


PROTOCOL™ DIGITAL OVEN CONTROLLER

INSTRUCTION MANUAL

OPERATING INSTRUCTIONS

1. Press **POWER ON**, the display reads (MANUAL).
2. Press **(H-LIMIT)**, press **(0)**.
3. Using the **+/-** keys, enter the **H-LIMIT** to a value slightly higher than the intended **SETPOINT**.
4. Press **(SETPOINT)**, press **(0)**.
5. Using the **+/-** keys, enter **SETPOINT** to the desired operating temperature.
6. Press **(READY)**.
7. Press **HEATER ON** and **START**, the **HEATER ON** light will illuminate. As the oven temperature approaches the **SETPOINT**, the **HEATER ON** light will cycle on and off.
8. When the heating cycle is complete, press **STOP** and **HEATER OFF**. Do not turn the **POWER OFF** until the oven temperature is below 100°C (212°F).

For further instructions on the operating modes, please consult the instruction manual.



Power on

WARNING

Failure to heed this warning can result in property damage, personal injury or death.

1. Read the entire instruction manual carefully before operating this equipment.
2. **DO NOT** use any flammable solvent or other or explosive materials in this equipment UNLESS the equipment is designed for a specific amount of solvent (ie LFD series). Exceeding this specified amount could result in an explosion.
3. Do not use this equipment in a wet, corrosive or explosive atmosphere.
4. Do not attempt any service on this equipment without disconnecting the main power switch or power cord.
5. Do not exceed the maximum operating temperature.

SETPOINT ACTUAL

PROTOCOL™

| | | | |
|---------|-------|------------|-----------|
| Manual | Cal | Start | Heater on |
| Timer | Tune | Stop | H-Limit |
| Program | D/Ag | Heater on | T/C Error |
| Home | Reset | Heater off | Control |

Heater on ●
H-Limit ●
T/C Error ●
Control ●
T/C Error ●
Over Temp ●
Soak Deviation ●
Heater Relay ●
Power on ●

Prepared by:
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Customer Service 800-473-7373

Notice

Users of this equipment must comply with operating procedures and training of operation personnel as required by the Occupational Safety and Health Act (OSHA) of 1970, Section 6 and relevant safety standards, as well as other safety rules and regulations of state and local governments. Refer to the relevant safety standards in OSHA and National Fire Protection Association (NFPA), section 86 of 1990.

Caution

Setup and maintenance of the equipment should be performed by qualified personnel who are experienced in handling all facets of this type of system. Improper setup and operation of this equipment could cause an explosion that may result in equipment damage, personal injury or possible death.

Thank you for choosing Despatch Industries. We appreciate the opportunity to work with you and to meet your heat processing needs. We believe that you have selected the finest equipment available in the heat processing industry.

At Despatch, our service does not end after the purchase and delivery of our equipment. For this reason we have created the Service Products Division within Despatch. The Service Products Division features our Response Center for customer service. The Response Center will direct and track your service call to ensure satisfaction.

Whenever you need service or replacement parts, contact the Response Center at 1-800-473-7373: FAX 612-781-5353.

Thank you for choosing Despatch.

Sincerely,

Despatch Industries

Despatch Product Warranty

Parts, Materials and Labor

Despatch warrants all parts and materials to be free from defects in material and workmanship for a period of one (1) year from the date of shipment unless otherwise mutually agreed upon in writing, or 2,000 hours of operation, whichever occurs first. (Note: Laboratory oven electric heaters are warranted for a period of five [5] years from date of shipment.)

Despatch will repair or replace, at Despatch's option, FOB Despatch's factory, parts and materials covered by this warranty. Despatch is not responsible for parts or material failures resulting from misuse, abuse, inadequate preventive maintenance, acts of nature, or non-conforming utilities, including electrical, fuel supply, environmental and intake/exhaust provisions. This warranty also does not cover normal wear or routine maintenance parts and materials expressly designed as expendable/consumable and replaceable.

Labor services for parts and materials replacement and repair to support this warranty are available at Despatch's normal service fees. This service is provided worldwide by a network of factory trained professionals.

Terms and Conditions

The foregoing warranty shall be deemed valid and binding upon Despatch if and only if the Customer:

1. Installs, loads, operates and maintains the equipment supplied hereunder in accordance with the instruction manual provided upon delivery and product labeling affixed to the subject equipment.
2. Agrees to follow the Emergency Procedure spelled out below.

Exclusions/Limitations of Liability

This warranty DOES NOT cover expenses incurred in the process of diagnosing and/or repairing equipment resulting from: a) operator error, b) attempted service or modifications by other than Despatch authorized technicians, c) any use of the equipment which is inconsistent with the operation manual or labeling, d) inadequate preventive maintenance, or e) acts of nature, such as floods, fire, earthquake, or acts of war or civil emergency.

Despatch shall not, in any event, be liable for indirect, special, consequential or liquidated damages or penalties, including loss of revenue, profits or business opportunities resulting from interruption of process or production. Despatch shall further be held blameless for any damages or expenses resulting from delays in our attempts to diagnose and repair the equipment, unavailability of spare parts or inaccessibility of the equipment. Specifically excluded from this warranty is responsibility for internal and external corrosion damages to the equipment.

Non-Compliance

Despatch reserves the right to suspend and withhold service as provided under this warranty in the event of non-compliance by the Customer to any terms and conditions of this warranty. Further, Despatch is held harmless for any loss of production, incurred expenses, and other inconveniences due to suspension of service under this non-compliance provision.

Emergency Procedure

In an emergency situation, Customer agrees to: a) immediately shut off fuel or energy supply (gas and electricity), b) call 911 for emergency assistance if needed, and c) call Despatch Service.

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER EXPRESS AND IMPLIED WARRANTIES WHATSOEVER, AND SPECIFICALLY THERE ARE NOT IMPLIED WARRANTIES OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE.

THE FOREGOING WARRANTY IS NOT TRANSFERABLE IN SITUATIONS WHERE EQUIPMENT OWNERSHIP IS TRANSFERRED TO ANOTHER PARTY.

Despatch Service
Worldwide Phone 612-781-5363; Worldwide Fax 612-781-5185; North American Phone 800-473-7373

Despatch Service Support Programs

Despatch continues to deliver exceptional products backed by a strong sense of responsibility and drive for long term customer satisfaction. Your partnership with Despatch can offer even higher value through your subscription to one of Despatch's high value service programs.

Warranty

Despatch's exclusive, comprehensive service programs start with the warranty which is described on the other side of this document. This warranty can be expanded immediately to meet your most stringent service needs. Despatch Service will be able to answer your service questions and provide a quotation for the immediate expansion of your product warranty.

Immediate Service Response

The key to an effective service program is response. Wherever your location, Despatch is only a phone call away. Our North American customers can reach Despatch at 1-800-473-7373. Worldwide customers can call 1-612-781-5363 or FAX 1-612-781-5485. Our Customer Service Technicians have over 200 years combined experience and access to detailed design and manufacturing documentation specific to your Despatch unit(s). This exacting level of service is a benefit only Despatch can provide and means that you can expect speedy, accurate and the most cost effective response.

Field Service Network

A worldwide network of factory trained Service Professionals is available to support your Despatch equipment. From routine repair to certified instrument calibration, the Despatch service network is positioned to respond to your needs. As a manufacturer of custom equipment, our service programs are customized to meet your specific needs regarding:

1. Service scope
2. Response time
3. Preventive maintenance frequency and content
4. Payment method

Sustained Service Support

At Despatch, long term customer satisfaction means more than just responding quickly and effectively to our customers' service needs. It means offering comprehensive customer support well beyond the scope and duration of our initial warranty. Despatch offers two basic service packages which are customized to each individual customer's need. These service packages are titled Full Service and Preventive Maintenance Plus+ service agreement products. Each is unique in the industry and offer the following benefits:

1. Priority response for minimum production interruption
2. Preventive maintenance for longer product life
3. Discounts on parts and services
4. Various payment plans to ease budgeting and recording expenses
5. Reduce purchase ordering costs

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INTRODUCTION

The special features of the Protocol™ include:

- PID Tuning
- Programmable up to 48 segments
- Built-in manual reset hi-limit control
- Built-in process timer
- Self-diagnostics
- Digital display
- Three (3) event outputs
- RS422/RS485 bi-directional communications capability
- Recursive profile capability

THEORY OF OPERATION

This section describes the Protocol installed in the LAC, LAD, LFD and LND Series ovens.

