MODEL 188CPS
POINT-SENSING INSTRUMENT

INSTALLATION, OPERATION, AND MAINTENANCE INSTRUCTIONS

American Magnetics, Inc.

PO Box 2509, 112 Flint Road, Oak Ridge, TN 37831-2509, Tel: 865 482-1056, Fax: 865 482-5472

Rev. 1, Feb 1998

Introduction

The American Magnetics, Inc. (AMI) Model 188CPS Point Sensing Instrument system is a microprocessor-based solution designed to provide sensing for up to five (5) points for virtually any non-conducting liquid.

Capacitance-based point sensing

The system consists of a Model 188CPS Point Sensing Instrument, plate sensors, and connecting cables. The instrument sensing elements are typically parallel plate capacitors which are mounted on a stainless steel support tube. The plate capacitors allow a non-conducting liquid (or other material) to become the dielectric between the plates. The instrument measures the plate capacitance which is directly related to the percentage of the plate immersed in the non-conducting liquid.

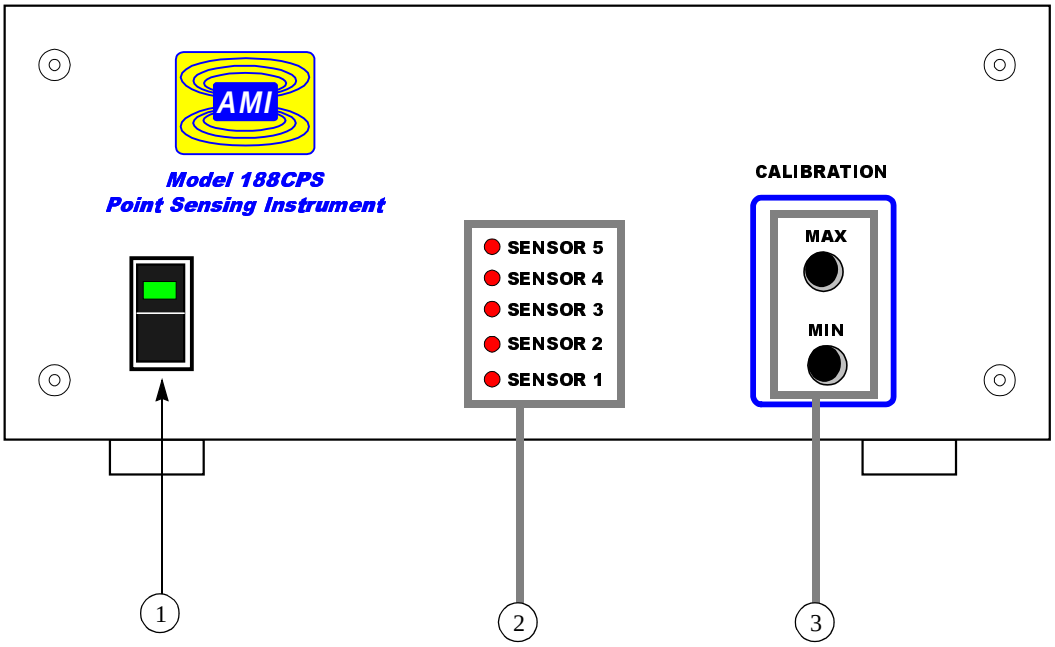
The plate sensors are normally constructed in diameters of 3.5" to 5", however, custom designs which require smaller diameter tank penetrations can be provided for specific needs. Up to five plate sensors can be monitored by a single Model 188CPS instrument. The support tube may also function as a cylindrical capacitor which may be used for continuous level measurement using a separate AMI level instrument.

