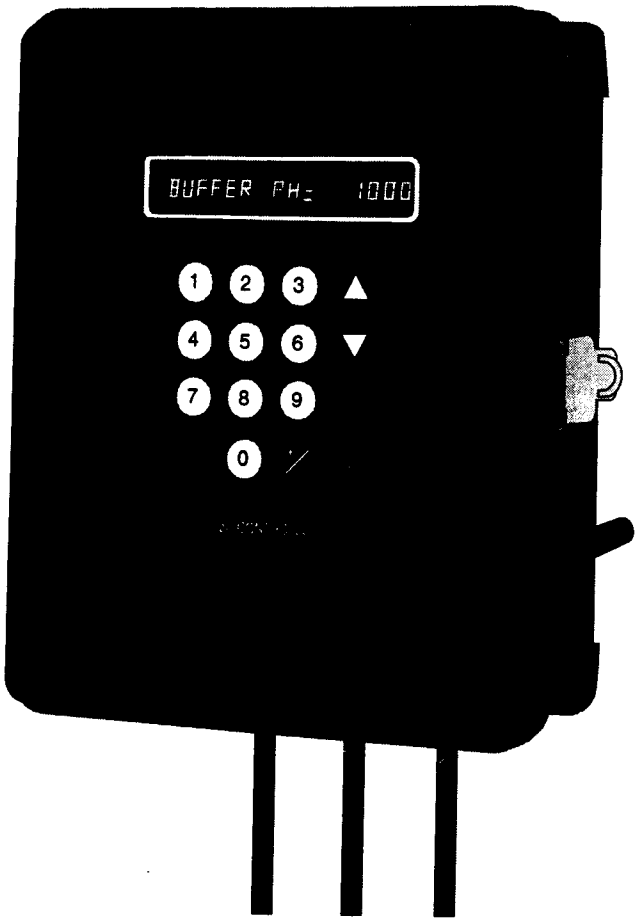
PHCN-150/160 SERIES

Wall Mount pH Controller



OMEGA®
An OMEGA Technologies Company

Operator's Manual
M1674/0793

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UNPACKING INSTRUCTIONS

Remove the Packing List and verify that you have received all equipment. If you have any questions about the shipment, please call the OMEGA Customer Service Department at 1-800-622-2378 or (203) 359-1660.

When you receive the shipment, inspect the container and equipment for any signs of damage. Note any evidence of rough handling in transit. Immediately report any damage to the shipping agent.

NOTE

The carrier will not honor any claims unless all shipping material is saved for their examination. After examining and removing contents, save packing material and carton in the event reshipment is necessary.

1.0 INTRODUCTION

The PHCN-150/160 series pH controllers are designed for a variety of industrial pH applications that require wall mountable packaging. These include water treatment, waste water treatment, food and beverage manufacturing and other industrial applications.

The PHCN-150 series controllers are microprocessor driven industrial controllers with on/off mechanical relay outputs. The dead band between control output on and off may be a set pH value (hysteresis) or a time in seconds after reaching set point (pump off delay), or a combination.

The PHCN-160 series controllers are microprocessor driven industrial controllers with proportional modulated pulse outputs designed to be compatible with externally controlled electronic metering pumps. The pH at which the maximum pulses (strokes per minute) occur may be any distance from the set point pH value.

They are compatible with any electrode that generates a millivolt signal, and may be used with Pt 1000 automatic temperature compensation elements. If no ATC probe is detected at power up, the controller will automatically go into manual compensation mode. If a preamplifier is required for long pH electrode cable lengths, the controller can supply ± 5 VDC to it. (Optional)

An access code is required to enter the menus used for calibration and set points. This may be disabled if desired. It may also be changed by the user.

The controller has a built-in audible alarm for high or low pH readings and diagnostic errors.

There are four available options: a ± 5 VDC hookup used to supply power to a preamplifier (-P), an isolated 4-20 mA output and ± 5 VDC (-M), independent high and low alarm contacts (-R), and all three previous options combined (-MR).

2.0 PACKING LIST

The carton should contain the following items. Notify your carrier immediately if there are any signs of damage to the controller or its parts. Contact your distributor if any parts are missing.

1. PHCN-150/160 series pH controller.
2. Operator's manual.

3.0 INSTALLATION

The PHCN-150/160 is designed to be wall mounted and is for the most part prewired. If the pH electrode will be greater than 20 feet from the controller, a preamplifier may be required. A preamplified signal may be run 1000 feet if no ATC is used, or if ATC is used it may be necessary to recalibrate the temperature using the procedure in Section 7.0 Troubleshooting. These distances are based on usage of 22 gauge wire.

3.1 Mounting the Electronic Enclosure

The PHCN-150/160 should be mounted with the display at eye level, on a vibration-free structure, in a location where it will not get splashed while the enclosure door is open. All four mounting holes should be used for structural stability. The control module requires the following clearances:

Top: 2″
Left: 10″
Right: 4″
Bottom: 4″

See Figure 1 (page 3) for template for the mounting holes.

3.2 Electrical Installation

All electrical connections are made to the controller via prewired plugs or connectors or internal terminals. There is a BNC connector for the pH input, a power cord for the AC input, and either AC receptacles (PHCN-150) or LMI microphone connectors (PHCN-160) for pump control outputs. A terminal strip is used for all other connections.

The range of wire gauges that may be used is 22 to 14 AWG.

3.2.1 AC Power Connections

The AC voltage required varies with the controller's model number:

PHCN-151, PHCN-161
115 VAC, 50/60 Hz
USA Cord

PHCN-152, PHCN-162
230 VAC, 50/60 Hz
DIN Cord

PHCN-153, PHCN-163
230 VAC, 50/60 Hz
UK Cord

Simply plug the control module into a receptacle of the correct voltage and style.

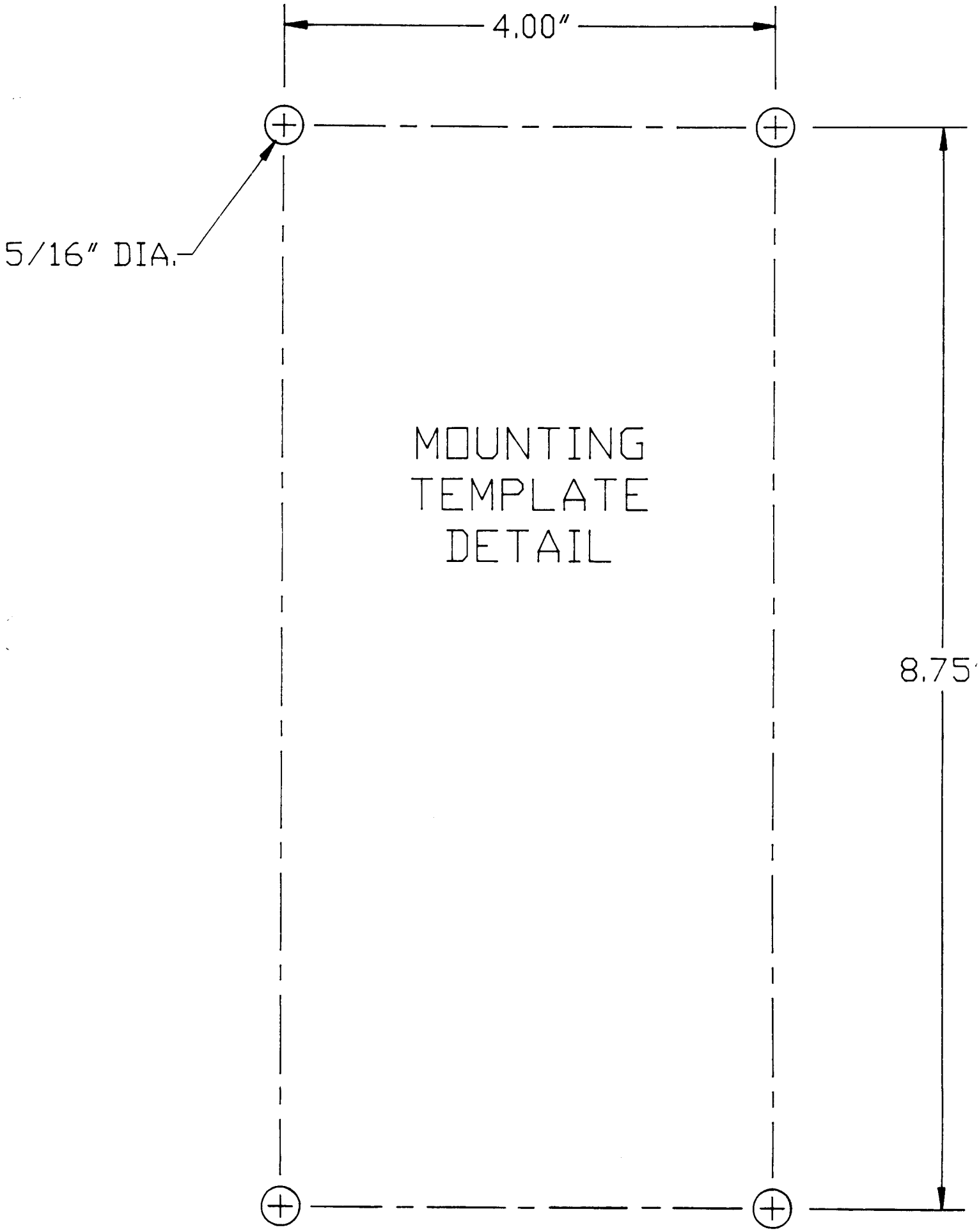


FIGURE 1 CONTROLLER MOUNTING TEMPLATE

3.2.2 Electrode Connections

If the distance between the pH electrode and controller is 20 feet or less, attach the electrode cable directly to the controller's BNC connector. (See Figure 3.)