Protocol

The ovens are equipped with a modular microprocessor based digital temperature controller.

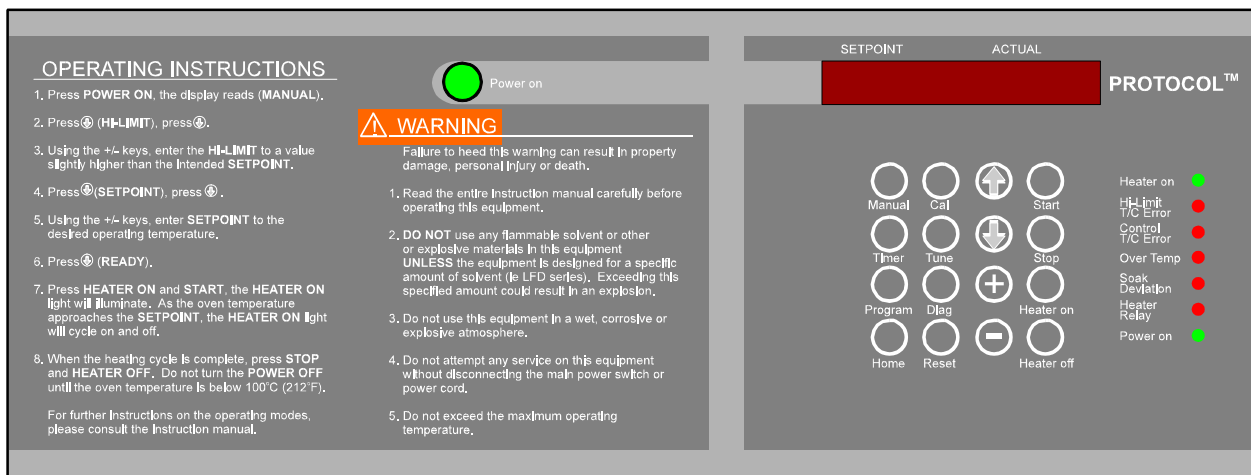


Figure 2. Main Display and Keypad on Protocol Control

The Despatch Protocol temperature controller is a dual functioning controller/high limit instrument. The control portion of Protocol incorporates a microprocessor to digitally control process variables with minimal temperature fluctuations.

The high limit portion of Protocol protects the product and/or the oven itself. If the product being processed has a critical high temperature limit, the Hi-Limit parameter should be set to a temperature somewhat below the temperature at which the product could be damaged. If the product does not have a critical high temperature limit, the Hi-Limit parameter should be set to a value slightly higher than the highest programmed setpoint to protect the oven equipment.

Keypad Controls

Table 1 Protocol Keypad Controls

| Mode | Display Code | Function | Description |
|-------------|--------------|-----------|---|
| Manual | MANUAL | Operation | Single setpoint control |
| Timer | TIMER | Operation | Single setpoint control with process timer |
| Program | PROGRAM | Operation | Programmable control with three event outputs |
| Tune | TUNE | Configure | Set instrument parameters |
| Calibrate | CAL-MODE | Service | Performs instrument calibration |
| Diagnostics | DIAGNOSE | Service | Performs instrument thermocouple tests, SSR power level and event output tests. |

Table 2 Protocol Touchkeys

| Key | Description |
|------------|--|
| ▲ | To move up through any mode |
| ▼ | To move down through any mode |
| + | To increase a setpoint or parameter |
| - | To decrease a setpoint or parameter |
| Home | To move to the beginning of any mode or segment |
| Reset | To reset the control when an error has been corrected or to view the profile number, segment number, and the number of loops (repeat times) remaining. |
| Heater On | To initiate heater relay |
| Heater Off | To disengage heater relay |
| Start | To start an operating mode |
| Stop | To stop an operating mode |

Status Indicator LEDs

Protocol has seven indicator LEDs that provide the following relevant information to the user.

Table 3 Protocol Indicator LEDs

| LED | Function |
|--------------------|---|
| Power on | Lights when the power on pushbutton is pressed. |
| Heater relay | Lights when a mode is ready for operation and the heater on key is pressed. |
| Soak Deviation | Lights when the process temperature is not held within the user-specified soak deviation limits. The light turns off when the temperature is within the soak deviation limit. |
| Over Temp | Lights when the process temperature exceeds the high limit value. The over temperature light remains lit until the Reset is pressed. |
| Control T/C Error | Lights when Protocol receives a control thermocouple error. the Reset key clears the error upon corrective action. |
| Hi-Limit T/C Error | Lights when Protocol receives a hi-limit thermocouple error. The Reset key clears the error upon corrective action. |

The Despatch Protocol temperature controller has been designed for ease of use while maintaining elaborate and versatile control capabilities.

Operating Modes

Protocol has three primary modes of operation: the Manual mode, the Timer mode and the Program mode.

Manual Mode

The Manual mode is a single setpoint control mode that controls the process at the user specified setpoint for an indefinite period of time. The Manual mode controls the oven temperature within close limits as specified by the PID tuning parameters.

Timer Mode

The Timer mode is a single setpoint control mode with a built-in process timer that starts timing either at the beginning of the process or at a user specified temperature. As in the Manual mode, the Timer mode uses the PID parameters set in the tune mode.

Program Mode

The Program mode is a programmable ramp and soak control consisting of up to eight profiles. Each profile consists of up to six segments for a total of 48 segments (8 x 6 = 48). Any one profile may be run recursively from two to 99 cycles or even continuously if it is desired.

Each segment consists of a ramp and soak period. During the ramp period, the control will track oven temperature. For example, a ramp is entered to heat from 100° C to 150° C in 50 minutes. Protocol will track the temperature 1° C every minute for 50 minutes. During the soak period, temperature is maintained as specified by the tuning and soak deviation parameters.

Protocol will not allow a soak time to begin until the actual oven temperature is within the soak deviation limit. This process is called assured soak. The ramp and soak periods are adjustable from 0 to 99 hours, 59 minutes. Within each ramp and soak period, up to three event outputs can be programmed either on or off.

The event relay is used for factory installed modifications, then disconnected before shipping. Please consult the factory for information on connecting the event outputs. When the events are connected, the user has the capability of controlling relays, solenoid valves, etc., throughout the programming cycle.

Calibration Zero Offset

The Calibration Zero Offset (CZO) of Protocol is factory preset and tested for the specified operating conditions. Special instructions for accessing the tune mode to change the CZO are referred to in the Appendix of this manual.



CZO 0.0

Figure 3. CZO Function in Tune Mode

The CZO may be useful to make the following small temperature corrections to the control system.

- Correction of known sensor calibration errors.
- Correction of any known steady temperature offset between the heated work-piece (load) and sensor. This is useful for applications where the sensor cannot be located exactly at the work-piece.
- Alignment of temperature indications in a multi-zone/multi-controller application, e.g., at ambient temperature.

Note that the CZO changes the value of the controlled temperature when used in closed loop control. The CZO function can be represented by the equations:

$$\text{Temp Indication } (^{\circ}F) = \text{Sensor Temp } (^{\circ}F) - \text{CZO}\% [100 (^{\circ}F) - \text{Sensor Temp } (^{\circ}F)]$$

$$\text{Temp Indication } (^{\circ}C) = \text{Sensor Temp } (^{\circ}C) - \text{CZO}\% [38 (^{\circ}C) - \text{Sensor Temp } (^{\circ}C)]$$

The CZO function is a straight line pivoted around 100° F (38°C). Thus, the CZO functions as an offset and has the ability to change the SLOPE of a temperature range.