Simple operation

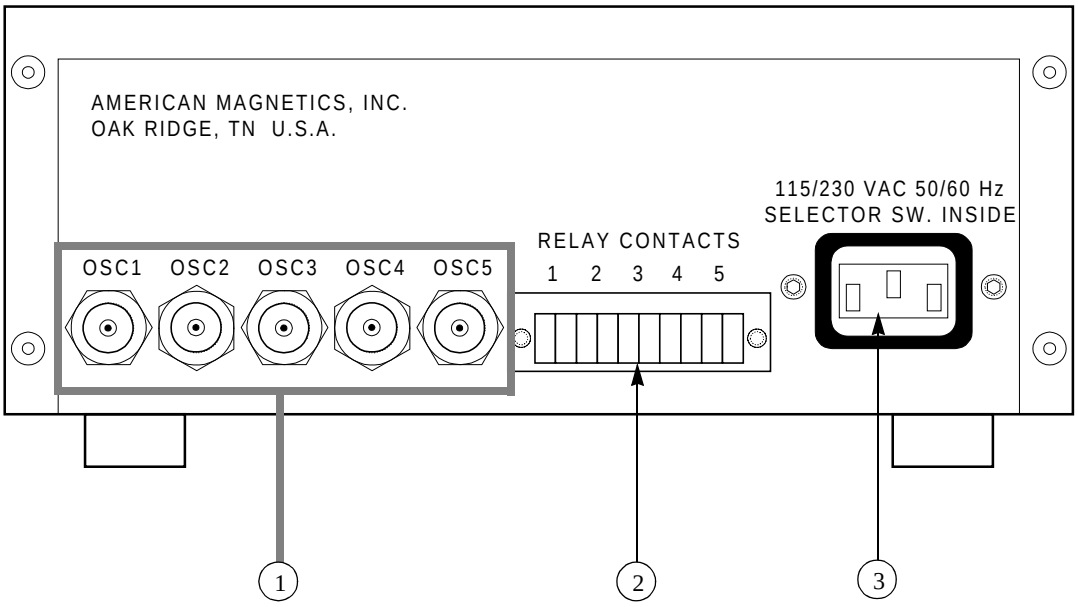
The instrument is equipped with five tri-color LED’s which provide positive indication of immersed or exposed state for each point, as well as providing fault indications. No user input is required for normal operation of the instrument.