NOTE: UNLESS THE ELECTRODE'S SIGNAL IS PREAMPLIFIED, NEVER CUT, SPLICE OR OTHERWISE DESTROY THE INTEGRITY OF THE CABLE FROM THE ELECTRODE TO THE CONTROLLER! UNSTABLE READINGS AND SUSCEPTIBILITY TO NOISE CAN RESULT.

NOTE: THE ELECTRODE WIRING SHOULD BE ISOLATED FROM ANY AC WIRING TO REDUCE THE POSSIBILITY OF NOISE INTERFERENCE.

If using the optional Pt 1000 ohm automatic temperature compensation, attach the green wire to ground, and the other two to the terminals labelled "temp cmp". The polarity is not important for the A.T.C. (See Figure 6.)

If connecting the pH electrode via our PHCN-1516 preamplifier, then use the following wiring diagram.

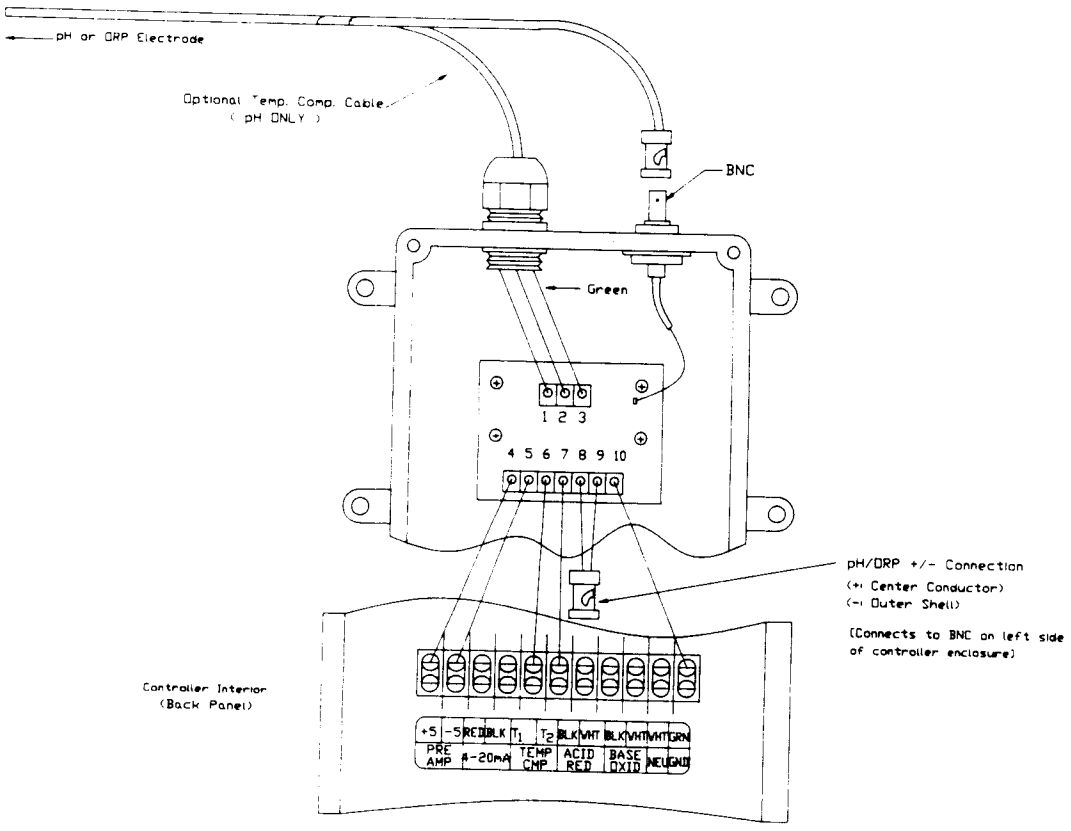


FIGURE 2 PREAMPLIFIER WIRING DIAGRAM

3.2.3 Control Device Connections

PHCN-150 SERIES controllers provide two powered mechanical relays for controlling pumps or valves. The "acid" relay is always configured to close if the pH rises above the upper set point, and the "base" relay will always close if the pH drops below the lower set point. The relay contacts are rated at 10 Amps maximum for a purely resistive load at 115 VAC, 5 Amps (resistive) at 230 VAC/28 VDC.

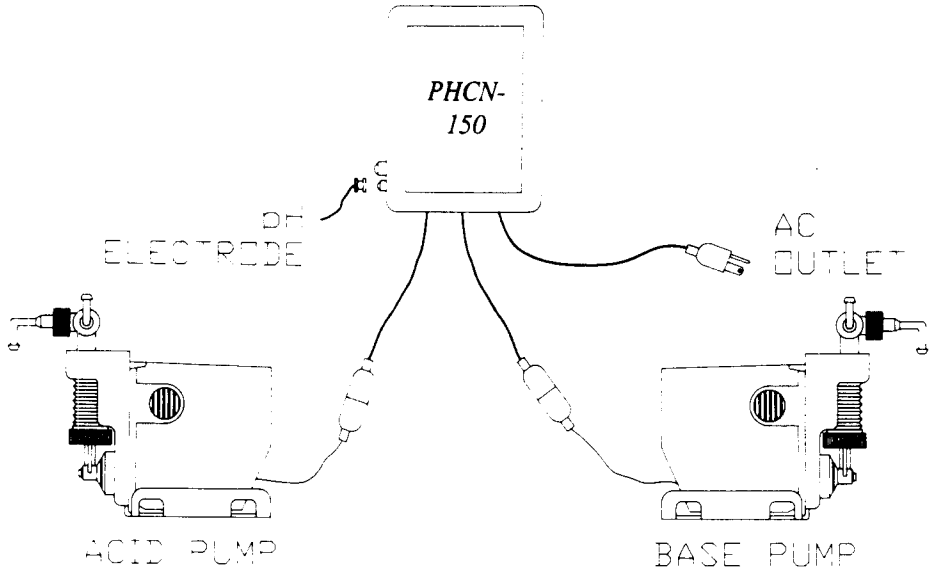


FIGURE 3 STANDARD CONNECTIONS, PHCN-150

PHCN-160 SERIES controllers provide unpowered solid state contact closures to directly pulse electronic metering pumps. The "acid" output will start to pulse when the pH rises above the upper set point, and the "base" output will pulse the contact closures when the pH drops below the lower set point. The opto-isolators are rated at 27 VDC maximum, 50 mA maximum.

The pumps should be plugged into the proper AC voltage power source, switched to the externally controlled mode, and wired to the controller as shown below. The pump will normally supply power to the "external" jack.

