

**GB4 TEMPERATURE
CONTROLLER
INSTRUCTION MANUAL**

Digitry Company, Inc.

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Dear Customer,

Welcome to the growing family of GB4 users. Digitry is proud of its record of delivering easy-to-use Programmable Temperature Controllers for ovens, kilns, lehrs and furnaces since 1980.

Your GB4 is shipped to you with the microprocessor-based controller, two Sending Units and this manual. Optional accessories, if ordered, are enclosed and detailed on your packing slip.

In the following pages, you will find complete information on the use and installation of your GB4. As you will quickly learn, ease of operation and programming flexibility are the trademarks of your Programmable Temperature Controller.

We appreciate hearing from the owners of the GB4. Please call us with any questions or application stories you would like to discuss. Our telephone numbers are listed in Chapter 6 of this manual under "Sales and Service."

Congratulations on your decision to increase efficiency and productivity in your workplace with Digitry's GB4 Programmable Temperature Controller.

Sincerely,

Richard L. Tenney
President

Contents

1	Introduction	1
2	Overview of the GB4	3
2.1	Features and Benefits	3
2.2	Modes	4
2.3	Status Indicator Lights	4
2.4	Numerical Displays	6
2.5	Keyboard	8
3	Programming	13
3.1	Introduction	13
3.2	Entering a Program	14
3.3	Reviewing a Program	16
3.4	Copying and Exchanging Programs	16
3.5	Looping	18
3.6	Delayed Start	19
3.7	Sample Program	20
4	Special Features of the GB4	25
4.1	Behavior During Power Failures	25
4.2	“COld” Readings	26
4.3	Memory Failure	27
4.4	Automatic Hold	27
5	Installation	29
5.1	Sending Units	29
5.2	Connecting the Relays	34
5.3	Powering Your GB4	37
5.4	Internal Protection	39
5.5	DOs and DON'Ts	39

5.6	Additional Help	40
6	Reference	41
6.1	GB4 Specifications	41
6.2	Accuracy	42
6.3	Sales and Service	42
6.4	Loaner Program	43
6.5	Warranty Information	43
7	Glossary	45
8	Troubleshooting	49
	Programming Forms	51

List of Figures

2.1	GB4 Face	5
2.2	Keyboard Functions	9
3.1	Simple Profile	15
3.2	Handwritten Programming Form	21
3.3	Sample Profile Graph	22
3.4	Sample Profile	23
5.1	GB4 back	31
5.2	Type K Thermocouple Sending Unit	32
5.3	Type K Thermocouple Connections	33
5.4	Relay Connections	36
5.5	Typical Mercury Contactor Connections	38

Chapter 1

Introduction

This manual introduces you to your GB4 Programmable Temperature Controller. Read it now to learn how to operate and install your GB4. In the future, use the manual as an easy reference on programming tips and technical points.

You do not need prior experience with temperature controllers or computers to use this manual. Just read carefully and follow the simple instructions for programming and installing your GB4.

This manual is divided into seven chapters. It is best to read Chapters 1 through 5 in succession. Chapter 6, the Glossary in chapter 7, and the troubleshooting guide in chapter 8 are handy reference sections to be used whenever needed.

Chapter 1 is this brief introduction.

Chapter 2 introduces you to the features and benefits of your GB4. The function of each operating mode, indicator light, LED display and keyboard button on the face of the GB4 is explained.

Chapter 3 teaches you how to program your GB4. The programming instructions are easy to learn once you are familiar with the layout of the GB4 controls explained in Chapter 1. The chapter ends with a sample program that you may want to try before developing your own library of time and temperature set-points.

Chapter 4 explains the special features of the GB4, including how it behaves when power failures occur.

Chapter 5 details the steps for installing your GB4. Pay particular attention to the first section on thermocouples and Sending Units.

You are now ready to begin.

Chapter 2

Overview of the GB4

2.1 Features and Benefits

Versatility is a key advantage of your GB4 Programmable Temperature Controller. The following features are incorporated into your GB4 to maximize user benefits. When using your GB4, remember to take full advantage of these system features.

- Programming up to 15 set-points per unit broadens creative boundaries through a nearly limitless number of temperature profile options.
- Independent time-temperature control lets you set your own work schedule. No need to be on-site for set-point changes or to fire up during costly peak energy times.
- Monitoring and control of five ovens, lehrs, kilns or furnaces eliminates the need for separate controllers or manual control. Reads out temperature, elapsed time and current step for each unit.
- Ease of operation lets you program the GB4 in the same amount of time required to operate a pocket calculator. With the push of a few keys, you can program up to 21 days of automatic control.
- Automatic calculation and monitoring of slope between set-points eliminates time consuming and awkward manual temperature adjustments while achieving smooth ramping.
- Temperature and ramping accuracy controls unit temperature to expand product range and creativity. Auto-hold feature ensures preset temperature is reached.
- Infinite looping permits continuous repeat of programmed cycles so that your unit is ready when you are.

- Skip-step capability increases programming flexibility by jumping to the following step with the push of a few buttons.
- Automatic memory back-up retains your program if electricity fails and resumes operation at preset ramp, thus protecting your product from damage.
- Audio alarm signals thermocouple burn-out.
- Sending Unit reduces the effect of electrical noise on temperature readings and eliminates the need for special thermocouple wire.
- Large LED display clearly indicates unit monitored, program step, elapsed time, temperature, mode and operation.
- Key lock prevents accidental or unauthorized program changes to any or all units (optional).
- Voltage transient protection: protection from malfunction caused by electrical disturbances.
- Standard features include solid state circuitry, durable construction, automatic cold junction compensation, readings in degrees Fahrenheit (Celsius, optional), product warranty and full corporate technical support.
- System options include chromel-alumel (Type K), platinum-rhodium (Type S) or any combination of the two thermocouples; key lock security; and customized hardware and software.

A diagram of the face of the GB4 is on the following page. Refer to this drawing as you read through Chapter 1 to learn the system layout.

2.2 Modes

There are two modes of operation for your GB4: MONITOR and PROGRAM. During standard operations, the GB4 usually is in the MONITOR MODE. When entering, changing or examining temperature curves, the GB4 must be in PROGRAM MODE.

2.3 Status Indicator Lights

There are two sets of indicator lights on the face of the GB4. The MODE lights are directly above the keyboard on either side of the STEP display. The four system status indicator lights are to the left of the keyboard, directly beneath the HOURS/MINUTES display.

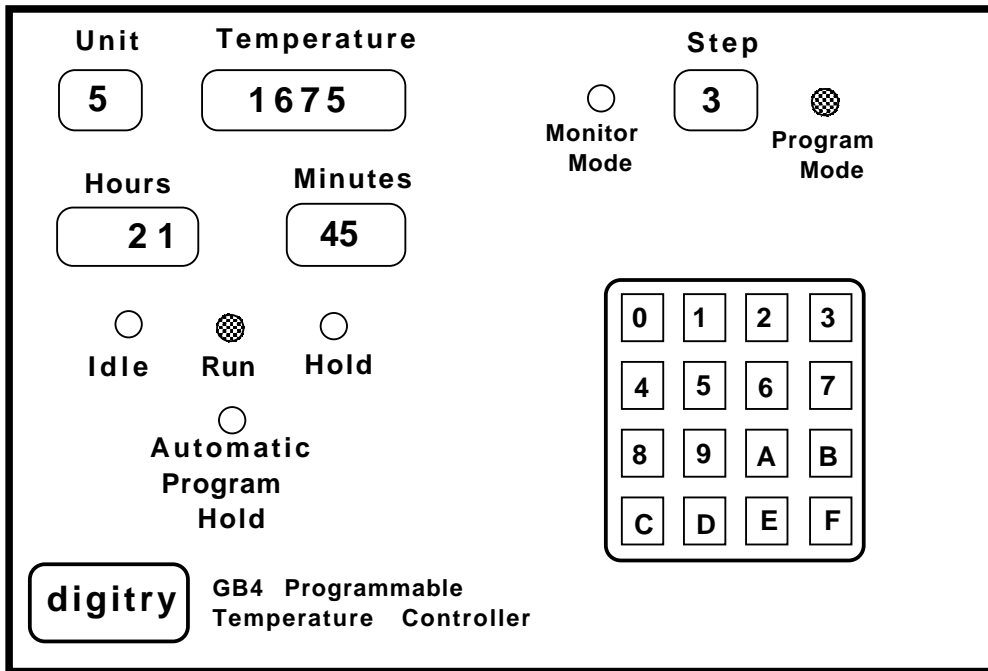


Figure 2.1: GB4 Face

MONITOR MODE: When the green MONITOR light is on, the GB4 is ready to display the time and temperature of a given unit. (Your units are constantly monitored by the GB4, even when the MODE light is not lit.)

PROGRAM MODE: When the red PROGRAM light is on, the GB4 is ready to receive, examine, or change temperature curves. Note that any programs that have already been started will continue to execute; working with one program has no effect on the others.

Button B on the keyboard (see section 2.5) is used to switch between MONITOR and PROGRAM MODE.

IDLE: The red IDLE light indicates that the control power to a selected unit is off and the unit timer is not running. Therefore, that unit is ready to begin STEP #1 of your program. Once the program has completed its cycle, the GB4 automatically returns the unit to IDLE. Resetting the unit using Button F also forces the GB4 into IDLE.

RUN: The green RUN light indicates that your unit has been activated. This means that the unit timer is running and the unit is following your program.

HOLD: The yellow HOLD light indicates that your program has reached an indefinite, programmed hold or that Button D has been pushed (also placing the unit in an indefinite hold). In either case, the unit timer stops running and the unit maintains the preset temperature.

AUTO-HOLD: The yellow AUTO-HOLD light indicates that the actual unit temperature is far below or above the calculated program temperature. This situation occurs when the programmed slope (calculated automatically according to the time and temperature set-points you entered into your program) is too steep to be achieved by your unit's capability to heat up or cool down. When this light appears, the unit timer stops and will remain stopped until the actual unit temperature comes within the required range.

2.4 Numerical Displays

There are four LED displays on the face of the GB4. Each indicates key settings selected for your programs.

UNIT: This display indicates the unit (*i.e.*, oven, kiln, lehr or furnace) that currently is being monitored or programmed.

TEMPERATURE: This display indicates temperature in degrees Fahrenheit (or degrees Celsius, if your GB4 was ordered with this option). In MONITOR MODE, this is the reading from your thermocouple. If no thermocouple Sending Unit is attached to the unit you are monitoring, this display will be 32° (for a type K channel). If the Sending Unit is attached to the GB4 but the thermocouple is not connected, the TEMPERATURE display will read about 4700°F (2590°C), the alarm on the Sending Unit will sound and power to the unit will be temporarily shut off until the thermocouple is reconnected or the Sending Unit is disconnected.

