

**PH 220 PH PROBE AMPLIFIER
INSTRUCTION MANUAL**

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PH 220 PH PROBE AMPLIFIER INSTRUCTION MANUAL

1. OVERVIEW

The PH 220 is a high impedance differential amplifier designed to interface pH and other ion-specific electrodes to CSI dataloggers. Typical electrodes include pH, NH_4^+ , CO_2 , NO_3^+ , K^+ , Cl^- , Ca^{++} , SO_4^{--} , and Na^+ .

2. SPECIFICATIONS AT 25°C

Input voltage range (gain = 1): ± 5 VDC
 Input voltage offset: ± 0.1 mV
 Input impedance: $> 3 \times 10^{12}$ Ohms

Bias current: < 0.1 pA (bias current * output impedance of electrode = offset voltage due to bias current).

Output: Jumper selectable to X1 or X5 of input voltage. Shipped with X1 gain set. Changing to X5 gain requires the use of a voltmeter with 5 digits of resolution (See Section 6.6).

Environmental: 100% RH with polycarbonate case, -25°C to $+50^\circ\text{C}$.

Size with polycarbonate case: 10.5 X 3.25 X 2.25 inches (Length X Width X Height).

3. CONNECTIONS

Ion specific electrodes have either internal or external reference cells. Wiring for each type is shown below.

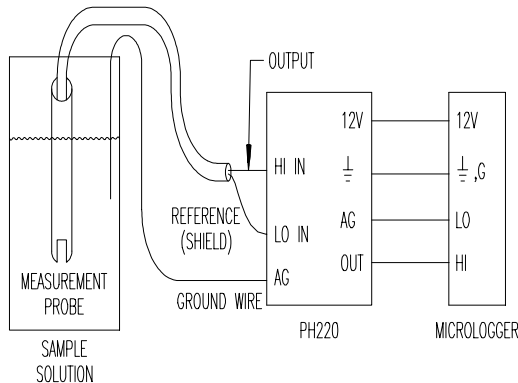


Figure 3-1. Internal Reference Cell Connections

When using a probe with an internal reference cell, place the vapor seal plug (P/N 5221) in the unused port of the polycarbonate case (Figure 3-2).

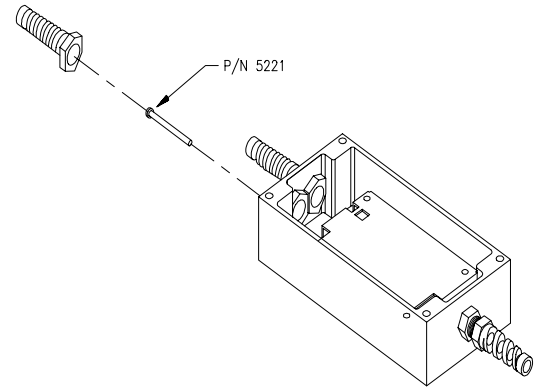


Figure 3-2. Installing Vapor Seal Plug

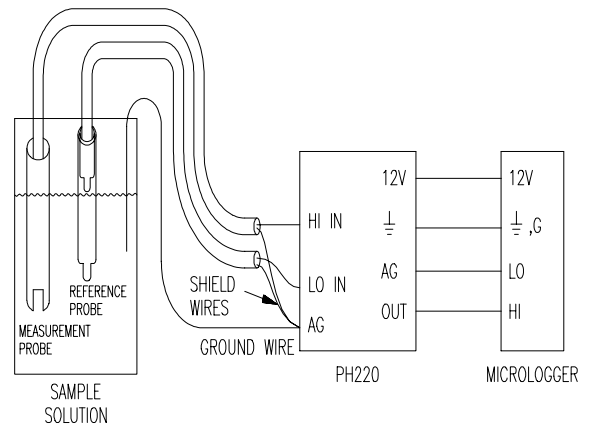


Figure 3-3. External Reference Cell Connections

4. PROGRAMMING

The output of the PH 220 is measured with Instruction 2 (differential voltage) when used with Campbell Scientific dataloggers. Specify the correct input voltage range for the output of the PH 220.

4.1 PH PROBE APPLICATION

Read and carefully follow preparation, maintenance, and storage instructions from the probe manufacturer.