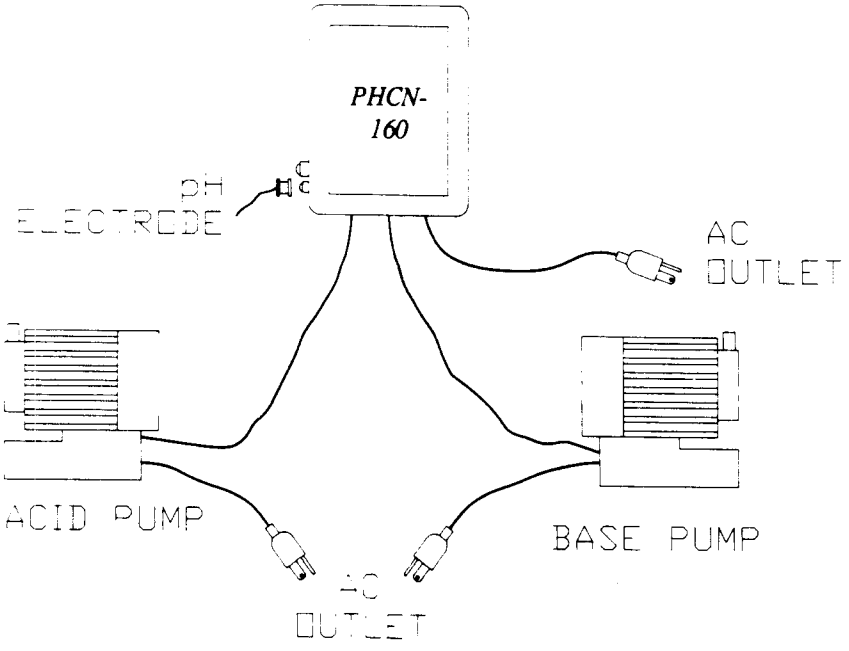


FIGURE 4 STANDARD CONNECTIONS, PHCN-160

3.2.4 Alarm Relay Connections (Optional)

The high and low alarm relays are rated at 1 Amp (resistive) at 230 VAC, not for use with DC voltage.

NOTE: THE ALARM RELAYS ARE INTENDED FOR USE WITH AC VOLTAGE ONLY! DO NOT CONNECT TO DC VOLTAGE.

NOTE: KEEP AC WIRING ISOLATED FROM THE pH ELECTRODE INPUT WIRING TO MINIMIZE THE RISK OF NOISE INTERFERENCE.

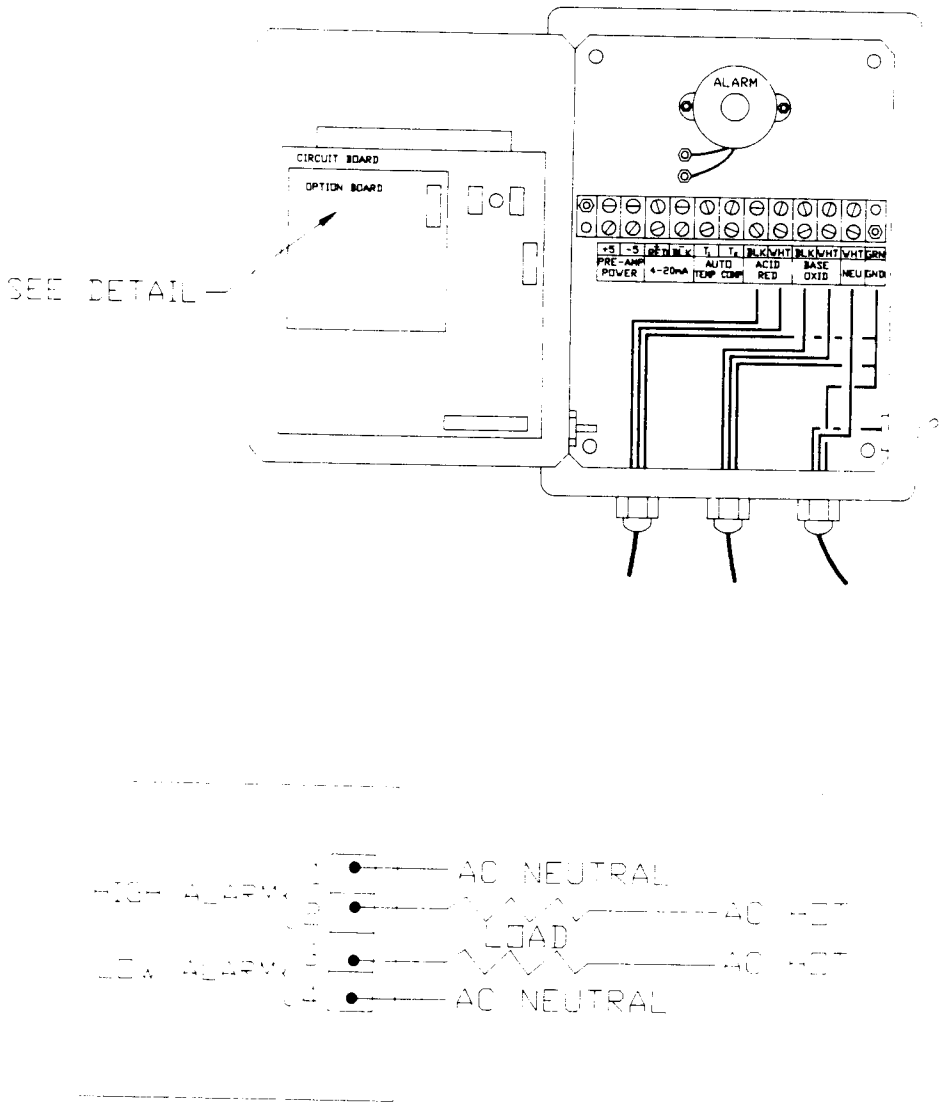


FIGURE 5 OPTIONAL HIGH/LOW ALARM RELAY WIRING DIAGRAM

3.2.5 4-20 mA Connections (Optional)

The isolated 4-20 mA analog output is proportional to the pH. The span of pH units that corresponds to the 4-20 mA span is adjustable in the software. The maximum loop impedance is 700 ohms if the controller is supplied with nominal AC power (115V or 230V). If the AC power is as low as 15% below nominal, the maximum loop impedance falls to 500 ohms.

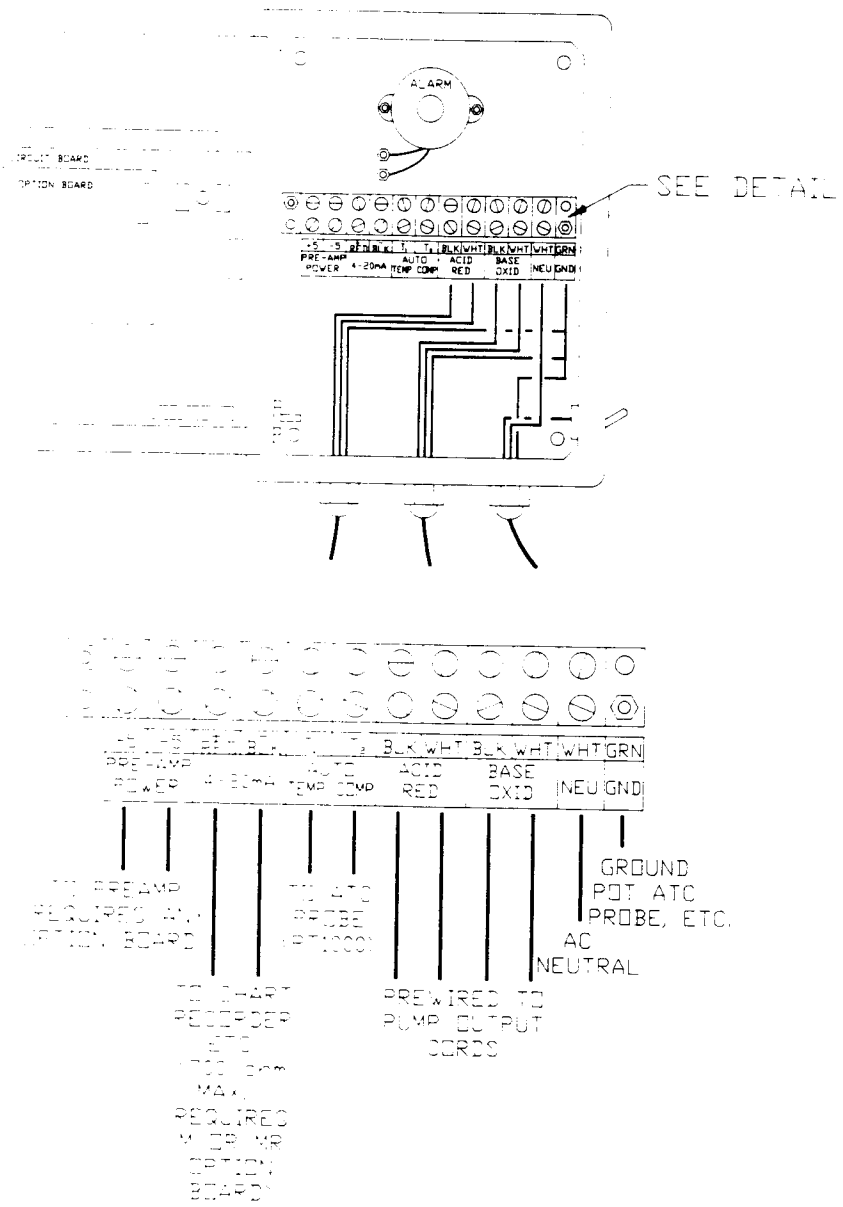


FIGURE 6 WIRING DIAGRAM FOR OTHER OPTIONS

3.2.6 Flow Switch Connections (Optional)

A flow switch that is normally closed when flow is sufficient may be connected to the connector labelled "Flow-Sw" on the right hand side of the main circuit board. Remove the jumper from the connector and replace it with the flow switch wires.

