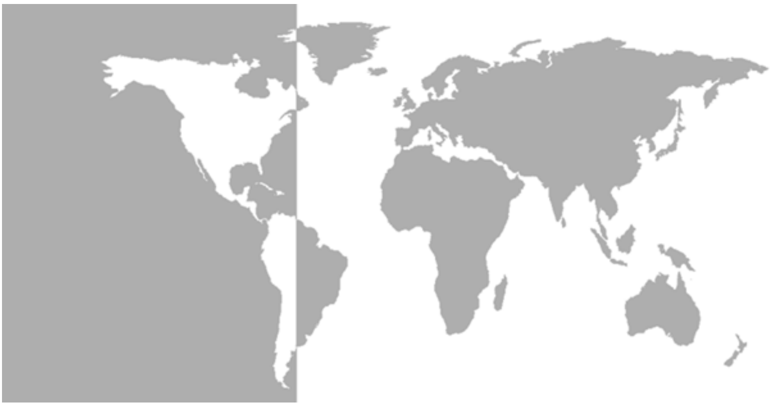
GE Infrastructure
Sensing



Moisture Monitor Series 35

Single-Channel Hygrometer

User's Manual

GE Infrastructure
Sensing

Moisture Monitor Series 35
Single-Channel Hygrometer

User's Manual
910-140E
September 2004

Warranty

Each instrument manufactured by GE Infrastructure Sensing, Inc. is warranted to be free from defects in material and workmanship. Liability under this warranty is limited to restoring the instrument to normal operation or replacing the instrument, at the sole discretion of GE Infrastructure Sensing, Inc. Fuses and batteries are specifically excluded from any liability. This warranty is effective from the date of delivery to the original purchaser. If GE Infrastructure Sensing, Inc. determines that the equipment was defective, the warranty period is:

- one year from delivery for electronic or mechanical failures
- one year from delivery for sensor shelf life

If GE Infrastructure Sensing, Inc. determines that the equipment was damaged by misuse, improper installation, the use of unauthorized replacement parts, or operating conditions outside the guidelines specified by GE Infrastructure Sensing, Inc. , the repairs are not covered under this warranty.

The warranties set forth herein are exclusive and are in lieu of all other warranties whether statutory, express or implied (including warranties or merchantability and fitness for a particular purpose, and warranties arising from course of dealing or usage or trade).

Return Policy

If a GE Infrastructure Sensing, Inc. instrument malfunctions within the warranty period, the following procedure must be completed:

1. Notify GE Infrastructure Sensing, Inc., giving full details of the problem, and provide the model number and serial number of the instrument. If the nature of the problem indicates the need for factory service, GE Infrastructure Sensing, Inc. will issue a RETURN AUTHORIZATION NUMBER (RAN), and shipping instructions for the return of the instrument to a service center will be provided.
2. If GE Infrastructure Sensing, Inc. instructs you to send your instrument to a service center, it must be shipped prepaid to the authorized repair station indicated in the shipping instructions.
3. Upon receipt, GE Infrastructure Sensing, Inc. will evaluate the instrument to determine the cause of the malfunction.

Then, one of the following courses of action will then be taken:

- If the damage is covered under the terms of the warranty, the instrument will be repaired at no cost to the owner and returned.
- If GE Infrastructure Sensing, Inc. determines that the damage is not covered under the terms of the warranty, or if the warranty has expired, an estimate for the cost of the repairs at standard rates will be provided. Upon receipt of the owner's approval to proceed, the instrument will be repaired and returned.

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Chapter 1

Features & Capabilities

The Series 35 is a microprocessor-based, single-channel hygrometer that measures moisture content in gases.
The Series 35 is suitable for a wide range of process conditions requiring real-time moisture measurement. It measures dew/frost points over a range of -110 to +60°C (-166 to +140°F), and comes equipped with two optional alarm relays, one fault alarm, and a single analog output.

Electronics Unit

The Series 35 is available in four configurations: rack mount, bench mount, panel mount, and NEMA-4X weatherproof.

All Series 35 configurations display measurement data on a one-line, 16-character alphanumeric LCD display screen. Users enter probe information into the unit via the programming keys on the front panel keypad (see Figure 1-1 below). The Series 35 accepts line voltages of 100, 120, 230, and 240 VAC, and can also be powered by 24VDC.

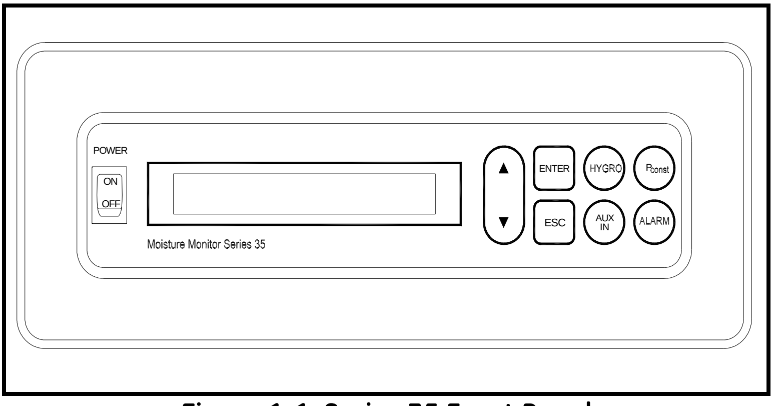


Figure 1-1: Series 35 Front Panel

Probes

The moisture probe is the part of the system that comes in contact with the process, and is usually installed in a sample system. The Series 35 uses any M Series probe to measure dew point temperature in °C or °F. A sensor assembly is secured to the probe mount and protected with a sintered stainless steel shield (see Figure 1-2 below). Other types of shields are available.

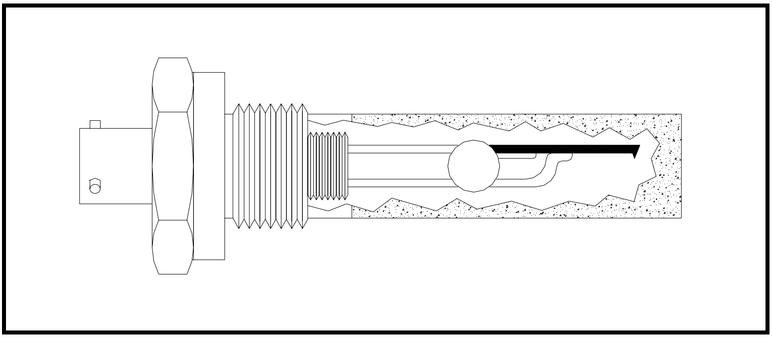


Figure 1-2: The M Series Probe

Sample System

The sample system delivers a controlled sample stream at the specifications of the measurement probe. Typically, the sample system is kept very simple, with as few components as possible located upstream of the measurement probe. The sample system may include a filter to remove particulates from the sample stream and/or a pressure regulator to control the pressure of the stream. In general, stainless steel is the preferred material for all wetted parts in the sample system. The sample system is located outside of the Series 35 enclosure.

User Program

The Series 35 *User Program* enables you to change moisture calibration data, set up and test alarms and recorders, and select a number of user-defined program functions. The main menu programming options include: DP RANGE, CURVE, REFERENCE, ALARMS, RECORDER, TEST, USER, and FACTORY SETUP menus.

All functions and features of the Series 35 *User Program* are discussed in Chapter 3, *Operation*.

Chapter 2

Installing the Series 35

This chapter discusses installing the Series 35 in all of its configurations. Below is a list of procedures that you must follow to install your unit.

Depending on the type of unit you have, refer to the appropriate section(s) that follow to install your Series 35 correctly.

Installing your Series 35 consists of the following procedures:

- Choosing a Site for Best Performance
- Precautions for Moisture Probes
- Sample System Guidelines
- Installing the Sample System
- Installing the Probe into the Sample System
- Mounting the Electronics Unit
- Making Wiring Connections to the Electronics Unit.

Proceed to the following sections to install your Series 35.

Choosing a Site for Best Performance

Before you receive your Series 35, discuss environmental and installation factors with a GE Infrastructure Sensing applications engineer or field sales person. The equipment should be suited to the application and installation site.

Before installing the unit, read the guidelines below to verify that you have selected the best installation site.

- Choose an installation site for the probes and sample systems that is as close to the process line as possible. Avoid long lengths of connecting tubing. If long distances are unavoidable, a fast sampling by-pass loop is recommended.
- Do not install any other components, such as filters, upstream of the probe or sample system unless instructed to do so by GE Infrastructure Sensing. Many common components, such as filters and pressure regulators, are not suitable for sample systems because they have wetted parts that may absorb or release materials such as moisture into the sample stream. They may also allow ambient contamination to enter the sample stream. In general, use stainless steel for all parts in contact with the sample.
- Observe all normal safety precautions. Use the probes within their maximum pressure and temperature ratings.
- Although the Series 35 may not need to be accessed during normal operation, install the electronics unit at a convenient location for programming, testing and servicing. A control room or instrument shed are typical locations.
- Locate the electronics unit away from high temperatures, strong electrical transients, mechanical vibrations, corrosive atmospheres, and any other conditions that could damage or interfere with the Series 35 operation. See Chapter 5, *Specifications*, for limitations.

Choosing a Site for Best Performance (cont.)

- Observe the proper cable restrictions for the probes. The M Series probes require specially shielded cable. You can locate the M Series probes up to 600 meters (2,000 feet) from the Series 35.
- Protect the probe cables from excessive physical strain (bending, pulling, twisting, etc.). Do not subject the cables to temperatures above +105°C (221°F) or below -40°C (-40°F). Avoid splicing the cables.

Precautions for Moisture Probes

The M Series probes consist of an aluminum oxide sensor located on a connector and covered by a protective stainless-steel shield.

The probe sensor materials and housing maximize durability and insure a minimum of water absorbing surfaces in the vicinity of the aluminum oxide surface. A sintered stainless-steel shield is used to protect the sensor from high flow rates and particulate matter (other shields are available). The shield should not be removed except upon advice from GE Infrastructure Sensing.

The sensor has been designed to withstand normal shock and vibration. Make sure that the active sensor surface is never touched or allowed to come into direct contact with foreign objects, since this may adversely affect performance.

Observing these precautions will result in a long and useful probe life. GE Infrastructure Sensing recommends that probe calibration be checked routinely, at one-year intervals, or as recommended by our applications engineers for your particular application.The probe measures the water vapor pressure in its immediate vicinity; therefore, readings will be influenced by its proximity to the system walls, materials of construction, and other environmental factors. The sensor can be operated under vacuum or pressure, flowing or static conditions. Observe the following environmental precautions.

a. **Temperature Range:** The standard probe is operable from-110 to +70°C (-166 to 158°F).

b. **Moisture Condensation:** Be sure the process/ambient temperature is at least 10°C higher than the dew/frost point temperature. If this condition is not maintained, moisture condensation could occur on the sensor or in the sample system, which will cause reading errors. If this happens, refer to the *Probe Cleaning Procedure* in Appendix A.

Precautions for Moisture Probes (cont.)

c. **Static or Dynamic Use:** The sensor performs equally well in still air or where considerable flow occurs. Its small size makes it ideal for measuring moisture conditions within completely sealed containers or dry boxes. It also performs well at gas flow rates as high as 10,000 cm/sec, and liquid flow rates up to 10 cm/sec. Refer to Appendix A for the maximum flow rates in gases and liquids.

d. **Pressure:** The moisture probe always senses the existing water vapor pressure, regardless of the total ambient pressure. The moisture sensor measures water vapor under vacuum or high pressure conditions from as little as 5 microns of Hg to as high as 5,000 psi total pressure.

e. **Long-Term Storage & Operational Stability:** Sensors are not affected by continuous abrupt humidity changes or damaged by exposure to saturation conditions, even when stored.

f. **Freedom from Interference:** The sensor is completely unaffected by the presence of a wide variety of gases or organic liquids. Large concentrations of hydrocarbon gases, Freon™, carbon dioxide, carbon monoxide, and hydrogen have no effect on sensor water vapor indications. The sensor operates properly in a multitude of gaseous or non-conductive liquid environments.

g. **Corrosive Materials:** Avoid all materials that are corrosive or otherwise damaging to aluminum or aluminum oxide. These include strongly acidic or basic materials and primary amines.

Sample System Guidelines

A sample system, although not mandatory, is highly recommended for moisture measurement. The purpose of a sample system is to condition or control a sample stream to within the specifications of the probe. The application requirements determine the design of the sample system. GE Infrastructure Sensing applications engineers will make recommendations based on the following general guidelines.

Typically, sample systems should be kept very simple.They should contain as few components as possible and all or most of those components should be located downstream of the measurement probe. Figure 2-1 on page 2-7 shows a simple sample system consisting of a general-purpose sample cell, a filter, and two shut-off valves, one at the inlet and one at the outlet.

The sample system components should not be made of any material that will affect measurements. A sample system may include a filter to remove particulates from the sample stream or a pressure regulator to reduce or control the pressure of the stream. However, most common filters and pressure regulators are not suitable for sample systems because they have wetted parts that may absorb or release components (such as moisture) into the sample stream. They may also allow ambient contamination to enter the sample stream In general, you should use stainless steel material for all wetted parts.

Sample System Guidelines (cont.)

Note: *The actual sample system design is dependent on the application requirements.*

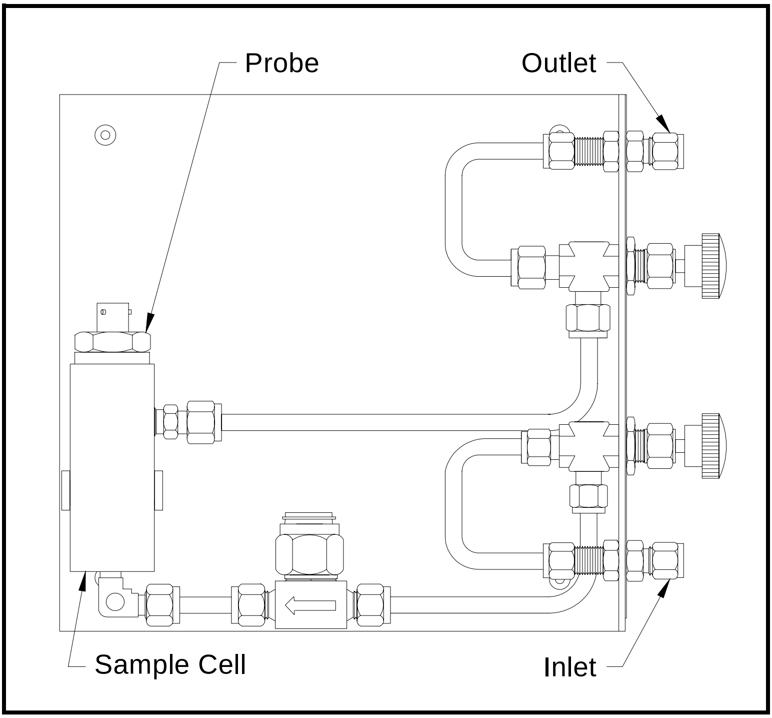


Figure 2-1: A Typical Moisture Sample System

Installing the Sample System

The sample system is usually fastened to a metal plate that has four mounting holes. GE Infrastructure Sensing also provides the sample system in an enclosure if requested. Outline and dimension drawings are included with all GE Infrastructure Sensing sample systems.

Follow the steps below to mount the external sample system and connect it to the process:

1. Mount the sample system plate or enclosure with four bolts, one in each corner.
2. Connect the process supply and return lines to the sample system inlet and outlet using the appropriate stainless steel fittings and tubing.

Caution!
Do not start flow through the sample system until the probe has been properly installed.

Installing a Probe in the Sample System

The sample system protects the probe from any damaging elements in the process. The probe must be inserted into the cylindrical shaped container called the sample cell that is included as part of the sample system.

M2 probes have 3/4-16 straight threads with an o-ring seal to secure the probe either into the sample system or directly into the process line. Other mounts are available for special applications.

Caution!
If mounting the probe directly into the process line, consult GE Infrastructure Sensing for proper installation instructions and precautions.

Follow the steps below to install the probe into the external sample cell.

1. Insert the probe into the sample cell so it is perpendicular to the sample inlet.
2. Screw the probe into the receptacle fitting, making sure not to cross the threads.
3. Tighten the probe securely.

Note: *Do not over-tighten the probe, or the o-ring seal may be damaged.*

Figure 2-2 on page 2-10 shows a typical probe installation, with the probe mounted in a sample cell.

Note: *For maximum protection of the aluminum oxide moisture sensor, the protective shield should always be left in place.*

Installing a Probe in the Sample System (cont.)

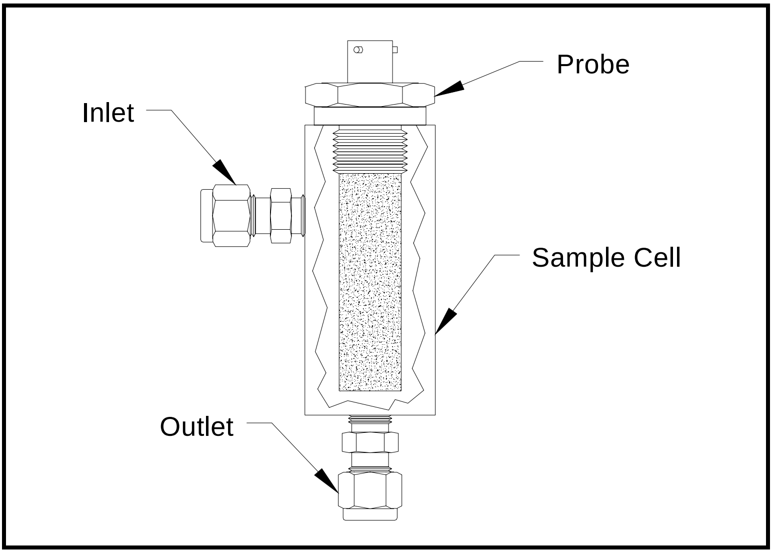


Figure 2-2: A Typical Probe Installation

Mounting the Electronics Unit

The rack mount Series 35 may be mounted into a standard 19” rack, the panel mount Series 35 may be mounted into a rectangular cutout on most instrument panels, and the weatherproof Series 35 may be mounted on any vertical wall. See Appendix B, *Outline and Installation Drawings*, for details.

To install the panel-mount unit:

1. Remove the nuts and washers from the four mounting screws on the front panel of the unit.
2. Slide the unit into the panel cutout.
3. Install the washers and nuts on the mounting bolts, and tighten them securely.

To install the rack-mount unit:

1. Insert four mounting screws into the front panel of the unit.
2. Slide the unit into the rack.
3. From behind the rack, install the washers and nuts on the mounting screws and tighten them securely.

To install the weatherproof unit:

1. Position the unit against a flat, vertical mounting surface (i.e., a structure wall). Mark and drill appropriate size holes to accommodate the mounting bolts.
2. Insert the four mounting bolts into the four mounting holes of the weatherproof enclosure.
3. Place the enclosure against the mounting surface so that the four bolts enter the pre-drilled holes. From behind the mounting surface, install washers and nuts on the mounting bolts and tighten them securely.

Making Wiring Connections to the Electronics Unit

This section covers the following topics:

- precautions for modified or non-GE Infrastructure Sensing cables
- connecting the probe
- connecting the alarms
- connecting a recorder output device
- connecting an auxiliary input
- connecting power to the unit
- performing an MH/calibration test adjustment

IMPORTANT: *To maintain good contact at each terminal block and to avoid damaging the pins on the connector, pull the connector straight off (not at an angle), make cable connections while the connector is away from the unit, and push the connector straight on (not at an angle) when the wiring is complete.*

Modified or Non-GE Infrastructure Sensing Cables

Many customers must use pre-existing cables, or in some cases, modify the standard GE Infrastructure Sensing-supplied moisture cable to meet special needs. If you prefer to use your own cables or to modify our cables, observe the precautions listed below. In addition, after connecting the moisture probe, you must perform a calibration adjustment as described on 22 to compensate for any electrical offsets.

IMPORTANT: *GE Infrastructure Sensing cannot guarantee operation to the specified accuracy of the Series 35 unless you use GE Infrastructure Sensing-supplied hygrometer cables.*

- Use cable that matches the electrical characteristics of the GE Infrastructure Sensing cable (contact the factory for specific information on cable characteristics). The cable must have individually shielded wire pairs. A single overall shield is incorrect.
- If possible, avoid all splices. Splices impair performance. When possible, instead of splicing, coil the excess cable.
- If you must splice cables, be sure the splice introduces minimum resistive leakage or capacitive coupling between conductors.
- Carry the shield through any splice. A common mistake is to not connect the shields over the splice. If you are modifying a GE Infrastructure Sensing cable, the shield will not be accessible without cutting back the cable insulation. Also, do not ground the shield at both ends. Only ground the shield at the hygrometer end of the cable.

Connecting the Probe

The moisture probe must be connected to the Series 35 electronics with a continuous run of GE Infrastructure Sensing two-wire shielded cable (see Figure 2-3 below).

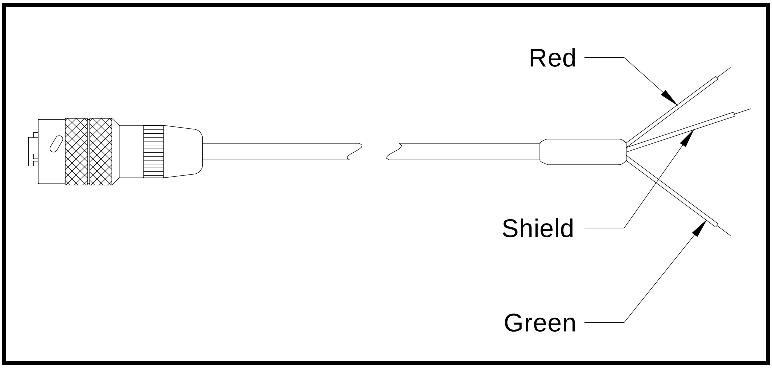


Figure 2-3: Two-Wire Shielded Cable

Be sure to protect cables from excessive strain (bending, pulling, etc.) Do not subject cables to temperatures above +105°C (221°F) or below -40°C (-40°F). Standard cable assemblies (including connectors) can be ordered from GE Infrastructure Sensing in any length up to 600 meters (2,000 feet).

Follow the steps below to connect the probe to the electronics:

1. Make sure the power is disconnected from the Series 35.
2. Connect the probe cable to the terminal block on the Series 35 electronics, as shown in Table 2-4 on page 2-15 and the interconnection diagrams in Appendix B.
3. Connect the cable to the probe by inserting the bayonet-type connector onto the probe and twisting the shell clockwise until it snaps into a locked position.

Connecting the Probe (cont.)

IMPORTANT: *To maintain good contact at each terminal block and to avoid damaging the pins on the connector, pull the connector straight off (not at an angle), make cable connections while the connector is away from the unit, and push the connector straight on (not at an angle) when the wiring is complete.*

Table 2-4: Probe Connections

Connect:	To PROBE Terminal Block:
Red (H2) wire	pin #1
Shield	pin #2
Green (H1) wire	pin #3

Connecting the Alarms

The Series 35 has one fault alarm, and two optional alarms that can be configured as high or low; that is, the contacts can be programmed to trip when the measured reading is over or under the alarm setpoint. The fault alarm, if enabled, will trip when there is a power failure, when a calibration error or a range error occurs, when there is a signal fault, or when the system is reset by the watchdog function.