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An ideal pH probe will output 59.2 mV per pH unit at 25° C. The following table shows the response of an ideal probe to calibration standards:

| <u>Buffer pH</u> | <u>mV</u> |
|------------------|-----------|
| 4.0 | 177.6 |
| 7.0 | 0.0 |
| 10.0 | -177.6 |

A typical probe, however, will vary from the ideal. A multiplier and offset must be calculated each time the calibration changes. The multiplier and offset can be entered into Instruction 2.

4.2 EXAMPLE

Millivolt readings were obtained from an ORION pH half cell Model 91-61 with a Model 90-01 Reference Cell in standard pH buffer solutions as follows:

| <u>pH</u> | <u>mV</u> |
|-----------|-----------|
| 4.0 | 135.61 |
| 7.0 | -38.39 |

Apply this data to the equation for a line:
 $y = mx + b$, where $y_2 = 7$, $y_1 = 4$, $x_2 = -38.39$, and $x_1 = 135.61$.

$$\text{Multiplier} = m = (y_2 - y_1)/(x_2 - x_1) \\ = (7-4)/(-38.39 - 135.61) = -0.01724$$

$$\text{Offset} = b = y_1 - (m * x_1) \\ = 4 - (-0.01724 * 135.61) = 6.338$$

5. TROUBLE SHOOTING

Measurement errors can usually be traced back to one or more of the following sources: operator error and datalogger function, sample / application, electrode, or the PH 220. Follow a systematic procedure to isolate the problem.

5.1 OPERATOR ERROR & DATALOGGER FUNCTION

Check the programming of the datalogger, wiring configuration, and battery voltage. Measuring the output of an independent mV source (such as the thermocouple provided with the datalogger), without the PH 220 in line, is a

quick way to determine if the program and datalogger are functioning properly.

5.2 SAMPLE/APPLICATION

Check the user's manual for your probe to ensure that the sample and application are compatible with the probe. Sample temperatures may also be affecting accuracy, so the probe should be calibrated at the temperature it will be used. The OMEGA [pH and Conductivity Handbook](#) and the ORION [pH Electrode Catalog](#) give good descriptions of temperature effects on pH measurements. Automatic temperature compensation can be accomplished by using a 107B temperature probe and programming the datalogger to calculate a temperature correction factor.

5.3 ELECTRODE

The probe's owner's manual should have a trouble shooting section. Pay particular attention to temperature compensation considerations.

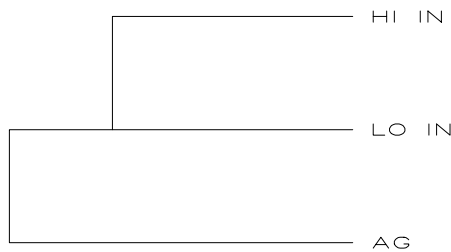
5.4 PH 220

Faulty Grounding. Erratic measurements can usually be eliminated by properly grounding all system components to a common earth ground. Refer to the wiring diagram for ground connections to and from the PH 220. The datalogger must be grounded to earth ground.

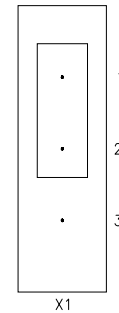
For high Humidity, Corrosion, and Contamination, check the humidity indicator card in the lid of the polycarbonate case. If the RH is greater than 30%, change or recharge the desiccant. The mylar sheet must be between the desiccant package and the PH 220 case. The presence of corrosion or contamination on connectors or on the circuit board may require factory service.

If the above sources of error have been eliminated, check the offset and input impedance with the following procedure.

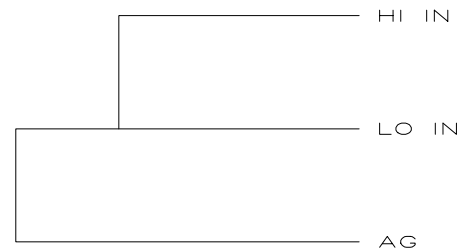
5.4.1 CHECKING THE OFFSET (ZERO)



Connect all input terminals on the PH 220 as shown. The output on the micrologger should be zero ± 0.1 mV. If the output is outside of the limits, the offset can be adjusted as outlined in Section 6.2 (this procedure requires a voltmeter with 5.5 digit resolution).