A similar liquid level switch could also be used to turn off the control mode until sufficient liquid is present.

4.0 SPECIFICATIONS

Summarized below are the equipment specifications.

4.1 Electrical Performance

pH range:	0–14 pH
pH resolution:	0.01 pH
pH stability:	0.01 pH
temperature range:	0–100°C
temperature resolution:	0.1°C
temperature accuracy:	±1°C

4.2 Mechanical Specifications

Enclosure material:	Fiberglass
NEMA rating:	4x
Dimensions:	7.5″×9.5″×5.0″
Net weight:	5.1 lbs.
Display:	16 character vacuum fluorescent

4.3 Operational Specifications

Power requirements: 115 VAC ± 15%, 50/60 Hz (PHCN-151, PHCN-161), 1/2 Amp
or 230 VAC ± 15%, 50/60 Hz (PHCN-152, PHCN-153, PHCN-162, PHCN-163), 1/2 Amp

Control outputs:

10 Amp (resistive)
6 Amp (inductive)
1/8 H.P. — at 115 VAC (PHCN-151), unpowered mechanical relays. 30 VDC max.

5 Amp (resistive)
3 Amp (inductive)
1/8 H.P. — at 230 VAC (PHCN-152, PHCN-153), unpowered mechanical relays. 30 VDC max.

50 mA Max, at 27 VDC, modulated pulse (PHCN-161, PHCN-162, PHCN-163)

High/Low alarm outputs (optional): 1 Amp (resistive) max at 230 VAC max, unpowered solid state triac, for AC voltage only.

4-20 mA output: Isolated, 700 ohm max. loop resistance at nominal input power; 500 ohm max. loop resistance at 15% less than nominal input power.

pH input: mV signal, 10^{13} ohm minimum input impedance.

Automatic temperature compensation: Pt 1000 ohm RTD. Not required, and no fixed resistor required to replace RTD.

5.0 OPERATION

The PHCN-150/160 controllers operate in two distinct modes, the menu mode and the control mode.

The menu mode is used to view or change set points, calibrate the pH electrode, manually activate the control outputs, etc.

The control mode is where the pH is monitored and the appropriate control or alarm output activated to keep the pH at set point, or to alert you to possible problems.

To get from the control mode to the menu mode, press any key. If not disabled, "ACCESS CODE" will be displayed. Enter the access code, and the first menu "2 Pt calibration" will be displayed. Then use the arrow keys to move to other menu selections.

See Section 5.3.1 for details on the "ACCESS CODE".

To go back to control mode from menu mode, press the "RUN" key. Also, if no key has been pressed for 3 minutes while in the menu mode, the controller will automatically go back to control mode. The only time that this will not happen is while calibrating the electrode. The controller will stay in the calibration menus indefinitely.

The pH WILL NOT be automatically controlled while in the menu mode, nor when an alarm other than high or low pH is on. The pH will be automatically controlled while in the run mode, and when the control outputs or high or low pH alarm relays are on.

5.1 Key Pad Functions

The PHCN-150/160 menu mode consists of a circular arrangement of menu selections which allows the user to input all the variables necessary to customize the machine for the application. The key pad is used for all inputs.

The "Up Arrow" and "Down Arrow" keys are used to scroll forward and backward through the available menu selections. The menu is circular because pressing the "Up Arrow" key when at the last menu selection displays the first menu selection.

Once in the desired menu, the numerical value may be changed by pressing the first digit of the new number and continuing until the desired number is displayed.

Pressing the "Enter" key enters the new number into the memory.

The "Clear" key zeros the display and clears the last entry. It does not clear the value from memory. Pressing clear a second time brings the value stored in memory to the display.

The "Run" key places the controller in the control mode. To get back into the menu mode, press any key. While in the control mode, the pump status and current pH value will be displayed.

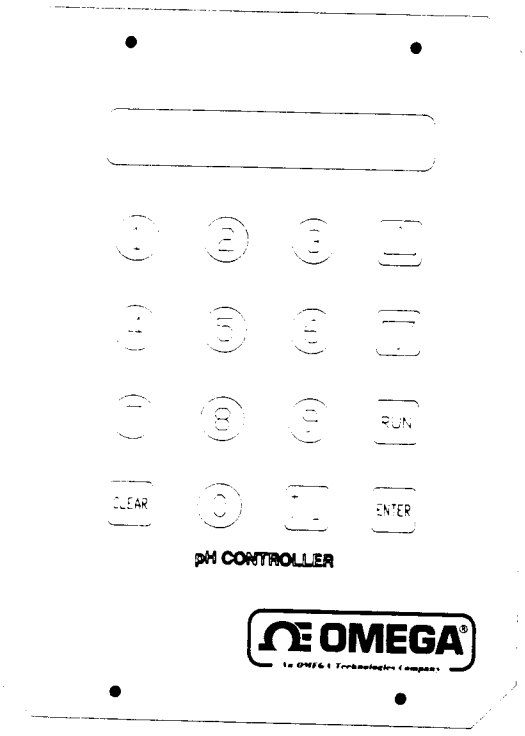


FIGURE 7 PHCN-150/160 KEYPAD

5.2 Menu Selection Descriptions

5.2.1 2 Pt Calibration

This is the menu that allows you to calibrate the pH electrode to the controller. This procedure will have to be followed at periodic intervals in order to compensate for changes in electrode characteristics as the electrode ages.

Press the ENTER key to begin the calibration.

CAL TEMP°C 20.0

If you are using automatic temperature compensation (ATC) the current probe reading will be displayed. Wait for this reading to change to the temperature of the buffer solution for best results. If you are not using ATC then enter the correct temperature of the buffer solution. For best results the pH electrode should be allowed to equilibrate with the buffer's temperature. If the electrode has been in a very hot process this could require as much as 20 minutes. Change the temperature as needed by pressing the number keys and press the ENTER key. Do not rush the calibration, pH is very temperature dependent and rushing through the procedure without allowing the electrode to truly read the pH buffer will have a negative impact on the accuracy of the pH reading and on the process control.

BUFFER 1 pH 7.00

Change this variable, if needed, to match the pH of the first buffer in your 2 point calibration sequence by pressing the number keys and then the ENTER key. Typically buffer 7 is used along with either 4 or 10. However, the controller will allow you to use any buffers that you have available.

mV STABLE ? 0.0

Watch the millivolt display on the controller. As the electrode equilibrates with the buffer, the display will settle on a mV reading. This reading is an indication of the pH electrode's response to various pH values. Excessive time to settle on this reading indicates that the probe is aging or requires cleaning. Some common mV readings for different pH values at various temperatures are tabulated below. Note that these values are using the "theoretical slope" of a perfect electrode, so your actual reading will probably not match this table exactly. Also, notice that readings below 7 pH are positive and readings above 7 are negative.

pH Value	mV @ 20.0°C	mV @ 25.0°C	mV @ 50.0°C
4.00	174.5	177.5	192.3
5.00	116.3	118.3	128.2
6.00	58.2	59.1	64.1
7.00	0.0	0.0	0.0
10.00	−174.5	−177.5	−192.3

The controller monitors your progress through the calibration procedure and will make every effort to alert you to potential problems. If you see the message **WRONG BUFFER** double check to be certain that you have the electrode in the buffer solution you entered in the buffer 1 step. This message may also mean that your electrode is not very close to a "theoretical electrode". It is okay to continue the calibration with **WRONG BUFFER** displayed, if you are using the correct buffer. When the mV reading is stable, press any key to accept the reading.

BUFFER 2 pH 4.00

As before, enter the value of the second pH buffer that you will be using in the calibration. Buffer 2 must be different from buffer 1 or the calibration will not yield valid results. If you see the message **ERR BUFFERS SAME**, the controller has determined that you are trying to use the same buffer for both points. If you have only one buffer available, please see the 1 point calibration section below.

mV STABLE ? 174.0

Refer to the table above to determine the approximate mV reading you should see at this step. When the reading is stable, press any key to continue. Again, be on the lookout for the **WRONG BUFFER** warning message.