Note: *The Watchdog Function is a supervisory circuit that automatically resets the* User Program *in the event of a system error (see* Setting Up Alarm Relays *in Chapter 3).*

Connecting the High and Low Alarms

The Series 35 has optional dual alarm relays available. Hermetically-sealed alarm relays are also optionally available. Each alarm relay is a single-pole, double throw contact set that has the following contacts:

- Normally Open (NO)
- Armature Contact (A)
- Normally Closed (NC)

Make connections to Alarm relays A and B using the terminal block on the Series 35, as shown in Table 2-5 on page 2-17 and the interconnection diagrams in Appendix B.

Note: *For European applications, the voltage levels at the alarm contacts must be less than 100 VRMS.*

IMPORTANT: *To maintain good contact at each terminal block and to avoid damaging the pins on the connector, pull the connector straight off (not at an angle), make cable connections while the connector is away from the unit, and push the connector straight on (not at an angle) when the wiring is complete.*

Connecting the Alarms (cont.)

Table 2-5: High & Low Alarm Connections

Connect Alarm A:	To ALARM A Terminal Block:
NC Contact	pin #4
NO Contact	pin #5
A Contact	pin #6
Connect Alarm B:	**To ALARM B Terminal Block:**
NC Contact	pin #7
NO Contact	pin #8
A Contact	pin #9

Connecting the Fault Alarm

The fault alarm connections are on the “OUT” connector, pins 1, 2, and 3. Pins 1 and 3 provide a “normally closed” contact. When the Series 35 is operating in a non-fault state, the contact between pins 1 and 3 is energized (open) to remain open. When a fault occurs or power is lost, the contact between pins 1 and 3 is de-energized (closed). Pins 2 and 3 work in the opposite way. (Refer to Chapter 3, *Operating the Series 35*, to enable the fault alarm.)

Make connections to the fault alarm relay using the terminal block on the back of the Series 35 (or on the side of a bench-mount unit), as shown in Table 2-6 below and the interconnection diagrams in Appendix B.

Table 2-6: Fault Alarm Connections

Connect Fault Alarm:	To FAULT ALARM Terminal Block:
NC Contact	pin #1
NO Contact	pin #2
A Contact	pin #3

Note: *For European applications, the voltage levels at the alarm contacts must be less than 100 VRMS.*

Connecting a Recorder Output Device

IMPORTANT: *The following instructions apply to Series 35 models with Output Board 703-1175. For models with Output Board 703-1180, see Appendix F.*

The Series 35 has one recorder output, which is isolated. This output provides either a current or voltage signal, which is set using switch S1 on the output circuit board (see Figure 2-7 on page 2-19 for the location of S1).

Although this switch is normally set at the factory to provide a current output signal, the setting should be checked before making any recorder output connections.

Use the following sections to check or reset the S1 setting and connect an output device.

Checking or Resetting Switch S1

1. Turn off the Series 35 and disconnect power before opening the unit.

!WARNING!
YOU MUST TURN OFF AND UNPLUG THE SERIES 35 BEFORE YOU CONTINUE WITH THE FOLLOWING STEPS.

---

2. To access the output circuit board, remove the screws from the Series 35 enclosure and remove the cover.
3. Locate switch S1 on the output circuit board (see Figure 2-7 on page 2-19).
4. Set switch S1 to the appropriate position: “I” for current output or “V” for voltage output.
5. Replace the enclosure cover and install the screws.

Connecting a Recorder Output Device (cont.)

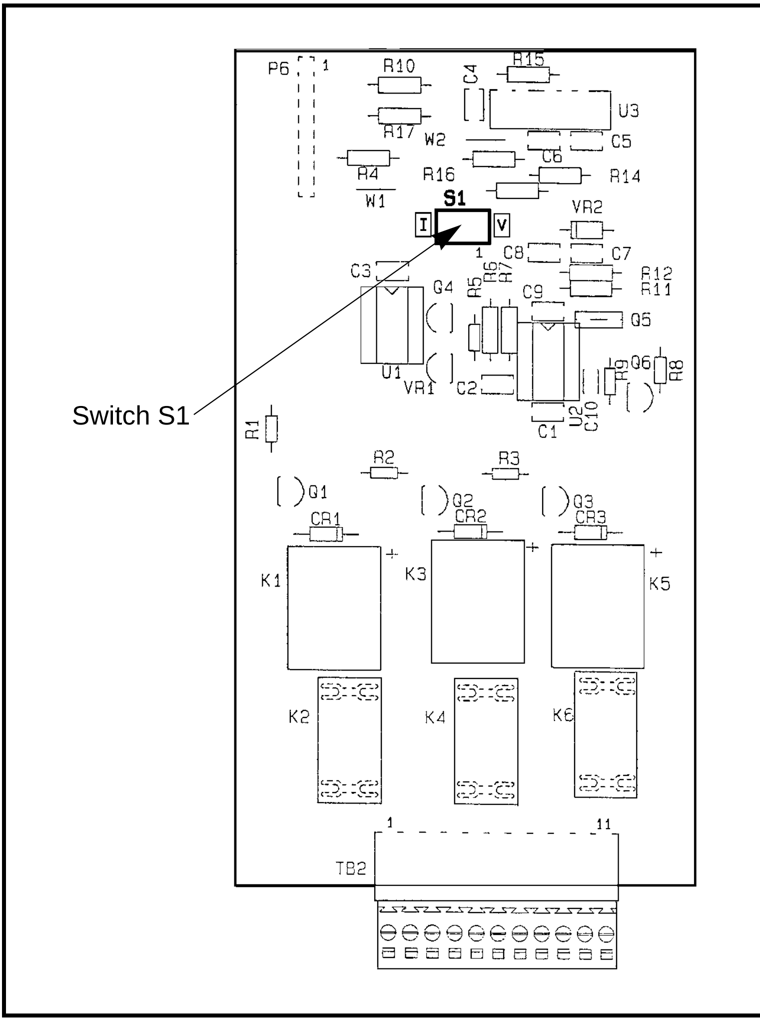


Figure 2-7: S1 Location on 703-1175 Output Board

Connecting a Recorder Output Device (cont.)

IMPORTANT: *To maintain good contact at each terminal block and to avoid damaging the pins on the connector, pull the connector straight off (not at an angle), make cable connections while the connector is away from the unit, and push the connector straight on (not at an angle) when the wiring is complete.*

Connecting an Output Device

After you check or reset the switch S1 setting, you can connect a recorder, computer, or other suitable device to the terminal block on the back of the Series 35 (or on the side of a bench-mount unit), as shown in Table 2-4 on page 2-20 and the interconnection diagrams in Appendix B.

Table 2-8: Recorder Output Connections

Connect:	To REC OUT Terminal Block:
Out (+)	pin #10
Return (-)	pin #11

Connecting an Auxiliary Input

The Series 35 can accept one auxiliary input. Connect the input to the IN terminal block as shown in Table 2-5 below and the interconnection diagrams in Appendix B.

Table 2-9: Auxiliary Input Connections

Connect:	To IN Terminal Block:
Out (+)	pin #7
Return (-)	pin #8
Power (+V)	pin #9

Connecting Power to the Unit

GE Infrastructure Sensing supplies a molded plug and cord for AC power connections in rack, bench and panel mount units; however, you must supply the power cable for 24 VDC units and weatherproof units.

Refer to the interconnection diagrams in Appendix B to make AC and DC power connections to the Series 35 electronics.

After you make power connections to the electronics unit, connect the power cord to an appropriate source, and turn the power on. The Series 35 displays “Loading....” while it initializes, then returns to whatever it displayed when it was last turned off.

!WARNING!
IF YOU HAVE A DIVISION 2 UNIT, DO NOT MAKE OR BREAK ELECTRICAL CONNECTIONS IN A HAZARDOUS ENVIRONMENT.

IMPORTANT: *For compliance with the European Union’s Low Voltage Directive (IEC 61010), this unit requires an external power disconnect device such as a switch or circuit breaker. The disconnect device must be marked as such, clearly visible, directly accessible, and located within 1.8 m (6 ft.) of the MMS 35. The power cord is the main disconnect device.*

Performing an MH Calibration/Test Adjustment

If you modify the supplied cables or do not use standard GE Infrastructure Sensing-supplied cables, you must perform a calibration test/adjustment to test the cable and, if necessary, compensate for any error or offset introduced by splicing or long cable lengths. This procedure is also recommended for testing the installation of GE Infrastructure Sensing cables.

Use the following steps to perform a calibration adjustment:

Preliminary Steps:

1. Power up the Series 35.
2. Set up the screen to display MH.
3. Make sure high, low and zero reference values are recorded on the sticker located on the inside chassis of the Series 35, or on the *Data Information Sheet* provided in Appendix D.

Calibration Procedure:

1. Disconnect the probe from the cable (leave the probe cable connected to the Series 35) and verify that the displayed MH value equals the zero reference value within ±0.0003 MH.
   a. If this reading is within specification, no further testing is necessary.

   b. If the reading is less than the specified reading (previous recorded zero reference value ±0.0003 on sticker), add this difference to the low reference value.

   c. If the reading is greater than the specified reading (previous recorded zero reference value ±0.0003 on sticker), subtract this difference from the low reference value.

2. Note the final corrected low reference value and record it

Performing an MH Calibration/Test Adjustment (cont.)

3. Reprogram the Series 35 with the new (corrected) low reference value (if required), as described in *"Entering Moisture Reference Values"* on page 3-13.

4. Verify that the probe cable is not connected to the probe.

5. Note the zero reference readings and verify that the readings are now within ±0.0003 MH.

6. Fill out a new high and low reference sticker with the final low reference value and/or record the information on the *Data Information Sheet* provided in Appendix D. Make sure you record the information below:

   HIGH REF = ORIGINAL VALUE
   LOW REF = NEW CORRECTED VALUE
   ZERO REF=ORIGINAL RECORDED VALUE

7. Reconnect the cable to the probe.

Note: *If the cables are ever changed in any way, repeat this procedure for maximum accuracy.*

The Series 35 is now ready for operation. Proceed to Chapter 3, *Operating the Series 35*, for instructions.

Chapter 3

Operating the Series 35

The Series 35 has been factory-programmed and set up to begin taking measurements as soon as it is powered on. This chapter describes starting the unit and beginning operation of the unit as quickly as possible. In addition, setting up the alarm relays, a recorder, and the user-defined functions are covered.

This chapter explains the following specific procedures. Proceed to the appropriate section to operate the Series 35.

- *Getting Started* - Use this section to get the Series 35 operating as quickly as possible.
- *Changing the Measurement Display* - Use this section to set up the display screen for the desired measurement.
- *Setting Up Alarm Relays* - Use this section to enable the fault alarm or to set up the optional high and low alarm relays.
- *Setting Up a Recorder* - Use this section to set up a recorder output device.
- *Setting Up User-Defined Functions* - Use this section to define and set up a variety of program functions to enhance the usability of the Series 35.

Getting Started

Since the calibration data has already been set up at the factory, you can begin taking measurements as soon as you power up the Series 35. Proceed to the appropriate section to power up your unit and verify that it is working correctly:

- Powering up the Series 35
- Entering Data into the *User Program*
- Verifying and Changing Factory Setup Data

To set up alarms, set up a recorder device, change the setup data, or configure the display, see the instructions on page 3-4 to learn how to use the Series 35 keypad for entering data into the *User Program*.

Powering Up the Series 35

After making the power connections to the electronics unit as described in Chapter 2, *Installing the Series 35*, connect the power cord to an appropriate power source. To power up the Series 35, flip the POWER switch, located on the left side of the front panel, to the ON position.

IMPORTANT: *Weatherproof MMS 35 units have no power switch, and the power switch on Division 2 modified units is disabled. Both units power up as soon as line power is applied.*

!WARNING!
IF YOU HAVE A DIVISION 2 UNIT, DO NOT MAKE OR BREAK ELECTRICAL CONNECTIONS IN A HAZARDOUS ENVIRONMENT.

Immediately after the power is applied, the Series 35 displays the "Loading..." message to indicate that the system is loading calibration and reference data. After this data is loaded, the Series 35 automatically calibrates (Autocal) the moisture circuitry. After the Autocal finishes, the Series 35 display returns to whatever it displayed when it was last powered down.

Entering Data into the User Program

The Series 35 *User Program* allows you to change factory set-up data, set up alarms and a recorder output device, and set up user-defined program functions. In order to enter and exit the *User Program*, move through the main menus, and enter numeric data into the *User Program*, you must first learn how to use the programming keys located on the front panel of the Series 35.

Use the appropriate sections that follow to learn how to enter data into the *User Program*.

Using the Programming Keys

The front panel of the Series 35 contains the following four keys for entering data into the *User Program*:

- ENTER - Use this key to select a menu option, to switch from viewing to editing data, to move to the next digit position during numeric entry, and to confirm an entry.
- ESC - Use this key to cancel an entry and to back out of a menu option.
- △ - Use this key to scroll upward through the menu options, and to increase the value during numeric entry.
- ▽ - Use this key to scroll downward through the menu options, and to decrease the value during numeric entry.

Entering and Exiting the User Program

This section describes how to use the [ENTER] and [ESC] keys to enter and exit the *User Program*. Refer to Table 3-1 below for the key sequence for entering the *User Program* main menu.

Note: *The first two steps must be performed within 5 seconds of each other or the unit will time out and return to displaying measurements.*

Table 3-1: Entering the User Program

Press These Keys:	To Display:
1. [ESC]	ESC
2. [ENTER], [ESC]	PROGRAM MENU displays for 1 sec, then: DP RANGE

To exit the *User Program*, press the [ESC] key until RUN? displays. Then press the [ENTER] key to return to displaying measurements.

Moving Through the User Program

Use the *arrow keys* to scroll through the eight *Main Menu* options as follows (refer to the *menu maps* in *Appendix C* as a guide):

- **DP RANGE -** use to enter high and low dew points for the calibration curve
- **CURVE -** use to enter a value for each point on the calibration curve
- **REFERENCE -** use to enter high and low reference values for moisture measurement
- **ALARMS -** use to set up the high, low, and fault alarms
- **RECORDER -** use to set up the recorder output range, measurement mode, and zero/span values
- **TEST -** use to test and adjust the alarms and the recorder output (see Chapter 4, *Troubleshooting*, for details)
- **USER -** use to set up user-defined program functions, such as offset value, constant pressure, PPMv constant multiplier, Autocal interval, computer enhanced response, backlight, range and calibration error handling
- **FACTORY SETUP -** for factory use only

Note: *While in programming mode, the Series 35 suspends taking measurements.*

Entering Numeric Data

To enter numbers one digit at a time, use the arrow keys to scroll to the desired number (0 to 9 or the decimal point), then press the [ENTER] key to move to the next digit position. Repeat this procedure until all numbers are entered.

Note: *From the programming mode, once an arrow key is pressed, you are in* edit mode. *Pressing* [ESC] *terminates the edit mode. While in edit mode, check all characters before pressing the* [ENTER] *key to move on to the next digit position.*

Refer to the sections that follow to enter data into the *User Program's* main menu options.

Verifying and Changing Factory Setup Data

Use this section to make sure factory setup data is correct and to make any necessary changes to the setup data.

Note: *Record all calibration data on the* Data Information Sheet *in* Appendix D.

In order for the Series 35 to take accurate measurements, it must have the correct moisture calibration data entered into its memory. All of the necessary data has been entered into your Series 35 at the factory; however, the data should be checked for accuracy.

To verify data, check the following:

- dew point range
- calibration data
- high and low reference values

Use the appropriate sections that follow to verify and/or change the moisture calibration data.

Entering the Dew Point Range

The **DP Range** is used to enter high and low dew point values. This range is used by the Series 35 to determine the number of points on the calibration curve.

Note: *The high and low dew points are listed on the* Moisture Probe Calibration Data Sheet *located in the probe box. Changing the* DP Range *affects the calibration data.*

The default values are: Low: –110, High: +20

DP RANGE	In the main menu, use the arrow keys to scroll to this prompt, then press the [ENTER] key.
Hi DP	Use the arrow keys to scroll to Hi DP, then press [ENTER].
Hi DP+20°C	Use the arrow keys to scroll to the desired dew point value, then press [ENTER].

Repeat this procedure to enter the low dew point value, then press the [ESC] key until you return to the main menu.

Entering Calibration Data

After entering the high and low dew point values, use the CURVE option to enter calibration data for the moisture probe or the auxiliary input. Refer to the appropriate section that follows to program the Series 35.

To Enter Moisture Probe Calibration Data:
Moisture probe calibration data is always taken at fixed dew point values in 10°C intervals. After entering the high and low dew point values, the Series 35 determines the appropriate number of data points for the moisture probe, so only the MH (raw data) values need be entered. The Series 35 automatically requests the MH value for the minimum dew point and keeps requesting data in 10°C increments until the maximum dew point is reached. The MH values are found on the *Calibration Data Sheet* supplied with the moisture probe.

CURVE	In the main menu, use the arrow keys to scroll to this prompt, then press the [ENTER] key.
MH CURVE	Use the arrow keys to scroll to MH CURVE and press [ENTER].
ENTER MH CURVE ENTER PROBE S/N	Use the arrow keys to scroll to either ENTER MH CURVE or ENTER PROBE S/N. Press [ENTER] at your choice.

If you select ENTER MH CURVE:

-110°CMH 0.1890	To view the curve, press the arrow keys to scroll through the values. To edit a value, press [ENTER], then either arrow key to delete the present value. Use the arrow and [ENTER] keys to change the value one digit at a time, then press [ENTER] twice.

Entering Calibration Data (cont.)

Note: *To abort the editing function without changing the value, press the* [ESC] *key.*

Repeat this procedure for each point on the MH Curve, then press [ESC] until you return to the CURVE menu.

If you select ENTER PROBE S/N:

xxxxxx S/N	The unit displays the current serial number. To edit the number, press an arrow key. A blinking cursor appears at the left-most digit. Use the arrow keys to scroll to the desired value, and the [ENTER] keys to move the cursor to the next digit. Repeat until you have entered all six serial number digits. Then press [ENTER] to confirm the change or [ESC] to cancel the change.

To Enter Auxiliary Input Calibration Data:
The Series 35 can have up to ten (10) calibration data points for its *Auxiliary* input. Each data point requires an electrical current value (0-20 mA) with a corresponding scale value.

CURVE	In the main menu, use the arrow keys to scroll to this prompt, then press the [ENTER] key.
AUX CURVE	Use the arrow keys to scroll to AUX CURVE and then press the [ENTER] key.

Entering Calibration Data (cont.)

To Enter Auxiliary Input Calibration Data (cont.):

Display	Instructions
#Aux Pts = 3	Use the arrow keys to scroll to the desired number of points, then press the [ENTER] key.
AxUnit#DecPlc 3	Use the arrow keys to scroll to the desired number of decimal places for the scale value, then press the [ENTER] key.
Edit Pt# 1	Use the arrow keys to scroll to the desired point, then press the [ENTER] key.
#1mA = 4.000	Press either arrow key to delete the present mA value and enter edit mode. Use the arrow and [ENTER] keys to enter a new value, one digit at a time, then press [ENTER] twice.
#1F = +0.00	Press either arrow key to delete the present scale value and enter edit mode. Use the arrow and [ENTER] keys to enter a new value, one digit at a time, then press [ENTER] twice to proceed to the next data point.

Repeat the above procedure for each point on the Auxiliary Curve, then press [ESC] until you return to the main menu.

Entering High and Low Reference Values

IMPORTANT: *Do not change these reference values unless instructed to do so by GE Infrastructure Sensing.*

The Series 35 requires high and low reference values for its moisture measurement circuitry. These references are factory calibration values that are specific to each unit. They are listed on a label located on the inside of the Series 35.

REFERENCE	In the main menu, use the arrow keys to scroll to this prompt, then press the [ENTER] key.
HYGRO REF	Press the [ENTER] key again.
High REF	Press either arrow key to scroll to the High REF edit mode, then press [ENTER].
H2.9999	Use the arrow and [ENTER] keys to change the value, one digit at a time, then press [ENTER] twice.
Low REF	Press either arrow key to scroll to the Low REF edit mode, then press the [ENTER] key.
L0.1790	Use the arrow and [ENTER] keys to change the value, one digit at a time, then press the [ENTER] key twice.

Note: *To abort the editing function without changing the value, press the* [ESC] *key.*

Press [ESC] until you return to the main menu.

Changing the Measurement Display

Use this section to set up the Series 35 display screen for the measurement modes you want to display. The front panel of the Series 35 contains four (4) display keys that let you quickly change the measurement display during operation.

The four display keys are as follows:

- **HYGRO -** press this key to display and scroll through all of the available moisture measurement units (DP/C, DP/F, PMv, MH)
- **Pconst -** press this key to display and scroll through all of the available constant pressure units (PSG, Bar, KPAg, Kcmg)
- **ALARM -** press this key to display and scroll through the status and set points of alarm relays A and B, as well as the status of the fault alarm relay
- **AUX IN -** press this key to display the auxiliary input measurement in either milliamps (mA) or a user-defined function (XF - Auxiliary Function)

Once you select a specific display mode, that display remains on the screen until another display mode is chosen, or until you enter programming mode. Upon exiting programming mode and returning to RUN mode, the screen automatically returns to the display mode previously selected.

Setting Up the Alarm Relays

The Series 35 has one fault alarm and two optional high/low alarms. Use this section to enable the fault alarm or to set up the optional high/low alarm relays. (Refer to Table 3-2 on page 3-16 for a list of possible alarm conditions.)

High/Low Alarms:
these alarm relays can be programmed to trip when the measured reading is over (high) or under (low) the alarm setpoint. To set up a high or low alarm, do the following:

- enable or disable the alarms
- set the alarm measurement mode
- set the alarm units
- configure the alarm as high or low
- set the alarm units and enter the setpoint

Fault Alarm:
To ensure failsafe operation during a power loss, the behavior of the fault alarm relay is the opposite of the high/low alarm relays. The fault alarm relay is energized under non-fault conditions, and de-energized under fault conditions.

When the Series 35 is operating in a non-fault state, the normally closed (NC) contact between pins 1 and 3 is energized to remain open. When a fault occurs or power is lost, the contact between pins 1 and 3 is de-energized and closes. The normally-open (NO) contact between pins 2 and 3 is energized closed in a non-fault state, and de-energized open when a fault occurs or power is lost.

The fault alarm, if enabled, trips during the following conditions:

- when there is a power failure
- when a calibration error or a range error occurs

Setting Up the Alarm Relays (cont.)

Fault Alarm (cont.):

- when there is a signal fault
- when the system is reset by the watchdog function.

Note: *The Watchdog Function is a supervisory circuit that automatically resets the* User Program *in the event of a system error.*

Table 3-2: Possible Alarm Conditions

Alarm Type	Fault Conditions		Non-Fault Conditions		Loss of Power	
Cont:	**NC**	**NO**	**NC**	**NO**	**NC**	**NO**
Alarm A	open	closed	closed	open	closed	open
	Energized		De-Energized		De-Energized	
Alarm B	open	closed	closed	open	closed	open
	Energized		De-Energized		De-Energized	
Fault Alarm	closed	open	open	closed	closed	open
	De-Energized		Energized		De-Energized	

Enabling or Disabling the Alarms

If alarm A or alarm B is disabled, the display returns to the alarm menu; if alarm A or alarm B is enabled, the alarm mode options are displayed. The fault alarm options are limited to the *"Enable"* or *"Disable"* choices. After the fault alarm is enabled or disabled, the display returns to the alarm menu.

Note: *Be sure to record all entered output data in the* Data Information Sheet *in* Appendix D.

ALARMS	In the main menu, use the arrow keys to scroll to this prompt, then press the [ENTER] key.
Alarm A	Use the arrow keys to scroll to the desired alarm, then press [ENTER].
Enable Alarm	Use the arrow keys to scroll to the desired choice, then press [ENTER].