Table 4 Calibration Zero Offset Examples

| CZO Display | Temperature measured by sensor | Offset °F | Temperature Indication |
|-------------|--------------------------------|-----------|------------------------|
| 0.0 | 100 °F | 0 ° | 100 °F |
| 4.0 | 150 °F | 2 ° | 152 °F |
| 10.0 | 150 °F | 5 ° | 155 °F |
| 10.0 | 300 °F | 20 ° | 320 °F |
| -10.0 | 300 °F | -20 ° | 280 °F |

A more useful formula is one the user can use to calibrate Protocol to match the center of the chamber. This requires a temperature measuring device with its thermocouple junction located at the center of the chamber. CZO can be directly calculated by:

NOTE: The CZO function is easily set for specific operating conditions.

$$CZO = 100 \left(\frac{CenterTemp (°F) - Protocol Display (°F)}{CenterTemp (°F) - 100 (°F)} \right)$$

$$CZO = 100 \left(\frac{CenterTemp (°C) - Protocol Display (°C)}{CenterTemp (°C) - 38 (°C)} \right)$$

Tune Setting

The Protocol has been preset and tested for normal operating conditions. Special instructions for changing the tune setting are referenced in the Appendix of this manual.

The Protocol on the oven can be manually tuned. For your convenience the factory has tested and preset the PID action to its optimum values. These values need not be changed under normal operating conditions.

Table 5 Factory PID Settings

| | |
|-------------------|-------------------|
| Proportional Band | 5 degrees |
| Reset Time | 30 seconds/repeat |
| Rate Time | 0 degrees/second |

NOTE: Reset times greater than 35 seconds/repeat are not recommended.

Protocol Hi-Limit

Protocol will not let the high limit value drop below the setpoint value. In certain situations, it may be necessary to change the setpoint first and then adjust the high limit value.

It will be necessary to reset the hi-limit whenever it has tripped. The hi-limit may be reset by first allowing the oven chamber to cool slightly (or increasing the parameter by several degrees) and pushing the Reset key. During a high limit condition the Over Temp LED will turn on thus deactivating the heater.

WARNING: Never operate the oven at a temperature in excess of the maximum operating temperature.

INSTRUCTIONS

Start-Up

An outline and examples for the Manual mode, Timer mode and Program mode are referenced in the Appendix. A completed typical program worksheet accompanies all programmable event outputs installed at the factory.

1. Start Fan.
 - a. Press **Power on** pushbutton. You will hear the recirculating fan start.
 - b. Check that the green **Power on** LED is on.

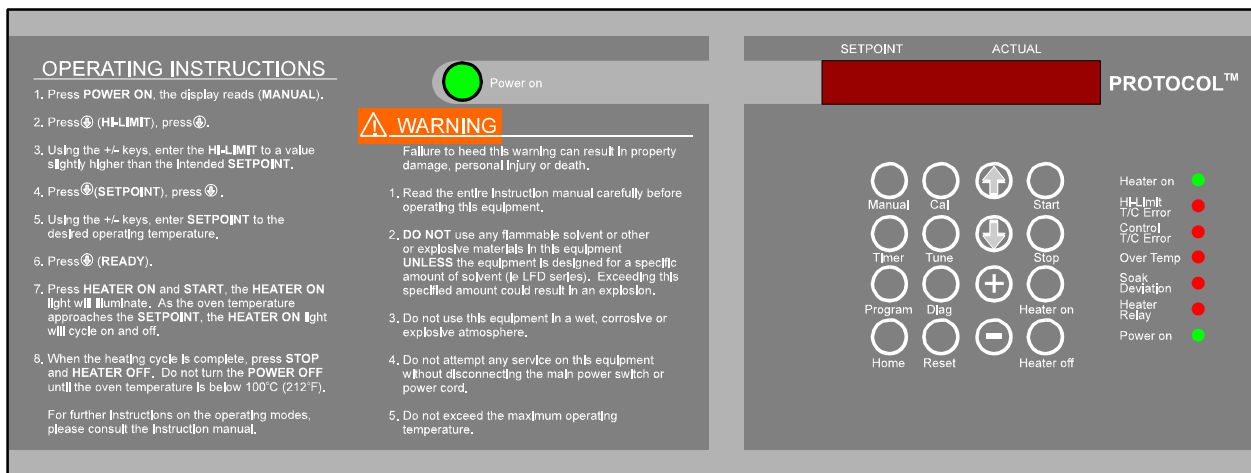


Figure 5. Protocol Control Panel

Manual Mode

Startup

The following are startup instructions for the Manual mode.

1. Select Manual mode.
 - a. Press the **Manual** key. MANUAL will be displayed.
2. Enter the high limit temperature.
 - a. Press ▼ key. HI-LIMIT will be displayed.
 - b. Press ▼ key.
 - c. Using the +/- keys, enter the high limit temperature to a value slightly higher than the intended SETPOINT.
3. Enter the Setpoint.
 - a. Press ▼ key. SETPOINT will be displayed.
 - b. Press ▼ key.
 - c. Using the +/- keys, enter the SETPOINT to the desired operating temperature.

NOTE: For safety reasons, Protocol will not let the operator set the Hi-limit below the setpoint. It may be necessary to adjust the Protocol setpoint first, then adjust the Hi-limit.

NOTE: During processing the display shows the setpoint on the left and the actual oven temperature on the right.

Run

The following are run instructions for the Manual mode.

1. Press ▼ key. READY will be displayed.
2. Press **Heater on** key. The Heater relay LED will illuminate.
3. Press **Start** key. The Heater on LED will illuminate. As the oven temperature approaches the setpoint, the Heater on LED will cycle on and off.

NOTE: When Protocol is run in the Manual Mode, the setpoint can be adjusted without stopping the operation. The setpoint is adjusted by using the +/- keys.

Stop

The following are stop instructions for the Manual mode.

1. Press the **Heater off** key. The Heater Relay LED will shut off.
2. Wait for oven temperature to fall below 100° C (212° F).
3. When the Manual mode is complete, press the **Reset** key to display the final process temperatures.
4. Press the **Stop** key.
5. Press the **Power on** pushbutton to turn power off.

An example of the Manual mode is referenced in the Appendix.

Timer Mode

Startup

The following are startup instructions for the Timer mode.

NOTE: During processing the display shows the setpoint on the left and the actual oven temperature on the right.

1. Select Timer mode.
 - a. Press **Timer** key. **TIMER** will be displayed.
2. Enter the high limit temperature.
 - a. Press ▼ key. **HI-LIMIT** will be displayed.
 - b. Press ▼ key.
 - c. Using the +/- keys, enter the high limit temperature to a value slightly higher than the intended setpoint.
3. Enter the Setpoint.
 - a. Press ▼ key. **SETPOINT** will be displayed.
 - b. Press ▼ key.
 - c. Using the +/- keys, enter the **SETPOINT** to the desired operating temperature.
4. Enter the process time.
 - a. Press ▼ key. **TIME** will be displayed.
 - b. Using the +/- keys, enter the time of the process. (HHMM (hours/minutes) or MMSS (minutes/ seconds) selected in the tune mode).
5. Enter timer starting temperature.
 - a. Press the ▼ key. **TEMP YES/NO** will be displayed.

NOTE: For safety reasons, Protocol will not let the operator set the Hi-limit below the setpoint. It may be necessary to adjust the Protocol setpoint first, then adjust the Hi-limit.

- b. Use the + or - keys to select either YES or NO.
 - Press the - key to display NO and begin timing at ambient.
 - Press the + key to display YES and begin timing at the following input temperature.
- c. Press the ▼ key. TEMP and the begin timing temperature will be displayed.
- d. If YES was selected in step b, use the + or - keys to enter the temperature at which the process timer begins timing.

If NO was selected in step b, this setpoint has no bearing on oven operation.

Run

The following are run instructions for the Timer mode.

1. Press the ▼ key. READY will be displayed.
2. Press the **Heater on** key. The **Heater Relay** LED will illuminate.
3. Press the **Start** key. The **Heater on** LED will illuminate and the setpoint and the actual temperature will be displayed. As the oven temperature approaches the setpoint, the **Heater on** LED will cycle on and off.

NOTE: When the Timer mode is running, pressing the **Start** key will display the time remaining in the cycle. The display will show TRHHMMSS which stands for the time remaining, hours, minutes and seconds.

Manually Stop

The following are manual stop instructions for the Timer mode.

1. Press the **Heater off** key.
2. Wait for oven temperature to fall below 100° C (212° F).
3. When the Timer mode is complete, press the **Reset** key to display the final process temperatures.
4. Press the **Stop** key.

5. Press the **Power on** pushbutton to turn power off.

An example of the Timer mode is referenced in the Appendix of this manual.

Program Mode

Startup

The following are startup instructions for the Program mode.

