**VALV RAMP READOUT**
#____ No____
Enter number (1 to 4) or enter 0/NO for this readout.

**VALV RAMP MIN @ 4 MA** _____ %
Min % which will correspond to 4 mA readout.

**VALV RAMP MAX @ 20 MA** _____ %
Max % which will correspond to 20 mA readout.

**ACT 1 POS READOUT**
#____ No____
Enter number (1 to 4) or enter 0/NO for this readout.

**ACT 1 POS @ 4 MA** _____ %
Min % which will correspond to 4 mA readout.

**ACT 1 MAX POS @ 20 MA** _____ %
Max % which will correspond to 20 mA readout.

**ACT 2 POS READOUT**
#____ No____
Enter number (1 to 4) or enter 0/NO for this readout.

**ACT 2 POS @ 4 MA** _____ %
Min % which will correspond to 4 mA readout.

**ACT 2 MAX POS @ 20 MA** _____ %
Max % which will correspond to 20 mA readout.

**RS-232**

**RS-232**
Yes___ No___
Configure RS-232 port and baud rates.

**300 BAUD**
Yes___ No___

**1200 BAUD**
Yes___ No___

**2400 BAUD**
Yes___ No___

NOTES

# APPENDIX B
# ORIGINAL SOFTWARE PROGRAMMING

Information in this Appendix (B) applies only to those controls with the original software. Your control has **revised software** if, while stepping through the "Shutdown Logic Block" of Section 4 of this manual, (CLR RESETS S/D RELAY) appears on your control's LCD display. If this item does NOT appear, your system has the **original software.**

Notes in the main part of this manual direct the reader to this appendix (B) when necessary.

## DROOP BLOCK

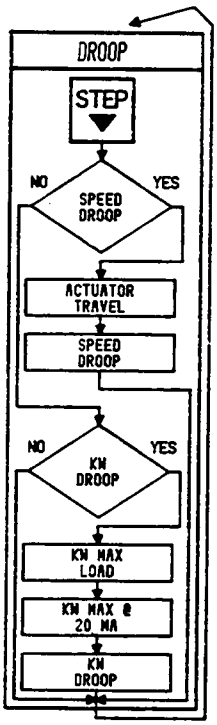



Figure 1. Droop Block

DROOP FUNCTION -- When (DROOP) (FUNCTION) appears in the LCD display, press the STEP down key to configure this block or press a FUNC key to select another block to configure.

SPEED DROOP -- Press YES if you want speed droop or NO if you do not want speed droop. Then press ENTR. If you enter YES, the control will display (ACTUATOR TRAVEL). If you enter NO, the control will display (KW DROOP).

ACTUATOR TRAVEL -- Enter the percentage of actuator travel required to obtain 100% load (maximum actuator travel is 99.99%, then press ENTR.

SPEED DROOP -- Enter the desired speed droop (%), then press ENTR. The control will now return to the beginning of this program block and display (DROOP) (FUNCTION).

KW DROOP -- Press YES if you want kW droop or NO if you do not want kW droop. Then press ENTR. If you enter YES, the control will display (KW MAX LOAD). If you enter NO, the control will return to the beginning of this program block and display (DROOP) (FUNCTION).

KW MAX LOAD -- Enter the maximum load (kW) the generator can carry, then press ENTR. This is the same value as the KW MAX LOAD entry in the Auxiliary Control block. When you change the entry in one place, the control automatically changes it in the other.

KW MAX @ 20 MA -- Enter the maximum kW which will correspond to 20 mA input current (the control assumes 4 mA corresponds to zero input). Then press ENTR. This is the same value as the AUX MAX LOAD entry in the Auxiliary Control block. When you change the entry in one place, the control automatically changes it in the other.

KW DROOP -- Enter the desired kW droop (%), then press ENTR. The control will now return to the beginning of this program block and display (DROOP) (FUNCTION).

==========

**RELAY OUTPUT BLOCK**

Three relay outputs are always provided by the control (Alarm, Electrical Overspeed Trip, and Shutdown). In addition, you may select up to five more (optional) relay outputs. Enter numbers 1 through 5 for the relay outputs you need. Enter 0/NO for those you don't need. The numbers correspond to the relay numbers on the plant wiring diagram (see Figure 2 of 85007). The control will tell you if the number is presently being used. You must then select another number or press 0/NO.

Seven of the optional relays are contained in this block (Relay Output), and four more are contained in the next block (Hand Valves). The relay numbers can be used only once in either block.

RELAY OUTPUT FUNCTION -- When (RELAY OUTPUT) (FUNCTION) appears in the LCD display, press the STEP down key to configure this block or press a FUNC key to select another block to configure.

RELAY OUTPUT -- Press YES if you want optional relay outputs or 0/NO if you do not want any optional relay outputs. Then press ENTR. If you enter YES, the control will display (SPEED REF MAX RELAY). If you enter 0/NO, the control will return to the beginning of this program block and display (RELAY OUTPUT) (FUNCTION).

SPEED AT MAX REF RELAY -- Enter a number (1 through 5), then press ENTR, if you want this relay. Press 0/NO, followed by ENTR, if you don't want this relay. (The relay energizes when the speed is at maximum reference.)

SPEED SWITCH 1 RELAY -- Enter a number (1 through 5), then press ENTR, if you want this relay. Press 0/NO, followed by ENTR, if you don't want this relay. (The relay energizes when turbine speed is at or above the set point for speed switch 1.) If you select this relay, the control will display (SPEED SWITCH 1 RPM). If you enter 0/NO, the control will display (SPEED SWITCH 2 RELAY).

SPEED SWITCH 1 RPM -- Enter the speed set point for speed switch 1 (rpm), then press ENTR.