Selecting the Measurement Mode

Select "ALM HYG" if you want the alarm to respond to measurements taken from the *probe* input connection; select "ALM AUX" if you want the alarm to respond to measurements taken from the *auxiliary* input connection.

ALM HYG ALM AUX	Use the arrow keys to scroll to the desired measurement option, then press [ENTER].

Selecting the Measurement Units

The next set of prompts that appears depends on the alarm mode selected. Choose the units to which you want the alarm to respond. Refer to the appropriate section below and to Table 3-3 on page 3-19 for a list of the available units.

If you selected "ALM HYG" the following prompts appear:

ALM HYGDP/°F
ALM HYGDP/°C
ALM HYGDVM
ALM HYGMH
ALM HYGPMv

Use the arrow keys to scroll to the desired measurement unit, then press [ENTER].

If you selected "ALM AUX" you can choose either a mA (milliamp) value or a user-defined XF (Auxiliary Function) value.

ALM AUXmA
ALM AUXXF

Use the arrow keys to scroll to the desired value type, then press [ENTER].

Selecting the Measurement Units (cont.)

Table 3-3: Alarm/Recorder Measurement Units

Measurement Mode	Units
Hyg - Hygrometry	DP/°F - dew point in °F DP/°C - dew point in °C DVM - internal voltage signal MH - raw signal from sensor PMv - parts per million by volume
Aux - Auxiliary	mA - milliamps XF - user-defined units

Configuring the Alarm

After selecting the desired measurement units, the following set of prompts appears:

Display	Action
Low Alarm Hi Alarm	Use the arrow keys to choose a high or low alarm, then press [ENTER]. (A high alarm trips when a reading is above the setpoint, while a low alarm trips when a reading is below the setpoint.)

Note: *The next prompts that appear depend on the selected alarm measurement mode, alarm measurement units, and alarm configuration (high or low).*

Display	Action
AL:+1.0 DP/°C	Press either arrow key to delete the current value and enter edit mode.
AL:+5.0 DP/°C	Enter the alarm setpoint. Use the arrow and [ENTER] keys to change the value one digit at a time, then press [ENTER] twice.

If necessary, repeat the above procedure to set up the other alarm; then press [ESC] until you return to the main menu.

Note: *Be sure to record all entered data in the* Data Information Sheet *in* Appendix D.

Setting Up a Recorder

Use this section to set up the one Series 35 recorder output. To configure the recorder output signal, do the following:

- select the output signal in milliamps or volts
- select the recorder measurement mode and units
- set the zero and span values

Note: *Be sure to record all entered output data in the* Data Information Sheet *in* Appendix D.

Selecting the Output Signal

Note: *Be sure the output signal selected (mA or V) agrees with the Series 35 recorder switch setting (see* Making Recorder Connections *in Chapter 2).*

RECORDER	In the main menu, use the arrow keys to scroll to this prompt, then press the [ENTER] key.
0-20 mA 4-20 mA 0-2 V	Use the arrow keys to scroll to the desired output range, then press [ENTER].

Selecting the Measurement Mode and Units

Selecting the Measurement Mode

Select “RCD HYG” if you want the recorder to respond to measurements taken from the *probe* input connection; select “RCD AUX” if you want the recorder to respond to measurements taken from the *auxiliary* input connection.

RCD HYG
RCD AUX

Use the arrow keys to scroll to the desired measurement mode, then press [ENTER].

Selecting the Measurement Units

The next set of prompts that appear depends on the measurement mode selected above for the recorder output. To choose the desired recorder output measurement units, refer to the appropriate section below and Table 3-3 on page 3-19 for a list of the available measurement units.

If “RCD HYG” was selected above, the following prompts appear:

RCD HYGDP/°F
RCD HYGDP/°C
RCD HYGDVM
RCD HYGMH
RCD HYGPMv

Use the arrow keys to scroll to the desired measurement unit, then press [ENTER].

Selecting the Measurement Mode and Units (cont.)

If "RCD AUX" was selected at the initial recorder prompt on page 3-22, either a mA (milliamp) output value or a user-defined XF (Auxiliary Function) output value may be chosen.

Display	Action
RCD AUXmA RCD AUXXF	Use the arrow keys to scroll to the desired output value, then press [ENTER].

Setting the Zero and Span Values

The next set of prompts that appears depends on the measurement mode and units previously selected for the recorder.

Display	Action
Ze:-80.0 DP/°C	Press either arrow key to delete the current zero value and enter edit mode.
Ze:+60.0 DP/°C	Use the arrow and [ENTER] keys to change the zero value one digit at a time, then press [ENTER] twice to proceed to the span value.
Sp:+20.0 DP/°C	Press either arrow key to delete the current span value and enter edit mode.
Sp:+9.0 DP/°C	Use the arrow and [ENTER] keys to change the span value one digit at a time, then press [ENTER] twice.

Press [ESC] until you return to the main menu.

Setting Up User-Defined Functions

Use this section to set up and define a variety of program functions to enhance the usability of the Series 35.

The USER menu lets you set up the following program functions:

- Offset Value
- Constant Pressure
- Automatic Calibration Interval
- Backlight-On Time Interval
- Computer Enhanced Response (optional)
- Range Error Processing
- Calibration Error Processing
- Entering a PPMv Constant Multiplier

Use the appropriate sections that follow to set up the desired program functions.

Entering an Offset Value

Use this option to adjust the displayed dew/frost point reading. A positive number increases the reading, while a negative number decreases the reading. The offset value is always displayed in dew/frost point degrees C.

Note: *Be sure to record all entered output data in the* Data Information Sheet *in* Appendix D.

USER	In the main menu, use the arrow keys to scroll to this prompt, then press the [ENTER] key.
OFFSET	Use the arrow keys to scroll to "OFFSET," then press [ENTER].
OFFSET+5.0°C	Press either arrow key to delete the current value and enter edit mode.
OFFSET+10.0°C	Use the arrow and [ENTER] keys to change the value one digit at a time, then press [ENTER] twice.

After entering the offset value, press [ESC] until you return to the USER menu.

Note: *The maximum positive value for the offset is +15.0°C, and the maximum negative value is -15°C.*

Entering a Constant Pressure

This option lets you enter a fixed value for the pressure of the sample gas at the moisture probe location. This value is used to calculate the moisture content in ppmv. Refer to Table 3-4 below for a list of the available constant pressure units.

Table 3-4: Constant Pressure Units

Available Units	Description of Units
KP PSIg	pounds per square inch gauge
KP Bar	bars absolute
KP KPAg	kilopascals gauge
KP Kcmg	kilograms per square centimeter gauge

Note: *Be sure to record all entered output data in the* Data Information Sheet *in* Appendix D.

CONSTANT PRESSUR	In the USER menu, use the arrow keys to scroll to this prompt, then press the [ENTER] key.
KPPSIg	Use the arrow keys to scroll to the desired pressure units, then press [ENTER].
KP:+ PSG	Press either arrow key to delete the current value and enter edit mode.
KP:+500.00 PSG	Use the arrow and [ENTER] keys to change the value one digit at a time, then press [ENTER] twice.

After entering the constant pressure value, press [ESC] until you return to the USER menu.

Entering an Automatic Calibration Interval

The Series 35 automatically calibrates itself at user-defined intervals, to compensate for any drift in the electronics. Normally, GE Infrastructure Sensing recommends setting the Autocal interval to 480 minutes (eight hours). However, a smaller Autocal interval is beneficial if the Series 35 is exposed to extreme temperature or weather conditions. Values between 0 and 1440 minutes (14 hours) may be specified for the Autocal interval.

Note: *Be sure to record all entered output data in the* Data Information Sheet *in* Appendix D.

AUTOCAL INTERVAL	In the USER menu, use the arrow keys to scroll to this prompt, then press the [ENTER] key.
ACAL (Mins)0	Press either arrow key to delete the current value and enter edit mode.
ACAL (Mins)3.0	Use the arrow and [ENTER] keys to change the value one digit at a time, then press [ENTER] twice.

After entering the Autocal interval, press [ESC] until you return to the USER menu.

Entering an Automatic Calibration Interval (cont.)

After you confirm the Autocal interval and return to the main menu, the Series 35 immediately performs an Autocal. The next time the Autocal occurs depends on the length of the time interval setting.

The Series 35 determines the times of subsequent Autocals by establishing a fixed schedule, beginning at midnight, using the specified interval. For example, if you enter a 90-minute time interval, Autocal occurs 16 times per day

(1 day = 1440 minutes ÷ 90 minutes = 16).

The following fixed schedule applies:

1. 1:30 a.m.	**9.** 1:30 p.m.
2. 3:00 a.m.	**10.** 3:00 p.m.
3. 4:30 a.m.	**11.** 4:30 p.m.
4. 6:00 a.m.	**12.** 6:00 p.m.
5. 7:30 a.m.	**13.** 7:30 p.m.
6. 9:00 a.m.	**14.** 9:00 p.m.
7. 10:30 a.m.	**15.** 10:30 p.m.
8. 12:00 p.m.(noon)	**16.** 12:00 a.m.(midnight)

If you enter a time interval not evenly divisible into 1440 minutes, the Series 35 rounds up to the next acceptable interval. For example, if you set the 90-minute Autocal interval at 6:10 p.m., the next Autocal occurs at 7:30 p.m. (excluding the Autocal performed when you exit the Autocal menu).

Entering a Backlight-On Time Interval

If your Series 35 is equipped with a backlight, you can program the backlight to turn off automatically after a predetermined time. If the display does not have the backlight, attempts to access this option results in an "Option Not Available" message; otherwise, the "Backlight" prompt appears. Values between 0 and 1440 minutes (24 hours) may be entered.

BACKLIGHT	In the USER menu, use the arrow keys to scroll to this prompt, then press the [ENTER] key.
BLITE (Mins)0	Press either arrow key to delete the current value and enter edit mode.
BLITE (Mins)0	Use the arrow and [ENTER] keys to change the value one digit at a time, then press [ENTER] twice.

After entering the Backlight interval, press [ESC] until you return to the USER menu.

Setting Up Computer Enhanced Response

Note: *This option may not be installed on your Series 35.*

Computer Enhanced Response uses a dynamic moisture calibration technique to extrapolate the moisture level to the end point, when making measurements in abrupt "dry down" conditions. The system response time depends on the relative change in dew point. For a change from ambient moisture levels to trace levels, the Series 35 can respond in under one minute.

A reasonably constant final dew point and flow rate are needed to use the computer enhanced response option. The minimum flow rate is 1 SCFH (500 cc/min).

If your Series 35 is equipped with *Computer Enhanced Response*, use this function to enable or disable the feature. If the enhanced response option is not available, the display will read "Option Not Avail." Otherwise, the Enhance Response display appears.

Note: *Be sure to record all entered data in the* Data Information Sheet *in* Appendix D.

ENHANCE RESPONSE	In the USER menu, use the arrow keys to scroll to this prompt, then press the [ENTER] key.
ENHANCE OFF ENHANCE ON	Use the arrow keys to scroll to the desired status, then press [ENTER].

Press [ESC] until you return to the USER menu. After you activate *Computer Enhanced Response*, a reverse video "E" symbol appears on the left side of the display as part of the mode. When the Series 35 determines the final value, the reverse video "E" changes to a normal "E."

Setting Up Range Error Processing

Range errors occur when an input signal that is within the capacity of the analyzer is outside the range of the probe calibration data. The Series 35 displays range errors with an OVER RANGE or UNDER RANGE message. The error condition extends to all displayed measurements of that mode. For example, if dew point displays OVER RANGE, then moisture in PPMv also displays OVER RANGE.

The *User Program* permits the selection of the manner in which errors are handled by the Series 35. To monitor the unit for error conditions, the fault alarm and/or the recorder output may be used as external indicators.

Refer to Table 3-5 on page 3-32 for a description of each RANGE ERROR option and the corresponding response of the Series 35.

Note: *Be sure to record all entered data in the* Data Information Sheet *in* Appendix D.

RANGE ERROR

In the USER menu, use the arrow keys to scroll to this prompt, then press the [ENTER] key.

R_ERR = No Response

R_ERR = Display

R_ERR = Hi/Lo RCD

R_ERR = Hi/Hi RCD

Use the arrow keys to scroll to the desired error response mode, then press [ENTER].

Press [ESC] until you return to the USER menu.

Setting Up Range Error Processing (cont.)

Table 3-5: Range Error Response Modes

Option	Display	Alarm/Recorder
No Action	none	range error disabled
Display	error displayed	fault alarm tripped
Hi/Lo RCD	error displayed	fault alarm tripped, recorder output high for over-range errors, recorder output low for under-range errors
Hi/Hi RCD	error displayed	fault alarm tripped, recorder output high for over-range errors, recorder output high for under-range errors

Setting Up Calibration Error Processing

A *Calibration Error* indicates a failure during measurement of the internal moisture references. During Autocal, internal references are read repeatedly, and the values measured are compared to a table of acceptable factory calibration values. Any deviation from the factory values is calculated and corrected. Should a reference value fall outside the acceptable range, a CAL ERROR message appears.

You can select whether the recorder output will be forced low (zero value) or high (span value) upon detection of a calibration error. When a calibration error is detected, the recorder output remains at the selected limit (low or high) until the error condition is corrected. Then, an Autocal is then executed or the system is restarted.

If you attempt to display data while a calibration error is in effect, the "CAL ERROR DP/°C" display appears.

Note: *Be sure to record all entered data in the* Data Information Sheet *in* Appendix D.

CAL ERROR	In the USER menu, use the arrow keys to scroll to this prompt, then press the [ENTER] key.
CAL_ERR = Lo Output CAL_ERR = Hi Output	Use the arrow keys to scroll to the desired selection, then press [ENTER].

Press [ESC] until you return to the USER menu.

Entering a PPMv Constant Multiplier

Use this option to apply a user-defined constant multiplier to the the PPMv value. Values up to 999.9999 may be entered.

PPMv MULTIPLIER	In the USER menu, use the arrow keys to scroll to this prompt, then press the [ENTER] key.
KPPMv1.0000	Press either arrow key to delete the current value and enter edit mode.
KPPMv2.0000	Use the arrow and [ENTER] keys to change the value one digit at a time, then press [ENTER] twice.

Note: *Be sure to record all entered data in the* Data Information Sheet *in* Appendix D.

After entering the PPMv constant multiplier, press [ESC] until you return to the USER menu.

Chapter 4

Troubleshooting and Maintenance

The Moisture Monitor Series 35 is designed to be maintenance and trouble free. Due to process conditions and other factors, however, minor problems may occur. This chapter discusses some of the most commonly encountered problems and the procedures for correcting them. If you cannot find the information you need in this chapter, contact GE Infrastructure Sensing.

Caution!
Do not attempt to troubleshoot the Series 35 beyond the instructions in this chapter. If you do, you may damage the unit and void the warranty.

This section includes the following information:

- Common Problems
- Screen Messages
- Replacing the *User Program*
- Replacing and Recalibrating the Moisture Probes
- Testing the Alarm Relays and Recorder Output
- Adjusting the Recorder Output Zero and Span Values

Common Problems

If the Series 35 measurement readings seem incorrect, there may be a problem with the probe or another system component. Table 4-1 on page 4-2 contains some of the most common measurement problems and suggested ways to resolve them.

Table 4-1: Solutions to Common Problems

Symptom	Possible Cause	System Response	Action
Accuracy of moisture sensor is questioned	Insufficient time for system to equilibrate.	Probe reads too wet during dry down, or too dry in wet up conditions.	Change the flow rate. A change in dew point indicates the sample system is not at equilibrium, or there is a leak. Allow sufficient time for sample system to equilibrate and moisture reading to become steady. Check for leaks.
	The dew point at the sampling point is different than the dew point of the main stream.	Probe reads too wet or too dry.	Readings may be correct if the sampling point and main stream do not run under the same process conditions. The different process conditions cause readings to vary. Refer to Appendix A for more information. If sampling point and main stream conditions are the same, check sample system pipes, and any pipe between the sample system and main stream for leaks. Also, check sample system for adsorbing water surfaces, such as rubber or plastic tubing, paper-type filters, or condensed water traps. Remove or replace contaminating parts with stainless steel parts.
	Sensor or sensor shield affected by process contaminant (Appx. A).	Probe reads too wet or too dry.	Clean the sensor and the sensor shield as described in Appendix A. Then reinstall the sensor.
	Sensor is contaminated with conductive particles (Appendix A).	Probe reads high dew point.	Clean the sensor and the sensor shield as described in Appendix A, then reinstall the sensor. Also, install a proper filter (i.e. sintered or coalescing element).

Table 4-1: Solutions to Common Problems

Symptom	Possible Cause	System Response	Action
Accuracy of moisture sensor is questioned	Sensor is corroded (refer to Appendix A).	Probe reads too wet or too dry.	Return the probe to the factory for evaluation.
	Sensor temperature is greater than 70°C (158°F).	Probe reads too dry.	Return the probe to the factory for evaluation.
	Stream particles are causing abrasion.	Probe reads too wet or too dry.	Return the probe to the factory for evaluation.
Slow response.	Slow outgassing of system.		Replace the system components with stainless steel or electro-polished stainless steel.
	Sensor is contaminated with non-conductive particles (Appendix A).		Clean the sensor and the sensor shield as described in Appendix A. Then reinstall the sensor.
Screen always reads the wettest (highest) programmed moisture calibration value while displaying dew/frost point.	Probe is saturated. Liquid water is present on sensor surface and/or across electrical connections.		Clean the sensor and the sensor shield as described in Appendix A. Then reinstall sensor.

Table 4-1: Solutions to Common Problems

Symptom	Possible Cause	System Response	Action
Screen always reads the wettest (highest) programmed moisture calibration value while displaying the dew/frost point.	Shorted circuit on sensor.		Run “dry gas” over sensor surface. If high reading persists, then probe is probably shorted and should be returned to the factory for evaluation.
	Sensor is contaminated with conductive particles (refer to Appendix A).		Clean the sensor and the sensor shield as described in Appendix A. Then reinstall the sensor.
	Improper cable connection.		Check the cable connections to both the probe and the Series 35.
Screen always reads the driest (lowest) programmed moisture calibration value while displaying the dew/frost point.	Open circuit on the sensor.		Return the probe to the factory for evaluation.
	Non-conductive material is trapped under the contact arm of the sensor.		Clean the sensor and the sensor shield as described in Appendix A. Then reinstall the sensor. If the low reading persists, return the probe to the factory for evaluation.
	Improper cable connection.		Check the cable connections to both the probe and the Series 35.

Screen Messages

The Series 35 may display several screen messages during operation. Refer to Table 4-2 on page 4-6 for a list of these messages and their possible causes and solutions.

Table 4-2: Screen Messages

Display	Possible Cause	System Response	Action
(None)	Loss of Power	System Shutdown	Be sure power connections are tight and unit is plugged in. Check electrical outlet.
"Loading..." (reinitializes) "Autocal..." (displays measurement)	Watchdog Reset (see Chapter 3)	System resets because watchdog signal is not generated within 1.6 seconds. Fault alarm is on for approximately 20 seconds.	Call GE Infrastructure Sensing if this happens more than 5 times within ten minutes.
"CAL ERROR"	Internal reference components may be out of specifications. (Occurs only when unit is set to measure DP/°C, DP/°F, ppm_v.)	Measurement stops for affected modes. Recorder responds as programmed (see *Cal Error Processing* in Chapter 3.)	Check wiring. Call GE Infrastructure Sensing.
(Reads over or under range.)	Signal received is lower or higher than calibration data supplied with probe.	System defaults to lowest or highest dew point found in calibration data. Recorder responds as programmed (refer to *Range Error Processing* in Chapter 3).	Check probe for open circuit or shorts if probe is not subjected to extreme dry or wet conditions. Contact GE Infrastructure Sensing regarding a higher calibrated probe.
"Signal Fault"	Electrical fault measurement signal exceeds capacity of unit.	System defaults to highest dew point found in calibration data. Recorder responds as if programmed for an over-range error.	Check cable connection for shorts. Check ground connections.

Replacing the User Program

The *User Program* is stored on an EPROM (Erasable Programmable Read Only Memory) chip. The EPROM is located on the main circuit board (part #703-1245), which is mounted inside the Series 35 electronics unit. If your Series 35 has a part #703-1180 circuit board, also see Appendix F.

For a **bench-mount** unit, complete the following steps to replace the *User Program*:

- remove the circuit board
- remove and replace the EPROM

For a **rack-mount, panel-mount, or weatherproof** unit, complete the following steps to replace the *User Program*:

- remove the unit from its location
- remove and replace the EPROM

Refer to the appropriate sections that follow to replace the *User Program*.

Removing the Circuit Board (Bench-Mount Only)

Note: *The circuit board for the bench-mount unit is mounted on the inside of the electronics cover.*

1. Turn the power OFF and, if applicable, unplug the unit.

!WARNING!
YOU MUST TURN OFF AND UNPLUG THE SERIES 35 BEFORE CONTINUING WITH THE FOLLOWING STEPS.

---

2. Discharge any static electricity from your body before touching the Series 35 enclosure.

Caution!
EPROMs can be damaged by static electricity.

---

3. Open the Series 35 enclosure by loosening the two quarter-turn screws on the back of the unit and gently lifting the cover off, from back to front.
4. Disconnect the OUT/IN terminal block connections from the inside of the unit.
5. Remove the circuit board by unscrewing the six screws from the bracket that holds the circuit board in place.
6. Turn the circuit board over to access the EPROM.

Removing and Replacing the EPROM (All Units)

1. Refer to Figure 4-3 on page 4-10 to locate the EPROM (labeled U28) on the #703-1245 circuit board.
2. Use a chip puller to remove the EPROM. If you do not have a chip puller, use a small screwdriver to carefully wedge the chip out of its mounting. Be sure none of the EPROM's legs get stuck in the socket.

Caution!

EPROMs can be damaged by static electricity. Take anti-static precautions when handling EPROMs.

---

3. Place the new EPROM in the socket labeled U28, making sure the notch on the EPROM matches the notch on the socket (see Figure 4-3 on page 4-10).
4. If the EPROM's legs do not enter the socket, gently remove the EPROM and place it on its side, with its legs against a flat surface. Then, gently tilt the EPROM to bend the legs slightly inward.

Caution!

Do not bend the EPROM legs too much. They are very delicate and may snap off if bent too far or too many times.

---

5. Repeat Step 4 on the opposite side of the EPROM. Then, place the EPROM back in the socket, making sure the EPROM's notch matches the socket's notch.
6. Gently press the EPROM into place, making sure not to bend or break any of its legs. **DO NOT FORCE THE EPROM INTO THE SOCKET.** Repeat Steps 4 and 5 if necessary.

Replacing the Circuit Board (Bench-Mount Only)

1. Replace the #703-1245 circuit board by turning it over and remounting the bracket that holds the circuit board to the inside of the Series 35 cover.