This sequence of events also occurs under two other conditions. The first is thermocouple burn-out. The second is improper temperature programming. If you program your unit to a temperature in excess of the 2400°F (1300°C) that the GB4 (with Type K thermocouples) is designed to monitor and your unit actually attains a temperature in excess of 2400°F, the GB4 will activate this protection sequence. With a Type S thermocouple, the temperature setting cannot exceed 3200°F (1760°C).

In PROGRAM MODE, this display shows the set-point temperature of a given step. In case of a memory failure, the TEMPERATURE display alternately will flash “P”s and the current temperature of the unit indicated in the UNIT display. Memory failures are discussed below in section 4.3.

TIME: This display indicates hours and minutes for each unit connected to the GB4. Each unit has its own timer. The times indicated when the GB4 is in PROGRAM MODE denote the points at which you are going to change to another step. This is the cumulative time from the start of your program; not the incremental time between steps. When programming, the letter “H” will be displayed to indicate a programmed hold or soak of indefinite length. In MONITOR MODE, the display gives the reading from the timer of the currently displayed unit.

The timer is running whenever the green RUN light is on. This timer stops when the unit is in IDLE, HOLD or AUTO-HOLD. When the GB4 is in any of these hold conditions, the elapsed time indicated on this display will be less than the actual elapsed time.

In case of a memory failure, the TIME display alternately flashes “P”s and meaningless numbers. This means that the program memory is no longer intact. Memory failures are discussed below in section 4.3.

STEP: In MONITOR MODE, the number displayed directly above the keyboard indicates the current step of the program you are executing. In PROGRAM MODE, this LED display indicates the step you are entering or reviewing. The steps are indicated by the numbers “1” through “9”, and then “A” for the tenth step, “B” for the eleventh step, and so forth, up to “F” for the fifteenth step (the maximum number that can be

programmed for any one unit). A horizontal bar “— — —” will appear in the TIME and TEMPERATURE displays if you try to enter more than 15 steps per unit.

2.5 Keyboard

The keyboard on the face of the GB4 consists of 16 buttons. There are 10 numerals, 0-9; and six special function buttons, A-F. The functions performed by the A-F buttons are printed above the keyboard. The chart in Figure 2.2 summarizes the functions performed in each operating mode.

Button A—Unit: Button A is used to select the unit that will appear in the display, i.e., the unit you will be monitoring or programming. Simply push Button A and immediately push the number of the unit (from 1-9) you wish to view. The unit number appears in the upper left hand corner of the GB4, below the word UNIT. Once selected, the unit being viewed changes to MONITOR MODE.

In addition to the five ovens that you can actually control, there are four units that are not connected to any temperature reading inputs or relay control outputs. These units, 6-9, are for storing programs which you may wish to use later. These “extra” programs may be either punched in directly, in the same way as with units 1-5, or exchanged or copied from other units, as will be explained shortly. Since units 6-9 do not correspond to real ovens, there is no monitor mode for them. They will always appear in the PROGRAM MODE.

The GB4 has a special Scan Function, where it monitors all five units and displays each unit’s time and temperature for about four seconds. No other buttons are active while the unit is Scanning. To select the Scan Function, press Button A followed by Button 0. The Scan Function automatically sets the GB4 to MONITOR MODE. To return to the normal control mode (and reactivate the keyboard), select any unit or program for display by pressing Button A followed by the digit 1-9.

Note that whenever the GB4 resets, it automatically invokes the Scan Function. In particular, if there has been a power outage, the GB4 will commence Scanning upon the return of power. As above, the keyboard will be mostly disabled; you will have to select a specific unit or program before you can do anything else.

Button B—Mode: Button B is used for switching between MONITOR and PROGRAM MODE. The mode you select is indicated by a light directly above the keyboard; red for PROGRAM MODE and green for MONITOR MODE.

MONITOR MODE is used for observing the status of any of your five units. When a given unit is in MONITOR MODE, you can perform any of the following functions:

Button	Function	In PROGRAM MODE	In MONITOR MODE
A	Unit pushed once followed by digit	Selects unit for viewing or changing	Selects unit for viewing or changing
	pushed once followed by ENTER	Backs up to previous step	
B	Mode	Select MONITOR MODE	Select PROGRAM MODE
C	Clear	Clears entries so changes can be made	(not functional)
D	Hold pushed once	Starts a hold, or soak, at a specified temperature	Starts a hold
	pushed twice	Starts looping feature	
E	Enter/Start	Enters or reviews a program	Starts, restarts, or skips steps in a program selected by digit [†]
F	Reset followed by digit [†]	Erases the entire program	Cancels a program and returns to IDLE

NOTE: All units can be operating simultaneously regardless of which unit operations are being displayed or which unit is being programmed.

[†]This digit is required by the Safety Sequence; see section 2.5.

Figure 2.2: Keyboard Functions

- Display the current setting for a given unit (see “Button A”).
- Start a program (see “Button E”).
- Initiate a non-programmed hold (see “Button D”).
- Skip a step in a program which is running (see “Button E”).
- Cancel the cycle (see “Button F”).

When the GB4 is in PROGRAM MODE, you can enter, review or change the times and temperatures (which constitute your temperature curve) for the currently displayed unit. As you enter times and temperatures, the current step of your curve is indicated by a number displayed directly above the keyboard. You may review or change a program even while it is running. Simply press Button B twice to review the program for the unit currently being displayed. See section 3.3 for details on changing time and temperature settings.

NOTE: Do not attempt to change the step which currently is being executed as this may cause your unit to return to IDLE.

Button C—Clear: Button C can be used only when the GB4 is in PROGRAM MODE.¹

It is used to clear entries that you need to change. If both a temperature and a time have been entered in a step, pushing Button C once will clear only the temperature. You then can enter a new temperature setting only if you do not want to change the time. If you want to clear both the existing time and temperature setting, push Button C twice; the first time to clear the temperature, the second to clear the time. You then can enter your new settings. Remember, there is no way to clear the time without first clearing the temperature.

NOTE: If your display reads all “E”s (error in entry), you must push Button C in order to proceed. (See section 3.2 for a further explanation.)

Button D—Hold: Button D is active in both the PROGRAM and MONITOR MODE.

Pushing Button D when the GB4 is in the MONITOR MODE immediately initiates a hold. This means that the timer for that unit stops and the elapsed time does not advance beyond its present reading. The unit will be maintained indefinitely at the temperature displayed when the button was pushed.

When a hold is started, the yellow HOLD light (to the left of the keyboard) will come on, and the green RUN light will go out. To resume normal operation, push Button E and immediately press the number of the unit being displayed.

¹There is one exception to this, which is quite rare: when a unit is marked as “COLD”, the clear button is used in MONITOR MODE to release it. See section 4.2 for details.

While in PROGRAM MODE, Button D can start a hold, or soak, at a determined temperature. Once the button is pushed, the hold is indicated by “H”s in the TIME display, directly above the status indicator lights. Once the hold is reached, its effect is the same as if it were selected from the MONITOR MODE. The unit will continue to hold forever or until you release it by pushing the enter sequence, whichever comes first. Do not use this button for a timed soak (see section 3.1).

You can start a program with HOLD. You then can attend to other business while your unit reaches working temperature. Once you load the unit, push Button E followed by the unit number, and the GB4 continues with the rest of the curing cycle for that unit. Of course, it has continued to monitor and control all running units during this time.

Button D also is used to start the special looping feature. Simply push Button D twice in succession while in the PROGRAM MODE. (See section 3.5 for a more complete description of the looping feature.)

Safety Sequence

The functions described below, activated by Buttons E and F, are used to start your units, skip steps in your programs, erase your programs, or reset your units to STEP #1. Because of the importance of these functions, a special sequence is incorporated to avoid accidental use. Immediately after pressing Button E or F, you must push the number of the unit currently displayed. Pushing any other button after Button E or F will violate the *Safety Sequence* and thus prevent the action. For Button E, the Safety Sequence is required only when the GB4 is in MONITOR MODE. For Button F, the Safety Sequence is always required whether the GB4 is in MONITOR or PROGRAM MODE.

Button E—Enter/Start: Button E can be used when the GB4 is in either the MONITOR or PROGRAM MODE. However, it serves a different function depending on the mode you select. In the MONITOR MODE, Button E is the start/reset/skip-step button. In the PROGRAM MODE, it serves as the enter button.

Before starting your programmed cycle, make sure the red IDLE and the green MONITOR MODE lights are lit and you have entered your program. Then, push Button E and press the number of the unit displayed in the upper left corner (UNIT). The red IDLE light will go out and the green RUN light will come on. This starts your program.

At any time during the cycle you may cancel a given step and go on to the next step (this is called “skip-step” capability). Push Button E and immediately press the number of the unit displayed. The GB4 then will skip to the next programmed step. The time shown at the beginning of the skip-step is the very last minute of

the current step. Once you have skipped a step, there is no direct way to back up. However, you can always cancel the whole cycle (Button F), restart the cycle and skip to where you want to be. Button E also is used to continue your program from HOLD. Leaving HOLD is, after all, nothing more than skipping on to the next step.

When the GB4 is in PROGRAM MODE, Button E is used to enter the times and temperatures you select for your program. The Safety Sequence feature is not in effect in this mode. After selecting any time or temperature, you must press Button E to record your entry into the GB4's memory. Then, proceed to your next entry.

Button E also is used to review your program. Each time you push Button E, the next time and temperature set-points appear in the LED displays labeled TEMPERATURE, HOURS and MINUTES. Pushing Button A followed by Button E backs up to the previous step. See section 3.3 for further information on reviewing a program.

Button F—Reset: Button F is active in both MONITOR and PROGRAM MODE. In MONITOR MODE, it is used to cancel a program and return the GB4 to IDLE. This does not erase your program; it returns it to STEP #1 for the displayed unit.

In PROGRAM MODE, Button F erases your entire program.

In both MONITOR and PROGRAM MODE, once you press Button F, remember immediately to enter the number of the unit displayed. Failure to do this will invoke the Safety Sequence feature, and the Button F function will be cancelled.

Chapter 3

Programming

3.1 Introduction

A program for the GB4 may be thought of as a series of points, with each point consisting of a time and a temperature. This series of points creates a continuous graph consisting of connecting slopes defined by the temperature pattern you want your unit to follow over a specific period of time. You construct this slope by selecting the temperature you want your unit to reach at a certain time. The time you choose is relative to your starting time; the temperature is in degrees Fahrenheit or Celsius, depending on your GB4. Your GB4 automatically calculates the rate at which the temperature rises or falls between two temperature set-points in a given time.