PERCNT DIFF 0.0

Once both buffers have been entered and their respective mV readings are recorded, the PHCN-150 calculates a mathematical equation to match the particular pH electrode's mV readings to actual pH values. This slope is defined below:

$$\text{Calculated slope is } \frac{(mV_2 - mV_1)}{(buffer_2 - buffer_1)}$$

The slope is then used to compare your pH electrode to the "theoretical slope" of a perfect pH electrode (used in the table above). The Percent difference is determined by the following formula (applicable only at 20°C).

$$\text{Percent Difference} = \frac{(58.2 - \text{ calculated slope})}{58.2} \times 100\%$$

Most electrodes will not match the theoretical slope even when new, so don't be concerned with a small percent difference. However, as an electrode ages, this percent difference will start to increase due to the dying electrodes limited span. Thus, a large percent difference could indicate that your electrode is due for replacement or cleaning, or that you did not complete the calibration procedure properly. The controller monitors this percent difference and will refuse to control if this number is greater than 75%. You will see the message **CAL FAILURE** on the display. Typically you can only get this high of a percent difference due to an incorrect calibration attempt or a broken pH electrode/cable.

5.2.2 1 Pt Calibration

This menu allows you to calibrate the electrode to the controller using only one buffer solution. It may also be used to make the controller's pH readout match that of another meter exactly.

Press the ENTER key to begin the calibration.

CAL TEMP°C 20.0

If you are using automatic temperature compensation (ATC) the current probe reading will be displayed. Wait for this reading to change to the temperature of the buffer solution for best results. If you are not using ATC then enter the correct temperature of the buffer solution. For best results the pH electrode should be allowed to equilibrate with the buffer's temperature. If the electrode has been in a very hot process this could require as much as 20 minutes. Change the temperature as needed by pressing the number keys and press the ENTER key. Do not rush the calibration, pH is very temperature dependent and rushing through the procedure without allowing the electrode to truly read the pH buffer will have a negative impact on the accuracy of the pH reading and on the process control.

BUFFER pH 4.00

Change this number, if necessary, to match the pH value of the solution that you will be using for calibration, using the number keys and then the ENTER key. This may be any pH, except 7.00. If you enter 7.00 here, the error message **7.00 NOT ALLOWED** will appear. If you see this message, press the ENTER key to return to the BUFFER pH 4.00 display, then enter a pH value other than 7.00.

mV STABLE ? 174.0

Watch the millivolt display on the controller. As the electrode equilibrates with the buffer, the display will settle on a mV reading. This reading is an indication of the pH electrode's response to various pH values. Excessive time to settle on this reading indicates that the probe is aging or requires cleaning. Some common mV readings for different pH values at various temperatures are tabulated below. Note that these values are using the "theoretical slope" of a perfect electrode, so your actual reading will probably not match this table exactly. Also, notice that readings below 7 pH are positive and readings above 7 are negative.

pH Value	mV @ 20.0°C	mV @ 25.0°C	mV @ 50.0°C
4.00	174.5	177.5	192.3
5.00	116.3	118.3	128.2
6.00	58.2	59.1	64.1
7.00	0.0	0.0	0.0
10.00	−174.5	−177.5	−192.3

The controller monitors your progress through the calibration procedure and will make every effort to alert you to potential problems. If you see the message **WRONG BUFFER** double check to be certain that you have the electrode in the buffer solution you entered in the buffer step. This message may also mean that your electrode is not very close to a "theoretical electrode". It is okay to continue the calibration with **WRONG BUFFER** displayed, if you are using the correct buffer. When the mV reading is stable, press any key to accept the reading.

The controller will now use the theoretical slope, and will make the line go through the point that you've given it. This method will only be accurate when the electrode is new, or when the actual pH measured is very near the calibration solution pH.

5.2.3 Lower Set Pt

The lower set point activates the base pump if the pH drops below the set point value.

Enter the lower control limit by pressing the desired numerical value and then the enter key. Any value between 0.00 and 14.00 is allowed. An operating pH below the lower set point will activate the base pump.

NOTE: The lower set point can't be higher than the upper set point, or a **CHECK SET POINTS** error will occur.

5.2.4 Upper Set Pt

The upper set point activates the acid pump if the pH rises above the set point value.

Enter the desired upper control limit by pressing the numerical value and then the enter key. Any value between 0.00 and 14.00 is acceptable. An operating pH above the upper set point will activate the acid pump.

NOTE: The upper set point can't be lower than the lower set point, or a **CHECK SET POINTS** error will occur.

5.2.5 High Alarm

Enter the desired upper alarm limit as above. Any value between 0.00 and 14.00 is acceptable. An operating pH above the high alarm limit activates the audible alarm and the optional high alarm relay. The alarm deactivates if the pH drops back to within limits.

NOTE: The acid pump output will remain active during a high alarm condition.

5.2.6 Low Alarm

Enter the desired lower alarm limit as above. Any value between 0.00 and 14.00 is acceptable. An operating pH below the low alarm limit activates the audible alarm and the optional low alarm relay. The alarm deactivates if the pH rises back to within limits.

NOTE: The base pump output will remain active during a high alarm condition.

5.2.7 Probe/pH Temp °C

If an ATC probe is detected at power up, "Probe Temp °C" should be displayed. If no ATC probe is detected at power up, "pH Temp °C" will be displayed.

If using an ATC probe, the actual operating temperature of the solution will be displayed. If not using an ATC probe, you should enter the exact operating temperature in degrees Celsius by pressing the numerical value and then the enter key. Any value between 0.0 and 100.0 is acceptable.

The error in pH calculated is a function of pH and temperature. If the pH is at exactly 7.0, there is no error at any temperature. If the temperature is exactly 25 degrees C, there is no error at any pH value. Otherwise, the error will be 0.03 pH units per pH unit away from pH 7 per 10 degrees C away from 25 degrees C. If you are operating at a pH value far from pH 7 and the temperature is variable, you may want to opt for automatic temperature compensation.

The ATC element must be 1000 ohms at 0 degrees C (Platinum RTD).

5.2.8 Max △ pH

This menu is used to set the maximum change in the pH readout per second during the control process. It should be set to a lower number only if the process is set up such that false high or low pH alarms occur under normal operating conditions.

NOTE: Setting this variable to a low value will delay the response of the controller to pH changes, and may result in overshooting of the set point!

The graphs below show the effects of a rapid increase in pH. In the first graph, the max △ pH is set at 14.00, and in the second it is set at 0.05.

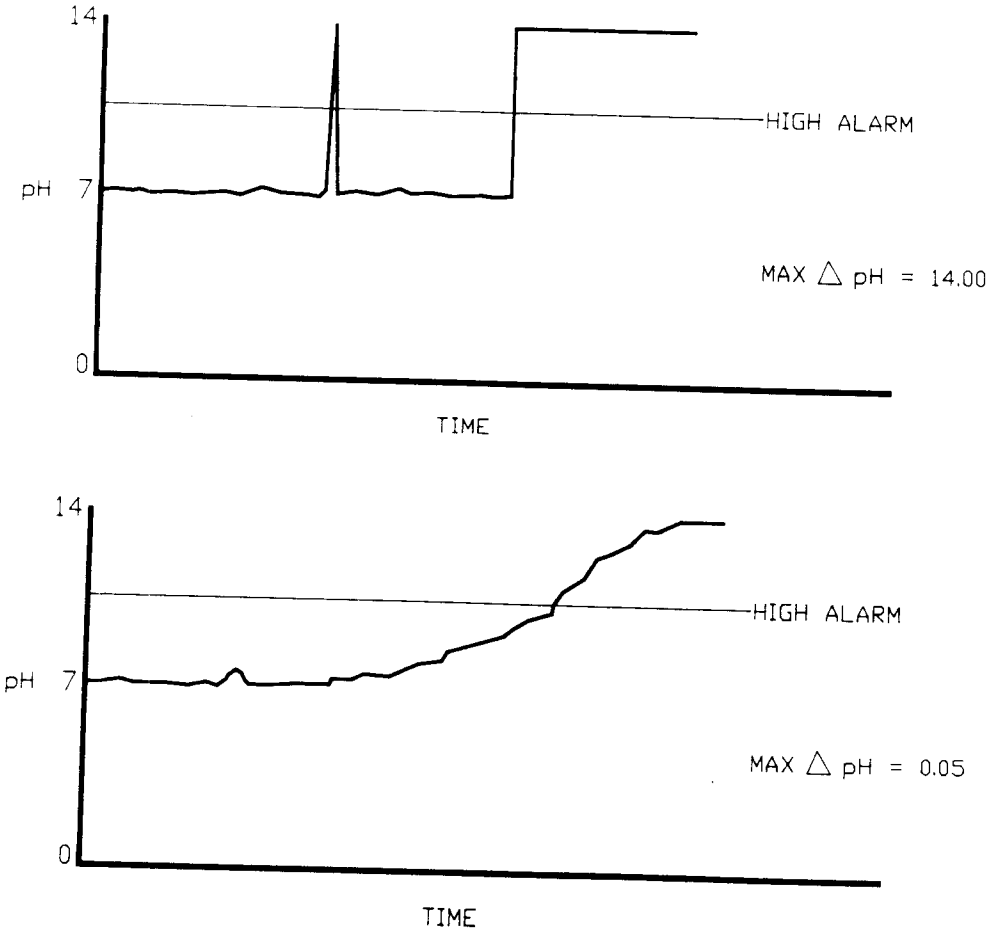


FIGURE 8 pH RATE OF CHANGE FILTER

Notice that when a short term high pH spike is sensed, a nuisance high alarm goes off if the max △ pH is at 14.00, but not if it is set at 0.05. Also, notice that if the pH rapidly climbs to pH 14 and stays there, the high alarm will go off immediately if the max △ pH is set at 14.00, but if set at 0.05 there will be a delay of 140 seconds.