2. Insert and tighten the six bracket screws.

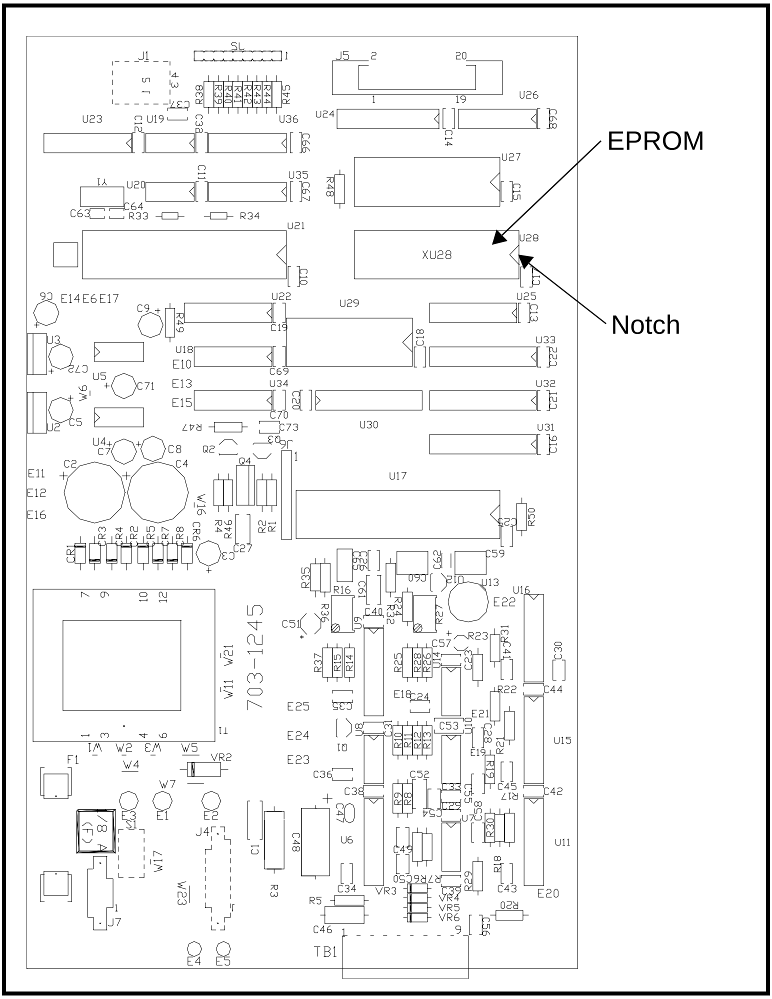


Figure 4-3: EPROM and Notch on 703-1245

Replacing the Circuit Board (Bench-Mount Only) (cont.)

3. Reconnect the OUT/IN terminal block connections on the inside of the unit.
4. Replace the Series 35 cover by attaching it to the unit, from front to back.
5. Tighten the two quarter-turn screws on the back of the unit.

Replacing and Recalibrating the Moisture Probes

For maximum accuracy you should send probes back to the factory for recalibration every six months to one year, depending on the application. Under severe conditions you should send the probes back for recalibration more frequently. Contact a GE Infrastructure Sensing applications engineer for the recommended calibration frequency for your application.

When you receive new or recalibrated probes, install and connect them as described in *Installing a Probe in the Sample System* in Chapter 2. Once you have installed and connected the probes, enter the calibration data as described in *Entering Data into the User Program* in Chapter 3. Note that each probe has its own *Calibration Data Sheet* with the corresponding probe serial number printed on it.

Testing the Alarm Relays and Recorder Output

Use this menu option to test the alarm relays and the recorder output, and also to adjust the recorder output if necessary.

Note: *Refer to Chapter 3 for instructions on how to enter and exit the* User Program *and scroll to the* Test Menu.

Testing the Alarm Relays

This test lets you manually trip and reset the alarm relays for testing purposes.

TEST	In the main menu, use the arrow keys to scroll to this prompt, then press the [ENTER] key.
TEST ALARM	Use the arrow keys to scroll to TEST ALARM, then press the [ENTER] key.
AlarmA ON AlarmA OFF AlarmB ON AlarmB OFF Fault Alarm ON Fault Alarm OFF	Use the arrow keys to scroll to the options to trip and reset the various alarms.

Testing the Alarm Relays (cont.)

As you scroll through the options, you should hear an audible click as the alarm relays change state from on to off. If an alarm or other device is connected to the alarm relay terminals, that device should also change state.

Note: *If an alarm does not trip or reset, check to see if it is wired correctly.*

After testing and resetting the desired alarm(s), press [ESC] to return to the TEST menu.

Testing the Recorder Output

This option lets you test the recorder output to make sure it is operating properly. You can test four percentages of the full-scale recorder range: 125%, 100%, 50%,and 0%.

TEST	In the main menu, use the arrow keys to scroll to this prompt, then press the [ENTER] key.
TEST RECORDER	Use the arrow keys to scroll to TEST RECORDER, then press the [ENTER] key.
RCD at 125%	Use the arrow keys to scroll to the output scale options.
RCD at 100%	
RCD at 50%	
RCD at 0%	

As you scroll through the options, the recorder pen should swing to the appropriate output value. The Series 35 automatically outputs the % of span displayed on the screen to the recorder.

Note: *If the recorder needs to be adjusted, refer to the following section.*

After testing the recorder, press [ESC] to return to the TEST menu.

Adjusting the Recorder Zero/Span Values

The measured value of the recorder output can vary from the programmed value due to resistance caused by the load (e.g., chart recorder, display, etc.) or by long wire runs or small gauge connecting wire. This menu option lets you adjust the recorder zero and span values to compensate for such variations.
To accurately adjust the recorder out, you need a digital multimeter capable of measuring 0-2 volts with a resolution of ± 0.0001 VDC or 0-20 mA with a resolution of ± 0.01 mA.

Adjusting the Recorder Zero

Note: *The zero adjustment is an offset adjustment, while the span adjustment is a slope adjustment. As a result, the zero and span adjustments affect each other. Therefore, after you adjust one value you should re-adjust the other.*

1. Make sure that switch S1 on the output circuit board is set to the appropriate position for the recorder output: "I" for current or "V" for voltage (see *Connecting a Recorder Output Device* in Chapter 2).
2. Connect the multimeter in series with the recorder terminals for a current output or in parallel with the recorder terminals for a voltage output.
3. Perform the following programming operations:

ADJUST RECORDER	In the TEST menu, use the arrow keys to scroll to this prompt, then press the [ENTER] key.
ADJ RCD ZERO	Use the arrow keys to scroll to ADJ RCD ZERO, then press the [ENTER] key.

Adjusting the Recorder Zero (cont.)

Note: *The recorder output cannot be adjusted to a value of 0.00 mA or 0.000 V due to limits imposed by electronic noise. The recorder output typically is 0.01 mA at a zero reading. Therefore, when checking for the zero value, the* MMS35 *automatically uses 5% of span for ranges of 0-20 mA and 0-2V (see the table below).*

4. Check the multimeter reading. It should display one of the following:

Table 4-4: Recorder Zero Reading per Output Range

Recorder Output Range	Desired Meter Reading
0-20 mA	1 mA
4-20 mA	4 mA
0-2 V	0.1 V

5. Adjust the recorder zero point to achieve the desired reading by performing the following operations.

ADJ RCDZ +	Press either arrow key to delete the current *Recorder Adjustment Value* and enter edit mode.
ADJ RCDZ -60	Use the arrow and [ENTER] keys to change the value one digit at a time; then press [ENTER].

Any *Recorder Adjustment Value* (RAV) between –150 and +150 is acceptable. Each increment of the RAV adjusts the recorder output by about 0.005 mA for 0-20 and 4-20 mA outputs, or 0.0005 volts for a 0-2 V output.

Adjusting the Recorder Zero (cont.)

Example:

A test of a 0-20 mA output results in a meter reading of 1.3 mA. This is 0.3 mA higher than the desired meter reading (1 mA) shown in Table 4-4 on page 4-17. Calculate the RAV that adjusts the meter reading by –0.3 mA as follows:

RAV = (–0.3 mA) (0.005 mA) = –60

Enter –60 as the new Recorder Adjustment Value (RAV).

6. Re-check the multimeter reading and, if necessary, repeat the procedure until the correct output reading is obtained.

Adjusting the Recorder Span

Note: *The zero adjustment is an offset adjustment, while the span adjustment is a slope adjustment. As a result, the zero and span adjustments affect each other. Therefore, after you adjust one value you should re-adjust the other.*

1. Make sure that switch S1 on the output circuit board is set to the appropriate position for the recorder output: “I” for current or “V” for voltage (see *Connecting a Recorder Output Device* in Chapter 2).
2. Connect the multimeter in series with the recorder terminals for a current output or in parallel with the recorder terminals for a voltage output.
3. Perform the following programming operations:

ADJUST RECORDER	In the TEST menu, use the arrow keys to scroll to this prompt, then press the [ENTER] key.
ADJ RCD SPAN	Use the arrow keys to scroll to ADJ RCD SPAN, then press the [ENTER] key.

4. Check the multimeter reading. It should display one of the following (see Table 4-5 below):

Table 4-5: Recorder Span Reading per Output Range

Recorder Output Range	Desired Meter Reading
0-20 mA	20 mA
4-20 mA	20 mA
0-2 V	2 V

Adjusting the Recorder Span (cont.)

5. Adjust the recorder span point to achieve the desired reading by performing the following operations.

ADJ RCDS +	Press either arrow key to delete the current *Recorder Adjustment Value* and enter edit mode.
ADJ RCDS +40	Use the arrow and [ENTER] keys to change the value one digit at a time; then press [ENTER].

Any *Recorder Adjustment Value* (RAV) between –150 and +150 is acceptable. Each increment of the RAV adjusts the recorder output by about 0.005 mA for 0-20 and 4-20 mA outputs, or 0.0005 volts for a 0-2 V output.

Example:

A test of a 0-20 mA output results in a meter reading of 19.8 mA. This is 0.2 mA lower than the desired meter reading (20 mA) shown in the table on page 4-19. Calculate the RAV that adjusts the meter reading by +0.2 mA as follows:

$$RAV = (+0.2\ mA)\ (0.005\ mA) = +40$$

Enter +40 as the new Recorder Adjustment Value (RAV).

6. Re-check the multimeter reading and, if necessary, repeat the procedure until the correct output reading is obtained.

Chapter 5

Specifications

Electronics

Functions:

Dew Point
PPMv in gases at constant pressure
(pressure by programmable constant)

Inputs:

Moisture:
Single input via M-Series probe connected to a terminal strip. Probe may be remotely located up to 600 m (2,000 ft) from electronic console.
Auxiliary:
4 to 20 mA input.

Intrinsic Safety:

Intrinsically safe probe and cable when used with appropriate external zener barriers. Consult GE Infrastructure Sensing for more information.

Recorder Output:

0 to 20-mA, 4 to 20-mA or 0 to 2-V analog, linear in parameter chosen.

Maximum Load:

Current Output:
500 ohms, maximum for AC units
Voltage Output:
10K ohms, minimum

Electronics (cont.)

Computer-Enhanced Response:

Optional.

Alarm Relays:

Fault alarm

Optional Form C:	Standard	Hermetically Sealed
	8A @ 250VAC	0.3A @ 115VAC
	8A @ 30VDC	2A @ 28VDC

Note: *To maintain Low Voltage Directive Compliance, EN Standard EN61010, the following rating applies: 2A @ 28VDC*

Display Units:

Dew/frost point temperature: ºC, ºF
PPMv
Pressure: psi(g), bar, kPa(g), kg/cm2(g)
MH: raw signal.

Power Requirements:

AC power supply: Specify as 100, 120, 220, or 240 VAC, 50/60 Hz
Optional DC power supply: 24 VDC
Input power: 12 watts, maximum.

Temperature:

Operating: 0° to 60°C (32º to 140ºF)
Storage: -20° to 70°C (-22º to 158ºF)

Configurations:

Rack-, Bench- and Panel-Mount, NEMA-4X Weatherproof

Electronics (cont.)

Dew/Frost Point Temperature:

Overall calibration range capability:
60° to -110°C (140º to -166ºF).

Available calibration range options:
Standard: 20 to -80°C with data to -110°C
(68 to -112°F with data to -166ºF)
Extended High: 60 to -80°C with data to -110°C
(140 to -112ºF with data to -166ºF)

Accuracy: ±2°C from 60 to -65°C (140 to -85ºF);
±3°C from -66 to -110°C (-86 to -166ºF)

Repeatability: ±0.5°C from 60 to -65°C (140 to -85ºF);
±1.0°C from -66 to -110°C (-86 to -166ºF)

Response Time:

5 sec for 63% of a step change in moisture content in either wet up or dry down cycle.

Gas Flow Range:

From static to 10,000 cm/sec linear velocity at 1 atm

Moisture Measurement

Sensor Type:

GE Infrastructure Sensing M-Series thin-film aluminum oxide

Traceability:

Each sensor is individually computer-calibrated against known moisture concentrations. Calibrations are traceable to National Institute of Standards and Technology (NIST).

Temperature:

Operating and Storage: 110 to +70ºC (-166 to 158ºF)

Pressure:

Operating: 5 microns Hg to 5,000 psig

Appendix A

Application of the Hygrometer

This appendix contains general information about moisture monitoring techniques. System contaminants, moisture probe maintenance, process applications and other considerations for ensuring accurate moisture measurements are discussed.

The following specific topics are covered:

Moisture Monitor Hints

GE Infrastructure Sensing hygrometers, using aluminum oxide moisture probes, have been designed to reliably measure the moisture content of both gases and liquids. The measured dew point will be the real dew point of the system at the measurement location and at the time of measurement. However, no moisture sensor can determine the origin of the measured moisture content. In addition to the moisture content of the fluid to be analyzed, the water vapor pressure at the measurement location may include components from sources such as: moisture from the inner walls of the piping; external moisture through leaks in the piping system; and trapped moisture from fittings, valves, filters, etc. Although these sources may cause the measured dew point to be higher than expected, it is the actual dew point of the system at the time of measurement.

One of the major advantages of the GE Infrastructure Sensing hygrometer is that it can be used for *in situ* measurements (i.e. the sensor element is designed for installation directly within the region to be measured). As a result, the need for complex sample systems that include extensive piping, manifolds, gas flow regulators and pressure regulators is eliminated or greatly reduced. Instead, a simple sample system to reduce the fluid temperature, filter contaminants and facilitate sensor removal is all that is needed.

Whether the sensor is installed in situ or in a remote sampling system, the accuracy and speed of measurement depend on the piping system and the dynamics of the fluid flow. Response times and measurement values will be affected by the degree of equilibrium reached within system. Factors such as gas pressure, flow rate, materials of construction, length and diameter of piping, etc. will greatly influence the measured moisture levels and the response times.

Assuming that all secondary sources of moisture have been eliminated and the sample system has been allowed to come to equilibrium, then the measured dew point will equal the actual dew point of the process fluid.

Moisture Monitor Hints (cont.)

Some of the most frequently encountered problems associated with moisture monitoring sample systems include:

- the moisture content value changes as the total gas pressure changes
- the measurement response time is very slow
- the dew point changes as the fluid temperature changes
- the dew point changes as the fluid flow rate changes.

GE Infrastructure Sensing hygrometers measure only water vapor pressure. In addition, the instrument has a very rapid response time and it is not affected by changes in fluid flow rate. If any of the above situations occur, then they are almost always caused by a defect in the sample system. The moisture sensor itself can not lead to such problems.

Pressure

GE Infrastructure Sensing hygrometers can accurately measure dew points under pressure conditions ranging from vacuums as low as a few microns of mercury up to pressures of 5000 psig. The calibration data supplied with the moisture probe is directly applicable over this entire pressure range, without correction.

Note: *Although the moisture probe calibration data is supplied as meter reading vs. dew point, it is important to remember that the moisture probe responds only to water vapor pressure.*

When a gas is compressed, the partial pressures of all the gaseous components are proportionally increased. Conversely, when a gas expands, the partial pressures of the gaseous components are proportionally decreased. Therefore, increasing the pressure on a closed aqueous system will increase the vapor pressure of the water, and hence, increase the dew point. This is not just a mathematical artifact. The dew point of a gas with 1000 PPMv of water at 200 psig will be considerably higher than the dew point of a gas with 1000 PPMv of water at 1 atm. Gaseous water vapor will actually condense to form liquid water at a higher temperature at the 200 psig pressure than at the 1 atm pressure. Thus, if the moisture probe is exposed to pressure changes, the measured dew point will be altered by the changed vapor pressure of the water.

It is generally advantageous to operate the hygrometer at the highest possible pressure, especially at very low moisture concentrations. This minimizes wall effects and results in higher dew point readings, which increases the sensitivity of the instrument.

Response Time

The response time of the GE Infrastructure Sensing standard M Series Aluminum Oxide Moisture Sensor is very rapid - a step change of 63% in moisture concentration will be observed in approximately 5 seconds. Thus, the observed response time to moisture changes is, in general, limited by the response time of the sample system as a whole. Water vapor is absorbed tenaciously by many materials, and a large, complex processing system can take several days to “dry down” from atmospheric moisture levels to dew points of less than -60°C. Even simple systems consisting of a few feet of stainless steel tubing and a small chamber can take an hour or more to dry down from dew points of +5°C to -70°C. The rate at which the system reaches equilibrium will depend on flow rate, temperature, materials of construction and system pressure. Generally speaking, an increase in flow rate and/or temperature will decrease the response time of the sample system.

To minimize any adverse affects on response time, the preferred materials of construction for moisture monitoring sample systems are stainless steel, Teflon® and glass. Materials to be avoided include rubber elastomers and related compounds.

Temperature

The GE Infrastructure Sensing hygrometer is largely unaffected by ambient temperature. However, for best results, it is recommended that the ambient temperature be at least 10°C higher than the measured dew point, up to a maximum of 70°C. Because an ambient temperature increase may cause water vapor to be desorbed from the walls of the sample system, it is possible to observe a diurnal change in moisture concentration for a system exposed to varying ambient conditions. In the heat of the day, the sample system walls will be warmed by the ambient air and an off-gassing of moisture into the process fluid, with a corresponding increase in measured moisture content, will occur. The converse will happen during the cooler evening hours.

Flow Rate

GE Infrastructure Sensing hygrometers are unaffected by the fluid flow rate. The moisture probe is not a mass sensor but responds only to water vapor pressure. The moisture probe will operate accurately under both static and dynamic fluid flow conditions. In fact, the specified maximum fluid linear velocity of 10,000 cm/sec for The M Series Aluminum Oxide Moisture Sensor indicates a mechanical stability limitation rather than a sensitivity to the fluid flow rate.

If the measured dew point of a system changes with the fluid flow rate, then it can be assumed that off-gassing or a leak in the sample system is causing the variation. If secondary moisture is entering the process fluid (either from an ambient air leak or the release of previously absorbed moisture from the sample system walls), an increase in the flow rate of the process fluid will dilute the secondary moisture source. As a result, the vapor pressure will be lowered and a lower dew point will be measured.

Note: *Refer to the* Specifications *chapter in this manual for the maximum allowable flow rate for the instrument.*

Contaminants

Industrial gases and liquids often contain fine particulate matter. Particulates of the following types are commonly found in such process fluids:

- carbon particles
- salts
- rust particles
- polymerized substances
- organic liquid droplets
- dust particles
- molecular sieve particles
- alumina dust

For convenience, the above particulates have been divided into three broad categories. Refer to the appropriate section for a discussion of their effect on the GE Infrastructure Sensing moisture probe.

Non-Conductive Particulates

Note: *Molecular sieve particles, organic liquid droplets and oil droplets are typical of this category.*

In general, the performance of the moisture probe will not be seriously hindered by the condensation of non-conductive, non-corrosive liquids. However, a slower response to moisture changes will probably be observed, because the contaminating liquid barrier will decrease the rate of transport of the water vapor to the sensor and reduce its response time.

Particulate matter with a high density and/or a high flow rate may cause abrasion or pitting of the sensor surface. This can drastically alter the calibration of the moisture probe and, in extreme cases, cause moisture probe failure. A stainless steel shield is supplied with the moisture probe to minimize this effect, but in severe cases, it is advisable to install a Teflon® or stainless steel filter in the fluid stream.

Non-Conductive Particulates (cont.)

On rare occasions, non-conductive particulate material may become lodged under the contact arm of the sensor, creating an open circuit. If this condition is suspected, refer to the *Probe Cleaning Procedure* section of this appendix for the recommended cleaning procedure.

Conductive Particulates

Note: *Metallic particles, carbon particles and conductive liquid droplets are typical of this category.*

Since the hygrometer reading is inversely proportional to the impedance of the sensor, a decrease in sensor impedance will cause an increase in the meter reading. Thus, trapped conductive particles across the sensor leads or on the sensor surface, which will decrease the sensor impedance, will cause an erroneously high dew point reading. The most common particulates of this type are carbon (from furnaces), iron scale (from pipe walls) and glycol droplets (from glycol-based dehydrators).

If the system contains conductive particulates, it is advisable to install a Teflon® or stainless steel filter in the fluid stream.

Corrosive Particulates

Note: *Sodium chloride and sodium hydroxide particulates are typical of this category.*

Since the active sensor element is constructed of aluminum, any material that corrodes aluminum will deleteriously affect the operation of the moisture probe. Furthermore, a combination of this type of particulate with water will cause pitting or severe corrosion of the sensor element. In such instances, the sensor cannot be cleaned or repaired and the probe must be replaced.

Obviously, the standard moisture probe can not be used in such applications unless the complete removal of such part by adequate filtration is assured.

Aluminum Oxide Probe Maintenance

Other than periodic calibration checks, little or no routine moisture probe maintenance is required. However, as discussed in the previous section, any electrically conductive contaminant trapped on the aluminum oxide sensor will cause inaccurate moisture measurements. If such a situation develops, return of the moisture probe to the factory for analysis and recalibration is recommended. However, in an emergency, cleaning of the moisture probe in accordance with the following procedure may be attempted by a qualified technician or chemist.

IMPORTANT: *Moisture probes must be handled carefully and cannot be cleaned in any fluid which will attack its components. The probe's materials of construction are Al, Al_2O_3, nichrome, gold, stainless steel, glass and Viton® A. Also, the sensor's aluminum sheet is very fragile and can be easily bent or distorted. Do not permit anything to touch it!*

The following items will be needed to properly complete the moisture probe cleaning procedure:

- approximately 300 ml of reagent grade hexane or toluene
- approximately 300 ml of distilled (not deionized) water
- two glass containers to hold above liquids (metal containers should not be used).

To clean the moisture probe, complete the following steps:

1. Record the dew point of the ambient air.
2. Making sure not to touch the sensor, carefully remove the protective shield from the sensor.
3. Soak the sensor in the distilled water for ten (10) minutes. Be sure to avoid contact with the bottom and the walls of the container!

Aluminum Oxide Probe Maintenance (cont.)

4. Remove the sensor from the distilled water and soak it in the clean container of hexane or toluene for ten (10) minutes. Again, avoid all contact with the bottom and the walls of the container!
5. Remove the sensor from the hexane or toluene, and place it face up in a low temperature oven set at 50°C ±2°C (122°F ±4°F) for 24 hours.
6. Repeat steps 3-5 for the protective shield. During this process, swirl the shield in the solvents to ensure the removal of any contaminants that may have become embedded in the porous walls of the shield.
7. Carefully replace probe's protective shield, making sure not to touch the sensor.
8. Connect the probe cable to the probe, and record the dew point of the ambient air, as in step 1. Compare the two recorded dew point readings to determine if the reading after cleaning is a more accurate value for the dew point of the ambient atmosphere.
9. If the sensor is in proper calibration (±2°C accuracy), reinstall the probe in the sample cell and proceed with normal operation of the hygrometer.
10. If the sensor is not in proper calibration, repeat steps 1-9, using time intervals 5 times those used in the previous cleaning cycle. Repeat this procedure until the sensor is in proper calibration.

A trained laboratory technician should determine if all electrically conductive compounds have been removed from the aluminum oxide sensor and that the probe is properly calibrated. Probes which are not in proper calibration must be recalibrated. It is recommended that all moisture probes be recalibrated by GE Infrastructure Sensing approximately once a year, regardless of the probe's condition.