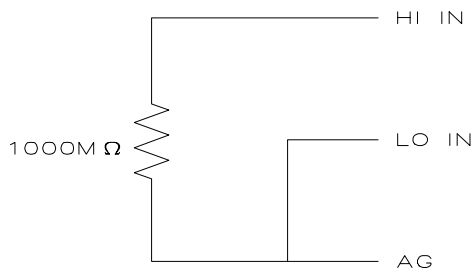


6.2. ADJUST THE OFFSET (ZERO)



Connect a 12 VDC supply to the terminals labeled +12 V and ground. Connect the volt meter to the output terminals with the positive lead to OUT and the negative lead to AG. Connect all input terminals as shown in the above figure. Adjust the offset potentiometer (C7) to zero ± 0.01 mV.

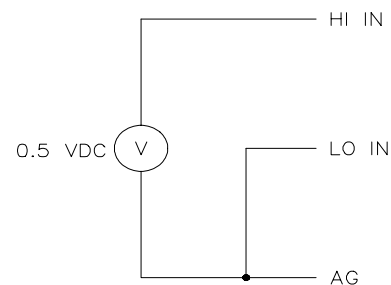
5.4.2 CHECKING THE INPUT BIAS CURRENT



Connect LO IN and AG. Put the 1000 Megohm resistor (provided with the PH 220) between HI IN and AG as shown. The output on the micrologger should be within ± 0.1 mV of the output with the terminal connected as in Section 5.4.1. This verifies that the input bias current is less than 0.1 pA.

If the PH 220 passes the tests in sections 5.4.1 and 5.4.2, the offset voltage and bias current are within specified limits. If a measurement error still exists, the PH 220 may need recalibration. This is rare, however. The calibration procedure is outlined in Section 6.

6.3. ADJUST THE GAIN



Connect a 0.5 VDC source to the input terminals as shown with the positive lead to HI IN, and the negative lead to AG. The CAO port on a 21X or CR7 is a good voltage source. Connect LO IN and AG as shown. Adjust the gain potentiometer (G3) until the volt meter reads 0.5 V ± 0.01 mV.

6. PH 220 CALIBRATION

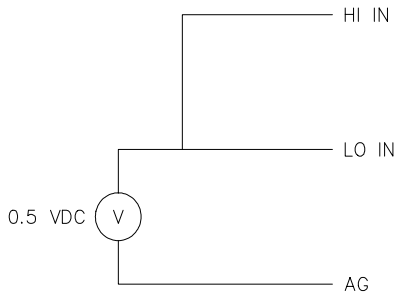
This procedure requires a volt meter with at least 5 digit resolution and a stable voltage source.

6.1. SET THE GAIN JUMPER TO GAIN = 1

Move the gain jumper (D4) to the position shown below. Changing the gain jumper requires a reset of the offset. See Section 6.2.

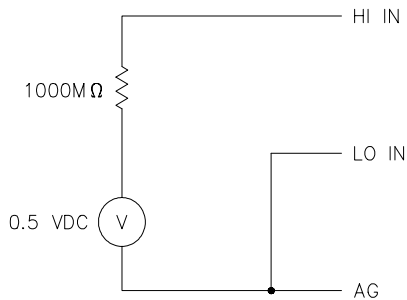
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6.4. ADJUST THE COMMON MODE REJECTION



Connect HI IN to LO IN. Connect the 0.5 VDC source as shown. Adjust the CMR potentiometer (D3) to zero ± 0.01 mV.

6.5. CHECK INPUT IMPEDANCE

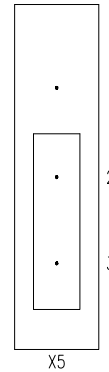


Connect the voltage source in series with a 1000 Megohm resistor as shown. The output should be ± 0.1 mV of the adjusted value from section 6.3. This test guarantees the input impedance to be greater than or equal to 3×10^{12} Ohms. Hold very still when observing the measurement because motion upsets the reading. Larger excursions indicate contaminated input terminals, or a bad amplifier; attempt to correct this problem by desiccating the PH 220 enclosure. If desiccating the chamber does not clear the problem, the unit must be sent to the factory for repair.

The next steps are required only if the PH 220 is to be used in the X5 gain mode.

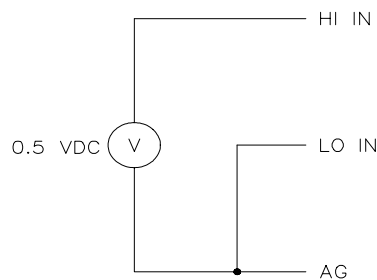
6.6. SET THE GAIN JUMPER TO GAIN = 5.