If no damping of the pH input response is desired, set this menu to a value of 14.00. Any value between 0.01 and 14.00 is acceptable.

5.2.9 Max Pump On

The purpose of this variable is to set the maximum amount of time in seconds that a pump is allowed to be continuously activated. It is intended to alert the operator to a potential problem, such as a faulty pump, a faulty pH electrode, an empty adjustment chemistry tank, etc., that could cause the pumps to be on too long without effect. Any value from 2 to 8000 seconds is acceptable. If you need an output on longer than 8000 seconds (2 hours, 13 minutes), a set point of 7999 allows for complete deactivation of this pump-on timer.

The output will shut off if the timer has timed out and will display **PUMP OVER RUN** until keypad is pressed.

5.2.10 Pump Off Delay (PHCN-150 Models Only)

This variable is used to set the number of seconds of delay in shutting off the pH adjustment pump after the control point plus hysteresis (dead band) has been reached. It is intended to work in conjunction with or in place of the hysteresis function to prevent the pump relays from chattering on and off and destroying the relay. Any value between 0 and 60 is acceptable.

The following graph shows the effect of the pump off delay.

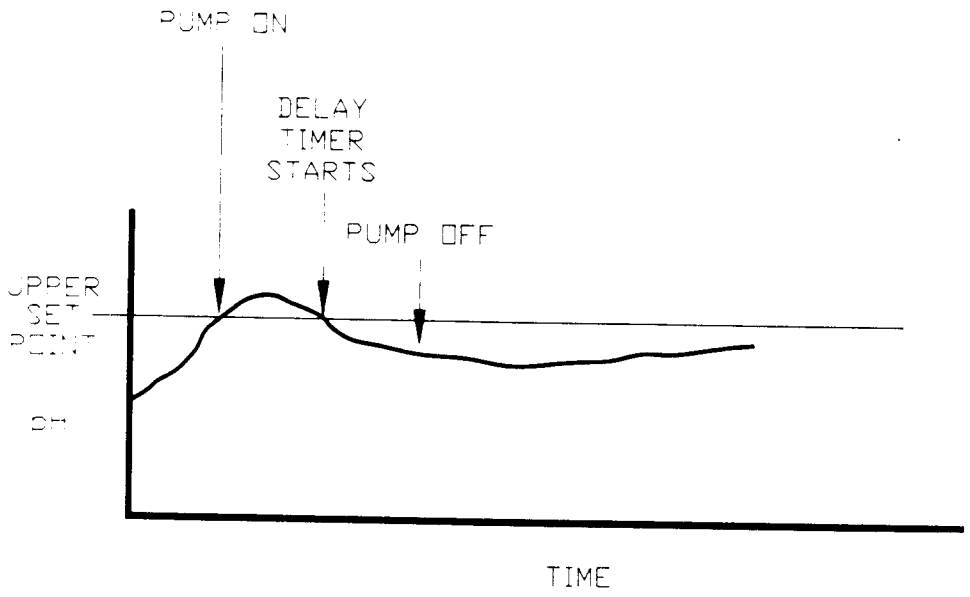


FIGURE 9 PUMP OFF DELAY

5.2.11 Dead Band (PHCN-150 Models Only)

The function of the hysteresis or dead band is to prevent pump relay chattering. It operates by allowing the pump to be turned on when the control point has been met, but does not allow the pump to turn off until the control point plus (or minus) the hysteresis value has been met. For example, if the lower set point is at 4.00 and the hysteresis value is 0.05, then the base pump will turn on at a pH of 3.99, but not turn off until a pH of 4.05. Any value from 0 to 14.00 is acceptable. If use of this function is undesirable, set it to 0. It is highly recommended that either the hysteresis or the pump off delay function be used, and set at the minimum value to be effective.

The following graphs show the effects of the dead band, as well as the effect of a zero pump off delay and a zero dead band simultaneously.

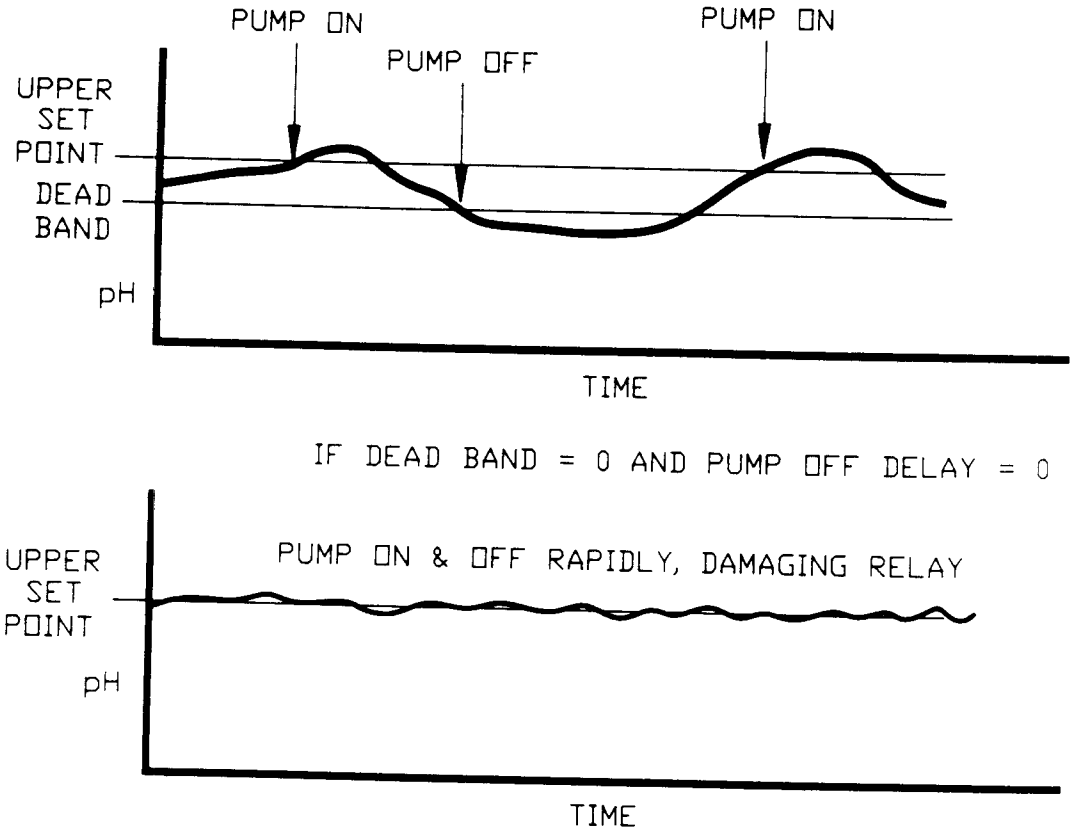


FIGURE 10 DEAD BAND

5.2.12 Max Acid SPM (PHCN-160 Models Only)

This menu is used to set the maximum number of strokes per minute that you want the controller to send to the pump for acid feed.

NOTE: If this variable is set at a higher number of strokes per minute than the pump is designed to accept, then the pump may not stroke at all at SPM above its maximum!

Any value between 0 and 200 is acceptable.

5.2.13 Max Base SPM (PHCN-160 Models Only)

This menu is used to set the maximum number of strokes per minute that you want the controller to send to the pump for base (alkali) feed.

Any value between 0 and 200 is acceptable.

5.2.14 △ pH = Max SPM (PHCN-160 Models Only)

The purpose of this menu is to allow you to customize the proportional output of the controller to fit the requirements of your application.

Choose how many pH units away from the set point that you want the pumps to be running at their maximum number of strokes per minute.