NOTE: If all event relays are disconnected or no modifications involving event relays have been made to your particular oven, programming the events has no effect on oven operation.

function in the TUNE mode.

In any one segment, if the ramp and soak times are zero, Protocol ignores the remaining segments of the profile. A soak period will not begin until the actual oven temperature is within the soak deviation limit. During any segment of a profile, if the actual oven temperature falls outside of the soak deviation limit, the Soak Deviation LED will be illuminated.

1. Select Program mode.
 - a. Press Program key. PROGRAM will be displayed.
2. Enter the high limit temperature.
 - a. Press ▼ key. HI-LIMIT will be displayed.
 - b. Press ▼ key.
 - c. Use the + or - keys to enter the high limit temperature to a value higher than the intended setpoints.
3. Enter the profile number.
 - a. Press ▼ key. PROFILES will be displayed.
 - b. Press ▼ key. PRO - 1 will be displayed.
 - c. Use the + or - keys to enter the profile number to program.
4. Program the profile.
 - a. Press ▼ key. SEG - 1 will be displayed.
 - b. Program the ramp rate.
 1. Press ▼ key. RAMP0001 will be displayed.

NOTE: For safety reasons, Protocol will not let the operator set the Hi-Limit below the setpoint. It may be necessary to adjust the Protocol setpoint first, then adjust the Hi-Limit.

NOTE: During processing the display shows the setpoint on the left and the actual oven temperature on the right.

2. Use the + or - keys to enter the ramp time.
- c. Program the events desired during the ramp time.
 1. Press ▼ key. EVENTS will be displayed.
 2. Press ▼ key for each event.
 3. Use the + or - keys to program the event outputs ON or OFF for the ramp period.
- d. Program the ramp ending temperature.
 1. Press ▼ key. TEMP and the ramp ending temperature will be displayed.
 2. Use the + or - keys to enter the desired ramp ending temperature.
- e. Program the soak time.
 1. Press ▼ key. SOAK and the soak time will be displayed.
 2. Use the + or - keys to enter the soak time.
- f. Program the events desired during the soak time.
 1. Press ▼ key. EVENTS will be displayed.
 2. Press ▼ for each event.
 3. Use the + or - keys to program the event ON or OFF for the soak period.
- g. Enter the remaining segments 2-6 by following steps a through f.

WARNING: Never operate the oven at a temperature in excess of the maximum operating temperature.

5. Enter the Soak-Deviation.

- a. Press ▼ key until SOAK-DEV is displayed.
- b. Press a key. The symbol +/- will be displayed.

c. Use the + or - keys to enter the soak deviation limit.

6. Enter the next profile to continue to, or end profile.

a. Press ▼ key. GOTO will be displayed.

b. Use the + or - keys to enter the profile number to continue to. Select End to stop at the end of this profile. For continuous profiles enter the same number of the profile that is currently being programmed.

7. Enter the number of profile recursions.

a. Press ▼ key. REPEAT will be displayed.

b. Press ▼ key. TIMES will be displayed.

c. Use the + or - keys to enter the number of times to complete the profile being programmed (1 - 99).

8. Enter the profile end condition. The hold command is contingent on the final segment of the last profile to be run only.

a. Press ▼ key. HOLD will be displayed.

b. Use the + or - keys to select YES or NO.

- Selecting YES will hold at last setpoint. The event outputs will be held at their last value.
- Selecting NO will not hold at last setpoint. The event outputs will be turned off.

NOTE: The SOAK-DEV limit is also the assured soak limit. This means that the soak times will not begin until the process temperature is within the SOAK-DEV parameter.

NOTE: If the Protocol is in a hold condition, pressing the **Reset** key will display that the control is in segment 7 (HOLD).

Run

The following are run instructions for the Program mode.

1. Press **Home** key until PROGRAM is displayed.
2. Press ▼ key until PRO-1 is displayed.
3. Make sure the correct starting profile is entered by pressing + or -.
4. Press the ▲ key until READY is displayed.
5. Press **Heater on** key. The Heater relay LED will illuminate.
6. Press **Start** key. The Heater on LED will illuminate. As the oven temperature approaches the setpoint, the Heater on LED will cycle on and off. During processing, the display shows the setpoint on the left and the actual oven temperature on the right.

NOTE: When in the Program mode, pressing the **Start** key will display the time remaining in the cycle (TRHHMMSS). Pressing the **Reset** key will display the profile number, segment number and the loops (REPEAT TIMES) remaining.

Manually Stop

The following are manual stop instructions for the Program mode.

1. Press **Heater off** key.
2. Wait for oven temperature to fall below 100°C (212°F).
3. Press the **Reset** key to display the final process temperature.
4. Press **Stop** key.
5. Press **Power on** pushbutton to turn power off.

Examples of the Program mode are referenced in the Appendix of this manual.

APPENDIX

Special Instructions

The Protocol has been preset and tested at the factory for normal operating conditions. In most applications, it will not be necessary to alter the oven's settings. This section contains additional information and reference for special operating conditions.

Control Instrument

Tune Mode

Various functions of the control instrument are set by parameters in the tune mode. To access the tune mode, it is necessary to enter the proper code.

1. Press **Tune** key. The display reads TUNE.
2. Press ▼ key. CODE *** will be displayed.
3. Enter +, -, -, +, -, +. PID TUNE will be displayed.

The PID tuning parameters may be entered. The units are listed below.

P = degrees
I = seconds/repeat
D = degrees/second

Table 6 Tuning Outline

| Display | Description |
|----------|---|
| TUNE | Selects tune mode. |
| CODE | Enter + - - + - + |
| PID TUNE | Enter tuning parameters. |
| P-1 | Proportional band in degrees (+/- keys). |
| I-1 | Reset in seconds/repeat (+/- keys). |
| D-1 | Rate in degrees/second keys). |
| DEG - | Select °C or °F (+/- keys). |
| SPL - | Setpoint limit, set to maximum temperature of oven (+/- keys) |
| CZO - | Calibration zero offset -99.9 to 99.9 (+/- keys). |
| DIS | Time set in MMSS (minutes/seconds) or HHMM (hours/minutes). |
| BEEP | Select beep on or off (+/- keys). |
| PF-RECVR | Power failure recovery mode. Use + or - keys to select from STOP, RESUME or |
| | HOLD. |
| | <ul style="list-style-type: none"> • STOP - Program terminates. must restart from the beginning of the program. • RESUME - When power is restored, program resumes at the point where power failure occurred. • HOLD - Program waits for the operator. The operator has a choice of terminating or resuming the program. |
| DIG COMM | Digital communications option. Disregard unless Protocol is supplied with optional |
| | digital communications interface. For proper setting, refer to the protocol software |
| | manual or the Digital Communication User Guide. Select from NO COMM, CPIF or |
| | ASCII (+ or - keys). Select from RS232C or RS422A (+ or - keys). Select address |
| | (ADDR) from 1 to 999 (+ or - keys). |
| | <ul style="list-style-type: none"> • NO COMM - No digital communication. • CPIF - Computer interface mode communications (used for Protocol software) • ASCII - ASCII line mode communications (used for user-created programs) |
| RECONFIG | For saving changes to DIG COMM options in memory. |
| PROF CLR | Entering code clears all profiles to default values. |
| VARS CLR | Entering code clears the SRAM in Protocol. All parameters must be reset. Should be |
| | done in EXTREME circumstances only. Recalibration is essential. |
| CODE *E* | To turn events relays on in the profile mode. Do not change the code setting. |

Experience and experimentation with tuning parameters will guide the user in determining the proper settings when normal conditions are not present.

Tuning Worksheet

In most applications it is not necessary to alter tuning parameters. To enter the tune mode, press the **Tune** key. Tune will be displayed. Press ▼ and enter +, -, -, +, -, +. Using the ▼ key and the +/- keys, enter the desired settings. Press **Home** when finished.

Tuning Worksheet

| Display | Setting | Factory Setting | Units |
|---------|---------|-----------------|--|
| P-1 | | 5 | degrees |
| I-1 | | 30 | seconds/repeat |
| D-1 | | 0 | degrees/second |
| DEG - | | C | °F (°C) |
| SPL - | | Max Temp | °F (°C) |
| CZO | | varies | factor calibrated to center of the chamber |
| DIS - | | HHMM | minutes/seconds (hours/minutes) |
| BEEP | | On | off (on) |

Notes:

1. The alternate is listed in ().
2. See Table 10, Tuning Outline, for further information regarding display codes.
3. Tuning parameters may change from those set at the factory. Load mass, fresh air and exhaust damper settings will affect tuning parameters. Some experimentation is required to determine optimum settings.