Move the gain jumper (D4) to the position shown below. Changing the gain jumper requires a reset of the offset. See Section 6.2.



6.7. SET THE ZERO PER SECTION 6.2 TO WITHIN ± 0.05 MV.

6.8. ADJUST THE X5 GAIN.



Connect the voltage source to the input terminals with the positive lead in HI IN, and the negative lead in AG. Jumper LO IN to AG as shown. Adjust the X5 gain potentiometer (B7) to 2.5 ± 0.05 mV.

7. SCHEMATICS

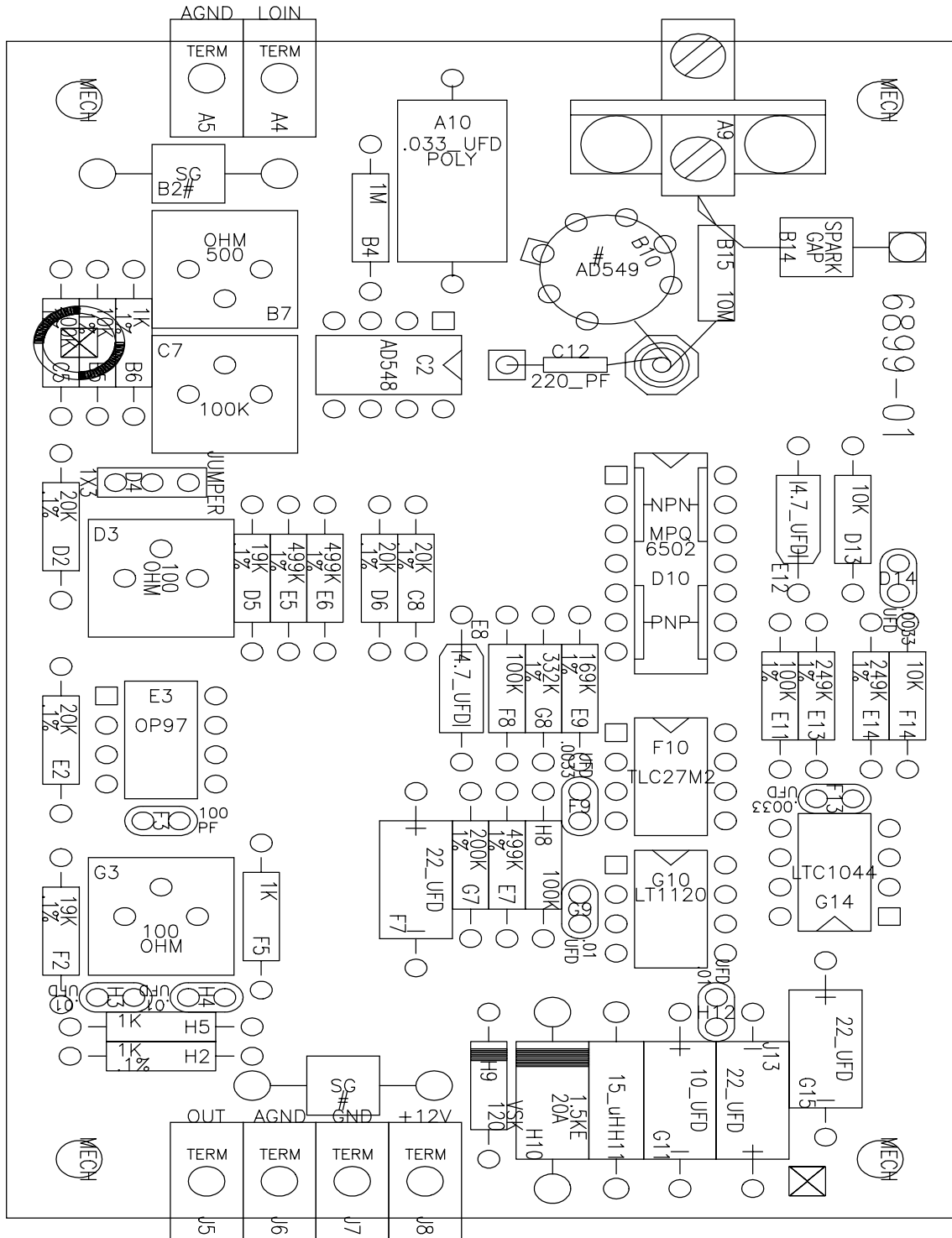


Figure 7-1. PH 220 Component Locations

PH 220 PH PROBE AMPLIFIER

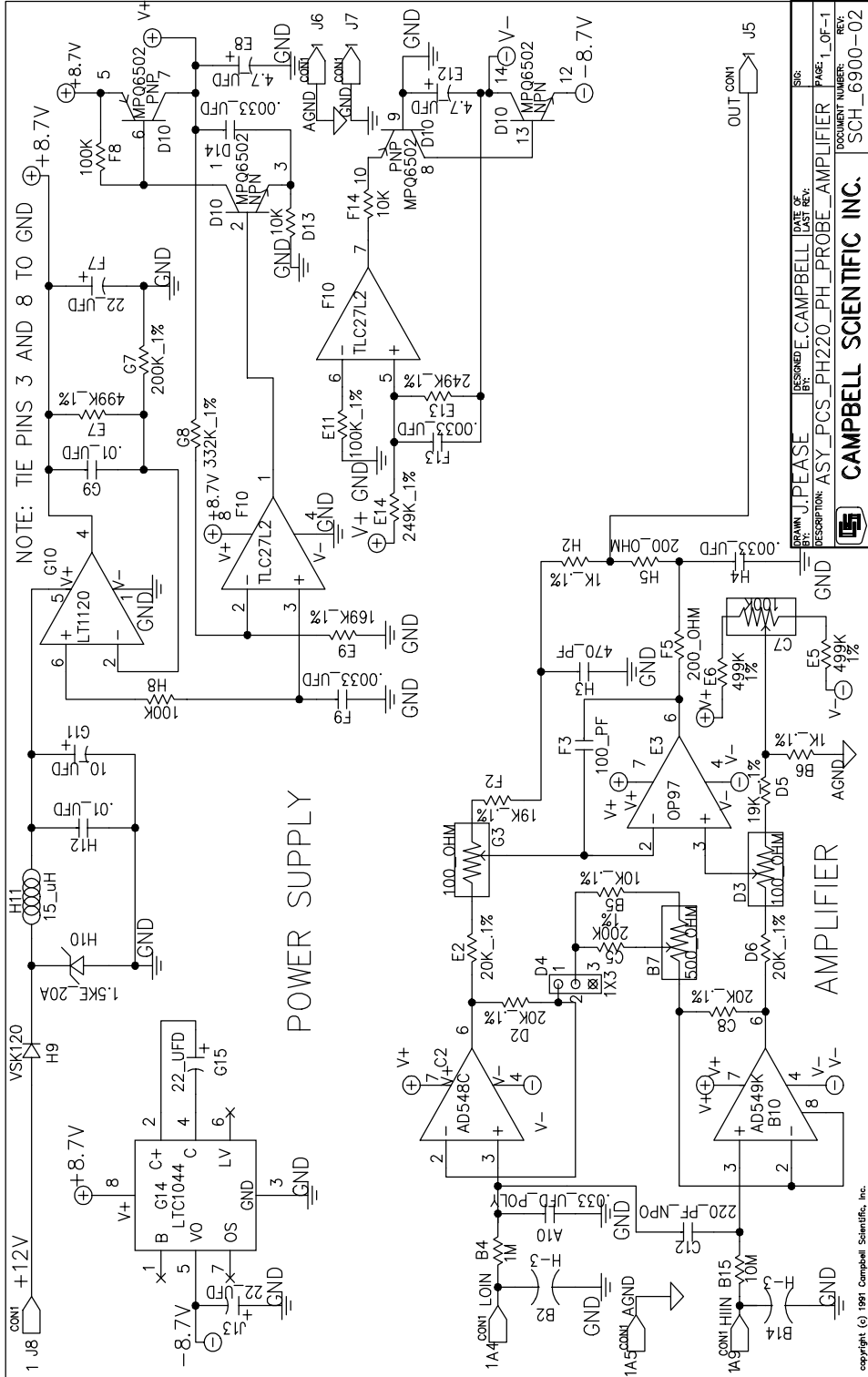


Figure 7-2. PH 220 Schematic