Remote monitoring

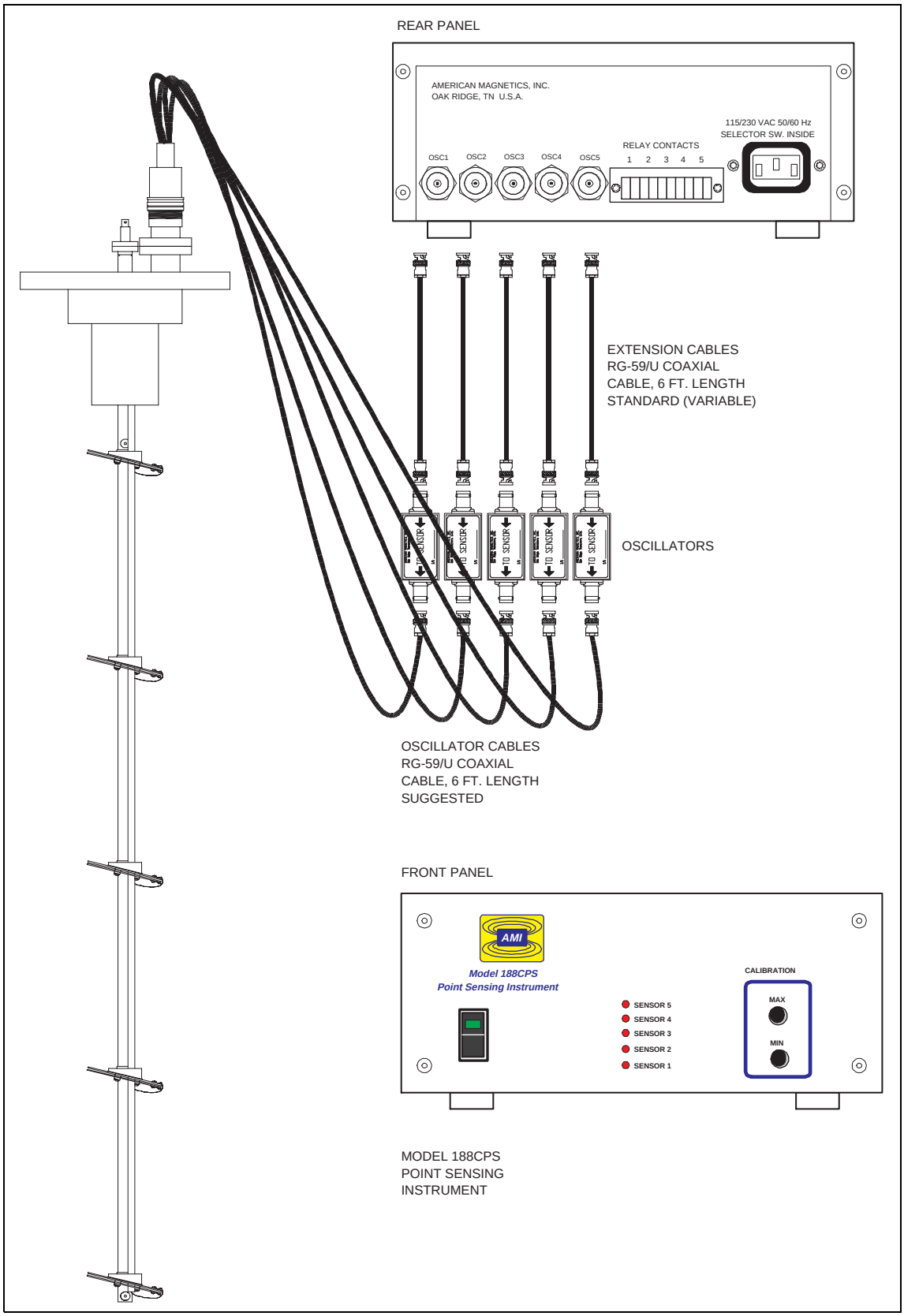
The Model 188CPS provides five relay contact pairs available through a terminal block located on the rear panel. When a plate sensor is immersed in the non-conducting liquid, the respective relay contact pair closes.



1	Power switch and indicator LED
2	LED indicators
3	Recessed calibration push-buttons



1	BNC coaxial connectors to oscillator units via the extension cables
2	Relay contacts terminal block (closed pair = immersed)
3	Input power connector



Model 188CPS Point-Sensing System Diagram (not drawn to scale).

Instrument Specifications

Input line voltage	115/230 or 100/200 VAC ±10%
Input line frequency	50-60 Hertz, 1 phase
Measurement accuracy	± 0.25 inches
Dimensions	3.8" H x 8.4" W x 11.1" D, Standard 3.475" H x 19" W x 11.1" D, Rack Mount
Weight	4.0 lbs. Standard; 4.9 lbs. Rack Mount
Operating environment	15 - 50°C non-condensing

Relay Contact Specifications

Max switching VA	10
Max switching voltage	200 VDC
Max switching current	0.5 A
Max continuous current	1.5 A
Dielectric between contacts	200 VDC minimum

Instruction manual symbol: the product is marked with this symbol when it is necessary for you to refer to the instruction manual in order to protect against damage to the product or personal injury.

Hazardous voltage symbol.

Warning

The Warning sign denotes a hazard. It calls attention to a procedure or practice, which if not correctly adhered to, could result in personal injury. Do not proceed beyond a Warning sign until the indicated conditions are fully understood and met.

Caution

The Caution sign denotes a hazard. It calls attention to an operating procedure or practice, which if not adhered to, could cause damage or destruction of a part or all of the product. Do not proceed beyond a Caution sign until the indicated conditions are fully understood and met.