For example, your unit is at 100° . In 2 hours, you want it to reach 500° . Then, in 3 more hours (which is a total elapsed time of 5 hours) you want your unit to be at 650° . The only information you must enter is the two time-temperature points: 2 hours, 500° ; and 5 hours, 650° . The GB1 then calculates and executes the ramp up between 100° and 500° in 2 hours, as well as a new ramp up from 500° to 650° in 3 hours. Thus it will ramp up at 200° per hour for the first two hours and 50° per hour for the next three hours.

A program may consist of up to and including 15 such slopes, each of which is called a *step*. A step constitutes one straight-line segment of your temperature profile. If you wish to hold a specific temperature for an indefinite period of time, you can use HOLD (see section 2.5). The hold acts as a substitute for a time setting. A programmed hold counts as one step. Since the unit timer does not run during HOLD, it adds nothing to the total elapsed time of your program.

If you wish to maintain a certain temperature for a specific time (a “timed soak”), you simply program it in the standard manner, using the same temperature for two consecutive set points. For example, to soak for two hours at 950° , eight hours after the first step, you would enter

```

800  ENTER/START  (eight hours)
950  ENTER/START  (950°)

1000 ENTER/START  (ten hours)
950  ENTER/START  (950°)

```

Do not use Button D (Hold) for a timed soak.

Now that you are familiar with the HOLD function, let's add three more steps to the previous example. Now, your third step is to HOLD at 650° for an indefinite amount of time. Then, cool off to 300° in 4 hours and 15 minutes. Finally, hold at 300° for 2 hours. The third step would then have "H" for time and 650° for temperature. The fourth step would have 9 hours and 15 minutes for time, and 300° for temperature. Note that more than 9 hours and 15 minutes now has passed in actual time. This is because the holding time is not included. The last step would have 11 hours and 15 minutes for time and 300° for temperature.

The graph in Figure 3.1 illustrates the slope created for this program. Note that the duration of the four steps is total elapsed time. The time differences between steps given in this example are used only for purposes of clarification. The GB4 itself deals only with elapsed time.

Section 3.7 shows another example program.

3.2 Entering a Program

First, select the unit to be programmed by pressing Button A and the unit number (from 1–9) on the keyboard. Put your GB4 into PROGRAM MODE by pressing Button B.

At this point, the STEP display will read "1" and the TIME display will read "0". Now, punch in the time (in hours and minutes) on the keyboard. Then press Button E to enter the time. At this point, "0" will appear in the TEMPERATURE display. If you wish to change the time, or if you have made an error, press Button C (Clear). The TEMPERATURE will become blank and the TIME will read "0". You can now enter a new time. Then, punch in a temperature [up to 2400°F (1300°C) when using Type K thermocouples] and press Button E, to enter the temperature. When using Type S thermocouples, the maximum temperature range is 3200°F (1760°C). After pushing button E, the TIME will read "0" and the TEMPERATURE will be blank. The STEP will read "2".

You now are ready to enter the second point in your program. This process is repeated until you have entered your entire program. Remember, you have as many as 15 steps to work with for each unit. If you enter less than 15 steps, your program will terminate upon reaching the first unfilled step (zero time).

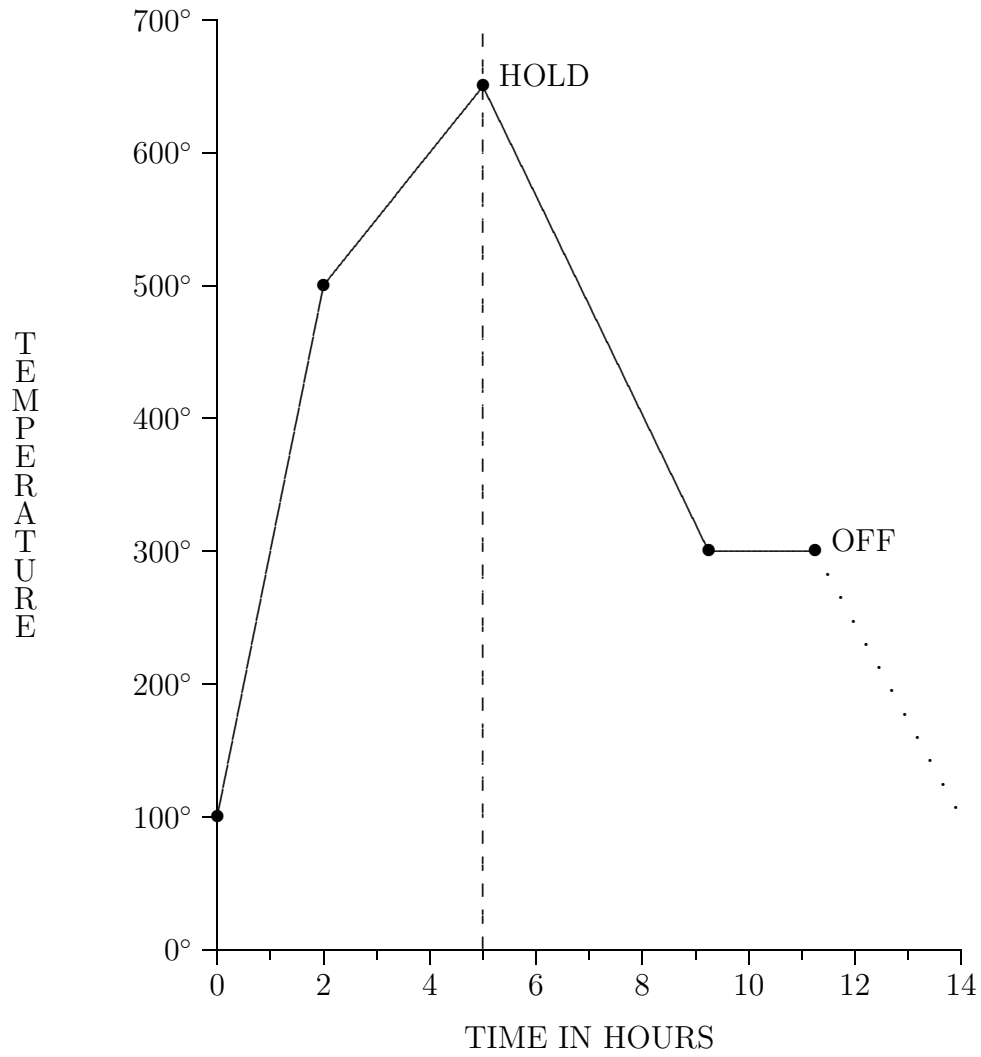


Figure 3.1: Simple Profile

NOTE: When your program has finished running, the GB4 will go into the IDLE MODE and the STEP display will read one greater than the number of steps in your program. For example, when a program with 6 steps is completed, the IDLE light goes on and the STEP display reads “7”. Similarly, when a program with 10 steps is completed, the IDLE light goes on and the STEP display reads “b” (which looks similar to a “6”).

It is essential to enter the total cumulative time at each step. Remember that no time you enter may be less than or equal to the time of the previous step. If such a time is entered, “E”s will appear in the TIME display, indicating an error. To continue programming, simply push Button C to clear the erroneous entry.

3.3 Reviewing a Program

Switching from PROGRAM MODE to MONITOR MODE, and back to PROGRAM MODE (by pressing Button B), automatically sets the STEP display to Step # 1. The time and temperature settings you selected for the first step now will be displayed. Pushing Button E (Enter) advances you through the succeeding steps of your program. Pushing Button A followed by Button E backs up to the previous step. You may review your program in this manner even while the program is running.

At any time during your review, you may make changes to your program by first clearing and then reentering new times and temperatures. However, it is generally not advisable to change the program for a unit that is currently running. If you choose to do so, be sure you do not change the time of the step that is currently being executed. This is because changing a time entails returning the time to zero which, in turn, will terminate your program and put the GB4 into IDLE for that unit.

NOTE: To change the time setting in your program, you first must clear the temperature by pressing Button C once. Then you can clear the time by pressing Button C again. This step of your program now is ready to receive a new time and temperature. If you want to change only the temperature, just push Button C once and the time will remain unchanged.

When entering a new time, remember that you must enter cumulative time. Failure to do so may result in an error reading in the TIME display. For example, if Step #1 is 5 hours and Step #3 is 7 hours, Step #2 must be a time between 5 hours, 1 minute and 6 hours, 59 minutes.

3.4 Copying and Exchanging Programs

As mentioned in section 2.5, units 6, 7, 8, and 9 have no hardware attached to them; you may think of them as “phantom ovens”. However, they may be programmed just as the ovens 1–5 are. Since there are no temperature inputs or relay outputs for these phantom

ovens, you cannot run them. There is nothing for them to do except to store extra programs for future use. The programs in 6–9 are entered, reviewed and edited (changed) just as those in one through five. To use one of these programs, you must copy it into unit 1, 2, 3, 4, or 5 as described in the following paragraphs. To simplify the language in what follows, we will call the program for unit 1, “program 1”, etc.

You can exchange any two programs with just a few button pushes. You can also copy (replicate) a program into a completely blank program. You will be notified whether a copy or exchange is to occur by the symbols in the TIME display: “LS-LS” for exchange or “LL-LL” for copy.¹ With regard to copying, all programs 1–9 are on equal footing. You may copy (or exchange) from any one to any other.

Now for the details:

- First select your target program with Button A as usual. Put unit in program mode if it is one of 1–5. (Units 6–9 will automatically be in program mode.)
- If you want to copy another program here without saving the current program, you must completely clear the target program. This means that all 15 steps must be zero. If only the first few steps have been cleared, the program may seem empty without being so. If you get the LS-LS symbol, you can be sure that one of the 15 steps has data in it. Using Button F, you can clear all steps without having to explicitly find it. If your target is not totally cleared, it will be exchanged with the source program. In other words, if you are not careful here, you will find that the source program has changed when you did not expect it to do so.
- Now push Button A twice in a row. The appropriate symbol, LL-LL or LS-LS, will appear in the TIME display and a dash will appear in the TEMPERATURE display. This dash will turn into the source program you wish to load or copy from when a digit (1–9) is pressed. If any other button is pushed, you will get an error (“E”s will appear in the TIME display), and then you need to push Button C (Clear Entry) and start again. You may change the number without first clearing it; just push a different one.
- After having chosen the source program, push the enter key. Voilà... the exchange or copy will take place! Note that when you do two exchanges in a row, you will be back to where you started. If you do a copy, the source program will remain where it is and also be replicated in the target program. We note the obvious fact that if you exchange two programs which are exactly the same, it is equivalent to having done absolutely nothing!

¹While these may not be the most obvious symbols, bear in mind that only a limited number of possible characters exist for the display. It may help to think of the exchange symbol as “load and store” and the copy symbol as “load”.