Corrosive Gases And Liquids

GE Infrastructure Sensing M Series Aluminum Oxide Moisture Sensors have been designed to minimize the affect of corrosive gases and liquids. As indicated in the *Materials of Construction* section of this appendix, no copper, solder or epoxy is used in the construction of these sensors. The moisture content of corrosive gases such as H_2S, SO_2, cyanide containing gases, acetic acid vapors, etc. can be measured directly.

Note: *Since the active sensor is aluminum, any fluid which corrodes aluminum will affect the sensor's performance.*

By observing the following precautions, the moisture probe may be used successfully and economically:

1. The moisture content of the corrosive fluid must be 10 PPMv or less at 1 atmosphere, or the concentration of the corrosive fluid must be 10 PPMv or less at 1 atmosphere.
2. The sample system must be pre-dried with a dry inert gas, such as nitrogen or argon, prior to introduction of the fluid stream. Any adsorbed atmospheric moisture on the sensor will react with the corrosive fluid to cause pitting or corrosion of the sensor.
3. The sample system must be purged with a dry inert gas, such as nitrogen or argon, prior to removal of the moisture probe. Any adsorbed corrosive fluid on the sensor will react with ambient moisture to cause pitting or corrosion of the sensor.
4. Operate the sample system at the lowest possible gas pressure.

Using the precautions listed above, the hygrometer has been used to successfully measure the moisture content in such fluids as hydrochloric acid, sulfur dioxide, chlorine and bromine.

Materials of Construction

M1 and M2 Sensors:

Sensor Element:	99.99% aluminum, aluminum oxide, gold, Nichrome, A6
Back Wire:	316 stainless steel
Contact Wire:	gold, 304 stainless steel
Front Wire:	316 stainless steel
Support:	Glass (Corning 9010)

Electrical Connector:

Pins:	Al 152 Alloy (52% Ni)
Glass:	Corning 9010
Shell:	304L stainless steel
O-Ring:	silicone rubber
Threaded Fitting:	304 stainless steel
O-Ring:	Viton® A
Cage:	308 stainless steel
Shield:	304 stainless steel

Calculations and Useful Formulas in Gas Applications

A knowledge of the dew point of a system enables one to calculate all other moisture measurement parameters. The most important fact to recognize is that *for a particular dew point there is one and only one equivalent vapor pressure*.

Note: *The calibration of GE Infrastructure Sensing moisture probes is based on the vapor pressure of liquid water above 0°C and frost below 0°C. GE Infrastructure Sensing moisture probes are never calibrated with supercooled water.*

Caution is advised when comparing dew points measured with a GE Infrastructure Sensing hygrometer to those measured with a mirror type hygrometer, since such instruments may provide the dew points of supercooled water.

As stated above, the dew/frost point of a system defines a unique partial pressure of water vapor in the gas. Table A-1, which lists water vapor pressure as a function of dew point, can be used to find either the saturation water vapor pressure at a known temperature or the water vapor pressure at a specified dew point. In addition, all definitions involving *humidity* can then be expressed in terms of the water vapor pressure.

Nomenclature

The following symbols and units are used in the equations that are presented in the next few sections:

- RH = relative humidity
- T_K = temperature (°K = °C + 273)
- T_R = temperature (°R = °F + 460)
- PPM_v = parts per million by volume
- PPM_w = parts per million by weight
- M_w = molecular weight of water (18)
- M_T = molecular weight of carrier gas

Nomenclature (cont.)

- P_S = saturation vapor pressure of water at the prevailing temperature (mm of Hg)
- P_W = water vapor pressure at the measured dew point (mm of Hg)
- P_T = total system pressure (mm of Hg)

Parts per Million by Volume

The water concentration in a system, in parts per million by volume, is proportional to the ratio of the water vapor partial pressure to the total system pressure:

$$PPM_V = \frac{P_W}{P_T} \times 10^6$$

In a closed system, increasing the total pressure of the gas will proportionally increase the partial pressures of the various components. The relationship between dew point, total pressure and PPM_V is provided in nomographic form in Figure A-1 on page A-25.

Note: *The nomograph shown in Figure A-1 is applicable only to gases. Do not apply it to liquids.*

To compute the moisture content for any ideal gas at a given pressure, refer to Figure A-1. Using a straightedge, connect the dew point (as measured with the GE Infrastructure Sensing Hygrometer) with the known system pressure. Read the moisture content in PPM_V where the straightedge crosses the moisture content scale.

Typical Problems

1. Find the water content in a nitrogen gas stream, if a dew point of -20°C is measured and the pressure is 60 psig.

   Solution: In Figure A-1, connect 60 psig on the Pressure scale with -20°C on the Dew/Frost Point scale. Read **200 PPM_V**, on the Moisture Content scale.

Parts per Million by Volume (cont.)

2. Find the expected dew/frost point for a helium gas stream having a measured moisture content of 1000 PPM_V and a system pressure of 0.52 atm.

   Solution: In Figure A-1, connect 1000 PPM_V on the Moisture Content scale with 0.52 atm on the Pressure scale. Read the expected frost point of **–27°C** on the Dew/Frost Point scale.

Parts per Million by Weight

The water concentration in the gas phase of a system, in parts per million by weight, can be calculated directly from the PPM_V and the ratio of the molecular weight of water to that of the carrier gas as follows:

$$PPM_W = PPM_V \times \frac{M_W}{M_T}$$

Relative Humidity

Relative humidity is defined as the ratio of the actual water vapor pressure to the saturation water vapor pressure at the prevailing ambient temperature, expressed as a percentage.

$$RH = \frac{P_W}{P_S} \times 100$$

1. Find the relative humidity in a system, if the measured dew point is 0°C and the ambient temperature is +20°C.

   Solution: From Table A-1, the water vapor pressure at a dew point of 0°C is 4.579 mm of Hg and the saturation water vapor pressure at an ambient temperature of +20°C is 17.535 mm of Hg. Therefore, the relative humidity of the system is 100 x 4.579/17.535 = **26.1%**.

Weight of Water per Unit Volume of Carrier Gas

Three units of measure are commonly used in the gas industry to express the weight of water per unit volume of carrier gas. They all represent a vapor density and are derivable from the vapor pressure of water and the Perfect Gas Laws. Referenced to a temperature of 60°F and a pressure of 14.7 psia, the following equations may be used to calculate these units:

$$\frac{\text{mg of water}}{\text{liter of gas}} = 289 \times \frac{P_W}{T_K}$$

$$\frac{\text{lb of water}}{\text{ft}^3\text{ of gas}} = 0.0324 \times \frac{P_W}{T_R}$$

$$\frac{\text{lb of water}}{\text{MMSCF of gas}} = \frac{PPM_V}{21.1} = \frac{10^6 \times P_W}{21.1 \times P_T}$$

Note: *MMSCF is an abbreviation for a "million standard cubic feet" of carrier gas.*

Weight of Water per Unit Weight of Carrier Gas

Occasionally, the moisture content of a gas is expressed in terms of the weight of water per unit weight of carrier gas. In such a case, the unit of measure defined by the following equation is the most commonly used:

$$\frac{\text{grains of water}}{\text{lb of gas}} = 7000 \times \frac{M_W \times P_W}{M_T \times P_T}$$

For ambient air at 1 atm of pressure, the above equation reduces to the following:

$$\frac{\text{grains of water}}{\text{lb of gas}} = 5.72 \times P_W$$

Table A-1: Vapor Pressure of Water

Note: *If the dew/frost point is known, the table will yield the partial water vapor pressure (P_W) in mm of Hg. If the ambient or actual gas temperature is known, the table will yield the saturated water vapor pressure (P_S) in mm of Hg.*

Water Vapor Pressure Over Ice

Temp. (°C)	0	2	4	6	8
-90	0.000070	0.000048	0.000033	0.000022	0.000015
-80	0.000400	0.000290	0.000200	0.000140	0.000010
-70	0.001940	0.001430	0.001050	0.000770	0.000560
-60	0.008080	0.006140	0.004640	0.003490	0.002610
-50	0.029550	0.023000	0.017800	0.013800	0.010600
-40	0.096600	0.076800	0.060900	0.048100	0.037800
-30	0.285900	0.231800	0.187300	0.150700	0.120900

Temp. (°C)	0.0	0.2	0.4	0.6	0.8
-29	0.317	0.311	0.304	0.298	0.292
-28	0.351	0.344	0.337	0.330	0.324
-27	0.389	0.381	0.374	0.366	0.359
-26	0.430	0.422	0.414	0.405	0.397
-25	0.476	0.467	0.457	0.448	0.439
-24	0.526	0.515	0.505	0.495	0.486
-23	0.580	0.569	0.558	0.547	0.536
-22	0.640	0.627	0.615	0.603	0.592
-21	0.705	0.691	0.678	0.665	0.652

Table A-1: Vapor Pressure of Water (cont.)

Water Vapor Pressure Over Ice (cont.)					
Temp. (°C)	0.0	0.2	0.4	0.6	0.8
-20	0.776	0.761	0.747	0.733	0.719
-19	0.854	0.838	0.822	0.806	0.791
-18	0.939	0.921	0.904	0.887	0.870
-17	1.031	1.012	0.993	0.975	0.956
-16	1.132	1.111	1.091	1.070	1.051
-15	1.241	1.219	1.196	1.175	1.153
-14	1.361	1.336	1.312	1.288	1.264
-13	1.490	1.464	1.437	1.411	1.386
-12	1.632	1.602	1.574	1.546	1.518
-11	1.785	1.753	1.722	1.691	1.661
-10	1.950	1.916	1.883	1.849	1.817
-9	2.131	2.093	2.057	2.021	1.985
-8	2.326	2.285	2.246	2.207	2.168
-7	2.537	2.493	2.450	2.408	2.367
-6	2.765	2.718	2.672	2.626	2.581
-5	3.013	2.962	2.912	2.862	2.813
-4	3.280	3.225	3.171	3.117	3.065
-3	3.568	3.509	3.451	3.393	3.336
-2	3.880	3.816	3.753	3.691	3.630
-1	4.217	4.147	4.079	4.012	3.946
0	4.579	4.504	4.431	4.359	4.287

Table A-1: Vapor Pressure of Water (cont.)

Aqueous Vapor Pressure Over Water

Temp. (°C)	0.0	0.2	0.4	0.6	0.8
0	4.579	4.647	4.715	4.785	4.855
1	4.926	4.998	5.070	5.144	5.219
2	5.294	5.370	5.447	5.525	5.605
3	5.685	5.766	5.848	5.931	6.015
4	6.101	6.187	6.274	6.363	6.453
5	6.543	6.635	6.728	6.822	6.917
6	7.013	7.111	7.209	7.309	7.411
7	7.513	7.617	7.722	7.828	7.936
8	8.045	8.155	8.267	8.380	8.494
9	8.609	8.727	8.845	8.965	9.086
10	9.209	9.333	9.458	9.585	9.714
11	9.844	9.976	10.109	10.244	10.380
12	10.518	10.658	10.799	10.941	11.085
13	11.231	11.379	11.528	11.680	11.833
14	11.987	12.144	12.302	12.462	12.624
15	12.788	12.953	13.121	13.290	13.461
16	13.634	13.809	13.987	14.166	14.347
17	14.530	14.715	14.903	15.092	15.284
18	15.477	15.673	15.871	16.071	16.272
19	16.477	16.685	16.894	17.105	17.319
20	17.535	17.753	17.974	18.197	18.422
21	18.650	18.880	19.113	19.349	19.587
22	19.827	20.070	20.316	20.565	20.815
23	21.068	21.324	21.583	21.845	22.110
24	22.377	22.648	22.922	23.198	23.476

Table A-1: Vapor Pressure of Water (cont.)

Aqueous Vapor Pressure Over Water (cont.)

Temp. (°C)	0.0	0.2	0.4	0.6	0.8
25	23.756	24.039	24.326	24.617	24.912
26	25.209	25.509	25.812	26.117	26.426
27	26.739	27.055	27.374	27.696	28.021
28	28.349	28.680	29.015	29.354	29.697
29	30.043	30.392	30.745	31.102	31.461
30	31.824	32.191	32.561	32.934	33.312
31	33.695	34.082	34.471	34.864	35.261
32	35.663	36.068	36.477	36.891	37.308
33	37.729	38.155	38.584	39.018	39.457
34	39.898	40.344	40.796	41.251	41.710
35	42.175	42.644	43.117	43.595	44.078
36	44.563	45.054	45.549	46.050	46.556
37	47.067	47.582	48.102	48.627	49.157
38	49.692	50.231	50.774	51.323	51.879
39	52.442	53.009	53.580	54.156	54.737
40	55.324	55.910	56.510	57.110	57.720
41	58.340	58.960	59.580	60.220	60.860
42	61.500	62.140	62.800	63.460	64.120
43	64.800	65.480	66.160	66.860	67.560
44	68.260	68.970	69.690	70.410	71.140
45	71.880	72.620	73.360	74.120	74.880
46	75.650	76.430	77.210	78.000	78.800
47	79.600	80.410	81.230	82.050	82.870
48	83.710	84.560	85.420	86.280	87.140
49	88.020	88.900	89.790	90.690	91.590

Table A-1: Vapor Pressure of Water (cont.)

Aqueous Vapor Pressure Over Water (cont.)

Temp. (°C)	0.0	0.2	0.4	0.6	0.8
50	92.51	93.50	94.40	95.30	96.30
51	97.20	98.20	99.10	100.10	101.10
52	102.09	103.10	104.10	105.10	106.20
53	107.20	108.20	109.30	110.40	111.40
54	112.51	113.60	114.70	115.80	116.90
55	118.04	119.10	120.30	121.50	122.60
56	123.80	125.00	126.20	127.40	128.60
57	129.82	131.00	132.30	133.50	134.70
58	136.08	137.30	138.50	139.90	141.20
59	142.60	143.90	145.20	146.60	148.00
60	149.38	150.70	152.10	153.50	155.00
61	156.43	157.80	159.30	160.80	162.30
62	163.77	165.20	166.80	168.30	169.80
63	171.38	172.90	174.50	176.10	177.70
64	179.31	180.90	182.50	184.20	185.80
65	187.54	189.20	190.90	192.60	194.30
66	196.09	197.80	199.50	201.30	203.10
67	204.96	206.80	208.60	210.50	212.30
68	214.17	216.00	218.00	219.90	221.80
69	223.73	225.70	227.70	229.70	231.70
70	233.70	235.70	237.70	239.70	241.80
71	243.90	246.00	248.20	250.30	252.40
72	254.60	256.80	259.00	261.20	263.40
73	265.70	268.00	270.20	272.60	274.80
74	277.20	279.40	281.80	284.20	286.60

Table A-1: Vapor Pressure of Water (cont.)

Aqueous Vapor Pressure Over Water (cont.)

Temp. (°C)	0.0	0.2	0.4	0.6	0.8
75	289.10	291.50	294.00	296.40	298.80
76	301.40	303.80	306.40	308.90	311.40
77	314.10	316.60	319.20	322.00	324.60
78	327.30	330.00	332.80	335.60	338.20
79	341.00	343.80	346.60	349.40	352.20
80	355.10	358.00	361.00	363.80	366.80
81	369.70	372.60	375.60	378.80	381.80
82	384.90	388.00	391.20	394.40	397.40
83	400.60	403.80	407.00	410.20	413.60
84	416.80	420.20	423.60	426.80	430.20
85	433.60	437.00	440.40	444.00	447.50
86	450.90	454.40	458.00	461.60	465.20
87	468.70	472.40	476.00	479.80	483.40
88	487.10	491.00	494.70	498.50	502.20
89	506.10	510.00	513.90	517.80	521.80
90	525.76	529.77	533.80	537.86	541.95
91	546.05	550.18	554.35	558.53	562.75
92	566.99	571.26	575.55	579.87	584.22
93	588.60	593.00	597.43	601.89	606.38
94	610.90	615.44	620.01	624.61	629.24
95	633.90	638.59	643.30	648.05	652.82
96	657.62	662.45	667.31	672.20	677.12
97	682.07	687.04	692.05	697.10	702.17
98	707.27	712.40	717.56	722.75	727.98
99	733.24	738.53	743.85	749.20	754.58
100	760.00	765.45	770.93	776.44	782.00
101	787.57	793.18	798.82	804.50	810.21

Table A-2: Maximum Gas Flow Rates

Based on the physical characteristics of air at a temperature of 77°F and a pressure of 1 atm, the following flow rates will produce the maximum allowable gas stream linear velocity of 10,000 cm/sec in the corresponding pipe sizes.

Inside Pipe Diameter (in.)	Gas Flow Rate (cfm)
0.25	7
0.50	27
0.75	60
1.0	107
2.0	429
3.0	966
4.0	1,718
5.0	2,684
6.0	3,865
7.0	5,261
8.0	6,871
9.0	8,697
10.0	10,737
11.0	12,991
12.0	15,461

Table A-3: Maximum Liquid Flow Rates

Based on the physical characteristics of benzene at a temperature of 77°F, the following flow rates will produce the maximum allowable fluid linear velocity of 10 cm/sec in the corresponding pipe sizes.

Inside Pipe Diameter (in.)	Flow Rate (gal/hr)	Flow Rate (l/hr)
0.25	3	11
0.50	12	46
0.75	27	103
1.0	48	182
2.0	193	730
3.0	434	1,642
4.0	771	2,919
5.0	1,205	4,561
6.0	1,735	6,567
7.0	2,361	8,939
8.0	3,084	11,675
9.0	3,903	14,776
10.0	4,819	18,243
11.0	5,831	22,074
12.0	6,939	26,269

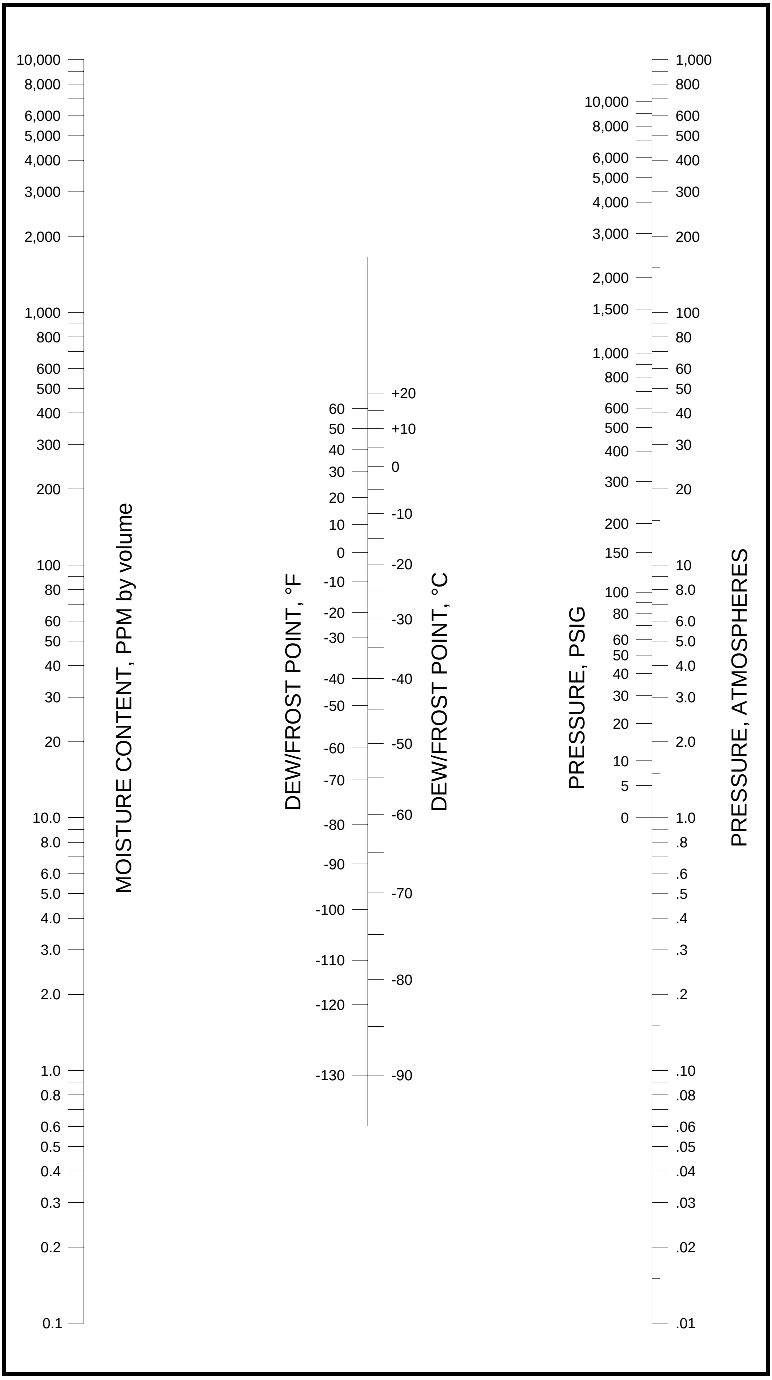


Figure A-1: Moisture Content Nomograph for Gases

Comparison of PPM_V Calculations

There are three basic methods for determining the moisture content of a gas in PPM_V:

- the calculations described in this appendix
- calculations performed with the slide rule device that is provided with each GE Infrastructure Sensing hygrometer
- values determined from tabulated vapor pressures

For comparison purposes, examples of all three procedures are listed in Table A-4.

Table A-4: Comparative PPM_V Values

Dew Point (°C)	Pressure (psig)	Calculation Method		
		Slide Rule	Appendix A	Vapor Pressure
-80	0	0.5	0.55	0.526
	100	0.065	N.A.	0.0675
	800	0.009	N.A.	0.0095
	1500	0.005	N.A.	0.0051
-50	0	37	40	38.88
	100	4.8	5.2	4.98
	800	0.65	0.8	0.7016
	1500	0.36	0.35	0.3773
+20	0	N.A.	20,000	23,072.36
	100	3000	3000	2956.9
	800	420	400	416.3105
	1500	220	200	223.9

Liquid Applications

Theory of Operation

The direct measurement of water vapor pressure in organic liquids is accomplished easily and effectively with GE Infrastructure Sensing Aluminum Oxide Moisture Sensors. Since the moisture probe pore openings are small in relation to the size of most organic molecules, admission into the sensor cavity is limited to much smaller molecules, such as water. Thus, the surface of the aluminum oxide sensor, which acts as a semi-permeable membrane, permits the measurement of water vapor pressure in organic liquids just as easily as it does in gaseous media.

In fact, an accurate sensor electrical output will be registered whether the sensor is directly immersed in the organic liquid or it is placed in the gas space above the liquid surface. As with gases, the electrical output of the aluminum oxide sensor is a function of the measured water vapor pressure.

Moisture Content Measurement in Organic Liquids

Henry's Law Type Analysis

When using the aluminum oxide sensor in non-polar liquids having water concentrations ≤1% by weight, *Henry's Law* is generally applicable. Henry's Law states that, at constant temperature, *the mass of a gas dissolved in a given volume of liquid is proportional to the partial pressure of the gas in the system*. Stated in terms pertinent to this discussion, it can be said that the PPM_W of water in hydrocarbon liquids is equal to the partial pressure of water vapor in the system times a constant.

As discussed above, a GE Infrastructure Sensing aluminum oxide sensor can be directly immersed in a hydrocarbon liquid to measure the equivalent dew point. Since the dew point is functionally related to the vapor pressure of the water, a determination of the dew point will allow one to calculate the PPM_W of water in the liquid by a Henry's Law type analysis. A specific example of such an analysis is shown below.