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1 Installation

Warning

Before energizing the instrument, the earth ground of the power receptacle must be verified to be at earth potential and able to carry the rated current of the power circuit. Using extension cords should be avoided, however, if one must be used, ensure the ground conductor is intact and capable of carrying the rated current.

In the event that the ground path of the instrument becomes less than sufficient to carry the rated current of the power circuit, the instrument should be disconnected from power, labeled as unsafe, and removed from place of operation.

Do not operate this instrument in the presence of flammable gases. Doing so could result in a life-threatening explosion.

Do not modify this instrument in any way. If component replacement is required, return the instrument to AMI facilities as described in the Troubleshooting section of this manual.

1. Unpack the instrument

Carefully remove the instrument, sensor, oscillators and interconnecting coaxial cables from the shipping carton and remove all packaging material. A rack mounting kit is supplied if the instrument was purchased with the rack mount option.

Note

If there is any shipping damage, save all packing material and contact the shipping representative to file a damage claim. Do not return the instrument to AMI unless prior authorization has been received.

If the chassis is a table top model, place the instrument on a flat, secure surface.

Warning

Do not remove the cabinet feet and then reinsert the original screws. Doing so could present a severe life-threatening electrical hazard. If removal of the cabinet feet is desired, replace the original screws with screws not to exceed 1/4" in length.

2. Rack mount the instrument if desired

If the instrument has a rack mount chassis, follow the following procedure:

a. Attach the rack mount adapter pieces to the instrument by first removing the four screws on the side of the instrument that attach the cover to the chassis. Attach the rack mount adapter pieces to the sides of the instrument by reinstalling the screws.

b. Install the monitor in a 19" rack by securing the front panel to the rail in each of the four corners with mounting hardware supplied by the cabinet manufacturer.

3. Install the sensor in the target vessel

Exercise care when installing the sensor since dents, crimps, bends or other physical distortions in the plate sensors will change electrical characteristics possibly causing calibration errors and/or disruption of proper instrument operation. Before installing the sensor, the user may want to review the *Calibration* and *Operation* sections to determine what, if any, calibration procedures may be necessary.

Note

The coaxial interconnecting cables and the oscillators are temperature sensitive and should be mounted in such a manner as to avoid very large temperature variations such as those encountered in the path of dewar vents. Large temperature gradients (for tank penetrations) are acceptable as long as the gradient is relatively constant during operation.

Make a note of the physical location of each point-sensing plate pair on the sensor assembly, and the physical location of the entire sensor assembly with respect to the vessel. This information will be necessary to associate an LED indication from the instrument with an actual liquid level.

4. Connect the oscillator cables to the AMI sensor

Connect the oscillators to the sensor using the supplied RG-59/U coaxial cable. Ensure the oscillator is connected in the correct orientation (see page 5 for a system diagram). The cable length between the oscillator and the sensor should not exceed 6 feet if possible.

Mark each oscillator cable with a labeling scheme that identifies a cable with a specific plate pair and its associated location on the sensor assembly.

Some sensor assemblies may integrate a continuous sensing element with several plate sensors. Do not connect the continuous sensing element to a Model 188CPS instrument. The Model 188CPS is designed only for point-sensing application.

Caution

Moisture or contaminants in any of the BNC coaxial connectors can short out the sensor and cause a false 'full' level indication or other erroneous readings. A pack of non-conductive electrical connection lubricant (ECL) has been included with the liquid level sensor packaging to reduce the possibility of this occurring. If desired, apply a small amount of ECL to any of the BNC connectors that may be exposed to moisture. Mate the doped connectors then remove any excess ECL from the outside of the connector. Added protection can be achieved by covering the doped connections with a short section of heat-shrink tubing.

Note: MSDS sheets for the ECL are available upon request.

5. Connect the instrument to the oscillators

Caution

Operation of the AMI Model 188CPS Liquid Level Instrument with a device other than an AMI Liquid Level Sensor may void the instrument warranty.