Reset times greater than 35 seconds/repeat are not recommended.

Calibration Mode

Protocol has been tested and calibrated at the factory. Under normal operating conditions recalibration should not be necessary. However, if the instrument does not comply with known standards recalibration may be necessary.

Calibration Instructions

We recommend using a certified analog thermocouple simulator/calibration source with less than $\pm 1^\circ \text{F}$ noise. We have experienced signal stability problems with some microprocessor based thermocouple simulator/calibrators which induce an error during the calibration procedure. This error generally results in a non-linear shift in the controller's indicated temperature.

WARNING: Calibration equipment without internal ambient compensation provisions requires subtracting the ambient mV signal from the calibration temperature mV signal to calibrate Protocol properly.

1. Disconnect AC power to the oven.
2. Remove Protocol controller to expose thermocouple input terminals.
3. Disconnect control and Hi-Limit thermocouples from controller thermocouple input terminals (Control T/C, and Hi-Limit T/C).

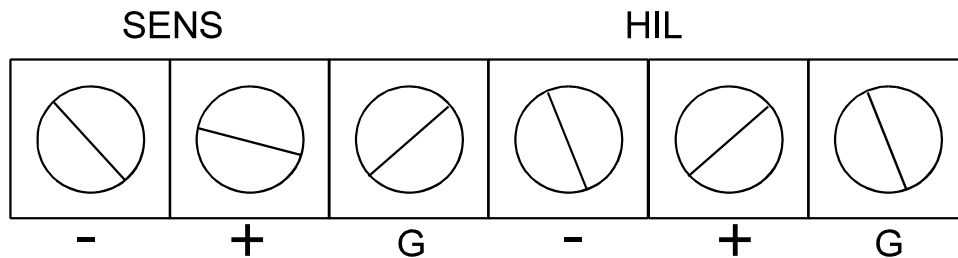


Figure 6. Top View of J Type Thermocouple Inputs on Protocol

4. Mark thermocouple leads if not labeled.
5. Connect a 6 foot piece of type J thermocouple lead wire to each of the Control T/C and Hi-Limit T/C terminals.
6. Twist together or jumper the lead wire end not connected to the Control T/C and Hi-Limit T/C terminals. This creates a junction and prevents a control sensor error [S-T/C ERR] and Hi-Limit sensor error [H-T/C ERR] caused by an open thermocouple.

All errors must be cleared to perform calibration. Any active error will inhibit the calibration function. To clear a Hi-Limit control error [HL ERROR] caused by lost of calibration (Hi-Limit indication of 500° C or 932° F in the diagnostic mode):

1. Increase the Hi-Limit setpoint to 500° C or 932° F.
2. Press the **Reset** key.

7. Loosely fasten the Protocol controller to the oven.
8. Re-connect AC power to the oven.
9. Press the **Power on** pushbutton to energize oven.
10. Press the **Tune** key. The display reads [TUNE].
11. Use the ▼ and ▲ keys to scroll through the tune mode configuration. The controller must be configured to operate in °F (Fahrenheit) and CZO should be set to zero (0.0).
 - a. Record initial tune mode parameters prior to making any changes.
 - b. Press the ▼ key. The display reads [CODE ***].
 - c. Press the following key sequence: +, -, -, +, -, +.
The display reads [PID TUNE]. Protocol is in the tune mode.
 - d. Use the following table to change the tune mode parameters.

Tune Mode Parameter Calibration

NOTE: ### or ##.# represents a numeric value or parameter.

| Press | Display | Factory Default Setting | Actual Setting | Press | Adjustable Range |
|-------|-------------|---|----------------|--|-----------------------------------|
| ▼ key | P-1 ### | 5 | | + or - keys | 0° C to 500° C 32° F to 932° F |
| ▼ key | I-1 ### | 30 | | + or - keys | 0 to 999 seconds/repeat |
| ▼ key | D-1 ### | 0 | | + or - keys | 0 to 999 degrees/second |
| ▼ key | DEG - C | C | | + key for C or - key for F. | |
| ▼ key | SPL - ### | maximum designed operating temperature ¹ | | + or - keys | 0° C to 500° C 32° F to 932° F |
| ▼ key | CZO - ##.# | can vary | | + or - keys to change parameter to 0.0 | -99.9 to 99.9 degrees |
| ▼ key | DIS HHMM | HHMM | | + key for HHMM (hours and minutes) or the - key for MMSS (minutes and seconds). | |
| ▼ key | BEEP ON | ON | | + key for ON or the - key for OFF. | |

¹ 204° C/400° F, 260° C/500° F, 343° C/650° F

- e. Press the **Manual** key. The display reads [MANUAL].
 - f. Allow the controller a thirty (30) minute warm up time before proceeding to the step #13 - CAL MODE.
12. Press the **Cal** key. The display reads [CAL--MODE].
 13. Press the ▼ key. The display reads [CODE ***].
 14. Press the following key sequence: -, +, +, -, +, -.
The display reads [HCAL 250].

15. Apply a 250° F signal to the high limit thermocouple input:
 - a. Connect the piece of type J thermocouple lead wire, wired to the High Limit T/C terminals, to a thermocouple simulator.
 - b. Set the simulator to output a type J thermocouple signal.
 - c. Twist together or jumper the piece of type J thermocouple lead wire, wired to the Control T/C terminals. This creates a junction and prevents a Control sensor error [S-T/C ERR] caused by an open thermocouple. Press the **Reset** key to clear a Control sensor error [S-T/C ERR] caused by an open thermocouple.
 - d. Adjust the simulator to supply a 250° F signal. Wait for 30 seconds while the control stabilizes.
16. Press the following key sequence: -, -, +. The display now reads HCAL 450.
17. Adjust the simulator to supply a 450° F signal. Wait for 30 seconds while the control stabilizes.
18. Press the following key sequence: +, +, -. The display now reads HIL 450.
19. To verify proper calibration, adjust the simulator to supply a 350° F signal. Within 30 seconds, the display should stabilize and read HIL 350.
20. To calibrate the control sensor, press the ▼ key. The display reads [SCAL 250].
21. Apply a 250° F signal to the control thermocouple input:
 - a. Connect the piece of type J thermocouple lead wire, wired to the Sensor T/C terminals, to a thermocouple simulator.
 - b. The simulator should be set to output a type J thermocouple signal.
 - c. Twist together or jumper the piece of type J thermocouple lead wire to the Hi-Limit T/C terminals. This creates a junction and prevents a hi-limit sensor error [H-T/C ERR] caused by an open thermocouple. Press the **Reset** key to clear a hi-limit sensor error [H-T/C ERR] caused by an open thermocouple.
 - d. Adjust the simulator to supply a 250° F signal. Wait for 30 seconds while the control stabilizes.

22. Press the following key sequence: -, -, +. The display now reads SCAL 450.
23. Adjust the simulator to supply a 450° F signal. Wait for 30 seconds while the control stabilizes.
24. Press the following key sequence: +, +, -. The display now reads SENS 450.
25. To verify proper calibration, adjust the simulator to supply a 350° F signal. Within 30 seconds, the display should stabilize and read SENS 350.
26. Press the Manual key. The display reads [MANUAL]. If the control did not calibrate properly repeat steps 12 - 25.
27. Press the **Power on** pushbutton to de-energize oven.
28. Disconnect AC power to the oven.
29. Remove Protocol controller to expose thermocouple inputs terminals.
30. Disconnect the two pieces of type J thermocouple lead wire connected to the Control T/C and Hi-limit T/C terminals.
31. Re-connect control and Hi-Limit thermocouples to the controller thermocouple terminals (Control T/C, and Hi-limit T/C).
32. Re-install the Protocol controller onto the oven.
33. Re-connect AC power to the oven.
34. Press the **Power on** pushbutton to energize oven.
35. Press the **Tune** key. The display reads [TUNE].
36. Reset any tune mode parameters that were changed in step 12 to perform calibration (examples: DEG = F and CZO = 0.0).
37. When changes have been completed, press the **Manual** key. The display reads [MANUAL].