The following graph shows the effect of various settings:

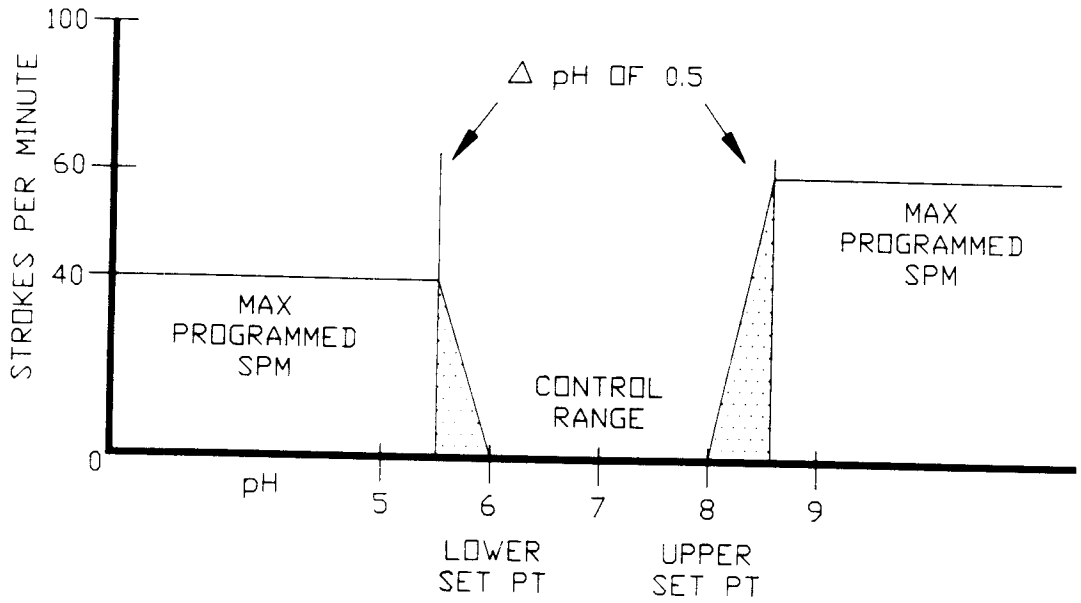


FIGURE 11 SPM SLOPE

If the controller overshoots the set point, make the △ pH = Max SPM value larger.

If the controller can't keep up with the additions, make the △ pH = Max SPM value smaller, or increase the Max Acid/Base SPM value, or source a pump with a higher flow output.

5.2.15 Manual Base

This menu is used to override the control process and manually turn on the basic (alkali) pH adjustment pump, at full speed. Press the enter key to turn the pump on and display the current pH. The maximum pump-on timer will also be active. Press any key to turn the pump off.

5.2.16 Manual Acid

This menu works the same as manual base, except for the acidic component. Press the enter key to turn the pump on and display the current pH. The maximum pump-on timer will also be active. Press any key to turn the pump off.

5.2.17 4 mA out pH (Optional)

The purpose of this menu is to set the pH value that you want to correspond to 4 mA on the analog output. Any value from 0 to 14 is acceptable. Note that it is possible to make the pH corresponding to 4 mA greater than the pH for 20 mA, for inverse control applications.

5.2.18 20 mA out pH (Optional)

This menu works as above, except it's for the pH value corresponding to the 20 mA analog output signal. Any value from 0 to 14 is acceptable.

NOTE: It is NOT acceptable for the minimum output pH to equal the maximum output pH! The output amperage is calculated from the formula:

mA = (pH Measured − 4 mA out pH)/(20 mA out pH − 4 mA out pH) × 16 + 4

If pH maximum output = pH minimum output, then the machine must divide by zero, causing unpredictable 4–20 mA signals!

5.3 Control Procedures

5.3.1 Initial Start Up

Turn on the controller by flipping up the toggle switch located on the lower right hand side of the enclosure. It will start in the control mode. Press an ARROW key to get into menu mode. The controller will display **ACCESS CODE**. Press 314 ENTER to get into the menu mode. If use of the access code is undesirable, press 318 ENTER when **ACCESS CODE** is displayed to disable the code. After that point, the menu mode may be accessed directly upon pressing an ARROW key.

If the battery is removed, or runs down, the access code will return.

To change the access code, press 316 ENTER. The controller will display the current access code. Use the number keys to key in the new three digit code, then press the ENTER key.

The controller will then revert back to the control mode. Press an ARROW key to get back to the display of **ACCESS CODE**. Enter your new code, and 2 PT CALIBRATION, the first menu selection, will be displayed.

Note that you can't change the ACCESS CODE to 316 or 318.

Note that if no keypad is pressed within 3 minutes of the last, while in menu mode, the controller will automatically go back to control mode.

Once in menu mode, go through the menus and change the set points to your desired values as described in Section 5.2. Then calibrate the electrode following the directions of either Section 5.2.1 or 5.2.2.

Return the pH electrode to the control location and press the RUN key to get in to control mode. Remember that if it will take longer than 3 minutes to reinstall the probe, the controller will go into run mode. If it will take longer, turn off the power to the controller, replace the probe, then turn the power back on and press the RUN keypad when ready to control. There is a 3V lithium battery to retain your parameters in memory.

5.3.2 Normal Start Up

Start up is an easy process once your parameters are in memory. Simply check your supply of pH adjusting chemicals, turn on the power switch, calibrate the electrode if necessary, and press the RUN keypad (or wait 3 minutes) and it will go into the run mode.

Remember to check your supply of chemistry frequently during operation!

5.3.3 Shut Down

To shut the PHCN-150/160 controller down, simply disconnect the power.

Storage of the pH electrodes during idle periods will vary depending upon the type of electrode used and the application. In general, the pH electrode should always be stored so that the glass bulb is kept wet, preferably in a solution with some ionic strength (not distilled water). Follow the manufacturer's recommendations for pH electrode storage. If the solution being controlled does not degrade the electrode, it may be left in place in the solution.

6.0 MAINTENANCE

The PHCN-150/160 requires very little preventative maintenance. Clean with a damp cloth. Do not use an abrasive. Do not allow electronics to get wet!

The most frequently replaced part is the pH electrode, which will deteriorate with age. Refillable electrodes should be checked for level frequently, and replenished with filling solution as necessary. An electrode may also fail for aging (slow response to changing pH), coatings over the glass bulb (again, slow response), abrasion of the glass bulb (shifts calibration), chemical attack and breakage. If you experience instability or lack of response, check the electrode, clean or replace if necessary and recalibrate.

The pH cable is another source of problems. Take care not to damage the cable, or allow the connections to get wet.

6.1 Changing the Battery

NOTE: DISCONNECT POWER TO THE CONTROLLER BEFORE OPENING THE FRONT PANEL!

NOTE: REMOVAL OR FAILURE OF THE BATTERY WILL RESULT IN LOSS OF MEMORY OF YOUR PROGRAMMED SET POINTS! USE THE PROGRAMMING LOG IN SECTION 8.0 TO SAVE YOUR SET POINTS IN CASE OF BATTERY FAILURE.

To change the battery, open the enclosure door.

Remove the four screws at the corners of the front panel.

With power disconnected, remove the front panel.

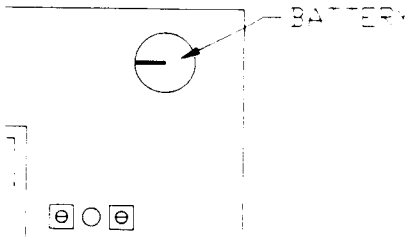


FIGURE 12 BATTERY

Locate the battery on upper right hand corner of the main circuit board (see Figure 12) which is attached to the front panel, and remove it by prying the battery up with a small screwdriver.

Replace with a new battery by sliding the new battery, with "+" side up, into the battery clip.

Replace the front panel and screws.

Reprogram the controller with your set points.

6.2 Replacing the Fuse for Control Outputs

NOTE: DISCONNECT POWER TO THE CONTROLLER BEFORE OPENING THE FRONT PANEL!

To replace the fuse, open the enclosure door.

Remove the four screws at the corners of the front panel.

With power disconnected, remove the front panel.

Locate the fuse on the main circuit board (see Figure 13). Pull the fuse out of the fuse holder and replace with a fuse rated as follows:

PHCN-161: 1 Amp
PHCN-162, PHCN-163: 1/2 Amp
PHCN-151: 6 Amp
PHCN-152, PHCN-153: 3.2 Amp

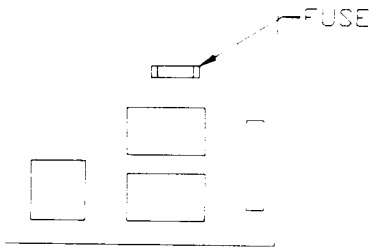


FIGURE 13 FUSE

Replace the front panel and screws.