- Also note that it is impossible for one program to overwrite another—they merely interchange themselves. If you want to overwrite the target, you must first wipe it out with Button F and then copy over the blank program.

Summary

- Target program completely empty means you will replicate the source program into the target. The symbol is “LL-LL”.
- Target program not completely empty means the source and target will be exchanged. The symbol is “LS-LS”.

3.5 Looping

Many people use a Type S channel to control a furnace. Unlike an annealer, a furnace usually runs on a repetitive, continuous cycle. To accommodate such use, the GB4 contains a loop command which allows indefinite repetition of a temperature curve. After reaching the last programmed step, the program immediately will return to Step #1. When the repeat feature is operational, the program will never stop by itself. The repeat can be cancelled by pressing Button F or removed by changing your program.

The loop command can be used only once in a program. It always sends the program back to the very beginning. It is invoked from the PROGRAM MODE by pushing Button D twice in succession. The “H”s and blanks in the TIME and TEMPERATURE displays will turn to “L”s, which designate the loop feature. After the “L”s appear, press Button E. (Failure to do this will result in an error. You then must clear the step by pressing Button C and start this step over again.)

When Button E is pushed, the display will show all horizontal bars indicating that no further program steps may be entered, regardless of what the STEP display reads. This is because the loop is always the last thing you do. Pushing Button E at this point will have no effect. You can gain access to the remaining program segments by clearing the “L”s (press Button C). If you push Button E after pushing Button D just once, the GB4 will assume that it is a hold. In this case, a subsequent push of Button D will result in an error, not in the appearance of the “L”s. This is because the next thing after a hold is a temperature. In short, the sequence of buttons to be pressed is:

For a HOLD: D, E, (temperature)

For a LOOP: D, D, E

When set on a 24-hour cycle, the times may slowly “creep” over a period of days. A unit set to come on at 8:00 a.m. gradually will come on later in the day. There are several

reasons for this. First, due to technical constraints, the GB4's internal clock is off by about 15 seconds a day. Although this only amounts to about 2 minutes a week, it eventually will add up. Second, anything which stops the timer, such as power failures (which may well go unnoticed because of the GB4 Memory Back-up) or pushing Button D (Hold), will delay the cycle. Third, if the unit goes into AUTO-HOLD for any reason, the cycle will be delayed.

When using the looping feature, the current unit temperature is read as the starting point for calculating the temperature slope on the first segment of the curve. Thus, if your unit temperature is hotter during the second run of the cycle, there will be a less steep curve than the first time.

For example, assume your first step is to raise the temperature to 700°F (371°C) in one hour, then go to 1100°F (593°C) in 3 hours before entering the looping feature. The second time around, your unit will start out at 1100°F and the GB4 will take it down evenly to 700°F in one hour. This may or may not be what you intended.

If you want the repeat to start from some cool point, you must specifically put that into your program. For example, if you want your cycle to always ramp up to 700°F from a maximum of 300°F (149°C), you must enter a cooling off segment in the program before the loop. If this segment is too short for the unit to cool down within the allotted time, then AUTO-HOLD will come on, changing your total cycle time.

3.6 Delayed Start

The GB4 has a *delayed start* feature. The main use of this is to have your oven waiting for you at working temperature when you arrive at your studio in the morning. With the GB4, you do not have to leave the oven on all night to accomplish this, thus saving on your fuel bill and your time. All you have to do is set the first step of your profile to zero temperature and set the time to indicate the amount of time that should elapse before the oven should begin to heat.² Then set the second step to HOLD at the desired morning temperature. Be sure to start the HOLD soon enough to allow the oven to attain desired temperature before you need to use it.

For example, if it is 7:30 p.m. and you are ready to go home, but you want your unit to come on at 7 a.m. the next morning so that it will be nicely hot (say 950°) by 9 and then hold that temperature, you could enter a three-step program:

Step	Time	Temperature	Comment
1	11:30	0°	11:30 hours from 7:30 p.m. is 7:00 a.m.
2	13:30	950°	13:30 hours from 7:30 p.m. is 9:00 a.m.
3	HOLD	950°	

²Whenever the programmed temperature is set to zero, the GB4 will run its clock without turning on the oven and without engaging AUTO-HOLD.

Alternatively, you could ramp up as quickly as possible to 950° starting at 8:00 a.m. by entering the following slightly simpler program:

Step	Time	Temperature	Comment
1	12:30	0°	12:30 hours from 7:30 p.m. is 8:00 a.m.
2	HOLD	950°	Auto-Hold will come on while the kiln ramps up to 950°.

3.7 Sample Program

To end this chapter, we include an example of a typical program. A sample profile is shown in the graph of Figure 3.3. This profile shows the unit starting at room temperature (around 70°F) and ramping up to 650°F in 2 hours 45 minutes. It then soaks for three hours and then ramps up to 1050°F over the next seven hours, where it soaks for two hours 15 minutes. After that, it ramps up to 1200°F over one hour and then immediately ramps down to 350°F over the next seven hours. This ends the program, so the unit will then shut off and coast down to room temperature. Figure 3.2 shows this program written by hand on a Digistry GB4 Programming Form. Blank forms may be found at the end of this manual or obtained from Digistry Company, Inc.

The sample program in Figure 3.4 shows you just how easy it is to program your GB4 to follow this profile for unit #5. By pushing the buttons indicated, you can enter this program into your GB4.

Figure 3.2: Handwritten Programming Form

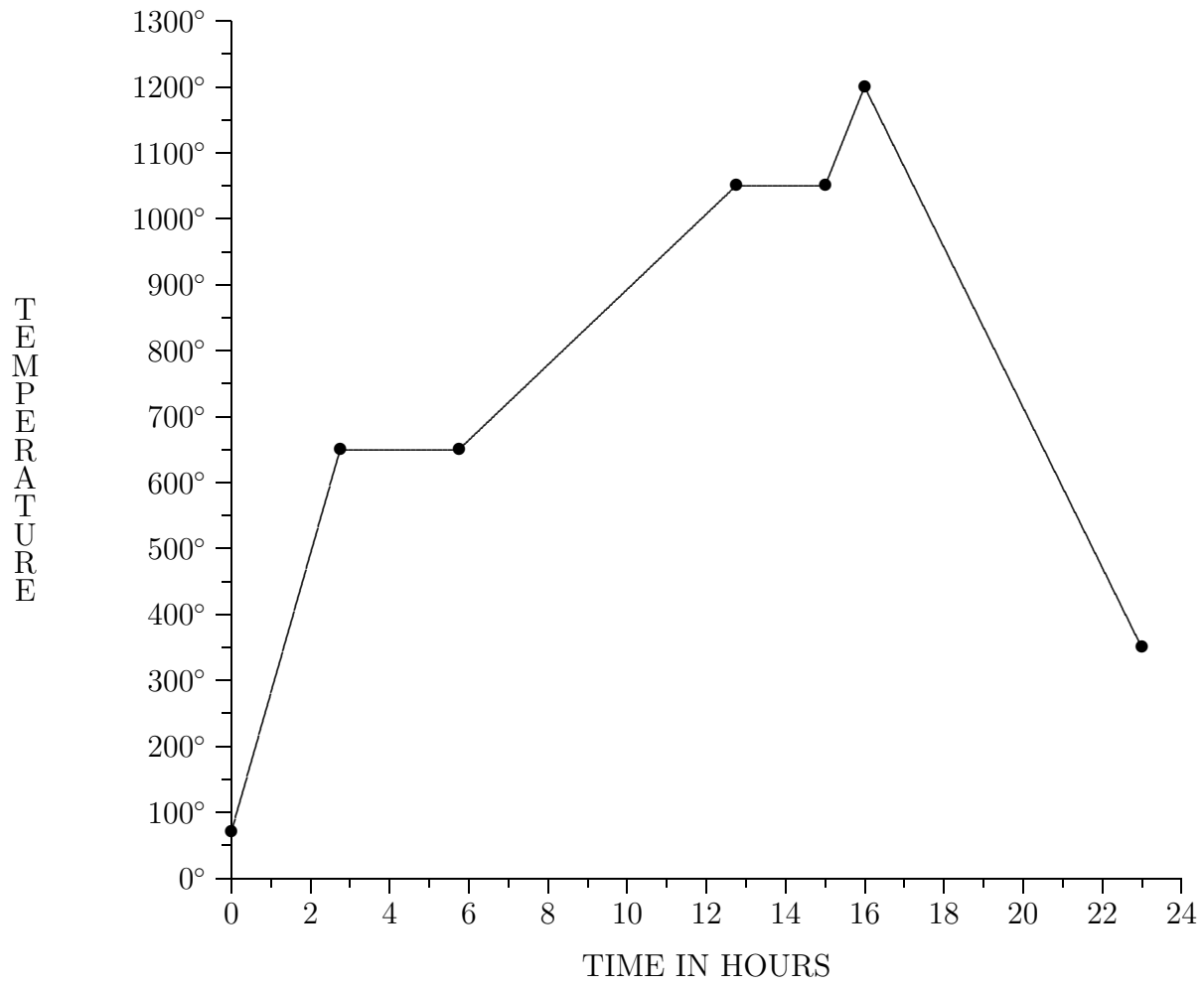


Figure 3.3: Sample Profile Graph

Press:	To:
A 5	let the GB4 know you want to program unit #5.
B	put the GB4 into PROGRAM MODE.
245 E	program unit #5 to ramp up evenly to 650°F
650 E	in 2 hours and 45 minutes. This is Step #1.
545 E	tell unit #5 to soak at 650°F for 3 hours
650 E	(adding 3 hours to the 2 hours and 45 minutes at the end of the previous step gives the 5 hours and 45 minutes used in this step). This is Step #2.
1245 E	ramp up to 1050°F in 7 hours
1050 E	(12 hours and 45 minutes is 7 hours after the 5 hours and 45 minutes at the end of Step #2). This is Step #3.
1500 E	soak at 1050°F for 2 hours and 15 minutes
1050 E	(bringing the elapsed time to 15 hours). This is Step #4.
1600 E	ramp up to 1200°F
1200 E	in 1 hour (an elapsed time of 16 hours is one hour after the end of Step #4). This is Step #5.
2300 E	ramp down to 350°F
350 E	in 7 hours (for a total elapsed time of 23 hours). This is Step #6.
	The program is now entered.
B	Return to MONITOR MODE.
E 5	start unit #5 running.

NOTE: When entering your time set-points, remember to use total elapsed time, not the time differences between steps.

Figure 3.4: Sample Profile

Chapter 4

Special Features of the GB4

The GB4 is designed with several special features to enhance its reliability. These include

- protecting your programs (and, consequently, your work) in the event of a power failure,
- continual internal validation of memory accuracy, and
- the ability to adapt a program to the capabilities of your kilns using automatic holds.