The calibration procedure is complete.

Calibration Recovery

The Protocol control has a factory calibration recovery feature. This feature allows the operator to restore the Protocol to an operational condition should a calibration error occur. The Factory Calibration Recovery feature should only be used as a temporary fix until a proper calibration procedure utilizing a calibration source can be performed. Only a complete calibration will restore the Protocol to an optimum performance level.

For proper calibration instructions refer to the calibration section of this manual.

Instructions

1. Select the Diagnose mode by pressing the DIAG key.
2. Press the ▼ (down arrow) key until RCVR SEN is displayed.
3. To recover the control sensor calibration value, press the key sequence +, -, -, +, -, +.
4. Press the ▼ (down arrow) key until RCVR HIL is displayed.
5. To recover the high limit sensor calibration value, press the key sequence +, -, -, +, -, +.

The calibration recovery is now complete.

Diagnostics Mode

The diagnostics mode is provided to give certain relative information about Protocol. The following table gives an outline of the diagnostics mode.

| Display | Description |
|----------|---|
| DIAGNOSE | Select Diagnostics mode. |
| SSR | Protocol SSR output level. |
| EVENTS | Events 1-3 follow |
| E-1 | Event 1 output |
| E-2 | Event 2 output |
| E-3 | Event 3 output |
| SENS-T/C | Control thermocouple display follows |
| GOOD | Control thermocouple test and input reading |
| HL - T/C | Hi-limit thermocouple display follows |
| GOOD | Hi-limit thermocouple test and input reading |
| PWR | % output |
| RCVR SEN | Recover factory calibration for control sensor |
| RCVR HIL | Recover factory calibration for high limit sensor |

Items that can be adjusted by the user include SSR (ON or OFF), Events E-1, E-2 and E-3(ON or OFF) and PWR. The SSR and PWR items can be used to test the solid state relay for proper operation. The SSR item allows the SSR to output 100% (ON) or 0% (OFF). The PWR item allows for adjustable output from 0% to 100%. to implement, adjust the PWR level with the +/- keys and turn on the heater relay.

RCVR SEN and RCVR HIL are used to restore the factory calibration should a calibration error occur.

Power Failure

In the event that the power supplied to Protocol is insufficient at any point during a running mode, the display will read PWR-FAIL. In the tune mode the user can choose the Power Fail Recovery mode from Stop, Resume and Hold. To restart after a power failure in the hold mode, press the **Start** key to resume oven operation. Otherwise, press the **Reset** key to clear the PWR-FAIL display. Do not shut off the power during a running mode. This creates an error condition and PWR-FAIL will be displayed the next time Protocol is powered up. Instead, press the **Stop** key and the **Heater Off** key. This will power off Protocol without creating an error condition.

Programming Examples and Outline

The following examples show a step by step procedure for programming Protocol in the Manual, Timer and Program modes. Example 1 covers the Manual mode and example 2 covers the Timer mode. A detailed outline covers the Program mode with a programming worksheet and examples 3-5 following the outline.

NOTE: Do not turn the power off until the oven temperature is below 100°C (212°F).

Example 1 - Manual Mode

Control the process at 250°F.

NOTE: °F is selected in the tune mode.

Manual Mode Example

| Key | DISPLAY | Description |
|------------|----------|--|
| Manual | MANUAL | Select Manual mode |
| ▼ | Hi-Limit | Enter the high limit temperature |
| ▼ | HL 200 | High limit temperature currently set at 200°F |
| + | HL 275 | Increase high limit temperature to 275°F |
| ▼ | SETPOINT | Enter the setpoint |
| ▼ | 180 75 | Setpoint at 180°F, actual oven temperature at 75°F |
| + | 250 75 | Increase setpoint to 250°F |
| ▼ | READY | Protocol is ready to run Manual mode |
| Heater On | READY | Heater relay initiated, heater ready for power |
| Start | 250 75 | Setpoint = 250°F, actual oven temperature = 75°F |
| Stop | READY | Stop Manual mode |
| Heater Off | READY | Heater relay LED is off, heater secured off |

Example 2 - Timer Mode

Control the process at 200°C for three hours and 15 minutes with the timer beginning at 195°C. Protocol will stop automatically when run in Timer mode.

NOTE: °C and HHMM (hours/minutes) is selected in the tune mode.

Timer Mode Example

| Key | DISPLAY | Description |
|------------|----------|--|
| Timer | TIMER | Select timer mode |
| ▼ | Hi-Limit | Enter the high limit temperature |
| ▼ | HL 225 | Hi-Limit currently set at 225°C |
| - | HL 215 | Decrease high limit to 215°C |
| ▼ | SETPOINT | Enter the setpoint |
| ▼ | 210 25 | Setpoint at 210°C, actual oven temperature at 25°C |
| - | 200 25 | Decrease setpoint to 200°C |
| ▼ | TIME0010 | Timer currently set for ten minutes |
| + | TIME0315 | Increase timer to three hours and 15 minutes |
| ▼ | TEMP NO | Timer currently set to begin timing at ambient |
| + | TEMP YES | Timer set to begin timing at the following temperature |
| ▼ | TEMP 79 | Timer currently set to begin timing at 79°C |
| + | TEMP 195 | Timer set to begin timing at 195°C |
| ▼ | READY | Protocol is ready to run Timer mode |
| Heater On | READY | Heater relay LED on, heater ready for power |
| Start | 200 25 | Setpoint = 200°C, actual oven temperature = 25°C |
| Stop | READY | Stop Timer mode |
| Heater Off | READY | Heater relay LED is off, heater secured off |

Program Mode

Program Mode Outline

| Display | Description |
|------------------|---|
| PROGRAM | Select Program mode. |
| Hi-Limit | Hi-Limit for Program mode |
| HL | Enter high limit temperature (+ or - keys). |
| PROFILES PRO- | Enter profile number (1-8). |
| SEG- | Segment number of profile (1-6) |
| RAMP | Ramp time entered |
| EVENTS | Event status for ramp time |
| E-1 | Event 1 status (ON or OFF) |
| E-2 | Event 2 status (ON or OFF) |
| E-3 | Event 3 status (ON or OFF) |
| TEMP | Ramp ending temperature |
| SOAK | Soak period of ramp ending temperature |
| EVENTS | Event status for soak period |
| E-1 | Event 1 status (ON or OFF) |
| E-2 | Event 2 status (ON or OFF) |
| E-3 | Event 3 status (ON or OFF) |
| SOAK-DEV | Soak-Deviation limit for profile (Also assured soak limit) |
| +/- | Enter soak-deviation limit. |
| GOTO | Enter profile to GOTO End = Move to REPEAT TIMES command 1 = GOTO profile 1 2 = GOTO profile 2 : 8 = GOTO profile 8 |
| REPEAT TIMES | Enter number of recursions (1-99) 1 = Execute profile 1 times 2 = Execute profile 2 times : 99 = Execute profile 99 times |
| HOLD | Hold at last setpoint? |
| YES | Hold at last setpoint indefinitely. Holds event outputs at last value. |
| NO | No hold at last setpoint. Event outputs turn OFF. |

Notes on the Program mode:

- The profile number is manually entered using the + or - keys.
- Six segments exist for each profile.
- If the ramp time and soak time for any one segment is zero, Protocol ignores the remaining segments.
- The REPEAT TIMES command is the number of times to execute the profile being programmed.
- The HOLD command is contingent on the final segment of the last profile to be run only.
- A soak time will not begin until the actual temperature is within the soak-deviation limit. (Assured soak limit).
- Make sure the proper starting profile number is displayed in the PRO- prompt before executing the profile to be run.

While a program is being executed, pressing the **Reset** key will display the profile number, segment number and the number of loops (REPEAT TIMES) remaining. Pressing the **Start** key will display the appropriate ramp or soak time remaining (TR.)

If Protocol is in a HOLD condition, pressing the **Reset** key will display that the control is in segment 7 (HOLD.)

Program Worksheet

The program worksheet serves as a guide to the input parameters for the program mode.