Using the OSC1 through OSC5 coaxial connectors, connect the instrument to the oscillators using an extension RG-59/U coaxial cable. The length of the extension cable can be varied to suit the specific application, however, varying the extension cable length has minor effects on the calibration. To eliminate calibration errors, calibrate the instrument with the desired custom extension cable in place.

Note

Once a calibration is performed, the particular oscillator, oscillator cable, and extension cable arrangement should remain connected. Do not rearrange the cable and oscillator connections after calibration, since minor variations between cabling and oscillators may exist.

The oscillators should be connected to the instrument in a manner that orders the instrument output in a physically meaningful way, i.e. OSC1 should be the lowest plate pair on the sensor assembly and OSC5 should be the highest. If multiple 188CPS instruments are required, then group the oscillator inputs according to contiguous plate pairs in ascending or descending order.

6. Connect the rear panel relay contact terminal block if desired

Using the mating connector supplied for the rear panel terminal block, connect the relay contact pairs to external equipment if desired. The contact pairs do not supply power. Observe the rating limits provided on page 7.

7. Connect the instrument to the appropriate power receptacle

> **Warning**
>
> *The Model 188CPS operates on 50-60 Hz power and may be configured for 115 or 230 VAC (100 or 200 VAC for Asian markets). The power requirements for each instrument is marked on the calibration sticker on the bottom of the instrument. Be sure your instrument is configured for your power source prior to plugging in the line cord. Do not fail to connect the input ground terminal securely to an external earth ground.*

Ensure the front panel switch is in the OFF position. Verify that the instrument is configured for the proper operating voltage by referring to the calibration sticker affixed to the bottom of the instrument. If the operating voltage is correct, plug the line cord into the appropriate power receptacle.

If the instrument operating voltage needs to be changed, ensure the instrument is de-energized by disconnecting the power cord from the power source. Remove the instrument cover and slide the voltage selector switch on the main printed circuit board to the proper voltage. Replace the instrument cover.

2 Calibration

Principle of operation

The capacitance-based method of measuring a point operates by measuring the frequency of an oscillator, which is contained in the oscillator/transmitter unit. The calibration MIN and MAX settings correspond to the maximum and minimum oscillation frequencies, respectively, for a given gas/liquid configuration. As the liquid level varies in relation to the location of a plate sensor, the value of the plate sensor capacitance varies within a minimum and maximum value. The minimum capacitance value occurs when the plate is *fully exposed* to gas. The maximum capacitance value occurs when the plate is *fully immersed* in liquid.

Since the dielectric properties of gases and liquids can vary and the component tolerances for the sensor and oscillator introduce variations, a calibration is required to assure maximum accuracy for a specific plate sensor configuration installed in a specific dewar.

Calibration procedure

Install the sensor in the target vessel. Refer to the particular drawings provided with the sensor for proper connection between the sensor and the 188CPS instrument.

The instrument should be energized with the sensor(s) connected to the instrument via the oscillator(s) (see the system diagram on page 5).

1. Cool the sensor to the approximate operating temperature. Drain the target vessel so that ***all*** plate pairs installed on the sensor are *fully exposed* to gas.

   Note

   It is important to cool the entire sensor assembly within the target vessel to the approximate operating temperature. The capacitance of the coaxial cabling within the sensor shifts as a function of very large temperature changes. Therefore, calibration at room temperature and subsequent operation at cryogenic temperatures is not recommended. The sensor should be thoroughly cooled for best calibration accuracy and point sensing performance.

2. While the plate pairs are exposed, press the MIN calibration button. The instrument will sound a constant tone for approximately 2 seconds. One short beep will sound at the end of the MIN calibration indicating successful calibration and storage to internal memory.

Caution

Three short beeps indicates a checksum failure of internal non-volatile memory. A checksum failure prevents the instrument from recovering calibration data. If this failure occurs, do not continue to use the instrument and contact an AMI Technical Support Representative for further assistance.