Henry's Law Type Analysis (cont.)

For liquids in which a Henry's Law type analysis is applicable, the parts per million by weight of water in the organic liquid is equal to the partial pressure of water vapor times a constant:

$$PPM_W = K \times P_W \qquad \text{(a)}$$

where, K is the Henry's Law constant in the appropriate units, and the other variables are as defined on page A-13.

Also, the value of K is determined from the known water saturation concentration of the organic liquid at the measurement temperature:

$$K = \frac{\text{Saturation } PPM_W}{P_S} \qquad \text{(b)}$$

For a mixture of organic liquids, an average saturation value can be calculated from the weight fractions and saturation values of the pure components as follows:

$$\text{Ave. } C_S = \sum_{i=1}^{n} X_i (C_S)_i \qquad \text{(c)}$$

where, X_i is the weight fraction of the i^{th} component, $(C_S)_i$ is the saturation concentration (PPM_W) of the i^{th} component, and n is the total number of components.

In conclusion, the Henry's Law constant (K) is a constant of proportionality between the saturation concentration (C_S) and the saturation vapor pressure (P_S) of water, at the measurement temperature. In the *General Case*, the Henry's Law constant varies with the measurement temperature, but there is a *Special Case* in which the Henry's Law constant does not vary appreciably with the measurement temperature. This special case applies to saturated, straight-chain hydrocarbons such as pentane, hexane, heptane, etc.

A: General Case

Determination of Moisture Content if C_S is Known:

The nomograph for liquids in Figure A-2 on page A-38 can be used to determine the moisture content in an organic liquid, if the following values are known:

- the temperature of the liquid at the time of measurement
- the saturation water concentration at the measurement temperature
- the dew point, as measured with the GE Infrastructure Sensing hygrometer

Complete the following steps to determine the moisture content from the nomograph:

1. Using a straightedge on the two scales on the right of the figure, connect the known saturation concentration (PPM_W) with the measurement temperature (°C).
2. Read the Henry's Law constant (K) on the center scale.
3. Using a straightedge, connect above K value with the dew/frost point, as measured with the GE Infrastructure Sensing' hygrometer.
4. Read the moisture content (PPM_W) where the straight edge crosses the moisture content scale.

Empirical Determination of K and C_S

If the values of K and C_S are not known, the GE Infrastructure Sensing hygrometer can be used to determine these values. In fact, only one of the values is required to determine PPM_W from the nomograph in Figure A-2 on page A-38. To perform such an analysis, proceed as follows:

1. Obtain a sample of the test solution with a known water content; or perform a *Karl Fischer* titration on a sample of the test stream to determine the PPM_W of water.

Empirical Determination of K and C_S (cont.)

Note: *The Karl Fischer analysis involves titrating the test sample against a special Karl Fischer reagent until an endpoint is reached.*

1. Measure the dew point of the known sample with the GE Infrastructure Sensing hygrometer.
2. Measure the temperature (°C) of the test solution.
3. Using a straightedge, connect the moisture content (PPM_W) with the measured dew point, and read the K value on the center scale.
4. Using a straightedge, connect the above K value with the measured temperature (°C) of the test solution, and read the saturation concentration (PPM_W).

Note: *Since the values of K and C_S vary with temperature, the hygrometer measurement and the test sample analysis must be done at the same temperature. If the moisture probe temperature is expected to vary, the test should be performed at more than one temperature.*

B: SPECIAL CASE

As mentioned earlier, saturated straight-chain hydrocarbons represent a special case, where the Henry's Law constant does not vary appreciably with temperature. In such cases, use the nomograph for liquids in Figure A-2 on page A-38 to complete the analysis.

Determination of moisture content if the Henry's Law constant (K) is known.

1. Using a straightedge, connect the known K value on the center scale with the dew/frost point, as measured with the GE Infrastructure Sensing hygrometer.
2. Read moisture content (PPM_W) where the straightedge crosses the scale on the left.

B: SPECIAL CASE (cont.)

Typical Problems

1. Find the moisture content in benzene, at an ambient temperature of 30°C, if a dew point of 0°C is measured with the GE Infrastructure Sensing hygrometer.
   a. From the literature, it is found that C_S for benzene at a temperature of 30°C is **870 PPM_W**.
   b. Using a straightedge on Figure A-2, connect the 870 PPM_W saturation concentration with the 30°C ambient temperature and read the Henry's Law Constant of **27.4** on the center scale.
   c. Using the straightedge, connect the above K value of 27.4 with the measured dew point of 0°C, and read the correct moisture content of **125 PPM_W** where the straightedge crosses the moisture content scale.

2. Find the moisture content in heptane, at an ambient temperature of 50°C, if a dew point of 3°C is measured with the GE Infrastructure Sensing hygrometer.
   a. From the literature, it is found that C_S for heptane at a temperature of 50°C is **480 PPM_W**.
   b. Using a straightedge on Figure A-2, connect the 480 PPM_W saturation concentration with the 50°C ambient temperature and read the Henry's Law Constant of **5.2** on the center scale.
   c. Using the straightedge, connect the above K value of 5.2 with the measured dew point of 3°C, and read the correct moisture content of **29 PPM_W** where the straightedge crosses the moisture content scale.

B: SPECIAL CASE (cont.)

Note: *If the saturation concentration at the desired ambient temperature can not be found for any of these special case hydrocarbons, the value at any other temperature may be used, because K is constant over a large temperature range.*

3. Find the moisture content in hexane, at an ambient temperature of 10°C, if a dew point of 0°C is measured with the GE Infrastructure Sensing hygrometer.
    a. From the literature, it is found that C_S for hexane at a temperature of 20°C is **101 PPM_W**.
    b. Using a straightedge on Figure A-2 on page A-38, connect the 101 PPM_W saturation concentration with the 20°C ambient temperature and read the Henry's Law Constant of **5.75** on the center scale.
    c. Using the straightedge, connect the above K value of 5.75 with the measured dew point of 0°C, and read the correct moisture content of **26 PPM_W** where the straightedge crosses the moisture content scale.

4. Find the moisture content in an unknown organic liquid, at an ambient temperature of 50°C, if a dew point of 10°C is measured with the GE Infrastructure Sensing hygrometer.
    a. Either perform a Karl Fischer analysis on a sample of the liquid or obtain a dry sample of the liquid.
    b. Either use the PPM_W determined by the Karl Fischer analysis or add a known amount of water (i.e. 10 PPM_W) to the dry sample.

B: SPECIAL CASE (cont.)

c. Measure the dew point of the known test sample with the GE Infrastructure Sensing hygrometer. For purposes of this example, assume the measured dew point to be -10°C.

d. Using a straightedge on the nomograph in Figure A-2 on page A-38, connect the known 10 PPM_W moisture content with the measured dew point of -10°C, and read a K value of **5.1** on the center scale.

e. Using the straightedge, connect the above K value of 5.1 with the measured 10°C dew point of the original liquid, and read the actual moisture content of **47** $\mathbf{PPM_W}$ on the left scale.

Note: *The saturation value at 50°C for this liquid could also have been determined by connecting the K value of 5.1 with the ambient temperature of 50°C and reading a value of 475* PPM_W *on the right scale.*

For many applications, a knowledge of the absolute moisture content of the liquid is not required. Either the dew point of the liquid or its percent saturation is the only value needed. For such applications, the saturation value for the liquid need not be known. The GE Infrastructure Sensing hygrometer can be used directly to determine the dew point, and then the percent saturation can be calculated from the vapor pressures of water at the measured dew point and at the ambient temperature of the liquid:

$$\%\ \text{Saturation} = \frac{C}{C_S} \times 100 = \frac{P_W}{P_S} \times 100$$

Empirical Calibrations

For those liquids in which a Henry's Law type analysis is not applicable, the absolute moisture content is best determined by empirical calibration. A Henry's Law type analysis is generally not applicable for the following classes of liquids:

- liquids with a high saturation value (2% by weight of water or greater)
- liquids, such as dioxane, that are completely miscible with water
- liquids, such as isopropyl alcohol, that are conductive

For such liquids, measurements of the hygrometer dew point readings for solutions of various known water concentrations must be performed. Such a calibration can be conducted in either of two ways:

- perform a Karl Fischer analysis on several unknown test samples of different water content
- prepare a series of known test samples via the addition of water to a quantity of dry liquid

In the latter case, it is important to be sure that the solutions have reached equilibrium before proceeding with the dew point measurements.

Note: *Karl Fischer analysis is a method for measuring trace quantities of water by titrating the test sample against a special Karl Fischer reagent until a color change from yellow to brown (or a change in potential) indicates that the end point has been reached.*

Either of the empirical calibration techniques described above can be conducted using an apparatus equivalent to that shown in Figure A-3 on page A-39. The apparatus pictured can be used for both the Karl Fischer titrations of unknown test samples and the preparation of test samples with known moisture content. Procedures for both of these techniques are presented below.

A. Instructions for Karl Fischer Analysis

To perform a Karl Fischer analysis, use the apparatus in Figure A-3 on page A-39 and complete the following steps:

1. Fill the glass bottle completely with the sample liquid.
2. Close both valves and turn on the magnetic stirrer.
3. Permit sufficient time for the entire test apparatus and the sample liquid to reach equilibrium with the ambient temperature.
4. Turn on the hygrometer and monitor the dew point reading. When a stable dew point reading indicates that equilibrium has been reached, record the reading.
5. Insert a syringe through the rubber septum and withdraw a fluid sample for Karl Fischer analysis. Record the actual moisture content of the sample.
6. Open the exhaust valve.
7. Open the inlet valve and increase the moisture content of the sample by bubbling wet N_2 through the liquid (or decrease the moisture content by bubbling dry N_2 through the liquid).
8. When the hygrometer reading indicates the approximate moisture content expected, close both valves.
9. Repeat steps 3-8 until samples with several different moisture contents have been analyzed.

B. Instructions for Preparing Known Samples

Note: *This procedure is only for liquids that are highly miscible with water. Excessive equilibrium times would be required with less miscible liquids.*

To prepare samples of known moisture content, use the apparatus in Figure A-3 on page A-39 and complete the following steps:

1. Weigh the dry, empty apparatus.
2. Fill the glass bottle with the sample liquid.
3. Open both valves and turn on the magnetic stirrer.
4. While monitoring the dew point reading with the hygrometer, bubble dry N_2 through the liquid until the dew point stabilizes at some minimum value.
5. Turn off the N_2 supply and close both valves.
6. Weigh the apparatus, including the liquid, and calculate the sample weight by subtracting the step 1 weight from this weight.
7. Insert a syringe through the rubber septum and add a known weight of H_2O to the sample. Continue stirring until the water is completely dissolved in the liquid.
8. Record the dew point indicated by the hygrometer and calculate the moisture content as follows:

$$PPM_W = \frac{\text{weight of water}}{\text{total weight of liquid}} \times 10^6$$

9. Repeat steps 6-8 until samples with several different moisture contents have been analyzed.

Note: *The accuracy of this technique can be checked at any point by withdrawing a sample and performing a Karl Fischer titration. Be aware that this will change the total liquid weight in calculating the next point.*

C. Additional Notes for Liquid Applications

In addition to the topics already discussed, the following general application notes pertain to the use of GE Infrastructure Sensing moisture probes in liquid applications:

1. All M Series Aluminum Oxide Moisture Sensors can be used in either the gas phase or the liquid phase. However, for the detection of trace amounts of water in conductive liquids (for which an empirical calibration is required), the M2 Sensor is recommended. Since a background signal is caused by the conductivity of the liquid between the sensor lead wires, use of the M2 Sensor (which has the shortest lead wires) will result in the best sensitivity.
2. The calibration data supplied with GE Infrastructure Sensing Moisture Probes is applicable to both liquid phase (for those liquids in which a Henry's Law analysis is applicable) and gas phase applications.
3. As indicated in Table A-3, the flow rate of the liquid is limited to a maximum of 10 cm/sec.
4. Possible probe malfunctions and their remedies are discussed in the *Troubleshooting* chapter of this manual.

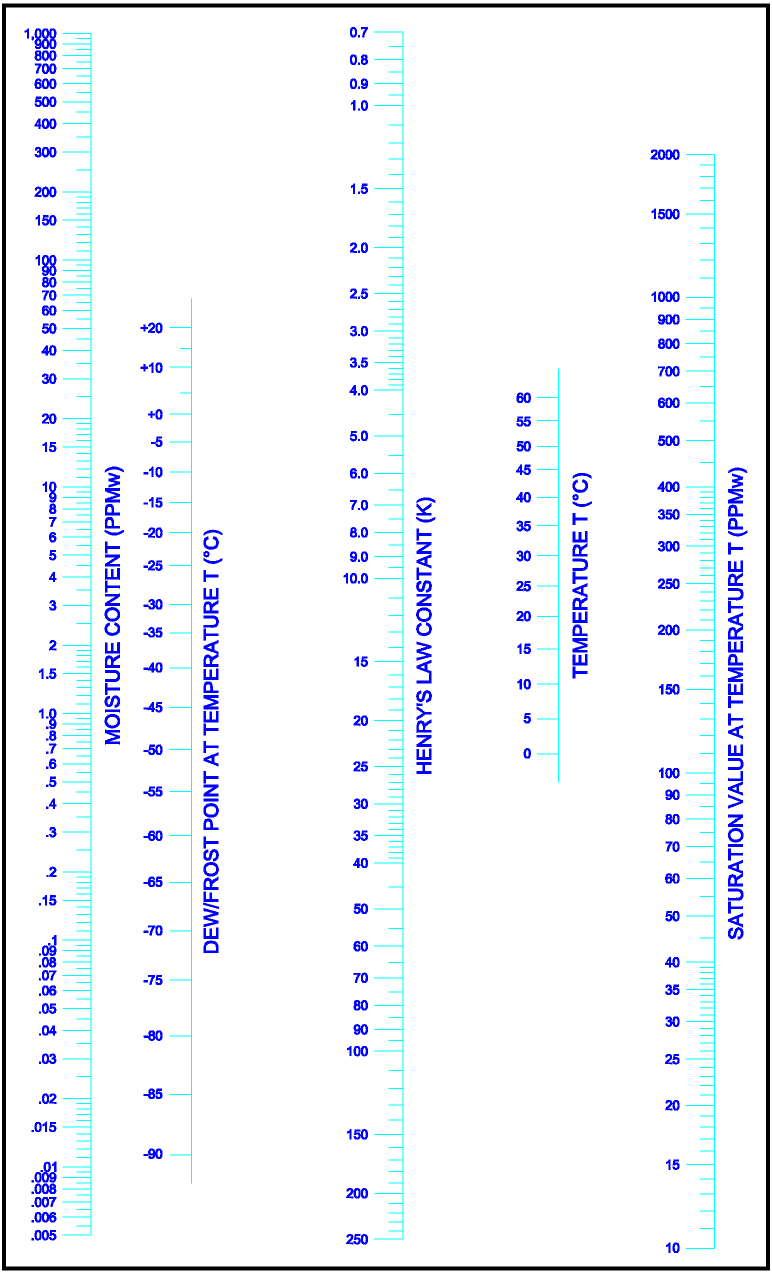


Figure A-2: Moisture Content Nomograph for Liquids

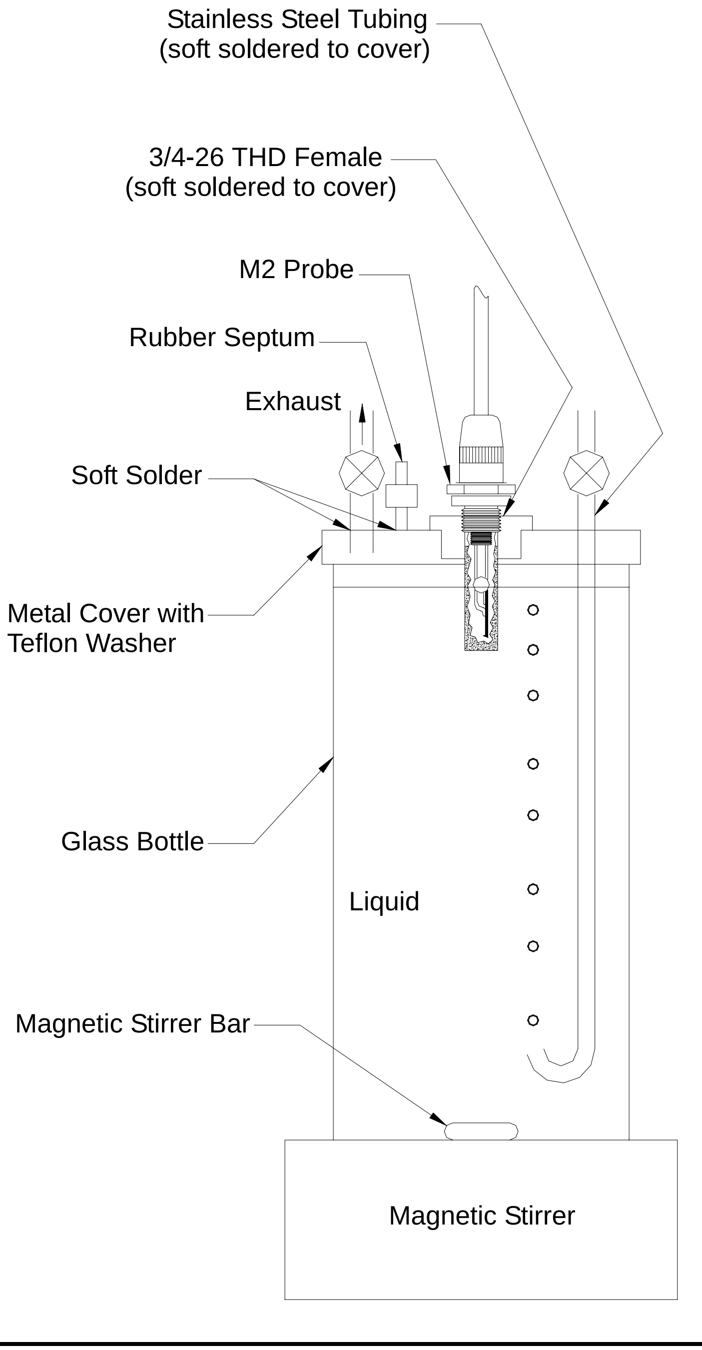


Figure A-3: Moisture Content Test Apparatus

Solids Applications

A. In-Line Measurements

GE Infrastructure Sensing moisture probes may be installed in-line to continuously monitor the drying process of a solid. Install one sensor at the process system inlet to monitor the moisture content of the drying gas and install a second sensor at the process system outlet to monitor the moisture content of the discharged gas. When the two sensors read the same (or close to the same) dew point, the drying process is complete. For example, a system of this type has been used successfully to monitor the drying of photographic film.

If one wishes to measure the absolute moisture content of the solid at any time during such a process, then an empirical calibration is required:

1. At a particular set of operating conditions (i.e. flow rate, temperature and pressure), the hygrometer dew point reading can be calibrated against solids samples with known moisture contents.
2. Assuming the operating conditions are relatively constant, the hygrometer dew point reading can be noted and a solids sample withdrawn for laboratory analysis.
3. Repeat this procedure until a calibration curve over the desired moisture content range has been developed.

Once such a curve has been developed, the hygrometer can then be used to continuously monitor the moisture content of the solid (as long as operating conditions are relatively constant).

B. Laboratory Procedures

If in-line measurements are not practical, then there are two possible laboratory procedures:

1. The unique ability of the GE Infrastructure Sensing sensor to determine the moisture content of a liquid can be used as follows:

   a. Using the apparatus shown in Figure A-3 on page A-39, dissolve a known amount of the solids sample in a suitable hydrocarbon liquid.

   b. The measured increase in the moisture content of the hydrocarbon liquid can then be used to calculate the moisture content of the sample.

   For best results, the hydrocarbon liquid used above should be pre-dried to a moisture content that is insignificant compared to the moisture content of the sample.

Note: *Since the addition of the solid may significantly change the saturation value for the solvent, published values should not be used. Instead, an empirical calibration, as discussed in the previous section, should be used.*

A dew point of -110°C, which can correspond to a moisture content of 10^{-6} PPM_W or less, represents the lower limit of sensor sensitivity. The maximum measurable moisture content depends to a great extent on the liquid itself. Generally, the sensor becomes insensitive to moisture contents in excess of 1% by weight.

B. Laboratory Procedures (cont.)

2. An alternative technique involves driving the moisture from the solids sample by heating:

   a. The evaporated moisture is directed into a chamber of known volume, which contains a calibrated moisture sensor.

   b. Convert the measured dew point of the chamber into a water vapor pressure, as discussed earlier in this appendix. From the known volume of the chamber and the measured vapor pressure (dew point) of the water, the number of moles of water in the chamber can be calculated and related to the percent by weight of water in the test sample.

   Although this technique is somewhat tedious, it can be used successfully. An empirical calibration of the procedure may be performed by using hydrated solids of known moisture content for test samples.