4.1 Behavior During Power Failures

Special components and circuitry are used within the GB4 to preserve its memory during power failures. The GB4 will remember:

- which units were running and which were idle when the power failed,
- the program step and time of each running unit when the outage occurred, and
- the last temperature reading of each running unit at the time of the power failure.

During the power failure, the face of the GB4 will look blank. When power is restored, “8”s will appear in the TIME and TEMPERATURE displays while the GB4 takes new, reliable temperature readings. Concurrently, the UNIT display counts down twice from 5 to 1, first slowly, then at a quicker pace.¹

The GB4 then evaluates the temperature loss of each unit from the time the power failed to the time it was restored. If the actual temperature loss is less than 200°F (or

¹It is important to realize that many power failures are extremely short, so short that you may not even notice them. As a consequence, from time-to-time your GB4 may appear to begin the count down cycle spontaneously. This is invariably a result of power difficulties of some sort.

100°C for Celsius models), that unit will continue as if the power failure had not occurred. Since the vast majority of power failures are quite short (under one minute), the unit temperature drop is insignificant and the unit thus will continue running according to your original program.

If a unit cools more than 200°F during a power failure, the temperature of the unit when power is restored will be maintained. The TIME and TEMPERATURE displays for that unit will read “COLD”. This procedure should protect your unit and its contents from reheating rapidly without your knowledge. When you check the unit and notice this condition, you then have the opportunity to decide the most appropriate course of action from this point (as described in the following section).

After the GB4 has measured the temperature of all units to determine whether the unit should continue running or be maintained at its current temperature, the Scan feature will be triggered (see section 2.5). The TIME and TEMPERATURE readings for each running unit will be displayed for approximately 4 seconds and the GB4 will be in MONITOR MODE. If no units were operating when the power failure occurred, UNIT #1 will be displayed. If only one unit was running prior to the power failure, its number will appear in the UNIT display. Note that even a very short power failure will cause the Scanning feature to be activated.

4.2 “COLD” Readings

As noted above, if a power failure has lasted long enough that one of your units has cooled more than 200°F (100°C) during the outage, its TIME and TEMPERATURE displays will read “COLD”. The current unit temperature will be maintained, and the Scanning feature will be activated so the “COLD” will be seen whenever that unit is scanned.

When this occurs, push Button A and the number of that unit. The GB4 will go into MONITOR MODE and “COLD” will be displayed. Push Button C to clear the “COLD” display. The last step and time reading for that unit before the power failure will be displayed along with the CURRENT temperature.

If you choose to continue with the program at this point, push Button E (Enter/Start) and the unit number. As the unit lost more than 200°F during the power failure, the unit will begin heating. If the unit was ramping up when the power failed, AUTO-HOLD will go into effect until the unit reaches the programmed temperature.

If you want to cancel your program and restart the unit, push Button F and the unit number. The GB4 will then be in IDLE.

When “COLD” is displayed and the GB4 is in MONITOR MODE, you can examine or change your program by putting the GB4 into PROGRAM MODE. Remember, it is best not to reprogram a unit that is running.

In summary, when “COLD” is displayed, push Button A and the unit number. You then

push:

C, E, (unit number) to continue with the program, or

C, F, (unit number) to cancel the program.

Follow the procedure above for each unit that is marked “COLD”.

4.3 Memory Failure

Your GB4 continually checks its internal memory for accuracy. In case of a memory failure, the green and red MODE lights alternately will light about every one-half second and “P”s (for “Problem”) will flash across the TIME and TEMPERATURE displays.

In the event of a memory failure, the GB4 is designed to protect your work and units by running the following sequence. First, it will turn off all units for about one minute to allow the temperature readings to stabilize. Then, it will read the current temperature of each unit and hold at that temperature until you reprogram the GB4.

When the GB4 signals a memory failure, pushing any button on the keyboard will reset it. It then will stop flashing, display UNIT #1, clear all memories and set all units to IDLE. If you do not reprogram the GB4, your units will begin to cool down.

Fortunately, memory failure is quite unusual. It can usually be traced to one of two causes:

- A voltage transient so fast and so powerful that it swamps the GB4’s protective circuitry and modifies program memory. Digistry’s memory assurance scheme is so sensitive that it will detect the alteration of even a single digit.
- Power failure while you are entering a program. In this case, the memory assurance scheme may detect inconsistent information.

4.4 Automatic Hold

Using the program you entered, the GB4 calculates a temperature for each minute of the cycle. It bases its decision about automatic holding on this temperature. Essentially, if your unit is not able to keep up with the temperature changes you requested, the GB4 clock for this unit will be stopped until the unit catches up.

On heating steps (ramping up), the AUTO-HOLD light will come on if the unit temperature is more than 40°F (20°C) below the calculated temperature for the current minute. On cooling or soak steps, the AUTO-HOLD light will come on whenever the unit temperature exceeds the calculated temperature for the current minute by more than 40°F (20°C).

Once the AUTO-HOLD is engaged, it keeps the clock stopped until the temperature calculated for the current minute is actually achieved.

Under normal circumstances, AUTO-HOLD is usually thought of as something that compensates for unusual demands placed on your oven's ability to follow a profile. However a creative use of AUTO-HOLD allows you to program your oven to ramp up to a given temperature as quickly as possible. Simply program the time set-point to one minute. The GB1 then will go into AUTO-HOLD until the desired temperature is reached.

Chapter 5

Installation

There are two aspects to the installation of your GB4:

- connecting the thermocouples, which measure the temperature of each unit and,
- connecting the relays, which control the heating elements.

Review Figure 5.1 on the following page to familiarize yourself with the layout of the back of the GB4. Then read all the following instructions before installing your GB4. As you will see, the entire procedure is relatively easy. The same installation procedure applies to each unit.

5.1 Sending Units

The very weak signal from the thermocouple is amplified by our specially designed thermocouple Sending Unit before being sent to the GB4.

There are various types of thermocouples in common use. For temperatures typical of most glass and ceramic techniques, the Type K (chromel-alumel) thermocouple is almost universally used. For the higher temperatures encountered in certain processes such as crystalline glazing of ceramics and for melting glass in furnaces, a platinum thermocouple is required. Most customers will have only Type K thermocouples and thus use only Type K Sending Units. Because of differences in calibration, a channel that has been designated as Type S should not be used with a Type K thermocouple nor Type K sending unit and *vice versa*. A mismatch will result in erroneous temperature readings but will not damage the GB4 nor sending unit.¹

The only difference between Type K sending units and Type S sending units as far as their installation is concerned is in the color coding: Type K are Red (for negative) and

¹The readings will be so abnormal that there will be no question as to whether something is amiss.

Yellow (for positive), while Type S are Red (for negative) and Black (for positive). These directions are written as though you are installing a Type K thermocouple, with the Type S color in parentheses where it differs.

If you are unsure about which channels are Type K and which are Type S, you can tell by checking what temperature is displayed when no Sending Unit is attached: Type K channels read 32°F (blank for Celsius), and Type S channels read 20°.

The Sending Unit is attached directly to the thermocouple leads. These leads should be of thermocouple wire or thermocouple extension wire of the appropriate type (K or S) and should be relatively short (suggested length of a thermocouple lead is between one and four feet). Also, the Sending Unit should not be exposed to excessive heat [anything greater than 170°F (75°C).]

The thermocouple itself should be situated so that it is certain to measure an even temperature. For example, if placed too near the heating element, it may read a temperature that is higher than the actual temperature.

Your Sending Unit has two terminal strips at each end (see Figure 5.2). The one with two terminals coded red and yellow (black) is for connecting your thermocouple leads. The other has three terminals, colored orange, blue and green. This is for connections to the GB4 itself. The connection between the Sending Unit and the GB4 is made with common wire (between 20 and 16 gauge hook-up wire is recommended). The longer the distance between the Sending Unit and the GB4, the thicker the wire should be.

It is recommended that you hook up the Sending Unit to the GB4 before connecting the thermocouple to the sending unit. This will allow you to check that these corrections are correct before introducing more variables in the form of thermocouple connections.

To prevent damage from static electricity during shipping, the Sending Unit terminals are shorted together with small jumper wires. Generally, these should be removed prior to installing the sending unit. However, to test your connections to the GB4 before connecting the thermocouple, leave the jumper between the red and yellow (black) terminals on, but remove the others. Then, when the sending unit is correctly connected, the GB4 should read room temperature. If the thermocouple jumper wire is removed but no thermocouple is connected, the Sending Unit will think there is a burned-out thermocouple. (The sending unit cannot tell the difference between a burned out thermocouple and the fact that there simply is none connected.) In this case, with a Type K Sending Unit, the audio alarm will buzz; there is no audio alarm for a Type S Sending Unit. In case of thermocouple burn-out, the temperature will drift to a very high number that has nothing to do with the actual temperature, and your oven will turn off. When a functioning thermocouple is reconnected, normal operation will resume. Of course, when a thermocouple is connected, any jumper wire used in testing must be removed.

As shown in Figure 5.1, there are 5 terminal strips arranged in 2 groups on the back of the GB4. Looking from the back, the 3 strips on the right side are for the Sending Units. The top row is color-coded green, the middle row blue, and the bottom row orange.