3. Fill the target vessel so that *all* plate pairs installed on the sensor are *fully immersed* in the liquid.

4. While the plate pairs are submerged in the liquid, press the MAX calibration button. The instrument will again sound a constant tone for 2 seconds. One short beep will sound at the end of the MAX calibration indicating successful calibration and storage to internal memory.

Note

The calibration procedure may be reversed, i.e. the MAX calibration can be performed before the MIN calibration if necessary. The MIN and MAX calibration values can be performed repeatedly in any order, but a valid MIN and MAX calibration pair is required for operation.

5. Proceed to the *Operation* section for directions for utilizing the instrument.

Variations in the dielectric with changing density

For *cryogenic liquids*, the dielectric of the liquid and/or gas will change with a change in density. The amount of change is dependent on the properties of the specific cryogen. Figure 2-1 illustrates the variations in dielectric for nitrogen vs. pressure under *saturated* conditions.[1] Since the 188CPS uses a capacitance-based method for determining liquid level, such a change in the dielectric of the liquid can result in a shift in the point sensing reading of the instrument. The 188CPS instrument is most accurate when applied in situations where the operating conditions of the cryo-vessel are relatively constant, i.e. the operating pressure and temperature of the cryo-vessel are relatively constant.

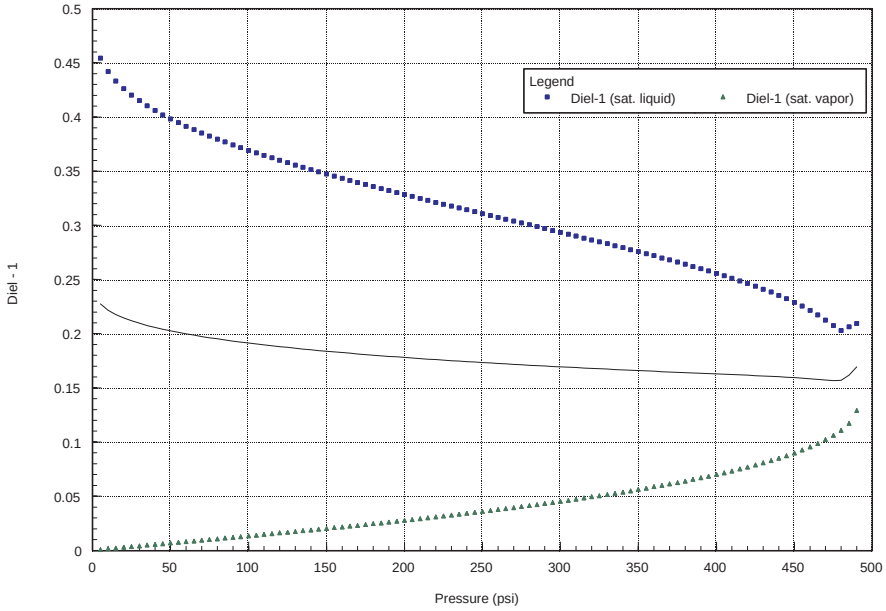

Figure 2-1. Dielectric vs. pressure for nitrogen under saturated conditions.
(The center line indicates the discrimination point for immersed or exposed indication.)

As can be seen in Figure 2-1, if the operating conditions of the cryo-vessel approach the critical point (far right in graph), then the discrimination range of the instrument can be significantly compressed. This extreme compression of the dielectric range between the liquid and gas can result in false indications of an exposed or immersed condition.

If the dielectric of the target liquid is relatively constant, and the gas used to pressurize the vessel does not display a significant dielectric shift, then the probability of the 188CPS displaying false indications is significantly reduced. If any questions exist in regard to calibration issues, contact AMI for assistance in determining the optimal calibration strategy.