Appendix B

Outline and Installation Drawings

This appendix contains the following drawings for the MMS 35:

- Rack Mount Dimensions (712-930)
- Bench Mount Dimensions (712-1006)
- Panel Mount Dimensions (712-931)
- Weatherproof Unit Dimensions (712-932)
- Rack and Panel Mount Wiring (702-176)
- Bench Mount Wiring (702-177)
- Weatherproof Unit Wiring (702-189)

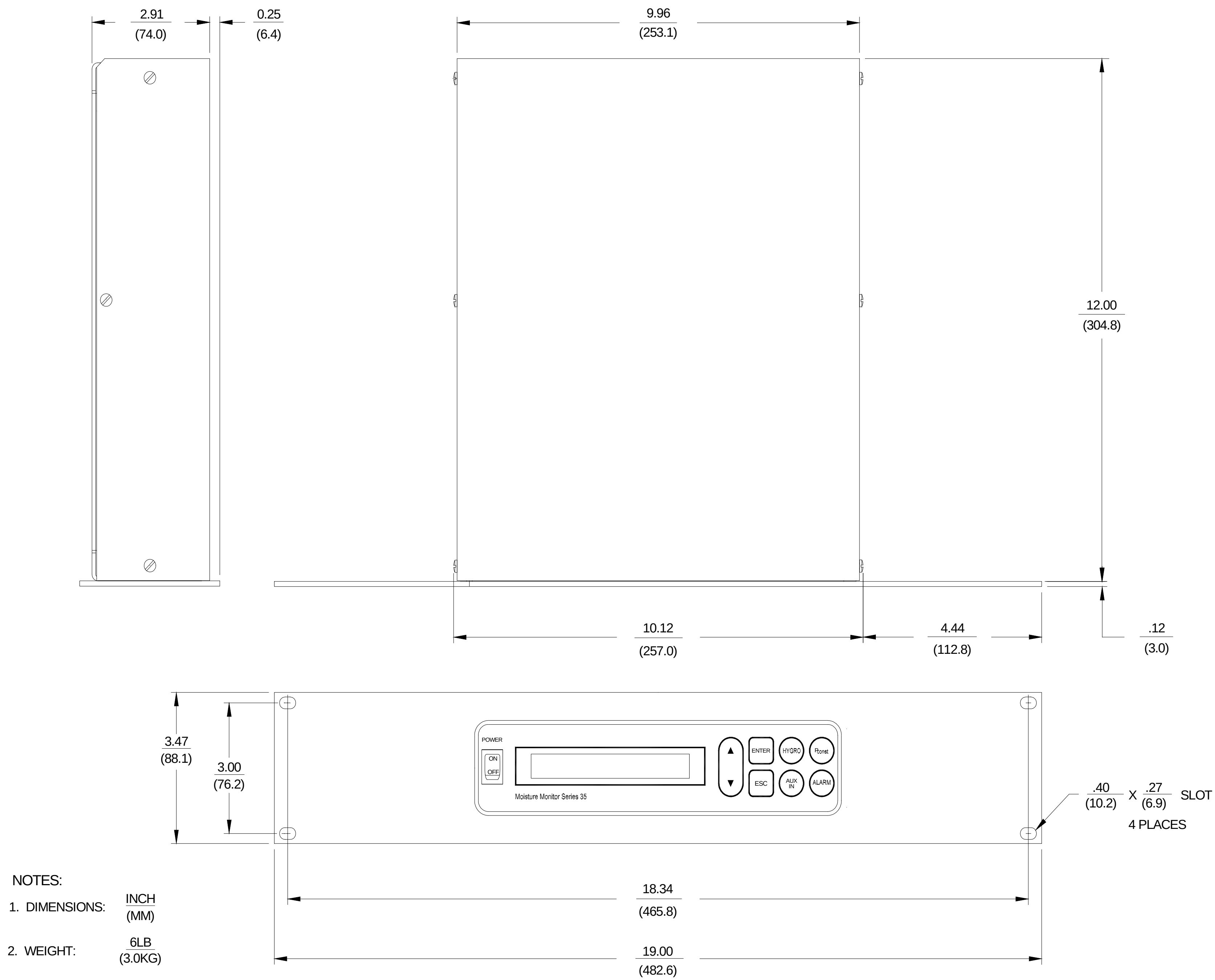
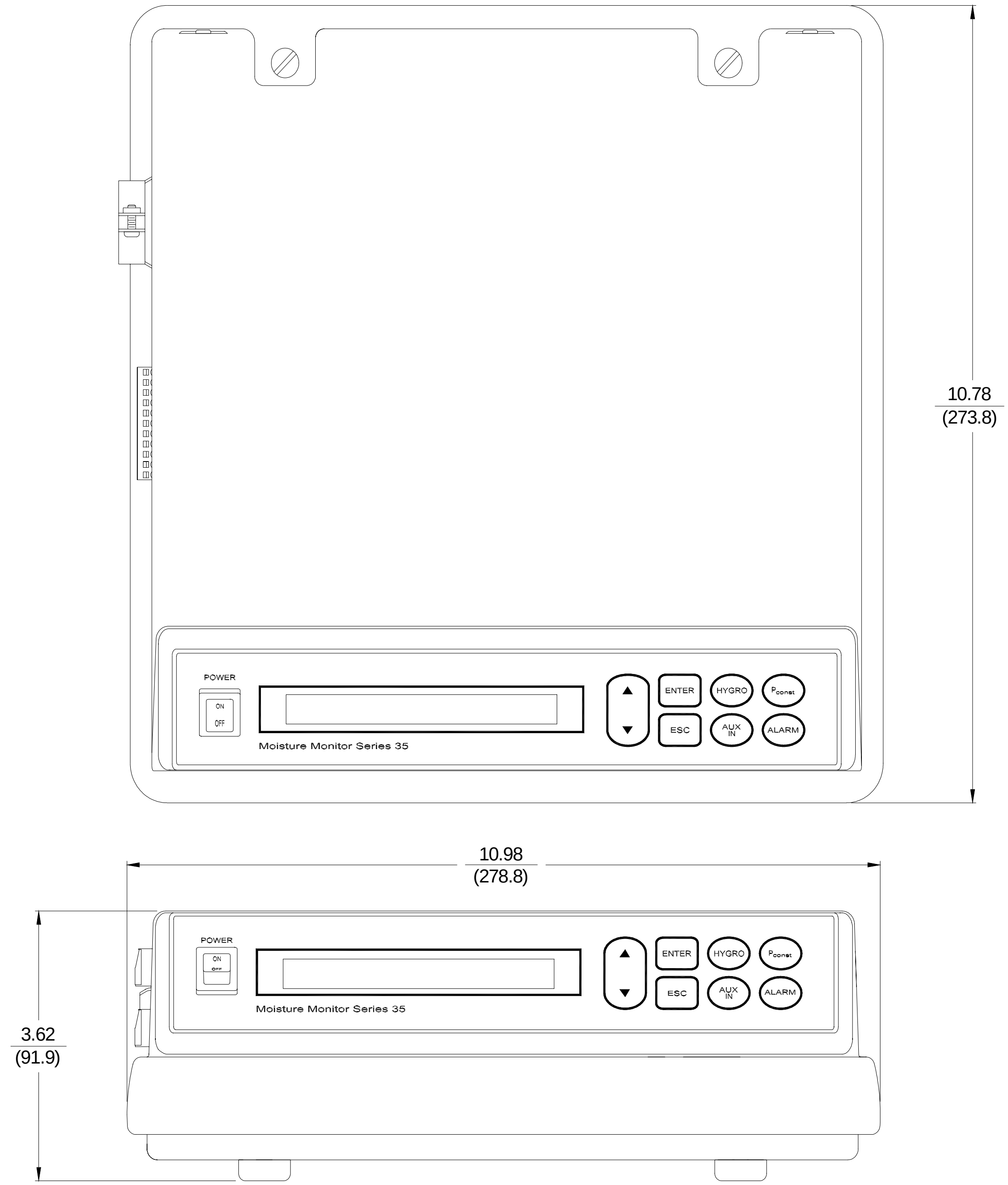


Figure B-1: Rack Mount Dimensions (712-930)

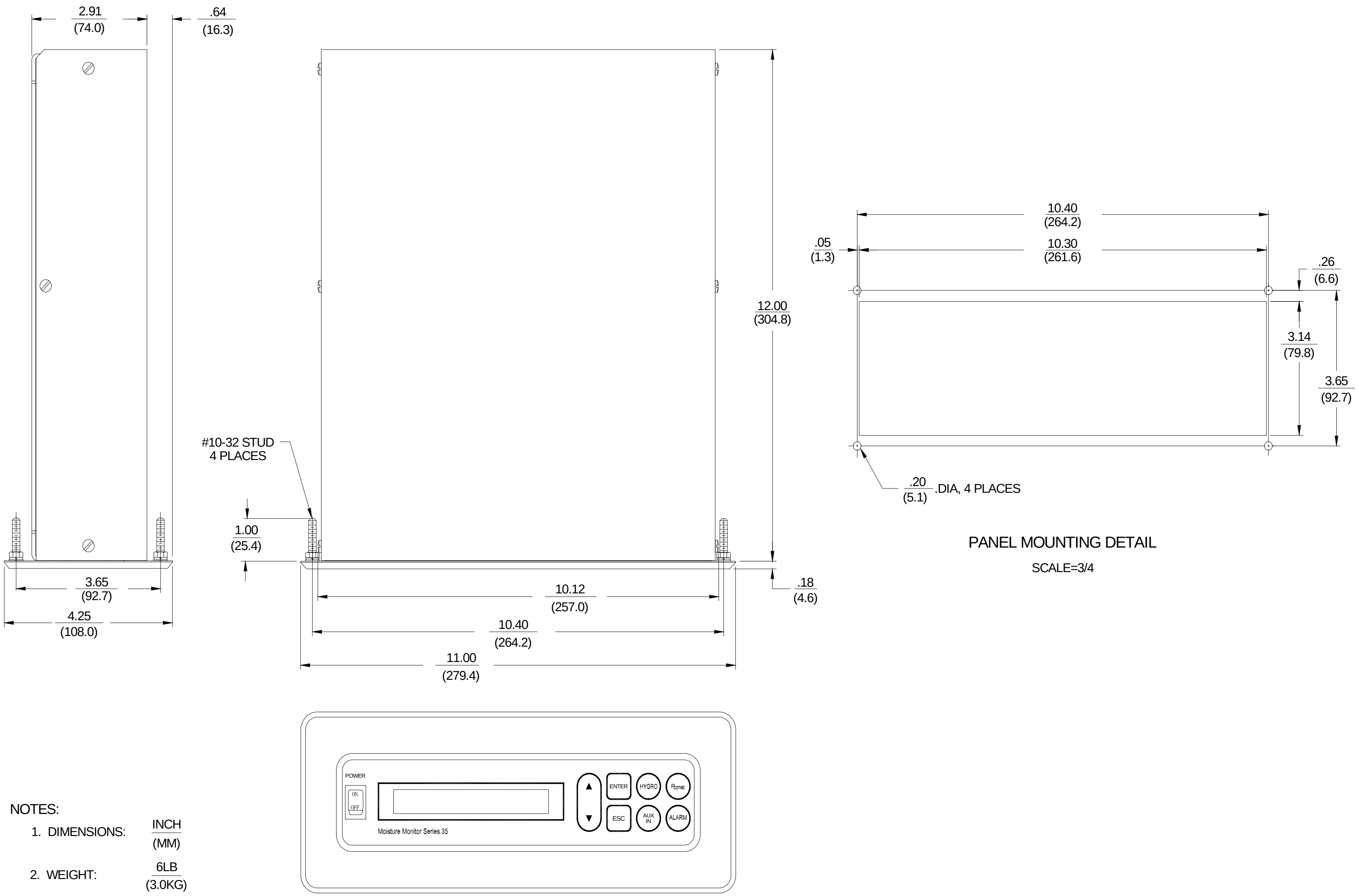


NOTES:

1. DIMENSIONS: INCH / (MM)

2. WEIGHT: 4.5 LB / (2.3 KG)

Figure B-2: Bench Mount Dimensions (712-1006)



NOTES:

1. DIMENSIONS: INCH / (MM)
2. WEIGHT: 6LB / (3.0KG)

Figure B-3: Panel Mount Dimensions (712-931)

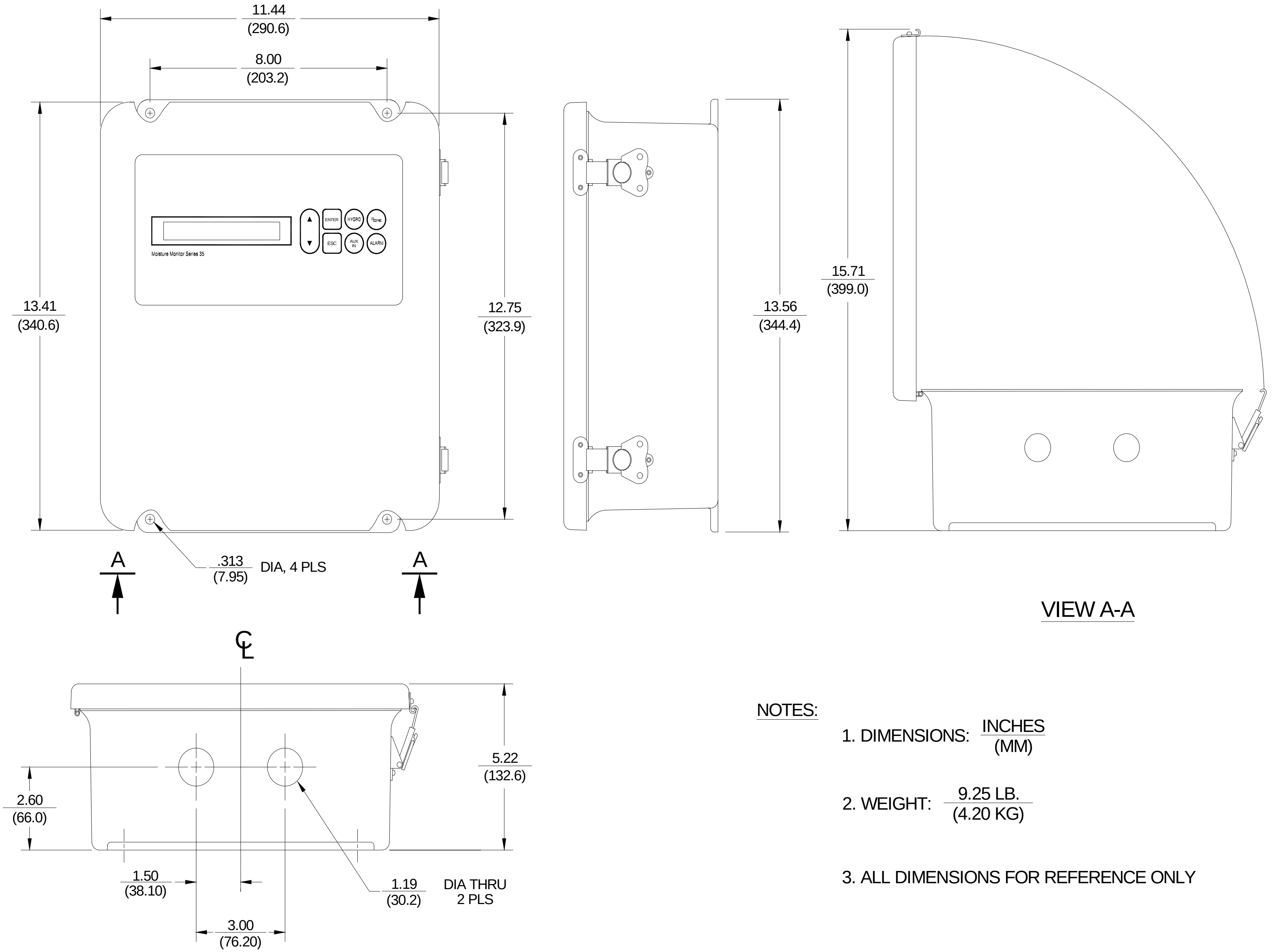


Figure B-4: Weatherproof Unit Dimensions

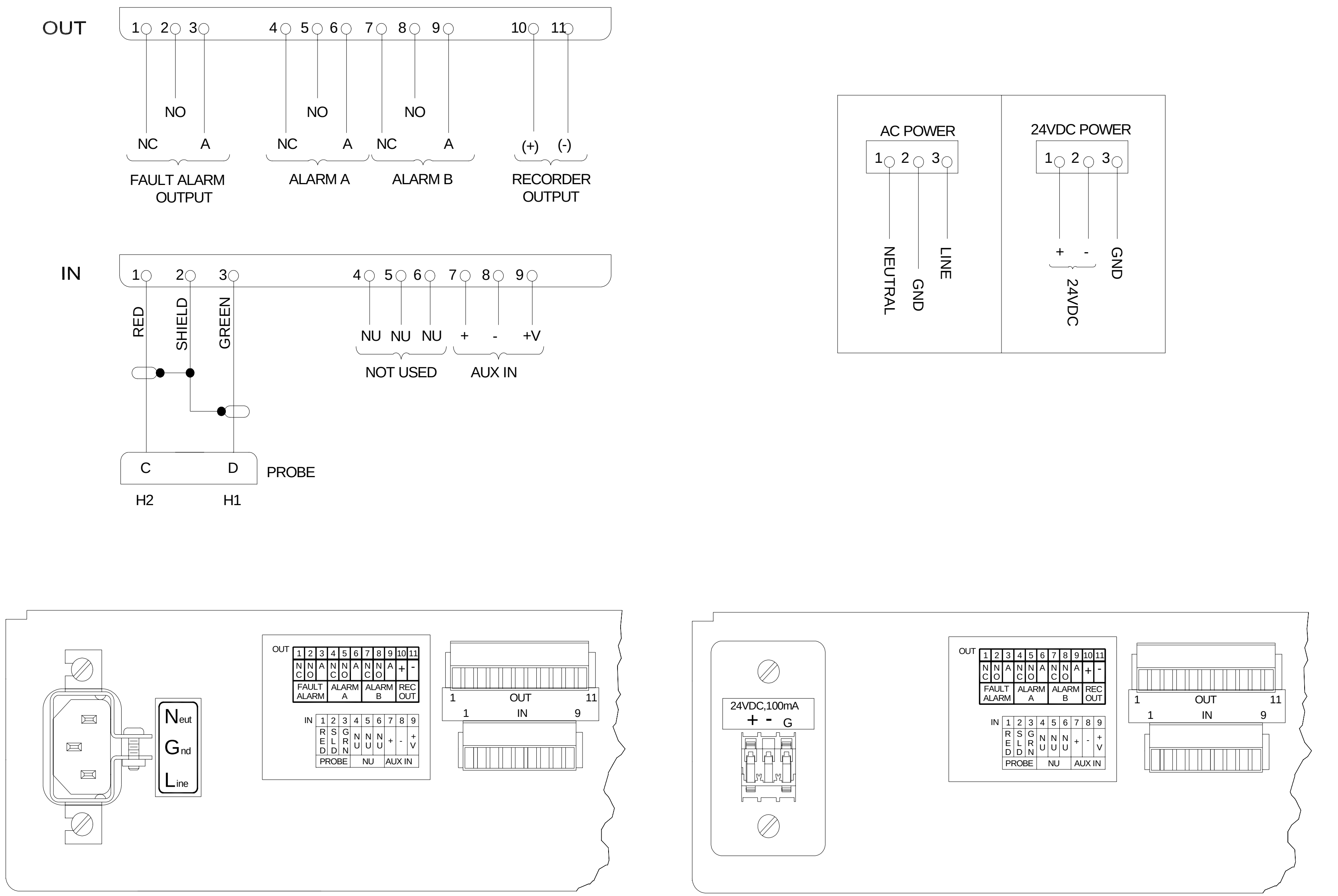


Figure B-5: Rack and Panel Mount Wiring (702-176)

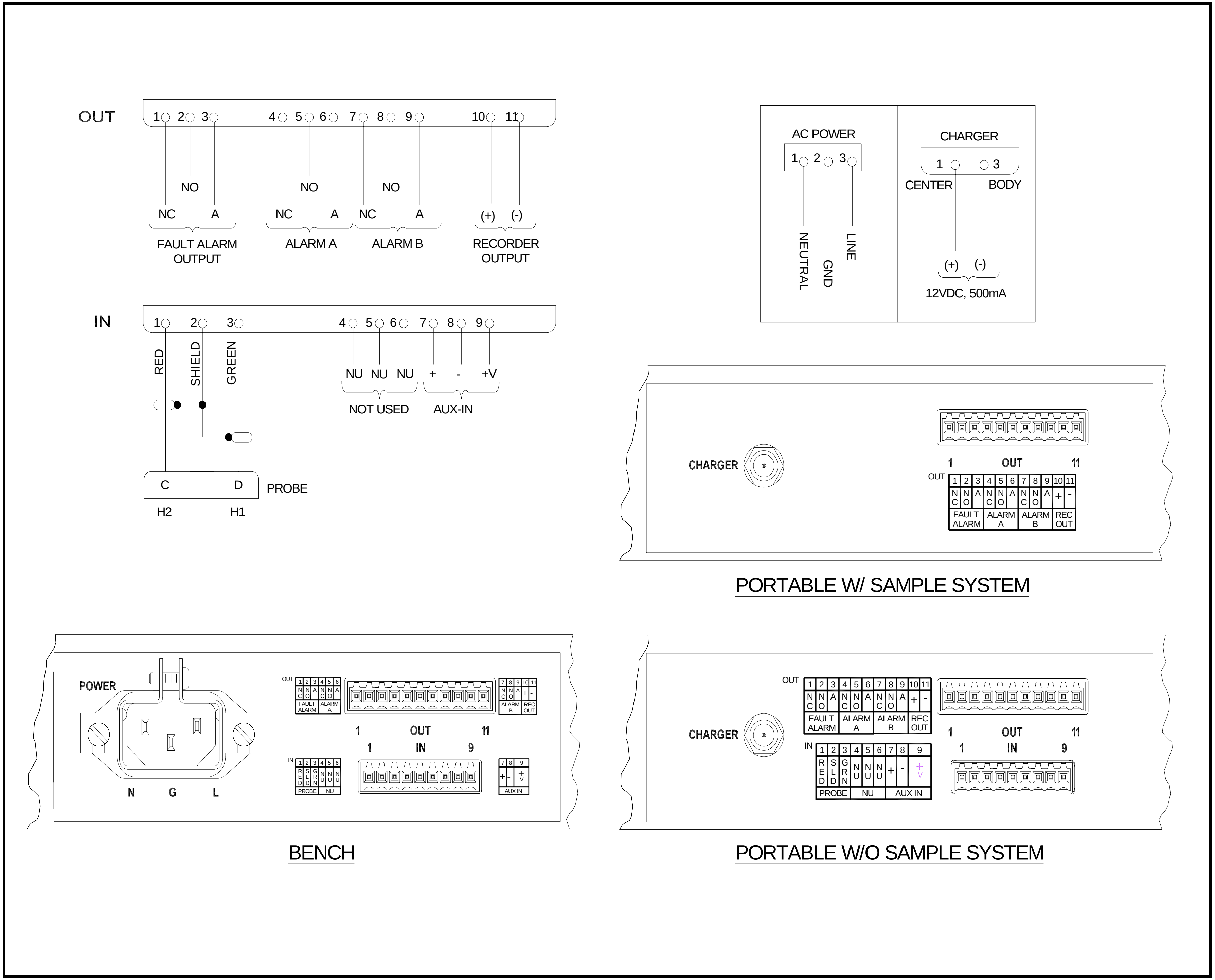


Figure B-6: Bench Mount Wiring (702-177)

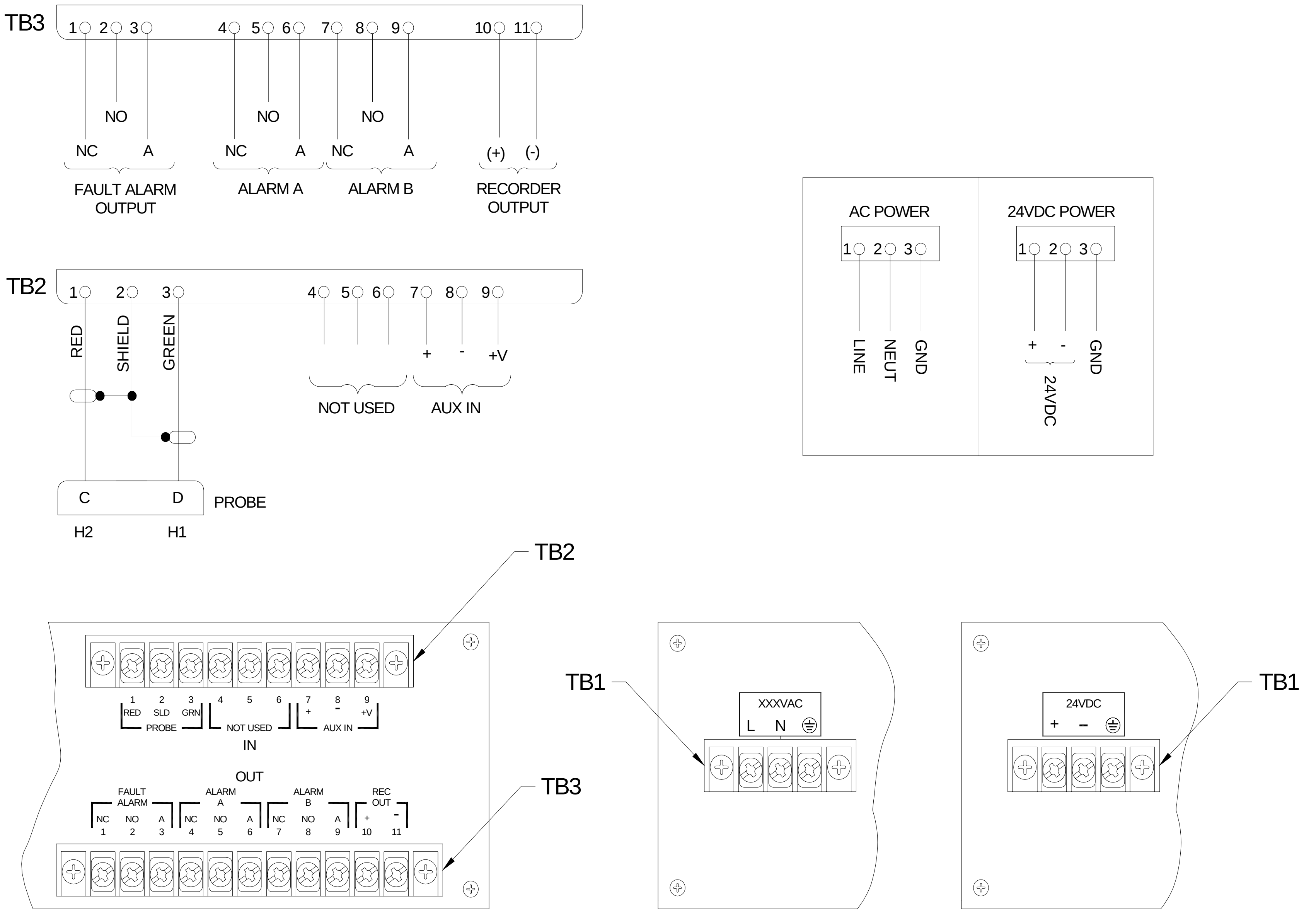


Figure B-7: Weatherproof Unit Wiring (702-189)

Appendix C

Menu Maps

Figures C-1, C-2 and C-3 on pages C-2, C-3 and C-4 are complete diagrams of the Series 35 menu structure. Once you are familiar with how the Series 35 operates, use these diagrams as a reference for moving through the *User Program*.