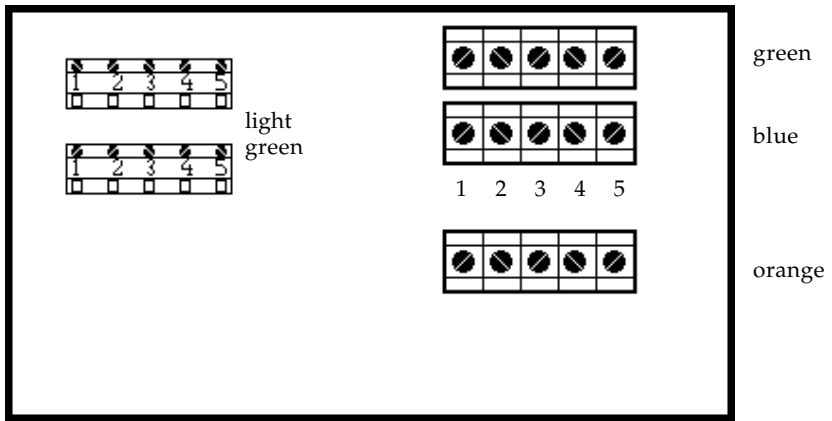


Figure 5.1: GB4 back

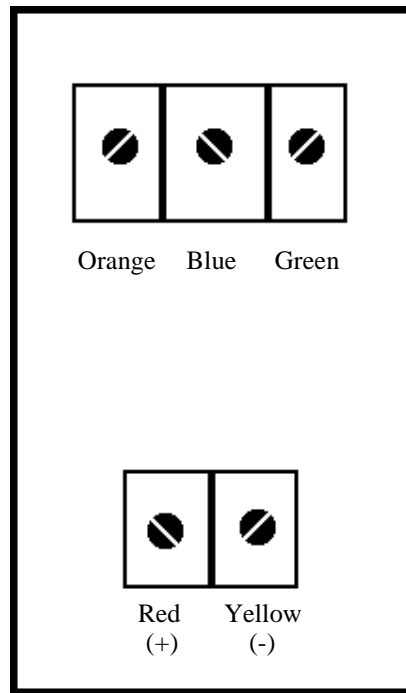


Figure 5.2: Type K Thermocouple Sending Unit

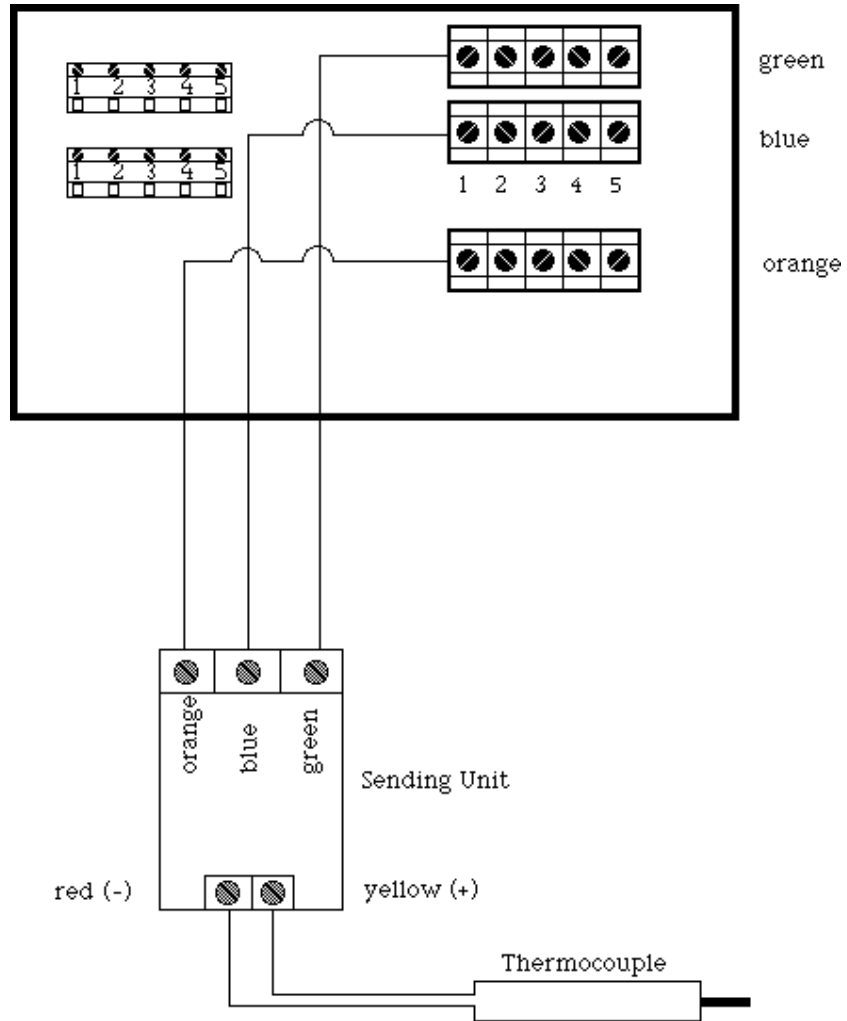


Figure 5.3: Type K Thermocouple Connections

The top row is for the temperature signals from the Sending Units. The middle row is common, and the bottom strip is for the power to the Sending Units. This bottom strip has +15 volts at every position. Since these are only for power, they do not correspond to any particular channel. The only reason there is more than one screw is convenience. All the orange are connected together. The blue are also all connected to each other.

Reading from left to right, the terminals correspond to channels (units) 1–5. Connect the Sending Units to the GB4 by attaching the three wires. When making the connections from the GB4 to the Sending Unit, it is very important that the colors match (*i.e.*, orange to orange, blue to blue, and green to green). The order of the colors on your Sending Unit may not match the order shown in Figure 5.2 but the color is all that is important.

When connecting wires between the Sending Unit and the GB4, try to avoid (as much as possible) running them parallel to heavy current-carrying wire (such as the main power lines in your heating elements or relay control power lines). If these lines run parallel, they can form an electro-magnetic coupling, which causes 60 cycle noise to be picked-up on the temperature input. Frequently, problems involving erratic temperature readings can be traced to a situation such as this.

The next step is to hook up the Sending Unit to the thermocouple. A typical thermocouple has red and yellow (black) wires that connect to the red and yellow (black) terminals, respectively. On the thermocouple side, the red is negative and the yellow (black) is positive. This may be confusing to those of us who associate red with positive. However, we must accept this inscrutable convention of the thermocouple world. If your thermocouple is not marked in this manner, you must determine which wire is positive and which is negative. [Try one way. If you make the wrong connection, the reading will not increase as the thermocouple is heated. Rather, it will go down from room temperature to 32°F (0°C). Type K Sending Units then stay at this temperature no matter how much heat is applied.

Connect the yellow (black) thermocouple lead to the yellow (black) terminal screw on your Sending Unit, and the red lead to the red screw. If you hook up the thermocouple with the leads interchanged, no damage will occur. However, the temperature readings will be wrong, as stated above.

5.2 Connecting the Relays

The relay outputs of the GB4 are controlled by the AC solid state relays capable of handling up to 3 amps (AC only). THIS IS A CONTROL CIRCUIT ONLY: NO MAIN ELEMENT POWER SHOULD BE RUN THROUGH THESE TERMINALS. Looking at the GB4 from the back (see Figure 5.1), the two strips on the left side are used for these control circuits. As with the thermocouple inputs, the relay outputs correspond to units 1–5 (when reading left to right). These circuits are optimized for reliable control of contactors, relays, and

solenoids; they completely isolate the external voltage from the rest of the GB4 circuitry. Because the control voltage is AC, there is **no difference** between the the upper and lower terminals. As long as they correspond to the same unit, they are symmetric. You should not think of one of them as “in” and the other as “out”.

When connecting the wires to these terminals, please use an appropriately small-sized screw driver. Our repair department has seen many units that were severely mangled by oversized screw drivers. These are captive screws and cannot be individually replaced. If they are damaged beyond use, the entire terminal strip must be replaced. This is, of course, never covered under warranty.

These are passive switches and do not supply any power.
These are passive switches and do not supply any power.
These are passive switches and do not supply any power.

We cannot stress this too strongly: it is the cause of much confusion during installation. These circuits will control any AC voltage from 12 to 240 volts². The voltage used will depend upon the type of coils in your contactors. If you are using contactors with less than 110 volt coils, you will probably need a step-down transformer to get the lower voltage. In new installations, a low voltage 24 or 36 volt control system may be preferable to a 110 volt system: such a system is safer and easier to install according to various electrical codes.

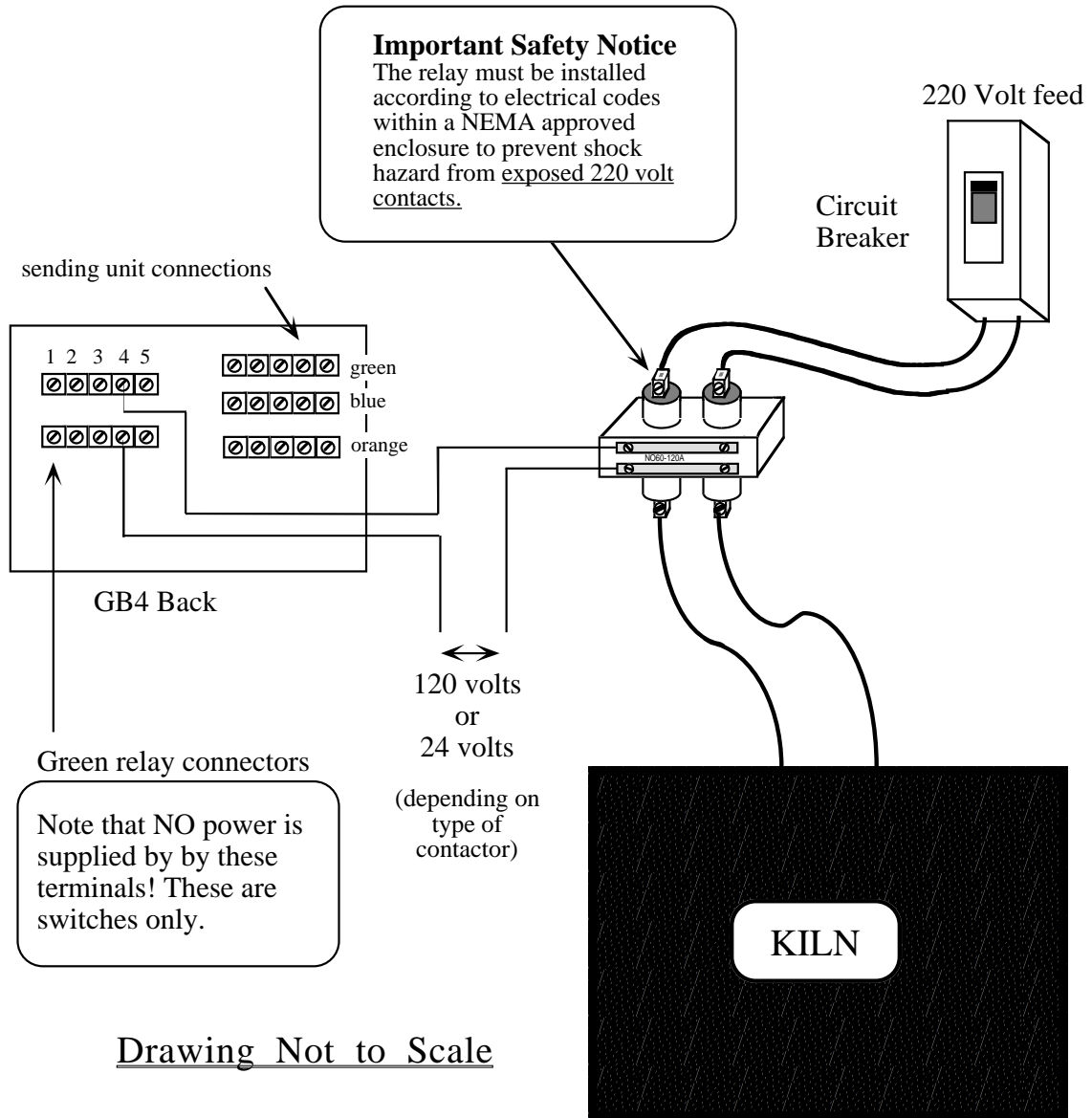
The control voltage, be it 24 or 220 volts AC, should be connected in series between the GB4 terminal and the appropriate contactor or solenoid. It is important to realize that the control voltage is not necessarily the same as that used to heat the oven. A 24 volt relay may still control a 240 volt oven.