NOTE: IF THE FUSE BLOWS AGAIN, CHECK THE CURRENT DRAW OF THE PUMPS ATTACHED TO THE CONTROL OUTPUT; IF OK, THE CONTROLLER SHOULD BE RETURNED TO THE FACTORY FOR EVALUATION.

6.3 Recalibrating the 4–20 mA Output

The calculation to convert pH displayed to mA to be output is as follows:

mA output = (pH measured − 4 mA out pH)/(20 mA out pH − 4 mA out pH) × 16 + 4

If the calculated mA output doesn't match the measured mA output (± 0.05 mA), then the measured 4–20 mA output may be calibrated as follows:

Set the "4 mA out pH" menu to 5.00 and the "20 mA out pH" menu to 9.00.

Remove the four screws at the corners of the front panel.

With power disconnected, remove the front panel.

Place the pH electrode in pH 4 buffer solution, and reconnect the power to the controller.

DO NOT TOUCH ANY COMPONENT EXCEPT THE 4–20 CALIBRATION POTENTIOMETERS!

Connect an ammeter in series with the load attached to the 4–20 mA terminals and read the mA output. Adjust to 4.00 mA ± 0.05 by turning potentiometer R7 with a small screwdriver or pot. screwdriver (see drawing below).

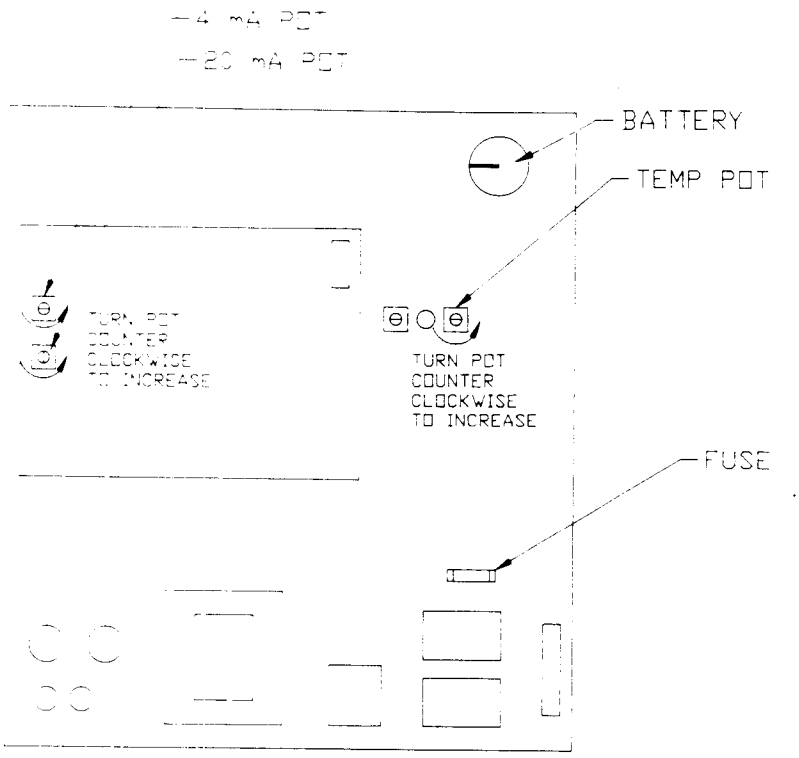


FIGURE 14 4–20 mA POTS

Place the electrode in pH 10 buffer solution.

The mA readout on the ammeter should go to 20.00 mA ± 0.05. Adjust to 20.00 by turning potentiometer R6.

Repeat the pH 4 and pH 10 adjustments until both the 4 and 20 mA readouts are accurate.

Place the electrode in pH 7 buffer solution. Verify that the ammeter readout is at 12.00 mA ± 0.05 when the displayed pH is 7.00.

If the displayed pH is not 7.00, but is 6.94, for example, calculate the expected mA output using the formula above, and verify that the mA output is now accurate. A pH of 6.94 should yield a mA output of 11.76.

Replace the front panel and screws.

Reprogram the "4 mA out pH" and "20 mA out pH" menus to the operating values.

If this procedure doesn't improve the 4–20 mA output accuracy, consult the factory for assistance.

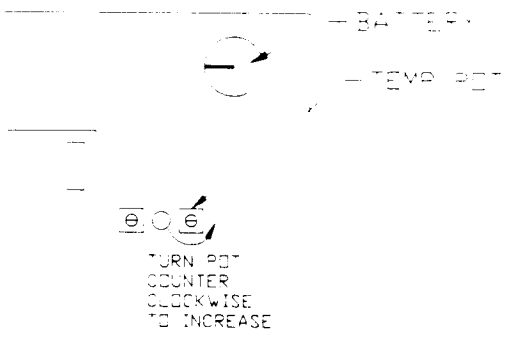
7.0 TROUBLESHOOTING

Troubleshooting and repair of the malfunctioning unit should only be attempted by qualified personnel using caution to insure safety and limit unnecessary further damage.

*NOTE: DISCONNECT THE CONTROLLER BEFORE REMOVING THE FRONT PANEL!

Error Messages: Should any error condition arise, the audible alarm will sound, and the kind of error will be displayed. Pressing any key will deactivate the alarm and clear the display of the error message. For any error, except high or low pH, all control functions stop while the alarm is on. If a high or low pH condition exists, the optional high or low alarm relay is activated, as well as the audible alarm, and control continues.

PROBLEM	CORRECTIVE ACTION
"Initialize All" at first power up.	Caused by removal of the battery prior to first power up. Controller will display "Initialize All". 1. Press enter to display "Recalibrate". 2. Press arrow key to display either "2 Pt Calibration" or 1 Pt Calibration". 3. Press enter and follow the Calibration procedure described in Section 5.2.1 or 5.2.2.
"Initialize All" error message at every power up.	Caused by failure of the lithium battery. Remove the 4 screws holding down the front panel. Locate the battery and replace. (See Section 6.1).
"Check set pts" error message.	Caused by entering the lower set point at a higher value than the upper set point. This would cause continuous pumping of one pump, then the other, with the pH fluctuating from one set point to the other. Press any key to get into the menu mode and silence the alarm, then re-enter the set points.
"Out of Range" error message.	Caused by attempting to enter a value that is not in the acceptable range for that variable. Press any key and then enter an allowable value.
"Pump Overrun" error message.	Caused by a pH adjustment pump running longer than the allowable time. Press any key to display the current value of the "max pump on" variable. Evaluate the pumping system, or increase the "max pump on" value. The pump may be faulty, the chemical supply empty, the tubing split or clogged, or the incorrect replenishment chemical installed.
"pH Probe Error" error message.	Caused by an open circuit at the pH input, usually due to a broken electrode, damaged electrode cable, or poor connection between electrode and BNC connector on the controller. If shorting the controller's BNC connector does not clear the error, then the problem is inside the controller, and you should consult the factory for service.

PROBLEM	CORRECTIVE ACTION
"Temp Probe Error" error message.	Caused by an open circuit to the automatic temperature compensation input, usually due to damage to the cable or a poor connection to the controller's terminal strip. NOTE: The controller will check for the presence or absence of an ATC probe at every power up, and will consider what it sees as a normal condition. This error message will NOT appear if the cable is damaged while the power to the controller is off.
"A/D Failure" error message.	Caused by a failure of the A/D converter chip to translate the pH electrodes' analog signal to digital within a set amount of time. Try resetting the controller by turning the power off, then on again. If still a problem, consult the factory.
"No Flow" error message.	Caused by the flow switch connector on the main circuit board not being shorted. Check for sufficient flow, faulty flow switch, poor connection of wires to connector, or missing jumper.
"Recalibrate" error message (other than at initial power up).	Caused by interruption of the calibration procedure. Perform one of the calibration procedures.
Display blank at power up.	Caused by no power to display. Verify that the controller is connected to a live circuit. Check the connections from the power cord to the terminal strip. With power disconnected, remove the 4 screws holding down the front panel and check the fuse on the circuit board. (See Section 6.2). If these items check out OK, consult the factory.
Pump will not turn on.	Verify that the pump is functional by plugging it into a live outlet. Check connections to pump. If pump works in manual mode, check control set point.
When using a preamplifier with ATC, the temp reading is high.  **FIGURE 15** **ATC TEMP CALIBRATION POT**	With preamp connected, put ATC probe in a solution of known temperature. Let stabilize for 10 minutes. Get into "Probe Temp" menu and see ATC reading. Remove the four screws that secure the front panel. Adjust P2 until that reading matches known temperature. P2 is the potentiometer that you see just to the right of the pH cable. See Figure 15 for location of P2. Note that 1000 feet of 22 gauge wire will yield a temperature of approximately 8 degrees C high.
Call OMEGA Customer Service if the above procedures prove fruitless.	