To enter the programming mode, perform the following sequence within five (5) seconds, or the Series 35 will time out and return to the measurement mode.

xx.x°C	While in run mode, press the [ESC] key.
ESC	Within 5 seconds of the appearance of this display, press the [ENTER] key followed by the [ESC] key.
PROGRAM MENU	This will display for 1 second.
DP RANGE	You are now in the *User Program* main menu.

From the main menu, use the arrow keys to scroll through the options to your selection. Use the [ENTER] key to confirm your selection or the [ESC] key to cancel your selection.

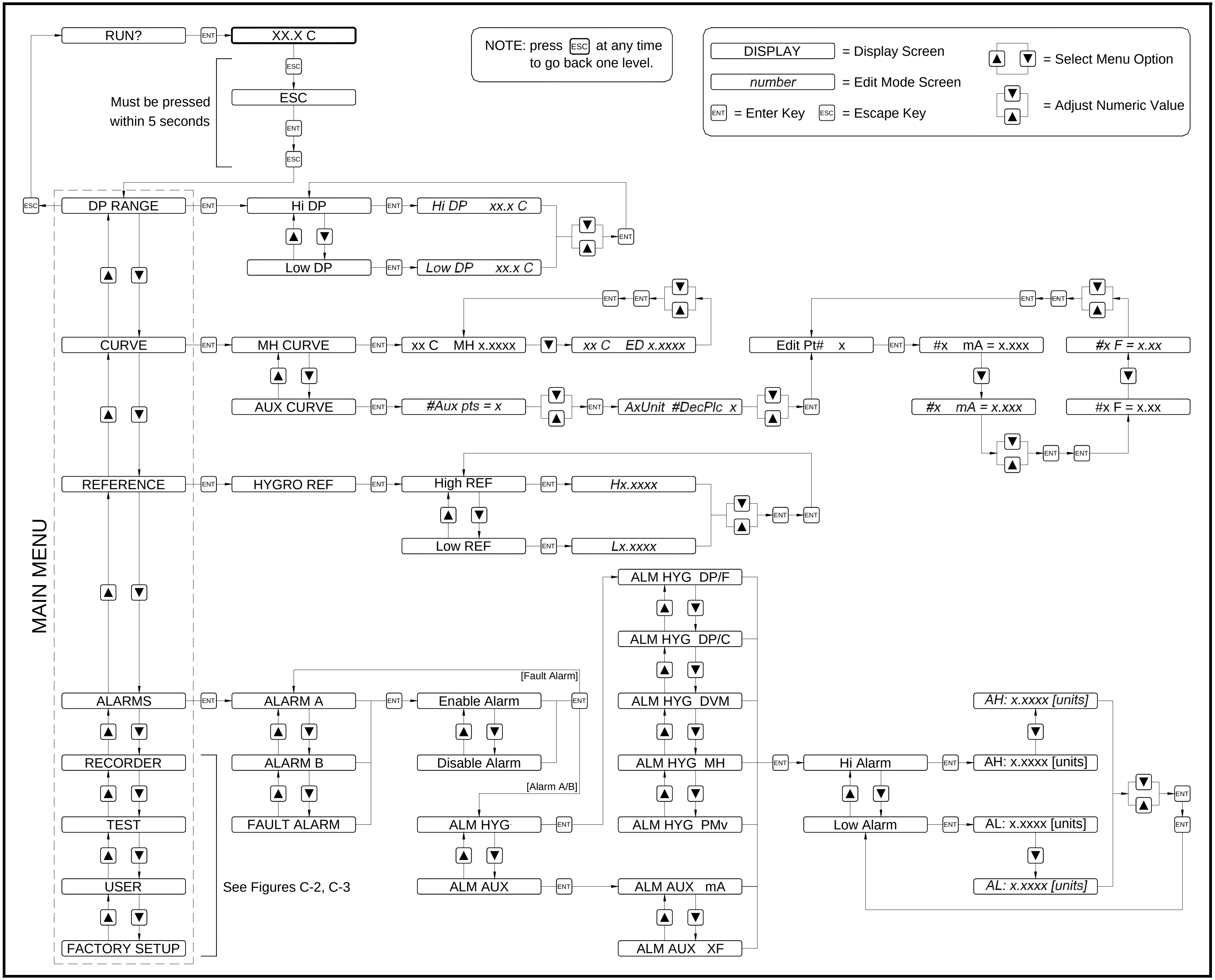


Figure C-1: DP RANGE, CURVE, REFERENCE and ALARMS Menus

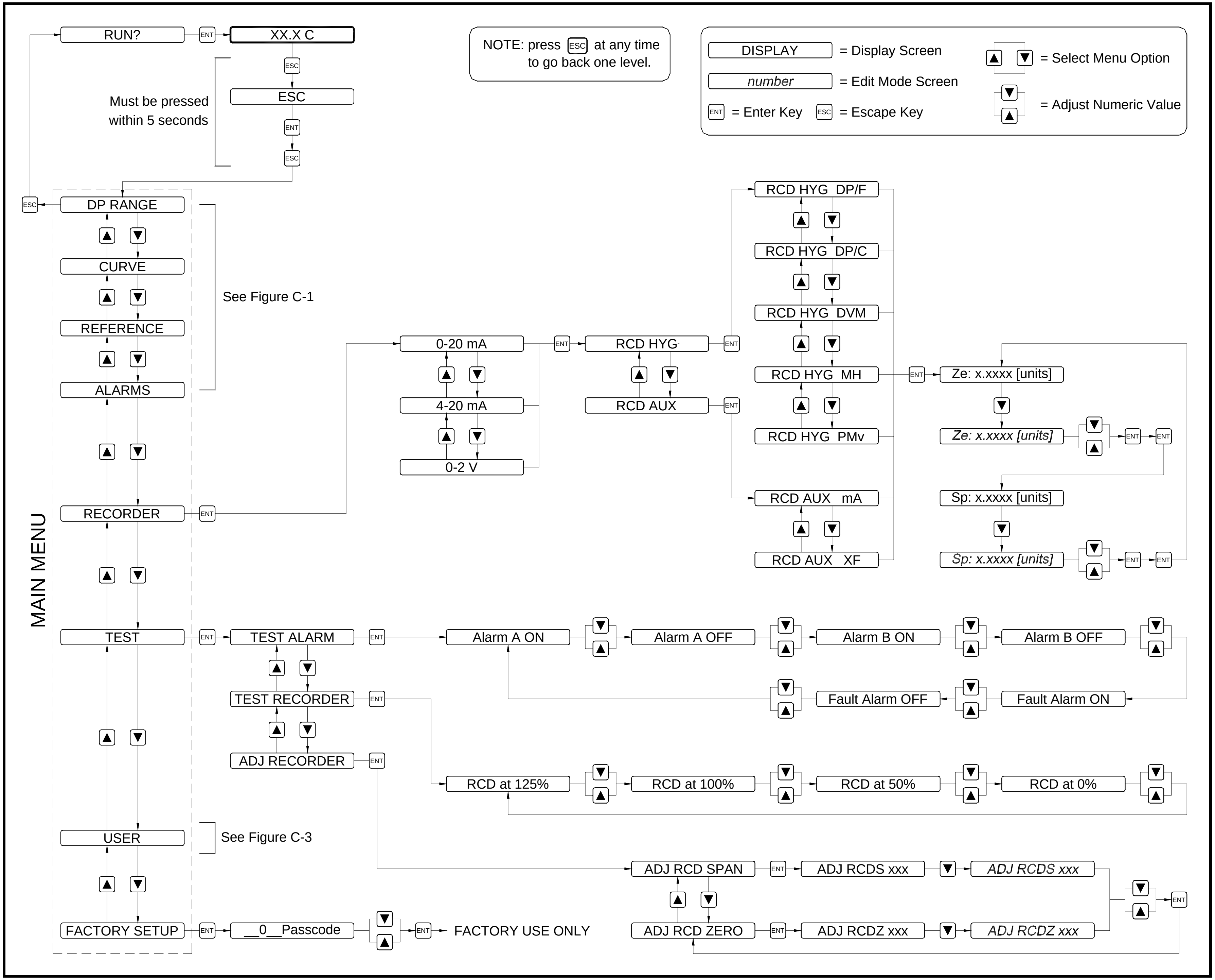


Figure C-2: RECORDER, TEST and FACTORY SETUP Menus

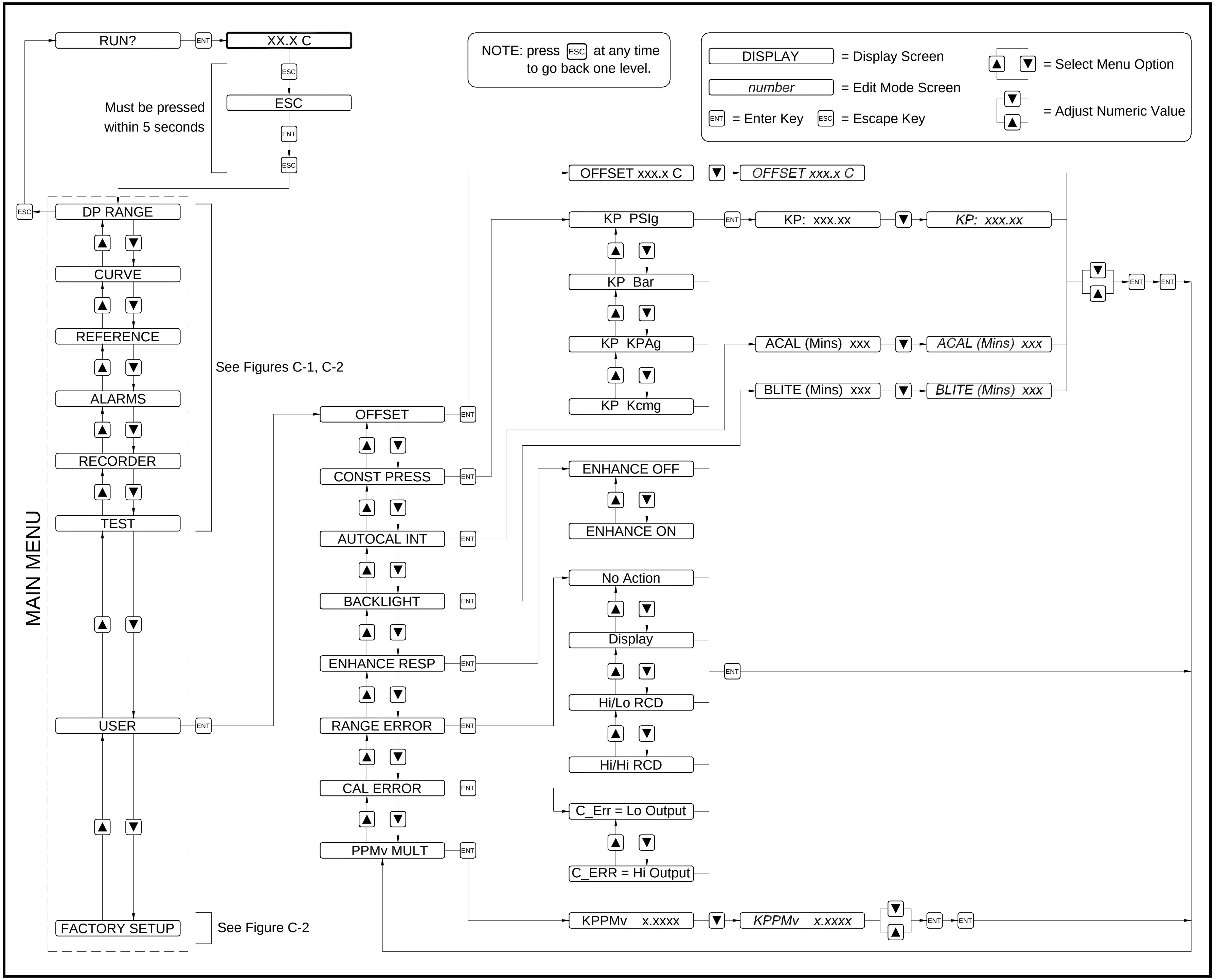


Figure C-3: USER Menu

Appendix D

Data Information Sheet

Use this sheet to record all of the data that you enter into the *User Program*. If data is lost for any reason, use this sheet to re-program your unit. Store this sheet and any other related documents in a safe place for future reference.

Tables are provided for entry of the following information:

- Dew Point Measurement Range [page D-2]
- Calibration Data for Moisture [page D-2]
- Calibration Data for Auxiliary Input [page D-3]
- Probe Serial Number [page D-3]
- MH Reference Values for Moisture [page D-3]
- Alarm Output Settings [page D-3]
- Recorder Output Settings [page D-4]
- User-Defined Functions [page D-4]

Series 35 Data Information Sheet

Notes:

Date:

Unit Serial Number:

Application Description:

Table D-1: Dew Point Measurement Range

High	Low

Table D-2: Calibration Data for Moisture

Point #	MH Value
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	

Series 35 Data Information Sheet (cont.)

Table D-3: Calibration Data for Auxiliary Input

Point #	Value
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Table D-4: Probe Serial Number

___ ___ ___ ___ ___ ___

Table D-5: MH Reference Values for Moisture

High	Low	Zero

Table D-6: Alarm Output Settings

Alarm A		Alarm B	
Mode:		Mode:	
Low:		Low:	
High:		High:	

Table D-7: Recorder Output Settings

Recorder A		Recorder B	
Range:		Range:	
Mode:		Mode:	
Zero:		Zero:	
Span:		Span:	

Table D-8: User-Defined Functions

Function	Setting
Offset Value	
Constant Pressure	
Auto-Cal Interval	
Backlight Interval	
Computer-Enhanced Response	
Range Error Processing	
Calibration Error Processing	
PPMv Constant Multiplier	

Appendix E

Series 35 Hygrometer Spare Parts List

Spare parts for the Moisture Monitor Series 35 are available directly from GE Infrastructure Sensing. Tables E-1 and E-2 below list the ordering information for the most commonly needed spare parts. If you require parts that are not listed here, contact GE Infrastructure Sensing for assistance.

Table E-1: Rack-, Bench-, and Panel-Mount

P/N	Qty	Note*	Description
703-1092-02	1		Display PCB
193-018	1	A, B	Fuse, 1/8 Amp
193-025	1	C	Fuse, 1/4 Amp
M2L	1	A	Moisture Probe
213-198-09	1		9-pin Terminal Plug
213-198-11	1		11-pin terminal Plug
*A = 0-2 yrs operation, B = AC units only, C = DC units only			

Table E-2: Weatherproof Unit

P/N	Qty	Note*	Description
703-1092-03	1		Backlit Display PCB
193-018	1	A, B	Fuse, 1/8 Amp
193-025	1	C	Fuse, 1/4 Amp
M2L	1	A	Moisture Probe
*A = 0-2 yrs operation, B = AC units only, C = DC units only			

Appendix F

Older Version Circuit Boards

If your Series 35 main circuit board is numbered 703-1180, use the instructions and figures in this appendix where they are referenced in the *User's Manual*.

Replacing the User Program

The *User Program* is stored on an EPROM (Erasable Programmable Read Only Memory) chip. The EPROM is located on the main circuit board, which is mounted inside the Series 35 electronics unit.

Follow the instructions in *Replacing the User Program* (starting on page 4-7). If your unit's main circuit board is numbered 703-1180, use Figure F-1 on page F-2 to locate the EPROM.

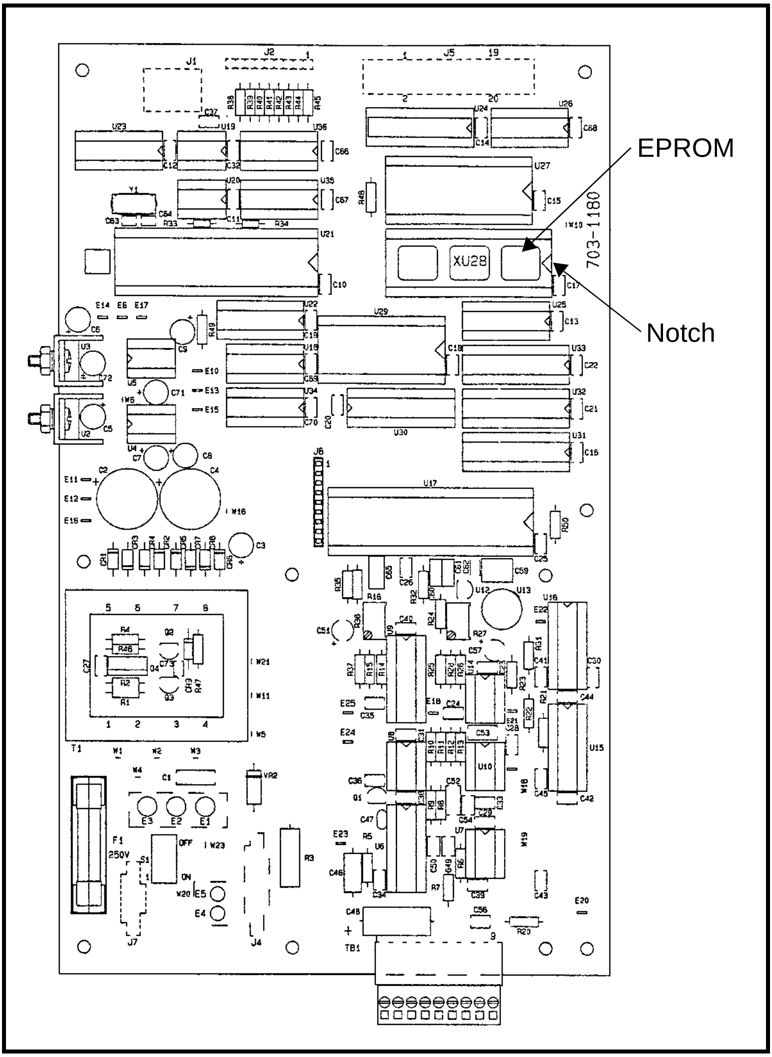


Figure F-1: EPROM and Notch on 703-1180

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T

U

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W

GE Infrastructure
Sensing

DECLARATION OF CONFORMITY

We,

Panametrics Limited
Shannon Industrial Estate
Shannon, County Clare
Ireland

declare under our sole responsibility that the

Moisture Monitor Series 35 Analyzer

to which this declaration relates, are in conformity with the following standards:

- EN 61326:1998, Class A, Annex A, Continuous Unmonitored Operation (for EN 61000-4-3, the **MMS 35** meets performance Criteria A and, in a limited number of frequencies, performance Criteria B per EN 61326.)
- EN 61010-1:1993 + A2:1995, Overvoltage Category II, Polution Degree 2

following the provisions of the 89/336/EEC EMC Directive and the 73/23/EEC Low Voltage Directive.

The *units listed above and any sensors and ancillary sample handling systems supplied with them* do not bear CE marking for the Pressure Equipment Directive, as they are supplied in accordance with Article 3, Section 3 (sound engineering practices and codes of good workmanship) of the Pressure Equipment Directive 97/23/EC for DN<25.

Shannon - July 1, 2003

Mr. James Gibson
GENERAL MANAGER

CE

nsai
I.S. EN ISO 9002
Shannon

TÜV
TÜV ESSEN
ISO 9001
U.S.

GE Infrastructure
Sensing

DECLARATION DE CONFORMITE

Nous,

Panametrics Limited
Shannon Industrial Estate
Shannon, County Clare
Ireland

déclarons sous notre propre responsabilité que les

Moisture Monitor Series 35 Analyzer

rélatif á cette déclaration, sont en conformité avec les documents suivants:

- EN 61326:1998, Class A, Annex A, Continuous Unmonitored Operation
  (for EN 61000-4-3, the **MMS 35** meets performance Criteria A and, in a limited number of frequencies, performance Criteria B per EN 61326.)
- EN 61010-1:1993 + A2:1995, Overvoltage Category II, Polution Degree 2

suivant les régles de la Directive de Compatibilité Electromagnétique 89/336/EEC et de la Directive Basse Tension 73/23/EEC.

Les *matériels listés ci-dessus, ainsi que les capteurs et les systèmes d'échantillonnages pouvant être livrés avec* ne portent pas le marquage CE de la directive des équipements sous pression, car ils sont fournis en accord avec la directive 97/23/EC des équipements sous pression pour les DN<25, Article 3, section 3 qui concerne les pratiques et les codes de bonne fabrication pour l'ingénierie du son.

Shannon - July 1, 2003

Mr. James Gibson
DIRECTEUR GÉNÉRAL

CE

NSAI I.S. EN ISO 9002 Shannon

TÜV ESSEN
ISO 9001
U.S.

CERT-DOC-H2
August 2004)

GE Infrastructure
Sensing

KONFORMITÄTS-ERKLÄRUNG

Wir,

Panametrics Limited
Shannon Industrial Estate
Shannon, County Clare
Ireland

erklären, in alleiniger Verantwortung, daß die Produkte

Moisture Monitor Series 35 Analyzer

folgende Normen erfüllen:

- EN 61326:1998, Class A, Annex A, Continuous Unmonitored Operation (for EN 61000-4-3, the **MMS 35** meets performance Criteria A and, in a limited number of frequencies, performance Criteria B per EN 61326.)
- EN 61010-1:1993 + A2:1995, Overvoltage Category II, Polution Degree 2

gemäß den Europäischen Richtlinien, Niederspannungsrichtlinie Nr.: 73/23/EG und EMV-Richtlinie Nr.: 89/336/EG

Die *oben aufgeführten Geräte und zugehörige, mitgelieferte Sensoren und Handhabungssysteme* tragen keine CE-Kennzeichnung gemäß der Druckgeräte-Richtlinie, da sie in Übereinstimmung mit Artikel 3, Absatz 3 (gute Ingenieurpraxis) der Druckgeräte-Richtlinie 97/23/EG für DN<25 geliefert werden.

Shannon - July 1, 2003

Mr. James Gibson
GENERALDIREKTOR

CE

I.S. EN ISO 9002
Shannon

TÜV ESSEN
ISO 9001
U.S.

CERT-DOC-H2

August 2004)

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