It is essential to have a switch or circuit breaker in the main heating element of each unit. This allows the independent shut-down of the unit in case of a malfunction or stuck contactor. Each output channel is fused internally. To check or replace these fuses, you must remove the front cover of the GB4.

WARNING: TO PREVENT POSSIBLE DANGEROUS ELECTRIC SHOCK TO YOURSELF AND DAMAGE TO YOUR GB4, REMOVE THE COVER ONLY WHEN THE AC POWER IS TOTALLY DISCONNECTED FROM BOTH THE GB4 AND ALL CONTROL CIRCUITS.

Note that even though fuses are provided, they do not guarantee total protection for the solid state output modules inside the GB4. In the event of excess current being drawn (from improper wiring, for example), these solid state devices may be damaged long before any fuse of a reasonable size could blow. Therefore, when installing your GB4, scrupulously review your wiring. Be certain there is no direct short across the output terminals before

²Older models of the GB4 control any AC voltage from 12 to 120 volts.



applying power to your relay control circuits, as this will definitely blow out the output module. Also, be certain that you have connected the relay wires to the correct terminal strips (on the left of the GB4, looking from the back).

WARNING: SERIOUS AND EXPENSIVE DAMAGE WILL OCCUR TO YOUR GB4 IF YOU APPLY 110 VOLTS, OR EVEN 24 VOLTS, TO THE THERMOCOUPLE INPUT TERMINALS. DO NOT BE CARELESS WHEN HOOKING UP THE RELAY POWER. YOUR UNIT IS NOT GUARANTEED AGAINST DAMAGE DUE TO INCORRECT RELAY WIRING.

It is not possible to use an ordinary ohm meter or continuity checker to determine whether the relay outputs are opened or closed. This is because these are generally DC devices and the solid state relays of your GB4 will control only AC. If you need to test the operation of the relays, you must apply an AC voltage. To guard against dangerous electrical shock while testing, it is wise to use 24 volts AC instead of 110 volts.

5.3 Powering Your GB4

The GB4 should be powered from a 110 volt AC grounded circuit (220 volt, 50 cycle available on special order). It is recommended that this circuit be used *only* for the GB4. If no independent circuit is available, do not operate motors or large equipment on this same circuit.

A proper ground is very important for the reliable operation of your GB4. Furthermore, it is needed to protect your GB4 from damage during fault conditions and voltage transients. Under no circumstances should the 3-pronged plug on the GB4 be removed or bypassed. If an extension cord must be used, it should be a 3-wire type (third wire is ground) with a 3-pronged plug.

The main power supply fuse is located inside of your GB4 near the transformer. It is rated at 1/2 amp even though your GB4 draws less than 1/8 amp. This is because line voltage transients can cause higher currents to flow temporarily. Our experience shows that it is quite unlikely that you will ever have to replace this fuse. After proper installation, the only reason that this fuse would blow (other than an internal component failure in the GB4) is a massive voltage transient on the power lines. In particular, problems with your contactors or with your thermocouples should not affect this fuse.

If it does need replacement, your GB4 will appear completely dark; it will not respond to any keys; and it will not control any kilns. To check or to replace the fuse, you will have to remove the cover of the GB4.

WARNING: TO PREVENT POSSIBLE DANGEROUS ELECTRIC SHOCK TO YOURSELF AND DAMAGE TO YOUR GB4, REMOVE THE COVER ONLY WHEN THE AC POWER IS TOTALLY DISCONNECTED FROM BOTH THE GB4 AND ALL CONTROL CIRCUITS.

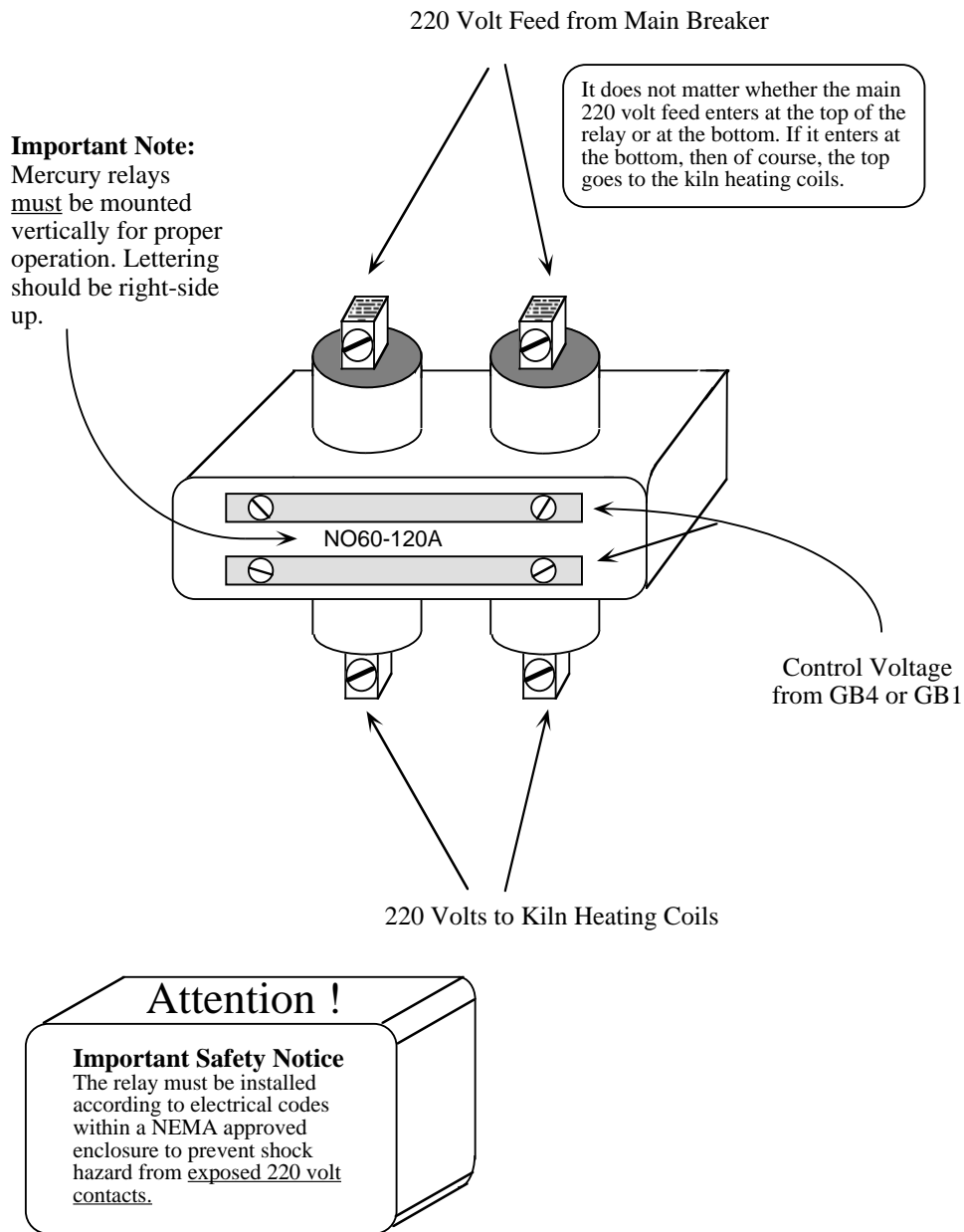


Figure 5.5: Typical Mercury Contactor Connections

5.4 Internal Protection

Considerable design effort has been devoted to protecting your GB4 against line voltage transients and transients at the Sending Unit connections. At the AC power input, transient spike protection is wired internally into the GB4. Any line voltage spike of more than about 130 volts automatically is shorted to ground by the internal solid state circuitry. If these spikes are abnormally large, the power fuse may blow. If this fuse blows more than rarely, you have unacceptably noisy power. Contact Digitry Company, Inc., for help in these circumstances.

There is also transient voltage spike protection both within each Sending Unit and where the signal lines enter the GB4. There are two fuses within each Sending Unit. You should not attempt to replace these fuses, because if they are blown, your Sending Unit and possibly your GB4 should be checked for additional damage. Furthermore, the fuses are soldered in and disguised so that you are unlikely to recognize them as fuses.

In spite of all this protection, contact between a thermocouple and a live heating element is likely to damage the Sending Unit as well as the GB4. The GB4 is not guaranteed against damage of this type. All thermocouples should be fastened securely to prevent contact with the heating elements.

Under no circumstances should you adjust the position of a thermocouple when the unit is heating. Not only do you risk damage to your equipment, you also risk a DANGEROUS ELECTRICAL SHOCK. Remember, the heating elements contain voltages as high as 220 volts (or even more), depending on exactly where they are touched. Thermocouples are made of metal. Metal conducts electricity. Even if your elements and thermocouples are encased in porcelain, care still must be used. Porcelain and other refractory materials become conductive at high temperatures and consequently do not give as much protection as you might assume.

5.5 DOs and DON'Ts

Like any tool you work with, the GB4 abides by a prescribed set of operating principles. Follow precisely the installation instructions detailed in this chapter. And, keep in mind the following “do”s and “don’t”s when installing your GB4.

- Do not run power for heating elements through GB4 relays.
- Do not misconnect or short together the wires to the Sending Units.
- Do remember that the GB4 controls contactors or solenoids by passive switches; it does not itself supply power.

- Do not run wires between the Sending Units and the GB4 in the same conduit or in close proximity to wires connected to heavy equipment or to power wires for relays or heating elements. This practice would introduce “noise” into the readings and may cause incorrect temperature readings.
- Do not reposition the thermocouple while the unit is running as it may touch a live heating element and put 110 (or 220) volts through the thermocouple input. This will cause expensive damage and possible shock.
- Do not remove the front cover of the GB4 until all AC power is removed from both the GB4 and all control circuits. This will prevent possible shock to you and damage to your GB4.
- Do ground your GB4 properly.
- Do not remove or bypass the 3-pronged plug on your GB4.

5.6 Additional Help

If you have any questions about installing your GB4 after reading this chapter, please call Digitry Company, Inc., so that we can provide you with the information you need.

Chapter 6

Reference

6.1 GB4 Specifications

The GB4 Programmable Temperature Controller, basic model, is equipped with two Sending Units for use with Type K thermocouples. Additional Sending Units, Type S capabilities, key lock security and customized hardware and software are optional.

Power Requirements: 10 watts at 110–120 volts AC, 60 cycle, grounded outlet (220 volts, 50 cycle available).