1. Data obtained from NIST Standard Reference Database 12.

3 Operation

1. Energize the instrument

After completion of the *Installation* procedures, energize the instrument by placing the power toggle switch in the POWER position. As a power-up test, all LEDs will energize (green color), all relays contact pairs will close, and the instrument will sound a constant tone for 1.5 seconds. At the end of the power-up test, a series of beeps will occur. **One beep** indicates the calibration has been successfully recovered from internal memory. **Two beeps** indicates that no calibration has been previously performed with the instrument.

Caution

Three beeps *at the end of the power-up test, or after a MIN or MAX calibration, indicates a checksum failure of internal non-volatile memory. A checksum failure prevents the instrument from recovering calibration data. If this failure occurs, do not continue to use the instrument and contact an AMI Technical Support Representative for further assistance.*

Note

The instrument should always beep at least once at the end of the power-up test. If this does not occur, the instrument is not functioning properly. Power the instrument OFF and then ON again. If the instrument fails to beep again at the end of the power-up test, please contact an AMI Technical Support Representative for assistance.

2. Perform a calibration if required

If the instrument has not been previously calibrated, refer to the *Calibration* section and perform the calibration procedure.

Note

If a rear panel oscillator input is not connected or is not operating properly during calibration, the calibration procedure will mark the input as inactive. The corresponding front panel LED will always be de-energized and the relay contact pair will always be open. The input will not be usable thereafter until a MIN and MAX calibration has been performed with the oscillator input properly connected to a functioning oscillator and sensor.

After calibration, power the instrument off and then on and verify one beep at the end of the power-up test which indicates successful calibration data recovery from internal non-volatile memory.

3. Observe the state of the front panel LEDs and rear panel relay contact pairs

When a plate sensor is immersed in liquid, the corresponding front panel LED will energize as a green color and the rear panel relay contact pair will close. If a plate sensor is exposed to gas, the corresponding front panel LED will energize as an amber color and the rear panel relay contact pair will open.

> **Note**
>
> *Rear panel input OSC1 corresponds to the front panel SENSOR 1 LED, input OSC2 corresponds to the SENSOR 2 LED, etc. The rear panel relay contact pairs are also ordered from 1 to 5 corresponding to the OSC1 through OSC5 inputs.*

If valid MIN and/or MAX calibration data is not available for a sensor input, then the corresponding LED will always be de-energized (OFF) and the corresponding relay contact pair will remain open at all times.

If a previously calibrated sensor input becomes shorted or disconnected, the corresponding LED will energize as a red color within 5 seconds of the fault occurrence. The state of the relay contact pair is unchanged from the last valid measurement.

The meaning of the LED color for a corresponding sensor input is summarized in the following table:

LED Color	Condition
Green	Sensor is immersed in liquid.
Amber	Sensor is exposed to gas.
Red	Sensor or oscillator cable is shorted, or oscillator has failed or has been disconnected.
OFF	MIN and/or MAX calibration data not available.

Table 3-1. LED color legend.

Plate sensor contamination

To ensure proper instrument calibration and operation, care must be taken to ensure each plate sensor is kept free of contaminants and not subjected to any force which would physically distort the sensor. Water or other electrically conducting substances in the sensor will disturb the measured capacitance and therefore instrument response. Physically distorting the sensor in any way will also cause abnormal instrument operation by introducing variations in the sensor capacitance not due to liquid level. The calibration of the instrument can also be inaccurate if care is not taken to ensure the sensor is in a proper environment.

Cold sensors exposed to humidified air can show erroneous readings due to the fact that the air contains moisture which can condense between the cold sensing plates. A small film of water can cause a shorted or partially shorted condition, which results in false readings. As the sensor warms, the moisture may evaporate and the sensor will again read correctly. This is a physical phenomenon and does not indicate any problem with your AMI level equipment. Limit or eliminate exposure of cold sensors to humidified air to avoid this condition.

If a sensor should require cleaning, flushing with alcohol is recommended. The sensor should not be used again until all the alcohol has been evaporated. Under no circumstances should the sensor be disassembled.