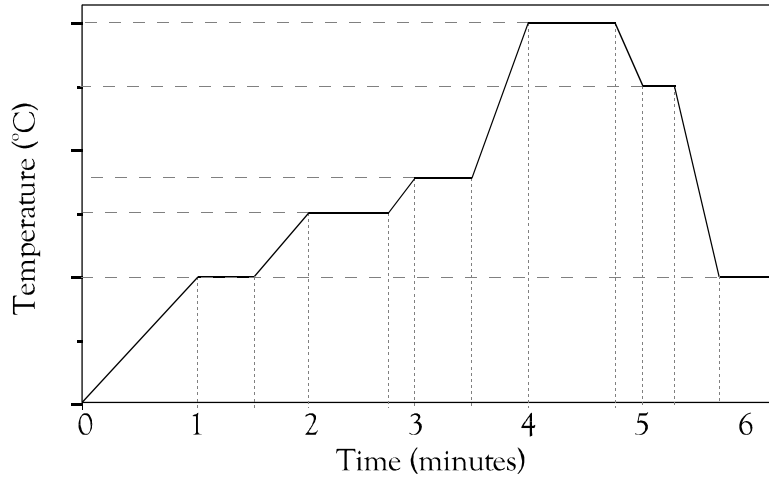


Figure 7. Sample Profile

| Display | Setting(s) | | | | | |
|--------------|------------|-------|-------|-------|-------|-------|
| HL | _____ | | | | | |
| PRO- | _____ | | | | | |
| SEG- | 1 | 2 | 3 | 4 | 5 | 6 |
| RAMP | _____ | _____ | _____ | _____ | _____ | _____ |
| E-1 | _____ | _____ | _____ | _____ | _____ | _____ |
| E-2 | _____ | _____ | _____ | _____ | _____ | _____ |
| E-3 | _____ | _____ | _____ | _____ | _____ | _____ |
| TEMP | _____ | _____ | _____ | _____ | _____ | _____ |
| SOAK | _____ | _____ | _____ | _____ | _____ | _____ |
| E-1 | _____ | _____ | _____ | _____ | _____ | _____ |
| E-2 | _____ | _____ | _____ | _____ | _____ | _____ |
| E-3 | _____ | _____ | _____ | _____ | _____ | _____ |
| SOAK-DEV | _____ | | | | | |
| GOTO | _____ | | | | | |
| REPEAT TIMES | _____ | | | | | |
| HOLD | _____ | | | | | |

Example 3 - Program Mode

Follow the characteristic curve listed below.

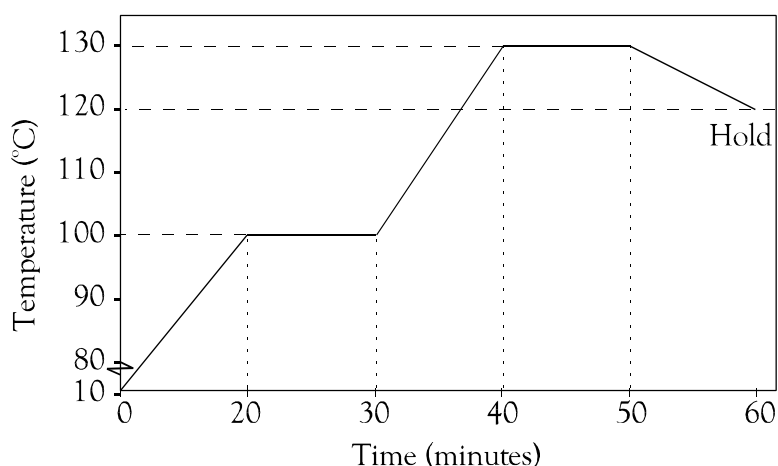


Figure 8. Example Temperature Profile

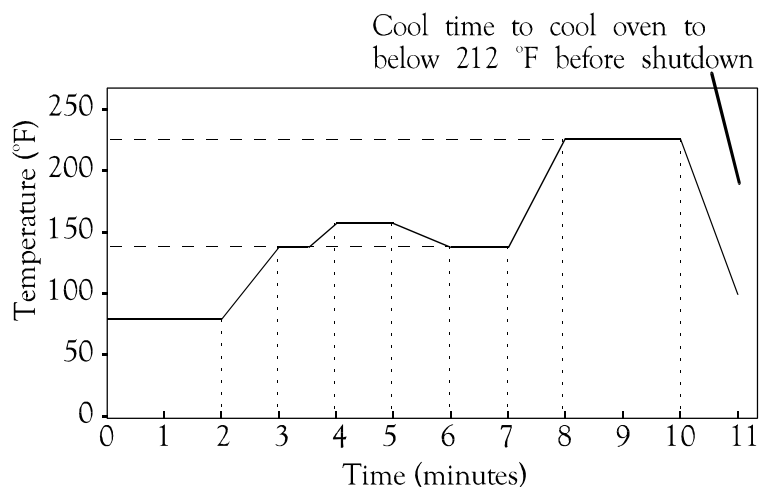
NOTES: HHMM (hours/minutes) and °C selected in the tune mode. No event outputs are being used. Soak-Deviation limit = $\pm 7^{\circ}\text{C}$ (also assured soak limit). Hold at last setpoint. Ramp and soak times of zero in any one segment ignores remaining segments.

| | | | | | | |
|--------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Display | Setting(s) | | | | | |
| HL | <u>150</u> | | | | | |
| PRO- | <u>1</u> | | | | | |
| SEG- | 1 | 2 | 3 | 4 | 5 | 6 |
| RAMP | <u>0020</u> | <u>0010</u> | <u>0010</u> | <u>0000</u> | <u>0000</u> | <u>0000</u> |
| E-1 * | _____ | _____ | _____ | _____ | _____ | _____ |
| E-2 | _____ | _____ | _____ | _____ | _____ | _____ |
| E-3 | _____ | _____ | _____ | _____ | _____ | _____ |
| TEMP | <u>100</u> | <u>130</u> | <u>120</u> | <u>0000</u> | <u>0000</u> | <u>0000</u> |
| SOAK | <u>0010</u> | <u>0010</u> | <u>0001</u> | <u>0000</u> | <u>0000</u> | <u>0000</u> |
| E-1 | _____ | _____ | _____ | _____ | _____ | _____ |
| E-2 | _____ | _____ | _____ | _____ | _____ | _____ |
| E-3 | _____ | _____ | _____ | _____ | _____ | _____ |
| SOAK-DEV | <u>7</u> | | | | | |
| GOTO | <u>End</u> | | | | | |
| REPEAT TIMES | <u>1</u> | | | | | |
| HOLD | <u>Yes</u> | | | | | |

* Events E-1, E-2, and E-3 will not be shown if they are not turned on.

Example 4 - Program Mode

Autostart the oven after two hours and follow the characteristic curve below.



NOTES: MMSS (minutes/seconds) and °F selected in the tune mode. Event 1 wired properly for autostart, events 2 - 3 are not used. No hold at last setpoint.

Soak-Deviation = $\pm 5^{\circ}\text{F}$ (also assured soak limit). Minimum operating temperature is 70°F .

Figure 9. Example Temperature Profile

| Display | Setting(s) | | | | | |
|--------------|---------------|---------------|---------------|---------------|---------------|---------------|
| HL | <u>240</u> | | | | | |
| PRO- | <u>1</u> | | | | | |
| SEG- | <u>1</u> | <u>2</u> | <u>3</u> | <u>4</u> | <u>5</u> | <u>6</u> |
| RAMP | <u>0001</u> | <u>0100</u> | <u>0030</u> | <u>0100</u> | <u>0100</u> | <u>0030</u> |
| E-1 * | <u>OFF</u> | <u>ON</u> | <u>ON</u> | <u>ON</u> | <u>ON</u> | <u>ON</u> |
| E-2 | <u> </u> | <u> </u> | <u> </u> | <u> </u> | <u> </u> | <u> </u> |
| E-3 | <u> </u> | <u> </u> | <u> </u> | <u> </u> | <u> </u> | <u> </u> |
| TEMP | <u>70</u> | <u>130</u> | <u>160</u> | <u>130</u> | <u>220</u> | <u>100</u> |
| SOAK | <u>0200</u> | <u>0030</u> | <u>0100</u> | <u>0100</u> | <u>0200</u> | <u>0001</u> |
| E-1 | <u>OFF</u> | <u>ON</u> | <u>ON</u> | <u>ON</u> | <u>ON</u> | <u>OFF</u> |
| E-2 | <u> </u> | <u> </u> | <u> </u> | <u> </u> | <u> </u> | <u> </u> |
| E-3 | <u> </u> | <u> </u> | <u> </u> | <u> </u> | <u> </u> | <u> </u> |
| SOAK-DEV | <u>5</u> | | | | | |
| GOTO | <u>End</u> | | | | | |
| REPEAT TIMES | <u>1</u> | | | | | |
| HOLD | <u>NO</u> | | | | | |

* Only E1 event is turned on.