Temperature Measurement Range: 5 channels, 32° to 2372°F (0° to 1300°C) with automatic cold junction compensation for Type K; 5° to 3200°F (10° to 1760°C) for Type S.

Resolution: 1 part in 4100.

Repeatability: 1°F.

Timing: crystal controlled.

Common Mode Rejection Ratio: at 60 Hz (at thermocouple) for Type K, 126 dB minimum; for Type S, 148 dB minimum.

Output: 5 channels, ON/OFF control via solid state relays with zero crossing detection; 3 amps at 24–140 volts AC, fused internally. Options: (a) 24–280 volts AC, (b) 3–60 volts DC, (c) 4 or 5 amps.

Programming: 9 programs; 15 set-points per program; maximum of 543 hours in one minute increments for each program.

Dimensions (H×W×D): $9'' \times 12\frac{11}{16}'' \times 6\frac{1}{8}''$

Shipping Weight: 7 lbs. (3.18 kg.)

Operator Interface: $\frac{1}{2}$ " , 7-segment, red LED; 16-position sealed keyboard (dust and moisture resistant).

6.2 Accuracy

While the absolute accuracy of the GB4 is limited to about 1%, the resolution always is approximately 0.5°F. This yields more than 0.025% of full scale reading. With a given GB4 and fixed thermocouple location, your temperature profiles are repeatable to an extremely high degree of accuracy. More variation will be introduced by the way you load your unit than by the accuracy of your readings.

To help ensure this repeatability, all Type K Sending Units are equipped with automatic cold junction compensation to account for variations in room temperature. Such variations ordinarily would appear as an error in the temperature reading. This is because a thermocouple measures the difference in temperature between the hot end and the point where the Sending Unit is attached, *not* the absolute temperature. With cold junction compensation, these errors are eliminated.

It is important to realize that because of the resolution of the GB4 temperature measurement, you will note swings in the temperature of your unit that would go unnoticed with a standard, meter type pyrometer. These swings are to be expected. They were always there, you just could not see them. You should notice that the more material you place in your unit, the less severe the swings.

6.3 Sales and Service

The main offices of Digitry Company, Inc., are located at:

188 State Street, Suite 21
Portland, ME 04101
Phone +1-207-774-0300
FAX +1-617-484-5220
Email info@digitry.com
Internet www.digitry.com

Write or call for all sales, service, or technical information.

6.4 Loaner Program

If your GB4 should malfunction after the warranty has expired, you can return the GB4 to Digitry for repair.

Realizing that the GB4 will become an indispensable part of your production facility, Digitry will, upon request, immediately send a GB4 “loaner” for the duration of the repair. Please call the Maine office for the current cost of the loaner and the deposit amount. There is a daily surcharge if the loaner is kept for more than 3 working days after you receive your repaired GB4.

6.5 Warranty Information

DIGITRY COMPANY, INC., (“SELLER”) WARRANTS THAT THE PROGRAMMABLE TEMPERATURE CONTROLLER (“PRODUCT”) SOLD TO PURCHASER SHALL BE OF STANDARD QUALITY OF SELLER. SELLER’S OBLIGATION AND LIABILITY UNDER THIS WARRANTY IS EXPRESSLY LIMITED TO REPAIRING OR REPLACING, AT SELLER’S OPTION, A PRODUCT NOT OF SELLER’S STANDARD QUALITY FOR A PERIOD OF NINETY (90) DAYS FROM THE DATE OF DELIVERY. SELLER MAKES NO OTHER WARRANTY, EXPRESS OR IMPLIED, AND MAKES NO WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR ANY PARTICULAR PURPOSE. SELLER’S OBLIGATION UNDER THIS WARRANTY SHALL NOT INCLUDE ANY TRANSPORTATION CHARGES OR COSTS OF INSTALLATION OR ANY LIABILITY FOR DIRECT, INDIRECT OR CONSEQUENTIAL DAMAGES, DELAY OR LOSS OF PROFITS, EVEN IF SELLER HAS BEEN INFORMED BY PURCHASER OF THE POSSIBILITY OF SUCH DAMAGES.

IF REQUESTED BY SELLER, A PRODUCT ON WHICH A WARRANTY CLAIM IS MADE SHALL BE RETURNED TRANSPORTATION PREPAID TO SELLER’S PRINCIPAL PLACE OF BUSINESS. ANY IMPROPER USE, OPERATION, SUBSTITUTION OF PARTS, OR ALTERATION OR REPAIR BY OTHERS IN SUCH A MANNER AS IN SELLER’S JUDGMENT AFFECTS A PRODUCT MATERIALLY AND ADVERSELY SHALL VOID THIS WARRANTY. NO EMPLOYEE OR REPRESENTATIVE OF SELLER IS AUTHORIZED TO CHANGE THIS WARRANTY IN ANY WAY OR TO GRANT ANY OTHER WARRANTY.

Chapter 7

Glossary

Auto-hold

Automatic function that halts the unit timer if the actual temperature varies too far from its programmed temperature.

Channel

All the components, both hardware and software, that refer to a given unit.

Cold Junction Compensation

Mechanism incorporated into Type K Sending Unit that adjusts for variations in room temperature.

Contactors

Another name for a large relay (see below).

Hold

Function that stops the unit timer and maintains the programmed temperature for an indefinite period of time.

Idle

Condition in which control power to a unit and the unit timer are off and the GB4 is ready to start at the beginning of a profile.

Key Lock

Optional feature that prevents accidental or unauthorized program changes.

Looping

Command that triggers the indefinite repetition of a temperature curve.

Memory Back-up

Safety device to ensure program retention in the event of power failure.

Mercury Displacement Relay

A special type of relay that uses liquid mercury to make electrical contact. This type of relay is quieter, more reliable, and more expensive than ordinary mechanical relays and is recommended for applications where currents in excess of 30 amps must be controlled.

Monitor Mode

Operating mode used to display current time and temperature set-points for a given unit. GB4 must be in this mode to start or stop a unit.

Output Module

Special electronic (“solid-state”) relay used within the GB4 by which it controls your contactors.

Oven

An oven, kiln, lehr or furnace.

Program Mode

Operating mode that permits the GB4 to receive, change or examine temperature curves.

Pyrometer

Instrument for measuring high temperatures, commonly (but incorrectly) used to refer to a thermocouple probe.

Ramping

The increase or decrease in unit temperature.

Relay

A electromagnetically actuated switch controlled by a small amount of power that, in turn, controls a larger amount of power. Large relays are also referred to as contactors.

Run

State in which the unit timer is activated and the unit follows its programmed operations.

Safety Sequence

A feature of the GB4 that requires you to enter a specific sequence of keys to prevent accidental starting, erasing, or resetting of programs.

Scan

Feature that automatically displays time and temperature every four to five seconds on each unit in operation.

Set-Point

The target temperature of the oven at any given instant. During a soak, the set-point is the soak temperature. When your GB4 is ramping up or down, the set-point can change as often as every minute. The GB4 automatically calculates the set-point based on elapsed time and the profile you have entered. This term is also used for the temperatures and times you punch in to define a program.

Single Phase Power

The normal type of electrical service. The power is delivered by means of two wires. The voltage may be 110-120 or 220-240. For 110-120 volt single phase power, a single pole relay is sufficient. For 220-240 volt single phase power a two pole relay is used.

Skip-step

Function that instructs the program to jump to the following programmed step.

Slope

The pitch, or rate of increase or decrease in temperature, determined by time and temperature set-points.

Soak

Function that holds a specific temperature setting for a designated period of time.

Step

A single set of time and temperature instructions to be executed in a program, corresponding to a single ramp up, ramp down, soak or hold.

Thermocouple

Temperature sensing device placed inside an oven or kiln. The composition of the thermocouple determines its type. Type K is chromel-alumel; Type S, platinum rhodium.

Thermocouple extension wire

Wire that has the same characteristics as thermocouple wire at low temperatures but different ones at higher temperatures. It is used for extensions, especially of Type S thermocouple leads, because it is cheaper than thermocouple wire.

Three-Phase power

A type of electrical service where the power is delivered by means of 3 separate wires instead of just 2. The voltage between any two wires is usually 208 volts AC. Three-phase power is usually found only in industrial or ex-industrial environments. To control three-phase power you need a 3 pole relay.

Unit

An oven, kiln, lehr or furnace.

Voltage transient

An electrical disturbance of very short duration, typically caused by lightning or by heavy electrical equipment.

Chapter 8

Troubleshooting

Symptom	Likely Cause	Suggested Actions
GB4 appears dead	No Power to GB4	<ol style="list-style-type: none">1. Check that GB4 is plugged in to a live circuit.2. Check internal fuse, lower right-hand side of back circuit board.
One channel reads 32°F	Defective sending unit, wires to sending unit broken or disconnected	<ol style="list-style-type: none">1. Try exchanging the sending unit with another that is known to work.2. Try using new wire to connect the sending unit to the GB4. Send defective sending unit to Digitry.
All channels read 32°F	Power for all sending units has failed	Send GB4 and sending units to Digitry for repair.
All channels read approximately 33–38°F	Short circuit between blue and orange wires or defective sending unit.	Remove all sending units. Add back one at a time until all have been tested. If one or more appear bad, send them to Digitry for repair. If all appear bad, send GB4 and sending units to Digitry for repair.

Symptom	Likely Cause	Suggested Actions
Sending unit buzzes	Burnt out or defective thermocouple, defective sending unit, or short circuit between green and orange wires	<ol style="list-style-type: none"> 1. Try exchanging sending unit with another that is known to work. 2. Try replacing thermocouple with one known to be good. 3. Try replacing thermocouple with short piece of wire. GB4 should display approximate room temperature, and sending unit should stop buzzing. If this happens, your thermocouple is bad. If it doesn't, send defective sending unit to Digitry for repair. 4. Disconnect both the GB4 and the sending unit from their wires. Then attach the GB4 to the sending with short lengths of wire, where you can see that they don't short out. If this stops the buzzing, the problem is in your wiring.
Erratic temperature readings for one or more units	Defective multiplexor chip	Contact Digitry for replacement chip. Most people can replace this themselves.
One or more units do not heat	Temperature too cold	Heat thermocouple above 50°F (hold in hand or apply direct heat).
One unit does not heat	Defective contactor or internal GB4 fuse has blown	Try actuating the contactor manually (carefully short out connectors at back of GB4—WARNING: electrical shock hazard). If unit begins to heat, check internal micro-fuse for that channel (if necessary, swap fuse with working channel). If fuse is bad, obtain replacements from Digitry; they are hard to find locally. If fuse is OK, return GB4 to Digitry for repair. If unit does not heat, check wiring or replace contactor.

Programming Forms