4 Troubleshooting

Power switch LED not on

1. Ensure that the instrument is energized from a power source of proper voltage.

   Warning

   If the instrument has been found to have been connected to an incorrect power source, return the instrument to AMI for evaluation to determine the extent of the damage. Frequently, damage of this kind is not visible and must be determined using test equipment. Connecting the instrument to an incorrect power source could damage the internal insulation and/or the ground requirements, thereby, possibly presenting a severe life-threatening electrical hazard.

2. Verify continuity of the line fuse, F1, located on the instrument printed circuit board.

   Warning

   This procedure is to be performed only when the instrument is completely de-energized by removing the power-cord from the power receptacle. Failure to do so could result in personnel coming in contact with high voltages capable of producing life-threatening electrical shock.

   a. Ensure the instrument is de-energized by disconnecting the power cord from the power source. Disconnect the power cord from the connector located on the rear panel of the instrument.

   b. Remove the instrument top cover and check the fuse F1 for continuity.

   c. If the fuse is bad, replace with a fuse of identical rating.

   Caution

   Installing fuses of incorrect values and ratings could result in damage to the instrument in the event of component failure.

   d. Replace the fuse and securely fasten the instrument top cover. Reconnect the power-cord.

3. Verify the input voltage selector switch on the instrument's printed wiring board is in the proper position for the available power receptacle at the customer's facility. Checking the input voltage selector requires removal of the top cover of the instrument. Observe the same safety procedures as presented in step 2.

Erratic or erroneous point-sensor reading

1. Verify that the sensor is properly connected to the oscillator cable and the extension cable (see the system diagram on page 5).

2. Verify the cabling has no breaks or cuts.

3. Ensure the oscillator unit is not exposed to large temperature variations such as those that occur near dewar vents. Extreme temperature changes of the oscillator unit can cause readout errors.

4. Rapidly varying or sloshing liquids will sometimes make one think the instrument is in error when it is actually operating properly. The Model 188CPS instrument implements a hysteresis band in order to minimize the effects of minor sloshing.

5. Capacitance-based sensors used in cryogenic liquid systems are sometimes exposed to humidified air when the cryogenic vessel is emptied. This often happens when a cold trap runs out of liquid. As the sensor warms, the electronics can display errors. This is due to the fact that air contains moisture which will condense between the cold sensing plates. This small film of moisture can cause a shorted or partially shorted condition. The electronics may recognize this as a higher reading and display an immersed condition. As the sensor warms over some period of time, the moisture can evaporate and the sensor will again approach the correct reading of 0%. This condition can also be corrected immediately if liquid nitrogen is added to the cold trap freezing the residual moisture. This is a physical phenomenon and does not indicate any problem with your AMI level equipment.

6. Verify the sensor is free of contaminants and not subject to any physical distortion. Disconnect the BNC connector for a specific plate sensor and measure the sensor resistance by placing an ohmmeter across the center pin and the outer barrel of the connector. The resistance of the plate sensor should typically be >10 MΩ.

If the cause of the problem cannot be located, contact an AMI Customer Service Representative at (865) 482-1056 for assistance. Do not send the unit back to AMI without prior return authorization.

Warranty

All products manufactured by AMI are warranted to be free of defects in materials and workmanship and to perform as specified for a period of one year from date of shipment. In the event of failure occurring during normal use, AMI, at its option, will repair or replace all products or components that fail under warranty, and such repair or replacement shall constitute a fulfillment of all AMI liabilities with respect to its products. Since, however, AMI does not have control over the installation conditions or the use to which its products are put, no warranty can be made of fitness for a particular purpose, and AMI cannot be liable for special or consequential damages. All warranty repairs are F.O.B. Oak Ridge, Tennessee, USA.

Return Authorization

Items to be returned to AMI for repair (warranty or otherwise) require a return authorization number to ensure your order will receive proper attention. Please call an AMI representative at (865) 482-1056 for a return authorization number before shipping any item back to the factory.

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