Example 5 - Program Mode

Complete characteristic curve five times.

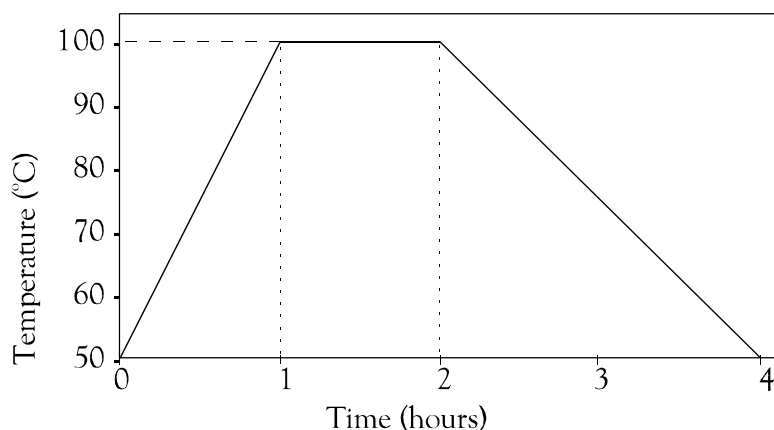


Figure 10. Example Temperature Profile

NOTES: HHMM (hours/minutes) and °C selected in the tune mode. No events used. Soak-Deviation = 10°C (also assured soak limit). Minimum operating temperature = 50°C. Ramp and soak times of zero in any one segment ignores remaining segments.

| Display | Setting(s) | | | | | |
|--------------|-------------|-------------|-------------|-------------|-------------|-------------|
| HL | <u>115</u> | | | | | |
| PRO- | <u>1</u> | | | | | |
| SEG- | <u>1</u> | <u>2</u> | <u>3</u> | <u>4</u> | <u>5</u> | <u>6</u> |
| RAMP | <u>0100</u> | <u>0200</u> | <u>0000</u> | <u>0000</u> | <u>0000</u> | <u>0000</u> |
| E-1 | _____ | _____ | _____ | _____ | _____ | _____ |
| E-2 | _____ | _____ | _____ | _____ | _____ | _____ |
| E-3 | _____ | _____ | _____ | _____ | _____ | _____ |
| TEMP | <u>100</u> | <u>0000</u> | <u>0000</u> | <u>0000</u> | <u>0000</u> | <u>0000</u> |
| SOAK | <u>0100</u> | <u>0001</u> | <u>0000</u> | <u>0000</u> | <u>0000</u> | <u>0000</u> |
| E-1 | _____ | _____ | _____ | _____ | _____ | _____ |
| E-2 | _____ | _____ | _____ | _____ | _____ | _____ |
| E-3 | _____ | _____ | _____ | _____ | _____ | _____ |
| SOAK-DEV | <u>10</u> | | | | | |
| GOTO | <u>End</u> | | | | | |
| REPEAT TIMES | <u>5</u> | | | | | |
| HOLD | <u>NO</u> | | | | | |

Troubleshooting

| PROBLEM/ SYMPTOM | PROBABLE CAUSE | SUGGESTED CORRECTIVE ACTION |
|--|---|--|
| Erratic temperature control | | <p>The controller typically has a proportion band (PB) of 5°F.</p> <ul style="list-style-type: none"> • If the heater is not cycling ON when the process displayed temperature is 3°F or more below the setpoint temperature, check: <ul style="list-style-type: none"> • Defective Controller (will not gate SSR) • Open Heater Fuses • Tripped Hi-limit controller • Open Hi-limit relay • If the heater is not cycling OFF when the process displayed temperature is 3°F or more above the setpoint temperature, check: <ul style="list-style-type: none"> • Defective Controller (Temperature runaway) • Shorted SSR • Tuning parameters are incorrect (ex. CZO value too large) |
| Temperature will not reach the Setpoint | <p>The heater is not turning ON</p> <p>Defective SSR</p> <p>The Hi-limit relay does not click or pull in when pressing the HEATER ON pushbutton</p> | <ul style="list-style-type: none"> • Defective Controller (will not gate SSR) • Open Heater Fuses • Tripped Hi-limit controller • Test SSR gate signal output. • Check both the incoming and output wiring and voltage. • Check for loose wiring connector. Replace Protocol. |
| Display reads "HL ERROR" (<i>blinking</i>) | <p>The process temperature has exceeded the Hi-limit temperature setpoint.</p> <p>Controller Calibration</p> | <p>Set the hi-limit to a higher temperature and press the RESET pushbutton.</p> <p>Check DIAGNOSTICS MODE for actual temperature readout of the Hi-limit (HL-T/C). If the reading is off by greater than 2-3 degrees or displays 500°C (932°F), calibrate the controller.</p> |
| Display reads "S-TC ERR" (<i>blinking</i>) | The Control thermocouple is open | <ul style="list-style-type: none"> • Check for loose connections on the Control T/C terminals (SEN). • Defective T/C. Remove the T/C and short the terminals with a jumper. The control should display ambient temperature. |
| Display reads "H-TC ERR" (<i>blinking</i>) | The Hi-limit thermocouple is open | <ul style="list-style-type: none"> • Check for loose connections on the Hi-limit T/C terminals (HIL) • Defective T/C. Remove the T/C and short the terminals with a jumper. The control should display ambient temperature |

| PROBLEM/ SYMPTOM | PROBABLE CAUSE | SUGGESTED CORRECTIVE ACTION |
|---|---|--|
| Temperature runaway - heater will not turn "OFF" | Shorted SSR Relay Defective controller | Disconnect the one of the SSR leads (SSR terminal #3 or #4). If the heater stays "ON", Replace SSR. If heater turns "OFF", controller may be defective (check DIAGNOSTICS MODE). |
| The center of the chamber temperature is different from the control temperature displayed | The hot air entering the chamber will be the hotter than center of the chamber. | Change the CZO value in the Tune Mode to shift the controller's displayed readout to the temperature in the center of the chamber. |
| No digital display with the power LED ON | The control power supply is defective | Replace the Protocol controller. |
| Test SSR gate signal output | | Connect a VOM (set on 20vdc/higher scale) across the SSR Relay input terminals (SSR terminal #3 and #4) 1) Adjust the setpoint temperature a minimum of 20°C degrees above the process displayed temperature (output should measure approximately (+)15vdc). 2) Adjust the setpoint temperature a minimum of 20°C degrees below the process displayed temperature (output should measure 0vdc). 3) Adjust the setpoint temperature at the process displayed temperature (voltage output should pulse somewhere between 0vdc & 15vdc). 4) If the controller output voltage does not follow the levels listed above, replace controller. |
| Keypad does not work or only some of the keys beep | Defective Protocol | <ul style="list-style-type: none"> • Turn the power ON and OFF by cycling the Green Power Pushbutton. • Press the Reset key. • Replace Protocol. |
| Hi-limit relay does not click or pull in when pressing the HEATER ON pushbutton | No power or voltage to the Protocol to energize the relay (ex. airflow switch is not closed). The Protocol hi-limit is not energizing relay even if the Heater Relay LED is ON or faintly lighted. | <ul style="list-style-type: none"> • Check the incoming wiring and voltage. • Check for loose wiring connector. • Check both the incoming and output wiring and voltage. • Check for loose wiring connector. • Replace Protocol. |
| No Events are displayed in Profile | Events not enabled | The CODE*E* is located under Tune Mode. Using the same code as required for the Tune Mode, change the number of relays to the number of events being used (ex. Display indicates zero (0) relays used change the number to one (1) for Event One). |

| PROBLEM/ SYMPTOM | PROBABLE CAUSE | SUGGESTED CORRECTIVE ACTION |
|---|---------------------|-----------------------------|
| Control or Hi-limit readout displays 500°C or 932°F | Loss of calibration | Perform calibration. |