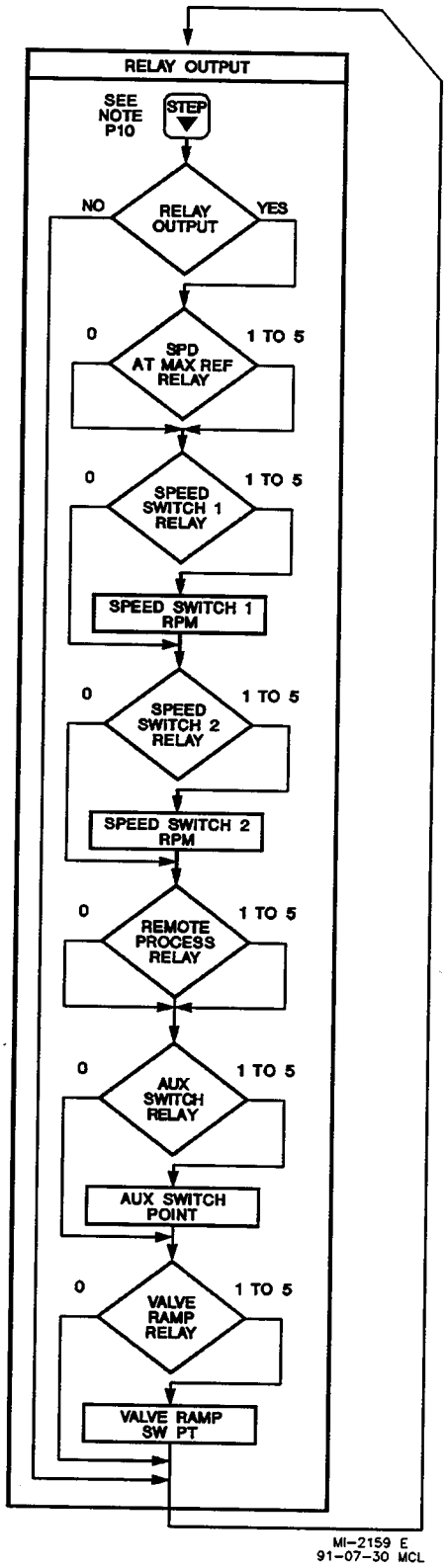



Figure 2. Relay Output Block

SPEED SWITCH 2 RELAY -- Enter a number (1 through 5), then press ENTR, if you want this relay. Press 0/NO, followed by ENTR, if you don't want this relay. (The relay energizes when turbine speed is at or above the set point for speed switch 2.) If you select this relay, the control will display (SPEED SWITCH 2 RPM). If you enter 0/NO, the control will display (REMOTE PROCESS RELAY).

SPEED SWITCH 2 RPM -- Enter the speed set point for speed switch 2 (rpm), then press ENTR.

REMOTE PROCESS RELAY -- Enter a number (1 through 5), then press ENTR, if you want this relay. Press 0/NO, followed by ENTR, if you don't want this relay. (The relay energizes when the remote process control is in control of the speed reference.)

AUX SWITCH RELAY -- Enter a number (1 through 5), then press ENTR, if you want this relay. Press 0/NO, followed by ENTR, if you don't want this relay. (The relay energizes when the auxiliary input is at or above the auxiliary switch set point).

AUX SWITCH POINT -- Enter the auxiliary switch set point (kW, pressure, or temperature), then press ENTR.

VALVE RAMP RELAY -- Enter a number (1 through 5), then press ENTR, if you want this relay. Press 0/NO, followed by ENTR, if you don't want this relay. (The relay energizes when the valve ramp is at or above the valve ramp switch point.) If you select this relay, the control will display (VALVE RAMP SW POINT). If you enter 0/NO, the control will return to the beginning of the program block and display (RELAY OUTPUT) (FUNCTION).

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**DROOP/ISOCH**

The 505 Speed Control can be configured to operate in one of three droop/isoch modes. These modes are:

Isochronous;
Speed Droop;
Kw Droop;

You must select one of these three options during control configuration. The auxiliary control block and the cascade control block also have optional droop feedback which you must reject or select during control configuration. If you select a droop option, the control will not permit a droop of greater than 10%.

If you have configured your control for speed droop, the turbine speed will always be less than the speed reference set point when speed droop is selected. The difference will depend on the amount (%) of droop selected during programming.

When configuring a maximum speed-reference set point, remember that it must be above the turbine overspeed value by the amount of droop if you want to be able to reach overspeed using the Overspeed Test Enable pushbutton (max speed reference = overspeed rpm + overspeed rpm times % droop).

For example, if overspeed is 5000 rpm and droop is set at 5%, max speed reference should be 5000 + (5000) (0.05) = 5000 + 250 = 5250 rpm.

The control is designed to reset the speed reference to some predetermined speed if either the generator or utility tie breakers open. If the generator breaker opens on a loaded generator, the overshoot caused by the load loss could overspeed the turbine. To prevent this, the control automatically resets the speed reference to the programmed below-synchronous-speed set point established when the control was configured.

If the utility tie breaker opens, the control automatically resets the speed reference to the programmed synch-speed set point. This may be synchronous speed or, if plant frequency needs to be maintained after separating from the utility, the synch speed must be above turbine synchronous speed. This speed is determined from the amount of droop (speed or kW) programmed into the control and the amount of load the generator is expected to carry. In a droop system, plant frequency varies with generator load. The speed set point can be adjusted manually to compensate for these load changes.

When the control is configured for of isochronous speed control on an isolated bus, both synchronous-speed and below-synchronous-speed set points could be set at the turbine's synchronous speed.

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